FINAL

CITY OF SANTA CRUZ ANADROMOUS SALMONID HABITAT CONSERVATION PLAN

for the

ISSUANCE OF AN INCIDENTAL TAKE PERMIT UNDER SECTION 10(a)(1)(B) OF THE ENDANGERED SPECIES ACT



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City of Santa Cruz

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August 2025
(Revised February 2026)

Photo courtesy of Jessica Martinez-McKinney

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Acknowledgements

Many City of Santa Cruz staff, Councilmembers, Water Commissioners, consultants, academic advisors, California Department of Fish and Wildlife and National Marine Fisheries Service staff shared in the development of this document and supporting materials over the course of nearly 25 years of City of Santa Cruz Anadromous Salmonid Habitat Conservation Plan development. Special gratitude should be expressed for the efforts of Pete Adams, Randi Adair, Don Alley, Jon Ambrose, Joyce Ambrosius, Kristine Atkinson, Jean Baldridge, Matt Baldzikowski, Ryan Bassett, Michelle Battaglia, Zeke Bean, Nicole Beck, Chris Berry, Ryan Bezerra, Sam Boland – Brien, Chuck Bonham, Ryan Broddrick, Tim Buller, Dick Butler, Joel Casagrande, Erin Chappell, Shawn Chartrand, Debie Chirco-Macdonald, Karen Christensen, Chris Coburn, Sean Cochran, Suzanne DeLeon, Mark Dettle, Joe Dillon, Sarah Easley-Perez, Marc Ebbin, Erik Ekdahl, Joaquin Esquivel, Melissa Farinha, Jeremy Farr, Kristina Finstad, Heidi Fish, Gary Fiske, Richard Fitzgerald, Rob Floerke, Serge Glushkoff, Bruce Goldstein, Corinne Gray, Stanley Gregory, Jeff Hagar, Chris Hammersmark, Kelleen Harter, Grey Hayes, Laired Henkel, Gesenia Hernandez, David Hines, Randy Holloway, Darren Howe, Mandy Ingham, Jon Jankovitz, Peter Kareiva, Noriko Kawamoto, Jim Keller, Don Kelly, Joe Kiernan, Gary Kittleson, Kristin Kittleson, Bill Kocher, John Laird, Alan Launer, Kirk Lenington, Mike Liquori, Jane Ling, Jay Lloyd, Heidi Luckenbach, Lisa Lurie, Steve Marquez, Jessica Martinez – McKinney, Jessica Maxfield, John McCamman, Terry McKinney, Rosemary Menard, Donna Meyers, Jim Moose, Peter Moyle, Lindsay Neun, Siobhan O'Neill, Kristoffer Patterson, Kristin Peer, Juliana Rebagliati, Nic Retford, John Ricker, Jim Robins, Terry Roelofs, David Rose, Scott Ruble, Pat Rutten, Penny Ruvelas, Ann Sansavero, Maryna Sedoryk, Sean Skaggs, Douglas Smith, Jerry Smith, Brian Spence, Wayne Spencer, Bill Stevens, Wes Stokes, Michelle Tarian, Terrill Tompkins, Woodie Trihey, Kevan Urquhart, Lisa Van Atta, Catherine Wade, Craig Weightman, Paula Whealen, Tommy Williams, Scott Wilson and Ryan Yarbrough. The completion of this document and related permits represent a significant milestone in the history of our City's natural resources management planning that would not have been reached without their contributions and patient but passionate dedication to habitat conservation planning.

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Executive Summary

Introduction

The City of Santa Cruz (City) has applied for an incidental take permit (ITP) from the National Marine Fisheries Service (NMFS) pursuant to section 10(a)(1)(B) of the Endangered Species Act of 1973 (ESA) as amended (16 U.S.C. §1531 *et seq.*) to incidentally take the federally threatened Central California Coast steelhead (*Oncorhynchus mykiss*) (steelhead) and federally endangered Central California Coast coho (*Oncorhynchus kisutch*) (coho). The incidental take is anticipated to occur as a result of City Covered Activities within the area covered by the City of Santa Cruz Anadromous Salmonid Habitat Conservation Plan (HCP). The HCP provides for permit coverage for a wide range of City activities. These Covered Activities include operation, maintenance, and rehabilitation of the City's water supply and water system facilities; operation and maintenance of the City's municipal facilities; and management of City lands. The City requests that the section 10(a)(1)(B) permit be issued for a period of 30 years.

Plan Area

The area covered by this HCP (Plan Area) is located in Santa Cruz County on the central coast of California, approximately 70 miles south of San Francisco. The Plan Area is shown on Figure 1-1. The Plan Area is contained on the Davenport, Santa Cruz, and Felton U.S. Geological Survey 7.5-minute quadrangles. The total watershed and water service/urban areas containing the general Plan Area are approximately 176 square miles and include three geographically distinct areas: the North Coast watersheds, the San Lorenzo River watershed, and the Santa Cruz urban center, as well as the water service areas outside of the City limits. The regional topography ranges from sea level to greater than 1,200 feet above sea level.

The 18 square mile North Coast watersheds (Liddell, Laguna, and Majors), which serve as drinking water source watersheds for the City, comprise a series of small coastal watersheds that drain the west and south-facing slopes of the Santa Cruz Mountains directly to the Pacific Ocean. In most cases, these watersheds include forested slopes in the upper reaches and canyon portions of the watershed, coastal foothill terraces, agricultural lands on the coastal plain, and streams that typically drain into seasonal lagoons.

The San Lorenzo River watershed is a 138 square mile area located along the Central Coast of California and drains from the Castle Rock area of Summit to the north, Ben Lomond Mountain on the west, and the Branciforte area on the eastside down to the Pacific Ocean at the north end of Monterey Bay by the Santa Cruz Beach Boardwalk. The watershed is significantly more

developed than the North Coast watersheds, though is also characterized by significant open space acreage as well.

Finally, the Santa Cruz urban center and water service areas are characterized by suburban and urban areas on the lower marine terraces ranging from approximately 41st Avenue on the east to Western Drive on the west and from the Pacific Ocean on the south to unincorporated areas of Santa Cruz County just north of the City of Santa Cruz limits. It should be noted that the City of Santa Cruz water service area overlaps with significant areas of both the North Coast watersheds and the San Lorenzo River watershed.

Covered Species

Steelhead (Oncorhynchus mykiss)

Steelhead inhabiting the drainages within the Plan Area are part of the Central California Coast Distinct Population Segment (DPS) listed as threatened under the federal ESA (NMFS 2006). The Central California Coast DPS consists entirely of winter-run steelhead and extends from the Russian River south to Aptos Creek in the southern end of Santa Cruz County. The Plan Area is located in the southern range of the Central California Coast DPS (Busby et al. 1996). Streams in the HCP plan area are included in the critical habitat designation for CCC Steelhead (NMFS 2005). Recovery of the Central California Coast Steelhead DPS is addressed in the *Coastal Multispecies Final Recovery Plan: California Coastal Chinook Salmon ESU, Northern California Steelhead DPS and Central California Coast Steelhead DPS*, released in October 2016 (NMFS 2016).

Coho (Oncorhynchus kisutch)

Coho in the Plan Area are part of the Central California Coast ESU, which is listed as endangered under the federal ESA. The Central California Coast Evolutionarily Significant Unit (ESU) extends from Punta Gorda in Humboldt County south to, and including Aptos Creek (NMFS 2005b). Critical habitat has been designated for the Central California Coast ESU and includes the accessible portions of the streams in the Plan Area. Recovery of the Central California Coast coho is addressed in the *Final Recovery Plan for Central California Coast Coho Salmon Evolutionarily Significant Unit* (NMFS 2012).

Covered Activities

The City's Water Department has several sources of surface water in its system that serve nearly 100,000 people with potable water in the City and surrounding areas of Santa Cruz County. The

City diverts water from its North Coast Diversions (including Liddell Spring, Reggiardo Creek, Laguna Creek and Majors Creek), the San Lorenzo River (including the Felton and Tait Street[1] diversions), Newell Creek Dam and Reservoir (commonly referred to as Loch Lomond Reservoir) and the Live Oak Wells (see Figure 3-1 - City of Santa Cruz Water System map). The HCP will provide coverage for water diversion and for operation, rehabilitation, replacement, repair and maintenance of conveyance facilities and other existing infrastructure such as water measurement devices, scientific measuring devices, and water quality monitoring stations. The Live Oak Wells draw from deep groundwater with no clear, direct connection to surface water dynamics and are not addressed in this HCP (Montgomery and Associates 2020).

In addition to the Covered Activities outlined above, the Plan provides coverage for the following Covered Activities: municipal facility operations and maintenance (including flood control channel operation and maintenance); land management; monitoring, and habitat restoration. Information on the Covered Activities is found in Chapter 3 of the HCP.

Conservation Strategy

The City's development of the conservation strategy included a thorough review of available data and literature on the species and extensive field data collection regarding the status and features of populations and habitat conditions within each stream. This analysis resulted in the identification of limiting factors (Chapter 2), and an understanding of the potential effects of Covered Activities on these species and their habitats. As described in Chapter 1, the City coordinated closely with NMFS and the California Department of Fish and Wildlife (CDFW) to address research methodologies and results and develop the conservation strategy. The primary focus of the City's conservation strategy is to avoid or minimize potential effects of Covered Activities to the maximum extent practicable by reducing surface water diversions and second to compensate for remaining effects by contributing to regional, non-flow conservation actions for steelhead and coho. The following describes the City's approach to the conservation strategy.

Instream Flows

A major element of the Conservation Strategy involves identification of minimum bypass flows at City diversions to minimize the effect of diversions on habitat conditions for steelhead and coho. Flow reductions, particularly during the summer low-flow season, represent one of the City's major effects on steelhead and coho in the Plan Area. There are currently no instream or bypass flow requirements for the Tait Street or North Coast diversions, although diversion

[1] The Tait Street Diversion is located adjacent to Crossing and River Streets in Santa Cruz and is sometimes also referred to as the San Lorenzo River Diversion.

amounts are limited by water rights and facilities limitations. The conservation strategy specifies minimum flows for each of the streams that the City diverts water from that would be maintained through flow bypasses at the City's diversions. Instream flow alternatives were modeled using the City's water supply operations model (*Confluence*® Model) to determine the effects on the City's ability to serve customer demands as well as the resulting instream habitat conditions. The minimum instream flows (Conservation Flows) and the strategy for implementing them are described in detail in Section 4.4.

Non-flow Conservation Actions

Where the avoidance and minimization measures are insufficient to entirely avoid potential effects to the Covered Species, the City will provide compensatory mitigation to fully offset those remaining effects. Specifically, the City will fund non-flow conservation actions aimed at habitat enhancement and restoration that provide opportunities to support species recovery (Section 4.5) (Appendix 1: *Summary of Approach to Non-Flow Mitigation of Biological Effects of the City Diversions*). These conservation actions will include improvement of instream habitat, riparian conservation, and prioritization of support for coho hatchery development and operations as well as other related recovery actions. Details of this program element can be found in Appendix 1: *Summary of Approach to Non-Flow Mitigation of Biological Effects of the City Diversions*.

Plan Implementation

The HCP identifies the issues that are related to implementation and the approaches that will be used to address those issues over the term of the HCP. Chapter 6 describes requirements for short-term and long-range planning, budgets, monitoring, and compliance reporting. The chapter further describes the regulatory assurances under the ESA that are expected to be provided to the City. It also describes the commitment of the City to respond to foreseeable changes in circumstances that may adversely affect Covered Species and habitats and identifies a process by which changes that are not foreseeable can be addressed. Finally, the chapter identifies the circumstances under which the permit may be suspended or revoked by NMFS.

Funding

The ESA requires that a conservation plan approved pursuant to the federal law must assure availability of adequate funding to implement the plan's conservation actions. ESA Section 10 (16 U.S.C. Sec. 1539) states that, prior to approving a habitat conservation plan and issuing an incidental take permit, the Secretary of Commerce must find, among other conditions, that "the applicant will ensure that adequate funding for the plan will be provided." The City has

identified in the HCP the funding that will be available to implement the actions identified and has committed to ensure that adequate funding for the HCP will be provided. The information outlining the costs of the HCP and the associated funding mechanisms to meet the requirements of the ESA are found in Chapter 7.

Alternatives

Section 10 of the ESA and its regulations require that an HCP describe alternatives considered that would avoid incidental taking and the reasons why they were not adopted. Chapter 8 describes the No Action Alternative, under which a section 10(a)(1)(B) permit would not be issued. Under the No Action Alternative, City activities with the potential to cause incidental take of listed species would require measures to avoid incidental take or individual incidental take authorizations on a project-by-project basis. Chapter 8 also describes a Reduced Covered Activities Alternative under which the City would limit the HCP to bypass flows and the numerous activities associated with operations and maintenance of the water supply system would not be covered by the permit.

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List of Acronyms and Abbreviations

ASR	Aquifer Storage and Recovery
BMP	best management practice
C	Celsius
CDFW	California Department of Fish and Wildlife
CDL	Coast Dairies and Land Co.
cfs	cubic feet per second
CIMIS	California Irrigation Management Information System
CIP	Capital Improvement Program
CLEAP	Comparative Lagoon Ecological Assessment Project
cm	centimeter
CMP	California Coastal Salmonid Population Monitoring Program
CPUE	catch per unit effort
CRA	critical riffle analysis
dbh	diameter at breast height
DIN	dissolved inorganic nitrogen
DO	dissolved oxygen
DPS	Distinct Population Segment
DSOD	Division of Safety of Dams
ESU	Evolutionarily Significant Unit
ESA	Endangered Species Act
FCC	flood control channel
FAO	Food and Agriculture Organization
FEMA	Federal Emergency Management Agency
FIB	Fecal Indicator Bacteria
FL	fork length
FTE	full time equivalent
GIS	geographic information system
gpm	gallons per minute
GRTS	general random tessellation stratified
HC	hydrologic conditions
HCP	Habitat Conservation Plan
in	inch
IPM	Integrated Pest Management
ITP	Incidental Take Permit
IWRP	Integrated Watershed Restoration Program
l	liter
LCRS	Leachate Collection and Removal System

LLRA	Loch Lomond Recreation Area
LWD	large woody debris
m	meter
MBSTP	Monterey Bay Salmon and Trout Project
mg	milligrams
MGD	million gallons per day
mm	millimeter
MOA	Memorandum of Agreement
msl	mean sea level
MS4s	Small Municipal Separate Storm Sewer Systems
MTC	Monitoring Technical Committee
MWAT	Seven-Day Moving Average Temperature
NCS	North Coast System
NEPA	National Environmental Policy Act
NFCF	Non-Flow Conservation Fund
NGVD 29	National Geodetic Vertical Datum of 1929
NMFS	National Marine Fisheries Service
NO_3^-	dissolved nitrate
NPDES	National Pollutant Discharge Elimination System
NTU	Nephelometric Turbidity Units
NWS	National Weather Service
PHABSIM	Physical Habitat Simulation
POD	points of diversion
POU	place of use
ppm	parts per million
PIT	passive integrated transponder
ppt	parts per thousand
PWA	Philip Williams and Associates
ROW	right-of-way
RWQCB	Regional Water Quality Control Board
SCWD	Santa Cruz Water Department
SKOF	Silver-King Ocean Farms
SOP	standard operating procedure
SRP	Soluble Reactive Phosphorous
SLVWD	San Lorenzo Valley Water District
SVWD	Scotts Valley Water District
SWMP	Stormwater Management Plan
SWRCB	State Water Resources Control Board
TAC	Technical Advisory Committee

TAMF	Take Avoidance and Minimization Fund
TMDL	Total Maximum Daily Load
UCSC	University of California, Santa Cruz
US EPA	U.S. Environmental Protection Agency
USGS	U.S. Geological Survey
USFWS	U.S. Fish and Wildlife Service
WMO	World Meteorological Organization
WSE	water surface elevation
WSAC	Water Supply Advisory Committee
WUA	weighted useable area
YOY	young-of-year

1.0 INTRODUCTION

The City of Santa Cruz (City) has applied for an incidental take permit (ITP) from the National Marine Fisheries Service (NMFS) pursuant to section 10(a)(1)(B) of the Endangered Species Act of 1973 (ESA) as amended (16 U.S.C. 1531 *et seq.*) to incidentally take the federally threatened Central California Coast steelhead (*Oncorhynchus mykiss*) (steelhead) and federally endangered Central California Coast coho salmon (*Oncorhynchus kisutch*) (coho). The incidental take is anticipated to occur as a result of City Covered Activities within the Plan Area for the City of Santa Cruz Anadromous Salmonid Habitat Conservation Plan (HCP). These Covered Activities include operation, maintenance, and repair of the City's water supply and water system facilities; operation and maintenance of the City's municipal facilities; and management of City lands. The City requests that the section 10(a)(1)(B) permit be issued for a period of 30 years.

1.1 Purpose

The City provides a wide range of essential public services for its citizens and visitors, such as the construction, operation and maintenance of water supply facilities, the construction and maintenance of roads, waste management activities, stormwater management, and the operation and maintenance of recreation and open space areas. The City has determined that activities it undertakes to provide these services may adversely affect the life history and habitat of steelhead and coho, the Covered Species under the HCP.

The ESA and the implementing regulations prohibit the unauthorized "take" of an animal species that is listed as threatened or endangered. "Take" includes a range of activities that could result in death or injury to a species, including harm that results from substantial adverse habitat modification. Under section 10 of the ESA, NMFS can authorize the taking of species that is incidental to an otherwise lawful activity, if the landowner first prepares and agrees to implement a habitat conservation plan that meets permit issuance criteria. Among other issuance criteria, a habitat conservation plan must minimize and mitigate to the maximum extent practicable the potential impacts of such incidental take.

To ensure the City's continued ability to provide these essential public services, the City is seeking to obtain a permit from NMFS under section 10(a)(1)(B) of the ESA for the incidental take of steelhead and coho. This HCP provides the basis for the issuance of a Permit under the ESA. This HCP further provides the basis for issuance of an incidental take permit for coho under Section 2081(b) of the California Endangered Species Act.

1.2 Plan Area

The area covered by this HCP (Plan Area) is located in Santa Cruz County on the central coast of California, approximately 70 miles south of San Francisco. The Plan Area is shown on Figure 1-1. The Plan Area is contained on the Davenport, Santa Cruz, and Felton U.S. Geological Survey 7.5-minute quadrangles. The total watershed and water service/urban areas within the Plan Area are approximately 176 square miles and include four geographically distinct areas: the North Coast Unit, the San Lorenzo River Unit, the City Urban Center Unit, and the water service areas outside of the City limits. The regional topography ranges from sea level to greater than 1,200 feet above sea level. See Figure 1-1: HCP Plan Area.

The North Coast Unit is located north of the City along Highway 1 and includes Majors Creek, Laguna Creek, Reggiardo Creek, Liddell Creek, and Lombardi Gulch. The 18-square mile North Coast watersheds serve as drinking water source watersheds for the City and comprise a series of small coastal watersheds that drain the west and south-facing slopes of the Santa Cruz Mountains directly to the Pacific Ocean. These watersheds include forested slopes in the upper reaches and canyon portions of the watershed, coastal foothill terraces, agricultural lands on the coastal plain, and streams that drain to the Pacific Ocean. See Figure 1-2, Figure 1-3, and Figure 1-4 for Liddell, Laguna and Majors Watershed maps respectively.

The 138-square-mile San Lorenzo River watershed drains west and east-facing slopes in the Santa Cruz Mountains that do not receive as much rain as their west-facing counterparts. The San Lorenzo River has a much longer run to the ocean than other Plan Area streams, and is fed by many tributaries including Branciforte, Zayante, Bean, Newell, Bear, Boulder and Fall Creeks. While many of the tributaries exhibit the physical characteristics of coastal streams (e.g., steep gradients, forested slopes), the San Lorenzo River runs through a comparably deep, wide canyon. Finally, the San Lorenzo River is densely developed throughout the floodplain and watershed.

The City's urban center encompasses approximately 12 square miles centered around the mouth of the San Lorenzo River. The Water Department provides service to the City as well as an area outside of the City limits that is approximately 8 square miles. The City is the largest city in Santa Cruz County, and is home to more than 65,021 residents. Major industries include tourism, manufacturing, food processing, and technology. The University of California, Santa Cruz (UCSC), a world-class university of approximately 19,457 students, is also located within the City. Streams within the City Urban Center Unit are the lower San Lorenzo River and tributaries, and the smaller urban drainages and aquatic resources potentially influenced by

Covered Activities, including Neary Lagoon, Laurel Creek, Moore Creek, and Arana Creek. The streams listed under the City Urban Center Unit are located either partially or wholly within the City limits and are influenced by urban land management activities such as vegetation management, flood control and stormwater management activities, rather than or in addition to surface water diversions. Therefore, the lower San Lorenzo River (from the City limits to the river mouth), Branciforte Creek, Carbonera Creek, and Pogonip Creek, although part of the San Lorenzo River watershed, are discussed under the City Urban Center Unit in this HCP.

The additional area covered by the water service area is located on the North Coast of unincorporated Santa Cruz County to the west of the City of Santa Cruz along the Highway 1 corridor, to the north of the City of Santa Cruz in the suburban areas of the lower San Lorenzo River watershed in the unincorporated areas of Santa Cruz County and to the east of the City of Santa Cruz in the urban unincorporated area of Santa Cruz County in Live Oak.

The City either has regulatory jurisdiction over areas in the Plan Area or has a property interest on lands where Covered Activities occur. As such, the City has sufficient control over the lands subject to Covered Activities to implement the provisions of this HCP.

Figure 1-1: HCP Plan Area

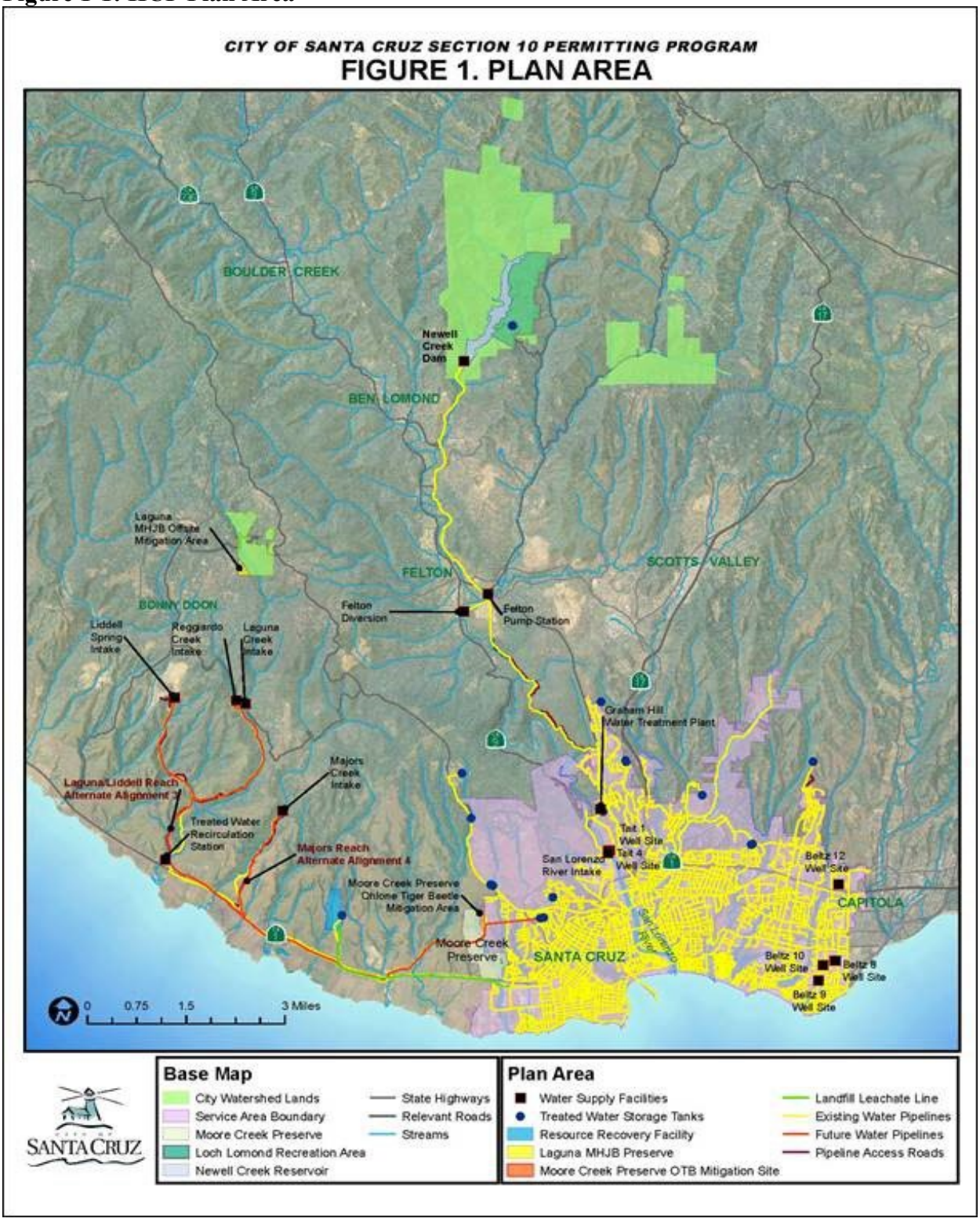


Figure 1-2: Liddell Watershed Map

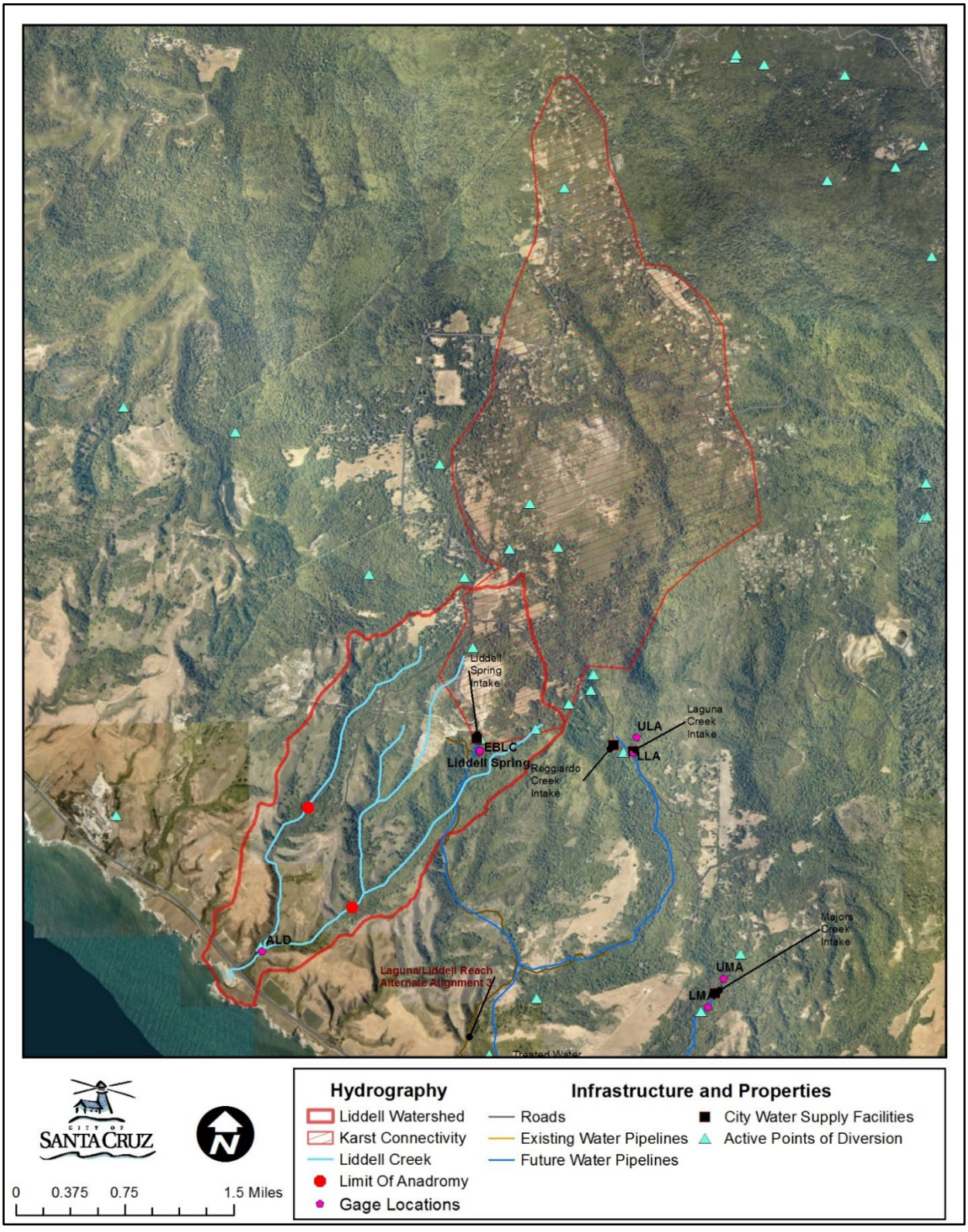


Figure 1-3: Laguna Watershed Map

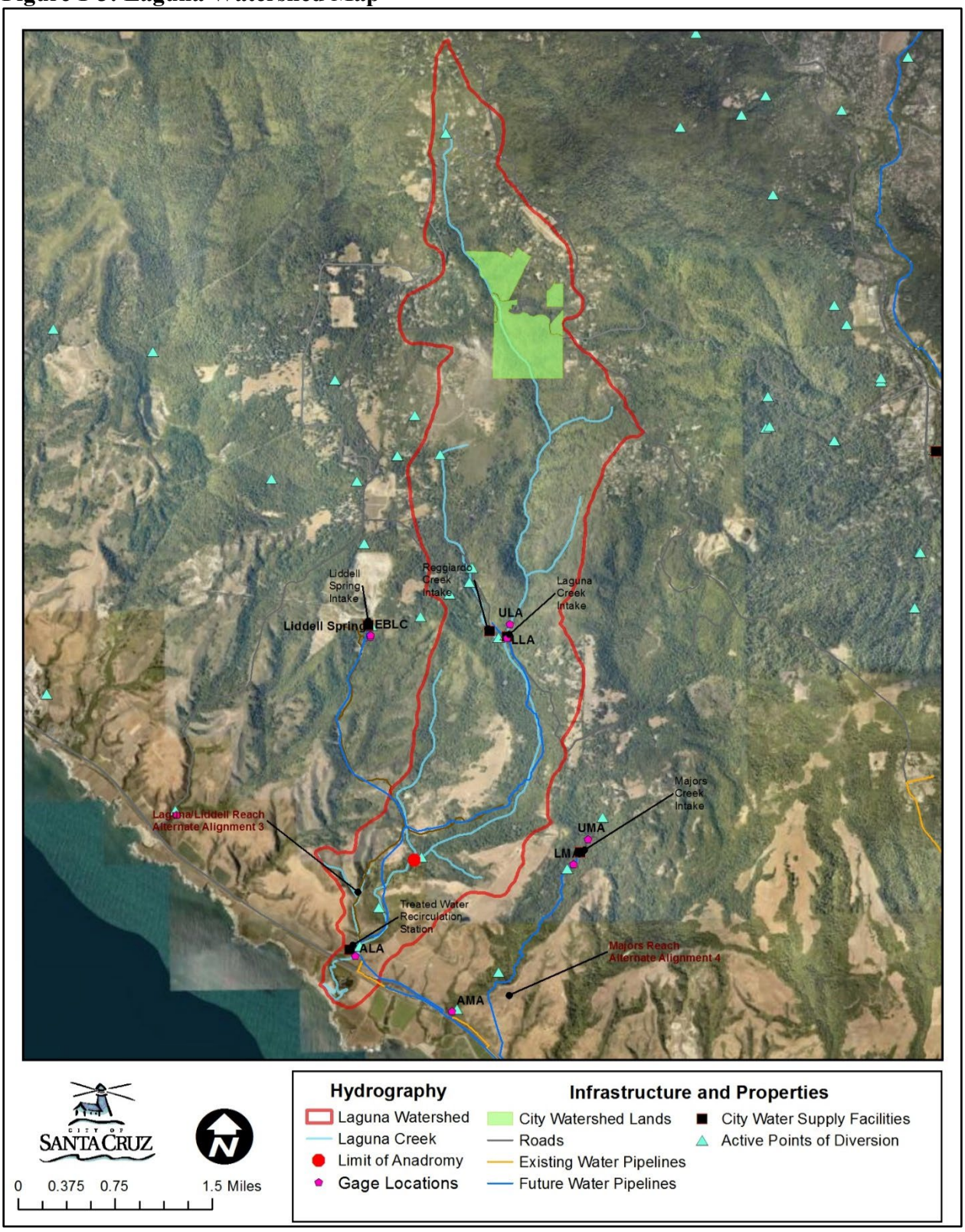


Figure 1-4: Majors Watershed Map

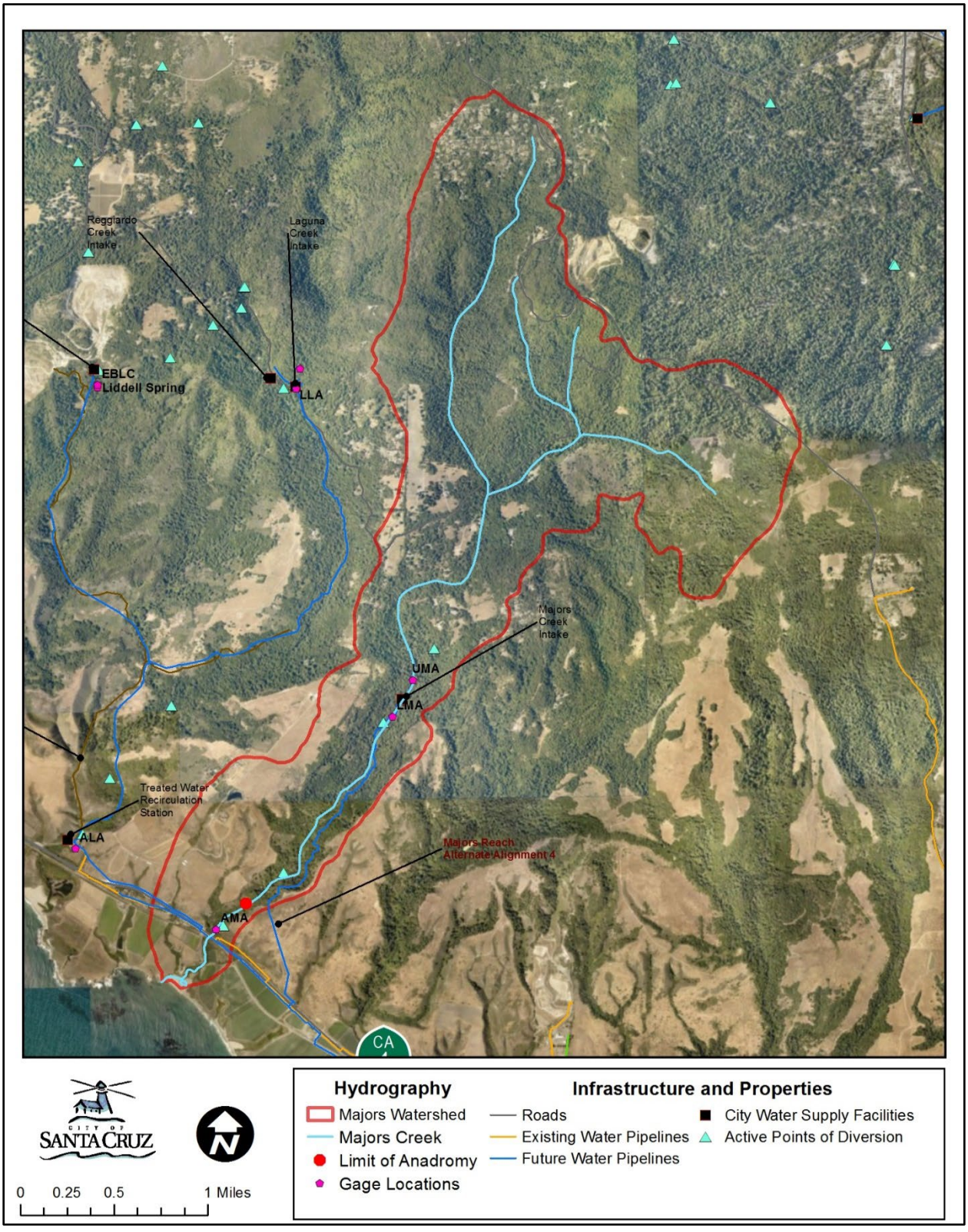


Figure 1-5: Newell Watershed Map

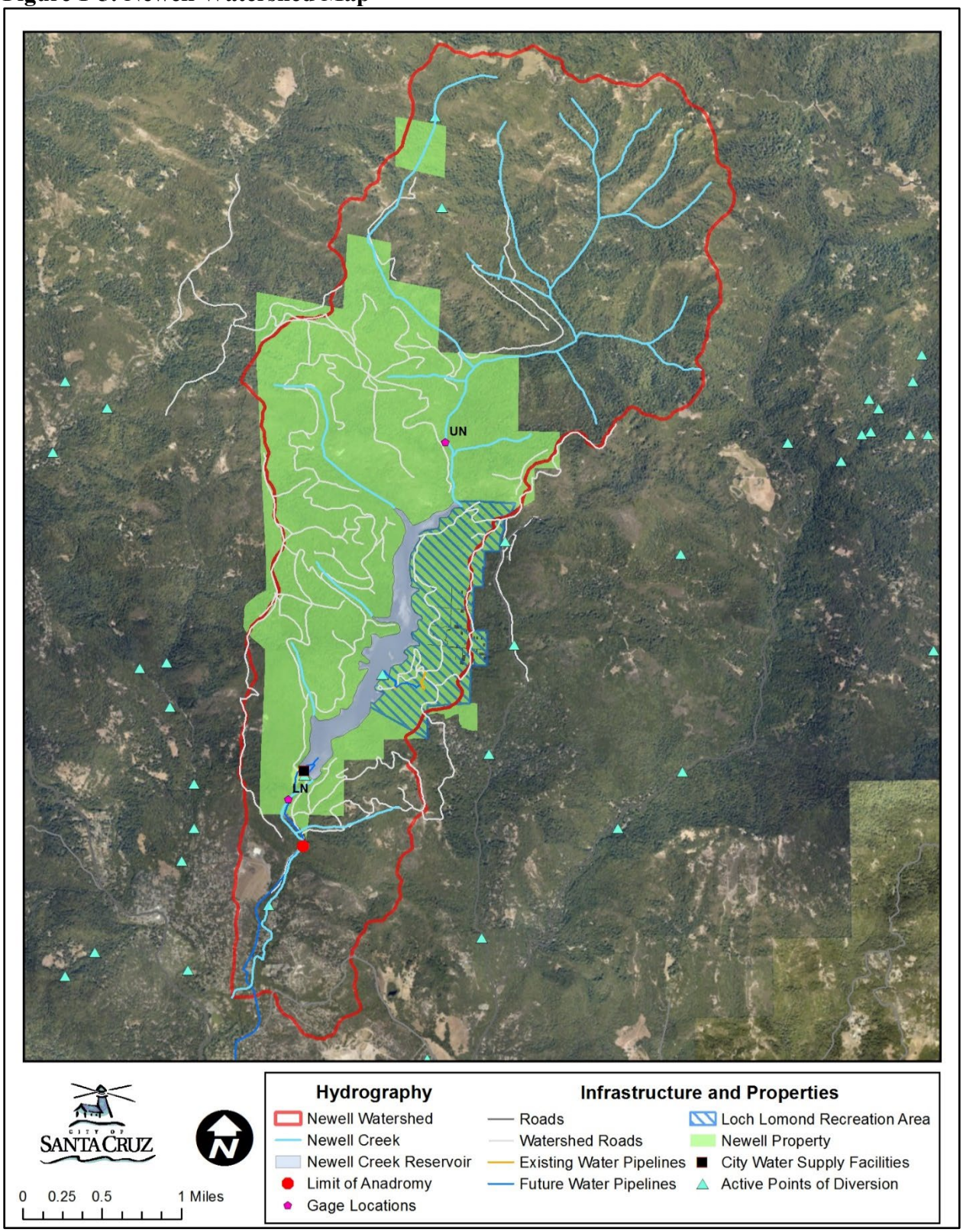


Figure 1-6: Zayante Watershed Map

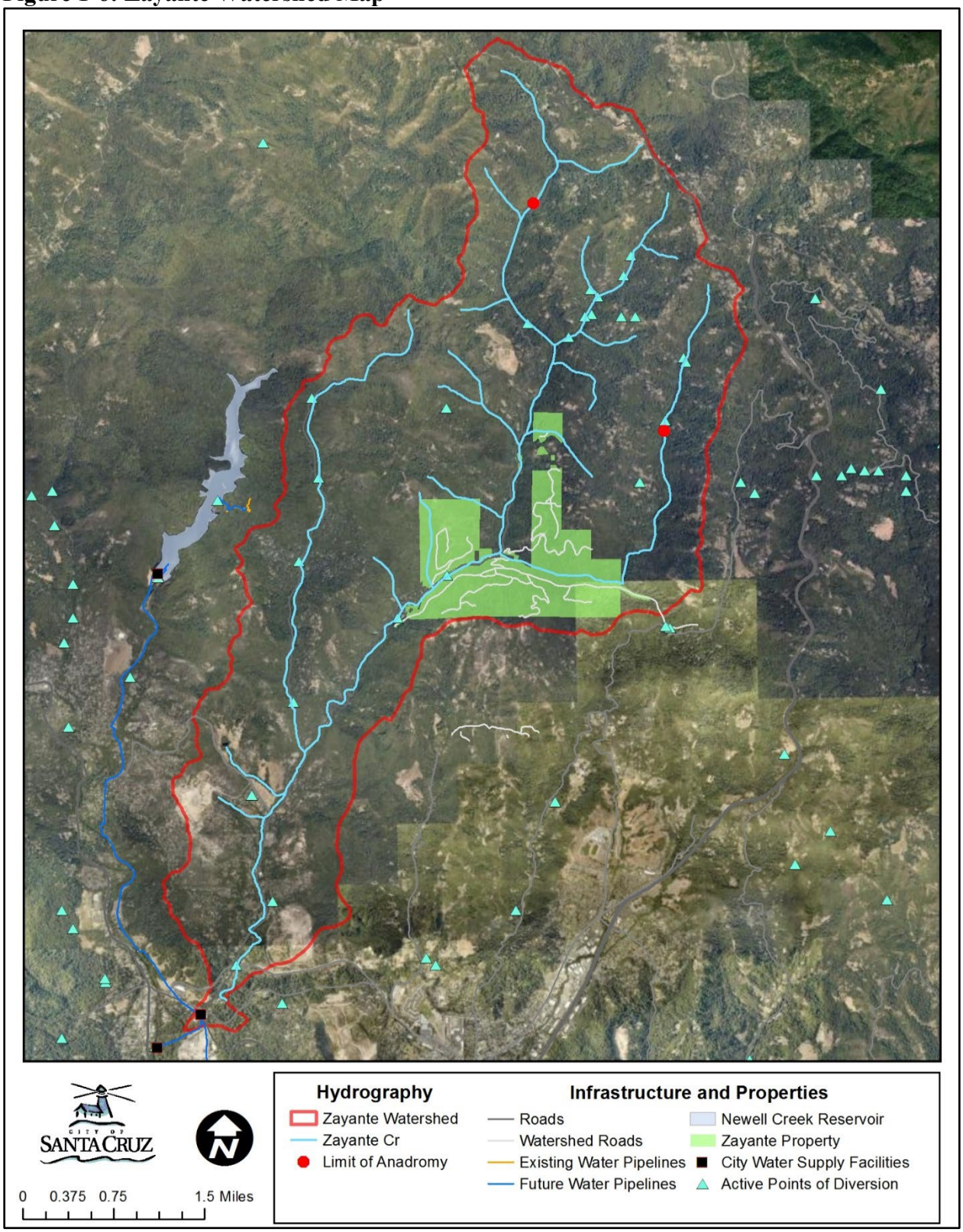
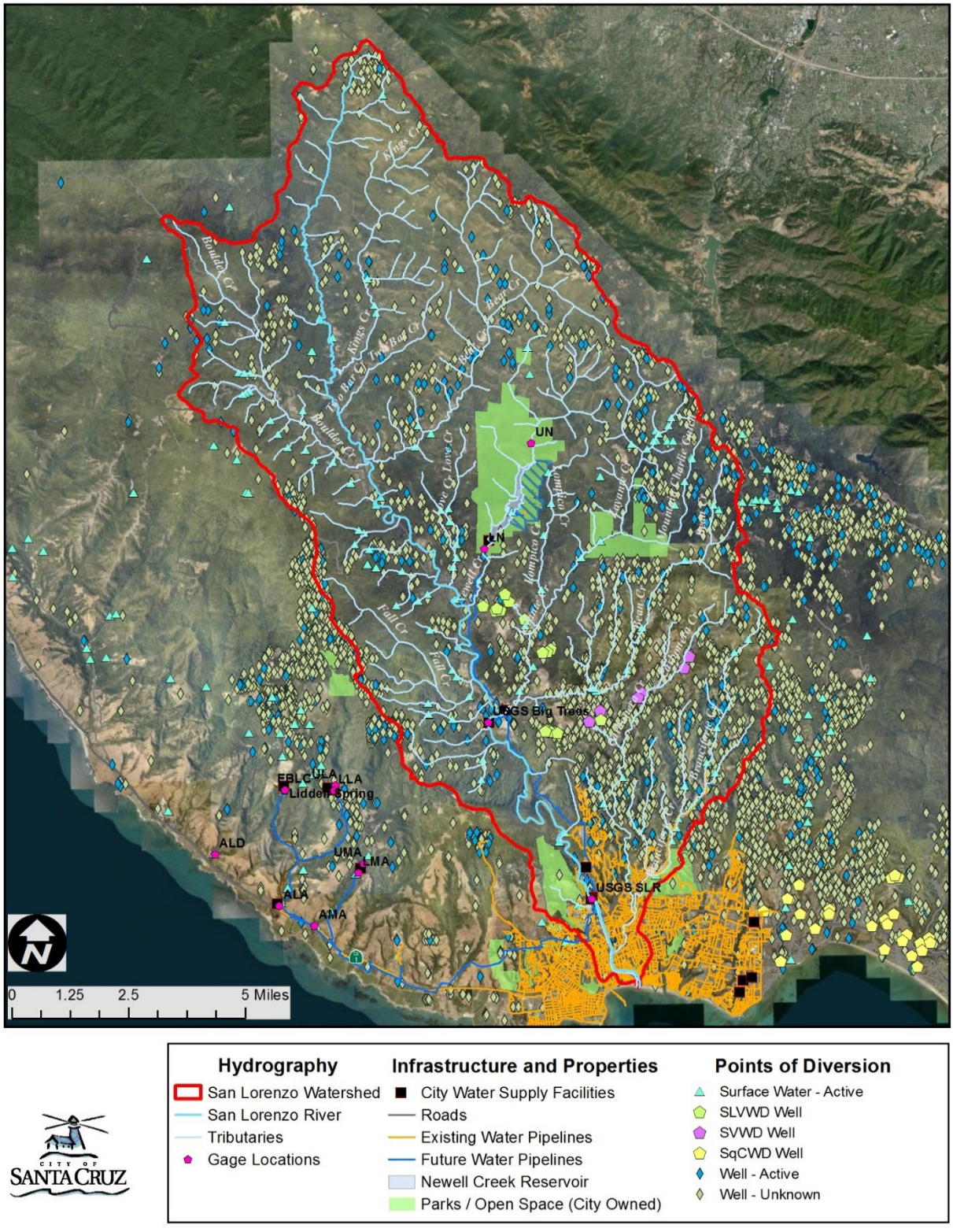


Figure 1-7: San Lorenzo Watershed Map



1.3 HCP Planning Process

The City developed the HCP in close coordination with NMFS and the California Department of Fish and Wildlife (CDFW) over a thirteen-year period.[2] During the initial stage of the process, the parties developed a comprehensive methodology for gathering data on the hydrology and geomorphology of the Plan Area. Following the methodology that was developed, the City conducted extensive field studies of the North Coast streams and the San Lorenzo River to characterize existing habitat conditions.

A major element in the development of the conservation strategy involved identification of minimum in-stream flows at City diversions to minimize the effect of diversions on habitat conditions for the Covered Species, steelhead and coho. The goal was to develop instream flow targets through an iterative process that considered both the habitat values of instream flows as well as the ability of the City to meet its water supply obligations. Instream flow alternatives were modeled using the City's water supply operations model (Confluence® Model) to understand the effect of various flow alternatives on the City's water supply obligations. The City also developed a habitat-based model to analyze the effect that the various flow alternatives would have on Covered Species habitat.

Based on the information developed through field studies and iterative model runs, a Water Supply Advisory Committee (WSAC) convened by the City recommended that the City adopt the flow alternative that was the most protective of the Covered Species and develop a new water supply that would make it practicable for the City to provide the flows for Covered Species while meeting its water supply obligations.

This flow alternative (Conservation Flows)[3] represents a substantial departure from the City's historical operations. Historically, North Coast and Tait Street diversions did not have required bypass flows. Bypass flows at City points of diversions have progressively increased through a tolled streambed alteration agreement process with CDFW since 2007. Conservation Flows included in this HCP entail bypass flows for all points of diversion and an increase in the bypass flow requirement for the Felton Diversion.

[2] CDFW participated in development of the HCP because it has jurisdiction over species listed under the California Endangered Species Act, which includes coho, and because it has jurisdiction over fish and wildlife resources subject to Section 1600 et seq. of the Fish and Game Code, which includes steelhead and coho.
[3] In the City's petitions for changes to water rights, the Conservation Flows are called "Agreed Flows" in recognition that they were developed through negotiations with NMFS and CDFW. The Conservation Flows and the Agreed Flows are identical.

Throughout the planning process, the parties continued to meet to address study plans and results, review existing conditions, and develop the various components of the conservation strategy. A comprehensive set of conservation measures was developed by the City to avoid and minimize the effects of City diversions as well as the operations and maintenance activities associated with the City's water supply system. The conservation measures include avoidance and minimization measures including standard operating procedures (SOPs) the City has followed in the past. The conservation measures also include upgrades to City facilities such as fish screens and operational changes to facilities to improve habitat conditions for Covered Species.

To ensure that any effects remaining after implementation of the HCP's conservation measures are mitigated to the maximum extent practicable, the City developed a non-flow conservation program to enhance and restore Covered Species habitat in the Plan Area. The program specifies funding levels and identifies a process for including NMFS and CDFW in technical meetings to identify appropriate habitat enhancement and restoration actions to be funded through the HCP.

1.4 Regulatory Framework

1.4.1 Endangered Species Acts

The United States Congress passed the ESA in 1973 to provide a means for conserving the ecosystems that endangered and threatened species require to prevent species extinctions. The ESA has two major components relevant to this HCP, the Section 9 prohibition against "taking" listed animal species and the Section 10 provisions for permitting the incidental take of listed animal species.

Section 9(a)(1)(B) of the ESA prohibits the "take" by any person of any endangered fish or wildlife species. The ESA authorizes NMFS to prohibit the take of threatened wildlife species through regulation. "Take" is defined broadly to mean harass, harm, hunt, shoot, wound, kill, trap, capture, or collect, or attempt to engage in any such conduct.[4] "Harm" is defined by regulation to mean an act which actually kills or injures wildlife, including those activities that cause significant habitat modification or degradation resulting in the killing or injuring of wildlife by significantly impairing essential behavior patterns, including breeding, feeding, or sheltering. The take prohibitions of the ESA apply unless take is otherwise specifically

[4] 16 U.S.C. § 1532 (2020).

authorized or permitted pursuant to the provisions of Section 7 or Section 10 of the ESA. The protections for listed plant species under the ESA are more limited than for fish and wildlife.[5]

The Section 9 take prohibitions apply unless take is otherwise specifically exempted pursuant to Section 7 or authorized pursuant to Section 10 of the ESA. Private individuals, corporations, state and local government agencies, and other non-federal entities who wish to conduct otherwise lawful activities that might incidentally take a listed species must first obtain a Section 10 incidental take permit from NMFS. The contents of a habitat conservation plan must meet the application criteria provided under ESA Section 10(a)(2)(A) and must describe:

- The impact which will likely result from such taking;
- What steps the applicant will take to minimize and mitigate such impacts, and the funding that will be available to implement such steps;
- What alternative actions to such taking the applicant considered and the reasons why such alternatives are not being utilized; and
- Such other measures that the Secretary may require as being necessary or appropriate for purposes of the plan.[6]

Under Section 10(a)(2)(B) of the ESA, NMFS may permit the incidental take of species only after finding that the habitat conservation plan meets the following criteria:

- The taking will be incidental;
- The applicant will, to the maximum extent practicable, minimize and mitigate the impacts of such taking;
- The applicant will ensure that adequate funding for the Plan will be provided;
- The taking will not appreciably reduce the likelihood of the survival and recovery of the species in the wild; and
- Other measures, if any, which NMFS requires as being necessary or appropriate for purposes of the Plan will be met.[7]

[5] Section 9(a)(2)(B) of the ESA prohibits removal, possession, or malicious damage or destruction of endangered plants in areas under federal jurisdiction, as well as actions that remove, cut, dig up, damage, or destroy endangered plants in areas outside of federal jurisdiction in violation of any state law or regulation, including state criminal trespass law. Protection for threatened plant species is limited to areas under federal jurisdiction. 50 C.F.R. § 17.71(a). The ESA Section 7(a)(2) prohibition against jeopardy applies to plants, wildlife, and fish equally, and NMFS may not issue a Section 10(a)(1)(B) permit if the issuance of that permit would result in jeopardy to any listed species.

[6] 16 U.S.C. § 1539(a)(2)(A)(2020).

[7] 16 U.S.C. § 1539(a)(2)(B)(2020).

This HCP is intended to meet all regulatory requirements necessary for NMFS to issue a Section 10 permit to allow incidental take of steelhead and coho as a result of Covered Activities undertaken by the City.

1.4.2 National Environmental Policy Act

The National Environmental Policy Act (NEPA) was enacted by Congress in 1969 to ensure that federal agencies consider the environmental impacts of their actions and decisions.[8] NEPA requires the federal government to use all practicable means and measures to protect environmental values and makes environmental protection a part of the mandate of every federal agency and department. NEPA further requires analysis and a detailed statement of the environmental impact of any proposed federal action that significantly affects the quality of the human environment.

An evaluation in accordance with NEPA will be prepared for the HCP permit decision. The NEPA document will (1) identify the purpose and need for a federal Section 10(a) ITP; (2) describe the environment that would be affected by the proposed Project; (3) discuss alternatives considered; (4) describe plans to minimize and mitigate the impacts to Covered Species and their habitats; and (5) identify possible environmental consequences of the proposed incidental take permit and mitigation measures.

2.0 ENVIRONMENTAL SETTING

2.1 Introduction

This section analyzes the environmental setting within the four regions of the Plan Area (see Figure 1-1: HCP Plan Area). The four regions that constitute the Plan Area are: 1) the North Coast Unit, 2) the San Lorenzo River Watershed Unit, 3) the City Urban Center Unit and 4) the City's water service area outside of the other aforementioned Plan Area regions. The North Coast Unit is located north of the City along Highway 1 and includes Majors Creek, Laguna Creek, Reggiardo Creek, Liddell Creek, and Lombardi Gulch. Streams in the North Coast Unit flow off the west flank of Ben Lomond Mountain and drain directly into the Pacific Ocean. The San Lorenzo River Watershed Unit includes the San Lorenzo River and its major tributaries, including Newell Creek and Zayante Creek. Streams within the City Urban Center Unit are the lower San Lorenzo River and tributaries, and the smaller urban drainages and aquatic resources

[8] 42 U.S.C. § 4371 *et seq*. (2020).

potentially influenced by Covered Activities, including Neary Lagoon, Laurel Creek, Moore Creek, and Arana Creek. The streams listed under the City Urban Center Unit are located either partially or wholly within the City limits and are influenced by urban land management activities such as vegetation management, flood control and stormwater management activities, rather than or in addition to surface water diversions. Therefore, the lower San Lorenzo River (from the City limits to the river mouth), Branciforte Creek, Carbonera Creek, and Pogonip Creek, although part of the San Lorenzo River watershed, are discussed under the City Urban Center Unit in this HCP. It should be noted that all of the planning units were affected by the recent CZU August Lightning Complex fire to various degrees. While there may be some positive effects of increased wood recruitment to the streams, water quality and stream sedimentation may be negatively impacted by post-fire debris flows. Additionally, there may be some short-term impacts on salmonid respiration and feeding behavior due to increased turbidity related to runoff from the burn zone. The full effects of this event may not be known for some time.

2.2 Climate

The Santa Cruz Mountains, like most of central California, are marked by winter rains and summer drought. Rainy winter periods and dry summer months are typical of the Mediterranean climate in the central coastal areas of California, including the Santa Cruz Mountains. Mean annual precipitation along the coast is about 26 inches but increases to about 50 inches at higher elevations near the headwaters of the project area streams.

Most precipitation falls between the months of November to April, with February typically being the wettest month of the year. Pacific frontal storms in combination with orographic lifting along the coastal range generate intense periods of precipitation. Streams in the project area tend to exhibit “flashy” (rapidly rising and falling) winter flows in response to these winter storms. During the dry season from May through October, the region typically receives no precipitation, the surface soils dry out, and perennial streams are fed by seeps and springs. The western edge of the coast range experiences mild temperatures during the dry season due to the on-shore marine breeze and summer fog.

2.3 Geology

The Plan Area is located in the Coast Ranges geomorphic province. This northwest-trending, 900-mile-long province contains mountain ranges and associated intervening valleys that are relatively comparable in age and share somewhat similar history, geologic composition, and

structure. The Santa Cruz Mountains, part of which are included in the Plan Area, represents one of these ranges. This mountain range forms the mountainous spine of the San Francisco Peninsula and extends about 80 miles, from the vicinities of Daly City to Watsonville. The average summit height reaches 2,500 feet above sea level. The Coast Ranges are considered very seismically active due to the abundance of active faults. The San Andreas and San Gregorio fault zones represent the two principal active faults within the region (Hall et al. 1974; Hart and Bryant 1997).

2.3.1 North Coast Unit

The Coast Ranges typically exhibit strong northwest-southeast trends, induced by folds and faults of the same trend. This complex presumably formed as a result of the subduction of the western oceanic plate beneath the continental plate beginning in the Mesozoic Period.

The three North Coast source streams drain the southwest side of Ben Lomond Mountain. Ben Lomond Mountain is a large mass of granitic rock that was uplifted and tilted to the southwest by the Ben Lomond fault, which parallels the San Lorenzo River Valley for much of its length. The granitic rock that forms the core of Ben Lomond Mountain is locally overlain by relatively thin deposits of metamorphic and sedimentary rocks (Nolan Associates 2016). These deposits are dominated in much of the watersheds by sandstones, mudstones, shale, and coastal terrace deposits (Brabb et al. 1997). These deposits generate less-dense substrate in stream beds and can contribute to high sand loads as is evident in all three creeks to varying degrees. The less dense sandstone and mudstone elements provide less suitable spawning substrate than heavier granitics as they are more easily mobilized under high flow conditions.

A large portion of the Majors Creek watershed is underlain by the Santa Margarita formation, which is composed of friable, fine to very coarse-grained sandstone (Brabb et al. 1997). The majority of the watershed upstream of the City's diversion is privately held and was historically logged for timber production. Old logging roads remain in several places in the watershed. These factors likely contribute to high fine sediment loads evident throughout the Majors Creek system. About 2,000 feet below the City's diversion, Majors Creek begins flowing through a zone dominated by igneous, Quartz diorite rock. The Quartz diorite is more resistant to erosion relative to other rocks within the North Coast Unit, and leads to a more confined, steep valley wall section with a high gradient. It may also serve as a good source of gravel, which was evident in the anadromous reach during habitat characterization conducted in 2003 (Entrix 2004b).

The Middle and East Branch Liddell watersheds are primarily (76 percent) composed of tertiary marine sedimentary rocks. The Santa Cruz Mudstone makes up about 48 percent of the Middle and East Branch basins and is composed primarily of silica-rich mudstones and sandy siltstones. About 26 percent of the watersheds are made up of the Santa Margarita sandstone, and the majority is concentrated in the upper East Branch watershed. The Santa Margarita formation consists of massive fine to coarse-grained arkosic sandstones with poor cementation of the sand grains. The Santa Margarita formation is weak and friable, and very erodible once the overlying soil layer is removed. The channel on the East Branch contains large amounts of fine sediment, and bed particles have an average 85 percent embeddedness (Environmental Sciences Associates 2001), which in part can be attributed to the large amount of highly erosive Santa Margarita sandstone (Entrix 2004b).

Limestone and marble outcroppings, commonly referred to as karst topography, occur in the upper reaches of Liddell and Laguna Creeks (Nolan and Associates 2016, Brabb et al. 1997). The karst topography has a significant influence on streamflow and summer baseflow by producing multiple springs within the watersheds. The karst topography is also more resistant to erosion than other material in nearby watersheds, which results in reduced fine sediment loads. The upper part of the Laguna watershed also has granitic formations that provide a good source of gravel and cobble. This is evident in the reaches downstream of the City's diversion where large cobble and gravel dominate the streambed substrate (Entrix 2004b).

A distinctive geomorphic feature of the lower watersheds in the North Coast area are the marine terraces (and associated deposits), which were formed in the past when the sea level was higher relative to the current sea level (Brabb et al. 1997). These flat, wave-cut platforms were formed primarily in the sandstone and mudstone sedimentary layers mentioned above. The marine terraces were created by the interplay between the constant erosive force of waves combined with the fluctuating sea level stands of the Pleistocene (1.8 million years ago to 10,000 years ago), glacial and interglacial cycles and the slow uplifting of the coastline. Each marine terrace is a former part of the continental shelf that has been cut by the waves over many millennia, then uplifted above sea level into its present position (Entrix 2004b).

2.3.2 San Lorenzo River Watershed Unit

In the San Lorenzo River Watershed Unit, two primary fault systems define the geologic conditions: the Zayante fault and the Ben Lomond fault. The Zayante fault trends primarily east to west through the middle of the San Lorenzo River basin. The Ben Lomond fault trends primarily north to south on the west edge of the basin along Ben Lomond Mountain. The two faults intersect near Jamison Creek in the northwest area of the basin. The two faults divide the

San Lorenzo Valley into three terrains: (1) north of the Zayante fault, (2) south of the Zayante fault and west of the Ben Lomond fault, and (3) south of the Zayante fault and east of the Ben Lomond fault. The following descriptions of these terrains are derived from Balance Hydrologics (Hecht and Kittleson 1998) report on streambed conditions and erosion control efforts in the San Lorenzo River watershed.

North of the Zayante fault, interbedded sandstones, shales, and mudstone predominate, with steeply inclined and folded strata. Complex mosaics of soils and vegetation have developed on these geologic structures, resulting in diverse and widespread sediment sources. Slopes tend to be steep, prone to moderate to severe erosion. Principal watersheds are the upper San Lorenzo River (above Boulder Creek), Kings, Two Bar, and Bear Creeks, plus the northern portions of the Boulder Creek and Zayante Creek basins. The Butano fault, which runs parallel and to the north of Zayante fault, once brought hard sandstones upward, resulting in a very steep slope rising from the River and Bear Creek abruptly toward the Summit ridge. This zone between the Butano fault and the Summit is now a belt of often-serious erosional sources, as roads and clearings are cut through this over-steepened slope. Dry-season flows are generally lowest in this geologic terrain, with streams often drying to isolated pools during mid-summer.

South of the Zayante fault, and west of the Ben Lomond fault, the tectonically uplifted eastern side of Ben Lomond Mountain forms the southwestern edge of the San Lorenzo watershed. Principal watersheds are Fall, Alba, Clear and Sweetwater creeks, Malosky, Peavine, and Jamison creeks, and the southern portion of the Boulder Creek basin. Crystalline bedrock types, principally granitics, schists, and marble, have developed residual soils which support steep small forested watersheds with low to moderate background erosion rates. Streams clear up quickly after storms. The lower portions of these watersheds have developed in downslope-dipping sandstones and mudstones and are prone to landslides, especially where disturbed. Summer flows are generally sufficient to support perennial stream threads and diverse aquatic habitat.

The third terrain is found south of the Zayante fault, and east of the Ben Lomond fault and the San Lorenzo River. It includes the Love Creek, Quail Hollow, Graham Hill Road, Mount Hermon, and Scotts Valley areas, as well most of the Bean and Branciforte Creek basins, and the southern portions of the Zayante and Newell Creek watersheds. Here, sandstones and shales form erodible soils which tend to be either very sandy or clay rich. Much of the area was once vegetated with unusual associations of trees and shrubs that exploited niches made available by these atypical soils. By far the largest continuous units of sandy soils are found in this area, and these tend to be sandier than other sandstone-derived soils elsewhere in the watershed. Erosion rates are often high to extreme in this terrain, especially where sandy soils occur in headwater areas or near channels. The sandy soils, which were capable of absorbing nearly all rainfall

under natural conditions, now form steep-walled gullies and gulches where runoff from paved or covered surfaces is concentrated.

2.3.3 City Urban Center Unit

The geologic description of the City Urban Center is based on the City-Wide Creeks and Management Plan prepared by the Biotic Resources Group (2002). The City of Santa Cruz can be divided fairly evenly into two geologic regimes split roughly at the San Lorenzo River where the Ben Lomond fault trends southeast to northwest. The geology on the west side of the San Lorenzo River is composed of a mix of granitic and metamorphic basement rocks overlain by a relatively thin layer of sedimentary rocks. The underlying geology on the east side of the San Lorenzo River, like the west side, is composed of a mix of granitic and metamorphic basement rocks. The east side basement rocks are overlain by a thick layer of sedimentary rocks and marine terraces up to hundreds of feet deep.

Most of the City of Santa Cruz sits primarily on marine sedimentary rocks, mainly sandstones and mudstones. These include the Purisima formation, which is a fine-grained sandstone formation that was deposited approximately two to six million years ago in a shallow marine environment. The slightly older Santa Cruz Mudstone formation is an even finer-grained silt/mud stone that was also deposited in a shallow marine or estuarine environment. Both of these formations underlie much of the City. Higher in elevation, particularly on the UCSC campus, other sedimentary formations such as limestone as well as the aforementioned metamorphic and igneous formations, begin to appear in outcroppings.

The San Lorenzo River and the other watercourses in the City incise the step-like series of marine terraces that typify the North Coast region. Much of the City sits upon the “first” marine terrace, typified by the flat areas that most of the westside and eastside neighborhoods sit upon. Above that is the “second” marine terrace, typified by the Westlake Pond area and the base of the UCSC campus and also the DeLaveaga Park area on the eastside. Several additional marine terraces are discernable higher up on the UCSC campus. The downtown area of the City lies below the first marine terrace, within the floodplain of the San Lorenzo River, and is underlain by an approximately 40-foot-deep layer of sediments that has been deposited by the San Lorenzo River over many centuries on top of another wave-cut marine terrace.

2.4 Aquatic Habitat

2.4.1 Introduction

This section summarizes and describes the existing environmental conditions relevant to steelhead and coho in streams within the North Coast Unit, the San Lorenzo River Watershed Unit, and the City Urban Center Unit of the Plan Area.

2.4.2 North Coast

The following discussion describes conditions in North Coast streams, including Liddell, Laguna, and Majors Creeks.

2.4.2.1 Habitat Conditions Liddell Creek

Liddell Creek supports resident rainbow trout populations and steelhead. Liddell Creek is not considered potential habitat for coho under current conditions in the Coho Recovery Plan (NMFS 2012). Three young-of-year (YOY) coho were observed in Liddell Creek in 2018, the first observation of *O. kisutch* in Liddell Creek since sampling began in 2006 (Berry et al. 2019). These fish are considered the progeny of strays from another system, likely nearby Scott Creek, and are not thought to represent a persistent population. For the purposes of the HCP, Liddell Creek is not considered potential coho habitat.

Watershed/hydrology

Liddell Creek is a second order stream that enters the Pacific Ocean at Bonny Doon Beach directly south of Davenport. The 4.0 square mile watershed drains in a southwest direction off of Ben Lomond Mountain (ENTRIX, Inc. 2004b). The elevation of the watershed ranges from sea level at the mouth to approximately 1,300 feet at its headwaters near Smith Grade Road. Liddell Creek consists of three distinct forks, the Middle, East, and West branches (see Figure 1-2: Liddell Watershed Map). The approximate stream channel length from the mouth of Liddell to the mainstem Liddell Creek headwaters is 3.2 miles. The channel gradient from the diversion to the mouth is approximately 3 percent along the East Branch of Liddell Creek (ENTRIX, Inc. 2004b).

Natural streamflow in Liddell Creek is influenced by the karst topography. Approximately 11 percent of the Middle and East Branch Liddell watersheds are composed of marble (metamorphosed limestone) outcrops (ENTRIX, Inc. 2004b). This results in more stable

streamflows and higher summer baseflows in Liddell Creek compared to Laguna and Majors Creeks. Streamflows are also influenced by diversions in the watershed.

The City diversion on Liddell Spring has a maximum capacity of approximately 2.5 cubic feet per second (cfs) and is located at a springbox on a tributary to the East Branch of Liddell Creek near its headwaters, approximately 2.5 miles upstream from the mouth (ENTRIX, Inc. 2004b). There have been no specified limits on diversion rates or quantities and a bypass flow has not been required at the diversion under the water right, though "tolling flows" which are protective of anadromous fisheries and which were developed with CDFW have been in place for several years. Proposed bypass flows under the HCP are described in Chapter 4. While the City diverts a significant portion of the flow in Liddell Creek, due to the distance to the anadromous reach and the accretion from tributaries downstream, the effect of the City's diversion on instream flows is muted relative to the City's other North Coast water supply streams. CEMEX (previously RMC Pacific Materials) operated a diversion located just upstream of the City's springbox diversion on a tributary to East Liddell Creek to support their quarry operations. The quarry is not currently in use, however a new industrial use is occupying the site and is routinely using this diversion. This diversion produced approximately 300 gallons per minute when it was operating under CEMEX (approximately 0.67 cfs) (Chris Berry, personal communication to Kindra Loomis, 2004, cited in ENTRIX, Inc. 2004a) and now appears to be diverting approximately 150 gallons per minute when it is in operation. Potentially, there are also other private diversions and numerous wells upstream in the recharge area for this creek (Chris Berry, personal communication to Kindra Loomis, 2004, cited in ENTRIX, Inc. 2004a). The City maintains control of all riparian water rights downstream of its diversion so the wells adjacent to the anadromous reach would be operating without water rights. In the lower watershed there are alluvial wells operated by The Coast Dairies and Land Co.[9] and an agricultural diversion of unknown status (ENTRIX, Inc. 2004b). Production volumes of these wells and their impacts on the hydrology and associated aquatic habitat in Liddell Creek are unknown. The City maintains control of all riparian water rights downstream of its diversion so the wells adjacent to the anadromous reach would be operating without water rights. Additionally, e-WRIMS filing status for these wells and for the quarry spring appear to be incomplete. This may not be a comprehensive accounting of the non - City operated diversions on Liddell Creek (ENTRIX, Inc. 2004b).

The lower portions of the East Branch Liddell Creek are characterized as having riffle-pool channel morphology with open valley walls (ENTRIX, Inc. 2004b). Large woody debris plays a significant role in shaping channel morphology as debris jams are prevalent throughout the East

[9] Coast Dairies and Land Co. land is now owned and managed by California State Parks and the Bureau of Land Management.

Branch. Debris jams also form multiple obstacles or partial barriers to anadromous fish migration (ENTRIX, Inc. 2004b). On the East Branch above these obstacles the channel becomes more confined, has a slightly steeper gradient, and is a combination of step-pool and riffle-pool channel morphology (ENTRIX, Inc. 2004b). The channel substrate on the East Fork is a mixture of sand, cobble, and gravel. There are large quantities of fine material on the channel bed throughout the East Branch that are related to the sedimentary geological characteristics and human activity, including the marble and limestone quarry previously operated by CEMEX that is located in the upper portions of the East Branch of Liddell Creek (ENTRIX, Inc. 2004a, ENTRIX, Inc. 2004b). Sedimentation ponds at the quarry, a conveyor belt transporting crushed limestone and marble, and quarry access roads all contributed a substantial amount of fine-grained sediment to each of the three branches resulting in 100 percent substrate embeddedness in several areas (Environmental Sciences Associates, 2001, ENTRIX, Inc. 2004a, Entrix, Inc. 2004b). Road and bank failures along Bonny Doon Road are also reported to be partially responsible for the relatively high levels of fine sediment in the Main Branch (Environmental Sciences Associates 2001 cited in ENTRIX, Inc. 2004a). Recent sediment analysis at Liddell Spring indicates sourcing from the CEMEX quarry (Strudley and Chartrand 2010).

Instream Habitat

Liddell Creek downstream of the west branch and in the east branch has good, dense riparian cover but poor instream habitat due to lack of pool development and shallow depths resulting from accumulations of sand (Hagar 2005). In many places, instream structures such as large woody debris are present but do not form scour pools due to the high sand load. Large amounts of sand are impounded behind many log debris jams. The stream is very narrow and confined, partly as a result of the karst topography with more seasonally stable streamflows and without extreme winter flows that would scour a wider active channel. Habitat in the West Branch is comparable to the East Branch though the West Branch is a slightly smaller stream. The East Branch contributes the majority of dry season flow below the confluence of the East and West Branches (Entrix 2004b).

Migration Barriers

The upstream limit of anadromy in Liddell Creek is a natural migration barrier formed where the stream passes over a bedrock ledge about 1.16 miles upstream from the mouth and 0.13 miles downstream of the confluence of the East Branch with the Middle Branch (Hagar et al. 2017a).

There are numerous obstacles to migration in the anadromous reach of Liddell Creek. Migration issues begin at the mouth where the channel was filled in the late 19th Century to create an

earthen causeway for a rail and roadway (Highway 1) transportation corridor. The stream was rerouted through a bedrock bore on the north side of the stream valley. The causeway is immediately behind the beach berm, and together with forcing the stream through the bedrock bore, impairs processes that would form a lagoon and results in lack of significant lagoon formation at the mouth of the creek. The outfall of the bedrock bore contains two concrete barriers that partially close the opening (ENTRIX, Inc. 2004a). This crossing may pose a passage problem to migrating salmonids in certain hydrologic conditions (HC) such as during the winter when the beach sand is scoured away and a vertical drop of up to 3 feet (with no significant plunge pool) forms at the culvert exit point (Environmental Sciences Associates 2001 cited in ENTRIX, Inc. 2004a). This condition is transient as conditions suitable for passage have been observed at this location on occasion (Chris Berry, personal communication to Jeff Hagar, 2006).

There is a concrete apron at the upper end of the bedrock bore associated with causeway. Under low flow conditions the cross-section of the apron results in a wide shallow channel with insufficient depth for passage of steelhead. A minimum flow of 8.1 cfs is needed to meet passage criteria for adult steelhead at this location and a flow of at least 2.0 cfs is required for downstream migration of steelhead smolts (HES 2014b). Without City diversions, a flow of 8.1 cfs is equaled or exceeded in Liddell Creek about 32% of the time in January, a peak month for adult steelhead migration. During the end of the peak smolt outmigration period in May, a flow of 2.0 cfs is equaled or exceeded about 98% of the time with no City diversions (Historical Hydrology Database - Water Years 1938-2015, Balance Hydrologics, Inc. 2020).

Bonny Doon Road runs adjacent to the Main and West Branches of Liddell Creek for approximately 1 mile upstream of Highway 1. Three culvert road crossings of the West Branch exist in this reach. All three were given a priority ranking of “high” in the County of Santa Cruz Stream Crossing Inventory and Fish Passage Evaluation (Ross Taylor and Associates, 2004). Passage problems are related to severe under-sizing of the culverts and a perched outlet at the lowermost crossing that likely impedes most migration attempts for both adult and juvenile steelhead (Ross Taylor and Associates, 2004). The middle culvert was replaced in 2003 and is no longer considered a passage barrier (K. Kittleson, County of Santa Cruz, personal communication to Jeff Hagar, January 15, 2020). The upper and lower culverts were re-evaluated as low priority due to poor passage at the Highway 1 bedrock bore and re-evaluation of habitat upstream of the upper culvert as fair/poor (Kittleson 2015).

Under low flow conditions, even riffles and other shallow cross-sections (such as the Highway 1 culvert aprons) may hinder migration of adult salmonids. Critical riffles are riffles with the widest, flattest cross-sections requiring the most flow to achieve sufficient depth for passage. Passage depth criteria for adult steelhead are not met at flows less than 11.3 cfs at

critical riffle cross-sections in the anadromous reach of Liddell Creek (HES 2014b). The passage depth criterion for adult steelhead is a depth of at least 0.6 feet continuous across at least 10% of the cross-section (Thompson 1972, CDFW 2012). A flow of at least 2.0 cfs is required to meet downstream passage criteria for steelhead smolts at critical riffles in Liddell Creek (HES 2014b). More information on passage flow determination is provided in HES (2014b) (Appendix 3: *Flow Studies*).

The natural hydrology (without City diversions) produces conditions that meet migration needs of adult steelhead for a significant amount of time during the migration season (December through April) in normal and wet years (Chapter 5). On average there are over 120 days during the migration season with flow meeting migration criteria in wet years and over 90 days in normal years. In dry years migration opportunities are lower with about 40 days meeting the criteria and in critical years there are 15 days with flows meeting migration criteria. Operation of the City diversion has reduced the frequency of suitable migration conditions, particularly in normal and dry years (Chapter 5). Bypass flows implemented as part of the HCP substantially restore migration opportunities in normal and wet years (Chapter 5). Suitable flow conditions for steelhead smolts exist most of the time without City diversions with 140 days or more in all hydrologic year types during the January to May potential smolt migration period (Chapter 5). City diversions have substantially reduced the amount of time with suitable smolt migration flows in dry and critical years during past operations. Bypass flows under the HCP will result in some improvement (Chapter 5).

Spawning Habitat

Substrate in the Liddell Creek watershed is primarily derived from the easily mobilized Santa Cruz mudstone and Santa Margarita sandstone formations, which result in numerous fines and lower-density gravels than those derived from granitic sources in the Laguna and Majors watersheds (ENTRIX, Inc. 2004a). About 25 percent of the Liddell Creek watershed consists of the Santa Margarita sandstone. As a result, large amounts of fine sediment and high degrees of embeddedness are common throughout the anadromous reach of Liddell Creek and limit the potential spawning habitat. This is especially true of the Main Branch reaches. Embeddedness reported by Environmental Sciences Associates (2001) (cited in ENTRIX, Inc. 2004a) in the Main Branch ranged from 40 to 95 percent and on the West Branch from 30-65 percent. Environmental Sciences Associates (2001) suggested that redds may have a high sand content and redd destruction from scouring is common (ENTRIX, Inc. 2004a). In some years (e.g., 1983) late spring storms may either have destroyed redds or caused severe mortality among recently emerged fry (Environmental Sciences Associates 2001 cited in ENTRIX, Inc. 2004a). Of the anadromous reaches, the lower reach of the West branch had substantially less fine sediment relative to the other reaches studied, increasing the quality of spawning gravels

(Environmental Sciences Associates 2001 cited in ENTRIX, Inc. 2004a).

During a spawning flow assessment in the winter of 2006-2007, HES located four study sites in potential spawning habitat in the anadromous reach (HES 2014b). Sites were selected to represent locations with good spawning potential based on micro-habitat, hydraulic, and substrate characteristics. Substrate at these sites was generally rated as only moderately suitable based on the Bovee system.[10] Three of the sites had a few cells with moderate to high substrate suitability ratings but only one of the four sites had consistently high ratings across the channel. Substrate at these sites was quite variable but consisted primarily of sand/gravel mixtures with relatively high proportions of sand. Lower suitability ratings were generally the result of excessive sand. Cobble size substrate was an infrequent component of the streambed in Liddell Creek.

Table 2-1: Substrate Size Class Coding Using the Bovee System

Substrate Size Code	Substrate Size Range
1	Organic debris or vegetation
2	Mud or soft clay (<0.002")
3	Silt (<0.002")
4	Sand (0.002"-0.25")
5	Gravel (0.25"-3.0")
6	Cobble/Rubble (3.0"-12.0")
7	Boulder (>12.0")
8	Bedrock

For steelhead in Liddell Creek the spawning suitability index[11] is high (at least 80% of the peak value) across a very broad range of flow between 7.4 and 24.6 cfs with a peak at about 13.7 cfs (HES 2014b). Suitability of spawning habitat is highest during wet years and declines with drier conditions to about half the wet-year value in critically dry years (Chapter 5). Operation of the City diversion has historically resulted in lower spawning habitat values than would have

[10] This method of substrate coding (Bovee 1978) uses a single digit (corresponding to particle size) and a decimal (corresponding to abundance). The two-digit code describes the mixture of the two adjacent-sized particle classes which dominate a particular cell by assigning the number (1 through 8 as in Table 2-1) of the smaller-diameter size class to the digit place and the volumetric percentage (0 through 9 for 0% to 90%) of the larger-diameter size class to the decimal place.

[11] The relationship between flow and spawning habitat quality for steelhead was assessed using the Physical Habitat Simulation (PHABSIM) model of the Instream Flow Incremental Methodology (Bovee et al. 1998). The spawning habitat assessment was completed by measuring hydraulic conditions at sites in the anadromous reach of Liddell Creek and constructing computer models to predict changes in suitability of water depth, velocity, and substrate with discharge. The PHABSIM model development and use is described in a separate report (HES 2014b).

occurred without the diversion (Chapter 5). Conservation Flows implemented as part of the HCP will result in some improvement relative to historical operation, particularly in wet and normal year types (Chapter 5).

Rearing Habitat

Habitat quality for rearing steelhead in Liddell Creek is fair to poor. Canopy is relatively dense and overhanging terrestrial vegetation provides cover in many locations (ENTRIX, Inc. 2004a, Hagar 2005). Good, dense riparian cover in the form of downed tree trunks, branches, and roots is present, however the large amount of sand substrate limits its utility as cover. Even where objects such as root masses, large woody debris, and bedrock ledges are located in a good position to cause scour of sand and formation of pools, these structures are largely buried in sand and there is often very little associated pool development (Hagar 2005). Riffle habitat is also limited, estimated at just 18% by stream length (ENTRIX, Inc. 2004a). This, together with the extensive sandy substrate may limit formation of a healthy benthic macro-invertebrate forage base for steelhead juveniles. Habitat is more limited in the East Branch upstream of the West Branch confluence than downstream of the confluence (Hagar 2005). Limiting factors for rearing steelhead would include pool depth, cover, substrate, and flow, in that order (Harvey & Stanley Associates 1982).

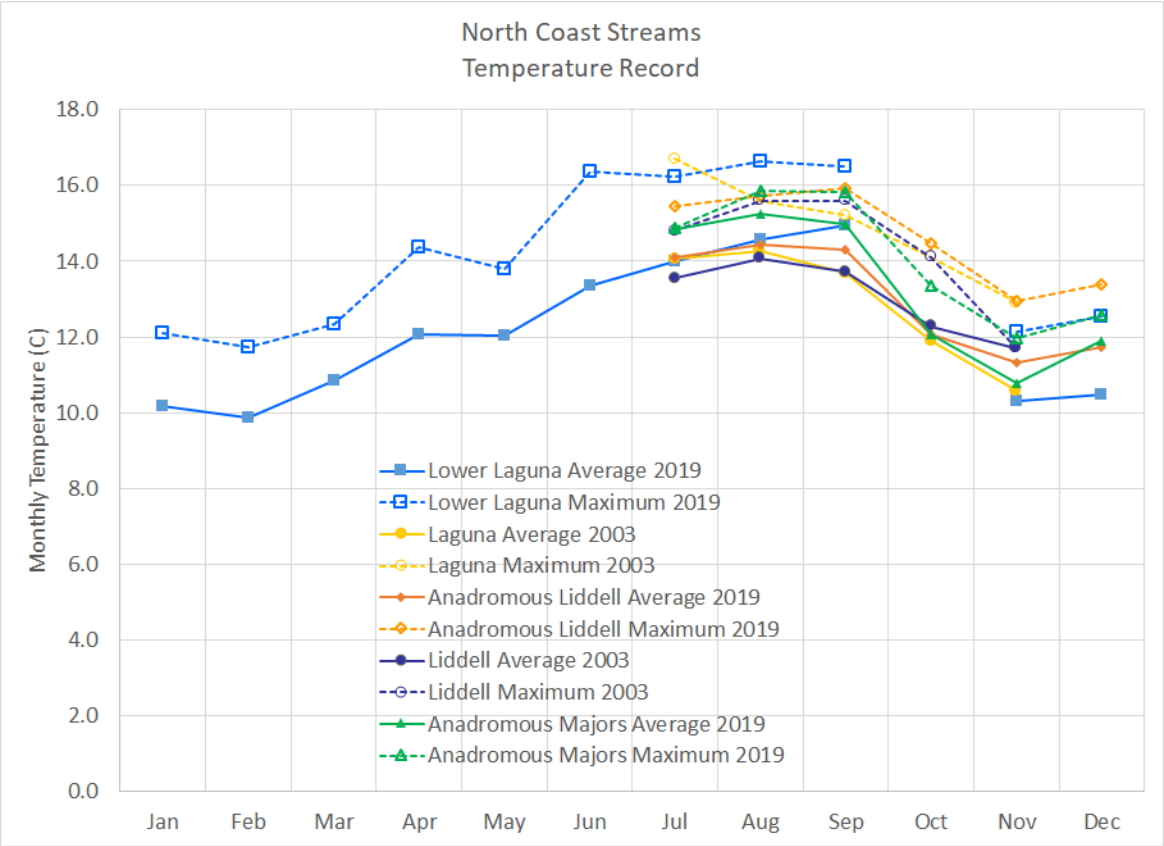
Habitat suitability for rearing steelhead in Liddell Creek increases gradually as flow increases from minimum levels and levels oat at a flow of 14 cfs and higher (HES 2014b). A flow of 5.2 cfs provides 80% of the rearing index[12] for steelhead as that provided at a flow of 14 cfs. Streamflow during the dry season falls well below these levels. Streamflow is most limiting for rearing during the spring and summer and during dry and critically dry years. Without City diversion, habitat value for rearing steelhead in Liddell Creek declines in summer (defined here as July-September) to about 80% to 90% of spring levels (defined here as April-June) depending on year type (Chapter 5). In wet years, the decline is greater and in critically dry years it is less. Spring flows in critical years are about 70% of those in wet years while summer flows in critical years are about 80% of summer flows in wet years. The effect of the City diversion is to reduce spring habitat values up to 30% on average in critical years and to reduce summer habitat values by up to 40% on average in critical years (Chapter 5).

[12] The relationship between flow and rearing habitat quality for steelhead was assessed using the Physical Habitat Simulation (PHABSIM) model of the Instream Flow Incremental Methodology (Bovee et al. 1998). The rearing habitat assessment was completed by measuring hydraulic conditions at sites in the anadromous reach of Liddell Creek and constructing computer models to predict changes in suitability of water depth, velocity, and substrate with discharge. The PHABSIM model development and use is described in a separate report (HES 2014b, Appendix 3: *Flow Studies*).

The dense riparian canopy in Liddell Creek and the marine influence on this coastal watershed result in good water temperature conditions for salmonids. Steelhead are generally expected to survive and grow well at temperature up to about 19°C to 21°C if food is abundant. Temperature of 19°C or less is considered optimal under most conditions (Bidgood and Berst 1969, Hokanson et al. 1977, Smith and Li 1983, Armour 1991, see also HES 2014b for a summary of these findings). Steelhead may actually grow faster at higher temperatures if food is abundant (Smith and Li 1983) but at temperature in excess of 21°C, increased mortality may offset the benefits of increased growth rates at the population level Hokanson et al. 1977 (see HES 2014b for discussion of temperature suitability). Temperatures of 25°C to 26°C are generally considered lethal (Bidgood and Berst 1969, Hokanson et al. 1977). Temperature monitoring at the anadromous gage site indicates that, during the summer period, 15-minute water temperature averages around 14°C with a maximum around 16°C[13] (City of Santa Cruz monitoring data, Figure 2-1).

[13] Temperature record at City of Santa Cruz anadromous gage pressure transducers (2016-2019) and temperature monitors (2003). Average and maximum by month of 15-minute readings (pressure transducer readings) and 30-minute readings (2003 data). These are all available data as of January 2020.

Figure 2-1: Water Temperature in North Coast Creeks



Source: City of Santa Cruz monitoring data

Lagoon Habitat

Liddell Creek does not have a fully functional lagoon because the area where a lagoon would form, behind the beach, is occupied by fill from the railway/Highway 1 causeway. The creek enters the beach via a 5-foot by 8-foot culvert bored beneath Highway 1 and through the cliff bordering the northern edge of the creek. The creek valley was filled at this location in the early part of the 20th century, forming a causeway to support rail lines and the present-day Highway 1 corridor. The causeway intersects the creek valley immediately behind the beach and appears to have completely obliterated any former lagoon habitat although there is no known documentation of pre-development conditions. The berm and associated tunnel have significantly altered the form and dynamic function of the Liddell Creek mouth/lagoon.

There is a small pocket beach formed at the mouth (approximately 500 feet wide in shore parallel direction) bounded by rocky headlands composed of Santa Cruz mudstone, a relatively resistant

fine-grained sedimentary rock (Phil Williams & Associates (PWA) 2004). Opening of the Liddell Creek mouth is dependent on storm runoff events to breach the sandbar and sustain the opening. During high flows, the Creek outlet may run straight out from the tunnel mouth into the ocean. At other times there may be a shallow channel to the south along the back beach or the foot of the railroad causeway. Under lower flow conditions the creek flow percolated completely into the beach sand without reaching the sea. Although trace amounts of water may pond behind the beach berm, a dry season lagoon of any substantial size or depth does not form at Liddell Creek.

2.4.2.2 Habitat Conditions Laguna Creek

Laguna Creek supports steelhead and resident rainbow trout populations and may support coho. At the time that the Coho Recovery Plan (NMFS 2012) was produced, Laguna Creek was determined to lack suitable habitat for coho. However, subsequent to that time, a few juvenile coho have been observed in annual snorkel surveys in 2015 (5 YOY), 2016 (2 age 1+), and 2020. For the purposes of the HCP, Laguna Creek is considered potential coho habitat and is managed accordingly.

Watershed/hydrology

Laguna Creek is a second order stream that flows into the Pacific Ocean along the North Coast area of Santa Cruz County. The two major tributaries to Laguna Creek are Reggiardo Creek and Y Creek. The Reggiardo Creek confluence is approximately 4.2 miles upstream of the mouth of Laguna Creek, while the Y Creek confluence is approximately 1.4 miles upstream of the mouth. Laguna Creek drains in a southwest direction off of Ben Lomond Mountain. The watershed area is approximately 7.8 square miles. The elevation of the watershed ranges from sea level at the mouth to approximately 2,420 feet at its headwaters near Empire Grade Road. The approximate stream channel length from the mouth of Laguna Creek to its headwaters is 8.5 miles. The City diversion on Laguna Creek has a capacity of approximately 6.3 cfs and is directly upstream (0.1 miles) of the Reggiardo Creek confluence. The channel gradient from the diversion to the mouth is about 3 percent, and the channel gradient upstream of the diversion to the headwaters is approximately 6 percent (ENTRIX, Inc. 2004b).

There are at least seven known non-City operated diversions on the Laguna-Reggiardo Creek system (ENTRIX, Inc. 2004b) (See Figure 1-3: Laguna Watershed Map). The Sand Hill Bluff site (Diversion #3) diverts through a 10-inch diameter pipe and probably represents the most significant non-City diversion in the Laguna Creek watershed and is directly upstream of the limit of anadromy. Downstream of the Sand Hill Bluff Diversion are the Mills and former Coast

Dairies and Land Co. (CDL) diversions (Diversions #1 and 2) (ENTRIX, Inc. 2004b). The CDL diversion may not be operating currently. CDL also historically operated an alluvial well along the lower reach of Laguna Creek that may influence surface flows when operating. This may not be a complete accounting of non- City operated diversions on Laguna Creek and its tributaries. Production numbers and seasons of diversion for the non-City diversions are unavailable and their impacts on Laguna Creek hydrology are unknown though they may divert in excess of 1 cfs (ENTRIX, Inc. 2004b). This level of water diversion can substantially reduce available flow for anadromous salmonids, particularly during the dry season. The City does not have definitive documentation on the legal status of the water rights for these diversions and they are not well documented in State Water Resources Control Board (SWRCB) databases. However, a SWRCB investigation in 2015 determined that the Sand Hill Bluff Diversion was being operated in an unauthorized manner at the time (Kathy Bare - SWRCB, personal communication to Chris Berry, 2015). In addition, the City has both appropriative water rights seniority and control over all downstream riparian rights downstream of its diversions on the north coast streams.

The channel from the Laguna Creek mouth to about 1.43 miles upstream is low gradient (≈ 1 percent) and moderately confined. At this point (near Y Creek confluence), a series of boulder cascades form a complete barrier to anadromous fish passage (Hagar et al. 2017a; also, see following section). In this reach, substrate is a mixture of sand, gravel, and cobbles, and aquatic instream cover is abundant and diverse. Above mile 1.43 to the City diversion, the channel gradient steepens to about 3.4 percent and the valley walls become more confined. The majority of the channel between the anadromous reach and the diversion is mixed bedrock and boulders with patches of sand and gravel deposits. The amount and level of complexity for aquatic instream cover decreases above mile 1.43 (ENTRIX, Inc. 2004b). See Appendix 2: *North Coast Passage Synthesis*.

Reggiardo Creek is a first order tributary to Laguna Creek. The City operates an instream water diversion structure along Reggiardo Creek directly upstream of its confluence with Laguna Creek. The elevation range of Reggiardo Creek watershed is 590 feet above mean sea level (msl) at its confluence with Laguna to 1800 feet msl near its headwaters. The channel length from Reggiardo's confluence with Laguna to its headwaters at Reggiardo Spring is 1.7 miles with a gradient of approximately 9 percent (ENTRIX, Inc. 2004b).

A significant portion of the Laguna Creek watershed is limestone and marble outcroppings, commonly referred to as karst topography. The karst topography has a significant influence on streamflow and summer baseflow by producing multiple springs within the watershed. The karst topography is also more resistant to erosion than other material in nearby watersheds, which results in reduced fine sediment loads. The Laguna watershed also has granitic formations that provide a good source of gravel and cobble. This is evident in the reaches downstream of the

City's diversion where large cobble and gravel dominate the streambed substrate (ENTRIX, Inc. 2004b).

The 7.8 square mile watershed is home to slightly over 1,000 people, all on septic service (2ndNature 2006). In a study of Santa Cruz County lagoons, including Scott Creek, San Lorenzo, Aptos, and Soquel, the seasonal loading of nutrients (measured as dissolved inorganic nitrogen or DIN) to Laguna Lagoon was found to be low in comparison to the other lagoons. Surface water DIN and soluble reactive phosphorous (SRP) values measured in the Laguna Creek Lagoon are consistently low, < 5uM and < 2uM respectively (2ndNature 2006).

Instream Habitat

Migration Barriers

The upstream limit of anadromy in Laguna Creek has been identified as a reach beginning near the Y Creek confluence about 1.43 miles upstream of the mouth where the stream gradient increases sharply and the channel is obstructed by large boulders. Observations were made at this site on May 24, 2017 by a team of biologists and engineers from CDFW, NOAA Fisheries, City of Santa Cruz, and Hagar Environmental Science (Hagar et al. 2017a). The team concluded that there may be some flows where adult steelhead could ascend the boulder fall but that the frequency of such events would be insufficient to support an anadromous population upstream (Hagar et al. 2017a).

Entry of steelhead and coho into Laguna Creek is regulated by opening of the mouth, generally under the combined influence of winter tidal and swell conditions and increased inflow resulting from winter storms. Historical alteration of the lower part of the creek and lagoon has created conditions that likely influence lagoon opening and closure. First, the creek valley at the upper end of the lagoon was filled for construction of a railroad in the early 1900s (2ndNature 2006). The creek was rerouted through a tunnel in the bluff at the north edge of the valley. Second, the morphology of the lagoon area was modified in the early 1900s to accommodate agricultural cultivation in the historic marsh area. There are also remnants of a concrete dam located approximately 150 feet downstream of the railroad tunnel. The dam is presently in disrepair and the stream passes unimpaired around the southern end of the structure; however, this dam may have interfered with fish migration in the past.

Observations beginning in 2004 and monitoring instrumentation in place since then indicate that it takes very little increased inflow to open the Laguna Creek Lagoon in the fall and that it generally opens in the mid-October to mid-November time period (2ndNature 2006 and subsequent annual reports for City of Santa Cruz).

Once upstream of the lagoon, migration of adult salmonids is limited only by a few low-flow obstacles, including the concrete apron at the upstream end of the Highway 1 culvert and a few shallow riffle cross-sections. Reduction of flows at these locations during the spawning season, such as through the City diversion or other diversions, can limit the periods when migrating salmonids can pass (HES 2014b). This would apply both to upstream migrating adults and downstream migrating adults and smolts. Analysis of flows needed for passage at these locations was used to set bypass flow requirements under the HCP (HES 2014b, Appendix 3: *Flow Studies*).

Spawning Habitat

The karst topography found in Laguna Creek watershed is considered a fair source for spawning gravel. Granitics are also present in the watershed (ENTRIX, Inc. 2004a). These geological conditions are frequently associated with stable summer/fall base flows and relatively clean streambed gravels and small cobbles. Surveys conducted by ENTRIX, Inc. in 2003 noted that suitable spawning substrate was not extensive and was concentrated within the lower 0.75 miles of stream (ENTRIX, Inc. 2004a). During a spawning flow assessment in the winter of 2006-2007, HES located four study sites in potential spawning habitat in the anadromous reach (HES 2014b). Substrate at these sites was rated as moderately to highly suitable based on the Bovee system (Table 2-1). Substrate suitable for spawning at these sites consisted primarily of sand/gravel mixtures or gravel/cobble mixtures with high proportions of gravel. Lower suitability ratings were generally the result of excessive sand. Cobble rarely made up more than 30% of the substrate at these locations and gravel was generally at 70% to 90% (HES 2014b).

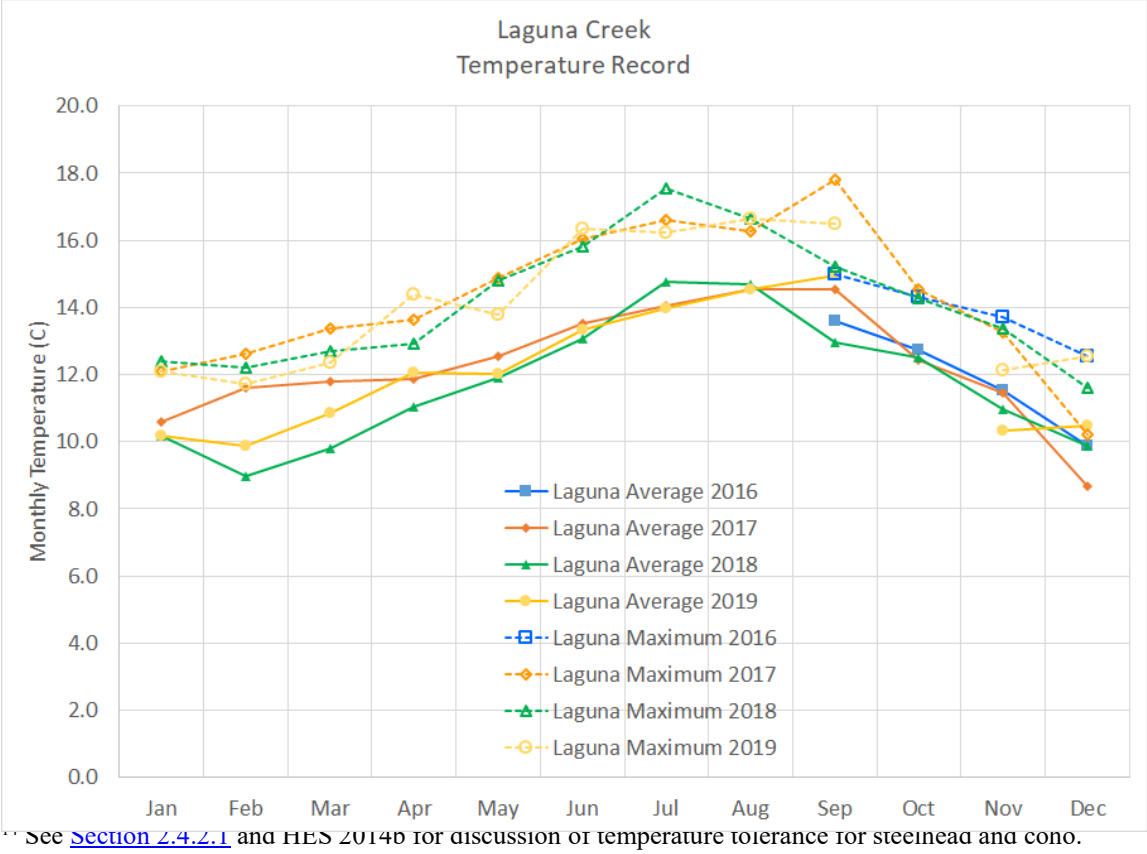
Suitability of habitat for salmonid spawning is partially dependent on flow and, as such, can be altered by the City diversion. A spawning flow assessment to define the relationship between flows and spawning habitat quality for steelhead and coho was conducted in 2006-2007 using the Physical Habitat Simulation (PHABSIM) model (HES 2014b, Appendix 3: *Flow Studies*).

The suitability of habitat for steelhead spawning increases rapidly as flow increases from about 2 cfs and peaks at a flow of 14 to 16 cfs (HES 2014b). Flows of 11 and 22 cfs provide 80% of the peak suitability index value for steelhead. The spawning suitability index for coho rises rapidly from a value of 0 at about 2 cfs to a peak at about 9 cfs. Flows of 7 and 16 cfs provide 80% of peak suitability index value for coho. A flow of 12 cfs in Laguna Creek provides 96% of the peak steelhead suitability index and 94% of the peak coho suitability index. Flows higher or lower than these levels result in increased frequency of depth, velocity, and substrate conditions that are outside the suitable range as defined by habitat suitability criteria used for steelhead and coho spawning (HES 2014b).

Rearing Habitat

Habitat surveys have revealed that rearing habitat in Laguna Creek is dominated by pools and that riffles were quite small and unlikely to be highly productive of aquatic invertebrates (ENTRIX, Inc. 2004a). Fifty-seven percent of the anadromous reach was pool habitat and only 9% was riffle during these surveys. Mean depth of pools averaged only 0.9 feet and maximum depths averaged 1.8 feet. Instream cover was complex and undercut banks were extensive in the lower anadromous reach while boulders, bedrock, and woody debris were important cover objects in the upper part of the creek. Canopy coverage was relatively dense, averaging 75% in the ENTRIX, Inc. survey. This level of canopy is good for salmonids as it allows sufficient light for aquatic plants and invertebrate production while maintaining good shade for cooler temperatures. Temperature monitoring data collected by the City indicates good water temperature conditions for rearing salmonids[14] (Figure 2-1 and Figure 2-2). Monthly average water temperature readings recorded from 2016 through 2019 peaked between July and September at 14°C to 15°C with monthly maximums peaking at 16°C to 18°C (Figure 2-2).

Figure 2-2: Water Temperature in Laguna Creek



[14] See Section 2.4.2.1 and HES 2014b for discussion of temperature tolerance for steelhead and coho.

Rearing habitat quality varies with flow and is potentially influenced by the City's diversion. During the winter of 2006-2007, the City conducted an assessment of the relationship between flow and rearing habitat quality using PHABSIM (HES 2014b, Appendix 3: *Flow Studies*). The habitat quality index for steelhead rearing in Laguna Creek increases gradually as flow increases from minimum levels and continues to increase, though at lower rates, through the range of simulated flows (HES 2014b). A flow of 5.5 cfs provides 80% of the habitat suitability for steelhead as that provided at a flow of 14 cfs. The rearing suitability index for coho is relatively insensitive to flow across the range of simulated flows. Habitat suitability at the lowest simulated flow of 0.1 cfs is 80% of the peak suitability for coho occurring from 2.25 and 3.75 cfs (HES 2014b). This is the result of the tendency of rearing juvenile coho to use relatively low velocity habitat (Hampton 1988, Hampton 1997, Bovee 1978, Hardy et al. 2001). A flow of 5.5 cfs provides 80% of peak rearing suitability for steelhead and 95% of peak suitability for coho (HES 2014b). See Appendix 3: *Flow Studies*.

Lagoon Habitat

General Lagoon Dynamics

Lagoon habitat has been shown to be very important for rearing juvenile steelhead. Smith (1990) estimated that relatively large numbers of juvenile steelhead were present in San Gregorio, Pescadero, and Waddell lagoons during 1986 in comparison to the numbers of steelhead rearing in upstream areas, particularly larger individuals; that juvenile steelhead that rear in the lagoon experience higher growth rates than stream-reared fish; and that lagoon reared fish comprise a high percentage of returning adult steelhead. Similarly, Bond (2006) found both high growth rates and high rates of return for estuary reared steelhead in Scott Creek. Bond calculated that estuary-reared steelhead comprised between 8% and 48% of all downstream migrating juveniles but 85% of the returning adult population.

While coho may use lagoon habitat, they have not been documented as often in Central California lagoons. When coho have been found in lagoons, it is often during the late spring when they would be migrating to sea as smolts. During monthly sampling of the Navarro River Estuary in 1996 and 1997, out-migrant coho smolts were captured in May, June, and July but coho were not observed at other times (Cannata 1998). All but two coho smolts were captured from the lower estuary sampling sites, suggesting that coho smolts may pass through the freshwater portions of the estuary rather quickly, but hold in the brackish water of the lower

estuary for relatively short periods of time (Cannata 1998). Within the Plan Area, in sampling from 2004 through 2019, coho YOY and smolts have been found in Laguna Creek Lagoon only during 2005. They were relatively numerous in May while the mouth was open, declined in the July sample, and all but disappeared by September (2ndNature 2006). There is some thought that Central Coast lagoons may be too warm for coho (Brian Spence, NMFS, personal communication to Jeff Hagar, November 2006).

Central coast lagoons are dynamic and variable environments that cycle between closed freshwater systems and open estuaries. For lagoons in the HCP planning area, streamflow is the dominant factor opening and maintaining a lagoon outlet. Onshore sediment delivery by wave action is the dominant factor closing off the lagoon outlet and temporarily halting streamflow to the ocean (PWA 2004). Under conditions of sufficient inflow, the lagoons operate under a "fill and spill" cycle. Streamflow fills the lagoon until its water surface elevation spills over the crest of the barrier beach. Water flowing over the barrier beach quickly erodes the unconsolidated sand, down-cutting and widening the outlet, thereby releasing even larger amounts of water. Once underway, this erosional process is irreversible until outflow from the lagoon subsides (ENTRIX, Inc. 2004a). Ocean conditions also influence this process through erosion of the beach under high swell conditions or seasonal building of the beach through on-shore delivery of sand (PWA 2004).

Detailed documentation of the timing and duration of sandbar closure for lagoons in Santa Cruz County, including the San Lorenzo River Lagoon, has been provided by the Comparative Lagoon Ecological Assessment Project (CLEAP) and 2ndNature (2ndNature 2006, 2008, 2009a, 2009b, 2009c, 2010a, 2010b, 2011, 2012, 2013, 2014, 2015, 2016). These studies also support the conclusion that the timing of the initial sandbar formation may be driven by sand delivery dynamics during large summer south swells coupled with a spring tidal cycle. Lagoon inflow also has an influence on the timing and persistence of closed lagoon conditions. Regardless of the timing of the sand bar formation, the duration of closure is variable across the lagoons and assumed to be partially dependent upon the water storage capacity of each respective lagoon, as described above. If the water surface elevation of the lagoon reaches the elevation of the sandbar, the bar will erode and eventually breach. In less laterally confined lagoons (little to no active flood control), the water impounded behind the bar can expand horizontally into connected marsh and lateral storage areas, thus reducing the rate at which the elevation of the water behind the bar increases as fresh water is impounded. In general, the less flood-controlled lagoons close earlier and stay closed longer than those located in urban areas where flood control is a priority (2ndNature 2006).

The available data indicate that the circulation regime of coastal lagoons plays a large role in the water quality of the lagoon. When the sandbar is open, marine water mixes with freshwater in an

estuarine environment. The lagoon is tidally influenced and possesses a well-mixed water column and relatively uniform vertical profile structure of temperature, dissolved oxygen (DO), pH, and salinity (2ndNature 2006). Depending on river inflows during open lagoon conditions, there may be some salinity stratification with relatively fresh water near the surface and increasing salinity with depth. Under these conditions the temperature is relatively cool with some diurnal warming in the surface layers and relatively high levels of DO throughout the water column (HES 2017). Within days of the sandbar closure, a halocline develops with denser marine water at the bottom overlain by freshwater delivered to the lagoon from the surrounding watershed. The density difference between the surface freshwater layer and the deep saline layer effectively isolates the two layers and prevents mixing of chemical constituents, most notably DO, between the layers.

Habitat conditions for juvenile salmonid rearing are influenced by three main water quality parameters: temperature, salinity, and DO. Lagoons tend to be warmer than upstream flowing reaches due to less influence of shading riparian vegetation. Lagoons also tend to be rich in nutrients and high levels of primary production supporting abundant food resources combined with higher temperatures can support rapid growth rates for rearing salmonids, provided that temperature is not too extreme.[15]

Juvenile steelhead appear to tolerate a range of salinity conditions. Certainly freshwater (~0-4 parts per thousand (ppt) salinity) would be considered highly suitable. Tolerance of full-strength seawater is likely limited, particularly for more juvenile fish, and may have seasonal components. Healthy and vigorous juvenile steelhead have been captured in the fall in the Carmel River Lagoon at salinities of 12-14 ppt and higher (HES 2002; HES 2003a). In the San Lorenzo River Lagoon during 2002, salinity was 4 ppt at the surface but increased to 30 ppt at 2 feet of depth at sites where juvenile steelhead were captured upstream of Riverside Drive in November (H.T. Harvey and Associates 2003b). In July 2004, juvenile steelhead were captured at three sites in the lower San Lorenzo River Lagoon with surface salinities (measured at 0.01 meter (m) depth) ranging from 0.02 ppt to 7.3 ppt, however, salinity at a depth of 0.25 meters (about 10 inches) at these stations ranged from 14.4 to 17.2 ppt (HES 2005b, CLEAP data). Juvenile steelhead are often present in higher salinity water at the mouth of the San Lorenzo River when the mouth is open. Association of juvenile steelhead with higher salinity water is not unique to these lagoons south of San Francisco Bay. In the Navarro River Estuary in 1996 and 1997, steelhead were captured year-round at most sampling sites (Cannata 1998). They were usually most abundant in samples collected from the lower estuary sites before the mouth closed and the lagoon formed (mouth closed September 20 in 1996 and September 5 in 1997) and increased in abundance in the middle and upper estuary sites after the lagoon formed. Steelhead

[15] See section 2.4.2.1 and HES 2014b for discussion of temperature tolerance for steelhead and coho.

larger than 110 millimeters (mm) fork length (FL) were almost exclusively captured from the lower sampling sites where water temperatures were cooler and salinities were higher than middle and upper estuary sites (Cannata 1998). Steelhead growth rates in the Navarro River Lagoon were lowest during the period the lagoon was closing but accelerated after a period of time. All of these observations would suggest that juvenile steelhead can tolerate relatively high salinity in lagoon habitats. Other factors, such as food abundance and levels of other parameters including temperature and DO, may also influence salinity tolerance.

Optimal DO levels for steelhead are 7 milligrams (mg) per liter (l) and above, although levels down to about 5 mg/l can be tolerated (US EPA 1976, US EPA 1986, Raleigh et al. 1984). Suitability falls off rapidly at levels below 5 mg/l and the incipient lethal level is approximately 3 mg/l or less, depending on environmental conditions, especially temperature (Raleigh et al. 1984).

The transition from a well-mixed, tidally influenced system under open lagoon conditions to a closed lagoon results in transitional water quality dynamics that influence habitat conditions for salmonids. Cessation of tidal inflows of cold, well-oxygenated marine water results in warming of lagoon waters, particularly in the San Lorenzo River Lagoon where air temperature is generally warmer. After lagoon closure there is usually a layer of marine water trapped in the deeper parts of the lagoon. The density difference between the surface freshwater layer and the deep saline layer effectively isolates the two layers and prevents mixing of chemical constituents, most notably DO, between the layers. DO is consumed by processes of decay in the saline water and is not replenished. This layer also becomes much warmer than the overlying freshwater. As a result, a layer of saline, warm, and de-oxygenated water forms at depth, which is not habitable by steelhead, forcing them into the surface freshwater layer. The saline water is gradually flushed out with timing dependent on the amount of freshwater inflows. The process can take up to two to four weeks and in the San Lorenzo River Lagoon a shallow saline lens may persist even longer.

Laguna Creek Lagoon

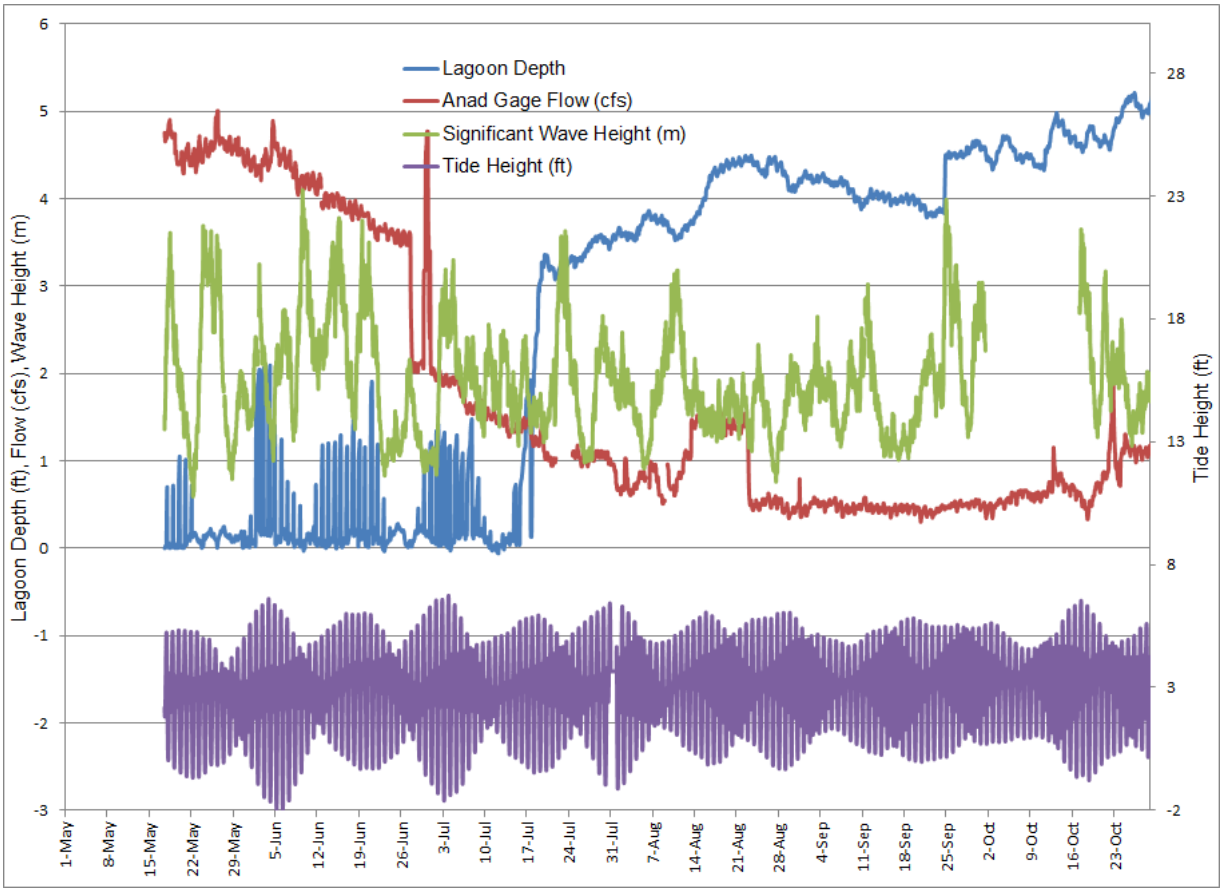
Laguna Creek Lagoon provides rearing habitat for steelhead and possibly for coho. As previously described, the morphology of the upper part of the lagoon has been significantly altered by construction of the railroad and Highway 1. The natural channel of Laguna Creek was filled in the early 1900s to create a bed for the rail line and highway. The fill is approximately 150 feet wide and crests about 80 feet above the lagoon (2ndNature 2006). Laguna Creek was rerouted through a tunnel dug into bedrock cliff at the northern edge of the valley. At some time after the creek channel was filled and rerouted, higher parts of the marsh to the west of the fill were used for agriculture. These areas were abandoned and have largely reverted to marsh

vegetation (2ndNature 2006). A small dam was built on the creek just west of the fill, presumably for an agricultural diversion. At present, the stream has eroded the bank at the southern edge of the dam and now flows around the remnants of the structure. Laguna lagoon consists of a narrow, relatively deep channel that runs along the base of the northern cliffs and then through the marsh, ultimately crossing to the base of the southern cliff. There is an extensive shallow pond in the marsh to the south of the lagoon channel that is connected to the main lagoon when the lagoon is at its highest stages and drains back into the lagoon through an artificial drainage ditch. The shallow pond does not provide habitat for rearing salmonids. In 2007, the City began bypassing a minimum of 0.25 cfs at the Laguna Creek Diversion and more recently the City has been bypassing interim flows that are similar to the proposed HCP Conservation Flows.

Sandbar Formation

Lagoon formation at Laguna Creek is dynamic and variable from year to year, although there is a general pattern of dry season closure (Table 2-2). Since regular observations began in 2004, the mouth of Laguna Creek has generally closed initially between late-April or May and early July. It generally remained closed until the fall or early winter (Figure 2-3). A typical seasonal pattern for Laguna Lagoon is depicted in Figure 2-3. An initial oscillating pattern of lagoon stage tracks tidal stage. As streamflows diminish, closure of the mouth is indicated by a rapid sustained increase in lagoon stage. In some years there has been a period of time when the mouth opens and closes intermittently, particularly in years with higher inflow in the spring and early summer, such as 2016 (Figure 2-4). The sequential closing and breaching in May, June and July show this pattern, with the lagoon volume quickly climbing to over 20 ac-ft before the lagoon reaches capacity and breaches. This pattern also occurred in 2005. Higher inflows may contribute by filling the lagoon to its capacity (approximately 20-25 ac-ft.) and providing enough stream power to erode the sandbar at the mouth, draining the lagoon. However, it is likely other factors, possibly a lower sandbar crest elevation, were in play as higher inflows have occurred in other years without such an extended breaching period (Table 2-2). The mouth has generally opened again between mid-October and early December, although intermittent closure and re-opening occurred through January in the winter of 2008-2009, a winter of low rainfall during the early winter. During the period when observations have been made, opening of the mouth in the fall has sometimes been associated with increased runoff from early storms (*e.g.* 2011) and sometimes not (*e.g.* 2016).

Figure 2-3: Laguna Lagoon Stage, Streamflow, Wave Height, and Tides 2012



Source: lagoon stage from 2ND Nature, streamflow from Balance Hydrologics, wave and tide data from NOAA.

Table 2-2: Lagoon Inflows and Summer Sandbar Closure and Opening Dates for Laguna Lagoon

	Water Year precipitation (in)[1]	August Average daily inflow to Lagoon (cfs)[2]	Date of initial sandbar closure	Date of final sandbar closure	Number of days sand bar closed May 15 to Oct. 31 (168 days in period)	Number of days microtidal May 15 to Oct. 31 (168 days in period)[3]	Mean of daily average water depth at YSI site (June-Aug)
2004	35.49	0.03	14-May	15-May	154	0 0%	0.91
2005	64.83	0.34	10-May	6-July	112	3 2%	2.45
2006*	67.78	1.17	N/A	N/A	N/A	N/A	N/A
2007	25.4	0.38	Before 15-May	Before 15-May[4]	168	N/A	3.93
2008	39.6	0.25	Before 15-May	Before 15-May[4]	168	N/A	3.68
2009	36.52	0.18	21-May	21-May	157	4 2.5%	2.57
2010	48.88	0.70	Mid-May	Estimate at 5-Aug	138	7 4%	3.01
2011	62.15	1.58	9-June	29-Jul	83	60 36%	2.66
2012	34.35	0.75	18-Jul	18-Jul	106	17 10%	2.01
2013	36.2	0.91	Before 15-May	Before 15-May	168	N/A	4.69
2014	24.5	0.26	Before 15-May	Before 15-May	168	N/A	3.21
2015	35.5	0.34	1-June	1-June	152	N/A	4.37
2016	48.6	2.01	15-Aug	15-Aug	100	0	2.96

Source: 2NDNATURE

N/A not available, no monitoring performed, or limited data

*2006 Monitoring did not begin until August 22nd, 2006.

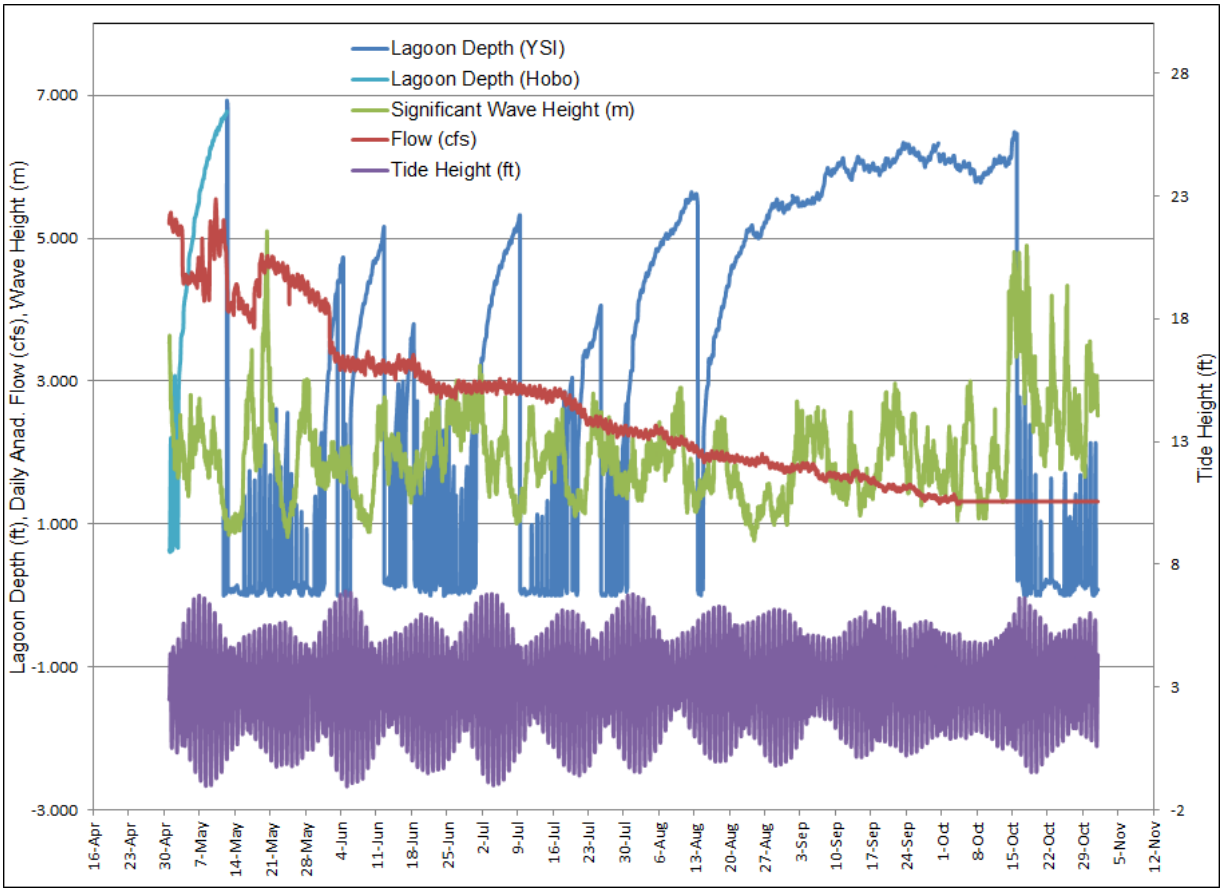
[1] Precipitation data provided by the County of Santa Cruz from the Felton Diversion rain gage station.

[2] Hydrology data from US Geological Survey (USGS) gage #11161000, San Lorenzo River at Santa Cruz, average Q integrated over one day.

[3] Microtidal conditions occur when the sandbar is partially present, reducing surface water exchange to every few days and water circulation within the lagoon is limited. It is determined using visual observations and the derivative of YSI depth data (dz/dt), using parameters established in CLEAP.

[4] Already closed when monitoring initiated on May 15.

Figure 2-4: Laguna Creek Lagoon Stage, Streamflow, Wave Height, and Tides 2016, Preliminary Data



Source: lagoon depth from 2ND Nature and City of Santa Cruz, streamflow from Balance Hydrologics, wave and tide data from NOAA.

Lagoon Circulation Regime and Water Quality

Laguna Creek Lagoon generally provides habitat with good conditions for rearing juvenile steelhead over the dry season. The greatest determinants of habitat quality are the degree to which the lagoon is closed and the amount of freshwater inflow. When the lagoon is closed it provides good rearing habitat and supports good growth rates for juvenile steelhead. An open lagoon can provide good rearing habitat when the sandbar elevation at the mouth is relatively high and depth is maintained in the lagoon. Alternatively, when the mouth is open and the sandbar elevation is low, the lagoon drains and there is little suitable rearing habitat. Freshwater inflows influence the lagoon stage, the speed of transition to freshwater habitat, and may influence the timing and duration of lagoon closure.

During the period of summer lagoon closure, the lagoon stage remains relatively high as long as there is sufficient inflow from Laguna Creek (Table 2-2). The highest summer lagoon stages have occurred since 2007 when the City began bypassing approximately 0.25 cfs at the Laguna-Reggiardo Diversion and later as the City began interim implementation of HCP proposed bypass flows. The lowest summer lagoon stages occurred in 2004 when inflow to the lagoon was extremely low.

During closed lagoon conditions, the Laguna lagoon transitions rather quickly to a freshwater system with little or no saline lens even in the deeper parts of the lagoon (Table 2-3). This condition is disrupted when high tide and swell result in waves washing over the sandbar or the lagoon breaches. For example, there were five such events between June and November 2005 (2ndNature 2006). These events are associated with salinity increases to between 10 and 20 ppt at the bottom of the lagoon and small increases in salinity (less than 2ppt) in surface waters. One event in September 2005 was sufficiently large to result in salinity increase to 15 ppt at the surface. Salinity gradually returned to near zero within one to two weeks for the smaller events but took three to four weeks for the larger event in 2005. Steelhead abundance was high during monthly surveys in September and November of 2005 (2ndNature 2006), indicating that higher salinity alone is not a problem for rearing steelhead.

Water temperature in Laguna lagoon is generally at levels providing good conditions for steelhead with abundant food resources[16] (Table 2-4). The CLEAP study found that a balanced mix of amphipods and isopods were the most common invertebrates in the Laguna invertebrate community, and that the lagoon had consistently moderate to high diversity and abundance values for the invertebrate community (including potential fish food) relative to other lagoons (2ndNature 2006). The warmest temperatures occur in July and August.

[16] See Section 2.4.2.1 and HES 2014b for discussion of temperature tolerance for steelhead and coho.

Table 2-3: Salinity Conditions from Continuous Monitoring Record in the Laguna Creek Lagoon in Comparison to Freshwater Inflow and timing and Duration of Sandbar Closure

	Water Year precipitation (in)[1]	August Average daily inflow to Lagoon (cfs)[2]	Date of initial sandbar closure	Date of final sandbar closure	Number of days sand bar closed May 15 to Oct. 31 (168 days in period)	Number of days microtidal May 15 to Oct. 31 (168 days in period)[3]	% of observations of surface salinity > 5 ppt (June-Aug)	% of observations of bottom salinity > 5 ppt (June-Aug)
2004	35.49	0.03	14-May	15-May	154	14 (8%)	N/A	7%
2005	64.83	0.34	10-May	6-July	112	21 (12.5%)	0%	43%
2006*	67.78	1.17	N/A	N/A	N/A	N/A	N/A	N/A
2007	25.4	0.38	Before 15-May	Before 15-May[4]	168	0	1%	0%
2008	39.6	0.25	Before 15-May	Before 15-May[4]	168	0	0%	39%
2009	36.52	0.18	21-May	21-May	157	4 2.5%	19%	25%
2010	48.88	0.70	Mid-May	Estimate at 5-Aug	138	7 4%	18%	86%
2011	62.15	1.58	9-June	29-Jul	83	60 36%	14%	40%
2012	34.35	0.75	18-Jul	18-Jul	106	17 10%	0%	22%
2013	36.2	0.91	Before 15-May	Before 15-May	168	0	0%	6%
2014	24.5	0.26	Before 15-May	Before 15-May	168	0	9%	0%
2015	35.5	0.34	1-June	1-June	152		30%	24%
2016	48.6	2.01	15-Aug	15-Aug	100	0	30%	65%

Source: 2NDNATURE

N/A not available, no monitoring performed, or limited data

*2006 Monitoring did not begin until August 22nd, 2006.

[1] Precipitation data provided by the County of Santa Cruz from the Felton Diversion rain gage station.

[2] Hydrology data from USGS gage #11161000, San Lorenzo River at Santa Cruz, average Q integrated over one day.

[3] Microtidal conditions occur when the sandbar is partially present, reducing surface water exchange to every few days and water circulation within the lagoon is limited. It is determined using visual observations and the derivative of YSI depth data (dz/dt), using parameters established in CLEAP.
[4] Already closed when monitoring initiated on May 15.

Table 2-4: Temperature Conditions from Continuous Monitoring Record in the Laguna Creek Lagoon in Comparison to Freshwater Inflow and Timing and Duration of Sandbar Closure

	Water Year precipitation (in)[1]	August Average daily inflow to Lagoon (cfs)[2]	Date of initial sandbar closure	Date of final sandbar closure	Number of days sand bar closed May 15 to Oct. 31 (168 days in period)	Number of days microtidal May 15 to Oct. 31 (168 days in period)[3]	Average of Daily Maximum Air Temperature (°C)[3]	Maximum Weekly average Temperature (MWAT)	Number of Days with Average Surface Temperature Exceeding 19°C. (June-Aug)	Number of Days with Average Surface Temperature Exceeding 21°C. (June-Aug)	Number of Days with Daily Maximum Surface Temperature Exceeding 25°C. (June-Aug)
2004	35.49	0.03	14-May	15-May	154	14 (8%)	21.5	N/A	N/A	N/A	N/A
2005	64.83	0.34	6-Jul	6-July	112	21 (12.5%)	20.8	N/A	N/A	N/A	N/A
2006*	67.78	1.17	N/A	N/A	N/A	N/A	21.8	N/A	N/A	N/A	N/A
2007	25.4	0.38	Before 15-May	Before 15-May[4]	168	0	22.2	20.7	59(66%)	5(6%)	0
2008	39.6	0.25	Before 15-May	Before 15-May[4]	168	0	22.0	20.5	50(54%)	0	0
2009	36.52	0.18	20-May	21-May	157	4 (2.5%)	21.7	20.9	57(62%)	8(9%)	0
2010	48.88	0.70	Estimate 5-Aug	Estimate 5-Aug	138	7 (4%)	20.6	18.0	1(1%)	0	0
2011	62.15	1.58	29-Jul	29-Jul	83	60 (36%)	19.9	19.2	6(8%)	2(3%)	4
2012	34.35	0.75	18-Jul	18-Jul	106	17 (10%)	21.1	18.3	1(1%)	0	0
2013	36.2	0.91	Before 15-May	Before 15-May	168	0	21.7	20.4	40(43%)	0	0
2014	24.5	0.26	Before 15-May	Before 15-May	168	0	21.3	21.7	66(72%)	19(21%)	0
2015	35.5	0.34	1-June	1-June	152	N/A	23.6	21.1	78(85%)	11(12%)	0
2016	48.6	2.01	15-Aug	15-Aug	100	0	20.9	16.8	0	0	0

Source: 2NDNATURE

N/A not available, no monitoring performed, or limited data

[1] Precipitation data provided by the County of Santa Cruz from the Felton Diversion rain gage station.

[2] Hydrology data from USGS gage #11161000, San Lorenzo River at Santa Cruz, average Q integrated over one day.

[3] Air temperature data provided by the California Irrigation Management Information System (CIMIS) website (https://cimis.water.ca.gov/). Data represents an average of two weather stations: DeLaveaga station (#104) is located in Santa Cruz, CA at an elevation of 91.4 MSL and Pajaro station (#129) is located adjacent to the Pajaro River at 65 MSL.

[4] Already closed when monitoring initiated on May 15.

Even though the Laguna lagoon is relatively shallow, there appears to be temperature stratification with cooler water at depth during periods when no saline bottom layer exists. Conversely, when saline bottom water occurs after lagoon closure or after waves wash over the beach, the bottom water can be significantly warmer than the surface water. The most favorable conditions for juvenile salmonids generally occur in the upper part of the water column though conditions can be good to the bottom when the lagoon has no saline layer at the bottom. Daily maximum surface temperatures have ranged from 13.6°C to 28.0°C during the June to August period while daily average temperatures have ranged from 12°C to 22.5°C. The coolest temperatures have occurred during open lagoon conditions with tidal influence. The seven-day MWAT often exceeds 19°C in Laguna lagoon during the June-August period, ranging from 65 days (76%) in 2014 to 3 days (4%) or less in 2011, 2010 and 2012 (Table 2-3). This is a rather conservative criterion and does not account for potentially high food levels in Laguna lagoon that ameliorate the effects of higher temperature. For example, annual City abundance monitoring indicated that steelhead were thriving in the lagoon in 2009, 2014, and 2015 (HES 2010, HES 2015, HES 2016) despite frequent occurrences of MWAT over 19°C (Table 2-4 and Table 2-6). In each year, abundance was high in the fall; catch rates increased between June and September; juvenile steelhead entered the lagoon between June and September; steelhead present in June grew over the summer; and tagging indicated that most fish present in June were still present in September (HES 2010, HES 2015, HES 2016). While daily average temperature frequently exceeds 19°C it exceeds 21°C much less frequently. Lethal temperature has occurred in bottom waters under high salinity conditions but in surface water only briefly in 2011 (Table 2-3).

Continuous monitoring conducted annually in Laguna lagoon demonstrates significant diel and seasonal variation in DO at the surface (for example 2ND Nature 2009b). The available data indicate that there is substantial oxygen demand in Laguna Lagoon and that DO levels may often drop to critical levels for steelhead (Table 2-5). For example, there were a substantial number of days with DO levels declining to less than 5 mg/l at both the surface and bottom in most years (Table 2-5). It is likely that many of the low values result from daily oxygen cycling with nocturnal depletion through the process of respiration, but higher levels during the day generated by photosynthesis. Juvenile steelhead may be able to tolerate this daily cycling.

Table 2-5: Dissolved Oxygen Conditions from Continuous Monitoring Record in the Laguna Creek Lagoon in Comparison to Freshwater Inflow and Timing and Duration of Sandbar Closure

	Water Year precipitation (in)[1]	August Average daily inflow to Lagoon (cfs)[2]	Date of initial sandbar closure	Date of final sandbar closure	Number of days sand bar closed May 15 to Oct. 31 (168 days in period)	Number of days microtidal May 15 to Oct. 31 (168 days in period)[3]	Number of days with minimum daily surface DO 5 mg/ l or less (June-Aug)	Number of days with minimum daily bottom DO 5 mg/ l or less (June-Aug).	% of observations of surface DO <=7 mg/l (June-Aug).	% of observations of bottom DO <=7 mg/l (June-Aug).
2004	35.49	0.03	14-May	15-May	154	14 (8%)	N/A	N/A	N/A	N/A
2005	64.83	-0.34	10-May	6-July	112	21 (12.5%)	N/A	61	N/A	32
2006*	67.78	1.17	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
2007	25.4	0.38	Before 15-May	Before 15-May[4]	168	0	N/A	N/A	N/A	N/A
2008	39.6	0.25	Before 15-May	Before 15-May[4]	168	0	0	76	63	77
2009	36.52	0.18	20-May	21-May	157	4 (2.5%)	1	74	6	43
2010	48.88	0.70	Estimate at 5-Aug	Estimate at 5-Aug	138	7 (4%)	0	64	29	61
2011	62.15	1.58	29-Jul	29-Jul	83	60 (36%)	42	70	77	48
2012	34.35	0.75	18-Jul	18-Jul	106	17 (10%)	6	31	20	16
2013	36.2	0.91	Before 15-May	Before 15-May	168	0	16	3	75	19
2014	24.5	0.26	Before 15-May	Before 15-May	168	0	2	15	27	25
2015	35.5	0.34	1-June	1-June	152		0	55	80	63
2016	48.6	2.01	15-Aug	15-Aug	100	0	0	23	4	25

Source: 2NDNATURE

N/A not available, no monitoring performed, or limited data

[1] Precipitation data provided by the County of Santa Cruz from the Felton Diversion rain gage station.
[2] Hydrology data from USGS gage #11161000, San Lorenzo River at Santa Cruz, average Q integrated over one day.
[3] Microtidal conditions occur when the sandbar is partially present, reducing surface water exchange to every few days and water circulation within the lagoon is limited. It is determined using visual observations and the derivative of YSI depth data (dz/dt), using parameters established in CLEAP.
[4] Already closed when monitoring initiated on May 15.

Low DO levels can be a problem during lagoon breaching in the fall/early winter. This was observed both in 2004 and 2005 (2ndNature 2006). This may be due to turbulence during the breach event that mobilizes partially decomposed organic matter. A significant phytoplankton/macroalgae bloom during September and early October 2005 was also associated with increased organic matter loading, increased biological oxygen demand, and sustained low DO, low pH and low ORP values during late September early October (2ndNature 2006).

Lagoon Steelhead Habitat Conditions and Salmonid Abundance Surveys

Abundance of rearing juvenile steelhead has been measured in annual surveys in 2004 and 2005 (2ndNature 2006) and since 2008 (HES 2005a, HES 2009a, HES 2010, HES 2011a, HES 2012, HES 2013, HES 2015, HES 2016, HES 2017, HES 2018, HES 2019 and HES 2020). Coho were captured in June 2005 and largely disappeared from samples by the end of the summer (2ndNature 2006). A few coho were also captured in the lagoon in June 2020 but none were captured in the fall (HES *in draft*). Abundance of juvenile steelhead was estimated as catch per haul before 2011 except 2005 (Table 2-5) and by both catch per haul and by mark-recapture population abundance estimates since 2011 (Table 2-6). In 2005, population estimates of juvenile steelhead in the lagoon (based on recaptures of passive integrated transponder (PIT) tagged fish) ranged from a high of 2,449 in July to a low of 675 by November 2005 (2ndNature 2006). Mark-recapture estimates have not been possible for all surveys due to low abundance after early fall breach (2011) and open lagoon conditions in the spring of 2012 and 2015 and spring and fall of 2019.

Abundance has fluctuated from year to year and with season. Lowest abundances have been observed on a few occasions when the lagoon is open with low sandbar elevation or has recently closed at the time of the survey. It is likely that steelhead migrate between the lagoon and upstream areas during the rearing season and may leave the lagoon for upstream areas when lagoon conditions deteriorate. This is consistent with observations of steelhead migrating between lagoon and upstream areas in nearby Scott Creek (Hayes et al. 2011) and in the San Lorenzo River (HES 2017, 2018). In other years mark-recapture estimates reveal that steelhead were more abundant in the lagoon in the fall than they had been in spring as occurred in 2014, 2016 and 2018 (Table 2-6).

Table 2-6: Steelhead and Coho Catch per Seine Haul in Laguna Creek Lagoon at Consistently Sampled Sites

	Steelhead Catch per Haul				Coho Catch per Haul			
	June	Jul	Sep	Oct	June	Jul	Aug	Oct
2004		2.4	0			0	0	
2005	N/A	N/A	N/A	N/A	P		P	
2008	11		6		0		0	
2009	7		19		0		0	
2010	13			1.7	0			0
2011	19.8			0.1	0			0
2012	11.3		10.3		0		0	
2013	28		8.6		0		0	
2014	20		33		0			
2015	0.1			11.4	0			0
2016	1.1		5.2		0		0	
2017	42.8		14.5					
2018	14.3		6.5					
2019	17.0		2.5		0		0	

Source: data from HES 2005, HES 2009, HES 2010, HES 2011a, HES 2012, HES 2013, HES 2014a, HES 2015, and HES 2016, HES 2017, HES 2018, HES 2019, and HES 2020

NA- not available, measured as biomass

P- present, numbers not reported

Table 2-7: Steelhead Population Abundance Estimates in Laguna Creek Lagoon

	Steelhead Population Estimate	
	Spring	Fall
2011	300	No estimate
2012	No estimate	370
2013	499	259
2014	256	828
2015	No estimate	267
2016	45	136
2017	641	548
2018	193	242
2019	No estimate	No estimate

Source: data from HES 2012, HES 2013, HES 2014a, HES 2015, HES 2016, HES 2017, HES 2018, HES 2019, and HES 2020.

Growth rates of steelhead in Laguna Lagoon are variable but generally good. Growth rates measured by NMFS in 2005 (estimated from recaptures of PIT tagged fish) were highest early in the summer at ~0.8mm/day (n=6) and were still high by September and November, but had dropped to just over 0.5mm/day (n=52 and 39 respectively). These growth rates were consistent with those observed for steelhead in other Santa Cruz County lagoons in 2005 (2ndNature 2006). The majority of the population in the lagoon reached smolt size (~150mm FL) by November (2ndNature 2006). Growth rates have ranged from 0.43 mm/day to 0.99 mm/day since 2012. In the year with highest growth (2018) the lagoon was open intermittently through mid-July but was moderately deep with a perched outlet. There was a moderate abundance of larger (100mm to 180mm FL) juvenile steelhead present in June but only about a third remained in September (HES 2019). In addition, a large number of smaller juveniles entered the lagoon after June. In the two years with lowest growth rates (2013 and 2014) the lagoon closed before mid-May and remained closed all summer with relatively low inflow but suitable water quality (HES 2014a, HES 2015). Both years had large numbers of relatively large juveniles (150mm FL or greater) present in June. In 2013 abundance decreased over the summer but in 2014 it increased (Table 2-8). Excluding the two years with only one recapture (2012 and 2015), the second highest growth rates were in 2017, another year with open lagoon until mid-July. The sandbar was also relatively high in 2017 with resulting higher lagoon stage. June had the highest abundance of juveniles recorded in all the June surveys plus large numbers of YOY that were too small to tag and not included in the population estimate. Abundance of the larger size class declined substantially by September. Interestingly, one of the June-tagged fish was recorded at the PIT tag antenna at the Felton Diversion on November 17 (HES 2018). This fish would have had to enter the ocean from Laguna Lagoon before mid-July when the mouth closed, and enter the San Lorenzo River Lagoon, which was mostly open between mid-July and November (2ND Nature 2018). This observation suggests the potential disposition of other members of the class.

Table 2-8: Laguna Creek Lagoon Steelhead Tagged in June and Recaptured in September, Annual Averages

	Number Recaptured	Average Growth Rate (mm/day)	Average Growth (mm)	Fall CPUE*	June CPUE*
2012	1	0.86	83	10.3	11.3
2013	10	0.48	47	8.6	28
2014	72	0.43	42	33	20
2015	1	0.99	124	11.4	0.1
2016	0	NA	NA	5.2	1.1
2017	13	0.66	64	14.5	42.8

2018	23	0.99	104	6.5	14.3

* catch per unit effort (CPUE)

Laguna lagoon is capable of supporting relatively large numbers of rearing steelhead over the summer and producing smolt-size fish in a single growing season. Although temperature, DO, and salinity can all be at levels thought to be marginal for steelhead, they appear to grow and survive quite well, likely due to an abundance of high-quality food organisms. Conditions for rearing steelhead appear to be much improved by the interim flow bypasses implemented since 2007.

2.4.2.3 Habitat Conditions Majors Creek

Majors Creek supports populations of steelhead and resident rainbow trout. Majors Creek is not considered potential habitat for coho under current conditions in the Coho Recovery Plan (NMFS 2012). Juvenile coho were observed in Majors Creek during annual snorkel surveys conducted by the City in 2020, the first time since surveys were initiated in 2006 (Berry et al. 2019). Juvenile coho were also observed in Laguna Creek in 2020. Numbers observed in Majors Creek were low relative to juvenile steelhead and this occurrence is considered transient. For the purposes of the HCP, Majors Creek is not considered potential coho habitat.

Watershed/hydrology

Majors Creek is a second order stream that flows into the Pacific Ocean along the North Coast area of Santa Cruz County. The elevation of the watershed ranges from sea level at the mouth to approximately 1800 feet at its headwaters near Felton peak. The watershed area is 5.9 square miles and the approximate stream channel length from the mouth of Majors to its headwaters is 5.9 miles. The City diversion on Majors Creek has a capacity of about 2.1 cfs and is located approximately 2.2 miles upstream from the mouth of Majors Creek. The average channel gradient from the diversion to the mouth is about 3 percent, although there are steeper sections, including a very steep section forming the limit of anadromy about 0.7 miles upstream from the mouth. The channel gradient upstream of the diversion to the headwaters averages approximately 6 percent (ENTRIX, Inc. 2004b). There are numerous small springs and seeps that contribute to Majors Creek downstream of the City's diversion, but there are no substantial tributaries (ENTRIX, Inc. 2004a).

There are at least four known non-City operated diversions on Majors Creek (ENTRIX, Inc. 2004b). Three diversions, operated by a private diverter, are located in the anadromous reach just upstream of the Highway 1 crossing. These diversions consist of two pumps with 2-inch

diameter intake pipes and a subsurface perforated pipe and they likely represent the most significant non-City diversions in the Majors Creek watershed (ENTRIX, Inc. 2004b). There are also diversions upstream of the City diversion (Chris Berry, personal communication to Kindra Loomis, 2004, cited in ENTRIX, Inc. 2004b). Production numbers and season of diversion for the non-City diversions are unavailable and their impacts on Majors Creek hydrology are unknown. No rigorous effort has been undertaken to identify or quantify all diversions from Majors Creek. This assessment is based on available observations and information and is not necessarily a comprehensive accounting of all non-City diversion facilities (ENTRIX, Inc. 2004b). The City has no definitive documentation on the status of the water rights for these diversions, however it is known that their validity is questionable given the inaccuracies and lack of document in the SWRCB e-WRIMS database and the fact that the City possesses the senior appropriative water right and controls riparian rights downstream of its diversion.

Upstream of the anadromous barrier located about 0.7 miles upstream from the mouth (see following section), the channel has a high gradient, as exemplified by a cascade and step-pool bedform with the dominant substrate alternating between boulder and sand (ENTRIX, Inc. 2004b). The channel has a low width-to-depth ratio, and is well-entrenched (i.e., vertically contained within the valley), with little opportunity for over-bank flows (ENTRIX, Inc. 2004b).

In the anadromous reach, downstream of the boulder cascade section, the channel gradient decreases and the channel becomes less entrenched as the valley walls widen. Large Woody Debris (LWD) and debris jams are found throughout this reach (ENTRIX, Inc. 2002, ENTRIX, Inc. 2004a, HES 2014b). Recruitment of LWD in Majors Creek may be in part due to the presence of late-succession forest (not logged for several decades) upstream of the City's diversion location, as well as the steep banks and canyon walls, which encourage tree falls. The area downstream of the City diversion was logged approximately 100 years ago, or possibly more recently, but appears to have more wood recruitment and/or less removal than other adjacent watersheds (Chris Berry, personal communication to Kindra Loomis, cited in ENTRIX, Inc. 2004b). Much of the LWD in Majors Creek is large diameter redwood and Douglas fir tree trunks that have fallen into the creek. In some locations LWD plays a key role in retarding the downstream movement of excessive fine sediment with deep pockets of sand found upstream of debris jams. LWD was much more prevalent in the non-anadromous reach of the stream than in the anadromous reach (ENTRIX, Inc. 2004b).

The dominance of sand substrate in pools, high embeddedness of riffles, and sand deposition in the lee of boulders and LWD are all indicative of a transport-limited system, where the sediment supply is greater than the capacity of the stream to transport the sediment load (ENTRIX, Inc. 2002). A large portion of the Majors Creek watershed is underlain by the Santa Margarita formation, which is composed of friable, fine to very coarse-grained sandstone (Brabb et al. 1997

cited in ENTRIX, Inc. 2004b). A substantial amount of the watershed upstream of the City's diversion is privately held and was historically logged for timber production. Old logging roads remain in several places in the watershed. These factors likely contribute to high fine sediment loads evident throughout the Majors Creek system (ENTRIX, Inc. 2004b). About 2,000 feet below the City's diversion, Majors Creek begins flowing through a zone dominated by igneous, quartz diorite rock. The quartz diorite is more resistant to erosion relative to other rocks within the North Coast Unit, and leads to a more confined, steep valley wall section with a high gradient (ENTRIX, Inc. 2004b). It may also serve as a good source of gravel, which was evident in the anadromous reach during habitat characterization conducted in 2003 (ENTRIX, Inc. 2004b).

Instream Habitat

Migration Barriers

The upstream limit of anadromy in Majors Creek is a natural migration barrier about 0.7 miles upstream of the mouth formed by a short reach (0.15 mi) of extremely steep (>10 percent gradient) bedrock and boulder cascades (Hagar et al. 2017a). Entry of steelhead to Majors Creek, as for the other north coast streams, is regulated by opening of the mouth, generally under the combined influence of winter tidal and swell conditions and increased inflow resulting from winter storms. The creek enters the back beach area confined between a raised parking area and a small topographic high point at the center of the back beach area (ENTRIX, Inc. 2004a). The available area for lagoon formation is very small and it is likely that early winter flows are sufficient to crest the beach and open the creek mouth. A local landowner reports that the sandbar stays open most of the winter and is breached during the summer by high tides and wave action (Chris Berry, personal communication to Kindra Loomis, 2004 cited in ENTRIX, Inc. 2004a).

Once upstream of the lagoon, migrating adult salmonids face few obstacles to migration in Majors Creek until the boulder fall 0.7 miles upstream. The creek was rerouted through a tunnel in the bluff at the south edge of the valley when the valley was filled for the Highway 1/railroad corridor. There is a shallow cross-section at the upper edge of the tunnel that may impair fish passage at lower flows. There is also a wide, steep riffle, just upstream from one of the lower diversions that also poses an obstacle at lower flows.

Three critical riffle cross-sections were evaluated during the winter of 2006-2007 using the

Thompson methodology[17] (HES 2014b). Passage criteria for adult steelhead (a depth of at least 0.6 feet across at least 10% of the cross-section) were met at flows of 10.2 cfs and 12.4 cfs at critical riffles and at a flow of 8.7 cfs at the Highway 1 apron. The most critical riffle section is the furthest upstream, just above the diversion location a few hundred feet upstream of the Highway 1 culvert.

Downstream migration of smolts can also be influenced at the shallow cross-sections evaluated for adult passage. Smolt migration typically occurs in April, May, and possibly into June, but is influenced by stream flow and conditions at the mouth. Using 0.3 feet as a minimum depth criteria for downstream smolt migration and using the same three critical riffle sections as for the adult analysis, smolt passage criteria would be met at flows of 1.8 to 2.9 cfs in Majors Creek (HES 2014b).

Spawning Habitat

As previously described, a large portion of the Majors Creek watershed is underlain by the Santa Margarita formation. In addition, the watershed was formerly logged, and both the underlying watershed material and logging activity contribute to high delivery of fine sediment to the anadromous reach (ENTRIX, Inc. 2004a). Substrate in the anadromous reach is predominantly sand (greater than 50 percent in most habitat units) and gravel with some bedrock, boulders, and large cobble (ENTRIX, Inc. 2004a). Gravels suitable for spawning are distributed sporadically within the anadromous reach and are fair quality (ENTRIX, Inc. 2004a). The primary limiting factor for spawning habitat in the anadromous reach is the limited availability of spawning gravels in the pool tails (ENTRIX, Inc. 2004a).

During a spawning flow assessment in the winter of 2006-2007, HES located four study sites in potential spawning habitat in the anadromous reach of Majors Creek (HES 2014b). Substrate at these sites was rated as moderately to highly suitable based on the Bovee system (Bovee 1978, see also Table 2-1). Substrate suitable for spawning at these sites consisted primarily of sand/gravel mixtures or gravel/cobble mixtures with high proportions of gravel. Lower suitability ratings were generally the result of excessive sand. Cobble rarely made up more than 30% of the substrate at these locations and gravel was generally at 70% to 90%.

Suitability of habitat for salmonid spawning is partially dependent on flow and, as such, can be altered by the City diversion. HES conducted an assessment of the relationship between flow

[17] As of 2012 the preferred method of critical riffle analysis (CRA) was updated by CDFW (CDFW 2012). The CDFW CRA has the same theoretical basis as the Thompson method but provides greater detail and clarity on methods.

and spawning habitat quality for steelhead and coho using PHABSIM (HES 2014b, Appendix 3: *Flow Studies*). The spawning habitat assessment was completed by measuring hydraulic conditions at 4 sites in the anadromous reach of Majors Creek and constructing computer models to predict changes in water depth, velocity, and substrate with discharge (HES 2014b).

The results of the habitat analysis for Majors Creek indicate that the spawning suitability index increases rapidly as flow increases from about 2 cfs and peaks at a flow of about 16 cfs (HES 2014b). Flows of 12 and 24 cfs provide 80% of the peak spawning suitability index for steelhead. Flows higher or lower than these levels result in increased frequency of depth, velocity, and substrate conditions that are outside the suitable range as defined by habitat suitability criteria used for steelhead or coho spawning (HES 2014b).

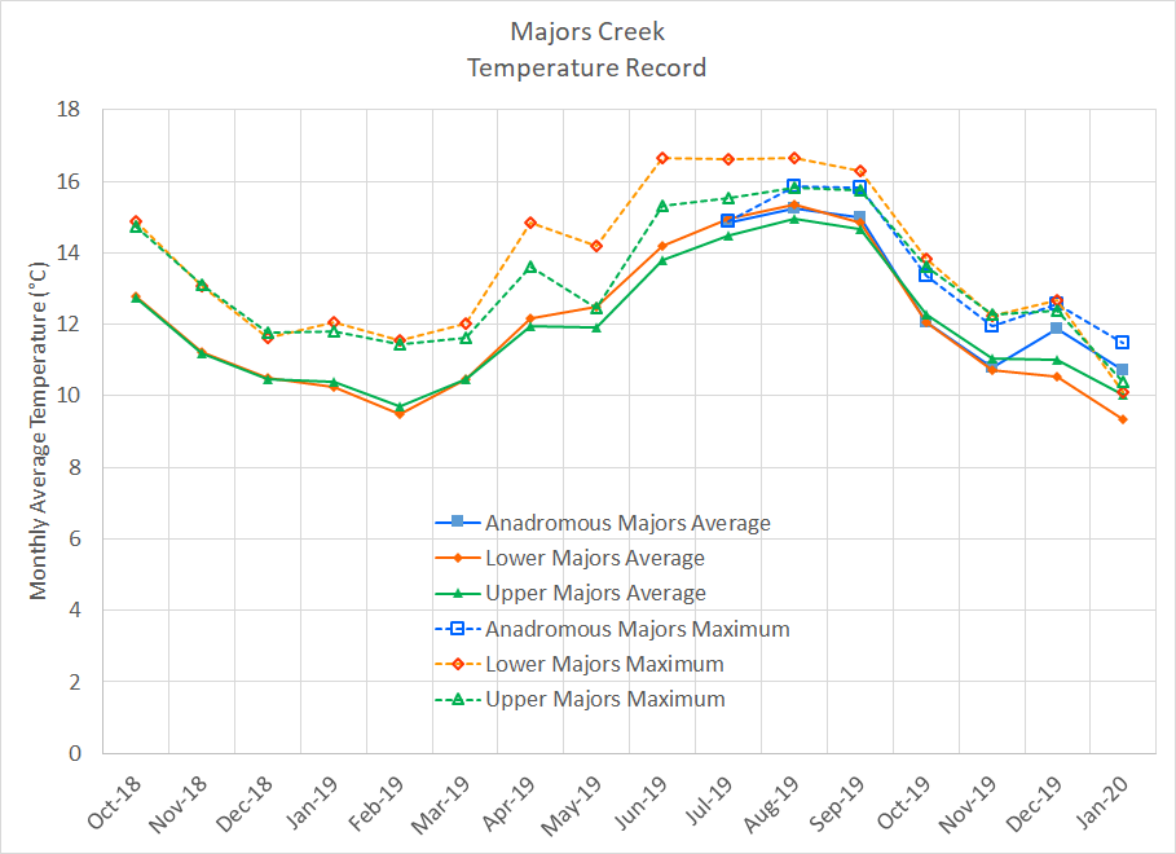
Rearing Habitat

The anadromous reach of Majors Creek provides relatively good quality rearing habitat with well-developed pools (Kawamoto Environmental Services (KES) 2001; ENTRIX, Inc. 2002, ENTRIX, Inc. 2004a). At a flow of approximately 0.8 cfs in the anadromous reach, without the City's diversion in operation, ENTRIX, Inc. (2004a) found habitat proportions in this reach were 60 percent pools, 37 percent runs, and 3 percent riffles. Extensive cover is available throughout the reach consisting of terrestrial vegetation, some boulder and cobble, and undercut banks (ENTRIX, Inc. 2004a). Mean pool depth was 0.9 feet and maximum pool depth averaged 1.8 feet (ENTRIX, Inc. 2004a). Observations by ENTRIX, Inc. (2002) in 2001 noted a few backwater pools with woody debris, which may provide high-flow refuge. Pools with openings in the canopy provided most of the suitable habitat for salmonids, where YOY and juveniles may feed efficiently by sight. The riffles in the anadromous reach tended to be short and heavily shaded (ENTRIX, Inc. 2004a).

Temperature monitoring data collected by the City indicates good water temperature conditions for rearing salmonids[18] (Figure 2-5) and comparable conditions to both Liddell and Laguna Creeks (Figure 2-1, Figure 2-2). Monthly average water temperature readings recorded from October 2019 through January 2020 peaked between June and September at 14°C to 15°C with monthly maximums peaking at 15°C to 17°C (Figure 2-2).

[18] See section 2.4.2.1 and HES 2014b for discussion of temperature tolerance for steelhead and coho.

Figure 2-5: Water Temperature in Majors Creek



During the winter of 2006-2007, HES conducted an assessment of the relationship between flow and rearing habitat quality using PHABSIM (HES 2014b, Appendix 3: *Flow Studies*). The rearing suitability index for steelhead increases gradually as flow increases from minimum levels and only begins to level out at the highest simulated flows of 18 to 20 cfs (HES 2014b). The rate of increase in the suitability index for steelhead rearing decreases with increasing flow and a flow of 5.5 cfs provides about 80% of the rearing suitability index for steelhead as that provided at a flow of 18 cfs. See Appendix 3: *Flow Studies*.

Lagoon Habitat

In a survey in June 2001, ENTRIX, Inc. (2002) found the Majors Creek Lagoon to be small, shallow, and with a sandy bottom devoid of any cover elements and concluded that the lagoon did not provide good rearing habitat for steelhead. PWA (2004) found the lagoon to be a small ponded area on the beach, approximately 5,000 square feet and only about 3 to 6 inches deep.

There was no open outlet to the ocean and inflow into the ponded area was very small at the time of the survey (August 26, 2003). The available area for lagoon formation is very small and during late summer the lagoon on Majors Creek is about 0.1 acres (ENTRIX, Inc. 2004a). Based on this information, it is expected that the lagoon at the mouth of Majors Creek does not provide significant rearing habitat for steelhead.

2.4.3 San Lorenzo River Watershed Unit

The San Lorenzo River Watershed Unit is located within the larger San Lorenzo Watershed. Steelhead are present throughout this unit, except for portions of Newell Creek that may be inaccessible due to the presence of bedrock ledges (HES 2014b). The San Lorenzo River Watershed Unit is near the southern boundary of the Central California Coast Coho ESU. While small numbers of hatchery and wild coho have been observed in the trap at the Felton Diversion in past years, (possibly strays from nearby drainages with more persistent runs, including San Vicente, Scott and Waddell Creeks) coho have been presumed to be functionally extirpated from the San Lorenzo River since the drought of the late 1980s (Alley et al. 2004). A few coho were documented during 2005 in lower Bean Creek (DW Alley and Associates 2007) and two coho YOY coho were found the same year in Zayante Creek near the Bean Creek confluence (HES 2005c). Young of the year coho were also observed in snorkel surveys conducted by NMFS in Bean Creek that year (Chris Berry, City of Santa Cruz, personal communication to Jeff Hagar 2005). More recently, a coho carcass was found during spawning surveys in Bean Creek in 2015 (Jon Jankovitz, CDFW, personal communication to Chris Berry, 2020). The San Lorenzo River is considered potential habitat for coho and is managed accordingly. The majority of potential spawning and rearing habitat for coho is in the tributaries and upper mainstem, with the middle and lower mainstem serving primarily as a migration corridor.

2.4.3.1 Habitat Conditions San Lorenzo Mainstem

The San Lorenzo River watershed has a total drainage area of approximately 138 square miles. Suburban residential development in the watershed is extensive and urbanized areas occur along Highway 9. Land use authority for this development resides with the County of Santa Cruz and the City of Scotts Valley as of the late 1990s. Other land uses that occur within the basin include private timber harvesting, quarry activities, agriculture, and ranching operations. There are large tracts of state and municipal parks and recreation areas in the San Lorenzo River watershed. Streams in the San Lorenzo River watershed supplied water to over 100,000 residents in unincorporated communities and the cities of Santa Cruz and Scotts Valley (County of Santa Cruz 2001). Numerous municipal surface water diversions and groundwater wells, as well as

other riparian and appropriative diversions, are scattered throughout the watershed (ENTRIX, Inc. 2004b).

Watershed/hydrology

The San Lorenzo River is a fifth order river flowing primarily to the south, which drains into the Pacific Ocean at the City. The elevation of the watershed ranges from sea level at the mouth to approximately 2700 feet at its headwaters. The approximate stream channel length of the mainstem from the mouth to its headwaters is 27.75 miles, of which there are approximately 26 miles of potential anadromous habitat. In addition, there are approximately 57 miles of anadromous habitat in tributary streams (ENTRIX, Inc. 2004b). See Figure 1-7: San Lorenzo Watershed Map.

The San Lorenzo River watershed has historically been a source of timber, minerals, recreation, and water resources. Since the 1950s, growth in the fulltime residential population, and related housing and infrastructure development has led to increased erosion and stream sedimentation, nutrient loading, stream flow reduction and habitat loss, water quality degradation and demand for water supplies (County of Santa Cruz 2001). In the 1970s, the watershed experienced a high rate of residential development, peaking at some 3,300 new units. The aggressive development contributed to water quality degradation from inadequate septic systems and urban runoff, increased levels of erosion and sedimentation, and alteration of wet and dry season runoff patterns (ENTRIX, Inc. 2004a). Negative impacts from urbanization are apparent throughout the lower San Lorenzo River watershed resulting in decreased habitat quality for salmonids (Alley et al. 2004).

Sedimentation from high levels of erosion can impair fish habitat and sedimentation has been identified as a significant negative impact on salmonid habitat quality in the San Lorenzo River since 1940 (California Department of Water Resources 1958, as cited in Swanson Hydrology & Geomorphology ((SH&G) 2001a). The San Lorenzo River Watershed Management Plan update reported that the greatest threat to aquatic habitat in the San Lorenzo is sedimentation (County of Santa Cruz 2001). A Regional Water Quality Control Board (RWQCB) staff report (RWQCB 2002) also identified sedimentation as the primary impact to aquatic habitats in the watershed. The San Lorenzo River is currently on the California 303(d) list for sediment impairment (ENTRIX, Inc. 2004b). In 2002 the Central Coast RWQCB adopted a Total Maximum Daily Load Plan (TMDL) for sediment in the San Lorenzo River (RWQCB 2002). Bed sedimentation has been reported by CDFW during stream surveys conducted in 1966 and in 1972 (ENTRIX, Inc. 2004a). Stream inventory surveys in San Lorenzo River tributaries conducted by CDFW in 1996 and 1997 reported the continued presence of extensive streambed sedimentation and numerous streamside sources of erosion (ENTRIX, Inc. 2004a). Work by Balance Hydrologics

(1998) indicated that the level of sedimentation in the San Lorenzo River had not improved since 1979 even though many erosion control measures had been implemented throughout the watershed and the pace of new development since the late 1970s had slowed considerably. Recent RWQCB work indicated improvements in several tributaries as of 2009 (Herbst, Medburst, Roberts, and Moore 2011), however this may not reflect current conditions subsequent to the historic storms of 2017. During the winter of 2017, the watershed experienced many landslide events and sediment transport was at a magnitude not seen since 1998 or earlier (East et al. 2018). In many stream reaches this translated as an overall coarsening of the bed, but in other stream reaches aggradation and subsequent embeddedness and pool filling occurred (Berry personal observation 2017).

Sources of sedimentation in the San Lorenzo River watershed appear to include both natural and anthropogenic processes. Extensive development in the sandhills geologic formations of the eastern side of the San Lorenzo watershed (e.g., Zayante Creek, Bean Creek and Carbonera Creek watersheds) has been implicated in substantial erosion and sedimentation in the lower portions of these tributaries as well as the middle and lower reaches of the San Lorenzo River (County of Santa Cruz 2001, Alley et al. 2004). Roads have been identified as likely primary sediment sources in other studies with unpaved or poorly maintained roads as the most persistent sources (Balance Hydrologics 1998, SH&G 2001a). Other sources of sediment include land clearing, disruption of riparian habitat, bank erosion, and landslides (ENTRIX, Inc. 2004a). A RWQCB staff report (RWQCB 2002) attributed 42% of the sediment loading to mass wasting, 29% to roads (including those associated with timber harvest activities), 15% to rural and urban lands, 14% to channel and bank erosion, and 0.4% to timber lands. According to the RWQCB (2002), the San Lorenzo River watershed is geologically pre-disposed to mass wasting with its steep slopes, high rainfall, and highly erosive geological formations (e.g. the Santa Margarita Formation). However, anthropogenic activities such as road building and construction activities can facilitate this process.

Nutrient loading is also an important issue for the San Lorenzo River. The issue of nutrient enrichment is particularly important for its effects in the San Lorenzo River Lagoon. Eutrophication of the lagoon affects rearing juvenile steelhead through effects on trophic relationships and water quality, including DO dynamics. Santa Cruz County adopted the San Lorenzo Nitrate Management Plan in 1995. The plan was used to develop an understanding of nitrate sources and transport. The plan findings and recommendations form the basis for the Nitrate TMDL Plan that was adopted by the Central Coast Regional Water Quality Control Board in 2000 (County of Santa Cruz 2001). The plan provides recommendations intended to reduce then current (2001) nitrate levels by 15 to 20 percent by 2010, with an additional 10 percent reduction in the following 10 years. Nutrient loading to the estuary may play a significant role in the quality and suitability of the estuary for steelhead rearing habitat (SH&G

2003) (ENTRIX, Inc. 2004b). According to a 2008 status report, observed nitrate trends show that reductions are occurring at a slower pace than desired, with an 11% decrease over the past 15 years. San Lorenzo River nitrate levels at Big Trees and the Tait Street Diversion during the period 2011-2017 also appear to be dropping slightly while they have risen slightly at Loch Lomond Reservoir (Kennedy Jenks Consultants, Inc. 2018). Ben Lomond and Boulder Creek sites have also experienced significant reductions of up to 60% recently. Although the 2008 status report suggested that "no significant adverse impacts resulting from nitrate loading at the current level have been identified" (Santa Cruz County 2008), given the potential effects on lagoon and riverine pool habitat eutrophication and on water storage at Loch Lomond Reservoir, nitrate trends will continue to be a consideration in the course of fisheries conservation planning.

The human population in the San Lorenzo River watershed relies exclusively on local surface water and groundwater supplies and water extraction is also an important factor in the health of aquatic habitats. Water demand is high enough during the dry season that the San Lorenzo River Watershed has been classified as fully appropriated for water supply between the months of June and October by the California State Department of Water Resources (ENTRIX, Inc. 2004b). A reduction in surface flow likely results in the reduced availability of spawning and rearing habitat in the tributaries and in the San Lorenzo River (County of Santa Cruz 2001, Alley et al. 2004).

In addition to the City's diversions, several other special districts or companies obtain water within the watershed (ENTRIX, Inc. 2004b) including:

- San Lorenzo Valley Water District (SLVWD) operates diversions on Fall, Lompico, Foreman, Harmon, and Peavine creeks, several springs and also operates several wells in the Santa Margarita aquifer; and
- There are more than 130 additional individual, private surface water diversions. See Figure 1-7: San Lorenzo Watershed Map.

In addition, groundwater pumping in the Bean Creek, Zayante Creek and Carbonera Creek watersheds is believed to influence baseflow in these streams and the San Lorenzo River (Alley et al. 2004). More recent observations indicate that flow in Bean Creek has been reduced 0.2-0.5 cfs by groundwater pumping (John Ricker personal communication to Chris Berry, 2019).

Instream Habitat

Migration Barriers

The entire Plan Area (Figure 1-1) in the San Lorenzo River mainstem is within the limits of anadromy for steelhead and coho. The limit of anadromy on Newell Creek is a short distance downstream of Newell Creek Dam and is discussed below. Migration past natural and anthropogenic passage obstacles in the San Lorenzo River mainstem may limit access by steelhead and/or coho to portions of the San Lorenzo Watershed, particularly in dry years or as a result of stream diversions. The following passage obstacles have been identified in previous work:

- Shallow riffles in the lower river downstream of the Tait Street Diversion
- Four Rock boulder field in the gorge
- Rincon Riffle in the gorge
- Shallow riffles in the vicinity of Henry Cowell State Park
- Felton Diversion Dam

Passage obstacles in the lower and middle mainstem of the San Lorenzo River (downstream of the Felton Diversion) are potential limiting factors for the entire River since they can restrict access to important spawning habitat in the tributaries (Alley et al. 2004). Good quality spawning habitat may be limited in the lower and middle River, so access to higher quality tributary spawning habitat upstream of the Felton Diversion is important to steelhead and coho abundance in both the mainstem and the tributaries (Alley et al. 2004). City operations may affect passage at some of these obstacles, either by reducing water in the river, or by the presence of physical structures associated with City facilities. The following describes what is known about flows necessary for salmonid migration at each of these obstacles.

The San Lorenzo River downstream from the Tait Street Diversion has been altered by urban development and for provision of flood control. Under low flow conditions, riffles in this reach can become very shallow and pose an obstacle to migrating steelhead and coho. The City diversion is limited in capacity but there are no required bypass flows downstream of the facility. During dry conditions, the flow in this reach and migration of steelhead and coho can be severely restricted. The relationship between flow and passage criteria (depth) in the 1.4 mile section from the Tait Street Diversion to the lagoon (roughly at Water Street) was evaluated by HES (2014b) through application of standard procedures commonly referred to as the Thompson method (Bjornn and Reiser 1991, Thompson 1972).

At four critical riffles in this reach, HES (2014b) determined that flows below the Tait Street Diversion between 17 and 25.2 cfs would provide conditions meeting standard depth criteria for adult migration (0.6 feet across 25% of channel width). Depth criteria for emigrating smolts would be met at flows of 3.8 to 10 cfs at the Tait Street Diversion (0.3 feet across 25% of channel width) (HES 2014b).

The Four Rock boulder field and Rincon Riffle in the San Lorenzo Gorge have been evaluated on several occasions. In most years, these locations are not passage problems, however, in drought years and years when storms are delayed, they can be serious barriers to steelhead and especially coho spawning migration (DW Alley & Associates 2009). Alley et al. (2004) estimated that flows of approximately 50-70 cfs would be required to meet passage criteria under the conditions observed in 2002. The assessment was based on the assumption that a minimum depth of 0.6 feet across 5 contiguous feet of channel width would be sufficient for adult passage (Alley et al. 2004). Alley also estimated that a flow of 35 cfs was probably sufficient to allow adult salmonid passage through the Gorge at all but these two sites.

During habitat surveys in 2008, it was discovered that the steep cascade at the base of the Rincon riffle had been altered by high flows and that conditions were much improved for fish passage up the main channel (DW Alley & Associates 2009). A project was also implemented by the Santa Cruz County Resource Conservation District in 2008 to alter the Four Rock barrier to improve conditions for fish passage.

The City conducted subsequent work based on the Powers and Orsborn methodology (Powers and Orsborn 1985) and showed that passage at the Four Rock site was likely possible by both coho and steelhead adults at 47 cfs since pool depths, jump distances, jump heights, high velocity reach lengths and water velocities were all within the capabilities of both species at this flow (Berry 2016).

Migration passage conditions were evaluated by CDFW biologist Paul Chappell who estimated that at a flow of 20 cfs, shallow riffles in the vicinity of Henry Cowell Park serve as partial barriers to migration while at 12 cfs they are complete barriers. The CDFW assessment concluded that a minimum flow of 40-50 cfs is needed to preserve the anadromous fishery (Ricker and Butler 1979).

At the request of the HCP Technical Team in 2016, the City also applied a desktop method utilized by CDFW (R2). The R2 results were comparable to the results of the Powers and Orsborn method and to results of the Thompson method at other sites, and to the conclusion of Chappell (Ricker and Butler 1979). The R2 estimate for suitable bypass flow for the San Lorenzo River in the vicinity of Four Rock was 39 cfs. This is consistent with the passage flow

estimate of 40 cfs presented in the San Lorenzo Watershed Management Plan (based on Ricker and Butler 1979). This estimate is also consistent with the observation of large juvenile steelhead (to 316 mm FL) moving from the San Lorenzo River Lagoon upstream past the Felton Diversion during summer 2016 at flows of 26 cfs or less (Berry 2016). The analysis concluded that a flow of 39 cfs appears to be a reasonable adult migration flow estimate for the San Lorenzo River below the Felton Diversion. Since adult migration is usually the life stage requiring the most flow, this bypass flow should be protective of other life stages as well. These findings were accepted by the HCP Technical Team.

The Felton Diversion Dam may have caused passage difficulties at certain streamflows in the past. In 1994, CDFW raised concerns that adult fish may have trouble swimming over the dam when streamflow was low and the dam was deflated and that when streamflow was high, spill over the inflated dam may reduce the effectiveness of fish ladder attraction flows (ENTRIX 1997). The City, in coordination with CDFW, developed operating procedures to address these concerns (Appendix 4: *Felton Diversion Memoranda of Agreement (MOA)*).

The Felton Diversion is fitted with a Denil style fishway. The current operating practice allows for fish passage through the Denil fishway when the dam is inflated and passage over or around the dam when it is deflated. During the period from June through August when there is no diversion and when flow is less than 40 cfs during the diversion season, the dam is not inflated. During these periods all fish passage is over the deflated dam or around the deflated dam through the pumping channel. The MOA calls for inflation of small air bladders under both ends of the deflated dam to concentrate streamflow near the center of the deflated dam and provide a flow depth of at least 8 inches during the period of November 1 to June 15. Additionally, the dam is rarely inflated prior to mid-December due to operational constraints. At flows of approximately 300 cfs or greater, there was concern that the flow through the fish ladder is reduced relative to spill over the dam and insufficient to attract fish to the ladder. The MOA calls for supplemental attraction flow at flows greater than 300 cfs provided by partially opening a slidegate next to the fishway. If flow in excess of 300 cfs persists for 5 days and fish are observed holding below the dam, the dam is partially deflated to allow adult steelhead and coho to more easily leap over the dam.

The Denil fishway consists of several 4-foot-wide fabricated metal chute modules featuring incrementally spaced baffles of standard configuration. Typical of roughened chute style fishways, the baffles produce shear stress at the water column boundaries in a manner which generates high momentum exchange/energy dissipation and suitable hydraulic conditions conducive to fish passage (Buller 2006). The existing fish ladder is vertically aligned with a 16.7% slope or profile from entrance to exit. Wood Rogers calculated its maximum capacity at approximately 70 cfs at the maximum forebay water surface elevation (WSE) of El. 242.50.

During operations when the forebay water surface is at the top of the inflatable dam (Forebay WSE = 240.50), the fishway conveys approximately 25 cfs (Buller 2006).

The Denil fish ladder design was conceived in the early 1900s and further developed through the 1930s and 1940s (Fulton et al. 1953). An early limited side-by-side comparison of a Denil fish ladder and a more widely used pool and weir fishway was conducted by the U.S. Fish and Wildlife Service (USFWS) in the Wenatchee River (Fulton et al. 1953). The USFWS study found the Denil ladder was preferred by fish migrating during two migration seasons in the Wenatchee River. Fish species using the Denil ladder included sockeye salmon, Chinook salmon, rainbow trout, Dolly Varden trout, suckers, and pikeminnow. A comprehensive review of fish passage by the Food and Agriculture Organization (FAO) concludes that the success of Denil passes has been adequately proven for salmonids and cyprinids but that, from a more holistic ecological perspective, smaller fish and invertebrates including benthic macroinvertebrates that can ascend other types of ladders are excluded (FAO 2002). An advantage of the Denil pass is that it usually forms a good attraction current in the tailwater and is relatively insensitive to variations in tailwater elevation. However, suitable functioning of the Denil pass is highly susceptible to variation in the headwater level. Like many types of ladders, the Denil requires regular maintenance as clogging with debris can disrupt functionality. The FAO concludes that Denil passes should only be used where other structures cannot be built, for example due to lack of space, remoteness, or difficult access.

Spawning Habitat

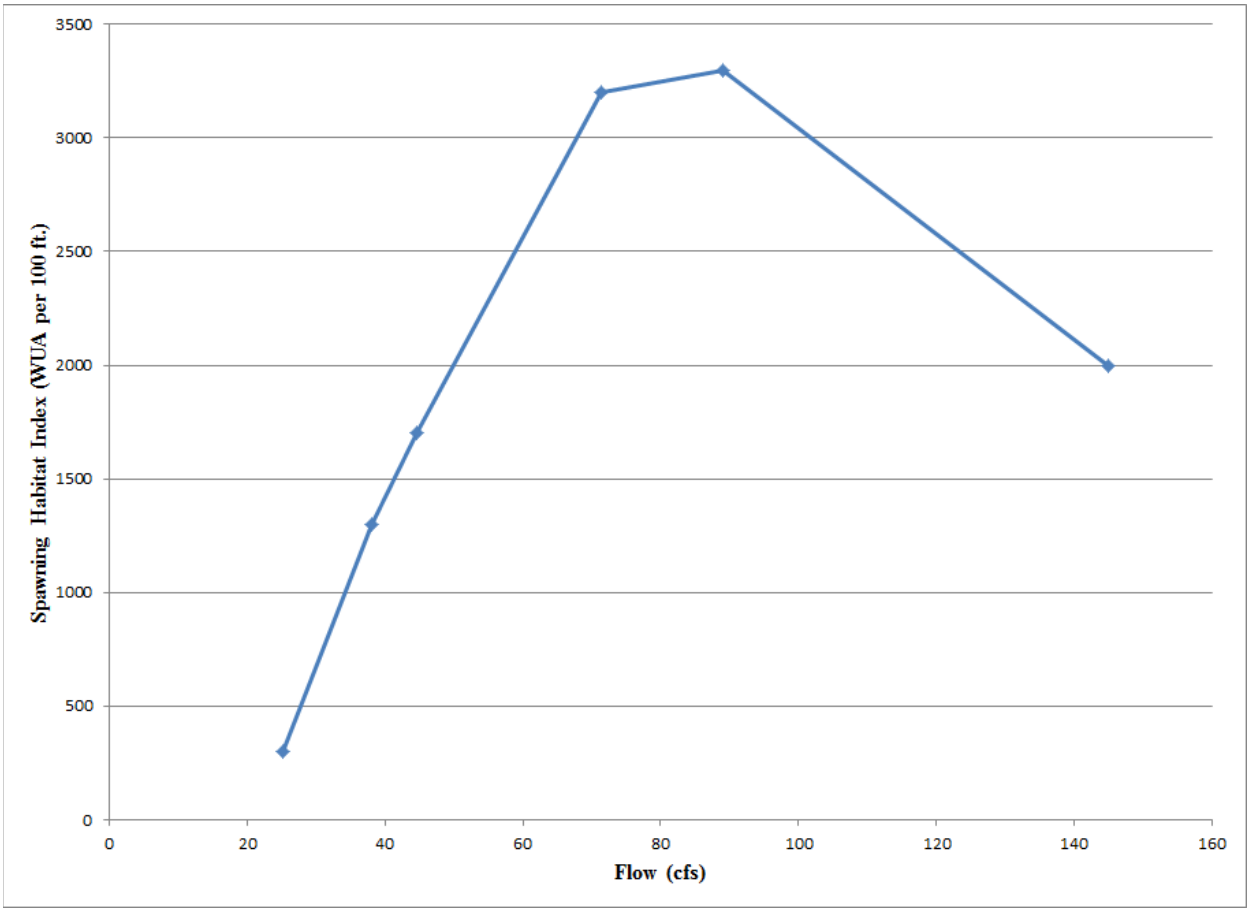
The quality of spawning habitat varies greatly throughout the San Lorenzo River. Generally, spawning habitat quality is high enough, particularly in the tributaries and upper river, to allow returning fish to saturate the available habitat with fry (Alley et al. 2004). Spawning conditions in the middle and lower mainstem are poorer than other areas (Alley et al. 2004). According to Alley et al., the primary causes of poor quality spawning habitat or limited success of emerging fry are excessive fine sediment in spawning gravels that limit use of impaired areas by adult fish or cause egg or alevin mortality after spawning has occurred, and mobile bed conditions that result in loss of redds after spawning has already occurred. In the lower and middle River, poor spawning conditions exist due to the input of high fine sediment loads from tributary streams such as Boulder, Bear, Kings, Zayante, and Bean Creeks (Alley et al. 2004):

> Fine sediment from these tributaries is deposited in the lower gradient reaches, increasing the fraction of fine sediment at the terminus of pools where spawning gravels are typically found. High amounts of fine sediment deposition in the lower and middle river forces spawning adults to use areas dominated by sand that become mobile during late winter and early spring high flow events. In the case of tributaries, the variability of

gradient and structural elements such as bedrock outcrops and large woody material may allow for good quality spawning habitat to exist in localized patches even if high fine sediment loads are present. Hydraulic variability created by these flow separators or constrictors allows fine sediment to be sorted and removed from certain locations, leaving higher quality gravel beds in their place that can be sought out by adult fish. (Alley et al. 2004)

Streamflow may also have some effect on the availability of spawning habitat. Ricker and Butler (1979) conducted instream flow studies to evaluate habitat conditions for steelhead in the San Lorenzo River and its tributaries. This work used a methodology that was a predecessor to the PHABSIM modeling used to develop bypass flows for the HCP. Data provided in Ricker and Butler (1979) for the reach near Henry Cowell Park indicates very low values of the suitability index at 25 cfs, a steep increase to a peak at 70 to 90 cfs, and a fairly steep decline from 90 cfs to about 60% of optimum at 145 cfs (Figure 2-6).

Figure 2-6: Relationship Between Flow and Spawning Habitat (WUA) Downstream of the Felton Diversion



Source: derived from data in Ricker and Butler 1979

Another indicator of flows that support good spawning habitat comes from the relationship between optimum[19] spawning flow and adult migration flow derived through PHABSIM studies in other streams in the Plan Area (Table 2-9, data from HES 2014b). Since migration and spawning of steelhead and coho generally occur in close sequence during higher flows in winter, it is reasonable to expect that flow conditions conducive to both would be similar. Data from PHABSIM studies in other streams (Table 2-9) show a good correlation between minimum migration flow and optimum spawning flow for both steelhead and coho with optimum spawning flow at an average of 108% of minimum migration flow for steelhead and 84% of minimum migration flow for coho (Table 2-9, data from HES 2014b).

Table 2-9: Relationship Between Minimum Migration Flow and Optimum Spawning Flow

	Minimum Migration Flow (cfs)	Steelhead Optimum Spawning Flow (cfs)	Percent of Migration Flow (steelhead)	Coho Optimum Spawning Flow (cfs)	Percent of Migration (coho)
Liddell	11.3	13	115 %	9	80 %
Laguna	15.5	16	103 %	12	77 %
Majors	16.0	19	119 %	16	100 %
Newell	24.4	23	94 %	19	78 %
Average			*108 %*		*84 %*
Felton Diversion (*projected*)	39*	***42***		***34***	

Source: PHABSIM studies of streams in the Plan Area
* from Berry 2016

The analysis based on PHABSIM studies in other streams is consistent with the R2 method described previously. The peak of the Ricker and Butler curve (70-90 cfs) is significantly above either the R2 or PHABSIM comparison estimate, suggesting that optimum spawning conditions in the San Lorenzo mainstem downstream of Felton Diversion may occur at lower flows than indicated by the Ricker and Butler data. Indeed, there may have been changes to the channel since the Ricker and Butler work that could influence the relationship between flow and spawning habitat. The earlier data (Ricker and Butler) was collected in the 1970s and may reflect more degraded sediment conditions occurring closer to the period when industrial logging was ongoing and suburban development was at a peak. An assessment of streambed conditions and erosion control efforts in the San Lorenzo Watershed completed in 1998 concluded that streambed sedimentation had not improved significantly since 1979 despite various erosion

[19] Optimum spawning flow refers to the peak of the WUA vs. discharge curve.

control efforts that had been implemented (Balance Hydrologics 1998). More recently, a monitoring program for the San Lorenzo sediment TMDL found that sediment loads at comparable flows have declined by about 80% at Zayante Creek and 50% in the San Lorenzo River at Big Trees compared to rating curves developed in the 1970s and 1980s by the USGS (County of Santa Cruz 2019). The report also cites surveys by the USGS that found the record rainfall of 2017 triggered a change in sediment characteristics, towards coarser particle sizes and that the sediment load was significantly reduced in comparison to the record storms of 1982 (East et al. 2018). Another source of recent data from annual fish and habitat surveys between 2001 to 2019 shows no significant trends over that period for riffle and pool substrate embeddedness, percent fines, or pool depth in both the mainstem San Lorenzo River and tributaries (SCCWRP 2021, Beck et al. 2019). In summary, the USGS found a declining trend in sediment loads over the entire period from the 1970s to present but the two shorter-term studies for the period 1970-1998 (Balance Hydrologics) and 2001-2019 (Santa Cruz County) failed to detect any significant trend. The assumption we make here is that, while the channel has no doubt evolved and shifted in position, the features that determine the relation between flow and spawning habitat quality such as channel morphology (slope, bankful width, width to depth ratio, etc.) and mesohabitat features (riffle:pool proportion, cover, dominant substrate, etc.) fall in the same range as at the time of original survey. The Ricker and Butler data is used in the effects analysis (Chapter 5) since it provides a relationship between flow and spawning habitat suitability across a range of flows rather than just the optimum flow, and because it is based on a more extensive data collection effort. As a result, the effects analysis may somewhat overestimate the value of higher flows.

Rearing Habitat

The lower San Lorenzo River mainstem is influenced by Loch Lomond Reservoir and the Felton Diversion Dam and provides important rearing habitat for steelhead. Although the upper mainstem and tributaries have better spawning habitat than the lower and middle mainstem, steelhead juveniles experience slower growth rates in these areas due to lower temperatures and productivity. On the other hand, the warmer, more productive lower and middle mainstem support higher growth rates of juvenile steelhead where many YOY may reach smolt size in one growing season (Alley et al. 2004). Elevated water temperature below the lethal threshold can result in high growth rates given abundant food (Hokanson et al. 1977, Smith and Li 1983).[20] Alley et al. surmise that sufficient numbers of YOY steelhead are produced in the tributaries to move down into the mainstem and saturate rearing habitat there.

[20] See Section 2.4.2.1 and HES 2014b for discussion of temperature tolerance for steelhead and coho.

Water temperature and streamflow are major potential limiting factors for steelhead and coho in the San Lorenzo River. Response to temperature is complex and variable but for the purposes here we consider a temperature in the range of 16°C as optimal for rearing juvenile *O. mykiss* and in the range of 14.5°C as optimal for coho (see HES 2014b for additional information, Appendix 3: *Flow Studies*). Upper incipient lethal temperature for both species would be near 26°C. Average daily temperatures in excess of 19.3°C would be near the upper zone of suitability for juvenile steelhead and average daily temperature in excess of 18.3°C would be near the upper suitable zone for rearing coho (HES 2014b).

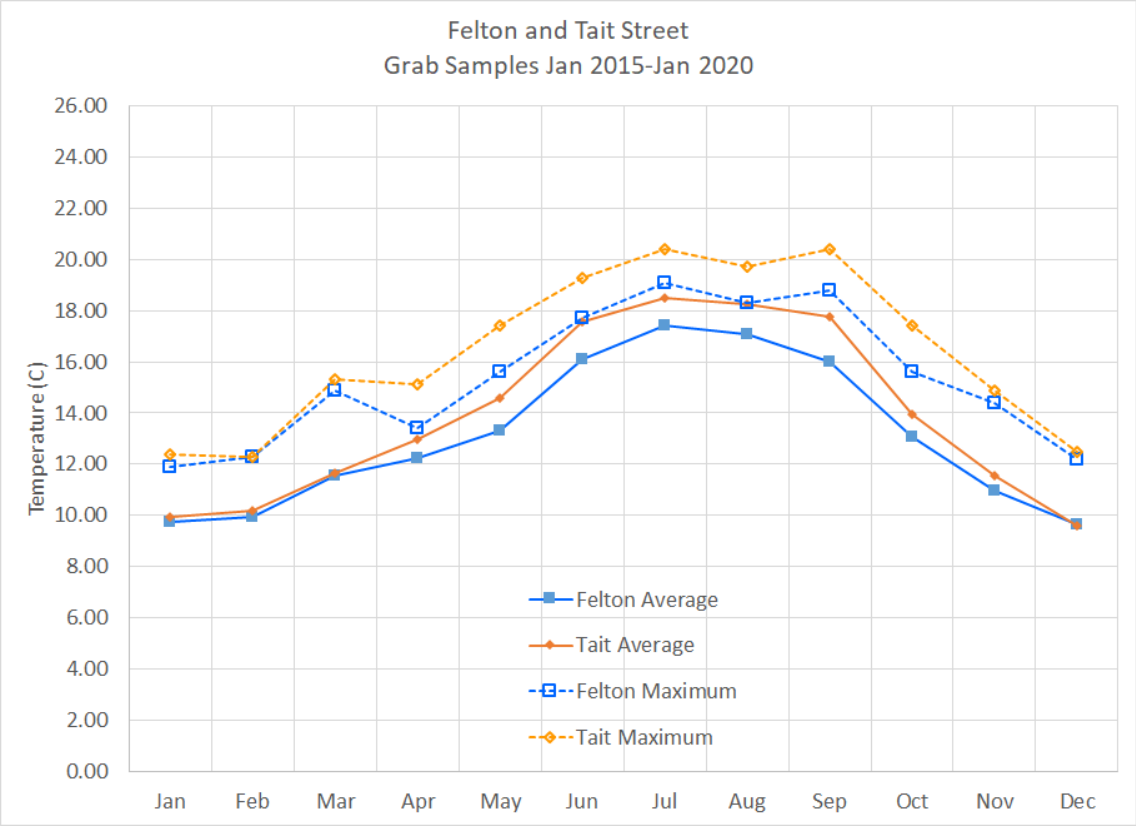
During a comprehensive survey in 2005, water temperature appeared suitable for steelhead at all monitoring locations but increased with distance downstream from Newell Creek and was near the upper range of suitability during the seasonal peak period and in the lower San Lorenzo River from above Tait Street Diversion to the lagoon (HES 2014b, Appendix 3: *Flow Studies*). Temperature is relatively warm for coho except in Newell Creek downstream of Newell Dam and Loch Lomond Reservoir. Suitability criteria for steelhead are generally met at all locations except the lower river. Temperature conditions are relatively warm upstream of the Tait Street Diversion and generally increase at Water Street (HES 2014b).

Newell Creek appears to have a moderating effect on temperature in the mainstem due to colder water released from Loch Lomond Reservoir to Newell Creek (see Section 2.4.3.2). During the summer months, there is a minimum release of 1 cfs from the Reservoir at an average temperature of 12°C to 14°C. Water temperature in the San Lorenzo River downstream of the Newell Creek confluence averaged approximately 1 degree cooler than water temperature immediately upstream of the confluence during the 2005 monitoring period (HES 2014b).

Water temperature at San Lorenzo River monitoring locations in 2005 (all downstream of the Felton Diversion) was lowest in the San Lorenzo Gorge (aka "Garden of Eden") and increased at downstream locations. Water temperature conditions in August were near the upper range of suitability for steelhead and slightly in excess of the suitable range for coho (HES 2014b). Water temperature was highest at the Water Street monitoring location. None of the monitoring locations had maximum daily water temperatures that approached lethal levels for either steelhead or coho. None of the locations had daily average temperatures high enough to reach hypothetical zero yield for steelhead (see HES 2014b). All of the locations except the "Garden of Eden" had seven-day moving average of daily maximum temperature (MWAT) that exceeded suitability criteria for both steelhead and coho although, with the exception of Water Street, exceedances were only slightly above the criteria for steelhead. The MWAT criterion used (19°C) is a rather conservative criterion and does not account for potentially high food levels that ameliorate the effects of higher temperature (HES 2014b, Appendix 3: *Flow Studies*). Grab samples at the Felton Diversion and the Tait Street Diversion between January 2015 and January

2020 show that temperature is similar at these two locations in the winter but is warmer at the Tait Street Diversion by 1°Cto 2°C during the warmest months (Figure 2-7). The grab samples were collected in the morning and do not reflect higher afternoon temperatures.

Figure 2-7: Water Temperature Comparison at the Felton Diversion and the Tait Street Diversion Based on City of Santa Cruz Water Quality Lab Grab Samples



Water temperature recordings at the Tait Street Diversion from September 2014 through December 2019 (record from turbidity meter) and June 2014 through November 2018 (summer only HOBO data) indicate monthly average temperatures at the Tait Street Diversion of 20°C or less and monthly maximum temperature of 23°C or less (Figure 2-8 and Figure 2-9). These data are consistent with the 2005 data and indicate that water temperature can reach the upper edge of the suitability range for steelhead and exceeds the suitability range for coho.

Figure 2-8: Water Temperature at the Tait Street Diversion Based on City of Santa Cruz Turbidity Logger

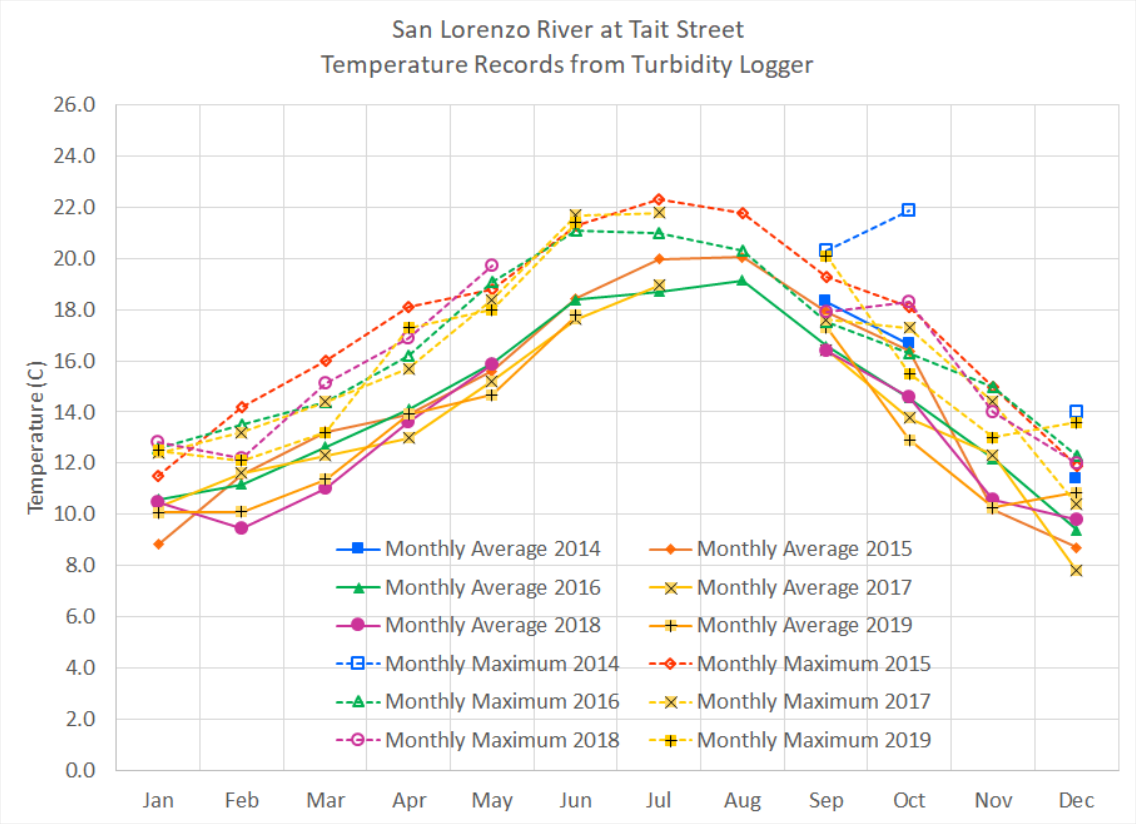
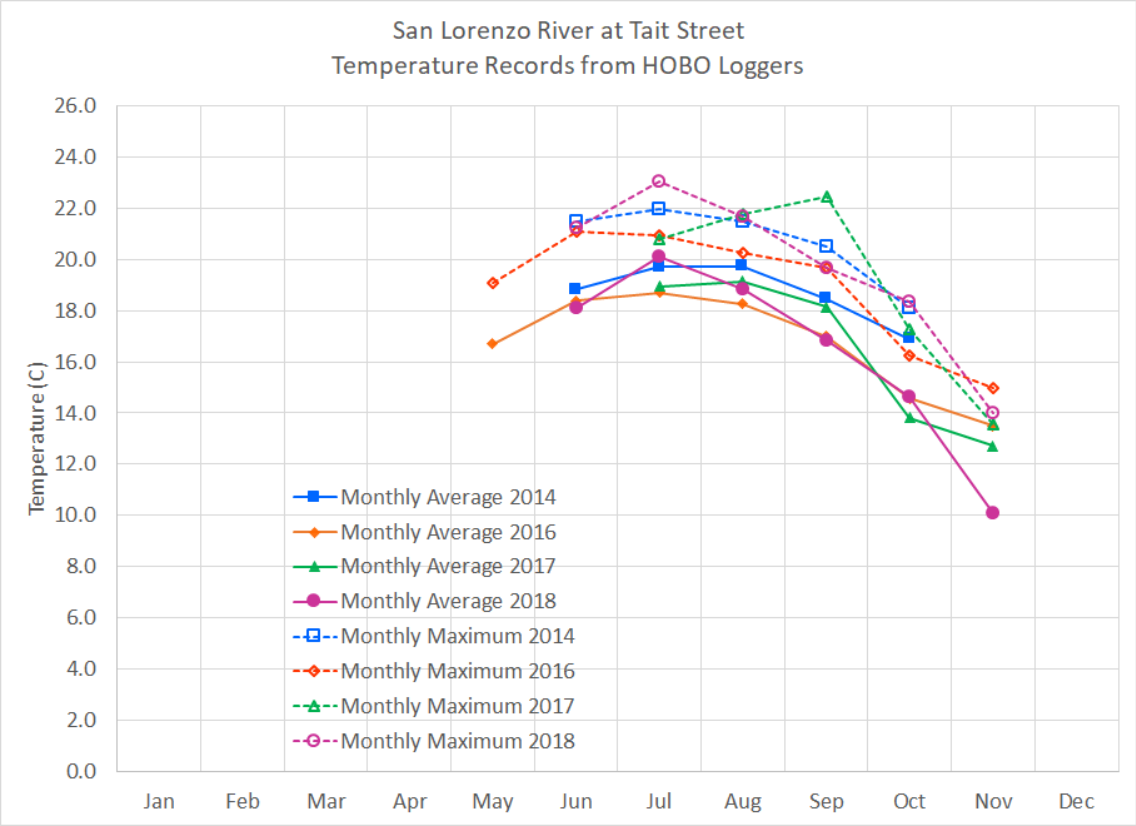


Figure 2-9: Water Temperature at the Tait Street Diversion Based on City of Santa Cruz HOBO Monitors



Water temperature was generally higher at Water Street than at the Tait Street Diversion with temperature differences ranging from -0.4°C to 1.9°C during the 2005 monitoring period (HES 2014b, Appendix 3: *Flow Studies*). The difference in temperature between the two locations was not correlated with flow in the observed range of 11 to 20 cfs. The temperature difference is likely explained by thermal gain in the relatively un-shaded flood control channel (FCC) upstream of Water Street (HES 2012b, Appendix 3: *Flow Studies*).

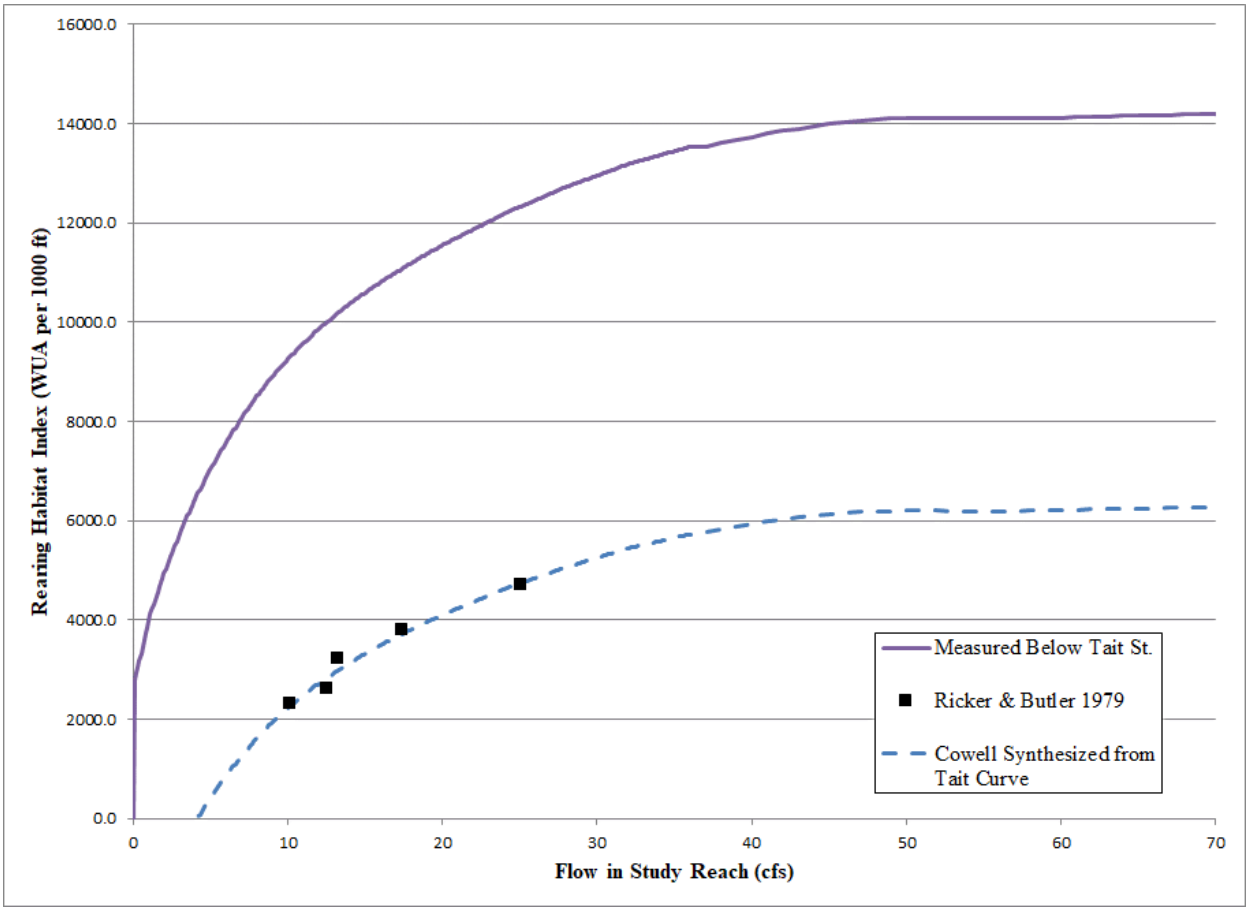
Potential riverine rearing habitat in the mainstem downstream of the Tait Street Diversion has been highly modified by construction of an FCC. The majority of riverine habitat suitable for rearing salmonids downstream of Tait Street is between Highway 1 and the lagoon, in the FCC (HES 2014b, Appendix 3: *Flow Studies*). Downstream of Highway 1, habitat consists primarily of relatively deep pools and runs with a small amount of relatively short riffles (HES 2014b, Appendix 3: *Flow Studies*). During a habitat survey in 2009, pools and runs downstream of Highway 1 were long and deep and comprised over 90% of the available habitat. The channel is

confined with low, but relatively dense, overhanging riparian vegetation, including dense growths of young willows. The overhanging terrestrial vegetation and dense beds of floating aquatic vegetation provide good cover in the FCC. Between Highway 1 and Tait Street Diversion, the river is relatively wide, shallow and has a predominantly sandy substrate with depth and cover characteristics not as favorable for rearing salmonids. Habitat in the reach upstream of Highway 1 consisted exclusively of long shallow glide and long, relatively shallow run. The substrate upstream of Highway 1 was dominated by sand (90%) and silt (5%).

HES evaluated the relationship of instream flow and rearing habitat conditions in the San Lorenzo River between Tait Street Diversion and the lagoon (HES 2014b) using the PHABSIM model (Bovee et al. 1998). The index of rearing habitat (weighted useable area or WUA per 1000 feet of stream) for steelhead in this reach increases steeply from minimum levels at a flow of 0 cfs (HES 2014b)). As flow reaches 8 to 12 cfs, the rate of increase in WUA becomes less. WUA increases very little at flows greater than about 28 cfs. A flow of 16 to 18 cfs provides 80% of the maximum WUA in both sub-reaches (upstream of Highway 1 and in the FCC). Depth and velocity conditions in rearing habitat downstream of Tait Street were characterized as prime for steelhead at flow in excess of 19 cfs, good at flow of 8 to 19 cfs, fair at flows of 3 to 8 cfs and poor at flows of 3 cfs or less (HES 2014b). The San Lorenzo River downstream of Tait Street does not provide good rearing habitat for coho due primarily to high water temperature.

Ricker and Butler (1979) collected data on the relationship between flow and juvenile steelhead rearing habitat in the reach of the San Lorenzo River running through Henry Cowell Park. Transects were selected to be representative of the reach from the Felton Diversion downstream to Tait Street Diversion. Their data showed a consistent increase in habitat value (WUA) between 10 cfs and 25 cfs. To extend this dataset to higher and lower flows, the data were fit to the relationship developed for the reach of the San Lorenzo River downstream of Tait Street Diversion, adjusted to account for the number of transects used. This resulted in a good fit to the observed data (Figure 2-5). This relationship indicates that a flow of 26 cfs provides 80% of the measured maximum rearing habitat value. This is somewhat higher than the 19 cfs flow estimated to provide 80% of the maximum rearing habitat downstream of Tait Street Diversion (HES 2014b). The Ricker and Butler data also show WUA for summer rearing peaking at just under 20 cfs in the reach of the San Lorenzo River downstream of Boulder Creek. Coho are not likely to rear in the lower mainstem San Lorenzo as the cooler habitat they prefer is primarily in the tributaries. If they were in the lower mainstem, habitat values would peak at lower flows than steelhead due to preference of coho for lower flow velocities.

Figure 2-10: Relationship Between Flow and Steelhead Rearing Habitat (WUA) Downstream of the Felton Diversion



Source: Ricker and Butler 1979

Another indicator of flows that support good rearing habitat comes from the relationship between peak rearing flow and recommended flow for steelhead rearing derived through PHABSIM studies in other streams in the Plan Area (HES 2014b). These data show a good correlation between minimum migration flow and recommended rearing flow,[21] with recommended rearing flow at an average of 51% of minimum migration flow (Table 2-9, data from HES 2014b). The

[21] Since rearing flow for steelhead can increase with flow without reaching a peak, recommended rearing flow was calculated as 80% of the WUA occurring at the penultimate (second highest) May average daily flow in the hydrologic record. May flow was used since this would be the highest flow during the summer rearing period and would presumably provide the best rearing habitat possible in the stream without any City diversion. The penultimate value was chosen because the highest value is often an outlier. For streams where the WUA vs. flow curve reaches a peak or asymptote the rearing flow was calculated as the flow where WUA reaches 80% of the peak or apparent asymptote value.

value for Tait Street Diversion may be anomalous since it partially reflects altered channel conditions in the FCC. The values provided are for steelhead; rearing suitability for coho peaks at lower flow levels than steelhead due to juvenile coho preference for lower flow velocity.

Table 2-10: Relationship Between Minimum Migration Flow and Optimum Rearing Flow

	Minimum Migration Flow (cfs)	Recommended Rearing Flow (cfs)	Rearing/Migration Ratio
Liddell	11.3	5.9	0.52
Laguna	15.5	6.9	0.45
Majors	16.0	6.7	0.42
Newell	24.4	9.9	0.41
San Lorenzo-Tait	25.2	18.8	0.75
Average for all streams			0.51
Felton Diversion (*projected*)	39*	***19.9***	

Source: PHABSIM studies of streams in the Plan Area
* from Berry 2016

The analysis based on PHABSIM studies in other streams supports the 20 cfs minimum bypass flow for rearing steelhead in the San Lorenzo mainstem downstream of the Felton Diversion, but indicates a slightly lower flow for optimum rearing conditions than indicated by the Ricker and Butler data. The Ricker and Butler data is used in the effects analysis (Chapter 5) since it provides a relationship between flow and rearing habitat suitability across a range of flows rather than just the optimum flow, and because it is based on a more extensive data collection effort. As a result, the effects analysis may somewhat overestimate the value of higher flows for rearing.

Lagoon Habitat

A description of general lagoon dynamics for the Plan Area has been presented in Section 2.4.2.2 (Habitat Conditions Laguna Creek) and that discussion applies to the San Lorenzo River Lagoon as well. The San Lorenzo River Lagoon provides extremely important habitat for steelhead in the Plan Area and for the CCC Steelhead DPS as a whole. Every steelhead in the San Lorenzo River Basin uses the lagoon for either rearing, migration or both. A large portion of the basin's steelhead spawning population likely uses the lagoon as rearing habitat. Coho also migrate through the lagoon, both as smolts and adults, although lagoon rearing does not appear to be as important for coho as it is for steelhead.

The San Lorenzo River Lagoon has been highly modified compared to historic conditions. Direct modifications include urban encroachment, marsh filling, railroad and road crossings, and levee construction, all resulting in significant reduction in the areal extent and volume of the lagoon. San Lorenzo River Lagoon habitat has been highly altered and is missing components favorable to steelhead rearing such as fringing marsh vegetation, riparian canopy, and fallen large tree trunks that may provide important cover.

The areal extent of the San Lorenzo River Lagoon has been reduced by 80% through mudflat filling and levee construction (2ndNature 2006). These physical modifications have changed the tidal prism,[22] the timing and duration of sandbar closure, the aquatic vegetation communities, and likely, many biotic processes. The urban development and other modifications within the contributing catchment of the San Lorenzo River Lagoon have increased nutrient loading, altered sediment delivery, and altered hydrologic patterns. Artificial summer sandbar breaching for flood-control alters water quality parameters and may influence the potential for steelhead to rear in the lagoon. This breaching activity appears to be limited to the San Lorenzo River lagoon. Water withdrawals have also altered the seasonal dynamics of the lagoon. Sorting out the influence of any single factor on habitat conditions in the lagoon, such as changes in freshwater inflows, is not easily accomplished. One of the primary processes of concern in the San Lorenzo River Lagoon is degradation of water quality conditions during the summer lagoon closures. In particular, sustained low DO concentrations and elevated water temperatures impact lagoon ecology and influence the productivity of steelhead and coho populations.

Studies by Smith (1990) and more recent studies in the San Lorenzo Lagoon and other Central Coast lagoons (SH+G 2001b, 2ndNature 2006, 2ndNature 2008, 2ndNature 2009a, 2ndNature 2009b, 2ndNature and HES 2016) suggest that the dynamics of habitat quality for rearing salmonids in the lagoon are complex and that many factors, including the timing of sandbar closure, freshwater inflows, tidal exchange, nutrient enrichment, nitrogen availability, lagoon morphology, water temperature, and water clarity may strongly influence the water quality conditions during the dry season and suitability of the lagoon for rearing juvenile steelhead.

Sandbar Formation

The modifications to the San Lorenzo Lagoon discussed previously have resulted in limited ability for the lagoon to expand horizontally and therefore, there is a strong relationship between lagoon inflow and elevation. Data from the lagoon monitoring studies show that the San Lorenzo River mouth can go through a number of closures and breaches during each dry season

[22] The volume of water that flows into a tidal channel and out again during a complete tidal cycle.

(May 15 through October 31 for this analysis) (2ndNature 2006, 2008, 2009a, 2009b, 2009c, 2010a, 2010b, 2011, 2012, 2013, 2014, 2015, 2016). In some instances, the breaches are natural due to water in the lagoon exceeding the elevation of the sandbar and some are due to illegal manual breaches of the mouth by surfers, beach goers or other entities. In any case, the lagoon cannot be opened manually without great effort and large equipment unless the water surface elevation is very near the beach crest elevation and close to breaching naturally.

Results of water quality sampling for the years from 2002 to 2015 (except 2006) indicate that relatively wetter water years, and higher stream flow discharge in August, do correspond with relatively shorter durations of sand bar closure at the mouth of the San Lorenzo River (Table 2-11). During the years with highest precipitation and highest August inflow to the lagoon (2005 and 2011), the lagoon was open the entire season. During years with lower inflow in August (2007-2009, 2014, and 2015), the lagoon was closed for greater amounts of time.

Sandbar closure has also been influenced by construction of the Santa Cruz small craft harbor jetty in 1963 (Griggs 2012). The 1200-foot-long west jetty creates a nearly complete trap for sand moving southeast along the coast as part of a littoral cell originating near Pillar Point in San Mateo County and terminating in the Monterey Submarine Canyon in central Monterey Bay (Griggs 2012). This has led to the widening of Seabright Beach, immediately east of San Lorenzo Point, and main beach, where the San Lorenzo River enters the ocean. On average, main beach has been widened by 140 to 150 feet and under low flow conditions the river is not able to maintain its path across this wider beach and a sandbar forms more frequently, damming the river (Griggs 2012). In addition, since the outer edge of the sandbar is higher than the back beach, the rising lagoon extends along the back beach to the west, in front of the boardwalk. Due to resulting flooding, the City has had to resort to manually opening and draining the lagoon at higher lagoon stages. In low flow years this process has had to be repeated as often as several times during the dry season. The City has now proposed to install a culvert through which the lagoon can be maintained at a determined elevation without serious flooding or the need for mechanical breaching (Environmental Sciences Associates 2018).

Table 2-11: Timing and Duration of San Lorenzo River Lagoon Sandbar Closure

	Water Year precipitation (in)[1]	August Average daily San Lorenzo River discharge to Lagoon (cfs) [2]	Date of initial sandbar closure	Date of final sandbar closure	Number of days sand bar closed May 15 to Oct. 31 (168 days in period)	Number of days microtidal May 15 to Oct. 31 (168 days in period)[3]	Mean of daily average water depth at YSI site (June-Aug)
2004	35.49	6.8	19-Jul	N/A	45 (27%)	20 (12%)	4.32
2005	64.83	22.1	Never closed	N/A	0 (0%)	56 (33%)	3.95
2006	67.78	29.8	N/A	N/A	N/A	N/A	N/A
2007	25.4	3.4	23-May	N/A	89 (53%)	32 (19%)	5.16
2008	39.6	2.3	26-Jul	26-Jul	97 (57%)	15 (9%)	4.99
2009	36.52	2.1	15-Jun	28-Jul	87 (51%)	13 (8%)	5.04
2010	48.88	12.4	4-Jul	4-Jul	60 (37%)	18 (11%)	4.68
2011	62.15	25.8	31-Aug	2-Nov	11 (7%)	35 (21%)	3.36
2012	34.35	9.0	23-Jul	27-Oct	54 (32%)	25 (15%)	3.20
2013	36.2	9.5	17-May	23-Oct	114 (67%)	12 (7%)	4.91
2014	24.5	1.9	15-May	17-Jul	151 (89%)	N/A	N/A
2015	35.5	4.1	15-May	22-June	149 (88%)	N/A	N/A
2016	48.6	9.8	6-June	23-June	19 (11.2%)	114 (67.5%)	N/A

Source: 2NDNATURE

N/A not available, no monitoring performed or limited data

[1]Precipitation data provided by the County of Santa Cruz from the Felton Diversion rain gage station.

[2]Hydrology data from USGS gage #11161000, San Lorenzo River at Santa Cruz, average Q integrated over one day.

[3]Microtidal conditions occur when the sandbar is partially present, reducing surface water exchange to every few days and water circulation within the lagoon is limited. It is determined using visual observations and the derivative of YSI depth data (dz/dt), using parameters established in CLEAP.

Lagoon Circulation Regime and Water Quality

Continuous monitoring of water quality (salinity, DO, temperature, pH, and depth) from two sites in the lagoon provide an indication of the dynamic nature of water quality in the lagoon. The lower site is located in deep water near the bend upstream from the railroad bridge. This site is more influenced by tidal exchange than more upstream locations. The upper site is located in deep water upstream of Riverside Bridge. Recording began at the lower site in approximately 2002, with the upper site added in 2014. Water quality data is recorded at the surface and at the bottom at both sites (2ndNature 2006). See Figure 2-6: San Lorenzo River Lagoon Water Quality Monitoring Locations.

Salinity in the San Lorenzo River Lagoon is highly dynamic though there is generally some degree of salinity at the lower water quality monitoring site most of the time during the June-October time period, both in surface and bottom waters (Table 2-12). Surface salinity is generally higher in the June-August period, when the lagoon is more likely to be open, than in the September-October period when the lagoon is either closed or tidal exchange is reduced. The lowest levels of surface salinity have been observed in 2005 and 2011 under conditions of an open lagoon and relatively high freshwater inflow. Bottom waters nearly always have salinity of at least 5 ppt. Only in 2005, with relatively high freshwater inflows, were there some observations of salinity less than 5 ppt.

Figure 2-11: San Lorenzo River Lagoon Water Quality Monitoring Locations


SL10
SL9
SL8
SL7
SL6
SL5
SL4
SL3
SL2
SL1
CITY OF SANTA CRUZ
0 250 500 1,000 Feet
San Lorenzo Lagoon Monitoring Locations
Inactive Monitoring Site
Water Quality Monitoring Site
Water Quality Monitoring Site with Sondes

Table 2-12: Salinity Conditions from Continuous Monitoring Record at Lower Monitoring Location in the San Lorenzo River Lagoon in Comparison to Freshwater Inflow and Timing and Duration of Sandbar Closure

	Water Year precipitation (in)[1]	August Average daily San Lorenzo River discharge to Lagoon (cfs) [2]	Date of initial sandbar closure	Date of final sandbar closure	Number of days sand bar closed May 15 to Oct. 31 (168 days in period)[3]	Number of days microtidal May 15 to Oct. 31 (168 days in period)[4]	% of observations of surface salinity > 5 ppt (June-Aug)	% of observations of bottom salinity > 5 ppt (June-Aug)
2004	35.49	6.8	19-Jul	N/A	45 (27%)	20 (12%)	98%	100%
2005	64.83	27.1	Never closed	N/A	0 (0%)	56 (33%)	27%	88%
2006	67.78	29.8	N/A	N/A	N/A	N/A	N/A	N/A
2007	25.4	3.4	23-May	N/A	89 (53%)	32 (19%)	68%	100%
2008	39.6	2.3	26-Jul	26-Jul	97 (57%)	15 (9%)	81%	100%
2009	36.52	2.1	15-June	28-Jul	87 (51%)	13 (8%)	81%	99%
2010	48.88	12.4	4-Jul	4-Jul	60 (37%)	18 (11%)	51%	99%
2011	62.15	25.8	31-Aug	2-Nov	11 (7%)	35 (21%)	38%	87%
2012	34.35	9.0	23-Jul	27-Oct	54 (32%)	25 (15%)	40%	100%
2013	36.2	9.5	17-May	23-Oct	114 (67%)	12 (7%)	N/A	100%
2014	24.5	1.9	15-May	17-Jul	151 (89%)	N/A	89%	100%
2015	35.5	4.2	15-May	22-June	149 (88%)	N/A	78%	100%
2016	48.6	9.8	6-June	23-June	19 (11.2%)	114 (67.5%)	18%	46%

Source: 2NDNATURE

N/A not available, no monitoring performed, or limited data

[1] Precipitation data provided by the County of Santa Cruz from the Felton Diversion rain gage station.

[2] Hydrology data from USGS gage #11161000, San Lorenzo River at Santa Cruz.

[3] Sandbar closure is determined from visual observations and the derivative of YSI depth data (dz/dt), using parameters established in CLEAP.

[4] Microtidal conditions occur when the sandbar is partially present, reducing surface water exchange to every few days and water circulation within the lagoon is limited. It is determined using visual observations and the derivative of YSI depth data (dz/dt), using parameters established in CLEAP.

The extended periods of lagoon closure in 2007-2009, 2014, and 2015 were associated with the highest temperatures in both surface and bottom waters (Table 2-13). It might be expected that lagoon water temperature would be correlated with atmospheric temperature and there is some support for this in the data (Table 2-13) however, there are also exceptions such as 2014 which had relatively lower air temperature but some of the warmest water temperature. If air temperature is a factor it appears less important than tidal exchange (Table 2-13).

Table 2-13: Water Temperature Conditions from Continuous Monitoring Record in the San Lorenzo River Lagoon in Comparison to Freshwater Inflow and Timing and Duration of Sandbar Closure

	Water Year precipitation (in)[1]	August Average daily San Lorenzo River discharge to Lagoon (cfs) [2]	Date of initial sandbar closure	Date of final sandbar closure	Number of days sand bar closed May 15 to Oct. 31 (168 days in period)[3]	Number of days microtidal May 15 to Oct. 31 (168 days in period)[4]	Average of Daily Maximum Air Temperature (°C)[5]	Maximum Weekly average Temperature (MWAT)	Number of Days with Average Surface Temperature Exceeding 19°C. (June-Aug)	Number of Days with Daily Average Surface Temperature Exceeding 21°C. (June-Aug)	Number of Days with Daily Maximum Surface Temperature Exceeding 25°C. (June-Aug)
2004	35.49	6.8	19-Jul	N/A	45 (27%)	20 (12%)	21.5	23.5	44 (75%)	18(31%)	4(7%)
2005	64.83	27.1	Never closed	N/A	0 (0%)	56 (33%)	20.8	21.5	54 (64%)	7(8%)	3(3%)
2006	67.78	29.8	N/A	N/A	N/A	N/A	21.8	N/A	N/A	N/A	N/A
2007	25.4	3.4	23-May	N/A	89 (53%)	32 (19%)	22.2	23.0	61(85%)	26(33%)	21(27%)
2008	39.6	2.3	26-Jul	26-Jul	97 (57%)	15 (9%)	22.0	24.2	69(80%)	35(38%)	29(32%)
2009	36.52	2.1	15-June	28-Jul	87 (51%)	13 (8%)	21.7	24.4	69(80%)	39(42%)	14(15%)
2010	48.88	12.4	4-Jul	4-Jul	60 (37%)	18 (11%)	20.6	21.4	37(48%)	8(10%)	1(1%)
2011	62.15	25.8	31-Aug	2-Nov	11 (7%)	35 (21%)	19.9	20.5	14(17%)	1(1%)	1(1%)
2012	34.35	9.0	23-Jul	27-Oct	54 (32%)	25 (15%)	21.1	21.0	55(64%)	9(10%)	6(7%)
2013	36.2	9.5	17-May	23-Oct	114 (67%)	12 (7%)	21.7	N/A	N/A	N/A	N/A
2014	24.5	1.9	15-May	17-Jul	151 (89%)	N/A	21.3	25.6	84(98%)	79(86%)	59(64%)
2015	35.5	4.2	15-May	22-June	149 (88%)	N/A	23.6	25.4	79(92%)	77(84%)	61(66%)
2016	48.6	9.8	6-June	23-June	19 (11.2%)	114 (67.5%)	20.9	23.3	75(87%)	53(58%)	3(3%)

Source: 2NDNATURE

N/A not available, no monitoring performed, or limited data

[1] Precipitation data provided by the County of Santa Cruz from the Felton Diversion rain gage station.

[2] Hydrology data from USGS gage #11161000, San Lorenzo River at Santa Cruz.

[3] Sandbar closure is determined from visual observations and the derivative of YSI depth data (dz/dt), using parameters established in CLEAP.

[4] Microtidal conditions occur when the sandbar is partially present, reducing surface water exchange to every few days and water circulation within the lagoon is limited. It is determined using visual observations and the derivative of YSI depth data (dz/dt), using parameters established in CLEAP.

[5] Air temperature data provided by CIMIS website (https://cimis.water.ca.gov/). Data represents an average of two weather stations: DeLaveaga station (#104) is located in Santa Cruz, CA at an elevation of 91.4 MSL and Pajaro station (#129) is located adjacent to the Pajaro River at 65 MSL.

Steelhead are generally expected to survive and grow well at temperature up to about 19°C to 21°C if food is abundant. Steelhead may actually grow faster at higher temperatures if food is abundant (Smith and Li 1983) but at temperature in excess of 21°C, increased mortality may offset the benefits of increased growth rates at the population level Hokanson et al. 1977). Food levels are generally high in Central Coast lagoons and should allow steelhead to thrive at relatively high temperatures. Temperatures of 25°C to 26°C are generally considered lethal (Bidgood and Berst 1969, Hokanson et al. 1977) (see HES 2014b for discussion of temperature suitability). Based on the temperature record from the San Lorenzo River Lagoon, lethal temperature conditions occurred at the surface[23] in every year but the frequency of lethal conditions was highest in 2007-2009, 2014, and 2015 when the lagoon was closed for extended periods (Table 2-13). These warm temperatures at or above the lethal threshold are associated with the lowest catch rates of steelhead in monitoring conducted in the fall (Table 2-13, Table 2-15, Table 2-16) including zero captures in 2014 and 2015, the years with highest surface water temperature and highest frequency of potentially lethal conditions.

Daily average temperature appears to be quite warm for steelhead in all years with a large number of days exceeding 21°C at the surface during the June-August period (Table 2-13). Temperature conditions are more moderate in the September-October period. The seven-day moving average of daily maximum temperature also exceeds 19°C frequently in all years. In stream type environments, this would indicate less than optimal conditions for rearing steelhead (see HES 2014b for discussion of temperature suitability). See Appendix 3: *Flow Studies*.

It is notable that the number of days with seven-day average of maximum temperature exceeding 19°C in 2005 was comparable to 2007 and 2008 but that number of days with daily average surface temperature exceeding 21°C was much lower and with only three days exceeding the lethal threshold in 2005 (compared to 21 and 29 days in 2007 and 2008) (Table 2-9). This, in combination with the fact that the standard deviation of temperature statistics was much lower in 2005 compared to 2007 and 2008, indicates that temperature extremes can be moderated under open lagoon conditions (Table 2-13).

It is more difficult to discern patterns of DO concentration relative to lagoon closure and inflow. Optimal DO levels for steelhead are 7 mg/l and above, although levels down to about 5 mg/l can be tolerated (US EPA 1976, US EPA 1986, Raleigh et al. 1984). Suitability falls off rapidly at levels below 5 mg/l and the incipient lethal level is approximately 3 mg/l or less, depending on environmental conditions, especially temperature (Raleigh et al. 1984).

[23] Water can sometimes be cooler with greater depth in the lagoon, however low DO and higher salinity may preclude steelhead from retreating there.

In the San Lorenzo River Lagoon, DO at the bottom of the water column was generally less than 5 mg/l most of the time regardless of closure or inflow conditions (Table 2-14). DO at the surface is a parameter that has great potential for discriminating between different closure/inflow conditions, but it was not consistently measured in the San Lorenzo River Lagoon in the initial monitoring period. For years with surface DO measurements, there are a substantial number of days with minimum daily surface DO concentration of 5 mg/l or less. There appears to be no good correlation between surface DO levels and either lagoon inflow in August or duration of lagoon closure. The lowest occurrences of DO concentrations of 5mg/l or less were in 2012, with high lagoon inflow and minimal closure, and 2014 and 2015 with low inflow and extended lagoon closure (Table 2-14).

Table 2-14: Dissolved Oxygen Conditions from Continuous Monitoring Record in the San Lorenzo River Lagoon in Comparison to Freshwater Inflow and Timing and Duration of Sandbar Closure

	Water Year precipitation (in)[1]	August Average daily San Lorenzo River discharge to Lagoon (cfs) [2]	Date of initial sandbar closure	Date of final sandbar closure	Number of days sand bar closed May 15 to Oct. 31 (168 days in period)[3]	Number of days microtidal May 15 to Oct. 31 (168 days in period)[4]	Number of days with minimum daily surface DO 5 mg/ l or less (June-Aug).	Number of days with minimum daily bottom DO 5 mg/ l or less (June-Aug).	% of observations of surface DO <=7 mg/l (June-Aug).	% of observations of bottom DO <=7 mg/l (June-Aug).
2004	35.49	6.8	19-Jul	N/A	45 (27%)	20 (12%)	N/A	57	N/A	71%
2005	64.83	27.1	Never closed	N/A	0 (0%)	56 (33%)	N/A	87	N/A	79%
2006*	67.78	29.8	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
2007	25.4	3.4	23-May	N/A	89 (53%)	32 (19%)	N/A	92	N/A	94%
2008	39.6	2.3	26-Jul	26-Jul	97(57%)	15 (9%)	89	92	50%	91%
2009	36.52	2.1	15-June	28-Jul	87 (51%)	13 (8%)	67	65	37%	86%
2010	48.88	12.4	4-Jul	4-Jul	60 (37%)	18 (11%)	77	92	60%	71%
2011	62.15	25.8	31-Aug	2-Nov	11 (7%)	35 (21%)	60	73	37%	45%
2012	34.35	9.0	23-Jul	27-Oct	54 (32%)	25 (15%)	43	92	33%	67%
2013	36.2	9.5	17-May	23-Oct	114 (67%)	12 (7%)	N/A	89	N/A	66%
2014	24.5	1.9	15-May	17-Jul	151 (89%)	N/A	43	77	28%	64%
2015	35.5	4.2	15-May	22-June	149 (88%)	N/A	33	81	20%	63%
2016	48.6	9.8	6-June	23-June	19 (11.2%)	114 (67.5%)	62	92	37%	91%

Source: 2NDNATURE

N/A not available, no monitoring performed, or limited data

[1] Precipitation data provided by the County of Santa Cruz from the Felton Diversion rain gage station.

[2] Hydrology data from USGS gage #11161000, San Lorenzo River at Santa Cruz.

[3] Sandbar closure is determined from visual observations and the derivative of YSI depth data (dz/dt), using parameters established in CLEAP.

[4] Microtidal conditions occur when the sandbar is partially present, reducing surface water exchange to every few days and water circulation within the lagoon is limited. It is determined using visual observations and the derivative of YSI depth data (dz/dt), using parameters established in CLEAP.

Of course, salinity, temperature, and DO are all inter-related to some degree. Cooler water holds more DO and the rate of biological processes that produce and consume DO are also temperature related. Nutrients and light availability are also significant factors. Higher temperature increases the potential maximum photosynthetic rates if light availability and nutrient supply are not limiting (Wetzel 2001).

The combination of relatively warm temperature and high nutrient availability result in a highly productive lagoon during the summer and early fall closures. The limiting nutrient in all Santa Cruz County lagoons evaluated during the CLEAP study is nitrogen (2ndNature 2006). The San Lorenzo River Lagoon has average surface water dissolved nitrate (NO_3^-) concentrations on the order of 30 um, or 0.4 mg/L (2ndNature 2001, 2003, 2006, 2008, 2009a), consistently higher than those observed in other Santa Cruz County lagoons evaluated in the CLEAP study (2ndNature 2006). While nitrate levels in the San Lorenzo River Lagoon do not exceed human health standards, they are relatively elevated from an aquatic ecosystem perspective and contribute to increased eutrophication (primary production rates) associated with increased production of phytoplankton and algal growth.

The increased biological production of phytoplankton and algal species in the surface waters produces oxygen through photosynthesis during daylight while biological respiration in the bottom waters (where light does not penetrate) and during night consumes oxygen. Even under conditions where the water column is not stratified, concentration of DO in the bottom waters can become depleted if the consumption of oxygen by respiration exceeds the supply of oxygen in the water column. Strong salinity (or thermal) stratification can exacerbate the low DO conditions in the bottom waters since the stratification prevents oxygen produced by photosynthesis in the upper water column from replenishing the oxygen that is consumed through respiration in the bottom waters. Depletion of DO in bottom waters is a common feature in highly productive aquatic systems, particularly, though not exclusively, when the water column is physically stratified by a thermal or salinity gradient. It can occur in fresh-water lakes, other lagoons in Santa Cruz County, and other non-stratified lagoons (Brock 1985, Burgi and Stadelmann 2002, Jónasson et al. 1974, Riemann and Søndergaard 1986, Søndergaard et al. 2005).

Low DO concentration is observed when a strong halocline is present. However, in a number of instances the San Lorenzo Lagoon also has low DO concentrations (<3 mg/L) in the bottom waters when the lagoon is unstratified with a relatively freshwater column (2ndNature 2008, 2009). The simultaneous occurrence of a freshwater column yet poor DO in the bottom water suggests that the nutrient availability and resulting primary production is exceeding the DO supply available (2ndNature 2006).

Another local Santa Cruz lagoon, Soquel Creek Lagoon, is manually closed in early summer each year in a manner that ensures a completely freshwater lagoon. Some form of this practice in Soquel Lagoon dates back to the early 1900s. The water quality in the Soquel Creek Lagoon is typically better for rearing steelhead than in the San Lorenzo River Lagoon, specifically lower surface water temperatures and higher DO concentrations. However, nitrate loads in the San Lorenzo River Lagoon are an order of magnitude higher than those observed in the significantly smaller Soquel Creek Lagoon (SH&G 2001b). The better DO levels in the Soquel Creek Lagoon during the summer closure conditions may be attributed to the combination of lower nitrate loading and the dense riparian canopy that keeps surface water temperatures on average 3-4ºC cooler than San Lorenzo and Aptos Lagoons (2ndNature 2006). Chlorophyll concentrations are also consistently lower in Soquel, and there is also less accumulation of organic detritus on the bed of the lagoon at the end of the summer season (2ndNature 2006). It is not merely the closure of the lagoon and resulting fresh-water column in the Soquel Creek Lagoon that provides conditions more conducive to rearing steelhead, but the fresh water column, in combination with lower temperature and higher DO levels associated with the lower nutrient loading and dense riparian canopy in the Soquel Creek Lagoon.

There remains some question as to how water quality conditions in the San Lorenzo River Lagoon would respond to forced closure with a culvert system similar to that practiced in Soquel Creek. A condition of sustained closure and moderate fresh water inflows has not been observed in the San Lorenzo River Lagoon. As previously discussed, sustained closures are not compatible with higher summer inflows due to the process of lagoon filling, spilling, and breaching. Bottom waters have only infrequently been observed with salinity below 5 ppt during the years when monitoring has occurred, and never during years when the lagoon was closed. Continued monitoring suggests warmer temperature under closed lagoon conditions and that the high primary production rate (supported by high nutrient availability) may exceed the supply of oxygen in the water column even in unstratified conditions (SH+G 2001b, 2ndNature 2006, 2008, 2009.

Habitat Conditions and Steelhead Abundance Surveys

Steelhead juveniles have been captured in the San Lorenzo River Lagoon during monitoring in 2002 (H.T. Harvey and Associates 2003b), 2004, and 2005 (2ndNature 2006), and since 2008 (HES 2009a, HES 2010, HES 2011a, HES 2012, HES 2013, HES 2014a, HES 2015, and HES 2016, HES 2017, HES 2018, HES 2019). Steelhead have been found rearing in the lagoon in every year when sampling has been conducted (Table 2-15). Abundance has been measured by two methods: CPUE and mark-recapture abundance estimates. CPUE is simply the total number of *O. mykiss* caught divided by the number of seine hauls completed (Table 2-15). In theory, if there are more fish in the lagoon, more will be caught with each haul and CPUE will be higher.

CPUE estimates are available for every year. The second estimate of abundance is an estimate of the actual number of *O. mykiss* obtained by marking fish initially and then observing the proportion of marked fish in a subsequent recapture period. Mark-recapture estimates have been made since 2011 (Table 2-16). Both methods have advantages and disadvantages. CPUE estimates work best when "catchability" is constant. Seining in the lagoon occurs under a variety of conditions of lagoon stage and beach access and catchability may be variable. Mark-recapture is less sensitive to catchability, but the method assumes that marked fish are evenly distributed in the population and that there is no movement in and out of the lagoon during the period between marking and recapture. The assumption of even distribution may be approximately achieved but we have indications that fish are sometimes moving in and out of the lagoon, even during the relatively short survey periods. Never-the-less, both methods give a reasonable index of abundance and both have been correlated with each other. It is certainly possible to determine when *O. mykiss* are abundant in the lagoon and when they are not.

Table 2-15: Steelhead CPUE for the San Lorenzo River Lagoon by Month and Year

	Steelhead Catch per Haul				
Year	**June**	**July**	**August**	**September**	**October**
2002[1]					12.8
2004		21.9		0.10	
2005[1]	8.9	4.6	48		15.7
2008	2.6				0.1
2009	0.3			1.0	0.5
2010	8.3	21.5			28.25
2011	13				2.5
2012	1.7			14.4	
2013	2	8.4		4.7	
2014	1.2	1.1		0	
2015	2.6	0	0		0
2016	39.7	1.0	2.0	7.8	
2017	134.4	452.0	272.0	328.5	
2018	23.3	2.5	6.4	6.3	

Source : data from H.T. Harvey and Associates 2003, 2NDNATURE 2006, Ellen Freund (NMFS), HES 2005, HES 2009, HES 2010, HES 2011, HES 2012, HES 2013, HES 2014a, HES 2015, HES 2016, HES 2017, HES 2018, and HES 2019)

[1] Data are averaged between sites.

Table 2-16: Steelhead Mark-Recapture Population Abundance Estimates in San Lorenzo River Lagoon

	Steelhead Population Estimate	
	Spring	**Fall**
2011	501	138
2012	60	714[1]
2013	207[2]	No estimate[3]
2014	No estimate[4]	None captured
2015	559[3]	None captured
2016	2697	1331
2017	3636	>3636[5]
2018	2378	704

Source: data from HES 2012, HES 2013, HES 2014a, HES 2015, and HES 2016

[1] May have been fish entering or leaving lagoon

[2] Low number of marks or recaptures, likely biased

[3] Evidence population not closed, violates assumption of the method

[4] No recaptures

[5] Estimate based on CPUE, mark-recapture estimate not possible, recapture period precluded due to incidental take limitations

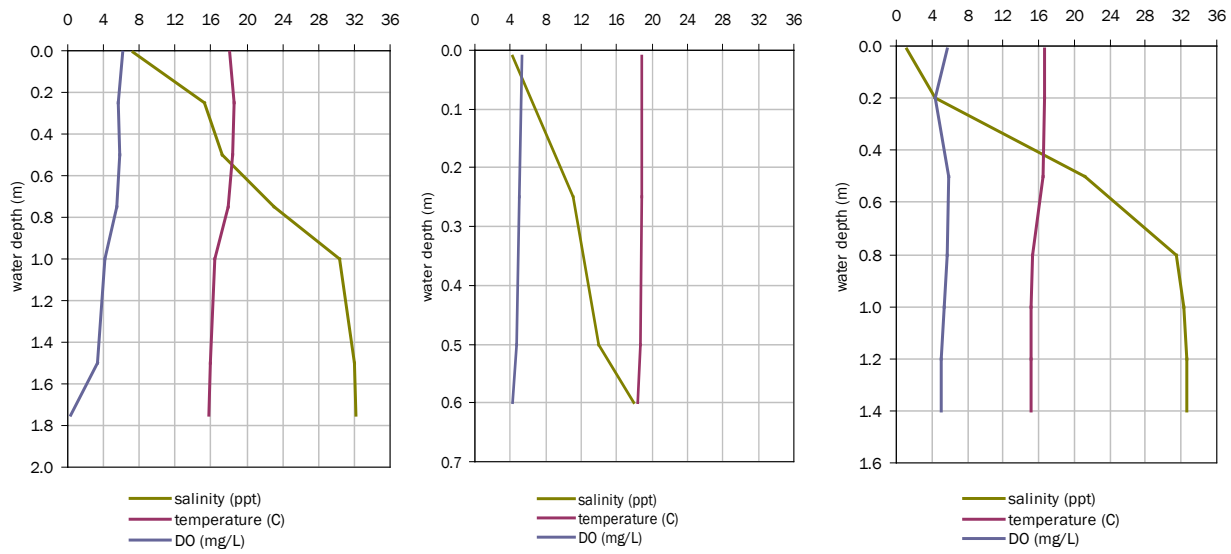
Both CPUE and abundance estimates have varied substantially between locations on any sampling date and between sampling dates. Part of the variability in steelhead abundance in the lagoon may be related to overall abundance of juvenile steelhead in the San Lorenzo River watershed as a result of differential spawning, incubation, emergence, and early rearing success. Variability in catch also results from movement of fish into and out of the lagoon in response to changing habitat conditions and life history timing.

While abundance of rearing juvenile steelhead in the lagoon at any particular time may be influenced by a number of factors, lagoon inflow and/or sandbar closure and associated water quality parameters likely play an important role. Water quality conditions at the time of steelhead population sampling provide an indication of what conditions may or may not be tolerable for steelhead in the lagoon.

Vertical profiles of temperature, DO and salinity measured in the lagoon on or about the dates of steelhead monitoring indicate highly variable conditions at locations where steelhead were captured. Steelhead juveniles were relatively abundant at the railroad bridge on July 6, 2004 with a catch rate of 24.5 steelhead per seine haul and an open lagoon. Temperature was relatively moderate at 18°C or less but DO was low, 6 mg/l or less, and salinity was high, about

8 ppt at the surface and increasing to 15 ppt at a depth of about 8 inches and about 30 ppt at a depth of 3 feet (Figure 2-12a).

Figure 2-12: Water Quality Parameters Measured in the San Lorenzo River Lagoon at Selected Locations and Dates



a). WQ Site 2 July 6, 2004 b). WQ Site 5 July 6, 2004 c). WQ Site 2 August 15,2005

Source: 2NDNATURE

Steelhead were also abundant at Riverside Bridge (Site 5) on that date with a catch rate of 62 fish per haul. Temperature was comparable to the Railroad Bridge site and salinity was somewhat less, but DO was lower, declining from about 5 mg/l at the surface to about 4 mg/l at a depth of about 2 feet (Figure 2-12b).

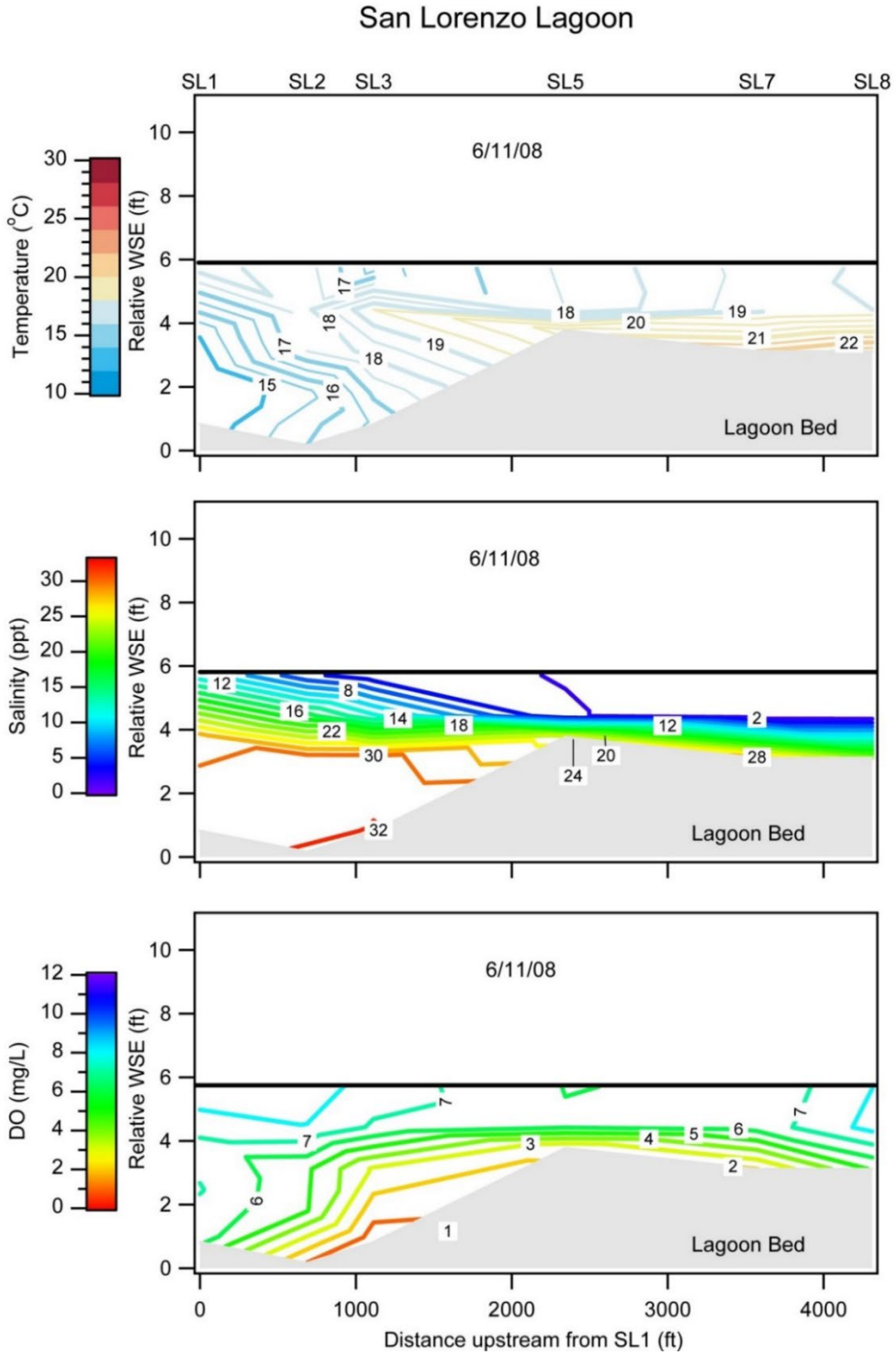
On August 15, 2005, the lagoon was open and had not closed yet during the season. The catch rate for steelhead was the highest of any of the surveys at 179.5 per haul. These fish were at a location with relatively cool temperature but high salinity and low DO (Figure 2-12c). Salinity, while relatively fresh at the surface increased to 4 ppt at about 8 inches of depth and over 14 ppt at about 1.3 feet of depth. DO was less than 6 mg/l throughout the water column.

In early June 2008, steelhead population sampling was conducted in an open lagoon at a number of locations but juvenile steelhead were captured at only one location, near the railroad bridge in

the lower part of the lagoon (Site SL2). Water quality monitoring at sites throughout the lagoon on June 11 revealed that this location had cooler temperature and higher DO than other locations, but also higher salinity (Figure 2-13).

These data indicate that depth is also a factor in suitability of habitat parameters for steelhead. Often, well-oxygenated, low-salinity water of suitable temperature can be found at a site, but only in the uppermost surface layer of water. At the surface, rearing steelhead are exposed to predation, particularly to the many fish-eating birds present in the lagoon. Suitable conditions of temperature, salinity, and oxygen at a depth of several feet would likely be much preferable to the same conditions at shallower depths. Cover in the form of large tree trunks or other structures may moderate the need for greater depth. This is complicated by the fact that the major prey items for rearing steelhead, such as gammarid amphipods, neomysis, and other invertebrate prey tend to be associated with the lagoon bed and are also sensitive to water quality parameters, particularly low DO.

Figure 2-13: Water Quality Parameter Values in the San Lorenzo River Lagoon Measured on June 11, 2008



Source: 2NDNATURE

As mentioned previously, lagoon inflow from the San Lorenzo River and sandbar closure are key variables influencing water quality conditions and suitability of the lagoon for rearing juvenile steelhead (2ndNature and HES 2016). Years with highest lagoon inflow (>20 cfs average August flow) had longer periods with an open lagoon (including micro-tidal) and, with the exception of 2011, supported the highest abundance of rearing juvenile steelhead observed (Table 2-17). The driest years (< 8 cfs average inflow in August) had the highest frequency of closed lagoon conditions and the lowest abundance of *O. mykiss*, including two years when none were detected after July. Years with intermediate levels of inflow varied in years had lagoon closure ranging from 11% to 67% (Table 2-17). The year with most extensive closure (67% in 2013) in this intermediate group also had the lowest CPUE for steelhead and the lowest growth rates while the year with least amount of closure (2016) had the highest *O. mykiss* abundance in the intermediate inflow group and relatively high growth rates. Extended lagoon closure in 2013, 2014, and 2015 was associated with high temperature conditions, temperature frequently in excess of lethal levels, and the apparent absence of steelhead in the lagoon by fall.

Table 2-17: Comparison of Lagoon Inflow and Sandbar Closure to Steelhead Population Variables

	Water Year precipitation (in)[1]	August Average daily San Lorenzo River discharge to Lagoon (cfs) [2]	Number of days sand bar closed May 15 to Oct. 31 (168 days in period)[3]	Number of days microtidal May 15 to Oct. 31 (168 days in period)[4]	Steelhead Fall CPUE	Steelhead Fall Population Estimate	Steelhead Average Growth Rate (mm/day)	Steelhead Average Growth Rate Range (mm/day)
2017	92.3	27.8	22 (13%)	10 (5.9%)	328.5	>3636	0.46	0.02-0.86
2011	62.2	25.8	11 (7%)	35 (21%)	2.5	138		0.5-0.7
2005	64.8	22.1	0 (0%)	56 (33%)	15.7	4000-5000		0.4-0.9
2010	48.9	12.4	60 (37%)	18 (11%)	28.2			
2016	48.6	9.7	19 (11.2%)	114 (67.5%)	7.8	1331	0.9	0.45-1.14
2013	36.2	9.5	114 (67%)	12 (7%)	4.7		0.34	0.27-0.41
2012	34.4	9	54 (32%)	25 (15%)	14.4	714	0.72	0.58-0.84
2018	29.0	8.7	102 (61%)	6 (3.6%)	6.3	704	0.39	0.26-0.49
2004	35.5	6.8	45 (27%)	20 (12%)	0.1			
2015	35.5	4.1	149 (88%)	N/A	0	0	N/A	N/A
2008	39.6	2.3	97(57%)	15 (9%)	0.1			
2009	36.5	2.1	87 (51%)	13 (8%)	0.5			
2014	24.5	1.9	151 (89%)	N/A	0	0	N/A	N/A

Source: 2ndNature 2019, HES 2019

N/A - not available, no monitoring performed, or limited data

[1] Precipitation data provided by the County of Santa Cruz from the Felton Diversion rain gage station.

[2] Hydrology data from USGS gage #11161000, San Lorenzo River at Santa Cruz.

[3] Sandbar closure is determined from visual observations and the derivative of YSI depth data (dz/dt), using parameters established in CLEAP.

[4] Microtidal conditions occur when the sandbar is partially present, reducing surface water exchange to every few days and water circulation within the lagoon is limited. It is determined using visual observations and the derivative of YSI depth data (dz/dt), using parameters established in CLEAP.

There are exceptions to this pattern which also provide interesting insights. In 2018, closure was extensive (61%) and growth rates were relatively low but abundance in the fall was relatively high. Abundance was also relatively high in June of that year (third highest CPUE, Table 2-15) but dropped to lower levels later in the summer after lagoon closure, particularly in July when the lagoon was warmest. A number of *O. mykiss* moved out of the lagoon and upstream in the

San Lorenzo River after mid-June as documented by observations of PIT tagged fish at the Felton Diversion in July and August (HES 2019). Also, a group of large (260mm FL to 390mm FL) *O. mykiss* appeared in the catch in September but had not been seen earlier in the summer except for a few individuals in June. These fish may have recently entered the lagoon from the ocean as all had an external appearance characterized as adult/ocean and three of them had sea lice (possibly *Lepeophtheirus salmonis*) (HES 2019).

Fall abundance of *O. mykiss* was lower in 2011 than other high-inflow years and there was indication that many fish may have left the lagoon for the ocean during the extensive open lagoon period. Abundance in June 2011 was high and comprised a large number of larger fish and a high percentage of smolts (25%). *O. mykiss* with the external appearance of smolts were also present in October, a highly unexpected occurrence (HES 2012) as were a number of larger fish, several with sea lice indicating recent return from the ocean (several Chinook salmon were also captured in October).

Fall abundance estimates may be influenced by movement of large juvenile/small adult *O. mykiss* into the lagoon from the ocean in years when the lagoon has been open around the time of the fall survey (HES lagoon survey reports 2012-2019). This has been described above for 2018 and 2011. In all years from 2011 to 2019, except 2014 and 2015 when the lagoon was closed and no *O. mykiss* were captured, large *O. mykiss* of 250-400 mm length (10 to 16 inches) and the external appearance of ocean fish (very silver, deep body) have been captured in the lagoon in the fall. The presence of sea lice was observed on some of these fish in 2011, 2012, 2013, 2018, and 2019. The appearance of these fish in the lagoon was associated with the capture of Chinook salmon in 2011 and 2012, and pink salmon in 2019. The movement of large fish into the lagoon in the fall has also been indicated by a shift in the length frequency distribution with a group of larger *O. mykiss* appearing in the catch after a breach event (2012) or appearing in the fall survey but not present in August (2013, 2016, 2018). In addition, an *O. mykiss* tagged in Laguna Creek lagoon on September 20 was recorded at Felton on November 8. This fish was 159mm FL at the time of tagging. It would have left Laguna lagoon after it opened October 15 and entered the San Lorenzo lagoon, also mostly open after October 14. The reproductive status (juvenile, adult) of any of these individuals is not known.

In summary, observed abundance of *O. mykiss* in the lagoon has been highest in years with high rainfall and lagoon inflow and extended open sandbar conditions. Abundance has been very low in years of low rainfall and lagoon inflow with extended closed sandbar conditions. There is both direct and indirect evidence that juvenile or small adult *O. mykiss* enter the lagoon in the early fall (September) when the mouth is open after spending a short time in the ocean.

Steelhead will not necessarily perish under poor conditions in the lagoon but may move upstream to habitat in the lower San Lorenzo River where water quality conditions are more favorable. Lower food resources and rearing capacity in upstream areas may result in lower smolt production than potentially occurs in the lagoon under favorable conditions. Movement of *O. mykiss* from the lagoon to upstream areas has been documented by observations of PIT tagged fish at an instream antenna installed just downstream of the Felton Diversion Dam by the NOAA Southwest Fisheries Science Center. The antenna has been operational since October 2015 (Table 2-18).

In each of the three years when the antenna has been operational, fish tagged in the lagoon have migrated upstream beginning as soon as the same month they were tagged. Two of the fish tagged in June 2016 were observed at the Felton Diversion that same month and 6 more were observed at the Felton Diversion in July. The majority of observations of lagoon-tagged fish has been in November and December of the year in which they were tagged. This is suggestive of a potadromous or estuary migrating life history strategy. The portion of tagged fish observed at the Felton Diversion in the first season after tagging has ranged from 5% in 2018 to 22% in 2016. Other lagoon-tagged fish have first appeared at the Felton Diversion Dam during the typical winter spawning season (December through April) one to two years after being tagged, indicative of the typical steelhead anadromous life history (Table 2-18).

Table 2-18: Number of Lagoon-Tagged Steelhead Observed at the Felton Diversion by Tag Date and Date of First Appearance at the Felton Diversion

Date Initially Observed at Felton		Date Tagged									Total
		2016		2017				2018			
		Jun	Sep	Jun	Jul	Aug	Sep	Jun	Aug	Sep	
		Number Tagged									
		405	190	667	157	121	314	551	46	202	
2016	Jun	2									2
	Jul	6									6
	Aug	1									1
	Sep										0
	Oct	11									11
	Nov	59	29								88
	Dec	15	5								20
2017	Jan										0
	Feb		1								1
	Mar		1								1
	Apr		1								1
	May										0
	Jun										0
	Jul			3							3
	Aug			2	1						3
	Sep			1							1
	Oct										0
	Nov			40	13	8	13				74
	Dec					1					1
2018	Jan			8	1	1					10
	Feb						1				1
	Mar	3	1				1				5
	Apr			1							1
	May										0
	Jun										0
	Jul							12			12
	Aug							3			3
	Sep										0
	Oct										0
	Nov							4	1	8	13
	Dec							4		9	13
2019	Jan	1	2					1		2	6
	Feb		1	2	1			1		1	6
	Mar			2	1			2		1	6
	Apr			2			1			1	4
Total		98	41	61	17	10	16	27	1	22	4

Source: Felton Diversion tag recoveries provided by NOAA Southwest Fisheries Science Center

Lagoon inflow and sandbar closure also influences other aspects of the lagoon ecosystem, including the types and abundance of available forage resources for juvenile steelhead. Martin (1995) found that prey types and feeding levels vary in response to open or closed lagoon conditions in the Pescadero Creek Lagoon (San Mateo County). Although the sample sizes and sample dates are somewhat limited, Martin concluded that when the lagoon mouth was open and the estuary was open to tidal action, steelhead in both the upper and lower parts of the estuary fed heavily on euryhaline species, including amphipods (*Corophium* and *Eogammarus*), mysid shrimp (*Neomysis*), and isopods (*Gnorimosphaeroma*), when tidal inflows boosted their populations. After sandbar formation and the lagoon mouth closed, populations of marine and euryhaline invertebrate species declined and fish often shifted much of their diet to the rising populations of freshwater dependent species. However, based on observations of stomach fullness, steelhead appeared to feed more heavily while the lagoon was open to tidal action or immediately after closure. This was true for steelhead collected in both the upper and lower lagoon (Martin 1995). Martin concludes that steelhead find abundant food throughout the lagoon when it is open to full tidal mixing but that, after sandbar closure food appears to be most available at sites where there is freshwater, abundant pondweed, and where freshwater and euryhaline invertebrates are abundant. This is consistent with distribution of steelhead in the Navarro River Lagoon discussed previously (Cannata 1998). Steelhead forage organisms were surveyed in the San Lorenzo River Lagoon as part of the CLEAP study (2ndNature 2006) in 2004. During extended closure of the San Lorenzo River Lagoon during late summer, significant blooms of dinoflagellates were observed, and the zooplankton community was dominated by large numbers of very small copepod cells. Smaller size zooplankton are likely less suitable as a food source for rearing steelhead (2ndNature 2006).

In a survey of several Central California lagoon systems, Smith (1990) concluded that juvenile steelhead survival and growth was excellent when lagoons were open to full tidal mixing and when the closed lagoons were converted to freshwater. Growth was poor during long, stratified transition periods between sandbar closure and conversion of the lagoon to freshwater.

Growth rates of steelhead rearing in the San Lorenzo River Lagoon were measured based on recaptures of tagged fish during the CLEAP study in 2005 (Table 2-19). In spite of water quality parameter levels that, at certain times and locations, were often outside the range generally thought suitable for steelhead, juvenile steelhead maintained relatively good growth rates through the summer of 2005. Average growth rates were 0.4 to 0.9 mm per day in August, September, and October (2ndNature 2006). Growth rates of steelhead in the San Lorenzo River Lagoon were generally higher than those in Aptos, Soquel, and Laguna lagoons during the same period though not as high as in Scott Creek (2ndNature 2006). Growth rates were also measured

by HES in 2012 through 2018. Growth rates were highest in 2012 and 2016. Both years had relatively high inflow (average August flow of 9 cfs in 2012 and 9.8 cfs in 2016, see Table 2-12) and were closed less than 50% of the time. The 2012 season had frequent open conditions with numerous breaches and short periods of closure (HES 2013). In 2016 the lagoon also underwent a pattern of filling and breaching throughout the summer (HES 2017) but the lagoon outlet formed a long channel to the west along the beach and breaches were relatively controlled with stage never dropping lower than 3 to 4 feet (National Geodetic Vertical Datum of 1929 (NGVD 29) and little, if any, tidal influx.

Table 2-19: Steelhead Growth Rates in the San Lorenzo River Lagoon

Year	N	Average June-Sept Growth (mm/day)	Range June-Sept Growth (mm/day)	September CPUE
2005			0.4-0.9	
2012	5	0.72	0.58-0.84	14.4
2013	2	0.34	0.27-0.41	4.7
2014	None captured			
2015	None captured			
2016	21	0.90	0.45-1.14	7.8
2017	40	0.46	0.02-0.86	328
2018	10	0.39	0.26-0.49	6.3

Source: data from 2NDNATURE 2006, Ellen Freund (NMFS), HES 2013, HES 2014a, HES 2015, HES 2016, HES 2017, HES 2018, and HES 2019)

Inflow was also high in 2017, with August average flow of 27.8 that kept the lagoon mostly open through the summer, but growth rates were lower than 2012 and 2016 (ANOVA single factor, Tukey HSD, $\alpha<0.01$). Abundance of *O. mykiss* in the lagoon was unprecedented in 2017 (Table 2-16) and there may have been density dependent growth depression.

Growth rates in 2013 and 2018 were comparable to 2017 but lower than 2012 and 2016 (ANOVA single factor, Tukey HSD, $\alpha<0.01$).[24] Inflows were similar to 2012 and 2016 (9.4 in 2013 and 8.7 in 2018) but the lagoon was mostly closed with only a few, short-duration breaches (HES 2014b, HES 2019, 2ndNature 2014, 2ndNature 2019). Growth rates were not measured in 2014 and 2015 since *O. mykiss* did not persist in the lagoon over the summer. Only a few fish were tagged in June and no fish were captured in the lagoon in the fall. Inflows were very low in

[24] The sample size was low in 2013 and may not have adequately represented the population as a whole.

both years with average August flow in the San Lorenzo River at the Tait Street Diversion of 1.9 cfs in 2014 and 4.2 cfs in 2015. The lagoon was closed most of the summer in both years. Water temperature during surveys was very warm in both years (HES 2015, HES 2016). Surface DO levels had also declined intermittently to levels below 2 mg/l during the late-July and early-August period in 2014 (2ndNature in prep.).

To provide some perspective, Cannata (1998) reported average growth rate of 0.13 to 0.61 mm/day between June 1 and November 16, 1996 in the Navarro estuary compared to 0.40 to 0.90 in the San Lorenzo estuary in 2005. Growth rates in the San Lorenzo estuary in 2005 were also higher than those reported by Cannata for the Mattole River estuary (maximum of 0.40 mm/day) (Cannata 1998 citing Zedonis 1992).

In summary, *O. mykiss* growth rates in the San Lorenzo Lagoon can be high but are quite variable and appear to be related to patterns of lagoon inflow and sandbar closure. When inflow was low, as in 2014 and 2015, the lagoon is closed for extended periods and growth rates of *O. mykiss* are low. At higher inflow levels, as in 2012, 2013, 2016, and 2018, growth rates were high in years when the lagoon was mostly open during the summer with periods of brief closure (2012) or closed with frequent breaches but little tidal inflow (2016). Growth rates were low in years with extended lagoon closure (2013 and 2018). In 2017, when inflow was very high and the lagoon was open and tidal for most of the summer, growth rates were also low but this may have been a density dependent effect due to the unprecedented population levels that year.

Peak abundance estimates for steelhead rearing in the San Lorenzo River Lagoon were more than 3,636 in 2017 and 4,000 to 6,000 during late summer 2005. To provide some context: Cannata estimated approximately 9,000 steelhead rearing in the Navarro River estuary in 1997. The Navarro River estuary is significantly larger than the San Lorenzo River Lagoon. The lower three miles of the estuary channel is about 93 acres (Cannata 1998) while the San Lorenzo River Lagoon has a surface area of 34 acres when closed. The Navarro is also a larger watershed at 303 square miles compared to 136 square miles for the San Lorenzo. Jankovitz reported population estimates ranging from 914 to 7,300 for steelhead rearing in the 296-acre Pescadero Creek Lagoon complex (San Mateo County California) which has an 81 square mile watershed, during multiple sampling events in 2018 (Jankovitz and Diller 2019). That same year, population estimates in the San Lorenzo Lagoon ranged from 2378 in June to 704 in September. While steelhead abundance in any watershed may fluctuate widely from year to year, it appears that the San Lorenzo Lagoon at least has the potential to support a healthy number of rearing steelhead under the right conditions.

Overall conclusions relevant to conditions in the San Lorenzo Lagoon for rearing steelhead that can be drawn from these data and other results of the CLEAP study include the following:

- San Lorenzo Lagoon habitat has been highly altered and is missing components favorable to steelhead rearing such as fringing marsh vegetation, riparian canopy, and cover such as large fallen tree trunks. Unlike the Scott Creek and Laguna Creek Lagoons, which have transition zones between freshwater and saltwater characterized by emergent vegetation and gravel substrate, the San Lorenzo River Lagoon has little to no emergent vegetation in this zone and sand substrate.
- Eutrophication is advanced in the lagoon. Eutrophic conditions are created by excess availability of DIN, the limiting nutrient in CLEAP study lagoons. Compared to the other CLEAP study lagoons, the seasonal loading of DIN to San Lorenzo River Lagoon is high.
- Vertical water column stratification due to either salinity or temperature induced density differences accelerates depletion of oxygen in bottom waters. Lagoon closure and/or conversion to freshwater does not necessarily eliminate water column stratification since temperature induced stratification can still occur.
- The water quality in San Lorenzo Lagoon is typically poorer during reduced circulation conditions (micro tidal and/or closed). High solar exposure, elevated DIN inputs, and large areas of deep water result in persistent density stratification during reduced circulation regimes coincident with low DO levels and elevated chlorophyll levels. Immediately following initial lagoon closure bottom water temperature typically increases and DO, pH and ORP all decline.
- Observed abundance of *O. mykiss* in the lagoon has been highest in years with high rainfall and lagoon inflow and extended open sandbar conditions. Abundance has been very low in years of low rainfall and low lagoon inflow with extended closed sandbar conditions.
- A variable portion of the lagoon population of *O. mykiss* move from the lagoon to upstream areas beginning in the summer and peaking in November. This is suggestive of a potadromous or estuary migrating life history strategy. There are also indications that, under certain conditions, juvenile or small adult *O. mykiss* enter the lagoon in the early fall (September) after spending a short time in the ocean.
- *O. mykiss* growth rates in the San Lorenzo Lagoon can be high but are quite variable and appear to be related to patterns of lagoon inflow and sandbar closure.

These data suggest that the relationship between lagoon closure, inflow, and conditions for steelhead rearing may be quite complex and variable as are patterns of use by rearing juvenile *O. mykiss*. The following are implications for management actions:

- A minimum lagoon inflow of at least 8 cfs appears to promote habitat conditions conducive to steelhead rearing although peak abundance has occurred at higher levels of inflow.
- An open lagoon with tidal exchange and/or inflows of 20 cfs appears to provide optimum conditions for rearing steelhead.
- Habitat conditions deteriorate after 2-3 days of lagoon closure. If inflow and sandbar status are such that the lagoon enters fill and spill cycles with periods of 1-2 weeks, conditions will be very poor for steelhead rearing. There may be an exception if the sandbar elevation is perched and tidal exchange is limited as occurred in 2016.
- Opening the lagoon for flood control, if needed, should be conducted to avoid full drawdown of the lagoon and minimize the potential for tidal inflows by controlling the release of the lagoon to a predetermined level and ensuring immediate closure of the lagoon following drawdown.
- Installation of the culvert project to maintain the lagoon elevation below a level that results in flooding should be operated in a way to avoid early closure of the lagoon, ensure timely opening of the lagoon in the fall, and ensure an open lagoon whenever it would occur in the absence of the project.
- There is evidence of life history diversity in the San Lorenzo River involving movement of steelhead between the lagoon and the ocean that occurs outside the commonly accepted smolt seaward migration (March through May) and adult upstream migration windows (December through March or April). This life history diversity should be protected by allowing open lagoon conditions for migration when it would occur in the absence of management actions and when it does not lead to unfavorable water quality conditions in the lagoon.
- Movement of steelhead from the lagoon to upstream rearing areas in the middle and upper mainstem San Lorenzo may be an important life history feature for part of the population and should be protected.
- Greater knowledge of steelhead and coho life history patterns in the San Lorenzo system and their response to variable habitat conditions would improve species conservation.

2.4.3.2 Habitat Conditions Newell Creek

Newell Creek supports resident rainbow trout populations and steelhead and is within the critical habitat designation for steelhead. No coho have been observed in Newell Creek during annual surveys conducted by Santa Cruz County, the City of Santa Cruz, and others since at least 1994 (Don Alley personal communication to Chris Berry, 2020). Since Newell Creek is within the

critical habitat designation for coho and since it has a relatively high intrinsic potential value[25] (NMFS 2012), the anadromous reach of Newell Creek is considered potential habitat for coho and is managed accordingly under the HCP.

Watershed/hydrology

Newell Creek is a third order tributary to the San Lorenzo River, joining the San Lorenzo River at Ben Lomond. The City's Water Department maintains a 190-foot-high earthen dam (completed in 1960) on Newell Creek about 1.7 miles upstream from the San Lorenzo River confluence. The entire Newell Creek watershed is about 9.9 square miles and Loch Lomond Reservoir captures runoff from approximately 8.3 square miles (ENTRIX, Inc. 2004b). The reservoir capacity is 8,991 acre-feet (ENTRIX, Inc. 2004b). The watershed upstream of Newell Creek Dam is rural open space with no significant residential or commercial developments (ENTRIX, Inc. 2004b). The Loch Lomond Recreation Area (LLRA) owned by the City and operated by the City's Water Department occupies 425 acres adjacent to the reservoir. The LLRA is managed for water quality as well as recreational benefits. The City also owns the Newell Creek Watershed Lands, which comprise 2,880 acres adjacent to Loch Lomond Reservoir and the LLRA (ENTRIX, Inc. 2004b). Downstream of the reservoir, Newell Creek is bordered by residential development in the first 0.9 miles from its confluence with the San Lorenzo River and relatively undisturbed in the remaining 0.8 miles. See Figure 1-5: Newell Creek Watershed Map.

Above the reservoir, the highest monthly average flows occur in February and the lowest flows occur in September (Figure 2-13). Average February flow during the hydrologic record (1936-2015) ranges from 3.6 in critical dry years to 69.9 in wet years. In September, average flow has ranged from 0.3 cfs in critical years to 0.9 cfs in wet years (Confluence Model Output, Gary Fiske and Associates, Inc.).

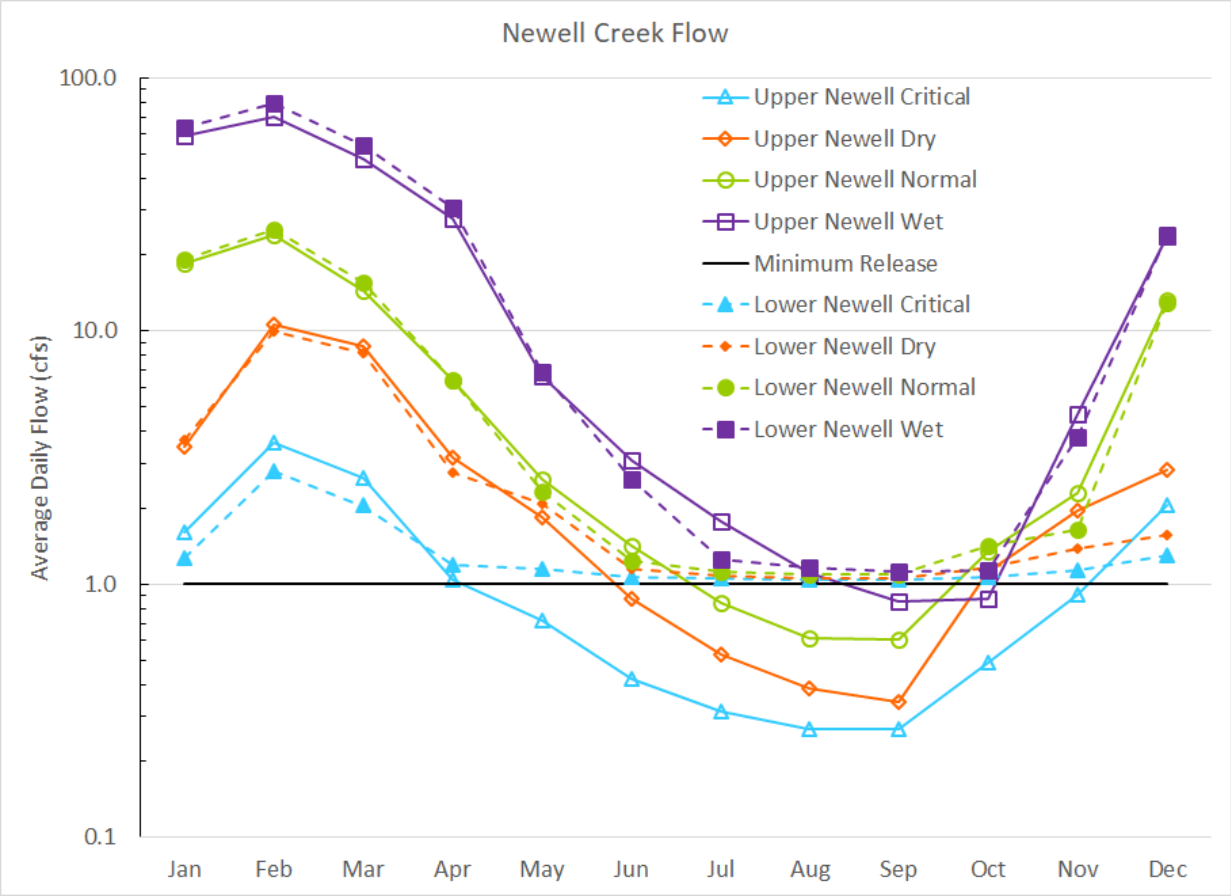
Flows downstream of Loch Lomond Reservoir are influenced by reservoir inflow and storage conditions. Standard facility operations for Newell Creek include a year-round minimum release requirement of 1 cfs below Newell Creek Dam. During the fully appropriated season (as defined by the California Water Resources Control Board), there is a requirement that the greater of 1 cfs or the natural flow of Newell Creek must be released.

Hydrologic modeling indicates that the operation of the reservoir results in a slight reduction in average flows through the anadromous reach (compared to reservoir inflows) during the early

[25] IP values represent the historical potential of channel width, mean annual discharge and gradient to provide suitable habitats and support higher abundances of coho salmon (Agrawal et al. 2005).

part of the rearing period in critical and dry years, and in an augmentation of average flows during the summer rearing period due to the 1 cfs minimum release (Figure 2-13). Flow augmentation is highest (begins earlier) in critical years, and lowest in wet years. During critical dry years, the 1 cfs release requirement augments the natural flow throughout the rearing period and essentially doubles the median reservoir inflow from June through October.

Figure 2-14: Inflow to Loch Lomond Reservoir from Upper Newell Creek and Release to Lower Newell Creek for 1937-2015 Water Years



Source: Data from Gary Fiske and Associates, Inc.

During periods of high runoff, the reservoir fills and spillway releases result in downstream flows that are similar to reservoir inflow levels, in addition to a small contribution from the small watershed area downstream of the dam. City records for the period 1961 to 2008 indicate that the reservoir has spilled during 34 out of the 56 years (Table 2-20). In those years, the first spill occurred in December in 6 years, January in 12 years, February in 9 years, March in 3 years, and

April in 1 year. No spill occurred in 22 of the 56 years of record. During the dry period from 1985 to 1994, there was no spill in 8 out of 10 years, including six consecutive years from 1987 through 1992.

Table 2-20: Record of Spill at Newell Creek Dam

Year	Spill	End of Spill	Second Spill	Second End of Spill
1961	No Spill			
1962	No Spill			
1963	4/24/1963	7/5/1963		
1964	No Spill			
1965	1/14/1965	5/19/1965		
1966	No Spill			
1967	1/30/1967	6/15/1967		
1968	3/24/1968	5/28/1968		
1969	1/20/1969	5/27/1969		
1970	1/25/1970	4/1/1970		
1971	No Spill			
1972	No Spill			
1973	2/13/1973	4/10/1973		
1974	3/17/1974	5/11/1974		
1975	No Spill			
1976	No Spill			
1977	No Spill			
1978	2/9/1978	5/9/1978		
1979	3/27/1979	4/15/1979		
1980	1/18/1980	4/18/1980		
1981	No Spill			
1982	1/19/1982	5/17/1982	12/23/1982	
1983		5/25/1983	12/31/1983	
1984		2/10/1984		
1985	No Spill			
1986	2/17/1986	5/11/1986		
1987	No Spill			
1988	No Spill			
1989	No Spill			
1990	No Spill			
1991	No Spill			
1992	No Spill			

1993	2/19/1993	3/2/1993		
1994	No Spill			
1995	1/28/1995	6/3/1995		
1996	2/15/1996	3/18/1996	12/31/1996	
1997		3/2/1997		
1998	2/3/1998	4/30/1998	6/1/1998	6/10/1998
1999	2/6/1999	6/9/1999		
2000	2/10/2000	4/23/2000		
2001	No Spill			
2002	1/9/2002	5/19/2002	12/22/2002	
2003		3/10/2003	3/16/2003	5/22/2003
2004	1/4/2004	4/28/2004		
2005	1/8/2005	6/1/2005	12/22/2005	
2006	12/22/2005	5/28/2006		
2007	No Spill			
2008	2/4/2008	4/14/2008		
2009	3/16/2009	4/23/2009	5/3/2009	5/9/2009
2010	1/20/2010	4/28/2010		
2011	1/6/2011	6/19/2011		
2012	3/17/2012	5/6/2012	12/23/2012	
2013		4/12/2013		
2014	No Spill			
2015	No Spill			
2016	3/13/2016	4/6/2016	4/22/2016	4/30/2016
2017	1/4/2017	5/11/2017	5/16/2017	5/24/2017
2018	4/1/2018	5/12/2018		
2019	2/3/2019	6/29/2019		
2020	No Spill			
2021	No Spill			

Instream Habitat

There are three distinct reaches of Newell Creek downstream of Loch Lomond Reservoir, each with different aquatic habitat characteristics and fish populations (HES 2007). A lower reach, approximately 0.85 miles in length, consists of relatively low gradient, gravel/cobble stream

channel that is accessible to anadromous fish and supports steelhead/rainbow trout and Pacific lamprey. A middle reach, of approximately 0.59 miles in length, is dominated by bedrock substrate that occurs in frequent shelves or steps of a few inches to a few feet in height. This middle reach supports *O. mykiss*, primarily in the lower part of the reach, which may be either anadromous or resident. The bedrock formations in this reach present numerous potential migration obstacles that may present barriers to migration in certain flow ranges. (HES 2014b, Hagar et al. 2017b). The uppermost reach begins about 1.45 mile upstream from the San Lorenzo River and continues for about 0.3 miles to the low water crossing at the spillway pool. This upper reach is relatively low gradient with predominantly gravel/cobble substrate but less suitable habitat for *O. mykiss*, which includes less extensive and shallower pools, less instream cover, and less potential spawning area than the lowermost reach. There is a very sparse population of *O. mykiss* in the uppermost reach, likely a resident (non-anadromous) population, with apparently low levels of production and/or low reproductive success (HES 2007).

Construction of Newell Creek Dam has had a major influence on instream habitat conditions downstream of the Dam. Residential development along the banks in the lower reach has also had detrimental effects. The dam has prevented the downstream movement of sediment and fallen trees into the lower reach. All gravel and cobble sediments that form habitat for spawning and rearing and all input of large wood objects (LWO) derived from fallen trees derives from inputs downstream of the dam. Disruption of sediment input to the upper and bedrock reaches has resulted in incision of the bed, diminishment of gravel and cobble substrate preferred by steelhead and coho, loss of recruitment of habitat forming LWO, and possibly led to greater exposure of bedrock outcroppings which limit pool depth and present migration obstacles (Holley 2010). Continued trapping of sediment behind the dam will result in continued acceleration of channel incision. The lower reach has also been severely impacted by channel incision but is more resilient due to the lower-gradient, alluvial nature of the channel and has the most intact salmonid habitat and the greatest potential for improvement (Holley 2010). In addition to channel incision, bank stabilization to protect riparian development has prevented lateral migration from recruiting LWO and cobble/gravel substrate, and incision has disconnected the channel from whatever floodplain may have existed before anthropogenic alterations (Holley 2010).

Migration Barriers

A bedrock chute downstream of Newell Creek Dam is judged to be a complete barrier to coho and a temporal barrier and practical limit of anadromy for steelhead (Hagar et al. 2017b). This bedrock chute is approximately 1 mile upstream from the confluence of Newell Creek with the San Lorenzo River and approximately 0.7 miles downstream from Newell Creek Dam (Figure 1-5). The chute occurs in a longer section of stream dominated by bedrock substrate and having

numerous bedrock shelves beginning about 0.85 miles upstream of the San Lorenzo River confluence. These bedrock shelves also limit the ability of steelhead or coho to migrate upstream and may make upstream areas inaccessible at certain flow levels (HES 2014b). During reconnaissance surveys in May 2006 at a flow of about 5 cfs, minimum thalweg depth on many of these shelves was only 0.1 to 0.2 feet (Hagar, personal observation).

A hydraulic survey conducted by HES at the bedrock chute concluded that an adult steelhead would not be able to leap the chute and that its ability to swim over it would be limited by shallow depth of flow and high velocity, but may be possible for a fish in peak condition at a flow in the range of about 200 to 325 cfs (HES 2014b). The survey also concluded that it is unlikely that adult coho would be able to pass this obstacle at any flow (HES 2014b). This is consistent with the previous assessment by Don Alley (Alley et al. 2004). On April 11, 2017, a team of biologists representing NOAA Fisheries, CDFW, and the City conducted a site visit at the bedrock chute. The team confirmed the HES assessment although there were different opinions about the level of flow that might be needed for passage (Hagar et al. 2017b).

In addition to the bedrock chute, other potential barriers have been identified during a high-resolution bathymetry survey in the inundation zone of Loch Lomond Reservoir (Hagar et al. 2017b). The survey, completed in 2008 with a 2-foot contour interval, shows two steep sections of 18% and 30% gradient located 1,700 feet and 2,000 feet upstream of the fish release (the point where flow is released to Newell Creek from Loch Lomond Reservoir). These locations seem to present even more severe obstructions than the bedrock chute 0.7 miles downstream of the dam. The lower feature has a 6-foot elevation gain over a 32-foot distance; the upper has an 8-foot elevation gain over a 26-foot distance. Separately or in combination, these features would have severely limited and likely precluded passage of steelhead and coho to upstream habitat (Hagar et al. 2017b).

Habitat conditions between the bedrock chute and the dam are not that good for steelhead. During habitat surveys conducted in 2007, it was found that the bedrock dominated reach (where the bedrock chute is located) and the upstream reach below Newell Creek Dam had markedly less instream cover and less potential spawning area than did the lower reach (HES 2007). The uppermost reach had the least suitable habitat for *O. mykiss*, including less extensive and shallower pools, less instream cover, and less potential spawning area. Abundance of *O. mykiss* in both visual surveys during the habitat assessment and in electrofishing surveys dropped off markedly in the upper half of the bedrock reach (beginning upstream of the bedrock feature) and in the uppermost reach (HES 2007).

Riffles in the lower 0.85 miles of Newell Creek may also impede passage of adult salmonids under low flow conditions. During reconnaissance surveys in May 2006 at a flow of about 5 cfs,

the minimum thalweg depth in these riffles was generally 0.5 to 0.7 feet; although shallower riffles were only 0.4 to 0.5 feet deep (HES field notes May 11, 2006). These depth conditions would likely not meet migration criteria for adult steelhead or coho, nor would they be met during periods when the reservoir is not spilling and stream flow is at the 1 cfs minimum fishery release. HES conducted an assessment of the relationship between flow in Newell Creek and hydraulic conditions (depth and velocity) at four critical riffles in Newell Creek downstream of Rancho Rio Bridge (HES 2014b). This survey indicated that minimum passage criteria for steelhead and coho adults (a depth of at least 0.6 feet across 25% of the channel width and a continuous section of 10% of the channel width) would be met when flow in Newell Creek reaches 12.3 to 21.7 cfs or more. Minimum passage conditions for steelhead or coho smolts (a depth of at least 0.3 feet across 25% of the channel width) would occur at flows of 2.8 to 6.2 cfs or more.

Based on these assessments, the potential for migration passage for adult salmonids appears to be very limited at times when Newell Creek is not spilling. The hydraulic model results suggest that passage for smolts may also be limited at times when the reservoir is not spilling (see Chapter 5 for details on lifestage timing and analysis of passage thresholds and duration of suitable passage conditions). Historical operations have resulted in some reduction in spill frequency early in the migration season (December) in critical and dry years but have preserved migration opportunities later in the migration season and in normal and wet years (Figure 2-14). Future operations that maintain Loch Lomond Reservoir at higher levels would be beneficial due to higher potential for spill.

Spawning Habitat

Potential spawning area is most extensive in the lowermost reach of the three sub-reaches of Newell Creek downstream of Loch Lomond Reservoir (HES 2007). Substrate is dominated by gravel and small cobble in the lower and upper sub-reaches and by bedrock in the middle sub-reach. Gravel or cobble were the dominant substrate in 71% of habitat units in the lower sub-reach and 90% of habitats in the upper sub-reach. Bedrock dominated in 59% of habitat units in the middle sub-reach and gravel was dominant in 28%. Sand was found as a dominant substrate in 12% of habitat units in the lower sub-reach but not a dominant in any habitat units in either the middle sub-reach or the upper sub-reach (HES 2007). This may be due to either more disturbance from adjacent residential development, lower gradient, or both. In riffle type habitat units, gravel or cobble was the dominant substrate in both the lower and upper sub-reaches while bedrock (in the form of bedrock sheets) dominated in the middle sub-reach. There were, on average, 24 square feet of potential spawning area per 100 feet of stream surveyed in the lower reach compared to only 13 square feet in the bedrock reach and 10 square feet in the upper reach.

Pool tail and spawning gravel embeddedness[26] ratings were low to moderate in all surveyed sub-reaches of Newell Creek in August 2007 (HES 2007). Only a few pool tails had embeddedness ratings of more than 30% while 50% to 65% had embeddedness of 15% or less. Most spawning areas had embeddedness ratings of less than 30% and 70% of spawning areas in the lower and middle sub-reaches had embeddedness of less than 15%. These values are indicative of relatively low amounts of fine sediments in the substrate of Newell Creek relative to other Central California Coastal streams.

HES conducted an assessment of the relationship between stream flow and the amount of potential spawning habitat in Newell Creek during a brief period when the reservoir spilled during late February and early March 2008 and during more extensive spill in 2010 (HES 2014b). For steelhead, the spawning suitability index increases at relatively high rates up to 10 to 14 cfs; is high (at least 80% of the peak value) across a very broad range of flow between 13 and 38 cfs with a peak at about 24 cfs; and declines gradually at higher flows (HES 2014b). The spawning suitability index for coho tends to peak at slightly lower flows than for steelhead with the highest suitability at flows between 8 and 35 cfs (80% of the peak value) and a peak at 20 cfs.

An adult steelhead was seen at one of the spawning study sites in late February 2008 immediately after the only spill event of the winter. Numerous YOY steelhead were also seen at this location during a reconnaissance survey in May 2006. These observations suggest that steelhead are still supported in Newell Creek and that they may be dependent on spill events to persist. Spill events have been relatively common since the drought of the late-1980s and early 1990s, occurring in 18 of the 22 years from 1995 to 2016 (Table 2-13). The relatively small storage capacity of Loch Lomond Reservoir and the City's operational strategy of keeping the reservoir as full as possible have assured relatively frequent and extensive spill and resulted in a hydrograph in Lower Newell Creek that is very similar to the unimpaired hydrograph for Upper Newell Creek (Figure 2-13). This has led to maintenance of suitable spawning and migration habitat conditions for steelhead and coho even without explicit bypass flow requirements for these life stages.

[26] Embeddedness ratings are an indication of the degree to which the surface layer of larger substrate particles (cobble or large gravel) are embedded in fine sediments. Incubation and emergence success are influenced by accumulation of fine sediments (generally less than 3.3 mm) in the substrate. Embryo survival for steelhead decreases when the percentage of substrate particles less than 6.4mm reaches 25% to 30% and is extremely low when fines are 60% or more. Emergence of steelhead and coho fry is generally high when fine sediments are less than 5% of substrate volume but drops sharply with fine sediment volume of 15% or more (Bjornn and Reiser 1991). While embeddedness ratings are not a direct measure of percentage of fine sediment in the substrate, they are related.

Rearing Habitat

In surveys of Santa Cruz County streams during 1981, Harvey & Stanley Associates (1982) characterized rearing habitat quality for steelhead in Newell Creek as good at a site downstream of Glen Arbor Road (lower sub-reach) and below average to fair at sites further upstream, near the border of the middle and upper sub-reaches. Rearing densities of *O. mykiss* were good compared to other streams sampled that year. According to City records, the reservoir did not spill in 1981 (Table 2-13).

Conditions for rearing steelhead were found to be relatively good in a habitat survey conducted in August 2007 for the reach of Newell Creek between Loch Lomond Reservoir and the San Lorenzo River confluence (HES 2007). Conditions were better in the lowermost sub-reach than in the middle or upper sub-reaches. Pools made up approximately 40% of the lower and middle sub-reaches, by length, but only about 28% of the upper reach (HES 2007). The upper sub-reach was dominated by step runs, glides, and runs. The middle sub-reach had a higher proportion of riffles (primarily bedrock sheets) than the upper and lower sub-reaches. Pools were longer in the lower sub-reach than the other two reaches, averaging 85 feet in length compared to 59 feet in the middle reach and 57 feet in the upper reach. Pools were more frequent in the middle reach than the other two reaches, averaging 35 pools per mile as compared to 25 and 26 pools per mile. Pools tended to be deepest in the lower sub-reach and shallowest in the upper sub-reach. Most pools in the lower and middle sub-reaches had maximum depths over 2 feet, while only 38% of pools in the upper sub-reach had pools that deep (HES 2007).

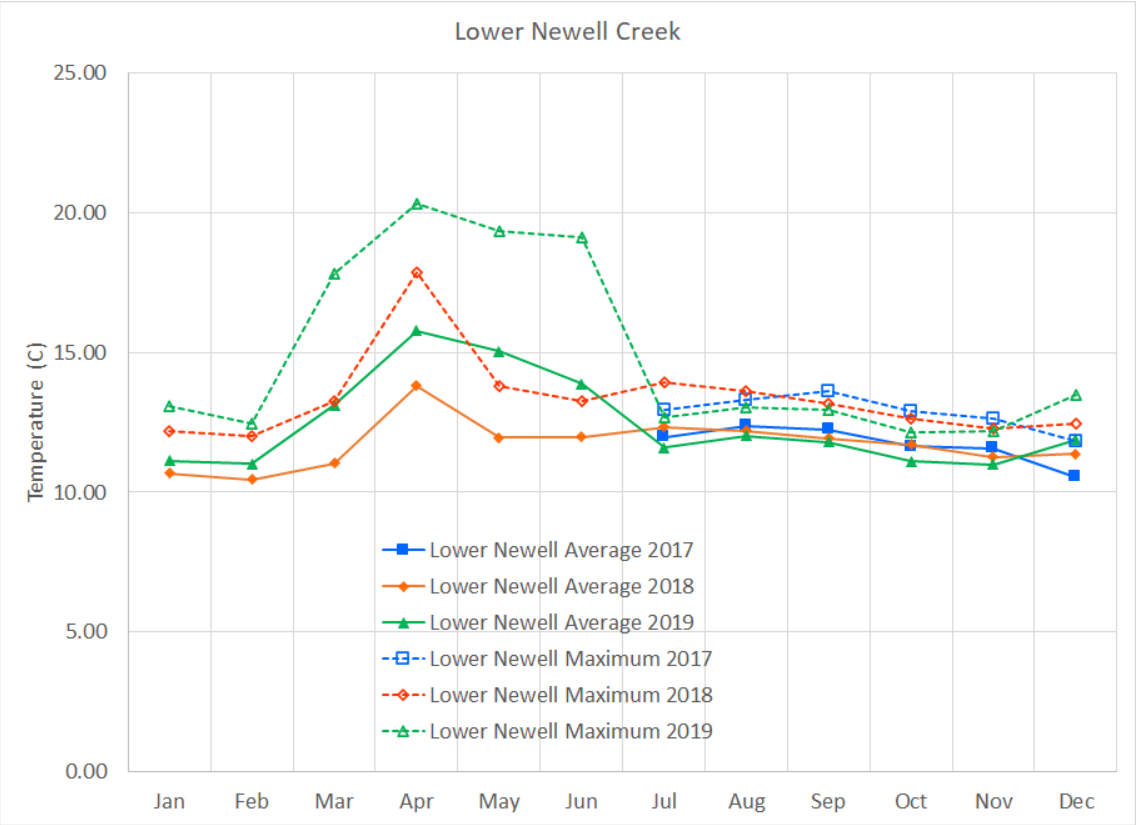
Shelter complexity, though mostly at low to moderate levels in all sub-reaches, tended to be higher in the lower sub-reach. Over 80% of pools in the lower sub-reach had shelter influencing at least 20% of the habitat area, while only 29% and 13% of pools in the middle and upper sub-reaches had shelter that extensive. The most extensive and frequently encountered cover type was the space around and between cobble and boulder substrate. Terrestrial vegetation hanging over the stream margin and undercut banks were important cover types in the lower sub-reach while bedrock ledge and undercut banks were important in the middle sub-reach. Nearly 80% of the cover in the upper sub-reach was provided by substrate and surface turbulence. Canopy coverage was relatively dense throughout all three reaches, averaging around 80%.

The 1 cfs minimum fishery release downstream of Loch Lomond Reservoir is often higher than reservoir inflow levels during the dry season (Figure 2-14), particularly during drier years and during the latter part of the dry season (July through October). These operational measures are likely to improve dry season rearing conditions most of the time, but in particular, during the most critical periods - late summer and very dry years. The instream flow requirement also

results in flow augmentation in the mainstem San Lorenzo River downstream of Newell Creek, although the proportional increase is much smaller.

The temperature of water released from Loch Lomond Reservoir is generally in the range of 10° to 14°C under normal storage levels and water temperature measured downstream of the reservoir release is generally in that range except during spill when it can be warmer (Figure 2-15). During periods when the reservoir spills, water from the surface of the reservoir is released down the spillway and mixes with the fish release downstream of the dam. Since spill is from the reservoir surface, it can be warmer than the fish release during the warmer parts of the year. However, the majority of spill occurs during or after precipitation events in the winter when Loch Lomond temperature is cool. The period when temperature effects are most likely is during the spring and early summer (May through July) when the lake surface is warming and there is still a potential for spill, at least in wetter years when storage is high.

Figure 2-15: Lower Newell Creek Temperature Monitoring Results

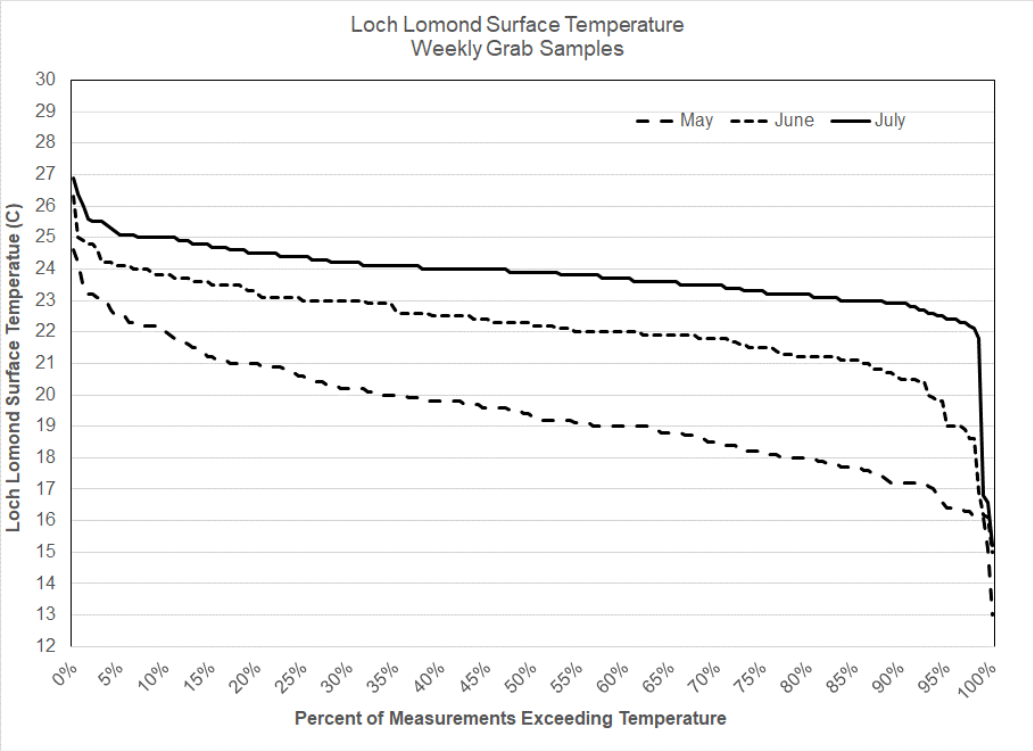


Source: City of Santa Cruz Water Department Monitoring Data

Temperature monitoring data collected by the City indicate that surface water temperatures in Loch Lomond Reservoir closest to the spillway can reach levels that are potentially harmful to steelhead and coho (Figure 2-16). Sub-optimal temperatures (21°C or greater) have occurred 98% of the time in July, 85% of the time in June, 19% of the time in May, and only 1% of the time in April. Surface temperatures in the City monitoring data have never been recorded above 18.3°C in March. Potentially lethal levels (25°C or higher) have also been recorded in June and July, although the frequency of such occurrence is low in June (less than 1% of readings).[27] Frequency of reservoir surface temperature of 25°C or higher in July has been observed 11% of the time. These data may slightly underestimate the frequency of temperature in the unsuitable range since it is generally recorded mid-morning while peak temperature usually occurs in the mid to late afternoon.

[27] Data are in the form of surface grab samples measured once per week, usually mid-morning, collected since 1987.

Figure 2-16**:** Loch Lomond Surface Temperature Measured by Weekly Grab Sample from 1987 to 2020



The effect of warm reservoir spills is moderated by the frequency, volume, and timing of spill. There is possible cooling at night (although potentially offset by additional warming during the day) as water flows down the spillway, and mixing with the cooler water from the fish release below the dam.

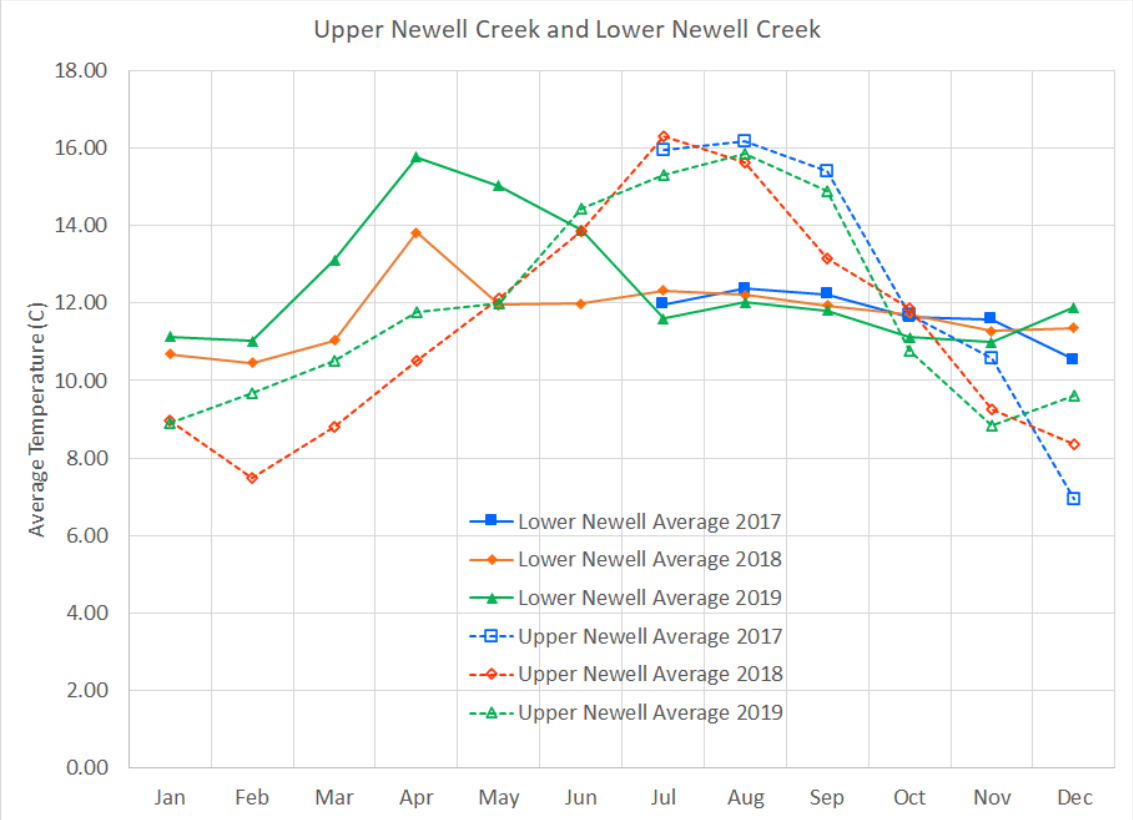
Limited temperature data available in Newell Creek downstream of the dam suggests that the effect of the spill on water temperature below the dam can be substantial but appears not to exceed suitable levels for rearing steelhead or coho. During 2019, the reservoir was spilling for most of the period from early February through late June. Maximum water temperature recorded below the dam[28] in April was 20.3°C when the reservoir was spilling at approximately 5 cfs or less (Figure 2-15). The average daily temperature below the dam, however, was never higher than 18.1°C in April. The reservoir was spilling at no more than 2 cfs in June 2019 and maximum recorded water temperature downstream reached 19.1°C. Average daily temperatures

[28] Temperature, reflecting both the fish release and reservoir spill, is continuously recorded by the City at the stream gage downstream of the dam at a 15-minute recording interval. Data has been collected since July 2017.

were below 17°C during June and declined to less than 12°C by the time spill ceased near the end of the month.

Due to the presence of the reservoir, temperature in Lower Newell Creek below the dam is warmer than Upper Newell Creek during winter and spring and cooler in the summer by up to 4°C on average (Figure 2-17). Warmer water in the spring can enhance salmonid growth rates if food resources are sufficient. The cooling influence in summer can extend downstream as far as the San Lorenzo River (City of Santa Cruz monitoring data, HES 2014b). Although the cooling influence in summer may depress growth rates this effect would be strongest closest to the dam. Spot measurements of water temperature during a habitat survey on August 7 and 8, 2007 ranged from 14°C to 16°C in the lower reach, 12°C to 13°C in the middle reach, and 13°C (in the upper reach (HES 2007). Temperature increases downstream due to atmospheric warming bring temperature closer to an optimum range, particularly for juvenile coho, which prefer slightly cooler temperature than steelhead.

Figure 2-17: Comparison of Upper and Lower Newell Creek Temperature Monitoring Results



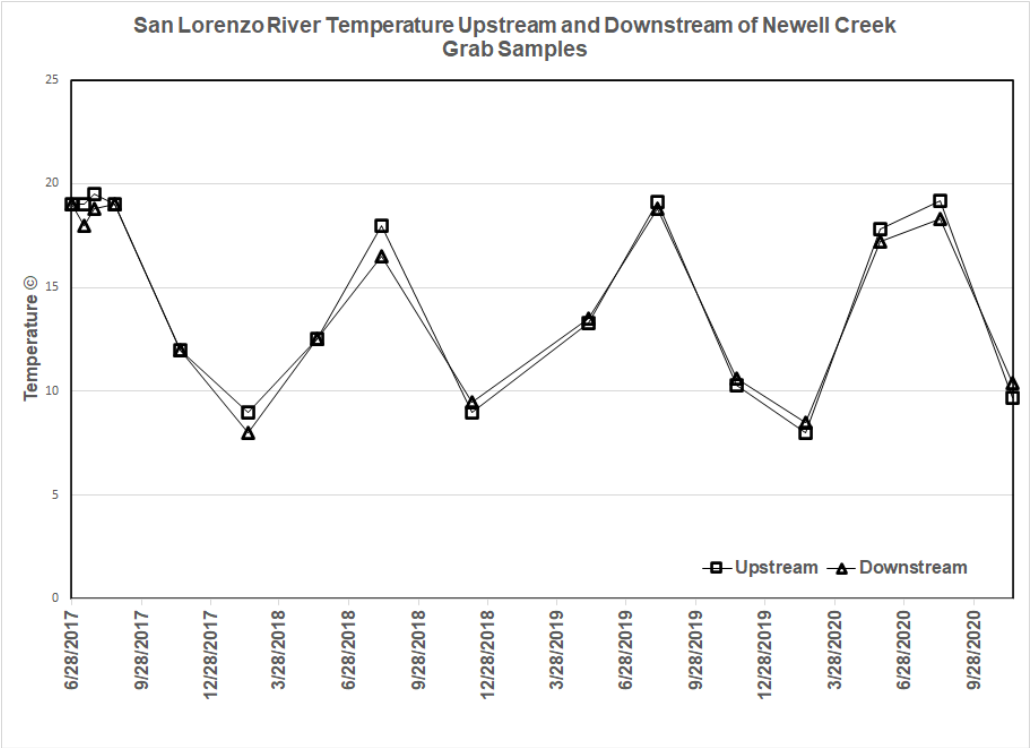
Source: City of Santa Cruz Water Department Monitoring Data

Release of water from the reservoir is likely to influence temperature conditions in the San Lorenzo River downstream of the Newell Creek confluence. There is a limited amount of temperature data for the San Lorenzo River at the Newell Creek confluence (Figure 2-18). These data indicate that water temperature in the San Lorenzo River approaches 20°C during peak summer warming and that Newell Creek appears to have a slight cooling influence during the summer (1°C or less) and a very slight warming influence in winter. The only datapoint potentially influenced by spill is May 9, 2019. Streamgage and reservoir elevation data indicate that the reservoir was spilling at a low volume (1 cfs or less) and temperature data records for Newell Creek below the dam show a value of 14 to 14.1°C bracketing the time temperatures were recorded in the San Lorenzo River. This is consistent with the observation of 13.3°C upstream of the Newell/San Lorenzo confluence and 13.5°C downstream of the confluence.

Warmer temperatures in April and May may actually be beneficial for rearing steelhead (and coho if present) as long as the temperature is still within the suitable range. Salmonids grow faster at warmer temperatures, within the suitable range, with adequate food supply. Increased

spill in June may also be beneficial as long as it does not result in temperature above the suitable level.

Figure 2-18: San Lorenzo River Temperature Upstream and Downstream of Newell Creek, 2017-2020



2.4.3.3 Habitat Conditions Mountain Charlie Gulch/Zayante Creek

Mountain Charlie Gulch supports resident rainbow trout populations and steelhead and potentially supports coho should they become re-established in the San Lorenzo River watershed. Coho have not previously been reported in Mountain Charlie Creek, although there has not been extensive sampling there either.

<u>Watershed/hydrology</u>

The City owns approximately 1.4 square miles in the watershed tributary to Zayante Creek and lower Mountain Charlie Gulch.

Mountain Charlie Gulch is a first order stream tributary to Zayante Creek. It drains a watershed of approximately 2.6 square miles and has approximately 4 miles of perennial stream (CDFW 1997b). Mountain Charlie Gulch has no stream gaging records. The watershed is mainly forested with some rural residential development and roads. Zayante Creek is a fourth order tributary to the San Lorenzo River. Flow in Zayante Creek was measured by the USGS (station # 11160300) from 1958 to 1992 at a stream gage located 3 miles upstream of the San Lorenzo River confluence. During the period of record, the median daily flow ranged from 8.6 cfs in February to 0.5 cfs in September (ENTRIX, Inc. 2004b). Winter flow is highly variable with daily average flows in January, for example, ranging between 0.4 and 1690 cfs. The bankfull discharge, approximated by the 1.5 to 2-year flood, is in the range of 430 to 825 cfs. The lowest flows occur in August and September. Average August and September flow for all years of record is 0.8 cfs, ranging from mean flows of 1.4 cfs in wet years to 0.2 cfs in critically dry years. See Figure 1-6: Zayante Watershed map.

Instream Habitat

Migration Barriers

Debris accumulations in Mountain Charlie Creek, exacerbated by the continuing effects of past logging activities, have resulted in transient migration passage impediments (CDFW 1997b). The City Water Department implemented a steelhead passage improvement project and modified several of these in 2002. A potential complete barrier to steelhead migration is located in Mountain Charlie Creek approximately 2.7 miles upstream of the confluence with Zayante Creek. This natural barrier consists of a series of bedrock ledges (ENTRIX, Inc. 2004a).

The anadromous reach of Zayante Creek extends upstream from the confluence with the San Lorenzo River past the confluence with Mountain Charlie Gulch, possibly to beyond Fern Ridge Road (Brian Spence personal communication to Chris Berry, 2005). There are bedrock ledges in Zayante Creek that have historically formed potential migration obstacles. A ladder was installed at one of the worst of these, near Quail Hollow, and some work to improve another was completed near Zayante Store (Chris Berry, personal communication to Jeff Hagar 2006). Another ledge, located just upstream from the Bean Creek confluence, is associated with the Mount Hermon flashboard dam. This location also has a seasonal fish ladder providing passage for juveniles in the summer when the dam is up and passage for adults in the winter when the dam is down.

Spawning Habitat

Spawning habitat is probably somewhat degraded by high levels of fine sediment. HES (2004) found embeddedness of both pool tails and other potential spawning areas typically ranged from 5% to 45%, although a few pool tails had embeddedness ratings of 60% or more (these were just downstream of a landslide in the lower part of the study reach). Embeddedness values were significantly less than those recorded by CDFW (1997b), however the Zayante Creek watershed has highly erodible soils and the stream bed is composed of a high proportion of fine-grained sediment (ENTRIX, Inc. 2004a). Fine particles (less than 4 mm) made up between 11 and 28 percent of the Zayante Creek streambed and larger substrate (particle sizes greater than 16mm) were 25% to 46% embedded in fine sediment (ENTRIX, Inc. 2004b, SH&G 2001b). The highest densities of steelhead redds in San Lorenzo River watershed are often observed in Zayante Creek (Jon Jankovitz, CDFW, personal communication to Jeff Hagar, 2019).

Rearing Habitat

Rearing habitat in Mountain Charlie Gulch consists primarily of run type habitat, limited amounts of instream cover, and high levels of fine sediments but with relatively dense canopy (ENTRIX, Inc. 2004b). CDFW characterized Mountain Charlie Gulch as an entrenched meandering riffle/pool channel at low gradient and with a high width/depth ratio and predominantly cobble substrate (CDFW 1997b). In surveys of Mountain Charlie Gulch adjacent to City managed lands during 2004, HES found cool temperatures and good canopy characteristics (HES 2005a). During the August surveys, early morning stream temperature was 13°C to 13.5°C. Maximum air temperature reached 27°C during the survey but stream temperature did not exceed 16°C. Temperature conditions are consistent with the moderating influence of the extensive canopy coverage and may also be influenced by topographic shading (HES 2005a). HES found that habitat types in Mountain Charlie Gulch were relatively evenly distributed between riffle, flatwater (run and glide), and pool types (HES 2005a) and that pools in general provided good depth for rearing steelhead with plunge pools and lateral scour pools formed by bedrock having the greatest maximum depths (in the 3.1 foot to 4 foot depth range). The habitat type proportions are somewhat different from those measured by CDFW in 1997, possibly since the CDFW survey extended another 8,857 feet upstream from the endpoint of this survey. HES confirmed relatively high amounts of fine sediment although embeddedness values were significantly less than those recorded by CDFW in 1997. HES also found limited amounts of instream cover in Mountain Charlie Gulch but good canopy characteristics. Canopy coverage ranged from 5% to 90% and averaged 71%. Aquatic productivity can be inhibited under conditions of continuous closed canopy, and the ideal condition is a moderately dense canopy (55%-85%) with occasional small openings. The surveyed reach of Mountain Charlie Gulch provides nearly ideal conditions of canopy coverage with over 80% of individual habitat units

having canopy coverage between 55% and 85% and 97% of units with coverage between 50% and 90% (HES 2005a).

Habitat surveys conducted in Zayante Creek indicated that pools account for the majority of existing instream habitat, with flatwater and riffles making up relatively small proportions, particularly in upper reaches of Zayante Creek and Mountain Charlie Gulch (H.T. Harvey and Associates 2003a).

2.5 Covered Species

2.5.1 Steelhead (*Oncorhynchus mykiss*)

Listing Status and Distribution

Steelhead (*Oncorhynchus mykiss*) inhabiting the drainages within the Plan Area are part of the Central California Coast DPS. CCC Steelhead are listed as threatened under the federal ESA (NMFS 2006). The Central California Coast DPS consists entirely of winter-run steelhead and extends from the Russian River south to Aptos Creek in the southern end of Santa Cruz County. The Plan Area is located in the southern range of the Central California Coast DPS (Busby et al. 1996). Streams in the Plan Area are included in the critical habitat designation for CCC Steelhead (NMFS 2005a). Recovery of the Central California Coast Steelhead DPS is addressed in the *Coastal Multispecies Final Recovery Plan: California Coastal Chinook Salmon ESU, Northern California Steelhead DPS and Central California Coast Steelhead DPS*, released in October 2016 (NMFS 2016).

Life History and Habitat Requirements

Steelhead life history is quite diverse and adaptive, providing the necessary flexibility to survive varied environmental conditions naturally occurring throughout their range and within their natal watershed. In general, steelhead grow and mature in the ocean and spawn in freshwater. In central California, adult steelhead enter coastal streams during the wet season in association with increased runoff. The majority of steelhead enter freshwater from December through March or April, and spawn relatively soon after entering freshwater. Spawning occurs in the tail-end of pools or runs where the female buries her eggs in pockets (or redds) excavated in a gravel-cobble substrate (Shapovalov and Taft 1954). The length of time it takes eggs to hatch is dependent on water temperature with hatching in about 30 days at 10.6°C and longer at cooler temperatures. The embryos remain within the gravel until they are fully developed and ready to begin feeding.

Upon emergence from the gravel, the young steelhead (or fry) typically disperse to the stream margins in close vicinity of the redd. As the fish grow, they move to areas with more suitable feeding and hiding conditions (e.g., heads of pools, pocket water, etc.). Juvenile steelhead can spend from 1 to 3 years in freshwater before beginning physiological processes that prepare them for life in seawater (termed smoltification). Steelhead begin the process of smoltification, most commonly at a size of 150 to 200 mm (6 to 8 inches) and migrate downstream to the ocean as early as the fall, but most commonly in the spring (March-May). Steelhead may spend from 1 to 2 years in the ocean before reaching maturity and returning to their natal stream to spawn (Shapovalov and Taft 1954).

Steelhead are unusual among the Pacific salmonids in that they are capable of spawning more than once, as they do not necessarily die after spawning. After spawning, some of these fish, called kelts, return to the ocean after holding for a short period of time in freshwater (Barnhart 1986). Steelhead are also unusual in that they have several life history strategies. Young steelhead produced from common parents have the capability of following distinctly different forms. Some may remain in freshwater even when the ocean is readily available. These fish can reach sexual maturity and spawn without ever entering the ocean. Furthermore, the progeny of these "resident" spawning fish can produce young that assume an anadromous life history and leave the freshwater environs as juveniles to grow and mature in the ocean before returning to spawn. This life history variability provides greater potential for population persistence, especially in areas with episodic periods of prolonged drought that can prevent fish from entering or leaving the stream for several generations (Titus et al. *In draft*).

Population Status and Limiting Factors

This section describes what is known about the abundance of steelhead populations and factors limiting those populations in each of the watershed areas covered by the HCP, including the North Coast Unit and the San Lorenzo River Unit. Abundance information is presented for each individual stream in each unit to the extent it is known.

North Coast

Steelhead populations in the North Coast streams are relatively small due to the short lengths of anadromous habitat. There are two primary sources of information relating to abundance of steelhead and coho in the North Coast Streams. The first is a synoptic survey of Santa Cruz County streams in the fall of 1981 by Harvey & Stanley Associates, Inc. (1982). The second is recent abundance estimates completed by the City since 2006. These are described below.

The Harvey & Stanley study measured the abundance of smolt sized steelhead (3 inches or larger, standard length[29]) in a number of Santa Cruz County streams using 2-pass electrofishing at several sites in each stream during the fall of 1981. In Liddell Creek, a total of eight sites were sampled, one in the main fork below the confluence of the East and West Branch, two in the West Branch, three in the East Branch below the Middle Branch confluence, and two in the East Branch upstream of the Middle Branch. Rearing density of steelhead was highest in the Lower West Branch (10 smolt-sized fish per 100 feet) and the Main Branch (6 smolt-sized fish per 100 feet). Rearing density was relatively low in the East Branch, ranging from 1 to 5 smolt-sized fish per 100 feet. Overall, abundance estimates for Liddell Creek fell in the moderate to low end of the range for this study, lower than both Laguna and Majors Creek (Table 2-14).

In Laguna Creek, a total of four sites were sampled in the Harvey & Stanley study, all of them upstream of what is now believed to be the limit of anadromy. Abundance of these resident *O. mykiss* populations may be quite different than for the anadromous population in the lower part of the creek. Abundance estimates for Laguna Creek fell in the moderate to low end of the range for this study (Table 2-14).

[29] In the Harvey & Stanley study fish equal to, or larger than, 3 inches were considered smolt-sized since it was believed that they would reach sufficient size for smolting by the following spring.

Table 2-21: Abundance Estimates for Smolt-sized Steelhead/Rainbow Trout (>75 mm Standard Length, ~85 mm Fork Length) in Santa Cruz County Streams

Stream	Average Density (# per 100 feet of stream)	Maximum Density (# per 100 feet of stream)
San Vicente	40.9	200.0
San Lorenzo River	29.8	97.0
Zayante	22.0	46.0
Browns	16.5	27.0
Corralitos	16.1	60.0
Valencia	15.0	17.0
Baldwin	13.8	25.0
Newell	13.0	18.0
Shingle Mill Gulch	12.7	14.0
Bear	12.0	19.0
Fall	12.0	17.0
Soquel West Fork	11.3	17.0
Boulder	10.5	20.0
Mill (San Lorenzo)	10.5	16.0
Aptos	9.6	24.0
Bean	9.5	22.0
Majors	9.4	22.0
Jamison	8.0	8.0
Hester	7.0	7.0
Laguna	7.0	13.0
Bates	6.0	6.0
Liddell	6.0	10.0
Pescadero	6.0	7.0
Ramsey	6.0	6.0
Soquel East Fork	6.0	13.0
Kings	5.0	10.0
Liddell West Fork	5.0	10.0
Moore's Gulch	5.0	5.0
Gamecock	4.0	4.0

Stream	Average Density (# per 100 feet of stream)	Maximum Density (# per 100 feet of stream)
Hinkley	3.0	3.0
Liddell East Fork	3.0	5.0
Lockhart Gulch	3.0	3.0
Soquel	3.0	6.0
Carbonera	1.7	3.0

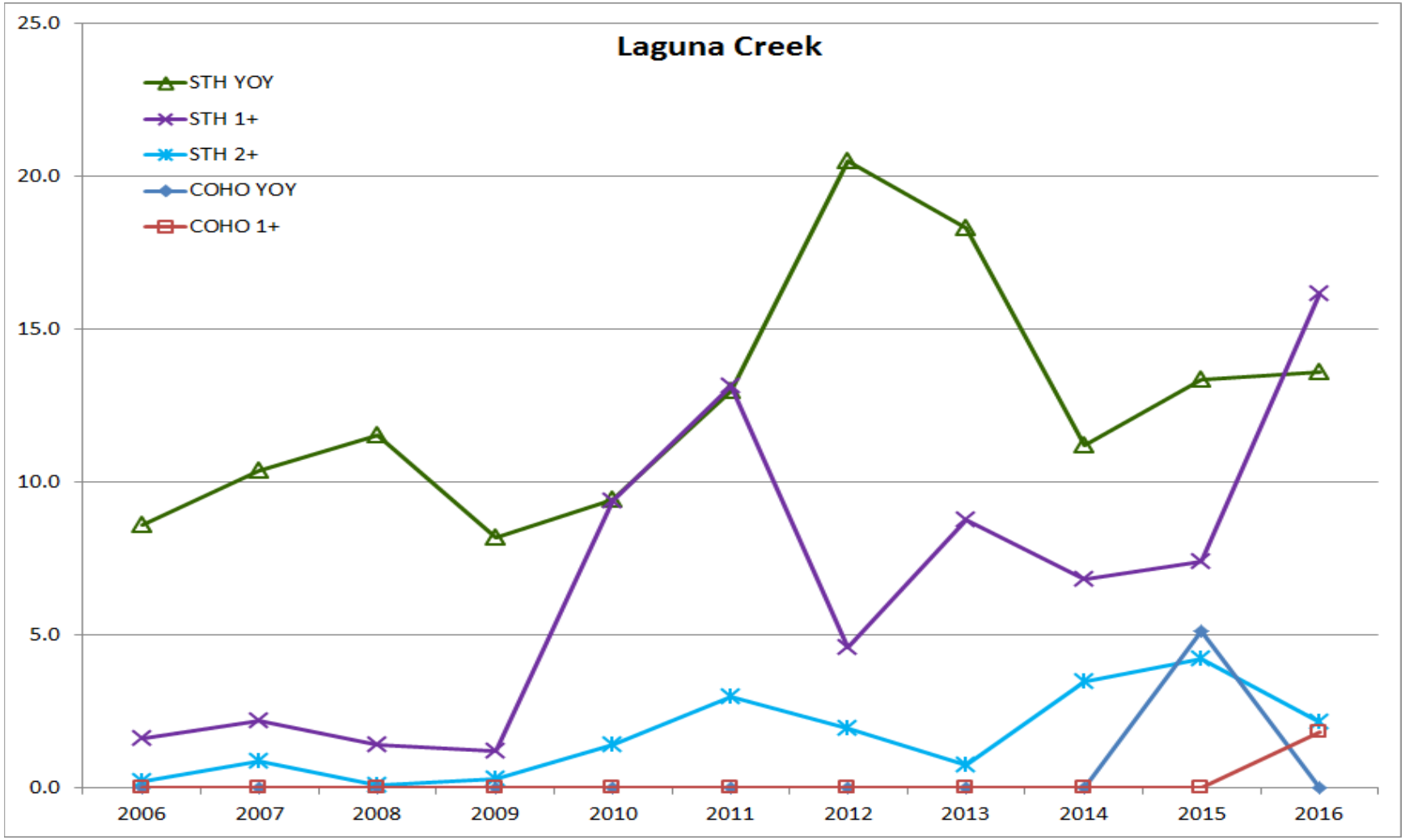
Source: Summarized from Harvey & Stanley 1982

A total of six sites were sampled in the Harvey & Stanley study in Majors Creek, but only two of them were within the anadromous section. Abundance in the anadromous reach was relatively low with no steelhead observed at the site downstream of Highway 1 and 8 per hundred feet of stream at a site near the upper limit of anadromy which is about 0.7 miles upstream of the mouth.

Since 2006, the City has developed abundance estimates for the anadromous reaches of Liddell, Laguna, and Majors Creeks based on annual fall snorkel surveys (Berry et al. 2019). Abundance of YOY steelhead has averaged 12.5 per 100 feet in Laguna Creek, 9.4 in Majors Creek, and 7.5 in Liddell Creek from 2006 to 2016 (Figure 2-19).[30] Similarly abundance of 1+ steelhead averaged 6.6 per 100 feet in Laguna Creek, 4.8 in Liddell Creek, and 3.8 in Majors Creek. Mean age 2+ steelhead abundance was highest in Liddell Creek at 2.3 per 100 feet and was 1.7 per 100 feet in both Laguna and Majors Creeks.

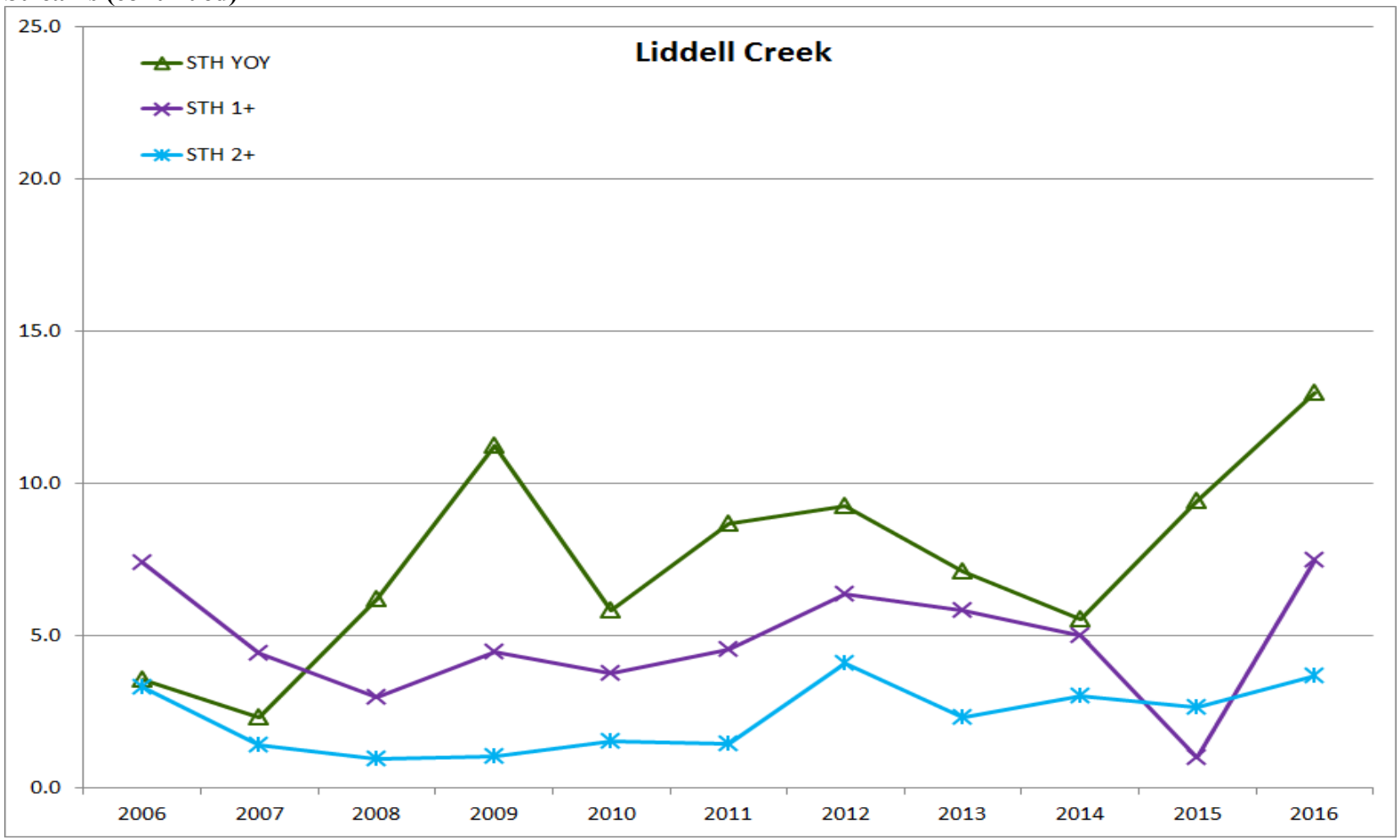
[30] More recent electrofishing data collected in 2009 indicate that these numbers could actually be somewhat higher, possibly by a factor of two (HES 2011b).

Figure 2-19: Abundance Estimates (number per 100 feet) for Steelhead/Rainbow Trout and Coho in Fall Snorkel Surveys of North Coast Streams



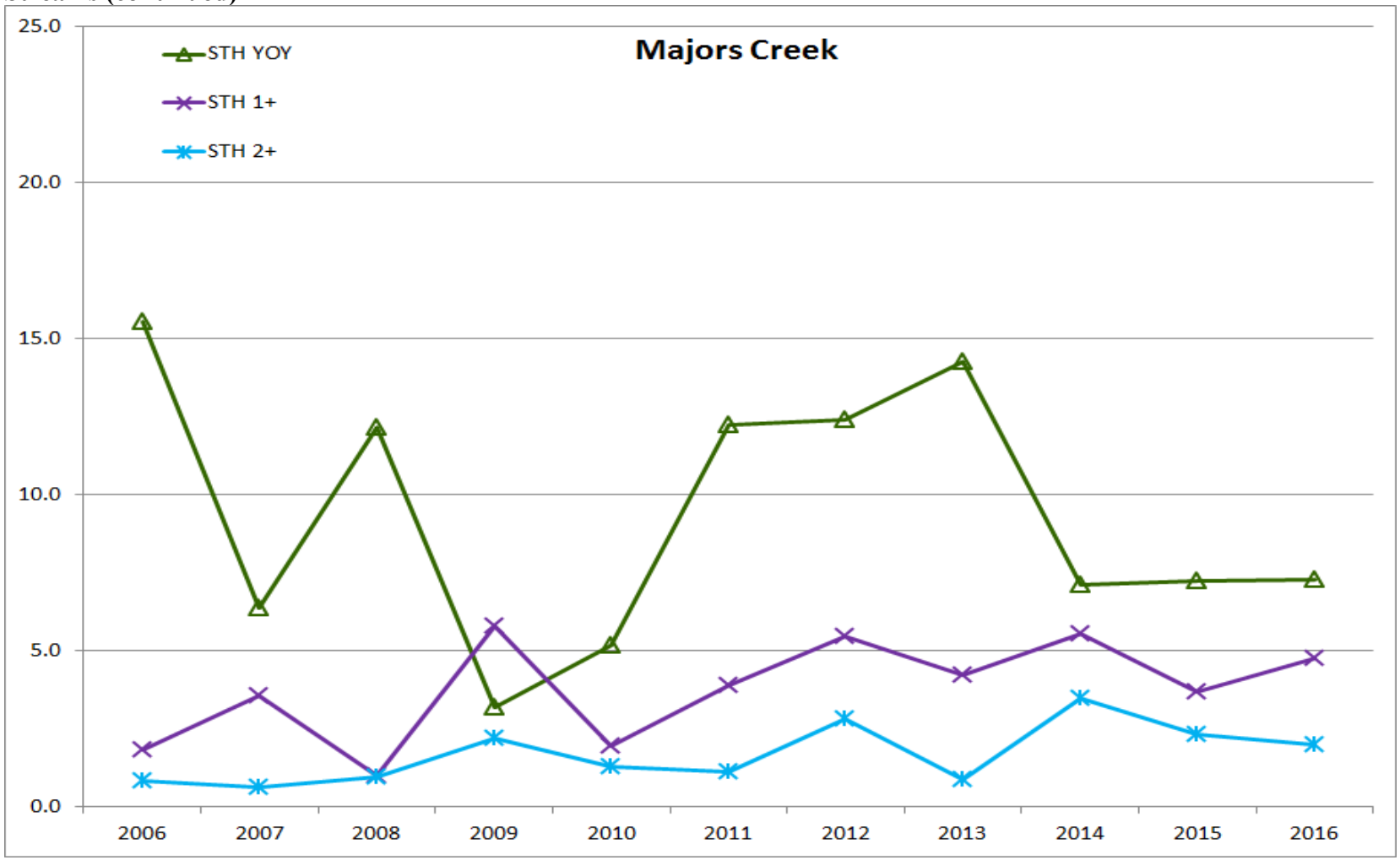
Source: City of Santa Cruz unpublished monitoring data

Figure 2-19: Abundance Estimates (number per 100 feet) for Steelhead/Rainbow Trout in Fall Snorkel Surveys of North Coast Streams (continued)



Source: City of Santa Cruz unpublished monitoring data

Figure 2-19: Abundance Estimates (number per 100 feet) for Steelhead/Rainbow Trout in Fall Snorkel Surveys of North Coast Streams (continued)



Source: City of Santa Cruz unpublished monitoring data

Abundance of both 1+ and 2+ steelhead shows an increase in Laguna Creek over the monitoring period (linear regression F-test, significance at 0.01). Increased abundance over time was also observed for YOY steelhead in Liddell Creek (linear regression F-test, significance at 0.03) and age 2+ steelhead in Majors Creek (linear regression F-test, significance at 0.04). It should be noted however that the efficiency of snorkel counts appears to have increased over the monitoring period based on calibration with electrofishing data (HES 2017). Nevertheless, this effect would likely be similar for all streams so the increase in abundance in Laguna Creek stands out. Combined abundance of age 1+ and 2+ steelhead is comparable to that observed in the early 1980s as reported by Harvey and Stanley (1982) (Table 2-21).

While adult population sizes have not been assessed in these streams, some context can be developed based on other information sources. Shapovalov and Taft (1954) marked juvenile steelhead on their downstream migration from Waddell Creek and estimated overall survival from returns of these marked fish in the adult steelhead spawning run. Returns ranged from 1.7% to 6% and averaged 3% for the five years evaluated. These estimates may be conservative since: (1) a number of downstream migrants actually remained in downstream reaches without migrating to sea for an additional season and would have experienced additional mortality before going to sea; (2) there was likely some loss of adults in the ocean due to fishing;[31] and (3) not all returning adults were checked for marks (some spawned downstream of the trapping station and some by-passed the trapping station during high flow conditions). However, the estimate is consistent with a more recent study in Scott Creek (Bond 2006). Bond estimated survival rates of downstream migrating steelhead in Scott Creek to be 3.3% and survival of estuary-reared juvenile steelhead to be 8.3 percent for the in 2003 cohort.

Using the City density estimates of smolt-sized steelhead in the fall, length of the anadromous reaches, pool proportions, and a 3% return rate for downstream migrating smolts, an estimate of adult returns from stream rearing fish is quite small with an average estimate of 4 adults returning to Liddell and Majors and 12 returning to Laguna Creek (Table 2-22). Even if stream densities were 3 to 4 times higher, these would still be very small populations. In contrast, the estimated Laguna Creek potential return of 69 adult steelhead from lagoon reared fish is substantially higher than the estimated total return of stream reared fish and more than an order of magnitude higher than Liddell and Majors Creeks. This is a result of the larger number of smolts produced and a higher survival rate of lagoon reared fish related to greater size at ocean entry.

[31] At the time of the S&T studies in the 1950s there was an active recreational fishery in northern Monterey Bay.

Table 2-22: Steelhead Production Estimates in North Coast Streams

	Anadromous Reach Length (miles)	Percent Pools by length[1]	Density of Smolt-size Stream Steelhead (# per 100 feet) [1]	Population Estimate for Stream Smolts	Fall Lagoon Population Estimate for Smolts[2]	Adult Returns of Stream Smolts	Adult Returns of Lagoon Reared Smolts	Total Adult Return
Liddell	1.16	0.33	7.2	146		4		4
Laguna	1.43	0.63	8.3	395	828	12	69	81
Majors	0.7	0.72	5.5	146		4		4

[1] City of Santa Cruz snorkeling data.

[2] Based on fall 2014 abundance (HES 2015).

Suitable rearing habitat exists in the coastal streams, however the extent of this habitat is limited by the presence of natural barriers to upstream passage (ENTRIX, Inc.2004). The portion of these creeks accessible to steelhead and coho ranges from 0.6 miles in Majors Creek to 1.4 miles in Laguna Creek. Access is also indicated as a limiting factor in the West Branch of Liddell Creek due to culverts at road crossings (Harvey & Stanley Associates, Inc. 1982).

Sedimentation is also high in these streams, particularly in Liddell Creek, and may be the primary limiting factor in the Liddell Creek watershed (Environmental Science Associates 2001, ENTRIX, Inc. 2004b, Hagar 2005). Sedimentation was also observed to be a problem in the non-anadromous reaches of Majors Creek (ENTRIX, Inc. 2002) although this could further constrain the suitability of spawning and rearing habitats in the anadromous reach if the sand migrates downstream (ENTRIX, Inc. 2004b). Sedimentation affects the amount of spawning habitat (embedding gravels), the amount of rearing habitat (infilling pools), and production of salmonid food.

Harvey & Stanley Associates, Inc. (1982) suggest that rearing habitat is the most limiting factor for Santa Cruz County streams. They list several factors as key for rearing habitat, including:

- adequate flows for pool formation and to provide feeding stations,
- hiding cover (i.e. undercut banks, surface turbulence, boulders, overhanging vegetation, etc.),
- aquatic and terrestrial food, and
- suitable summer water temperatures.

The Harvey & Stanley report indicates that it is not necessarily the low late summer/fall flows in these streams that limits density of smolt-sized fish but the amount of adequate cover (pool development, undercut banks, and unembedded cobble). The importance of streamflow appears to be in spring when these fish show a large increase in size (Harvey & Stanley Associates, Inc. 1982). Limiting factors specifically indicated in the Harvey & Stanley study include pool depth, cover, substrate, and flow in Liddell Creek; flow, cover, pool depth, and substrate as most limiting in Laguna Creek; and flow as the major limiting factor for the anadromous reach of Majors Creek. Harvey & Stanley (1982) also rated spawning habitat as poor to fair in Majors Creek and rearing habitat as none (downstream of Highway 1) to below average and fair upstream of Highway 1 below "the falls".

ENTRIX, Inc. (2004b) concluded that flow can constrain suitable habitat during the dry summer and fall rearing seasons however suitable rearing conditions exist under current conditions. High canopy cover in the canyon-portions of the anadromous reaches maintain suitable water temperatures and instream cover is typically not a problem in these canyons (ENTRIX, Inc. 2004b).

Lagoon rearing may be critical to sustaining populations in these small streams with limited anadromous habitat. Of the three north coast streams with City diversions, only Laguna Creek has a relatively intact and functional lagoon. The lack of a functional lagoon may be a significant limiting factor in Majors and Liddell Creeks.

San Lorenzo River Watershed Unit

Available analyses suggest that steelhead have declined in the Central California Coast DPS and in the San Lorenzo River from historic levels. Alley et al. (2004) provide the following synopsis of steelhead population status in the San Lorenzo River:

> Over the last several years, a considerable amount of attention has been paid to salmonid populations and habitat conditions on the San Lorenzo River due to historical accounts that suggest a rapid decline in fish numbers since the 1960s. The California Department of Fish and [Wildlife] (CDF[W]) estimated that 20,000 adult steelhead were present in the San Lorenzo River prior to 1965 (Johansen, 1975). In the mid-1960s, CDFW estimated that 19,000 adult steelhead occurred in the San Lorenzo River. Estimates by the NMFS, made in 1996, put the number of adults spawning in the San Lorenzo River at 500.
>
> Unfortunately, estimates of historic adult steelhead numbers were based on conjecture and lack supportable scientific data. Most of the estimates were based on creel census data, which are inadequate to obtain accurate estimates of adult numbers and are more reflective of the extensive planting program in the San Lorenzo River rather than natural

production. Scientifically supportable juvenile population and density estimates did not occur on the San Lorenzo until 1981 when Dr. Jerry Smith, with assistance from Donald Alley, conducted habitat surveys and sampling site density estimates on steelhead-bearing streams throughout Santa Cruz County (Smith 1982). Comprehensive habitat condition and population estimates were continued in 1994 by D.W. ALLEY and Associates and have been monitored every year since (Alley 1994-2001). These data suggest fairly stable steelhead populations between 1981 to present with year-to-year variations dependent upon sedimentation, streamflow, and habitat conditions in the River.

The San Lorenzo River Lagoon has the potential to produce a large number of steelhead smolts. In 2005, NMFS estimated that there were 4,000-6,000 smolts rearing in the lagoon over the summer months (2ND Nature 2006). In spring 2017, there were an estimated 3600 steelhead juveniles in the lagoon and monthly estimates of catch per unit effort doubled to tripled through September (HES 2018). These likely represent the maximum rearing capacity of the lagoon under present conditions. Using Bond's estimate of 8.3% return rates for estuary-reared steelhead, this would potentially result in a maximum return of approximately 400 adult steelhead from the lagoon in addition to those from production in the mainstem and tributaries.[32]

The primary factors limiting salmonid production in the San Lorenzo River watershed are related to excessive accumulation of fine sediments in rearing and spawning habitat, reductions in streamflow during critical life history phases, impediments to adult passage, and inhospitable water temperature conditions (Alley et al. 2004, Ricker and Butler 1979). Accumulation of fine sediments in the stream bed has degraded fisheries habitat by infiltrating gravel and cobble substrate and reducing water depth, particularly in pools. Mobilization and delivery of fine sediment from upland sources to the streambed has been accelerated beyond natural processes by timber harvesting and residential and associated development, including roads. Increased sedimentation may impair spawning success due to suffocation of embryos, failure of emergence, or excessive bed mobilization. The accumulation of fine sediments may also impair production of organisms used for food by rearing juveniles and thereby reduce rearing success or retard growth rates. Excessive accumulation of fine sediment can also reduce cover for rearing juveniles by filling the spaces around larger cobbles, boulders, and woody debris or under banks. Increased turbidity - which is often related to increased delivery of sediment to a given watercourse – can impair feeding success (as salmonids are visual feeders) and impair respiration (by clogging gills).

[32] To put this estimate in context, estimates of adult steelhead returns to the San Lorenzo River summarized from various sources by D.W. Alley & Associates (2005) range from around 300 to 3000 during discreet periods between the mid-1930s and 2004 when estimates were made.

Ricker and Butler (1979) concluded that excessive sedimentation is widespread in the streams of the San Lorenzo Watershed and that sedimentation is the major cause of the fishery decline in the San Lorenzo Watershed. Observations of insect production in streams of the San Lorenzo Watershed show biomass to be 75% to 90% lower in silted reaches of Bean, Zayante, and Carbonera Creeks as compared to the Upper San Lorenzo River. Ricker and Butler (1979) cite CDFW surveys on the main river showing that the percentage of stream bottom classified as silt measured from 8% in 1966 to 65% in 1972 and the amount of gravel present dropped from 20% to 2%.

Streamflow reduction is related to extraction of both surface and groundwater throughout the watershed. Rearing conditions affected by low stream flows during the dry season (May to October) are often a limiting factor in Central Coast streams. Density of rearing YOY steelhead has been shown to be positively correlated with various measures of stream flow in different parts of the San Lorenzo River basin and particularly in the mainstem below Boulder Creek (Alley et al. 2004). In some cases, low stream flows may further impede adult passage in the San Lorenzo River at critical locations related to either natural or anthropogenic features.

Ricker and Butler (1979) estimate that total stream diversions at the time of their study result in a 40% reduction in summer rearing habitat in lower Boulder Creek and a 20% reduction in summer rearing habitat in the middle portion of the river, lower Bear Creek, lower Fall Creek, and lower Zayante Creek. These reductions represented a 10% decrease in overall summer rearing habitat for the Watershed during normal years and a 20% reduction in rearing habitat during dry years attributable to stream diversions (Ricker and Butler 1979).

In critically dry years, populations can be limited by constraints on outmigration as well. High water temperatures in the middle and lower San Lorenzo River (downstream from Boulder Creek) may limit overall production by restricting rearing juveniles to limited fastwater habitat. However, warmer temperatures may also result in faster and more robust growth (with abundant food resources), which may be a significant consideration for this part of the mainstem since it produces a substantial proportion of the watershed's smolt-sized juveniles. Degradation of lagoon habitat through filling, maintenance as a FCC, nutrient enrichment, and reduced freshwater inflows may also limit production of smolts.

The Harvey & Stanley Associates, Inc. (1982) study found the average density of smolt-sized steelhead in Newell Creek at 13.0 per 100 feet was in the upper third of all streams sampled (Table 2-21). Rearing densities of smolt-sized fish in Newell Creek averaged about 18.3 per 100 feet of stream during population surveys conducted from 1994 to 2001 and 10.6 per 100 feet from 2009 to 2019

(Santa Cruz County Environmental Health, Steelhead Monitoring Data Explorer[33]). In 2007, average density for all age classes of *O. mykiss* in sampled units was 21 per 100 feet of stream in the Lower Reach, 15 per 100 feet in the Bedrock Reach, and 2 per 100 feet in the Upper Reach (HES 2007).

During the 1997 to 2015 time period, average density of size class II/III (75 mm SL or larger) steelhead in Newell Creek was among the highest for all consistently sampled sites in the San Lorenzo River and its tributaries (D.W. Alley & Associates 2016). Average density was nearly as good as the best mainstem sites and in the tributaries, only Zayante Creek and Branciforte Creek supported higher densities (Table 2-23). The high density of size class II/III fish relative to other parts of the basin indicates good rearing conditions in Newell Creek, and high potential smolt production.

Table 2-23: Steelhead Abundance Estimates in the San Lorenzo River Mainstem and Tributaries as Average Number of Size Class II/III (>=75 mm SL) per 100 feet of Stream at Consistently Sampled Locations from 1997 to 2015

Survey Location	Density	Location Description
San Lorenzo Main 2a	13.5	Gorge-Rincon
San Lorenzo Main 4	13.2	Henry Cowell
San Lorenzo Main 12b	12.4	Waterman Gap
San Lorenzo Main 0a	9.0	Santa Cruz
San Lorenzo Main 1	7.0	Paradise Park
San Lorenzo Main 11	6.0	Upper Mainstem
San Lorenzo Main 8	5.6	Brookdale
San Lorenzo Main 6	4.0	Felton Diversion
Zayante (13d)	16.3	
Zayante (13c)	15.2	
Branciforte (21b)	13.1	
Newell (16)	13.0	
Fall (15b)	12.6	
Bean (14b)	12.0	
Boulder (17b)	10.5	
Boulder (17a)	10.2	
Zayante (13a)	9.4	
Bear (18a)	9.4	

[33] http://scceh.com/steelhead/data.aspx.

Branciforte (21a-2)	9.1	
Bean (14c)	7.8	
Lompico (13e)	6.9	

Source: excerpted from D.W. Alley & Associates 2016

Because of the relatively short reach of the anadromous portion of Newell Creek (0.8 to 1.0 mile), Newell Creek contributes a relatively small proportion of the San Lorenzo watershed steelhead production (Alley et al. 2004). If densities in Table 2-these fish were all anadromous, this would result in an estimate of about 580 smolts in the 0.85 miles of most productive habitat in the anadromous reach. Using the same 3% return rate, this would result in an estimated return of about 17 adult steelhead, on average, depending on ocean conditions and many other factors.

The primary limiting factors for salmonids in Newell Creek are related to habitat alteration from channel incision and riparian development and flow reduction during migration and spawning seasons due to operation of Loch Lomond Reservoir. Unlike the rest of the San Lorenzo watershed, fine sediments do not appear to be a significant issue in Newell Creek, possibly related to the fact that much of the smaller bedload from the upper watershed is deposited in Loch Lomond Reservoir. On the other hand, gravel and cobble substrate preferred by steelhead and coho are also deposited in the reservoir. Upstream passage of adults and spawning habitat availability are likely limited by low flows during winters when Loch Lomond Reservoir does not spill. Flow during the rearing period has been enhanced by operation of Loch Lomond Reservoir and temperature is cooler. The cooler temperature due to cold releases from Loch Lomond Reservoir may somewhat reduce growth rates but there is no clear evidence of this in recent basin-wide juvenile abundance surveys. In fact, given the warm temperatures in the lower San Lorenzo River, the slight cooling provided by Newell Creek may be beneficial to the system as a whole.

Population surveys in Mountain Charlie Gulch have been extremely limited. CDFW electrofished 16 sites within the survey reach and steelhead were found at all sampling sites. None were found above the migration barrier (ENTRIX, Inc. 2004b). During a survey in 2004, HES found the density of young of year *O. mykiss* averaged 110 per 100 feet in the survey reach and density of older *O. mykiss* averaged 8 per 100 feet. While difficult to draw firm conclusions from a single survey, these density estimates are within the range of observations from other San Lorenzo River tributaries.

Abundance (number of fish per 100 feet of stream) of both YOY and smolt sized steelhead in Zayante Creek has varied considerably from year to year, but on average, is among the highest of San Lorenzo River tributary areas surveyed (ENTRIX, Inc. 2004b). Given large annual variability in population sampling results over the past 9 years when consistent sampling has occurred (DW Alley and

Associates 2007), there are no clear trends in abundance of rearing steelhead over time in Zayante Creek.

In Zayante Creek, the primary limiting factor for steelhead appears to be the excessive accumulation of fine-grained sediment in the substrate. The watershed has highly erodible soils and disturbance from unpaved or poorly maintained roads, landslides, debris flows, and residential development. The sedimentation is at a level that adversely affects aquatic habitat values (ENTRIX, Inc. 2004b). Lack of large woody material may also be a limiting factor as downed trees and limbs are frequently removed from the stream for the perceived benefit of avoiding flood damage, thereby reducing cover and resulting in more simplified habitat structure.

2.5.2 Coho (*Oncorhynchus kisutch*)

Listing Status and Distribution

Coho in the Plan Area are part of the Central California Coast ESU, which is listed as endangered under the federal ESA and under CESA.[34] Under the ESA, the Central California Coast ESU extends from Punta Gorda in Humboldt County south to, and including Aptos Creek (NMFS 2005b, NMFS 2012c). Critical habitat has been designated for the Central California Coast ESU, including the accessible portions of the streams in the Plan Area. NMFS published a recovery plan for Central California Coast coho in September (NMFS 2012). In spite of the protections afforded by these listings, the development of a recovery plan and ongoing implementation of many actions recommended in the recovery plan, the population has not stabilized and continues to decline (NMFS 2012).

Central California represents the southern margin of the species' natural distribution, and coastal streams of Santa Cruz County constitute the current southernmost extent of coho distribution (NMFS 2016c). Historically, coho were found in as many as 50 coastal drainages in San Mateo and Santa Cruz counties but spawning runs were limited to 11 stream systems by the 1960s (Anderson 1995). More recently, the two independent populations in the Santa Cruz Mountain diversity strata (Pescadero Creek and San Lorenzo River) were considered likely extirpated in the last NMFS 5-year status review (NMFS 2016c). Sporadic observations of coho continue to occur in Santa Cruz County streams,

[34] CCC coho (inclusive of coho south of San Francisco Bay) were listed as a federally threatened species on October 31, 1996 (61 Fed. Reg. 56138). Due to severe population declines between 1996 and 2004, NMFS relisted CCC Coho Salmon and changed its status from threatened to endangered (i.e., in danger of extinction throughout all or a significant portion of its range) on June 28, 2005 (70 Fed. Reg. 37160) (NMFS 2012). The State of California listed coho south of San Francisco Bay as a state endangered species in 1995 and listed the CCC Coho Salmon ESU as State endangered in 2002.

primarily the result of production from the Kingfisher Flat Hatchery in the Scott Creek watershed. For example, there was a release of 10,000 juvenile coho into Pescadero Creek in November 2020. Scott Creek experienced the largest coho run in a decade during 2014/15, and researchers recently detected juvenile coho within four dependent watersheds where they were previously thought to be extirpated (San Vincente, Waddell, Soquel and Laguna creeks) (NMFS 2016c). The increase appears to be related to improved hatchery strategies (Williams et al. 2016).

There has been some contention around the historical status and origin of coho populations south of San Francisco Bay (McCrary 2003, McCrary 2005, Spence et al. 2011). The NMFS status review of coho in Washington, Oregon, and California (Weitkamp et al. 1995) delineated the Central California Coast Coho Salmon ESU (CCC Coho Salmon ESU), as the southernmost coho ESU in the Pacific Northwest and California and determined that it comprised salmon spawning in streams and rivers from Punta Gorda in the north to and including the San Lorenzo River in central California, including tributaries of San Francisco Bay but excluding the Sacramento-San Joaquin River system (Weitkamp et al. 1995). The status review supported the NMFS listing of the CCC Coho Salmon ESU as "threatened" under the ESA in 1996 (61 Fed. Reg. 56138).

Coho have been introduced in Santa Cruz County streams since 1906, beginning with stocking fry reared at Brookdale Hatchery (San Lorenzo River) from as many as 500,000 eggs received from Baker Lake, Washington between 1906 and 1910, and in 1913 and 1915 (Spence et al. 2011). During the period 1929-1941 approximately 1.2 million coho fry were planted into waters of Santa Cruz and San Mateo Counties, with the majority of these being released in the San Lorenzo River, Scott Creek and its tributaries, and Soquel Creek (Spence et al. 2011). These fry were reared at Brookdale Hatchery and the newly established Big Creek Hatchery on Scott Creek with egg sourcing not always clear from the records but evidently, fish from Fort Seward (Humboldt County), Prairie Creek (Humboldt County), and Scott Creek provided broodstock during this period (Spence et al. 2011).

A twenty-year hiatus in supplementation between 1941 and 1962 has been followed by almost continuous planting of hatchery-produced coho. From 1963 to 1979, the California Department of Fish and Game planted a reported 446,159 coho in the San Lorenzo River, Aptos Creek, Soquel Creek, Scott Creek, Gazos Creek, and Waddell Creek. Brood sources for these plantings included Noyo River (58%), the Klaskanine and Alsea rivers in Oregon (13.5% and 10.8%, respectively), and the Green River in Washington (2.2%), with origin of the remainder (15.1%) unknown (Spence et al. 2011).

From 1980 to 1989, an attempt was made by Silver-King Ocean Farms (SKOF) to establish commercial aquaculture in the region. Over the 10-year period, SKOF released approximately 1.1 million coho (mostly YOY) into Davenport Landing Creek, a small seasonal stream near the town of Davenport. Broodstock for this effort consisted of a wide range of stocks, including a number of

Washington and Oregon stocks, smaller numbers of fish from the Klamath and Noyo rivers in California, and hatchery fish that returned to Davenport Creek. Due to poor returns of adult fish and inability to attract them back to Davenport Landing Creek, this aquaculture venture was abandoned in 1989 (Spence et al. 2011).

Since 1976, the Monterey Bay Salmon and Trout Project (MBSTP) has reared and released coho from various broodstocks, including Ten Mile River, Noyo River, Russian River, Prairie Creek, as well as Santa Cruz County streams. Between 1991 and 2009 all broodstock were from Scott Creek and the San Lorenzo River, with fish generally planted back into their stream of origin, except plantings of Scott Creek coho into Waddell Creek (2 plantings), Pescadero Creek (2 plantings), and Aptos Creek (1 planting) (Spence et al. 2011).

In 2003, NMFS received a petition to redefine the southern extent of the CCC Coho Salmon ESU to exclude populations that spawn in coastal streams south of the entrance to San Francisco Bay, arguing that historical accounts suggest the southern boundary of the CCC Coho Salmon ESU was at or north of San Francisco Bay; that there is a lack of evidence in the archaeological record of coho south of San Francisco Bay; that the physical environment of the Santa Cruz mountains is not conducive to persistent coho populations; and that coho that have occurred in this region for the last century are the result of introduction of nonnative stocks from locations north of San Francisco (McCrary 2003).

In response to the petition, NMFS determined that while there has been introduction of non-native coho stocks in the region, the petitioned action was not warranted. Specifically, NMFS relied on: (1) museum specimens of coho collected from four separate watersheds (Gazos, Waddell, Scott, and San Vicente creeks) south of San Francisco in 1895; (2) new archaeological evidence (published after the 2003 petition) establishing the presence of coho from the Año Nuevo region, and salmonid vertebrae from middens at Elkhorn Slough (northern Monterey County) and a late-1800s home site in Santa Barbara tentatively identified as coho; (3) evaluation of environmental conditions with the conclusion that they are not appreciably different from watersheds immediately to the north where the historical occurrence of coho is not in dispute; and (4) genetic evidence identifying contemporary coho populations south of the Golden Gate as genetically part of the CCC Coho Salmon ESU, and while not ruling out some contribution of fish imported from other populations within the CCC Coho Salmon ESU (e.g., the Noyo River), ruling out the possibility that contemporary coho populations south of the Golden Gate are entirely the result of such importations (Spence et al. 2011). NMFS also determined that the effectiveness of early hatchery practices is questionable and likely led to low return rates of adult fish since the practice of releasing fish as fry likely led to very low survival rates, and stock from distant and more northern sources like Baker Lake evolved in a cold, snow-melt driven system with adaptations such as summer adult run timing that would be highly maladaptive in the Santa Cruz Mountain region (Spence et al. 2011).

As part of its review in response to the petition, NMFS concluded that the CCC coho ESU should be extended southward from its previously defined southern limit at the San Lorenzo River to include the Soquel and Aptos creek watersheds. This conclusion was based on the ecological similarity and close proximity of the Soquel and Aptos creek watersheds to those immediately to the north, coupled with the documented natural recolonization of the Soquel Creek watershed by coho during the 2007–2008 spawning season (Spence et al. 2011).

Although there is good evidence that coho were present in the Plan Area before extensive hatchery influence, only rough estimates exist of the historical coho adult abundance and those estimates are only available since the 1940s (NMFS 2012). Lack of information for how abundant or persistent these early populations were is not an inconsequential consideration in development of this HCP and recovery of the species. The inherent capacity of habitat in the Plan Area to support coho bears heavily on the responsiveness of the species to management actions in Plan Area streams, even if all human influence could be removed or remediated.

Life History and Habitat Requirements

Coho spawning migrations from the ocean to freshwater streams or rivers usually begin after the first heavy rains in late fall or winter. The timing of their migration varies somewhat throughout their range, but in the short coastal streams of central California, coho typically return to fresh water during November through February with the peak in December and January. Females construct redds near the head of a riffle in substrate consisting of gravel and small cobble. The female may dig several pits to complete spawning, probably laying a few hundred eggs in each pit. Coho average 2,500 eggs per female. Shapovalov and Taft (1954) found that the average incubation time for coho on Waddell Creek was 35 to 50 days.

Temperatures at this time should not exceed 55ºF (12.8°C) (Shapovalov and Taft 1954). Newly hatched fry (embryos) remain in the interstices of the gravel for approximately 3 weeks before emerging and schooling in still, shallow water along stream margins. As they grow during the spring, juvenile coho disperse to pools where they set up individual territories. After spending the ensuing summer, fall and winter in the stream, the immature yearling coho begin to migrate downstream toward the ocean in spring. During this time, juveniles undergo smoltification. Growth in freshwater varies with a number of factors, but typically smolts leaving California streams at 12-15 months old measure 8 to 15 centimeters (cm) FL. Some juveniles may achieve even larger sizes before emigration by staying 2 years in the stream (Moyle 2002). Outmigration typically peaks from late April to mid-May, if conditions are favorable (Moyle 2002). After entering the ocean, immature coho initially

remain inshore, close to the parent stream. Gradually, they spread out, over the continental shelf, where they grow much more rapidly than in the stream.

Coho have a fairly strict 3-year life cycle, with about half spent in freshwater and half spent in salt water. After 2 years of growing and sexually maturing in the ocean, coho return to their natal streams as 3-year-olds to spawn and die. Some precocious males (jacks) return to freshwater at two years of age (NMFS 2012). There is very little variability in age of spawning for female coho with the result that nearly all wild female CCC coho spawn at three-year old (Anderson 1995, Shapovalov and Taft 1954). This results in distinct brood-year lineages with the majority of progeny in any year class produced by females hatched three years previously. If a particular brood-year is lost or depleted due to catastrophic events such as wildfire, flood, poor ocean survival, or chemical spills, it is very difficult for it to rebuild. For coho south of San Francisco Bay, Anderson (1995) reported the extirpation of the 1991-1994 lineage in Waddell and Scott Creeks (the only streams south of San Francisco Bay still sustaining natural runs at that time) and the near elimination of the 1992-1995 lineage on both streams. At that time, only the 1993-1996 lineage was sustaining (Anderson 1995).

Shapovalov and Taft (1954) found the average rate of survival for coho was 0.13 percent from the egg to adult return (varying from .02 to 0.3 percent in different seasons), and survival from the entrance into the ocean to adult return averaged 2.3 percent (ranging in different seasons from 0.6 to 5.4 percent). Rates of survival tend to vary inversely with the size of the year class (Shapovalov and Taft 1954). Rates of survival are highly variable both during freshwater and ocean residence.

Habitat requirements for coho are variable and depend on life stage. Key habitat features are summarized in the CCC coho recovery plan as follows (NMFS 2012). Adults returning from the ocean to spawn need adequate flows to migrate upstream and cool temperatures. Deep pools for resting and cover from overhanging riparian vegetation, downed trees, rootwads, and undercut banks are beneficial for protection from predation. Gravel/cobble substrate free of fine sediments and with adequate flow through the pore spaces is selected by females for laying eggs.

After laying eggs, stable streamflows are beneficial so that sufficient flow is maintained through the gravel to irrigate developing embryos. Significant declines in streamflow during the incubation period can dewater redds and floods can mobilize the substrate and destroy redds and eggs or fill voids in the gravel with fine sediments and smother eggs. Incubation of eggs is optimal in stable, undisturbed substrate supplied with adequate flows of clean, well-oxygenated water not contaminated with toxic substances. After hatching, alevins remain in the small spaces between the gravels and feed from their attached yolk sacs. They are highly vulnerable to siltation and scour and need to be able to swim up through the gravels and emerge into open water.

Free-swimming fry feed on small invertebrates of both aquatic and terrestrial origin. Deep pools with extensive cover and cool temperatures become important as juveniles rear over their first summer. Dense riparian vegetation supports some of the insects consumed by juveniles, provides cover from potential predators, and maintains cooler temperatures by limiting solar radiation. Large trees bordering the stream also moderate temperature and dense root systems provide cover and stabilize stream banks. CCC coho are strongly associated with redwood forests. Downed trees and branches and accumulations of same (debris jams) provide important instream habitat functions such as hydraulic and habitat diversity, substrate for production of invertebrates, shelter from high flows, cover from potential predators, storage of fine sediment, and deposition of gravels and cobble. Side channels with pool habitat provide refuge during high flow periods.

After their first year in freshwater juvenile salmon undergo a physiological change known as "smoltification" that enables them to transition from freshwater to seawater. Smoltification can occur primarily with freshwater or in the nearshore environment. Smoltification is accompanied by downstream migration from rearing habitat to the ocean and migration success is enhanced by sufficient flow to move efficiently and safely downstream without impediment. In some streams coho use estuaries or lagoons during this transition, in others they migrate directly from freshwater to the sea with little time in an estuary. In streams where time is spent in an estuary, the quality of the habitat in terms of production of food, ability to evade predation, and water quality conditions are important factors.

Maturation of sub-adults occurs during ocean residency over a two-year period, leading up to the adult salmon's return, usually to the stream of its birth. The patterns of migration in the ocean vary and shifts in ocean conditions affect food, migration patterns, and survival. As the salmon return to their natal stream to reproduce they undergo change from saltwater to freshwater and may depend on nearshore or estuarine environments for this transition.

Population status and Limiting Factors

Only rough estimates exist for historical CCC coho adult abundance. Assessing changes in the viability of the CCC-Coho Salmon ESU remains a challenge due to the scarcity of long-term datasets for most populations, although implementation of the California Coastal Salmonid Population Monitoring Program (CMP)[35] across significant portions of the ESU have resulted in a number of shorter time series since 2010 (Williams et al. 2016). The existing data indicate that all independent and dependent populations are well below recovery targets and, in some cases, exceed high-risk thresholds (Williams et al. 2016). Although the longer-term (12–17 year) trends tend to be downward,

[35] https://www.calfish.org/ProgramsData/ConservationandManagement/CaliforniaCoastalMonitoring.aspx

data from the past 5 years suggest that some populations reached their lowest levels around 2008–2009 and have rebounded slightly since then. An area of particular concern is the downward trends in abundance of virtually all dependent populations across all diversity strata. These trends suggest that dependent populations are less able to maintain connectivity or act as buffers against declines in neighboring independent populations, suggesting that the independent populations are becoming more isolated with time. Populations continue to be the strongest in the Mendocino County watersheds from the Navarro River northward, and weaker to the south, with the exception of Lagunitas Creek. The viability of coho in the Santa Cruz Mountain Diversity Stratum, where virtually all recently observed salmon have been the result of hatchery operations, remains especially dire. The CCC-Coho Salmon ESU continues to be in danger of extinction (Williams et al 2016).

North Coast

Sampling for salmonids in the North Coast streams has been limited to the synoptic survey of Santa Cruz County streams in the fall of 1981 by Harvey & Stanley Associates, Inc. (1982), annual snorkel surveys conducted by the City of Santa Cruz since 2006, and lagoon surveys in Laguna Creek conducted since 2004. The 1981 surveys were conducted by electrofishing at "spot checks" in representative locations. All sites in Laguna Creek and all but three sites in Liddell Creek and 1 site in Majors Creek were above currently identified limits of anadromy. The year the survey was conducted, 1981, was a dry year with low streamflows. No coho were reported in any of the three Creeks in the HCP area (Liddell, Laguna, or Majors) in the 1981 study.

The City of Santa Cruz annual surveys involve snorkel surveys throughout the anadromous reach of each stream and cover a total distance of 2,000 to 3,000 linear feet in each stream. A few coho have been observed in the snorkel surveys. A carcass of a spawned adult coho was found by City of Santa Cruz personnel in the winter of 2005 (Chris Berry, City of Santa Cruz, personal communication to Jeff Hagar, 2006). Seven YOY coho were observed in snorkel surveys in Laguna Creek in 2015 and four age 1+ coho were observed in 2016 (Berry et al. 2019). Three coho YOY were also observed in Liddell Creek in 2018 (Berry et al. 2019). Smolt-sized and YOY coho were captured in seining surveys in the Laguna Creek lagoon in 2005 (2ndNature 2006) indicating that coho spawned successfully in Laguna Creek both during the winter of 2003-2004 and the winter of 2004-2005. Coho YOY were relatively abundant in the lagoon in May and July but had largely disappeared by September (2ndNature 2006). These observations indicate that suitable conditions for coho reproduction in at least Laguna and Liddell Creeks in some years. This production is likely the result of natural spawning by hatchery produced fish.

As in other Santa Cruz County streams, the North Coast streams are near the southern range limit of coho. Factors thought to limit coho in these streams include: extreme hydrologic variability typical of

the Central California Coast, including frequent droughts and high peak flows; and the narrow and early coho spawning season and inflexible coho life history that subject the coho to catastrophic losses on a frequent basis and provide little ability to rebound during brief periods of more suitable conditions. In addition, the high sedimentation levels and lack of pool development in Liddell Creek are at least as limiting for coho as for steelhead.

According to watershed characterization protocols developed in the NMFS Recovery Plan for Central California Coastal coho (NMFS 2012), Majors, Laguna, and Liddell creeks are described as Dependent Populations. In general, under current conditions neither Majors nor Liddell likely maintain suitable spawning and rearing conditions for coho. Long-term persistence in Laguna Creek is likely tenuous due to the relatively small quantity of accessible habitat coupled with the significant amount of water diverted from the upper watershed (NMFS 2012).

Climatic conditions affect salmonid abundance, productivity, spatial structure, and diversity through direct and indirect impacts at all life stages and while salmon have adapted to a wide variety of climatic conditions in the past and could likely survive substantial climate change at the species level, the adaptive ability of these species is currently depressed due to reductions in population size, habitat quantity and diversity, and loss of behavioral and genetic variation (Williams et al. 2016). Without these natural sources of resilience, systematic changes in local and regional climatic conditions due to anthropogenic global climate change will likely reduce long-term viability and sustainability of populations in many of these ESUs and DPSs (Williams et al. 2016). This is particularly for those populations, such as the San Lorenzo River and dependent populations on the North Coast, at the margins of the species range. The period from 2012-2015 in California was characterized by well below average precipitation in each year and may be the most extreme drought in the past 500 years. The drought was accompanied by record high surface air temperatures in 2014 and 2015 which amplified annual water deficits (Williams et al. 2016).

San Lorenzo River Unit

Anderson (1995) reported that coho were abundant and supported a significant sport fishery on the San Lorenzo River into the 1960s, when a severe population decline occurred. Estimated annual river sport catch was 200 -1,500 adult coho (Anderson 1995). By the early 1970s the river sport catch had declined to 383 adults in 1970-71, 370 adults in 1971-72 and 342 adults in 1972-73, (Anderson 1995). The decline in the San Lorenzo River coho sport catch in the 1970s reflected a corresponding drastic decline in the annual coho spawning runs (Anderson 1995). Estimated escapement in the San Lorenzo River was 1,600 in 1963 and 500 in 1984-1985 (NMFS 2012).

In an effort to reestablish coho runs for River recreational fishing, the MBSTP started a hatchery coho smolt planting program in 1986 primarily using eggs from Noyo River and Prairie Creek stocks. As returning runs developed, MBSTP began capturing adults by seining the lagoon or operating the Felton Diversion Dam Trap and artificially spawning them to produce eggs and smolt. These progeny of non-native coho stocks were used to restock the River (Anderson 1995 citing MBSTP Annual Reports, Brown et al. 1994). Although small returning runs developed which generated some local interest in a winter sport fishery for sea-run salmon, these runs failed to produce a naturally spawning population (due in part to lost and degraded habitat conditions and the non-native ancestry of the San Lorenzo River coho), and the resultant runs are entirely hatchery-maintained (Anderson 1995 citing Brown et al. 1994, Bryant 1994).

Recent sampling within Pescadero Creek and San Lorenzo River, the only two independent populations within the Santa Cruz Mountains strata, suggest coho have likely been extirpated within both basins (NMFS 2016c). The San Lorenzo River lost its naturally spawning coho population during the 1976-1977 drought. However, much or all of that population was the result of stocking from the 1950s through the mid-1970s (Brown et al. 1994). Basin-wide salmonid abundance surveys of the San Lorenzo River and tributaries, conducted from 1994 through 2004 failed to capture a single coho (Alley et al. 2004, Alley 1994-2001, Santa Cruz County Environmental Health 2020). Four juvenile coho were observed in Bean Creek (tributary to Zayante Creek) in the fall of 2005 (DW Alley and Associates 2007) and two YOY coho were captured in September 2005 in Zayante Creek just upstream of the Bean Creek confluence (HES 2005a). YOY coho were also observed by NMFS in 2005 during snorkel surveys in Bean Creek (Brian Spence personal communication to Chris Berry, 2005). Based on accounts in the literature, these were likely progeny of hatchery strays (Brown et al. 1994, Anderson 1995, Williams et al. 2016).

Extirpation of coho from the San Lorenzo River is likely a result of habitat loss and drought conditions in the late 1980s, and early 1990s (NMFS 2012). The severe drought of 1976-77 also had impacts. The period of severe population decline in the 1960s and early 1970s noted by Anderson (1995) was associated with the effects of booming residential growth in the watershed, including disturbance of land, increased erosion, and deposition of fine sediments in the streambeds (Alley et al 2004, County of Santa Cruz 2001, NMFS 2012). Anderson (1995) cites reports that fine sediments within the San Lorenzo River streambed increased from 8 percent in 1961 to 65 percent in 1972, confirming an observed dramatic increase in sediments during the 1960s -1970s, concurrent with the decline of the coho spawning population. (Anderson 1995).

Factors limiting coho in the San Lorenzo River are similar to those for steelhead, primary among which are the lack of deep pools, high stream channel gradient, high summer temperatures, and

hydrologic patterns which result in low flows for early upstream passage during November and December (which is critical for coho) and excessively high flood flows that are destructive to redds during late winter and early spring. In addition, habitat preferred by coho, including low gradient streams in old-growth coniferous forest with deep pools and lots of woody cover, is not extensive in the San Lorenzo River watershed. The San Lorenzo River is at the extreme southern boundary of the species range (Spencer et al. 2004) and as such, any one of a number of factors may be limiting. Limited water temperature studies have indicated that areas in the San Lorenzo River watershed with otherwise suitable habitat conditions and highest intrinsic potential for supporting coho, such as the lower mainstem and lagoon, have temperature conditions that often exceed the suitable range for coho (Section 2.4.3.1). The extreme hydrologic variability typical of the Central California Coast, including frequent droughts and high peak flows, may be the single most limiting factor for coho. The narrow and early coho spawning season and inflexible life history subject the coho to catastrophic losses on a frequent basis and provide little ability to rebound during brief periods of more suitable conditions (Anderson 1995).

NMFS has identified numerous anthropogenic induced factors leading to a decline in habitat quality, including urbanization, water diversions, inadequate road management practices coupled with high road density, large wood removal, past timber harvest practices, bank hardening, and channelization (NMFS 2012). Many of the low gradient habitats in the lower portion of the watershed with high Intrinsic Potential to support coho are extensively urbanized and their function as coho rearing habitat is compromised (NMFS 2012).

In Newell Creek, the factors most limiting for coho, aside from their overall status in the watershed, are likely to be low flows during the adult migration and spawning periods. This is potentially even more of a problem for coho than for steelhead since coho are dependent on early migration (December and January) when Loch Lomond Reservoir is less likely to have filled enough to spill.

In Zayante Creek, excessive accumulation of fine-grained sediment in the substrate is likely to be limiting in absence of these other factors. A lack of large woody material is also a likely limiting factor for steelhead and coho.

3.0 COVERED ACTIVITIES

3.1 Introduction

This section describes the “Covered Activities” under the HCP, including rehabilitation of water system facilities, operations and maintenance activities that the City routinely performs including

operation, maintenance and repair of the City's water supply and water system facilities, operation and maintenance of the City's municipal facilities such as the San Lorenzo River flood control channel, management of City open space and other lands and emergency response. More detail on these activities is provided below. See Figure 3-1: City of Santa Cruz Water System map.

Figure 3-1: City of Santa Cruz Water System Map



3.2 Rehabilitation of Diversion Structures and Pipeline Reaches

The North Coast System (NCS) is the part of the City's water system that diverts water from Liddell Spring, Laguna Creek, Reggiardo Creek and Majors Creek and delivers that water to the Coast Pump Station; located along the San Lorenzo River just upstream of Highway 1 in Santa Cruz. The NCS is located within the Coastal Zone of Santa Cruz County (Figure 1-1). The NCS includes five distinct pipeline reaches (Liddell, Laguna, Laguna/Liddell, Majors, and the North Coast Pipeline Reach [NCP Reach]). The system extends above ground and underground through developed and undeveloped areas, and traverses along, above or beneath roadways and waterways from Bonny Doon to the west side of Santa Cruz. See Figure 3-1: City of Santa Cruz Water System map. Rehabilitation work on the NCS entails replacement of portions of the supply pipelines and rehabilitation of the diversion structures. The pipeline replacement work includes replacement of the pipelines in their current alignments or the construction of new alternative alignments, designed to avoid sensitive habitats (e.g., potentially sensitive riparian areas). Due to the size of the NCS and funding limitations, work on each of the five pipeline reaches will occur in phases and includes a mix of existing and new alignments. It is also possible that the pipeline routing may require a change from the present "gravity-flow" system to a "pumped" system for the Laguna and/or Majors reaches.

Under the proposed Project, rehabilitation of the two 120+-year old diversion structures at Majors and Laguna Creeks also would occur. Modifications to these structures, which are located above the anadromous reaches on the creeks, would likely include dewatering by way of the installation of a cofferdam and a temporary bypass system, earthwork, reinforced concrete demolition and construction, metal work fabrication and installation, bank armoring, and miscellaneous electrical and mechanical services, including a pneumatically operated spillway gate. This work would enable the diversion structures to facilitate bypass flows and passage of suspended sediment and bed load downstream in a more natural manner, minimizing the need for manual clearing of these materials and deposition in downstream habitat. Rehabilitation of the Tait Street and Felton Diversions on the San Lorenzo River would also occur and primarily involve improvements for fish passage, screening and pumping capacity (at Tait Street only) to take advantage of high winter flows, thereby allowing deferral of winter pumping at North Coast diversions and improvements in groundwater storage that can serve water system demand during low flow periods.

The City maintains an 8- to 10-foot right-of-way (ROW) along the existing pipeline route in most areas. Specifically, the18-mile NCS includes:

- approximately 5.5 miles of the system located within developed areas (mountain residential and City of Santa Cruz)

- approximately 1.5 miles of the system extending beneath City surface streets from the Meder Street extension to High Street
- approximately 4 miles of the system running along Highway 1 from Laguna Creek on the west to Wilder Ranch State Park entrance on the east (Jones & Stokes 2000)
- the remaining 12.5 miles of the system running through undeveloped areas (Cotoni-Coast Dairies National Monument, Wilder Ranch State Park, and Moore Creek Preserve)

3.3 Water Supply Operations

3.3.1 Water Diversions

The City has several sources of water supply in its system. These include the North Coast Diversions (including Liddell Spring, Reggiardo Creek, Laguna Creek and Majors Creek), the San Lorenzo River (including Felton and Tait Street Diversions), Newell Creek Dam and Reservoir (commonly referred to as Loch Lomond Reservoir) and the Live Oak Wells. While drought-period demand is substantially lower, the historic and projected future water demand in the service area averages about 3.2 billion gallons annually, of which the majority occurs in the six-month May-October peak season. Historically, only the Felton Diversion and Newell Creek Dam had requirements for bypass flows. The Live Oak Wells draw from deep groundwater with no clear, direct connection to surface water dynamics and are not addressed in this HCP (Montgomery and Associates 2020).

The HCP will provide coverage for existing water diversion facilities including operation, rehabilitation, replacement, repair and maintenance of existing infrastructure and related facilities such as water measurement devices, scientific measuring devices, and water quality monitoring stations. The level of diversion for each facility is based on bypass flows ("Conservation Flows") negotiated for anadromous salmonids for the City's HCP. Conservation Flows for minimization of biological effects resulting from water diversion will be discussed in detail in the conservation strategy.

Liddell Spring Diversion

The Liddell Spring Diversion was developed in 1913 and is a natural spring located at the headwaters of the East Branch of Liddell Creek, approximately 2.5 miles upstream from the mouth of Liddell Creek and 1.34 miles from the anadromous limit (See Figure 3-1: Water System map). The spring box/diversion structure consists of a concrete box with a corrugated locking door. The structure sits on top of the natural spring and is approximately 25 feet above Liddell Creek. Because the water right for the diversion is a pre-1914 right there are no specified limits on diversion rates or quantities and a bypass flow is not required.

The Liddell Spring Diversion operates year-round and historically produced approximately 1.2 to 1.7 million gallons per day (mgd) with a maximum facility diversion capacity of approximately 2.5 cfs prior to recent implementation of bypass flows. Future diversion capacity increases are not proposed for coverage in this HCP. See Section 6.2.1 for a discussion of water supply reliability – related future water rights changes associated with this facility. Water is diverted directly from the spring into a 10-inch pipeline that then connects to the North Coast Pipeline via the Laguna Creek pipeline. The flow is controlled by an inline slide gate valve. The valve may be shut during storms and a separate drain valve is most often cracked open to allow sediment transport and passing of the peak of the hydrograph. Sediment is also removed via pumping when it inundates the drain valves during significant storms. When not diverted, the spring flow passes under the access road adjacent to the spring through a culvert and discharges into a tributary to the East Branch of Liddell Creek. See Figure 3-2: Liddell Diversion Schematic and Figure 3-3: Laguna Diversion photo.

Figure 3-2: Liddell Diversion Schematic

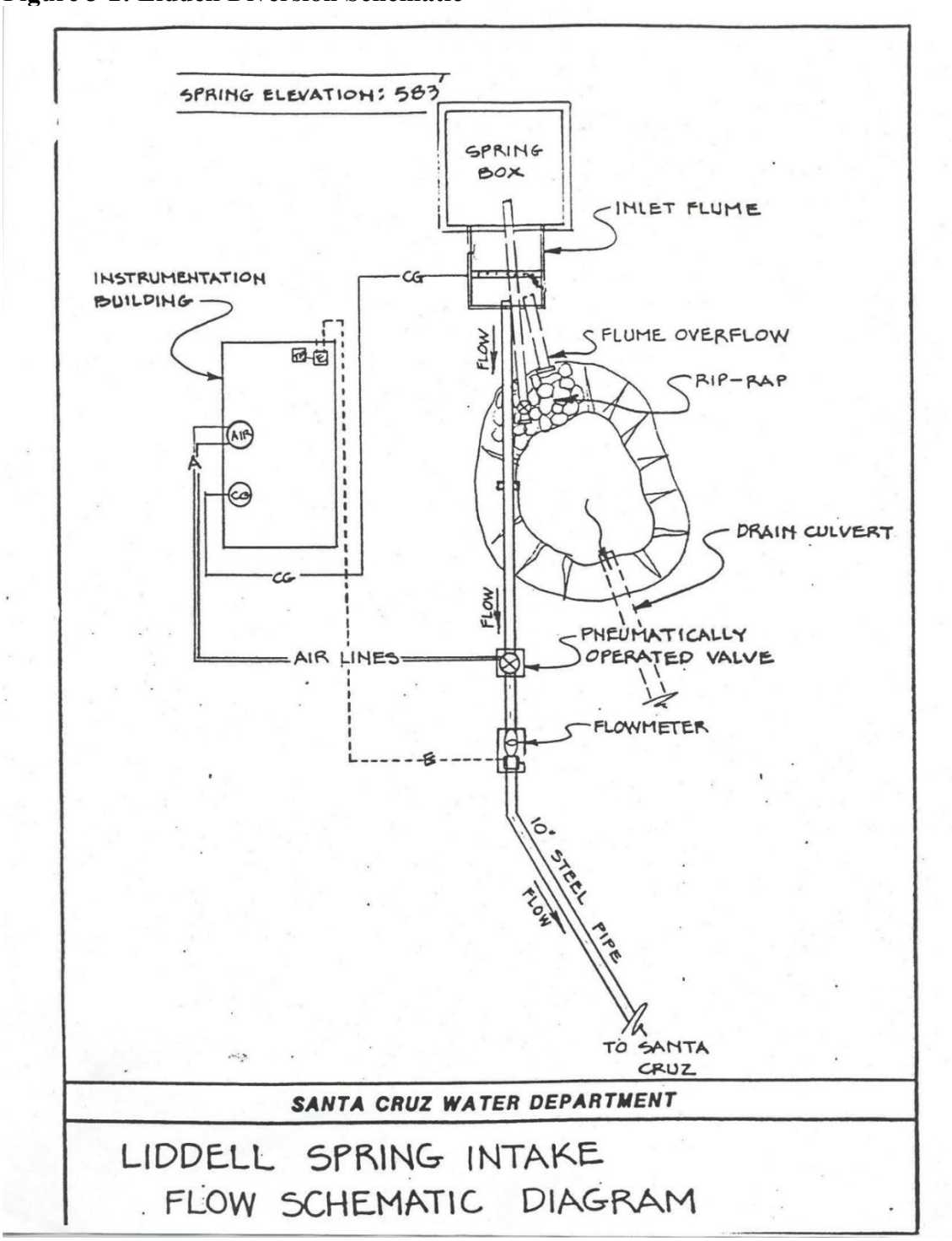


Figure 3-3: Liddell Diversion



Photo: Looking upstream from right bank toward the Liddell Diversion

Reggiardo Creek Diversion

The Reggiardo Creek Diversion is located on Reggiardo Creek approximately 300 feet above its confluence with Laguna Creek (See Figure 3-1: Water System map). Water rights for the Reggiardo Creek Diversion were acquired along with Laguna Creek in about 1912 (Camp, Dresser & McKee 1996). Since the diversion is part of a pre-1914 water right, there are currently no legal restrictions on diversion rates or quantity from the diversion nor is there a bypass flow requirement. A concrete dam spans the full width of the creek and is approximately 10 feet high. Immediately behind the concrete dam, the channel is filled with sediment. A small pond is created at the crest of the concrete dam.

The Reggiardo Creek Diversion typically operates year-round, 24 hours a day. However, due to recent inundation by sediment, the diversion is currently inoperable. Historic maximum facility diversion capacity ranged from 1.6-2.8 cfs. Surface water diverted from Reggiardo Creek enters a 14-inch pipe and flows by gravity approximately 850 feet into the upstream side of the Laguna Creek Diversion pond. A valve is located at the discharge of the pipe allowing flow to be regulated or shut off completely. Future diversion capacity increases are not proposed for coverage in this HCP. See Figure 3-4: Laguna/Reggiardo Diversion Schematic, Figure 3-5 Reggiardo Diversion Schematic and Figure 3-6 Reggiardo Diversion photo.

Figure 3-4: Reggiardo and Laguna Creeks Diversions Schematic

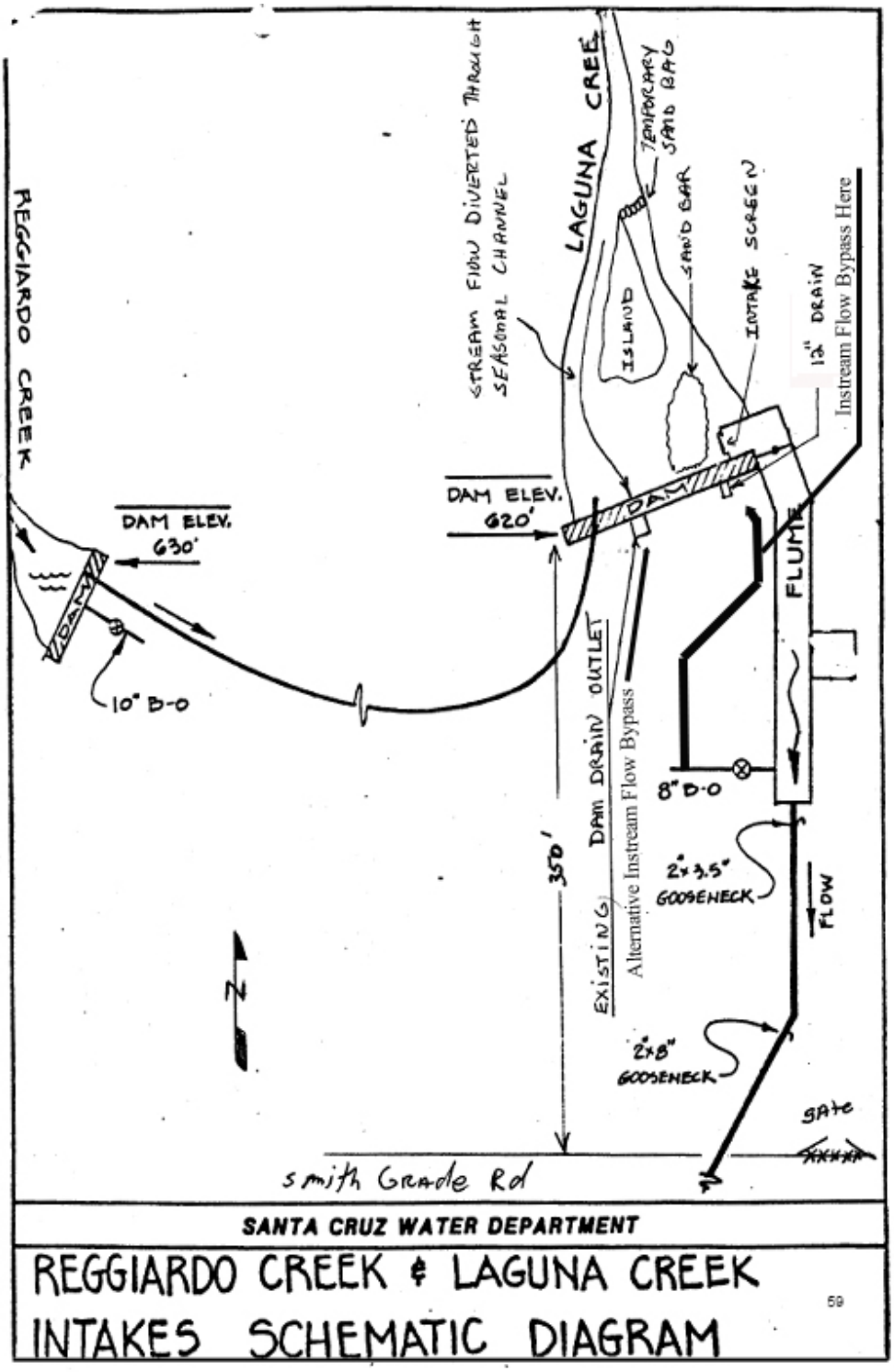


Figure 3-5: Reggiardo Diversion Schematic

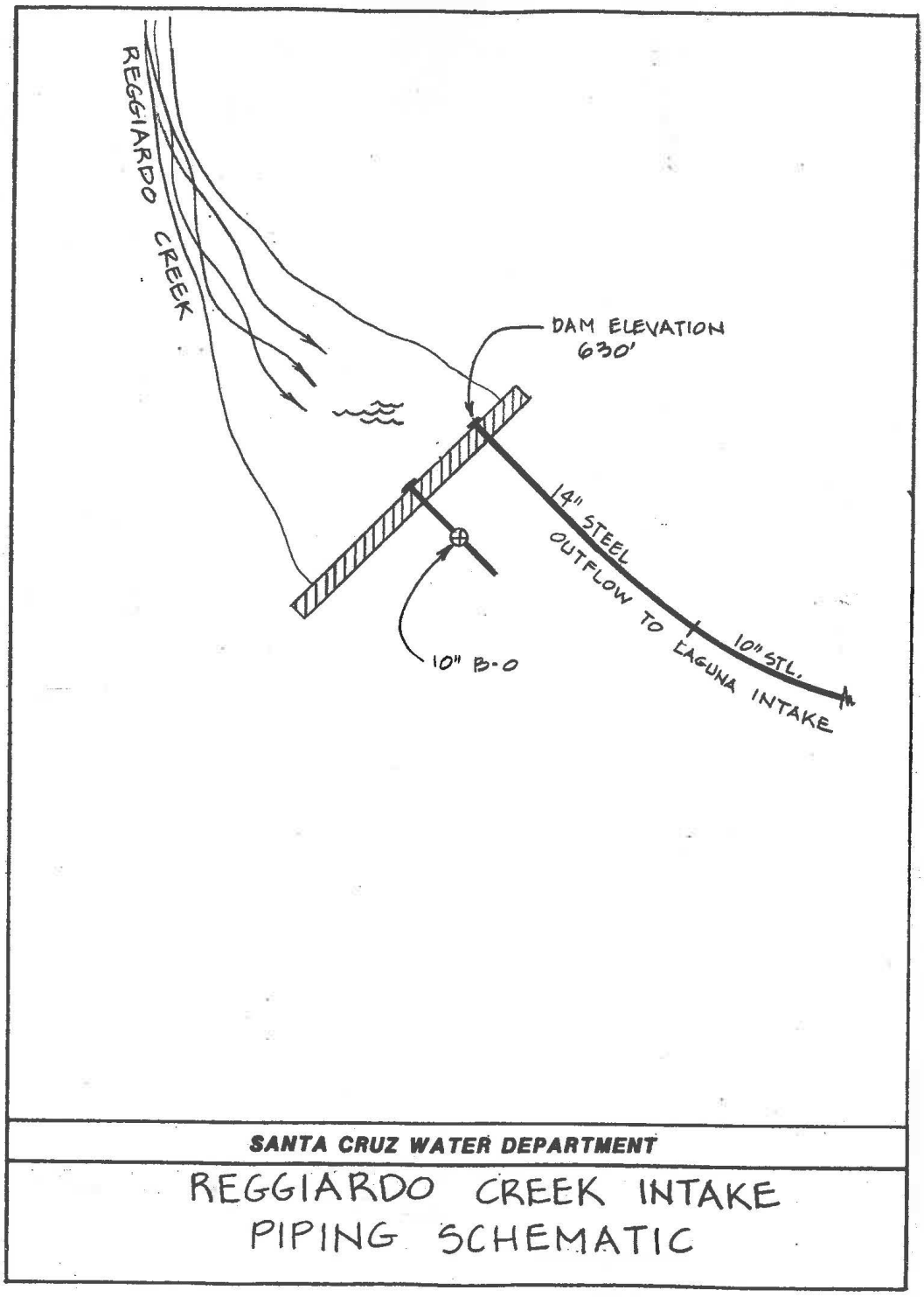


Figure 3-6: Reggiardo Diversion



Photo: Reggiardo Diversion from right bank downstream looking across the channel

Laguna Creek Diversion

The Laguna Creek Diversion is located 4.23 miles upstream from the mouth and 2.8 miles upstream from the anadromous limit (See Figure 3-1: Water System map). It was developed as a water source in 1890 and remains in use currently. Since the diversion is part of a pre-1914 water right, there are currently no legal restrictions on diversion rates or quantity from the diversion nor is there a bypass flow requirement. The concrete dam limit spans the full width of the creek and is approximately 12 feet high. Immediately behind and below the dam are small pools, however sediment has substantially filled the upstream pool.

The diversion operates year-round and has no seasonal restrictions nor bypass requirements. The maximum diversion capacity is approximately 6.3 cfs. Future diversion capacity increases are not proposed for coverage in this HCP. See Section 6.2.1 for a discussion of water supply reliability – related future water rights changes associated with this facility. The intake passively diverts water from the impoundment pool through a 5/32 inch woven-wire intake screen. This screen acts to keep debris from entering the intake pipeline and is periodically cleaned of debris by hand. Water enters a flume that conveys flow to the 14-inch pipeline. A pneumatically operated (air pressure) slide gate at the inlet of the pipe is used to open or close the inlet. During storm events the diversion intake is shut down as turbidity rises above 25 Nephelometric Turbidity Units (NTU). When turbidity begins to fall below 25 NTU the diversion is turned back on. Water from the diversion is transported through a 14-inch pipeline to the junction of the transmission pipeline from Liddell Spring. After joining at the Liddell junction, the raw water is transferred via the North Coast Pipeline to the water system. See Figure 3-7: Laguna Diversion Schematic and Figure 3-8 Laguna Diversion photo.

Figure 3-7: Laguna Diversion Schematic

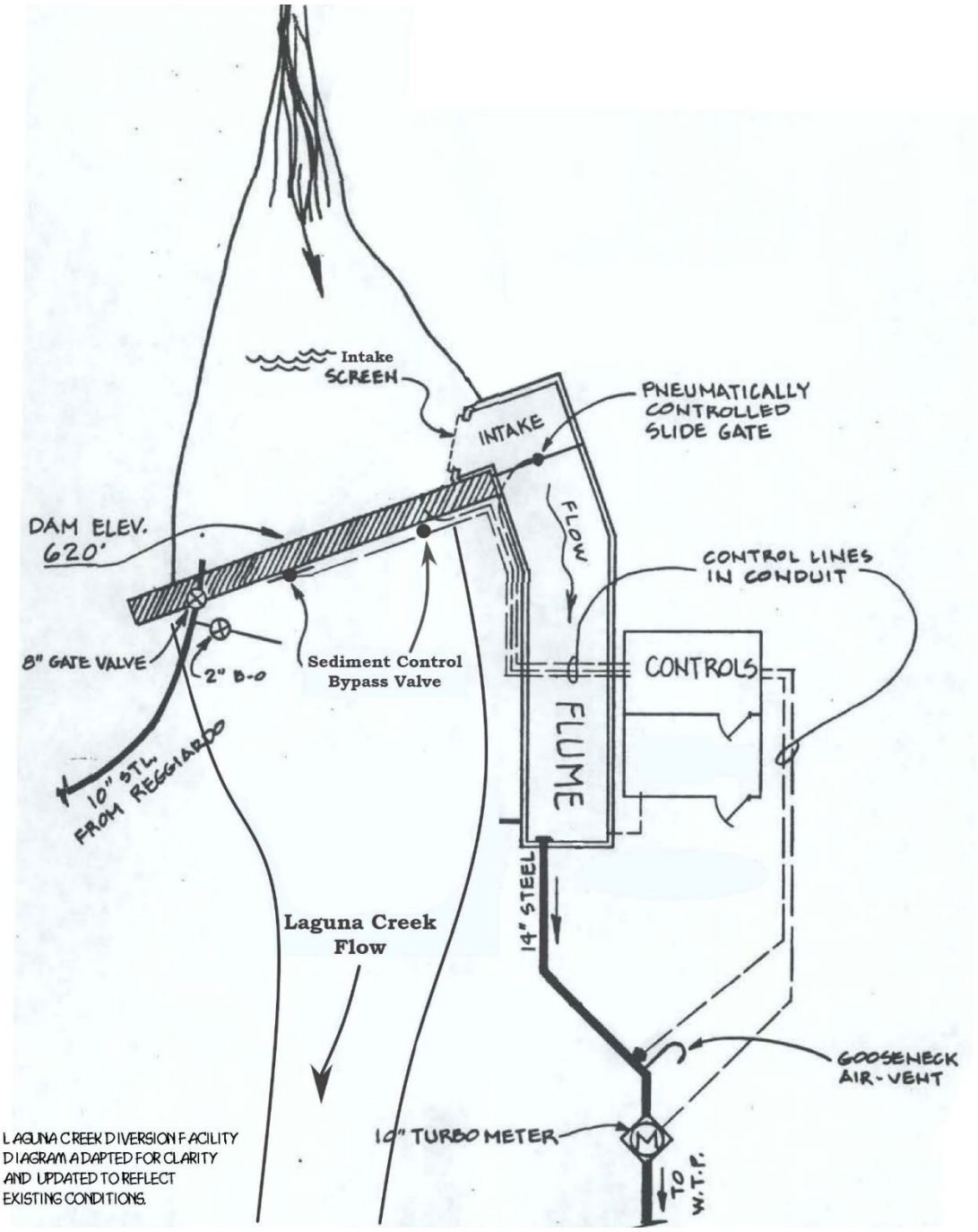


Figure 3-8: Laguna Creek Diversion



Photo: Laguna Creek Diversion from right bank downstream looking across the channel

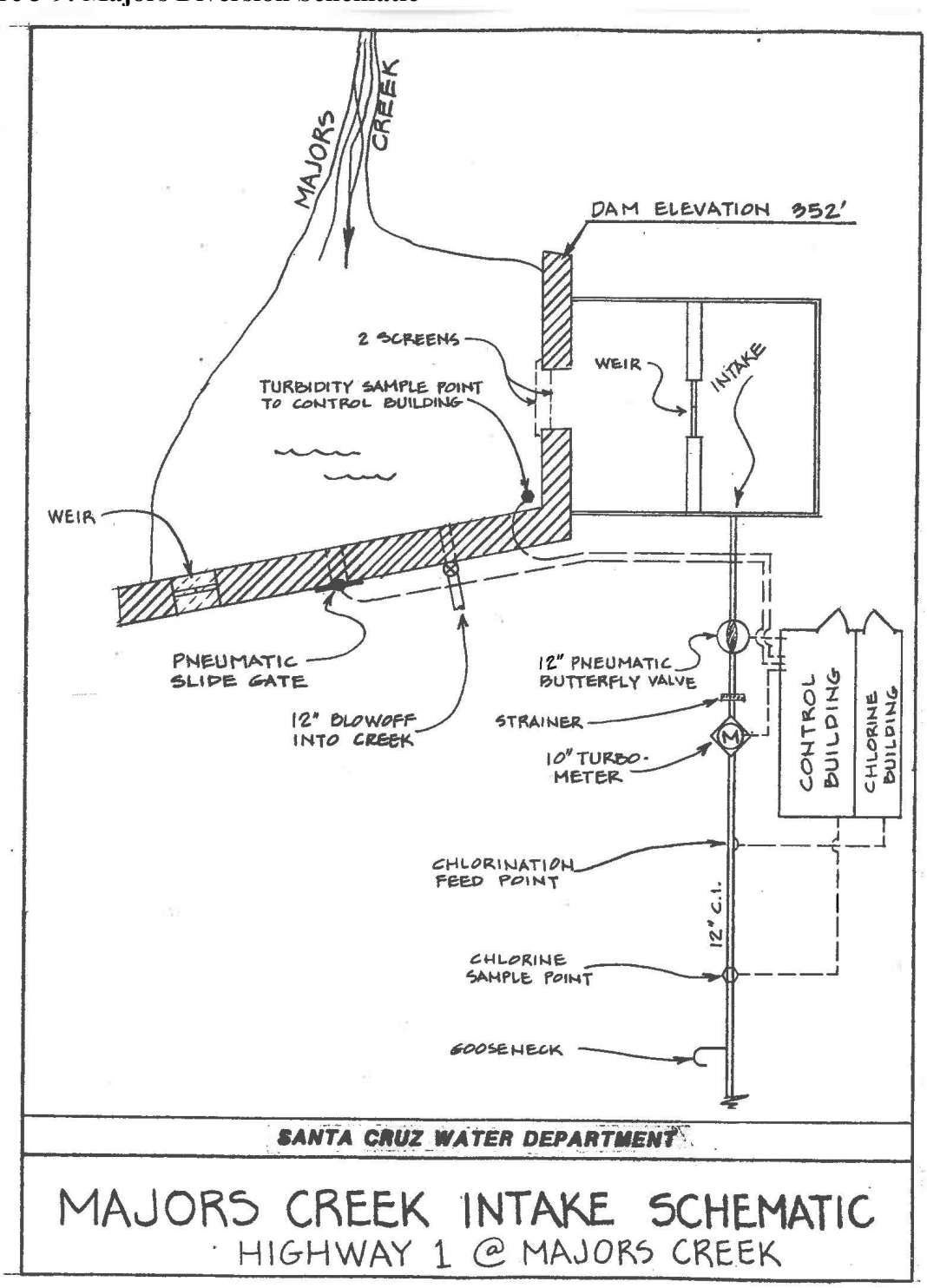
Majors Creek Diversion

The Majors Creek Diversion is located 2.2 miles upstream from the mouth and 1.5 miles upstream from the anadromous limit (See Figure 3-1: Water System map). Diversion on Majors Creek has occurred since 1882. The water right for the diversion was established in 1881 and the City operates the diversion under the pre-1914 water right (Camp, Dresser & McKee 1996). The Majors Creek Diversion operates year-round and has no seasonal restrictions nor bypass requirements. The concrete dam spans the full width of the creek and is approximately 12 feet high. Immediately behind and

below the dam are small pools which are periodically inundated by the high sediment loads present in Majors Creek.

The diversion operates year-round and has no seasonal restrictions nor bypass requirements. The maximum diversion capacity is approximately 2.1 cfs. Future diversion capacity increases are not proposed for coverage in this HCP. See Section 6.2.1 for a discussion of water supply reliability – related future water rights changes associated with this facility. The intake passively diverts water from the impoundment pool through a 1/4 inch woven-wire intake screen. This screen acts to keep debris from entering the intake pipeline and is periodically cleaned of debris by hand. Water enters a flume that conveys flow to the 12-inch pipeline. A pneumatically operated (air pressure) slide gate at the inlet of the pipe is used to open or close the inlet. During storm events the diversion intake is shut down as turbidity rises above 25 NTU. When turbidity begins to fall below 25 NTU the diversion is turned back on. Water from the diversion is conveyed through a 12-inch pipeline to the North Coast Pipeline. The Majors Creek Diversion is located approximately 300 feet lower in elevation than the other North Coast diversions, thus use of the Majors Creek Diversion is presently limited by the hydraulic loading from the other north coast sources. This hydraulic condition affects the influence that this diversion has on hydrology downstream by limiting Majors Creek diversion potential when production from the Liddell and Laguna diversions is relatively high. See Figure 3-9: Majors Diversion Schematic and Figure 3-10: Majors Diversion photo.

Figure 3-9: Majors Diversion Schematic[36]



[36] Chlorine is no longer used at the diversion.

Figure 3-10: Majors Diversion



Photo: Majors Diversion from left bank downstream looking across the channel

Newell Creek Diversion and Loch Lomond Reservoir

The Newell Creek Diversion consists of the Loch Lomond Reservoir impounded by the Newell Creek Dam (commonly referred to as Loch Lomond). Loch Lomond Reservoir is located on Newell Creek approximately 1.7 miles upstream from the confluence with the San Lorenzo River and 0.7 miles upstream of a significant migration barrier (See Figure 3-1: Water System map). Loch Lomond Reservoir is a drinking water reservoir and is the City's only water storage facility. Loch Lomond Reservoir is approximately 2.5 miles long with an approximate width of 1,500 feet. Newell Creek extends 3 miles upstream of the upper end of the reservoir. In 2009 the maximum volume of Loch Lomond Reservoir was determined to be 8,646 acre-feet (McPherson et al. 2011).

The Newell Creek Diversion (License No. 9847) is an appropriative right for diversion to storage not direct diversion to use. This license allows for a maximum of 5,600 acre feet or 1,825 million gallons per year to be collected from September 1 to July 1 and requires a year-round release of 1 cfs to Newell Creek downstream of the reservoir and release of the natural flow during July/August (due to the fully appropriated status of the San Lorenzo watershed) if the natural inflow exceeds 1cfs. Withdrawals from Loch Lomond Reservoir under the Newell Creek water right can occur from January 1 through December 31 and is limited to 3,200-acre feet or 1,042 million gallons per year. See Section 6.2.1 for a discussion of water supply reliability – related future water rights changes associated with this facility. Water that is removed from storage is passed through a valve on the dam face and flows by gravity to the Felton Booster Pump Station for delivery to the Graham Hill Water Treatment Plant.

Legal action taken by the SLVWD subsequent to the date the City obtained the Newell Creek license, resulted in a court decision that provides SLVWD up to 313 acre-feet or 102 million gallons per year from Loch Lomond Reservoir. This leaves a maximum withdrawal for the City of approximately 2,890 acre-feet or 940 million gallons per year from Newell Creek Reservoir.

The Felton Diversion on the San Lorenzo River also provides water to Loch Lomond Reservoir under two separate diversion to storage water rights permits. This water does not count against the provision in the Newell Creek license nor the SLVWD court decision. Details on the Felton Diversion are provided below.

Newell Creek Dam has five water intakes spaced at 20-foot intervals from 550 to 470 feet above sea level respectively, allowing withdrawals from the level with the best water quality, usually either 510 or 490 feet. Loch Lomond Reservoir is oxygenated by a hypolimnetic aerator[37] during the summer/fall months. The Newell Creek Diversion bypass is provided through a valve at the base of the Newell Creek Dam located approximately 10 feet from the toe of the dam.[38] The water released from this bypass is from the level of draw that is also used for production – which is aerated by the aforementioned hypolimnetic aerator, as well as by the diffuser at the outlet from the dam to Newell Creek just below the dam. Due to the small size of Loch Lomond Reservoir, spilling often occurs in years of average to above average rainfall. See Figure 3-11: Newell Creek Diversion Schematic and Figure 3-12: Newell Creek Diversion photo.

[37] Hypolimnetic aeration, involves the oxygen demand of deep water being provided by oxygen from the atmosphere via mechanical methods without destroying the lake's natural stratification. As the deep water becomes aerobic, the phosphate dissolution is reduced significantly and the mineralization of sediments improves - thereby improving water quality and conditions for cold water fish species.

[38] The future location of this release will be adjacent to the spillway pond.

Figure 3-11: Newell Creek Diversion Schematic

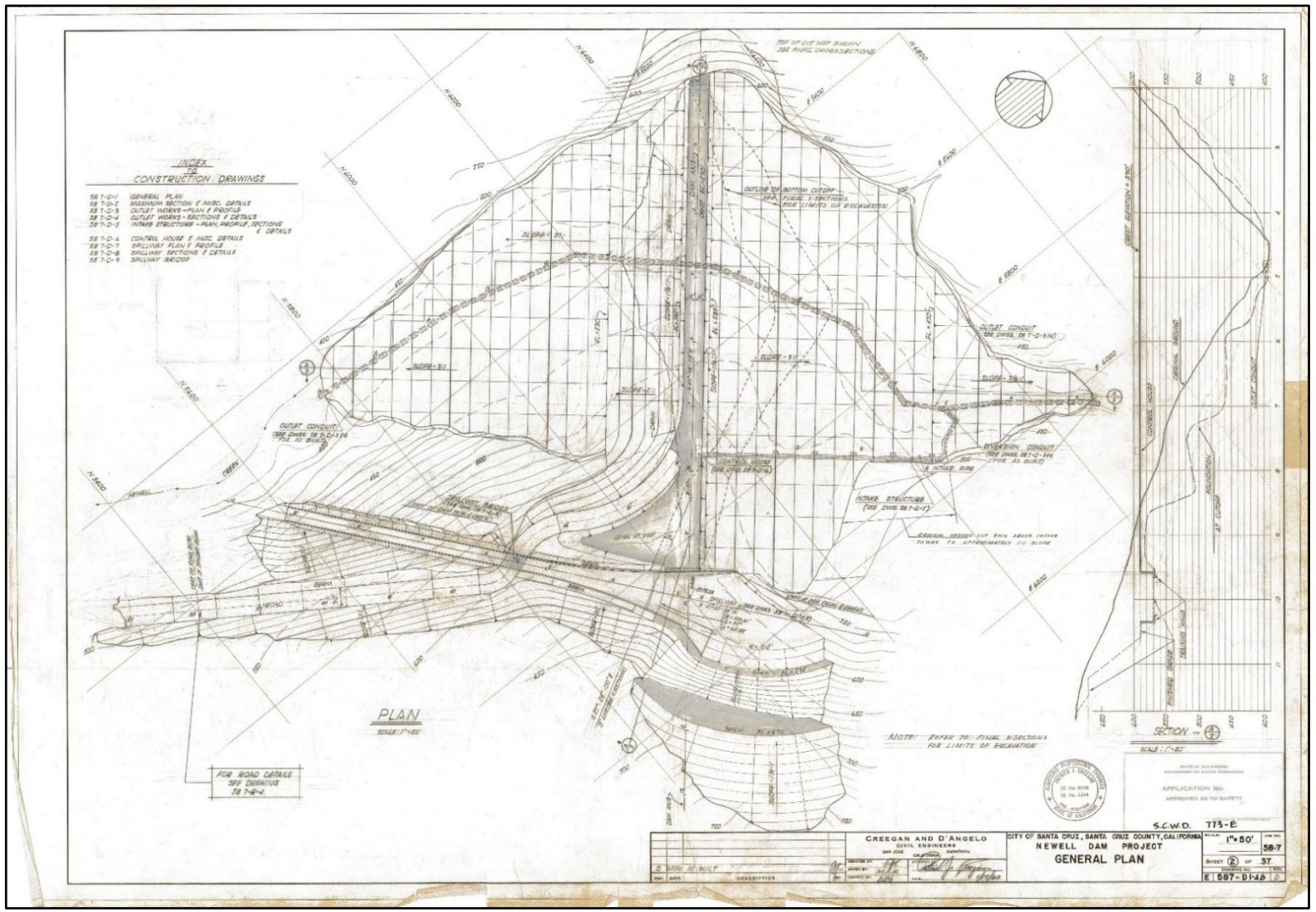


Figure 3-12: Newell Creek Diversion



Photo: Newell Creek Diversion from above left bank downstream looking upstream

Felton Surface Water Diversion at San Lorenzo River

The Felton Diversion is located on the San Lorenzo River just downstream of the Zayante Creek confluence and approximately five miles upstream of the Tait Street Diversion on the San Lorenzo River (See Figure 3-1: Water System map). The Felton Diversion consists of a three-foot-high concrete weir spanning the stream channel with an inflatable rubber dam attached to the top of the weir structure. The rubber dam is inflated after flushing flows (approximately >100 cfs) have occurred and antecedent precipitation is sufficient to keep river flows elevated above 40 cfs for a several weeks. When flows approach approximately 40 cfs, the dam is typically deflated. The dam is automatically deflated during channel-forming flows to avoid infrastructure damage and exacerbating upstream flood hazards. When not in operation, the dam is completely deflated and lays flat against the riverbed. The dam is eight feet high when fully inflated. A pump station is located on the west bank adjacent to the dam and weir structure. Water from the diversion is diverted into a screened intake sump and transferred via a pipeline to the Felton Booster Station located near Graham Hill Road. The flows are transferred via the Felton Booster Station to Loch Lomond Reservoir for storage and later use.

The City has appropriative water rights at the Felton Diversion. The Felton Diversion is implemented by two permits (Nos. 16123 and 16601) which allow a maximum annual diversion of 3,000-acre feet to Loch Lomond Reservoir for storage and later use.

The Felton Diversion operates according to two Memorandum of Agreements (MOAs) signed with the CDFW (Agreement Between City of Santa Cruz and CDFW for Streamflow Maintenance and Operation of Fishway at Felton Diversion Project on San Lorenzo River for the Protection and Preservation of the Fish and Wildlife Resources, 1971 (Appendix 4: *Felton Diversion Memoranda of Agreement*) and Memorandum of Agreement between CDFW and the City of Santa Cruz Regarding Operation of the Felton Water Diversion, 1998 (Appendix 4: *Felton Diversion Memoranda of Agreement*). These MOAs primarily focus on preservation of downstream instream flows and fish passage through the diversion. The maximum rate of withdrawal for October 1 to May 31 is 20 cfs with a minimum bypass flow of 25 cfs for October and 20 cfs for the period November 1 through May 31. In September, the diversion rate is 7.8 cfs with a 10 cfs bypass requirement – though diversion in September is often impossible and unnecessary. The Felton Diversion does not operate June through August. Under the HCP, the City will continue to operate the Felton Diversion in accordance with the existing MOAs. See Appendix 4: *Felton Diversion Memoranda of Agreement*.

Future rehabilitation of the Felton Diversion will include pump, screen, and ladder improvements, though no pumping capacity increases are currently planned. See Section 6.2.1 for a discussion of water supply reliability – related future water rights changes associated with this facility. The hydraulic performance evaluations conducted by Entrix in 2001 and Borcalli and Associates in 2006

indicate approach and sweeping velocities at the two existing screen panels are virtually all within criteria for continuously cleaned screens. Accordingly, no suggestions are warranted for improvements to the fish screen arrangement from the standpoint of impingement velocities, velocity distribution, or exposure duration. However, the existing screen material requires replacement with either wedge wire with a 1.75 mm slot width or perforated plate with 3/32" diameter perforations to account for the presence of fry-sized salmonids within the water course. To keep the fish screens operating at optimum efficiency and since no means are currently employed at the site for continuous screen cleaning, a mechanical traveling brush system is also recommended to minimize screen clogging. Additionally, provision of a continuous bypass route for escapement of juvenile out-migrants would reduce effects of this diversion on special-status fisheries. The existing intake currently maintains connectivity between the forebay and tailwater pool only when the MOA dictates the existing sluice gate be opened at the terminal end of the structure. Under most operating conditions the intake structure functions as a "blind alley" which requires fish that have entered the intake to return upstream past the fish screen panels in order to exit the structure and locate an alternative downstream migration route. These improvements will be included in future rehabilitation of this facility associated with implementation of the water rights modifications included in the proposed Santa Cruz Water Rights Project (as described in Section 6.2.1). See Figure 3-13: Preliminary Future Felton Diversion Plan Profile, Figure 3-14: Preliminary Future Felton Diversion Plan Profile, and Figure 3-15: Felton Diversion photo.

Figure 3-13: Preliminary Future Felton Diversion Plan Profile

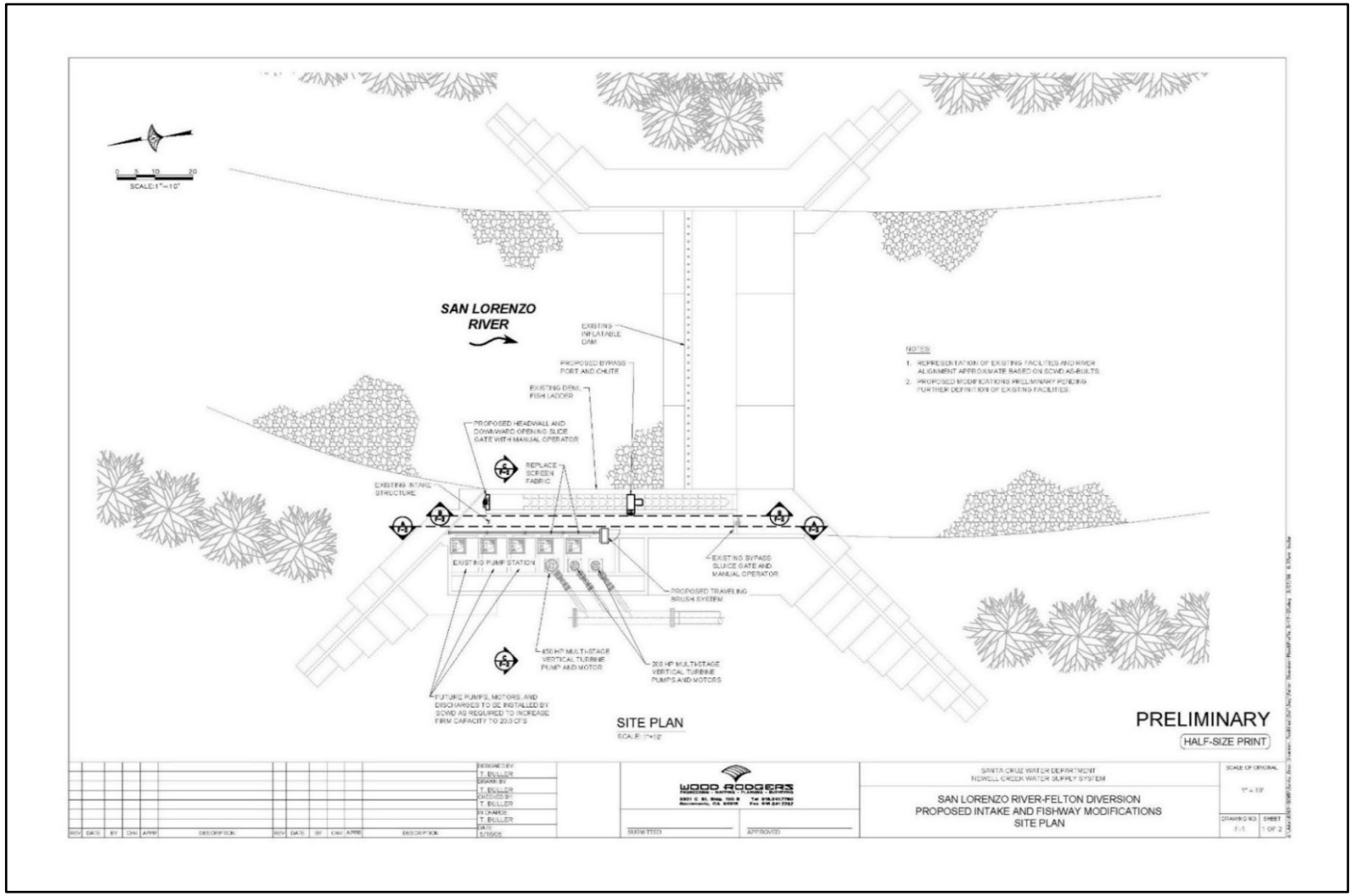


Figure 3-14: Preliminary Future Felton Diversion Plan Profile

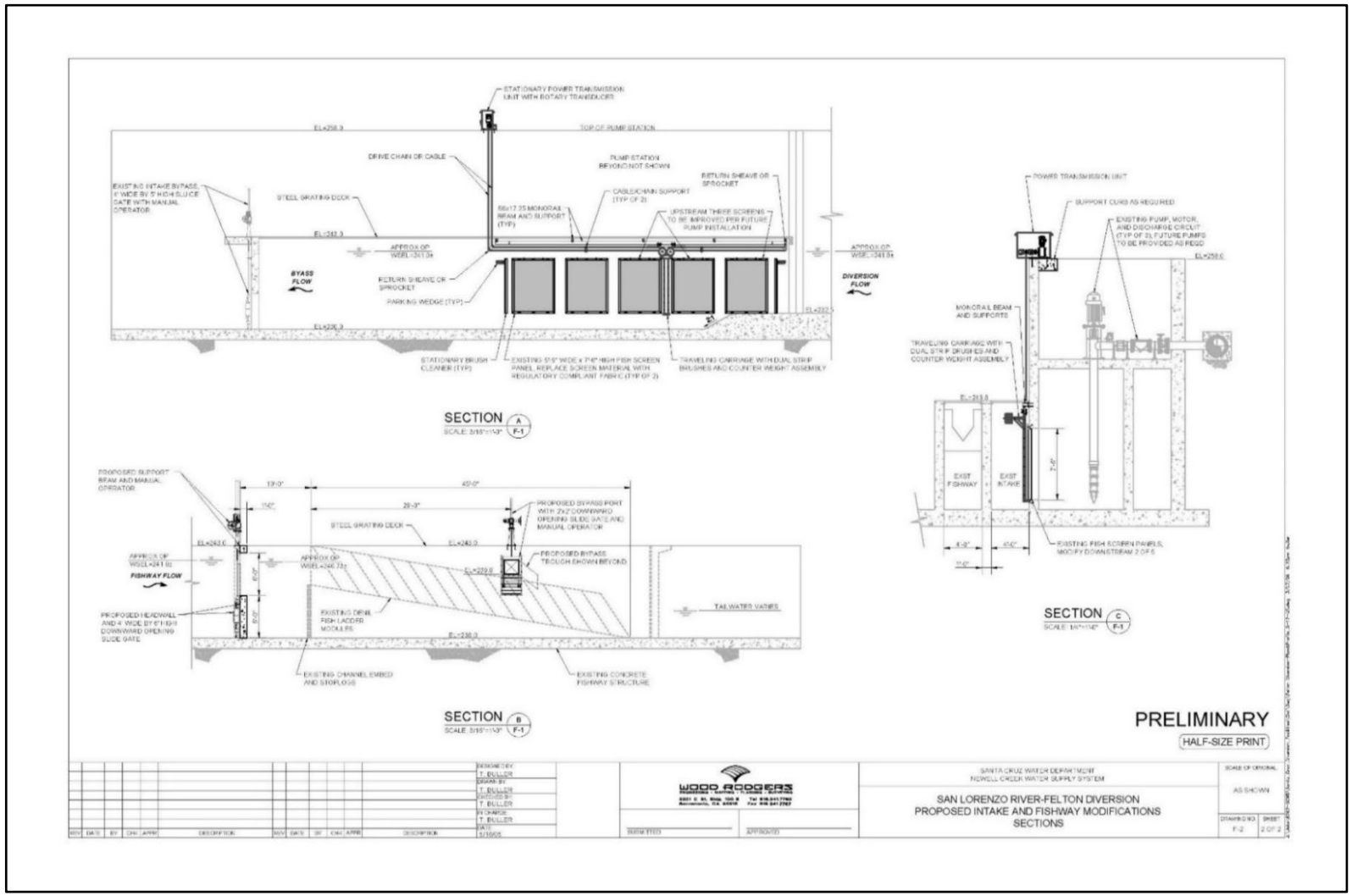


Figure 3-15: Felton Diversion



Photo: Felton Diversion from left bank downstream looking across the channel

Tait Street Diversion and Wells[39]

The Tait Street Diversion is located approximately 1 mile north of Highway One on the west bank of the San Lorenzo River at the terminus of Crossing Street (*aka Tait Street*) (See Figure 3-1: Water System map). The diversion consists of a low diversion dam (approximately three feet in height) that spans the width of the river and a concrete intake structure. The Tait Street Diversion also includes several wells located on the east side of the river. The wells range in depth from 71 - 89 feet and are considered to be under the influence of surface water.

Current water rights at the Tait Street Diversion and Wells consist of two licenses (Nos. 1553 and 7200) for appropriative rights to a maximum combined diversion rate of 12.2 cfs year-round. There is no annual limit specified in the licenses nor are there downstream release requirements included in the licenses. The future diversion rate at this facility may increase to up to 27.85 cfs during high winter flow periods to support water supply reliability. See Section 6.2.1 for a discussion of water supply reliability – related future water rights changes associated with this facility. Water is diverted on a continuous basis, interrupted only for excessive turbidity due to storms, short term water quality degradation resulting from spills of potentially harmful materials, mechanical breakdown, or routine maintenance.

Surface water is directed to the intake by the low diversion dam. The intake structure is concrete, built parallel to the stream bank, and extends downstream from the dam. The intake structure is protected by a debris rack and the downstream end of the intake is fitted with a hydraulic slide gate that is normally open during high flows and closed during low flows. This ensures the intake screens remain submerged and also maintains a continuous flow of water through the intake back into the river. A pipeline carries water from the intake to the pumping clearwell, where three vertical turbine pumps pump the water to the Graham Hill Water Treatment Plant. The diversion does not currently have a fish ladder, however fish passage and screening improvements are being considered currently in the context of overall facility rehabilitation. All improvements will be informed by discussion with CDFW and NMFS and will abide by NMFS criteria as applicable.

The wells operate in the summer and fall to reduce surface water diversion effects on instream flows and during the winter to improve the quality of unfinished/raw water coming from the facility. Water is delivered to the pumping clear well on the west side of the river. The groundwater is then pumped into a common transmission line to the Graham Hill Water Treatment Plant. These wells account for about five percent of total volume of water diverted at this San Lorenzo River facility and less than three

[39] This facility is generally called “Tait Street Diversion” but is also called “San Lorenzo River Diversion” on occasion.

percent of total annual production from all water sources. See Figure 3-16: Tait Street Diversion Schematic, Figure 3-17: Tait Street Well #1b photo, and Figure 3-18: Tait Street Diversion photo.

Figure 3-16: Tait Street Diversion Schematic

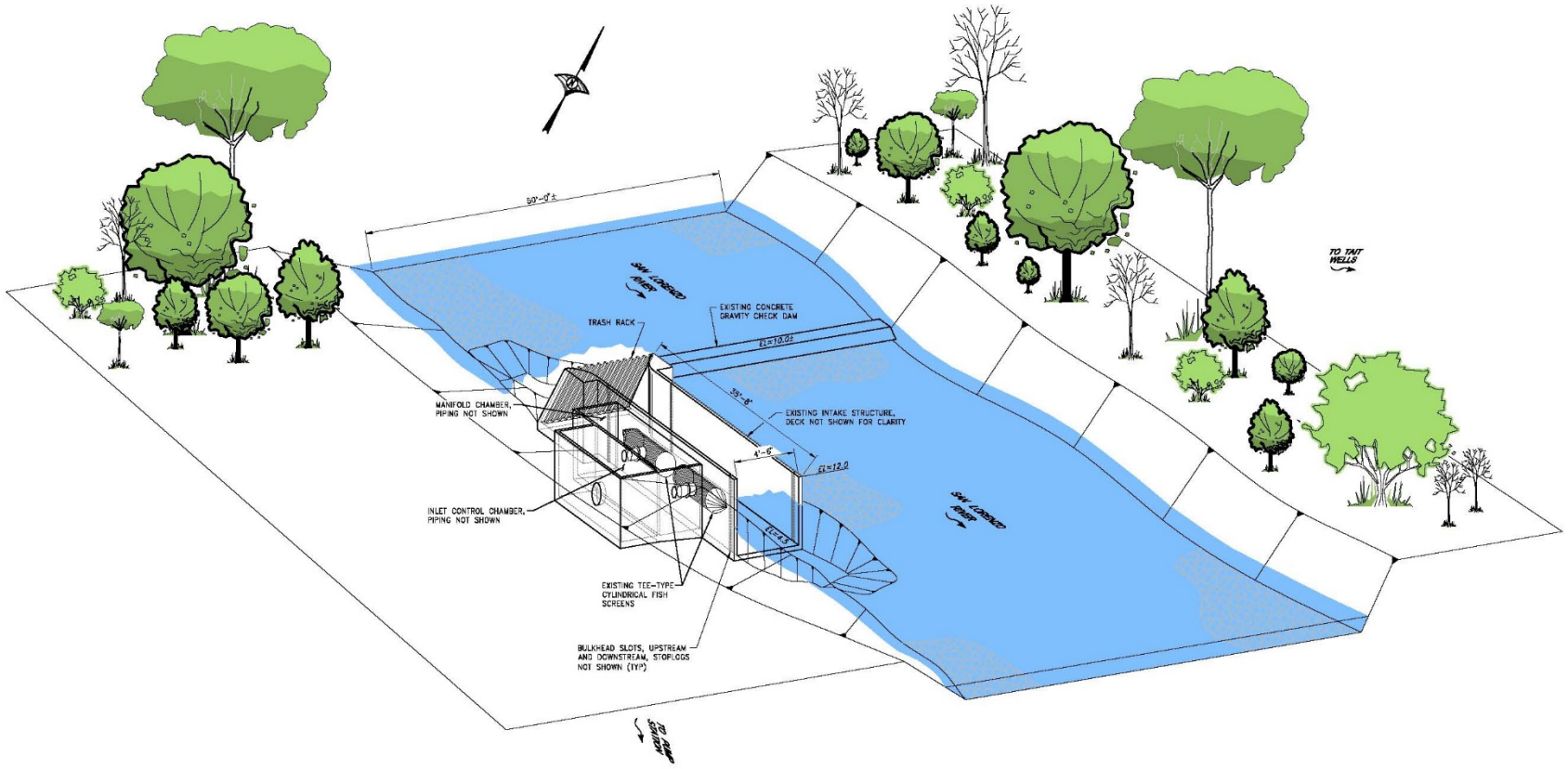


Figure 3-17: Tait Street Well #1b



Photo: Tait Well #1b

Figure 3-18:Tait Street Diversion



Photo: Tait Street Diversion from left bank downstream looking across the channel

3.3.2 Reservoir Operations

Reservoir operations focus on activities that occur at the Loch Lomond Reservoir to provide a safe, reliable source of water for water customers. The activities are required by either the California Division of Dam Safety or the California Safe Drinking Water Act through the California Department of Health and Safety. Covered activities include reservoir water quality treatment and dam facility maintenance.

Chemical Algaecide Treatment of Reservoir

Loch Lomond Reservoir is a lacustrine environment and although not nutrient enriched, nevertheless annually experiences blue green algal blooms during the late spring-early fall months due to available nutrients, warm water temperatures, and abundant sunlight. When algal blooms do occur or are predicted to occur, chemical algaecide applications are made to the Loch Lomond Reservoir to protect against degradation of beneficial uses (e.g., objectionable taste and odor, production of disinfection by-product precursors and cyanotoxins, and oxygen depletion and subsequent fish kills). Algaecides used include copper carbonate or hydrogen peroxide. These algaecide applications are regulated by a National Pollutant Discharge Elimination System (NPDES) permit issued by the State Water Resources Control Board and implementation is described in the City's Aquatic Pesticide Application Plan. See Appendix 6: *Loch Lomond Aquatic Pesticide Application Plan and SWRCB Aquatic Pesticide General Permit*.

The Water Department conducts weekly water quality sampling at one station in the lake to assess overall algae population. Species present at the surface and at the levels of the two upper water intakes (elevations 550 and 530 feet respectively) are identified and counted and may be analyzed for chlorophyll. When known nuisance species are on the increase (i.e., *Anabaena, Aphanizomenon, etc.*), sampling is increased to daily and when the counts and chlorophyll values indicate a bloom appears certain, algaecide is applied.

The applications generally occur once or twice between the months of April through September. Annual frequency of applications ranges from as low as 1 time/year to as high as 5x/year. A private applicator or City staff under the direction of a licensed applicator may conduct the application. The lake shallows are surveyed by staff prior to application to identify any Western Pond Turtle, fish breeding or early fish life stage presence. If located, these areas are not treated or treated at a reduced concentration, per direction of the City's SWRCB NPDES permit for aquatic algaecide application. The treatment area is tested the day after treatment to confirm that no high levels of algaecide are present. Hydrogen peroxide is not persistent in the environment and is not discharged to Newell Creek below the dam, so monitoring is primarily focused on copper carbonate. Weekly copper monitoring is continued at the surface and 20-foot depth intervals until copper returns to near pre-treatment levels. The fish release below the dam into Newell Creek is also sampled weekly. Upstream and downstream, copper sampling may occur on a regional scale to provide context for the copper dynamics observed in the reservoir and feedback on permit compliance. The Central Coast Regional Water Quality Control Board Basin Plan objective for copper is 30 ug/l.[40] The downstream permitted limit of copper

[40] https://www.waterboards.ca.gov/centralcoast/publications_forms/publications/basin_plan/docs/2019_basin_plan_r3_complete_webaccess.pdf

discharge is 13 ug/l under the California Toxics Rule,[41] though temporary exceedances of this value – if below the Basin Plan objective – are allowed under the SWRCB NPDES permit during the algaecide application season of April - September. Copper may be discharged for weeks or months at low levels (< 13 ug/l) subsequent to a treatment. The discharge point is 0.7 miles upstream of the typical limit of anadromy and 1725 feet upstream of the confluence with an unnamed tributary which contributes significant flow to Newell Creek (and thereby dilution of the discharge). Copper levels observed at the barrier 0.7 miles below the dam are an average of 3.7 ug/l while data collected further downstream at the Glen Arbor Bridge shows an average value of 2.1 ug/l.

Testing Deluge and Gate Valves

Testing of the deluge and gate valves on the dam involves opening the deluge valve located on the downstream side of the dam face approximately 0.7 miles above the typical limit of anadromy and seeing water released and then closing the valve and not seeing water released. Additionally, the five intake gates in the lake on the upstream side of the dam face are closed and the pipeline in the dam is drained to determine that the gates are holding as determined by no water passing through them. This testing is done at the direction of the Division of Safety of Dams (DSOD) and occurs in both the dry season and wet season in an alternating fashion annually (i.e. one year will be done in the dry season and the next year will be done in the wet season). The testing typically occurs for a period of several hours at a rate of discharge of approximately 5-10 cfs during the testing period. Future DSOD-required testing may involve a higher rate of discharge but will be coordinated with higher flows to mitigate potential effects on instream habitat and water quality. The procedures can result in the discharge of approximately 100,000 gallons of moderate to low oxygen (1-6 parts per million (ppm) at a range of 9-17 C˚ approximately) water discharged to Newell Creek immediately below the dam when done in the dry season. During the wet season when the reservoir is fully mixed, discharge water is well-oxygenated and <14 C˚.

Woody Debris Removal on Reservoir Face

Woody debris removal is conducted annually in the late fall when the fire hazard is low (after rains and during burn season). The work requires approximately 4-10 days to complete. A log boom is used to remove the wood at the top of the spillway and a boat, rubber-tired skidder and hand crews are used to remove the woody debris from the inside of the dam face. Wood removed is typically less than 10” in diameter and 8’ long. Average total volume of wood removed is approximately 10 cubic yards, annually. Bigger pieces are set aside for later use in instream restoration projects. Heavy equipment is excluded from the dam face to minimize soil disturbance. The wood is then piled on the inside face of

[41] Future downstream permitted limits may be contingent on a site-specific Biotic Ligand Model rather than the California Toxics Rule

the dam, cut up with a chainsaw, and burned. Large woody debris pulled from the lake is retained in the wood lot below the dam for restoration projects if possible.

3.4 Water System Operation and Maintenance

Water system operation and maintenance includes activities conducted to maintain operations of the water diversions and water transmission lines, and associated diversion features such as fish screens and fish ladders.

These activities are covered under the HCP and include operation, rehabilitation, replacement, repair and maintenance of existing infrastructure and related facilities such as water measurement devices, scientific measuring devices, and water quality monitoring stations.

3.4.1 Water Diversion Sediment Management

Laguna, Reggiardo, and Majors Creek diversions on the North Coast are concrete impoundments that can collect sediment and debris during storm flows. Sediment management at these diversions primarily focuses on managing bedload and suspended sediment during storm flows with an attempt to mimic the natural hydrograph as much as possible. Each diversion has a dual slide gate valve mechanism in the dam face. The upper gate is opened during the ascending limbs of sediment-transporting storms (generally speaking, storms that are predicted by the National Weather Service (NWS) to result in 2" of precipitation in 24 hours or result in turbidity over 25 NTU) if it is free of sediment prior to the storms, and then closed on the receding limb of the storm or following storms if several storms follow in succession. The receding limb is identified either onsite with staff plates, or through real-time dataloggers installed at the Laguna and Liddell diversions, with these gages serving as a surrogate for Majors and Reggiardo Creek – which have no real time communications. If sediment does collect behind the impoundments, the impoundments are dredged. Dredging is conducted during the dry season (August – October) if possible, but always during low flows with heavy equipment and/or hand tools and the material is removed from the site as soon as possible. If excavation is necessary, the volume of sediment involved will range from 5-10 cubic yards per event up to 1-3x/year. The instream work area is limited to the area immediately adjacent to the intake screens and is isolated from the wetted channel with sandbag diversions, turbidity curtains or related materials. Fish removal in the work area is performed by an agency-approved biologist if necessary. The work area typically involves less than 50 linear feet of stream immediately adjacent to the intakes.

The Laguna Creek and Majors Creek diversions will be rehabilitated in order to allow more natural passage of sediment, avoid instream maintenance work and more effective implementation of instream bypass flows in the future and this project is covered under the HCP. The rehabilitation will make part of the dam face movable or otherwise improved with wedge wire screens so that during stormflows sediment transport occurs in an unimpeded fashion and impacts associated with dredging will be reduced in the future. It is likely that the Reggiardo Diversion will be removed in the future.

Although the Liddell Spring Diversion is located on top of a natural spring and is not an in-channel diversion structure, sediment can still accumulate in the spring box during large storm events. When needed (up to 3x annually), the City removes up to 3 yards of sediment with hand tools, suction pumps or vacuum equipment and removes the material from the site immediately or after brief temporary storage. As previously mentioned, sediment is also allowed to "meter out" continuously by leaving the drain valve slightly ajar – thereby preventing accumulation in the spring box and providing an informal small instream flow to an unnamed, non-fish bearing tributary to the east branch of Liddell Creek.

3.4.2 Fish Ladder and Screen Maintenance

The only City facility with a fish ladder is the Felton Diversion on the San Lorenzo River.[42] The ladder is a standard removable Denil fish ladder located at the western side of the weir that operates when the dam is inflated. The ladder consists of a fishway with a removable fish trap. The fish ladder is operated according to the MOA described in Section 3.3.1. The ladder is approximately 60' long x 3.5' wide and has a floor slope of 6:1. The ladder is inspected 2-3 times per week and manually cleaned and cleared of debris as needed. A log boom at the upstream end of the ladder reduces accumulation of debris in the ladder, but 1-3 times per winter up to a cubic yard of sediment and woody material needs to be removed from the ladder. Debris removed from the ladder is removed from the site or is mobilized downstream during high flow events. Future improvement of the ladder includes installation of improved outmigration features. The fish screens at all the diversions are inspected regularly and cleaned by hand of any debris. The San Lorenzo River at the Tait Street Diversion has two Johnson-type well screens that are cleaned by compressed air back flush at intervals ranging from 10 minutes to 2 hours when the diversion is on. The screens are protected by a debris rack that is inspected daily and manually cleaned as needed. Future screening improvements at diversions described in Section 3.3.1 will reduce maintenance needs in the future.

[42] Fish ladder maintenance procedures for a future, rehabilitated Tait Street Diversion are expected to involve similar activities.

3.4.3 Pipeline Operations

Adequate operation of the water transmission lines requires system flushing and repairs and specialized operations, including pumping well return to prevent sand accumulation and valve blow-offs to prevent breaks in the transmission lines.

Conveyance Pipeline System Inspections and Repairs

The City's two major unfinished water (raw, unchlorinated water) conveyance lines are the Newell Creek Conveyance Pipeline and the North Coast Conveyance Pipeline. These lines are 9.57 and 9.66 miles long, respectively. See Figure 3-1: City of Santa Cruz Water System map. Additionally, the City has 6.8 miles of finished (chlorinated) water line that runs from the City limits west to North Coast customers. These lines are part of the City's existing infrastructure and are critical to safe and reliable transmission of water to customers. While the Newell Creek pipeline is located primarily in upland areas, it does cross several streams and run adjacent to both Newell Creek below Loch Lomond Reservoir and the mainstem San Lorenzo River from Ben Lomond to Henry Cowell State Park. Similarly, the North Coast pipeline crosses several streams between Bonny Doon and the west side of the City. Pipeline routes are regularly inspected for leaks and pipeline rights of way are maintained to allow for inspection of the pipeline. Usually an eight-foot swath of predominantly upland vegetation is mowed to allow inspection of rights of way in rural areas. Clearing in riparian corridors is done by hand on an as-needed, infrequent basis. Inspection occurs in the fall and spring of each year, and when decreases in flow indicate a leak. Inspection includes walking the route by foot or traveling the route with an all-terrain vehicle.

Pipeline repairs are conducted on an as-needed basis. Repairs may result from damage to the pipeline through natural causes (earthquakes, landslides, etc.) or through deterioration of infrastructure over time. Staging areas for repair projects may be required depending on the location of the repair and may include areas for storage of construction materials and construction equipment. Pipeline repairs may also require trenching and construction of temporary access ways. Standard avoidance and minimization measures are employed for pipeline repairs to reduce or eliminate instream effects from this work, as described in Chapter 4, *Conservation Strategy*.

The approximately 3.28-mile sanitary landfill leachate line which runs from the solid waste recovery center on Dimeo Lane to the City's wastewater treatment plant near Neary Lagoon has similar maintenance needs. While it is located in the proximity of only one known anadromous salmonid stream (Wilder Creek), standard avoidance and minimization measures are also employed for this work to reduce or eliminate instream effects, as described in Chapter 4, *Conservation Strategy*.

Finished Water Pipeline System Flushing and Repairs

The finished water pipeline distribution and conveyance system includes approximately 263 miles of pipeline in the water distribution area which includes the entire City, as well as a portion of unincorporated Santa Cruz County and a small portion of the City of Capitola. These pipes are generally located within streets and may include stream crossings or be located adjacent to water bodies. The distribution line must be kept clean of bacteria and contaminants and requires testing for hydrant capacity as well as pipeline repairs. See Figure 3-1: City of Santa Cruz Water System map.

Regular maintenance activities that occur on the distribution system may include the flushing of the line for fire hydrant testing; repair of main breaks; sediment removal; taste and odor control; control of color, high turbidity, low chlorine residuals, or bacterial growth; corrosion control; or response to customer complaints. Flushing is a water quality practice required by the California State Water Resources Control Board – Division of Drinking Water under the Safe Drinking Water Act. These maintenance activities occur year-round on various parts of the distribution system according to management priorities. Most repairs do not involve sensitive habitat, but those that do include standard avoidance and minimization measures to reduce or eliminate instream effects from this work, as described in Chapter 4, *Conservation Strategy.*

Pumping Well Return to the San Lorenzo River

At high and moderate flows, sand accumulates in the pumping clearwell of the San Lorenzo Wells located at the Tait Street Diversion (aka Crossing Street) adjacent to the San Lorenzo River just upstream of Highway 1. To reduce damage to equipment and prevent re-deposition in the Graham Hill Water Treatment Plant, sump pumps remove sand from the clear well, pump it to an adjacent decanting basin located in the parking lot of the Coast Pump Station and ultimately returns decanted water to the river immediately downstream through a riparian vegetation buffer without any elevation in turbidity. This activity typically occurs routinely in the winter and spring when flows are elevated and sediment is being transported by the river. The discharge from the decanting basin through the riparian corridor to the river results in no change in receiving water quality or changes in habitat.

North Coast Valve Blow Off to the San Lorenzo River

The North Coast Pipeline delivers unfinished/raw (non-chlorinated) water from the North Coast sources to the Coast Pump Station, which ultimately delivers water to the Graham Hill Treatment Plant. At the Coast Pump Station (at Tait Street) water from the pipeline is discharged to the San Lorenzo River when pressure within the pipeline threatens to rupture the line. The discharge prevents pressure from blowing out the North Coast Pipeline (subsequently preventing environmental impacts

related to such blowouts) when sources are changed and during situations such as emergencies. Recently installed pressure relief valves minimize the potential for this occurrence.

The North Coast Pipeline Blow Off may occur year-round but only when the North Coast sources are on. This activity occurs rarely (less than 1 time annually) and only under special circumstances where dewatering the main elsewhere is not possible. The approximate amount of discharge during this operation ranges from 5-10 cfs and could persist for approximately 1-4 hours. The water is discharged over rip rap to the San Lorenzo River downstream of the intake located at the Coast Pump Station at Tait Street just upstream of Highway 1.

3.4.4 Dewatering of Creeks for Maintenance and Repairs

The City performs various types of instream work including, repair and maintenance of diversion facilities, sediment management, fish ladder and fish screen maintenance and repair, pipeline operations and maintenance, flood control and stormwater maintenance, vegetation management, and aquatic habitat management. During the course of these activities it is often necessary to dewater and otherwise disturb portions of stream channels. Dewatered stream reaches can range from approximately 20-200 feet and dewatering may occur for up to several weeks in any given year or not at all at 1-10 sites annually. In order to minimize effects of these activities on aquatic species, including protected species, the City captures aquatic species in the project area and relocates them to suitable habitat outside the project area. Additionally, other standard best practices are employed during dewatering such that effects on special-status fish species are limited to relocation. (Chapter 4).

3.5 Municipal Facility Operations and Maintenance

Municipal facility operations and maintenance activities include flood control maintenance, stormwater maintenance, emergency repairs and response, and vegetation management. These activities occur on City facilities and properties in the HCP Program Area. These activities include operation, rehabilitation, replacement, repair and maintenance of existing infrastructure and related facilities.

3.5.1 Flood Control Maintenance

Flood control maintenance is conducted to prevent flooding of city waterways and damage to public and private property. Flood control preventative activities are conducted in July through October on an

as-needed basis. Emergency response during storms is conducted if damage to life, property, or public safety is imminent. Flood control maintenance includes debris/obstruction removal, sediment management/removal, and vegetation management. This work has historically been covered by Section 7 consultations due to the federal nexus with the U. S. Army Corps of Engineers (Corps). However, for the purposes of expediting permitting in the future and ensuring alignment between the diversity of City operations that affect the San Lorenzo River, Flood Control Maintenance is included as a Covered Activity in this HCP. Historic Section 7 consultations are provided for reference in Appendix 7: *Example Historic Flood Control Biological Opinions*.

Debris/Obstruction Removal

Debris/obstruction removal is necessary when a material is either deposited or washes downstream into a waterway and creates a hazard to property or infrastructure. Under these hazardous conditions, the City may conduct debris/obstruction removal, including log jam modification (cutting larger logs into smaller segments that may float downstream in larger flows, moving with cranes, etc.) and vegetation removal. Typically, these events happen 1-3 times in wet water years but may not be necessary during drier conditions. These wet conditions may occur anywhere from 10-50% of the time during the life of the permit (Shawn Chartrand, personal communication with Chris Berry, 2020). Volume of debris removed may range from 0-100s of cubic yards depending on the magnitude of storm events and upstream delivery of instream wood. These activities are only conducted in an emergency setting where property, life, or public safety is threatened and are done in consultation with NMFS, USFWS, and CDFW staff as appropriate. During and immediately after flood events, City staff inspects conditions at bridges, road culverts, diversions, pipelines, and other public infrastructure to ascertain whether threat to structures are imminent and will only take action if the structure or property is in immediate danger. Such work is typically overseen by environmental monitors and involves standard avoidance and minimization measures for streamside projects as described in Section 4.4.3.

Flood Control Sediment Management/Removal

The City takes a preventative approach to sediment management by implementing best management practices (BMPs) for stormwater facilities including vacuuming storm drains before the winter season and cleaning culverts, vaults, and ditches before winter, usually from August through October. See Section 4.4.4.2. Work is completed with mechanized equipment and hand tools. Mechanized equipment used for this work is kept outside of the wetted stream channel.

The San Lorenzo River Flood Control Project includes 18 drainage discharge structures which are maintained to prevent flood waters from backing into neighboring areas and to prevent spills from entering the river. See Figure 3-19, Figure 3-20, Figure 3-21, Figure 3-22, and Figure 3-23: City of

Santa Cruz Stormwater System. Branciforte Creek also has several drainage discharge structures to be cleaned. The drainage discharge structures are cleaned on an annual or biannual basis. An excavator is used to remove sediment that has built up near the drainage gates. The amount of sediment averages 2 cubic yards per drainage discharge structure. The sediment is dewatered on site and the dried sediment is spread above ordinary high water on the riverbank to be removed by storm flows during the winter. See Figure 3-24: Flood Control Drainage Structure Example.

Sediment removal is only done as necessary to maintain and/or restore capacity of stormwater conveyance facilities or to prevent flood events. The nature and exact location of sediment removal in flood control areas is not know from season to season and is dependent on variation of winter storms flows, upper watershed events that produce sediment, and flood control monitoring data that documents aggraded areas that may not meet flood control standards established by the Corps. The flood control management prescriptions for the lower San Lorenzo River entail managing sediment outside of the wetted channel within the levees to facilitate transport of sediment and maintenance of adequate levee freeboard for flood control purposes. This work entails disking of dry sand bars during dry periods with heavy equipment as described in Table 3-1. This work is typically overseen by environmental monitors and involves standard avoidance and minimization measures for streamside projects as described in Section 4.4.3.

Sediment management in the Branciforte FCC is mostly limited to the lower reaches of the FCC from May Street to Water Street and is performed annually. The work occurs outside the wetted channel and is performed with a long-reach excavator from the top of the FCC. Approximately 270 cubic yards of sediment is removed with each maintenance event. The FCC is currently being evaluated for rehabilitation that will provide both additional flood control reliability as well as improved fish passage.

Figure 3-19: City of Santa Cruz Stormwater System



Figure 3-20: City of Santa Cruz Stormwater System

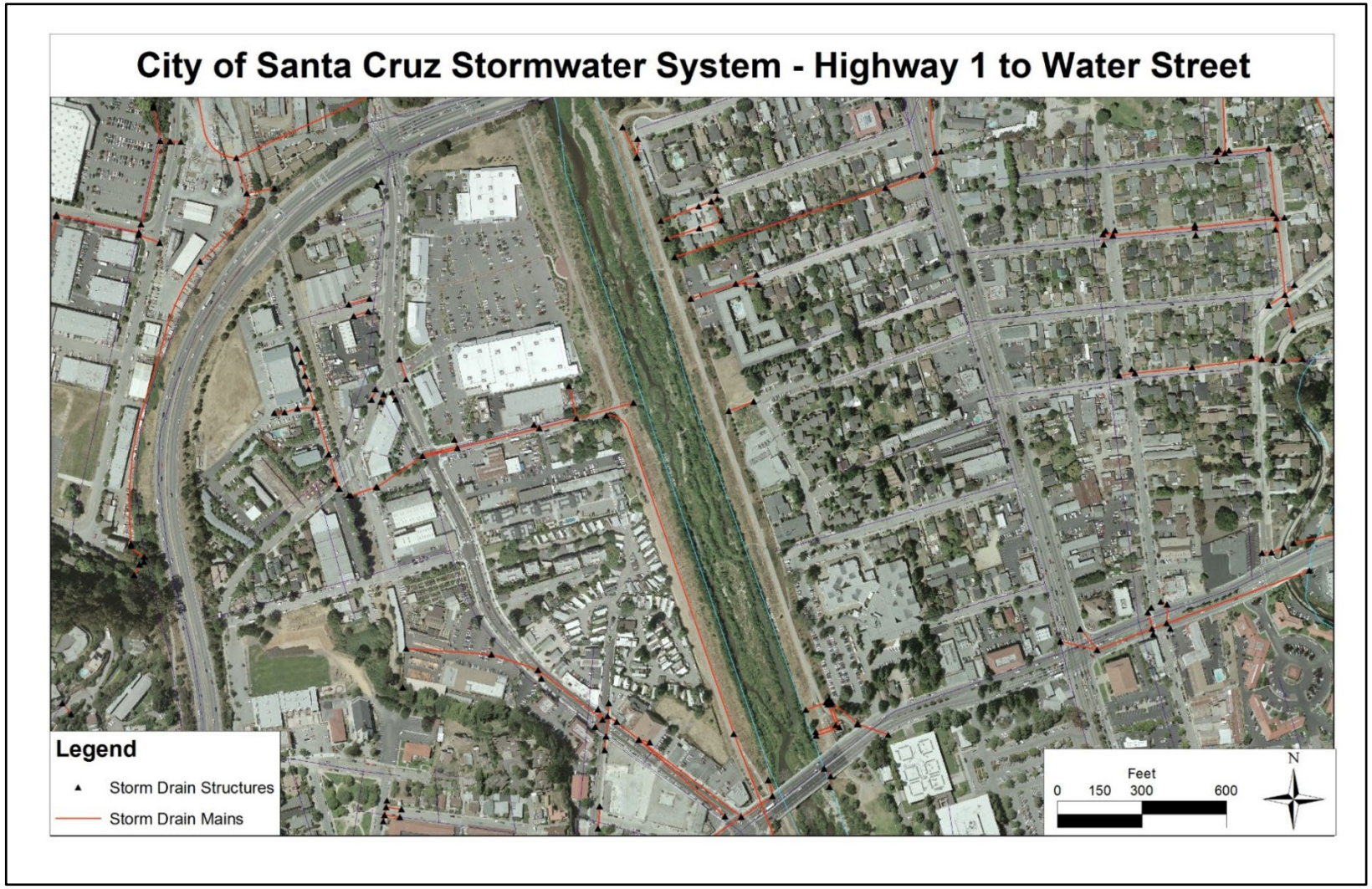


Figure 3-21: City of Santa Cruz Stormwater System

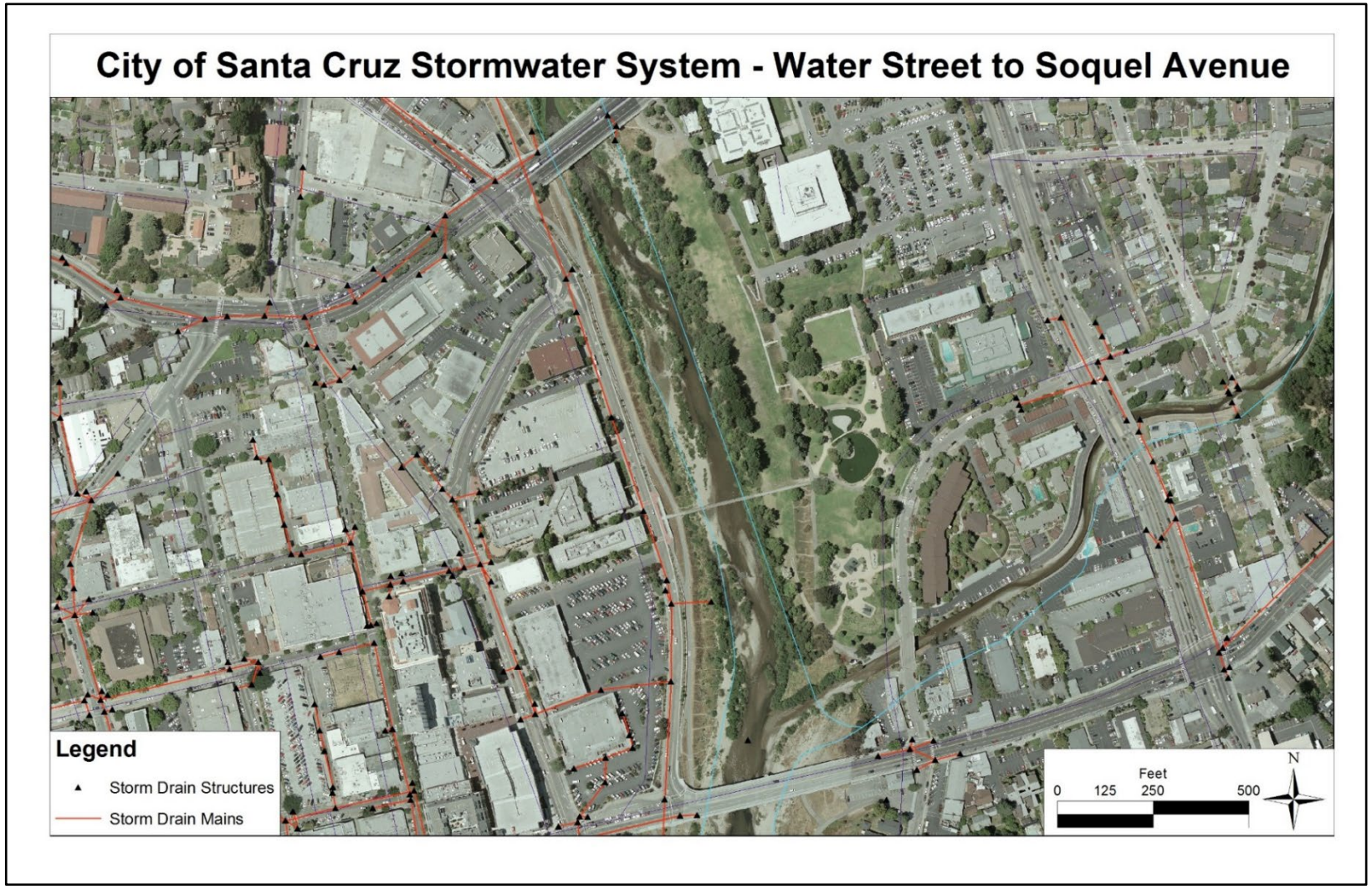


Figure 3-22: City of Santa Cruz Stormwater System

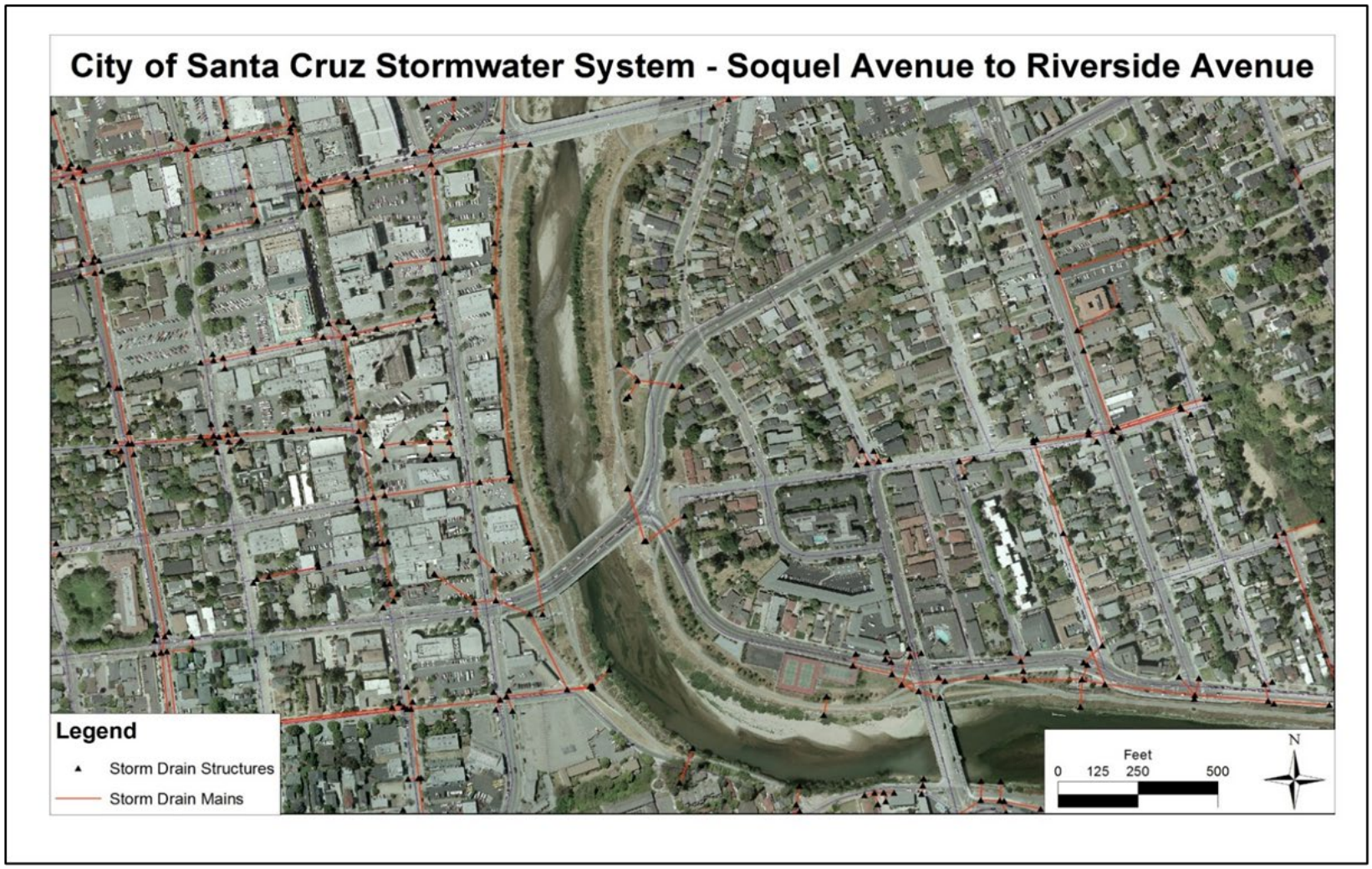


Figure 3-23: City of Santa Cruz Stormwater System

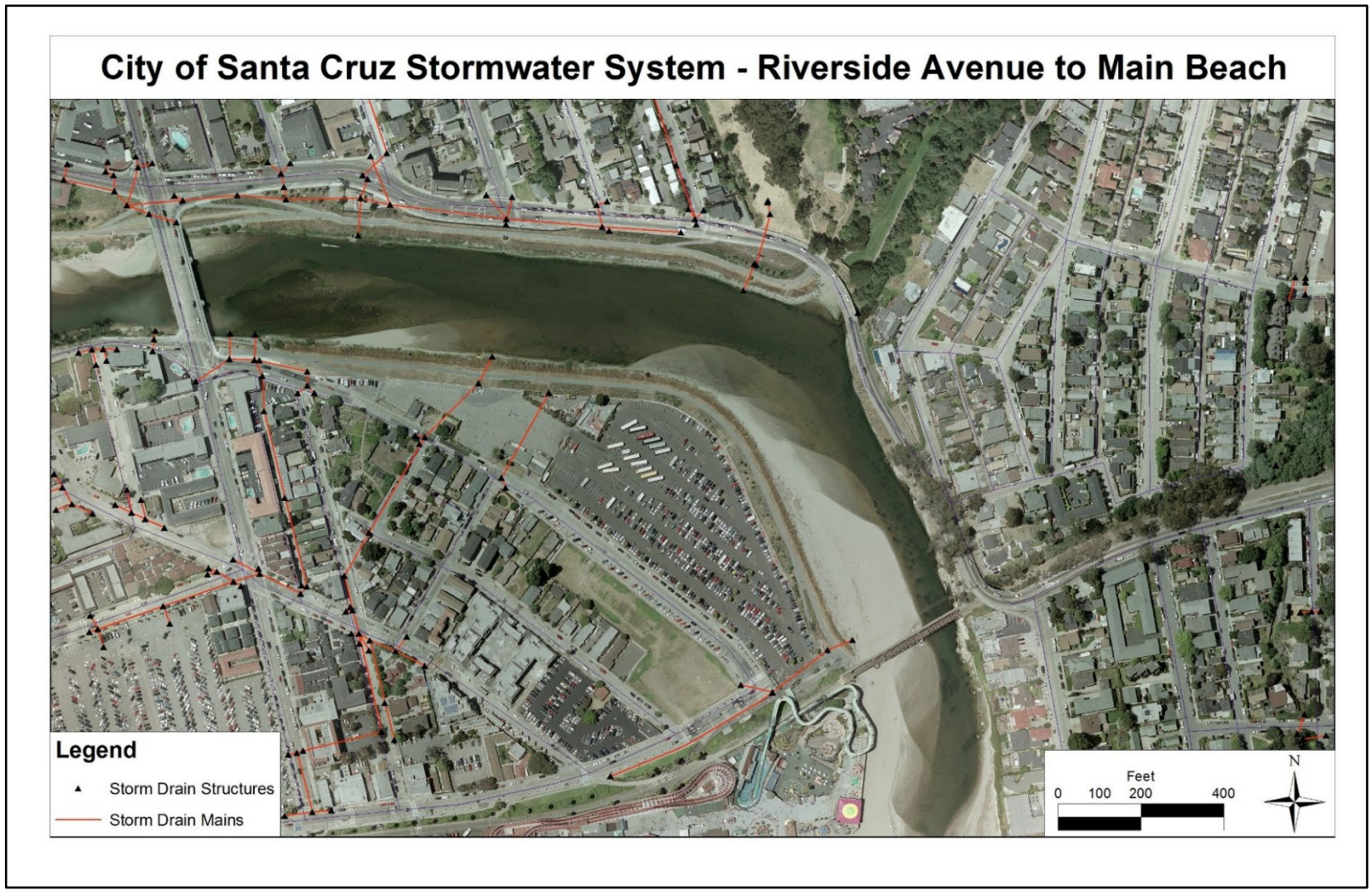


Figure 3-24: Flood Control Drainage Structure Example



Vegetation Management

Vegetation management focuses on trimming or removing riparian vegetation that may impede storm flows, result in bank erosion, or result in damage to property. In the majority of waterways other than the San Lorenzo River and Branciforte Creek FCCs, mature riparian trees are not removed, but riparian shrubs may be trimmed from ground level to 6-8 feet in height. Mature riparian trees are removed in the San Lorenzo FCC and Branciforte Creek FCC per maintenance requirements of the Corps to reduce roughness and ensure that the FCCs can pass design flows. Branciforte FCC maintenance typically occurs in the transitional reach below Water Street only and occurs as needed. Design criteria for the channel dictates that the channel be kept entirely clear of sediment and vegetation at all times, but resource limitations result in maintenance occurring infrequently (1 – 2x every 10 years). Cuttings are removed from the work area and recycled as green waste at the landfill or chipped and left on the outboard side of the FCCs. A 5 – 10-foot-wide buffer of vegetation is typically retained adjacent to the wetted channel. Work is generally conducted in late August and may last from a few days to a few weeks depending on the area. The vegetation management prescriptions are set out in Table 3-2. Such work is typically overseen by environmental monitors and involves standard avoidance and minimization measures for streamside projects as described in Section 4.4.3.

Table 3-1: Flood Control Sediment Management Prescriptions by San Lorenzo River Stream Reach*

Reach	Sediment Management Prescription	Frequency
Riverine Reach	Instream bars outside the wetted channel should be disked annually to loosen root materials and promote scour. Existing cross-channel scour areas should be encouraged through disking and manipulation of discarded root wads/vegetation material. Sediment removal areas should be defined by cross section and HEC-6 analysis and should avoid important salmonid habitat areas including riffles, pools, and runs.	1-3x Annually
Transitional Reach	Disking on the west bank should occur east of levee toe up until outside edge of 5-foot vegetation buffer. Existing cross-channel scour areas should be encouraged through disking and manipulation of discarded root wads/vegetation material.	As determined by cross-section monitoring. Will occur less frequently than every other year dependent on previous winter's sediment transport dynamics.
Estuarine Reach	Sediment management or removal is not necessary in this reach.	NA[43]

*See Figure 3-25: Urban San Lorenzo River Stream Reaches

[43] This reach typically meets FCC design criteria without maintenance and sediment management is not currently proposed as a Covered Activity.

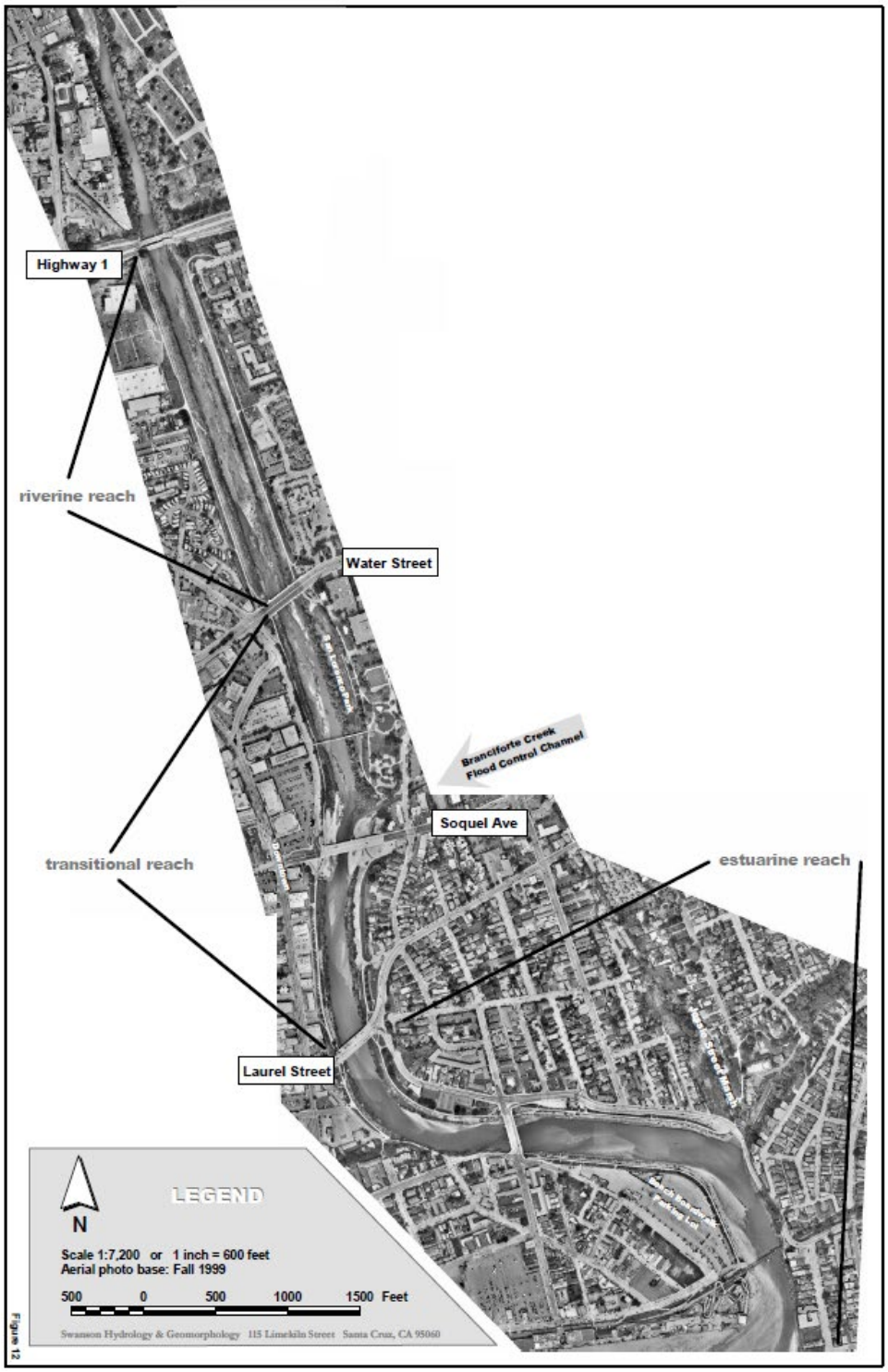
Table 3-2: Vegetation Management Prescriptions by Stream Reach*

Reach	Vegetation Management Prescription	Frequency
Bankfull Channel Area **Instream Channel Bed**	Remove riparian vegetation that exceeds accepted Corps Manning's "n" roughness coefficient for the FCC[44]. A 5-foot edge of stream buffer area should be maintained on either side of the wetted edge.	1x Annually
Riverine Reach	Allow 10-foot-wide strip of willow and alder along toe of levee. Willows allowed to grow to 3" diameter at breast height (dbh). Alders allowed to grow to 6" dbh. The lower limbs of the alder trees should be trimmed. The willows should be thinned to favor providing overhanging cover to the low flow channel. Maintain a 5-foot buffer along wetted edges of channel, but thin groves and limb up trees. Remove any trees in 5-foot buffer area that are greater than 6" dbh.	1x Annually
Transitional Reach	A 10-foot-wide strip of woody riparian vegetation and tules and cattails should be maintained on the west bank. The east bank should be maintained to keep trees overhanging water. Trees or branches that fall in the water should be assessed for cutting into smaller pieces and may be removed entirely if they cause an immediate safety hazard. Sandbars should be maintained to allow volunteer groves to establish but remove all trees greater than 6 " dbh.	1x Annually
Estuarine Reach	A 5-foot-wide strip of willow, cattail and tule should be maintained at the levee toe. Willows should have stem diameter of no greater than 0.5 inches and be limbed up and periodically thinned to create defined groves.	1x Annually

*See Figure 3-25: Urban San Lorenzo River Stream Reaches

[44] Roughness coefficient targets can vary by stream reach and change depending on channel morphology dynamics with an overall goal of maintaining flood capacity for (at minimum) 100-year events.

Figure 3-25: Urban San Lorenzo River Stream Reaches



3.5.2 Stormwater Maintenance

Stormwater maintenance is conducted on the City's stormwater conveyance system and at the sanitary landfill. The City has an adopted Stormwater Management Program and has fulfilled the requirements for the NPDES Phase II General Permit for Discharges of Stormwater from Small Municipal Separate Storm Sewer Systems. The Stormwater Management Program is designed to reduce discharge of pollutants to the maximum extent practical and to protect water quality. The Stormwater Maintenance Program includes inspection and cleaning of streets, storm drains, public areas such as alley ways, parks and other City facilities, and structural retrofits of the storm drain inlets and basins as needed.

The City's stormwater system serves the entire City limits. The City assesses and prioritizes maintenance of the storm drain system, including the following: catch basins, pipelines, five San Lorenzo River pump stations, the Neary Lagoon pump station, two CDS (hydrodynamic pollution separator) units, and above-ground conveyances. See Figures 3-10, 3-11, 3-12, 3-13, and 3-14 for stormwater infrastructure adjacent to the San Lorenzo River.

The City has determined that the lower Ocean Street, Beach Flat and Downtown areas are the highest priorities for storm drain system maintenance based upon the following factors:

1. High or intensive use,
2. High density, and
3. Direct impact or proximity to receiving waters such as the San Lorenzo River, San Lorenzo River pump stations, and Monterey Bay/Pacific Ocean.

In addition to the catch basins in the high priority areas above in the high/intensive use or high density areas, which tend to have accumulation of sediment, trash and debris, catch basin meeting any of the following criteria will also be considered high priority:

1. Catch basins known to accumulate a significant amount of sediment, trash, and/or debris;
2. Catch basins collecting large volumes of runoff;
3. Catch basin collecting runoff from area that do not receive regular sweet sweeping;
4. Catch basins collecting runoff from drainage areas with exposed or disturbed soil; or
5. Catch basins that receive citizen complaints/reports.

Staff also reviews the storm system areas that needed attention during the previous year and adds these areas to the priority list as necessary.

Inspection and Cleaning

Inspection and cleaning of streets and storm drains are a key component of the Stormwater Maintenance Covered Activity. The City implements an annual storm drain inspection and cleaning program, "Team Clean", to remove pollutants transported by stormwaters to receiving waters such as streams and the San Lorenzo River. The City is currently developing a Geographic Information System (GIS) for storm drains to further refine cleaning frequency for catch basins and inlets. A maintenance tracking software system is also under development and will help with scheduling and tracking inspections, cleanings, upgrades, and tracking flooding of stormwater facilities. The City also conducts TV camera inspections of at least 5,000 feet of storm drain line each year. These inspections are very helpful in evaluating the conditions of storm drain lines and identifying repair needs. Cleaning is completed both through the use of a Vactor truck and through hand cleaning. Storm drain lines are plugged at both ends and the Vactor truck, using reclaimed water, "jets" the line and then vacuums the line to remove sediment and material. The resulting sediment and material are disposed of in the sanitary sewer or landfill after dewatering at the Wastewater Treatment Plant. In general, the City operates according to the following schedule for inspecting and cleaning all inlets, catch basins, pipelines, pump stations, and other portions of the storm drain system.

- Problem basins (known basins that collect sediment and trash): Inspect and clean at least monthly or more frequently during wet season.
- Intensive use basins (located in high use areas of the City): Inspect and clean semi-annually. Clean monthly during September and October.
- Commercial basins (located in commercial areas): Inspect and clean annually.
- Residential basins (located in residential areas): Inspect on an eight-year cycle and clean, as necessary.
- Pump stations along San Lorenzo River: inspect weekly and cleaned at least annually.
- Large diameter stormwater pipelines (including inlets, culverts, and vaults): Inspected annually and cleaned at least on a five-year cycle.
- Small diameter stormwater pipelines (including inlets, culverts, and vaults): Inspected on a two-year cycle, cleaned as needed or on a fifteen-year cycle.

The street sweeping program is conducted daily and covers approximately 35 miles of streets daily.

Manual hand sweeping is conducted "on call" in order to clean up after a particular event or accident. Cleaning of City-owned areas (such as alleys) is conducted with a garden hose, without the use of soap. Prior to hosing, spills and large debris are cleaned or picked up. Also, aluminum grates with small mesh size are inserted into nearby storm drains inlets to prevent small debris from entering the storm drain system. Catch basins in public parking lots are cleaned with a Vactor truck annually. Wastewater from the cleaning is collected and disposed into a sanitary sewer line. City staff oversees these cleaning events to ensure proper disposal of the wastewater.

The City also maintains numerous public areas and facilities, including medians, parks and other landscape areas with hand crews and standard landscaping equipment (lawn mowers, trowels, shovels, string trimmers, etc.). The primary pollutants of concern from these properties are sediment from erosion, nutrients from fertilizer use and organic matter, and heavy metals and toxic organics from pesticides/herbicide use. The City has an active Integrated Pest Management (IPM) program and pesticide/herbicide use is very limited, conducted according to label instructions when they are used and generally avoided adjacent to waterways. Medians and embankments are planted with vegetation and maintained for both aesthetics and erosion control or hard-scaped in situations where maintenance and safety concerns warrant it.

Structural Retrofits of Storm Drain Inlets and Basins

The City selects structural retrofit projects of storm drain inlets and basins in the interest of improving performance of said infrastructure and reducing transport of stormwater pollutants to adjacent waterbodies. The City focuses on two types of structural controls to improve water quality associated with the storm drain system. The first are dry-weather diversion systems to divert flow to the sanitary sewer for treatment at the Wastewater Treatment Facility. The second are in-line treatment systems such as sediment basins and oil/water separators. Additional projects such as sealing slide/flap tide gates along the San Lorenzo River to prevent spills from entering the river have been identified as a priority for implementation in the future. This work typically occurs within street rights of way and standard best practices are employed during construction to prevent runoff and degradation of water quality in adjacent waterways. Any streamside work is also isolated from the water with coffer dams. See Section 4.4.3 for detail on best practices for water quality protection during stream work.

Leachate Management

The goal of the operation of the Leachate Collection and Removal System (LCRS) is to prevent leachate from entering into Lombardi Creek from the City's sanitary landfill and prevent the public from coming into contact with leachate. The LCRS consists of four major components: a groundwater

interceptor trench-barrier wall at the toe of the RRF, two Class II surface ponds; a leachate transport pumping station and electric control building; and a transport pipeline.

There are two leachate collection ponds located at the south toe of the RRF, up gradient of the groundwater interceptor trench-barrier wall. These ponds do not support steelhead or coho but do provide habitat for California red-legged frog. These ponds serve to collect leachate resulting from rainfall and underground springs and prevent the leachate from entering into Lombardi Creek. The ponds are operated in a sedimentation and overflow scheme. The ponds are approximately 11 feet deep including 2 feet of freeboard. The primary and overflow ponds have nominal capacities of 100,000 and 175,000 gallons, respectively. The leachate sediments settle in the primary collection pond and the leachate overflows to the transfer pump station manhole. At the base of this pond is a 4-inch clean-out where operations vacuum out the sediments on an as needed basis.

The leachate transport pumping station was built between the two ponds, and houses three submersible 200 gallons per minute (gpm) wastewater pumps. Leachate flows by gravity to the pumping station or into the overflow pond when storage is required. Pumping to the Wastewater Treatment Plant is frequent enough so that the overflow pond is empty most of the time. The pump station was designed so that one pump could meet the peak month flow requirements; the third pump was provided as a backup. Most of the solids in the leachate settle out in the sedimentation pond, minimizing cleaning of the overflow pond and leachate transport line.

In the case that the leachate line would require repair due to a natural disaster (e.g., earthquake), the City would undertake repairs as expeditiously as possible, normally within 24-48 hours depending on damage. The process by which the line repair would be undertaken would include assessment by City engineers for fixing the break, assessment of equipment and operation needs, obtaining necessary permits and building the repair. Conveyance of leachate is discussed under the Conveyance Pipeline System Inspections and Repairs Covered Activity description. Work on the leachate system employs standard best practices for protection of water quality and aquatic habitat. See Section 4.4.3 for detail on best practices for water quality and aquatic habitat protection.

3.5.3 Emergency Operations and Response

Emergency operations are developed in response to specific emergency incidents of a scale that are smaller than those that trigger “Changed Circumstances”. Anticipated types of incidents that may occur in the Plan Area include localized storms, floods, fire, earthquakes, and hazardous spills that are

of a short (days – weeks) time period. These incidents may result in log jams, flooding, damage to pipelines, bridges and levees, mudslides, structures damaged by high surf, and spills into waterways.

The incidence of these types of events is highly variable and unpredictable. They are likely to occur less frequently than annually and involve special-status species or designated critical habitat on an even less frequent basis. In the case emergency response is required, operations may include the use of heavy equipment near waterways and removal of debris and structures in waterways, drainage improvements, pipeline repairs, erosion control and revegetation. Operations are completed according to the City's Emergency Management Plan. The overall Project Manager during emergency situations is the City Manager with support from Fire and Public Works departments and may involve activation of the City's Emergency Operations Center. Field work is guided by authorized environmental monitors and in consultation with NMFS and CDFW as needed. Standard best practices for the protection of water quality and aquatic habitat will be employed for this activity as well. See Section 4.4.3 for detail on best practices for water quality and aquatic habitat protection.

3.5.4 General Vegetation Management Within Riparian Corridors

Vegetation management is generally conducted at City properties and facilities, pipeline rights-of-way, water diversions, tanks, pump stations, and open space and watershed lands. Vegetation management is conducted to provide access to City facilities, provide protection from fire, prevent proliferation of non-natives and illicit activity, and to improve habitat and water quality at some facilities. Vegetation removal is generally done through cutting, flaming, pulling, mowing or targeted herbicide application consistent with the City's IPM Program. Removal areas are targeted based on facility maintenance needs, safety, non-native plant invasion potential, available resources and funds, and other natural resource management priorities. Planting may also occur for landscaping or restoration purposes and is typically focused on native or drought tolerant species. Generally speaking, vegetation removal is limited to the dry months, while planting is limited to the early winter period when rooting potential is maximized. However, these activities may not occur on a regular or seasonal schedule, nor occur at a specific time of day or rate of frequency, and may occur at any time as needed.

Vegetation management for pipeline ROW access is done primarily through hand trimming and mowing on an annual basis. An eight-foot right of way along the pipeline right of way is maintained the length of pipelines and involves up to five stream crossings annually. Pruning in riparian corridors along pipeline ROWs and adjacent to other utility infrastructure is typically limited <5,000 square feet on annual basis and mostly occurs along non-anadromous stream reaches. Trimming in riparian areas is done by hand and maintains canopy, downed trees and snags to the extent possible. Mature trees are

typically retained unless they are failing and threaten infrastructure. All mature trees are inspected by a certified arborist or registered professional forester before being felled and downed wood is left and not lopped as possible. All tree work is done outside of the nesting season if possible, and trees are inspected for nests prior to felling if felled within the nesting season.

3.6 Land Management

Land management activities include recreation, facility maintenance and management, and sensitive habitat management. These activities occur on City Water Department watershed lands, including the LLRA in Newell Creek watershed, and the Zayante and Laguna watershed properties in the Plan Area. The HCP includes coverage for operation, rehabilitation, replacement, repair and maintenance of existing infrastructure and related facilities. Activities associated with facility maintenance and management include facility repair, trail maintenance and management, trail construction, and road maintenance and decommissioning. These activities occur on all the watershed lands and open space properties owned by the City Water Department, particularly in the Newell Creek and Zayante Creek watersheds.

3.6.1 Management of Loch Lomond Recreation Area and Watershed Lands

The City operates the LLRA Area in the Newell Creek watershed as a condition of approval for construction of the Newell Creek Dam. Loch Lomond Recreation area is approximately 180 acres. The Water Department operates this facility with a staff of planners, rangers, and maintenance personnel. The area is operated to provide appropriate recreational opportunities for the public, to preserve and maintain habitat areas and to provide drinking water source (i.e. watershed) protection at Loch Lomond Reservoir and surrounding Newell Creek watershed lands. The City also manages approximately 3,880 acres of watershed lands in the Newell, Zayante and Laguna watersheds solely for the purpose of drinking water source protection. These lands are not open to the public and the Laguna property has no road or trail network but does include an offsite mitigation area in upslope areas for the conservation of Mount Hermon June Beetle. See Figure 1-3, Figure 1-5, and Figure 1-6 for location of Loch Lomond Recreation Area and watershed lands and associated roads.

Trail Maintenance and Repair

This activity includes repair to 7.5 miles of trails during or after natural events such as winter storms, earthquakes, or landslides. The City does not undertake this activity on a regular basis, only on an as

needed basis. It typically involves less than 50 yards of trail in any given year. In cases where a project has been identified as needed to ensure public safety and prevent degradation to sensitive resources, the City prepares a project description, obtains repair specifications, obtains project specific approvals from NMFS, CDFW if riparian corridor or stream work is involved and constructs the project. Trail maintenance and management occurs year-round on open space properties and watershed lands. Trail maintenance and management is a preventative activity to keep trails in good physical conditions to avoid blow-outs due to natural events. Trail maintenance can include installing drainage improvements such as culverts, dips and bars and realigning trail segments outside of stream channels and geologically unstable areas and steep slopes and otherwise avoid other sensitive habitats. Culverts are not installed on salmonid streams. Remediation of existing erosion areas is implemented annually as needed. Informal and unauthorized trails are discouraged or removed as resources permit. Ranger patrols are provided to ensure appropriate use of trails and adherence to closures or restrictions. Areas that have sensitive resources (such as riparian areas) are also closed to public use to prevent disturbance to those resources. Standard BMPs are required for facility repair work near riparian corridors and streams. More detail on such measures can be found in Section 4.4.

Road Maintenance and Decommissioning

Road maintenance and decommissioning occurs on the Newell Creek and Zayante Watershed properties owned and operated by the Water Department. Road maintenance and decommissioning is conducted on the watershed lands to maintain access on vital roads. Road maintenance occurs annually on the property, from May-September and can take a few days to several weeks to complete. Road decommissioning is a new activity for the Department and is in its initial stages of planning and implementation but is expected to continue over the next 20 years. All road work is conducted with the support of a Registered Professional Forester and Certified Erosion Control Specialist, with engineers also being involved on more difficult road projects.

Roads are maintained to provide access for patrolling the properties for security and trespass concerns (off road vehicles, poaching, camping, etc.), for fire access, resource management and restoration, and for maintenance of drainage infrastructure. Roads not necessary for these purposes, or which are significant sediment sources which cannot be treated by maintenance activities, will be decommissioned.

Road maintenance takes place on “restricted use” or seasonal roads within the Newell Creek and Zayante watershed lands and on City park properties. Maintenance is done on the paved maintenance road to the LLRA and unpaved roads in the watershed lands. Maintenance activities focus on maintaining 117 culverts and associated trash racks, maintaining proper energy dissipation at outlets,

clearing bank slough, and conducting bank stabilization, and hand digging rolling dips and/or water bars as necessary to maintain appropriate drainage. This work does not occur in salmonid streams but may occur in ephemeral or perennial tributaries to salmonid streams. Drainage maintenance is usually done with hand tools and bank slough is accomplished with hand tools or a small tractor or loader. Large fill failures or crossing failures are emergency repairs and are not considered standard maintenance.

Unpaved roads are managed as "restricted use" roads. The restricted use refers to roads that are not appropriate for driving in the winter under saturated conditions. These roads are generally maintained as out-sloped dirt roads, with rolling dips and/or water bars to manage drainage. Culverts are utilized to route drainages that the road would otherwise intercept, through the road prism, or in a few areas where in-sloping had to be maintained to pick up bank seepage, or control drainage away from a landslide or road fill failure. These roads have been historically maintained as dirt surface roads, with no wet season use. In an attempt to reduce road surface sediment production, to improve access for patrols or emergencies, and to extend the season that the roads can be traveled, these roads can be rocked. At this time, the main road on the Newell Creek watershed lands, from the dam to the Bear Creek access is envisioned for rocking. The east side road in the recreation area may be treated with drain rock at stream crossings, or at road segments which could introduce sediment into water courses, but is not as vital to upgrade for patrol.

Additional maintenance activities for roads would include culvert replacement and road reshaping. These activities would not occur annually as the prescriptions described above, but would rather be done according to management priorities. Culvert replacement or upgrades would occur in July – September with hand tools and heavy equipment. Projects could take several days to several weeks to complete. The Water Department is planning for a 30-year rotational schedule for culvert replacement and upgrades. Road maintenance on the 34 miles of watershed lands forest roads would occur approximately every five years and would include reshaping roads to maintain outslope drainage as appropriate for the road and topography. Effectively, this means that approximately 136-170 miles of forest roads are reshaped every 20 years and an average of 6.9 miles of road will be maintained annually. Reshaping work is done within the existing road width and cut fill area for most roads and no additional disturbance is done to adjacent areas. After reshaping, the roadbed is rocked and straw and seed are applied to bare soil areas as necessary. Once reshaping has been accomplished for identified roads, the frequency of repeat treatment would be approximately every 8-10 years.

Road decommissioning may occur for up to 5 miles of roads in the Newell Creek and Zayante Creek watershed lands in the future. Road decommissioning varies according to topography, road placement and construction technique when the road was built. Many segments of the roads proposed for

decommissioning traverse relatively mild slopes and have few drainage structures (culverts). These road segments would be more severely out-sloped than a drivable road, or sloped as close to natural grade as possible without generating excessive levels of disturbance. Where water may still concentrate on the road, frequent, large water bars will also be constructed. A small bulldozer (D-6) could adequately decommission these roads, possibly with the assistance of an excavator or backhoe.

These road segments would require all fill to be removed from the down slope portion of the road. This material would then be placed on top of the roadbed cut surface (keyway) and compacted against the existing cut bank. Compaction could be track walking or tamping with excavator in more benign areas. In the more difficult, steep areas, the fill would be engineered (with compactor, sheepsfoot, etc.) and watered per geotechnical recommendations. A severe out-slope would be constructed to bring the contour to as close as natural grade as possible. The area of disturbance associated with road decommissioning is the 14-16 foot width of the roadbed plus an additional 15-20 feet for the recontouring of the more benign roads, and 20-30 feet for the more difficult ones. The number of culverts involved in any given road segment could range from 15-20 culverts (average of 3.4 culverts/mile of road) on either perennial or ephemeral drainages. These drainages do not support the presence of steelhead or coho but may support resident trout.

Culvert removal will consist of excavating the culvert fill with an excavator or backhoe, down to native grade, and removal of the culvert. The area of disturbance associated with culvert removal would typically consist of the 14-16 foot wide roadbed, plus the area to the outer edge of the fill (10-20 feet). The road length at a particular crossing would typically vary from 20-50 feet. Depending on the grade of the channel to be reestablished, and other channel conditions, additional work may be necessary for grade control and energy dissipation above and below the culvert removal site. It is anticipated that most channel adjustments from culvert removal would occur within 30-50 feet of the existing crossing. Gabion sized rock to small rip-rap, or placement of large wood in the channel, may be necessary for channel stabilization upstream and/or downstream of the removed crossing. Erosion control measures for surface stabilization following removal would be required (straw, seed, straw rolls, blankets etc.), and the area replanted with native species, particularly conifer and riparian species.

Road decommissioning would take place during June – September. Road segments would be chosen so that they could be decommissioned, stabilized for erosion, and replanted within one season. Once decommissioned, maintenance would be reduced to any follow-up erosion control and further planting/care necessary for an additional period of one to two years until the area is stabilized and growing.

3.6.2 Habitat Management and Restoration

Habitat management includes resource management activities to improve, preserve and maintain existing sensitive habitats and species. Activities include habitat management and restoration, and public education.

Aquatic Habitat Management and Restoration

Aquatic habitat management is conducted to protect and enhance aquatic habitat for fish, amphibians, and reptiles and will be a fundamental component of the non-flow components of the conservation strategy. Fisheries restoration projects focus on adding or protecting fisheries habitat, stabilizing streambank erosion problems when it benefits salmonid habitat, protecting riparian corridors, removing fish passage barriers and related actions within the Santa Cruz Mountains coho diversity stratum. Projects are completed in accordance with the methods detailed in the California Salmonid Stream Habitat Restoration Manual (Flossi et al. 1998) and appropriate state and federal authorizations will be obtained prior to doing the work. Project priorities will be made with the assistance of a Technical Advisory Committee (TAC) as described in the Non-flow Conservation Fund (NFCF)(Appendix 1: *Summary of Approach to Non-Flow Mitigation of Biological Effects of the City Diversions*). Project types and respective equipment details are variable. For example, equipment used may range from chainsaws (for dropping trees into the streams), to excavators and log skidders for placement of large wood/boulders/gravel and related materials which must be brought into an area where there is existing access from roads. Hand crews are also typically involved in instream projects.

These activities take place during the summer/ fall period, when work conditions are dry, and the critical spawning and smolting periods are over. These projects could occur annually for smaller focused projects to every few years for larger projects (longer stream reaches, more complex construction). Typically, streams are dewatered for this work though they may not be for more simple projects where dewatering would be more impactful than working within the wetted channel. It is estimated that these types of projects would involve dewatering and fish removal in < 100 yards of stream per year. It is estimated that the time length of the projects will vary from 2 to 6 weeks. Standard BMPs are required for work near riparian corridors and streams. More detail on such measures can be found in Section 4.4.

Monitoring

The HCP monitoring program will provide the information necessary to assess compliance with the terms of the HCP, verify progress toward the biological goals and objectives, validate effectiveness of

habitat management and restoration actions and implement a feedback loop to ensure that management/mitigation measures of the HCP can be changed as needed in response to changing conditions and new knowledge. The monitoring program is summarized here and more fully described in Section 6.4. The monitoring program will be overseen by the HCP Administrator and methods and results will be reported in an annual monitoring Covered Species report.

The monitoring program outlined below will provide data on the distribution and abundance of their habitats, and potential threats. Using these data, the City will be able to assess changes in the quality and quantity of the specific habitat of the Covered Species, identify significant changes in the populations of the Covered Species, measure progress towards meeting the HCP's Biological Goals and Objectives, and decide if changes in management or monitoring are warranted. The results of the annual monitoring activities will also inform management decisions, including selection of projects to be funded from the mitigation fund.

All monitoring activities will be performed under the HCP Administrator's guidance and supervision, or under the guidance and supervision of a designated Conservation Program Manager. Prior to the implementation of the HCP, the Conservation Program Manager will prepare a monitoring manual that specifies the methods and protocols to be used in the Monitoring Program. Monitoring objectives, methods, and specific protocols will be developed in close coordination with NMFS and CDFW through a TAC to reflect the state of the art in regional salmonid assessment and to ensure consistency with regional efforts as they develop. Training will be provided for all individuals performing monitoring activities and these individuals will have qualifications, knowledge, and experience relevant to the type of research and monitoring activities that are being performed. The HCP Administrator may engage third parties (such as biological consultants with specific technical expertise regarding a Covered Species) who are qualified and authorized by NMFS to conduct, or to directly supervise, activities conducted under the HCP's monitoring program.

Monitoring program coordination with NMFS and CDFW will be achieved through regular meetings (at least one to two per year) of the HCP TAC. Meetings will include a review of results of the past seasons monitoring and finalization of plans for the upcoming monitoring season. The value of existing studies will be appraised, and monitoring elements may be revised accordingly. An annual report will be prepared to document all monitoring activities and results. The three elements of the monitoring program (Compliance Monitoring, Population and Habitat Monitoring, Mitigation Effectiveness Monitoring) are summarized below. A full description of the monitoring plan is provided in Chapter 6.

Compliance monitoring will include the following:

- Incidental take tracking
- Instream flow targets
- Felton Diversion operations
- Copper monitoring at Loch Lomond Reservoir
- Testing deluge and gate valves
- Relocation of LWD downstream of Loch Lomond Reservoir
- Installation of Sediment Management upgrades at Laguna, Reggiardo, and Majors Diversions
- Installation of Felton Diversion and Tait Street Diversion Fish Screen Upgrades and juvenile bypass improvements
- Water System Operations and Maintenance avoidance and minimization measures
- Municipal Facilities Operations and Maintenance effects on listed species and habitat (debris/obstruction removal, sediment removal, and vegetation removal)

Covered species population and habitat monitoring will include:

- Juvenile population abundance in HCP stream reaches
- Juvenile population abundance in San Lorenzo and Laguna Creek lagoons
- Adult population abundance at the Felton Diversion Dam
- PIT tag antenna array in the San Lorenzo River
- Stream habitat quality
- Instream temperature
- Passage obstacles
- Lagoon habitat quality

Monitoring activity specifically requiring take authorization includes habitat typing of up to 20 miles of streams and tagging/handling of <10,000 fish annually, visual census of up to 5,000 feet of stream annually and maintenance of up to 10 stream gages, 2 pit tag readers, 10 temperature loggers, 1 fish trap and 2 water quality data sondes annually. Monitoring will utilize typical best practices for working in streams as described in Section 4.4.3 and be covered under the 10(a)(1)(B) and related Scientific Collector's permit.

Mitigation effectiveness monitoring will be completed for each mitigation project after 1, 3, 5, and 10 years. Monitoring objectives and methods, and specific protocols will be specified for each mitigation project by the TAC as part of the mitigation planning process. The mitigation strategy is based on a

stepwise process of habitat enhancement that will occur over the life of the HCP. The City will provide annual funding for projects, and the TAC will decide on projects and allocate funds (see Chapter 4 for a description of the mitigation program).

Reporting for each mitigation project will be provided in the annual and five-year mitigation summary reports and will include information on attainment of project-specific success criteria (via review of assessment variables to be prescribed for each project by the TAC), responsible party, specific monitoring methods, a schedule of monitoring activities, analytical methods, and reporting requirements.

Table 3-3: Covered Activities Summary

General Activity	Sub-Activity	Notes
Rehabilitation of Diversion Structures and Pipeline Reaches	1. Laguna Diversion 2. Majors Diversion 3. Felton Diversion 4. Tait Street Diversion	1. Sediment transport improvements 2. Fish screening improvements 3. Fish passage improvements at the Tait Street and Felton diversions 4. Diversion capacity increase at the Tait Street Diversion.
Water Diversion	1. Liddell Diversion 2. Reggiardo Diversion 3. Laguna Diversion 4. Majors Diversion 5. Newell Creek Dam 6. Felton Diversion 7. Tait Street Diversion and Wells	Provision of drinking water utilizing existing water rights (as described in the proposed Santa Cruz Water Rights Project) with addition of "Conservation Flows"
Reservoir Operations	1. Chemical Algaecide Treatment of Reservoir 2. Testing Deluge and Gate Valves 3. Woody Debris Removal on Reservoir Face	1. 1-5 algaecide treatments annually 2. 1 test annually of 5-10 cfs for several hours. Bigger tests during winter/high flows as possible. 3. 10 cubic yards of < 10" diameter/8' long wood removed annually
Water Diversion Sediment Management	1. Liddell Spring 2. Laguna Diversion 3. Majors Diversion	1. Excavation of up to 3 yards per event up to 1-3x/year. Valve operations. 2. Excavation of 5-10 cubic yards per event up to 1-3x/year. Valve operations. 3. Excavation of 5-10 cubic yards per event up to 1-3x/year. Valve operations.

Fish Ladder and Screen Maintenance	1. Felton Diversion 2. Tait Street Diversion	1. 1-3 x/year up to a yard of sediment and woody material needs to be removed from the ladder. 2. 1-3x/year up to a yard of sediment and woody material needs to be removed from intake.
Pipeline Operations	1. Conveyance Pipeline System Inspections and Repairs 2. Finished Water Pipeline System Flushing and Repairs 3. Pumping Well Return to the San Lorenzo River 4. North Coast Valve Blow Off to the San Lorenzo River	1. Inspection and leak response on 19.23 miles of water line and 5.5 miles of leachate line. 2. Flushing and leak response on 270 miles of water line. 3. Ongoing pumping from clear well to remove sediment during high and moderate flows in winter and spring. 4. 5-10 cfs blow off to riverbank occurring < 1x time/year during any part of the year for 1-4 hours.
Dewatering of Creeks for Maintenance and Repairs	1. NA	1. Dewatered stream reaches can range from approximately 20-200 feet at 1-10 sites for 1-4 weeks in any given year.
Flood Control Maintenance	1. Debris/Obstruction Removal 2. Flood Control Sediment Management/Removal 3. Vegetation Management	1. 1-3x/year in wet water years up to 100 cubic yards of material. 2. Removal of approximately 2 cubic yards of sediment per drainage structure/annually or biannually for up to 30 drainage structures. 3. Thin riparian groves and remove willows >3” dbh and alders >6” dbh. Retain 5-10 foot wide riparian buffer adjacent to low flow channel, but remove vegetation >6” dbh annually.

Stormwater Maintenance	1. Inspection and Cleaning 2. Structural Retrofits of Storm Drain Inlets and Basins 3. Sanitary Landfill Leachate Management	1. Inspect and clean as needed but as frequently as weekly. Sweep 35 miles of streets daily. 2. As needed improvements of storm drain infrastructure. 3. Ongoing maintenance of two leachate ponds, transmission of leachate to wastewater plant and repair of leachate line.
Emergency Operations and Response	1. NA	1. Response to flood, fire, spill, or other related incident on a <1 time/year basis and lasting from a few days to several weeks.
General Vegetation Management Within Riparian Corridors	1. NA	1. Pruning and limited removal of riparian trees <5,000 square feet on an annual basis during the summer/fall months as needed adjacent to pipeline ROWs, water diversions and other utility infrastructure.
Land Management	1. Management of Loch Lomond Recreation Area and Watershed Lands 2. Trail Maintenance and Repair 3. Road Maintenance and Decommissioning	1. Operation and management of 180-acre recreation area and 3,880 acres of open space. 2. <50 yards of trail in non-anadromous watersheds annually. 3. Maintenance: Approximately 6.9 miles of road maintained annually. Decommissioning: 0-1 miles of road including up to 3.4 culverts on non-anadromous drainages annually
Habitat Management and Restoration	1. Aquatic Habitat Management and Restoration 2. Monitoring	1. Dewatering and fish removal in <100 yard stream reach annually 2. Habitat typing up to 20 miles of stream and tagging/handling of <10,000 fish annually. Visual census

		of up to 5,000 feet of stream annually. Maintenance of up to 10 stream gages, 2 pit tag antennas, 10 temperature loggers, 1 fish trap and 2 water quality data sondes annually

4.0 CONSERVATION STRATEGY

The conservation strategy is designed to avoid, minimize, and fully mitigate the effects of City covered activities on Covered Species and their habitat in support of the long-term viability of these populations within streams affected by the Covered Activities. The ultimate fate of these populations depends on the actions of many other entities and natural processes both within and beyond areas under the City's control. The conservation strategy recognizes that the City's efforts will support and coordinate with overarching efforts to preserve these species within Santa Cruz County and the larger DPS and ESU boundaries. The biological goals and objectives address key limiting conditions in the Santa Cruz Mountain diversity stratum, particularly effects of diversions, as identified in the recovery plans for steelhead and coho (NMFS 2016, NMFS 2012). The Conservation Strategy assumes, and is dependent upon, approval of the pending Santa Cruz Water Rights Project with the State Water Resources Control Board (as described in Section 6.2.1).

4.1 Introduction

The City's process in developing the conservation strategy included a thorough review of available data and literature on the species and extensive field data collection, including the status and features of populations and habitat conditions within each stream. This analysis resulted in the identification of limiting factors (Chapter 2) and an understanding of the potential effects of Covered Activities on these species and their habitats. As described in Chapter 1, the City coordinated closely with NMFS and CDFW to address research methodologies and results, and to develop the conservation strategy. The following sections describe the City's approach to the conservation strategy, the overall biological goals and objectives, and specific measures to achieve those goals and objectives.

4.2 Approach to the Conservation Strategy

The primary focus of the City's conservation strategy is to avoid or minimize existing and potential effects of Covered Activities to the maximum extent practicable. To achieve this, the Conservation Strategy has been structured around Biological Goals and Objectives (Section 4.3), avoidance and minimization measures (Section 4.4), and a non-flow conservation program (Section 4.5). The biological goals and objectives provide a statement of desired future conditions and provide the basis for determining strategies, monitoring effectiveness, and evaluating the success of actions. The avoidance and minimization measures define specific tools and techniques and measurable steps to meet HCP objectives and achieve desired future conditions. The avoidance and minimization measures may involve the removal of an activity from a particular location or the scheduling of an

activity to occur during a period in which the species is unlikely to be affected. Avoidance and minimization measures may also apply constraints or limitations on an activity that allow it to proceed while avoiding or minimizing effects to species. In cases where avoidance and minimization measures are insufficient to entirely avoid potential effects, the City will implement a mitigation program that will fund habitat enhancement and restoration through the NFCF to fully offset those remaining effects (Section 4.5).

Steelhead populations in the North Coast streams are relatively small due to the short lengths of anadromous habitat. Analysis of monitoring data suggests adult populations on the order of less than half a dozen for Liddell and Majors Creeks and about 60 for Laguna Creek, of which over 90% would be from the lagoon (Section 2.5). Even if stream densities were 3 to 4 times higher, these would still be very small populations. A similar analysis of data from Newell Creek suggests potential spawning populations of about 17 adult steelhead on average (Section 2.5). The San Lorenzo River Lagoon has the potential to produce a relatively large number of steelhead smolts. Analysis based on juveniles rearing in the lagoon suggests a potential adult return of up to approximately 400 adult steelhead from these juveniles in addition to those from production in the mainstem and tributaries (Section 2.5).

This analysis, while somewhat hypothetical, indicates the relative importance of the San Lorenzo River Lagoon and Laguna Creek Lagoon in supporting steelhead populations in the Plan Area and the relatively small contribution of Newell Creek and the other North Coast streams. The San Lorenzo River is a high priority for restoration. It is a large watershed with extensive anadromous habitat with approximately 26 miles of anadromous habitat in the mainstem and 57 miles in the tributaries (ENTRIX, Inc. 2004b). The San Lorenzo River supports steelhead and potentially supports coho. Although the lagoon is highly altered from pre-development conditions and the habitat is significantly degraded, it is still important for rearing juvenile steelhead (Chapter 2). While coho are functionally extirpated from the San Lorenzo River and North Coast streams, the river is a focus of recovery efforts by NMFS and together with some of its tributaries, may play an important roles in the recovery strategy for Central California Coast coho (NMFS 2010).

The City's objective is to use available water supplies to restore natural flow regimes at times and locations where it will have the most beneficial effects on steelhead and coho production. In order to meet this objective, priorities were established for the different streams and life-stages influenced by City diversions. The San Lorenzo River is important because of the large amount of potential habitat compared with other Plan Area streams, the potential to support both steelhead and coho, and the relative magnitude of potential effects of City activities on anadromous species. The San Lorenzo River Lagoon is important for its potentially large contribution to the steelhead population from juveniles reared there. Of the North Coast streams, Laguna Creek was given highest priority since it has the greatest length of anadromous habitat influenced by City diversion; it is the only one with a

functional lagoon system; it has experienced the largest proportional flow diversion; and it has more frequent observations of coho reproduction in recent years (2005, 2015, 2016, 2020). Liddell Creek was given the lowest priority since the City diversion influences only a portion of the potential anadromous habitat; base flows are generally higher in the anadromous reach due to augmentation from the West Branch, the Middle Branch, and basin hydrology; there is no lagoon; and there is a high level of fine particles in the substrate that diminish habitat quality and potentially limit the benefits of any flow augmentation.

4.3 Biological Goals and Objectives

This section describes the Biological Goals and Objectives. Biological Goals are broad, guiding principles based on the conservation needs of the resources. Biological Objectives are expressed as conservation targets or desired conditions for each Biological Goal. As described below, Biological Goals involve provision of bypass flows at each diversion source to improve habitat conditions; creation, restoration, and enhancement of physical habitat to mitigate any residual effects of the diversions; and avoiding, minimizing, and fully mitigating effects to Covered Species resulting from City operations and maintenance activities.

Biological Goal # 1 Contribute to the conservation of Covered Species by providing flows sufficient to improve habitat conditions and increase the likelihood of persistence of populations within the Plan Area.

Objective 1.1 Within two (2) years of permit issuance, and for the duration of HCP implementation, increase the quantity and quality of habitat supporting adult migration in terms of average number of days with flow meeting minimum migration criteria during the adult migration period (December through April for steelhead, December and January for coho).

North Coast Streams

Objective 1.1.1 Steelhead

Provide at least 95% of no-diversion levels in Laguna Creek in all year types and at least 90% of no-diversion levels in Majors and Liddell Creeks in normal and wet year types.

Objective 1.1.2 Coho

Provide at least 90% of no-diversion migration levels in Laguna Creek.

San Lorenzo River

Objective 1.1.3 Steelhead

Provide a minimum of 92% of no-diversion migration levels below Tait Street in dry, normal, and wet years; 75% in critical dry years. Provide 100% of no-diversion migration levels downstream of the Felton Diversion.

Objective 1.1.4 Coho

Provide a minimum of 84% of no-diversion levels for average migration days below Tait Street in dry, normal, and wet years; Provide 70% of no-diversion levels in critical dry years. Provide 100% of no-diversion levels downstream of the Felton Diversion.

Objective 1.2 Within two (2) years of permit issuance, and for the duration of Plan implementation, increase the quantity and quality of habitat supporting spawning as measured by average annual WUA during potential spawning periods (after migration event in December-May for steelhead, December-March for coho).

North Coast Streams

Objective 1.2.1 Steelhead

Provide a minimum of 94% of no-diversion spawning habitat index levels in Laguna Creek in all year types. Provide a minimum of 90% of no-diversion habitat index levels in Majors and Liddell Creeks in normal and wet year types.

Objective 1.2.2 Coho

Provide at least 95% of no-diversion spawning habitat index levels in Laguna Creek in all year types.

San Lorenzo River

Objective 1.2.3 Steelhead

Provide at least 90% of no-diversion spawning habitat index levels downstream of the Felton Diversion.

Objective 1.3 Within two (2) years, and for the duration of Plan implementation, increase the quantity and quality of habitat supporting juvenile rearing as measured by seasonal average (winter, spring, summer) rearing WUA.

North Coast Streams

Objective 1.3.1 Steelhead

Provide at least 83% of no-diversion rearing habitat index levels in Laguna Creek in all year types during the spring (April through June) and summer (July through September) periods. Provide at least 70% of no-diversion habitat index levels in Majors and Liddell Creeks during spring and summer in normal and wet year types.

Objective 1.3.2 Coho

Provide 100% of no-diversion rearing habitat index levels in Laguna Creek during spring and summer in all year types.

San Lorenzo River

Objective 1.3.3 Steelhead

Provide at least 85% of no-diversion rearing habitat index levels downstream of the Tait Street diversion; provide at least 98% of no-diversion habitat index levels downstream of the Felton Diversion.

Objective 1.4 Smolt Outmigration - Within two (2) years of permit issuance, and for the duration of Plan implementation, increase the quantity and quality of habitat supporting smolt outmigration as measured by annual number of days with flows meeting minimum migration criteria during the smolt migration period (January through May).

North Coast Streams

Objective 1.4.1 Steelhead and Coho

Provide an average of at least 98% of no-diversion migration levels in Laguna Creek in all year types. Provide at least 94% of no-diversion migration levels in Majors and Liddell Creeks in normal and wet year types.

San Lorenzo River

Objective 1.4.2 Steelhead and Coho

Provide at least 96% of no-diversion migration levels below the Tait Street Diversion in dry, normal, and wet year types; provide 88% of no-diversion migration levels below the Tait Street Diversion in critical dry years; provide at least 98% of no-diversion levels downstream of the Felton Diversion.

Objective 1.5 Within two (2) years of permit issuance and for the duration of Plan implementation, improve rearing habitat in the San Lorenzo River Lagoon by providing minimum inflow of 8 cfs to improve temperature and DO levels during periods when the lagoon is closed.

Biological Goal # 2 Contribute to the conservation of Covered Species by creating, restoring, or enhancing aquatic habitat in the Plan Area.

Objective 2.1 Between years 1-10, fund and oversee habitat restoration or enhancement projects worth $2.7M (2018 dollars excluding administration) and potentially including removal of passage obstacles, placement of large wood structures, riparian conservation easements, spawning gravel augmentation, riparian restoration, and sediment control projects.

Objective 2.2 Between years 11-20, fund and oversee habitat restoration or enhancement projects worth $2.7M (2018 dollars excluding administration) and potentially including removal of passage obstacles, placement of large wood structures, riparian conservation easements, spawning gravel augmentation, riparian restoration, and sediment control projects.

Objective 2.3 Between years 21-30, fund and oversee habitat restoration or enhancement projects worth $2.7M (2018 dollars excluding administration) and potentially including removal of passage obstacles, placement of large wood structures, riparian conservation easements, spawning gravel augmentation, riparian restoration, and sediment control projects.

Biological Goal # 3 Avoid, minimize, and fully mitigate effects to Covered Species resulting from City operations and maintenance activities.

Objective 3.1 During all years of Plan implementation, operate facilities to avoid stranding Covered Species by implementing a ramping rate during flow changes at the Felton Diversion Dam, Tait Street Diversion, Laguna Creek Diversion, Liddell Spring Diversion, Majors Creek Diversion, and Newell Creek Dam to limit flow reductions such that change in stage is limited.

Objective 3.1.1 Manage inflation and deflation of the Felton Diversion Dam to maintain stage increase of less than 1.68 feet per hour during deflation of the dam and stage decrease of no more than -0.55 feet per hour during inflation of the dam. This will be accomplished through manual operation of the dam bladder by a trained operator. Inflation and deflation of the dam in response to anticipated changes in the hydrograph from forecast storms will be planned in advance in consultation with staff hydrologists to minimize stage changes to the maximum extent practicable.

Objective 3.1.2 Implement a ramping rate during flow changes at Tait Street Diversion, Laguna Creek Diversion, Liddell Spring Diversion, Majors Creek Diversion, and Newell Creek Dam to limit flow reductions such that change in stage is no greater than 0.16 feet per hour when fry may be present (January 15 through May 31) and no greater than 0.3 feet per hour at other times.

Objective 3.2 During all years of Plan implementation, operate facilities to reduce introduction of sediment.

Objective 3.2.1 Deflate the Felton Diversion Dam during the first one or two rainstorms of the season to flush sediments and organic matter from the channel and at flows greater than 2,000 cfs, when the majority of sediment is being transported.

Objective 3.2.2 Within ten (10) years of permit issuance, upgrade diversion facilities on Laguna, Reggiardo, and Majors Creek to provide sediment transport during high flows so as to avoid "pulsing" of sediment to downstream habitat.

Objective 3.3 Within ten (10) years of permit issuance, enhance fish passage through the Felton Diversion Dam by upgrading facilities to meet current NMFS and CDFW criteria for fish screens and passage.

Objective 3.4 Within ten (10) years of permit issuance, enhance fish passage through the Tait Street Diversion by modifying the Tait Street Diversion to prevent entrainment and impingement and provide bypass in accordance with current criteria issued by NMFS and CDFW (NMFS 2006) and (CDFW 2000).

4.4 Avoidance and Minimization Measures for Covered Activities

The City has reviewed the Covered Activities and their possible effect on steelhead and coho life stages and has identified avoidance and minimization measures to eliminate or reduce effects to the extent practical. These avoidance and minimization measures include existing standard practices and SOPs previously put into place by the City to avoid or minimize effects on habitat and species and include approaches such as work area and work period restrictions. Avoidance and minimization measures also include City programs that provide environmental benefits through reducing pollutants and conserving water. Avoidance and minimization measures are an important part of the conservation strategy for steelhead and coho because they provide either complete protection for the species from the activity or provide for minimization of effects through implementing practices that reduce effects on life cycle stages or habitat.

This section describes measures that will be adopted under the HCP to avoid and minimize effects on steelhead and coho applicable to each City Covered Activity. City activities with the potential to affect steelhead and coho include: rehabilitation of diversion structures and pipelines, water supply operations, including diversion of streamflows and reservoir management; water system operations and maintenance including sediment management, fish ladder and fish screen maintenance, and pipeline operations and maintenance; municipal facility operations and maintenance, including maintenance of flood control facilities in the Lower San Lorenzo River and Branciforte Creek; and management of watershed lands in the Mountain Charlie/Zayante Creek and Newell Creek watersheds.

4.4.1 Rehabilitation of Diversion Structures and Pipeline Reaches

The NCS pipeline reaches extend above and below ground, through developed and undeveloped areas, and traverses along, above or beneath roadways and waterways from Bonny Doon to the west side of Santa Cruz (Section 3.2). Rehabilitation work entails replacement of portions of the supply pipelines, rehabilitation of the Majors Creek and Laguna Creek diversion structures, and rehabilitation of the Tait Street and Felton Diversions on the San Lorenzo River.

The potential for effects to steelhead and coho from pipeline rehabilitation is very low. Construction practices and measures to minimize and avoid sediment discharge to water courses, and contain sediment and spills are expected to result in negligible residual effects of this activity to steelhead or coho (Section 4.4.3, Measures WO-1 through WO-14). Work in and around stream channels will incorporate avoidance and minimization measures associated with pipeline repair (Section 4.4.3.3) and dewatering of creeks for maintenance and repairs (Section 4.4.3.4).

The Majors Creek and Laguna Creek diversion structures are located upstream of the anadromous reaches on the creeks and potential construction effects would be limited to the local non-anadromous sites. Neither rehabilitation project would affect established bypass flows for fish and both would result in more natural sediment transport in the stream channels. Rehabilitation of the Tait Street and Felton Diversions are addressed in Section 4.4.2.1.

4.4.2 Water Supply Operations

This section describes the overall approach to minimizing the effects of water diversions on the Covered Species.

4.4.2.1 Water Diversions

This section describes the potential effects of water diversions on the Covered Species and presents specific measures to avoid or minimize those effects. Flow reductions due to diversion of water at the six City diversion facilities is the Covered Activity with the greatest potential to affect steelhead and coho in the Plan Area. There are currently no instream or bypass flow requirements for the Tait Street or North Coast diversions, although diversion amounts are limited by water rights and facilities limitations. In this section, minimum instream flows are specified for each of these sources that would be maintained through flow bypasses at the City diversions. As previously mentioned, ongoing provision of minimum instream flows is contingent upon successful implementation of the proposed Santa Cruz Water Rights Project (as described in Section 6.2.1).

Early work in developing the HCP focused on understanding the relationships between flow and habitat quality downstream of each of the diversions (HES 2014b, Appendix 3: *Flow Studies*). Streamflow-habitat relationships were developed using the PHABSIM model of the Instream Flow Incremental Methodology (Bovee et al. 1998), and other analytical techniques (Thompson 1972, Powers and Orsborn 1985). This allowed quantification of habitat metrics (such as number of days with streamflow levels suitable for migration, spawning area, and rearing area) as a function of streamflows. Bypass flow scenarios were developed and evaluated using the City's operations model (Confluence), historical hydrologic data, and habitat models to optimize instream habitat conditions for covered species and City water supply needs. This process was the combined effort of a technical working group convened by the City beginning in 2005 and composed of resource agency personnel representing NMFS and CDFW, City staff, and consultants. A more detailed description of the overall approach to minimizing the effects of the City diversions and the common rationale for determining minimum instream flow targets is provided in Appendix 9: *Rationale for Determining Minimum*

Instream Flow Targets. Avoidance and minimization measures, including bypass flow schedules, is provided for each of the City diversions in the following sections.

Due to the extreme range of seasonal and inter-annual flow variation occurring in HCP streams and the inability to predict flow conditions from month to month during the wet season, the bypass flows are specified on a month-by-month basis for each of five different hydrologic exceedance conditions. The hydrologic conditions (HC) are based on the record of cumulative daily average flow at the Big Trees gage on the San Lorenzo River (see Appendix 9: *Rationale for Determining Minimum Instream Flow Targets*). Cumulative water-year flow was calculated for each month in the record (water-years 1937-2015) and sorted from lowest to highest. This record was split into five equal parts representing a range of exceedance categories from 100% (flow exceeded 100% of the time) to 0% (flow never exceeded). This results in five HC classes for very dry, dry, normal, wet, and very wet conditions as HC 5, 4, 3, 2, and 1, respectively). Hydrologic condition limits by month are shown in Table 4-1. Over time, and particularly with changing climate conditions, frequency of occurrence in each Category may diverge from historical frequencies.

Operationally, the hydrologic category is determined each month based on the cumulative water year flow at Big Trees for the preceding month. This approach is not intended to replace, and is not incompatible with, the forecasting model used by the City, which is based on four year-types with a determination made in March for the current water-year. Rather, it provides an additional tool for dealing with the complexity of species habitat needs. Using the water-year type to define bypass flow requirements means that the water-year type is undefined until March and there would be no basis for provision of bypass flows during the important and dynamic winter months. Bypass flows based on the previous seasons runoff result in the potential for in-stream flows that can be too low in wetter winters following a dry year (negatively impacting habitat), or too high in dryer winters following a wetter year (negatively impacting City supply). Although bypass flows are determined based on the HC system, results are still presented by water-year type for consistency with other City programs. The hydrologic condition changes from month to month while the water year applies to a complete annual cycle. Each water year may be composed of months having a variety of hydrologic conditions. For example, a wet water year may start with a dry fall and early winter with HC-4 or HC-5 from October through January, then have a very wet February ending in HC-2 or HC-3 and a wet March ending in HC-1 or 2.

Table 4-1: Hydrologic Condition Limits for End of Month Cumulative Daily Flow (cfs) for Water Year at San Lorenzo River Big Trees Gage, Period of Record 1 October, 1936 to 30 September, 2015*

Hydrologic Condition Limits (End of Month Cumulative Daily Flow from October 1 in cfs)					
	Category 5 80-100 %	**Category 4 60-80%**	**Category 3 40-60%**	**Category 2 20-40%**	**Category 1 0-20%**
Oct	<=459	460 to 539	540 to 709	710 to 875	>875
Nov	<=1186	1187 to 1497	1498 to 1827	1828 to 2485	>2485
Dec	<=2397	2398 to 3134	3135 to 5642	5643 to 10196	>10196
Jan	<=4322	4323 to 8456	8457 to 16694	16695 to 28019	>28019
Feb	<=8442	8443 to 16368	16369 to 29140	29141 to 42995	>42995
Mar	<=13004	13005 to 22948	22949 to 35371	35372 to 57968	>57968
Apr	<=14203	14204 to 24491	24492 to 39487	39488 to 67884	>67884
May	<=15448	15449 to 25279	25280 to 41659	41660 to 71412	>71412
June	<=16005	16006 to 26116	26117 to 43123	43124 to 73420	>73420
Jul	<=16364	16365 to 26819	26820 to 44073	44074 to 74718	>74718
Aug	<=16653	16654 to 27355	27356 to 44799	44800 to 75591	>75591
Sep	<=16978	16979 to 27843	27844 to 45398	45399 to 76368	>76368

* Hydrologic condition limits are set by the historical record period as indicated. These limits will be applied over the life of the HCP to maintain consistency with effects analyses. Over time, and particularly with changing climate conditions, frequency of occurrence in each Category may diverge from historical frequencies.

Minimum instream flow targets are presented in the following sections in tables for each diversion (e.g. Table 4-2). Bypass flows are presented by month, life stage, and hydrologic condition. In any month, the bypass flow is driven by the life stage having the highest flow requirement. Rearing baseflows are provided when other life stages are not controlling. Flows for adult migration are provided when natural flow (i.e. without City diversions) would be at that level. Adult migration flows are presented as an upper and lower threshold with diversion halted when the lower threshold is reached and not resumed until natural flows exceed the upper threshold or recede below the lower threshold. Only the amount of flow in excess of the upper threshold is available for diversion. If flow drops below the lower threshold, the life stage with the next highest flow requirement would determine the minimum bypass level. Spawning flows are provided for a period of 14 days following the last occurrence of a migration flow. Incubation flows are provided for a period of 60 days following the last spawning flow or until May 31st, whichever occurs first. These general provisions may be relaxed in specific circumstances noted in the Tables. A more detailed description of the development and

application of the bypass flows is provided in Appendix 9: *Rationale for Determining Minimum Instream Flow Targets*.

Liddell Spring Diversion

The Liddell Spring diversion may affect steelhead and coho by flow reduction that impairs ability of adult fish to migrate upstream in the winter and for smolts to migrate downstream in the spring; limits suitability of habitat for spawning, egg incubation, and juvenile rearing; reduces the productivity of benthic macro-invertebrates in the stream; and causes stranding, particularly of fry, when abrupt flow changes result from changes in diversion rates.

Restoration of flow in Liddell Creek was given lower priority than Laguna Creek and the San Lorenzo River due to limited productive capacity for steelhead, unsuitability of habitat for coho, relatively short anadromous length, and relatively small size of the diversion relative to Laguna Creek and the San Lorenzo River. Productive capacity is limited due to excessive amounts of fine sediment and lack of a functional lagoon (Chapter 2). A schedule of instream flow targets to minimize effects for the Liddell Spring Diversion under the HCP is presented in Table 4-2 and described as specific measures as follows.

Measure WS-1: Provide 0.25 cfs minimum bypass flow for rearing juvenile steelhead in Liddell Creek in the two driest hydrologic conditions (80%-100% exceedance and 60%-80% exceedance). A flow of 0.25 cfs provides approximately 27% of the maximum habitat index for steelhead rearing in the reach (HES 2014b).

Measure WS-2: Provide up to 5.2 cfs minimum bypass flow for rearing juvenile steelhead in the anadromous reach of Liddell Creek in normal, wet, and very wet hydrologic conditions (0%-60% exceedance). This provides approximately 76% of the maximum habitat index for steelhead rearing in the reach (HES 2014b).

Measure WS-3: Provide minimum bypass flows for adult migration in the anadromous reach in December through April of 0%-60% hydrologic conditions with a lower flow threshold of 4.9 cfs and an upper threshold of 11.3 cfs whenever flow would be at this level without City diversions.

Measure WS-4: Provide minimum bypass flows for spawning in the anadromous reach in December through May of 0%-60% hydrologic conditions of 7.4 cfs for 14 days following any adult migration period (provides estimated 80% of peak habitat index for steelhead spawning and 97% of the peak for coho).

Measure WS-5: Provide bypass flows for egg incubation in January through May of 0%-60% hydrologic conditions. The incubation flow in Liddell Creek is 2.0 cfs. Incubation flows are provided for 60 days after the last spawning day or until May 30, whichever is earliest.

Measure WS-6: Provide bypass flows for smolt migration in the anadromous reach during January through May in 0-60% hydrologic conditions (hydrologic conditions 1-3), and for at least 3 consecutive days per week in March, April, and May in 60%-100% conditions (hydrologic conditions 4 and 5). The smolt migration minimum is 2 cfs.

Measure WS-7: Implement a ramping rate during flow changes at Liddell Spring Diversion to limit flow reductions such that change in stage is no greater than 0.16 feet per hour when fry may be present (January 15 through May 31) and no greater than 0.3 feet per hour at other times.

The instream flow targets in Table 4-2 apply to the City maintained stream gage in the anadromous reach of Liddell Creek, a short distance upstream of Highway 1. The point of diversion is approximately 2 miles upstream of the anadromous gage and there is accretion of flows from other sources, including the Middle Branch and West Branch of Liddell Creek. There are also other diverters in the watershed, including the former CEMEX quarry, numerous wells in the recharge area for the creek, two alluvial wells near the confluence of the West and East Branches owned by the Bureau of Land Management and an agricultural diversion just upstream of Highway 1 (Chapter 2). The magnitude and timing of other diversions is not known with any certainty and cannot be predicted. The point of compliance is at the Anadromous Liddell gage; other gages will also be used to ascertain effects of these other diversions on flows and habitat availability in the anadromous reach.

Table 4-2: Minimum instream flow targets for avoidance and minimization of effects on steelhead due to the Liddell Spring Diversion

	Minimum Flow at Liddell Creek Anadromous Gage (cfs)								
	Rearing Base flow					Migration		Spawning	
	Hydrologic Condition 5 80-100% (driest)	Hydrologic Condition 4 60-80% (dry)	Hydrologic Condition 3 40-60% (normal)	Hydrologic Condition 2 20-40% (wet)	Hydrologic Condition 1 0-20% (very wet)	Adult[1]	Smolt[2]	Spawn[3]	Incubate[4]
Jan	0.25	0.25	2.9	3.6	4.7	4.9/11.3	2.0	7.4	2
Feb	0.25	0.25	4.6	3.9	5.1	4.9/11.3	2.0	7.4	2
Mar	0.25	0.25	3.5	4.8	5.2	4.9/11.3	2.0	7.4	2
Apr	0.25	0.25	3.0	4.3	4.6	4.9/11.3	2.0	7.4	2
May	0.25	0.25	2.6	3.3	4.0		2.0	7.4	2
June	0.25	0.25	2.0	2.4	2.9				
Jul	0.25	0.25	1.6	1.9	2.2				
Aug	0.25	0.25	1.4	1.7	1.8				
Sep	0.25	0.25	1.3	1.5	1.6				
Oct	0.25	0.25	1.5	1.5	1.6				
Nov	0.25	0.25	1.8	1.9	1.9				
Dec	0.25	0.25	2.1	2.6	3.0	4.9/11.3		7.4	

[1] Provided in 0%-60% hydrologic conditions only.
[2] Smolt migration flows provided in 0-60% (hydrologic conditions 1-3), and for 3 consecutive days per week in March, April, and May in 60%-100% (hydrologic conditions 4 and 5).
[3] 80% of peak steelhead spawning WUA for 14-day period after any potential migration event in 0-60% hydrologic conditions; not provided in 60-100% hydrologic conditions.
[4] Provided in 0-60% hydrologic conditions for 60-day period following occurrence of last spawning flow or May 30, whichever occurs first; not provided in 60-100% hydrologic conditions.

Reggiardo Creek Diversion

The Reggiardo Creek Diversion, while currently inoperable, historically diverted from 1.6-2.8 cfs continuously with conveyance through an 850 foot gravity pipeline to the Laguna Creek Diversion pond (Section 3.3.1). The Reggiardo Diversion is approximately 300 feet upstream of the confluence with Laguna Creek. As such, any effect of the Reggiardo Creek Diversion on species in the anadromous reach of Laguna Creek is incorporated in the operation of the Laguna Creek Diversion (see following section).

Laguna Creek Diversion

The Laguna Creek diversion may affect steelhead and coho by flow reduction that impairs ability of adult fish to migrate upstream in the winter and for smolts to migrate downstream in the spring; limits suitability of habitat for spawning, egg incubation, and juvenile rearing; degrades water quality conditions in the lagoon at the mouth of the creek; reduces the productivity of benthic macro-invertebrates in the stream; and causes stranding, particularly of fry, when abrupt flow changes result from changes in diversion rates.

The City/TAC has assigned Laguna Creek a high priority for restoration of flows relative to the other North Coast streams covered in this HCP due to underlying habitat conditions that have a higher potential to support recovery of salmonids. It is the largest watershed and has the longest reach of anadromous habitat of all the North Coast streams where the City diverts water. It also has a nearly intact lagoon system that can be very productive for steelhead. Laguna Creek also has the potential to support coho as evidenced by recent observations of juveniles there (Chapter 2). A schedule of instream flow targets to minimize effects of the Laguna/Reggiardo Diversion[45] under the HCP is presented in Table 4-3 and described as specific measures as follows.

Measure WS-8: Provide 2 cfs minimum bypass flow for rearing juvenile steelhead in the anadromous reach of Laguna Creek at all times. This is approximately the 44% exceedance flow for August in the historical hydrologic record and equates to about 70% of the maximum habitat index for steelhead rearing in August in the reach and approximately 99% of the maximum habitat index for coho rearing (HES 2014).

Measure WS-9: Provide minimum bypass flows for adult migration in the anadromous reach with a lower flow threshold of 10.6 cfs and an upper threshold of 15.5 cfs in December through March of all

[45] Instream flow targets for the Reggiardo Diversion are included in the Laguna Creek bypass flow targets. The Reggiardo and Laguna Creeks Diversions operate in tandem and are miles above the Laguna Creek limit of anadromy. Therefore, they have a cumulative effect on anadromous reach flows.

hydrologic conditions and April when hydrologic condition is 0-60% whenever flow would be at this level without City diversions.

Measure WS-10: Provide minimum bypass flows for spawning in the anadromous reach of 9.4 cfs during December through May for 14 days following any adult migration period (providing 80% of peak habitat index for steelhead spawning and 97% of the peak for coho).

Measure WS-11: Provide bypass flows for egg incubation in January through May in all hydrologic conditions. The incubation flow in Laguna Creek is 4.0 cfs. Incubation flows are provided for 60 days after the last spawning day or until May 30, whichever is earliest.

Measure WS-12: Provide bypass flows for smolt migration in the anadromous reach during January through May in 0-80% hydrologic conditions (hydrologic conditions 1-4), and for at least 3 consecutive days per week in 80%-100% conditions (hydrologic condition 5). The smolt migration minimum is 3.8 cfs. For background on the various hydrologic conditions, see Appendix 8: Hydrologic, Water Supply, and Fisheries Habitat Effects Modeling.

Measure WS-13: Implement a ramping rate during flow changes at Laguna Creek Diversion to limit flow reductions such that change in stage is no greater than 0.16 feet per hour when fry may be present (January 15 through May 31) and no greater than 0.3 feet per hour at other times.

The instream flow targets in Table 4-3 apply to the City maintained stream gage in the anadromous reach of Laguna Creek, a short distance upstream of Highway 1. The point of diversion is approximately 4 miles upstream of the anadromous gage and there is accretion of flows from other sources, including Y Creek. Although the point of compliance is at the anadromous gage, other gages will also be used to ascertain effects of these other diversions on flows and habitat availability in the anadromous reach.

Table 4-3: Minimum Instream Flow Targets for Avoidance and Minimization of Effects on Steelhead Due to the Laguna Creek Diversion

	Minimum Flow at Laguna Creek Anadromous Gage (cfs)								
	Rearing Base flow					Migration		Spawning	
	Hydrologic condition 5 80-100% (driest)	Hydrologic condition 4 60-80% (dry)	Hydrologic condition 3 40-60% (normal)	Hydrologic condition 2 20-40% (wet)	Hydrologic condition 1 0-20% (very wet)	Adult	Smolt Migration[1]	Spawn[2]	Incubate[3]
Jan	2	2	2	2	2	11.3/15.5	3.8	9.4	4
Feb	2	2	2	2	2	11.3/15.5	3.8	9.4	4
Mar	2	2	2	2	2	11.3/15.5	3.8	9.4	4
Apr	2	2	2	2	2	11.3/15.5[4]	3.8	9.4	4
May	2	2	2	2	2		3.8	9.4	4
June	2	2	2	2	2				
Jul	2	2	2	2	2				
Aug	2	2	2	2	2				
Sep	2	2	2	2	2				
Oct	2	2	2	2	2				
Nov	2	2	2	2	2				
Dec	2	2	2	2	2	11.3/15.5		9.4	

[1] Smolt migration flows shall be provided in 0-80% (hydrologic conditions 1-4), and for 3 consecutive days per week in 80%-100% (hydrologic condition5) in March, April, and May.
[2] 80% of peak steelhead spawning WUA for 14-day period after any potential migration event.
[3] For 60-day period following occurrence of last spawning flow or May 30, whichever occurs first.
[4] April adult migration flows provided in 0-60% exceedance conditions/hydrologic conditions 1-3.

Majors Creek Diversion

The Majors Creek diversion may affect steelhead and coho by flow reduction that impairs ability of adult fish to migrate upstream in the winter and for smolts to migrate downstream in the spring; limits suitability of habitat for spawning, egg incubation, and juvenile rearing; reduces the productivity of benthic macro-invertebrates in the stream; and causes stranding, particularly of fry, when abrupt flow changes result from changes in diversion rates.

Restoration of flow in Majors Creek was given lower priority than Laguna Creek and the San Lorenzo River due to the short anadromous reach length (0.6 miles) and lack of a developed lagoon (Chapter 2). It also has a relatively small diversion capacity (2.1 cfs) relative to Laguna Creek (6.3 cfs) and the San Lorenzo River at the Tait Street Diversion (12.2 cfs). A schedule of instream flow targets to minimize effects of the Majors Creek diversion under the HCP is presented in Table 4-4. Comparisons of actual habitat values that would occur under HCP flows are provided in Chapter 5.

Measure WS-14: Provide 0.25 cfs minimum bypass flow for rearing juvenile steelhead in Majors Creek in the two driest hydrologic conditions (80%-100% and 60%-80%). A flow of 0.25 cfs equates with approximately 27% of the maximum WUA for rearing juvenile steelhead occurring in Majors Creek.

Measure WS-15: Provide up to 4.7 cfs minimum bypass flow for rearing juvenile steelhead in the anadromous reach of Majors Creek in normal, wet, and very wet hydrologic conditions (0%-60%). This is more than the maximum August flow and approximately the 10% exceedance flow for June in the historical hydrologic record and equates to about 86% of the maximum habitat index for steelhead in June (HES 2014b).

Measure WS-16: Provide minimum bypass flows for adult migration in the anadromous reach in December through April of 0%-60% hydrologic conditions with a lower flow threshold of 9 cfs and an upper threshold of 16 cfs whenever flow would be at this level without City diversions.

Measure WS-17: Provide minimum bypass flows for spawning in the anadromous reach in December through May of 0%-60% hydrologic conditions of 12.1 cfs for 14 days following any adult migration period (provides estimated 80% of peak habitat index for steelhead spawning and 97% of the peak for coho).

Measure WS-18: Provide bypass flows for egg incubation in January through May of 0%-60% hydrologic conditions. The incubation flow in Majors Creek is 2.9 cfs. Incubation flows are provided for 60 days after the last spawning day or until May 30, whichever is earliest.

Measure WS-19: Provide bypass flows for smolt migration in the anadromous reach during January through May in 0-60% hydrologic conditions (hydrologic conditions 1-3), and for at least 3 consecutive days per week in March, April, and May in 60%-100% conditions (hydrologic conditions 4 and 5). The smolt migration minimum is 3.4 cfs.

Measure WS-20: Implement a ramping rate during flow changes at Majors Creek Diversion to limit flow reductions such that change in stage is no greater than 0.16 feet per hour when fry may be present (January 15 through May 31) and no greater than 0.3 feet per hour at other times.

The instream flow targets in Table 4-4 apply to the City-maintained stream gage in the anadromous reach of Majors Creek, immediately upstream of Highway 1. The point of diversion is approximately 2 miles upstream of the anadromous gage and there is accretion of flows in the intervening reach. There are at least four known non-City operated diversions on Majors Creek (ENTRIX, Inc. 2004c), including three diversions operated by Edwards, two of which are located in the anadromous reach just upstream of the Highway 1 crossing. There are also several diversions upstream of the City diversion (Chris Berry, personal communication to Kindra Loomis, 2004, cited in ENTRIX, Inc. 2004c). Production numbers and season of diversion for the non-City diversions are unavailable and their impacts on Majors Creek hydrology are unclear. The point of compliance is at the anadromous gage; other gages will also be used to ascertain effects of other diversions on flows and habitat availability in the anadromous reach.

Table 4-4: Minimum Instream Flow Targets for Avoidance and Minimization of Effects on Steelhead Due to the Majors Creek Diversion

	Minimum Flow at Majors Creek Anadromous Gage (cfs)								
	Rearing Base flow					Migration		Spawning	
	Hydrologic condition 5 80-100% (driest)	Hydrologic condition 4 60-80% (dry)	Hydrologic condition 3 40-60% (normal)	Hydrologic condition 2 20-40% (wet)	Hydrologic condition 1 0-20% (very wet)	Adult[1]	Smolt[2]	Spawn[3]	Incubate[4]
Jan	0.25	0.25	2.2	2.7	4.1	9/16	3.4	12.1	2.9
Feb	0.25	0.25	4.1	3.0	4.4	9/16	3.4	12.1	2.9
Mar	0.25	0.25	2.4	4.3	4.7	9/16	3.4	12.1	2.9
Apr	0.25	0.25	1.7	3.1	3.2	9/16	3.4	12.1	2.9
May	0.25	0.25	1.4	1.8	2.4		3.4	12.1	2.9
June	0.25	0.25	1.0	1.2	1.6				
Jul	0.25	0.25	0.8	1.0	1.1				
Aug	0.25	0.25	0.7	0.8	0.9				
Sep	0.25	0.25	0.6	0.7	0.7				
Oct	0.25	0.25	0.8	0.9	0.8				
Nov	0.25	0.25	1.1	1.2	1.2				
Dec	0.25	0.25	1.5	1.9	2.1	9/16		12.1	

[1] Provided in 0%-60% hydrologic conditions only.
[2] Smolt migration flows provided in 0-60% (hydrologic conditions 1-3), and for 3 consecutive days per week in March, April, and May in 60%-100% (hydrologic conditions 4 and 5).
[3] 80% of peak steelhead spawning WUA for 14-day period after any potential migration event in 0-60% hydrologic conditions; not provided in 60-100% hydrologic conditions.
[4] Provided in 0-60% hydrologic conditions for 60-day period following occurrence of last spawning flow or May 30, whichever occurs first; not provided in 60-100% hydrologic conditions.

Newell Creek Diversion

Operation of Loch Lomond Reservoir and the Newell Creek Diversion alters the natural hydrograph of Newell Creek except during periods when the reservoir is spilling. During non-spill periods flow reduction may impair the ability of adult fish to migrate upstream in the winter and for smolts to migrate downstream in the spring; limit the suitability of habitat for spawning, egg incubation, and juvenile rearing; reduce the productivity of benthic macro-invertebrates in the stream. There are generally not abrupt changes in flow since the creek is either influenced by the 1 cfs minimum release or the natural pattern of reservoir spill. The presence of Newell Creek Dam also prevents transport of sediment and LWD potentially impairing the recruitment of spawning gravels and LWD as a source of potential cover (Holley 2010). While these effects cannot be avoided or minimized, they can be mitigated under the non-flow conservation fund (Section 4.5) through programs such as gravel replenishment and LWD placement.

Management actions to replace spawning gravels may improve conditions but would not be naturally sustainable as the smaller gravels would be transported downstream and not replaced from upstream. Only a sustained effort to replace gravel could improve conditions indefinitely. Wherever possible bank protection measures should be restricted to allow lateral migration of the creek. Incised channels should be allowed to evolve into a more stable stage where the creek is free to erode banks and migrate within its floodplain, actively recruiting LWD. Management actions that include adding LWD to the stream could help to create scour pools where LWD recruitment is limited by riparian encroachment by development or immature vegetation. The most immediate and effective action to improve salmonid habitat is to stop removal of LWD in the channel. Evidence of large logs being removed from the channel can be seen in all reaches (Holley 2010).

Passage above Newell Dam is not part of the HCP because passage conditions downstream of the dam are marginal and, even if fish could routinely pass the bedrock chute identified as the current limit of anadromy, bathymetry studies of the reservoir indicate that anadromy likely historically ended at a very steep reach of channel that is now beneath the reservoir (located close to the dam). Thus, the reservoir does not impede passage to significant amounts of historic above-reservoir habitat.

Streamflows

Standard facility operations related to the City's water right for Newell Creek (license # 9847) include a year-round minimum release requirement of 1 cfs below Newell Creek Dam. During the fully appropriated season, the license requires that the greater of 1 cfs or the natural flow of Newell Creek must be released.

Restoration of flow in Newell Creek was given lower priority than Laguna Creek and the San Lorenzo River. The anadromous reach length is relatively short and habitat conditions in the majority of the anadromous reach are degraded due to close proximity of residential development on both sides of the creek (Chapter 2). Providing flow for migration and spawning would severely constrain storage in the reservoir and increase reliance on other diversions. Adult migration, spawning, incubation, and smolt migration bypass flows have not been specified for Newell Creek however flows sufficient for these uses occur during periods of reservoir spill. Existing agreements attached to the aforementioned water right specify a minimum bypass flow of 1 cfs at all times.

Hydrologic modeling indicates that the operation of the reservoir results in a slight reduction in median flows through the anadromous reach (compared to reservoir inflows) during the early part of the spring rearing period in wet, normal and dry years, and an augmentation of median flows during the latter part of the rearing period due to the 1 cfs minimum release (ENTRIX, Inc. 2004c). Flow augmentation is highest (begins earlier) in dry years, and lowest in wet years. During critical dry years, the 1 cfs release requirement augments the natural flow throughout the rearing period and essentially doubles the flow downstream of the dam relative to median reservoir inflow from July through October.

Since the 1 cfs minimum release is above unimpaired levels at certain times and in order to preserve storage in Loch Lomond Reservoir an exception minimum of 0.25 cfs would be instituted when storage is low enough to result in supply shortages (Table 4-5). PHABSIM model results indicate that the habitat suitability index for rearing steelhead at 0.25 cfs is 70% of the value at 1.0 cfs (HES 2014b). The City, in consultation with NMFS and CDFW, implemented a release of 0.2 cfs during recent drought conditions from February 2014 to February 2016 under a Temporary Urgency Change Petition with the State Water Resources Control Board. The 0.2 cfs flow level (68% of the habitat index at 1.0 cfs flow) provided reasonable habitat conditions during that period based on observations made by the City Water Department and reviewed by NMFS and CDFW (Chris Berry, personal communication to Jeff Hagar, 2014). Provision of a slightly higher flow during exception years in the future should ensure that this continues to be the case. Exception minimum flows would be provided when Loch Lomond Reservoir storage falls below the following storage conditions:

Table 4-5: Storage Conditions in Loch Lomond Reservoir Triggering Exception Minimum Flows

	Minimum storage for 1 cfs release (mg)	Percent of Capacity
Nov	1,500	53%
Dec	1,700	60%
Jan	2,000	70%
Feb	2,000	70%
Mar	2,000	70%
Apr	2,000	70%
May	2,000	70%
June	2,000	70%
Jul	1,800	64%
Aug	1,500	53%
Sep	1,500	53%
Oct	1,500	53%

In Confluence modeling results for the proposed Water Rights Project, exception minimum flows would be applied in portions of 9 years (27 out of 948 months or 3% of the time) during the 79-year model period. This compares with modeled existing demand and infrastructure with interim bypass flows (2018 tolling agreement flows before HCP agreed flows are in place) predicting exception minimum flows during 87 months (9% of the time) in portions of 16 years. Duration of exception minimum flows was between 1 and 5 months for the proposed project except for one model year (1977) with 12 months. Exception minimum flows are primarily imposed during October through April and are most frequent in December and January. The exception minimum flows would most likely be implemented in Newell Creek in years when there has been no spill. Adult migration and spawning are less likely to occur in the absence of higher flows that result from spill conditions and rearing abundances are therefore likely to be lower. Comparisons of actual habitat values that would occur under HCP flows are provided in Chapter 5. Model results show that, even with the exception minimum flows, the 1 cfs bypass flow requirement at Newell Creek Dam provides improved summer rearing habitat value as compared to no City diversion in all hydrologic year types (Chapter 5). The base hydrology (no diversion) shows 31 years with flow less than 0.33 cfs below Newell Creek Dam during portions of the June through October period (24% of the time during this period overall). The 1 cfs instream flow requirement also results in flow augmentation in the main stem San Lorenzo River downstream of Newell Creek, although the proportional increase is much smaller. A schedule of

instream flow targets to minimize effects of the Newell Creek Diversion under the HCP is presented in Table 4-6.

Water Temperature

Due to the presence of the reservoir, temperature in Lower Newell Creek below the dam is warmer than Upper Newell Creek during winter and spring and cooler in the summer by up to 4°C on average (Section 2.4.3.2). Warmer water in the spring can enhance salmonid growth rates if food resources are sufficient. The cooling influence in summer can extend downstream as far as the San Lorenzo River (City of Santa Cruz monitoring data, HES 2014b). Although the cooling influence in summer may depress growth rates, this effect would be strongest closest to the dam.

Reservoir spill can result in increased temperature downstream of the dam during periods when the reservoir surface temperature is high. The majority of spill occurs during or after precipitation events in the winter when Loch Lomond temperature is cool. The period when temperature effects are most likely is during the spring and early summer (May through July) when the lake surface is warming and there is still a potential for spill, at least in wetter years when storage is high. Potential effects on steelhead and coho can be avoided by ensuring that sufficient cool water is released through the fish release to blend with and moderate warm flows through the spillway (Measure WS-24).

Measures for avoiding and minimizing the effect of Loch Lomond Reservoir operations on habitat for Covered Species in Newell Creek include the following:

Measure WS-21: Provide 0.25 cfs minimum bypass flow for rearing juvenile steelhead in the anadromous reach of Newell Creek when Loch Lomond Reservoir storage is less than specified storage levels (Table 4-5).

Measure WS-22: Provide 1 cfs minimum bypass flow for rearing juvenile steelhead in the anadromous reach of Newell Creek at all other times.

Measure WS-23: During changes in bypass rates downstream of Newell Creek Dam, a ramping rate will be implemented to limit flow reductions in Newell Creek such that the change in stage is no greater than 0.16 feet per hour when fry may be present (January 15 through May 31) and no greater than 0.3 feet per hour at all other times.

Measure WS-24: At times when the Loch Lomond Reservoir is spilling during late spring and summer when surface temperatures in the reservoir are warmer and the cooler 1 cfs fish release below the dam (generally between 11°C and 14°C) may not be sufficient to maintain temperature in Newell

Creek below 21°C, which is within the suitable range for steelhead and coho salmon, the City will release additional flow through the fish release to achieve a maximum instantaneous temperature of less than 21°C as measured in the anadromous reach of Newell Creek and verified at the City stream gage in Newell Creek below the dam. The point of compliance for minimum bypass flows is the City maintained stream gauge in Newell Creek immediately downstream of Newell Creek Dam.

Table 4-6: Minimum Instream Flow Targets for Avoidance and Minimization of Effects on Steelhead Due to the Newell Creek Diversion

		Minimum Flow at Newell Creek below Dam (cfs)								
		Rearing Baseflow					Migration		Spawning	
	Exception Minimum	Hydrologic Condition 5 80-100% (driest)	Hydrologic Condition 4 60-80% (dry)	Hydrologic Condition 3 40-60% (normal)	Hydrologic Condition 2 20-40% (wet)	Hydrologic Condition 1 0-20% (very wet)	Adult	Smolt Migration	Spawn	Incubate
Jan	0.25	1.0	1.0	1.0	1.0	1.0				
Feb	0.25	1.0	1.0	1.0	1.0	1.0				
Mar	0.25	1.0	1.0	1.0	1.0	1.0				
Apr	0.25	1.0	1.0	1.0	1.0	1.0				
May	0.25	1.0	1.0	1.0	1.0	1.0				
June	0.25	1.0	1.0	1.0	1.0	1.0				
Jul	0.25	1.0	1.0	1.0	1.0	1.0				
Aug	0.25	1.0	1.0	1.0	1.0	1.0				
Sep	0.25	1.0	1.0	1.0	1.0	1.0				
Oct	0.25	1.0	1.0	1.0	1.0	1.0				
Nov	0.25	1.0	1.0	1.0	1.0	1.0				
Dec	0.25	1.0	1.0	1.0	1.0	1.0				

Felton Surface Water Diversion at San Lorenzo River

Operation of the Felton Diversion potentially influences sediment transport, fish passage, and streamflow in the San Lorenzo River. Constraints on operation of the Felton Diversion under existing agreements and planned upgrades avoid and minimize effects of this activity to migration, spawning, and rearing of Covered Species.

Sediment Transport

Sediment may collect behind the dam during periods when the dam is inflated and be released when the dam is deflated. The following measures are adapted from current SOPs for the dam and will result in minor alterations to storm hydrographs due to facility operations and avoid any potential effects on sediment transport:

Measure WS-25: Deflate dam during the first one or two rainstorms of the season to flush sediments and organic matter from the channel.

Measure WS-26: Deflate dam during high flows when the majority of sediment is being transported.

Fish Passage

Under the 1998 MOA with CDFW (Chapter 3), operations are managed to allow adult steelhead and coho to migrate upstream. Operations are based on streamflow conditions during winter months and include specific operational changes based on low, moderate, and high streamflow conditions as outlined below. The following measures maintain the provisions of the 1998 MOA but are altered to accommodate new winter bypass flows for adult migration and spawning.

Measure WS-27: During November 1 through March 31 when the mouth of the San Lorenzo River is open and streamflow is less than 40 cfs and the City is diverting water, the dam will be inflated to allow 20 cfs bypass flow through the fish ladder. During the same period, if the City is not diverting, the City will inflate small air bladders beneath the deflated dam or employ similar, comparable measures for the purpose of facilitating fish passage over or around the facility. If passage over the deflated dam is provided, the depth of flow within the zone of concentrated flow crossing the dam will be 8 inches or greater. Similarly, if passage is provided around the dam through the pumping channel, 8 inches of depth or greater will be provided.

Measure WS-28: During December 1 through April 30 when the mouth of the San Lorenzo River is open and streamflow is 40 cfs or more configure the dam to bypass 40 cfs with a minimum of 20 cfs through the fish ladder.

Measure WS-29: For moderate streamflow conditions, during November 1 through March 31 when the mouth of the San Lorenzo River is open and streamflows are between 40 and 200 cfs, the City will divert water by inflating the dam and allowing a minimum 40 cfs bypass flow. During these moderate streamflow conditions, the City will keep the dam deflated during the first one or two rainstorms to flush sediments and organic matter from the channel. During these conditions of winter operation, migrating fish can pass over the deflated dam.

Measure WS-30: In high streamflow conditions (exceeding 200 cfs) from November 1 through March 31, when the City is diverting, the dam will be inflated such that the fish ladder is operational. When streamflow exceeds approximately 300 cfs, the slide gate on the fish ladder will be opened approximately 8 inches to increase attraction flow to the ladder entrance. When streamflows have equaled or exceeded 300 cfs for five consecutive days and adult steelhead or salmon are observed holding downstream of the dam, on the following day the dam will be partially deflated and the slidegate closed in the evening and overnight. This allows the steelhead and salmon the opportunity to jump and swim over the partially deflated dam. When streamflows exceed 2,000 cfs the City will fully deflate the dam.

The Felton Diversion intake is screened and provides adequate average approach and sweeping velocities, although it does not meet all current NMFS criteria for screen openings, cleaning frequency and bypass systems (Borcalli and Associates 2001). The City operates under specific BMPs for fish ladder and fish screen maintenance (see Section 4.4.3.2) and those measures are incorporated here as well.

Measure WS-31: Inspect fish ladder 2-3 times per week and manually clean and remove debris as needed. Remove debris from site and dispose at approved waste disposal facility.

Measure WS-32: Inspect all fish screens regularly (daily) and manually clean and remove debris from screens and debris racks as needed.

Measure WS-33: Upon implementation of the proposed Santa Cruz Water Rights Project (as described in Section 6.2.1), the City will undertake a facility upgrade at the Felton Diversion. Planning for the facility upgrade will include a comprehensive evaluation of existing fish migration conditions at the facility and potential improvements for upstream and downstream migration of both juvenile and adult steelhead. Findings of this evaluation will be used to design state of the art fish passage

components that may include revisions to the pumping channel, the Denil fish ladder, or both. The evaluation will consider the potential for channel changes downstream of the diversion and revisions will be designed to accommodate possible channel changes. Any revisions based on these findings will be incorporated in the upgrade project. The upgrade will include screen replacement, continuous cleaning system, and juvenile passage modifications to meet current fish screen and fish passage criteria. The fish screen material will be replaced with either wedge wire with a 1.75 mm slot width or a perforated plate with 3/32" diameter perforations. A mechanical traveling brush system will be installed for continuous screen cleaning. The brush system will provide a 5-minute continuous cleaning cycle. A continuous bypass route will be installed so that out-migrants entrained in the intake structure can continue their movement downstream. Ladder upgrades to improve passage will be evaluated and incorporated as appropriate as well.

These measures will be incorporated into future operations of the Felton Diversion Dam and together with planned facility upgrades will fully avoid the effects of facility operation on migration of Covered Species.

Streamflows

Diversion of flow at the Felton Diversion Dam potentially influences migration, spawning, and rearing of Covered Species in downstream reaches. Current agreements specify diversion rates and bypass flows to minimize these potential effects. In addition, new bypass flows for adult migration and spawning have been adopted under the HCP based on recent information provided by Berry (2016).

Berry (2016), using the R2 approach (see Section 2.4.3.1 under Instream Habitat, Migration Barriers), estimated that a flow of 39 cfs appears to be a reasonable adult migration flow estimate for the San Lorenzo River below the Felton Diversion (Chapter 2). This estimate was vetted with NMFS and CDFW in meetings of the technical review team and it was decided that bypass flows for the Felton Diversion would be determined consistent with the other diversions (HCP Technical Team Draft Minutes, 12/13/2016; HCP Technical Team Meeting #5 Minutes 1/17/2017). Specifically, 40 cfs would be used as the adult migration minimum and would be provided whenever it would occur in the absence of the diversion. Optimum spawning flows are typically slightly below migration flows and are provided for two weeks following the most recent occurrence of migration flows. Rearing flows are usually on the order of about half of migration flow levels. These flows are generally consistent with data and recommendations provided in Ricker and Butler (1979) and HES (2014) (Chapter 2).

The 40 cfs bypass flow for adult migration (rounded up from 39 cfs) will be extended to provide for spawning for 14 days after potential passage events. The existing winter bypass flow of 20 cfs is half the recommended adult migration flow and is consistent with the proportional relationship between

optimum rearing flow and adult migration flow derived through PHABSIM studies in other streams (Section 2.4.3.1, HES 2014b). This bypass flow regime should also be protective of incubation and smolt migration based on these same results. A schedule of instream flow targets to minimize effects of the Felton Diversion under the HCP is presented in Table 4-7 and described as specific measures as follows.

Raising and lowering of the Felton Diversion Dam has the potential to result in stage changes in the San Lorenzo River downstream of the dam. The Dam may be raised or lowered at flows up to 2,000 cfs but must be fully deflated at flows above 2,000 cfs. The HCP has adopted criteria for levels of stage change at North Coast diversions that are protective of juvenile salmonid life stages based on review of the literature and standards developed by fisheries resource Agencies (Hagar 2014). The criteria call for change in stage no greater than 0.16 feet per hour when fry may be present (January 15 through May 31) and no greater than 0.3 feet per hour at all other times. However, the San Lorenzo River at Felton exhibits rapid changes in stream flow and stage under winter storm flow conditions that can exceed those criteria. The greatest changes in stage occur at flows over 2,000 cfs. Still, stage changes during storm flows less than 2,000 cfs, even without operation of the diversion dam, can exceed established criteria. For example, during the winter of 2016-2017 when the diversion dam was not operated and rainfall and streamflow was above normal, stage change during the ascending limb of the hydrograph (increasing flows) at flows less than 2,000 cfs peaked at 1.68 feet per hour during storm flows and exceeded 0.30 feet per hour on 195 occasions during 23 days between December and April (USGS streamflow monitoring data for the San Lorenzo River at Big Trees gage, located just downstream of the Felton Diversion). Stage declines ranged as high as -0.55 feet per hour during the descending limb of the hydrograph (decreasing flow) and exceeded -0.30 feet per hour on 42 occasions and exceeded -0.16 feet per hour on 178 occasions during 14 days between December and April. Stage decrease is more of a concern than stage increase for juvenile salmonids because of the potential to strand sensitive life-stages in areas of the channel margin that are relatively low-gradient, or where pockets or side channels exist in the stream channel.

Existing MOAs for operation of the Felton Diversion and new bypass flows for migration and spawning are incorporated into the following measures that fully avoid effects to Covered Species from diversion related flow changes below the Felton Diversion.

Measure WS-34: Do not divert at the Felton Diversion during June through August.

Measure WS-35: Provide 20 cfs minimum bypass flow for rearing and smolt migration during November 1 through May 31 in all hydrologic categories.

Measure WS-36: Provide 10 cfs minimum bypass flow during September and 25 cfs minimum bypass in October in all hydrologic categories.

Measure WS-37: Provide 40 cfs minimum bypass flow for adult migration in December through April whenever natural flow would occur at this level in the absence of a diversion.

Measure WS-38: Provide 40 cfs minimum bypass flow for spawning in December through April for 14 days after potential passage events (i.e. 40 cfs flow and mouth of the river is open).

Measure WS-39: The City will manage inflation and deflation of the Felton Diversion Dam to maintain stage increase of less than 1.68 feet per hour during deflation of the dam and stage decrease of no more than -0.55 feet per hour during inflation of the dam. This will be accomplished through manual operation of the dam bladders by a trained operator. Inflation and deflation of the dam in response to anticipated changes in the hydrograph from forecast storms will be planned in advance in consultation with staff hydrologists to minimize stage changes to the maximum extent practicable.

Table 4-7: Minimum Instream Flows for Avoidance and Minimization of Effects on Steelhead and Coho due to Operation of the Felton Diversion

	Minimum Flow below the Felton Diversion (cfs)								
	All Life Stages					Migration		Spawning	
	Hydrologic Condition 5 80-100% (driest)	Hydrologic Condition 4 60-80% (dry)	Hydrologic Condition 3 40-60% (normal)	Hydrologic Condition 2 20-40% (wet)	Hydrologic Condition 1 0-20% (very wet)	Adult[1]	Smolt Migration	Spawn[2]	Incubate
Jan	20	20	20	20	20	40		40	
Feb	20	20	20	20	20	40		40	
Mar	20	20	20	20	20	40		40	
Apr	20	20	20	20	20	40		40	
May	20	20	20	20	20			40	
June	No Diversion								
Jul									
Aug									
Sep	10	10	10	10	10				
Oct	25	25	25	25	25				
Nov	20	20	20	20	20				
Dec	20	20	20	20	20	40		40	

[1] Provided in all hydrologic conditions when mouth has been open and natural flow would occur at this level without diversion.
[2] Provided for 14 days following any potential migration event.

Tait Street Diversion and Wells

The primary potential effects on steelhead and coho from the Tait Street Diversion are related to deterioration of migration and rearing habitat from reduction instream flow. At most times, except when water quality is poor during storm runoff periods, the City relies on the full amount of the diversion authorization. It is assumed that maximum diversion rate capacity for the diversion, as modified under the proposed Santa Cruz Water Rights Project, will remain unchanged over the period of the HCP.

The Tait Street Diversion dam and screens also potentially influences fish passage though no issues with either delay of adult upstream migration, juvenile migration, or entrainment or impingement of juveniles have been noted.

The Tait Street diversion neither creates nor discharges sediments. In the reach of river where the facility is located, the predominant substrate is sand. During high flows, suspended sediments and bedload pass the facility relatively unobstructed. Some sand, entrained by the inflow to the pumps, settles in a chamber before the pumps and is later removed by suction to the parking lot. Water from this process is allowed to flow back to the river downstream of the diversion (Section 4.4.3.3).

Fish Passage

The Tait Street Diversion is a run-of-river facility without a ladder. Juvenile fish can currently swim through holes in the diversion dam. Migrating fish can swim past the intakes or over the dam in the main channel at moderate to high flows. At lower flows, a moderate jump is required to pass this facility (Jon Jankovitz, CDFW, personal communication to Chris Berry, 2020). Although no issues related to the intake fish screens have been identified, the City will undertake a facility upgrade at the Tait Street Diversion to meet current fish screen criteria during the term of the HCP.

Measure WS-40: Modify the Tait Street Diversion to prevent entrainment and impingement and provide bypass per criteria issued by NMFS and/or CDFW. This may include: screens aligned parallel to river flow and composed of either perforated plate with screen openings not exceeding 3/32 inches (2.38 mm), measured in diameter; profile bar with screen openings not exceeding 0.0689 inches (1.75 mm) in width; or woven wire with screen openings not exceeding 3/32 inches (2.38 mm), measured diagonally (e.g. 6-14 mesh). Screen material shall provide a minimum of 27% open area. The screen material shall be corrosion resistant and sufficiently durable to maintain a smooth and uniform surface with long-term use. Design features will also include: uniform flow across the screens; approach velocities not exceeding 0.33 f/s; sweeping velocities that exceed approach velocities; provision for appropriate juvenile bypass; and provision for continuous cleaning. Fish Screens shall be

automatically cleaned as frequently as necessary to prevent accumulation of debris. Open channel intakes shall include a trash rack in the screen facility design which shall be kept free of debris. In certain cases, a satisfactory profile bar screen design can substitute for a trash rack. The head differential to trigger screen cleaning for intermittent type systems shall be a maximum of 0.1 feet (0.03 m), unless otherwise agreed to by NMFS. It should be noted that, because the Tait Street Diversion currently has a "drum" type screen, the alternative CDFW/NOAA criteria for diversions under 40 cfs may apply. Final retrofit will be determined pending ongoing feasibility studies. Additionally, a feasibility analysis for horizontal wells, which also will prevent take of listed salmonids at this location, is also ongoing. Upgrades to improve passage will be evaluated and incorporated as appropriate.

In addition to this measure, the City operates under specific BMPs for fish ladder and fish screen maintenance (see Section 4.4.3.2). These measures, together with planned facility upgrades and bypass flow provisions, will avoid the effects of facility operation on migration of Covered Species.

Stream flows

Diversion of flow at the Tait Street Diversion potentially influences migration and rearing of Covered Species in downstream reaches. There is no suitable spawning habitat downstream of the Tait Street Diversion for either steelhead or coho. Rearing habitat is present for steelhead but is too warm for coho.

The San Lorenzo River is a high priority for restoration. It is a large watershed with extensive anadromous habitat (approximately 26 miles of anadromous habitat in the mainstem and 57 miles in the tributaries) (ENTRIX, Inc. 2004b). The San Lorenzo River supports steelhead and potentially supports coho. Although the lagoon is highly altered from pre-development conditions and the habitat is significantly degraded, it is still important for rearing juvenile steelhead (Chapter 2).

The strategy for streamflow restoration below Tait Street emphasized improving rearing conditions, particularly as inflow to the lagoon during the summer. This entails preserving storage in Loch Lomond Reservoir to support reduced summer diversions, particularly in drier years. As a result, winter bypasses for adult migration were more limited, also in part since ample opportunities for migration could still be achieved. A schedule of instream flow targets to minimize effects of the Tait Street Diversion under the HCP is presented in Table 4-8 and described as specific measures as follows.

Measure WS-41: Provide 8 cfs minimum bypass flow for rearing juvenile steelhead and lagoon inflows in the San Lorenzo River below the Tait Street diversion in dry and very dry hydrologic

conditions (Table 4-8) This is approximately 60% of the maximum habitat index for steelhead rearing in the reach (HES 2014b).

Measure WS-42: Provide up to 18 cfs minimum bypass flow for rearing juvenile steelhead in the San Lorenzo River below the Tait Street diversion and for inflow to the lagoon in normal, wet, and very wet hydrologic conditions (Table 4-8). This is approximately 80% of the maximum habitat index for steelhead rearing in the reach (HES 2014b).

Measure WS-43: Provide minimum bypass flows for adult migration downstream of Tait Street with a lower flow threshold of 17 cfs and an upper threshold is 25.2 cfs in December through March of dry and very dry years. Adult migration bypass flows are to be provided whenever flow would be at this level without City diversions and when storage in Loch Lomond Reservoir is sufficient (Table 4-8), otherwise provide bypass flow for 3 consecutive days per week or 5 consecutive days depending on Loch Lomond Reservoir storage levels (Table 4-8).

Measure WS-44: Provide minimum bypass flows for adult migration downstream of Tait Street with a lower flow threshold of 17 cfs and an upper threshold is 25.2 cfs in December through April of normal, wet, and very wet years whenever flow would be at this level without City diversions (Table 4-8).

Measure WS-45: Provide minimum smolt migration flows of 10 cfs during January through May in dry, normal, wet, and very wet hydrologic conditions, and for at least 3 consecutive days per week in very dry conditions during March through May (Table 4-8). If the City determines that conditions will require diversion of stored water from Loch Lomond Reservoir that cannot be offset by diversions at Felton, or from Liddell and Majors Creeks, the City may further reduce smolt outmigration requirements at the Tait Street Diversion provided that: (a) drought has been officially declared; and (b) this reduction in smolt outmigration opportunities will not reduce smolt migration more than one full day/week in the lower San Lorenzo River system or there is evidence from the San Lorenzo River or neighboring watersheds (i.e. Scott Creek) indicating that smolt migration is no longer occurring.

Measure WS-46: Implement a ramping rate during flow changes at the Tait Street Diversion to limit flow reductions such that change in stage is no greater than 0.16 feet per hour when fry may be present (January 15 through May 31) and no greater than 0.3 feet per hour at other times.

The point of compliance for these flows is the City maintained stream gage immediately downstream of the Tait Street Diversion. Tributaries contribute additional flow below the diversion though this contribution is limited, particularly in the dry season. These include Pogonip Creek, Branciforte Creek, Pasatiempo Creek, Arroyo de San Pedro Regaldo, and Ocean Villa Creek.

Table 4-8: Minimum Instream Flows for Avoidance and Minimization of Effects on Steelhead and Coho Due to Operation of the Tait Street Diversion

	Minimum Flow in the San Lorenzo River below Tait Street (cfs)								
	Rearing Baseflow					Migration		Spawning[1]	
	Hydrologic condition 5 80-100% (driest)	Hydrologic condition 4 60-80% (dry)	Hydrologic condition 3 40-60% (normal)	Hydrologic condition 2 20-40% (wet)	Hydrologic condition 1 0-20% (very wet)	Adult[2]	Smolt Migration[3]	Spawn	Incubate
Jan	8	8	15.8	16.4	17.5	17/25.2	10		
Feb	8	8	15.9	16.7	18.0	17/25.2	10		
Mar	8	8	16.3	17.3	18.2	17/25.2	10		
Apr	8	8	17.2	17.9	18.4	17/25.2[4]	10		
May	8	8	17.7	18.2	18.5		10		
Jun	8	8	16.6	18.1	18.5				
Jul	8	8	12.4	15.8	18.2				
Aug	8	8	9.8	11.9	16.4				
Sep	8	8	9.0	11.1	13.3				
Oct	8	8	9.8	11.4	13.3				
Nov	8	8	12.5	14.1	16.4				
Dec	8	8	15.1	16.2	17.6	17/25.2			

[1] No spawning occurs in this reach.
[2] Adult migration flows may be reduced to 3 consecutive days a week if storage levels in Loch Lomond Reservoir fall below the following levels (MG): Dec-1900 MG; Jan-2,000 MG; Feb-2,100 (MG); Mar-2,200 (MG). Further, adult migration flows may be reduced to 5 consecutive days after each storm event that exceeds 17 cfs if storage levels in Loch Lomond Reservoir fall below the following levels: Dec-1600 (MG); Jan-1700 (MG); Feb-1800 (MG); Mar-1900 (MG).

[3] During critically dry conditions (80%-100% Hydrologic condition) smolt outmigration flows shall be provided at least 3 days per week in March, April, and May. If additional water is determined to be required, the City may further reduce smolt outmigration requirements at the Tait Street Diversion provided that: (a) drought has been officially declared; and (b) this reduction in smolt outmigration opportunities will not reduce smolt migration more than one full day/week in the lower San Lorenzo River system or there is evidence from the San Lorenzo River or neighboring watersheds (i.e. Scott Creek) indicating that smolt migration is no longer occurring.

[4] April adult migration flows provided in hydrologic conditions 1-3.

4.4.2.2 Reservoir Operations

This section describes the overall approach to minimizing the effects of the City reservoir operations.

Chemical Algaecide Treatment of the Reservoir

Operation of Newell Reservoir has the potential to indirectly affect Covered Species habitat related to treatment of the reservoir with algaecide containing copper but is expected to have minimal effects. Monitoring of copper levels below the reservoir has shown that copper levels are in compliance with applicable limits of the State Water Resources Control Board Basin Plan. Reservoir releases are further diluted in the San Lorenzo River and by additional downstream tributaries, including the Zayante Creek and Branciforte Creek watersheds. The following measures are meant to avoid or minimize effects of this activity to negligible levels.

Measure WS-47: Avoid application of algaecide except when algae blooms occur. In the case where reservoir overflow cannot be prevented or is imminent, allow algae to bloom and do not apply copper-containing aquatic pesticides.

Measure WS-48: Minimize copper application through use of peroxide-based algaecides whenever possible and GPS-guided application.

Measure WS-49: Adhere to the Aquatic Pesticide Application Plan and algaecide label instructions.

Measure WS-50: Avoid release of treated surface water by application of algaecide at least 50 days before there is any potential for the Reservoir to spill (City of Santa Cruz Water Department 2005)

Measure WS-51: Lower the lake level prior to application of copper-containing aquatic pesticides if there is a risk of rain by drawing more water to the plant for treatment, releasing reservoir water from the deluge valve, and/or increasing release through the creek flow maintenance system.

Measure WS-52: Implement a monitoring program to assess the copper application, verify that application control goals are met, and to monitor copper discharges to Newell Creek through the fish water release.

Testing Deluge and Gate Valves

Testing of the deluge and gate valves on the dam can result in the discharge of approximately 100,000 gallons of moderate to low oxygen (1-6 ppm) at a range of 9-17˚C approximately) water to Newell Creek immediately below the dam. The following measures should reduce the potential for effects to negligible levels (below the threshold for take):

Measure WS-53: Do not release water warmer than 18 ˚C.

Measure WS-54: Release discharge into boulders/broken concrete below the dam to prevent scour of the streambed and provide aeration.

Measure WS-55: Monitor DO and turbidity levels just below the Newell Creek Dam road crossing to confirm aeration of released water and control of turbidity. Discontinue releases if DO levels are less than 5 mg/l. Also, increase in turbidity attributable to deluge valve discharges shall not exceed the following limits: 1. Where natural turbidity is between 0 and 50 Nephelometric Turbidity Units (NTU), increases shall not exceed 20 percent. 2. Where natural turbidity is between 50 and 100 NTU, increases shall not exceed 10 NTU. 3. Where natural turbidity is greater than 100 NTU, increases shall not exceed 10 percent.

Measure WS-56: Meter out releases so that changes in streamflow are minimized and the change in stage is no greater than 0.16 feet per hour when fry may be present (January 15 through May 31) and no greater than 0.3 feet per hour at other times. Record flows at the stream gaging station located several hundred feet downstream of the dam.

Measure WS-57: Conduct releases at times when lake coppering is not occurring, or otherwise ensure that releases do not have copper levels higher than that allowable by the Basin Plan.

Woody Debris Removal on Reservoir Face

The presence of Newell Creek Dam prevents the movement of woody debris to downstream reaches. Woody debris can be an important component of habitat for steelhead and coho. On average, there are 10 cubic yards of wood removed annually. Larger pieces are set aside for later use in instream restoration projects. Effects of this activity cannot be completely avoided but could be mitigated through projects that install large woody structures in downstream reaches, possibly in combination with gravel enhancement.

Measure WS-58: Continue the practice of reserving larger pieces of wood for use in restoration projects.

4.4.3 Water System Operations and Maintenance

This section describes the overall approach to minimizing the effects of the City's operations and maintenance activities related to water systems operations and maintenance. There are general measures in place that apply to work around water bodies and avoid or minimize effects to Covered Species and their habitats. These measures include:

Measure WO-1: Conduct activities outside of the wetted channel whenever feasible by timing work to the low flow season or by utilizing equipment or methods that do not require access in the channel.

Measure WO-2: Conduct activities during the low flow season (June through October) whenever possible.

Measure WO-3: Minimize sediment input into the channel by installing erosion control devices and fencing as appropriate.

Measure WO-4: Store construction materials outside of the stream channel area and cover loose soils and materials while stored.

Measure WO-5: Minimize disturbance to banks and riparian vegetation. Proactively restore impacted riparian vegetation with native species.

Measure WO-6: Minimize removal of overstory/canopy trees that provide shade to the stream channel or banks through marking trees to not be removed.

Measure WO-7: Limit management of vegetation that is stabilizing the stream banks to trimming and pruning.

Measure WO-8: Remove non-native vegetation where accessible and where removal would have demonstrable habitat benefits.

If work within the wetted channel cannot be avoided, the following measures will be implemented.

Measure WO-9: Isolate the work area and bypass flowing water around the work site.

Measure WO-10: Relocate fish from areas to be dewatered to nearby suitable habitat (see Measures WO-24 through WO-32 for fish relocation measures).

Measure WO-11: Remove any foreign materials from the channel before re-watering.

Measure WO-12: Minimize potential for hazardous spill from heavy equipment by not storing equipment in the channel and equipping vehicles with spill kits.

Measure WO-13: Refuel vehicles a minimum of 50 feet outside the channel.

Measure WO-14: Develop staff training manual for working in waterways and protecting water quality. The manual will describe applicable conservation measures, agency and permitting authorities, biological issues, and habitat types and for conducting work in waterways and for protecting water quality. This manual will be distributed to field staff and via the City's intranet system. Annual field training will accompany the manual.

These general measures apply whenever work is performed near water. Avoidance and minimization measures for specific activities conducted under Water System Operation and Maintenance are described in the following sections.

4.4.3.1 Water Diversion Sediment Management

Laguna, Reggiardo and Majors Creek diversions on the North Coast are concrete impoundments that can collect sediment and debris during storm flows. The Reggiardo impoundment has filled with sediment and is only minimally functional (Chapter 3). The City diversions do not create sediment, but sediment may accumulate behind the dams during storm flows and if the diversion is not properly operated this sediment may be passed downstream in a concentrated plug. These sediment plugs may impair habitat for production of benthic macro-invertebrates as a food source for Covered Species, and impair habitat for spawning, egg incubation, and juvenile rearing. Implementation of the following measures will avoid effects to steelhead or coho habitat in the North Coast streams.

Measure WO-15: Until completion of rehabilitation projects provided in WO-17, operate diversions to pass the bedload and suspended sediment through the impoundment on stormflows by opening a slide gate in the dam face during the ascending hydrograph and then closing it again on the receding limb. At the Liddell Spring Diversion crack the valve to allow sediment to

pass through without accumulating in the spring box and to allow transport of the peak of the hydrograph when necessary.

Measure WO-16: Remove any sediment that does collect behind the dams or in the Liddell Spring Box using hand tools, suction pumps, backhoes or vacuum equipment during the dry season (August – October) or in occasional emergency conditions in the winter time during low flow conditions. Remove sediment from site immediately or store it temporarily on site with appropriate sediment and turbidity containment.

Measure WO-17: Rehabilitate Majors Creek diversion to allow flow and sediment to move naturally down the stream channel during high flows and avoid any potential for "pulsing" of sediment to downstream habitat (Chapter 3).

4.4.3.2 Fish Ladder and Screen Maintenance

The only City facility with a fish ladder is the Felton Diversion on the San Lorenzo River.[46] If the ladder becomes clogged with debris it can impair migration of Covered Species. There are fish screens at each of the diversions. Design screen face velocities can be altered by accumulation of debris on the screens, increasing the potential for impingement of smaller fish. Damage to the screens or seals can result in entrainment of susceptible life stages into the diversion. Although no issues with impingement or entrainment of fish have been observed at any of these facilities, inspection and maintenance measures will ensure such effects are avoided or minimized.

Measure WO-18: Inspect fish ladder 2-3 times per week or daily during storm flows and manually clean and remove debris as needed. Remove debris from site and dispose at approved waste disposal facility.

Measure WO-19: Inspect all fish screens daily and manually clean and remove debris from screens and debris racks as needed.

4.4.3.3 Pipeline Operations

[46] Should the future rehabilitated Tait Street Diversion include a fish ladder, similar activities will also occur there.

Adequate operation of the water transmission lines requires system flushing and repairs and specialized operations, including pumping from clearwells to prevent sand accumulation and valve blow-offs to prevent breaks in the transmission lines.

Conveyance Pipeline System Inspection and Repairs

The City's two major raw water conveyance lines are the Newell Creek Conveyance Pipeline and the North Coast Conveyance Pipeline (Chapter 3). Discharges from leaks on these pipelines may cause erosion and turbid runoff to surface waters when located adjacent to waterways. Pipeline routes are regularly inspected for leaks and pipeline rights of way are maintained to allow for inspection of the pipeline. Repairs are conducted under the oversight of environmental monitors, and include relevant avoidance and minimization measures as provided in Section 4.4 and standard City SOPs (Appendix 10: *Pipeline Repair and Flushing Standard Operating Procedures*).

The potential for effects to steelhead and coho from pipeline maintenance and repair is very low. Major pipeline leaks are an isolated and infrequent occurrence. Construction practices and BMPs to minimize and avoid sediment discharge to water courses, and contain sediment and spills are expected to result in negligible effects of this activity to steelhead or coho (Measures WO-1 through WO-14, Section 4.4.3).

Finished Water Pipeline System Flushing and Repairs

The finished water pipeline distribution and conveyance system includes approximately 300 miles of pipeline in the water distribution area (Chapter 3). The distribution line must be kept clean of bacteria and contaminants and requires testing for hydrant capacity as well as pipeline repairs. As described in Chapter 5, flushing at high velocities can erode soil and cause instability, uproot vegetation and cause drainage problems. Chlorine is toxic to nitrifying bacteria and other aquatic life, including the Covered Species. Spikes of ammonia and nitrite result in gill damage in fish, which can cause respiratory failure and suffocation.

Three SOPs (SOP nos. 7102-01, 7102-02 and 7105-01) describe the procedures to be followed when flushing any part or portion of the distribution system for the reduction of impacts of potential chlorine and sediment discharges. The SOPs provide details on dechlorination and flushing procedures as well as follow-up water quality testing for turbidity, chlorine residual, temperature, and pH. In addition, the Department's coverage under the Statewide General NPDES Permit for planned and emergency Drinking Water System Discharges (order WQ 2014-0194) describes procedures for BMPs and monitoring to be followed when flushing and repairs

result in discharges to waters of the United States. Dechlorination is accomplished by addition of sodium sulfite tablets or ascorbic acid solution to the discharge flow. For main flushing, hydrant testing, or main dewatering through a blow off, a dechlorinating diffuser assembly is typically used. Additionally, Vactor trucks or flushing directly to the sewer line are used to prevent discharges when feasible. See Appendix 10: *Pipeline Repair and Flushing Standard Operating Procedures* for SOP details. See Appendix 12: *Drinking Water Discharge General NPDES Permit*.

Other measures may include preventing riparian erosion and hydromodification by implementing flow dissipation, erosion control, and hydromodification-prevention measures; and minimizing sediment discharge, turbidity, and color impacts by implementing sediment, turbidity, erosion, and color control measures.

Measure WO-20: Follow Stormwater SOPs, including SOP 7102-01 Superchlorinated Potable Water Discharges, SOP 7102-02 Low-Chlorine Potable Water Discharges, and SOP 7105-01 Sediment and Turbidity Control During Open Channel Water Discharges.

Measure WO-21: Follow Sediment Control for Open Water Channel Discharges – Water Department SOP #8300-01, including procedures for controlling sediment during main or service break repair activities and any other activities that involve open channel discharges to the storm drain system or receiving waters. This includes use of vacuum truck to eliminate discharge; filtration with pea gravel bags before discharge to storm drain; and overland filtration.

Pumping Well Return to San Lorenzo River

As described in Chapter 5, there is virtually no effect from this activity on Covered Species and no avoidance or minimization measures are required.

North Coast Valve Blow Off to San Lorenzo River

When pressure in the North Coast Pipeline threatens to rupture the line, water is discharged to the San Lorenzo River at the Coast Pump Station at the Tait Street Diversion (Chapter 3). The approximate amount of discharge during this operation ranges from 5-10 cfs. The water is discharged over rip-rap to the San Lorenzo River downstream of the intake. Recently installed pressure relief valves minimize the potential for this occurrence. There is very little potential for effects from this activity on Covered Species and no avoidance or minimization measures are required.

4.4.3.4 Dewatering of Creeks for Maintenance and Repairs

The City performs various types of instream work including, repair and maintenance of diversion facilities, sediment management, fish ladder and fish screen maintenance and repair, pipeline operations and maintenance, flood control and stormwater maintenance, vegetation management, and aquatic habitat management. During the course of instream work for various purposes (Chapter 3) it is often necessary to dewater up to 200 feet and otherwise disturb portions of stream channels. In order to minimize effects of these activities on aquatic species, including Covered Species, the City captures aquatic species in the project area and relocates them to suitable habitat outside the project area. The following measures will be implemented to minimize and avoid effects to Covered Species from these activities.

Measure WO-22: If work areas are to be de-watered, as many individuals of the Covered Species as possible will be captured and relocated prior to draining the site. The work area will be isolated with block nets and Covered Species will be captured, transported in buckets, and released in the most appropriate habitat (i.e., similar habitat conditions) immediately adjacent to the de-watered area. Methods will be determined based on the site conditions but may include electrofishing, dipnet, or seine. The number of individuals relocated will be estimated for each species prior to release. As the work site is de-watered, the remaining pools will be inspected for presence of Covered Species. Handling and holding time will be minimized to the maximum extent practicable.

Measure WO-23: Only NMFS-approved biologists will participate in activities associated with the capture, handling, and monitoring of Covered Species. The City will provide NMFS with the names and credentials of personnel proposed to conduct these activities for review and approval at least 15 days prior to the onset of the activities. No capture, handling, or monitoring activities will begin until NMFS notifies the City in writing that the biologist(s) is approved.

Measure WO-24: Prior to the onset of activities that result in disturbance of potential Covered Species habitat or individuals, a NMFS-approved biologist will conduct a training session for all construction personnel. At a minimum, the training will include: a description of the Covered Species and their' habitat; the importance of the species and their habitat; the general measures that are being implemented to conserve the species as they relate to the project; and the boundaries within which the project may be accomplished. Brochures, books, and briefings may be used in the training session.

Measure WO-25: A NMFS-approved biologist will monitor the work site until all removal of Covered Species, and habitat disturbance have been completed. After this time, the City will designate a person to monitor on-site compliance with all minimization measures. The approved biologist will ensure that this individual receives training in the identification of Covered Species and on the topics outlined above in Measure WO-26. The monitor and the approved biologist will have the authority to halt activities to avoid death or injury to individuals of the Covered Species. If work is stopped, the City will notify NMFS of the event within 48 hours.

Measure WO-26: If a work site is to be temporarily de-watered by pumping, intakes will be completely screened with wire mesh not larger than five millimeters (mm) to prevent Covered Species from entering the pump system. Water will be released or pumped downstream at an appropriate rate to maintain instream flows during construction. Upon completion of construction activities, any barriers to flow will be removed in a manner that would allow flow to resume with the least disturbance to the substrate.

Measure WO-27: If project activities could degrade water quality, the existing water quality parameters will be determined (e.g., temperature, DO, pH, and turbidity) prior to the onset of work. Water samples will be taken in a manner that minimizes disturbance, injury, or mortality of Covered Species. Results will be used to monitor water quality parameters during and after maintenance and sediment removal activities.

Measure WO-28: Work activities will be conducted between July 1 and October 31 to the maximum extent practicable. Should the City need to conduct activities outside this period, it will notify NMFS.

Measure WO-29: If the substrate of the natural stream channel is altered during work activities, it will be graded or otherwise restored to approximate natural conditions after the work is completed.

Measure WO-30: The number of access routes, number and size of staging areas, and the total area of the activity will be limited to the minimum necessary to achieve the project goal. Routes and boundaries will be clearly demarcated, and these areas will be outside of sensitive riparian and wetland areas.

Measure WO-31: To mitigate for the small residual effects of this activity, the City will incorporate habitat improvement features with any scheduled (non-emergency) instream repair work whenever feasible. This could be relatively efficient since there will likely be heavy equipment on site for the repair work and habitat features (e.g. LWD, boulder placement, or

additional riparian plantings beyond what is needed for bank stabilization) could be efficiently added. If installation of habitat features at the work site is judged to be impractical or not particularly beneficial, an offsite installation of similar dimensions will be installed elsewhere to achieve a 1:1 mitigation ratio.

4.4.4 Municipal Facility Operations and Maintenance

Municipal facility operations and maintenance activities include operation, rehabilitation, replacement, repair and maintenance of existing infrastructure and related facilities, flood control maintenance, stormwater maintenance, and vegetation management. This section describes the overall approach to minimizing the effects of the City's operations and maintenance activities related to municipal facilities.

4.4.4.1 Flood Control Maintenance

This section describes the overall approach to minimizing the effects of the City's flood control maintenance activities which are conducted to prevent flooding of city waterways and damage to public and private property. These activities can occur anywhere on City facilities and properties in the HCP Plan Area but are largely centered on the San Lorenzo River and Branciforte Creek FCC.

The major effect of the FCCs has been through extreme habitat alteration as a result of its construction. Given the scale of alteration through construction, maintenance has relatively contained effects. The City has worked with the Corps of Engineers to incorporate growth of limited riparian vegetation into the maintenance parameters for the FCC. Flood control maintenance includes debris/obstruction removal, sediment management/removal, and vegetation management (Chapter 3). The San Lorenzo River FCC has habitat components that support salmonid adult migration, smolt migration, and rearing. Sediment and vegetation management has the potential to alter this habitat to the detriment of salmonids. The Branciforte Creek FCC has structural components that likely impede adult salmonid migration and diminish suitability for smolt migration and juvenile rearing (bare concrete rectangular channel with minimal central low-flow channel). Accumulation of sediment in the Branciforte FCC can lead to development of minimal habitat features including riffle-pool sequences and colonization of cover producing vegetation. When sediment bars and vegetation are present, fish species including juvenile steelhead and lamprey, can occupy the habitat in low numbers and there is potential for improved conditions for migration (HES 2003b).

Debris/Obstruction Removal

Debris/obstruction removal has the potential to damage aquatic habitat and even cause direct injury or mortality to Covered Species. Removal of logs, root wads, and other large woody material removes potential habitat elements and can result in simplification of the habitat and loss of material that would have provided valuable cover. Instream work with heavy equipment may directly impact Covered Species if they are present in the area and contacted by machinery or moving objects.

The following measures, in addition to WO-1 through WO-14, will avoid and minimize effects of this activity.

Measure MF-1: Only remove material that creates a hazard to life, property, infrastructure, or public safety.

Measure MF-2: Involve a biologist with knowledge of Covered Species habitat needs as part of the team that evaluates need to remove materials and methods to be used. Have work overseen by environmental monitors and implement standard measures for instream work (See preceding).

Measure MF-3: Whenever possible leave natural habitat-forming material in the stream by moving it downstream of structures to be protected or cutting larger material into smaller segments that may float downstream in larger flows, as long as these segments retain habitat forming characteristics.

Measure MF-4: Allow retention of up to 3-foot square root wads in the channel every 500 feet for habitat value, provided there are no undesirable changes in channel hydraulics and provided such root wads do not show signs of developing into larger log jam structures in the future.

Flood Control Sediment Management/Removal

Accumulation of sediment in City waterways can provide habitat for benthic invertebrates and certain vertebrate species such as larval Pacific lamprey. Accumulated sediment also forms a matrix for establishment of rooted aquatic, emergent aquatic, and riparian vegetation including shrubs and trees. Together these features have the potential to create habitat suitable for Covered Species. Although this habitat is somewhat degraded and transient, its removal has the potential to effect Covered Species that are using it, both through removal of habitat and potential direct harm resulting from use of equipment for removal of vegetation and sediment.

Sediment removal in the FCCs is conducted in habitat that is degraded by construction of the channel. Few Covered Species are present in much of the area where sediment is to be removed. Sediment removal in the Branciforte FCC occurs annually, primarily in the lower part of the channel. Sediment accumulation in this reach forms limited amounts of low quality potential rearing habitat in a short section of the channel (HES 2014c). The potential habitat in the FCC represents an insignificant component of the total rearing habitat in the watershed. The 2004 Biological Opinion for sediment removal from the project concluded that the steelhead rearing capacity of Branciforte Creek was reduced with construction of the concrete FCC and remains reduced with ongoing channel maintenance activities (NMFS 2004). Branciforte Creek upstream of the concrete FCC provides 10.5 miles of salmonid spawning and rearing habitat and another 8 miles in three major tributaries. Salmonid spawning in Brancifote Creek occurs upstream of the FCC as does higher quality summer rearing habitat (NMFS 2004). The value of any habitat that forms in the FCC via sediment accumulation and establishment of vegetation is limited and much larger areas of higher value habitat exist in the Creek and San Lorenzo River watershed (NMFS 2004). Impacts to Covered Species potentially rearing in areas where sediment removal will occur will be minimized by capturing and relocating them prior to sediment removal activities (Section 4.4.3.1).

The FCC reach of Branciforte Creek also provides migration habitat for access to the rest of the watershed. Removal of sediment and vegetation has the potential to change migration conditions but only in the lower part of the FCC where it occurs. If the presence of sediment and vegetation improves conditions for migration in the lower part of the FCC migration would still be limited by conditions in the remaining, upper part of the FCC. In the Biological Opinion for FCC Maintenance, NMFS did not expect that the quality of adult steelhead migration habitat would be reduced as a result of sediment and vegetation removal activities (NMFS 2004). Presumably this finding would apply to coho as well.

The following measures are consistent with the City's ongoing management practices implemented in coordination with the Army Corps of Engineers. Implementation of these measures, in addition to WO-1 through WO-14, will avoid and minimize the effects of this activity.

Measure MF-5: Conduct sediment removal only as necessary to maintain and/or restore capacity of stormwater conveyance facilities or to prevent flood events; define sediment removal areas in the San Lorenzo River FCC by cross section and HEC-6 analysis.

Measure MF-6: Conduct a pre-project survey to define important salmonid habitat areas, including riffles, pools, and runs, and avoid sediment removal in these areas.

Measure MF-7: Conduct annual surveys to identify vegetation characteristics and sediment aggradation within the San Lorenzo River FCC between Highway 1 and Soquel Avenue, and in the Branciforte Creek FCC.

Measure MF-8: In the San Lorenzo River FCC maintain a 5-foot vegetation no-work buffer along both sides of the wetted channel where sediment removal activities will not occur.

Measure MF-9: In the San Lorenzo River FCC disk bars annually during dry season to loosen root materials and promote scour. Encourage existing cross-channel scour areas through disking and manipulation of discarded root wads/vegetation material.

Measure MF-10: Do not conduct sediment removal in San Lorenzo River FCC downstream of Laurel Street.

Vegetation Management

Under current management practices vegetation management focuses on trimming or removing riparian vegetation that may impede storm flows, result in bank erosion, or result in damage to property. Growth of riparian vegetation in the San Lorenzo River FCC is allowed as long as the Army Corps of Engineers requirements for channel capacity and roughness criteria are met. This has resulted in riparian vegetation, including overhanging willows and other shrubs and small trees to become established and provide rearing habitat for steelhead. Removal of aquatic and riparian vegetation has the potential to diminish habitat value for covered species and to directly harm Covered Species if work is conducted instream.

Measure MF-11: Do not remove mature riparian trees except in the San Lorenzo River FCC and Branciforte Creek FCC; riparian shrubs may be trimmed from ground level up to 6-8 feet in height. Remove cuttings from the work area and recycle as green waste at the landfill or chip and leave in place.

Measure MF-12: Avoid vegetation management in the wetted channel to the maximum extent practicable. For work in the wetted channel follow measures for in-channel work (WO-9 through WO-14).

Measure MF-13: Conduct vegetation management late in the dry season, preferably August.

Measure MF-14: Selectively remove riparian vegetation that could possibly undermine the stability of the levees or exceeds accepted Army Corps of Engineers' "Manning's n roughness coefficient" for the FCC. Retain a minimum 5-foot vegetated buffer on either side of the wetted channel.

Measure MF-15: In the reach from Highway 1 to Water St., allow 10-foot-wide strip of willow and alder along toe of levee. Willows allowed to grow to 3 inches dbh; alders allowed to grow to 6 inches dbh. Trim lower limbs of the alder trees to reduce flood impacts. Thin willows to favor providing overhanging cover to the low flow channel. Maintain a 5-foot buffer along wetted edges of channel, but thin groves and limb-up trees. Remove any trees in 5-foot buffer area that are greater than 6 inches dbh.

Measure MF-16: In the reach from Water St. to Laurel St. maintain a 10-foot-wide strip of woody riparian vegetation and tules and cattails on the west bank. Maintain east bank to keep trees overhanging water. Trees or branches that fall in the water may be left, cut into smaller pieces, or removed entirely if they cause an immediate safety hazard. Maintain sandbars to allow volunteer groves to establish but remove all trees greater than 6 inches dbh.

Measure MF-17: In the reach downstream of Laurel St. maintain a 5-foot-wide strip of willow, cattail and tule at the levee toe. Willows will be maintained with stem diameter of no greater than 0.5 inches and be limbed-up and periodically thinned to create defined groves.

4.4.4.2 Stormwater Maintenance

The City's Public Works Department maintains a system of drains, conduits, and pumps for the purpose of draining storm flows. The system can be a source of pollutants, increases peak storm flows in receiving waters, and minimizes percolation of rainfall into the ground.

City stormwater runoff mainly influences steelhead habitat in the San Lorenzo River Lagoon, and mainly during the winter months. During the winter months, steelhead are transient within the lagoon, with adults moving upstream from December through April and smolts moving downstream, primarily in April and May.

The City developed and is implementing a Stormwater Management Plan (SWMP) in compliance with the NPDES Phase II General Permit for Stormwater Discharges from Small Municipal Separate Storm Sewer Systems (MS4s) and for general reduction of pollutants in

urban runoff. The City has also developed implementation plans for TMDLs for pathogens (Fecal Indicator Bacteria, (FIBs)) and sediment in the San Lorenzo River Watershed. The SWMP[47] includes the following measures that avoid and minimize effects of stormwater discharges.

Measure MF-18: Continue to implement Municipal Operations/Pollution Prevention and Good Housekeeping Program to prevent pollutants generated by municipal operations and activities from entering the storm drain system by implementing measures to prevent or reduce pollutant runoff from municipal operations.

Measure MF-19: Continue Illicit Discharge Detection and Elimination Program is to detect and eliminate illicit connections and illegal discharges to the storm drain system from a variety of sources, including industrial facilities, commercial establishments, residential areas, and construction sites.

Measure MF-20: Continue Public Education Program to increase public awareness on urban runoff pollution issues, to educate the community about specific sources of pollutants and what people can do to reduce them, to foster participation through community-based projects or volunteer activities focused on pollution prevention, and to decrease the amount of illegal dumping and polluted urban runoff that is discharged into the storm drain system.

Measure MF-21: Continue "Construction Site Stormwater Runoff Control Program" to protect the City's storm drain system and receiving waters from pollutants that may be discharged as a result of construction activities, including clearing, grading, excavation, landscaping, building, and remodeling of existing buildings. Minimize land disturbance at all permitted construction sites, protect water quality from pollutants generated by construction activities, and require measures to be implemented at all permitted construction sites.

Measure MF-22: Continue Post-Construction Stormwater Management to ensure that new developments and remodeled sites are designed and constructed in a manner that minimizes the alteration of natural watercourses and drainage patterns, as well as alleviating the impact of new developments or remodeling projects on a site's and surrounding natural hydrology.

Measure MF-23: Continue the Industrial Facilities Program to reduce urban runoff pollution generated by industrial facility operations and activities and to ensure that industrial facilities

[47] http://www.cityofsantacruz.com/government/city-departments/public-works/stormwater/storm-water-management-plan

comply with the City's Stormwater Ordinance, mandatory measures, and Industrial Waste Discharge Permit requirements (as applicable).

Measure MF-24: Continue the Program Effectiveness Assessment and Improvement Plan to track annual and long-term effectiveness of the Stormwater Program at protecting water quality. Use results of the assessment to adaptively manage Stormwater Program by providing supporting documentation for proposed modifications.

Measure MF-25: Reduce pollutant loading from multiple City sources to the maximum extent practicable in the San Lorenzo River, San Lorenzo River Lagoon, Branciforte Creek and Carbonera Creek consistent with Implementation Plans for TMDLs for sediments and pathogens.[48]

Storm Drain Inspection and Cleaning

A variety of urban pollutants can flow to and accumulate in the storm drain system. These pollutants could ultimately be washed into receiving waters occupied by Covered Species. In response to this, the City implements an annual storm drain inspection and cleaning program, "Team Clean," to remove pollutants prior to them being transported by stormwaters (Chapter 3). The following elements of this program avoid and minimize effects of the storm drain system on Covered Species to the maximum extent practicable.

Measure MF-26: Use City developed GIS layer for storm drains to create preventative maintenance schedules for catch basins and inlets and maintenance tracking software system, CMMS Maintenance Connection, to help with scheduling and tracking inspections, cleanings, and upgrades of stormwater facilities.

Measure MF-27: Conduct CCTV camera inspections of storm drain lines as needed each year to help evaluate the condition of storm drain lines and identify repair needs.

Measure MF-28: Use Combination Sewer Cleaning unit[49] or similar appropriate tool and hand cleaning to clean storm drains. Plug lines at both ends and employ combination unit, using reclaimed water, to "hydro-jet" the line, and then vacuum the line to remove sediment and other

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[48] https://www.waterboards.ca.gov/rwqcb3/water_issues/programs/tmdl/docs/san_lorenzo/sediment/slr_sed_tmdl_proj_rpt.pdf
https://www.waterboards.ca.gov/rwqcb3/board_decisions/adopted_orders/2008/2008_0001_slr_path_tmdl_att_2_proj_rept_21mar08.pdf

[49] https://cdn2.hubspot.net/hubfs/6860826/FED12-Impact%20Brochure_1.20_WEB.pdf

material. Dispose of resulting sediment and other material at the Resource Recovery Facility (landfill) after dewatering at the Wastewater Treatment Plant.

Measure MF-29: Inspect sediment basins and clean known problem basins (basins that collect large amounts of sediment and trash) at least monthly or more frequently during wet season. Dispose of collected debris at the Resource Recovery Facility.

Measure MF-30: Inspect and clean intensive-use basins semi-annually using a combination unit. Clean monthly during September and October. Dispose of collected debris at the Resource Recovery Facility.

Measure MF-31: Inspect and clean commercial basins annually.

Measure MF-32: Inspect residential basins on an eight-year cycle and clean, as necessary.

Measure MF-33: Inspect pump stations along San Lorenzo River weekly and clean at least bi-annually and after large storm events.

Measure MF-34: Inspect large diameter stormwater pipelines (including inlets, culverts, bar racks, screens, and vaults) annually, and clean at least on a five-year cycle.

Measure MF-35: Inspect small diameter stormwater pipelines (including inlets, culverts, and vaults) on a two-year cycle, and clean as needed or on a fifteen-year cycle.

Structural Retrofits and Storm Drain Inlets and Basins

The City focuses on two types of structural controls to improve water quality associated with the storm drain system: dry-weather diversion systems to divert flow to the sanitary sewer for treatment at the Wastewater Treatment Facility and sewer replacement projects in the Beach Flats area in order to reduce inflow/infiltration, including installation of Tideflex valves on multiple storm drain outlets along the San Lorenzo River. The valves open to release storm drain water through gravity flow into the river and close to prevent high river levels from back-flowing into the storm drain lines (Chapter 3).

The overall effect of this activity is beneficial in that it improves water quality conditions, particularly in the Lower San Lorenzo River and Lagoon, during the summer when rearing steelhead may be present. There may be very limited potential for this activity to temporarily

adversely affect Covered Species during project construction. These effects can be avoided and minimized through implementation of Measures WO-1 through WO-14 (Section 4.4.3).

Sanitary Landfill Stormwater Management

As described in Chapter 5, operation of the Santa Cruz Landfill has no effect on Covered Species and no avoidance or minimization measures are required.

4.4.4.3 Emergency Operations and Response

Emergency operations are developed in response to specific emergency incidents such as storms, floods, fire, earthquakes, and hazardous spills. Response may include the use of heavy equipment near waterways and removal of debris and structures in waterways, placement of bank revetment, excavation of sediment which occludes valves and pipelines, patching and shoring of pipelines and related actions to preserve the functions of City infrastructure. Measures discussed under Water System Operations and Management and Municipal Facilities Operations and Management for these activities are applicable to emergency situations as well.

4.4.4.4 General Vegetation Management Within Riparian Corridors

The vast majority of vegetation management activities occur on land with only limited proximity to stream courses supporting steelhead or coho. For vegetation management in riparian areas refer to Measures WO-1 through WO-8. In addition, the following measures avoid and minimize the effects of this activity on Covered Species to the maximum extent practicable.

Measure MF-36: Trim vegetation using hand tools and maintain canopy, downed trees, and snags to the extent possible. Leave downed wood on the ground and lop only as required for fire safety or to facilitate moving downed wood off of roads and trails.

Measure MF-37: Remove non-native invasive plants through hand trimming and limited herbicide application according to the City's Integrated Pest Management Program.

4.4.5 Land Management

This section describes the overall approach to minimizing the effects of the City's land management activities.

4.4.5.1 Management of Loch Lomond Recreation Area and Watershed Lands

Activities associated with facility maintenance and management include facility repair, trail maintenance and management, trail construction, and road maintenance and decommissioning. These activities occur on all the open space properties owned by the City and in the Newell Creek and Zayante Creek watershed properties.

Trail Maintenance and Repair

City maintained trails can result in generation of sediments that find their way into watercourses inhabited by Covered Species. The City practices trail maintenance and management on open space and watershed lands to keep trails in good physical conditions and avoid mobilization of sediments. The following measures ensure that effects of this activity are fully avoided.

Measure LM-1: Restrict vehicle access during wet weather (except for emergency access); require use of ATVs for winter access.

Measure LM-2: Install drainage improvements such as culverts, dips, and bars; and realign trail segments to avoid sensitive habitats and steep slopes.

Measure LM-3: Remediate existing erosion areas on an annual basis.

Measure LM-4: Conduct ranger patrols to ensure appropriate use of trails and adherence to closures or restrictions. Remove unauthorized trails as resources permit.

4.4.5.2 Road Maintenance and Decommissioning

The City maintains roads on the watershed lands it manages. These roads potentially contribute increased sediment loads to water courses that may support Covered Species through erosion from road surfaces, slope failures, and culvert malfunction or failure. The following measures will be implemented to avoid and minimize effects of this activity on Covered Species.

Measure LM-5: Conduct all road work with the support of a Registered Professional Forester and Certified Erosion Control Specialist, with engineers also being involved on more difficult road projects (City of Santa Cruz 2010).

Measure LM-6: Use culverts: (1) to route drainages through the road prism; (2) where in-sloping has to be maintained to pick up bank seepage; or (3) to control drainage away from a landslide or road fill failure. Maintain culverts and trash racks; maintain proper energy dissipation at outlets; clear bank slough; conduct bank stabilization; and hand dig rolling dips and/or water bars as necessary to maintain appropriate drainage. Conduct culvert replacement or upgrades in July – September with hand tools and heavy equipment.

Measure LM-7: Maintain unpaved roads as out-sloped dirt roads, with rolling dips and/or water bars to manage drainage. Manage unpaved roads as "restricted use" roads that are not used in winter under saturated conditions. These roads may be rocked to reduce road surface sediment production, to improve access for patrols or emergencies, and to extend the season that the roads can be traveled.

Measure LM-8: Reshape forest roads periodically as needed to maintain out-slope drainage and as appropriate for the road and topography. Complete reshaping work within the existing road width and cut fill area for all forest road maintenance projects according to forest road best management practices and consistent with the California Forest Practice Rules to avoid additional disturbance to adjacent areas. Apply rock, straw, and seed to bare soil areas, as necessary.

Measure LM-9: Decommission roads that are not necessary for patrolling the properties for security and trespass concerns (off-road vehicles, poaching, camping, etc.); fire access, resource management and habitat restoration; and maintenance of drainage infrastructure. To the extent practicable, decommission roads that are significant sediment sources and that cannot be treated by maintenance activities (Chapter 3).

Measure LM-10: To the extent practicable, roads no longer required for Covered Activities in the Newell Creek and Zayante Creek watershed lands will be decommissioned. For roads traversing relatively mild slopes with few drainage structures (culverts), complete more severe out-slope or slope as close to natural grade as possible without generating excessive levels of disturbance. Construct frequent, large water bars where water may still concentrate on the road. For roads in steeper topography, remove all fill from the down slope portion of the road and place this material on top of the roadbed cut surface (keyway) and compact against the existing cut bank. Construct a severe out-slope to bring the contour to as close to natural grade as

possible. Restrict the area of disturbance associated with road decommissioning to the 14-16 foot width of the roadbed, plus an additional 15-20 feet for re-contouring of more benign roads, and 20-30 feet for the more difficult ones.

Measure LM-11: Install erosion control as necessary, including straw wattles, native duff, straw, jute netting, etc.

Measure LM-12: During road decommissioning, remove culverts by excavating the culvert fill with an excavator or backhoe, down to native grade, and removing the culvert. Restrict the area of disturbance associated with culvert removal to the 14-16 foot wide roadbed, plus the area to the outer edge of the fill (10-20 feet). Conduct additional work as needed for grade control and energy dissipation above and below the culvert removal site. Use gabion-sized rock to small rip-rap, or placement of large wood in the channel, as needed for channel stabilization upstream and/or downstream of the removed culvert. Restrict majority of channel adjustments from culvert removal to within 30-50 feet of the existing crossing.

Measure LM-13: Install erosion control measures for surface stabilization following culvert removal (straw, seed, straw rolls, blankets, etc.), and replant the disturbed area with native species, particularly conifer and riparian species.

Measure LM-14: Complete road decommissioning during June – September; select road segments that can be decommissioned, stabilized for erosion, and replanted with native species within one season. Conduct follow-up erosion control and further planting/care until the area is stabilized and growing.

4.4.5.3 Habitat Management

Habitat management includes resource management activities to improve, preserve and maintain existing sensitive habitats and species on City properties. Activities include habitat management and restoration, and public education.

<u>Aquatic Habitat Management and Restoration</u>

Aquatic habitat management protects and enhances habitat for Covered Species by adding or protecting fisheries habitat features, stabilizing stream bank erosion problems, and removing fish passage barriers. This results in a long-term beneficial effect on Covered Species. Short-term

effects related to project construction will be avoided and minimized through implementation of WO-1 through WO-14 and the following measures.

Measure LM-15: Obtain appropriate state and federal permits prior to doing the work.

Measure LM-16: Complete projects in accordance with methods detailed in the California Salmonid Stream Habitat Restoration Manual (Flossi et al. 1998).

Measure LM-17: Complete work during the summer/ fall period (and before October 15), when streamflows are lower and work conditions are dry to minimize soil disturbance and mobilization, and the critical spawning and smolting periods are over.

Measure LM-18: Retain services of geomorphologists and aquatic biologists as necessary to consult on projects for design and implementation. Conduct ongoing physical profiling and biological surveys of project sites post-implementation to demonstrate effectiveness and provide feedback for future projects.

Monitoring

Monitoring activities involve access to sensitive instream and riparian habitat and capture and handling of protected species. The following measures are intended to avoid and minimize potential effects on steelhead, coho, and their habitat from monitoring activities.

Measure LM-19: Perform all monitoring activities under the guidance and supervision of the HCP Administrator or Conservation Program Manager in compliance with a Monitoring Manual prepared by the Conservation Program Manager. All individuals performing monitoring will have qualifying knowledge and experience and will be trained in implementation of the Monitoring Manual.

Measure LM-20: The monitoring program will be conducted in coordination with NMFS and CDFW through regular meetings (one to two per year) of an HCP Technical Advisory Committee.

Measure LM-21: Monitoring will be conducted under applicable Section 10, Scientific Collector's Permit, or other required authorizations. Standard practices for minimizing effects to protected species will be implemented.

4.5 Non-flow Conservation Fund

The application of avoidance and minimization measures will eliminate the effects of many of the Covered Activities on Covered Species. Some residual effects are unavoidable, however, including diversion-related effects at most diversions, effects of sediment and vegetation management in the FCCs, and repairs conducted instream that involve dewatering. These effects are summarized in Table 5-1 and described in Chapter 5. To ensure that effects remaining after the implementation of avoidance and minimization measures are fully mitigated, the City will implement a compensatory mitigation program to fund enhancement and restoration of Covered Species habitat. This section describes the approach to compensate for the residual effects of Covered Activities through the funding of non-flow habitat improvement projects. Mitigation will focus on actions that improve salmonid habitat in the North Coast and San Lorenzo watersheds.

The mitigation program is designed to address key limiting factors in watersheds where Covered Activities take place. The mitigation program will prioritize measures that address the life-stage and/or location directly affected by a specific activity. In some cases, however, direct on-site conservation actions may be impracticable or of limited benefit to the species. As such, conservation actions funded may include areas outside the Plan Area or be focused on other life-stages than those directly affected by Covered Activities.

4.5.1 Program Need and Goals

4.5.1.1 Program Need

Adoption of bypass flows under the HCP minimizes and avoids many of the existing sources of potential incidental take related to City activities. Nevertheless, some residual effects to Covered Species remain after implementation of bypass flows. The NFCF will provide funding for restoration and enhancement projects that will fully mitigate for the effects of Covered Activities.

4.5.1.2 Program Goals

The goal of the NFCF is to mitigate for residual effects of Covered Activities after implementation of BMPs and avoidance and minimization measures previously outlined in the Plan. Because most other Covered Activities do not have residual effects on Covered Species,

once BMPs and avoidance and minimization measures are implemented, the NFCF analysis focuses primarily on water operations. The NFCF program has been designed to:

- engender collaboration between the City and NMFS to address new conservation issues and opportunities as they arise – maximizing the impact of funds from the NFCF;
- enable the City to work with NMFS to identify and implement projects that directly address residual effects to Covered Species, and also provide benefits to species habitat more generally and result in more resilient watersheds.
- create a program that balances administrative oversight and procedures for accountability with flexibility so that funding can be directed to projects that will provide the greatest conservation benefit.

4.5.2 Program Oversight and Decision-making

While implementation of the NFCF will require collaboration between the City and the agencies, the City will be responsible for implementing the program. The NFCF will be managed by the HCP Administrator.

The City will work with NMFS, CDFW, and an array of local partners (including private landowners) to develop a working list of potential NFCF projects. The City will propose projects from this list for approval by NMFS and CDFW. The City, NMFS, and CDFW will form a TAC to collaboratively develop the working NFCF project list, to review project concepts, and to provide design-level review of selected projects at key milestones (e.g. conceptual designs, 60% designs, etc.) during the planning process. Suggested projects can come from the agencies and others, including through a call for proposals. After review of potential project opportunities, the City will propose a project or suite of projects to NMFS and CDFW members of the TAC for approval. Projects that cannot garner support from both agencies will not be funded.

The TAC will use the following metrics to assess a given project for funding[50]:

- Does the project have the potential to benefit coho recovery as well as steelhead recovery?

[50] Projects may include actions that remediate adverse effects to habitat caused by third-party violations of natural resource laws. Recovery hatchery support will be prioritized as appropriate and in consultation with the TAC. Timing of projects is contingent upon TAC priorities and financial projections described in Chapter 7.

- Does the project address a known residual impact resulting from implementation of the HCP?
- Does the project address a known limiting factor (as articulated in the Coho Recovery Plan or Steelhead Recovery Plan) for the covered species?
- Does the project enhance watershed conditions that lead to ecological resilience and healthy aquatic environments?
- Does the project have landowner support and stakeholder support necessary to ensure implementation?
- Are there any known constraints (stakeholders, technical, etc.) that are likely to significantly impede the ability of this project to be completed?
- Do the costs, in terms of financial commitment from the NFCF, and benefits to covered species compare favorably to other potential project opportunities?
- Is the estimated timeline for design, permit and construction within a 1-3 year window based on expected complexity of the project?

Potential projects will be evaluated over a planning cycle of 5 years. The 5-year project list can be revisited, as needed, during the planning cycle to address changed conditions or new opportunities. The number of projects selected for funding through the NFCF will vary for each 5-year planning cycle based on the size and complexity of projects. It is expected that most projects funded through the NFCF will require a 1-3 year project timeline from initial planning to construction.

4.5.3 Quantifying and Linking Impacts and Benefits

Ideally, impacts can be translated into a transparent, meaningful, and accurate common spatial metric such as acres, linear feet, etc. to enable translation into adequate mitigation. Creating this common variable for this process is particularly complex in light of the fact that the residual impacts identified through the Plan (such as those resulting from ongoing water diversion) utilizes comparative metrics or metrics of "change" (e.g., relative passability) versus specific spatial metrics. While the comparative metric approach makes sense for understanding the relative effects of the City's water diversions and operations, it does not enable simple translation to an absolute quantity of residual impact on physical habitat features. Moreover, the temporal nature of the impacts (impacts appearing only in certain water years) and biological scope of the impacts (impacts affecting only a specific life history stage) further complicate the calculus of developing an absolute (versus relative) spatial metric. Without a clear precedent in the literature or template for translating these impacts into a common spatial metric, the "Ecological Portfolio Method" was developed to translate residual impacts into a hybrid

quantitative-qualitative mitigation metric (ecological portfolio) and then into a purely quantitative mitigation metric (dollars).

One of the most critical tasks for development of the NFCF has been creating a clear and direct link between the potential project types that could be funded and the specific residual impacts identified through the HCP. Table 4-9 displays this linkage by providing both a summary of the modeled residual impacts and a linked ecological portfolio of potential NFCF projects that would directly off-set these impacts. It is important to note that while the residual impacts are generally limited to a specific life history stage and/or water year type, many of the potential projects that would be implemented through the NFCF provide benefits across life history and water year types. An example of this might be placement of LWD structures to offset impacts to rearing in dry years. While these structures will provide deeper pools and pool tail-outs, which will increase summer rearing opportunities, if designed correctly they can also provide high flow refuge during wet winters and improve spawning opportunities through better substrate sorting.

Table 4-9 represents a conceptual approach for identifying the appropriate level of non-flow mitigation. The Ecological Portfolio concepts identified in this table for the purpose of estimating the financial size of the NFCF may or may not become the actual projects funded under the Plan. The actual projects selected for funding will be determined by the TAC based on restoration opportunities and priorities during Plan implementation. In Chapter 7, Table 7-3 sets out the schedule and cost allocation of the $8 million to fund twenty-two proposed projects over the thirty-year term of the Plan.

Table 4-9: NFCF Linkage between Residual Impacts and Ecological Portfolios[51]

	Residual Effect after Avoidance and Minimization			Possible Ecological Portfolios to Mitigate Residual Impacts		
Reach	***Steelhead***	***Coho[3]***	***Areal Extent***	***Action***	***Unit***	***Estimated Cost***
Laguna Anadromous	Small decrease in habitat suitability index (WUA) for spawning in normal (6% reduction) and wet (6% reduction) years	NA	1.4 mile anadromous reach with estimated 180 ft^2 of spawning gravel (2 square feet per 100 feet of stream) (ENTRIX, Inc. 2004)	Expand lower floodplain by 0.5 acres and complete Riparian corridor restoration along ~1.8 acres of SP property	2.3	$ 555,036
				Remove defunct bridge, abutments, and restore slope on Coast Rd (cost equivalent to small dam removal)	1	$ 151,650
	Moderate reduction in the habitat suitability index (WUA) for rearing by 16% in wet years and 6% in normal years	NA	1.4 mile anadromous reach	Install 14 anchored LWD structures in low 3/4 miles (~ every 200 ft)	14	$ 257,497
Liddell Anadromous	Decrease in number of days with suitable conditions for adult migration in normal (9% reduction to 86 days), dry (42% reduction to 23 days) and critical dry years (31% reduction to 9 days)	NA	1.2 mile anadromous reach	San Vicente Creek as a proxy for Liddell and Majors[1]		

[51] Residual effects due to reduced wetted habitat resulting from water diversion at stream cross sections is translated from left to right in the table above more broadly into areal extent of habitat impacts in the respective stream and then into compensatory actions in the ecological portfolio. Unit refers to the number of project elements (i.e. one bridge, 2.3 acres, etc.). Costs estimated from comparable projects that have been recently planned or completed and include permitting/administrative costs.

	Decrease in WUA for spawning in normal (10% reduction), dry (31% reduction) and critical dry years (38% reduction)	NA	1.2 mile anadromous reach with estimated 716 square feet of spawning gravel (11 square feet per 100 feet of stream)			
	Decrease in WUA for rearing in wet (20% reduction), normal (23% reduction), dry (40% reduction) and critical dry years (44% reduction)	NA	1.2 mile anadromous reach	Cost share with County of Santa Cruz Sanitation District and others in the effort to develop a new, more sustainable water source for Davenport, which would improve instream flows for Covered Species.	lump sum	$ 500,000
	Decrease in number of days with suitable conditions for smolt migration in normal (6% reduction to 141 days), dry (35% reduction to 99 days) and critical dry years (57% reduction to 61 days)	NA	1.2 mile anadromous reach	Remove or modify 2 Mill Creek dams for fish passage and develop a new back-up intake for Davenport that enables fish passage to ~0.5 mile of stream and add 10 unanchored LWD structure in Mill Cr to improve rearing and spawning.	2 & 10	$ 587,883
Majors Anadromous	Decrease in WUA for spawning in normal (5% reduction), dry (23% reduction) and critical dry years (17% reduction)	NA	0.7 mile anadromous reach with estimated 49 square feet of spawning gravel (1.3 square feet per 100 feet of stream)	Restore downstream floodplain/backwater, remove historic spoils, and reconnect to mainstem (~1 acre) to improve rearing conditions for both species.	1	$ 895,695
	Decrease in WUA for rearing in all year types (20% to 24% reduction)	NA	0.7 mile anadromous reach	Cost-Share continue Cape Ivy and Clematis eradication efforts for 5 years to reduce overall potential impacts to riparian corridor, shade, and future LWD recruitment.	lump sum	$ 250,000

	Decrease in number of days with suitable conditions for smolt migration by 3 days in dry years (12% reduction) and 1 day in critical dry years (11% reduction)	NA	0.7 mile anadromous reach			
	Residual Effect after Avoidance and Minimization			**Possible Ecological Portfolios to Mitigate Residual Impacts[2]**		
Reach	*Steelhead*	*Coho[3]*	*Areal Extent*	*Action*	*Unit*	*Estimated Cost*
San Lorenzo below the Tait Street Diversion[4]	Decrease in WUA for rearing in wet (9% reduction), normal (15% reduction), dry (16% reduction) and critical dry years (15% reduction)	NA	Up to 1.4 miles of riverine habitat, including 0.9 miles of FCC, depending on lagoon stage, and up to 1.5 miles of lagoon habitat	Create shade, scour and refugia for rearing in lagoon/tidal areas downstream of Laurel Street through installation of 10 dynamic anchored LWD clusters	10	$ 390,237
	Decrease in number of days with suitable conditions for adult migration in dry (8% reduction to 133 days) and critical dry years (28% reduction to 105 days)	Decrease in number of days with suitable conditions for adult migration in normal (11% reduction to 55 days), dry (20% reduction to 47 days) and critical dry years (32% reduction to 40 days)	Access to 25.8 miles of anadromous steelhead habitat in the mainstem and substantial additional miles in tributaries; up to 6 miles in the mainstem for coho and 20.8 in tributaries	Install 20 “notched” rock weirs, anchored LWD and/or off-set wood or rock structures to focus low flows, and improve conditions for resting and rearing, along ~1 mile between Tait Street and Water Street	20	$ 1,202,941

	Decrease in number of days with suitable conditions for smolt migration in critical dry years (28% reduction to 105 days)	Decrease in number of days with suitable conditions for smolt migration in critical dry years (28% reduction to 105 days)		Remove or modify 2 mainstem San Lorenzo River dams (Lewis & Barker) plus 1 tributary dam to improve movement throughout the system during dry years.	3	$ 682,425
San Lorenzo downstream of the Felton Diversion[5]	Flow reductions during early rearing period (April, May) in dry years (7.5% reduction)	Flow reductions during early rearing period (April, May) in dry years (7.5% reduction)	Up to 7 miles of riverine habitat down to Tait Street could be affected in dry years	Work with partners to identify, design, and implement 5 permanent instream flow improvement projects on the middle reach of the San Lorenzo River to increase instream flows during April, May and into the summer to improve rearing.	5	$ 500,000
Newell Anadromous[6]	Decrease in number of days with suitable conditions for adult migration in normal (15% reduction to 37 days), dry (44% reduction to 9 days) and critical dry years (76% reduction to 1 day)	Decrease in number of days with suitable conditions for adult migration in wet (21% reduction to 24 days), normal (38% reduction to 14 days), dry (52% reduction to 1 day) and critical dry years (67% reduction to 0 days)	About 1 mile of anadromous habitat	<u>Branciforte Creek as a Proxy for Newell Cr</u>		
				Remove Casa de Montgomery dams and develop a fish friendly replacement diversion to open up passage to 4-5 miles of anadromous stream.	2	$ 606,600

	Decrease in WUA for spawning in normal (9% reduction), dry (21% reduction) and critical dry years (34% reduction)	Decrease in WUA for spawning in dry (20% reduction) and critical dry years (42% reduction)	Total of 21 potential spawning locations with maximum 1095 square feet of useable habitat (24 sq. ft. per 100 ft. of stream)		Install 12 anchored LWD structures at appropriate locations to improve spawning gravel sorting and increase square footage of spawning by ~100 sf per site (1200 sf in total)	12	$ 220,712
					Remove 4 additional high and medium priority passage obstructions (all small) along Branciforte Cr to enable unimpeded passage	4	$ 210,804
	Decrease in number of days with suitable conditions for smolt migration in normal (13% reduction to 42 days), dry (35% reduction to 14 days) and critical dry years (80% reduction to 1 day)	Decrease in number of days with suitable conditions for smolt migration in normal (13% reduction to 42 days), dry (35% reduction to 14 days) and critical dry years (80% reduction to 1 day)	About 1 mile of anadromous habitat		Cost-share planning and implementation of passage improvement on upper 1/3 of FCC to enable access across a range of migration flows through the channel	flat fee	$ 1,000,000
						TOTAL	***$8,011,479***[7]

[1] A proxy is used to firstly, put conservation effort into streams that are higher recovery priorities and secondly, provide options for conservation work when those opportunities may be limited in the watershed where the residual biological effect occurs. Proxies are intended to be adjacent, similar watersheds when possible.

[2] Ecological Portfolios are designed as concepts and are not meant to be interpreted as prescriptive, NFCF projects will be determined by the TAC based on opportunities available and perceived benefits in real time.

[3] No residual effects on coho in Laguna Creek of 5% or more; no suitable habitat for coho in Liddell and Majors Creeks; no suitable rearing habitat for coho downstream of the Tait Street Diversion.

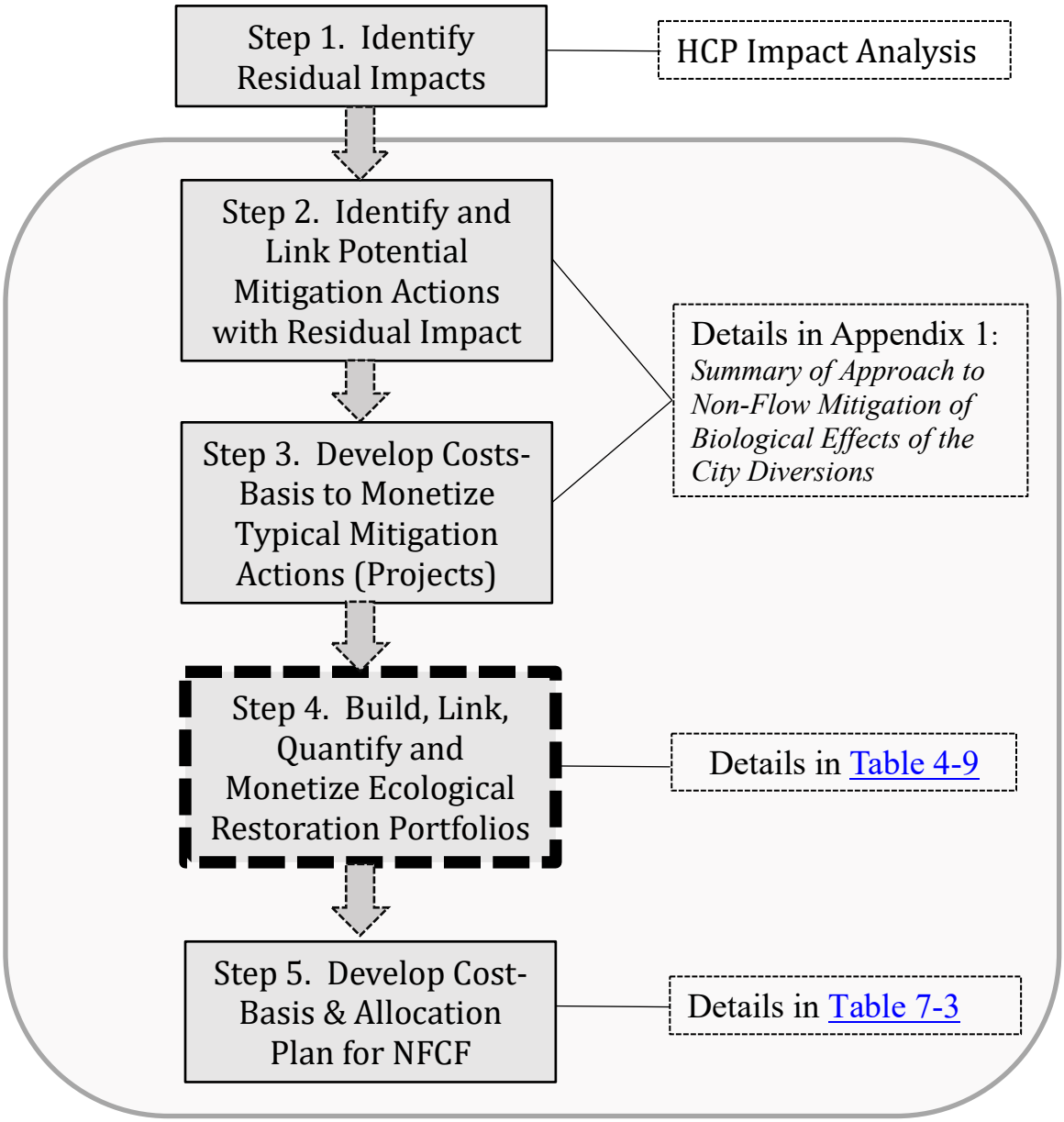
[4] Reductions in adult and smolt migration opportunities at this location may not translate into significant biological effects since there is still a substantial period when migration criteria are still met.

[5] Spawning and rearing values downstream of the Felton Diversion based on hydrology only.
[6] All residual effects largely determined by spill frequency.
[7] Includes administrative and permitting costs.

4.5.4 Developing the Process and Data to Support the NFCF

Figure 4-1 describes the 5-step process utilized to develop the NFCF, which starts with identifying residual impacts and culminates with a translation of appropriate mitigation into a quantitative metric – dollars. Appendix 1: *Summary of Approach to Non-Flow Mitigation of Biological Effects of the City Diversions* provides a series of tables that were used to support development of the NFCF. The two critical components that provide the foundation for the NFCF are the development of the ecological portfolios and the translation of the portfolios into dollars.

Figure 4-1: Flowchart for Quantifying and Monetizing Impacts and Mitigation through the Ecological Restoration Portfolio Approach



4.5.4.1 Developing Ecological Portfolios

Creating the portfolio requires identification of a suite of projects or actions that would directly mitigate for potential residual impacts. The portfolios were developed using a combination of

quantitative tools (e.g. relative size or location of the residual impacts) and qualitative tools. The qualitative tools are based on known site conditions, opportunities for meaningful improvement of conditions for fisheries, and professional judgement. While most of the portfolios are focused on directly mitigating residual impacts in the impacted reaches, for Newell Creek the mitigation could occur in Branciforte Creek, and for Liddell Creek and Majors Creek, the mitigation would occur in San Vicente Creek. These particular streams were used as proxies for the impacted reaches because (a) the level of potential residual impact resulting from implementation of the HCP in Newell Creek makes it a more difficult stream for implementing meaningful mitigation actions and (b) higher priority recovery streams exist in nearby watersheds that may provide greater mitigation opportunities and benefits for both coho and steelhead. The replacement portfolio streams either currently support steelhead and coho (San Vicente Creek) or support steelhead and are a priority for coho recovery (Branciforte Creek).

It is critical to emphasize that these portfolios were designed to enable a realistic quantification and monetization of mitigation costs and they were not designed to be prescriptive as to exactly what mitigation should be implemented with the NFCF funding. While the projects within each portfolio have been identified based on the residual impacts, local conditions, and known limiting factors, they do not take into consideration a number of critical externalities (e.g. flood management, access, ownership, recovery priority, etc.) that could affect the ability or the desire to implement a given conservation project.

4.5.4.2 Translating Ecological Portfolios into Dollars

Development of locally appropriate costs for implementing the ecological portfolios is a critical step for monetizing each portfolio in 2018 dollars. While there are a number of sources in the literature that provide ranges of costs for an array of restoration practices, this effort focused on using locally and regionally available data from 15 years of the Integrated Watershed Restoration Program (IWRP). Finally, in situations where IWRP data was not available, the database has been completed with additional data compiled through (a) personal communication with local experts; (b) professional experience; and (c) consulting and cross-referencing with NOAA's 2008 Technical Memorandum Habitat Restoration Cost References for Salmon Recovery Planning by Thomson and Pinkerton. Appendix 1: *Summary of Approach to Non-Flow Mitigation of Biological Effects of the City Diversions* contains tables with known costs and an average cost-basis for a suite of restoration actions that could be implemented as part of the NFCF.

5.0 ASSESSMENT OF EFFECTS AND LEVEL OF TAKE

The ESA requires that an HCP provide an estimate of the effects anticipated to result from the proposed covered activities. This chapter provides an estimate of the effects anticipated to occur to steelhead and coho from implementation of the conservation strategy and the Covered Activities. Effects were evaluated in the context of existing habitat conditions and conditions expected over the life of the Plan under changing climate scenarios.

Incidental take is estimated in terms of numbers of individuals for activities that potentially result in direct take of steelhead or coho life-stages and where there is an estimate of abundance for relevant life-stages and a rational basis for estimating potential effects. An example of such a situation would be related to the monitoring program which proposes seining surveys in the San Lorenzo and Laguna Creek lagoons. It is possible to estimate average or maximum numbers that may be caught and to assume an average mortality rate related to this activity. Other activities where this approach may be appropriate include such activities as sediment removal in the flood-control channel where the work area is dewatered and fish are relocated.

Incidental take can be quantified in a number ways, such as numbers of affected individuals, nesting groups, or a surrogate measure like acres of habitat or stream miles. Numbers of individuals, nesting territories, breeding pairs, etc. often come to mind first, but it is not always practical to survey and count affected wildlife populations directly. More often we use a surrogate measure, such as acres of habitat or a measurable ecological condition that we define and use to express incidental take authorized by a permit (USFWS and NMFS 2016). The majority of potential effects of the City's activities involve modification of stream flows below diversion facilities. Take related to this activity is indirect and, in many cases temporary or transient. For example, reduction of flow during the rearing period in dry years may hypothetically result in lower feeding rates at certain times and locations, reduced growth rates, and increased risk of predation due to smaller size at ocean entry. None of these hypothetical processes is sufficiently understood or quantified to provide meaningful estimation of take. It is possible to provide quantitative estimates for changes in length of potential migration periods and changes in habitat quantity/quality for spawning and rearing (WUA) but there is not, at this time, a rationally defensible method to convert these metrics into numbers of fish. The best scientific and commercial data available are not sufficient to enable the City to estimate a specific amount of incidental take of CCC steelhead or CCC coho related to operation of the diversion facilities. Therefore, the habitat conditions (expressed as WUA for spawning or rearing and migration days) for various steelhead and coho life stages that would result from implementation of the HCP shall serve as an ecological surrogate for the anticipated amount of incidental take associated with the ongoing operation of the City's diversions.

The bypass flows adopted as part of the avoidance and minimization measures for the diversion activities are still expected to have an associated level of incidental take, which will be fully offset through compensatory mitigation. The Conservation Strategy (Chapter 4), was developed in close coordination with the National Marine Fisheries Service and the California Department of Fish and Wildlife, and it is anticipated that implementation of the avoidance, minimization and mitigation measures in the Conservation Strategy will contribute to the conservation of the Covered Species.

5.1 Effects of Covered Activities

5.1.1 Steelhead

Activities with residual effects to steelhead after implementation of the Covered Activities and the conservation strategy are summarized in Table 5-1. Residual effects from the Covered Activities are largely confined to habitat effects downstream of diversions, primarily in Liddell Creek and Majors Creek in dry and critically dry years; downstream of the Tait Street diversion in critically dry years; habitat effects in Newell Creek; effects of capture and relocation during instream projects; and monitoring. Residual effects are quantified in Section 5.2.

Table 5-1: City Activities, Avoidance and Minimization Measures, and Remaining Effects to be Mitigated for Steelhead. Remaining Effects are Relative to No City Diversion

City Activity	Potential Effect	Avoidance and Minimization Measures	Residual Effects to be Mitigated in NFCF
Water Supply Operations: Water Diversions			
Liddell Spring Diversion	• Flow reduction	• Implement minimum stream-flow targets • Implement ramping rates	• Reduction in average adult migration days in dry and critically dry years by up to 42% (17 days) in dry years and 40% (6 days) in critically dry years • Reduction in average spawning habitat index by up to 30% in dry years and 38% in critically dry years • Reduction in average summer rearing habitat index by up to 44% in critically dry years and 40% in dry years • Reduction in average smolt migration days by up to 56% in critically dry years (79 days) and 35% in dry years (53 days)
Laguna/Reggiardo Creek Diversion	• Flow reduction	• Implement minimum stream-flow targets • Implement ramping rates	• Slight reduction in spawning habitat index in wet and normal years (6%) • Up to 17% average reduction in rearing habitat index in wet years; 2% or less reduction in dry and critically dry years
	• Lagoon water quality	• Implement minimum stream-flow targets	• None

Majors Creek Diversion	• Flow reduction	• Implement minimum stream-flow targets • Implement ramping rates	• Reduction in average spawning habitat index by 3% in wet years up to 24% in critically dry years • Reduction in average rearing habitat index by 21% to 24% • Reduction in average smolt migration days up to 14.5% (3 days) in dry years
Newell Creek Diversion	• Flow reduction	• Existing instream flow requirements • Implement ramping rates	• Reduction in average adult migration index by 35% in dry years; and 89 % (from 5 days to 1 day) in critically dry years • Reduction in average spawning habitat index by 16% in dry years up to 34% in critically dry years • Net positive effect on rearing habitat index with up to 7% reduction in spring of normal years but 8.5 % increase in critically dry springs and increase in summer by 13%, 27%, and 33% in normal, dry, and critically dry years respectively • Reduction in smolt migration index by 23% in dry years (21 days to 14 days) and by 80% in critically dry years (from 5 days to 1 day)
	• Temperature effects	• Maintain temperature below 21° during warm spill	• None
Felton Surface Water Diversion at San Lorenzo River	• Flow reduction	• Existing instream flow requirements • Implement ramping rates	• Reduction in average spawning habitat index by 3% in dry years and 6% in critically dry years • Maximum 1.3% reduction in average rearing habitat index
	• Sedimentation	• Existing operating agreements	• None
	• Fish Passage at diversion	• Existing operating	• None

		agreements, BMPs, and SOPs • Install fish screen and passage upgrades	
Tait Street Diversion and Wells	• Flow reduction	• Implement minimum stream-flow targets • Implement ramping rates	• Reduction in average adult steelhead migration in critically dry years of 13% (18 days) • Up to 16% reduction in rearing habitat index during summer of dry and normal years • Reduction in average smolt migration days in critically dry years by 8.5% (13 days)
	• Lagoon water quality	• Implement minimum stream-flow targets	• Average reduction in summer lagoon inflow by up to 42% in dry years
	• Fish Passage	• Install fish screen and passage upgrades	• None

City Activity	Potential Effect	Avoidance and Minimization Measures	Residual Effects to be Mitigated in NFCF
Water Supply Operations: Reservoir Operations			
Chemical Algaecide Treatment of Reservoir	• Copper Toxicity	• Follow label instructions • Aquatic Pesticide Application Plan • Treatment SOPs and BMPs • Adherence to SWRCB NPDES permit • Monitoring plan in place	• In compliance with Basin Plan, negligible effect
Testing Deluge and Gate Valves	• Low dissolved oxygen • Erosion	• SOPs and BMPs including: Aeration at release point • Erosion control measures	• None
Woody Debris Removal on Reservoir Face	• Eliminate downstream recruitment	• Stockpile larger pieces for habitat restoration projects	• Average annual loss of 10 cubic yards woody debris

City Activity	Potential Effect	Avoidance and Minimization Measures	Residual Effects to be Mitigated in NFCF
Water System Operations and Maintenance			
Water Diversion Sediment Management (North Coast)	• Sedimentation of downstream habitat	• Sediment removal BMPs and SOPs • Install sediment management upgrades	None
Fish Ladder and Screen Maintenance	• None	• Fish screen upgrades	None
Conveyance Pipeline System Inspection and Repairs	• Turbidity and sedimentation of downstream habitat	• Construction SOPs and BMPs	None
Finished Water Pipeline System Flushing and Repairs	• Disinfection toxicity (chlorine) • Turbidity	• Dechlorination • SOP Nos. 7102-01 and 7102-02 • Supervision by environmental monitor	None
Pumping Well Return to San Lorenzo River	• Turbidity and sedimentation	• Discharge to decanting basin	None
North Coast Valve Blow Off to San Lorenzo River	• Turbidity and sedimentation	• Discharge onto rip-rap	None
Dewatering of Creeks for Maintenance and Repairs	• Injury or mortality to fish as a result of relocation activities	• SOPs for dewatering and fish relocation	Temporary dewatering with capture and relocation of up to 600 steelhead with incidental mortality of 18 steelhead

City Activity	Potential Effect	Avoidance and Minimization Measures	Residual Effects to be Mitigated in NFCF
Municipal Facility Operations and Maintenance			
Flood Control Debris/Obstruction Removal	• Habitat simplification	• Supervision by environmental monitor • BMPs and SOPs for streamside projects	• Some loss of habitat structural elements, mostly in lagoon
Flood Control Sediment Management/Removal	• Temporary habitat disruption, Turbidity, Direct mortality	• Fish removal and protection during operations. • SOPs for dewatering and fish relocation. • Preventive maintenance for storm drains	• Sediment removal without dewatering in San Lorenzo main channel. • Relocation of 62 steelhead with incidental mortality of 2 steelhead during each of six events in the Branciforte FCC (every 5 years)
Flood Control Vegetation Management	• Loss of habitat components-cover, shading; increased temperature; reduced productivity	• Avoid work in wetted channel • Avoid removal of mature trees except in FCCs • Buffer strips in FCC	• Minor degradation of riparian habitat
Stormwater Maintenance	• Discharge of pollutants • Increased peak storm flows • Reduced infiltration to ground	• SWMP, Measure E, Stormwater BMPs • Storm drain inspection and cleaning • Structural retrofits and storm drain inlets and basins	• None

Stormwater BMPs	• Discharge of pollutants	• Stormwater Management Program • Stormwater BMPs	• None
Storm Drain Inspection and Cleaning	• Discharge of pollutants	• Storm drain inspection and cleaning	• None
Structural Retrofits of Storm Drain Inlets and Basins	• Discharge of pollutants	• Dry weather diversion to WTP • Inline treatment systems	• None
Sanitary Landfill Stormwater Management	• Discharge of pollutants	• Bypass system and stormwater outfall • Sediment management of bypass ponds • Leachate management	• None
Emergency Operations and Response	• Negligible potential effects on anadromous fish		• None
Vegetation Management Within Riparian Corridors	• Negligible potential effects on anadromous fish	• Integrated Pest Management program	• None

City Activity	Potential Effect	Avoidance and Minimization Measures	Residual Effects to be Mitigated in NFCF
		Land Management	
Loch Lomond Recreation Area and Watershed Lands	• Negligible potential effects on anadromous fish	• BMPs for work near streams	• None
Trail Maintenance and Repair	• Negligible potential effects on anadromous fish	• BMPs for work near streams	• None
Road Maintenance and Decommissioning	• Sediment delivery	• Work in dry season • Work supported by Certified Erosion Control Specialist • Maintenance of appropriate drainage to avoid erosion potential • Out-sloping, rolling dips, water bars, winter closures, rocking • Road decommissioning • Conduct timber harvest solely for restoration or forest resiliency purposes	• None

Aquatic Habitat Management	• Temporary habitat disturbance • Fish relocation	• Work under permit conditions • BMPs and SOPs for work near streams • Work conducted during dry season with SOPs and BMPs for in-channel work • Post-project monitoring	• Beneficial effects of habitat improvement • Temporary dewatering with capture and relocation of up to 4,500 steelhead over term of HCP with incidental mortality of up to 150 steelhead

City Activity	Potential Effect	Avoidance and Minimization Measures	Residual Effects to be Mitigated in NFCF
HCP Monitoring Program			
Compliance Monitoring	• No potential effects on anadromous fish	• None needed	• None
Juvenile Abundance – Riverine	• Potential effects from capture by electrofishing, examination, holding, tagging	• Standard fish sampling protection measures	• Observation of up to 1,500 juvenile steelhead, 5 adult steelhead annually in snorkel surveys • Capture and tagging of up to 2,000 juvenile steelhead annually in electrofishing surveys with incidental mortality of up to 60 steelhead
Juvenile Abundance – Lagoons	• Potential effects from capture by seine, examination, holding, tagging	• Standard fish sampling protection measures	• Capture and tagging of up to 12,700 juvenile steelhead annually in lagoon abundance surveys with incidental mortality of up to 254 steelhead
Adult Abundance	• Potential effects from capture in the Felton Diversion fish trap, holding, examination, tagging	• Standard fish sampling protection measures	• Capture and tagging of up to 3,000 adult steelhead with incidental mortality of up to 30 adult steelhead
PIT Tag Monitoring Antenna	• No potential effects	• None needed	• None
Habitat Assessment	• No potential effects	• None needed	• None

5.1.2 Coho

Residual effects of Covered Activities that could occur to coho, after application of avoidance and mitigation measures, are summarized in Table 5-8. Coho do not currently maintain viable, self-sustaining populations in the Plan Area. However, to inform the goals and objectives that are designed to provide conditions that would support the reestablishment of coho populations in the Plan Area, effects on coho are described hypothetically and are dependent on re-establishment of coho in the Plan Area. Potential residual effects are limited to habitat effects downstream of the Tait Street diversion in critically dry years, habitat effects in Newell Creek, effects of capture and relocation during instream projects, and monitoring. Residual effects are quantified in Section 5.2.

Table 5-2: City Activities, Avoidance and Minimization Measures, and Remaining Effects to be Mitigated for Coho. Remaining Effects are Relative to No City Diversion

City Activity	Potential Effect	Avoidance and Minimization Measures	Residual Effects to be Mitigated in NFCF
Water Supply Operations: Water Diversions			
Liddell Spring Diversion	• N/A Liddell Creek is not considered coho habitat		• None
Laguna/Reggiardo Creek Diversion	• Flow reduction	• Implement minimum stream-flow targets • Implement ramping rates	• Reduction in average spawning index of up to 2% in normal years • Less than 1 day average reduction in smolt migration index in all year types
	• Lagoon not considered coho habitat	• Implement minimum stream-flow targets	• None
Majors Creek Diversion	• N/A Majors Creek is not considered coho habitat		• None
Newell Creek Diversion	• Flow reduction	• Existing instream flow requirements • Implement ramping rates	• Reduction by 2-4 days annually in average adult migration index: 3 days in normal years; from 3.5 days to 1.2 days in dry years; and from 2 days to 0 days (100%) in critically dry years • Reduction in average spawning habitat index by 15% in dry years and 36% in critically dry years • Increase in average rearing habitat index in critically dry spring by 2%; increase in summer by 3%, 5%, and 7%

			in normal, dry, and critically dry years respectively • Reduction in smolt migration index by 23% in dry years (21 days to 13.5) and by 80% in critically dry years (from 5 days to 1 day)
Felton Surface Water Diversion at San Lorenzo River	• Flow reduction	• Existing instream flow requirements • Implement ramping rates	• None
	• Sedimentation	• Existing operating agreements	• None
	• Fish Passage at diversion	• Existing operating agreements, BMPs, and SOPs • Install fish screen and passage upgrades	• None
Tait Street Diversion and Wells	• Flow reduction	• Implement minimum stream-flow targets • Implement ramping rates	• Reduction in average adult migration index of up to 10% in critically dry years • Reduction in average smolt migration index by up to 8.5% in critically dry years
	• Lagoon water quality	• Implement minimum stream-flow targets	• None
	• Fish Passage	• Install fish screen and passage upgrades	• None

City Activity	Potential Effect	Avoidance and Minimization Measures	Residual Effects to be Mitigated in NFCF
Water Supply Operations: Reservoir Operations			
Chemical Algaecide Treatment of Reservoir	• Copper Toxicity	• Follow label instructions • Aquatic Pesticide Application Plan • Treatment SOPs and BMPs • Adherence to SWRCB NPDES permit • Monitoring plan in place	• In compliance with Basin Plan, negligible effect
Testing Deluge and Gate Valves	• Low dissolved oxygen • Erosion	SOPs and BMPs including: • Aeration at release point • Erosion control measures	• None
Woody Debris Removal on Reservoir Face	• Eliminate downstream recruitment	• Stockpile larger pieces for habitat restoration projects	• Average annual loss of 10 cubic yards woody debris

City Activity	Potential Effect	Avoidance and Minimization Measures	Residual Effects to be Mitigated in NFCF
Water System Operations and Maintenance			
Water Diversion Sediment Management (North Coast)	• Sedimentation of downstream habitat	• Sediment removal BMPs and SOPs • Install sediment management upgrades	• None
Fish Ladder and Screen Maintenance	• None	• Fish screen upgrades	• None
Conveyance Pipeline System Inspection and Repairs	• Turbidity and sedimentation of downstream habitat	• Construction SOPs and BMPs	• None
Finished Water Pipeline System Flushing and Repairs	• Disinfection toxicity (chlorine) • Turbidity	• Dechlorination • SOP nos. 7102-01 and 7102-02 • Supervision by environmental monitor	• None
Pumping Well Return to San Lorenzo River	• Turbidity and sedimentation	• Discharge to decanting basin	• None
North Coast Valve Blow Off to San Lorenzo River	• Turbidity and sedimentation	• Discharge onto rip-rap	• None
Dewatering of Creeks for Maintenance and Repairs	• Injury or mortality to fish as a result of relocation activities	• SOPs for dewatering and fish relocation	• Temporary dewatering with capture and relocation of undefined number of juvenile coho, if re-established; incidental direct mortality of up to 3%

City Activity	Potential Effect	Avoidance and Minimization Measures	Residual Effects to be Mitigated in NFCF
Municipal Facility Operations and Maintenance			
Flood Control Debris/Obstruction Removal	• Habitat simplification	• Supervision by environmental monitor • BMPs and SOPs for streamside projects	• None, habitat not suitable for coho even if re-established
Flood Control Sediment Management/Removal	• Temporary habitat disruption, Turbidity, Direct mortality	• Fish removal and protection during operations. • SOPs for dewatering and fish relocation. • Preventive maintenance for storm drains.	• None, habitat not suitable for coho even if re-established
Flood Control Vegetation Management	• Loss of habitat components-cover, shading; increased temperature; reduced productivity	• Avoid work in wetted channel • Avoid removal of mature trees except in FCCs • Buffer strips in FCC	• Minor degradation of riparian habitat • May affect migrating smolts if re-established
Stormwater Maintenance	• Discharge of pollutants • Increased peak storm flows • Reduced infiltration to ground	• SWMP, Measure E, Stormwater BMPs • Storm drain inspection and cleaning • Structural retrofits and storm drain inlets and basins	• None

Stormwater BMPs	• Discharge of pollutants	• Stormwater Management Program • Stormwater BMPs	• None
Storm Drain Inspection and Cleaning	• Discharge of pollutants	• Storm drain inspection and cleaning	• None
Structural Retrofits of Storm Drain Inlets and Basins	• Discharge of pollutants	• Dry weather diversion to WTP • Inline treatment systems	• None
Sanitary Landfill Stormwater Management	• Discharge of pollutants	• Bypass system and stormwater outfall • Sediment management of bypass ponds • Leachate management	• None
Emergency Operations and Response	• Negligible potential effects on anadromous fish		• None
Vegetation Management Within Riparian Corridors	• Negligible potential effects on anadromous fish	• Integrated Pest Management program	• None

City Activity	Potential Effect	Avoidance and Minimization Measures	Residual Effects to be Mitigated in NFCF
Land Management			
Loch Lomond Recreation Area and Watershed Lands	• Negligible potential effects on anadromous fish	• BMPs for work near streams	• None
Trail Maintenance and Repair	• Negligible potential effects on anadromous fish	• BMPs for work near streams	• None
Road Maintenance and Decommissioning	• Sediment delivery	• Work in dry season • Work supported by Certified Erosion Control Specialist • Maintenance of appropriate drainage to avoid erosion potential • Out-sloping, rolling dips, water bars, winter closures, rocking • Road decommissioning • Conduct timber harvest solely for restoration or forest resiliency purposes	• None
Aquatic Habitat Management	• Temporary habitat disturbance, fish relocation	• Work under permit conditions • BMPs and SOPs for work near streams • Work conducted during dry season with SOPs and BMPs for in-channel work • Post-project monitoring	• Beneficial effects of habitat improvement; • Temporary dewatering with capture and relocation of up to 750 juvenile coho, if re-established; incidental direct mortality of up to 3%

City Activity	Potential Effect	Avoidance and Minimization Measures	Residual Effects to be Mitigated in NFCF
HCP Monitoring Program			
Compliance Monitoring	• No potential effects on anadromous fish	• None needed	• None
Juvenile Abundance-Riverine	• Potential effects from capture by electrofishing, examination, holding, tagging	• Standard fish sampling protection measures	If re-established: • Observation of up to 100 juvenile coho annually in snorkel surveys • Capture and tagging of up to 500 juvenile coho annually in electrofishing surveys with incidental mortality of up to 15 coho
Juvenile Abundance-Lagoons	• Potential effects from capture by seine, examination, holding, tagging	• Standard fish sampling protection measures	If re-established: • Capture and tagging of up to 200 juvenile coho annually in lagoon abundance surveys with incidental mortality of up to 4 coho
Adult Abundance	• Potential effects from capture in the Felton Diversion fish trap, holding, examination, tagging	• Standard fish sampling protection measures	• Capture and tagging of up to 10 adult coho. • If re-established, capture and tagging of up to 200 coho with incidental mortality of up to 2 adult coho
PIT Tag Monitoring Antenna	• No potential effects	• None needed	• None
Habitat Assessment	• No potential effects	• None needed	• None

For additional information on potential take of covered species resulting from covered activities please see Appendices 14 and 15.

5.2 Effects of Water Supply Operations – Water Diversions

5.2.1 Steelhead

Steelhead habitat exists below each of the City water diversion locations. This section describes the residual effects to steelhead from HCP bypass flows at the City's diversions after application of avoidance and minimization measures (Chapter 4). Water diversions are the Covered Activity with the greatest potential effect on Covered Species. Although the effects of water diversions are greatly minimized through bypass flows, some residual effects remain. Those effects are described in the rest of this section and summarized in Table 5-1 (steelhead) and Table 5-2 (coho).

As described in Chapter 4, effects are evaluated through use of linked hydrologic and habitat models. Effects on habitat through flow modifications may result in disruption of adult migration patterns; alteration of spawning behavior including reduced spawning success, changes in embryo survival and emergence of fry from spawning gravels; alteration of growth rates and survival rates of rearing juveniles; changes in the numbers of smolts produced; changes in ability of juveniles to migrate within streams and ability of smolts to reach the ocean.

Changes in actual abundance (numbers of individuals) of any life stage cannot be quantitatively linked in any reliable way to changes in flow due to lack of data and lack of rigorous analytical frameworks. Therefore, incidental take cannot be predicted in terms of precise numbers of fish. Instead, surrogate measures of take in terms of habitat metrics are relied upon. These include the number of days during annual cycles with conditions suitable for migration of adults or smolts, an index of habitat suitability for spawning, and an index of habitat suitability for rearing. Habitat metrics for spawning and rearing are expressed in units of WUA calculated through application of the PHABSIM methodology (see HES 2014b for a technical discussion of the development of these indices). In a few cases, change in flow itself is used as a surrogate for incidental take.

Habitat conditions for various steelhead life stages that would result from implementation of the City's operations and bypass flow prescriptions are expressed as changes measured against habitat conditions with no City diversion. These changes will serve as an ecological surrogate for the anticipated amount of incidental take associated with the on-going operation of City facilities and diversions.

The effects analysis compares three scenarios representing a base hypothetical condition with no City diversions; an existing operations scenario reflecting facilities and flow requirements in

place before implementation of the HCP; and an HCP scenario. The existing operations scenario is model output using a reconstructed hydrologic database for the period 1937-2015 as input (data generated by Balance Hydrologics), and assuming unconstrained City diversions using existing facilities and operating procedures and 2010 level of demand. The "no-diversion" scenario is the hydrologic database with no City diversion. The HCP bypass flows are as described in Section 4.4.2.1 and assume implementation of the proposed Santa Cruz Water Rights Project (as described in Section 6.2.1) to enhance the City's operational flexibility. Effects are evaluated for each of the four City year type classifications because of the wide variability in flow and related habitat metrics between different year types. This gives an indication of the conditions species would encounter over different annual cycles. It is anticipated that operation of the City's diversion facilities in conformance with the associated bypass flow requirements will maintain instream flow conditions in a manner that adequately protects and conserves habitat downstream of City water diversions. If operation of the City's facilities creates flow conditions that deviate from the bypass flow requirements, the anticipated level of effect caused by the conservation strategy would be exceeded.

The level of effects below each diversion reflects the order of priority for habitat enhancement that is expressed in the Conservation Strategy (Chapter 4). Laguna Creek and the lower San Lorenzo River were given top priority because both streams potentially support coho as well as steelhead and both have functional lagoon systems important to production of steelhead. Laguna Creek has the greatest length of stream habitat for the North Coast streams. The San Lorenzo River is identified as a focus population in the Central California Coast Coho Recovery Plan (NMFS 2012). Newell Creek had the lowest priority due to degraded habitat from residential development and because increased reliance on Loch Lomond Reservoir is required to provide the flows in the higher priority reaches.

Liddell Creek

The Liddell Creek Diversion influences 1.2 miles of anadromous habitat in Liddell Creek including about 0.24 miles downstream of the confluence with the West Branch. Under the HCP, habitat effects are minimized in Liddell Creek through bypass flows in normal and wet years. HCP bypass flows result in improved habitat indices relative to existing conditions in all year types. The average adult migration index in normal and wet years is at least 93% of no-diversion levels (Figure 5-1). In dry and critically dry years, the index is increased by up to 15% relative to existing conditions to at least 57% of no-diversion levels. Similarly, the spawning index with HCP bypass flows is at least 91% of no-diversion levels in normal and wet years and is increased in dry and critically dry years by up to 18% to at least 62% of no-diversion levels (Figure 5-2). The rearing index is increased with HCP bypass flows in normal and wet years by

up to 18% from existing conditions to at least 78% of no-diversion levels (Figure 5-3). In dry and critically dry years, the rearing index is increased from existing operations by up to 10% to at least 56% of no-diversion levels. The average smolt migration index in normal and wet years is at least 94% of no-diversion levels (Figure 5-4). In critically dry years the index is increased by more than 150% relative to existing conditions to 44% of no-diversion levels.

Figure 5-1: Effects of Water Diversions on Steelhead Migration in Liddell Creek

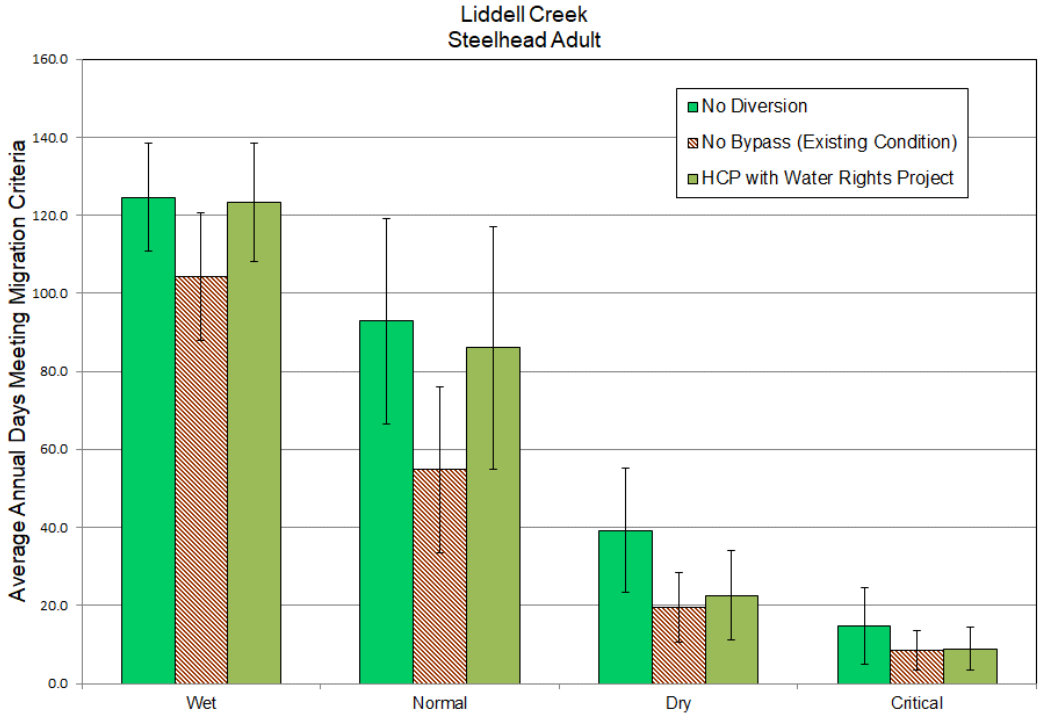


Figure 5-2: Effects of Water Diversions on Steelhead Spawning Habitat in Liddell Creek

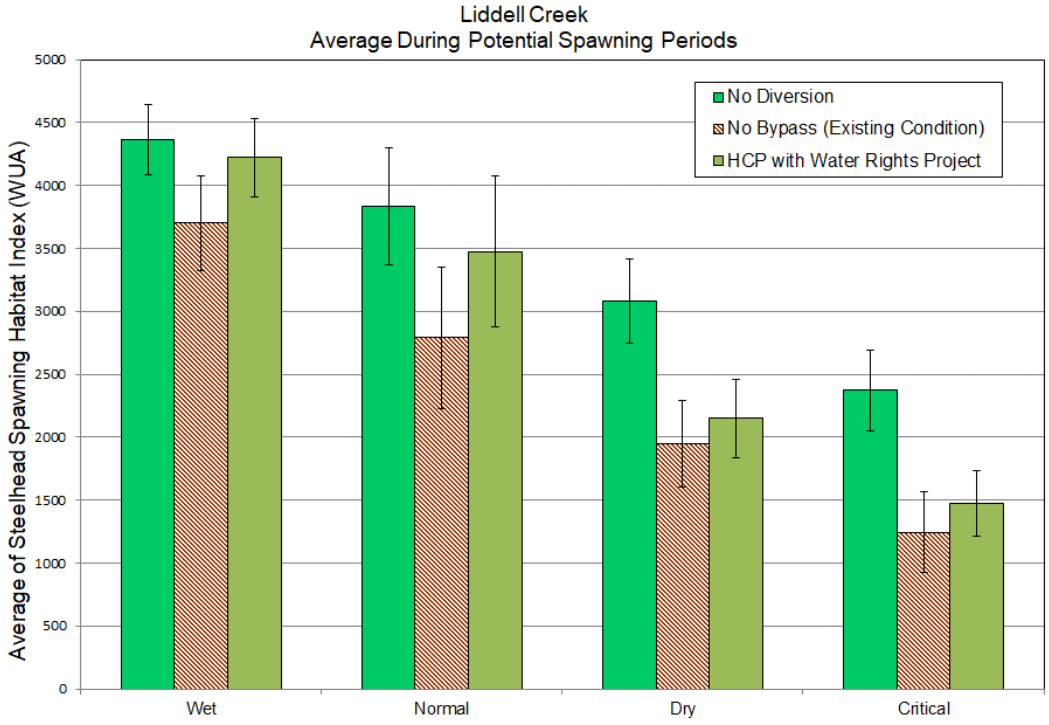


Figure 5-3: Effects of Water Diversions on Steelhead Rearing Habitat in Liddell Creek

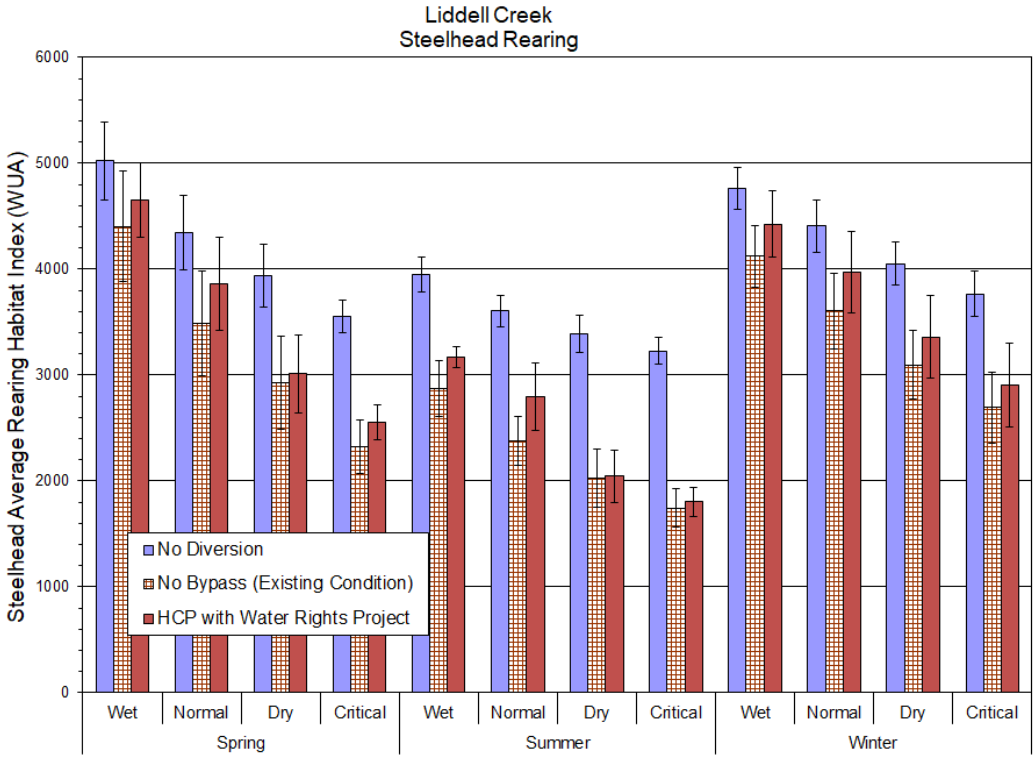
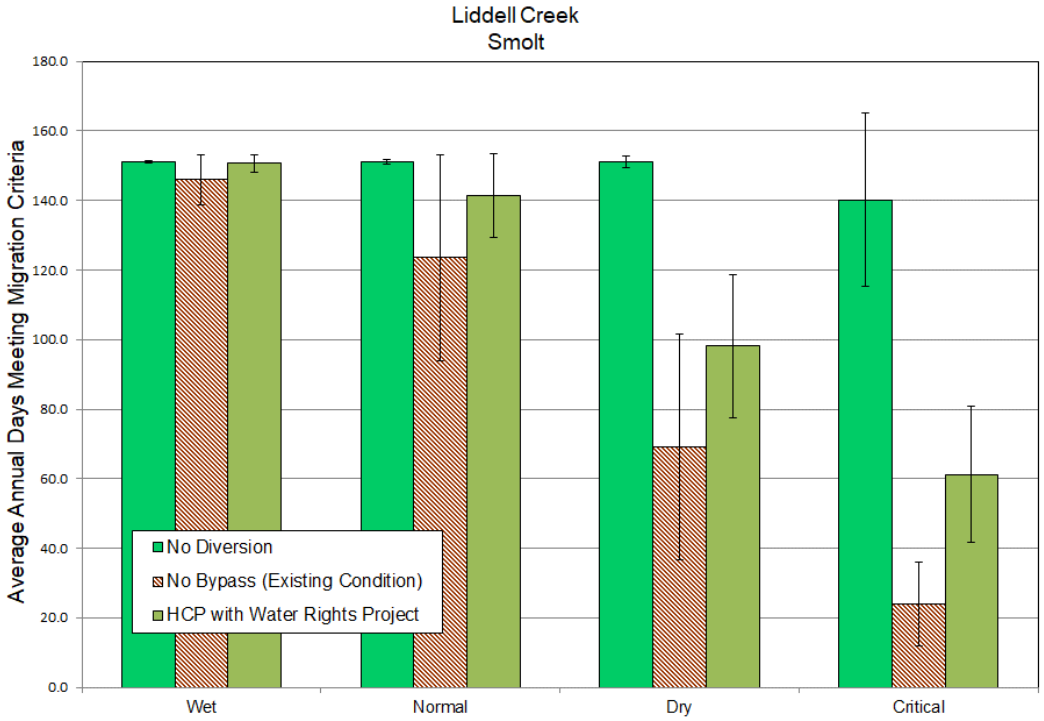


Figure 5-4: Effects of Water Diversions on Steelhead Smolt Migration in Liddell Creek



The largest residual effects occur in dry and critically dry years and include a 43% decrease (-17 days) in the adult migration index in dry years, compared to no-diversion levels, a 38% decrease in the spawning index in critically dry years, 44% decrease in the rearing index in critically dry years, and a 56% decrease (79 days) in the smolt migration index in critically dry years (Table 5-3).

Table 5-3: Residual Effects of HCP Bypass Flows on Steelhead in Liddell Creek

	Steelhead			
	Adult migration	Spawning/ incubation	Rearing	Smolt migration
Wet	-1.1%	-3.2%	-19.7%	-0.4%
Normal	-7.4%	-9.3%	-22.5%	-6.4%
Dry	-42.5%	-30.2%	-39.7%	-35.0%
Critically dry	-39.9%	-37.9%	-44.2%	-56.4%

Laguna Creek

The Laguna Creek Diversion influences all of the 1.4 miles of anadromous habitat in Laguna Creek. Habitat effects for steelhead are substantially avoided in Laguna Creek by providing bypass flows that result in habitat index values that are close to levels that would occur with no City diversions. The average adult migration index under HCP flows is nearly identical to the level in the absence of City diversions and is changed by less than 1 day annually (Figure 5-5). There is some reduction in average spawning habitat values in normal and wet years with decreases of 6% in each compared to no-diversion levels on average (Figure 5-6). The HCP spawning index is at least 94% of the level with no-diversion. The HCP bypass flows result in up to 69% improvement in average WUA for rearing compared to existing operations. WUA with HCP bypass flows is at least 83% of no-diversion levels in all year types (Figure 5-7). The largest percentage reductions compared to no-diversion are in the spring and summer of wet years. The HCP rearing index is nearly identical to the no-diversion index in spring and summer of dry and critically dry years. The smolt migration index is increased from existing operations up to 181% to at least 99% of no-diversion levels in all year types (Figure 5-8). Habitat conditions in Laguna Creek with the HCP are always better than existing conditions for all life-stages. The largest residual effects are a 16% reduction in the rearing habitat index in wet years and a 6% reduction in the spawning habitat index, also in wet years (Table 5-4).

Figure 5-5: Effects of Water Diversions on Steelhead Adult Migration in Laguna Creek

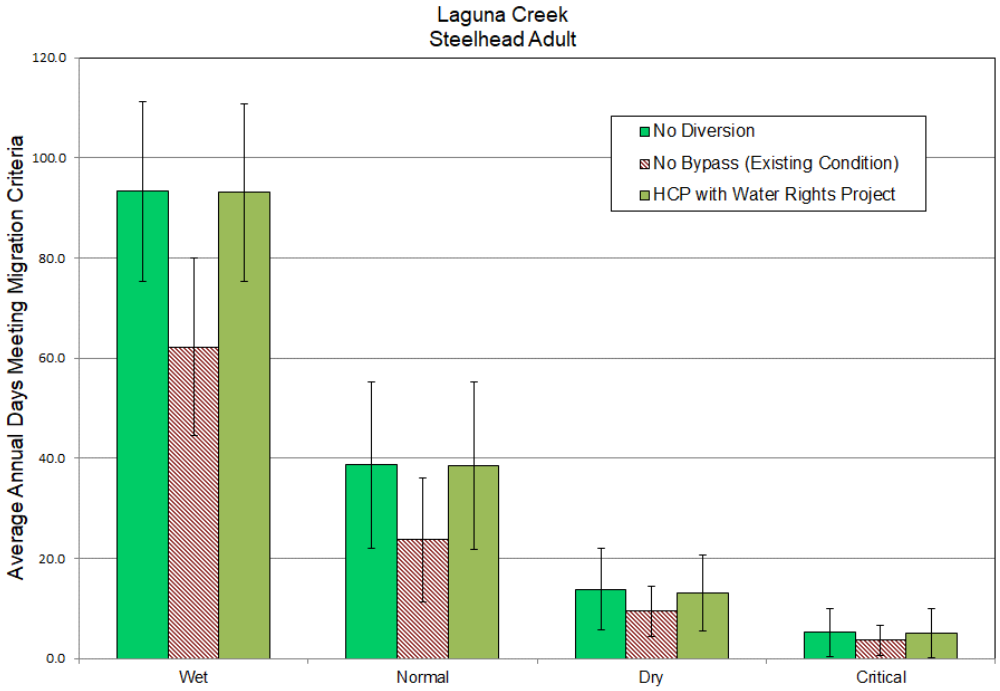


Figure 5-6: Effects of Water Diversions on Steelhead Spawning Habitat in Laguna Creek

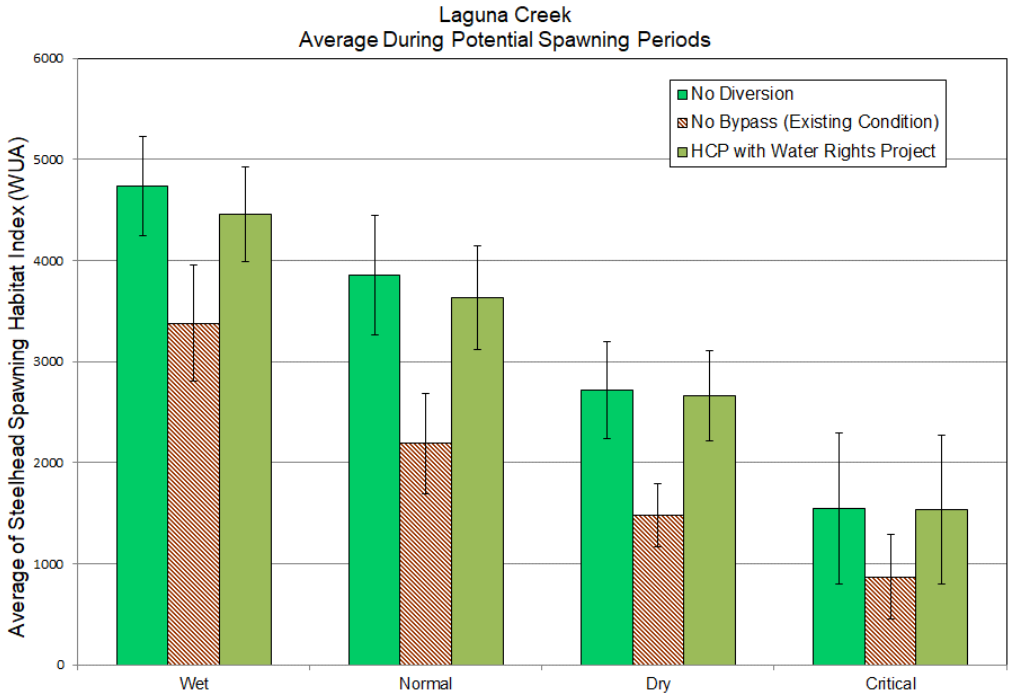


Figure 5-7: Effects of Water Diversions on Steelhead Rearing Habitat Laguna Creek

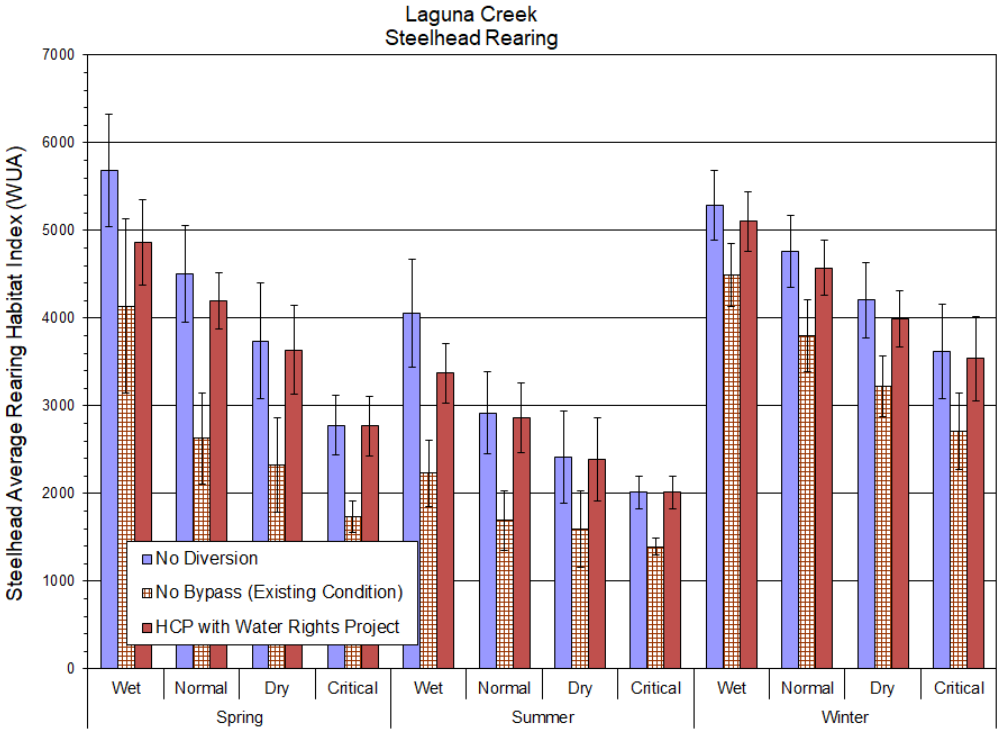


Figure 5-8: Effects of Water Diversions on Steelhead Smolt Migration in Laguna Creek

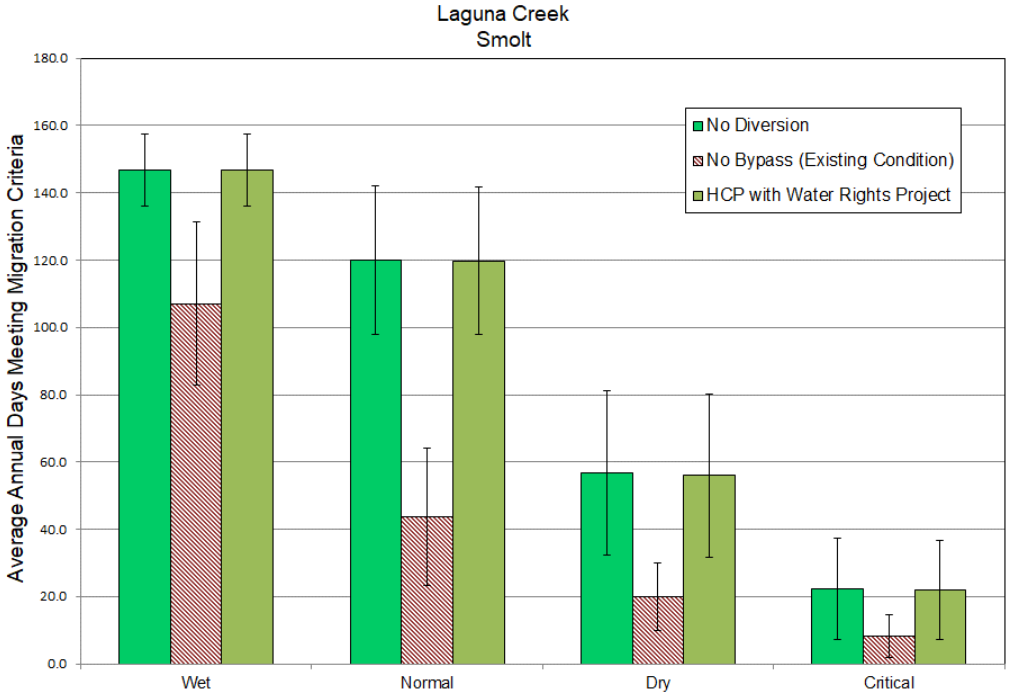


Table 5-4: Residual Effects of HCP Bypass Flows on Steelhead in Laguna Creek

	Steelhead				
	Adult migration	Spawning / incubation	Rearing-spring	Rearing-summer	Smolt migration
Wet	*	-5.9%	-14.4%	-16.9%	*
Normal	*	-5.9%	-6.8%	-1.9%	*
Dry	*	-2.1%	-2.8%	-0.9%	*
Critically dry	*	-1.0%	-0.2%	0.0%	*

* Difference of 1 day or less

Majors Creek

The Majors Creek Diversion influences all of the approximately 0.7 miles of anadromous habitat in Majors Creek. As in Liddell Creek, habitat effects in Majors Creek are minimized under the HCP through bypass flows that are highest in normal and wet years, though HCP bypass flows result in improved habitat indices relative to existing conditions in all year types. Model results indicate reduction in the average adult steelhead migration index is less than one day per year under both existing conditions and with HCP bypass flows in all year types[52] (Figure 5-9). The spawning index is increased in normal and wet years to at least 95% of no-diversion levels. In dry and critically dry years, the spawning index is increased by up to 34% to at least 76% of no-diversion levels (Figure 5-10). The Majors Creek steelhead rearing index is increased by up to 50% in normal and wet years to at least 76% of no-diversion levels (Figure 5-11). In dry and critically dry years, the rearing index improves by up to 46% to at least 77% of no-diversion levels. The smolt migration index is improved by up to 35% in normal and wet years to at least 97% of no-diversion levels. In dry and critically dry years, the improvement is 6% or less and the index under the HCP is at least 85% of no-diversion levels (Figure 5-12).

[52] Use of the Majors Creek Diversion is presently limited by the hydraulic loading from the other north coast sources. This means that diversion during higher flow periods is limited and winter habitat conditions for steelhead migration and spawning is less effected by the diversion. The City's long-term plan is to pump this water into the Coast Main so that the hydraulic restriction will no longer limit the diversion. Bypass flows for migration and spawning are still in place for normal and wet years and improvements are expected to have their biggest effect in wet periods.

Figure 5-9: Effects of Water Diversions on Adult Steelhead Migration in Majors Creek

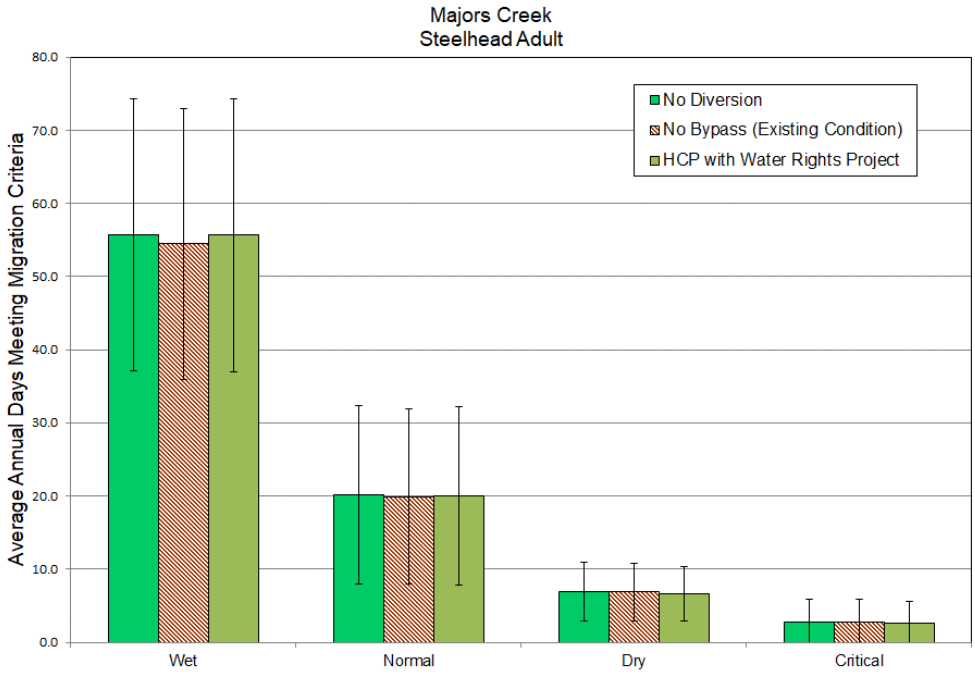


Figure 5-10: Effects of Water Diversions on Steelhead Spawning Habitat in Majors Creek

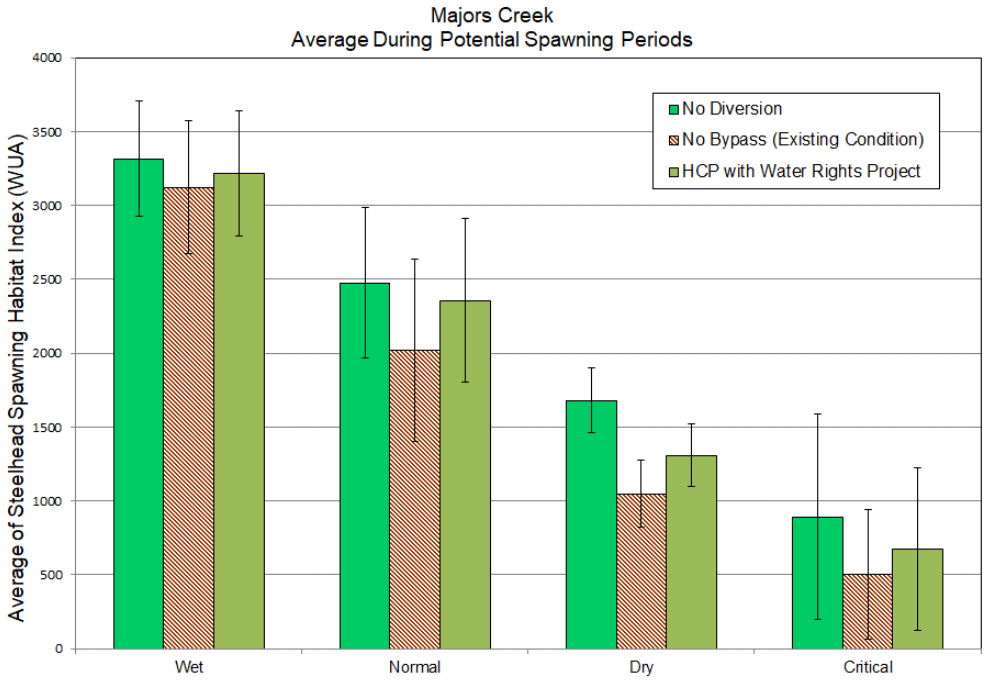


Figure 5-11: Effects of Water Diversions on Steelhead Rearing Habitat in Majors Creek

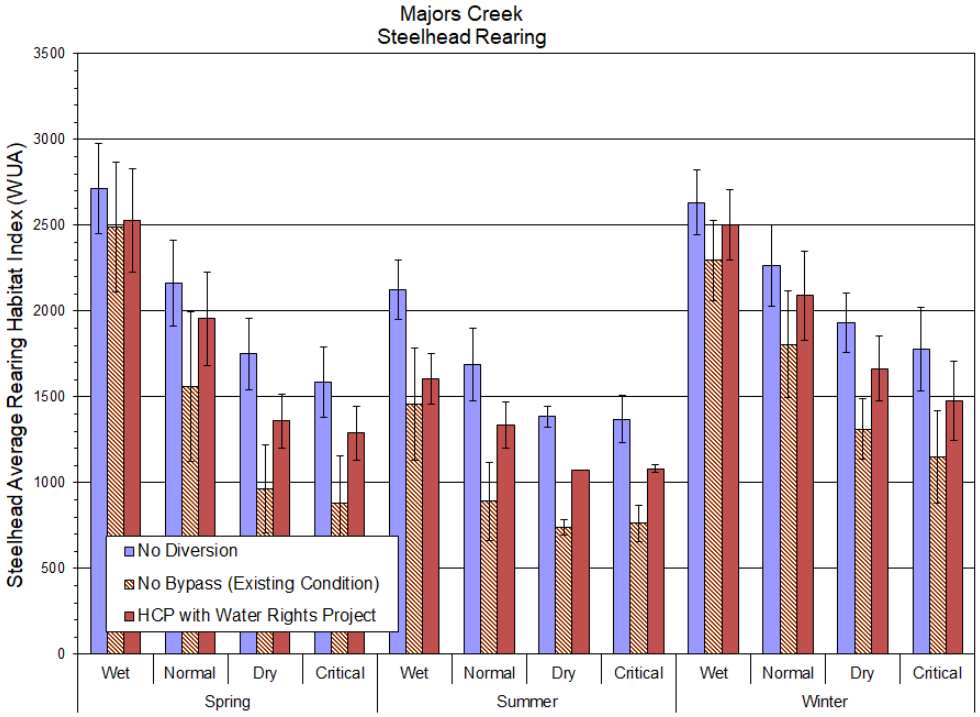
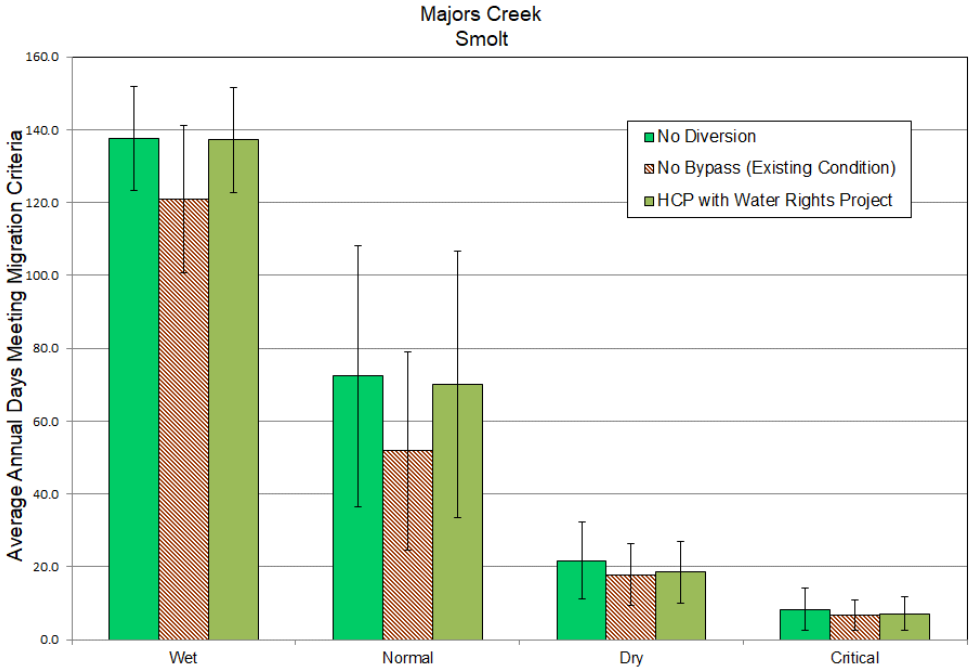


Figure 5-12: Effects of Water Diversions on Steelhead Smolt Migration in Majors Creek



The largest residual effects in Majors Creek include reductions of up to 24% in the spawning habitat index in dry and critically dry years, reductions of 21-24% in the rearing habitat index in all year types, and reductions in the smolt migration index of up to 14% in dry and critically dry years (Table 5-5).

Table 5-5: Residual Effects of HCP Bypass Flows on Steelhead in Majors Creek

	Steelhead			
	Adult migration	Spawning/ incubation	Rearing	Smolt migration
Wet	*	-2.9%	-24.5%	*
Normal	*	-4.8%	-21.0%	-3.1%
Dry	*	-22.1%	-22.7%	-14.5%
Critically dry	*	-24.3%	-21.0%	-14.0%

* Difference of 1 day or less

Newell Creek

Implementation of HCP bypass flows results in somewhat greater fluctuation in storage in Loch Lomond Reservoir with slightly higher storage and more frequent spill during wetter years and lower frequency and duration of reservoir spill in drier conditions, influencing about 1 mile of anadromous habitat in Newell Creek downstream of Newell Creek Dam. Frequency of flows sufficient for adult steelhead migration are reduced compared to no-diversion levels by 0% in wet years, 2% in normal years, 35% in dry years, and 89% (from 5 days to 1 day) in critically dry years (Figure 5-13). The spawning habitat index is reduced by 0.6% in wet years, 2%in normal years, 16% in dry years, and 34% in critically dry years (Figure 5-14). Migration and spawning indices with the Project are not substantially different from Existing Conditions.

The steelhead rearing habitat index is beneficially affected by operation of Loch Lomond Reservoir as a result of the 1 cfs minimum release requirement (Figure 5-15). During the spring (defined here as April, May, and June) the rearing habitat index is reduced by up to 7% in normal years but increased by over 8% on average in critically dry years. During summer (July, August, and September), the wet year habitat index is reduced by 4% but it is increased on average in normal, dry, and critically dry years by 13%, 27%, and 33% respectively (Figure 5-16). The rearing habitat index with the Project is not substantially different from the Existing Condition.

Figure 5-13: Effects of Water Diversions on Adult Steelhead Migration in Newell Creek

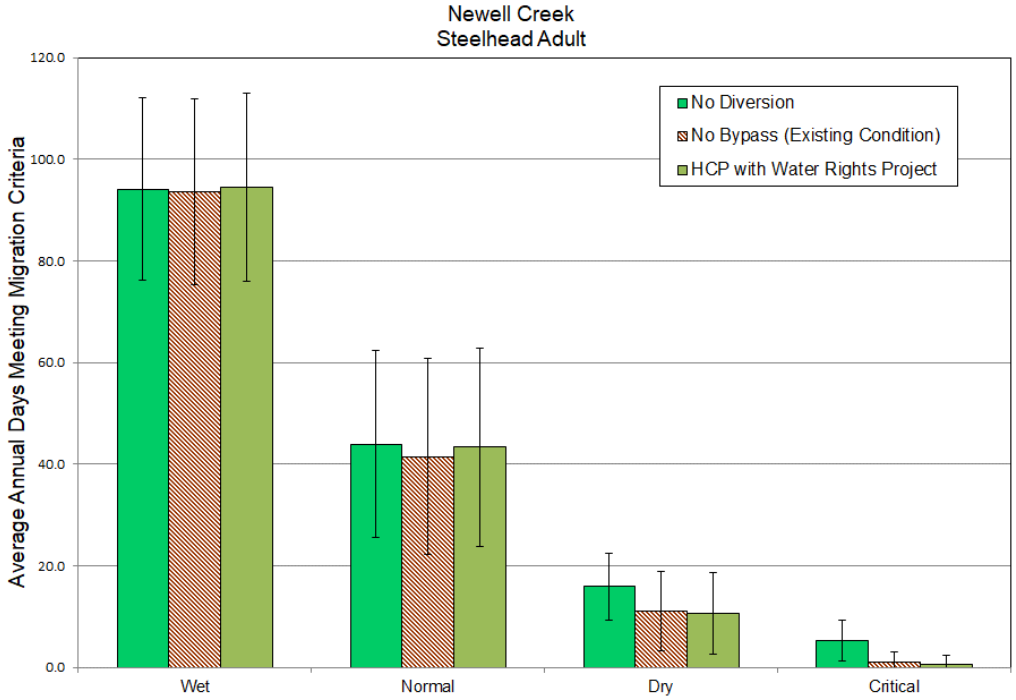


Figure 5-14: Effects of Water Diversions on Steelhead Spawning Habitat in Newell Creek

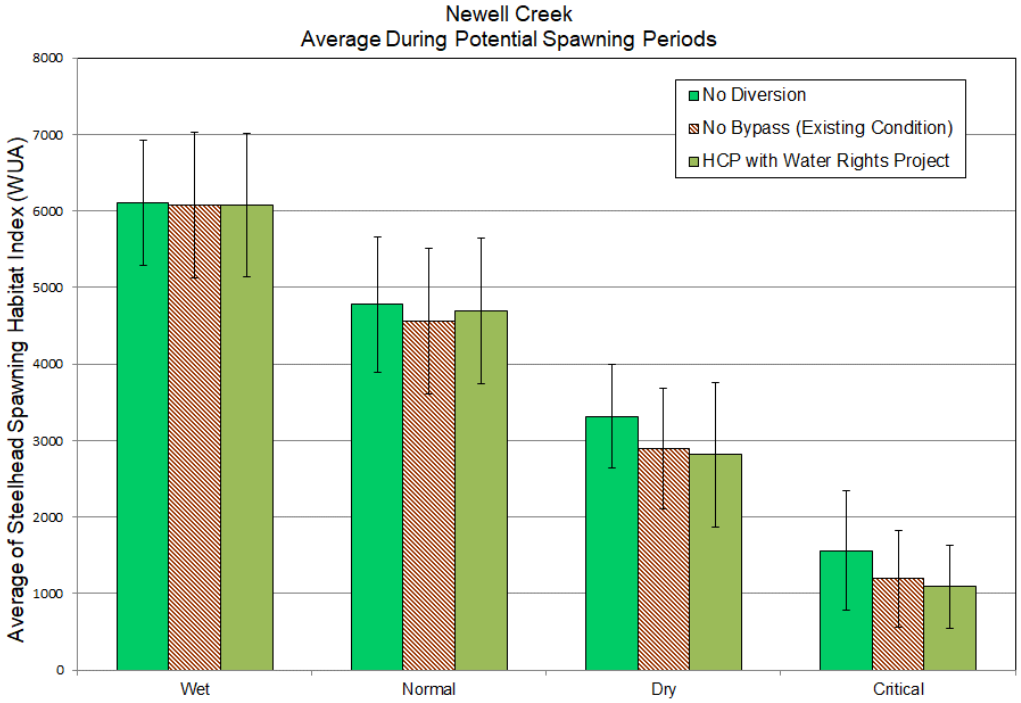
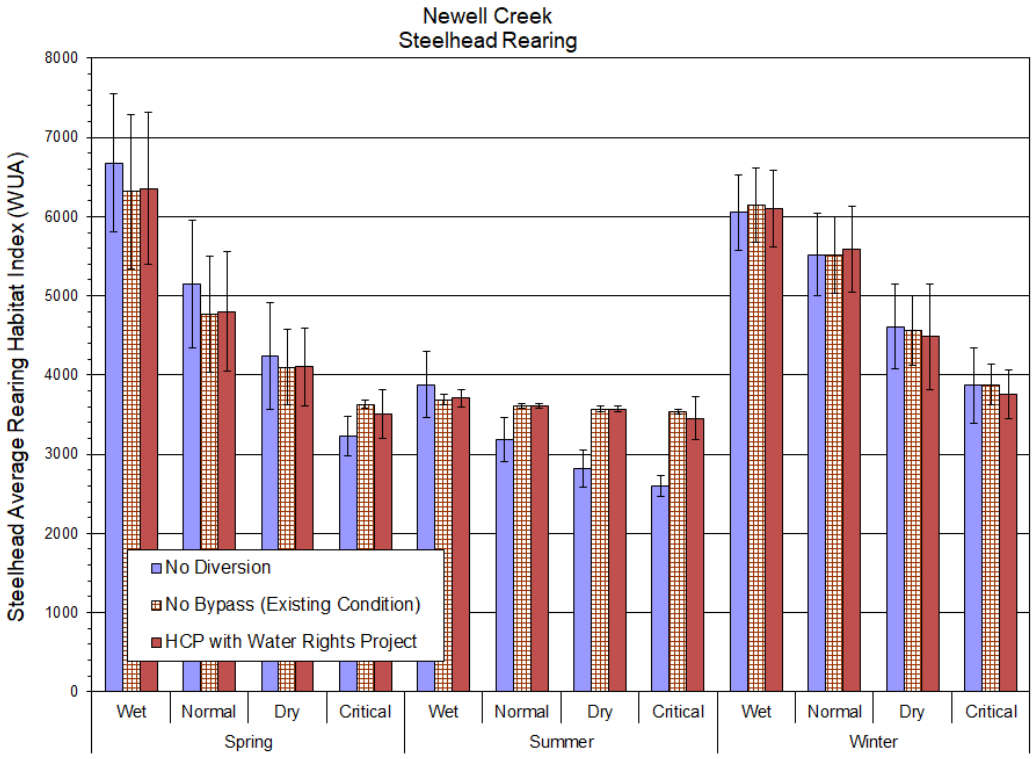


Figure 5-15: Effects of Water Diversions on Steelhead Rearing Habitat in Newell Creek



Flows suitable for smolt migration are reduced by up to 7 days in dry and normal years, 4 days in dry, and 2 days in wet years compared to No-Diversion levels (Figure 5-24). The greatest reductions in percentage terms are in dry years (23% reduction from 21 days to 14) and critically dry years when the average number of days with suitable migration conditions is reduced from 5 days with no diversions to 1 day with HCP flows, an 80% reduction. The smolt migration index with the project is not substantially different than the Existing Condition.

The greatest residual effect for steelhead in Newell Creek is the increase in the rearing habitat index during the spring and summer of drier years relative to the No Diversion scenario. Reductions in adult migration and spawning indices of up to 89% for migration in critically dry years and 34% for spawning, also in critically dry years (Table 5-6), while large in percentage terms are not likely to be biologically significant since the habitat indices are quite low even without the reservoir (No Diversion). The reduction in flows suitable for smolt migration may also be less biologically meaningful since there are very few days in the smolt migration range

even without the effect of the reservoir and diversions in dry and critically dry years (21 days and 5 days respectively, out of the 5-month smolt migration period).

Figure 5-16: Effects of Water Diversions on Steelhead Smolt Migration in Newell Creek

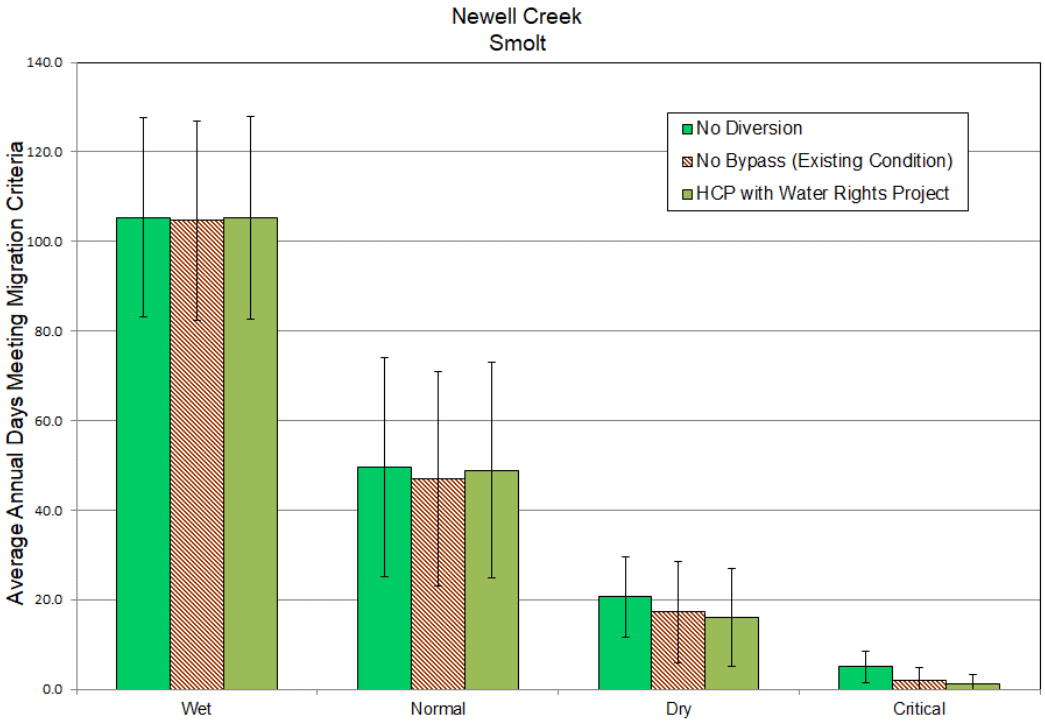


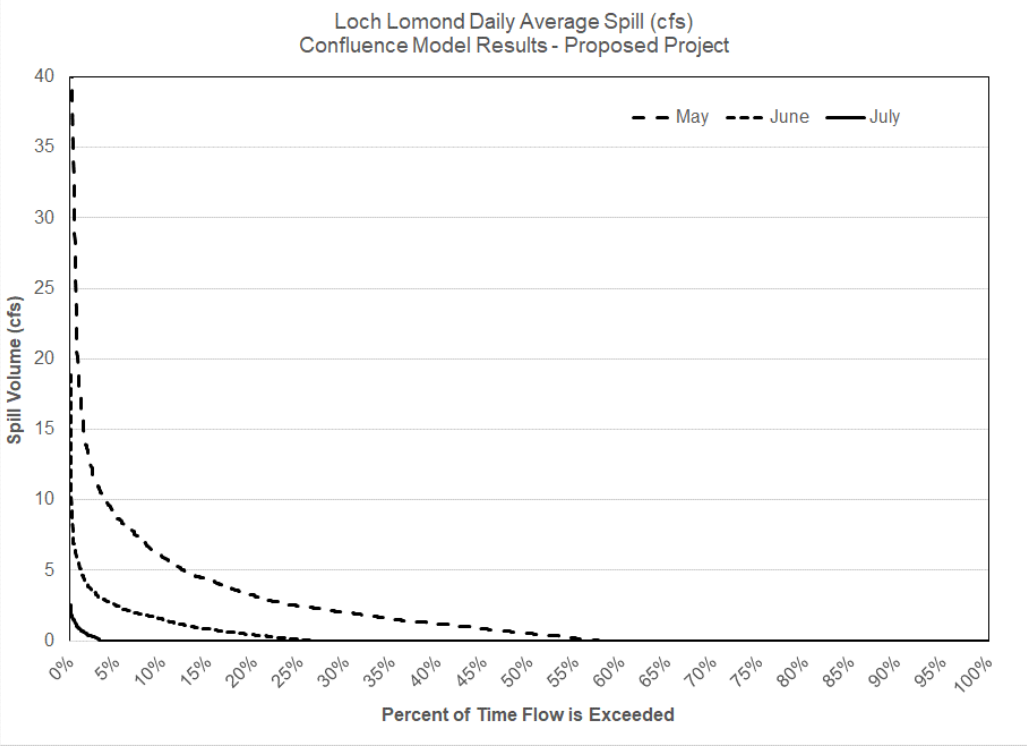
Table 5-6: Residual Effects of HCP Bypass Flows on Steelhead in Newell Creek

	Steelhead				
	Adult migration	Spawning/incubation	Rearing-spring	Rearing-summer	Smolt migration
Wet	0.0%	-0.6%	-4.8%	-4.4%	-0.2%
Normal	-2.4%	-1.9%	-6.7%	13.3%	-2.1%
Dry	-34.9%	-16.2%	-3.2%	26.6%	-23.3%
Critically dry	-88.7%	-33.6%	8.6%	33.0%	-80.0%

* Difference of 1 day or less

The effect of warm reservoir spills is moderated by the frequency, volume, and timing of spill. There is possible cooling at night (although potentially offset by additional warming during the day) as water flows down the spillway, and mixing with the cooler water from the fish release below the dam. Data collected by the City were evaluated to better understand the potential and magnitude of this effect. At times when the spill is warmest later in the spring, the amount of spill tends to be declining and it is diluted to a greater degree by the colder fish release. Daily spill volumes estimated by the Confluence model for the HCP using the historical hydrological record (1937-2015) indicate that spill would occur about 58% of the time in May, 27% of the time in June, and 3% of the time in July (Figure 5-17). Maximum spill amounts would be 77 cfs in May, 19 cfs in June, and 2.5 cfs in July. The model results predict two days in August during the entire record when spill would occur and a maximum spill of 0.20 cfs. No spill was predicted to occur in September, or October. The highest spill amount for May is a result of data from 1983, which was a very wet year, the second wettest in the hydrologic record. The reservoir was spilling continuously from mid-November 1982 and storms in late April resulted in increased spill through early May of up to 77 cfs. Spill declined to 15 cfs by mid-May and continued dropping until it ceased on August 2. It is likely that reservoir temperature was moderated during this period by cool air temperature and overcast conditions typical during storm passage. Late season storms, such as occurred in 1957, 1996, 1998, 1995, and 1941, were responsible for the majority of high spill events in May that are evident in the Confluence model results. Similar to the 1983 data, these events are likely associated with relatively cool reservoir temperatures. Absent late season storms in May, spill amount is rarely in excess of 16 cfs.

Figure 5-17: Loch Lomond Daily Average Spill from Confluence Model Results for the Proposed Project



The effect of warm spill from the reservoir is offset by cold water released through the fish release. In May, the warmest surface temperature in the City database for Loch Lomond surface temperature is 24.6°C. If 16 cfs is flowing over the spillway at that temperature, a simple mass/energy balance would predict that the resulting flow in Newell Creek downstream of the spillway would be 23.9°C after mixing with a flow of 1 cfs from the fish release at 12°C. Increasing the fish release to 6.5 cfs would result in a temperature of 21°C. An upgrade to the Newell Creek Dam outlet structure, currently under construction, will allow for significantly higher releases. During June, the Confluence model predicts much lower spill levels. The highest spill amount for June was modeled at 19 cfs but this was the result of a late season storm in the historic hydrologic record for 2011 representing a single day of the record. In all other model years, predicted spill in June was 10 cfs or less and only exceeded 5 cfs about 1% of the time. The amount of cold release to cool this level of spill to 21°C or less (~3 cfs), is well within the capacity of the fish release, even at the maximum observed June reservoir surface temperature of 26.3°C. For July, the maximum spill in the model results is 2.5 cfs but the maximum temperature in the City monitoring data is 26.9°C. Under these conditions a flow of 2 cfs through the fish release at 12°C would be sufficient to lower the resulting temperature to less than 21°C.

Increased frequency of spill in April and May with associated warmer temperatures may actually be beneficial for rearing steelhead (and coho if present) as long as the temperature is still within the suitable range. Salmonids grow faster at warmer temperatures within the suitable range with adequate food supply. Increased spill in June may also be beneficial as long as it does not result in temperature above the suitable level.

At times when the reservoir is spilling and the 1 cfs fish release is not sufficient to maintain temperature in Newell Creek below 21°C, Measure WS-24 requires the City to release additional flow through the fish release to achieve a maximum instantaneous temperature of less than 21°C as measured in the anadromous reach of Newell Creek and verified at the City stream gage in Newell Creek below the dam. With the implementation of this operational practice, potential adverse temperature effects in Newell Creek and the San Lorenzo River due to an increase in spill frequency would be avoided.

San Lorenzo River downstream of Felton

Operation of the Felton Diversion potentially influences about 7 miles of anadromous habitat down river to the Tait Street Diversion. Analysis of modeled flow data indicates that average annual migration potential is the same as it would be under a scenario with no City diversions (Figure 5-18). The analysis assumes that a flow of 40 cfs is the minimum required to meet

passage criteria between the Felton Diversion and the Tait Street diversion (Section 4.4.2.1). The HCP bypass of 40 cfs provides 100% of the average number of migration days as with no City diversion at the Felton Diversion (Figure 5-18).

The analysis also used data from Ricker and Butler (1979) to assess the quality of spawning habitat provided for steelhead downstream of the Felton Diversion (Chapter 2). The HCP bypass flows result in small declines in normal, dry, and critically dry years, providing 100% of no-diversion levels in wet years, 99% in normal years, 97% in dry years, and 94% in critically dry years (Figure 5-19).

Based on the relationship between flow and WUA for rearing developed from the analysis of Ricker and Butler (1979) (see Chapter 2), HCP bypass flows provide at least 99% of the WUA index levels for rearing steelhead that would occur in the absence of City diversion (Figure 5-20).

Figure 5-18: Effects of Water Diversions on Adult Steelhead Migration in the San Lorenzo River Downstream of the Felton Diversion

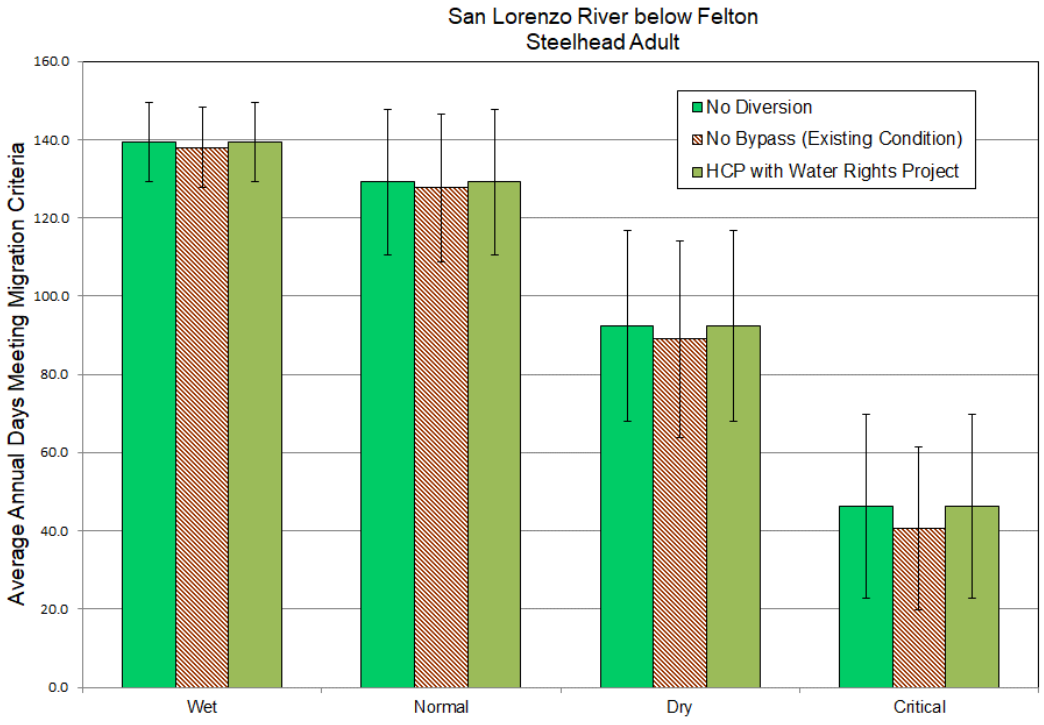


Figure 5-19: Effects of Water Diversions on Steelhead Spawning Habitat[53] in the San Lorenzo River Downstream of the Felton Diversion

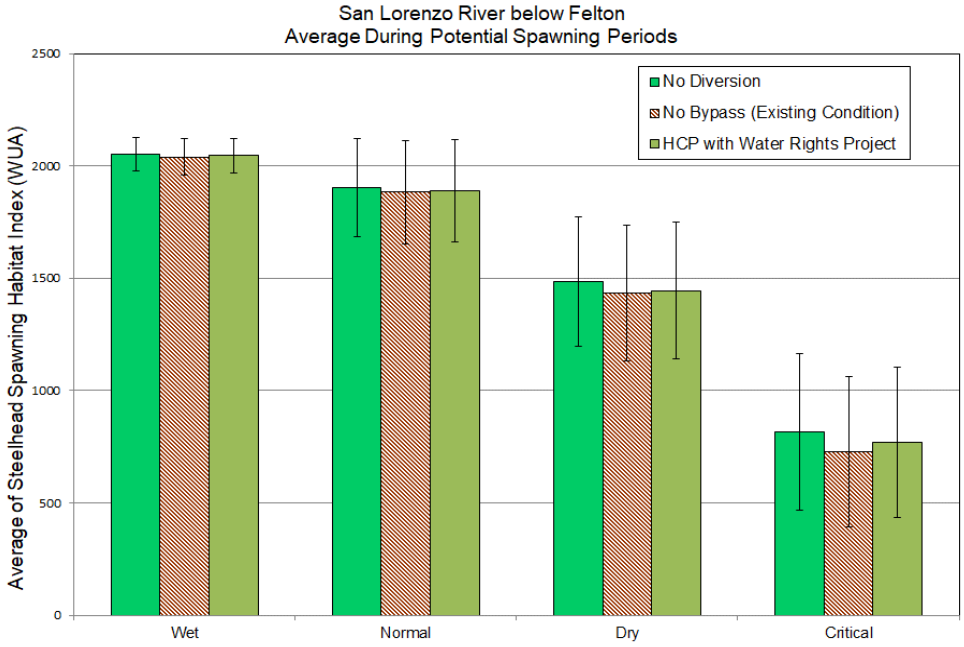
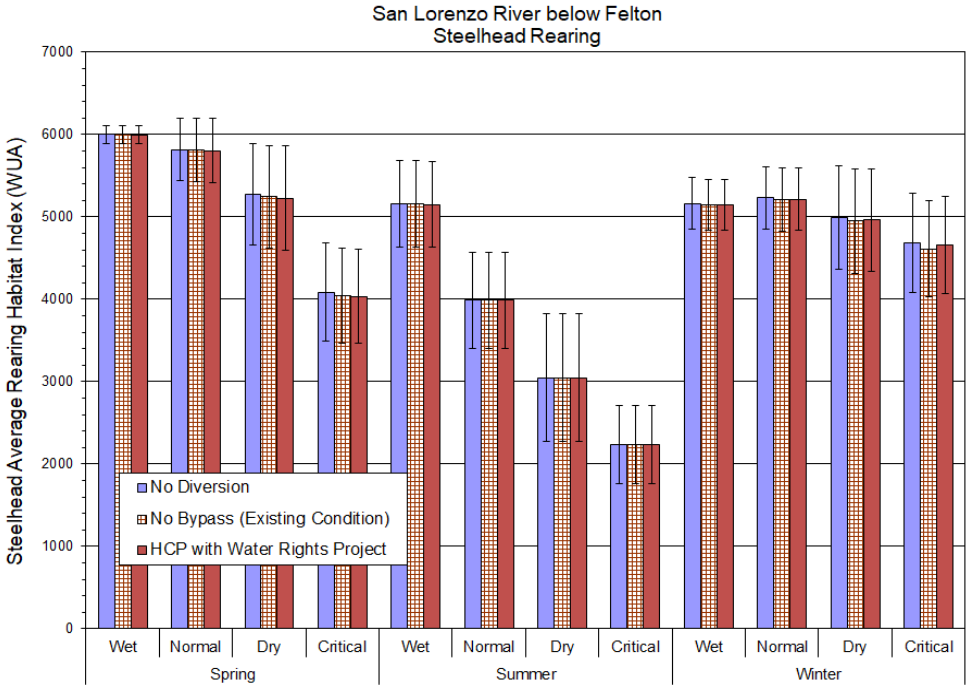
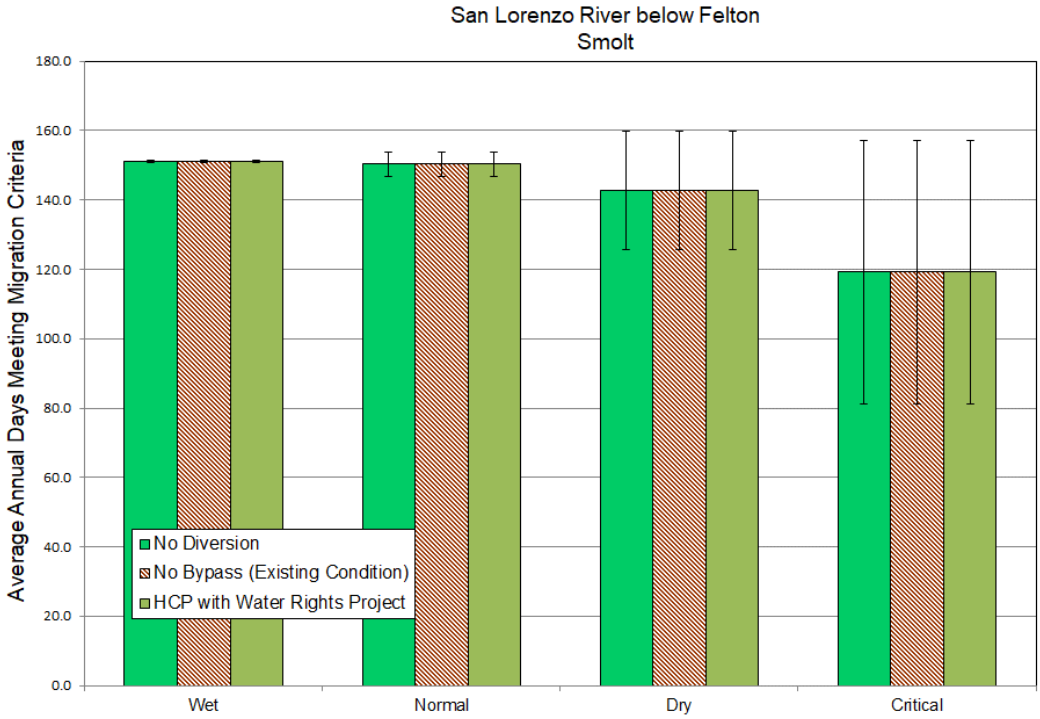


Figure 5-20: Effects of Water Diversions on Steelhead Rearing Habitat in the San Lorenzo River Downstream of the Felton Diversion



[53] Habitat is expressed as Weighted Useable Area in square feet per 100 feet.

Figure 5-21: Effects of Water Diversions on Steelhead Smolt Migration in the San Lorenzo River Downstream of the Felton Diversion



To estimate the effect of flows on smolt migration, a minimum migration threshold of 20 cfs was used. While estimates for minimum migration flow for smolts in this reach are not available, there is evidence that smolts can migrate at flows at least as low as 26 cfs. During the summer of 2016, several smolt sized *O. mykiss* tagged in the lagoon in mid-June were observed at the Felton Diversion in July and August (HES 2017). The highest flow at Big Trees during that period was 26 cfs in mid-June. Flow declined to 11 cfs by late September so these fish migrated upstream at flows of no more than 26 cfs. Downstream migration would likely be easier and could presumably be accomplished at even lower flow. Comparison of minimum flows for smolt migration to minimum flows for adult migration from the other reaches yields an average estimate of smolt flows at 0.27 times the adult migration flow (Section 2.4.3.1). For the Felton reach this would yield an estimate of 11 cfs based on Berry's (2016) estimate for adult migration flows. The minimum threshold of 20 cfs used in this analysis is intermediate between the other two estimates. The HCP provides bypass flows during the smolt migration period that meet minimum migration criteria an average of 100% of the time that they would be met with no City diversions for both steelhead and coho (Figure 5-21).

The greatest residual effects for steelhead after implementation of HCP bypass flows downstream of the Felton Diversion are a 6% reduction in the spawning index in critically dry years and a 1% reduction in the rearing index in the spring of dry years (Table 5-7). The lower mainstem is important for rearing due to greater productivity and warmer water temperature resulting in greater growth rates of rearing juveniles (Chapter 2, Alley et al. 2004). The reach downstream of the Felton Diversion may also be important for spawning in drier years when access to the upper mainstem and tributaries may be difficult (Chris Berry, personal communication to Jeff Hagar, 2016.)

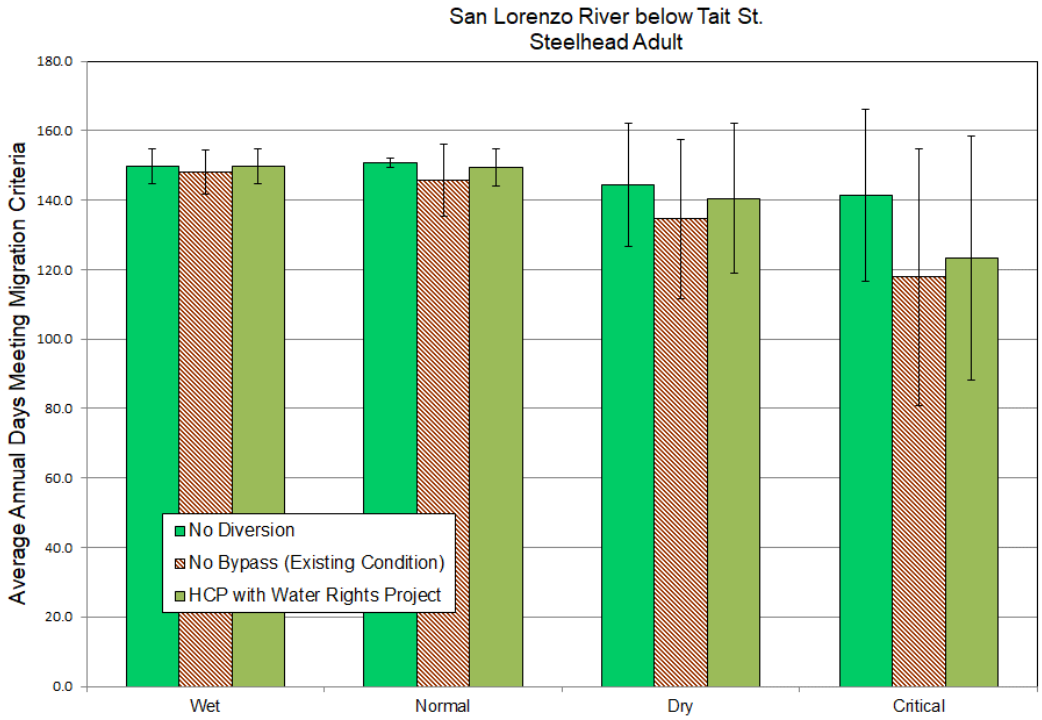
Table 5-7: Residual Effects of HCP Bypass Flows on Steelhead in San Lorenzo River Downstream of the Felton Diversion

	Steelhead			
	Adult migration	Spawning/ incubation	Rearing	Smolt migration
Wet	0.0%	-0.4%	-0.1%	0.0%
Normal	0.0%	-0.7%	-0.2%	0.0%
Dry	0.0%	-2.8%	-0.8%	0.0%
Critically dry	0.0%	-5.5%	-1.3%	0.0%

San Lorenzo River Downstream of Tait Street

The Tait Street Diversion influences up to 1.4 miles of riverine habitat, including 0.9 mile of FCC, depending on lagoon stage, and up to 1.5 miles of lagoon habitat. In the San Lorenzo River below Tait Street HCP bypass flows result in adult steelhead migration opportunities that are comparable to no-diversion levels in normal and wet years but somewhat less in critically dry years. Model results for operation of the Tait Street diversion indicate that the average number of days for suitable passage for steelhead are 100% of no-diversion levels in wet years, 99% in normal years, 97% in dry years, and 87% in critically dry years (Figure 5-22). These declines are comparable to existing conditions; however, there is still a significant amount of time when suitable passage flows exist in all year types. Even in critically dry years there is an average of over 100 days with conditions suitable for migration (Figure 5-23). In comparison, Laguna Creek in wet years, with no diversions, has less than 100 days available for migration (Figure 5-5).

Figure 5-22: Effects of Water Diversions on Adult Steelhead Migration in the San Lorenzo River below the Tait Street Diversion



The largest residual effects are 16% reductions in the rearing index in dry and normal years, is a 13% reduction in the number of days with suitable migration conditions for adults and a 8.5% reduction for smolts in critically dry years (Table 5-6).

The HCP bypass flows below Tait Street focus on improvements to rearing conditions and lagoon inflows. HCP flows, including the new minimum bypass of 8 cfs (60% of the maximum rearing index in this reach), significantly improve the rearing habitat index from existing conditions and provide a rearing index that is at least 84% of no-diversion levels in all year types (Figure 5-23). Improvements in rearing flows downstream of Tait Street also result in greater inflows to the San Lorenzo River Lagoon and potentially improve rearing conditions there as well.

Bypass flows under the HCP result in passage conditions for smolts that are nearly the same as no-diversion levels except in critically dry years. Suitable conditions for smolt migration occur on an average number of days that is 100% of no-diversion levels in wet and normal years, 98% in dry years, and 91% in critically dry years (Figure 5-24). The greatest residual effect is a

reduction in the number of days with suitable passage conditions for smolts from 151 days to 138 days (9%) during the January to May smolt migration season in critically dry years (Table 5-8).

The San Lorenzo River Lagoon provides very important rearing habitat for steelhead. During the summer and particularly in low flow years when the lagoon closes for greater amounts of time, habitat conditions can become too warm for juvenile steelhead and oxygen levels can drop to unsuitable levels. Flow into the lagoon from the San Lorenzo River may benefit rearing habitat in the lagoon by refreshing the warm, deoxygenated, saline lens that can develop in the deeper waters of the lagoon. Inflows of fresh water from the San Lorenzo River may help maintain cooler temperatures throughout the water column and increase DO levels. Under existing operations there is no requirement to bypass flow at the Tait Street Diversion to the lagoon. The HCP imposes a minimum bypass of 8 cfs at the Tait Street Diversion under dry and very dry hydrologic conditions and higher bypass in wetter years. As a result, inflow to the lagoon is greatly improved in critically dry years and some dry years (Figure 5-25). The HCP bypass flows result in an average increase in summer inflow of 17% in normal years, 102% in dry years, and 963% in critically dry years relative to existing conditions. Average summer inflow with HCP bypass flows is 66% of no-diversion levels in wet years, 59% in normal years, 58% in dry years, and 77% in critically dry years (Figure 5-25). The largest residual effect of the Tait Street diversion on lagoon inflows is an average reduction of 42% in dry years compared to no-diversion levels.

Figure 5-23: Effects of Water Diversions on Steelhead Rearing Habitat in the San Lorenzo River below the Tait Street Diversion

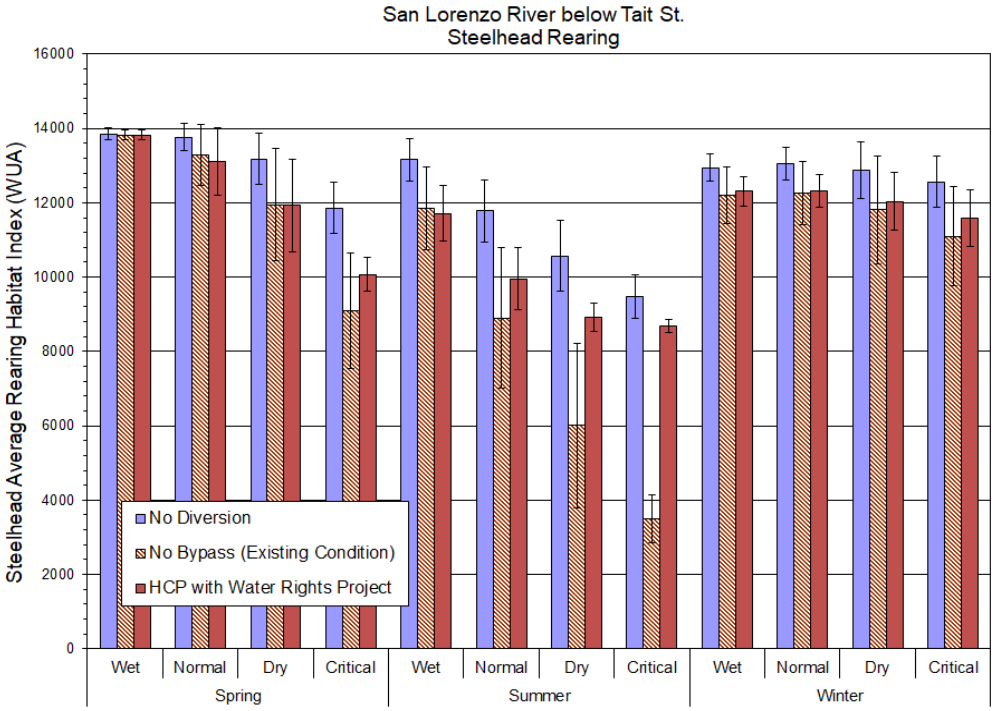


Figure 5-24: Effects of Water Diversions on Steelhead Smolt Migration in the San Lorenzo River below the Tait Street Diversion

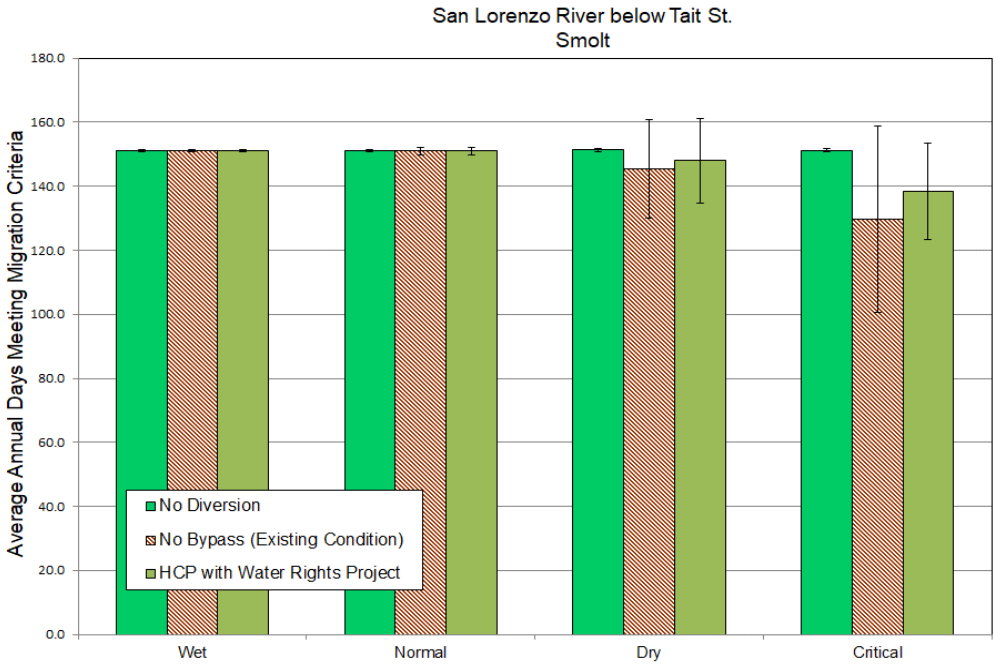


Figure 5-25: Effects of Water Diversions on Inflow to the San Lorenzo River Lagoon

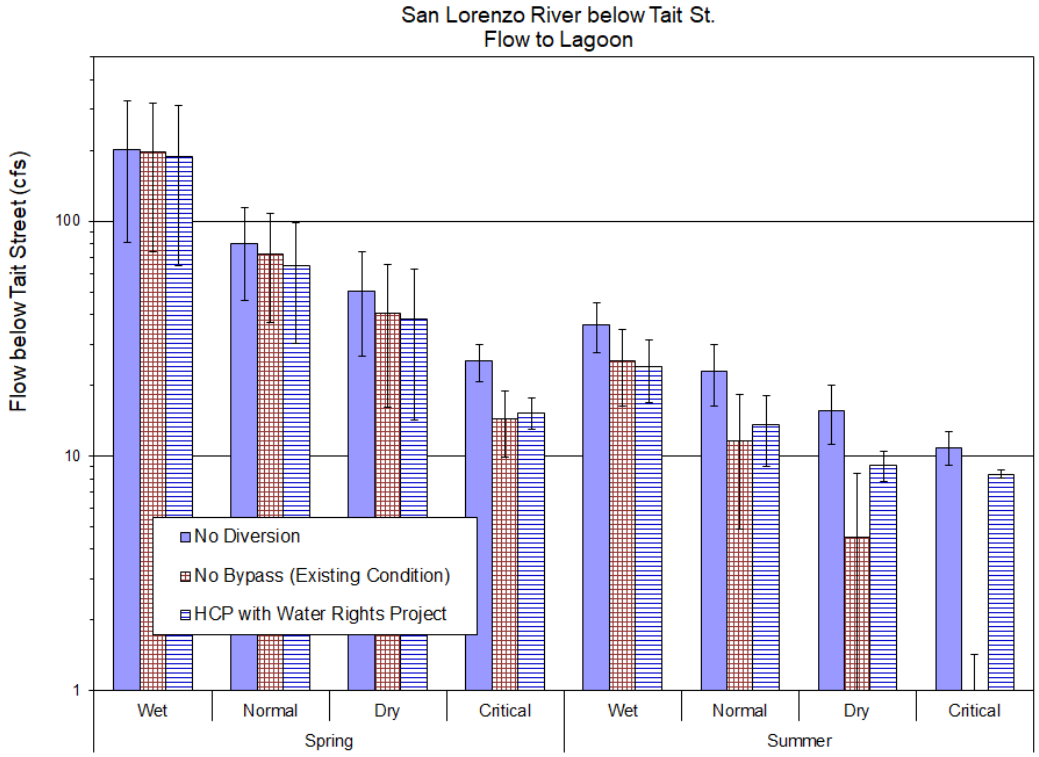


Table 5-8: Residual Effects of HCP Bypass Flows on Steelhead in the San Lorenzo River Downstream of Tait Street

	Steelhead			
	Adult migration	Spawning / incubation	Rearing	Smolt migration
Wet	-*		-11.0%	*
Normal	-*		-15.6%	*
Dry	-2.7%		-15.7%	-2.3%
Critically dry	-12.8%		-15.1%	-8.5%

* Difference of 1 day or less

5.2.1.1 Consideration of Climate Change Scenarios

The preceding analysis is based on the assumption of climate conditions that are consistent with the period of hydrologic record that has been observed since 1936. However, climate scientists are projecting shifts in climatic conditions as a result of increasing concentrations of carbon dioxide and other gasses released into the Earth's atmosphere. These shifts have the potential to influence climate parameters such as temperature and precipitation at the regional level, potentially altering streamflow regimes and habitat conditions for the Covered Species. As part of development of the HCP, as well as for water supply planning purposes, the City developed local hydrologic projections for climate change conditions based on global climate models developed by others (Chartrand 2018).

Climatic extremes of year-to-year and month-to-month precipitation variability is a hallmark of California's physical setting, and climate scientists expect variability observed in the historical record to become more pronounced in the future. On top of this, average and maximum air temperatures are expected to rise significantly across the State (Chartrand 2018). Higher average and maximum air temperatures will increase the frequency and occurrence of fire and increase water supply demand curves as use and consumption generally increase with temperature (Chartrand 2018). Changes in precipitation patterns and fire frequency and severity can also alter vegetation communities and hydrologic processes relating to channel form, thus also potentially impacting steelhead habitat.

The precise nature of future climate conditions is unknown and cannot be predicted with any degree of certainty. Temperature regimes in the Plan Area are already in the upper range of steelhead tolerance. Increasing temperatures may therefore result in population declines in the Plan Area. This is particularly true for the San Lorenzo River Lagoon, which likely produces the majority of steelhead in the San Lorenzo River system. NMFS determined that climate change will result in a variety of challenges for steelhead, including climate related threats which would increase vulnerability of steelhead in the San Lorenzo River and result in a 19.6 percent increase in the threat ranking (NMFS 2016b). The north coast streams and Laguna Creek Lagoon are cooler and steelhead populations in those streams may be more buffered from the effects of a warming climate. In addition, climate models used in Chartrand's analysis do not include the effects of the summer marine layer that substantially moderate temperature in these streams (S. Chartrand, personal communication, 3/23/2019).

More pronounced variability in precipitation patterns could result in more extreme dry years or longer drought periods and more damaging flood flows in wet years. Neither extreme is beneficial for steelhead populations, although steelhead have flexible life-history patterns that

make them very adaptable to variable weather conditions, which they experience to some degree in the Plan Area at present. Under extreme climate change scenarios, it is possible that the range of steelhead will shrink into smaller core areas in the north Pacific basin. Although there are still steelhead populations south of the Plan Area (their range in the past has extended into Baja California), these populations are small and have limited productive capacity. Many species experience range expansions and contractions along the edges of their distributions in response to changing environmental parameters, and the Plan Area is near the edge of present-day steelhead distribution. As a result, during the duration of the Plan it is possible that the range of steelhead will contract in the face of changing climatic conditions despite measures in the conservation strategy designed to increase steelhead abundance.

5.2.2 Coho

Potential habitat for coho is limited to the San Lorenzo River watershed and possibly Laguna Creek. This section describes the effects to coho resulting from the proposed bypass flows at the City's diversions. Hydrologic model results were evaluated for effects on each life stage of coho below each applicable City diversion.

Laguna Creek

Habitat exists for coho in Laguna Creek and all life stages are potentially supported in the 1.4 miles of anadromous habitat. Habitat effects for coho are substantially avoided in Laguna Creek by providing bypass flows that result in habitat index values that are close to levels that would occur with no City diversions. The adult migration index under HCP flows is changed by less than 1 day annually on average compared with No Diversions (Figure 5-26). Similarly, there is minimal change in the spawning habitat index with the HCP spawning index at least 98% of the level with No-Diversion (Figure 5-27). The rearing habitat index for coho in Laguna Creek equals or slightly exceeds no-diversion levels (Figure 5-28). Coho have a preference for lower velocities than steelhead and diversions during the highest flow periods can actually improve the index. The smolt migration index is also greatly improved from existing conditions and averages at least 98% of no-diversion levels in all year types (Figure 5-29) with less than 1 day reduction on average in any year type. Habitat index values represent significant improvement relative to the Existing Condition. The effects of the Laguna Creek Diversion on coho are fully avoided and there are no residual effects (Table 5-9).

Figure 5-26: Effects of Water Diversions on Coho Adult Migration in Laguna Creek

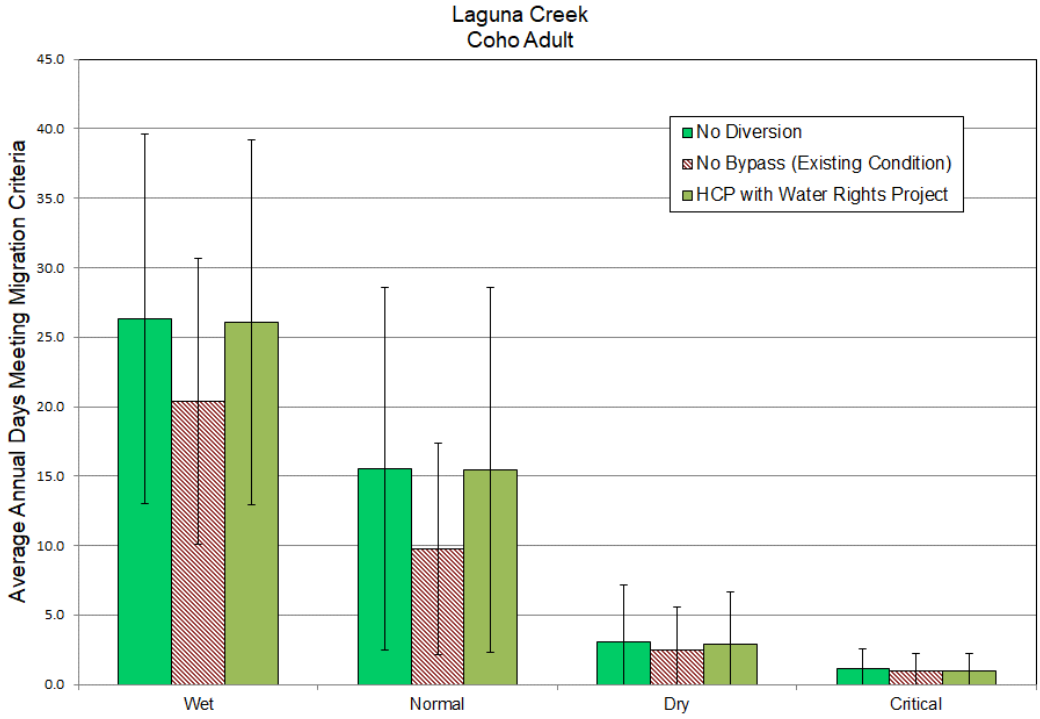


Figure 5-27: Effects of Water Diversions on Coho Spawning Habitat in Laguna Creek

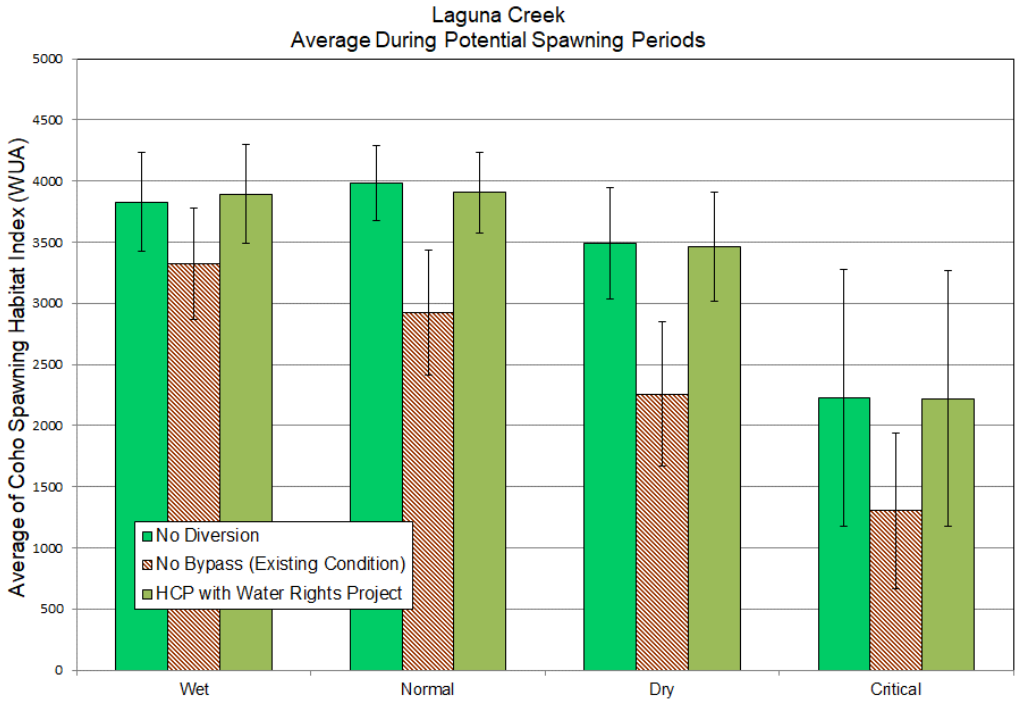


Figure 5-28: Effects of Water Diversions on Coho Rearing Habitat in Laguna Creek

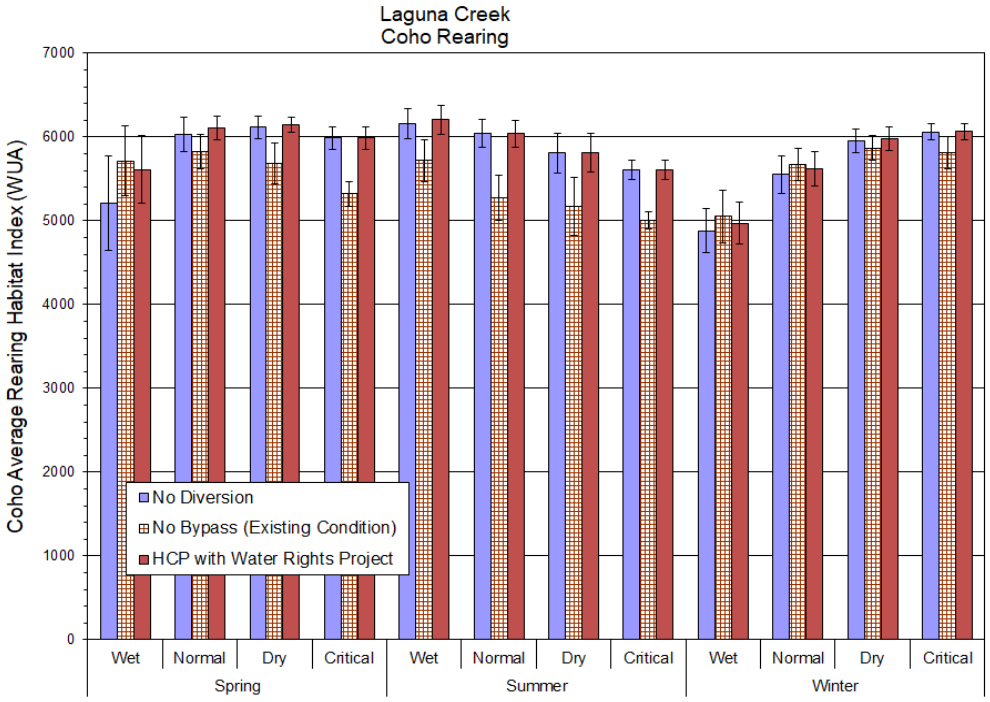


Figure 5-29: Effects of Water Diversions on Coho Smolt Migration in Laguna Creek

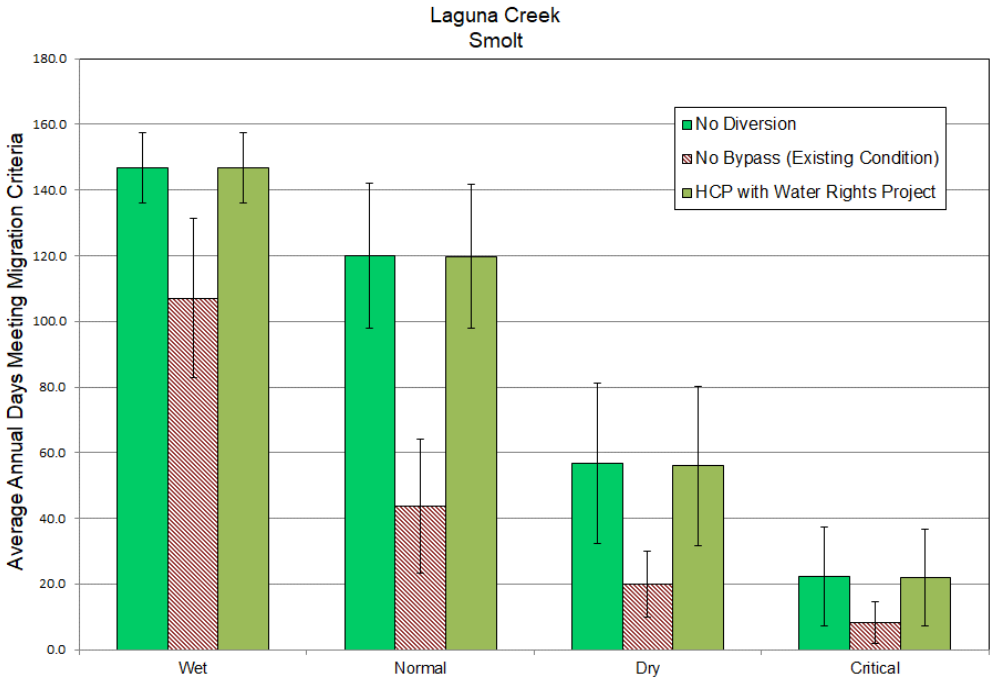


Table 5-9: Residual Effects of HCP Bypass Flows on Coho in Laguna Creek

	Coho			
	Adult migration	Spawning/ incubation	Rearing	Smolt migration
Wet	*	1.6%	0.6%	*
Normal	*	-2.0%	-0.1%	*
Dry	*	-0.8%	0.0%	*
Critically dry	*	-0.3%	0.0%	*

* Difference of 1 day or less

Newell Creek

As described previously for steelhead, implementation of HCP bypass flows results in somewhat greater fluctuation in storage in Loch Lomond Reservoir with higher storage and slightly greater spill frequency in wetter years and lower frequency and duration of reservoir spill in drier years, influencing about 1 mile of anadromous habitat in Newell Creek downstream of Newell Creek Dam. Frequency of flows sufficient for adult coho migration are reduced compared to no-diversion levels by 2 to 4 days on average corresponding to changes of 5 % (3.6 days) in wet years, 10 % (3 days) in normal years, 44% in dry years (from 3.5 days to 1.2 days), and 100% (from 2 days to 0 days) in critically dry years (Figure 5-30). The spawning habitat index is increased slightly in wet years (+1.0%) and normal years (+0.6%), but decreases 15% in dry years, and 36% in critically dry years (Figure 5-31). Coho are more affected than steelhead by reduced spills from Loch Lomond Reservoir because they migrate and spawn early in the winter, while the reservoir is more likely to spill in the late winter after more runoff has accumulated.

Habitat conditions for rearing coho have relatively high index values at all times as a result of juvenile coho preference for lower velocities. The lowest index values occur in wet winters when flow velocity is greatest (Figure 5-32). There is some benefit from the 1 cfs minimum release during drier summers under both existing conditions and HCP flows. Overall, the HCP flows have beneficial effects on coho rearing habitat in Newell Creek and beneficial residual effects.

Habitat conditions for smolt migration are the same as for steelhead since both migrate during the same time period. Flows suitable for smolt migration are reduced by 2 to 7 days from no-diversion levels (Figure 5-33). The greatest reductions in percentage terms are in dry years (23%

reduction from 21 days to 13.5 on average) and critically dry years when the average number of days with suitable migration conditions is reduced from 5 days with no diversions to 1 day with HCP flows, an 80% reduction.

The greatest residual effects, in terms of percentage change for coho in Newell Creek are the reductions in adult migration and spawning indices in critically dry years of up to 100 % for migration and 36 % for spawning; the increase in rearing index in summer and critically dry springs; and reduction in the average smolt migration index of up to 80% in critically dry years (Table 5-10). The migration and spawning effects are not likely to be biologically significant since they involve a relatively small magnitude of actual habitat change and very low habitat values even with no diversions. In the case of adult migration, the change in the actual number of days with suitable migration conditions averages between 3.6 days in wet years to 1.9 days in critically dry years. For smolt migration, the maximum change in percentage terms of 80% in critically dry years corresponds with a potential migration index of only 5 days based on No-Diversion levels during the 150-day potential migration period. The 30% reduction in the spawning habitat index in critically dry years is also not likely to be biologically significant since the habitat indices are quite low even without the reservoir (No Diversion).

Figure 5-30: Effects of Water Diversions on Coho Adult Migration in Newell Creek

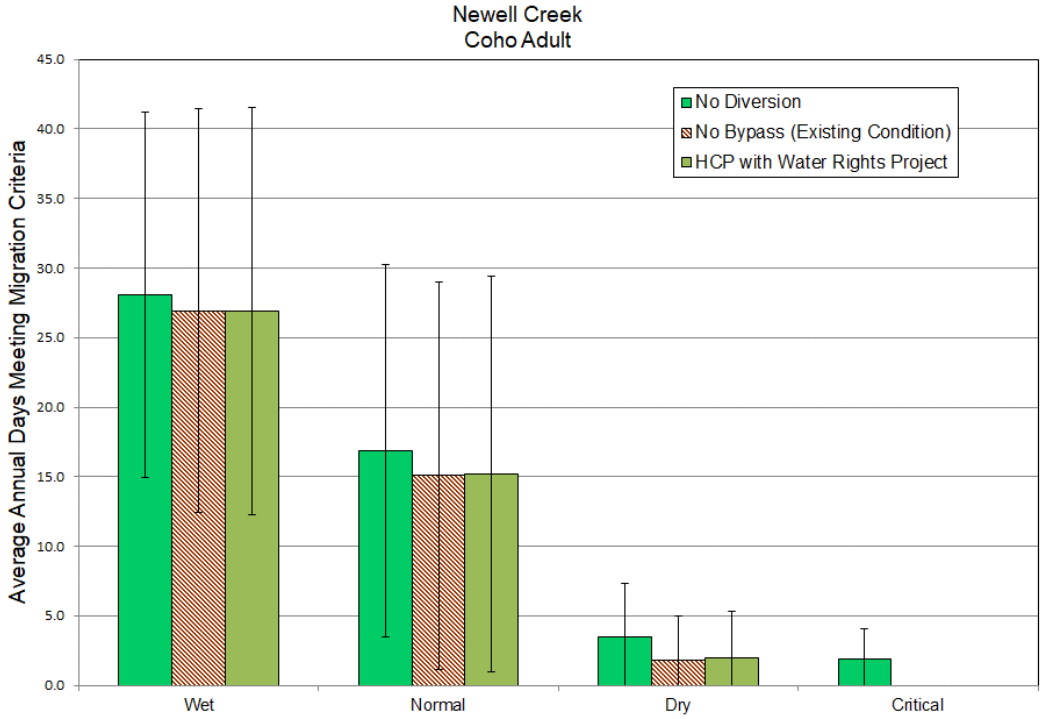


Figure 5-31: Effects of Water Diversions on Coho Spawning Habitat in Newell Creek

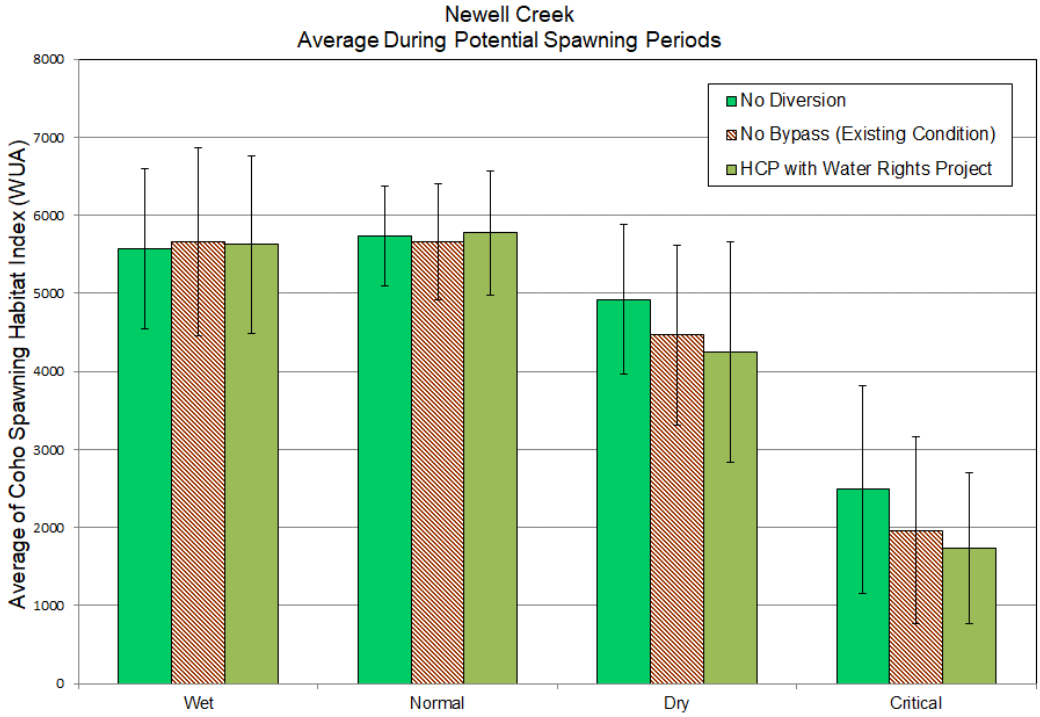


Figure 5-32: Effects of Water Diversions on Coho Rearing Habitat in Newell Creek

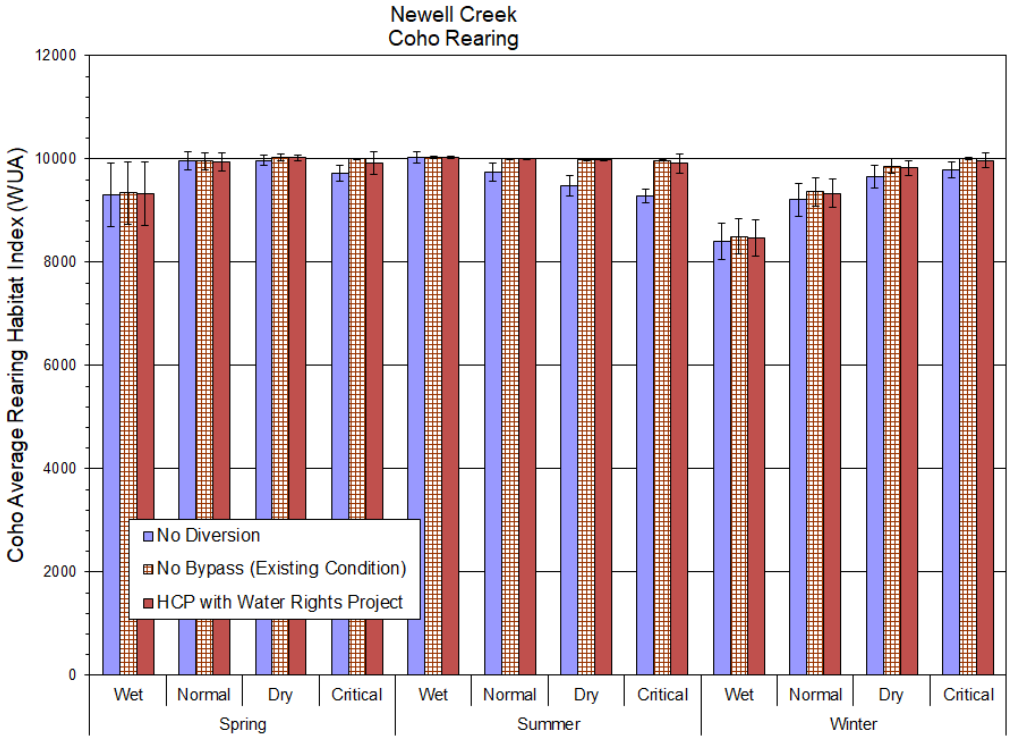


Figure 5-33: Effects of Water Diversions on Coho Smolt Migration in Newell

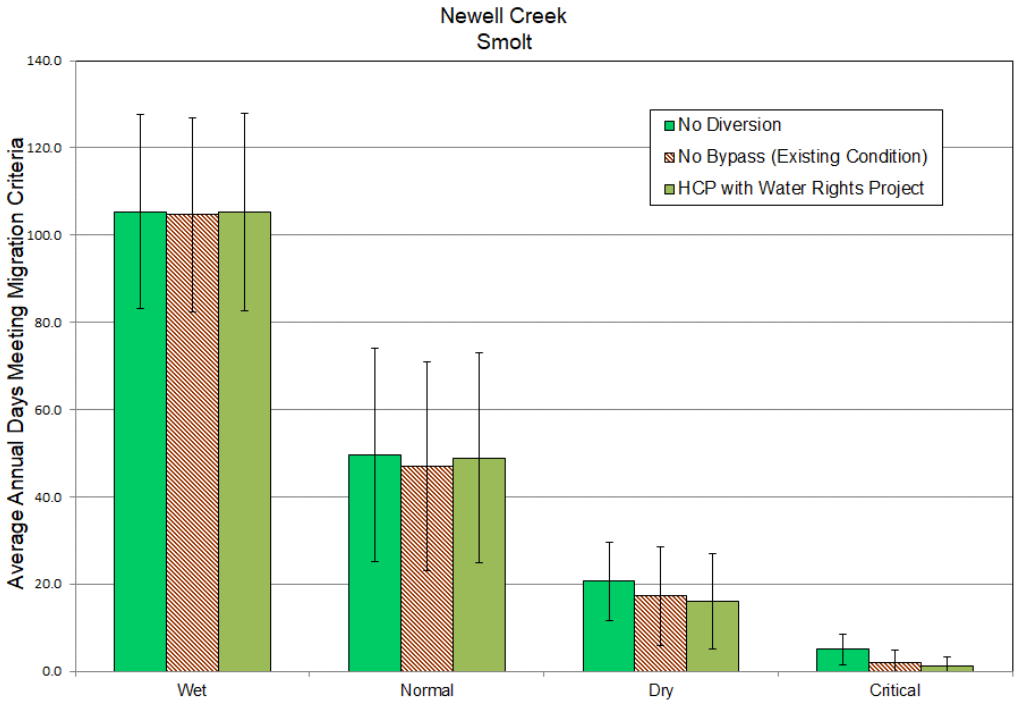


Table 5-10: Residual Effects of HCP Bypass Flows on Coho in Newell Creek

	Coho				
	Adult migration	Spawning/ incubation	Rearing-spring	Rearing-summer	Smolt migration
Wet	-5.2%	1.0%	0.3%	0.0%	-0.2%
Normal	-10.0%	0.6%	-0.1%	2.7%	-2.1%
Dry	-44.2%	-14.9%	0.5%	5.3%	-23.3%
Critically dry	-100.0%	-36.0%	2.0%	6.8%	-80.0%

San Lorenzo River Downstream of the Felton Diversion

Coho potentially use the San Lorenzo River mainstem downstream of the Felton Diversion for adult and smolt migration. It is expected that, due primarily to temperature considerations, the majority of potential spawning and rearing habitat for coho is in the tributaries and upper mainstem. As was the case for steelhead, and assuming a flow of 40 cfs or more is required for adult migration (Section 4.4.2.1), average annual migration potential for coho is the same as what it would be with no City diversions (Figure 5-34). The HCP bypass of 40 cfs provides 100% of the average number of migration days for coho below the Felton Diversion as with no City diversion. A 20 cfs minimum migration flow was used for the smolt evaluation (see discussion under steelhead effects downstream of the Felton Diversion). The HCP provides bypass flows that meet minimum migration criteria for coho smolts 100 % of the time that they are met with no City diversions (Figure 5-35).

Based on these analyses, there are no residual effects of the HCP bypass flows on coho downstream of the Felton Diversion (Table 5-11).

Figure 5-34: Effects of Water Diversions on Coho Adult Migration in the San Lorenzo River below the Felton Diversion

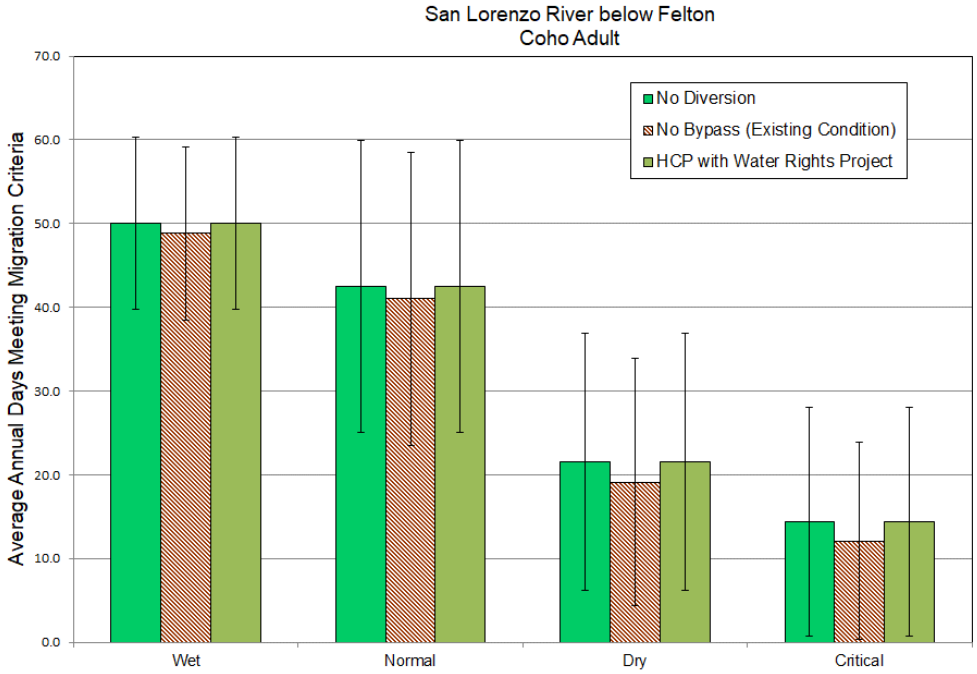


Figure 5-35: Effects of Water Diversions on Coho Smolt Migration in the San Lorenzo River Downstream of the Felton Diversion

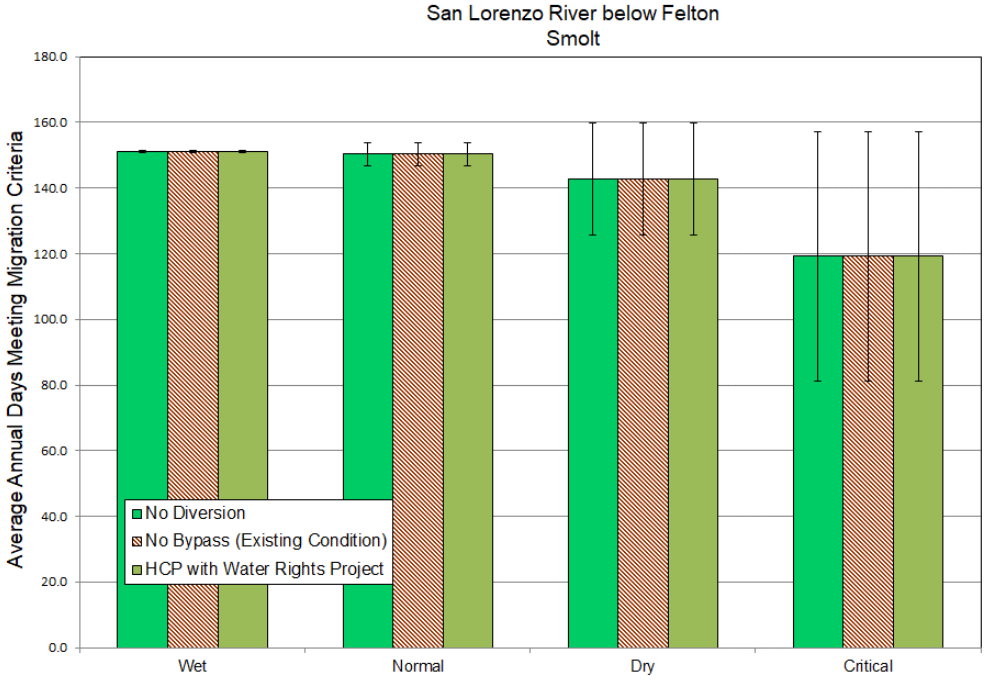


Table 5-11: Residual Effects of HCP Bypass Flows on Coho in the San Lorenzo River Downstream of the Felton Diversion

	Coho			
	Adult migration	Spawning/ incubation	Rearing	Smolt migration
Wet	0.0%			0.0%
Normal	0.0%			0.0%
Dry	0.0%			0.0%
Critically dry	0.0%			0.0%

San Lorenzo River Downstream of Tait Street

Coho potentially use the San Lorenzo River mainstem below the Tait Street Diversion for adult and smolt migration. There is no spawning habitat for coho in this reach and temperature and other habitat conditions are not suitable for rearing. Unlike steelhead, coho do not appear to use estuaries for rearing in this part of their range (Section 2.5.2). The effect of the Tait Street diversion on coho adult migration is very similar to the effects on steelhead. There are no declines in adult migration periods of more than 1 day in wet, normal, or dry years compared to no-diversion levels. In critically dry years, adult migration periods average 9.8% less than no-diversion levels. HCP bypass flows result in an average number of days with suitable migration conditions for coho that is 100% of no-diversion levels in wet years, 98 % in normal years and dry years, and 90% in critically dry years (Figure 5-36). As for steelhead, the critically dry year reductions in the migration index may not have a biologically significant effect since there are still a significant amount of migration opportunities. There are an average of 45 days when migration conditions are suitable out of the 60 possible during the December-January migration period for coho in critically dry years.

The residual effect on smolt migration is the same as that for steelhead since both species migrate at the same time. Bypass flows under the HCP result in passage conditions for smolts that are nearly the same as no-diversion levels except in critically dry years when they occur at 91% of no-diversion levels, a reduction from 151 days with suitable conditions to 138 days (Figure 5-37).

Maximum residual effects of the HCP flows on coho habitat downstream of Tait Street include a reduction in the number of days with suitable conditions for adult migration of 20% in critically dry years and a maximum reduction of 8.5% in the index for smolt migration, also in critically dry years (Table 5-12).

Figure 5-36: Effects of Water Diversions on Coho Adult Migration in the San Lorenzo River below Tait Street

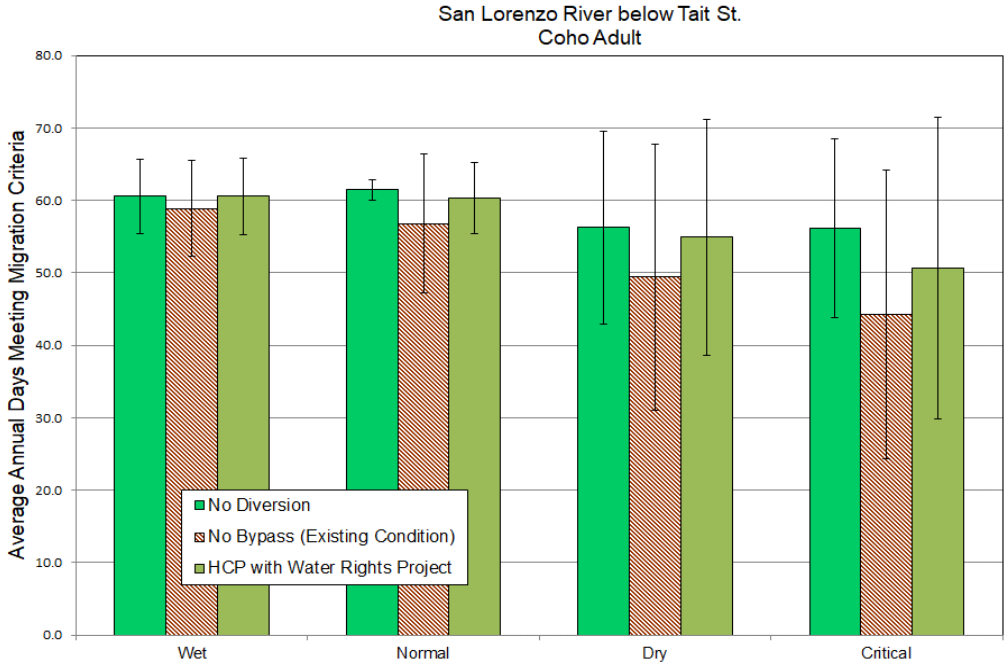


Figure 5-37: Effects of Water Diversions on Coho Smolt Migration in the San Lorenzo River below Tait Street

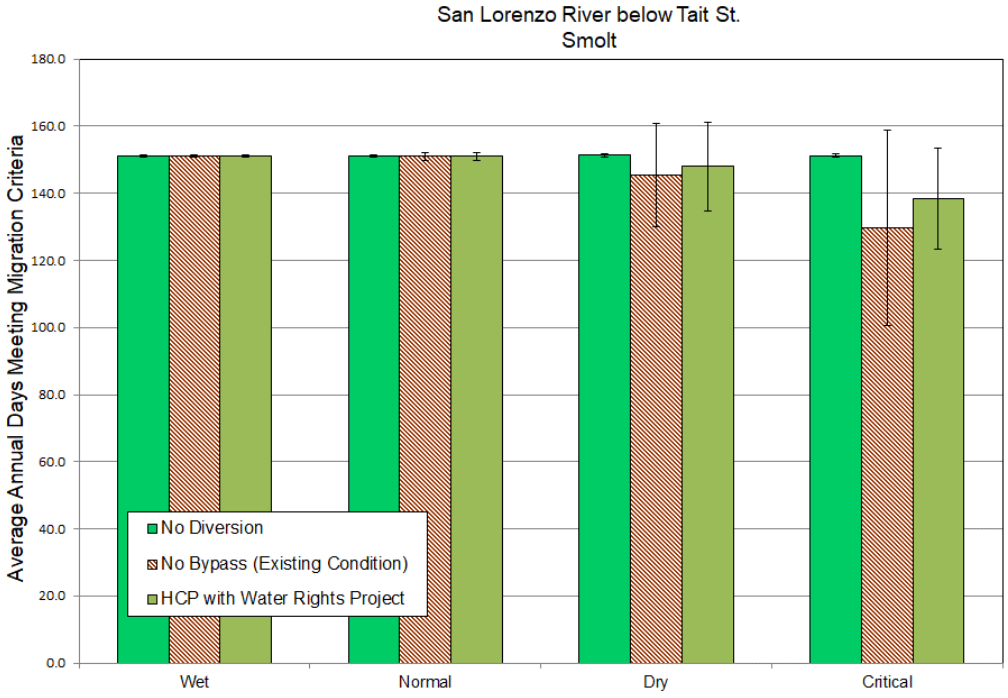


Table 5-12: Residual Effects of HCP Bypass Flows on Coho in the San Lorenzo River Downstream of Tait Street

	Coho			
	Adult migration	Spawning/ incubation	Rearing	Smolt migration
Wet	*			*
Normal	*			*
Dry	*			-2.3%
Critically dry	-9.8%			-8.5%

* Difference of 1 day or less

5.2.2.1 Consideration of Climate Change Scenarios

Coho have been rated as "critically vulnerable" to the effects of climate change. Unlike steelhead, coho have a relatively fixed life-history pattern with an approximate 1.5-year freshwater rearing period and a 1.5-year ocean maturation period. This means that weakness in any year-class cascades from generation to generation and weak year-classes are not readily rebuilt. Coho lack the diversity in life-history strategies characteristic of steelhead and do not do as well with excessive variability in environmental conditions. In that sense, they are less adaptable and will have more difficulty adapting to changing climatic conditions that are projected for the Plan Area under various climate change scenarios. Increasing air temperatures have the potential to limit the quality and availability of summer rearing habitat for juvenile coho by increasing water temperatures. Increases in fall and winter temperature regimes might shorten incubation and emergence times for developing eggs, which has been predicted to lead to lower survival rates. Increases in summer temperatures will lead to thermal stress, decreased growth and affect survival of out-migrating juveniles (NMFS 2012b).

In addition, coho spawning activity is concentrated early in the wet season (primarily in December and January). This makes their redds and fry vulnerable to damage from storms during the peak runoff months of February and March that follow. The possibility of more extreme flooding under climate change scenarios modeled for the region suggests that it will be

difficult to reestablish coho populations in the Plan Area. In analyzing the rangewide data for coho, NMFS determined the San Lorenzo River population of coho to be at a high or very high risk of threat from climate change (NMFS 2012b).

The Plan Area is at the southern end of the coho range. Coho have lower thermal tolerance and preferences than steelhead and any increase from present levels could be problematic for coho. In fact, existing variability in hydrologic patterns and peak storm flows, combined with warmer thermal regimes that have developed to date may in large part explain the absence of coho from the Plan Area at the present time, and may severely limit the potential for their re-establishment and recovery in the Plan Area despite the efforts of the City, as set forth in the conservation strategy, and conservation efforts of the fishery agencies and other conservation partners.

5.3 Effects of Water System Operation and Maintenance

The majority of potential effects from this activity are avoided by application of BMPs and SOPs already incorporated in Covered Activities (Section 4.4). The exception is the incidental take associated with capturing and relocating Covered Species from work areas when instream work is conducted. The level of effect is dependent on the frequency of projects requiring instream work, the location and areal extent of the projects, and the numbers of Covered Species present in the work area that need to be relocated. Activities that may generate the need to relocate Covered Species include repair and maintenance of diversion facilities; sediment management; fish ladder and fish screen maintenance and repair; and pipeline operations and maintenance.

Sediment removal is occasionally necessary at the Laguna Creek and Majors Creek diversions; however, both diversions are located well upstream of the limit of anadromy and would not require relocation of Covered Species. Maintenance or repair of fish screens and ladders at the Felton Diversion and the Tait Street Diversion as well as planned rehabilitation of fish screens at both fish facilities may require dewatering and relocation of Covered Species. It is likely that this activity would only occur once or twice at each facility during the life of the HCP. A limited length of stream would be affected, probably not more than 300 feet. Effects of relocation may include temporary interruption in feeding activity, increased exposure to predation, traumatic injury, and mortality. These effects can be minimized by protective measures (Section 4.4.3.4).

5.3.1 Steelhead

Based on rearing juvenile steelhead surveys in the San Lorenzo River, rearing densities of juvenile steelhead might range from 4 to71 juveniles per 100 feet of stream at the time work is performed (based on annual abundance measured at SL-main-4 between 2007 and 2018, Santa Cruz County Environmental Health Steelhead Monitoring Data[54]). Assuming an average density of 50 steelhead per 100 feet of stream and total length of stream affected of 1,200 feet (300 feet per event, two events at each facility over the term of the permit), a total of 600 steelhead may be relocated. Relocations conducted by professional biologists using protective measures typically result in direct mortality due to handling stress and incidental mortality that is less than 3%, or 18 fish out of 600.

5.3.1 Coho

No coho have been observed in the mainstem San Lorenzo River downstream of the Felton Diversion in annual juvenile salmonid surveys in recent years and even if coho become re-established in the San Lorenzo River they are more likely to be found rearing in the tributaries. Based on current low abundance of coho, no coho are expected to be relocated. If coho become re-established, relocation efforts may affect a small number of individuals. Relocations conducted by professional biologists using protective measures typically results in direct mortality that is less than 3%.

5.4 Effects of Municipal Facility Operation and Maintenance

The majority of potential effects from this activity are avoided by BMPs and SOPs incorporated into the Covered Activities (Section 4.4). Potential residual effects are related to sediment removal activities conducted in the San Lorenzo and Branciforte FCCs. This activity could involve dewatering sections of the FCCs and relocation of Covered Species. Effects are described in the following Section and summarized in Table 5-1 (steelhead) and Table 5-2 (coho).

5.4.1 Steelhead

This activity has been conducted infrequently in the past and would be expected to be infrequent during the term of the HCP, perhaps as often as three times in the San Lorenzo FCC and every

[54] http://scceh.com/steelhead/data.aspx

five years in the Branciforte FCC. Densities of rearing juvenile steelhead are variable. The San Lorenzo River FCC supports reasonably good rearing habitat for juvenile steelhead. Recent surveys have documented abundances ranging from 2 to 27 steelhead per 100 feet of stream in 11 annual surveys between 2000 and 2018[55] (Santa Cruz County Environmental Health Steelhead Monitoring Data[56]). Sediment removal in the San Lorenzo FCC is generally conducted by removing sediment from outside the wetted channel, leaving a narrow buffer and it is expected to be conducted this way in the future (Chris Berry, personal communication, 3-26-2019).

The Branciforte Creek FCC was characterized in three reaches with different habitat conditions during a survey in 2003 (HES 2003b). The upper portion of FCC (about 1,900 feet) was relatively high gradient with little sediment accumulation. It is a concrete box culvert with dry-season flows largely confined to a small, central, trapezoidal low-flow channel with a top width of 3 feet and depth of about a foot that provides minimal habitat for Covered Species. The middle section, from about Water Street to about Ocean Street, was lower gradient and had accumulations of sediments up to gravel size that formed bars with some colonization by vegetation. The lower part of the Branciforte FCC, downstream of Ocean Street, had a thin layer of sand accumulation but no vegetation. The lower and middle portions of the FCC comprised about 3,100 feet. The lower end of the FCC may be inundated by the lagoon at higher lagoon stages. Four juvenile steelhead were captured in a 193-foot section of the uppermost portion, but none were captured in the middle section and none were seen in visual surveys of the lower section (HES 2003b). The population density in the upper portion would be estimated at 2 steelhead per 100 feet of FCC. If it is assumed that sediment removal is conducted three times over the term of the HCP for the 3,100-foot lower and middle portions where sediment accumulates and that density of rearing juvenile steelhead is comparable to the upper section encountered in 2003, then up to 62 juvenile steelhead may be relocated during each sediment removal episode with direct mortality of 2 juvenile steelhead.

5.4.1 Coho

The San Lorenzo and Branciforte FCCs do not provide suitable habitat for coho and juvenile coho are not expected to be found there. Therefore, this activity is unlikely to have any effect on coho.

[55] Survey results for Station SLR-main-0a (between Highway 1 and the pedestrian bridge).
[56] http://scceh.com/steelhead/data.aspx

5.5 Effects of Land Management

The majority of effects related to Covered Activities in this category are avoided through application of BMPs and SOPs (Chapter 4). Aquatic habitat management has the potential for residual effects if Covered Species need to be relocated during construction of instream habitat improvement projects. The species and numbers affected will depend on the location and areal extent of the projects. It is assumed that up to 30 locations may be affected over the term of the HCP and that the average areal extent will involve 300 feet of stream channel that requires dewatering. Effects are described below and summarized in Table 5-1 (steelhead) and Table 5-2 (coho).

5.5.1 Steelhead

Average density of rearing juvenile steelhead is assumed to be 50 per 100 feet of stream. Over the term of the HCP up to 4,500 juvenile steelhead may need to be relocated and there may be direct mortality of up to 150 juvenile steelhead.

5.5.1 Coho

Some of these activities could occur in the tributaries where rearing coho may be present. Average densities are expected to be very low in the near term, but effects could occur if coho become re-established in the Plan Area. Under such future conditions coho may be found at up to one-third of the project locations, likely at densities not more than half those of rearing steelhead. Therefore, it is possible that, under these assumptions, as many as 750 coho may need to be relocated over the term of the HCP and there may be direct mortality of up to 75 juvenile coho.

5.6 Effects of the HCP Monitoring Program

The HCP monitoring program is described in detail in Chapter 6. Effects of the monitoring program are described in detail in the following Section and summarized in Table 5-1 (steelhead) and Table 5-2 (coho).

5.6.1 Steelhead

Three elements of the monitoring program have the potential to affect steelhead: juvenile abundance monitoring in riverine reaches, juvenile abundance monitoring in lagoons, and adult abundance at the Felton Diversion.

Juvenile abundance monitoring involves near-term continuation of existing snorkel surveys in the initial 3-year term of the HCP. Snorkel surveys involve direct observation of Covered Species in pools in the anadromous reaches of each of the north coast streams. Potential effects include disturbance, temporary dislocation from preferred habitats, and interruption of normal behaviors, including feeding. Numbers observed, based on past surveys, is expected to be on the order of 1,500 juvenile steelhead, 5 adult steelhead, and 100 juvenile coho.

Juvenile abundance monitoring may involve electrofishing surveys using mark-recapture estimates with PIT tagging in portions of the San Lorenzo River (Chapter 6). This monitoring element is intended to be consistent with the CMP which is still under development. The City monitoring program may change in response to evolution of the CMP. Any changes will be addressed through the TAC. The following assessment uses hypothetical assumptions for electrofishing to represent a "most likely" effects assessment.

Eight sample reaches will be selected each year and each reach will be sampled twice: once for marking, once for recapture. Sampled lengths will be on the order of 300 to 500 feet per sample reach or up to 4,000 feet total annually. Assuming average density of 50 steelhead per 100 feet of stream based on the Santa Cruz County monitoring data[57] a total of up to 2,000 juvenile steelhead may be captured with incidental mortality of up to 60 individuals.

Juvenile abundance monitoring in lagoons involves capture with large seine nets with tagging and release. The San Lorenzo River Lagoon is sampled monthly between June and October and Laguna Creek Lagoon is sampled once in June and September. Past surveys since 2007 have resulted in capture of up to 12,000 steelhead in a season in the San Lorenzo River Lagoon and up to 700 steelhead in the Laguna Creek Lagoon. Incidental mortality may be as high as 2% or as many as 240 in the San Lorenzo and 14 in Laguna Creek.

Monitoring of adult abundance at the Felton Diversion involves capture in a trap installed in the fish ladder, holding, examination, tagging, and release by the Monterey Bay Salmon and Trout

[57] http://scceh.com/steelhead/data.aspx

Project (MBSTP - a local fisheries conservation hatchery volunteer organization). This work is currently covered by permits between DFW, NMFS, and MBSTP. Past operation of the Felton Diversion trap (through 2013) has resulted in capture of as many as an estimated 3,000 steelhead (Alley 2015). This would likely be the maximum number of adult steelhead affected by the trapping operation in the future. There have been isolated events of MBSTP permit non-compliance that have resulted in mortality of adult steelhead in the past. It is anticipated that future monitoring overseen by the City would have a greater level of regulatory oversight than was historically the case with MBSTP. Subsequently, it is expected that there will be lower risk of mortality with future trapping operations.

5.6.1 Coho

The HCP monitoring program is described in detail in Chapter 6. The three elements of the monitoring program that have the potential to affect coho are juvenile abundance-riverine, juvenile abundance-lagoons, and adult abundance at the Felton Diversion. Juvenile abundance based on snorkel surveys has the potential to effect up to 100 juvenile coho based on the results of past surveys conducted by the City in the north coast streams. Juvenile abundance monitoring involving electrofishing has the potential to affect coho if they become re-established in the San Lorenzo River and Laguna Creek. In that case, they may occur in half the eight sample reaches, primarily in San Lorenzo River tributaries. Assuming they would occur at a density of 25 per 100 feet of stream, about half the density of steelhead, it is estimated that up to 500 coho may be captured each year with incidental mortality of 15 individuals.

Coho do not appear to use lagoon habitat for rearing as steelhead do and are less likely to be captured in lagoon monitoring surveys. In annual surveys from 2004 to present coho have been captured in only one year in Laguna Creek and never in the San Lorenzo River Lagoon. That could change if coho become re-established in the Plan Area. Based on past surveys it is possible that up to 200 coho might be captured in a season in both lagoons with incidental mortality as high as 4 individuals.

Upstream migrating coho have been trapped at the Felton Diversion by the Monterey Bay Salmon and Trout Project and peaked at 183 adults in 1989-1990 (Brown et al. 1994); however, in most years, few coho were captured (ENTRIX, Inc. 2004). A few coho have occasionally been observed in the trap since that time, with the most recent in the winter of 2012-2013 (Alley 2015). It is expected that few coho will be encountered in the adult monitoring trap at the Felton Diversion, likely less than 10 per year. If coho become re-established in the San Lorenzo River, numbers would increase but would not be likely to exceed 200 adults in a season.

6.0 PLAN IMPLEMENTATION

6.1 Introduction

This chapter identifies the issues that are related to Plan implementation and the approaches that will be used to address those issues over the term of the Plan. The chapter describes requirements for short-term and long-range planning, and budgets, monitoring, and compliance reporting. The chapter further describes the regulatory assurances under the ESA that are expected to be provided to the City. It also describes the commitment of the City to respond to foreseeable changes in circumstances that may adversely affect Covered Species and habitats and identifies a process by which changes that are not foreseeable can be addressed. The chapter also identifies the circumstances under which regulatory authorizations may be suspended or revoked.

6.2 Role of the City

6.2.1 Process for Water Supply Reliability

In 2014, the City Council convened the WSAC to engage a multi-disciplinary, stakeholder-driven process that would advise the Council on future water supply development. The overarching goal of the Committee's effort is to provide significant improvement to the sufficiency and reliability of the Santa Cruz water supply by 2025. The recommendations made by the group reflect consensus among WSAC members for how best to address an agreed-upon worst year gap of 1.2 billion gallons between water supply and water demand during times of extended drought. The strategies recommended include: (1) strengthened water conservation programs; (2) storage of available San Lorenzo River flows during the rainy season in regional aquifers, through processes known as "In Lieu" water transfers, for passive recharge, and Aquifer Storage and Recovery (ASR) for active recharge; and (3) a supply augmentation plan to use advanced-treated recycled water with desalination as a back-up, should the use of advanced-treated recycled water not be feasible. The Committee's Plan accomplishes the City's water supply goal while providing robust instream flows to support and enhance fish habitat restoration and protection.

Specifically, the second element of the City's Water Supply Reliability plan is required in order to implement improved instream flows or "Conservation Flows" described in this HCP. The

elements of this strategy that the City may implement to ensure sufficient water supply to implement the HCP are referred to as the Santa Cruz Water Rights Project and include:

- An extension of time to perfect the City's Felton Diversion water rights
- Alignment of all City's water rights place of use (POU) designation
- Flexibility in use of City's San Lorenzo River water rights points of diversion (POD)
- Addition of direct diversion to the City's Felton and Newell Creek water rights
- Improvements to the Graham Hill Water Treatment Plant that will enable more use of turbid winter high flows.
- Development of underground storage rights for diverted high winter flows.
- Designation of "Conservation Flows" for the City's San Lorenzo River and North Coast water rights

These changes will enable better use of high winter flows in the San Lorenzo River (primarily diverted from the Tait Street Diversion) to assist recharge of regional aquifers and enable supply reliability. This will provide additional water storage for the City for drought periods and generally support implementation of groundwater sustainability plans in their efforts to protect impacted groundwater basins such as the Santa Margarita and Mid-County basins. Each of the changes involving the City's water rights would be integrated with the addition to those rights of key environmental requirements. The Conservation Flows for fisheries conservation that the City has developed in close coordination with CDFW and NMFS would be added as minimum flow requirements that must be met before diversions occur in the applicable streams. In addition, requirements for fish passage and screening improvements at City diversion facilities would be added to the City's water-right permits and licenses that authorize diversions at the respective facilities (as described in Section 3.3.1 - Water Diversions). Minimum flow requirements would be added to the City's pre -1914 water rights in the North Coast streams through the Santa Cruz City Council's adoption of a resolution amending those rights. Minimum San Lorenzo River flow requirements would be added to the City's Felton water-right permits and its Tait Street water-right licenses through the City's water-right petitions to the SWRCB and the SWRCB's approval of those petitions.

The City's approach to water supply, and the required approvals by the State Water Resources Control Board, are foundational to regional water supply reliability and the City's ability to effectively implement the HCP.

6.2.2 Administrative Structure for Roles and Responsibilities for Implementation

The HCP Administrator will be housed in the Santa Cruz Water Department (SCWD) and will provide for coordinated and effective implementation of the Plan. The HCP Administrator will have the following roles and responsibilities:

- Financial planning and management of funding for habitat protection and biological and compliance monitoring.
- Reporting on Plan implementation, including annual accounting of activities.
- Maintenance and updates of the monitoring database on habitat, Covered Species, and other relevant information.
- Program implementation and coordination, including coordination between the City and NMFS.
- General administrative support for the above activities, including support personnel, accounting, facilities, and equipment.

6.3 Role of National Marine Fisheries Service

NMFS' role and responsibilities under the Plan include:

- Conferring with the HCP Administrator regarding Plan implementation.
- Participating in the adaptive management and monitoring program.
- Participating in the TAC.
- Providing assistance to third parties engaged in activities in the Plan Area to help ensure that such activities proceed in compliance with State and federal endangered species laws and in a manner that does not compromise the likelihood of success of the Plan.

6.4 Monitoring Program

The HCP monitoring program will provide the information necessary to assess compliance with the terms of the HCP, verify progress toward the biological goals and objectives, and implement a feedback loop to ensure that management/mitigation measures of the HCP can be changed as

needed in response to changing conditions and new knowledge. The monitoring program will be flexible to allow addition of new monitoring techniques or modification of monitoring methods that are not obtaining needed information. The monitoring program will be overseen by the HCP Administrator and methods and results will be reported in an annual monitoring report.

The monitoring program outlined below will provide data on the distribution and abundance of the Covered Species, their habitats, and potential threats within the Plan Area. Using these data, the City will be able to assess changes in the quality and quantity of the specific habitat of the Covered Species, identify significant changes in the populations of the Covered Species, measure progress towards meeting the HCP's biological goals and objectives, and decide if changes in management or monitoring are warranted. The results of the annual monitoring activities will also inform management decisions, including selection of projects to be funded from the NFCF.

All monitoring activities will be performed under the HCP Administrator's guidance and supervision, or under the guidance and supervision of a designated Conservation Program Manager. Prior to the implementation of the HCP, the Conservation Program Manager will prepare a monitoring manual that specifies the methods and protocols to be used in the Monitoring Program. Training will be provided for all individuals performing monitoring activities and these individuals will have qualifications, knowledge, and experience relevant to the type of research and monitoring activities that are being performed. A list of all individuals who participate in the monitoring activities and copies of training materials will be submitted to NMFS with the Annual Monitoring Report. The HCP Administrator may engage third parties (such as biological consultants with specific technical expertise regarding a Covered Species) who are qualified and authorized by NMFS to conduct, or to directly supervise, activities conducted under the HCP's monitoring program.

Monitoring program coordination with NMFS and CDFW will be achieved through regular meetings (at least one to two per year) of a Monitoring Technical Committee (MTC). Meetings will include a review of results of the past seasons monitoring and finalization of plans for the upcoming monitoring season. The value of existing studies will be appraised and monitoring elements may be revised accordingly.

6.4.1 Compliance Monitoring

The City is committing to meeting instream flow targets, operational constraints, and facility upgrades as avoidance and minimization measures under the HCP. The compliance monitoring element addresses these commitments. Annual monitoring and reporting will be completed to

demonstrate compliance with the terms and conditions of the permit, including incidental take limits (see Chapter 5 for determination of incidental take under this HCP). An annual compliance monitoring report will be completed with monitoring procedures and results as specified in the following areas:

- Incidental take tracking: The major effect of Covered Activities on listed salmonid species is alteration of habitat related to the City diversions and water supply facilities (Chapter 5). It is anticipated that operation of the City's diversion facilities and performance of other activities in conformance with the associated operating procedures and bypass flow requirements will maintain instream flow conditions in a manner that adequately protects and conserves habitat downstream of City water diversions. If operation of the City's facilities creates flow conditions which deviate from the bypass flow requirements, the anticipated level of incidental take caused by the proposed action will be exceeded. Therefore, tracking of incidental take will primarily involve documentation of flows and operating procedures as a surrogate for habitat. The annual compliance monitoring report will include an accounting of incidental take for each of the Covered Activities, including take associated with capture and including total number and any incidental mortality.
- Instream flow targets: The City will continue to maintain a streamflow monitoring network and to report anadromous gage daily flow records for Liddell (anadromous and upper), Laguna (anadromous, below diversion, above diversion), Majors (anadromous, below diversion, above diversion), Newell (upper and below dam), Felton (below the diversion), and Tait Street (below the diversion). The monthly exceedance category based on cumulative flow at the Big Trees gage[58] will be calculated and compared to the flow record at each gage to document compliance with appropriate instream bypass flows. Results of streamflow monitoring and analysis to document compliance with flow targets will be provided in the annual HCP monitoring report. Interim reporting will occur on an as-needed basis whenever the City determines that it is out of compliance with provision of bypass flows or is expecting to be out of compliance at some point in the future. This could result from facility outages, extreme weather conditions, or other unforeseen circumstances. Specific criteria and procedures for notification will be established by the MTC as part of implementation of the HCP.
- Felton Diversion operations: A description of the Felton Diversion operations is provided in Section 3.3.1 and minimization and avoidance of effects are described in Section 4.4. The City will provide a record of dam operations (Operations Log), including dates when fully inflated, deflated, partially inflated; position of slide gate,

[58] See Section 4.4 for description of exceedance categories and bypass flow prescriptions.

dates of operation and counts at the fish trap. Any issues involving fish ladder maintenance; fish screen maintenance; observation of sediment accumulations or sediment transport issues will also be reported with a focus on what did not work rather than details of what was done. These records will be included in an annual HCP monitoring report.

- Copper monitoring at Newell Creek Reservoir (Section 3.3.2, Section 4.4.2.2): The City will include an annual monitoring report as specified in the Aquatic Pesticide Application Plan, including dates of treatment and copper concentrations at standard measurement sites in the annual HCP monitoring report.
- Testing deluge and gate valves (Section 3.3.2, Section 4.4.2.2): The City will provide an annual report documenting the dates of testing, flows, and quality of water released to Newell Creek (temperature, turbidity, DO concentrations) measured at standard sampling points downstream.
- Relocation of LWD downstream of Loch Lomond Reservoir (Section 3.3.2, Section 4.4.2.2): During the dry season the City will remove tree trunks and limbs that collect at the dam and place them in areas downstream of Newell Creek where they can provide habitat for rearing juvenile salmonids. The City will include an annual report documenting the number and dimensions of material moved, dates, and locations of placement in the annual HCP monitoring reports.
- Installation of Sediment Management upgrades at Laguna, Reggiardo, and Majors Diversions (Section 3.3.1, Section 4.4.2.1): The City will install sediment management upgrades and sediment removal practices as specified in Streambed Alteration Agreements reached with CDFW. The City will include documentation of sediment management activities including dates, amount of sediment removed, etc., and dates for installation of upgrades in the annual HCP monitoring reports.
- As part of the Covered Activities, Fish Screen Upgrades and juvenile bypass improvements will be installed at the Felton and Tait Street Diversions. These activities will be documented in the annual HCP monitoring report, including a project description and date for installation. Monitoring of screen operation after installation will be provided under the Felton Diversion Operations Log (see previous).
- Water System Operations and Maintenance (Section 3.4, Section 4.4.2): The City will document operations completed for conveyance pipeline repair, finished pipeline flushing or repair, well return to San Lorenzo River, NC blow off to San Lorenzo River in the annual HCP monitoring report. This will include dates, description of the activity, and possible effects on steelhead, coho or habitat. The intent of this element is to demonstrate compliance with the terms of the HCP, and specifically to demonstrate that the avoidance and minimization measures are followed and completed.

- Municipal Facilities Operations and Maintenance (Section 3.5, Section 4.4.4): The City will provide a report on operations completed for debris/obstruction removal, sediment removal, and vegetation removal in the annual HCP monitoring report. Any fish protection operations completed will be described along with the numbers and species of fish captured, their disposition, and any losses encountered. There will also be a narrative description of potential effects on steelhead, coho, or their habitat.

6.4.2 Mitigation Effectiveness Monitoring

The mitigation effectiveness monitoring element addresses the non-flow component of the conservation strategy. The mitigation strategy is based on a stepwise process of habitat enhancement that will occur over the life of the HCP. The City will provide annual funding for projects, and a TAC will decide on projects and allocate funds (see Section 4.5 for a description of the mitigation program). Ongoing monitoring of mitigation efforts is important to verify or correct current assumptions, choose the best course of action to ensure that future efforts are based on the best available science, ascertain whether the Plan is achieving its biological goals and objectives, and provide information used to revise methods if necessary to improve attainment of biological goals and objectives. The proposed mitigation strategy is compatible with an adaptive management approach in that funding decisions for mitigation measures will be made on an annual basis and will reflect the current knowledge base and status of the species. Decisions on implementation of specific projects will be informed by the success of past measures as determined through specific monitoring studies addressing the mitigation measures. Monitoring and reporting will be conducted for each mitigation project implemented (see Individual Project Monitoring, below), and annual and five-year reporting of the overall mitigation program will be provided.

6.4.2.1 Individual Project Monitoring

Each mitigation project will be monitored after 1, 3, 5, and 10 years. Reporting for each mitigation project will be provided in the annual and five-year mitigation summary reports and will include information on attainment of project-specific success criteria (via review of assessment variables to be prescribed for each project by the TAC), responsible party, specific monitoring methods, a schedule of monitoring activities, analytical methods, and reporting requirements.

6.4.2.2 Annual and 5-Year summary Report

Annual reporting for the mitigation effectiveness monitoring will include the level of funding provided to the TAC for the year and a description of the projects implemented with that funding. The rationale for project selection and its relationship to effects to be mitigated under the HCP will be described. The HCP annual report will also incorporate a listing of all mitigation projects involving City funding implemented to-date together with their status as complete or not, an assessment of their success, and an accounting of City funds allocated to each project to date. Every five-year HCP update report will include a synopsis of effectiveness monitoring results for each project completed during the five-year period.

6.4.3 Population and Habitat Monitoring

This monitoring element addresses the status of Covered Species populations and habitat. Population and habitat monitoring will be consistent with the CMP (Adams et. al 2011). The CMP is a coordinated effort involving CDFW and NMFS with the goal of measuring progress to recovery of listed species under CESA and ESA listings. The City 's HCP requires monitoring to evaluate levels of take and effects of the City's activities on populations and habitat of covered species. To the extent that these efforts have common goals, the City's monitoring program can contribute to the wider evaluation of population status at the regional level.

The methodology of the CMP is still under development and implementation of the program is ongoing. There are limitations to monitoring capabilities and differing priorities between the CMP and City monitoring goals that still need to be resolved. For example, the CMP design calls for different objectives and methods in Northern Area (Aptos Creek and north) and Southern Area (Pajaro River and south). The HCP area, and especially the San Lorenzo River, is on the boundary and though technically in the Northern Area, it has much in common with the Southern Areas and may be better approached from that perspective. Methodological limitations in the HCP streams will need to be addressed as well. The most problematic of these include: inability to distinguish juvenile steelhead from juvenile resident trout in snorkel or other surveys; diver health considerations for snorkel surveys in the San Lorenzo River; effects of high stream flow and poor visibility for conducting redd surveys; and security of remote monitoring equipment installations, especially on the San Lorenzo River.

It is anticipated that there will be a period of initial development of the monitoring program that is best accomplished through a MTC composed of both Agency (CDFW and NOAA) and City representatives. The MTC may be a sub-committee of the HCP TAC. The MTC will ensure

consistency with the CMP and this process will yield the most rigorous approach to resolving monitoring issues identified. For this reason, the monitoring program presented here should be viewed as an initial representation of the program that will be refined as it is implemented. It should be recognized that there needs to be some flexibility in the design to allow for incorporation of improvements resulting from better definition of the CMP and possible technological advances in monitoring methods over time. The monitoring elements are described here from the perspective of current monitoring efforts, modifications consistent with the CMP, and recognition that the final design will come under the guidance of a MTC to reflect the state of the art in regional salmonid assessment and to ensure consistency with regional efforts as they develop. Details for each monitoring element, including key measurement variables, methods, location, frequency, and timing, are also provided in Table 6-1.

Unless noted otherwise, field monitoring programs will follow established protocols from published sources including the Salmonid Field Protocols Handbook (Johnson et al 2007), California Salmonid Stream Habitat Restoration Manual (Flossi et al. 1998), California Coastal Salmonid Population Monitoring: Strategy, Design, and Methods (Adams et. al 2011), the Central California Coast Coho Salmon Recovery Plan (NMFS 2012), and other peer-reviewed scientific literature. Detailed monitoring protocols will be developed and refined within the context of the MTC. At five-year intervals the City will review the monitoring program in association with representatives of NOAA and CDFW and the value of existing studies will be appraised and monitoring elements may be revised accordingly.

6.4.3.1 Steelhead and Coho Population Viability

The CMP uses the Viable Salmonid Population (VSP) (McElhany et. al. 2000) concept as the framework for plan development. The VSP conceptual framework assesses salmonid viability in terms of four key population characteristics: abundance, productivity, spatial structure, and diversity (Adams et al. 2011). The City's monitoring program, as described below, is designed to be consistent with this framework. The City will also collaborate on an informal basis with other agencies to share information providing population abundance monitoring over a wider area, including areas outside the Plan Area and wider ESU level trends. For example, NMFS has operated a life-cycle research station in Scott Creek where detailed information is collected on rearing abundance, smolt migration, and adult return rates of steelhead and coho. This research provides valuable information for addressing the effects of marine survival on salmonid populations and distinguishing these effects from those derived from freshwater survival and

productivity. The City will refer to the information from this and other stations to make inferences and comparisons and interpret the abundance data it collects.

Abundance and Productivity

The CMP uses adult population size as the key measure of abundance and productivity (trend in abundance over time). Adult abundance monitoring is approached differently in the Northern and Southern Areas with expanded redd surveys in the North and counts at fixed stations in the South (Adams et al. 2011).

Current abundance monitoring in the HCP area involves annual snorkeling surveys for juvenile abundance in the anadromous reaches of Liddell Creek, Laguna Creek, and Majors Creek and annual quantitative electrofishing in the San Lorenzo River watershed. In order to be consistent with the CMP, abundance monitoring would be shifted to adults and the emphasis of juvenile monitoring would be shifted to measuring spatial structure and diversity (see below).

The CMP uses a combination of fixed station total adult census in selected intensively monitored watersheds (Life-cycle monitoring stations), and regional redd surveys to estimate total salmon and steelhead abundance on a region wide scale. CDFW has previously conducted regional adult spawner surveys in Santa Cruz Mtn streams although this monitoring is no longer occurring (Sean Cochran, CDFW, personal communication, January 2021). For the San Lorenzo River, total adult population is the monitoring objective and therefore a fixed station count is the most appropriate method. Redd surveys in the San Lorenzo River may have some utility as a complement to fixed station counts, particularly in parts of the watershed that may be missed by fixed station counts. The potential for redd surveys in Liddell, Laguna, and Majors Creeks should be explored though the small size and complex habitat in these streams may be problematic in terms of disturbance to spawning fish, damage from walking on redds, and ability to observe redds and/or spawning fish, especially with the small run sizes likely to occur in the short anadromous reaches.

The trap at the Felton Diversion Dam offers a potential opportunity for a fixed station counting location. The trap would have to be combined with other methods such as a DIDSON[59] camera or PIT tag monitoring to achieve an estimate of the adult population passing Felton. Adult trapping can be used to enumerate; tag (external spaghetti or PIT); identify species and sex; examine for scars, parasites, and body condition; and collect tissue samples for genetic analysis

[59] Dual-Frequency Identification Sonar (DIDSON) is an acoustic "camera" that has been adapted to fisheries monitoring (Maxwell and Gove 2004). The device is a high-frequency sonar system with a lens capable of focusing sound waves onto a high-resolution sensor array.

and scales for life history analysis from captured listed species. The Monterey Bay Salmon and Trout Project is a potential partner for this work. A drawback of the Felton location is that any fish spawning lower in the watershed (Gorge, Branciforte Creek) would not be counted. A fixed station count lower in the watershed, such as at the Tait Diversion, would be necessary to overcome this limitation. This could be accomplished by a resistance weir in the lower river, possibly in conjunction with the Tait Diversion structure; a trap at the diversion; or a DIDSON installation. DIDSON has the advantage of being operable at higher flows than a resistance weir and avoiding the elaborate structure and equipment requirements of a trap or weir. The drawback is that it is unable to accurately distinguish species, steelhead and coho for example. Any count at the Tait Diversion would also fail to incorporate fish using the Branciforte watershed.

Spatial Structure and Diversity

The CMP uses spatial structure and diversity as measures of population viability. Spatial structure refers to the geographical and ecological distribution of salmonids across the landscape. Broad spatial distribution and connectivity among populations are important traits that protect against the effects of catastrophic events and buffer extinction risk, particularly at low abundance. Although some information on spatial structure can come from adult surveys where redd surveys are conducted, the CMP proposes using visual (snorkel) surveys for juvenile salmonids as the most efficient means to monitor spatial structure (Adams et al. 2011). A larger number of juvenile surveys can be accomplished in less time and expense than adult surveys because it is simpler and can occur at a more operationally favorable time of the year. Snorkel surveys are also more efficient than electrofishing surveys, allowing a wide geographic area to be surveyed. Under the CMP, the key elements of measuring spatial structure are distribution and relative abundance on a regional scale, not population abundance quantification per se.

The City currently conducts snorkel surveys in the fall of the year to estimate the abundance of juvenile steelhead and coho in Liddell Creek, Laguna Creek, and Majors Creek. The City also contributes funding to Santa Cruz County and research partners for annual surveys of juvenile abundance in the San Lorenzo River system including Newell Creek. The San Lorenzo River survey has been implemented since 1997 and develops population abundance data using a combination of depletion electrofishing (DW Alley and Associates 2010) and visual (snorkel) surveys in larger, deeper pools that are not effectively sampled by electrofishing. The San Lorenzo surveys emphasize a basinwide abundance estimate for both young-of-year and older juveniles but also allow for comparisons between defined subreaches within the watershed. The City also conducts abundance surveys in Laguna Creek Lagoon and the San Lorenzo River

Lagoon using beach seines. The beach seining surveys employ mark-recapture techniques and PIT tagging to estimate population size in each of the lagoons.

City snorkel surveys in the North Coast streams are consistent with the CMP as currently conducted. Although the CMP sampling scheme may not select these reaches in any given year, the data would be available for incorporation whenever selected. Annual data provides a finer grain than required under the CMP but it is useful under the HCP as an indicator of status and trends relative to operation of the City diversions.

The current annual electrofishing/visual surveys in the San Lorenzo River and Newell Creek are not consistent with the CMP due to 1) different definition of reaches, 2) primary use of electrofishing instead of snorkeling and, 3) use of a subjective representative site selection method instead of random sampling. The lack of random sampling under the current surveys prevents rigorous statistical analysis for comparison of annual or spatial differences in abundance. Nevertheless, the current surveys include a long term, consistently sampled dataset that has value even if not consistent with the CMP methods and should not be abandoned lightly. A comparison of the non-random methodology with a more rigorous randomized sampling scheme conducted in 2002 found that both methods gave generally comparable results in terms of parameter estimates for both habitat features and steelhead abundance (H.T. Harvey & Associates 2003a). The chief advantage of the randomized sampling is that it provides a statistically rigorous basis for spatial and temporal comparisons that the non-randomized design does not.

Under the HCP, the City will monitor juvenile salmonid spatial structure and distribution by conducting annual juvenile surveys during the late summer or fall by either snorkeling or electrofishing. The juvenile surveys will be conducted within a statistically valid spatially balanced sampling design, consistent with the CMP (Adams et al. 2011), using established sampling protocol in salmonid monitoring literature (Johnson et al. 2007; Boughton 2010, Hankin and Reeves 1988). Snorkel surveys are generally preferred as they can cover a wider area for a given level of effort than electrofishing. On the other hand, electrofishing is advantageous for collecting more precise size data and providing an opportunity for PIT tagging. Snorkel surveys may be precluded in some areas due to lack of landowner approval for access, excessively deep pools, dense cover, concerns for diver health due to poor water quality, and other safety concerns. The general random tessellation stratified (GRTS) sampling scheme can easily accommodate unusable sample reaches (Adams et al. 2011). It is also likely that the City will add samples in segments of the San Lorenzo River that are influenced by City water diversions in order to allow evaluation of status and trends within the sub-watershed areas affected by altered flow regimes. The GRTS framework also allows for augmented sampling for

domain estimates (Adams et al. 2011). The City monitoring program will be more fully defined by the MTC before full implementation and may change in response to evolution of the CMP. Any changes will be addressed through the MTC.

The City sampling frame will include all reaches in the San Lorenzo watershed downstream of operations (San Lorenzo River downstream of the Newell Creek confluence and Newell Creek below the Newell Creek Dam), and the anadromous reaches of Laguna Creek, Majors Creek, and Liddell Creek. To provide statistical integrity, the City surveys will conform with spatially balanced reaches designated by CDFW using a GRTS sampling scheme (McDonald 2004; Adams et al. 2011). The use of a common spatial sample scheme is to provide consistency in the sampling universe, so that data gathered is spatially comparable (Adams et al. 2011). This will allow for future coordination with other conservation partners and the fishery agencies for a complete assessment of the watershed. Juvenile surveys conducted under the HCP will be more intensive than envisioned in the CMP and will likely include the entire reaches affected by City operations. Consistency with the CMP will be maintained by structuring sampling within the GRTS reaches identified in the CMP and by developing and reporting data with the same methodologies employed in the CMP.

Juvenile Abundance and Spatial Distribution- Lagoons

The City will monitor rearing populations of juvenile steelhead and coho in Laguna Creek Lagoon and the San Lorenzo River Lagoon (the only two streams with functional lagoon systems) on an annual basis using seining surveys. Population abundance in each lagoon will be estimated from Petersen mark-recapture methods (Ricker 1975) using PIT tag technology and catch per unit effort (CPUE). Population abundance will be estimated in June and September at a minimum and intervening status checks may also be conducted, with or without tagging and population estimates. Seining is conducted at standard sampling sites within each lagoon which are largely determined by accessibility and suitability for use of seine equipment (HES 2009, HES 2010, HES 2011, HES 2012, HES 2013, HES 2014a, HES 2015, HES 2016, HES 2017).

PIT Tag Monitoring Antenna

Although not specifically identified as a component of the CMP, PIT tag monitoring can provide valuable supplemental information and will be performed in the San Lorenzo River. A PIT tag monitoring antenna is currently maintained by the NOAA Southwest Fisheries Science Center below the Felton Diversion. The City will install an additional antenna in the lower river, potentially at the Tait Street Diversion and/or Branciforte Creek. This supports both juvenile monitoring and adult monitoring. PIT tags will be placed in juveniles during electrofishing and

seining surveys and in adults during trapping at the Felton Diversion Dam (see above). Installation and maintenance of a PIT tag antenna array in the San Lorenzo River will allow the City to passively monitor movement of tagged individuals (Johnson et al. 2007; Boughton 2010) including movement of juveniles or smolts tagged during stream electrofishing surveys, movement of juveniles tagged in lagoon seining surveys, and movement of adults tagged in the Felton Diversion Dam trap. Using PIT antenna data, the City can identify life history strategies, identify movement and migration timing across habitats, and quantify trap capture efficiency. The NOAA Southwest Fisheries Science Center is a potential partner for this work.

6.4.3.2 Steelhead and Coho Habitat Quality

Instream flow targets are keyed to existing channel structure and habitat conditions. Habitat conditions may shift in response to flow management under the HCP and due to a variety of other factors, including altered hydrology and vegetation under climate change, wildfires, drought, and increased development. Changes in habitat quality will be monitored to better understand any observed changes in population abundance. Habitat monitoring will involve both instream habitat and lagoon habitat. Habitat assessment methods should be consistent with existing accepted methods (Flossi et al. 1998) or with the CMP which have not currently been developed. The City monitoring program may change in response to evolution of the CMP. Any changes will be addressed through the MTC.

Instream Habitat

Instream habitat will be surveyed by the City following the occurrence of a 5 year or larger flow event (as measured at the Big Trees USGS gage) in the anadromous reaches of Liddell Creek, Laguna Creek, Majors Creek, Newell Creek, and the San Lorenzo River downstream of Newell Creek Dam. The habitat survey will include detailed characterization of stream habitat conditions in accordance with the California Salmonid Stream Habitat Restoration Manual (CDFW Method) (Flossi et al. 1998) or other appropriate methodology determined by the MTC. Surveys will include: channel instream habitat typing, quantification of stream habitat by mesohabitat type (riffle, pool, flatwater, etc.) including length, width, depth, substrate characteristics (embeddedness and dominant substrate), instream shelter characteristics, and canopy characteristics. Habitat surveys will occur with reference to the CMP GRTS reaches. Habitat monitoring will also include periodic evaluation of passage obstacles including critical riffles and other obstacles to ensure that minimum passage flow levels previously estimated remain valid. Critical riffles will be evaluated using methodology agreed upon by the MTC (e.g. the Standard Operating Procedure for Critical Riffle Analysis for Fish Passage in California

(CDFW 2012)). Reports will include a compilation of results and summary of trends over the previous reporting period. The SLVWD, Scotts Valley Water District (SVWD), and County of Santa Cruz are potential partners for this work.

Instream Temperature

Current water temperature conditions are well within suitable ranges for steelhead and coho in North Coast streams but may be limiting in parts of the San Lorenzo River, particularly for coho (Chapter 2). Global climate change may alter temperature regimes in all these streams. A water temperature monitoring network will be established using continuous instream recorders set to record at 30-minute intervals. Recorders will be placed annually during the period of maximum thermal loading (May 1 through September 30). Recorders will be placed to avoid discovery and will be downloaded on a monthly basis. Recorders will be maintained at the following locations:

- Laguna Creek (2): Below diversion and anadromous
- Liddell Creek (2): Below diversion and anadromous
- Major Creek (2): Below diversion and anadromous
- San Lorenzo River (4): Upstream of Water St in the riverine reach, Tait Street, Gorge, Ben Lomond upstream and downstream of Newell Creek confluence
- Newell Creek (2): Below dam (fish release outlet) and anadromous (Glen Arbor)

Water temperature monitoring protocols will be developed in advance and approved by the TAC. Protocols for monitoring and analysis will follow accepted methods as presented in the scientific literature (e.g. US EPA 2014, Toohey et al. 2014, Dunham et al. 2005). The temperature monitoring plan will specify standardized protocols and data-quality standards to produce generally consistent, unbiased, and reproducible data. The program will include definition of data-quality objectives, site selection criteria, selection of instrumentation, protocols for installation of sensors, schedule of periodic site visits to maintain sensors and download data, pre- and post-deployment verification against an NIST-certified thermometer, potential data corrections, database management and proper documentation, review, and approval procedures.

Lagoon Habitat

Lagoon habitat quality conditions will be monitored annually by the City in both the Laguna Creek and San Lorenzo River lagoons[60] consistent with previous surveys conducted since 2004 (2NDNATURE 2017, 2NDNATURE 2006). Water quality monitoring will document patterns

[60] Majors Creek and Liddell Creek do not have functional lagoons.

of DO, temperature, salinity, tidal and freshwater inflow, climate, lagoon stage, lagoon volume, and nutrients throughout the water column and along the length of both lagoons during the late spring, summer and fall months when they provide important rearing habitat for steelhead smolts. Data will continue to be collected at two standard monitoring locations as well as periodic profiles of these same parameters at an additional 6 standard sampling locations at regular intervals throughout each lagoon. Winter water surface elevation data will also be collected and assessed annually to help evaluate lagoon breach dynamics.

Table 6-1: Salmonid Population and Habitat Monitoring Elements

Monitoring Element	Source	Key Measurement Variable(s)	Method	Location	Frequency	Timing
Population Abundance-Juvenile	City of Santa Cruz	Count per 100 ft. of stream by age class	Spatially balanced snorkel survey and per CDFW CMP protocol.	Liddell Creek Laguna Creek Majors Creek	Annually	Fall
Population Abundance-Juvenile	City of Santa Cruz	Count per 100 ft. of stream by age class	Spatially balanced electrofishing/ snorkel survey per CDFW CMP protocol.	Newell Creek Dam downstream to Water St.	Annually	Fall
Population Abundance-Juvenile	City of Santa Cruz	Total population estimate	Seine: Petersen Mark-recapture with PIT tags	Laguna Creek Lagoon San Lorenzo River Lagoon	Annually	Early Summer/Fall
Population Abundance Adult	City of Santa Cruz	Adult Escapement Sex ratio	Trap/DIDSON/PIT counting station	Felton Diversion Dam	Annually	December-April
PIT tag antenna array	City of Santa Cruz	Juvenile and adult movement	Passive antenna	San Lorenzo River-specific location to be determined	Constant	Year around
Stream Habitat	City of Santa Cruz	Channel cross-section Habitat type composition Wetted width Mean and maximum depth Instream cover Spawning area Gravel embeddedness Dominant substrate	California Salmonid Stream Restoration Manual, Level IV	Anadromous reach: Liddell Creek Laguna Creek Majors Creek Newell Creek Dam downstream to Water St.	Subsequent to each 5-year flood event as measured at Big Trees USGS gage	Late Summer

Instream temperature	City of Santa Cruz	Water temperature (°C) accuracy +/- 0.1 °C	Instream continuous temperature recorder	Below Laguna Diversion Anadromous Laguna Below Liddell Diversion Anadromous Liddell Below Majors Diversion Anadromous Majors San Lorenzo River above Water St. in riverine reach San Lorenzo River at the Tait Street Diversion San Lorenzo River Gorge San Lorenzo River upstream and downstream of Newell Creek Newell below Dam Anadromous Newell (Glen Arbor)	30 minutes	May 1-September 30
Passage Obstacles	City of Santa Cruz	Minimum passage flow estimate	CDFW Critical Riffle Analysis Powers and Orsborn California Salmonid Stream Restoration Manual	Anadromous reach: Liddell Creek Laguna Creek Majors Creek Newell Creek San Lorenzo River below Tait Street San Lorenzo River gorge	Subsequent to each 5-year or larger flood event as measured at Big Trees USGS gage	Winter high flows and summer low flows
Lagoon Habitat	City of Santa Cruz	Dates open and closed Depth/Water surface elevation (WSE) Thermal record DO record Salinity Nutrient concentrations Aquatic veg. types and area	Continuous recorder at mid-point; monthly profiles at set stations	Laguna Creek Lagoon San Lorenzo River Lagoon	Annually	May-November WSE Year-round

6.4.4 Adaptive Management Process and Options

Monitoring results will be used to guide management activities to help ensure attainment of the HCP goals and objectives. Steelhead and coho life cycles are typically completed in three to five years. The City's adaptive management planning will be completed in five-year review periods. This time period allows for data capture covering different life-stages and inherent population fluctuations due to timing of fish maturity and annual weather cycles. Each five-year review will be based on a summary report for the preceding five-year period. The report will integrate information in the annual reports for the review period and describe population abundance trends and habitat quality changes since the last review. Biological parameters will be compared with any observed changes in physical parameters or project operations to identify possible linkages. Progress and level of attainment of each of the HCP goals and objectives (Section 5.3) will be summarized.

The conservation strategy is designed to support improved habitat conditions relative to the current condition with the implication that populations of steelhead and coho will be benefited and that population parameters would also respond in a positive fashion. The key evaluation factor triggering the need for adaptive management under the HCP is a lack of improvement in habitat values for Covered Species. Habitat indices (average spawning or rearing WUA, annual number of days meeting adult or smolt migration criteria) provide logical assessment variables and lack of improvement in any of these indices, relative to conditions existing before implementation of HCP related improvements, could trigger adaptive management actions. Declining habitat values may also be indicated by trends in lagoon habitat parameters (depth, temperature, oxygen, salinity, and vegetation characteristics); trends in stream temperatures; or trends in stream habitat parameters (channel cross-sections, critical riffle analysis; mesohabitat proportions; substrate composition; instream cover characteristics, etc.). Parameter values are assessed over appropriate time frames using valid statistical approaches. A minimum period of three to five years will likely be necessary for identifying significant trends.

The Plan Area is only a subset of the wider geographic areas that are the basis for population recovery under the ESA. It is anticipated that others (NMFS, CDFW) will be conducting monitoring programs that address population viability over these wider geographic areas (Crawford and Rumsey 2011). Monitoring conducted by the City under the HCP and within its limited geographic range may augment but will not replace these efforts. Data from the wider recovery area must be considered in addressing long-term viability and this data will provide an important context for evaluating monitoring data collected by the City within the HCP plan area.

The HCP monitoring program will produce a large amount of data from which habitat indicators may be drawn. These may include:

Instream Habitat

- Average life-stage WUA for spawning and rearing (based on streamflow monitoring and existing habitat models)
- Days with suitable passage conditions for adults and smolts
- Maximum seven-day moving average of daily maximum temperature
- Maximum seven-day moving average of daily average temperature
- Quantification of stream habitat by mesohabitat type (riffle, pool, flatwater, etc.) including length, width, depth, substrate characteristics, instream shelter characteristics
- Channel type definition
- Channel cross-section
- Stream bank and canopy characteristics
- Instream cover characteristics
- Spawning area
- Dominant substrate and gravel embeddedness

Lagoon Habitat:

- August average daily inflow (cfs)
- Dates of sandbar closure (initial and final)
- Number of days of sandbar closure between May 15 and October 1
- Number of days of microtidal conditions between May 15 and October 1
- Mean of daily average water depth or lagoon stage (July and August)
- Minimum water depth or lagoon stage (July and August)
- Seven-day moving average of daily maximum air temperature (July and August)
- Seven-day moving average of daily maximum surface water temperature (July and August)
- Number of days with daily maximum surface temperature exceeding 25°C
- Number of days with daily maximum surface temperature exceeding 21°C

Should the monitoring data indicate a consistent declining trend or lack of improvement in habitat conditions relative to conditions existing before implementation of HCP related improvements, the City will implement adaptive management responses. The need for adaptive management decisions and actions will be an ongoing process best pursued within the TAC and will be based on trends in the monitoring data and in consideration of the biological goals and objectives of the HCP. Adaptive management actions may be based on declines in habitat indicators or lack of improvement in those indicators. Many of the indicators have been measured during development of the HCP and some have long-term datasets of 10 years or more. These indicators will be used as a baseline for comparison of

the first five years of the HCP. For other indicators with shorter data histories or no previous monitoring, trends will be evaluated during the first five years of monitoring and this period will serve as a baseline for future monitoring. For a number of reasons, including that coho numbers in the Plan Area are essentially zero due to local extirpation and very low, sporadic abundance in recent years, habitat indicators have been selected for understanding baseline conditions instead of population counts.

Outcomes of the adaptive management decision making process can include, within the limits set by the HCP and permit, changes to choice of conservation projects, monitoring programs, analytical tools, and targets. There are other factors in addition to controlling streamflows and improving stream and lagoon habitat that contribute to the long-term persistence and viability of steelhead and coho populations in the HCP area, including:

- ESU/DPS wide and regional trends in target species populations
- Climate change, precipitation patterns, temperature trends, ocean productivity
- Fish health / disease factors
- Invasive species
- Watershed conditions, surface water/groundwater interactions

Changes in any of these factors may trigger adaptive management decisions under the HCP. These factors, many not fully understood, are being monitored by other agencies. Through monitoring and continued information exchange with the fishery agencies, and in coordination with NMFS review and approval, the City may modify non-flow conservation and monitoring programs to address new information in these areas.

6.5 Regulatory Assurances and Changed Circumstances and Unforeseen Circumstances

6.5.1 Regulatory Assurances

ESA regulations provide for regulatory and economic assurances to parties covered by approved HCPs concerning their financial obligations under a plan, as long as a permittee is implementing the requirements of the HCP, permit, and other associated documents in good faith, and their permitted activities will not jeopardize the species. Specifically, these assurances are intended to provide a degree of certainty regarding the overall costs associated with species mitigation and other conservation measures and add durability and reliability to agreements reached between permittees and

NMFS. That is, if unforeseen circumstances occur that adversely affect species covered by an HCP, NMFS will not require additional land, water, or financial compensation or impose additional restrictions on the use of land, water, or other natural resources, unless the permittee consents.

The assurances provided under the ESA do not limit or constrain NMFS, or any other public agency, from taking additional actions to protect or conserve species covered by an HCP. The state and federal agencies may use the variety of tools at their disposal and take actions to reduce the effects of other stressors to ensure that the needs of species affected by unforeseen events are adequately addressed.

6.5.1.1 Regulatory Assurances Under the ESA – The No Surprises Rule

Under the No Surprises Rule, once an incidental take permit has been issued pursuant to an HCP, and its terms and conditions are being fully implemented, the federal government will not require additional conservation or mitigation measures, including land, water (including quantity and timing of delivery), money, or restrictions on the use of those resources, without the consent of the permittee, provided the HCP is being properly implemented.[61] If the status of a species addressed under an HCP unexpectedly declines, the primary obligation for undertaking additional conservation measures rests with the federal government, other government agencies, or other non-federal landowners who have not yet developed HCPs. As explained by the federal fish and wildlife agencies:

> Once an HCP permit has been issued and its terms and conditions are being fully complied with, the permittee may remain secure regarding the agreed upon cost of conservation and mitigation. If the status of a species addressed under an HCP unexpectedly worsens because of unforeseen circumstances, the primary obligation for implementing additional conservation measures would be the responsibility of the Federal government, other government agencies, and other non-Federal landowners who have not yet developed an HCP.[62]

However, NMFS may, in the event of unforeseen circumstances, require additional measures provided they are limited to modifications within conserved habitat areas or to the conservation plan's operating conservation program for the affected species, and that these measures do not involve additional financial commitments or resource restrictions without the consent of the permittee. These assurances are provided to all HCP permittees that properly implement their plans.

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[61] 63 Fed. Reg. 8859 (Feb. 23, 1998).

[62] *Id*. at 8868. The No Surprises rule was promulgated jointly by the Department of the Interior (Service) and the Department of Commerce (National Marine Fisheries Service).

6.5.2 Changed Circumstances

This section of the HCP addresses future changed circumstances affecting the Covered Species. Federal regulations define the concepts of "changed and unforeseen circumstances" and set forth the parameters of the Permittee's potential responsibilities in response to such changed and unforeseen circumstances.

Generally, a "changed circumstance" is a change in the circumstances affecting a Covered Species that can be reasonably anticipated, which allows a plan to be developed in advance to respond to the change. Changed Circumstances are defined under the Federal "No Surprises" rule as changes in circumstances affecting a species or geographic area covered by a conservation plan that can reasonably be anticipated by plan developers and NMFS and that can be planned for (e.g., the listing of a new species, or a fire or other natural catastrophic event in areas prone to such events).

Changed circumstances typically include unplanned but relatively predictable events, such as fires, flooding, and other natural occurrences like an invasion of pests or non-native plants. Anticipating and addressing changed circumstances adds to the conservation value of the HCP by reducing the potential risks to the Covered Species associated with the changed circumstance. This approach also provides NMFS with additional assurance that the Permittee will take certain actions if such changed circumstances occur, while providing the Permittee with assurance that its future responsibilities are defined and not open-ended.

6.5.2.1 Changed Circumstances Provided for in this HCP

The following Changed Circumstances can reasonably be anticipated to occur throughout the Plan Area during the term of the Plan:

- Climate Change
- Drought
- Fire
- Flood
- New Listings of Species not Covered by the Plan

Each of the defined Changed Circumstances includes a description of the Changed Circumstance and a summary of planned responses to be undertaken in the case of such Changed Circumstances. The City and NMFS agree that the Changed Circumstances defined by this section of the Plan represent all

Changed Circumstances to be addressed by the City. Planned responses will not include any actions beyond those expressly identified in this section, nor for any event not specifically identified as a Changed Circumstance.

Climate Change

During the implementation period for the Plan, the Plan Area will undergo a change in climatic conditions. The signs of global climate change continue to mount and include melting glaciers, heat waves, rising seas, flowers blooming earlier, lakes freezing later, and migratory birds delaying their flights south. The World Meteorological Organization stated that "[t]he decade 2001–2010 was also the warmest on record. Temperatures over the decade averaged 0.46°C above the 1961–1990 mean, 0.21°C warmer than the previous record decade 1991–2000. In turn, 1991–2000 was warmer than previous decades, consistent with a long-term warming trend." (World Meteorological Organization (WMO) 2010). The California Energy Commission's Public Interest Energy Research Program reports that climate change will have significant societal impacts, including effects on the water supply, flood risk, levee vulnerability, air quality, agriculture, and human health (Bonfils et al. 2007). In addition to societal impacts, California's vulnerability to climate change and its associated changes in temperature and precipitation will affect natural ecosystems (Mastrandrea et al. 2009).

The effects of climate change on the Covered Species and communities can be difficult to predict as they will be influenced by a number of indirect effects and species interactions but NMFS has determined that freshwater streams important to salmonids may experience increased frequencies of floods, droughts, lower summer flows and higher temperatures as a result of climate change (NMFS 2016b). In particular, the potential effects of climate change on fog frequency along the central coast may have important implications for the Covered Species, as fog provides approximately one-third of the water received by coastal ecosystems. Increases in air temperature could be exacerbated by continuation of a trend of 33% reduction in the frequency of summer fog in coastal California (Johnstone and Dawson 2010). But the predictions for future summer fog frequency on California's central coast are unclear. While a 33% reduction in the frequency of California summer fog has been observed over the past century (Johnstone and Dawson 2010), the predicted increase in temperature differential between coastal and inland areas may increase the frequency of summer fog, thereby offsetting the effects of climate change on temperatures in coastal areas. Despite the uncertainty regarding the role of fog, it is possible that the annual average maximum temperature for the Plan Area could increase by 4-5° F during the term of the Plan (Langridge 2018).

Analysis of climate change trends indicate that in California average air temperatures, rising sea levels, changes in precipitation, and change in the frequency and/or severity of extreme events such as heat waves, droughts, and catastrophic fires are all expected as a result of climate change (NMFS 2016b).

Overall, climate change can reasonably be expected to influence the ecological response of Covered Species over the term of the Plan. However, the specific type and magnitude of these changes is uncertain. Nonetheless, for the Covered Species climate change will present enormous challenges. All California native anadromous fishes have been rated as "highly or critically vulnerable" to climate change. Increasing air temperatures have the potential to limit the quality and availability of summer rearing habitat for juvenile coho by increasing water temperatures. The range of surface water temperatures are likely to shift, resulting in higher high temperatures as well as higher low temperatures in streams. These higher low stream temperatures have a variety of impacts on juvenile salmonids, including the potential to limit the quality and availability of summer rearing habitat (NMFS 2012b). Increases in summer temperatures will lead to thermal stress, decreased growth, and adverse effects on the survival of out-migrating juveniles. There may also be shifts in migration timing and contraction of species range – a recent bioclimatic analysis of major fish distributions predicts significant range contractions and local extinctions at the southern portion of the California Current System (Cheung et al. 2015).

Climate change will be considered a Changed Circumstance if the annual average maximum air temperature increases by 4° F compared to 2018 during the term of the Plan.

Planned Response to Climate Change

Under the Plan, actions to help address the effects of climate change will be a consideration in the selection of NFCF projects through the TAC, and actions to address the effects of climate change will also be taken through the adaptive management program in response to information obtained from the monitoring program. In addition, in the event of a changed circumstance, the City will develop additional response actions funded by the insurance fund, if deemed appropriate in coordination with NMFS. Given the global scale of climate change, it is expected that numerous federal, state, and local agencies would be responding to the circumstance. The City would look to climate adaptation strategies developed by NMFS to address the Covered Species and would coordinate with NMFS and other agencies to ensure that City-funded responses complement the response actions of those agencies.

While the direct effects of climate change on ecosystems and species within the Plan Area are difficult to quantify at this time, it is clear that climate change has the potential to increase the frequency and severity of the other Changed Circumstances addressed by the Plan (e.g., drought, fire, and flood).

Drought

The 2012-2015 prolonged drought in central coastal California likely foreshadows future conditions in the Plan Area. Anticipated warming air temperatures will make the combination of dry and warm years more likely, increasing the negative impacts of drought (Diffenbaugh et al. 2015). Drought conditions limit water availability and stress various salmonid life stages and overall ecosystem health. Drought can also lead to an increased incidence of wildfire (Langridge 2018; Chartrand 2018). These reductions in precipitation will likely decrease streamflows during spring and summer which result in reduced availability of flows that support smolt migration to the ocean and reduced availability of summer rearing habitat (NMFS 2012b).

Drought is defined as under the Plan as a climatic drought extending beyond a three-year period. The occurrence of a drought extending beyond three years will be considered a changed circumstance.

Planned Response to Drought

The conservation strategy specifies fish flows for specific water year types, thereby anticipating climatic variability and the possibility of an increase in dry and critically dry years during the term of the Plan. The prescribed flows for dry and critically dry years were designed to be protective of the Covered Species during those water year types. In addition, the City will respond to extended drought conditions through the adaptive management program based on input from the monitoring program. In the event of a drought extending beyond three years, adaptive management responses would be augmented through responses funded by the Changed Circumstances insurance fund.

Fire

The frequency, intensity, and magnitude of wildfires are expected to increase in California (Luers et al. 2006; Westerling and Bryant 2006). It is "highly likely" that the Central Coast will continue to see large severe fires (Langridge 2018), including "megafires." The National Interagency Fire Center defines "megafire" as a fire that burns more than 100,000 acres.

Fires in riparian areas can result in canopy cover loss and increased water temperature in streams sensitive to heating. Fires also increase the incidence of erosion by removing vegetative cover from steep slopes. Subsequent rainstorms can produce destructive debris flows that bury habitat in tons of sediment and block passage.

Under the Plan, the occurrence of a megafire or a fire that occurs in the same location as previous fires that have occurred within the prior 5 years constitute a changed circumstance.

Planned Response to Fire

In the event of a fire, the HCP Administrator will assess the proportion of the Plan Area that burned and its likely effects on habitat used by the Covered Species and will make an initial determination of whether or not a Changed Circumstance exists. The HCP Administrator will notify NMFS and coordinate with NMFS and other agencies regarding a response to the fire event, if warranted. If a Changed Circumstance is determined to exist, the HCP Administrator will implement a post-fire monitoring plan for a two-year period. If the monitoring indicates that vegetation is not recovering sufficiently in burned riparian areas to reestablish the pre-fire functions of the affected habitat, the HCP Administrator will develop and implement a habitat restoration plan to enhance recovery of the affected habitat area. Actions in the restoration plan could include stabilizing soils, reestablishing native vegetation, and controlling invasive plant species.

Flood

Under climate change scenarios, precipitation will take the form of increased rain instead of snow, and the intensity of rain events is expected to increase. In general, wet years will be wetter, and dry years will be drier (Chartrand 2018). The projected increases in precipitation intensity during storms may result in destructive debris flows in areas recently burned, resulting in adverse conditions for salmonids by covering habitat with mud and debris, blocking passage, and affecting water quality. Winter flooding during storm runoff events may also reduce the early life stage survival rates for anadromous salmon.

Floods that are greater than 50-year and up to and including 100-year levels, as classified by the Federal Emergency Management Agency (FEMA), constitute a Changed Circumstance under the Plan.

Planned Response to Flood

Responses to floods in the Plan Area would first include responses taken through the adaptive management program, augmented in circumstances where a Changed Circumstance has occurred through additional responses utilizing the Changed Circumstances insurance funding. Response actions could include clearing out sediment and debris to restore or improve passage conditions. City responses would be coordinated with NMFS.

New Listings of Species not Covered by the Plan

NMFS or USFWS may list additional species as threatened or endangered under the ESA that occur in the Plan Area or add new species listings that are not Covered Species. In the event that a species not

covered by the HCP is listed, the provisions of this Changed Circumstance will be automatically triggered.

Planned Response to New Species Listing

Upon a new listing of a species under federal endangered species laws, the City will undertake the following measures:

- Evaluate the potential impacts of Covered Activities on the newly listed species and conduct an assessment of the presence of suitable habitat in areas of potential effect.
- Implement measures to avoid impacts to the newly listed species until such time as the Plan has been amended to include the newly listed species as a covered species.

In the event that a species not covered by the Plan becomes listed as threatened or endangered or designated as a candidate species, or is proposed or petitioned for listing, the City may request that NMFS add the species to the relevant take authorizations issued pursuant to the Plan. In determining whether to seek take coverage for the species, the City will consider, among other things, whether the species is present in the Plan Area, if the Covered Activities could result in the take of the species, and if the existing conservation measures benefit the species and avoid and minimize effects of covered activities on the species. The procedures for Plan modifications and amendments are described in Section 6.6.4 Formal Amendment.

For more information on Changed Circumstances, please refer to Appendix 13 – Changed Circumstances Response Actions.

6.5.3 Unforeseen Circumstances

NMFS defines unforeseen circumstances as those changes in circumstances that affect a species or geographic area covered by an HCP that could not reasonably have been anticipated by the Plan participants during the development of the conservation Plan, and that result in a substantial and adverse change in the status of a Covered Species.[63] Under ESA regulations, if unforeseen circumstances arise during the life of the Plan, NMFS may not require the commitment of additional land or financial compensation, or additional restrictions on the use of land, water, or other natural resources other than those agreed to in the Plan, unless the Permittees consent.

[63] 50 C.F.R. §222.102.

Within these constraints, NMFS may require additional measures, but only if: (1) the agency demonstrates that an unforeseen circumstance exists; (2) such measures are limited to modifications of the Plan's operating conservation program for the affected species; (3) the original terms of the Plan are maintained to the maximum extent practicable; and (4) the overall cost of implementing the Plan is not increased by the modification. NMFS bears the burden of demonstrating that unforeseen circumstances exist. A finding of unforeseen circumstances must be clearly documented, based upon the best available scientific and commercial information and made considering certain specific factors.[64] If such a finding is made and additional measures are required, the City will work with NMFS to appropriately redirect resources to address the unforeseen circumstances.

6.5.4 Applicability of Other Endangered Species Act Issues to the Plan

6.5.4.1 Future Section 7 Consultations

NMFS will evaluate the direct, indirect and cumulative effects of the Covered Activities in its internal biological opinion that will be issued in connection with the Plan and issuance of the section 10(a) permits and the biological opinion that will be issued to the City. Accordingly, in any consultation under Section 7 that occurs after the approval of the Plan, NMFS will ensure that any biological opinion issued in connection with the proposed project that is the subject of the consultation is consistent with the Plan biological opinion. The proposed project must be consistent with the terms and conditions of the Plan. Unless otherwise required by law or regulation, any reasonable and prudent measures included under the terms and conditions of a biological opinion issued subsequent to the approval of the Plan with regard to the Covered Species and Covered Activities will, to the maximum extent appropriate, be consistent with the measures of the Plan. The No Surprises Rule will apply to instances in which measures are imposed in excess of those that have been or will be required by the City pursuant to the Plan.

6.6 Permit Duration and Renewal, Plan Amendments, Permit Suspension and Revocation

[64] These factors include the following: (1) Size of the current range of the affected species; (2) Percentage of range adversely affected by the conservation plan; (3) Percentage of range conserved by the conservation plan; (4) Ecological significance of that portion of the range affected by the conservation plan; (5) Level of knowledge about the affected species and the degree of specificity of the species' conservation program under the conservation plan; and (6) Whether failure to adopt additional conservation measures would appreciably reduce the likelihood of survival and recovery of the affected species in the wild. 50 C.F.R. §222.307(g)(3)(iii).

6.6.1 Permit Duration

The City is seeking take authorization from NMFS with a term of 30 years. The term of the take authorizations issued under the Plan would begin from the date of their issuance. A permit term of 30 years provides a practicable timeframe in which to carry out the activities that will be authorized under the Plan.

6.6.2 Plan Administrative Actions that do not Require Modification or Amendment

The administration and implementation of the Plan will require frequent and ongoing interpretation of the provisions of the Plan. Actions taken on the basis of these interpretations that do not substantively change the purpose or intent of the Plan provisions will not require modification or amendment of the Plan or its associated authorizations. Such actions related to the ordinary administration and implementation of the Plan may include, but are not limited to, the following:

- Clerical corrections to typographical, grammatical, and similar editing errors that do not change the intended meaning or to maps or other exhibits to address insignificant errors;
- Adaptive management changes to conservation measures, including actions to avoid, minimize, and mitigate impacts;
- Adjustments to monitoring protocols to incorporate new protocols approved by NMFS.

6.6.3 Minor Modifications or Revisions

As part of the process of Plan implementation, the City may need to make minor changes ("Minor Modifications or Revisions") to the Plan from time to time to respond appropriately to new information, scientific understanding, technological advances, and other such circumstances. Minor Modifications or Revisions will, in many instances, be technical in nature and will not involve changes that would adversely affect Covered Species, the level of take, or the obligations of the City.

6.6.3.1 Procedures for Minor Modifications or Revisions

The City may propose Minor Modifications or Revisions by providing written notice to NMFS. Such notice will include a description of the proposed Minor Modifications or Revisions, an explanation of the reason for the proposed Minor Modifications or Revisions, an analysis of its environmental effects

including any impacts to Covered Species, and an explanation of why the City believes the effects of the proposed Minor Modifications or Revisions would not:

- Significantly differ from, and would be biologically equivalent to, the effects described in the Plan, as originally adopted;
- Conflict with the terms and conditions of the Plan, as originally adopted; and
- Significantly impair implementation of the Plan Conservation Strategy.

NMFS may submit comments on the proposed Minor Modification or Revision in writing within sixty (60) days of receipt of notice. If NMFS does not concur that the proposed Minor Modification or Revision meets the requirements for a Minor Modification or Revision, the proposal must be approved according to the Amendment process. If the City and NMFS concur that the requirements for a Minor Modification or Revision have been met and the modification or revision should be incorporated in the Plan, the Plan will be modified accordingly.

6.6.4 Formal Amendment

Under some circumstances, it may be necessary to substantially amend the Plan. Any proposed changes to the Plan that do not qualify for treatment under Section 6.6.3 will require Formal Amendment. Formal Amendment to the Plan will also require corresponding amendment to the Permit, in accordance with applicable laws and regulations regarding permit amendments. The City will be responsible for submitting any proposed Amendments to NMFS.

Amendments to the Plan will likely occur infrequently. The process for making Formal Amendments is set forth in Section 6.6.4.1 below. Formal Amendments include, but are not limited to, the following:

- Substantive changes to the boundary of the Plan Area;
- Additions of species to the Covered Species list;
- Substantial changes in covered activities that would have effects on the Covered Species outside of the range established in the Plan;

6.6.4.1 Process for Formal Amendment

The Permit may be amended in accordance with all applicable legal requirements, including but not limited to the ESA, NEPA, and NMFS' permit regulations. The Party proposing the amendment shall

provide a statement of the reasons for the amendment and an analysis of its environmental effects, including its effects on operations under the Plan and on Covered Species.

6.6.5 Suspension of the Permit

Under certain circumstances defined by federal regulation, NMFS may suspend, in whole or in part, the regulatory authorizations they issue under the Plan. However, except where NMFS determines that emergency action is necessary to avoid irreparable harm to a Covered Species, it will not suspend an authorization without first (1) attempting to resolve the issue through the informal dispute resolution process set forth in Section 6.6.8, and (2) identifying the facts or action/inaction which may warrant the suspension and providing the City a reasonable opportunity to implement appropriate responsive actions.

6.6.6 Reinstatement of Suspended Permit

If NMFS suspends the Permit, as soon as possible but no later than 10 days after the suspension, it will meet and confer with the City to discuss how the Permit can be reinstated. At the conclusion of the meeting, NMFS will identify reasonable, specific actions needed to address the suspension. Upon performance or completion of the actions, NMFS will immediately reinstate the Permit. It is the expectation of the Plan participants that NMFS and the City will strive to reinstate the Permit as soon as possible.

6.6.7 Revocation of the Permit

Unless immediate revocation is necessary to avoid the likelihood of jeopardy to a listed species, NMFS will not revoke the Permit unless the City fails to fulfill its obligations under the Plan, and only after (1) completing the informal dispute resolution process described in Section 6.6.8, and (2) identifying the actions/inactions that may warrant the revocation and giving the City a reasonable opportunity to implement appropriate responsive actions.

6.6.8 Dispute Resolution

The City and NMFS (Party or collectively Parties) recognize that disputes concerning implementation of, compliance with, or termination of the Plan, and the Permit may arise from time to time. The

Parties agree to work together in good faith to resolve such disputes, using the informal dispute resolution procedures set forth in this section, or such other procedures upon which the Parties may later agree. However, if at any time any Party determines that circumstances so warrant, it may seek any available remedy without waiting to complete informal dispute resolution.

6.6.8.1 Informal Dispute Resolution Process

Unless the Parties agree upon another dispute resolution process, or unless an aggrieved Party has initiated administrative proceedings or suit in federal court as provided in this section, the Parties may use the following process to attempt to resolve disputes:

(a) The aggrieved Party will notify the other Parties of the provision that may have been violated, the basis for contending that a violation has occurred, and the remedies it proposes to correct the alleged violation.

(b) The Party alleged to be in violation will have 30 days, or such other time as may be agreed, to respond. During this time, it may seek clarification of the information provided in the initial notice. The aggrieved Party will use its best efforts to provide any information then available to it that may be responsive to such inquiries.

(c) Within 30 days after such response was provided or was due, representatives of the Parties having authority to resolve the dispute will meet and negotiate in good faith toward a solution satisfactory to all Parties, or will establish a specific process and timetable to seek such a solution.

(d) If any issues cannot be resolved through such negotiations, the Parties will consider non-binding mediation and other alternative dispute resolution processes and, if a dispute resolution process is agreed upon, will make good faith efforts to resolve all remaining issues through that process.

7.0 COSTS AND FUNDING

7.1 Financial Summary

The City's HCP involves four programs to be funded by the City:

1) Habitat Conservation Program (Section 7.2.1);
2) Monitoring Program (Section 7.2.2);
3) Adaptive Management program (Section 7.2.3); and,
4) Program Administration (Section 7.2.4).

The habitat conservation strategy described in this chapter includes a suite of potential NFCF measures to be implemented in the Santa Cruz Mountains Ecoregion. These measures focus on key independent and dependent watersheds in southern San Mateo County south to Aptos Creek in Santa Cruz County. Additionally, a Take Avoidance and Minimization Fund (TAMF) will be instituted for measures related to operations and maintenance and Capital Improvement Program (CIP) related habitat conservation measures. Chapter 6 describes the compliance, effectiveness, and research monitoring programs.

The adaptive management program, also described in Chapter 6, includes provisions to select, fund, and implement additional measures if the measures described in Chapter 4 do not achieve the expected biological results. Program administration is described in Section 7.2.4 of this chapter. The total 30-year estimated cost of this HCP is $ 36,674,500 in 2018 dollars. Figure 7-1 and Figure 7-2 show how the forecasted HCP costs are spread over the 30-year term. The total cost for each of the four program areas and their respective subcategories is provided in Table 7-1. Additional detail is provided later in this chapter.

Table 7-1: Habitat Conservation Plan Financial Summary

Program	Estimated Cost (2018 dollars)
Habitat Conservation (see Table 7- 2) NFCF TAMF[65]	 $ 8,000,000 *$ 157,400,000*
Monitoring (see Table 7- 4 & Table 7-5) Compliance Effectiveness Research	$18,377,500
Adaptive Management (see Table 7-6) Contingency Account Insurance Account	 $ 1,600,000 $ 2,640,000
Administration (see Section 7.2.4)	$ 6,057,000
TOTAL COST	**$36,674,500[66]**

7.2 Program Costs

7.2.1 Habitat Conservation Programs Costs

The estimated habitat conservation program costs are primarily associated with NFCF habitat conservation measures. TAMF costs are not included in the analysis of HCP implementation funding because many of the projects associated with those costs have independent utility in that they are necessary for future water system reliability but also have conservation benefit in most cases. Nonetheless, the total cost is shown here to provide context. Totals are provided in Table 7-2 below.

Table 7-2: Habitat Conservation Programs Estimated Costs

Habitat Conservation Program Measure Category	Estimated Cost in 2018 Dollars (30-year total)
NFCF	$8,000,000
TAMF	$157,400,000
TOTAL COSTS	**$165,400,000[67]**

[65] TAMF costs include supplemental water supply development, Majors, Laguna, Tait Street and Felton Diversions rehabilitation, treatment improvements, construction best practices implementation and related take avoidance and minimization measures.
[66] TAMF costs are not included in the analysis of HCP implementation funding because many of the projects associated with those costs have independent utility.
[67] TAMF costs are not included in the analysis of HCP implementation funding.

TAMF - related operations and maintenance costs are mainly associated with staff time and therefore are also not included in this analysis. TAMF related CIP costs include measures such as supplemental water supply development, Felton Diversion fish screen improvements, North Coast Diversion sediment management improvements, operational and infrastructure improvements as well as standard best practices for protection of natural resources employed during operations and maintenance of the water system. These improvements and system rehabilitation are not entirely precipitated by this HCP; however, significant system-wide improvements are required for a variety of reasons and have independent utility, with regard to water operations beyond compliance with the ESA. This improvements and rehabilitation work will, in many cases, require mitigation of impacts caused by historical operations. While these improvements have not been fully evaluated to the extent that firm budget estimates are possible, it is likely that their costs will be in the range of $100-150 million dollars (2018 dollars) and be implemented within the first 10 years of issuance of the HCP. Most TAMF costs are associated with implementation of these projects.

Habitat Conservation Program Measures

Table 4-9, as previously discussed in Section 4.5.3, provides a clear linkage between residual impacts and potential mitigation projects presented through the ecological portfolios. Table 4-9 also associates each of the potential portfolio projects with an estimated cost in 2018 dollars. Based on this two-phase process of linking impacts to projects in a portfolio and developing costs for projects in the portfolio, the level of funding required for the NFCF can be quantified.

Once the ecological portfolios have been completed and this hybrid quantitative-qualitative metric has been translated into dollars, the final step is to develop a cost allocation plan for implementation of the NFCF. The costs allocation plan is a 30-year budget for the NFCF that is divided into six 5-year planning cycles with associated work plans. The allocation is further divided into annual expenditures. The cost allocation plan is presented in 2018 dollars and provides a snapshot of annual funding as well as a realistic view of what can be accomplished with the NFCF funding currently recommended. The cost allocation is included in Table 7.3. See also Appendix 1: *Summary of Approach to Non-Flow Mitigation of Biological Effects of the City Diversions*. Most of the planning, permitting, and project management for these measures will be done by 1.0 new full-time equivalent Water Department staff, and related costs are included in the staff time subtotal shown in Table 7-3.

If measures are not implemented as planned and substitute measures are implemented (per the Adaptive Management Programs described in Chapter 6), the funding will come from the amounts allocated to the original measures (with inflation if implemented at a later date).

If NFCF projects require minor maintenance, such as replanting or invasive plant removal, costs will be paid from the 20% contingency funds in the Adaptive Management Program – as approved in consultation with the TAC. Five-year funding increments for the NFCF are described further in Table 7-3 below.

Table 7-3: Estimated NFCF Habitat Conservation Measure Costs[68]

Fiscal Year	Task	Amount (In Fiscal Year 2019 dollars)
HCP Years 1 - 5	Develop 5 yr. project list	$ 55,000
	Project 1 Permit	$ 15,000
	Project 1 Design	$ 60,000
	Project 1 Construction	$ 15,000
	Project 1 Implementation	$ 200,000
	Project 2 & 3 Permit	$ 35,000
	Project 2 Design	$ 70,000
	Project 3 Design	$ 65,000
	Project 2 & 3 Construction	$ 70,000
	Project 2 & 3 Implementation	$ 350,000
	Project 4 Permit	$ 20,000
	Project 4 Design	$ 60,000
	Project 4 Construction	$ 15,000
	Project 4 Implementation	$ 270,000
	Project 5 Permit	$ 65,000
	Project 5 Design	$ 100,000
	HCP Years 1 - 5 Subtotal	**$ 1,465,000**
HCP Years 6 - 10	5 yr. NFMP Review	$ 30,000
	Develop 5 yr. project list	$ 20,000
	Project 9 Design	$ 60,000
	Project 5 Implementation	$ 500,000
	Project 6 Permit	$ 15,000
	Project 6 Design	$ 60,000
	Project 6 Construction	$ 15,000
	Project 6 Implementation	$ 200,000
	Project 7 & 8 Permit	$ 30,000
	Project 7 Design	$ 60,000
	Project 8 Design	$ 75,000
	Project 7 Construction	$ 20,000
	Project 8 Construction	$ 20,000
	Project 7 Implementation	$ 200,000
	HCP Years 6 - 10 Subtotal	**$ 1,305,000**
HCP Years 11 - 15	Develop 5 yr. project list	$ 55,000
	Project 8 Implementation	$ 275,000
	Project 9 Permit	$ 20,000
	Project 9 Design	$ 10,000
	Project 9 Implementation	$ 220,000
	Project 9 Construction	$ 15,000
	Project 10 & 11 Permit	$ 25,000
	Project 10 Design	$ 65,000

[68] Specific habitat conservation measure priorities have not been identified or committed to. However, support for coho recovery hatchery development and operations is a high priority.

	Project 11 Design	$ 70,000
	Project 10 & 11 Construction	$ 20,000
	Project 10 & 11 Implementation	$ 300,000
	Project 12 Permit	$ 55,000
	Project 12 Design	$ 125,000
	Project 12 Construction	$ 25,000
	Project 13 Design	$ 60,000
	HCP Years 11 - 15 Subtotal	**$ 1,340,000**
HCP Years 16 - 20	5 yr. NFMP Review	$ 30,000
	Develop 5 yr. project list	$ 20,000
	Project 12 Implementation	$ 475,000
	Project 13 Permit	$ 20,000
	Project 13 Construction	$ 15,000
	Project 13 Implementation	$ 220,000
	Project 14 Permit	$ 20,000
	Project 14 Design	$ 50,000
	Project 14 Construction	$ 15,000
	Project 14 Implementation	$ 220,000
	Project 15 & 16 Permit	$ 25,000
	Project 15 Design	$ 60,000
	Project 16 Design	$ 70,000
	Project 17 Permit	$ 20,000
	Project 17 Design	$ 120,000
	HCP Years 16 - 20 Subtotal	**$ 1,380,000**
HCP Years 21 - 25	5 yr. NFMP Review	$ 30,000
	Develop 5 yr. project list	$ 30,000
	Project 15 & 16 Construction	$ 20,000
	Project 15 & 16 Implementation	$ 250,000
	Project 17 Permit	$ 50,000
	Project 17 Construction	$ 20,000
	Project 17 Implementation	$ 500,000
	Project 18 & 19 Permit	$ 25,000
	Project 18 & 19 Construction	$ 15,000
	Project 18 & 19 Implementation	$ 275,000
	Project 18 Design	$ 60,000
	Project 19 Design	$ 70,000
	Project 20 Design	$ 30,000
	HCP Years 21 - 25 Subtotal	**$ 1,375,000**
HCP Years 26 - 30	5 yr. NFMP Review	$ 30,000
	Project 22 Implementation	$ 450,000
	Project 20 & 21 Permit	$ 30,000
	Project 20 & 21 Construction	$ 15,000
	Project 20 & 21 Implementation	$ 250,000
	Project 20 Design	$ 40,000
	Project 21 Design	$ 70,000
	Project 22 Permit	$ 75,000

	Project 22 Design	$ 120,000
	Project 22 Construction	$ 25,000
	Final Project Review	$ 30,000
	HCP Years 26 - 30 Subtotal	**$ 1,135,000**
Total Cost		**$ 8,000,000**

7.2.2 Monitoring Programs Estimated Costs

Costs for the monitoring program are shown in Table 7-4. The monitoring activities included are described in Chapter 6.

Table 7-4: Monitoring Programs Estimated Costs

Monitoring Measure Category	Estimated Cost in 2018 Dollars (30-year total)
Compliance	$ 3,000,000
Effectiveness	$ 800,000
Research	$ 14,577,500
$18,377,500	$18,377,500

7.2.2.1 Research Program Estimated Costs

The estimated costs to implement the research measures described in Chapter 6 are shown in Table 7-5. Some of these dollar amounts are part of larger partnership programs (see details in Chapter 6). The City has committed to a research monitoring program that is significantly broader in scope than many comparable HCPs.

Table 7-5: Research Monitoring Estimated Costs

Monitoring Measure	Estimated Cost in 2018 Dollars (30-year total)
Riverine Juvenile Abundance and Spatial Distribution Monitoring	$4,033,500
Estuarine Juvenile Abundance	$ 3,000,000
Riverine Habitat Monitoring	$ 330,000
Estuarine Habitat Monitoring	$ 1,674,000
Felton Diversion Adult Migration Monitoring	$ 310,0000
Temperature Monitoring	$ 420,000
Pit Tag Monitoring	$ 410,000
Reporting and Equipment	$ 660,000
Data Management	$ 950,000
TOTAL COST	**$ 14,577,500**

7.2.3 Adaptive Management Programs Estimated Costs

Costs involved in the Adaptive Management Program include:

1) Unanticipated maintenance needs of NFCF projects;
2) Responses to monitoring of measures if effectiveness monitoring indicates original measures have not met their stated objectives;
3) Responses to assessments of the overall effectiveness of the HCP; and,
4) Changes in research monitoring priorities and methodologies that would exceed the cost estimate in Table 7-5.

Elements of the adaptive management programs are described in Chapter 6. Actual future costs associated with adaptive management are dependent on information not yet available. (See Program Funding - Section 7.3 below for total dollars allocated). The adaptive management funding allocations are shown in Table 7-6 and total $4,240,000 over 30 years. These amounts are capped totals (with inflation adjustment), except as affected by provisions of Section 6.5, Changed and Unforeseen Circumstances. To fund the planned responses to address changed circumstances, an "insurance account" will be established concurrent with HCP adoption as a component of the adaptive management funding. A total of $2,640,000 will be deposited into the insurance account over 30 years (Table 7-6 insurance account).

7.2.4 Administration Program Estimated Costs

Costs associated with program administration include staffing for overall implementation of the HCP including indirect costs for support of all HCP activities.

The indirect cost for implementation of the HCP is comprised of 15% of the fully loaded ongoing salary costs for monitoring, data management, and compliance reporting, as well as the fully loaded cost of the salary plus 15% indirect costs of 1.0 new full time equivalent (FTE) position for implementation of the NFCF.

The overall administration costs of the HCP are approximately $6,057,000.

7.3 Program Funding

The City will pay the costs of the HCP from water rate revenues. Each spring, the City Council adopts an annual budget for the Water Department based on anticipated costs and revenues. The annual budget is a public document and is available on the City's web site. Commitments made in the HCP will be included in the annual budget requests to the Council. Although the City Council will not automatically fund these expenses, adoption of the HCP demonstrates the City's commitment to fund and implement it. Further, the City understands that permit coverage would be at risk, and federal and state enforcement measures would be possible, if adequate budgets are not approved and measures are not implemented as planned.

City Constraints Associated with Funding

The City recognizes that changes in the allocation of funds from one project or action to another might be necessary during the 30-year term of the HCP. Reallocation decisions will be made by the City, but will take into account advice given by the HCP TAC. To allow flexibility, the City will accommodate reallocation of funds within the following constraints:

- The total funding must adhere to the schedule in Figure 7-1.
- The annual increments of funding must adhere to the schedule in Figure 7-2.
- Funds can be reallocated within programs and categories, but not between programs and categories; some category totals are capped.

Details of these constraints are described in the sections below.

Scheduled Funding Increments

The City has carefully spread HCP investments over the 30-year timeframe to achieve habitat conservation benefits, to accommodate adaptive management contingencies, and to manage the impact on water ratepayers. The total funding allocated for the life of the permit by category is shown in Figure 7-1, while annual increments of investment by category are shown in Figure 7-2. The City's analysis has shown that shifting funds forward or backward in time from the defined increments will have unacceptable effects on water rates. For this reason, the funding allocations are confined to the time periods shown. Shifts in the allocation of project costs can occur only within, not between, the allocated time periods.

Limits on City's Financial Commitments

The City's total financial commitments to all elements of this HCP are capped at the totals previously shown in Table 7-1. These capped amounts will be inflation-adjusted (see Section 7.4). Details are provided in Section 7.3.1.

Figure 7-1: Total Habitat Conservation Plan Funding by Program Area in 2018 Dollars

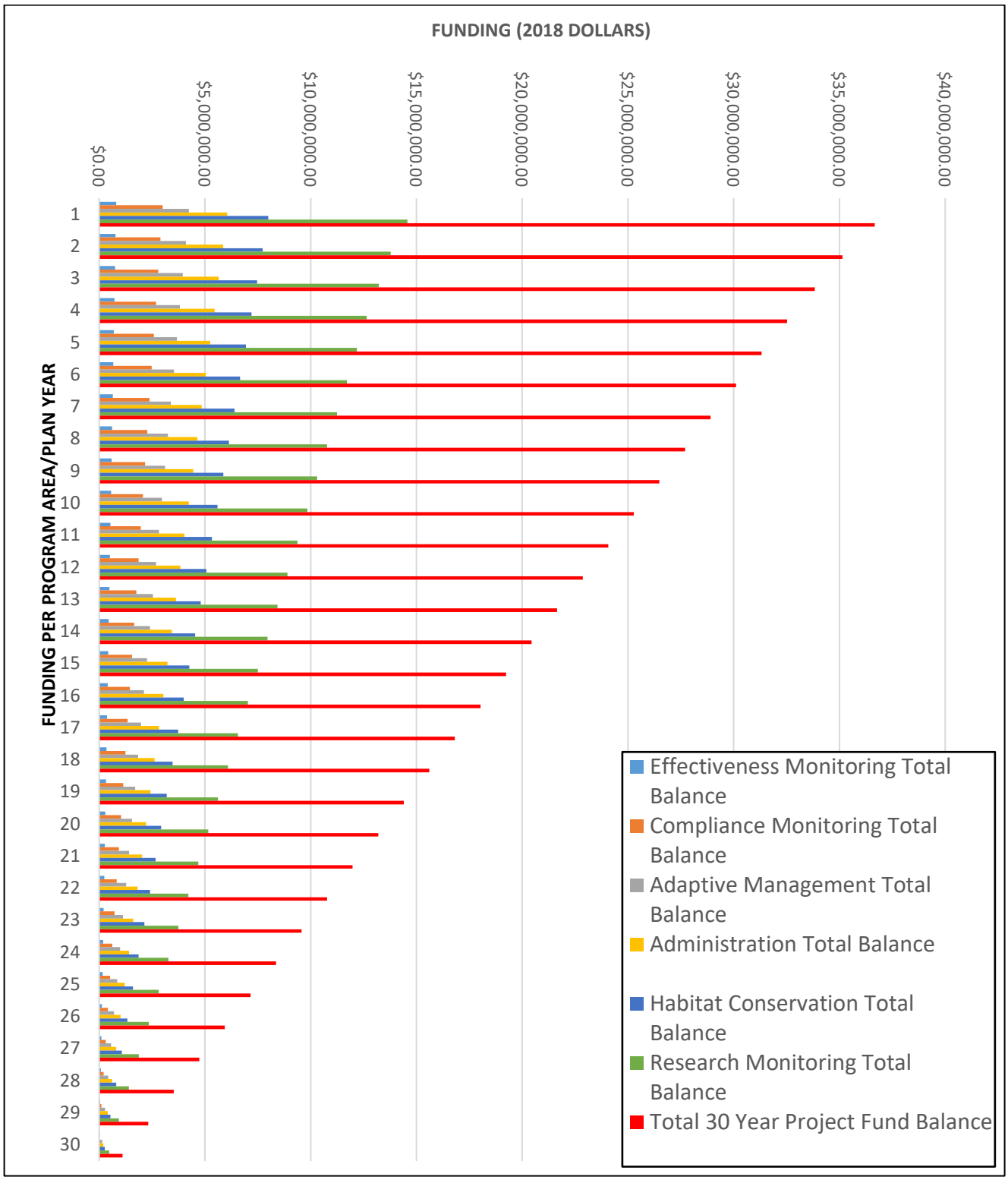
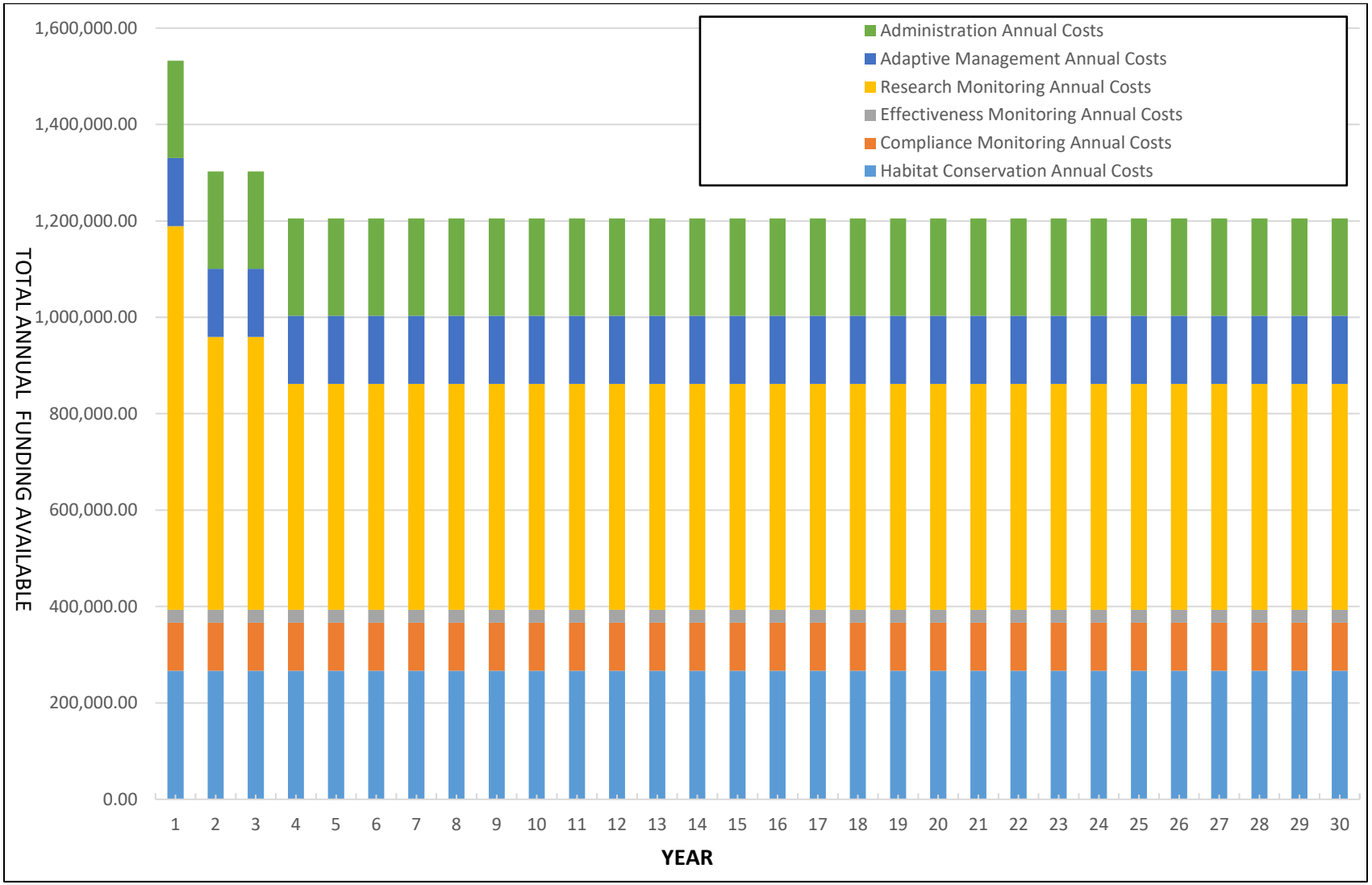


Figure 7-2: Total Annual Funding Committed to Non-Flow Conservation Fund Program/Adaptive Management and Insurance Fund in 2018 Dollars



7.3.1 Habitat Conservation Programs Funding

The City has allocated $8 million[69] to the NFCF. Funding will be available in the scheduled increments as shown in Figure 7-1 and Figure 7-2. The amounts shown in Table 7-3 are the estimated cost of each habitat conservation measure, not including a 20 percent contingency allowance. The City will pay up to the amount shown in Table 7-4 for each measure plus additional costs accounting for inflation by utilizing the national implicit price deflator (deflator) up to the date of implementation. The deflator measure is used to apply the effects of inflation for state and local government expenditures according to the California Department of Finance.[70] For example, the funding for a measure implemented in 2025 would be inflated from the 2018 estimate to 2025 based on the total rate of inflation between these periods as measured by the deflator. The deflator inflated amount represents the financial limit of the City's commitments for each project.

Annual spending on design, permitting and implementation is expected to average approximately $275,000 per year (in 2018 dollars) within each 5-yr planning cycle over the 30-year lifetime of the HCP. The City may, at its discretion, choose to allocate the total funding for the program equally throughout the 30-year Permit term as depicted in Figure 7-2 or front-load funding in the early years of the Plan.

The City is confident the dollar amounts allocated will be adequate to meet the measurable objectives described in Chapter 4. If, however, after detailed project planning, the measure is shown to cost more than the amount shown in Table 7-3 (inflated to the implementation date), the City will consult with the TAC about how to proceed. A variety of options are possible, including the following:

- The extra cost, above the amount shown in Table 7-3 plus the deflator rate of inflation, could be paid with savings from NFCF habitat measures that cost less than expected.
- The extra cost, above the amount shown in Table 7-3 plus deflator rate of inflation, could be deducted from remaining unallocated dollars in the NFCF.
- An alternative funding source could be found to supplement City funding for the project.
- A lower-cost measure with similar habitat benefits could be identified and implemented.
- The scope of the project could be modified.

[69] The NFCF analysis presented in Appendix 1 estimated a range of approximately $8,011,479 to $8,250,000 specifically for habitat conservation spending over the permit term. $8 million is used for simplicity's sake in this discussion and future planning purposes.

[70] Economic Research Unit, "How to Use CPI Data" State of California Department of Finance, Economic Research Unit, 2018, http://www.dof.ca.gov/Forecasting/Economics/Documents/How_to_Use_CPI_Data.pdf .

The City will not pay for expenses that exceed the per-project totals shown in Table 7-3 (as inflated to implementation date), except as provided in the Adaptive Management Program or in Chapter 6, Changed and Unforeseen Circumstances. The scheduling of the offsite measures is also constrained by the availability of the funding increments shown in Table 7-3.

If needed, effectiveness monitoring for NFCF projects will be paid from the total allocated to the NFCF if funds are available there. Concurrent with adoption of the HCP, the City will establish a "contingency account" and over the 30-year term will deposit a $1.6 million subset of the Adaptive Management Program funding into the contingency account to cover unanticipated costs of NFCF projects and related effectiveness monitoring. In addition, a $2.64 million subset of the Adaptive Management Program funding will be deposited into a separate "insurance account" specifically set aside for adaptive management and changed circumstances responses in accordance with the schedule in Figure 7-2. If needed, research monitoring can be funded from this insurance account as well. If the $2.64 million is not needed for adaptive management or changed circumstances responses, it will remain available to fund additional habitat conservation measures through the NFCF.

7.3.2 Monitoring Programs Funding

The City will fund the monitoring programs as shown in Table 7-4. The amounts defined in Table 7-4 are capped totals. The City will accommodate reallocation of funds within the categories shown in the table, but will not pay more than the totals shown for each category, as adjusted for inflation unless needed for adaptive management purposes (see Section 7.2 and Section7.4).

7.3.3 Adaptive Management Programs Funding

The adaptive management funding allocations are shown in Table 7-6. These amounts are capped totals (with inflation adjustment, see Section 7.4), except as affected by provisions of Section 6.5, Changed and Unforeseen Circumstances.

As mentioned above, up to $1.6 million representing a 20% contingency of the NFCF as well as the insurance account of $2.64 million are available for adaptive management and changed circumstances responses, according to the framework described in Chapter 6 and shown in Figure 7-1 and Figure 7-2. If needed, research monitoring can be funded from the $2.64 million insurance account and effectiveness monitoring can be funded by the $1.6 million contingency account. If the funds in the contingency account are not needed for adaptive management or changed circumstances at the

milestones described in Chapter 6 and shown in Figure 7-2, they will remain available to fund additional habitat conservation measures through the NFCF .

The adaptive management funding allocations are shown in Table 7-6. These amounts are capped totals (with inflation adjustment, see Section 7.4), except as affected by provisions of Section 6.5, Changed and Unforeseen Circumstances.

Table 7-6: Adaptive Management Program Funding Allocations

Adaptive Management Programs Funding Category	Allocation in 2018 Dollars (30-year total)
NFCF Contingency Account	$1,600,000
Insurance Account	$2,640,000
TOTAL COST	**$4,240,000**

7.3.4 Jump Start and Stay Ahead Provision

To jump start non-flow conservation actions, the City will implement initial funding for the year 1 project in fiscal year 2025. Subsequent to permit issuance, the City will implement funding of year 2 and 3 project work, monitoring, adaptive management and administrative costs. This is anticipated to occur in fiscal year 2026. Future years' funding will be allocated similarly. Conservation flows will be implemented upon permit issuance. After implementation of these flows, residual effects to steelhead and coho habitat will be relatively minor. As such, early implementation of projects with FY 2025 and FY 2026 funding will more than fully offset impacts to coho and steelhead during the initial phases of HCP implementation. Subsequent implementation of NFCF projects in accordance with the schedule set out in Table 7-3 over the 30-year term will ensure that mitigation stays well ahead of impacts from Covered Activities.

7.4 Adjustments for Inflation or Deflation

All cost estimates and commitments in the HCP are shown in 2018 dollars. These dollar commitments will be adjusted annually for inflation or deflation using the historical deflator rates of change for state and local governments published by the U.S. Department of Commerce, which measures price changes in goods and services purchased by government programs on behalf of consumers. Deflators are not available below the national level so regional modifications are not possible.

8.0 ALTERNATIVES

8.1 No-action Alternative

Under the No Action Alternative, a section 10(a)(1)(B) permit would not be issued. City activities with the potential to cause incidental take of listed species would require measures to avoid incidental take or individual incidental take authorizations on a project-by-project basis, as is currently the case. Incidental take authorizations for activities with the potential to incidentally take listed species would be obtained either through the section 7 consultation process or through the development of individual HCPs.

Under this approach, few of the conservation and economic benefits associated with the HCP would be realized. The HCP establishes uniform conservation measures to ensure that biological goals and objectives for the Covered Species will be met and that opportunities to ensure the long-term survival of Covered Species are maximized.

Under the No Action alternative, many of the regulatory efficiencies provided by the HCP would not be available to the City. Rather, the City would continue to engage in the time-consuming process of reaching agreement with NMFS on the conditions under which activities that may affect listed species may proceed. Through this process, project mitigation requirements may vary from project to project, adding uncertainty and confusion over regulatory obligations. In contrast, the HCP would provide the City with long-term predictability concerning the nature of its operations and activities for which incidental take is permitted, avoiding cumbersome procedures and potential delays that would compromise the operation and maintenance of City facilities.

8.2 Reduced Covered Activities Alternative

Under a reduced covered activities alternative, the City would limit the HCP to bypass flows, and the numerous activities associated with operations and maintenance of the water supply system would not be covered. As with the No Action Alternative, under this alternative the City would need to evaluate individual operations and maintenance activities to determine whether incidental take of listed species could be avoided through seasonal restrictions and other modifications to the activity, or whether an activity-specific incidental take authorization would instead be required.

When determined to be required, project-by-project incidental take authorizations would be sought through the Section 7 consultation process or through a project-specific Section 10 permit application. In contrast to a comprehensive HCP, project-by-project incidental take authorizations would tend to

result in small piecemeal mitigation that can be more expensive and time-consuming and provide less conservation benefit than a regional or watershed level approach. Such authorizations can also result in inconsistent and changing minimization measures that complicate implementation of operations and maintenance activities.

Processing individual applications for numerous operations and maintenance activities would also require a substantial expenditure of resources by the City and NMFS over the years and would require NMFS to balance competing priorities from other entities and projects. This could interfere with timely implementation of operations and maintenance activities that are critical to providing a safe and reliable water supply. Accordingly, this alternative was not selected.

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APPENDICES

Appendix 1 – Summary of Approach to Non-Flow Mitigation of Biological Effects of the City Diversions

NON-FLOW CONSERVATION FUND

1. PROGRAM NEED & GOALS

Program Need

Adoption of bypass flows under the HCP minimizes and avoids many of the existing sources of potential incidental take related to City activities. Nevertheless, some residual effects to Covered Species remain after implementation of bypass flows. The Non-Flow Conservation Fund (NFCF) will provide funding for restoration and enhancement projects that will compensate for the residual effects of Covered Activities. This section describes the following critical components of the NFCF:

- roles and responsibilities for the City and the HCP permitting agencies;
- the linkage between modeled residual impacts from HCP implementation and benefits provided by mitigation projects funded under the NFCF;
- program development and rationale; and
- funding allocation plan to assure that the NFCF is viable and effective.

Program Goals

The goal of the NFCF is to mitigate for modeled residual impacts that result from on-going water supply operations outlined in the Plan. The specific biological goals for the NFCF are detailed in Chapter 4 of the Plan. In addition to addressing this goal, the program has been designed to:

- engender collaboration between the City and the agencies to address new conservation issues and opportunities as they arise – maximizing the impact of funds from the NFCF;
- enable the City to work with the agencies to identify and implement projects that directly address residual impacts to Covered Species, and also provide benefits to species habitat more generally and result in more resilient watersheds.
- create a program that balances administrative oversight and procedures for accountability with flexibility so that funding can be directed to projects that will provide the greatest conservation benefit.

2. PROGRAM OVERSIGHT & DECISION-MAKING

While implementation of the NFCF will require a collaboration between the City and the agencies, the City will be responsible for implementing the program. The NFCF will be managed by the HCP Administrator.

The City will work with NMFS, CDFW, and an array of local partners to develop a working list of potential NFCF projects. The City will propose projects from this list for approval by NMFS and DFW. The City, NMFS, and DFW will form a Technical Advisory Committee (TAC) to collaboratively develop the working NFCF project list, to review project concepts, and to provide design-level review of selected projects at key milestones (e.g. conceptual designs, 60% designs, etc.) during the planning process. Suggested projects can come from the agencies and others, including through a call for proposals. After review of potential project opportunities, the City will propose a project or suite of projects to NMFS and DFW members of the TAC for approval. Projects that cannot garner support from both agencies will not be funded.

The TAC will use the following metrics to assess a given project for funding:

- Does the project have the potential to benefit coho recovery as well as steelhead recovery?
- Does the project address a known residual impact resulting from implementation of the HCP?
- Does the project address a known limiting factor (as articulated in the CCC Coho Recovery Plan or CCC Steelhead Recovery Plan) for the covered species?
- Does the project enhance watershed conditions that lead to ecological resilience and healthy aquatic environments?
- Does the project have landowner support and stakeholder support necessary to ensure implementation?
- Are there any known constraints (stakeholders, technical, etc.) that are likely to significantly impede the ability of this project to be completed?
- Do the costs, in terms of financial commitment from the NFCF, and benefits to covered species compare favorably to other potential project opportunities?
- Is the estimated timeline for design, permit and construction within a 1-3 year window based on expected complexity of the project?

Potential projects will be evaluated over a planning cycle of 5 years. The 5-year project list can be revisited, as needed, during the planning cycle to address changed conditions or new opportunities. The number of projects selected for funding through the NFCF will vary for each 5-year planning cycle based on the size and complexity of projects. It is expected that most projects funded through the NFCF will require a 1-3 year project timeline from initial planning to construction. Annual spending on design, permit and implementation is expected to average approximately $275,000 per year (in 2018 dollars) within each 5-yr planning cycle over the 30-year lifetime of the HCP. The City may also,

at its discretion, choose to allocate the total funding for the program either equally throughout the 30-year permit term or front load funding in the early years of the Plan.

3. QUANTIFYING & LINKING IMPACTS AND BENEFITS

Ideally, impacts can be translated into a transparent, meaningful, and accurate common spatial metric such as acres, linear feet, etc. to enable translation into adequate mitigation. Creating this common variable for this process is particularly complex in light of the fact that the residual impacts identified through the Plan utilizes comparative metrics or metrics of "change" versus specific spatial metrics. While the comparative metric approach makes sense for understanding the relative effects of the City's water diversions and operations, it does not enable simple translation to an absolute quantity of residual impact. Moreover, the temporal nature of the impacts (e.g. they may only appear in certain water years and may only affect a specific life history stage) further complicates the calculus of developing an absolute (vs relative) spatial metric. Without a clear precedent in the literature or template for translating these impacts into a common spatial metric, the "Ecological Portfolio Method" was developed to translate residual impacts into a hybrid quantitative-qualitative mitigation metric (ecological portfolio) and then into a purely quantitative mitigation metric (dollars).

One of the most critical tasks for development of the NFCF has been creating a clear and direct link between the potential project types that could be funded and the specific residual impacts identified through the HCP. Table 1 displays this linkage by providing both a summary of the modeled residual impacts and a linked ecological portfolio of potential NFCF projects that would directly off-set these impacts. It is important to note that while the residual impacts are generally limited to a specific life history stage and/or water year type, many of the potential projects that would be implemented through the NFCF provide benefits across life history and water year types. An example of this might be placement of large woody debris (LWD) structures to offset impacts to rearing in dry years. While these structures will provide deeper pools and pool tail-outs, which will increase summer rearing opportunities, if designed correctly they can also provide high flow refuge during wet winters and improve spawning opportunities through better substrate sorting.

Table 1 provides a clear linkage between residual impacts and potential mitigation projects presented through the ecological portfolios. Table 1 also associates each of the potential portfolio projects with an estimated cost in 2018 dollars. Based on this two phase process of linking impacts to projects in a portfolio and developing costs for projects in the portfolio, the level of funding required for the NFCF can be quantified.

Table 1. NFCF Linkage between Residual Impacts and Ecological Portfolios

	Residual Effect after Avoidance and Minimization			Possible Ecological Portfolios to Mitgate Residual Impacts (1)			
Reach	*Steelhead*	*Coho Salmon (2)*	*Areal Extent*	*Action*	*Unit*		*Estimated Cost*
Laguna Anadromous	Small decrease in habitat suitability index (WUA) for spawning in normal (6% reduction) and wet (6% reduction) years	NA	1.4 mile anadromous reach with estimated 180 ft2 of spawning gravel (2 sf /100 ft of stream)(ENTRIX 2004)	Expand lower floodplain by 0.5 acres and complete Riparian corridor restoration along ~1.8 acres of SP property	2.3	$	555,036
	Moderate reduction in the habitat suitability index (WUA) for rearing by 16% in wet years and 6% in normal years	NA	1.4 mile anadromous reach	Remove defunct bridge, abutments, and restore slope on Coast Rd (cost equivalent to small dam removal)	1	$	151,650
				Install 14 anchored LWD structures in lower 3/4 miles (~ every 200 ft)	14	$	257,497
Liddell Anadromous	Decrease in number of days with suitable conditions for adult migration in normal (9% reduction to 86 days), dry (42% reduction to 23 days) and critical dry years (31% reduction to 9 days)	NA	1.2 mile anadromous reach	<u>San Vicente Creek as a proxy for Liddell and Majors</u>			
	Decrease in WUA for spawning in normal (10% reduction), dry (31% reduction) and critical dry years (38% reduction)	NA	1.2 mile anadromous reach with estimated 716 square feet of spawning gravel (11 sf/100 ft of stream)				
	Decrease in WUA for rearing in wet (20% reduction), normal (23% reduction), dry (40% reduction) and critical dry years (44% reduction)	NA	1.2 mile anadromous reach	Cost share with County of Santa Cruz Sanitation District and others in the effort to develop a new, more sustainable water source for Davenport, which would improve instream flows for Covered Species.	lump sum	$	500,000
	Decrease in number of days with suitable conditions for smolt migration in normal (6% reduction to 141 days), dry (35% reduction to 99 days) and critical dry years (57% reduction to 61 days)	NA	1.2 mile anadromous reach	Remove or modify 2 Mill Creek dams for fish passage and develop a new back-up intake for Davenport that enables fish passage to ~0.5 mile of srream and add 10 unanchored LWD structure in Mill Cr to improve rearing and spawning.	2 & 10	$	587,883
Majors Anadromous	Decrease in WUA for spawning in normal (5% reduction), dry (23% reduction) and critical dry years (17% reduction)	NA	0.7 mile anadromous reach with estimated 49 square feet of spawning gravel (1.3 sf/100 ft of stream)	Restore downstream floodplain/backwater, remove historic spoils, and reconnect to mainstem (~1 acre) to improve rearing conditions for both species.	1	$	895,695
	Decrease in WUA for rearing in all year types (20% to 24% reduction)	NA	0.7 mile anadromous reach	Cost-Share continue Cape Ivy and Clematis eradication efforts for 5 years to reduce overall potential impacts to riparian corridor, shade, and future LWD recruitment.	lump sum	$	250,000
	Decrease in number of days with suitable conditions for smolt migration by 3 days in dry years (12% reduction) and 1 day in critical dry years (11% reduction)	NA	0.7 mile anadromous reach				

San Lorenzo below Tait St (3)	Decrease in WUA for rearing in wet (9% reduction), normal (15% reduction), dry (16% reduction) and critical dry years (15% reduction)	NA	Up to 1.4 miles of riverine habitat, including 0.9 miles of flood control channel, depending on lagoon stage, and up to 1.5 miles of lagoon habitat		Create shade, scour and refugia for rearing in lagoon/tidal areas downstream of Laurel Street through installation of 10 dynamic anchored LWD clusters	10	$ 390,237
	Decrease in number of days with suitable conditions for adult migration in dry (8% reduction to 133 days) and critical dry years (28% reduction to 105 days)	Decrease in number of days with suitable conditions for adult migration in normal (11% reduction to 55 days), dry (20% reduction to 47 days) and critical dry years (32% reduction to 40 days)	Access to 25.8 miles of anadromous steelhead habitat in the mainstem and substantial additional miles in tributaries; up to 6 miles in the mainstem for coho and 20.8 in tributaries		Install 20 "notched" rock weirs, anchored LWD and/or off-set wood or rock structures to focus low flows, and improve conditions for resting and rearing, along ~1 mile between Tait Street and Water Street	20	$ 1,202,941
	Decrease in number of days with suitable conditions for smolt migration in critical dry years (28% reduction to 105 days)	Decrease in number of days with suitable conditions for smolt migration in critical dry years (28% reduction to 105 days)			Remove or modify 2 mainstem SLR dams (Lewis & Barker) plus 1 tributary dam to improve movement throughout the system during dry years.	3	$ 682,425
San Lorenzo below Felton (4)	Flow reductions during early rearing period (April, May) in dry years (7.5% reduction)	Flow reductions during early rearing period (April, May) in dry years (7.5% reduction)	Up to 7 miles of riverine habitat down to Tait Street could be affected in dry years		Work with partners to identify, design, and implement 5 permanent instream flow improvement projects on the middle reach of the San Lorenzo River to increase instream flows during April, May and into the summer to improve rearing.	5	500,000
Newell Anadromous (5)	Decrease in number of days with suitable conditions for adult migration in normal (15% reduction to 37 days), dry (44% reduction to 9 days) and critical dry years (76% reduction to 1 day)	Decrease in number of days with suitable conditions for adult migration in wet (21% reduction to 24 days), normal (38% reduction to 14 days), dry (52% reduction to 1 day) and critical dry years (67% reduction to 0 days)	About 1 mile of anadromous habitat		<u>Branciforte Creek as a Proxy for Newell Cr</u> Remove Casa de Montgomery dams and develop a fish friendly replacement diversion to open up passage to 4-5 miles of anadrmous stream.	2	$ 606,600
	Decrease in WUA for spawning in normal (9% reduction), dry (21% reduction) and critical dry years (34% reduction)	Decrease in WUA for spawning in dry (20% reduction) and critical dry years (42% reduction)	Total of 21 potential spawning locations with maximum 1095 square feet of useable habitat (24 sf/100 ft. of stream)		Install 12 anchored LWD structures at appropriate locations to improve spawning gravel sorting and increase square footage of spawning by ~100 sf per site (1200 sf in total)	12	$ 220,712
					Remove 4 additional high and medium priority passage obstructions (all small) along Branciforte Cr to enable unimpeded passage	4	$ 210,804
	Decrease in number of days with suitable conditions for smolt migration in normal (13% reduction to 42 days), dry (35% reduction to days to 14 days) and critical dry years (80% reduction to 1 day)	Decrease in number of days with suitable conditions for smolt migration in normal (13% reduction to 42 days), dry (35% reduction to days to 14 days) and	About 1 mile of anadromous habitat		Cost-share planning and implementation of passage improvement on upper 1/3 of Flood Control Channel to enable access across a range of migration flows through the channel	flat fee	$ 1,000,000
						TOTAL	*$ 8,011,479*

(1) Ecological Portoflios are designed as concepts and are <u>not meant to be interpreted as perscriptive</u>, NFCF projects will be determined by the TAC based on opportunities available and perceived benefits in real time
(2) No residual effects on coho in Laguna Creek of 5% or more; no suitable habitat for coho in Liddell and Majors Creeks; no suitable rearing habitat for coho downstream of Tait St.

(3) Reductions in adult and smolt migration opportunities at this location may not translate into significant biological effects since there is still a substantial period when migration criteria are still met
(4) Spawning and rearing values below Felton based on hydrology only
(5) All residual effects largely determined by spill frequency

4. DEVELOPING THE PROCESSES AND DATA TO SUPPORT THE NFCF

Figure 1 describes the 5 step process utilized to develop the NFCF, which starts with identifying residual impacts and culminates with a translation of appropriate mitigation into a quantitative metric – dollars. Appendix A provides a series of tables that were used to support development of the NFCF. The two critical components that provide the foundation for the NFCF are the development of the ecological portfolios and the translation of the portfolios into dollars.

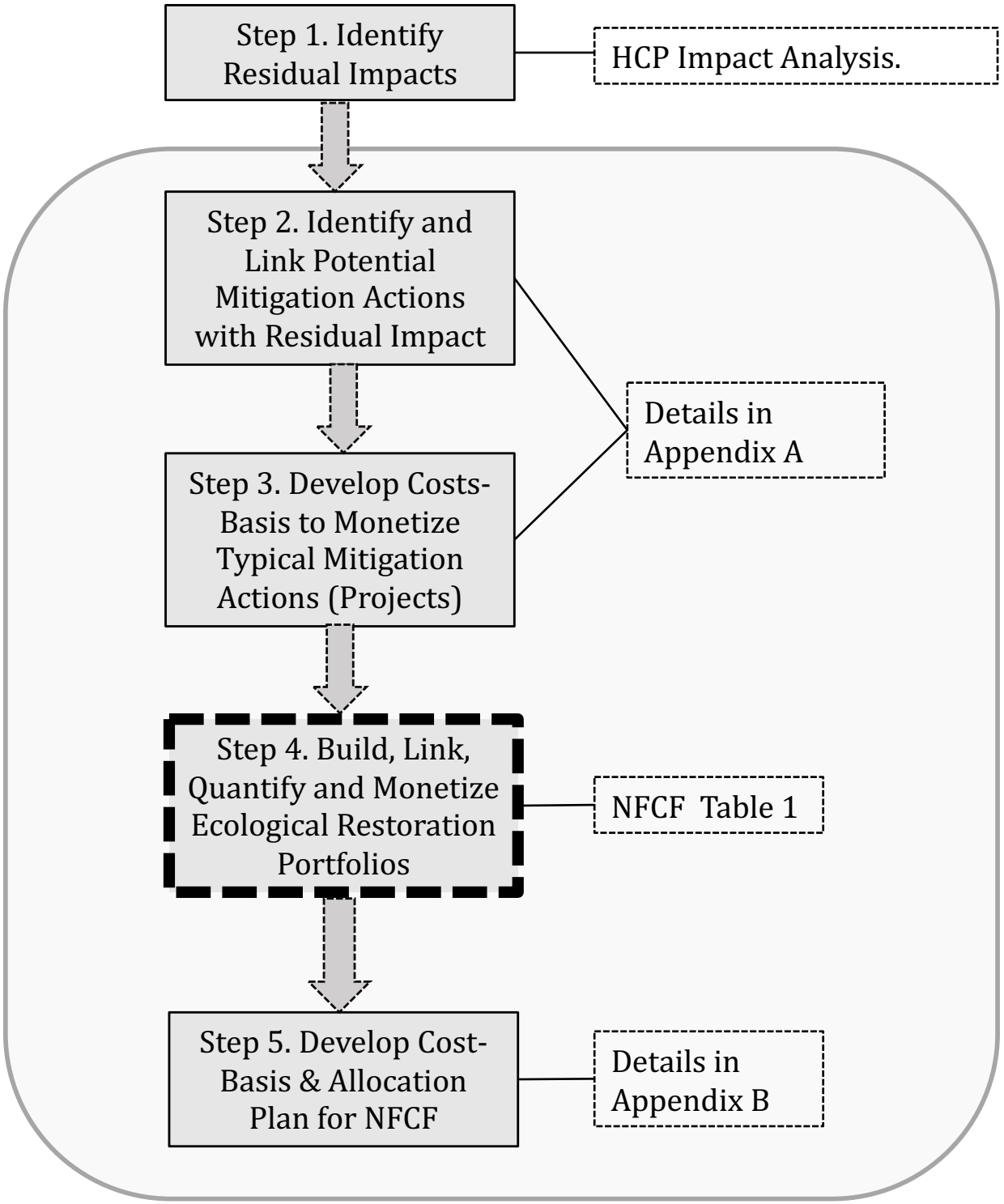
Developing Ecological Portfolios

Creating the portfolio requires identification of a suite of projects or actions that would directly mitigate for potential residual impacts. It is critical to emphasize that these portfolios were designed to enable a realistic quantification and monetization of mitigation costs and they were not designed to be prescriptive as to exactly what mitigation should be implemented with the NFCF funding. While the projects within each portfolio have been identified based on the residual impacts, local conditions, and known limiting factors, they do not take into consideration a number of critical externalities (e.g. flood management, access, ownership, recovery priority, etc.) that could affect the ability or the desire to implement a given project. Moreover, the portfolios were developed using a combination of quantitative tools (e.g. relative size or location of the residual impacts) and qualitative tools. The qualitative tools are based on known site conditions, opportunities for meaningful improvement of conditions for fisheries, and professional judgement. While most of the portfolios are focused on directly mitigating residual impacts in the impacted reaches, for Newell Creek the mitigation would occur in Branciforte Creek, and for Liddell Creek and Majors Creek, the mitigation would occur in San Vicente Creek. These particular streams were used as proxies for the impacted reaches because (a) the level of potential residual impact resulting from implementation of the HCP in Newell Creek makes it a more difficult stream for implementing meaningful mitigation actions and (b) higher priority recovery streams exist in nearby watersheds that may provide greater mitigation opportunities and benefits for both coho and steelhead. The replacement portfolio streams either currently support steelhead and coho (San Vicente Creek) or support steelhead and are a priority for coho recovery (Branciforte Creek).

Translating Ecological Portfolios into Dollars

Development of locally appropriate costs for implementing the ecological portfolios is a critical step for monetizing each portfolio in 2018 dollars. While there are a number of sources in the literature that provide ranges of costs for an array of restoration practices, this effort focused on using locally and regionally available data from 15 years of the Integrated Watershed Restoration Program

Figure 1. Flowchart for Quantifying and Monetizing Impacts and Mitigation through the Ecological Restoration Portfolio Approach



(IWRP). Finally, in situations where IWRP data was not available, the database has been completed with additional data compiled through (a) personal communication with local experts; (b) professional experience; and (c) consulting and cross-referencing with NOAA's 2008 Technical Memorandum *Habitat Restoration Cost References for Salmon Recovery Planning* by Thomson and Pinkerton. Appendix A contains tables with known costs and an average cost-basis for a suite of restoration actions that could be implemented as part of the NCFC.

Once the ecological portfolios have been completed and this hybrid quantitative-qualitative metric has been translated into dollars, the final step is to develop a cost allocation plan for implementation of the NFCF. The costs allocation plan is a 30-year budget for the NFCF that is divided into six 5-year planning cycles with associated work plans. The allocation is further divided into annual expenditures. The cost allocation plan is presented in 2018 dollars and provides a snap-shot of annual funding as well as a realistic view of what can be accomplished with the NFCF funding currently recommended. The cost allocation is included in Appendix B and Chapter 7 (table 7.2) of the HCP.

Appendix A

Appendix A: Table A-1. Restoration Action Linked to Residual Impact/Benefit

NFCF Example Project Types	Steelhead				Coho				Water Year Type				Comments
	Adult migration	Spawning/incubation	Rearing	Smolt migration	Adult migration	Spawning/incubation	Rearing	Smolt migration	Wet	Normal	Dry	Critically Dry	
Large Woody Debris (unanchored)	x	**X**	**X**	x	x	**X**	**X**	x	**X**	**X**	**X**	**X**	LWD forcing pool creation and sediment sorting will directly address impacts to spawning and rearing across all years, but will also provide high flow regufia for migrating adults, juveniles and smolts.In critically dry years, LWD forced pools maybe the only dry season refugia available.
Large Woody Debris (anchored)	x	**X**	**X**	x	x	**X**	**X**	x	**X**	**X**	**X**	**X**	See above
Dam or Obstruction Removal	**X**	x	x	x	**X**	x	x	x	**X**	**X**	**X**	**X**	Removal of obstruction will focus on enabling all life stages of fish to move upstream to find spawning or rearing habitat or downstream to find rearing habitat and smoltify during a range of water years and flows.
Dam or Obstruction Modification	**X**	x	x	x	**X**	x	x	x	**X**	**X**	**X**	**X**	See above
Culvert Removal (include replacement w/bridge)	**X**	**X**	x	x	**X**	**X**	x	x	**X**	**X**	**X**	**X**	In addition to enabling passage of all life stages (especially adults), culvert removals will should enable natural sediment transport improving LWD and spawning as well as reducing chronic erosion from undersized and/or perched culverts. Reduced chronic erosion should improve localized spawning success and rearing success.
Culvert or Flood Channel Retrofit /Upgrade	**X**	**X**	x	x	**X**	**X**	x	x	**X**	**X**	**X**	**X**	See above
Creation/Enhancement of Alcoves	x		x	x	x		**X**	x	**X**	**X**	**X**	x	Alcoves provide critical rearing habitat for coho as well as rearing for steelhead. They also can address residual impacts to migration by providing high water refugia for adults and outmigrants.
Reconnection of Floodplains	x		**X**	x	x		**X**	x	**X**	**X**	x		Major benefit will be for rearing coho and steelhead, if projects are able to sustain duration of inundation to allow food production. Floodplains will provide high flow refugia, which is a limiting factor in many of the SC watersheds. While floodplain benefits accrue with inudation and benefits increase with flows. Indirect benefits can also include groundwater recharge and elevated downstream baseflows.
Lagoon enhancements	**x**		**X**	**X**	**x**		**x**	**X**	**X**	**X**	**X**	**X**	Mechanical breaching, engineering solutions to improve timing and duration of breaching, and enhancements to provide cover will benefit adults, rearing steelhead, possibly rearing coho, and smolt outmigration.
Riparian easement w/restoration	**x**	X	**X**	x	**x**	X	**X**	x	x	**X**	**X**	**X**	Increase food input through litterfall, reduced erosion through vegetated roughness and reduce solar input will benefit rearing through food and temperature control, incubation via sediment reduction) and long-term benefit across life history stage for natural LWD recruitment.
Bio-Engineered bank stabilization	**x**	**X**	**X**	**x**	**x**	**X**	**X**	**x**	**X**	**X**	x	x	Reducing fine sediment loading will benefit spawning/incubation and rearing through predation effeciency with lowered turbidty. If engineered with refugia in-mind, these projects can also provide high flow and dry season refugia.
Gravel augementation		**X**	**X**			**X**	x						Gravel augmentation is critical in systems with modified transport regimes and will not only improve spawning and incubation success, but will support riffle feeding for juvenile steelhead and to a lesser degree feeding by juvenile coho.

Road Decomissioning	x	**X**	x	x		x	**X**	x	x						Reduced sediment loading will improve spawning/inubation success through reduced embeddedness of gravels and maintaining oxygenation. Additional benefit is derived from reduced loading of fine sediment, which can affect feeding efficiency and health of migrating adults, rearing juveniles, and out- migrating fish.
Road Improvements	x	**X**	x	x		x	**X**	x	x						See above
Offstream storage w/forebearance	x		**X**	**X**		x		**X**	**X**		x	**X**	**X**	x	Benefits of increased instream flows will postively affect all life-stages. Oversummering juveniles (coho and steelhead) are likely to derive the most significant benefit, while adult migration and smolt outmigration conditions can be improved, depending on flow schedule. In critical dry years, benefits to rearing should be significant, while benefits to migration may be negligible. Will directly address residual impacts from water withdrawals.
Increased Water Use Efficiency w/forebearance		x	**X**	x			x	**X**	x		x	x	**X**	**X**	See above, benefits will be most pronounced during irrigation season (March-October) for outdoor crops, year round for green houses, etc. Will directly address residual impacts from water withdrawals.
Managed or Improved Recharge		x	**X**	x			x	**X**	x		x	x	**X**	**X**	Benefis will be more pronounced during dry and critically dry years when GW augementation of baseflows may prove critical to enabling oversummer survival. Depending on ancedent climate conditions and timing of rains, benefits for spawning/incubation and outmigration may also be realized. May directly address residual impacts from water withdrawals.
1707 Dedication or Water Rights Purchase	x	x	**X**	x		x	x	**X**	x		x	**X**	**X**	**X**	Dedication of water rights to instram flows will provide benefit to all life stages of both species of salmonid across all water year types. Benefits will be most pronounced during the dry season and in dry years, but can benefit adult migration over critical riffles, spawning/incubation, rearing and out migration to varying extents and directly address residual impacts from water withdrawals.

Appendix A: Table A-2. Restoration Action Comparables

Project Type	*Design/ Permit*	*Construction*	*Total*	*unit*	*# of units*	*cost/unit*
LWD (anchored)						
Zayante	$ 97,041	$ 235,000	$ 332,041	structure	20	$ 16,602
Soquel LWD	$ 52,000	$ 138,000	$ 190,000	structure	9	$ 21,111
Scotts LWD and Floodplain(I/II)	$ 104,000	$ 197,000	$ 301,000	structure	14	$ 21,500
Scotts LWD and Floodplain (III) [mix]	$ 76,000	$ 84,000	$ 160,000	structure	10	$ 16,000
SV LWD (I/II) (NRCS did engineering)	$ 35,000	$ 162,000	$ 197,000	structure	9	$ 21,889
San Greg Apple	$ 52,000	$ 132,000	$ 184,000	structure	12	$ 15,333
San Greg Driscoll	$ 68,000	$ 160,382	$ 228,382	structure	14	$ 16,313
average						*$ 18,393*
average presented in the Draft HCP Conservation Strategy						$ 22,000
LWD (unanchored)						
SV LWD (III)	$ 22,000	$ 58,000	$ 80,000	structure	12	$ 6,667
Soquel Demo Forest Phase 1 (mix of anchor/unanch	$ 52,000	$ 71,000	$ 123,000	structure	12	$ 10,250
average						*$ 8,458*
Floodplain & Channel Reconfiguration						
Soquel Corridor	$ 97,000	$ 480,000	$ 577,000	linear ft	1000	$ 577
Butano Floodplain	$ 102,000	$ 980,000	$ 1,082,000	linear ft	1,200	$ 902
average						*$ 739*
average presented in the Draft HCP Conservation Strategy						*$ 1,100*
Floodplain/Backwater Via Excavation						
Laguna Floodplain	$ 50,397	$ 178,250	$ 228,647	acre	0.6	$ 381,078
Lower San Vicente Backwater Pond	$ 88,000	$ 191,096	$ 279,096	acre	0.50	$ 558,192
Upper San Vicente Backwater Pond	$ 43,000	$ 211,344	$ 254,344	acre	0.30	$ 847,813
average						*$ 595,695*
Lagoon Refuge						

Carmel Lagoon Enhancement Project	$ 100,015	$ 145,277	$ 245,292	structure	11	$	*22,299*
						$	*22,299*
Rock Weirs							
San Clemente Dam new Carmel River Channel	$ 200,000	$ 3,426,000	$ 3,626,000	weir	53	$	68,415.09
Dam Removal							
Cahill	$ 59,900	$ 96,000	$ 155,900	dam	1	$	155,900
Memorial	$ 52,000	$ 95,400	$ 147,400	dam	1	$	147,400
average						$	*151,650*
average presented in the Draft HCP Conservation Strategy						$	*78,000*
Small Instream Obstruction Removal							
SLR Boulder Cascade Modification	$ 11,142	$ 38,000	$ 49,142	boulders	1	$	49,142
Remove Concrete Slabs (estimate Branciforte)	$ 18,500	$ 66,000	$ 84,500	concrete	4	$	21,125
average						$	*35,134*
average presented in the Draft HCP Conservation Strategy						$	*78,000*
Culvert Upgrade or Bridge							
Deer Creek			$ 456,900	bridge	1	$	456,900
Koinonia Crossing	$ 35,460	$ 757,394	$ 792,854	bridge	1	$	792,854
Olson Ford	$ 156,382	$ 840,000	$ 996,382	bridge	1	$	996,382
Memorial Park Sequoia Flats	$ 48,000	$ 347,600	$ 395,600	culvert	1	$	395,600
Corralitos/Shingle Mill PM 5.24	$ 84,108	$ 315,000	$ 399,108	culvert	1	$	399,108
Gold Gulch	$ 94,388	$ 913,500	$ 1,007,888	culvert	1	$	1,007,888
average						$	*674,789*
average presented in the Draft HCP Conservation Strategy						$	*78,000*
Culvert Retrofit (weirs and/or baffles)							
Valencia Cr @ Valencia Dr	$ 52,000.0	$ 209,843	$ 261,843	both	1	$	261,843
Valencia Cr @ Hwy 1 & Soquel Dr	$ 87,000.0	$ 378,508	$ 465,508	baffles	2	$	232,754
Corralitos /Shingle Mill PM 4.8	$ 72,625.0	$ 220,000	$ 292,625	weirs	1	$	292,625
Corralitos Cr PM 2.95	$ 58,000.0	$ 371,268	$ 429,268	both	1	$	429,268

average								*$ 304,123*
average presented in the Draft HCP Conservation Strategy								*$ 78,000*
Bio-Engineered Large Bank Stabilization								
Corralitos Bio-Eng Bank Stabilization (private orchar	$ 47,000	$ 268,000	$ 315,000	linear ft	113	$ 2,787.61		
Soquel Bio-Eng Bank Stabilization (Demo Forest)	$ 50,000	$ 234,640	$ 284,640	linear ft	140	$ 2,033.14		
ADLL Bio-Eng Bank Stabilization (Pleasanton)			$ 1,100,000	linear ft	300	$ 3,666.67		
average						*$ 2,829.14*		
Road Repair/Decommissioning								
Wilder Peasey Road & Crossing Decom	$ 37,000	$ 86,000	$ 123,000	crossings	4	$ 30,750		
SLR Trib Culvert Removal and Road Decom	$ 11,890	$ 34,675	$ 46,565	crossings	1	$ 46,565		
Geyer Quarry Rd Decommissioning	$ 23,000	$ 40,000	$ 63,000	sections	4	$ 15,750		
average						$ 31,022		
Invasive Plant Eradication (3-4 yr total time)								
SV Clematis Control			$ 1,350,000	acres	2.75	$ 490,909.09		
SV Ivy Control			$ 336,000	acres	0.75	$ 448,000.00		
Ivy Eradication and Reveg on Johnston Ranch			$ 397,000	acres	0.8	$ 496,250.00		
average						$ 478,386.36		
Riparian Restoration (+ 2 yrs of maintenance)								
Hanson Slough Riparian Restoration	$ 15,000	$ 126,000	$ 141,000	acres	2.55	$ 55,294		
From Thomson and Pinkerton (2008) (average)			$ 65,000	acres	1	$ 65,000		
average						$ 60,147		
Instream Flow Projects (Storage)								
Loma Mar Mutual Water Storage Upgrade	$ 35,000	$ 250,000	$ 285,000	acft	0.5	$ 570,000		
Memorial Park Wate System Storage Upgrade	$ 100,000	$ 1,250,000	$ 1,350,000	acft	3	$ 450,000		
average						$ 510,000		
Instream Flow Projects (Efficiency)								
Repetto Farm Water Efficiency Upgrade (pump and sprinklers)			$ 150,000	acft	13	$ 11,538		

Easements or Acquisition						
Riparian (2008 Farm Bill WRP for Santa Cruz Co)	$ 10,000	$ 12,000	$22,000	acres	1	$ 22,000
Water Rights	fair market value?					

Appendix B

Appendix B: Table B-1. NFCF 30 yr cost allocation in 2018 $

Year	Task	Cost	Total Costs	Notes
				additional $/time to develop/vet projects for
1	Develop 5 yr project list	$ 25,000		5 yr cycle
1	Project 1: Design	$ 60,000		projects 1, 2, and 3 all smaller & ready to go
1	Project 2 Design	$ 50,000		
1	Project 3: Design	$ 50,000		
			$ 185,000	
2	Project 1: Permit	$ 15,000		
2	Project 2: Design	$ 20,000		
2	Project 3: Design	$ 15,000		
2	Project 2&3: Permitting (batch)	$ 35,000		
2	Project 1: Bid & Contract	$ 15,000		
2	Project 4: Design	$ 60,000		
2	Project 5: Design	$ 90,000		
			$ 250,000	
3	Project 1: Implement	$ 200,000		**Complete 1**
3	Project 2&3: Bid & Contract	$ 25,000		batch
3	Project 4: Permit	$ 20,000		batch
3	Project 5: Design	$ 10,000		
			$ 255,000	
4	Project 2&3: Implement	$ 350,000		**Complete 2 & 3**
4	Project 4: Bid & Contract	$ 15,000		
4	Project 5: Permit	$ 15,000		
			$ 380,000	
5	Project 4: Implement	$ 220,000		**Complete 4.**
5	Project 5: Permit	$ 50,000		larger project, more complex permitting, maybe IS/MND
5	Develop 5 yr project list	$ 30,000		staff/consultant time; assume some of this has been done over time
			$ 300,000	
			$ 1,370,000	End of Yr 5, 4 projects implemented, large project (5) nearly ready
6	5 Yr NFMP Review	$ 30,000		staff and/or consultants, reports, mtgs, and field visits
6	Project 5: Implement Phase 1	$ 250,000		
6	Project 6: Design	$ 20,000		get 3 more project started with small investment (6, 7 & 8)
			$ 300,000	
7	Project 5: Implement Phase 2	$ 250,000		**Complete 5.**
7	Project 6: Design	$ 40,000		
7	Project 7: Design	$ 10,000		
7	Project 8: Design	$ 10,000		
			$ 310,000	
8	Project 6: Permit	$ 15,000		
8	Project 6: Bid & Contract	$ 15,000		
8	Project 7: Design	$ 50,000		
8	Project 8: Design	$ 65,000		
8	Project 7&8: Permit (batch)	$ 30,000		
			$ 175,000	
9	Project 6: Implement	$ 200,000		**Complete 6**
9	Project 7: Bid & Contract	$ 20,000		batch ?
			$ 220,000	
10	Project 7: Implement	$ 200,000		**Complete 7**
10	Project 8: Bid & Contract	$ 20,000		
10	Project 9: Design	$ 60,000		
10	Develop 5 yr project list	$ 20,000		staff and/consultant
			$ 300,000	
			$ 1,305,000	
11	Develop 5 yr project list	$ 25,000		
11	Project 8: Implement	$ 275,000		**Complete 8**
11	Project 9: Design	$ 10,000		
			$ 310,000	
11	Project 9: Permit	$ 20,000		
12	Project 9: Bid & Contract	$ 15,000		

12	Project 10: Design	$	65,000		
12	Project 11: Design	$	70,000		
12	Project 12: Design	$	125,000		large and complex project
				$ 295,000	
13	Project 9: Implement	$	220,000		**Complete 9**
13	Project 10&11: Permit (batch)	$	25,000		
13	Project 10&11: Bid & Contract (batch)	$	20,000		
13	Project 12: Permit	$	40,000		
				$ 305,000	
14	Project 10&11: Implement	$	300,000		**Complete 10 & 11**
14	Project 12: Permit	$	15,000		
				$ 315,000	
15	Project 12: Bid & Contract	$	25,000		
15	Project 13: Design	$	60,000		
15	Develop 5 yr project list	$	30,000		
				$ 115,000	
				$ 1,340,000	
16	5 Yr NFMP Review	$	30,000		
16	Project 12: Implement Phase 1	$	250,000		
16	Project 13: Permit	$	20,000		
				$ 300,000	
17	Project 12: Implement Phase 2	$	225,000		**Complete 12**
17	Project 13: Bid & Contract	$	15,000		
				$ 240,000	
18	Project 13: Implement	$	220,000		**Complete 13**
18	Project 14: Design	$	50,000		
18	Project 15: Design	$	20,000		
				$ 290,000	
19	Project 14: Permit	$	20,000		
19	Project 14: Bid & Contract	$	15,000		
19	Project 15: Design	$	40,000		
19	Project 16: Design	$	70,000		
19	Project 17: Design	$	120,000		large project
				$ 265,000	
20	Project 14: Implement	$	220,000		**Complete 14**
20	Project 15&16: Permit	$	25,000		
20	Project 17: Permit	$	20,000		
20	Develop 5 yr project list	$	20,000		
				$ 285,000	
				$ 1,380,000	
21	5 Yr NFMP Review	$	30,000		
21	Project 15&16:Bid & Contract	$	20,000		
21	Project 17: Permit	$	50,000		
21	Project 18: Design	$	60,000		
21	Project 19: Design	$	70,000		
				$ 170,000	
22	Project 15&16: Implement	$	250,000		**Complete 15 and 16**
22	Project 17: Bid & Contract	$	20,000		
				$ 270,000	
23	Project 17: Implement Phase 1	$	250,000		
23	Project 18&19: Permit (batch)	$	25,000		
				$ 275,000	
24	Project 17: Implement Phase 2	$	250,000		**Complete 17**
24	Project 18&19 Bid & Contract (batch)	$	15,000		
24	Project 20: Design	$	30,000		
				$ 295,000	
25	Project 18&19: Implement	$	305,000		**Complete 18 and 19**
				$ 305,000	
				$ 1,315,000	
26-30	Final 5 years and $ to be used as adpative management & close-out.				
				$1,315,000	
		TOTAL (in 2018 $)		**$8,025,000**	

Appendix 2: North Coast Passage Synthesis

North Coast Streams Limit of Anadromy

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Prepared by:

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August 23, 2017

Summary

This report provides documentation for limits of anadromy in HCP plan area streams on the North Coast (Liddell, Laguna, and Majors Creeks). The report relies on previously collected information and a field survey May 24, 2017 by a team of biologists and engineers from California Department of Fish and Wildlife, NOAA Fisheries, City of Santa Cruz, and Hagar Environmental Science[1]. The team confirmed previously identified natural barriers as the limits of anadromy for each of the streams (Figure 1). The anadromous reach limit in Laguna Creek occurs at a boulder fall near the Y-creek confluence approximately 1.43 miles upstream of the mouth. In Liddell Creek, though there are significant migration issues at the Highway 1/railroad tunnel, the natural limit of anadromy occurs at a bedrock ledge about 1.16 miles upstream from the mouth and 0.13 miles downstream of the confluence of the East Branch with the Middle Branch. In Majors Creek the limit of anadromy is a long section of bedrock and boulder cascades beginning approximately 0.7 miles upstream of the mouth.

[1] The survey team included Randi Adair, CDFW; Zeke Bean, City of Santa Cruz; Chris Berry, City of Santa Cruz; Jeff Hagar, Hagar Environmental Science; Darren Howe, NMFS; Jon Jankovitz, CDFW; Monica Oey, CDFW; and Marcin Whitman, CDFW

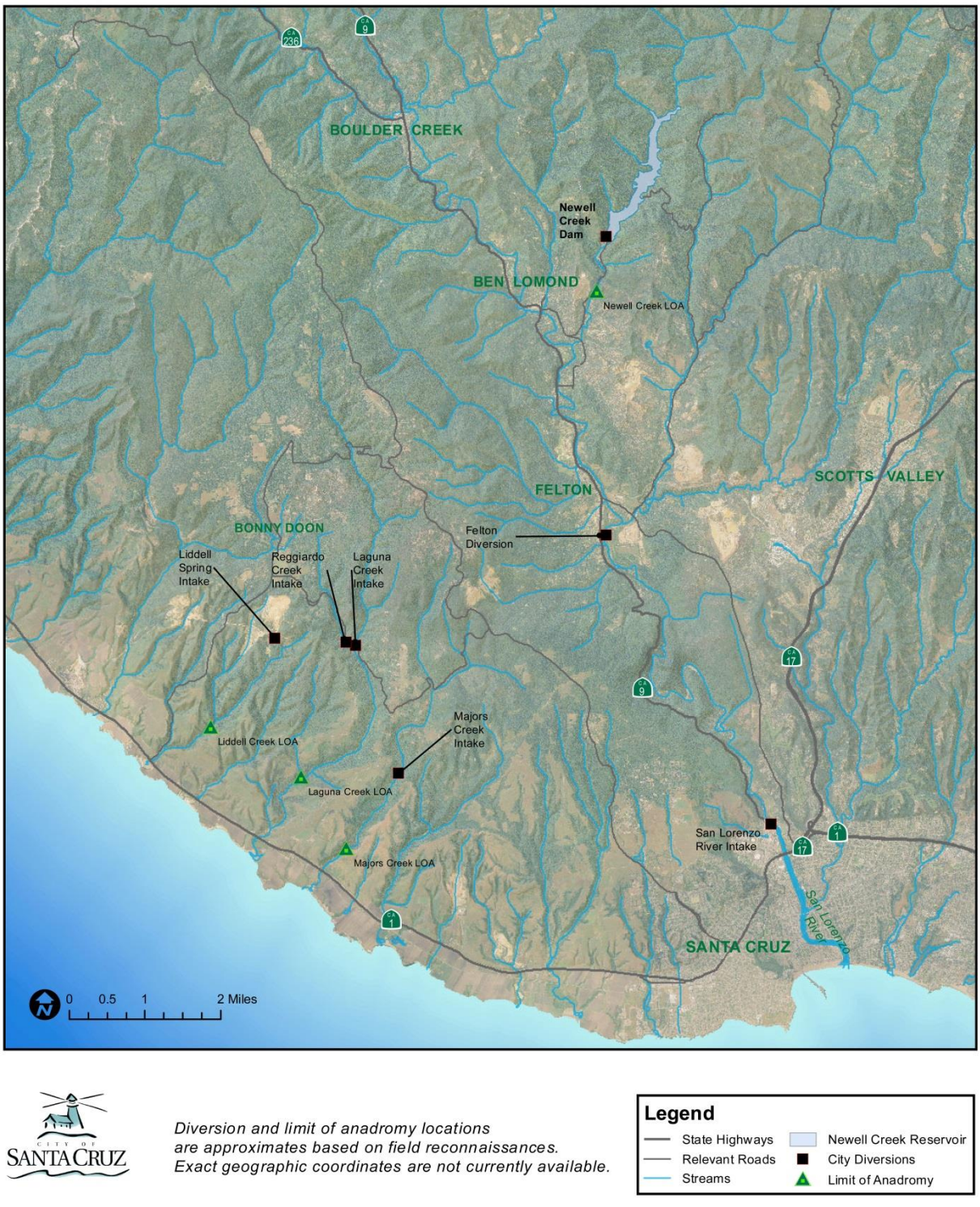


Figure 1. City of Santa Cruz stream diversions and limits of anadromy.

Laguna Creek

The channel from the Laguna Creek mouth to a point about 1.43 miles upstream is low gradient (~1.5 percent) and moderately confined. At this point (near Y Creek confluence), a series of large boulders fills the channel and forms at least one major cascade (Figure 2). This location forms a barrier to anadromous fish passage.

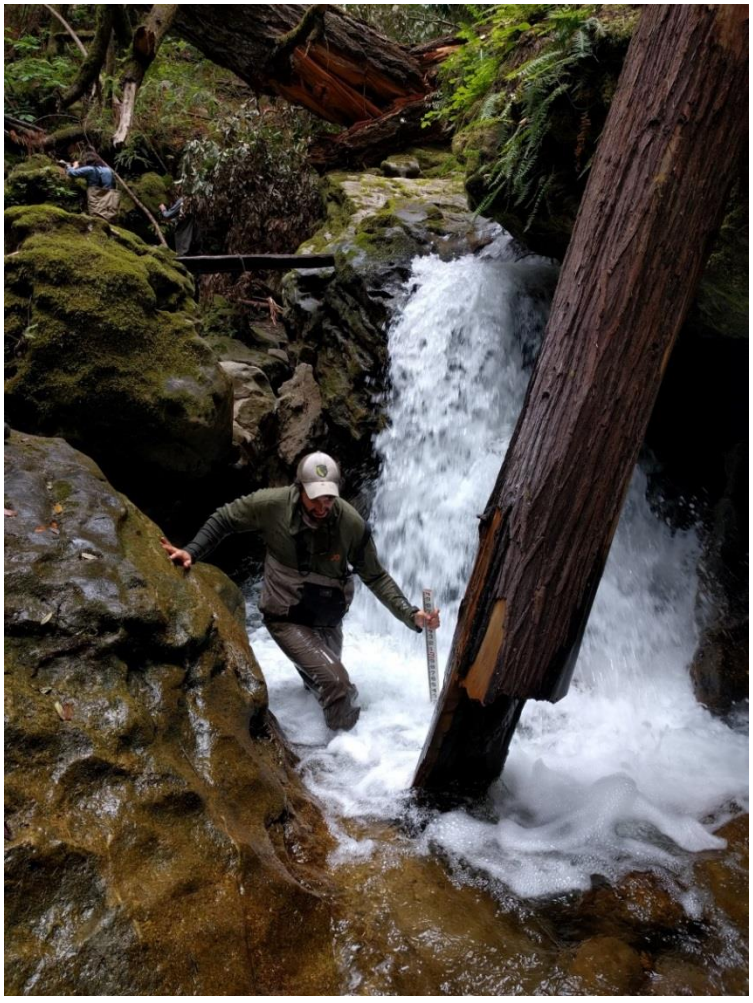


Figure 2. Boulder falls in Laguna Creek at Y Creek confluence.

Observations were made at this site on May 24, 2017 by a team of biologists and engineers from California Department of Fish and Wildlife, NOAA Fisheries, City of Santa Cruz, and Hagar

Environmental Science. The team concluded that there may be some flows where adult steelhead could ascend the boulder fall but that the frequency of such events would be insufficient to support an anadromous population upstream. City staff followed up with stream channel slope surveys subsequent to this site visit. Measurements were taken over a 90 foot section including the steepest section with cascade and 2-3 channel widths upstream and downstream of the high gradient section (Figure 3). The overall 90 ft. section had a gradient of 11.5 percent while the steepest 43 foot portion had a gradient of 28%, including one significant jump of 8.61 feet (streamflow approximately 7 cfs at the anadromous stream gage).

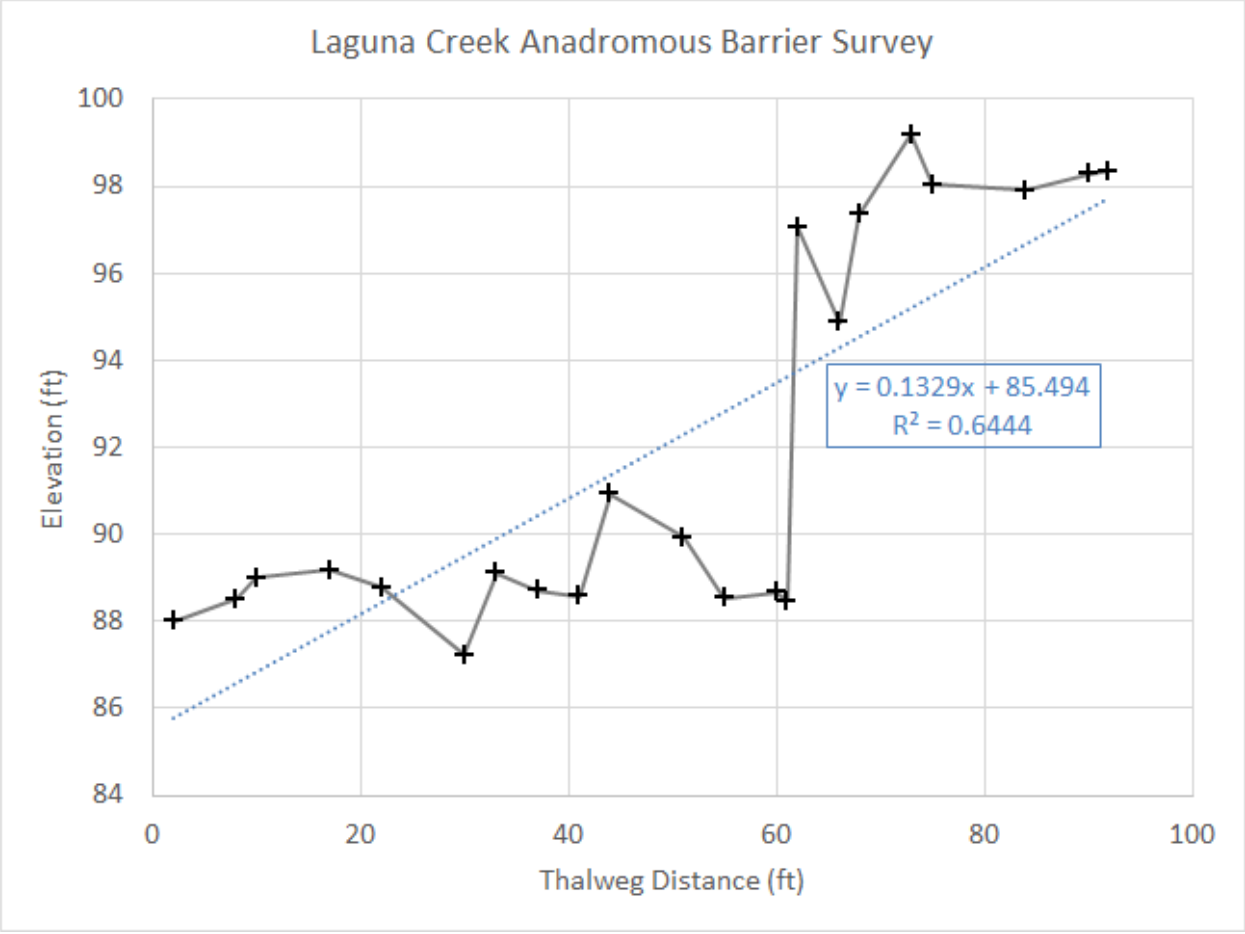


Figure 3. Thalweg survey results for Laguna Creek boulder fall.

In the anadromous reach, substrate is a mixture of sand, gravel, and cobbles, and aquatic instream cover is abundant and diverse. Above mile 1.43 to the City diversion, the channel

gradient steepens to about 3.4 percent and the valley walls become more confined. The majority of the channel between the anadromous reach and the diversion is mixed bedrock and boulders with patches of sand and gravel deposits (ENTRIX, Inc. 2004).

Twenty-two migration passage issues were identified in the 2.45 miles between the anadromous limit and the City diversion (HES 2014). These included two dams, a culvert, 12 cascades or falls, and 7 logjams. Logjams were often associated with an upstream sediment wedge that contributed to the passage issue but may be transient with changing flows. In fact, the logjams themselves are likely to be more or less transient as they can shift and move under high flow conditions, although some appeared to be relatively stable, particularly when associated with large boulders and bedrock formations. In some locations a logjam occurred in conjunction with a cascade. Eight of the locations were judged to present an obstacle to passage but not a complete barrier. The degree of difficulty would vary with flow with many of these being more an issue at lower flows and for smaller fish. The other 14 locations were considered barriers to resident trout movement. The passage issues tended to group together at several locations, for example about halfway through the surveyed reach between 7,000 and 8,000 feet upstream from Y Creek.

Liddell Creek

In Liddell Creek a natural migration barrier is formed where the stream passes over a bedrock ledge about 1.16 miles upstream from the mouth and 0.13 miles downstream of the confluence of the East Branch with the Middle Branch[2]. Observations were made at this site on May 24, 2017 by a team of biologists and engineers from California Department of Fish and Wildlife, NOAA Fisheries, City of Santa Cruz, and Hagar Environmental Science. Flow at the time of the survey was approximately 5 cfs at the anadromous gage. The ledge was approximately 30 feet in length with a slope of about 14% in the downstream direction (Figure 4).



Figure 4. Bedrock ledge in Liddell Creek 1.16 miles from mouth.

[2] It should be noted however, that there are significant problems with migration passage at the mouth due to fill placed in the original channel for the railroad and Hwy 1, and rerouting of the creek through an artificial tunnel. The mouth of Liddell Creek is blocked during the dry season and low flow periods by the beach berm. There is not a well-developed lagoon. The channel behind the beach, downstream of the Highway 1 culvert, is often braided, shallow, and choked with aquatic plants. Passage through this section may require substantial flow to open the mouth and provide sufficient depth for adult salmonids to migrate through the shallow, braided section. At the Highway 1 crossing the Main Branch of Liddell Creek passes under the highway and adjacent railroad tracks through a bedrock bore (reinforced with concrete). The outfall of the Highway 1 tunnel contains two concrete barriers that partially close the opening. This crossing may pose a passage problem to migrating salmonids during certain hydrologic conditions. During the winter when the beach sand is scoured away, a vertical drop of up to 3 feet (with no significant plunge pool) may form at the culvert exit point.

At the lower end of the bedrock shelf there was a 2 foot drop with maximum depth of flow of only about 1.5 feet in the stream immediately below it. The stream channel cuts upstream along the edge of the bedrock on the west side, with another cascade at the top. This upper cascade had a vertical drop of about 6 feet with no pool and shallow depth of flow below. There was a debris jam at the top of the ledge. Average depth of flow across the bedrock ledge was 0.5 feet. The downstream channel was relatively unconfined and there was no indication on the banks of significant backwatering below the ledge (Figure 5). This location was judged to be a total barrier to migration of all life-stages of steelhead and coho salmon and the limit of anadromy in Liddell Creek.



Figure 5. Stream channel downstream of Liddell bedrock ledge.

Seventeen additional passage issues were identified in the reach of Liddell Creek between the bedrock shelf and the tributary from the City diversion, a distance of 1.33 miles (HES 2014). These included a culvert, 8 logjams, and 8 cascades. The majority of locations were considered obstacles (10 plus one possible barrier) and four of the barriers were judged to be a problem only at low flows (i.e., dry season). This reach has a very narrow active channel that is entrenched in many areas and thickly overgrown with willow and poison oak. The average gradient is about 2.8%.

Majors Creek

About 0.7 miles upstream of the mouth, Majors Creek enters a short reach (0.15 mi) of very steep (>10 percent gradient) bedrock and boulder cascades. This reach forms a barrier for fish passage at a distance of 0.71 miles upstream from the creek mouth (Figure 6).



Figure 6. Beginning of boulder cascades in Majors Creek.

Observations were made at this site on May 24, 2017 by a team of biologists and engineers from California Department of Fish and Wildlife, NOAA Fisheries, City of Santa Cruz, and Hagar Environmental Science. Follow up measurements made by City staff show the overall reach of stream containing the first several cascades extends for 261 feet at an average gradient of about 42%[3] (Figure 7). The City's survey indicated the presence of seven discreet obstacles in this section (Table 1).

[3] Stream flow measured at the anadromous gage was approximately 3 cfs at the time of this survey.

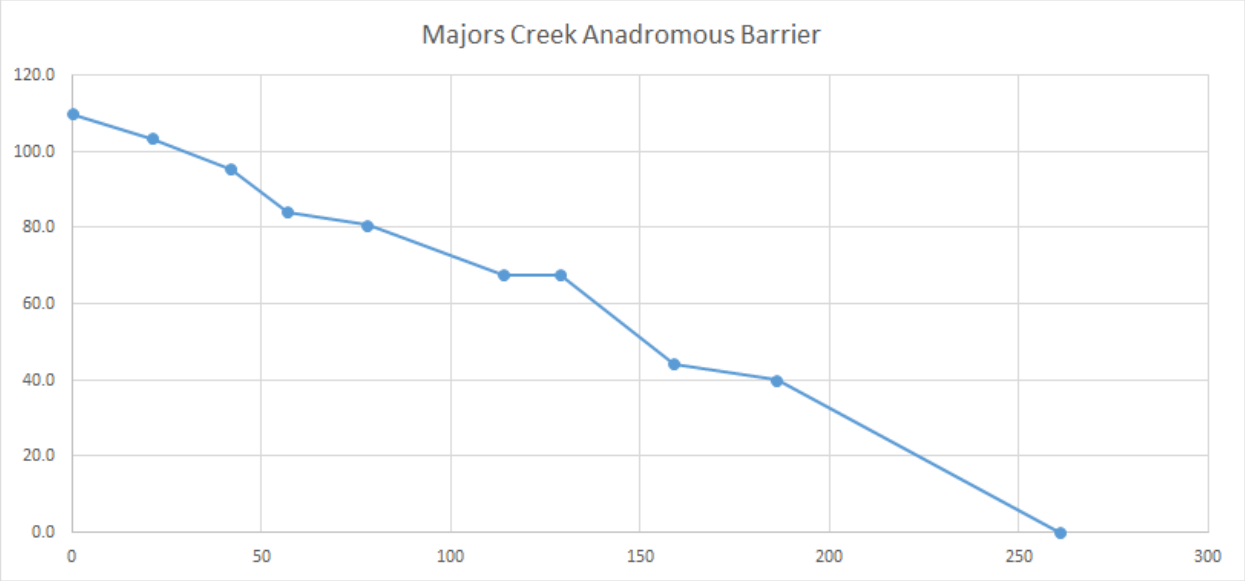


Figure 7. Slope estimates for Majors Creek boulder fall.

Table 1. Discreet passage obstacles in Majors Creek barrier reach (City of Santa Cruz survey).

Feature ID	Station (ft.)	Bottom Pool Depth (ft.)	Barrier Height (ft.)	Upper Landing Pool Depth (ft.)	Jump Length (ft.)	Notes
1	21	3.9	3.1	0.9	2	Large cut redwood log in bedrock notch
2	37.1	2.3	4	1.35	9.6	Landing at station 37.1
3	62.6	1	5.6	0.7	4	Landing at 62.6; bedrock and boulder
4	91	2.5	5.5	1.45	3.8	Bedrock chute
5	122	2.54	11	0.55	13	
6	204.5	3	13.5	1.34	3	tall waterfall, with log
7	239.4	1.58	6.5	1.28	4	
end	285					end just downstream of last feature, clear break in slope (flattens out downstream)

The initial cascade drops 18 feet over a distance of 49 feet (Figure 8). The pool below this cascade was 3 feet deep at its deepest point. Although there may be some backwatering below the cascades at higher flows the channel immediately downstream of the lower cascade is relatively steep, limiting the potential increase in stage (Figure 9). Measurements off USGS topographic map show a 28% gradient over a distance of 630 feet in the vicinity of these cascades.



Figure 8. Initial cascade in Majors Creek boulder cascade complex.



Figure 9. Stream reach immediately downstream of Majors Creek boulder cascade complex.

The stream section was judged a total barrier to all life-stages of steelhead and coho salmon under conditions at the time of observation. There may be passages that open during certain high flow conditions that would allow an individual steelhead to occasionally ascend through this section. However, such conditions would likely occur infrequently and the overall extended steep gradient of this section, the number and complexity of obstacles, and the likely infrequent periods when flow conditions would allow ascent, support the conclusion that this would be considered the limit of anadromy in Majors Creek. The California Salmonid Stream Habitat Restoration Manual considers the limit of anadromy to be a sustained channel slope of eight to ten percent (Flossi et al. citing Robison et al. 2000 and SSHEAR 1998).

The stream reach downstream of the cascades is relatively low gradient and supports steelhead. In this lower section, the channel gradient decreases and the channel becomes less entrenched as the valley walls widen. Upstream of the boulder falls area to the City diversion, a distance of about 1.60 miles, the average gradient is about 4.2% with several steeper sections of boulder falls, cascades, and logjams (HES 2014). Eight distinct passage issues were identified in the upstream reach, all logjams except for one cascade (HES 2014). Three were considered complete barriers while 5 were primarily barriers at low flows.

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Robison, E.G., A. Mirati, and M. Allen. 2000. Oregon road/stream crossing restoration guide: spring 1999. Advanced Fish Passage Training Version. 75 p.

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Appendix 3: Flow Studies

REVISED 2014

Assessment of Streamflow Effects on Migration, Spawning, and Rearing Habitat for Anadromous Salmonids in Streams Influenced by City of Santa Cruz Water Diversions including Newell Creek

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December 1, 2014

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Notes for the 2014 Revised Report

In early January 2013 the City of Santa Cruz discovered an error in stage observations resulting from an error in measurement of the angle of the staff plate installed at the Lower Newell Creek stream gaging station below Newell Dam. The error resulted in recalculation of flow estimates during the period when instream flow studies were being conducted in Newell Creek. Since the flow data in question were used in development of stage-discharge relationships used in the PHABSIM modeling and passage assessments the habitat modeling and other analyses have been corrected to be consistent with the revised flow data. The revised data result in small changes to the minimum passage estimates (Table i) and to the shape of WUA vs. discharge relationships for spawning and rearing (Figures i and ii). The revisions also affect data on the Newell Creek extreme critical riffle presented in Appendices F; WUA vs. discharge data for Newell Creek presented in Appendix G; and WUA vs. discharge for individual transects in Newell Creek presented in Appendix H.

Table i. Changes to passage flow estimates for Newell Creek.

Transect Name	Adult Steelhead and Coho		Steelhead and Coho Smolts	
	Previous	Revised	Previous	Revised
N P-1 (below Rancho Rio)	**21.7**	**24.4**	**6.2**	**8.3**
N P-2 (below Rancho Rio)	20.0	22.7	4.6	6.4
N P-A1 (below Glen Arbor)	12.3	11.4	3.9	3.9
N P-A2 (above Glen Arbor)	19.7	21.3	2.8	3.2

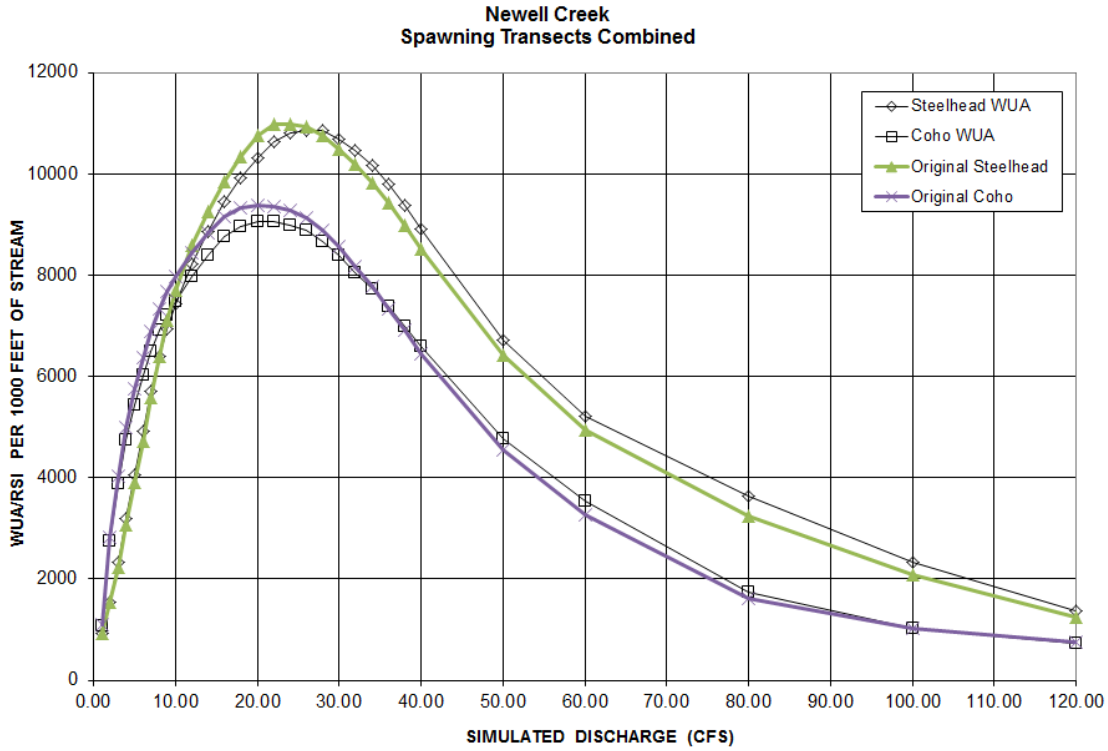


Figure i. Spawning habitat suitability for steelhead and coho salmon as a function of flow in Newell Creek.

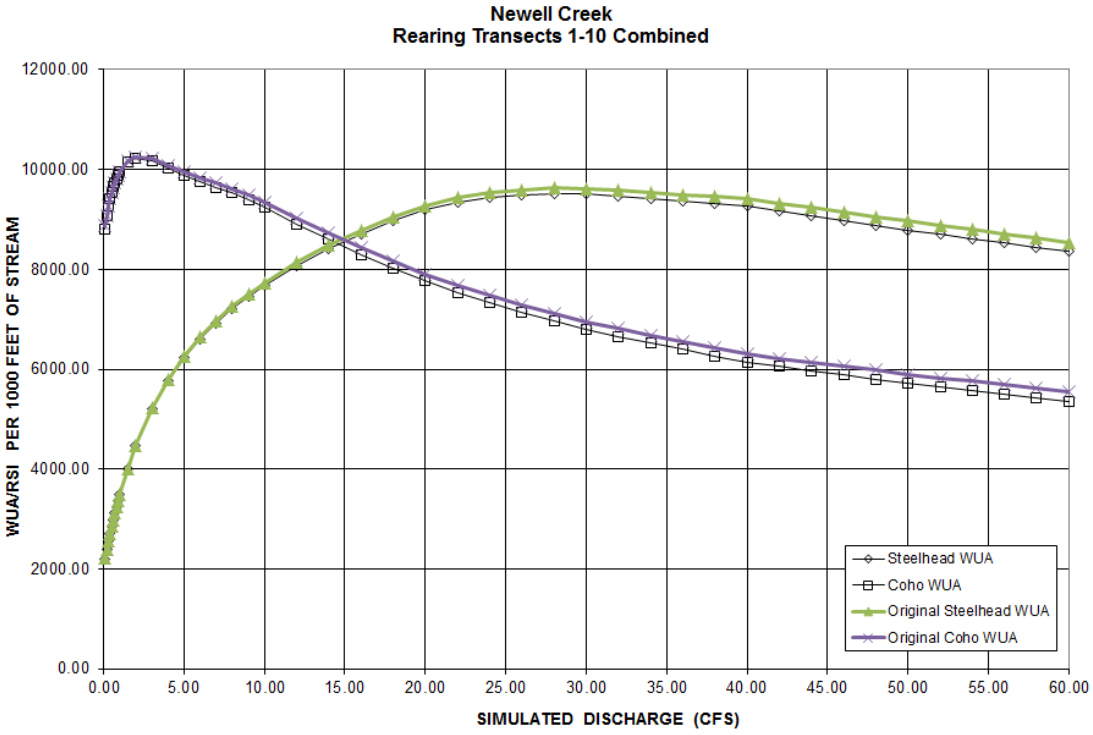


Figure ii. Rearing habitat suitability for steelhead and coho salmon as a function of flow in Newell Creek.

1 Introduction

Development of the City of Santa Cruz Habitat Conservation Plan (HCP) has resulted in the need to explore changes in operation of City diversions from the San Lorenzo River and North Coast streams to provide better conditions for steelhead (*Oncorhynchus mykiss*) and coho salmon (*Oncorhynchus kisutch*) populations in those streams (San Lorenzo River, Newell Creek, Liddell Creek, Laguna Creek, and Majors Creek). This may include limitations on diversions during certain periods to bypass flows to provide migration, spawning and rearing habitat. There is a limited amount of capacity within the City's water supply system for augmenting streamflow, and any augmentation of streamflow needs to be directed at achieving incremental improvement in habitat conditions that has the greatest potential for increasing the stability and productivity of target steelhead and coho salmon populations. The analysis described here is intended to support development of an HCP that makes the best use of available water supply to protect these species within the constraints of maintaining a reliable level of water supply for the City of Santa Cruz.

The study described in this report was conducted to develop data that quantify changes in habitat features as a function of streamflow. The study addresses flow-related habitat features during key life-history periods of anadromous salmonids including: adult migration between the stream mouth and spawning areas; migration of juvenile salmonids as smolts and during the rearing period; spawning and egg incubation; and juvenile rearing during low flow periods. The methodology involved selection of study sites (transects) to represent each of the life-history phases of interest and development of computer models to simulate changes in habitat metrics (depth, velocity, and substrate) as a function of streamflow. This information can be used, together with other existing information on limiting factors, hydrology, geomorphology, population characteristics, and so on, to develop operational and flow management options to improve habitat conditions for steelhead and coho salmon.

The City diversions on each of the North Coast streams (Liddell, Laguna, and Majors Creeks) are located upstream of the anadromous reaches of these streams and operate year round, potentially influencing migration, spawning, and rearing of both steelhead and coho salmon. This study therefore addresses each life stage for both species in the North Coast streams. Diversion at Tait Street also occurs year round and potentially influences migration passage opportunities for both smolts and adult steelhead and coho salmon and at critical passage locations in the 1.4 mile section between the diversion and the lagoon. Diversion at Tait Street also potentially influences habitat conditions for steelhead rearing in this reach. No spawning of either steelhead or coho salmon is known to occur downstream of Tait Street and coho salmon are not expected to rear there, primarily due to warm temperature during the summer (see Appendix A). Operation of Newell Reservoir has the potential to influence migration and spawning. The existing instream flow requirement of 1 cubic feet per second (cfs) augments rearing flows above levels that would occur naturally so the relationship between streamflow and juvenile rearing was not evaluated in Newell Creek. The Felton Diversion is also subject to existing agreements to avoid and minimize flow related effects on salmonid lifestages downstream of the diversion so this study does not address flow/habitat relationships in the San Lorenzo River between Felton and Tait Street (HES 2009).

1.1 Study Objectives

The objective of this assessment is to quantitatively determine the relationship between streamflow and potential migration, spawning, and rearing habitat for steelhead and coho salmon in each of the streams that feed the City of Santa Cruz water supply. Flow/habitat relationships were assessed for four distinct life stages of steelhead and coho salmon including, adult upstream migration passage, spawning and egg incubation, smolt downstream migration passage, and juvenile rearing.

Assessment of migration habitat was completed using the Thompson methodology (Bjornn and Reiser 1991, Thompson 1972). The spawning and rearing habitat assessments were completed using the Physical Habitat Simulation (PHABSIM) model of the Instream Flow Incremental Methodology (Bovee et al. 1998). PHABSIM consists of three principal components: a hydraulic model, habitat suitability criteria, and a habitat simulation. The hydraulic modeling component is used to simulate the transect depths and velocities that would occur over a range of simulated flows. The Habitat Suitability Criteria (HSC's) describe the suitability of different values of depth, velocity, and substrate to different species and lifestages. The habitat simulation component uses the HSC component to interpret the results of the hydraulic modeling to develop an index of habitat quality. This index is commonly termed Weighted Usable Area (WUA), although it is more accurately termed a Relative Suitability Index (RSI) (Payne 2003) or Physical Habitat Index (Payne 2007). Methods for each life stage are summarized in Section 3.0.

This is a habitat-based approach and changes in hydrology are related to predicted changes in habitat conditions. Change in habitat condition is not directly predictive of change in population status. The methods used are subject to potential error in measurement of parameters in the field, inadequacies of hydraulic modeling techniques, and errors due to invalid assumptions.

1.2 Target Species

This assessment includes steelhead and coho salmon. The North Coast watersheds and the San Lorenzo River watershed are part of the Central California Coast Distinct Population Segment (DPS). Steelhead composing this DPS are listed as threatened under the Federal Endangered Species Act (FESA) (NOAA Fisheries 1997). The Central California Coast DPS consists entirely of winter-run steelhead and extends from the Russian River south to, but not including, the Pajaro River at the southern border of Santa Cruz County. The HCP area is located in the southern part of the Central California Coast DPS (Busby et al. 1996). Steelhead are known to be present in all streams influenced by City water diversions.

Coho salmon in the HCP area are part of the Central California Coast DPS which is listed as threatened under the FESA and endangered under the California Endangered Species Act (CESA). Under FESA, the Central California Coast ESU extends from Punta Gorda in Humboldt County south to, and including, the San Lorenzo River (NOAA Fisheries 1996). Central California represents the southern margin of the species natural distribution, and coastal streams of Santa Cruz County constitute the southernmost extent of current coho distribution. In Santa Cruz County, historically coho salmon are believed to have used Gazos, Waddell, Scott, San Vicente, Soquel, and Aptos Creeks and the San Lorenzo River (CDFG 2003a). During recent

surveys (2000-2002) coho salmon were found in Gazos, Waddell and Scott Creeks. No juvenile coho salmon were captured during electrofishing surveys conducted throughout the San Lorenzo River watershed (including both mainstem and tributary locations) between 1994 and 2002 (H.T. Harvey 2003; DWA 2000, 2002). Four juvenile coho salmon were observed in Bean Creek (tributary to Zayante Creek) in the fall of 2005 (DW Alley and Associates 2007) and two young-of-year coho were captured in September 2005 in Zayante Creek just upstream of the Bean Creek confluence (HES 2005). Some investigators contend that much of the former coho production in the San Lorenzo River was the result of stocking from the 1950s throughout the mid-1970s (DWA 2000, ENTRIX, Inc. 2004a, Kaczynski and Alvarado 2006). Others argue against this position (Adams et al. 2007).

No coho salmon have been observed in Liddell, Laguna, or Majors Creeks during electrofishing surveys of Santa Cruz County streams in the fall of 1981 (Harvey & Stanley Associates, Inc. 1982) or in recent visual surveys completed by the City of Santa Cruz in 2006 and 2007. Smolt-sized and young-of-year coho were captured in the Laguna Creek lagoon in 2005 (2nd Nature 2006) indicating that coho spawned successfully in Laguna Creek both during the winter of 2003-2004 and the winter of 2004-2005.

Habitat was evaluated for migration, spawning, and rearing of steelhead in all three of the North Coast streams and for coho salmon in Laguna Creek. Habitat conditions for migration and rearing of steelhead and coho were evaluated for the San Lorenzo River downstream of Tait Street although coho are not expected to rear in this area. There is no spawning of either species known to occur or expected there. Habitat conditions for migration, spawning, and rearing of both species were evaluated in Newell Creek. Coho salmon are not known to have ever occurred in Newell Creek but were included in the assessment since Newell Creek is included in the coho recovery plan (NMFS 2010).

O. mykiss exhibit the capacity for remarkable adaptability in life history strategies, with the ability to complete their life cycle completely in freshwater (rainbow trout) or as sea-run (anadromous) steelhead. Many streams in central California support both anadromous and resident forms with no distinguishable genetic differentiation (Moyle 2002, Nielsen 2003). Both forms can interbreed and the progeny of either life history trait may adopt the alternate life history pattern. In some streams, the non-migratory form may exist upstream of an impassible barrier while the anadromous form persists downstream. Unless they have been stocked in a stream, resident rainbow trout populations are believed to have derived, whether recently or at some point in the past, from steelhead.

ENTRIX, Inc. (2004b) identified barriers to anadromous runs in each of the North Coast streams within approximately 1.6 miles or less of the stream mouths. Therefore, this assessment of streamflow effects on habitat were limited to the identified anadromous reaches and considered only the anadromous life-history. Newell Creek likely supports anadromous populations downstream of migration obstacles downstream of Newell Dam and resident populations upstream of these obstacles (Hagar Environmental Science (HES) 2007). Assessment sites for migration and spawning in Newell Creek were therefore placed downstream of the migration obstacles. Assessment sites for migration and rearing in the San Lorenzo River were placed between Water Street (the upper limit of lagoon influence) and Tait Street, where the City diversion is located.

2 Background and Life History Considerations

2.1 Adult Migration Passage

Steelhead and coho salmon along the central California coast enter freshwater to spawn when winter rains have been sufficient to raise streamflows and breach the sandbars that form at the mouths of many streams during the summer. Increased streamflow during runoff events also appears to provide cues that stimulate migration and allows better conditions for fish to pass obstructions and shallow areas on their way upstream. The season for upstream migration and spawning of steelhead adults lasts from late October through the end of May but typically the bulk of migration (over 95% in Waddell Creek) occurs between mid-December and mid-April (Shapovalov and Taft 1954). Coho salmon have a more abbreviated spawning season that occurs earlier in the winter. In California, coho spawning migrations occur between late October and early March with more southern populations typically spawning slightly later. Between 1933 and 1942, the coho migration in Waddell Creek occurred between early December and early March with 90% of the run completed by early February (Shapovalov and Taft 1954). This relatively early spawning period for coho salmon increases the probability that their embryos will be exposed to severe conditions during high flow episodes and has resulted in very weak year classes in some of the remaining runs south of San Francisco Bay (Anderson 1995).

Steelhead have strong swimming and leaping abilities that allow them to ascend streams into small tributary and headwater reaches. Steelhead can swim at rates of up to 4.5 feet per second (fps) for extended periods of time and can achieve burst speeds of 14 to 26 fps during passage through difficult areas (Bell 1986). Leaping ability is dependent on the size and condition of fish and hydraulic conditions at the jump. Given satisfactory conditions, a conservative estimate of steelhead leaping ability is a height of 6 to 9 feet (Bjornn and Reiser 1991), although other estimates range from 11 feet (Bell 1986) to as high as 15 feet (McEwan 1999). Coho have slightly lower swimming and leaping ability than steelhead, with cruising speeds up to 3.5 fps and burst speed of 10 to 21 fps (Bell 1986). Maximum jumping height for coho is reported by Bell (1986) at just over 7 feet. These differences in swimming ability may limit coho to relatively lower gradient reaches of coastal streams. In Waddell Creek, Shapovalov and Taft (1954) found that coho consistently spawned lower in the creek.

Diversion during the winter (December through March) may potentially reduce passage opportunities for adult steelhead and coho salmon at critical passage locations in the anadromous reaches of streams. The relationship between flow and passage criteria (depth) was evaluated in the anadromous reaches of study streams by application of standard procedures commonly referred to as the Thompson method (Bjornn and Reiser 1991, Thompson 1972). Using this method, critical riffles or other sites that are exceptionally wide and shallow or otherwise hinder fish passage can be identified. The objective of this method is to estimate the stream flow level that meets accepted criteria for depth of flow and flow velocity that facilitate passage of a fish species and life-stage of interest, in this case steelhead and coho salmon.

Streamflow can also influence opening and closing of the lagoons at the mouths of coastal streams. In the Santa Cruz County streams in this study, the lagoons are relatively small and tend to open in the fall with small increases in streamflow (HES 2009). Generally, initial precipitation events in the fall are associated with conditions favoring lagoon opening including increased streamflow and wave energy. Flow levels at which suitable migration conditions exist at critical riffles appear sufficient to open or maintain the lagoons in an open state in these streams (HES 2009). In addition, the magnitude of City Diversions is relatively small compared to flows during migration periods so the potential effect of City Diversions on lagoon opening and closing is minimized. City Diversions are usually curtailed during runoff events due to concerns with excessive sediment and turbidity.

2.2 Spawning and Egg Incubation

Both steelhead and coho salmon select spawning sites with gravel substrate and with sufficient water velocity to maintain circulation through the gravel and provide a clean, well-oxygenated environment for incubating eggs. Flowing water also enables the female to clean spawning gravels of fine sediment when constructing the nest site (redd). Preferred flow velocity is in the range of 1 to 3 fps for steelhead (Raleigh et.al 1984) and 0.7 to 2.3 fps for coho (McMahon 1983). Moyle (2002) states that water velocity over steelhead redds (spawning nests) is typically 0.5 to 5 fps and depth is 0.3 to 5 feet. Preferred gravel substrate is in the range of 0.25 to 4 inches in diameter for steelhead and 0.5 to 4 inches for coho (Bjornn and Reiser 1991).

Typically, sites with preferred features for spawning occur most frequently in the pool tail/riffle head areas where flow accelerates out of the pool into the higher gradient section below. In such an area, the female will create a pit, or redd, by undulating her tail and body against the substrate. This process also disturbs fine sediment in the substrate and lifts it into the current to be carried downstream, cleaning the nest area. Incubation and emergence success are influenced by accumulation of fine sediments (generally less than 3.3 mm) in the substrate. Embryo survival for steelhead decreases when the percentage of substrate particles less than 6.4 mm reaches 25 to 30% and is extremely low when fines are 60% or more. Emergence of steelhead and coho fry is generally high when fine sediments are less than 5% of substrate volume but drops sharply with fine sediment volume of 15% or more.

Steelhead eggs hatch in 3 to 4 weeks at temperatures of 10 to 15°C, and fry emerge from the gravel 2 to 3 weeks later (Moyle 2002). Coho embryos hatch after 8 to 12 weeks of incubation with timing highly dependent on temperature conditions. Hatchlings remain in the gravel another 4 to 10 weeks until their yolk sacs have been absorbed (Moyle 2002). In central California, near the southern edge of their range and presumably where temperature conditions are highest, the time between spawning and emergence from the gravel would be expected to be closer to 12 weeks. Survival of fertilized eggs through hatching and emergence from the gravel are often limited by severe changes in flow that can dislodge eggs from the substrate, result in sedimentation, or de-water incubation sites.

Diversion of flow during the winter has the potential to alter habitat conditions for spawning of salmonids in the study streams. The relationship between flow and spawning habitat quality was assessed in the anadromous reaches of study streams by collecting data to calibrate a

Physical Habitat Simulation Model (PHABSIM). Salmonid spawning habitat is well-modeled with PHABSIM since salmonids have quite specific preferences for type of substrate, water depth, and flow velocity and tend to select locations that have hydraulic features that are relatively easy to model.

2.3 Rearing

In Central California streams coho typically rear for one year in freshwater and steelhead typically rear one or two years. Habitat selection and use by juvenile salmonids is complex and variable. After emergence from the gravel, fry inhabit low velocity areas along the stream margins. As they feed and grow they gradually move to deeper and faster water. Steelhead juveniles (parr) of 4 to 6 inches (generally in their second year of life) may be found in a variety of habitat types including pools, runs, and riffles. Parr larger than 6 inches are more often found in deeper waters where low velocity areas are in close proximity to higher velocity areas and cover is provided by boulders, undercut banks, logs, or other objects. Heads of pools generally provide classic conditions for older trout. Coho parr are most abundant in large, deep pools (greater than 1 foot) with abundant cover in the form of logs, roots, woody debris, undercut banks, and overhanging vegetation (McMahon 1983). Some studies have shown positive correlations between coho standing crop and pool volume (McMahon 1983). Trout and juvenile coho can inhabit quite small streams, particularly in coastal streams. Often habitat may be far more limiting for older juveniles than habitat for younger fish. The critical period is during base flow conditions that generally occur between May and October in Central California. Streamflow can drop to very low levels with loss of depth and velocity in riffle and run habitats, or in the extreme, only isolated pools with intervening dry sections of stream. Winter high flows may also be limiting, particularly for coho salmon, if backwater refuge areas are not available.

Food and cover are key factors for rearing steelhead and coho (Mason and Chapman 1965; Shapovalov and Taft 1954). Food availability, in terms of production of aquatic and terrestrial insects, is influenced by substrate composition, extent of riffles, riparian vegetation, and flow. The highest production of aquatic invertebrates is in gravel and cobble substrate with low amounts of fine sediments, often occurring in riffle type habitats. Production of coho has been shown to be higher in pools with larger riffles upstream (Pearson et al. 1970). Coho production decreases with high levels of fine sediments and high embeddedness of cobble substrate (Crouse et al. 1981). Bjornn et al. (1977) found that the density of rearing steelhead and chinook salmon in artificial channels was reduced in nearly direct proportion to increased cobble embeddedness. Response to increased embeddedness was even greater during the winter. During the high flows, reduced food abundance, and lower temperatures occurring in winter, both coho and steelhead may move into the substrate or other cover. Backwater habitat, small tributaries, or other low velocity areas may also be important winter habitat. The influence of flow on food production or availability or on sediment transport was not a component of this study.

Temperature is an important factor for steelhead/rainbow trout and coho, particularly during the over-summer rearing period. In many Central California streams growth slows or ceases in conjunction with warm, low flow conditions in late summer. Temperature monitoring in the North Coast streams indicates that temperature is well within the suitable ranges for both

steelhead and coho salmon juveniles and cooler than in many streams that support steelhead in the region (HES 2009). The existing temperature monitoring data were collected during periods when the diversions were operational. The diversions are not expected to negatively influence temperature conditions and temperature was not a factor considered in this analysis.

Steelhead/rainbow trout populations in Central California can occur in streams with relatively low baseflow and in streams varying widely in terms of standard evaluation parameters such as pool:riffle ratio and mean depth. Often, local populations thrive under conditions that may depart widely from species norms (Behnke 1992). The anadromous life history of both steelhead and coho salmon is an adaptation that allows them to avoid the limited rearing potential in the relatively unproductive streams of their birth in favor of the much richer potential provided by the marine environment. This life history is a tradeoff between remaining in the relative safety of their freshwater rearing environment long enough to achieve a size that provides relatively greater protection from the abundant potential predators in marine waters.

Diversions throughout the year have the potential to alter habitat conditions for rearing salmonids in the study streams. Given the complexity and variability of habitat selection and use by juvenile salmonids and that hydraulic conditions in good rearing habitat are generally complex and difficult to model effectively, predicting change in habitat quality for rearing juveniles based only on change in flow is exceedingly problematic. Nevertheless, the relationship between flow and two components of rearing habitat quality, i.e., depth and velocity, was described in study streams through application of the PHABSIM model. This information, while not necessarily useful in isolation, may be combined with other information sources to provide some basis for assessing the effect of flow on rearing habitat.

2.4 Smolt Migration

Shapovalov and Taft (1954) conducted an extensive study of steelhead and coho salmon migration in Waddell Creek. Behavior of steelhead/rainbow trout in Waddell Creek is probably typical for most Central California populations. Trout of various ages migrated out of Waddell Creek in all months of the year but the majority migrated in April, May and June. Downstream migration of young-of-year fish (less than a year old) extended from late-April through the following spring; however this movement may have been just dispersal to downstream rearing areas and not a true seaward migration. Downstream migration of 1-year old steelhead was from April through late June and 2-year old fish from March through late May. Coho in Waddell Creek migrated almost exclusively as one-year old fish and 96% of all migration occurred between April 1 and June 15.

Temperature and flow conditions may influence smolt migration and in addition, smolts are subject to predation, primarily by birds including cormorants, mergansers, and herons. Although predation by fish can be high in certain situations, large predatory fish are generally not present in smaller coastal streams. Predation by birds can increase under conditions where smolts have to traverse shallow sections of streams without cover. With clear water, birds can be particularly effective predators. Conditions favoring predation by birds occur in channel reaches modified for flood control where the channel is maintained in a wide, shallow configuration and is largely devoid of in-stream large woody debris and riparian vegetation.

Diversion during the spring, particularly during April and May, may potentially reduce passage opportunities for steelhead and coho salmon smolts at critical passage locations in the anadromous reaches of streams. The relationship between flow and passage criteria (depth) was evaluated in the anadromous reaches of study streams by application of the Thompson method as described in greater detail in Section 3. Migration passage for rearing juveniles at these locations can also be evaluated with the data collected although depth criteria may be different.

3 Methodology

3.1 Flow Measurements

Flow associated with water surface elevations or velocity transects was determined from site measurements or estimated from the 15 minute gage record maintained by the City of Santa Cruz in the anadromous reach of each stream. In some cases where there was significant distance between the study site and the stream gage and the potential for flow accretion, regression equations were developed from site measured flow to relate flow at the study sites to flow at the stream gage.

One of the passage sites in Liddell Creek was located upstream of the West Branch confluence and flow at the anadromous gage, downstream of the West Branch confluence, was higher due to the contribution of the West Branch. Flow at the upstream passage site was estimated from flow measurements made near the site or by linear regression of measured flows above the West Branch with corresponding flow from the anadromous gage record (Section 3.3.2). In Laguna Creek, two of the passage transects were in the vicinity of the anadromous gage and two were further upstream, near the confluence with Y Creek. Flows at the upper sites were also estimated from flow measurements made near the site or by linear regression of measured flows in the upper study site with corresponding flow from the anadromous gage record to account for accretion of flows between the two sites, particularly during runoff periods. In Majors Creek there was a diversion a short distance upstream from Highway 1 that influenced flows at the anadromous gage location. One passage site was located upstream from the diversion and flow at this site was estimated from flow measurements made near the site or by linear regression of measured flows in the upper study site with corresponding flow from the anadromous gage. In both Newell Creek and the San Lorenzo River downstream of Tait Street the respective reference gages were the gage maintained by the City of Santa Cruz below the outlet of Newell Reservoir and the USGS San Lorenzo River at Santa Cruz Gage located immediately downstream of the City's Tait Street Diversion. In Newell Creek, many transects were located near Glen Arbor Road, about 1.5 miles downstream of the gage. Flow measurements made by the City of Santa Cruz were used to develop an equation for estimating flows at these study sites from flow at the City gage.

3.2 Passage at Critical Riffles

Passage at critical riffles was analyzed using a methodology attributed to Thompson (1972). Thompson's method entails identifying a series of shallow riffles that potentially affect fish passage, establishing transects across the shallowest locations, and then determining, for each transect, the flow at which a minimum depth criterion is maintained across both at least 25% of the total channel width and a contiguous minimum width of 10% of the channel. Thompson then recommends averaging the results for all the study transects, and the averaged value is the passage flow recommendation for the stream segment. Thompson (1972) recommends a minimum passage depth criterion of 0.6 feet for adult steelhead, although other depth criteria have been used depending on specific site conditions and objectives. This basic methodology has been widely adapted and modified since its introduction as a proposed method in 1972. For example, some recent studies have adopted a specified width (e.g., 10 feet) for attainment of minimum depth criteria rather than a percentage of the channel width.

Three to four critical riffles were identified during an initial walk-through of the anadromous reach of each of the North Coast streams during the fall of 2006. Critical passage locations in the San Lorenzo River downstream of Tait Street were identified during a habitat survey conducted in October 2005 (Appendix B) and critical passage locations were identified in Newell Creek downstream of the reservoir during the fall of 2007 and during the winter of 2009-2010. A single transect was placed along the shallowest cross-section of each riffle. Transects were marked with head pins at each critical riffle by driving a section of rebar into the bank above the bankfull channel. Transects incorporated the shallowest portion on the probable route a migrating salmonid would follow. A fiberglass survey tape was stretched between rebar head pins with the zero point of the tape on the west side of the channel. Streambed elevations were measured at regular intervals along the tape using an autolevel and leveling rod. The reference elevation for each cross-section was the west head pin. Water surface elevations were also measured at both sides of the channel and at the thalweg (deepest point on the cross-section), including the time of each measurement. Water surface elevation measurements were repeated at each transect under varying flow conditions during the following winter and early spring. Water surface elevation was measured relative to the west headpin at each transect. Flow associated with water surface elevations or velocity transects was determined from site measurements or estimated from the 15 minute gage record maintained by the City of Santa Cruz in the anadromous reach of the North Coast streams and below Loch Lomond Dam in Newell Creek.

Cross-section data were entered in a spreadsheet configured to allow determination of the critical water surface elevation at which depth criteria were met. Each measurement point on the cross-section represented a cell with boundaries extending halfway to both adjacent measurement points. Depth of each cell was calculated for any given water surface level as the water surface elevation minus the bed elevation. A depth criterion (e.g., 0.6 feet) was set for each iteration of the spreadsheet and both the total width of cells meeting that depth criteria as well as the longest contiguous group of cells meeting the criteria were tallied and compared to the total wetted width corresponding to that stage. A stage was selected for which 25% of the wetted channel width and a contiguous portion totaling at least 10% of the wetted width had a depth equal to or greater than the criteria value. A stage/discharge relationship was estimated

for each transect using the field stage measurements and discharge data. The stage/discharge relationship was used to calculate the flow required to meet critical water surface elevations.

Critical flow levels for passage at each cross-section were determined in the data analysis stage using standard passage criteria values for adult steelhead and coho salmon (i.e., minimum depths and widths). For adults migrating upstream, the minimum passage flow is that flow providing a depth of 0.6 feet or greater across 25% of the wetted channel width and a contiguous minimum width of 10% of the wetted channel. Factors to consider in choosing a depth or width criteria are the number, length, and difficulty of critical passage points; distance from the ocean; and size and condition of the fish. In each of the study streams the reach between the mouth and the upper limit of the anadromous reach is quite short (from 0.7 to 1.6 miles) and generally has low gradient. Riffles make up a relatively small portion of the habitat in each stream (ENTRIX, Inc. 2004b, HES 2007) and other obstructions are infrequent. The riffles are relatively short and interspersed with pools with good cover characteristics, including undercut banks and roots. Therefore, migrating adults should be in good condition at each of the critical passage locations and fatigue from having to pass many obstacles over great distances should not be an issue. The benefit of meeting a higher value (e.g., 0.8 or 1.0 feet) should be weighed against the potential benefits of using limited supplies for flow augmentation during other life history stages. In this study, the standard passage criteria were judged to be applicable. Given swimming speeds cited previously, high velocity was not a factor at any of the identified passage sites.

The transect data were also used to assess conditions for smolt migration passage and for juvenile in-stream migration during the rearing period. The channel cross-section and hydraulic data are all identical to the adult passage assessment, only the depth criteria are altered (a depth of 0.3 feet or greater across 25% of the wetted channel width and a contiguous minimum width of 10% of the wetted channel. Velocity was not considered to be a factor in downstream migration success. Downstream migration of both steelhead and coho salmon smolts is expected to occur in April, May and June (Section 2.4), although the stream mouths may close at varying points during this period in any given year.

The analysis can also be applied to downstream migration passage of adult steelhead. Steelhead that survive spawning return downstream to re-enter the ocean. All coho die following spawning. As many as 20% of adult steelhead spawners may be repeat spawners and some fish may return to spawn up to 3 or 4 times (Shapovalov and Taft 1954). In some streams fish return downstream immediately after spawning while in others they may remain for a period up to several months. After spawning, these fish do not typically resume feeding while in freshwater. In Waddell Creek the bulk of adults returned downstream from April through June. Fish that remain in the stream for any period of time generally reside in deeper pools. Adequate cover and cool temperature are critical habitat variables for adults that hold over for the entire summer.

3.3 Passage at Bedrock Sheets in Newell Creek

Two bedrock sheet passage obstacles upstream of Rancho Rio Bridge in Newell Creek were more complex than the critical riffles and were assessed using a methods described by Powers and Orsborn (1985). Both obstacles were analyzed as chutes, using the Powers and Orsborn terminology, since they were relatively uniform in cross-section with steep but relatively constant slope. These bedrock sheets present an obstacle to migrating salmonids due to the very shallow depth of flow and high flow velocity. Both had shallow entrances (downstream end) and negative exit slopes (the bed slope at the top of the chute is downward in the upstream direction). The shallow depth at the base of the chute precludes steelhead from jumping so, in order to pass the obstacle, they must swim up it. At each site a bed cross-section and profile were surveyed. The cross-section for N P-3a was about a third of the way from the top of the chute and for N-P4a it was at the top of the chute. Water surface and spot velocity measurements were made at different flow levels. Water velocity and depth were calculated for a range of flow conditions using the Mannings Equation. The Mannings equation predicts mean velocity from wetted width, cross-sectional area, bed slope, and an empirical roughness coefficient (the Mannings coefficient). Cross-sections were also placed through the hydraulic control below each chute and a stage/discharge relationship developed at each control to determine the water surface elevation below each chute for given flows. This affects the length of the chute that must be negotiated by a migrating fish.

For each cross-section, the stage allowing passage was calculated for a range of depth criteria between 0.3 and 0.6 feet. This part of the analysis used criteria as described previously for evaluation of critical riffles (i.e. the criteria depth is achieved across 25% of the wetted channel width and at least a contiguous portion equaling 10% of the wetted channel width). Because the Manning's equation is sensitive to choice of roughness coefficient, minimum and maximum velocity (and corresponding flow estimates) were calculated. For this analysis we used Mannings coefficients of 0.025 and 0.040 as minimum and maximum values consistent with smooth rock substrate.

The analysis assumes that adult steelhead require a depth of flow at least equal to their body depth in order for the fish to make full use of its propulsive power. Steelhead body depth was assumed to be between 0.4 and 0.6 feet. Steelhead are assumed to have burst speeds of 13.7 to 26.5 fps and coho are assumed to have burst speeds of 10.6 to 21.5 fps (Powers and Orsborn 1985). It is assumed that burst speed can be maintained for an estimated 5 to 10 seconds (Powers and Orsborn 1985). Maximum speed for passing an obstacle was assumed to be a percentage of burst speed depending on fish condition. Condition coefficients were 100% for fish fresh out of salt water or still a long way from spawning areas, 75% for fish in the river a short time and still migrating upstream (good condition), and 50% for fish in the river a long time and close to the spawning grounds (poor condition) after Powers and Orsborn (1985). The distance from the mouth of the San Lorenzo River to Newell Creek is relatively short (about 14 miles) and migrating steelhead or coho salmon should be able to reach the barrier location within a few days of entering freshwater. Therefore, fish would be assumed to be in relatively good condition and a condition coefficient of 75% to 100% would be appropriate. The distance a fish can swim at an obstacle is computed as:

$$LFS = ((VF*c) - VW) * TF \qquad 1)$$

Where: LFS is the length a fish can swim, VF is the fish swimming velocity, c is the coefficient of condition, VW is the water velocity, and TF is the time to fatigue.

3.4 Analysis of Spawning and Rearing Habitat Using PHABSIM

The PHABSIM method assesses habitat conditions by measuring hydraulic conditions at representative cross sections and constructing computer models to predict changes in water depth and velocity with discharge. The model output includes an index representing habitat suitability in terms of depth and velocity conditions. For spawning, the suitability index also incorporates substrate size characteristics.

There are many important components of salmonid rearing habitat that are not included in the analysis such as food availability, cover, and inter-species interactions. In addition, there are limitations on the ability of the models to accurately represent depth and velocity conditions and fish response to those conditions. Fish response to these conditions is assumed to be related to observations of habitat use either in the study streams or in other studies. In this study, it was impractical to develop site-specific data and the observations come from studies in the Trinity River in Northern California (Hampton 1997). Observations made in studies of steelhead and coho in the Trinity River may not be completely applicable to these species in the San Lorenzo River and other relatively small coastal drainages in Central California. Nevertheless, this type of study provides some indication of how rearing habitat changes in response to flow and can provide a gross measure of habitat quality when used in conjunction with other information.

3.4.1 STUDY SITES

In general, study sites were selected by walking the stream and identifying locations where, in the professional opinion of an experienced fisheries biologist, conditions were generally favorable for either spawning or rearing of steelhead or coho salmon. Spawning transects were generally near the transition areas between a pool-tail and the head of a riffle where substrate and velocity conditions favor spawning. Some transects were also placed in run type habitat or in deeper riffles where suitable substrate occurred. Rearing transects were located in pool, flatwater, or deeper riffle habitat roughly in proportion to the abundance of each type. Habitat type composition was based on information in ENTRIX, Inc. 2004b for North Coast Streams; HES 2007 for Newell Creek; and a 2005 HES survey of the Lower San Lorenzo River (Appendix B). Sites were selected to cover the range of variability in factors such as stream width, cross-section depth, and substrate conditions. Sites were located close to access wherever possible. One or more transects were marked perpendicular to the flow at each site to cover the range of conditions at individual sites. Information on individual transects is provided in Table 1.

North Coast Streams

The study areas included the anadromous reaches of the three North Coast streams influenced by City diversions. There are three main branches of Liddell Creek including the mainstem (also

referred to as the Middle Branch), the West Branch which joins the mainstem about 0.25 miles upstream from Highway 1, and the East Branch which joins the mainstem about 0.9 miles upstream from the West Branch. The East Branch is not accessible to steelhead due to a migration barrier in the mainstem about 0.75 miles upstream from the West Branch confluence. Although the West Branch likely supports steelhead, at least in the lower part of the stream, only the East Branch and mainstem are influenced by the City diversion, thus all PHABSIM study sites were located in the mainstem downstream of the East Branch. Transects were distributed in two study areas in Liddell Creek, one downstream of the West Branch confluence and one between the West Branch confluence and the East Branch confluence (Figure 1). Each study area in Liddell Creek had two spawning transects and three rearing transects. PHABSIM study sites were dispersed within two discreet areas in the anadromous reach of Laguna Creek: a lower area was in the reach just upstream of Highway 1 and an upper area was near the upper end of the anadromous reach about 0.5 miles downstream of the Y Creek confluence (Figure 2). There were two spawning transects and three rearing transects in each of the two study areas in Laguna Creek (Table 1). In both Liddell and Laguna Creeks the area downstream of Highway 1 is influenced by the summer lagoon and these areas are not appropriate for PHABSIM modeling. In Majors Creek, study sites were divided between the reach downstream of Highway 1 and the reach upstream of Highway 1 (Figure 3). The lower study area in Majors Creek had two spawning transects, and three rearing transects; the upper study area had two spawning transects, and four rearing transects (Table 1).

San Lorenzo River Downstream of Tait Street

This study is specific to the reach downstream of the City's Tait Street diversion and is not applicable to reaches upstream of Tait Street. The relationship between streamflow and rearing habitat quality was investigated in the fall of 2005 by measuring habitat characteristics in this reach under different flow conditions. An initial habitat assessment using the CDFG Salmonid Stream Restoration Manual was conducted to quantify the number and extent of different habitat types in the study reach (Appendix B). Flow during the habitat survey, measured at Tait Street (USGS gage 11161000 San Lorenzo River at Santa Cruz), was approximately 17 to 18 cfs. Flow in Pogonip Creek, entering the San Lorenzo River between Tait Street and Highway 1, was approximately 0.5 cfs (Chris Berry, personal communication, October 2005). At this relatively high level of flow it was difficult to distinguish some of the boundaries between habitat types. Several units were first categorized as deep run type habitat since there was significant velocity throughout the unit but they were later re-categorized as pools based on depth characteristics and subsequent observations at lower flow levels.

Representatives of each habitat type that are likely to support rearing steelhead were selected for study. A total of 9 transects were selected to represent the range of conditions for rearing juvenile steelhead in each of the habitat types identified in the survey reach (Figure 4) Four of the transects were in pool habitat, four were in run habitat, and one was in a riffle. Information on individual transects is provided in Table 2.

Newell Creek

The relationship between streamflow and spawning habitat quality was investigated during the winters of 2007-2008 and 2009-2010. Potential spawning areas for the 2007-2008 study were identified during habitat assessment in August 2007 using the CDFG Salmonid Stream

Restoration Manual (Appendix C). The PHABSIM study focused on the reach of Newell Creek downstream of bedrock outcrops beginning just upstream of Rancho Rio bridge, since they likely limit or preclude the anadromous life history in upstream areas (Figure 5). In 2007-2008, there was sufficient flow to complete the study during a single storm event in late February that resulted in sufficient runoff to fill the reservoir and result in spill to the lower portion of the Creek. Significant spill began on February 23 and flow peaked at about 80 cfs on the night of February 24 and fell to less than 20 cfs on the morning of February 26. Due to limited access to the creek and the extremely short duration of higher flows necessary for the study, only 2 transects in spawning habitat were evaluated. Both transects were located in glide type habitat in the transition from a pool-tail to a riffle head (Table 2). Evidence of redds had been observed at this location during previous surveys and it appeared to be one of the better spawning sites in the entire reach of Newell Creek downstream of the dam. During the winter of 2009-2010, spawning habitat was evaluated at two additional sites and rearing habitat was evaluated at ten sites. PHABSIM transects for spawning and rearing were selected in a walk-through of the project reach with David Hines of NOAA Fisheries using the same approach described at the beginning of this section.

3.4.2 DATA COLLECTION AND PRE-PROCESSING

The study required collection of channel geometry and hydraulic data including an elevation profile, depth and velocity cross-sections, and water surface elevation (stage) across a range of flows that bracketed the suitable range for a given lifestage. Cross-sections were selected and initial surveys were conducted during low-flow conditions since channel features and substrate conditions are more easily observed at that time. At each cross-section, a transect was located across the stream channel perpendicular to the predominant flow direction. Transects were marked at each end by a 0.5 inch by 3 foot length of rebar driven into the streambank. These headpins served as the site benchmarks to reference water stage. The right bank headpin was used as the zero point for all stationing. Initial transect data collection included an elevation cross-section (channel geometry) and substrate code for stations at intervals sufficient to describe the habitat and provide a maximum number of data points for hydraulic modeling. Measurements were made at intervals of 1.5 feet or less, depending on the width of the channel and the distribution of flow across the transect. Water stage data were collected at each cross-section to serve as the low-flow point for stage/discharge relationships. One transect was selected for flow estimation in each study area and a depth and velocity set was collected for this purpose. The flow transect was usually one of the passage or spawning transects since they were generally placed in more suitable locations for flow measurement. Rearing transects were often in pools where flow measurement is imprecise and problematic due to low velocities and more complex flow direction due to eddies and potentially large differences between surface and bottom flow velocity. Flow measurements were supplemental to the City's 15-minute gage data for each stream.

Subsequent data collection required collection of a high flow velocity set (velocity at each station) at the upper end of the model range of flows and a series of stage/discharge measurements over the range of flows to be modeled to include (at a minimum) a high flow, a low flow, and an intermediate flow. These data were collected during storm runoff periods.

Stage measurements were correlated with flow to develop a stage/discharge relationship for each transect location. Flow corresponding to each stage measurement was estimated using either the City gage data, site measured flow, or a correlation of site measured flow with City gage data.

In Liddell Creek, the City gage is located downstream of the West Branch. All sites in the lower study area were also below the West Branch and were well-represented by the City gage. Sites in the upper study area were upstream of the West Branch and therefore, flow at cross-sections in the upper study area would be lower than simultaneous flow at the City gage, particularly during periods of storm runoff. Therefore an equation was developed using flow measurements at upper study area sites and simultaneous City gage readings. The observed relationship can be expressed by a simple linear regression of the form: $Q_u = 0.1694 + 0.6616Q_c$, where Q_u is flow in the upper study reach, upstream of the West Branch and Q_c is flow at the anadromous gage (Appendix D).

In Laguna Creek, the lower study transects were all close to the City gage and gage data was used as the best estimate of flows for these transects. There are no significant tributaries between the upper and lower study areas; however they are far enough apart for significant accretion, particularly during stormflows. Therefore, development of stage/discharge relationships for the upper study transects used site measured flows or correlation with the City gage.

In Majors Creek, there is a diversion within the upper study area that potentially influences the City gage as well as transects located downstream, particularly during lower flows. Flows for the four sites upstream of the diversion location were either measured independently or estimated by regression with the City gage data.

In the lower San Lorenzo River, the City's Tait Street gage is located at the upper end of the study reach. Pogonip Creek contributes flow in the upper part of the study reach, upstream from Highway 1. At the time of the study flow in Pogonip Creek was about 0.5 cfs and no modification to the flow estimates was made for transects downstream of Pogonip Creek.

The City's Newell Creek stream gage measures flow downstream of Newell Creek dam. There are no major tributaries between the dam and the San Lorenzo River; however, flows measured at the study sites were consistently higher than simultaneous gage data indicating significant accretion of flows downstream of the dam. For sites measured in 2007, gage data were adjusted by a factor of 1.17 based on the additional watershed area contributing to the study site downstream of the gage. This gave better agreement with study site measured flows and also provided stage/discharge relationships with low mean error. For sites measured in 2009-2010, flows were measured independently or estimated by regression with the City gage data.

Multiple stage measurements were restricted to a maximum of five data pairs per transect due to limitations in the modeling software. These stage and discharge data were utilized for calibration of the hydraulic model in the analysis. At some of the North Coast cross-sections, high flows in February 2007 resulted in changes in the channel profile. Data collected after these changes were not used for developing stage discharge relationships. All data used to develop stage/discharge relationships are provided in Tables 3 through 7.

Substrate observations were collected at each interval across the transects at the lowest calibration flow when visibility and access were the greatest. Substrate particle size classes and relative abundance were characterized at each measurement point (along the study transect) using the Bovee substrate coding system (see Table 8). This method of substrate coding (Bovee 1978) uses a single digit (corresponding to particle size) and a decimal (corresponding to abundance). The two-digit code describes the mixture of the two adjacent-sized particle classes which dominate a particular cell by assigning the number (1 through 8 as in Table 8) of the smaller-diameter size class to the digit place and the volumetric percentage (0 through 9 for 0% to 90%) of the larger-diameter size class to the decimal place. Suitability curves for substrate size classes for steelhead and coho salmon spawning using the Bovee system are depicted in Figure 6.

3.4.3 HYDRAULIC MODEL DEVELOPMENT AND CALIBRATION

The purpose of hydraulic simulation under the PHABSIM framework is to simulate depths and velocities in streams under varying stream flow conditions. Simulated depth and velocity data are then used to calculate the physical habitat index, either with or without substrate and/or cover information. Depths are not directly determined, but are calculated from water surface elevations and bottom contours. The calibration flows commonly enable the hydraulic and habitat models to reliably simulate depths and velocities from 40% of the low measured flow to 250% of the high measured flow. Calibration flows and flow ranges for WUA/RSI estimates are shown in Table 9.

3.4.3.1 Water Surface Elevation Prediction

Water surface elevations were predicted for each transect using the IFG-4 component of the PHABSIM model. The IFG-4 method uses an empirical log/log regression formula of stage and discharge (flow) based on the measured data in Tables 3 through 7. The stage-discharge relationships are used to determine water surface elevations across a series of simulation flows. Each cross section is treated independently of all others in the data set. A minimum of three stage-discharge measurement pairs is used to calibrate the stage-discharge relationship.

3.4.3.2 Water Velocity Prediction and Calibration

Water velocity predictions can be made in several ways. These include predicting velocities from a template of measured velocities from a single flow (one-flow method), regressing measured velocities against discharge for two or more flows (three-flow regression method), or deriving velocities from flow apportioned into cells based on cell depth (no-velocity method). Velocity regression is rarely used in instream flow studies and is no longer recommended (Milhous & Schneider 1985).

The "one-flow" technique was used for predicting water velocities on study cross-sections in this study. This technique uses a single set of measured velocities and depths, and using Manning's formula, the Manning's n is solved on an individual cell basis along a transect. The high flow velocity and depth data were used for this purpose whenever possible so that measured values were available for the maximum number of cells on each transect. At the simulated discharges, the model uses Manning's formula and these previously derived Manning's n values together with the projected depth to predict velocities. In this sense, the one set of velocities is used as a template to predict the simulated velocities at other discharges. Simulated velocities are inspected during hydraulic calibration.

The purpose of velocity calibration is to determine, through examination of the simulated velocity adjustment factors (VAF's) and velocity patterns, the adequacy of velocity simulations up to a given flow level. It is also important to preserve as closely as possible the measured velocities. Generally, few cells require adjustment during velocity calibration. In those cases when adjustments are needed, individual cell calibration modifications are limited to minor velocity changes in shallow edge cells or to cells that either significantly deviated from surrounding patterns or contributed to substantial errors in discharge calculations. Calibration is generally accomplished by specifying an adjacent cell's Manning's n roughness value and applying it to the target cell. A second technique is to average Manning's n values or velocities from adjacent cells, then substitute a new Manning's n in the target cell.

Other calibration adjustments involve changing negative velocities to positive, or not applying observed angles to velocities, especially for cases when a transect under-calculates discharge. These situations usually occur in edge cells, or in cells where an upstream obstruction creates a negative or angular velocity that is likely to change or turn positive at higher levels of flow. This method has little effect on habitat index simulations because the program uses absolute values of the velocities for habitat suitability.

3.4.3.3 Habitat Suitability Criteria

An important component of an instream flow study is the habitat suitability criteria (HSC) that describe the relative suitability of water depth, water velocity, stream substrate, and cover types to the fish species being evaluated. For the current study, HSC are required for spawning and rearing of both steelhead and coho salmon. The preferred method for developing HSC is to make numerous site-specific observations of the target species in the study streams or suitable surrogates (Category II and III HSC). Such observations involve a large expenditure of effort and more commonly, existing HSC from other studies are used. HSC may also be developed using professional judgment (Category I HSC). No site-specific observations of either steelhead or coho life stages are available for the study streams. Due to relatively low numbers of these species in the study streams, particularly coho salmon, and other limitations of the HCP process, collection of site specific data was not feasible for this study. Therefore, existing HSC from similar streams were used.

For spawning adult steelhead and coho salmon and rearing juvenile steelhead and coho salmon, HSC depth and velocity criteria were developed for sea-run steelhead and coho salmon in the Trinity River by the U.S. Fish and Wildlife Service (Hampton 1997). While the Trinity River is a

significantly larger stream and is located some distance to the north of Santa Cruz County, these HSC were judged to be most compatible with steelhead in the study streams given other alternatives. The Trinity River HSC are more likely to be applicable to these streams than HSC developed in larger, more northerly streams in Oregon and Washington. The Trinity River HSC are Category II or Category III curves (developed from actual observations), while many of the HSC available from other studies are Category I (developed using professional judgment). HSC for spawning steelhead are available from the Carmel River; however, these curves were developed by measuring conditions at existing redds and flow conditions may have varied from those at the time of spawning. Suitability criteria for spawning substrates were taken from Bovee (1978) due to a lack of data from Hampton (1997). Figure 6 illustrates the HSC for spawning steelhead and coho salmon including velocity (in feet per second), depth (in feet), and substrate (Bovee code). Figures 7 and 8 show a comparison of all the HSC curves available for spawning steelhead and coho salmon. Figure 9 illustrates the HSC for rearing steelhead and coho salmon and Figures 10 and 11 show a comparison of all HSC curves available for rearing steelhead and coho salmon.

3.4.3.4 Habitat Index Simulation

Habitat index simulation is the process that combines hydraulic estimates of velocity and depth (i.e., the results of the hydraulic simulation) with the suitability values for those attributes (i.e., the habitat suitability criteria) to weight the area of each cell at the simulated flow. The weighted values for all cells are summed to give a single habitat index, called weighted usable area or relative suitability index (WUA/RSI). The WUA/RSI index of aquatic habitat suitability describes the incremental relationship between physical habitat and stream discharge. Hydraulic and habitat index modeling were conducted using RHABSIM Version 3.0 (Riverine Habitat Simulation, Payne 1994).

3.4.3.5 Hydraulic Simulation and Calibration

All transect water surface elevations were simulated using log-log stage-discharge regression (IFG4). Sources of error in the stage-discharge regressions include stage measurement error, flow measurement error, changes in stage and flow during the period when the measurements are being made, and change in the channel cross-section elevations or stage of zero flow due to bed mobilization or deposition during high flows. Stage measurements are generally quite precise and are expected to be in error by no more than +/- 0.02 feet. Flow measurements can be more variable, generally within +/- 5% of the actual flow. In some cases, field data were adjusted within these ranges when there was a reasonable basis for doing so (i.e., evidence of stage or flow changes during the measurement period) in order to minimize the mean error in the stage-discharge regressions. Stage and flow estimates used in this analysis are shown in Tables 3 through 7.

The mean errors for the log-stage/log-discharge regressions for most transects are below five percent (Tables 10 and 11). In some cases, the mean error is slightly greater than 5% and could not be reduced further by adjusting stage or flow estimates within reasonable limits. In these cases the slope of the regression and intercepts are comparable to the other transects in

the respective study areas. Transect R1 in Liddell Creek had exceptionally high error, possibly due to changes in the channel cross-section at this location during the study period. The altered cross-section may have been due to movement of a large tree trunk under high flow conditions. This transect was omitted from the analysis. Results of the rearing WUA vs. discharge analysis in Liddell Creek are comparable with and without inclusion of transect R1. The slopes for these regressions are within the range of 2 to 4.5 as recommended by the Instream Flow Group (1995), and, in general, the Y-intercept values for the transects in each study area are also consistent. These characteristics meet the established quality control standards for PHABSIM hydraulic simulation.

Standard procedures were followed in making velocity calibration adjustments to account for "edge effect", excessive velocity prediction, and over- or under-calculation of discharge. After calibration, the velocity adjustment factors (VAF) were within the recommended 0.1 to 10 over the range of simulated flows (Instream Flow Group 1995). The VAFs for transects in each study area are illustrated in Figures 12 through 16. The VAFs for most transects generally transition through 1.0 in the vicinity of their velocity calibration flow.

3.4.3.6 Transect Weighting

Each of the PHABSIM transects can be given a weighting to ensure its contribution to the habitat index simulation is indicative of its relative proportional representation in the total habitat character of the study area being modeled. In this study, all spawning transects were placed across likely spawnable run/riffle habitat. Therefore, the spawning transects in each study stream were weighted equally. Similarly, rearing transects were selected primarily in pool and flatwater habitat, consistent with the results of habitat surveys conducted as part of this study and previously conducted by ENTRIX, Inc. (2004b) in the North Coast streams. Pool and deeper flatwater habitat is also most critical to rearing steelhead and coho salmon to smolt size and is most limiting in these small coastal streams. Transects were placed to represent the range of suitable rearing habitat in each study stream and all transects were weighted equally in initial model runs.

4 Results and Discussion

4.1 Adult and Smolt Migration Passage

4.1.1 LIDDELL CREEK

Three critical riffles were selected for analysis in Liddell Creek, including the concrete apron at the upper end of the culvert under Highway 1 (LD P-3), a shallow riffle downstream of the West Branch confluence (LD P-1), and a shallow riffle in the upper study area, upstream of the West Branch confluence (LD P-2). The culvert outlet at the beach downstream of Highway 1 is also a potential passage issue but was not included in this study since improvement of passage at this location is the subject of mitigation plans being prepared by CEMEX. Channel cross-sections and critical water surface stages are shown in Appendix E. Stage/discharge data for each transect are presented in Table 12, and the regression equations for log stage and log discharge are shown in Table 14. Minimum passage flow estimates for adult migration ranged from 4.9 cfs to 11.3 cfs (Table 15). The site with the highest flow requirement for adult migration was near the anadromous gage, downstream of the West Branch confluence (LD P-1). Channel cross-section, stage-discharge data, and analytical results for this site are in Appendix F. Minimum passage flow estimates for smolt migration ranged from 0.8 to 2.0 cfs with the most critical location for smolt passage being the apron at the upper end of the Highway 1 culvert (LD P-3)[1].

4.1.2 LAGUNA CREEK

Four critical riffles were selected for analysis in Laguna Creek including the concrete apron at the upper end of the culvert under Highway 1 (LG P-1), a shallow riffle just upstream of the anadromous gage site (LG P-2), and two critical riffles in the upper study area near the City of Santa Cruz aqueduct crossing (LG- P-3 and LG P-4). Channel cross-sections and critical water surface stages are shown in Appendix E. Stage/discharge data for each transect are presented in Table 12, and the regression equations for log stage and log discharge are shown in Table 14. Minimum passage flow estimates for adult migration ranged from 10.6 cfs to 15.5 cfs (Table 15). The site with the highest flow requirement (most critical riffle) for adult passage was in the lower study area, just upstream of the anadromous gage (LG P-2). Channel cross-section, stage-discharge data, and analytical results for this site are in Appendix F. Minimum passage flow estimates for smolt migration ranged from 1.7 cfs to 3.8 cfs with the most critical location being the apron at the upper end of the Highway 1 culvert (LG P-1).

[1] Since the depth criteria is different for adults and smolts, the most critical riffle for adults may be different than the most critical riffle for smolts. This is due to the irregular nature of the cross-sections and the "percentage of wetted width" calculation.

4.1.3 MAJORS CREEK

Three critical riffles were selected for analysis in Majors Creek including a wide, shallow riffle between Highway 1 and Scaroni Road (M P-1), a reinforced section immediately upstream of the Highway 1 culvert (M P-2), and a wide, shallow riffle upstream from Highway 1 just upstream of a diversion (M P-3). Channel cross-sections and critical water surface stages are shown in Appendix E. Stage/discharge data for each transect are presented in Table 12, and the regression equations for log stage and log discharge are shown in Table 14. Minimum passage flow estimates for adult migration ranged from 9.0 cfs to 16.0 cfs (Table 15). The site with the highest flow requirement for adult passage was M P-1 in the lower study area, downstream of Highway 1. Channel cross-section, stage-discharge data, and analytical results for this site are in Appendix F. Minimum passage flow estimates for smolt migration ranged from 2.0 cfs to 3.4 cfs with the most critical location being M P-3, the shallow riffle upstream of the diversion.

4.1.4 SAN LORENZO RIVER DOWNSTREAM OF TAIT STREET

Downstream of Highway 1, habitat consisted primarily of relatively deep pools and runs with a small amount of relatively short riffles (Table 16). Upstream of Highway 1, habitat consisted of one long shallow glide and a long, relatively shallow run. There were shorter sections within the run that had pool-like characteristics but these were not distinct enough to break out as separate units. The glide had a deeper channel along one bank but this was generally very narrow and constituted a minor part of the habitat. The substrate upstream of Highway 1 was dominated by sand (90%) and silt (5%).

A total of six low-gradient riffles were classified between Water Street and Highway 1. In addition, there were two shallow riffle sections within larger habitat units that were too short to break out as individual habitat units (including one that was evaluated as a passage site). The riffles were all relatively short, ranging from 27 to 54 feet in length and averaging 38 feet. Upstream of Highway 1 there were no riffles classified although there were short riffle-like sections located at transverse sand bars. Four transects were placed in potentially critical riffles identified between Water Street and the Tait Street Diversion.

Transect P-1 was placed about 120 feet downstream from the Tait Street diversion. The sand bed channel was exceptionally wide and shallow forming a bar at this location (Figure 17). Downstream, the thalweg followed the east bank closely, in association with aquatic plants and overhanging riparian vegetation, forming an ideal migration route for adult steelhead and coho salmon. This migration channel was pinched out by the sandbar at the east end of the transect and the thalweg moved toward the center of the channel as it passed over the bar. Transect P-1 was placed to intersect the thalweg at its shallowest location on the bar.

Transect P-2 was placed behind the tannery, about 0.4 miles downstream of the Tait Street diversion and about 600 feet upstream from the Highway 1 Bridge. This was also an exceptionally wide, shallow sand bar (Figure 18). The channel between Highway 1 and transect P-2 was characterized as a wide, shallow, sandy glide with average depth of 0.9 feet. As at transect P-1, the thalweg downstream from P-2 closely followed the east bank in association with aquatic plants and overhanging riparian vegetation. This migration channel was pinched

out by the sandbar at the east end of the transect. Migrating fish would have to follow the thalweg over the sandbar and continue to the west bank where the channel became deeper again in association with aquatic vegetation and overhanging riparian vegetation. The analysis was configured to require that depth criteria be met in only the center cells adjacent to the thalweg. The deeper cells at each end of the transect were omitted from the analysis since they were not actually on the migration pathway and were closed out by the bar either upstream (east bank) or downstream (west bank) of the cross-section (Appendix E).

Transect P-3 was a short but shallow gravel/cobble transverse riffle about 900 feet downstream of Highway 1, in the river adjacent to Petsmart in the Gateway Mall. A well-developed pool was located immediately downstream of the riffle and the riffle formed the tail of another pool immediately upstream (Figure 19). The transect followed the shallowest portion of the riffle including slightly deeper portions at each end. Fish could move across the riffle at virtually any point.

Transect P-4 was placed in a riffle under the Water Street Bridge (Figure 20). There was a relatively well-defined thalweg along the west bank that would serve as the main migration route for fish passing this location. The substrate was dominated by cobbles and boulders.

In the reach between Water Street and Tait Street the riffle sections are generally short and relatively low gradient (HES 2007). Downstream of Highway 1, the riffles are generally within close proximity to deep pool habitat and there is a substantial amount of cover from aquatic plants and dense overhanging riparian vegetation. The study reach is immediately upstream of the lagoon and migrating adults are likely to be in good condition passing through this reach. The 0.6 foot depth criterion applied to a contiguous width of 10% of the wetted width is likely to result in minimum difficulty for steelhead and coho salmon migrating in the San Lorenzo River downstream of Tait Street. Similarly, a 0.3 foot depth criterion applied to 10% of the wetted width is likely to provide suitable conditions for downstream migrating smolts and would be achieved at a flow of 6 to 12 cfs.

Channel cross-sections and critical water surface stages are shown in Appendix E. Stage/discharge data for each transect are presented in Table 13, and the regression equations for log stage and log discharge are shown in Table 14. Minimum passage flow estimates for adult migration ranged from 17 cfs to 25 cfs (Table 15). The site with the highest flow requirement for adult passage was SL P-1, just below the Tait Street diversion. Channel cross-section, stage-discharge data, and analytical results for this site are in Appendix F. Minimum passage flow estimates for smolt migration ranged from 3.8 cfs to 10 cfs with the most critical location being SL P-2, the shallow riffle upstream of Highway 1, near the tannery.

4.1.5 NEWELL CREEK

A total of four critical riffles were selected for analysis in Newell Creek. Two were located downstream of Rancho Rio Bridge, one was a short distance upstream of Glen Arbor Road, and one was a short distance downstream of Glen Arbor Road. Channel cross-sections and critical water surface stages are shown in Appendix E. Stage/discharge data for each transect are presented in Table 13, and the regression equations for log stage and log discharge are shown in Table 14. Minimum passage flow estimates for adult migration ranged from 11.4 cfs to 24.4 cfs. Channel cross-section, stage-discharge data, and analytical results for the most critical site,

P-1, are in Appendix F. Minimum passage flow estimates for smolt migration ranged from 3.2 cfs to 8.3 cfs.

Two obstacles at bedrock sheets in Newell Creek were also selected for analysis. The first bedrock obstacle (N-P3) was located about 0.3 miles upstream of Rancho Rio Bridge and about 0.95 miles upstream from the San Lorenzo River (Figure 5). It consisted of a sloped bedrock ledge rising a total of about 2 feet over a distance of about 17 feet (Figure 21). The Mannings equation was used to generate velocity predictions and flow predictions for a range of passage depths (Table 17). Depending on the value of Mannings coefficient used, the estimated flow at which depth becomes sufficient for passage (0.6 feet) is between 145 and 275 cfs. Velocity, depth, and channel measurements from February 25, 2008 indicate that this is a suitable range for the Mannings coefficient suggested by Powers and Orsborn (1985) for smooth rock. Using equation 1 to determine the length a fish could swim and assuming a critical passage depth of 0.6 feet and a length of 17 feet for the ledge, a steelhead in good condition or better (c = 75% or more) swimming for 5 seconds at maximum burst speed of 25.6 fps would be able to swim far enough to ascend the bedrock ledge at this flow level (145 to 275 cfs) but would have difficulty if able to sustain only average or minimum burst speed (Table 17). A coho salmon would also be able to ascend the ledge at this flow level if swimming at maximum burst speed and assuming the higher Mannings coefficient of 0.040 (Table 17). However, at the lower Mannings coefficient of 0.25, velocity estimates indicate that a coho salmon would not be able to pass the obstacle unless swimming at top burst speed. Since the downstream water surface rises with increasing flow the length of ledge to be passed would be somewhat less at higher flows. For example, the length would be approximately 9 feet at a flow of 145 cfs, approximately 6 feet at a flow of 197 cfs, and only about 4 feet at a flow of 275 cfs.

The second bedrock obstacle (N-P4) was located about 0.1 miles upstream of N-P3. It consisted of a sloped bedrock ledge that rises a total of about 4.9 feet over a distance of about 27 feet (Figure 22). Even if a steelhead could leap from the relatively shallow pool at the base of the ledge, data presented in Powers and Orsborn (1985) indicates that the horizontal distance (27 feet) is too great for even a steelhead in prime condition (condition coefficient of 100%). This obstacle is more complex than N P-3 with 3 distinct potential migration pathways. The center of the bedrock ledge is a relatively uniform chute with relatively constant slope and laminar flow, similar to N-P3. On the right side there is an overflow channel with two drops of 1.5 to 2 feet and shallow flow over relatively steep bedrock only in the lower part. On February 25, 2008 at a flow of approximately 43 to 49 cfs, this channel was too shallow and had insufficient depth in the plunge pools to be passable. At higher flows this side may be passable. On the left side, the bedrock is more stepped forming a turbulent cascade with two small, shallow plunge pools. Although the plunge pools are quite small (about 2-3 feet in diameter) and have depths of only 1 to 1.5 feet, they may offer enough velocity reduction to allow fish to ascend this side of the ledge. On February 25, 2008 at a flow of 46 cfs the depth of flow along this pathway was too shallow in places to meet passage criteria. In addition, there was significant air entrainment in the highly turbulent flow along this pathway, reducing the fluid density and the propulsive force of a fishes swimming movements. For short chutes velocity may be determined by the equation:

$$V_{SC} = (2gH)^{0.5} \qquad 2)$$

where V_{SC} is the velocity down a short chute, g is the acceleration due to gravity (32.2 fps^2), and H is the total vertical drop between two pools (Powers and Orsborn 1985). Using this equation, velocity in the steepest part of the cascade would be approximately 11 fps. While this is within the burst speed range for both steelhead and coho salmon, the turbulence in this cascade presents difficulty by deflecting the fish from its course and causing excessive expenditure of energy to resist upwellings, eddies, entrained air, and vortices. Most of the fish's energy is utilized simply to maintain position and direction (Powers and Orsborn 1985).

The central chute in this obstacle is comparable to N P-3 but has a slightly steeper slope (17% compared to 12% at N P-3). The uneven face of this ledge is more difficult to survey for cross-sectional area, wetted perimeter, or mean depth. Due to the steeper slope, it is likely that higher levels of flow are required to meet a 0.6 foot depth criteria than the estimated 230 cfs required at N P-3. Assuming other channel variables are similar to N P-3 the increased slope at N P-4 alone would result in suitable passage depth (0.6 feet) at a flow of 204 to 327 cfs. This flow range would correspond to mean velocity estimates of 10 to 16 fps. Only a steelhead in top condition would be capable of ascending at the upper end of the velocity range. A coho salmon would likely be incapable of passing this obstacle, even at the lower velocity estimate. However, these are extrapolations from conditions at N P-3 and more detailed information should be collected at N P-4 before accepting these conclusions.

4.2 Spawning and Egg Incubation

The relationship between flow and spawning habitat suitability is expressed as a habitat suitability index (WUA/RSI). These relationships generally show an increase in habitat suitability to some level, a peak, and then a gradual decline as flows continue to increase. WUA/RSI values that are 80% to 100% of the maximum values represent highly suitable or optimum conditions. Flows higher or lower than these levels result in increased frequency of depth, velocity, and substrate conditions that are outside the suitable range as defined by habitat suitability criteria used for steelhead and coho salmon spawning. Tabular values of the WUA/RSI verses streamflow relationship are presented in Appendix G.

Flows which provide higher WUA/RSI are more likely to support greater numbers of spawning fish, although the exact numbers and the specific relationships are influenced by too many other factors to be quantitative. Higher levels of WUA for spawning will only benefit the population if spawning habitat is limiting. If other factors, such as poor ocean conditions for production of returning adults, poor summer rearing habitat, or poor embryo survival due to high winter flows are limiting a population, then simply increasing the amount of suitable spawning habitat will have little or no benefit.

The relationships between flow and spawning habitat suitability can be used with hydrologic data to explore the effects of different flow conditions on spawning habitat quality. This information has been used in the City of Santa Cruz HCP to evaluate existing conditions for steelhead and coho salmon in streams influenced by City diversions and determine the extent to which spawning habitat may be limiting these populations. The information is also used in the HCP to evaluate the potential effects of flow augmentation on spawning habitat quality and the implications for viability of steelhead and coho salmon populations in these streams.

4.2.1 NORTH COAST STREAMS

The form of the relationships between stream flow and the index of spawning habitat suitability (WUA/RSI) for steelhead and coho salmon is relatively similar in each of the three study streams (Figures 23, 24, and 25). The suitability index is expressed in dimensionless units per 1,000 feet of stream and represents the extent of match to the habitat suitability criteria of depth, velocity, and substrate. Generally, the rate of increase in the suitability index is relatively high at the lower simulated flows, reaches a peak at more moderate flow levels, and then declines gradually at higher flows. The spawning suitability index for coho salmon tends to peak at slightly lower flows than for steelhead and does not reach peak values as high as those for steelhead. In Liddell Creek, the peak of the suitability index curve for coho salmon occurs at a flow of about 9 cfs and is highest between 4.4 and 17.3 cfs (80% of the peak value). For steelhead in Liddell Creek the spawning suitability index is high (at least 80% of the peak value) across a very broad range of flow between 7.4 and 24.6 cfs with a peak at about 13.7 cfs (Figure 23). In Laguna Creek, the spawning suitability index for coho salmon is highest between 5.4 and 29.8 cfs and is highest for steelhead between 9.3 and 34.9 cfs (Figure 24). In Majors Creek the spawning suitability index peaks between 8.9 and 23.7 cfs for coho salmon and between 12.1 and 32.6 cfs for steelhead (Figure25). Individual WUA vs. discharge curves for each spawning transect in the study streams is in Appendix H.

4.2.2 NEWELL CREEK

The WUA vs. discharge relationships for steelhead and coho spawning in Newell Creek increase at relatively high rates up to 10 and 16 cfs, respectively, peak at flows around 20 and 26 cfs, respectively, and decline gradually at higher flows (Figure 26). The spawning suitability index for coho salmon tends to peak at slightly lower flows than for steelhead. In Newell Creek, the peak of the suitability index curve for coho salmon occurs at a flow of about 20 cfs and is highest between 9 and 37 cfs (80% of the peak value). For steelhead in Newell Creek the spawning suitability index is high (at least 80% of the peak value) across a very broad range of flow between 13 and 41 cfs with a peak at about 26 cfs (Figure 26). Individual WUA vs. discharge curves for each spawning transect in the study streams is in Appendix H.

4.3 Juvenile Rearing

Stream flows with higher rearing suitability index values have a greater frequency of depth and velocity conditions associated with observed utilization by rearing steelhead or coho salmon. In this study, it is important to remember that the observations of rearing juvenile steelhead and coho salmon were made in the Trinity River and not in the study streams. Although depth and velocity are key factors, habitat selection by steelhead and coho salmon juveniles is likely the result of many factors in addition to these two. Other important factors likely include the presence or proximity of hiding cover from potential predators, diet preferences, food availability and distribution, the presence of potential competitors, and thermal regulation. An important assumption of this study is that, all other factors being equal, flows which provide higher levels of WUA/RSI are more likely to support greater numbers of rearing juveniles. This

would only be true if the abundance of rearing juveniles were limited by the availability of suitable depth and velocity conditions. Other factors may limit abundance of rearing juveniles such as low numbers of adult spawners, poor survival of eggs and fry, low food abundance, or high rates of predation. Although these factors may also be influenced by flow, there is no practical, generally accepted methodology for assessing them and they have not been considered in the present analysis. Cover is likely a very important factor determining potential juvenile salmonid rearing density. Some habitat preference data incorporating cover has been developed in other studies (Smith and Aceituno (1987) although the applicability of these data to the study streams is questionable. In any case, the objective of this study is to address the effects of changes in flow *under the existing levels of cover.* Cover is not influenced by the City diversions but depth and velocity certainly are. Never the less, changing cover conditions through habitat improvement projects is a way to potentially get higher habitat value for any given level of flow. This will be explored further in development of a conservation strategy.

The relationships between streamflow and rearing habitat suitability developed here are most appropriately used to explore differences between various hydrologic regimes in the study streams. Evaluation of existing hydrologic conditions may indicate periods when depth and velocity suitability are exceptionally low. Evaluation of alternative hydrologic scenarios can be used to explore the relative effects of different levels of streamflow augmentation on habitat conditions.

4.3.1 NORTH COAST STREAMS

The form of the relationships between stream flow and rearing habitat suitability for steelhead and coho are also relatively consistent between the three study streams (Figures 27-29). For steelhead juveniles, the suitability index rises steadily across the range of simulated flows, although the rate of increase tends to be higher at lower flow levels and more gradual at higher flow levels. Although the WUA/RSI values are still increasing at the highest simulated flows in each of the streams (about 14 cfs), the index reaches 80% of the maximum simulated value when flow is 5.2 cfs in Liddell Creek, 6.4 cfs in Laguna Creek, and 5.7 cfs in Majors Creek. Streamflows during the dry season often fall well below these levels in each of the streams, even if City diversions were not operating. Individual WUA vs. discharge curves for each rearing transect in the study streams is in Appendix H.

The rearing suitability index for coho salmon is relatively high across the range of simulated flow in each of the three streams. Even at the lowest simulated flow, WUA/RSI for coho salmon rearing was 74% to 80% of peak levels. This is the result of the underlying suitability curves for depth and velocity for coho juveniles reflecting their preference for low velocity, deeper habitat such as found in pools (Figure 9b). The peak suitability index values for coho juveniles occur at relatively low flows in the study streams: 1.5 cfs in Liddell Creek, 2.9 cfs in Laguna Creek and 3 cfs in Majors Creek.

The relationships developed here suggest that rearing habitat for coho salmon is little influenced by changes in streamflow in the study streams and that steelhead are most likely to be influenced by streamflow changes as flows drop below 2 to 4 cfs. The information developed in these analyses is used in the City's HCP to evaluate existing conditions and evaluate the potential effect of streamflow augmentation as part of the HCP Conservation Strategy.

4.3.2 SAN LORENZO RIVER DOWNSTREAM OF TAIT STREET

The PHABSIM model was based on stage-discharge data collected in fall 2005 when gaged flows were in the range of 14 to 30 cfs. Based on standard criteria for calibration flows, the PHABSIM extrapolation would be considered valid down to 5.6 cfs (Table 9). Although the model was used to extrapolate WUA estimates at flows down to 0.5 cfs, estimates may be less accurate at flows below 5.6 cfs. The index of rearing habitat (WUA per 1000 feet of stream) for steelhead in the San Lorenzo River below Tait Street increases steeply from minimum levels at a flow of 0 cfs (Figure 30). As flow reaches 7 to 10 cfs, the rate of increase in WUA becomes less. WUA does not change significantly with flow increase over about 40 cfs. The suitability index for steelhead rearing in this reach reaches 60% of peak levels when flow is 7.9 cfs and 80% of peak levels when flow is 18.8 cfs. Although the channel conditions are different in the two sub-reaches (upstream and downstream of Highway 1), the relationship between WUA and flow is similar.

Response of WUA to changes in flow is different in pools, runs, and riffles (Figures 31 and 32). Individual WUA vs. discharge curves for each spawning transect in the study streams is in Appendix H. In pools, which comprise 49% of the habitat in the flood control channel, most of the increase in WUA occurs at flows up to 6 to 8 cfs (a flow of 7 cfs provides approximately 80% of the maximum WUA). This is because pools in this reach, particularly in the flood control channel, are generally quite deep and within the high suitability range for steelhead even at lower flows (Table 2, Table 16). Therefore, most of the increase in WUA in pools comes from increases in velocity.

Runs made up approximately 42% of the habitat downstream of Highway 1 and 45% of the habitat upstream of Highway 1. Runs in the flood control reach are also quite deep (Table 16) and in some respects behave more like pools. The run cross-sections selected for the PHABSIM study are shallower than most of the run habitat in the reach (Table 2). In run habitats selected for the study, WUA increases with flows up to about 40 cfs before reaching a plateau. Increase in WUA is related to increases of both depth and velocity at lower flows and mostly related to increase in depth at higher flows.

Riffles were a minor component of the habitat downstream of Tait Street, making up only 8% of the total stream length in the flood control channel. WUA in riffles increased at a steady rate up to about 48 cfs, mainly as a result of increasing depth. The response of the majority of steelhead rearing habitat downstream of Tait Street is best reflected by the response for pools (Figure 31) since pools and deeper run habitats are expected to provide the majority of summer habitat for rearing steelhead.

Because of the underlying suitability criteria and the way WUA is calculated in the model, depth is often the major determinant of WUA in this application of the model (HES 2008). There is some question in this case whether the observed increase in depth and, more importantly, the degree of improvement in WUA, would have the degree of biological significance suggested by the WUA values. Selection of greater depths in rearing steelhead may be advantageous in providing some degree of protection from avian predators. At most locations in the flood control channel, there is a large amount of overhead cover in the form of overhanging

terrestrial vegetation and floating aquatic vegetation (Appendix B), mostly at the edges of the channel in shallower depths. In such cases, overhead cover may minimize the importance of depth and alter the suitability function. The underlying suitability data for this application of the model was collected in a larger river (the Trinity) where many observations may be further from shore and where depth is a more important component of cover. This is one instance where more site specific suitability data might affect the model results.

Given these uncertainties in application of the model and interpretation of the results a more general classification was adopted rather than adhere strictly to the numerical output in terms of WUA. Based on evaluation of the model results and on-site observations during the study we have defined the following categories to characterize habitat conditions for rearing steelhead under different levels of flow:

Prime conditions occur at flows of about 19 cfs up to the highest simulation range of 75 cfs for this study. Under these flow conditions velocity suitability ranges from 0.9 to 1.0 over substantial portions of each cross-section. Six of the nine cross-sections (all except shallower run and riffle cross-sections) have depth suitability in near optimum range (suitability of 0.9 to 1.0) over at least portions of the cross-section. There is good continuity between pools and depths suitable for movement of rearing juveniles between pools (a depth of at least 0.3 feet over 25% of the channel width and a contiguous portion of 10% of the channel width). Average wetted width is 75% or more of maximum.

Good conditions for steelhead rearing occur between about 8 and 19 cfs. At these flows, velocity suitability in lower gradient habitats (pools and deep runs) declines somewhat but is still at least 65% of optimum levels on portions of the cross-section. Depth suitability at the six deeper cross-sections is in the range of 0.8 to 1.0, and there is still good continuity between pools and depths suitable for movement of rearing juveniles between pools. Average wetted width is still about 75% of the maximum simulated flow (72 cfs).

Fair conditions occur at flows of about 3 to 8 cfs. At these flows, velocity on pool cross-sections drops to levels corresponding with suitability for rearing steelhead of 0.4 to 0.7, although velocity in the runs and riffles is still at high suitability levels. Depth in pools and deep runs remains at levels corresponding to high suitability for rearing steelhead. Average wetted width declines to about two- thirds the width at the highest simulation flow and although there is still continuity between pools, passage is likely more difficult for rearing steelhead or coho in larger size classes.

Poor conditions occur at flows less than 3 cfs. At these flow levels, velocity in pools and deep runs drops to levels corresponding to suitability for rearing steelhead of 0.4 to 0.5 and less although depth remains at suitable levels. In shallower, swift water locations velocity is still at high suitability levels but depth has declined to suitability levels of 0.1 to 0.2 or less. While average wetted width is still at least 60% of the maximum simulated flow, wetted width in riffle habitat declines from 30% to 18% of maximum as flow is reduced. Continuity between pools and potential for movement of rearing fish begins to disappear.

The width of the wetted channel in riffles may be important during the summer rearing period if a significant proportion of the food items in the diet of steelhead or coho salmon is produced in the riffles and if greater numbers of food organisms are produced when the wetted area of the

riffle is increased. These are common working assumptions but there is little quantitative work to support them. If a substantial portion of fish diets are derived from other sources such as terrestrial insects or aquatic organisms produced in non-riffle aquatic habitats, or if a relatively small areal extent of riffle is capable of meeting the dietary intake of a large number of rearing fish, the assumption may not be valid. Also, the need for rearing steelhead or coho salmon to move from pool to pool during the summer is questionable. In many smaller Central California streams, even in unimpaired conditions, this is not possible during low flow conditions that recur on an annual basis. Nevertheless, we have included consideration of these factors in evaluating rearing habitat quality in this reach of the San Lorenzo River.

For coho salmon, the index of rearing habitat (WUA per 1,000 feet of stream) in the San Lorenzo River below Tait Street is uniformly high for simulation flows from 0 cfs to 72 cfs (Figure 30). The lowest values of WUA are at zero flow; however, even at that level, WUA is over 75% of the peak value. Peak values of WUA occur at a flow of about 5 cfs. In pools, peak WUA for rearing coho occurs at 2 cfs, while in runs the peak is at 6 to 7 cfs (Figure 32). WUA decreases at higher flows in these habitats due to increasing velocity, which for coho salmon, has lower suitability. In riffle habitat, where very low values of WUA are obtained, WUA increases gradually across the range of simulation flows, primarily due to increasing depth. Velocity is only suitable for coho salmon in a narrow band along the banks in this swift flowing habitat type. The WUA curves reflect the underlying suitability criteria that include higher suitability for low velocity and relatively deep habitat typical of the preferred deep pool habitat of rearing coho salmon. Indeed, the flood control portion, with its extensive deep pools and slower velocity deep run habitat and cover consisting of overhead vegetation, appears to provide reasonably good rearing conditions for coho salmon. Warm temperature is probably a significant limiting factor for coho in this reach (see Appendix A).

If rearing habitat for coho salmon is described using the same approach as for steelhead and considering only WUA, there would be only two categories: ***Prime*** conditions would occur at WUA values between 80% and 100% of the peak value and ***Good*** conditions would be defined at levels between 60% and 80% of the peak. Flows of 1 to 72 cfs would result in ***Prime*** conditions while flow less than 1 cfs would be considered ***Good***. If we also consider wetted width and continuity of passage between pools, then flows of 3 cfs or less might be defined as ***Fair***. At this level there is a decrease in average wetted width down to as little as 50% of the maximum simulated flow and decrease in wetted width in riffle habitat to 25% of maximum or less. In addition, continuity between pools and potential for movement of rearing fish begins to disappear. Therefore habitat conditions for rearing coho salmon would be defined as ***Prime*** for flows between 3 cfs and 72 cfs and as ***Fair*** for flows of less than 3 cfs.

During the instream flow assessment in the fall of 2005, trout were active throughout the study reach at flows near 15 cfs. Trout were observed feeding at the surface in deep run habitat near Pogonip Creek on October 11 at a flow of about 17 cfs and again on October 24 with heavy activity in cells with depths of 1.7 to 2.0 feet and mean column velocity of 0.2 to 0.3 feet per second (fps). Trout were observed surface feeding at site R-4 (head of pool) on October 12 when flow had just dropped from 18 cfs to 11 cfs. Surface feeding was also observed at site R-4 on October 20 at a flow of about 12 cfs and surface feeding was particularly heavy on October 21, also at a flow of 12 cfs. At the location where fish were feeding, cells with suitable depths (>0.8 feet) had mean column velocity ranging from 0.4 to 0.6 fps. A smolt-sized trout (150-160 mm) was observed feeding at the surface in deep pool habitat at R-3 on October 20

with flow at about 12 cfs. The site had abundant overhead cover and the highest mean column velocity at all cells on this date was 0.55 fps.

4.3.3 NEWELL CREEK

The PHABSIM model was based on stage-discharge data collected in the winter of 2009-2010 when gaged flows were in the range of 1.1 to 36 cfs. Based on standard criteria for calibration flows, the PHABSIM extrapolation would be considered valid in the range from 0.6 cfs to 40 cfs (Table 9).

The form of the relationships between stream flow and rearing habitat suitability for steelhead and coho salmon in Newell Creek (Figure 33) are similar to those in the North Coast streams and the San Lorenzo River downstream of Tait St. (Figures 27-30). For steelhead juveniles, the suitability index rises to a peak at about 28 cfs then gradually declines at higher simulated flows. The rate of increase tends to be higher at lower flow levels and more gradual at higher flow levels. The index reaches 80% of the maximum simulated value when flow in Newell Creek is 10 cfs. Streamflows during the dry season would fall well below this level even if Newell Reservoir were not there. Individual WUA vs. discharge curves for each rearing transect in Newell Creek are in Appendix H.

The rearing suitability index for coho salmon is highest at relatively low flows and declines gradually at flows greater than 2 cfs. Even at the lowest simulated flow, WUA/RSI for coho salmon rearing was 83% of peak levels. This is the result of the underlying suitability curves for depth and velocity for coho juveniles reflecting their preference for low velocity, deeper habitat such as found in pools (Figure 9b). The peak suitability index value for coho juveniles occurs at about 2 cfs in Newell Creek.

The relationships developed here suggest that rearing habitat for coho salmon, at least with respect to depth and velocity, is maximized at lower flows while optimum flow for steelhead is higher. The information developed in these analyses is used in the City's HCP to evaluate existing conditions and evaluate the potential effect of streamflow augmentation as part of the HCP Conservation Strategy.

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Figure 1. PHABSIM study areas in Liddell Creek.



Figure 2. Flow study sites in Laguna Creek.

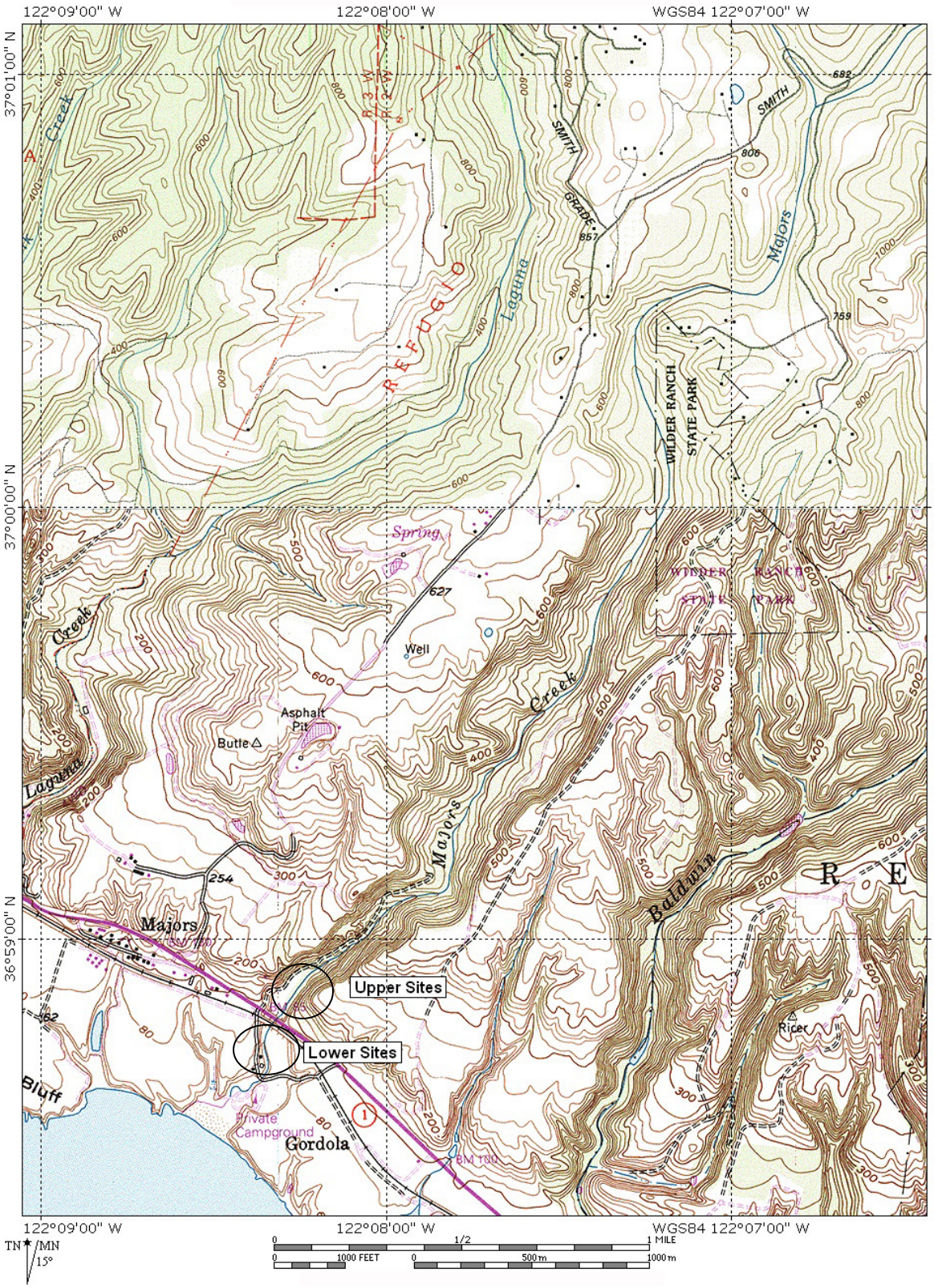


Figure 3. Flow study sites in Majors Creek.

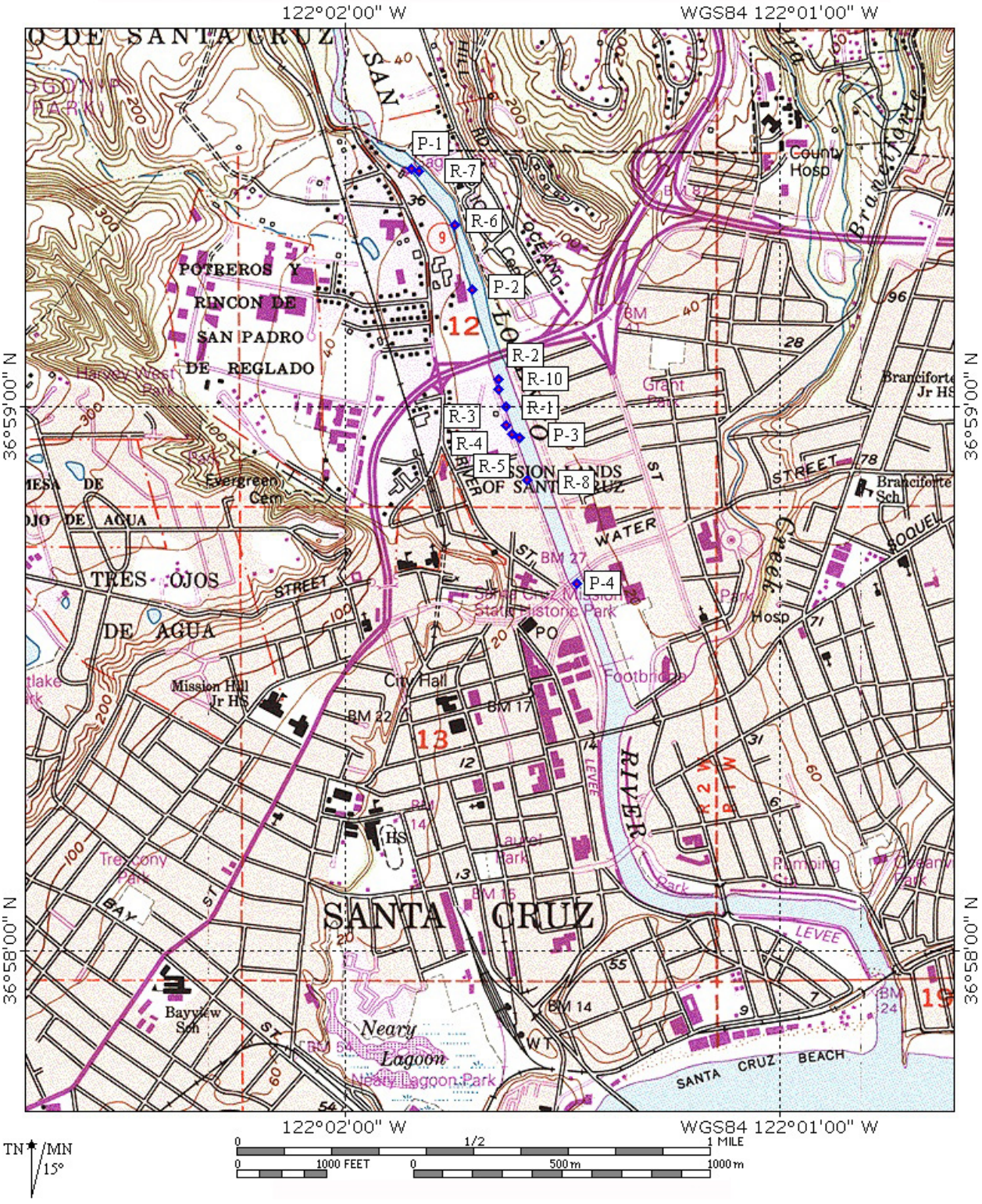


Figure 4. Flow study sites in San Lorenzo River downstream of Tait St.

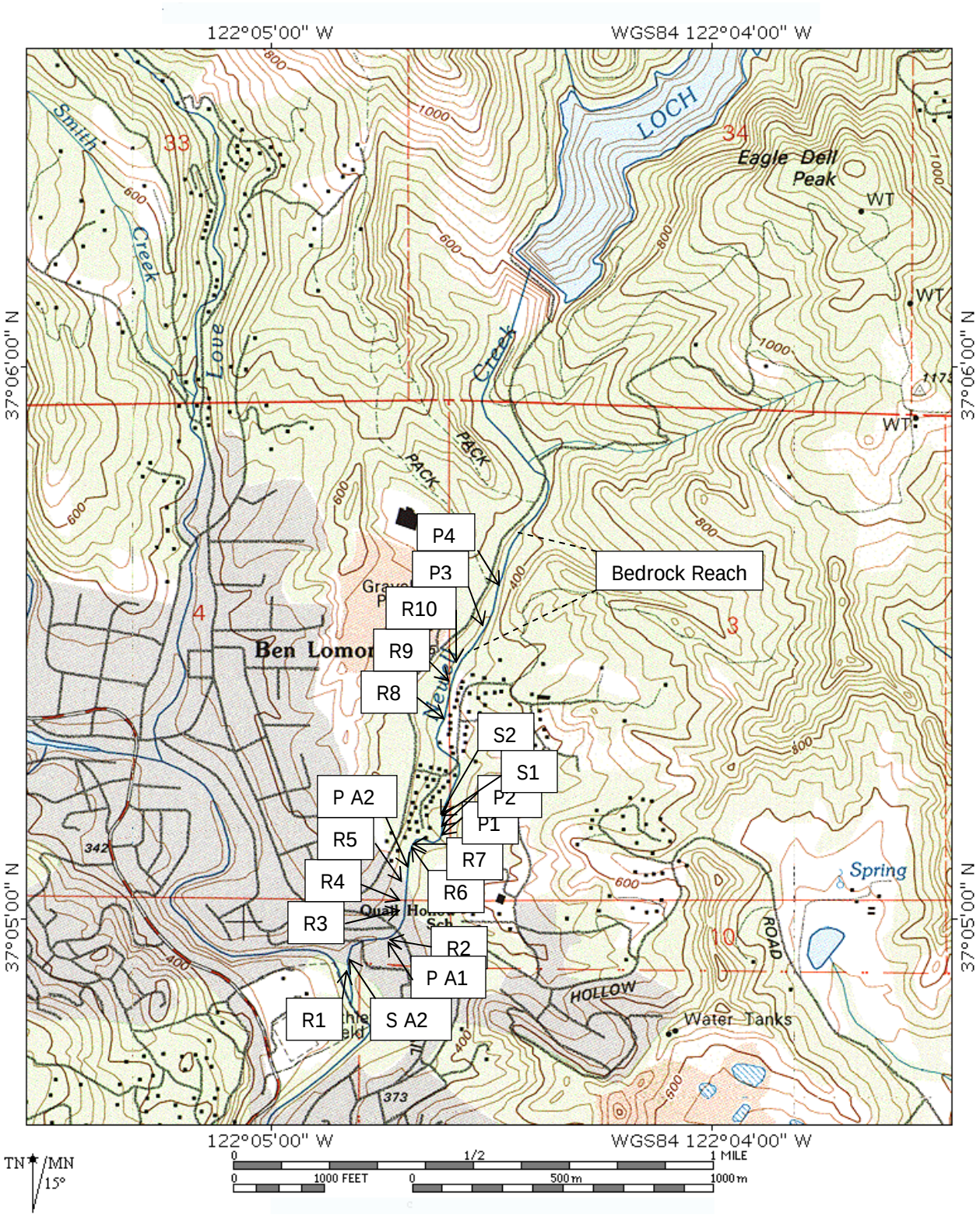
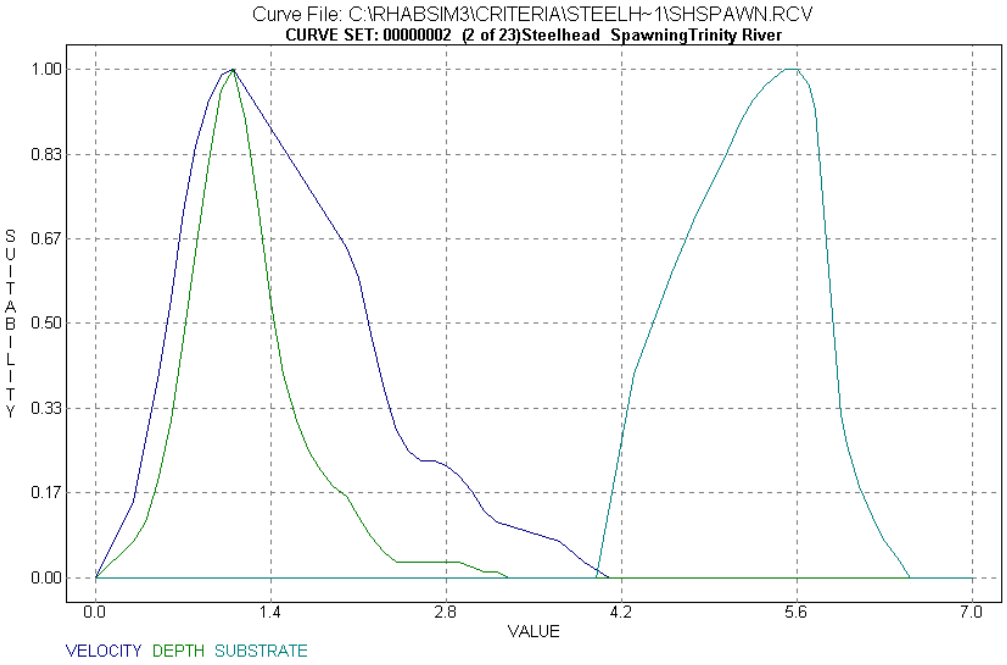


Figure 5. Flow study sites in Newell Creek.

a)



b)

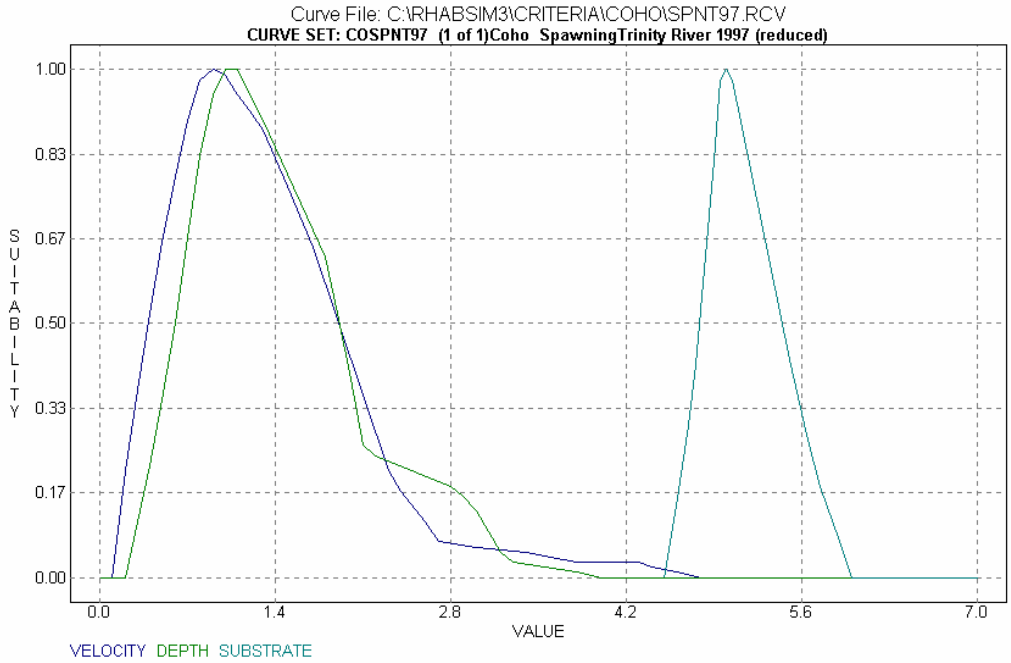
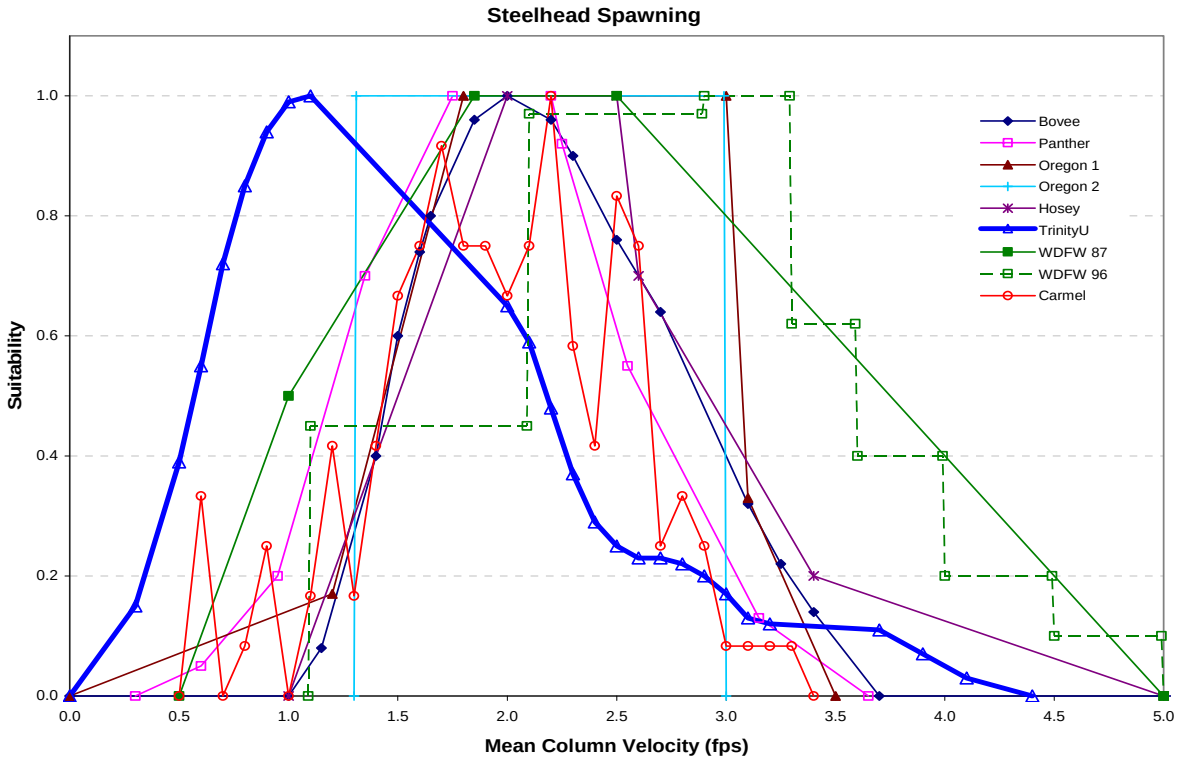


Figure 6. Habitat Suitability Criteria used for PHABSIM analysis of relationship between spawning suitability and flow in HCP study streams for steelhead (a), and coho salmon (b).

a)



b)

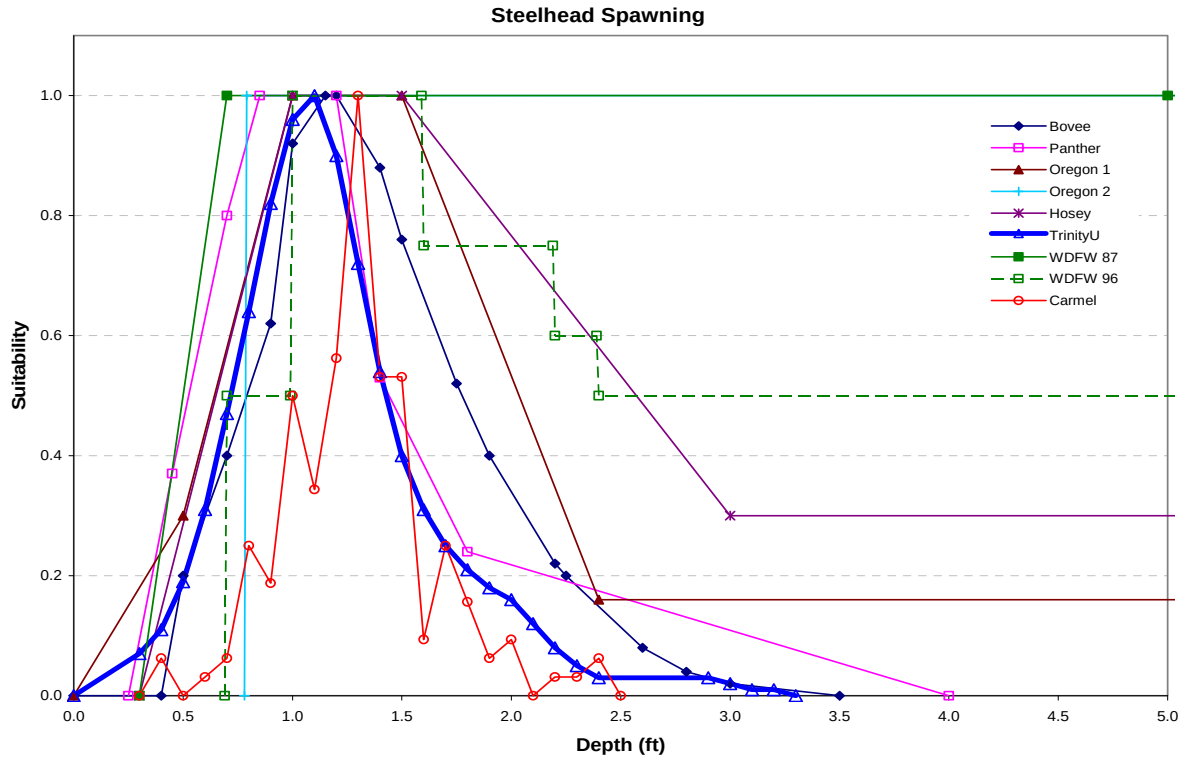
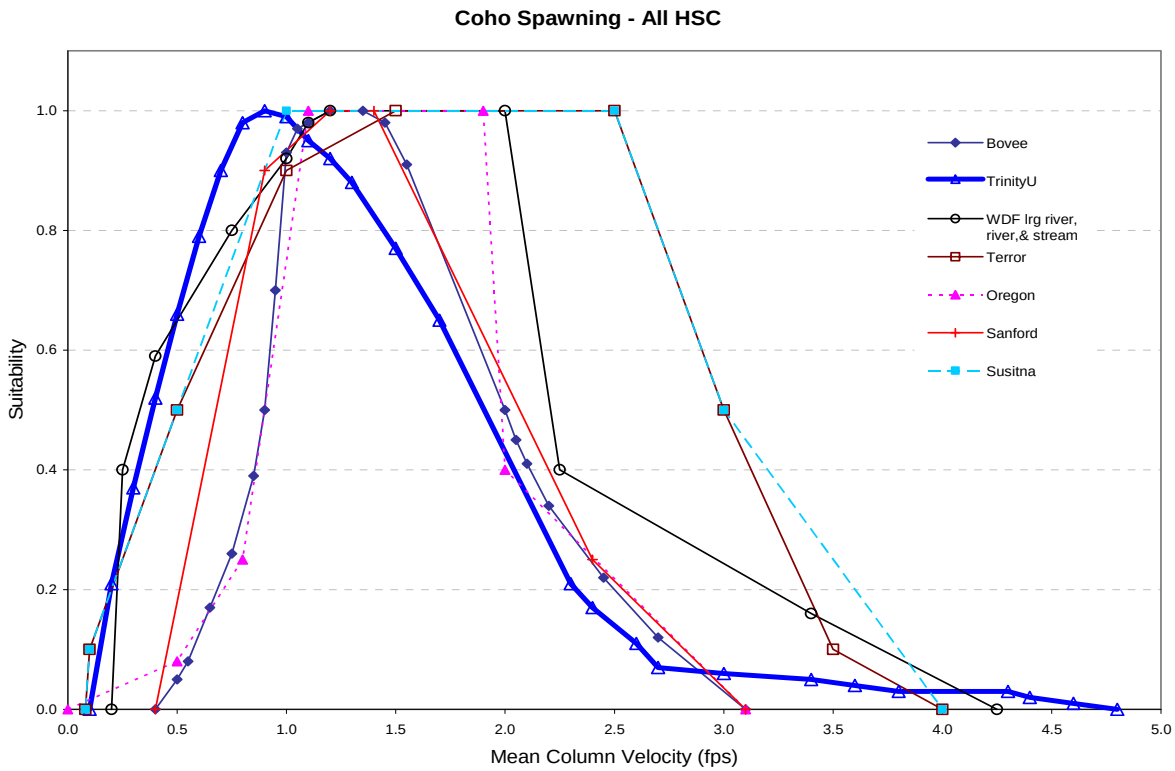


Figure 7. Habitat Suitability Criteria for steelhead spawning in other studies for velocity (a) and depth (b). ***Source: Thomas R. Payne and Associates.***

a)



b)

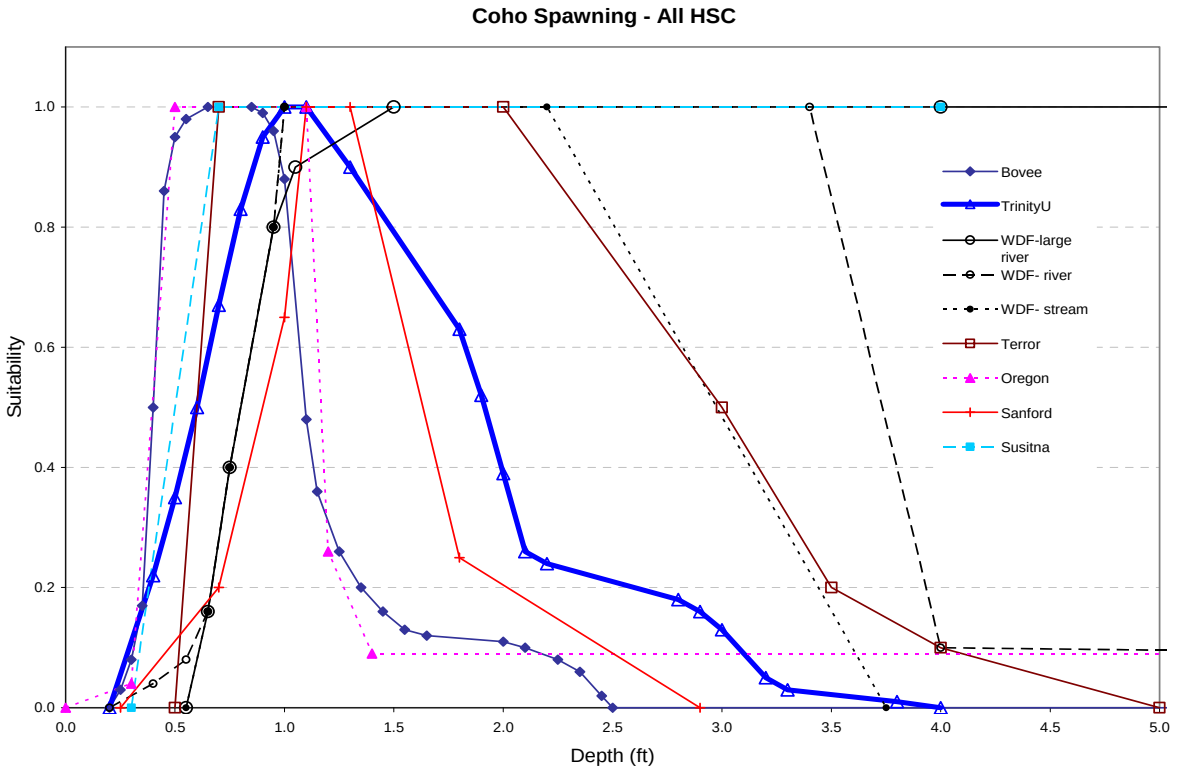
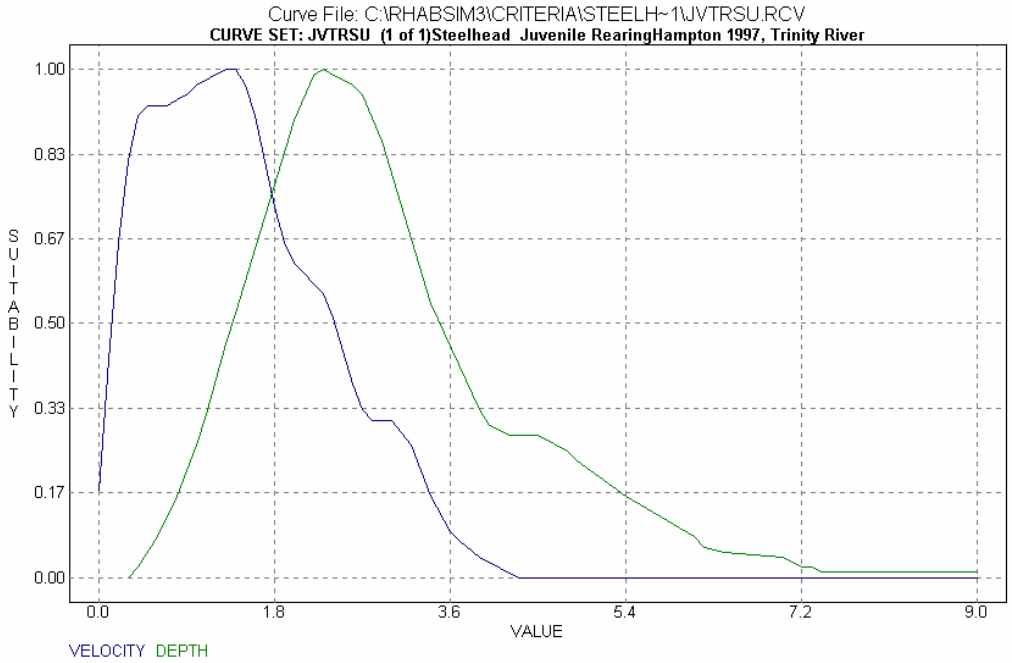


Figure 8. Habitat Suitability Criteria for coho spawning in other studies for velocity (a) and depth (b). ***Source: Thomas R. Payne and Associates.***

a)



b)

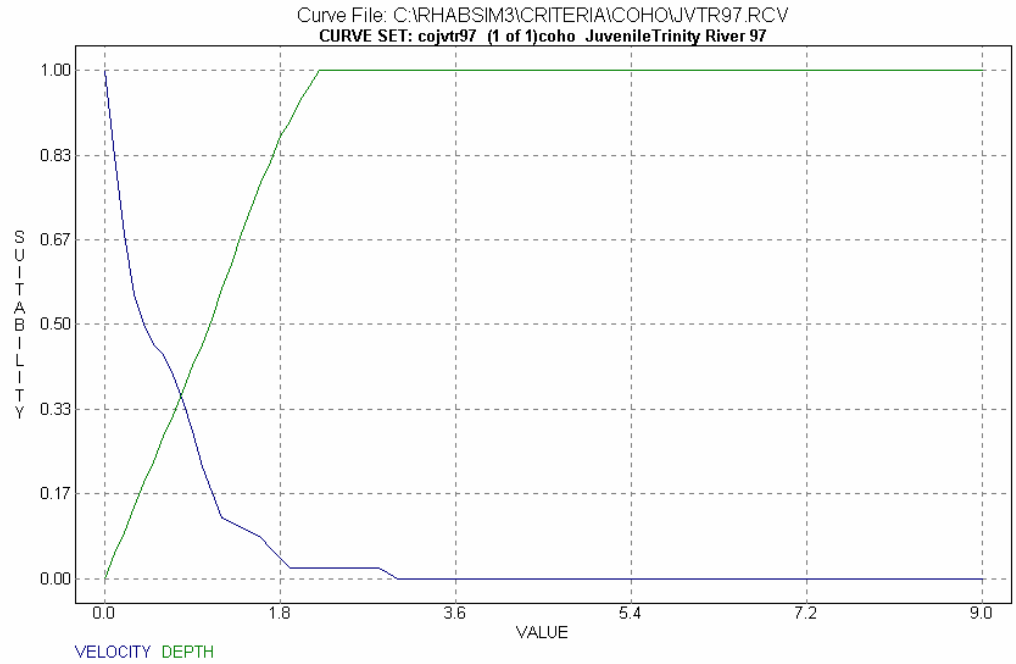
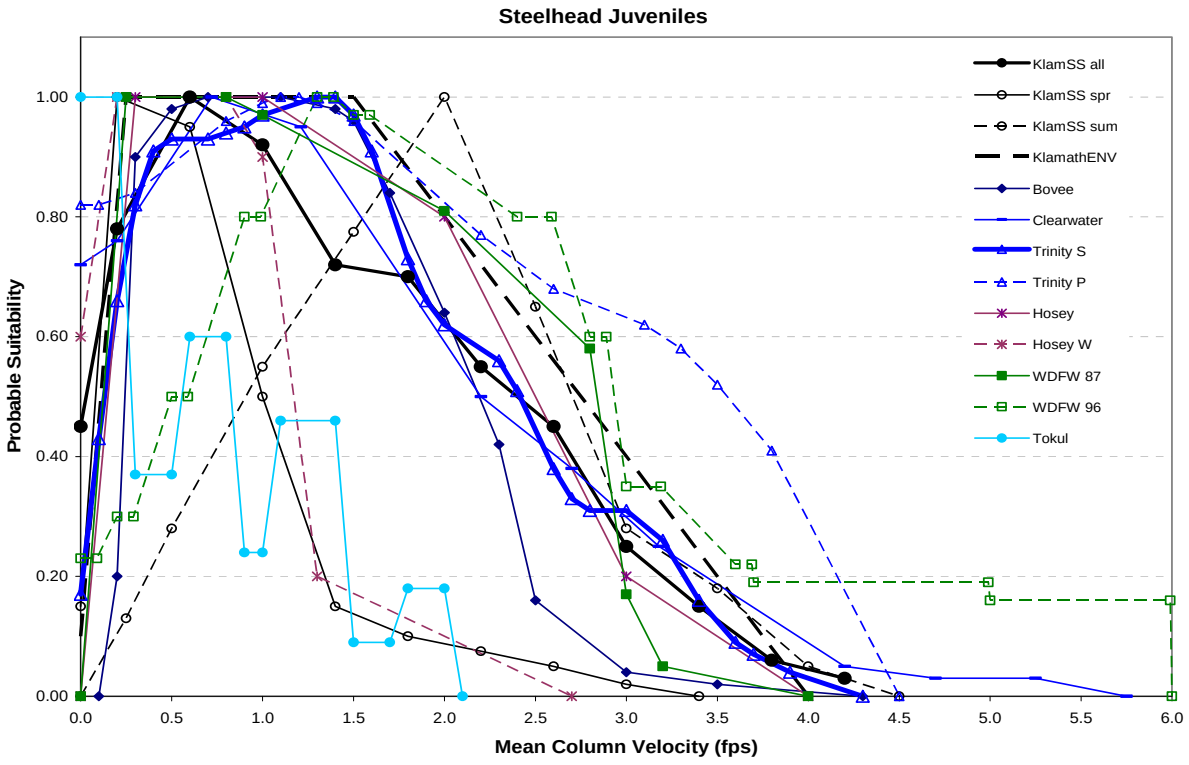


Figure 9. HSC used for PHABSIM analysis of relationship between juvenile rearing suitability and flow in HCP study streams for steelhead (a), and coho salmon (b).

a)



b)

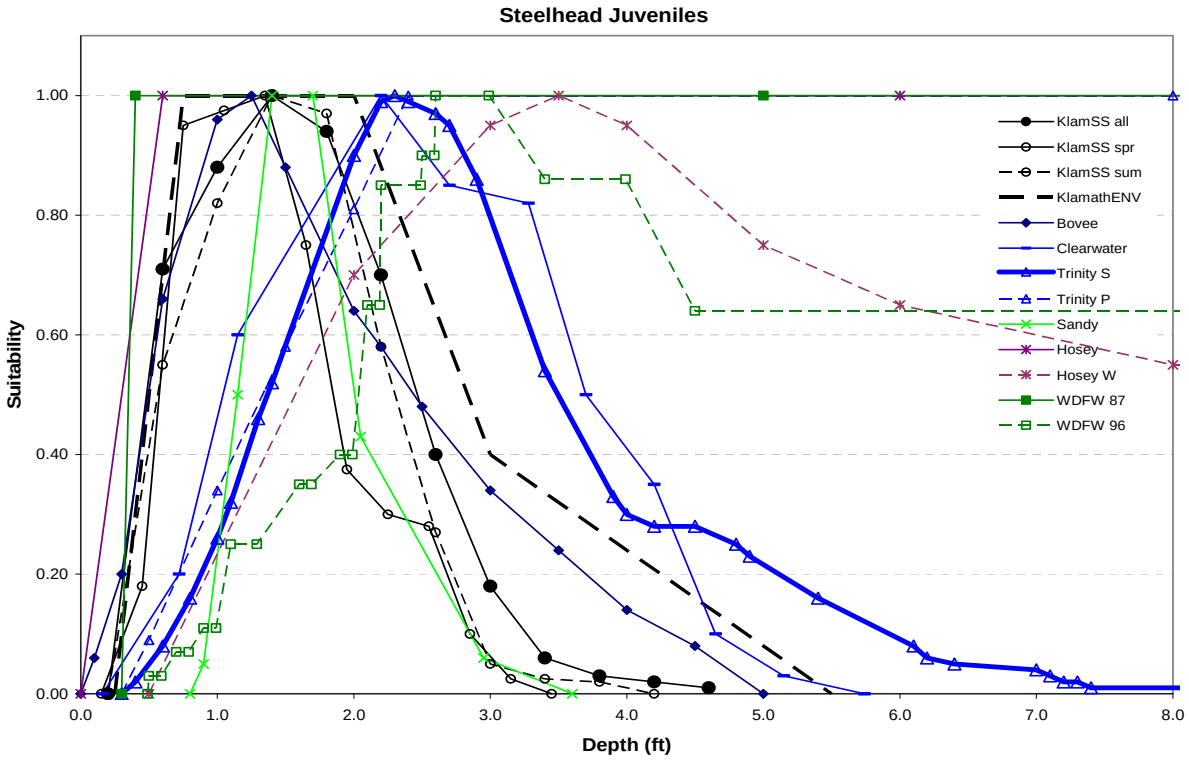


Figure 10. Habitat Suitability Criteria for steelhead juvenile rearing in other studies for velocity (a) and depth (b). ***Source: Thomas R. Payne and Associates.***

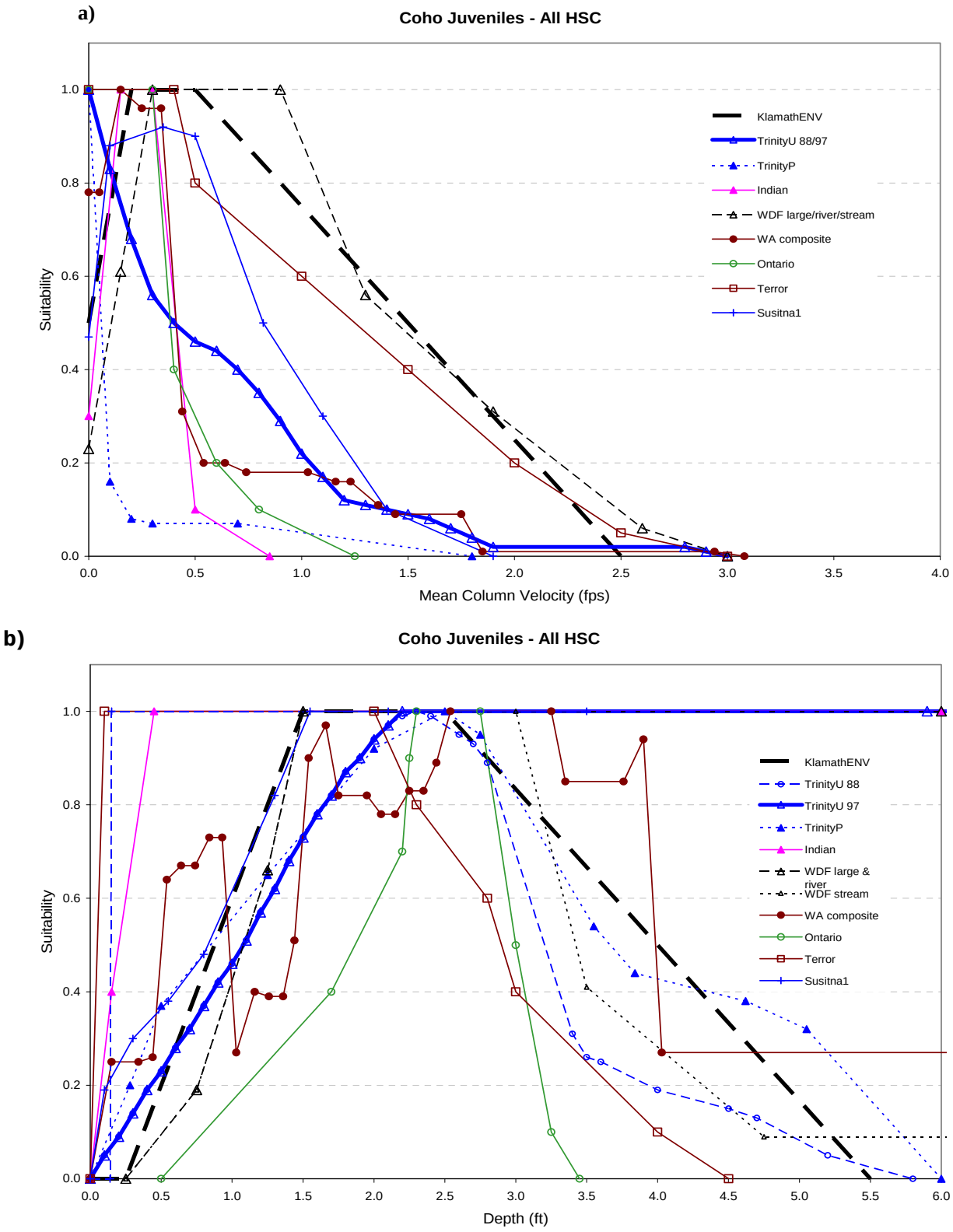
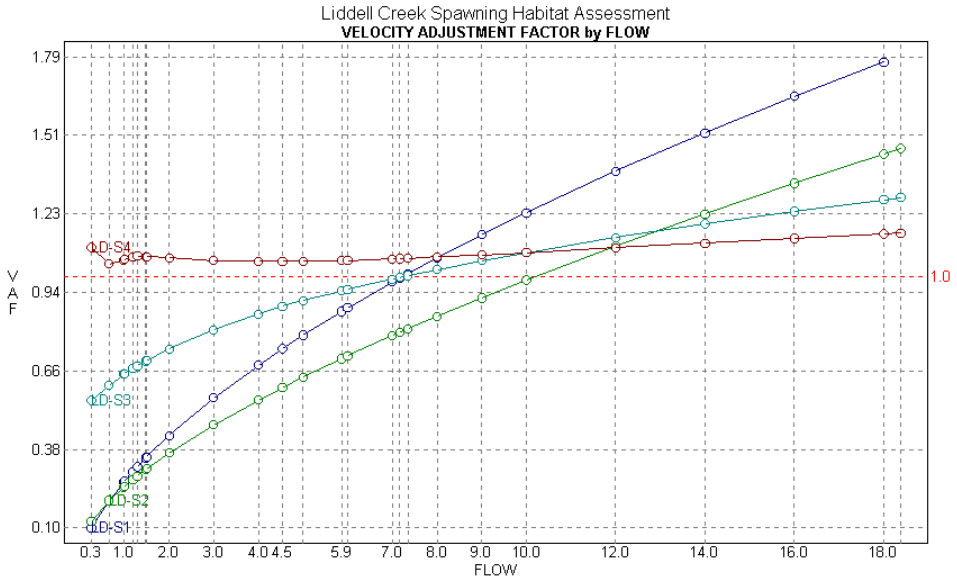


Figure 11. Habitat Suitability Criteria for coho juvenile rearing in other studies for velocity (a) and depth (b). *Source: Thomas R. Payne and Associates.*

a)



b)

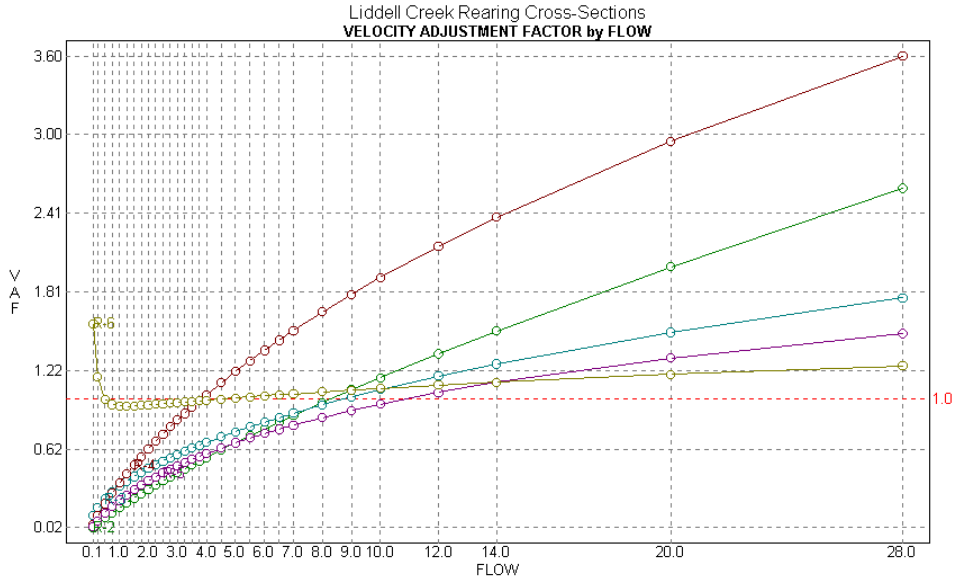
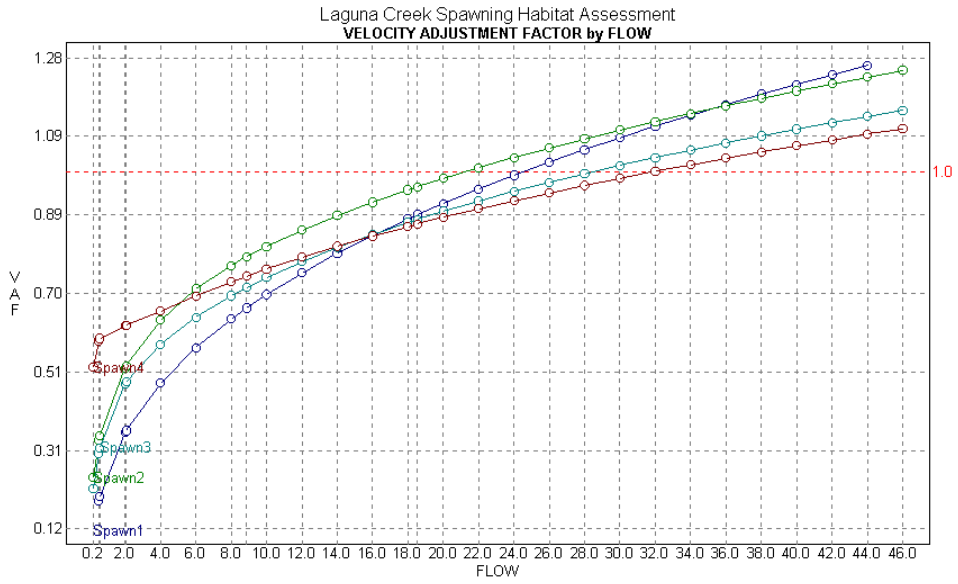


Figure 12. Velocity adjustment factors used for RHABSIM velocity simulations on spawning transects (a), and rearing transects (b) in Liddell Creek.

a)



b)

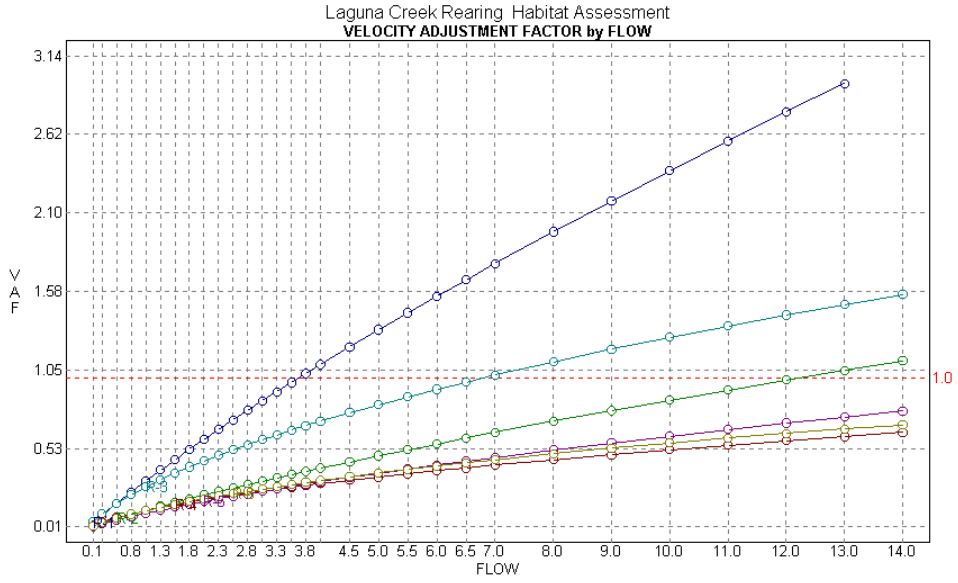
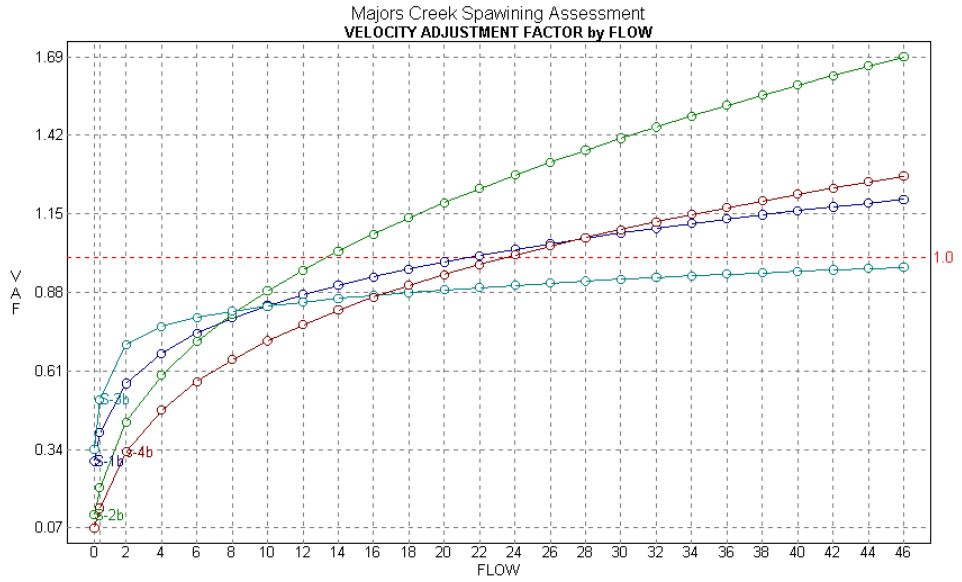


Figure 13. Velocity adjustment factors used for RHABSIM velocity simulations on spawning transects (a), and rearing transects (b) in Laguna Creek.

a)



b)

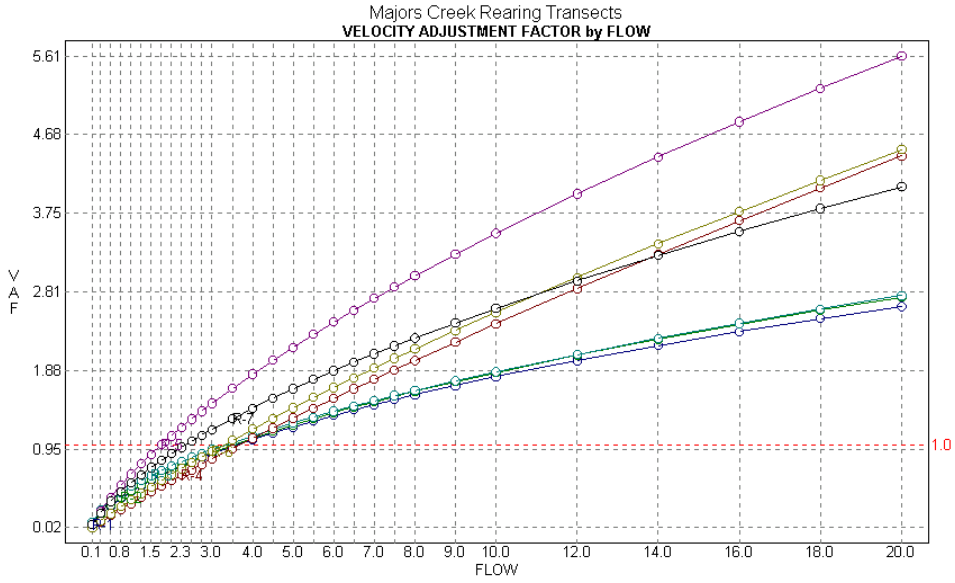


Figure 14. Velocity adjustment factors used for RHABSIM velocity simulations on spawning transects (a), and rearing transects (b) in Majors Creek.

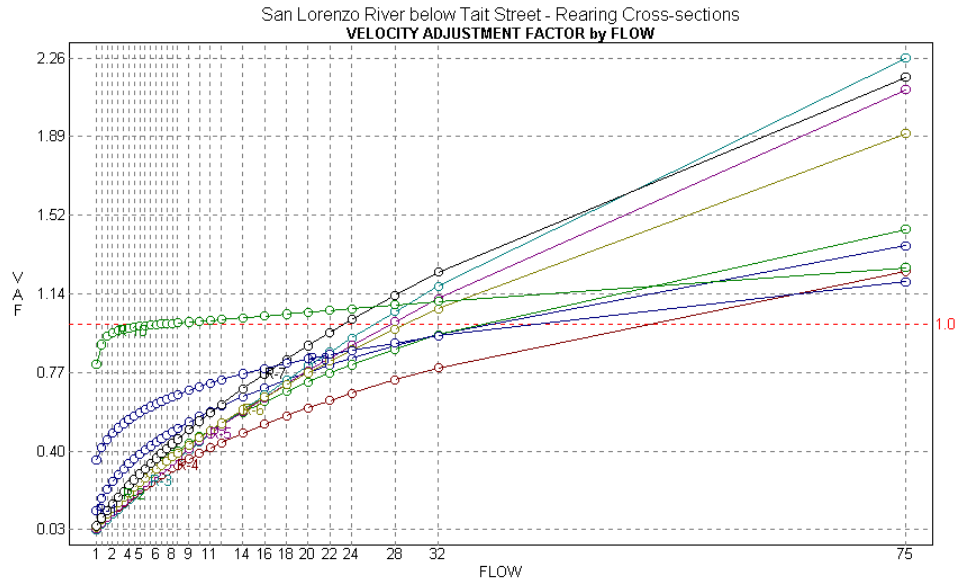
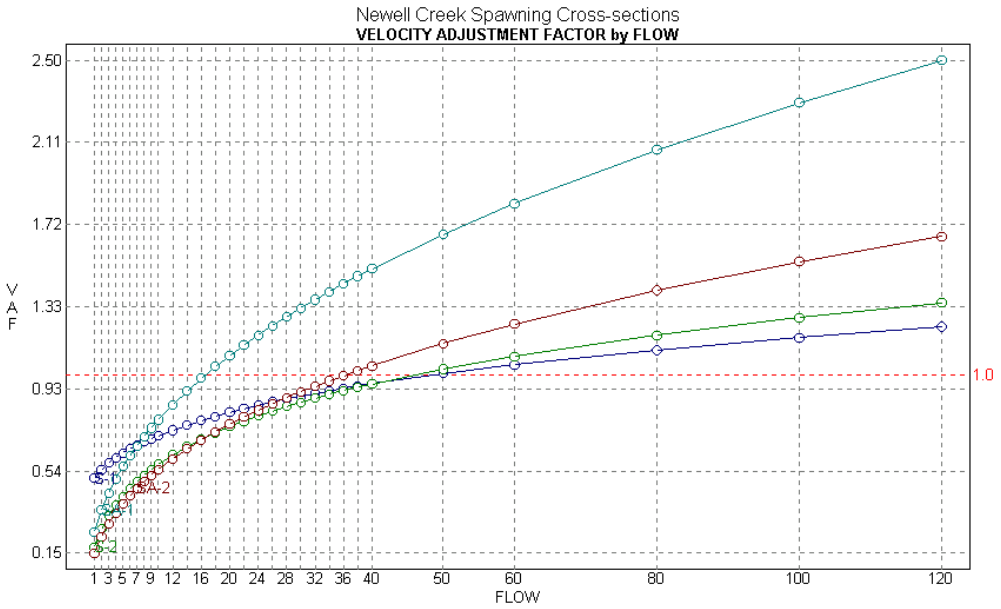


Figure 15. Velocity adjustment factors used for RHABSIM velocity simulations on rearing transects in the San Lorenzo River downstream of Tait Street.

a)



b)

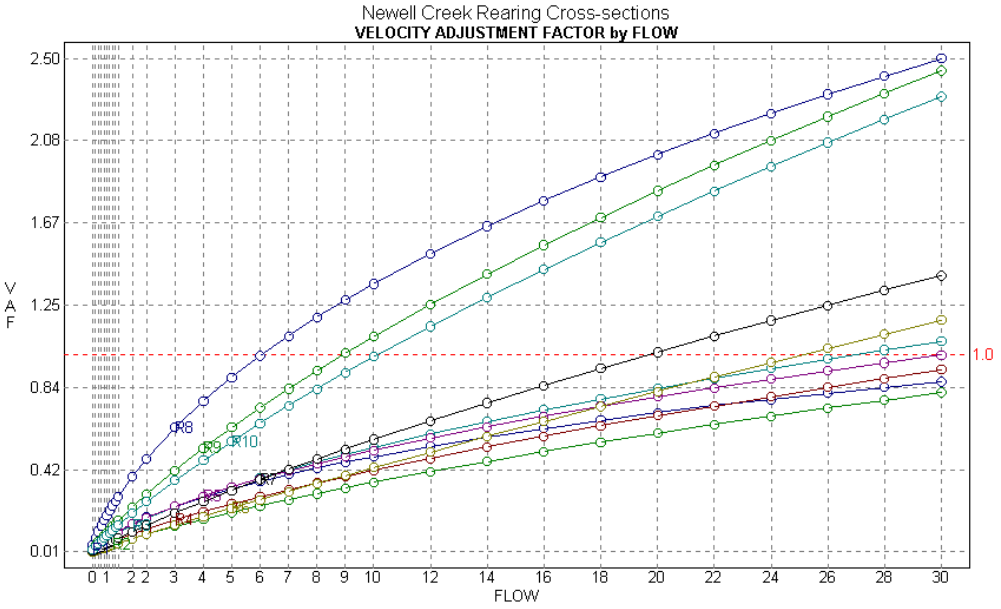


Figure 16. Velocity adjustment factors used for RHABSIM velocity simulations on spawning transects (a), and rearing transects (b) in Newell Creek.



Figure 17. San Lorenzo River downstream of Tait Street, Passage transect P-1.

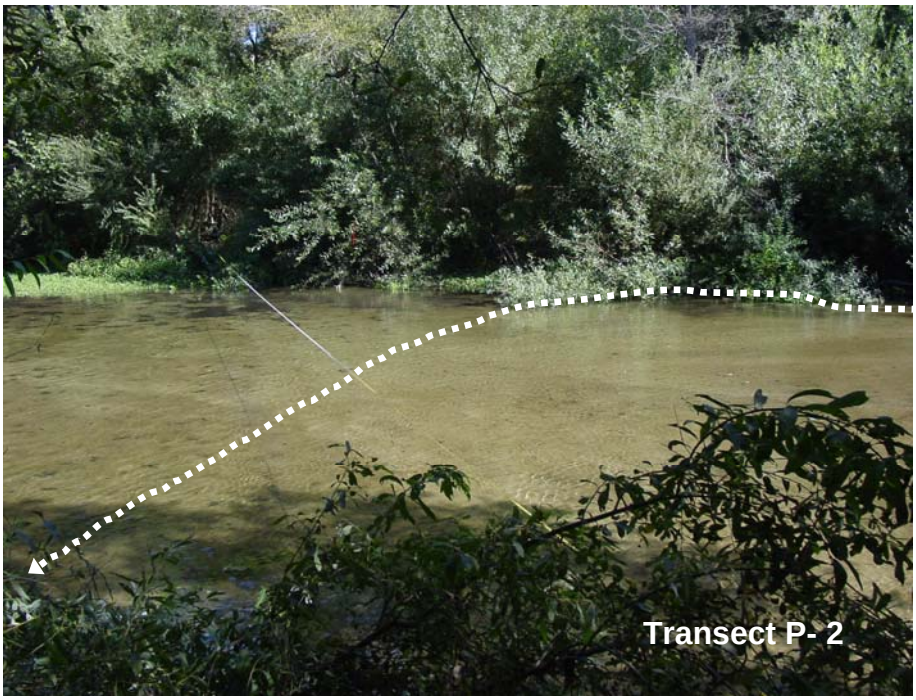


Figure 18. San Lorenzo River downstream of Tait Street, Passage transect P-2.

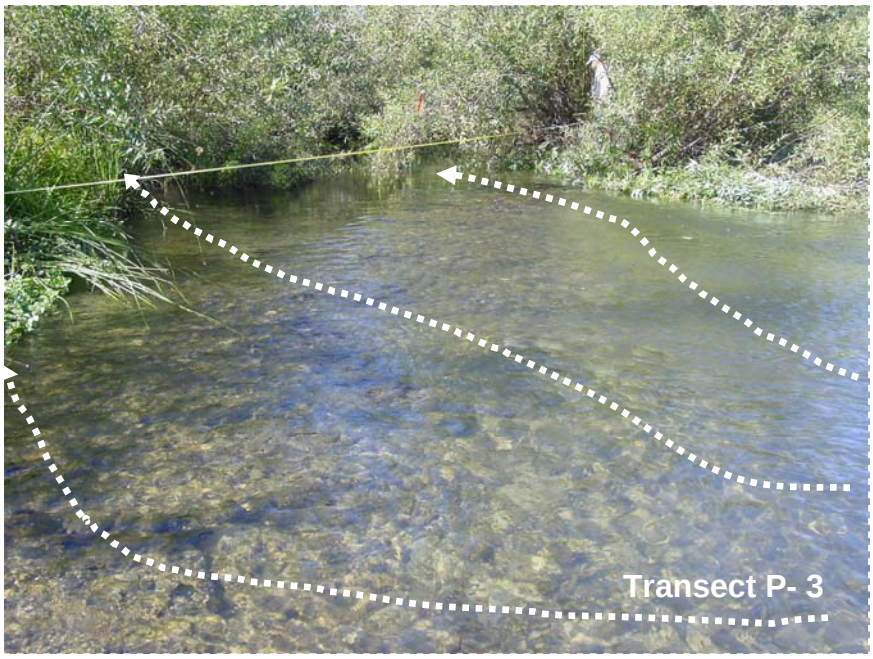


Figure 19. San Lorenzo River downstream of Tait Street, Passage transect P-3.

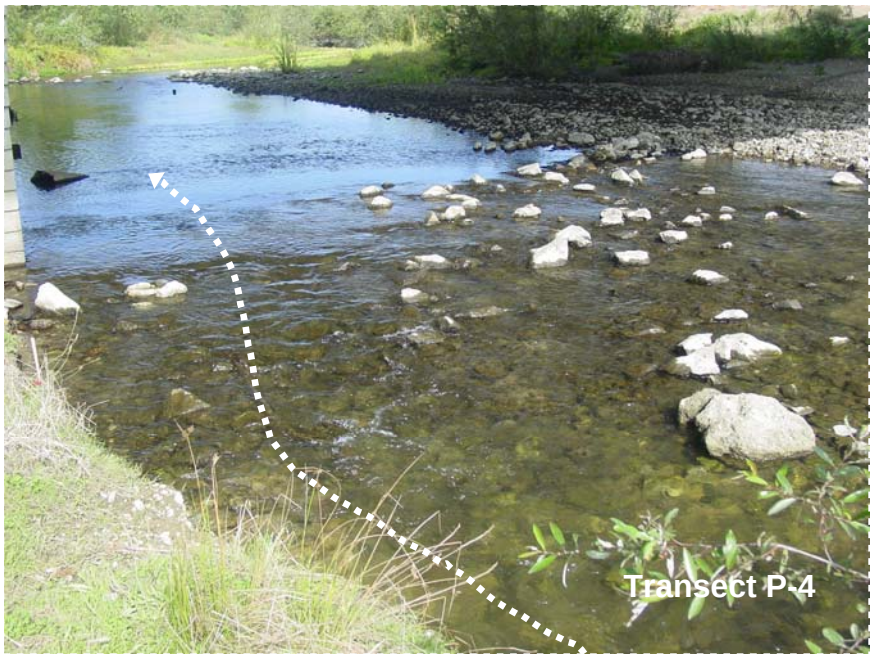


Figure 20. San Lorenzo River downstream of Tait Street, Passage transect P-4.



Figure 21. Newell Creek passage obstacle N P-3 (flow 40-45 cfs)



Figure 22. Newell Creek passage obstacle N P-4 (flow about 50 cfs).

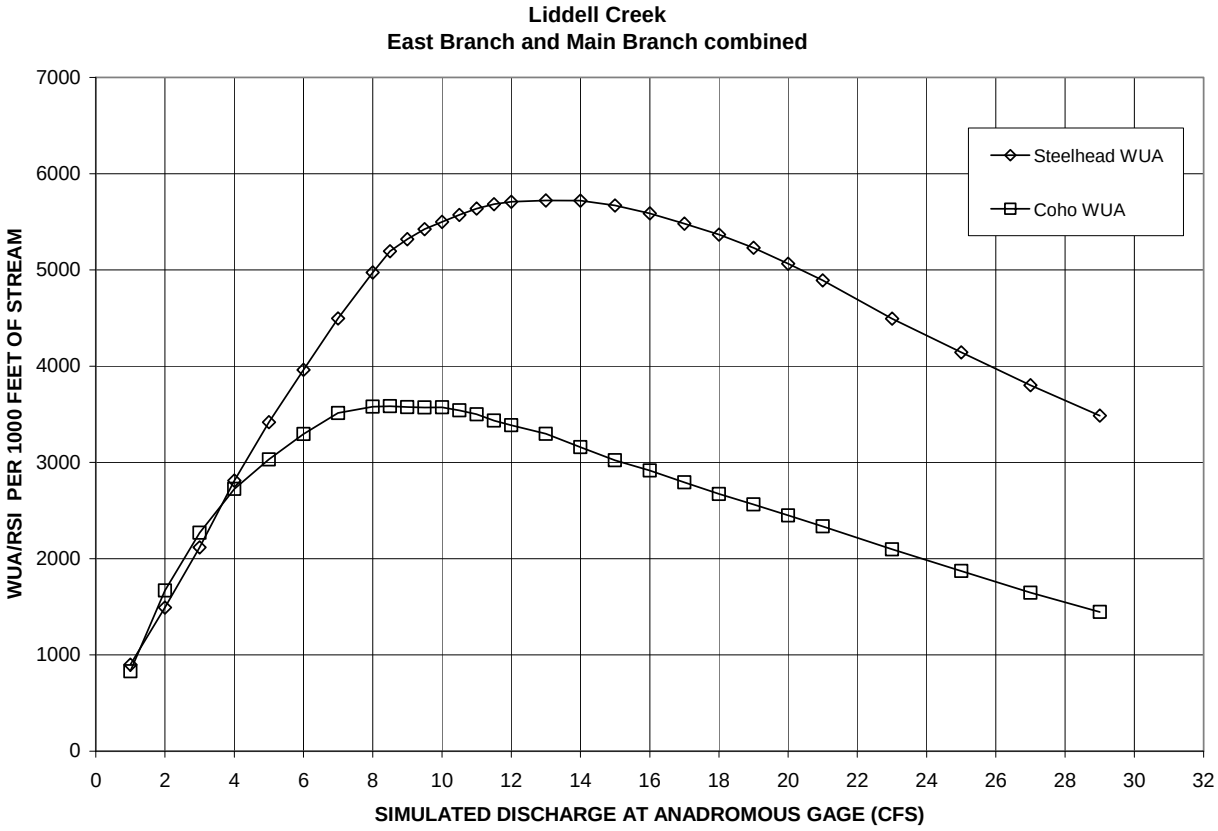


Figure 23. Spawning habitat suitability for steelhead and coho salmon as a function of flow in Liddell Creek.

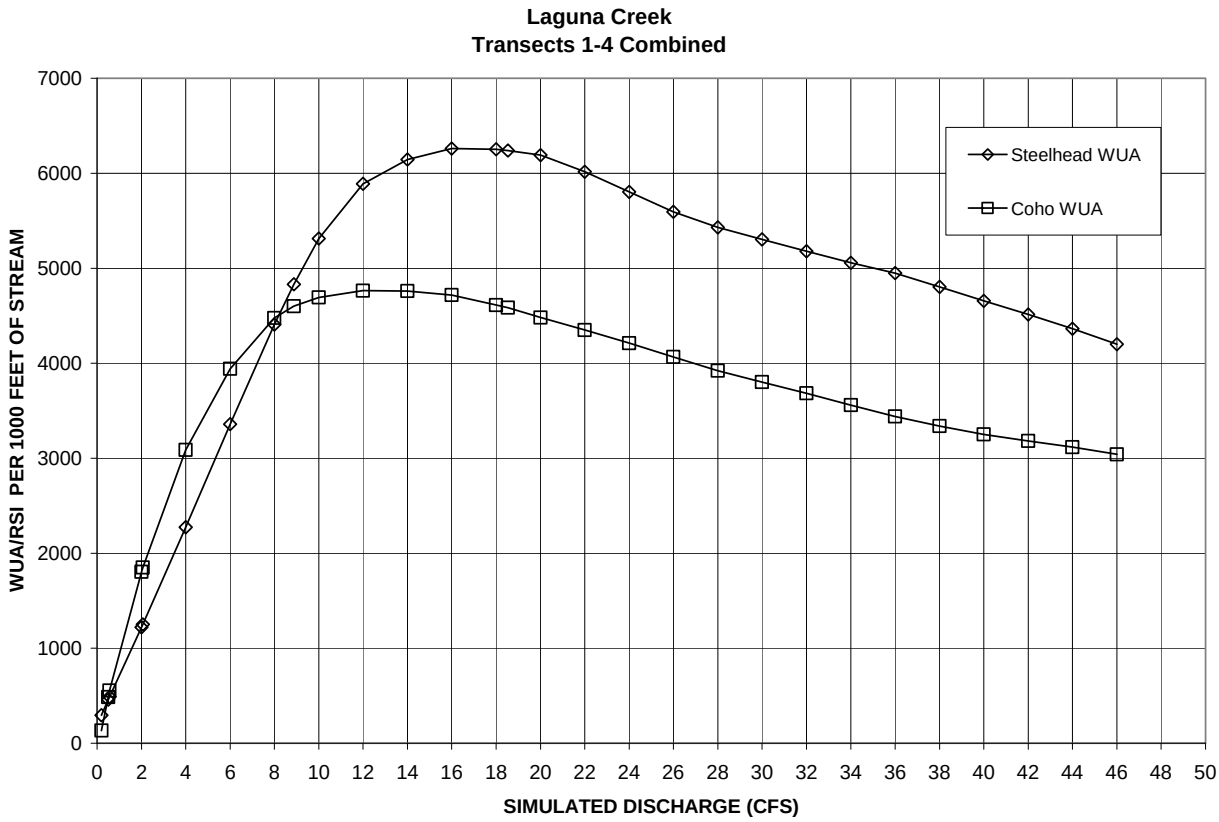


Figure 24. Spawning habitat suitability for steelhead and coho salmon as a function of flow in Laguna Creek.

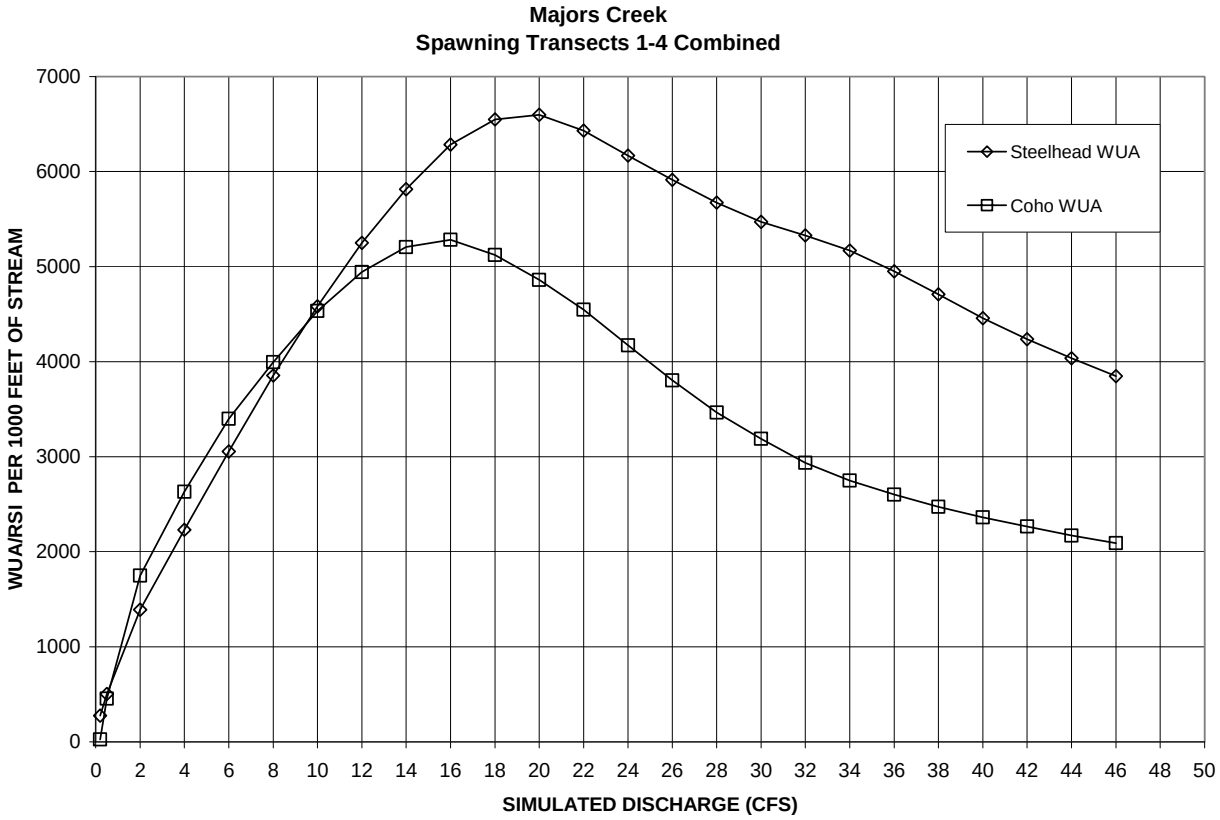


Figure 25. Spawning habitat suitability for steelhead and coho salmon as a function of flow in Majors Creek.

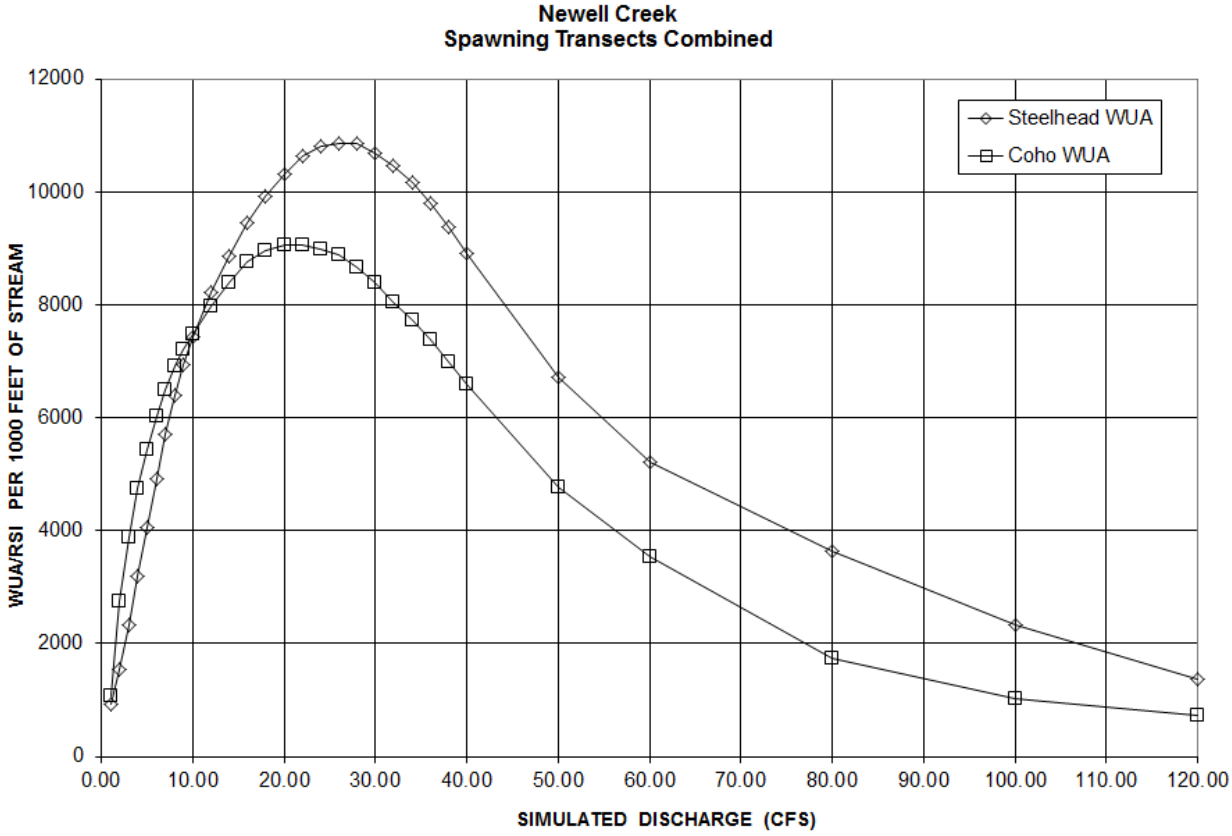


Figure 26. Spawning habitat suitability for steelhead and coho salmon as a function of flow in Newell Creek.

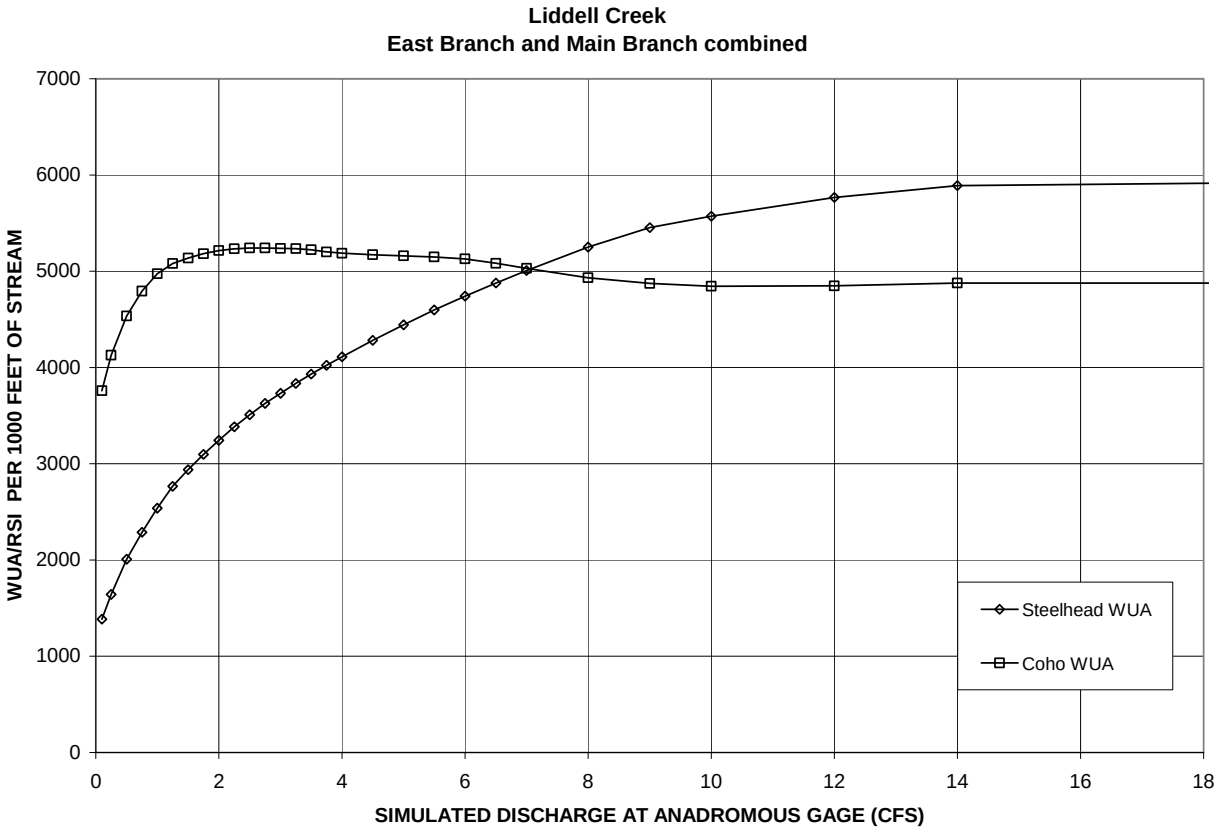


Figure 27. Rearing habitat suitability for steelhead and coho salmon as a function of flow in Liddell Creek.

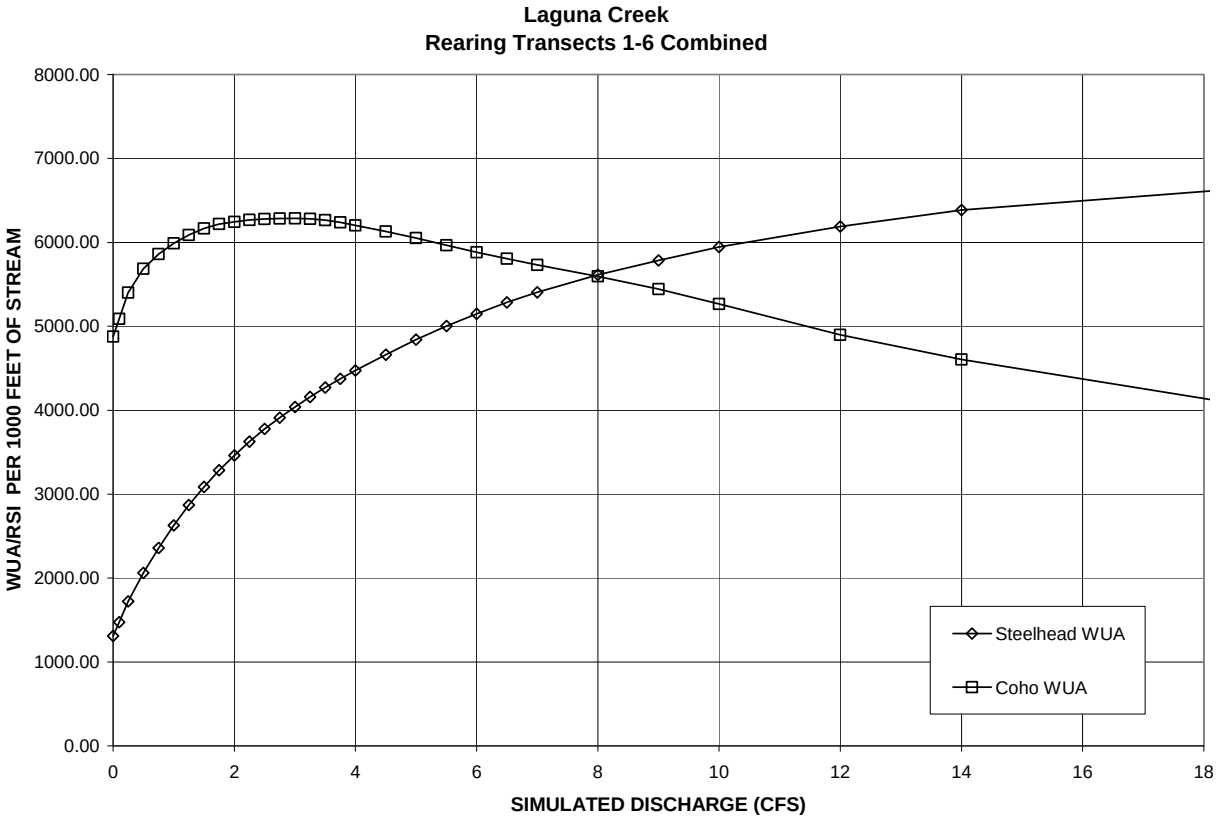


Figure 28. Rearing habitat suitability for steelhead and coho salmon as a function of flow in Laguna Creek.

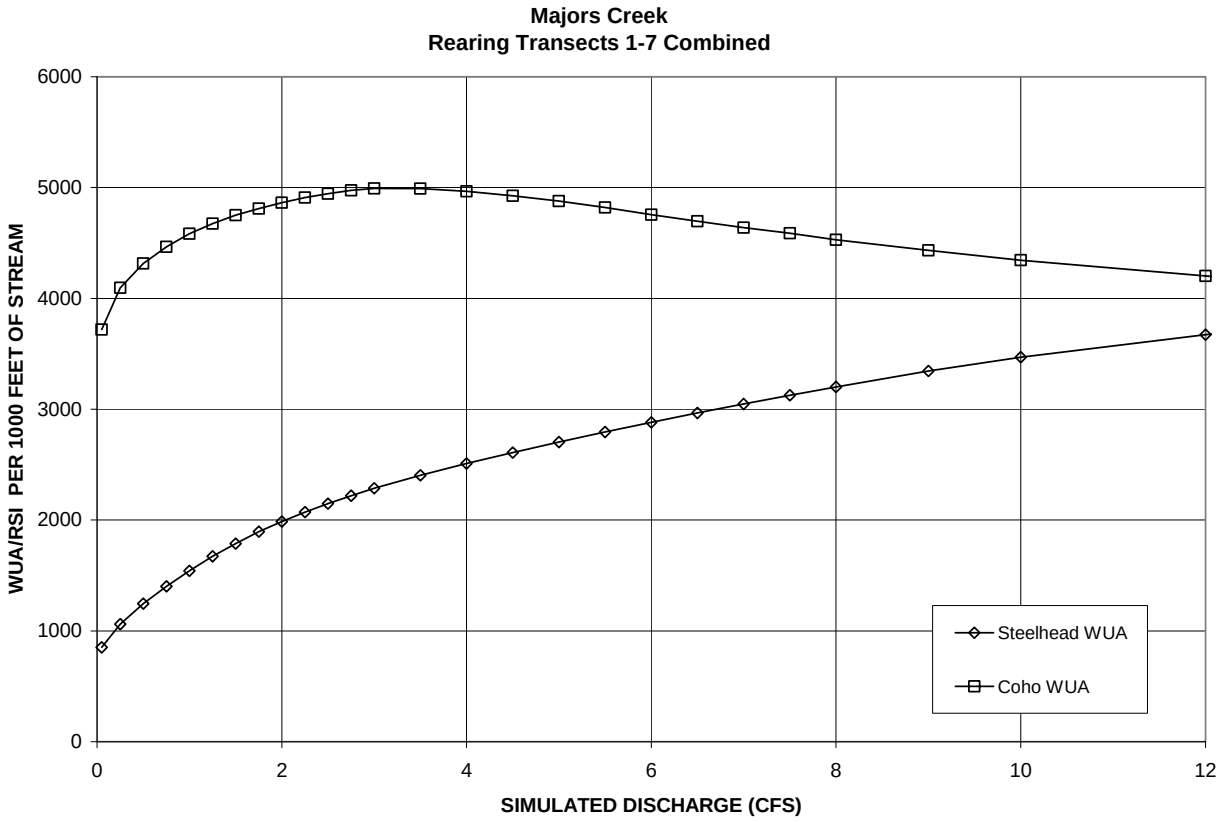


Figure 29. Rearing habitat suitability for steelhead and coho salmon as a function of flow in Majors Creek.

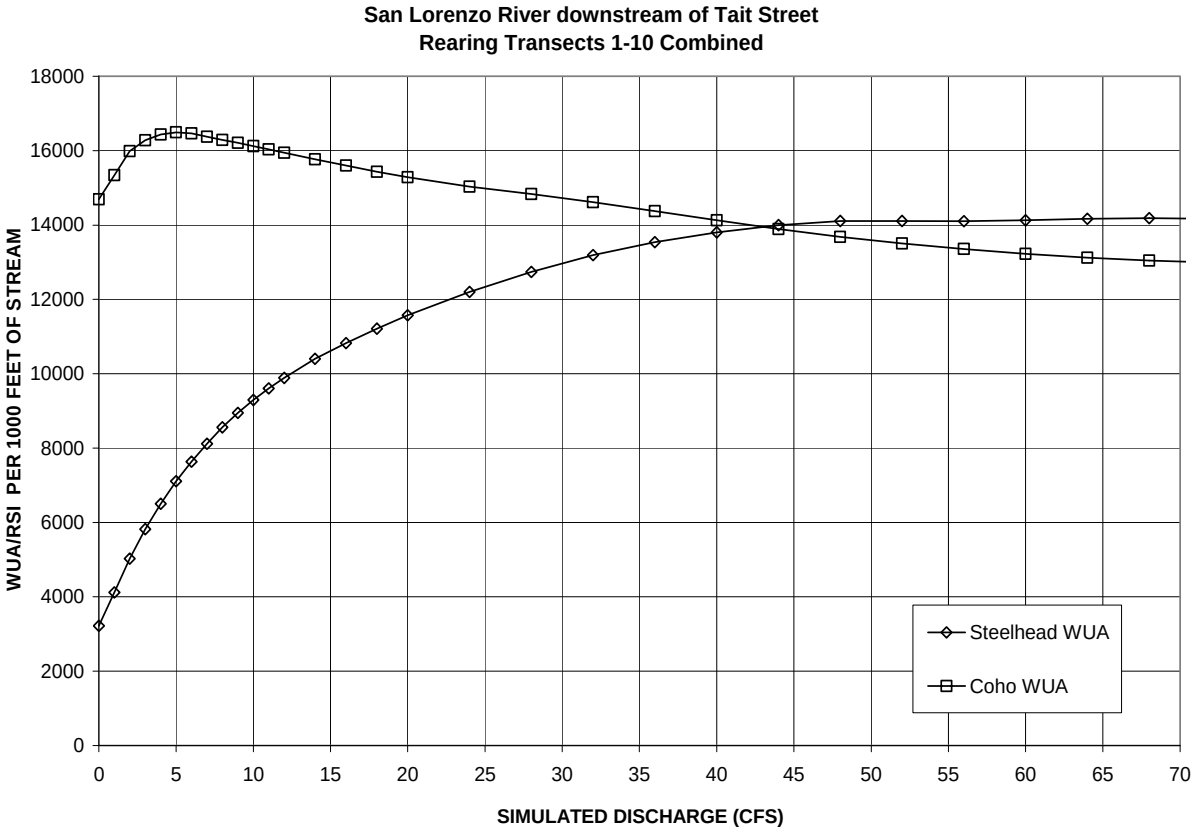


Figure 30. Rearing habitat suitability for steelhead and coho salmon as a function of flow in the San Lorenzo River downstream of Tait Street.

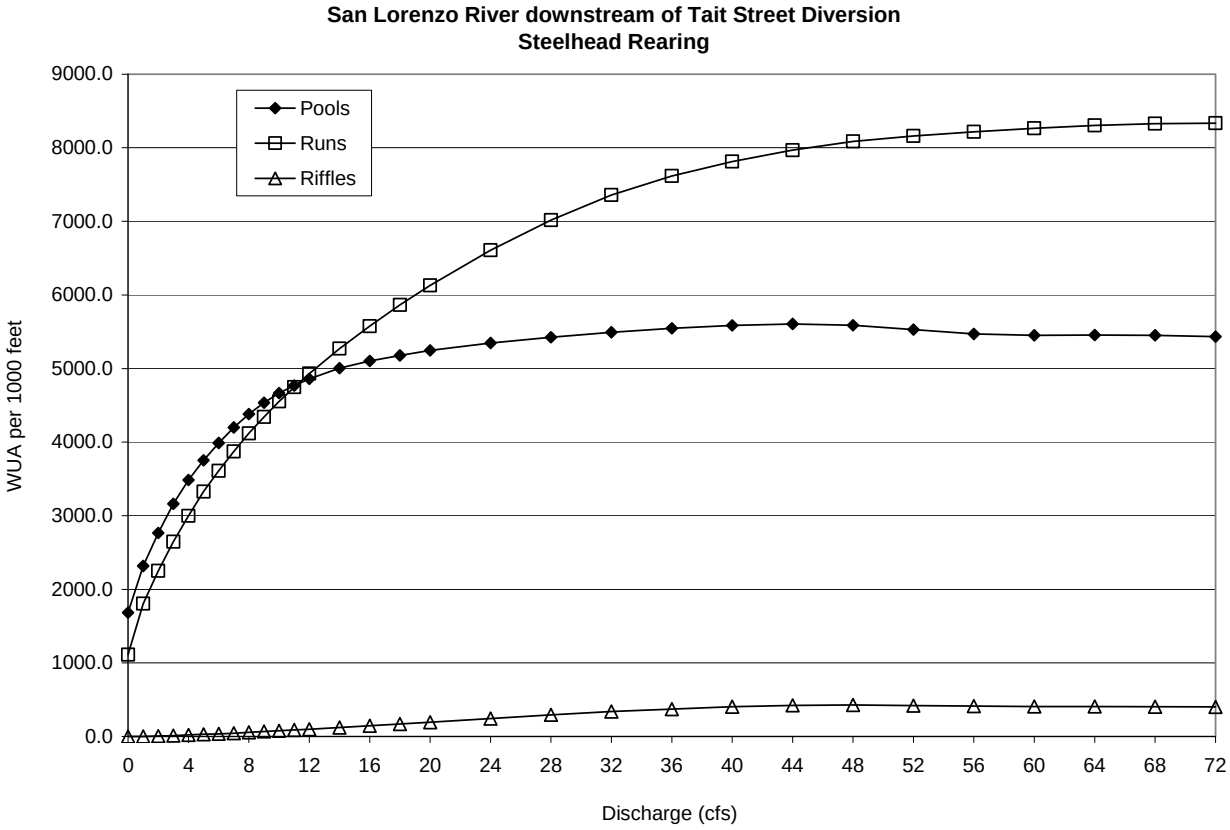


Figure 31. Rearing habitat suitability for steelhead in the San Lorenzo River downstream of Tait Street by habitat type.

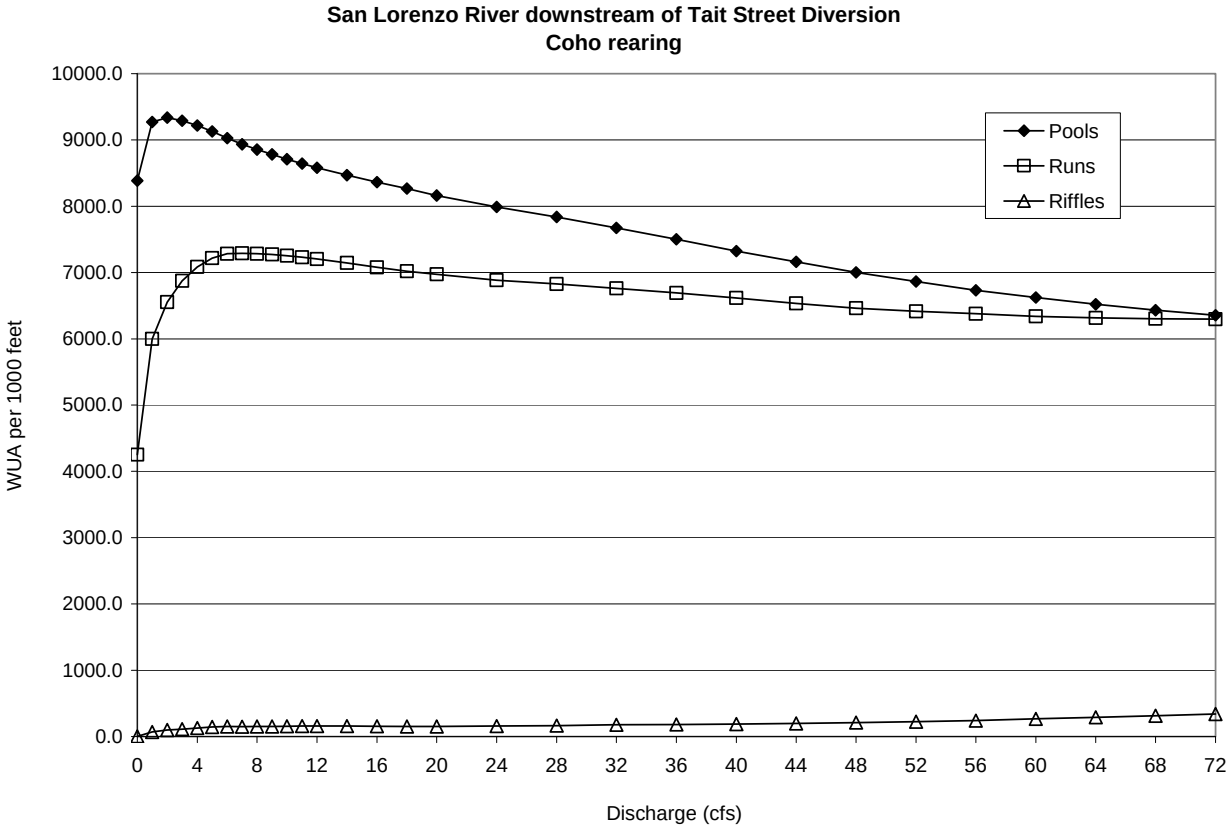


Figure 32. Rearing habitat suitability for coho in the San Lorenzo River downstream of Tait Street by habitat type.

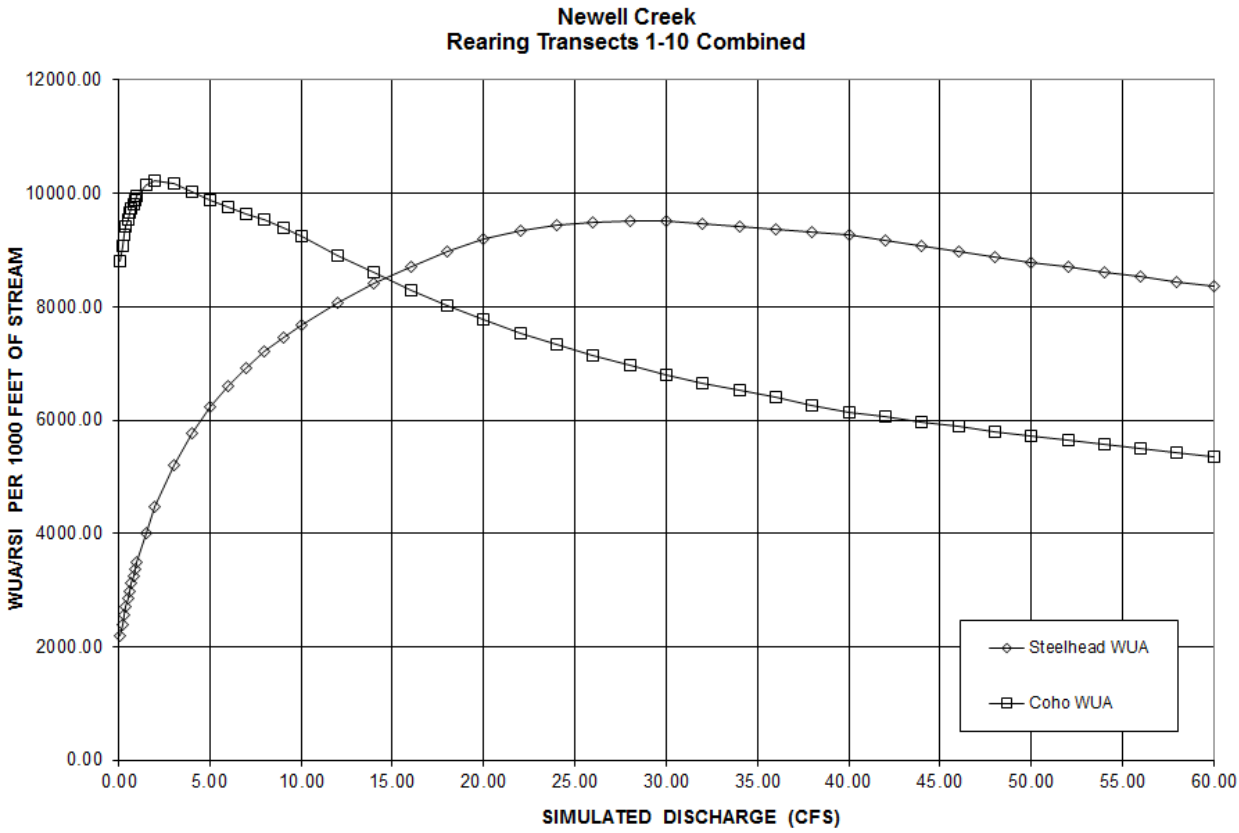


Figure 33. Rearing habitat suitability for steelhead and coho salmon as a function of flow in Newell Creek.

Table 1. North Coast PHABSIM transect characteristics.

Transect Name	Lifestage	Habitat Type	Maximum Depth (on transect)	Substrate (on transect)
Lower Liddell				
S-1	Spawning	Run	0.6	Sand/gravel
S-2	Spawning	Pool tail	0.5	Gravel/sand
R-1	Juvenile Rearing	Pool, lower part, below snag	2.0	Sand/gravel
R-2	Juvenile Rearing	Pool	1.5	Sand/silt
R-3	Juvenile Rearing	Run	0.6	Gravel/sand/cobble
Upper Liddell				
S-3	Spawning	Tail of glide	0.45	Gravel/sand
S-4	Spawning	Deep riffle	0.3	Gravel/sand/cobble
R-4	Juvenile Rearing	Pool	1.3	Sand/gravel
R-5	Juvenile Rearing	Pool, in debris jam	1.4	Sand/gravel/silt
R-6	Juvenile Rearing	Deep riffle	0.4	Gravel/sand
Lower Laguna				
S-1	Spawning	Deep riffle	0.4	Gravel/cobble/sand
S-2	Spawning	Pool tail	0.3	Gravel/sand/cobble
R-1	Juvenile Rearing	Pool, near head	2.3	Sand/silt
R-2	Juvenile Rearing	Head of pool	2.6	Silt/sand/bedrock
R-3	Juvenile Rearing	Run/glide	0.8	Sand/gravel
Upper Laguna				
S-3	Spawning	Pool tail	0.3	Gravel/sand/cobble
S-4	Spawning	Glide, toward tail	0.4	Gravel/sand
R-4	Juvenile Rearing	Run	1.1	Gravel/cobble/sand
R-5	Juvenile Rearing	Pool, just downstream of R-6	1.9	Silt/sand
R-6	Juvenile Rearing	Pool, near head	1.5	Silt/sand
Lower Majors				
S-1	Spawning	Pool tail	0.35	Gravel/sand
S-2	Spawning	Pool tail	0.3	Gravel/sand
R-1	Juvenile Rearing	Run	1.1	Gravel/sand
R-2	Juvenile Rearing	Pool, lateral scour with roots	1.5	Sand/gravel/silt
R-3	Juvenile Rearing	Run	0.6	Sand/gravel
Upper Majors				
S-3	Spawning	Pool tail	0.3	Gravel/sand
S-4	Spawning	Pool tail	0.6	Gravel/cobble
R-4	Juvenile Rearing	Pool, near head	2.9	Silt/gravel/sand
R-5	Juvenile Rearing	Run, near transition to pool	0.9	Gravel/sand/cobble
R-6	Juvenile Rearing	Pool, near head	2.5	Sand/silt
R-7	Juvenile Rearing	Mid-Pool, downstream of R-6	1.0	Sand/gravel/boulder

Table 2. San Lorenzo PHABSIM transect characteristics.

Transect Name	Lifestage	Habitat Type	Maximum Depth (on transect)	Substrate (on transect)
San Lorenzo River downstream of Tait Street				
R-1	Juvenile Rearing	Run, swift	1.2	Gravel/sand/cobble
R-2	Juvenile Rearing	Run, deep/slow	2.1	Sand
R-3	Juvenile Rearing	Pool, middle	4.0	Sand
R-4	Juvenile Rearing	Pool, head	3.7	Sand/gravel
R-5	Juvenile Rearing	Pool, middle, d/s from R-4	3.6	Sand
R-6	Juvenile Rearing	Run, slow	2.7	Sand/silt
R-7	Juvenile Rearing	Pool, upper 1/3	2.4	Sand
R-8	Juvenile Rearing	Run, moderately swift	1.6	Sand/gravel
R-10	Juvenile Rearing	Riffle, deep, low-gradient	0.8	Gravel
Newell				
S-1	Spawning	Pool tail, closer to riffle head	0.6	Gravel/sand
S-2	Spawning	Pool tail, further into pool	0.9	Gravel/sand
S-A1	Spawning	Glide/riffle	1.2	Gravel/cobble
S-A2	Spawning	Pool tail/glide	1.8	Gravel/cobble
R-1	Juvenile Rearing	Run	1.8	Cobble/gravel
R-2	Juvenile Rearing	Pool, middle/head	2.7	Gravel/cobble
R-3	Juvenile Rearing	Pool, middle	3.2	Sand/gravel
R-4	Juvenile Rearing	Pool, head	2.4	Sand/gravel
R-5	Juvenile Rearing	Run	2.0	Cobble/gravel
R-6	Juvenile Rearing	Pool, middle/head	5.5	Sand/gravel
R-7	Juvenile Rearing	Pool, head	5.1	Sand/gravel
R-8	Juvenile Rearing	Glide	1.6	Cobble/gravel
R-9	Juvenile Rearing	Pool	2.4	Cobble/gravel
R-10	Juvenile Rearing	Pool	2.9	Gravel/sand

Table 3. Stage and flow data collected at Liddell Creek PHABSIM study sites.

Site	DateTime	Velocity Data	Stage Data	Flow at Gage	Measured Flow	Estimated Flow (cfs)[2]	Stage above Zero Flow
Lower Study Area							
LD S-1	10/24/2006 10:37		X	1.18		1.18	0.58
LD S-1	12/14/2006 10:59		X	1.41		1.45	0.63
LD S-1	2/12/2007 9:28	X	X	7.54	7.08	7.54	0.96
LD S-2	10/24/2006 13:28		X	0.57		0.57	0.48
LD S-2	12/14/2006 11:43		X	1.44		1.44	0.57
LD S-2	2/12/2007 10:57	X	X	7.4	8.63	7.4	0.79
LD R-1	10/24/2006 11:30		X	0.96		0.96	0.36
LD R-1	12/14/2006 11:18		X	1.44		1.44	0.55
LD R-1	2/12/2007 11:42	X	X	8.76	8.65	8.76	0.59
LD R-2	10/24/2006 14:20		X	0.25	0.25	0.55[3]	0.48
LD R-2	12/14/2006 11:52		X	1.44	1.44	1.44	0.58
LD R-2	2/12/2007 12:54	X	X	9.34	9.34	9.34	0.90
LD R-3	10/24/2006 15:05	X	X	0.36	1.29	0.51[2]	0.49
LD R-3	12/14/2006 12:04		X	1.43		1.43	0.60
LD R-3	2/12/2007 13:43	X	X	8.78	9.78	8.78	0.92
Upper Study Area							
LD S-3	10/24/2006 16:53		X	0.49		0.98	0.44
LD S-3	12/14/2006 12:33		X	1.41		1.29	0.48
LD S-3	2/12/2007 10:34	X	X	7.36	4.54	4.54	0.77
LD S-4	10/25/2006 15:00		X	0.37		0.98	0.32
LD S-4	12/14/2006 14:12		X	1.40		1.29	0.39
LD S-4	2/12/2007 11:08	X	X	8.14	5.86	5.86	0.70
LD R-4	10/24/2006 17:24		X	0.59		1.03	0.38
LD R-4	12/14/2006 12:42		X	1.41		1.22	0.39
LD R-4	2/12/2007 14:38	X	X	7.46	4.07	4.45	0.65
LD R-5	10/25/2006 13:00		X	0.86		0.95	0.40
LD R-5	12/14/2006 13:00		X	1.41		1.29	0.46
LD R-5	2/12/2007 13:59	X	X	8.38	7.29	5.30	0.95
LD R-6	10/25/2006 14:05	X	X	0.65	0.98	0.93	0.31
LD R-6	12/14/2006 13:35	X	X	1.40	1.29	1.35	0.39
LD R-6	2/12/2007 13:08	X	X	9.07	5.43	5.43	0.71

[2] Estimated flow is gaged flow for lower study area. For upper study area estimated flow is measured flow on October and December survey dates (measured at R-6) and either measured or calculated based on measured flow adjusted for declining flows on February survey date.
[3] Adjusted based on field staff gage readings.

Table 4. Stage and flow data collected at Laguna Creek PHABSIM study sites.

Site	DateTime	Velocity Data	Stage Data	Flow at Gage	Measured Flow	Estimated Flow (cfs)[4]	Stage above Zero Flow
Lower Study Area							
LG S-1	10/17/2006 11:27	X	X	0.64	0.41	0.64	**.28**
LG S-1	12/12/2006 12:46		X	7.83		7.83	**0.66**
LG S-1	2/9/2007 15:00	X	X	16.95	20.22	16.95	**0.88**
LG S-1	3/12/2007 11:15	X	X	1.94	1.51	1.94	**0.40**
LG S-2	10/17/2006 13:08		X	0.55		0.55	**0.29**
LG S-2	12/12/2006 13:10		X	7.87		7.87	**0.78**
LG S-2	2/9/2007 15:45	X	X	28.01	24.60	28.01	**1.18**
LG S-2	3/12/2007 11:37		X	1.83		1.83	**0.44**
LG R-1	10/17/2006 10:43		X	0.68		0.68	**0.35**
LG R-1	2/9/2007 9:12	X	X	6.30	3.66	6.30	**0.79**
LG R-1	12/12/2006 12:30		X	7.46		7.46	**0.86**
LG R-2	10/17/2006 14:38		X	0.42		0.42	**0.34**
LG R-2	2/9/2007 11:35	X	X	8.86	11.53	8.86	**0.80**
LG R-2	12/12/2006 13:37		X	7.86		7.86	**0.82**
LG R-3	10/17/2006 13:41		X	0.51		0.51	**0.30**
LG R-3	2/9/2007 10:38	X	X	7.67	7.41	7.38	**0.74**
LG R-3	12/12/2006 13:19		X	7.76		7.76	**0.78**
Upper Study Area							
LG S-3	10/18/2006 10:10		X	0.79		0.61[5]	**0.25**
LG S-3	12/13/2006 11:10		X	2.68		2.21[6]	**0.38**
LG S-3	2/11/2007 10:33	X	X	47.46	38.19	40.1[7]	**1.08**
LG S-3	2/13/2007 13:23		X	11.80		6.19[5]	**0.54**
LG S-4	10/18/2006 13:13	X	X	0.71	0.42	0.39[6]	**0.33**
LG S-4	12/13/2006 9:50	X	X	2.75	2.21	2.21	**0.62**
LG S-4	2/11/2007 13:55	X	X	37.99	27.21	27.21	**1.50**
LG S-4	2/13/2007 14:34	X	X	11.18	6.17	6.48[6]	**0.94**
LG R-4	10/18/2006 12:02		X	0.75		0.44[6]	**0.37**
LG R-4	12/13/2006 11:50		X	2.45		2.21[5]	**0.55**
LG R-4	2/11/2007 15:12	X	X	35.29	29.76	29.76	**1.14**
LG R-5	10/18/2006 14:25		X	0.66		0.42[5]	**0.33**
LG R-5	12/13/2006 10:10		X	2.78		2.21[5]	**0.62**
LG R-5	2/11/2007 16:22	X	X	32.29	21.33	24.82[4]	**1.43**
LG R-6	10/18/2006 14:50		X	0.65		0.42[5]	**0.25**
LG R-6	12/13/2006 10:46		X	2.69		2.21[5]	**0.53**
LG R-6	2/11/2007 17:17	X	X	30.26	23.51	23.26[4]	**1.32**

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[4] Estimated flow is gaged flow for lower study area. For upper study area estimated flow is measured or calculated from regression with City gage.
[5] Calculated by regression with City gage.
[6] Measured at upper study area reference site (S-4)
[7] 5% adjustment of measured flow

Table 5. Stage and flow data collected at Majors Creek PHABSIM study sites.

Site	DateTime	Velocity Data	Stage Data	Flow at Gage	Measured Flow	Estimated Flow (cfs)*	Stage above Zero Flow
Lower Study Area							
M S-1	10/20/2006 9:26		X	0.33		0.33	0.16
M S-1	3/8/2007 13:12		X	1.58		1.67[8]	0.34
M S-1	2/11/2007 13:15	X	X	19.50	21.39	20.08[7]	1.05
M S-1	12/12/2006 15:42		X	25.62		25.62	1.10
M S-2	10/20/2006 11:12	X	X	0.31	0.44	0.31	0.22
M S-2	3/8/2007 13:52	X	X	1.54	1.80	1.54	0.37
M S-2	2/11/2007 15:48	X	X	17.81	16.56	17.81	0.82
M S-2	12/12/2006 16:15		X	24.66		24.66	0.87
M R-1	10/20/2006 8:44		X	0.34		0.34	0.32
M R-1	3/8/2007 12:49		X	1.60		1.68[7]	0.56
M R-1	12/28/2006 16:23	X	X	4.12	2.96	2.58[9]	0.61
M R-1	12/12/2006 15:28		X	26.34		27.42[7]	1.44
M R-2	10/20/2006 13:08		X	0.28		0.28	0.32
M R-2	3/8/2007 14:55		X	1.54		1.50[7]	0.52
M R-2	12/28/2006 15:33	X	X	4.01	2.85	2.69[8]	0.62
M R-2	12/12/2006 16:35		X	24.66		24.66	1.26
M R-3	10/20/2006 13:55		X	0.25		0.25	0.38
M R-3	3/8/2007 15:09		X	1.54		1.54	0.58
M R-3	12/28/2006 14:35	X	X	3.92	2.88	2.64[8]	0.64
M R-3	12/13/2006 13:55		X	4.77		4.77	0.75
Upper Study Area							
M S-3	3/8/2007 10:57		X	1.62		1.62	0.21
M S-3	12/13/2006 14:53		X	4.49		4.49	0.33
M S-3	2/10/2007 14:30	X	X	43.89	44.26	43.89	1.15
M S-4	3/8/2007 8:44	X	X	1.63	1.97	1.63	0.24
M S-4	2/22/2007 12:40	X	X	7.33	8.49	7.33	0.46
M S-4	2/11/2007 8:49	X	X	24.32	22.54	24.32	0.72
M R-4	10/18/2006 17:07		X	0.21		0.21	0.20
M R-4	3/8/2007 10:44		X	1.62		1.62	0.37
M R-4	12/28/2006 9:15	X	X	4.16	2.88	2.58[8]	0.42
M R-4	12/13/2006 15:09			4.49		4.49	0.50
M R-5	10/20/2006 15:10		X	0.23		0.23	0.23
M R-5	3/8/2007 10:31		X	1.64		1.64	0.4
M R-5	12/28/2006 10:52	X	X	4.00	1.90	2.69[8]	0.45
M R-5	12/13/2006 15:20		X	4.49		4.49	0.52

[8] Up to 5% adjustment of gage record
[9] Average of measured flows at all sites on date +/- up to 5%

Table 5 (continued) Stage and flow data collected at Majors Creek PHABSIM study sites.

Site	DateTime	Velocity Data	Stage Data	Flow at Gage	Measured Flow	Estimated Flow (cfs)*	Stage above Zero Flow
Upper Study Area (continued)							
M R-6	10/20/2006 16:27		X	0.23		0.76[10]	0.37
M R-6	3/8/2007 8:56		X	1.65		1.65	0.45
M R-6	12/28/2006 12:56	X	X	3.91	3.11	2.74[8]	0.51
M R-6	12/13/2006 16:14		X	4.46		4.24[7]	0.58
M R-6	2/22/2007 12:03	X	X	9.30	5.04	9.76[7]	0.74
M R-7	10/20/2006 17:37		X	0.24		0.76[9]	0.35
M R-7	3/8/2007 9:10		X	1.65		1.65	0.43
M R-7	12/28/2006 12:13	X	X	3.89	2.46	2.78[8]	0.49
M R-7	12/13/2006 16:06		X	4.46		4.24[7]	0.55
M R-7	2/22/2007 13:19	X	X	10.14	8.91	10.65[7]	0.73

[10] Upstream of diversion, flow estimate based on field readings of staff gage and measured flows on 25 Oct 2006

Table 6. Stage and flow data collected at San Lorenzo PHABSIM study sites.

Site	Date Time	Velocity Data	Stage Data	Flow at Gage (cfs)	Measured Flow (cfs)	Estimated Flow (cfs)*	Stage above Zero Flow
SL R-1	11/3/05 14:32		X	11	0	11	0.82
	10/20/05 13:12		X	13	0	13	0.85
	12/5/05 11:13	X	X	35	35.36	35	1.24
SL R-2	11/3/05 14:00		X	11	0	11	0.63
	10/20/05 14:46		X	13	0	13	0.68
	12/5/05 9:50	X	X	37	35.27	37	1.15
SL R-3	11/3/05 14:59		X	11	0	11	0.48
	10/21/05 9:30		X	13	0	13	0.51
	12/5/05 12:19	X	X	33	25.92	33	0.87
SL R-4	11/3/05 15:38		X	11	0	11	1.00
	10/21/05 12:32		X	13	0	13	1.03
	12/5/05 13:32	X	X	32	39.92	32	1.41
SL R-5	11/3/05 15:59		X	11	0	11	0.98
	10/21/05 14:56		X	13	0	13	1.03
	12/5/05 14:40	X	X	32	27.38	32	1.42
SL R-6	10/24/05 9:58		X	13	0	13	0.86
	11/4/05 10:59		X	14	0	14	0.92
	12/6/05 13:00	X	X	30	27.49	30	1.16
SL R-7	10/24/05 11:51		X	13	0	12.8	0.54
	11/4/05 9:43		X	13	0	13.2	0.56
	12/6/05 11:34	X	X	30	24.97	30	0.76
SL R-8	11/3/05 16:59		X	11	0	11	1.33
	10/25/05 10:00		X	13	0	13	1.37
	11/4/05 13:33		X	14	0	14	1.44
	12/6/05 14:23	X	X	30	32.12	30	1.87
	12/5/05 15:55		X	32	0	32	1.92
SL R-10	11/4/05 14:30		X	14	0	14	0.83
	12/6/05 15:25		X	30	0	30	1.09
	12/5/05 10:32	X	X	37	33.69	37	1.22

Table 7. Stage and flow data collected at Newell Creek PHABSIM study sites.

Site	DateTime	Velocity Data	Stage Data	Flow at City Gage (cfs)	Measured Flow (cfs)	Estimated Flow at Site (cfs)[11]	Stage above Zero Flow
N S-1	2/25/08 12:20	X	X	41.81	46.71	49.21	1.22
	2/26/08 13:40	X	X	16.30	21.95	19.79	0.87
	2/27/08 12:55	X	X	12.32	15.80	15.21	0.80
	3/6/08 9:55	X	X	4.60	5.56	6.30	0.58
N S-2	2/25/08 13:04	X	X	39.87	48.77	46.98	1.26
	2/26/08 13:31		X	16.37		19.87	0.88
	2/27/08 12:48		X	12.40		15.29	0.79
	3/6/08 11:10	X	X	4.57	4.95	6.26	0.60
N S-A1	3/1/2010 15:04	X	X	23.52	27.67	28.50	1.10
	3/9/2010 14:43		X	14.32		17.45	0.91
	3/12/2010 14:25		X	12.56		15.34	0.90
	3/15/2010 14:38		X	7.95		9.81	0.80
	5/13/2010 11:21		X	0.93	1.45	1.39	0.46
N S-A2	2/12/2010 9:01	X	X	14.45		17.61	0.96
	3/2/2010 9:46			27.52	33.86	33.30	1.28
	3/9/2010 9:54		X	14.45		17.61	0.91
	3/12/2010 11:11		X	8.95		11.01	0.78
	3/15/2010 10:59		X	7.54		9.31	0.75
	5/12/2010 14:18		X	0.91	1.81	1.35	0.40
N R-1	2/11/2010 12:00	X	X	15.12	18.05	18.41	1.03
	3/2/2010 9:50	X	X	27.52	35.88	33.30	1.37
				14.30		17.43	0.95
	3/12/2010 10:49		X	8.81		10.85	0.84
	3/15/2010 10:35		X	7.54		9.31	0.83
	5/12/2010 13:36		X	0.92	1.81	1.36	0.44
N R-2	3/2/2010 12:20	X	X	29.67	39.67	35.88	1.09
	3/9/2010 11:20		X	14.17		17.28	0.79
	3/12/2010 11:43		X	8.94		11.00	0.67
	3/15/2010 11:42		X	7.86		9.70	0.64
	5/12/2010 15:06		X	0.91	1.81	1.36	0.31
N R-3	2/12/2010 14:33	X	X	14.35		17.49	1.40
	3/2/2010 12:00			28.89	29.58	34.95	1.97
	3/12/2010 13:03		X	10.81		13.24	1.30
	3/15/2010 12:45		X	7.88		9.72	1.17
	5/12/2010 16:07		X	0.92	1.81	1.37	0.68

[11] Estimated flow for sites below Rio Rancho Rd. is measured flow or calculated from regression of flow at Glen Arbor with flow at the gage (below dam); for sites above Rancho Rio is measured flow or flow at gage.

Table 7 (continued) Stage and flow data collected at Newell Creek PHABSIM study sites.

Site	DateTime	Velocity Data	Stage Data	Flow at City Gage (cfs)	Measured Flow (cfs)	Estimated Flow (cfs)[12]	Stage above Zero Flow
N R-4	2/12/2010 15:24		X	14.21		17.33	1.40
	3/2/2010 13:25	X	X	30.07	35.43	36.36	1.82
	3/12/2010 13:12		X	10.81		13.24	1.30
	3/15/2010 12:58		X	7.88		9.72	1.17
	5/12/2010 16:46		X	0.92	1.81	1.36	0.68
N R-5	2/11/2010 15:32		X	14.66		17.87	1.13
	3/2/2010 12:38	X	X	29.48	32.86	35.65	1.49
	3/12/2010 13:20		X	11.28		13.81	1.03
	3/15/2010 13:12		X	8.00		9.87	0.92
	5/12/2010 17:08		X	0.92	1.81	1.37	0.49
N R-6	2/18/2010 9:30		X	6.73		8.35	0.85
	3/1/2010 15:01	X	X	23.52	25.99	28.50	1.33
	3/12/2010 13:56		X	11.90		14.55	1.03
	3/15/2010 13:59		X	7.91		9.76	0.89
	5/13/2010 0:00		X	0.94	1.45	1.39	0.47
N R-7	2/18/2010 8:41		X	6.89		8.53	0.84
	3/1/2010 11:15	X	X	25.17		30.48	1.33
	3/12/2010 14:08		X	12.20		14.91	1.04
	3/15/2010 14:09		X	7.93		9.79	0.88
	5/13/2010 10:52		X	0.94	1.45	1.39	0.45
N R-8	2/17/2010 12:20	X	X	8.78	7.41	10.29	0.70
	3/9/2010 17:08		X	13.79		16.17	0.84
	3/12/2010 8:30		X	8.49		9.96	0.70
	5/12/2010 11:22		X	0.94		1.10	0.31
N R-9	2/17/2010 11:00	X	X	8.22	9.02	9.64	0.71
	3/9/2010 16:51		X	13.44		15.76	0.86
	3/12/2010 8:50		X	8.52		9.99	0.72
	5/12/2010 10:49		X	0.94		1.11	0.30
N R-10	2/17/2010 9:10	X	X	7.26	9.65	8.51	0.83
	3/9/2010 16:31		X	13.57		15.91	0.99
	3/12/2010 9:20		X	8.68		10.18	0.85
	5/12/2010 10:12		X	0.95		1.12	0.39

[12] Estimated flow for sites below Rio Rancho Rd. (1-7) is measured flow or calculated from regression of flow at Glen Arbor with flow at the gage (below dam); for sites above Rancho Rio (7-10) is measured flow or flow at gage.

Table 8. Substrate size class coding using the Bovee system.

Substrate Size Code	Substrate Size Range
1	Organic debris or vegetation
2	Mud or soft clay (<0.002")
3	Silt (<0.002")
4	Sand (0.002"-0.25")
5	Gravel (0.25"-3.0")
6	Cobble/Rubble (3.0"-12.0")
7	Boulder (>12.0")
8	Bedrock

Examples: 5.0 is pure gravel

4.6 is 60% gravel and sand subdominant

5.5 is gravel and 50% cobble

5.3 is gravel and 30% cobble

Table 9. Range of PHABSIM Calibration Flows and Extrapolation Range for WUA/RSI Estimates.

Stream	Lifestage	Uppermost Low Flow (cfs)	Lowermost High Flow (cfs)	Range for WUA/RSI Estimates[13]
Liddell	Spawning	1.18	7.08	0.5 - 18 cfs
	Rearing	0.96	6.92	0.4 - 17 cfs
Laguna	Spawning	0.64	16.95	0.2 - 42 cfs
	Rearing	0.68	7.46	0.3 - 18 cfs
Majors	Spawning	0.33	24.32	0.2 - 60 cfs
	Rearing	0.76	4.49	0.3 - 11 cfs
San Lorenzo	Rearing	14	30	5.6 – 75 cfs
Newell	Spawning	6.30	28.50	2.5-71 cfs
	Rearing	1.39	16.17	0.6-40 cfs

[13] 40% of low measured flow to 250% of high measured flow.

Table 10. Log-stage/log-discharge regression statistics for North Coast PHABSIM spawning and rearing transects.

Transect Name	N	Y-Intercept	Slope	Mean Error (%)	Variance	Standard Deviation
Lower Liddell						
S1	3	8.7079	3.7566	3.8151	6.6073	2.57046
S2[14]	3	25.0226	5.1282	1.8252	0.7718	0.87853
R-1[15]	3	23.4296	3.2452	65.6279	3890.6995	62.37547
R-2	3	15.2607	4.4613	4.6051	5.4019	2.32421
R-3	3	13.0595	4.4753	4.9139	5.6681	2.38077
Upper Liddell						
S3	3	9.2577	2.7138	1.3973	0.8803	0.93827
S4	3	13.2709	2.3356	4.7688	8.7504	2.95812
R-4	3	13.9057	2.6392	3.4380	7.6224	2.76086
R-5	3	5.8803	1.9745	1.0861	0.5216	0.72224
R-6	3	11.1837	2.1683	4.8800	7.7171	2.77796
Lower Laguna						
S1	4	25.1467	2.8524	3.4931	1.9000	1.37841
S2	4	16.9590	2.7646	4.4040	10.0905	3.17656
R-1	3	11.5188	2.6925	2.0831	2.4062	1.55119
R-2	3	17.2536	3.4445	1.1730	0.9486	0.97398
R-3	3	16.7566	2.8981	3.5054	7.7527	2.78436
Upper Laguna						
S3	4	33.6551	2.8522	5.0392	1.4578	1.20740
S4	4	8.3386	2.7832	4.0368	12.4125	3.52314
R-4	3	18.8195	3.7229	5.5396	6.3621	2.52233
R-5	3	8.9155	2.7878	4.1764	3.9255	1.98129
R-6	3	11.3544	2.4184	6.8397	11.1151	3.33393
Lower Majors						
S1	4	19.1940	2.2301	4.9742	5.6412	2.3751
S2	4	35.5578	3.1408	4.2320	10.0275	3.1666
R-1	4	9.7158	2.9185	5.7357	15.4758	3.93393
R-2	4	12.0992	3.2571	4.7815	0.5757	0.75873
R-3	4	17.3586	4.3796	3.5297	7.3032	2.70245
Upper Majors						
S3	3	34.3786	1.9159	5.8535	9.8205	3.1338
S4	3	52.3526	2.4494	4.3034	4.3247	2.0796
R-4	4	46.1519	3.3514	1.2228	0.9614	0.98053
R-5	4	48.1736	3.6429	2.1244	2.5663	1.60197
R-6	5	30.8270	3.6790	3.4913	3.6058	1.89891
R-7	5	34.8065	3.6055	3.7900	3.3382	1.82707

Note: N is the number of calibration flows

[14] Pool tail with relatively high gradient, unconfined riffle downstream results in high slope and intercept.
[15] Cross-section omitted from analysis due to excessive mean error.

Table 11. Log-stage/log-discharge regression statistics for San Lorenzo PHABSIM spawning and rearing transects.

Transect Name	N	Y-Intercept	Slope	Mean Error (%)	Variance	Standard Deviation
San Lorenzo River downstream of Tait Street						
R-1	3	19.5303	2.7266	2.40450	3.28610	1.81277
R-2	3	27.9779	2.0065	0.49100	0.12040	0.34704
R-3	3	42.5723	1.8068	2.01790	2.20220	1.48397
R-4	3	11.4180	3.0096	2.71660	4.20450	2.05049
R-5	3	11.7892	2.8528	0.89560	0.39030	0.62471
R-6	3	19.1432	2.9217	4.64890	8.15540	2.85577
R-7	3	60.4959	2.5685	2.20920	2.63900	1.62451
R-8	5	5.0697	2.8323	2.19540	3.62370	1.90361
R-10	3	22.9284	2.5738	3.11950	2.62380	1.61982
Newell Creek						
S1	4	28.5375	2.7689	0.9746	0.5511	0.74238
S2	4	26.267	2.701	4.8611	1.2836	1.13295
S-A1	4	21.2262	3.4939	2.5548	3.1407	1.77221
S-A2	4	18.4698	2.7388	5.1184	2.915	1.70734
R-1	5	15.9167	2.8512	5.7669	7.8034	2.79345
R-2	5	30.6134	2.6297	4.0981	3.3941	1.8423
R-3	5	5.3135	3.1395	10.6407	19.2676	4.38948
R-4	5	5.2463	3.375	5.3798	4.5613	2.13573
R-5	5	11.908	2.9717	5.2782	6.1464	2.47919
R-6	5	13.0985	2.9266	3.6437	2.6246	1.62006
R-7	5	13.7812	2.8541	1.63	0.4343	0.65903
R-8	4	26.0742	2.6314	1.195	0.8243	0.90789
R-9	4	22.8966	2.5149	0.3507	0.0347	0.18615
R-10	4	15.639	2.8121	4.2831	10.9769	3.31314

Note: N is the number of calibration flows

Table 12. Stage and flow data collected at North Coast migration passage assessment sites.

Site	DateTime	Velocity Data	Stage Data	Flow at Gage (cfs)	Measured Flow (cfs)	Estimated Flow (cfs)*	Stage above Zero Flow
Liddell Creek							
LD P-1	10/24/2006 12:46		X	0.70		0.70[16]	0.34
LD P-1	12/14/2006 11:27		X	1.44		1.44	0.39
LD P-1	2/12/2007 9:55	X	X	7.44	7.35	7.35	0.59
LD P-2	10/25/2006 15:38		X	0.33		0.98	0.25
LD P-2	12/14/2006 14:23		X	1.39		1.29	0.27
LD P-2	2/12/2007 11:44	X	X	8.54	5.78	5.78	0.71
LD-P3	10/24/2006 9:15		X	1.21		1.21	0.22
LD-P3	12/14/2006 9:44		X	1.44		1.44	0.30
LD-P3	2/12/2007 9:12	X	X	7.48	8.10	7.48	0.56
Laguna Creek							
LG P-1	10/17/2006 9:52		X	0.70		0.70[17]	0.12
LG P-1	3/12/2007 9:53		X	2.09		2.09	0.22
LG P-1	12/12/2006 12:14		X	7.20		7.20	0.47
LG P-2	10/17/2006 15:45		X	0.39		0.39	0.22
LG P-2	3/12/2007 13:08		X	1.75		1.75	0.31
LG P-2	12/12/2006 14:10		X	8.00		8.00	0.56
LG P-3	10/18/2006 9:10		X	0.80		0.61	0.19
LG P-3	3/12/2007 14:30		X	1.73		1.33	0.26
LG P-3	12/13/2006 11:10		X	2.68		2.06	0.29
LG P-3	2/11/2007 9:32	X	X	50.53	40.39	38.85	1.06
LG P-4	10/18/2006 11:20		X	0.77		0.59	0.75
LG P-4	3/12/2007 15:02		X	1.71		1.32	0.77
LG P-4	12/13/2006 11:36		X	2.60		2.00	0.87
LG P-4	2/11/2007 12:05	X	X	42.49	31.66	32.67	1.45
Majors Creek							
M P-1	10/20/06 10:11			0.34		0.34	0.21
M P-1	12/12/06 16:02			25.62		25.62	0.80
M P-1	3/8/07 13:25			1.57		1.57	0.28
M P-2	10/18/06 15:50			0.22		0.22	0.25
M P-2	2/10/07 12:59			45.56	45.92	45.56	1.35
M P-2	3/8/07 11:18			1.69	2.11	1.69	0.40
M P-3	10/20/06 15:47			0.24		0.75[18]	0.36
M P-3	12/13/06 15:43			4.48		4.82	0.56
M P-3	2/10/07 16:00			36.48	37.10	36.44	1.16
M P-3	3/8/07 10:11			1.65		2.10	0.43

[16] Estimated flow is gaged flow or measured flow for lower study area (LD P-1 and P-3). Site LD P-2 is upstream of the West Branch and flow is measured flow above the West Branch confluence (Site P-2 when available, otherwise flow reference site R-6.

[17] Estimated flow is gaged flow for Sites LG P-1 and P-2 and estimated from regression for Sites LG P-3 and P-4.

[18] Site M P-3 is above diversion location, gage site is below diversion. Estimated flows for all dates calculated from regression of gage site with measured flows at Sites P-3 and S-4 (also above diversion).

Table 13. Stage and flow data collected at San Lorenzo migration passage assessment sites.

Site	DateTime	Velocity Data	Stage Data	Flow at Gage	Measured Flow	Estimated Flow (cfs)*	Stage above Zero Flow
San Lorenzo River downstream of Tait Street							
SL P-1	10/12/05 9:25		X	18		18	0.83
	10/20/05 9:10		X	13		13	0.68
	12/6/05 8:40		X	28		28	0.89
	12/6/05 11:22		X	30		30	0.95
SL P-2	10/12/05 11:55		X	19		19	1.03
	10/20/05 10:09		X	13		13	0.78
	11/4/05 11:34		X	14		14	0.86
SL P-3	10/12/05 14:35		X	12		12	0.52
	10/20/05 10:46		X	13		13	0.49
	11/3/05 15:59		X	11		11	0.48
	12/5/05 13:20		X	32		32	0.82
SL P-4	10/12/05 16:20		X	12		12	0.58
	10/20/05 11:24		X	13		13	0.55
	12/5/05 16:20		X	32		32	0.73
Newell Creek							
N P-1	2/25/08 12:39		X	41.27		48.59	1.24
	2/26/08 14:34		X	16.26		19.74	0.81
	2/27/08 13:45		X	12.16		15.01	0.69
	3/6/08 12:30		X	4.57		6.27	0.53
N P-2	2/25/08 12:38		X	41.35		48.68	1.03
	2/26/08 14:32		X	16.33		19.83	0.63
	2/27/08 13:37		X	12.25		15.12	0.61
	3/6/08 11:52		X	4.55		6.24	0.43
N P-A1	2/12/2010 12:10		X	14.48		17.65	0.98
	3/2/2010 11:50		X	29.15		35.26	1.24
	3/9/2010 10:22		X	14.36		17.51	0.92
	3/12/2010 11:30		X	8.94		11.00	0.80
	3/15/2010 11:19		X	7.76		9.58	0.78
	5/12/2010 14:47		X	0.90	1.56	1.35	0.56
N P-A2	2/18/2010 10:34		X	6.62		8.22	0.75
	3/1/2010 17:04		X	23.21		28.12	0.99
	3/9/2010 13:11		X	14.53		17.71	0.83
	3/12/2010 13:34		X	11.46		14.02	0.82
	3/15/2010 13:34		X	7.98		9.84	0.76
	5/13/2010 9:32		X	0.95	1.56	1.40	0.47

Table 14. Log-stage / log-discharge regression statistics for migration passage transects.

Transect Name	N	Y-Intercept	Slope	Adjusted R^2
Liddell				
LD P-1 (below West Br)	3	1.8353	4.1888	99.19%
LD P-2 (above West Br)	3	1.0082	1.6382	98.84%
LD P-3 (Highway 1)	3	1.3496	2.0479	88.14%
Laguna				
LG P-1 (Highway 1)	3	1.4222	1.7008	99.86%
LG P-2 (lower study area)	3	1.7424	3.1691	95.51%
LG P-3 (upper study area)	4	1.5400	2.3892	99.62%
LG P-4 (upper study area)	4	0.6190	5.6096	96.41%
Majors				
M P-1 (below Highway 1)	3	1.7410	3.0831	95.52%
M P-2 (Highway 1)	4	1.3165	3.0332	94.59%
M P-3 (above diversion)	4	1.4001	3.1640	97.14%
San Lorenzo				
SL P-1 (below Tait St. div)	4	1.5328	2.6073	88.17%
SL P-2 (behind tannery)	3	1.2549	1.4060	94.40%
SL P-3 (near Petsmart)	4	1.6676	1.9332	96.00%
SL P-4 (Water St.)	3	1.8993	3.1278	86.82%
Newell[19]				
N P-1 (below Rancho Rio)	4	1.4941	2.3475	97.34%
N P-2 (below Rancho Rio)	4	1.6879	2.3309	96.88%
N P-A1 (below Glen Arbor)	6	1.3048	4.0782	91.12%
N P-A2 (above Glen Arbor)	6	1.4990	4.1899	98.45%

Note: N is the number of stage/discharge points.

[19] Passage at Newell transects P-3 and P-4 was evaluated using a different methodology (see Section 3.3).

Table 15. Minimum passage flow estimates.

Transect Name	Adult Steelhead and Coho	Steelhead and Coho Smolts
Liddell		
LD P-1 (below West Br)	***11.3***	0.8
LD P-2 (above West Br)	4.9	1.7
LD P-3 (Highway 1)	8.1	***2.0***
Laguna		
LG P-1 (Highway 1)	11.7	***3.8***
LG P-2 (lower study area)	***15.5***	2.4
LG P-3 (upper study area)	10.6	1.8
LG P-4 (upper study area)	11.6	1.7
Majors		
M P-1 (below Highway 1)	***16.0***	2.6
M P-2 (Highway 1)	9.0	2.0
M P-3 (above diversion)	14.5	***3.4***
San Lorenzo		
SL P-1 (below Tait St. div)	**25.2**	5.3
SL P-2 (behind tannery)	17.0	**10.0**
SL P-3 (near PetCo)	24.6	8.7
SL P-4 (Water St.)	23.7	3.8
Newell		
N P-1 (below Rancho Rio)	**24.4**	**8.3**
N P-2 (below Rancho Rio)	22.7	6.4
N P-A1 (below Glen Arbor)	11.4	3.9
N P-A2 (above Glen Arbor)	21.3	3.2

Note: Maximum values for each stream and life-stage in ***bold italic***.

Table 16. Habitat survey results for the San Lorenzo River between Water Street and Tait Street Diversion.

	Number of Habitat Units	Total Length (ft)	% by Length	Min/Max Length (ft)	Average Length (ft)	Average Depth (ft)	Maximum Depth (ft)
Downstream of Highway 1							
riffles	6	231	8	27/54	38	0.55	1.1
pools	3	1,404	49	101/760	468	2.9	4.3
runs	6	1,209	42	101/318	202	1.9	3.0
Upstream of Highway 1							
glides	1	1,409	55			0.9	2.4
runs	1	1,167	45			1.5	2.8

Table 17. Analysis of Flows for Passage at Newell Creek Passage Obstacle N P-3.

Passage Depth (ft)	Mean Velocity (fps)	Flow (cfs)	Estimated Swimming Distance (ft)					
			Steelhead Burst Swim Speed			Coho Salmon Burst Swim Speed		
			13.7 fps)	20.1 fps	26.5 fps	10.6 fps	16.1 fps	21.5 fps
Mannings =0.025								
0.4	10.1	129	1	25	49	-11	10	30
0.5	12.0	197	-8	16	40	-20	1	21
0.6	13.5	275	-16	8	32	-28	-7	13
Mannings = 0.040								
0.4	5.3	68	25	49	73	13	34	54
0.5	6.3	104	20	44	68	8	29	49
0.6	7.1	145	16	40	64	4	25	45

Table 18. Habitat suitability for rearing steelhead in the San Lorenzo River downstream of Tait St.

Habitat Characterization	WUA Level	Corresponding Flow Level	Average Wetted Width (ft)	Riffle Width (ft)
Prime	80%-100% of maximum WUA	19-72 cfs	32-39	21-37
Good	60% to 80% of maximum WUA	8-19 cfs	29-32	16-21
Fair	40% to 60% of maximum WUA	3-8 cfs	27-29	11-16
Poor	Less than 40% of maximum WUA	0.5-3 cfs	25-27	6.5-11

Appendix A

Temperature Monitoring Results

Temperature Monitoring

During the summer and early fall of 2005 the City installed temperature monitoring devices to assess temperature conditions in the lower San Lorenzo River (downstream of Felton) and Newell Creek and potential relationship to City activities at Felton Diversion, Newell Diversion and Tait Street Diversion. Temperature monitors were installed at the following locations:

- Newell Creek
  - Limit of anadromy
  - San Lorenzo mainstem above confluence with Newell Creek
  - San Lorenzo mainstem below confluence with Newell Creek
  - Newell Creek above reservoir (2004)
  - Newell Creek below dam (2004)
- San Lorenzo gorge
- Tait Street upstream from diversion
- Tait Street below diversion
- San Lorenzo River at Water Street

This report presents a summary of temperature monitoring data including graphs of daily average temperatures, daily maximum temperatures, and 7-day average of maximum daily temperature (MWAT) for each of the recorder locations.

Background

Water temperature is one of the more important environmental factors affecting fish. Fish and fish communities are often classified in terms of thermal preferences and tolerances as coldwater, coolwater, or warmwater species or assemblages. Fish cannot regulate their body temperature independent of environmental conditions. For any species there is a range at which growth and other functions are optimum. As temperature increases or decreases from the optimum range there is a zone of tolerance where the fish can survive but may experience compromised performance (i.e., reduced growth, reduced reproductive capacity, increased susceptibility to disease). Further temperature changes outside the zone of tolerance result in increasingly stressful conditions and deleterious but sublethal effects. Finally, extended exposure beyond a certain upper and lower limit will result in death.

Temperature is a particularly important factor for steelhead/rainbow trout and coho salmon in Central California where seasonal water temperatures can be higher than in much of the natural range of these species. In many streams in this region, growth slows or ceases in conjunction with warm, low flow conditions in late summer. The influence of water temperature on steelhead and other salmonids has been well studied and the influence on individual populations is complicated by a number of factors such as behavioral responses, daily and annual thermal cycles, food availability, habitat conditions, and possibly, local adaptations.

The upper thermal limit for rearing juvenile rainbow trout/steelhead and coho salmon depends on several factors such as acclimation temperature, food ration levels, activity levels, and others. A temperature of 24-26°C has generally been shown under laboratory conditions to result in 50% mortality rates of well fed fish held under otherwise acceptable environmental conditions and acclimated to high temperature (Brett 1952; Hokanson et al. 1977). This is a common measure of thermal tolerance and is known as the upper incipient lethal temperature (UILT). Upper incipient lethal temperature has been estimated at 26°C for both steelhead (Hokanson et al. 1977) and coho salmon (Brett 1952).

In most streams, water temperature varies over the course of a day and from day to day, generally tracking changes in air temperature. Although the peak temperature on a given day may exceed the lethal level, salmonids can survive short periods at temperatures above the lethal threshold. For example, in a study of juvenile chinook salmon, test fish experienced no mortality at temperatures up to 75°F (24ºC) for 7 days. At 79°F (26ºC), half the juvenile salmon survived a 5-hour exposure period and at 81°F (27ºC) half survived a 1.5-hour exposure (Brett 1952). The temperature that the fish are acclimated to is also an important variable. Juvenile salmon acclimated to 75°F (24ºC) experienced 50% mortality after 8.5 days at 77°F (25ºC) while those acclimated to 59°F (15ºC) experienced 50% mortality after only 42 hours of exposure at 77°F (25ºC) (Brett 1952). Elevated temperature below the lethal threshold can have indirect influence on survival due to depression of growth rate, increased susceptibility to disease, and lowered ability to evade predators. It is more difficult to establish the linkage between these indirect effects and definite temperature thresholds.

Under experimental conditions, Hokanson et al. (1977) found that the maximum growth rate for rainbow trout fed excess rations occurred at 17.2-18.6°C when temperature was held constant, but occurred at 15.5-17.3°C when temperature fluctuated +/-3.8°C around the mean each day. At higher temperatures, growth still occurred but at a slower rate. Mortality rates in these experiments increased as mean temperature increased from 18.6°C to 21.2°C at constant temperatures and, in the fluctuating temperature regime, when mean temperature increased from 19.1°C to 21°C. If one considers the population as a whole there is some point when increased biomass due to growth will be balanced by reduced biomass due to mortality and the population experiences no change in weight (a yield of zero). Hokanson et al. (1977) estimated that at fluctuating temperatures with a mean of 21°C or more, the population yield would become negative.

Food availability is a critical factor influencing thermal tolerance, growth rates, and overall health. Smith (1999) describes two different habitat types used by Central Coast steelhead and resident trout. The primary habitat consists of shaded pools of small, cool, low-flow upstream reaches typical of the original steelhead habitat in the region. In addition, they can use warmwater habitats below some dams or pipeline outfalls, where summer releases provide high summer flows and fast-water feeding habitat. Trout metabolic rate and thus food demand increases with temperature. Trout rely heavily on insect drift for food and drift increases with flow velocity. Under conditions of low flow and high temperatures trout have increasing difficulty obtaining sufficient food to meet metabolic costs. Smith and Li (1983) found that in Uvas Creek (Santa Clara County), a relatively warm stream with summer maximum water temperature of 23ºC to 25°C, steelhead/rainbow trout move into higher velocity microhabitats in riffles and runs where sufficient food can be obtained. These habitats are created by summer

releases from an upstream reservoir. Under augmented flow conditions trout can occupy warmer habitats than may otherwise be possible.

Analysis Methods

Data collected by the City were summarized to characterize stream reaches in terms of their suitability for rearing steelhead and coho salmon, primarily by comparing standard summary statistics to standards for steelhead/rainbow trout and coho (Armour 1991). The temperature records were converted to daily maximum and daily average water temperature and the following summary statistics were calculated:

- Number of days with daily maximum exceeding upper incipient lethal level (26°C for steelhead, 25°C for coho).
- Number of days with daily average exceeding hypothetical zero yield for steelhead (21°C, based on Hokanson 1977).
- Number of days with seven-day moving average of daily maximum temperature exceeding MWAT. (19.3°C for steelhead and 18.3°C for coho based on Armour 1991).

Armour (1991) has proposed MWAT as criteria for developing temperature regimes to protect fish. MWAT is the Maximum Weekly Average Temperature that should not be exceeded and is calculated for a given species of fish when experimental temperature tolerance data is available. MWAT is calculated as the optimal temperature for a given species or life-stage plus one third of the difference between the optimal temperature and the upper incipient lethal temperature, or:

MWAT = OT + (UILT-OT)/3

where:

OT = a reported optimal temperature for the particular life stage or function, and

UILT = the upper incipient lethal temperature that does not increase with increasing acclimation temperatures.

Optimal temperature was derived from methods presented in Armour (1991) and was generally consistent with values presented in other literature sources (Bjornn and Reiser 1991, Raleigh et al. 1986; McMahon 1983; Laufle et al. 1986; Brett 1952). In the case of rearing juvenile *O. mykiss*, we used 16°C as the optimal temperature and 26°C as the upper incipient lethal temperature to obtain an MWAT of 19.3°C. For rearing coho salmon we used 14.5°C as the optimal temperature and 26°C as the upper incipient lethal temperature to obtain an MWAT of 18.3°C.

Monitoring Results

Water temperature downstream of Newell Dam (at City streamgage location downstream of spillway pool) averaged one to two degrees cooler than inflow from Newell Creek upstream of the reservoir (about 0.25 mile above the lake high water line) in monitoring data collected during the summer of 2004 (Table A-1, Figure A-1). Cold water is released from Loch Lomond Reservoir to Newell Creek during the summer months at a rate of at least 1 cfs. The effect of this release is apparent where Newell Creek joins the San Lorenzo River. Water temperature downstream of the Newell Creek confluence averaged approximately 1 degree cooler than water temperature immediately upstream of the confluence (Figure A-2). There were no exceedences of the upper incipient lethal temperature for either steelhead or coho at either the Newell Creek locations or in the San Lorenzo River above and below Newell Creek. There were also no days with temperature high enough to reach hypothetical zero-yield for steelhead at any of these locations. There were no occurrences of seven-day moving average of daily maximum temperature that exceeded the MWAT suitability criteria for steelhead in the San Lorenzo River either upstream or downstream of the Newell Creek confluence during the monitoring period but likely occurrences before the monitoring began upstream of the confluence (Figure A-2). There were 4 days that had MWAT that exceeded suitability criteria for coho upstream of the confluence and no days downstream of the confluence although both locations probably exceeded the coho MWAT criteria before the monitoring period began (Figure A-2).

Water temperature monitoring at San Lorenzo River monitoring locations was initiated in August, near the expected seasonal peak in temperature, although July may have had higher temperatures. Water temperature was lowest in the San Lorenzo gorge (Garden of Eden) and increased at downstream locations (Figure A-3). Water temperature conditions in August were near the upper range of suitability for steelhead and slightly in excess of the suitable range for coho salmon. Water temperature was highest at the Water Street monitoring location. None of the monitoring locations had maximum daily water temperatures that approached lethal levels for either steelhead or coho salmon (Figure A-4). None of the locations had daily average temperatures high enough to reach hypothetical zero-yield for steelhead (Figure A-3, Table A-1). All of the locations except the Garden of Eden had seven-day moving average of daily maximum temperature that exceeded the MWAT suitability criteria for steelhead and all locations exceeded the MWAT criteria for coho. With the exception of Water Street, exceedences were only slightly above the criteria for steelhead and only during August and early September (Figure A-5).

Water temperature was generally higher at Water Street than at the Tait Street diversion with temperature differences ranging from -0.4°C to 1.9°C during the monitoring period. The temperature difference is likely explained by thermal gain in the relatively exposed (un-shaded) flood control channel upstream of Water Street. Water temperature at Water Street is influenced by increasing lagoon stage during periods with higher tidal cycles (Figure A-6) as occurred on September 16 during the monitoring period. There does not appear to be a significant relationship between flow levels and temperature increase downstream of the Tait Street diversion under the range of flows and environmental conditions occurring during the monitoring period (Figure A-6). At flows in excess of 21 cfs there may be a tendency for differences in

temperature between Water Street and Tait Street to approach zero but data are very limited at higher flow levels (Figure A-6).

Conclusions

Water temperature appears suitable for steelhead at all monitoring locations but increases with distance downstream from Newell Creek and is near the upper range of suitability during the seasonal peak period and in the lower San Lorenzo River from above Tait Street to the lagoon. Temperature is relatively warm for coho salmon except in Newell Creek downstream of Newell Dam. Suitability criteria for steelhead are generally met at all locations except the lower river. Temperature conditions are relatively warm upstream of the Tait Street diversion and generally increase at Water Street.

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TABLES

Table A-1 Summary of San Lorenzo River Temperature Monitoring Records and Suitability Criteria

Location	Monitoring Period	Highest Daily Maximum (°C)	Highest Daily Average (°C)	Highest MWAT (°C)
SLR Upstream of Newell Creek	29 Aug to 7 Oct, 2005	20.0	19.1	19.9
SLR Downstream of Newell Creek	29 Aug to 7 Oct, 2005	19.0	18.2	18.8
Newell Ck Upstream of Newell Reservoir	16 June to 11 Aug, 2004	17.4	16.4	16.1
Newell Ck below Newell Dam	16 June to 11 Aug, 2004	15.2	14.0	13.6
San Lorenzo Gorge (Garden of Eden)	22 Aug to 7 Oct, 2005	19.6	18.2	19.1
Tait Street Upstream From Diversion	10 Aug to 21 Oct, 2005	20.5	19.7	19.7
Tait Street Below Diversion	10 Aug to 21 Oct, 2005	20.5	19.7	19.7
Downstream of Tait Street	10 Aug to 24 Aug, 2005	20.5	19.7	19.6
San Lorenzo River at Water Street	26 Aug to 21 Oct, 2005	20.9	19.2	20.9

FIGURES

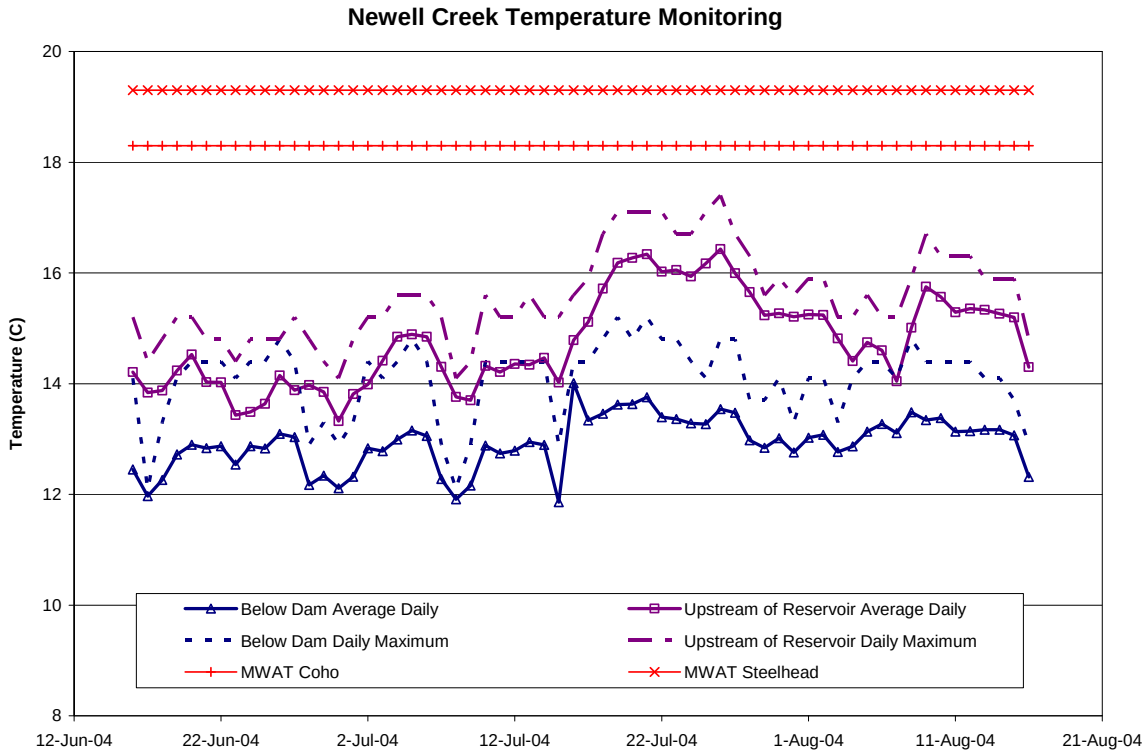


Figure A-1 Newell Creek temperature monitoring results.

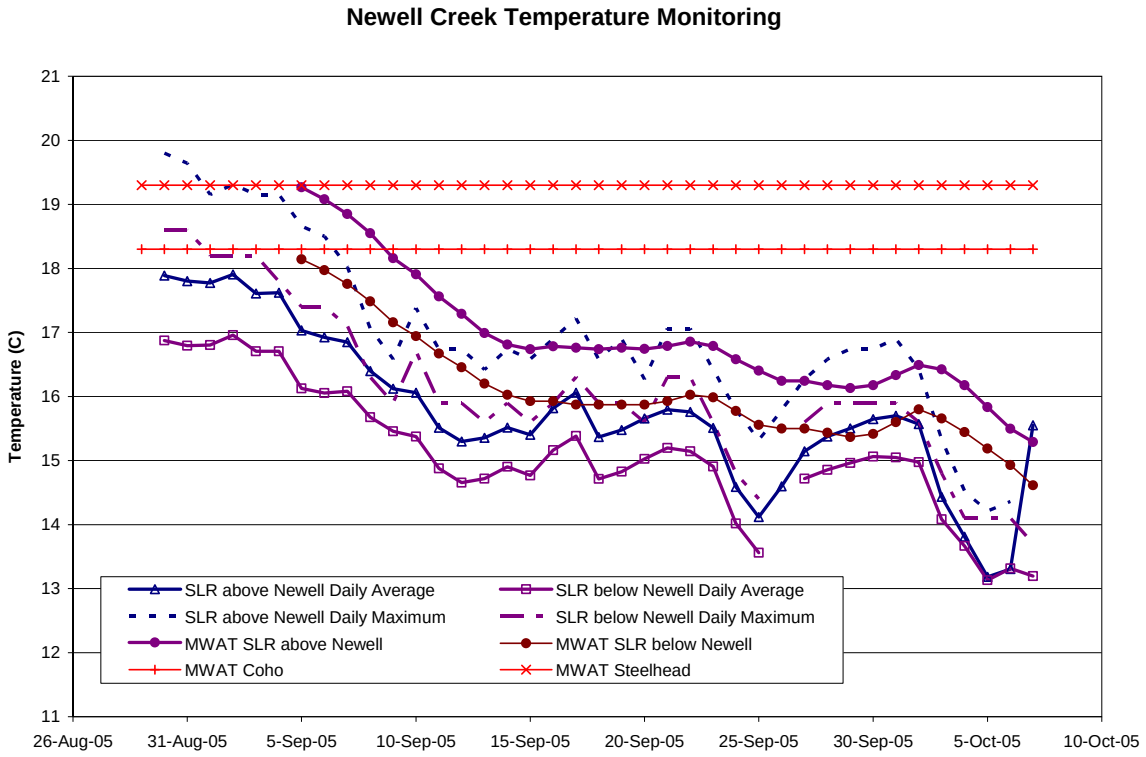


Figure A-2 Newell Creek temperature monitoring results.

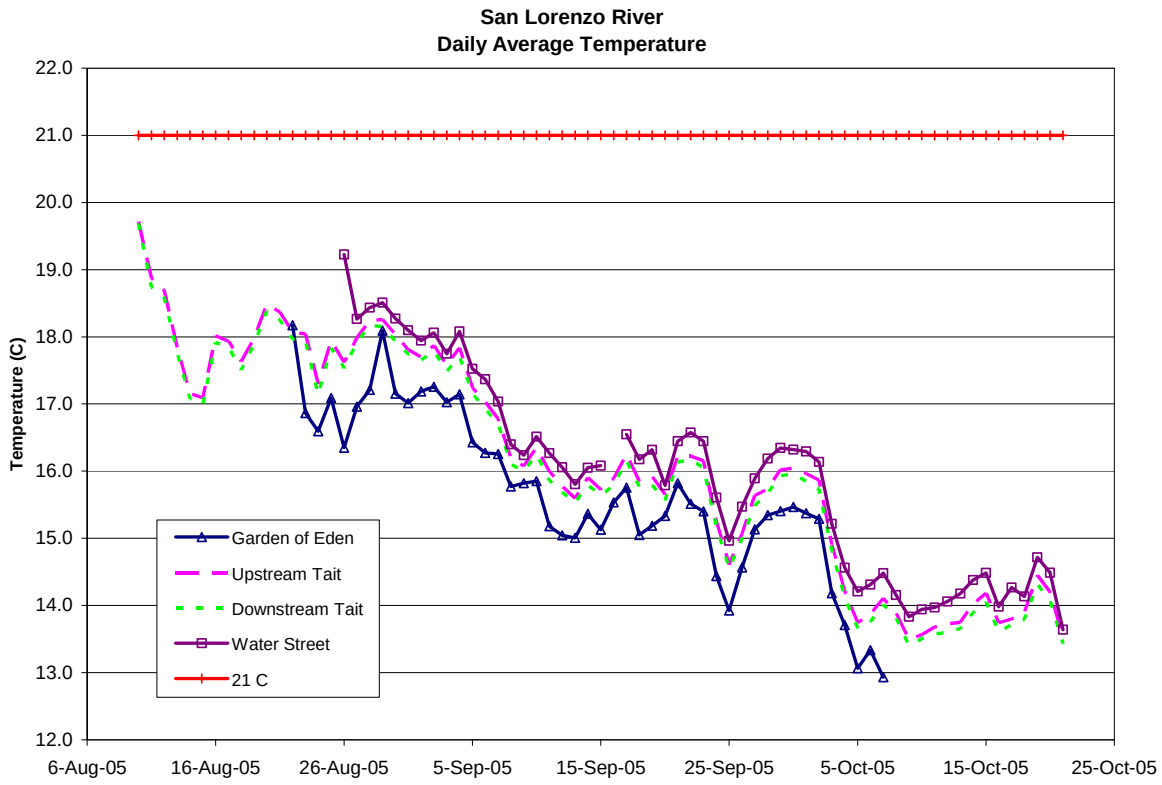


Figure A-3 San Lorenzo River Daily Average Temperature

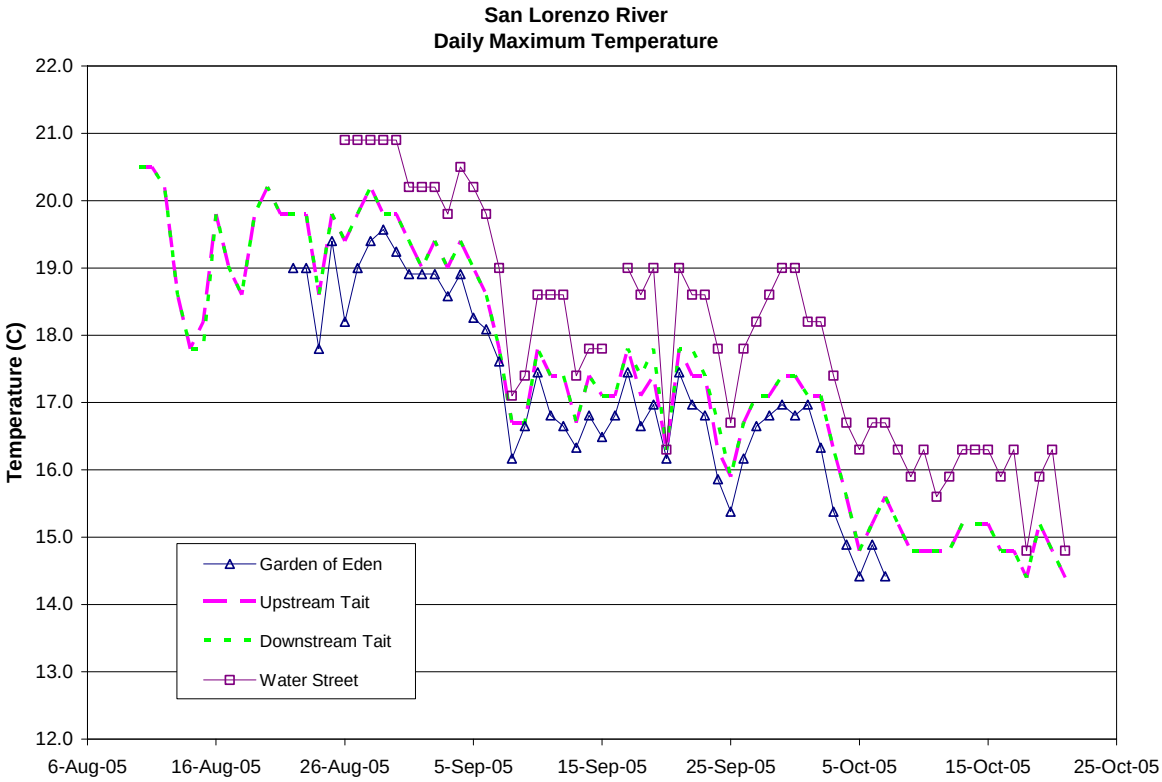


Figure A-4 San Lorenzo River Daily Maximum Temperature.

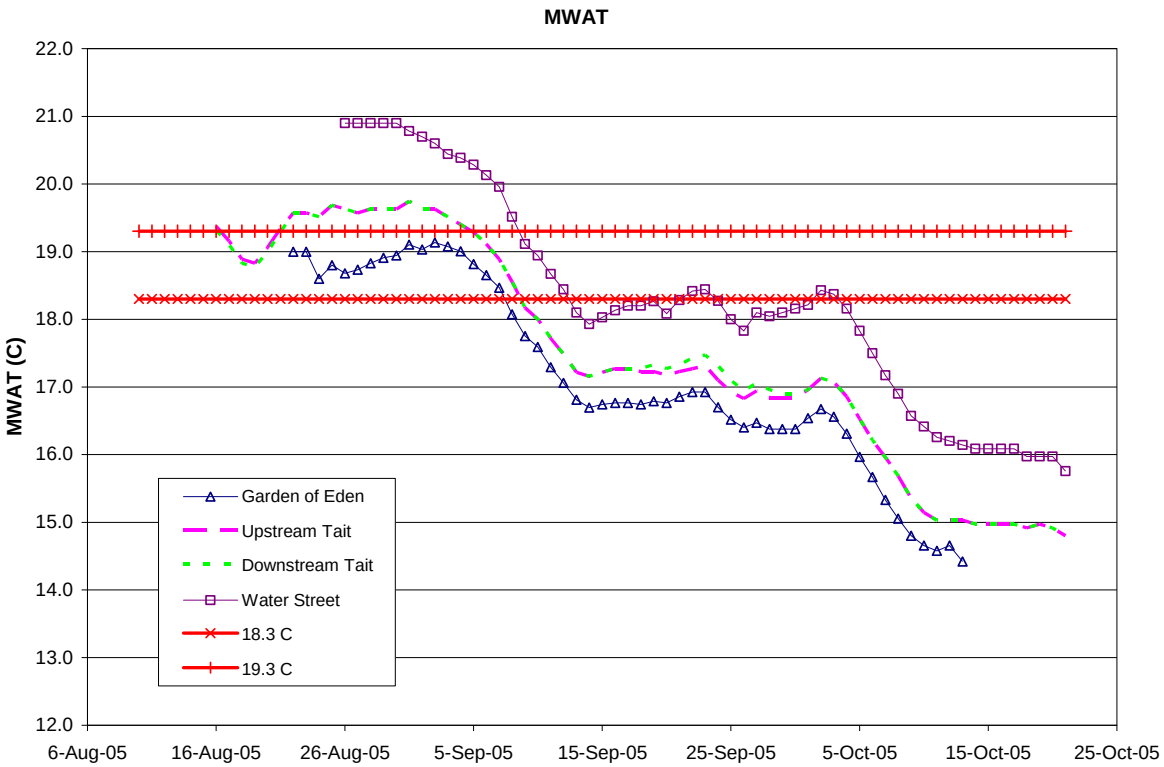


Figure A-5 San Lorenzo River Weekly Average of Maximum Daily Temperature.

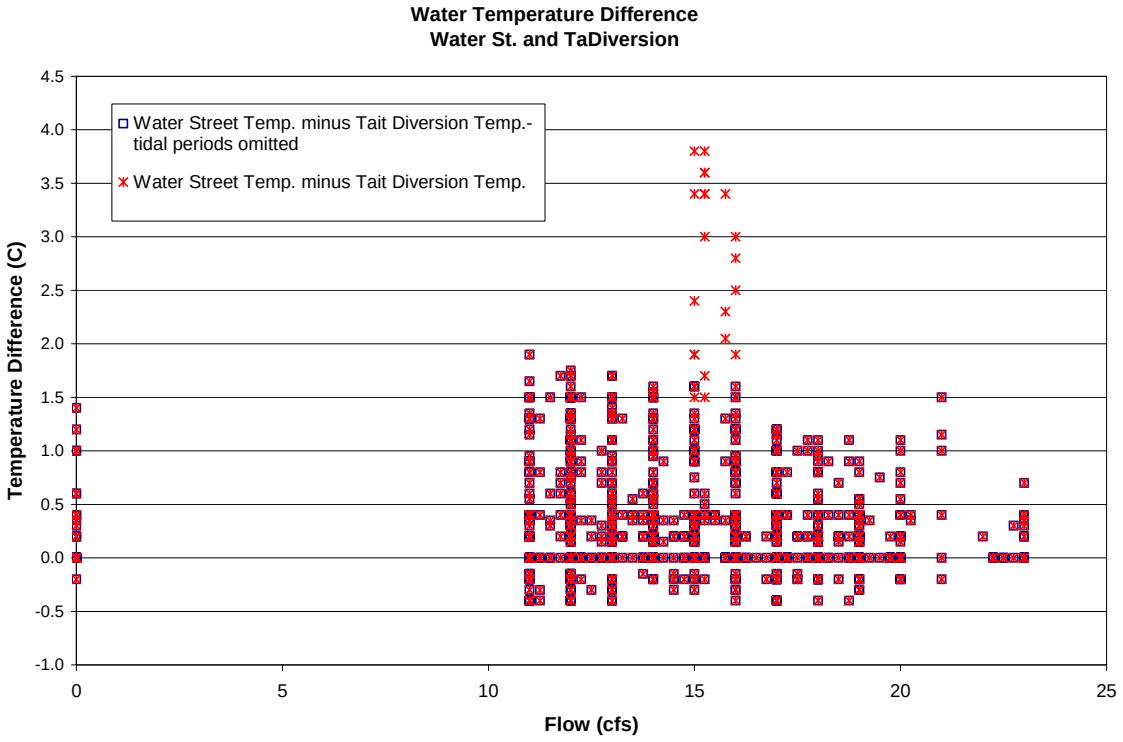


Figure A-6 Difference in Water Temperature between Tait Street and Water Street in relation to river flow

Appendix B

Habitat Survey
Lower San Lorenzo River Below Tait Street

Purpose and Methods

The main purpose of the habitat survey was to identify critical passage sites and sites for evaluation of rearing conditions in the reach of the Lower San Lorenzo River influenced by the Tait Street diversion. The information developed in this study is intended to provide background for development of the City of Santa Cruz HCP concerning habitat quality for migrating steelhead and coho salmon and for rearing of steelhead in relation to operation of the Tait Street diversion.

The habitat assessment included detailed characterization of stream habitat features in accordance with the California Salmonid Stream Habitat Restoration Manual (CDFG Method) (Flosi et al. 1998). Surveys were conducted between June 4 and June 9, 2009. The survey was completed by a two-person team with one person estimating habitat parameters and one recording the data.

Flow during the habitat survey, measured at Tait Street (USGS gage 11161000 San Lorenzo River at Santa Cruz), was approximately 17 to 18 cubic feet per second (cfs). This level of flow represents above average conditions for the time of year (Table B-1). Flow in Pogonip Creek, entering the San Lorenzo River downstream of Tait Street, was approximately 0.5 cfs (Chris Berry, personal communication, October 2005). At this relatively high level of flow it was difficult to distinguish some of the boundaries between habitat types. Several units were first categorized as deep run type habitat since there was significant velocity throughout the unit but they were later re-categorized as pools based on depth characteristics and subsequent observations at lower flow levels.

Results

Downstream of Highway 1, habitat consisted primarily of relatively deep pools and runs with a small amount of relatively short riffles (Table B-2). Upstream of Highway 1, habitat consisted of long shallow glide and long, relatively shallow run habitat with sand substrate. There were shorter sections within the run habitat that had pool-like characteristics but these were not distinct or extensive enough to break out as separate units. The glide had a deeper channel along one bank but this was generally very narrow and constituted a minor part of the habitat. The substrate upstream of Highway 1 was dominated by sand (90%) and silt (5%).

Pools and runs downstream of Highway 1 were long and deep and comprised over 90% of the available habitat. The reach downstream of Highway 1 was generally associated with good cover in the form of emergent and floating aquatic vegetation and overhanging terrestrial vegetation including dense growths of young willows (Figure B-2A). Pool habitat was poorly developed between Highway 1 and Tait Street and mainly consisted of deeper sections within run type habitat. Depth and cover characteristics were not as favorable for rearing salmonids upstream of Highway 1 (Figure B-2B).

A total of six low-gradient riffles were classified between Water Street and Highway 1. In addition, there were two shallow riffle sections within larger habitat units that were too short to break out as individual habitat units (including one that was evaluated as a passage site). The riffles were all relatively short, ranging from 27 feet to 54 feet in length and averaging 38 feet. Upstream of Highway 1 there were no riffles classified although there were short riffle-like sections located at transverse sand bars.

The majority of habitat suitable for rearing salmonids in the study reach is downstream of Highway 1. .

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TABLES

Table B-1 Monthly flow exceedance statistics for San Lorenzo River at Tait Street.

FLOW (cfs)

% Exceed.	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Maximum	14,378	13,680	8,277	6,336	819	151	86	48	545	3,385	4,192	16,256
1	3,541	3,091	2,247	1,380	280	108	59	40	32	98	570	1,785
5	1,269	1,389	943	533	171	79	48	33	26	33	159	594
25	240.3	352.1	317.0	167.0	77.4	47.1	29.4	20.2	17.3	18.4	29.2	79.6
50	**53.4**	**128.8**	**129.5**	**78.4**	**47.0**	**29.8**	**18.4**	**14.3**	**13.1**	**13.9**	**19.1**	**24.4**
75	20.8	47.4	57.8	37.0	23.2	16.4	12.1	10.5	10.5	11.7	13.8	18.6
95	13.4	16.4	18.7	17.4	14.4	10.5	8.4	7.6	7.3	8.3	9.5	10.5
99	0.0	10.8	12.1	11.2	10.5	7.9	5.8	5.4	6.1	6.7	8.2	8.5
Minimum	0.0	0.0	0.0	10.5	3.4	7.0	4.6	4.8	5.3	5.8	0.0	0.0
Average	**291.0**	**353.3**	**278.9**	**161.7**	**62.6**	**35.0**	**22.3**	**16.4**	**14.8**	**19.8**	**48.8**	**137.3**

Source: Entrix, 2004

Table B-2. Habitat survey results for the San Lorenzo River between Water Street and Tait Street Diversion

	Number of Habitat Units	Total Length (ft)	% by Length	Min/Max Length (ft)	Average Length (ft)	Average Depth (ft)	Maximum Depth (ft)
Downstream of Highway 1							
riffles	6	231	8	27/54	38	0.55	1.1
pools	3	1,404	49	101/760	468	2.9	4.3
runs	6	1,209	42	101/318	202	1.9	3.0
Upstream of Highway 1							
glides	1	1,409	55			0.9	2.4
runs	1	1,167	45			1.5	2.8

FIGURES



Figure B-1. Typical habitat conditions between Highway 1 and Water St (A), and between Tait Street and Highway 1 (B).



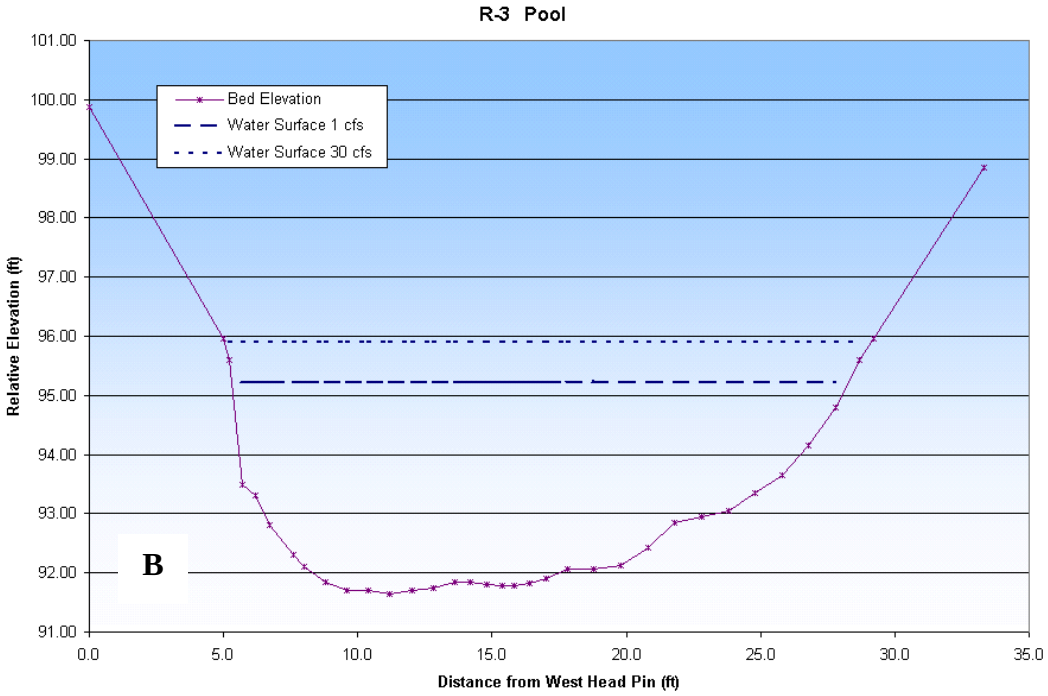


Figure B-2. Pool Site R-3: (A) Transect photo and (B) Cross-section



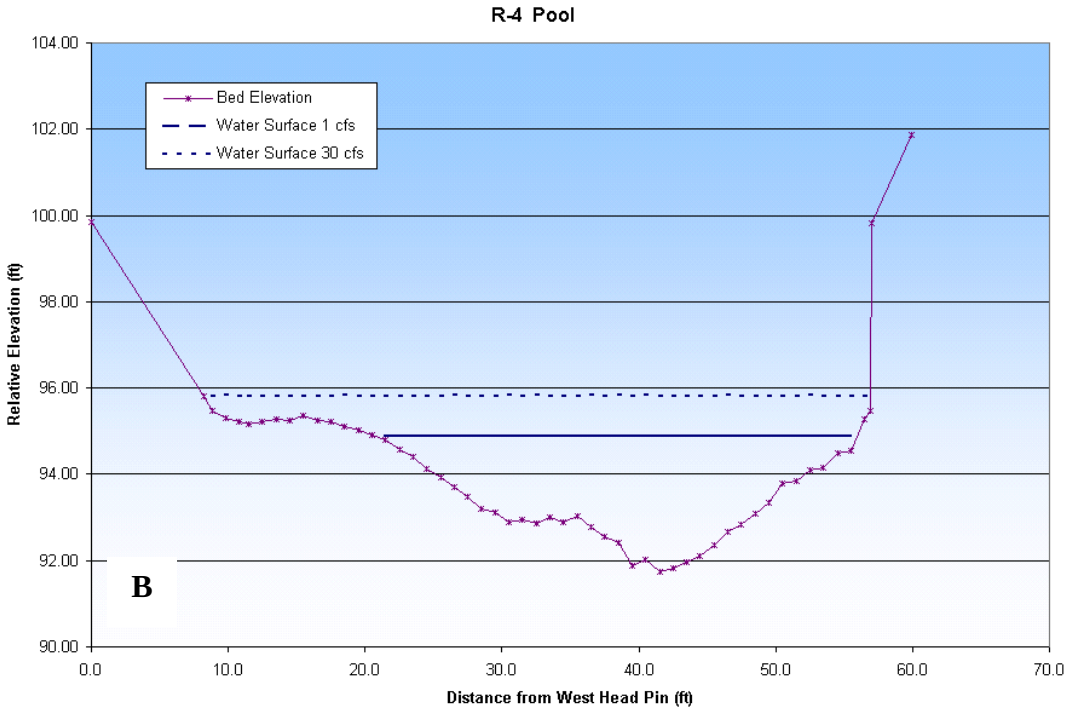


Figure B-3. Pool Rearing Site R-4: (A) Transect photo and (B) Cross-section



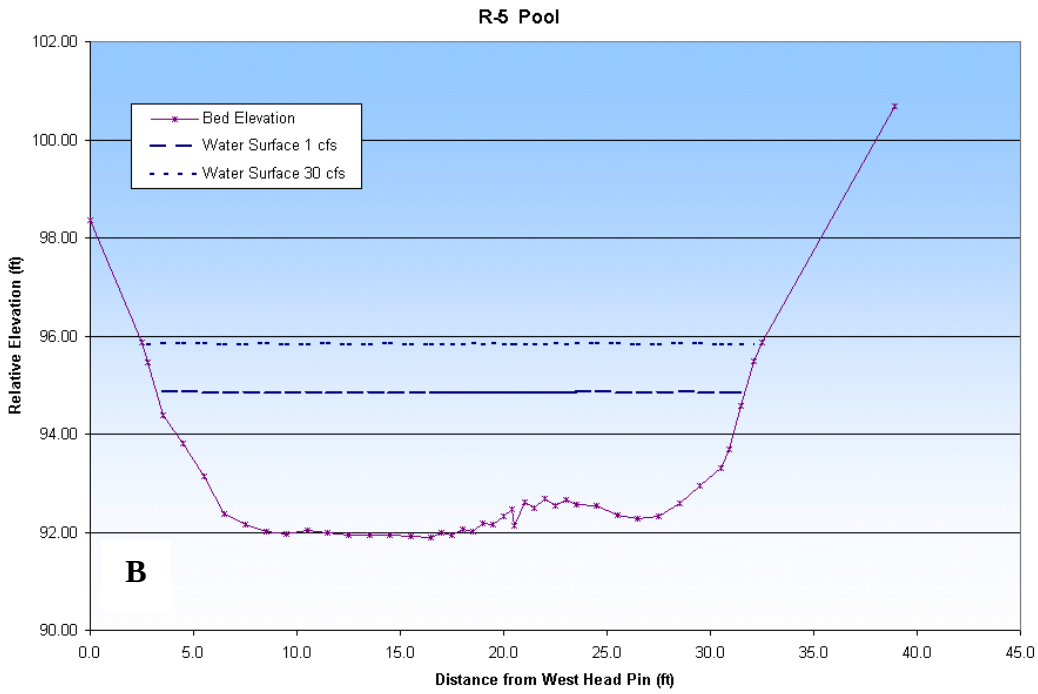


Figure B-4. Pool Rearing Site R-5: (A) Transect photo and (B) Cross-section



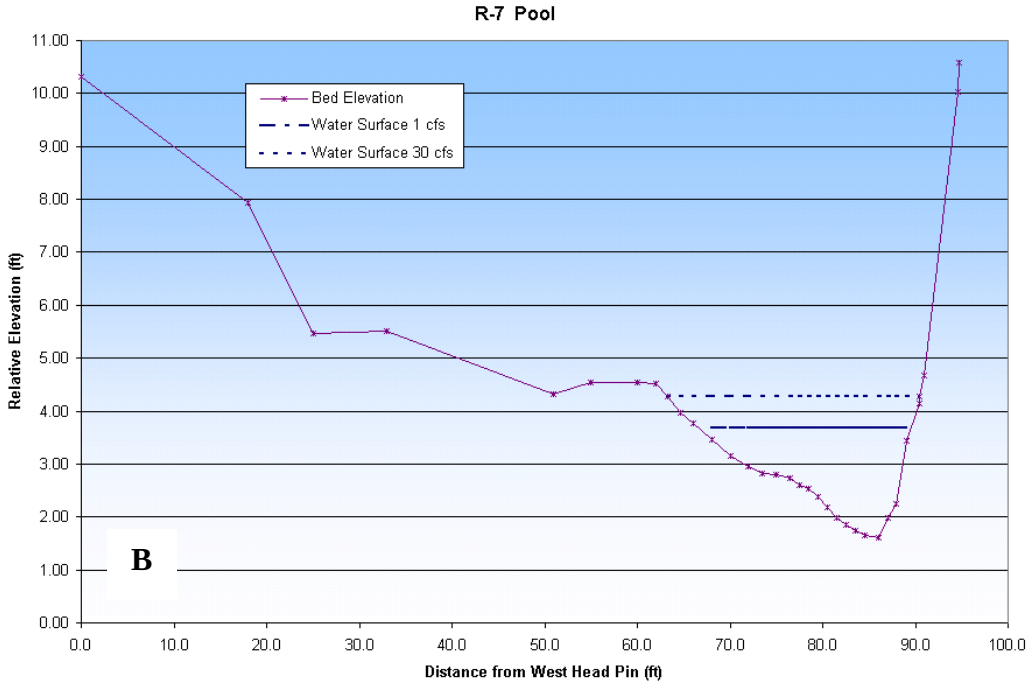


Figure B-5. Pool Rearing Site R-7: (A) Transect photo and (B) Cross-section



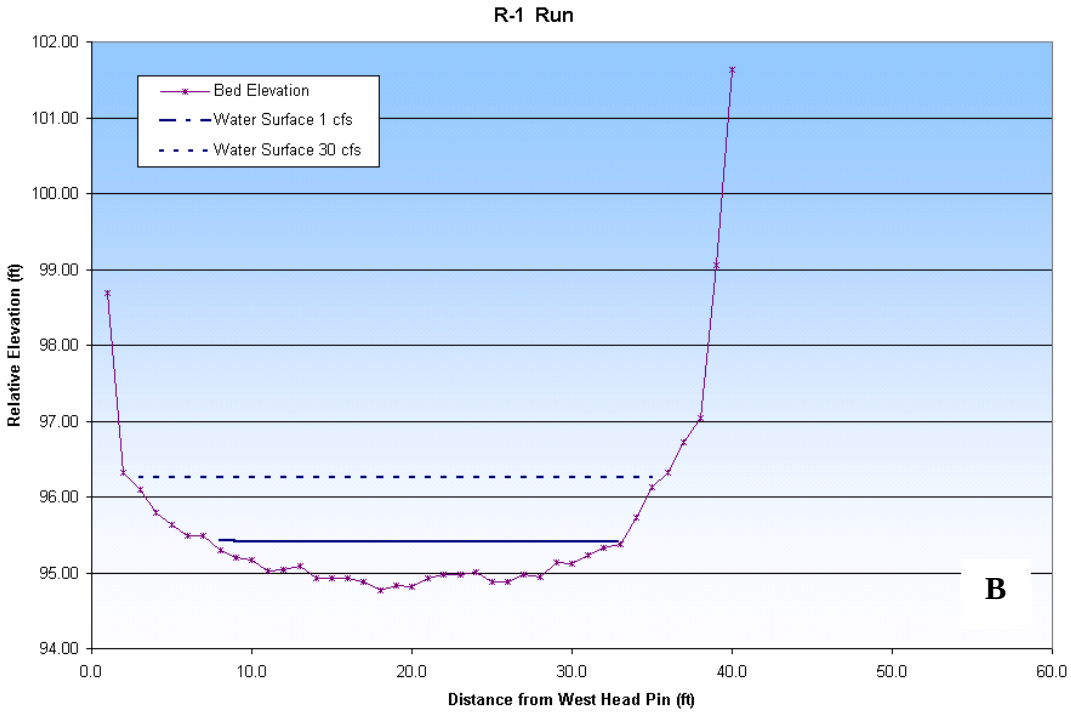


Figure B-6. Run Rearing Site R-1: (A) Transect photo and (B) Cross-section.



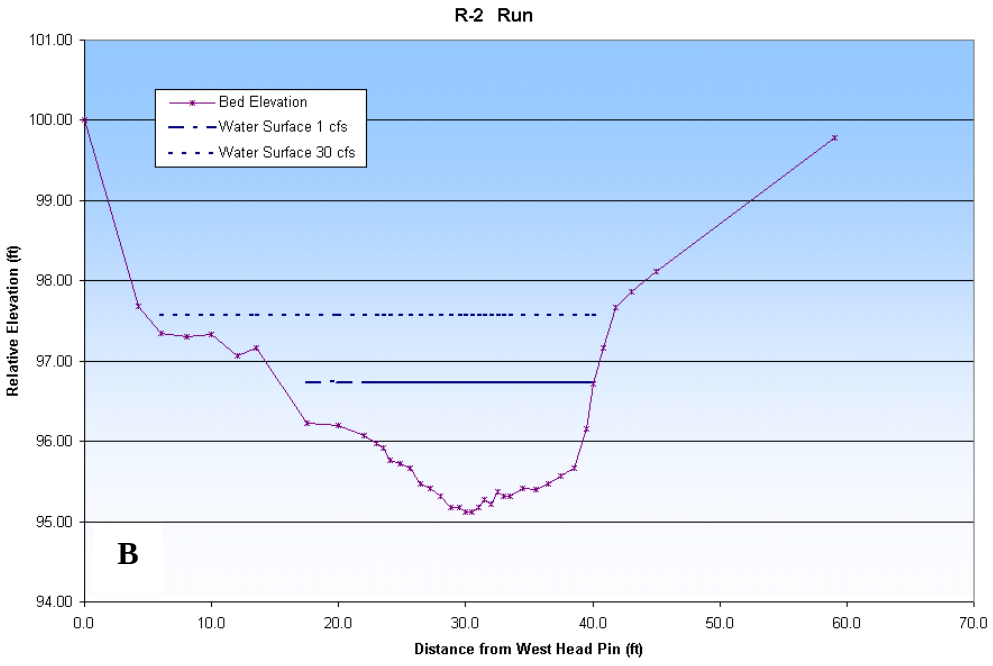


Figure B-7. Run Rearing Site R-2: (A) Transect photo and (B) Cross-section



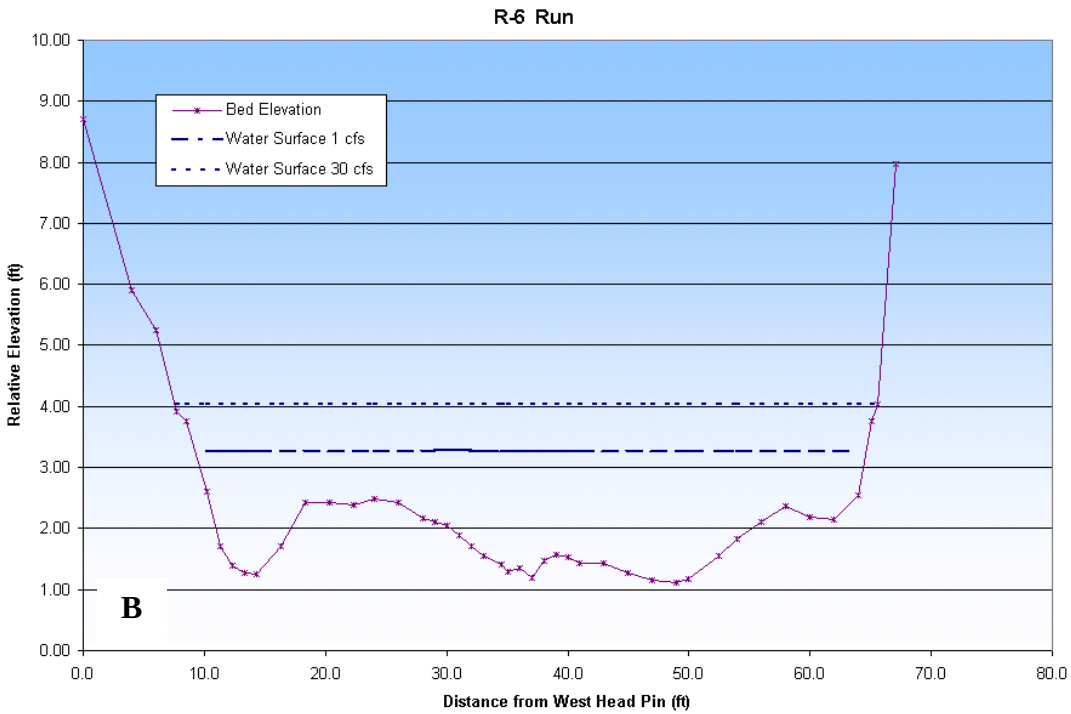


Figure B-8. Run Rearing Site R-6: (A) Transect photo and (B) Cross-section



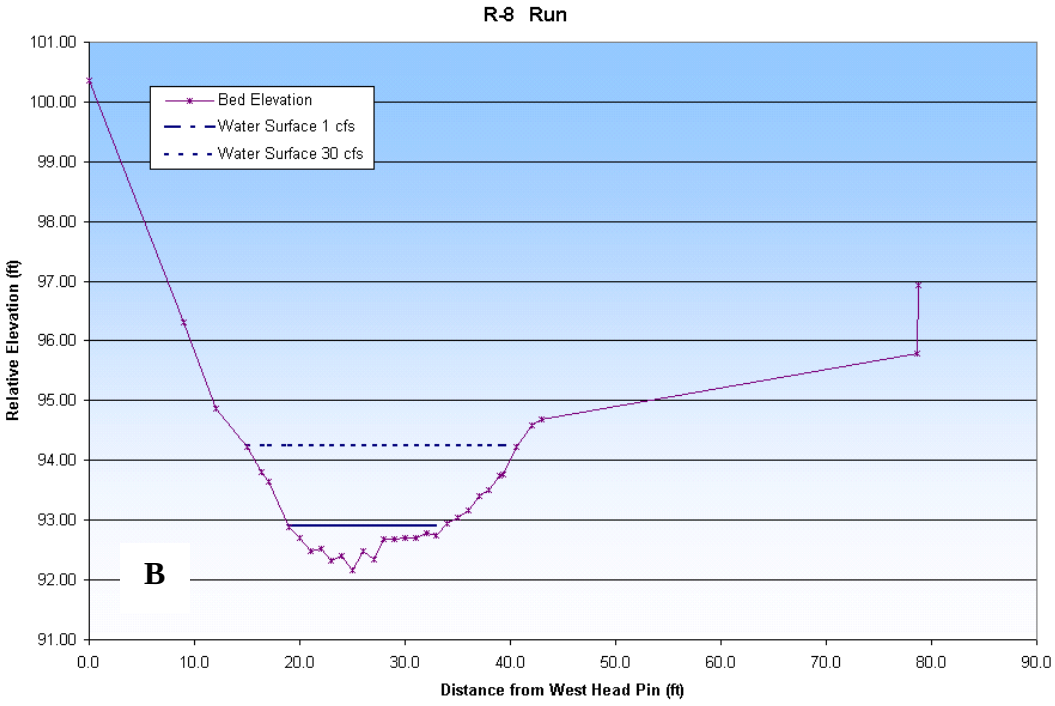


Figure B-9. Run Rearing R-8: (A) Transect photo and (B) Cross-section



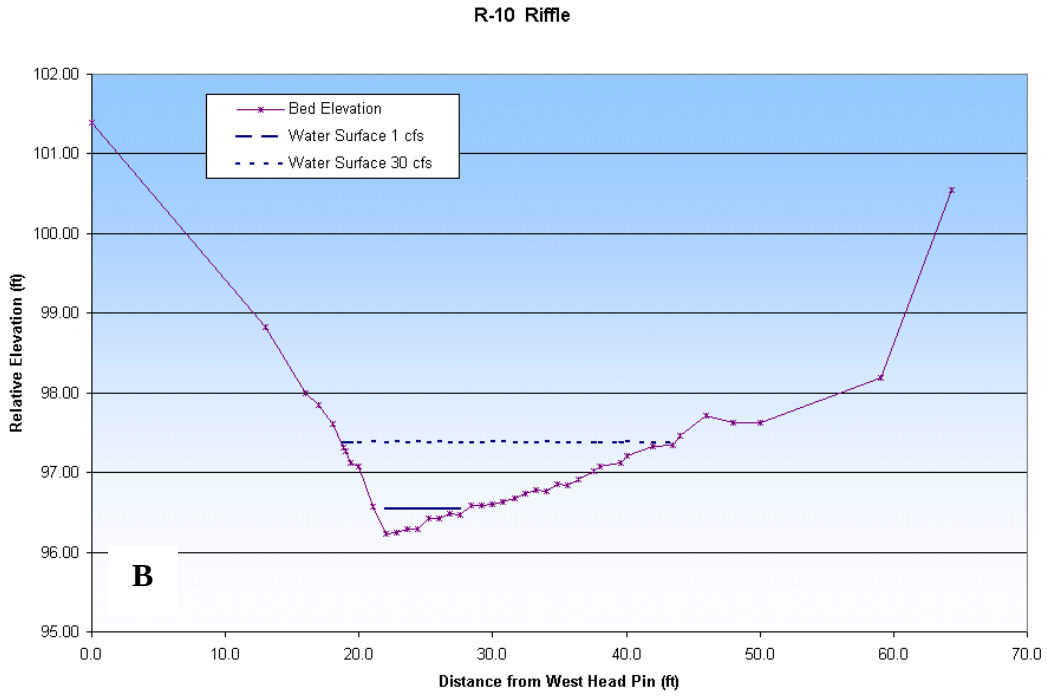


Figure B-10. Riffle Rearing Site R-10: (A) Transect photo and (B) Cross-section.

Appendix C

Newell Creek Habitat and Fish Population Assessment

Technical Memorandum

Prepared for: **Marc Ebbin, Ebbin, Moser, and Skaggs**

Prepared by **Hagar Environmental Science**

Newell Creek Habitat and Fish Population Survey 2007

Summary

There are three distinct reaches of Newell Creek downstream of Newell Reservoir, each with different aquatic habitat characteristics and fish populations. A lower reach, approximately 0.85 miles in length is accessible to anadromous fish and supports steelhead/rainbow trout (*Oncorhynchus mykiss)* and Pacific lamprey. A middle reach of approximately 0.59 miles is dominated by bedrock substrate and supports *O. mykiss* that may be either anadromous or resident in the lower part of the reach. There are bedrock formations in this reach that present numerous potential migration obstacles and one likely passage barrier. The uppermost reach has less suitable habitat for *O. mykiss* which includes less extensive and shallower pools, less Instream cover, and less potential spawning area. There is a very sparse population of *O. mykiss* in the uppermost reach, likely a resident (non-anadromous) population, with apparently low levels of production and reproductive success.

Background and Objectives

Stream habitat assessment and electrofishing surveys were conducted in Newell Creek downstream of Newell Reservoir during August 2007 to assess aquatic habitat conditions and abundance and distribution of steelhead/rainbow trout. This information was collected in support of development of the City's Habitat Conservation Planning (HCP) process.

Although previous San Lorenzo basinwide surveys (Alley 1995, Alley 1999, Alley 2000, Alley 2002, Alley 2004, Alley 2006, Alley 2007) have included part of Newell Creek, more detailed data was desired for the HCP development process. Specifically, during a reconnaissance survey in May 2006 it was observed that there was a significant amount of bedrock forming the substrate of Newell Creek beginning about 0.8 miles upstream of the San Lorenzo River confluence (Figure 1). Bedrock shelves in this section form potential passage obstacles to migrating *O. mykiss* (Figure 2). One bedrock ledge forms a major obstacle that is likely a complete passage barrier under most flow levels (Figure 3). The importance of passage obstacles in Newell Creek depends in part on the quality of habitat upstream of the obstacles and its productive potential for supporting steelhead and coho salmon in Newell Creek. The survey was structured to compare reaches upstream and downstream of the bedrock shelves in terms of habitat features such as depth of pools, cover, extent of cobble/gravel riffles for food production, areal extent of suitable spawning substrate, and amount of fine sediments. Differences in *O. mykiss* population structure upstream and downstream of the bedrock area were also of interest.

The quality of spawning and rearing habitat was quantified using standard methods (CDFG Salmonid Stream Restoration Manual) for the entire reach of Newell Creek from the San Lorenzo River confluence to Newell Dam. Visual observations of relative abundance of fish of different age classes were also recorded during the habitat survey. Population surveys were

completed using multiple-pass electrofishing. Sample units for *O. mykiss* population surveys were selected at random from the habitat mapping data.

Habitat Assessment Methods

Surveys covered approximately 1.76 miles in Newell Creek from the San Lorenzo River confluence to the base of the spillway at Newell Dam. The habitat survey included detailed characterization of stream habitat conditions in accordance with the California Salmonid Stream Habitat Restoration Manual (CDFG Method) (Flosi et al. 1998). This is a widely accepted, repeatable, and quantifiable method. Surveys were conducted on August 7 and 8, 2007. Although rainfall was infrequent during the winter of 2006-2007 and the 2007 water year has been classified as a critically dry year, streamflow conditions in Newell Creek downstream of Newell Reservoir were typical since there is a minimum 1 cubic feet per second (cfs) required release from the reservoir in all year types. Habitat characterization was conducted using the following protocols and modifications to the CDFG Method:

- Habitat typing was conducted at a Level IV classification using a one-hundred percent sampling protocol (Flosi et al. 1998). Complete characterization of all features of each identified habitat unit was conducted.
- In each sample reach all habitat units were identified by type and length measured.
- The proportion of each habitat unit that was influenced by some type of shelter was estimated as a percentage of the total surface area of the unit. A shelter complexity rating of low, medium, or high was also estimated for each habitat unit based on structural complexity and diversity of cover types present. Presence of cover is most important in the pool and flatwater habitats used most frequently by trout and is not as important in riffle habitats.
- Maximum depth, pool tail crest depth, and pool tail embeddedness were recorded for every pool encountered. In addition to other characteristics, pools were defined as having a residual maximum depth of 1 foot or more.
- Canopy density was estimated as the proportion of sky obscured directly above each habitat unit (bank to bank).
- Bank composition and vegetation estimates are standard components of the California Salmonid Stream Habitat assessment method. This information was not central to the objectives of the present survey. To streamline data collection, bank composition and vegetation parameters were omitted from the habitat assessment.

Although fish population surveys are not usually part of the habitat assessment, visual observations of fish can be easily incorporated into the habitat assessment and this documentation can provide valuable information to support conclusions concerning habitat quality and suitability. The habitat assessment was completed during the late summer when visibility is best and conditions are likely to be most limiting for rearing parr.

The results of habitat surveys and fish sampling were evaluated to identify key factors that potentially limit fish populations in the watershed. Several key factors were considered in determining potentially limiting factors and potential for improvement including the frequency and quality of summer pool habitat, substrate conditions, bank and canopy conditions, stream temperature, and obstacles to fish movement.

Fish Population Assessment Methods

Sampling sites were selected at random from each of the three reaches identified during the habitat assessment: below the bedrock shelves (lower reach), within the bedrock dominated reach (bedrock reach), and upstream of the bedrock dominated reach (upper reach). A total of 9 sites were sampled for fish populations, four in the Lower Reach, 3 in the Bedrock Reach, and 2 in the Upper Reach.

Sampling was conducted using the multiple-pass depletion method to estimate population abundance (Zippen 1958). Each sample site consisted of a discreet habitat unit that was isolated by placing a 3/16 inch mesh block-net across the channel at the lower and upper ends of the unit. Three complete passes with the electrofisher were made in each unit where *O. mykiss* were found. If no *O. mykiss* were found on the first pass, no further passes were made. If, in the opinion of the lead biologist, subsequent passes did not indicate a good depletion pattern after 3 passes then additional passes were made as needed.

Fish captured in each pass were measured (fork length) and held until all passes had been completed. The condition of each measured fish was noted along with the presence of diseases and overall health. Fish species other than trout were noted for presence/absence. Habitat conditions, such as temperature and discharge, were recorded for each unit sampled. A population estimate and confidence limit were calculated for each habitat unit. Population estimates were not completed by age class due to small sample sizes. All fish were released at the sample site after all electrofishing passes had been completed.

Habitat Assessment Results

The creek was surveyed for approximately 1.76 miles upstream of the San Lorenzo River confluence on August 7 and 8, 2007. From the San Lorenzo confluence upstream to about 0.23 miles upstream of Rancho Rio Bridge (hereafter referred to as the Lower Reach), Newell Creek is a relatively low gradient gravel/cobble bed stream. For the next 0.6 miles upstream the substrate becomes dominated by bedrock that occurs in frequent shelves or steps of a few inches to a few feet in height. This section is referred to as the Bedrock Reach. The uppermost reach, or Upper Reach, beginning about 1.45 miles upstream from the San Lorenzo River and continuing for about 0.3 miles to the low water crossing at the spillway pool, is also relatively low gradient with gravel/cobble substrate.

There is a continuous release of 1 cfs from Newell Reservoir throughout these three reaches. Spot measurements of water temperature during the habitat survey ranged from 14°C to 16°C (57°F to 61°F) in the Lower Reach, 12°C to 13°C (54°F to 55°F) in the bedrock reach, and 13°C (55°F) in the Upper Reach.

Pools made up approximately 40% of the Lower Reach and Bedrock Reach but only about 28% of the Upper Reach (Table 1, Figure 4). The Bedrock Reach had a higher proportion of riffles (primarily bedrock sheets) than the Upper and Lower Reaches. The Upper Reach was dominated by step runs, glides, and runs (Table 1, Figure 4). Pools were longer in the Lower Reach than the other two reaches, averaging 85 feet in length compared to 59 feet in the Bedrock Reach and 57 feet in the Upper Reach (Table 2). Pools were more frequent in the Bedrock Reach than the other two reaches, averaging 35 pools per mile as compared to 25 and 26 pools per mile (Table 2). Pools tended to be deepest in the Lower Reach and shallowest in the Upper Reach (Table 2, Figures 5 and 6). Most pools in the Lower and Bedrock Reaches had maximum depths over 2 feet while only 38% of pools in the Upper Reach did (Table 3).

Shelter complexity, though mostly at low to moderate levels in all reaches, tended to be higher in the Lower Reach. Over 80% of pools in the Lower Reach had shelter influencing at least 20% of the habitat area while only 29% and 13% of pools in the Bedrock Reach and Upper Reach had shelter that extensive (Table 4). The most extensive and frequently encountered cover type was the spaces around and between cobble and boulder substrate. Substrate was encountered as a cover type in 80% to 95% of the habitat units in each reach and provided between 31% and 59% of the overall area with cover (Tables 5 and 6, Figures 7 and 8). Terrestrial vegetation and undercut banks were important cover types in the Lower Reach while bedrock ledge and undercut banks were important in the Bedrock Reach. Nearly 80% of the cover in the Upper Reach was provided by substrate and surface turbulence.

Canopy coverage was relatively dense throughout all three reaches, averaging around 80% (Table 7). The Lower Reach had slightly more habitat units with lower canopy coverage but overall, canopy coverage was similar between the reaches. The author regards canopy coverage of 55% to 85% as ideal for streams supporting *O. mykiss* and 50% to 60% of habitat units fell in this range (Table 7). A relatively high proportion of habitat units (35% to 40%) had canopy coverage of more than 85% in all reaches. This may somewhat reduce productivity due to extensive shading. The dominant canopy species were alder and box elder in the Lower Reach with increasing importance of maple and in the Bedrock Reach and maple and fir in the Upper Reach (Table 8).

Substrate was dominated by gravel and small cobble in the Lower and Upper Reaches and by bedrock in the Bedrock Reach (Table 9, Figure 9). Gravel or cobble were the dominant substrate in 71% of habitat units in the Lower Reach and 90% of habitats in the Upper Reach. Bedrock dominated in 59% of habitat units in the Bedrock Reach and gravel was dominant in 28%. Sand was found as a dominant substrate in 12% of habitat units in the lower reach but not a dominant in any habitat units in either the Bedrock Reach or the Upper Reach. This may be due to either more disturbance from adjacent residential development, lower gradient, or both. In riffle type habitat units, gravel or cobble was the dominant substrate in both the Lower and Upper Reaches while bedrock (in the form of bedrock sheets) dominated in the Bedrock Reach (Table 10).

Embeddedness ratings are an indication of the degree to which the surface layer of larger substrate particles (cobble or large gravel) is embedded in fine sediments. Incubation and emergence success are influenced by accumulation of fine sediments (generally less than 3.3 mm) in the substrate. Embryo survival for steelhead decreases when the percentage of substrate particles less than 6.4mm reaches 25% to 30% and is extremely low when fines are 60% or more. Emergence of steelhead and coho fry is generally high when fine sediments are less than 5% of substrate volume but drops sharply with fine sediment volume of 15% or more (Bjornn and Reiser 1991). While embeddedness ratings are not a direct measure of percentage of fine sediment in the substrate, they are related.

Pool tail and spawning gravel embeddedness ratings were low to moderate in Newell Creek (Tables 11 and 12). Only a few pool tails had embeddedness ratings of more than 30% while 50% to 65% had embeddedness of 15% or less (Table 13). Pool-tail embeddedness ratings were not possible in some habitat units in the Bedrock and Upper Reaches since the pool tail was composed of bedrock. Most spawning areas had embeddedness of less than 30% (Table 12) and 70% of spawning areas in the Lower and Bedrock Reaches had embeddedness of less than 15% (Table 13). These values are indicative of relatively low amounts of fine sediments in the substrate of Newell Creek relative to other Central California Coastal streams. Potential spawning area was more extensive in the Lower Reach than in the Bedrock and Upper Reaches. There were, on average, 24 square feet of potential spawning area per 100 feet of

stream surveyed in the Lower Reach compared to only 13 square feet in the Bedrock Reach and 10 square feet in the Upper Reach (Table 13).

O. mykiss of various size classes were seen through the Lower Reach and the lower part of the Bedrock Reach but few, if any, were seen in the upper Bedrock and Upper Reaches.

Fish Population Assessment Results

O. mykiss and sculpin were captured in all three reaches. The sculpin were not examined closely for classification but appeared to be prickly sculpin (*Cottus asper*). In the Lower Reach, California roach, speckled dace, Sacramento sucker, and Pacific lamprey ammocoetes were also captured (Table 14). *O. mykiss* were most abundant in the Lower Reach and the lower part of the Bedrock Reach. Capture efficiency was poor in two of the habitat units (Table 15), resulting in no population estimate for one unit (#26b) and unreasonably large population estimate in another (#26). Average density for *O. mykiss* in sampled units was 21 per 100 feet of stream in the Lower Reach, 15 per 100 feet in the Bedrock Reach, and 2 per 100 feet in the Upper Reach (Table 16). The small sample sizes did not justify population estimates by age class although the catch was dominated by fish in the 60 mm to 110 mm (2.3 inches to 4.3 inches) length range (fork length). Age determination was not completed but most of these fish are presumed to be young-of-year (Figure 10). Of the two *O. mykiss* captured in the Upper Reach, neither were young-of-year.

Nearly all *O. mykiss* exhibited a high incidence of a condition known as black spot disease (BSD). BSD is indicated by external dark spots attributed to the resting stage of trematodes that encyst under the scales of the fish. Melanin deposits are formed around the developing trematode and are visible under the scales. The trematode is dormant at this stage and does not appear to harm the trout in any way. It is found in trout that inhabit warmer waters (the trematode requires temperatures above 18°C to complete its life history).

Overall density estimates for *O. mykiss* in the Lower Reach are slightly lower but comparable to those obtained in 2006 by Alley in the same section of stream (Alley 2007) although the proportion of smolt sized fish (as defined by Alley) was probably higher in 2006.

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Table 1. Newell Creek Fish Habitat Summary

	Lower Reach	Bedrock Reach	Upper Reach
Length of Stream Surveyed (feet)	4502	3140	**1652**
Average of Mean Width (feet)	16.1	20.7	**18.0**
	Number of units		
Flatwater	18	11	**9**
Pool	21	21	**8**
Riffle	13	14	**3**
Total	*52*	*46*	***20***
	Percentage by length		
Flatwater	44%	30%	**61%**
Pool	39%	40%	**28%**
Riffle	**17%**	**30%**	**11%**

Table 2. Newell Creek Habitat Survey Pool Depth Summary

	Lower Reach	Bedrock Reach	Upper Reach
Total Number of Pools	21	21	8
Wetted Length Surveyed (ft)	4502	3140	1652
Average Number Pools/Mile	25	35	26
Average Pool Length (ft)	85	59	57
Average Pool Depth (ft)	**Number of Pools**		
0.0 – 0.5			
0.5 – 1.0	2	4	3
1.0 – 1.5	7	7	4
1.5 – 2.0	7	8	
2.0 – 2.5	5	1	
2.5 – 3.0			1
Maximum Pool Depth (ft)	**Number of Pools**		
1.0 – 1.5			2
1.5 – 2.0	6		3
2.0 – 2.5		9	2
2.5 – 3.0	7	4	
3.0 – 3.5	2	3	
3.5 – 4.0	2	3	
4.0 – 4.5	2	1	
4.5 – 5.0	1		1
5.0 – 5.5		1	
5.5 – 6.0	1		

Table 3. Newell Creek Habitat Survey Pool Depth Summary

	Lower Reach	Bedrock Reach	Upper Reach
% pools with mean depth >=1 ft	90%	76%	63%
% pools with mean depth >=2 ft	24%	5%	13%
% pools with mean depth >= 3ft	0%	0%	0%
% pools with max depth >=2 ft	71%	100%	38%
% pools with max depth >=3 ft	38%	38%	13%
% pools with max depth >= 5ft	5%	5%	0%

Table 4. Newell Creek Habitat Survey Shelter Complexity

	Lower Reach	Bedrock Reach	Upper Reach
Shelter Complexity	Number of Habitat Units		
Low	22	28	7
Medium	18	11	10
High	12	5	3
	Percent of all Pools		
>=20% of Unit with Shelter	81%	29%	13%
>=25% of Unit with Shelter	52%	10%	13%
>=30% of Unit with Shelter	33%	10%	0%

Table 5. Newell Creek Habitat Survey Frequency of Occurrence of Shelter Components

	Lower Reach	Bedrock Reach	Upper Reach
Cover Type	**Proportion of Habitat Units With Cover Type**		
undercut bank	44%	50%	55%
small woody debris	42%	45%	55%
large woody debris	13%	11%	40%
root mass	38%	34%	15%
terrestrial vegetation	77%	50%	25%
rooted aquatic vegetation	2%	2%	20%
floating aquatic vegetation	0%	0%	0%
surface turbulence	38%	36%	35%
substrate	90%	80%	95%
bedrock ledge	8%	73%	15%
Total Surveyed Units	52	44	20

Table 6. Newell Creek Habitat Survey Relative Extent of Shelter Components

	Lower Reach	Bedrock Reach	Upper Reach
Cover Type	**Contribution to Total Areal Extent**		
undercut bank	12.5%	12.4%	7.2%
small woody debris	5.3%	9.9%	7.7%
large woody debris	1.7%	2.4%	7.6%
root mass	12.5%	8.2%	1.3%
terrestrial vegetation	28.8%	7.0%	3.9%
rooted aquatic vegetation	1.6%	0.1%	1.7%
floating aquatic vegetation	0.0%	0.0%	0.0%
surface turbulence	5.2%	5.3%	9.4%
substrate	31.1%	37.0%	59.4%
bedrock ledge	1.3%	17.8%	1.8%
Total Surveyed Units	52	44	20

Table 7. Newell Creek Habitat Survey Canopy Characteristics

	Lower Reach	Bedrock Reach	Upper Reach
Average canopy (%)	79	80	79
Maximum canopy (%)	95	95	95
Minimum total canopy (%)	15	45	45
Canopy Coverage (%)	Number of Habitat Units		
15	1		
40	1		
45	2	1	1
50	1		
55	2	2	1
60	2	3	
65	3	3	1
70	1	3	
75	6	6	3
80	3	3	1
85	9	6	1
90	6	8	
95	15	9	1
	Proportion of all Habitat Units		
55%-85% Canopy Coverage	50%	59%	60%
>85% Canopy Coverage	40%	39%	35%

Table 8. Newell Creek Habitat Survey Canopy Species

	Lower Reach	Bedrock Reach	Upper Reach
Dominant Canopy Species	Number of Habitat Units		
Willow	1		
Alder	35	26	6
Sycamore	1		
Bay	2	2	1
Locust	1		
Box Elder	10		
Dogwood	1		
Cottonwood	1		
Maple		13	8
Fir		2	5
Other		1	
Total Surveyed Units	52	44	20

Table 9. Newell Creek Habitat Survey Substrate Characteristics

	Lower Reach	Bedrock Reach	Upper Reach
Total Surveyed Units	52	46	20
Dominant Substrate Class	Proportion of all Habitat Units		
Silt/clay	17%	4%	0%
Sand	12%	0%	0%
Gravel	44%	28%	50%
Small cobble	25%	7%	30%
Large cobble	2%	2%	10%
Boulder	0%	0%	0%
Bedrock	0%	59%	10%
Gravel-cobble dominant	71%	37%	90%
Sand as dominant	12%	0%	0%
Sand dominant or subdominant	13%	2%	0%
Bedrock dominant or subdominant	4%	85%	10%

Table 10. Newell Creek Habitat Survey Riffle Substrate Characteristics

	Lower Reach	Bedrock Reach	Upper Reach
Total Riffles Surveyed	13	14	3
	Proportion of all Riffles		
Gravel-cobble dominant	100%	21%	100%
Sand as dominant	0%	0%	0%
Sand dominant or subdominant	0%	7%	0%
Bedrock dominant or subdominant	0%	71%	0%

Table 11. Newell Creek Habitat Survey Pool-Tail Embeddedness

	Lower Reach	Bedrock Reach	Upper Reach
Pool Tail Embeddedness (%)	**Number of Habitat Units**		
0			
5	6	4	
10		3	3
15	3	6	2
20		1	
25	3		1
30	3		
35	1	2	
40	1		1
45		1	
50	1		
N/A		3	1
Number of Pools Surveyed	18	20	8

Table 12. Newell Creek Habitat Survey Spawning Gravel Embeddedness

	Lower Reach	Bedrock Reach	Upper Reach
Spawning Gravel Embeddedness (%)	**Number of Habitat Units**		
0			
5	7	4	
10	2	4	2
15	6	6	3
20	4	2	
25		2	3
30	2	1	
35		1	
Number of Spawning Areas Surveyed	21	20	8

Table 13. Newell Creek Habitat Survey Gravel Quality Summary

	Lower Reach	Bedrock Reach	Upper Reach
Number of Spawning Areas Surveyed	21	20	8
Sum of Spawning gravel area (sq.ft.)	1095	406	170
Wetted Length (ft)	4502	3140	1652
Spawning area (sq. ft.) per 100 feet	24	13	10
Percent of pool tails with embeddedness of 15% or less	50%	65%	63%
Percent of spawning areas with embeddedness of 15% or less	71%	70%	63%

Table 14. Fish Species Captured in Newell Creek Fish Sampling by Location

Species	Species	Lower Reach				Bedrock Reach			Upper Reach	
		Unit 25 Pool	Unit 26 Glide	Unit 26b Riffle	Unit 29 Pool	Unit 55 Bedrock sheet	Unit 69 Pool	Unit 80 Steprun	Unit 105 Pool	Unit 110 Steprun
		Number of Fish								
Steelhead/rainbow trout	*Oncorhynchus mykiss*	15	16	4	14	15	4	0	2	0
Speckled dace	*Rhinichthys osculus*			1						
California roach	*Lavinia symmetricus*	19			126					
Sculpin	*Cottus sp.*	16	1	1	7	34	10	6	24	33
Sacrameto sucker	*Catostomus occidentalis*	3								
Pacific lamprey (ammocoete)	*Lampetra tridentata*	5								

Table 15. Number of *O. mykiss* captured in Newell Creek Fish Sampling by Reach, Unit, and Electrofishing Pass

Reach	Habitat Unit	Habitat Type	Pass 1	Pass 2	Pass 3	Pass 4	Pass 5
			Number of O. mykiss				
Lower	25	Pool	10	2	3		
	26	Glide	4	5	5	2	
	26b	Riffle	0	1	3		
	29	Pool	10	3	1		
Bedrock	55	Bedrock sheet	4	6	5	0	
	69	Pool	1	1	1	1	0
	80	Steprun	0				
Upper	105	Pool	2	0			
	110	Steprun	0				

Table 16. *O. mykiss* Population Estimates for Newell Creek Fish Sampling in 2007

Reach	Habitat Unit	Habitat Type	*O. mykiss* Captured	Population Estimate	Upper 95% Confidence Limit	Length Sampled	*Density (fish*/100 ft)	Reach Average Density
Lower	25	Pool	15	17	21	81	21	21[1]
	26	Glide	16	36	53	42	85	
	26b	Riffle	4	N/A	N/A	N/A	N/A	
	29	Pool	14	15	17	71	21	
Bedrock	55	Bedrock sheet	15	19	26	67	29	15
	69	Pool	4	5	9	38	14	
	80	Step run	0	0	N/A	66	0	
Upper	105	Pool	2	2	2	39	5	2
	110	Step run	0	0	N/A	61	0	

[1] Units 25 and 29 only

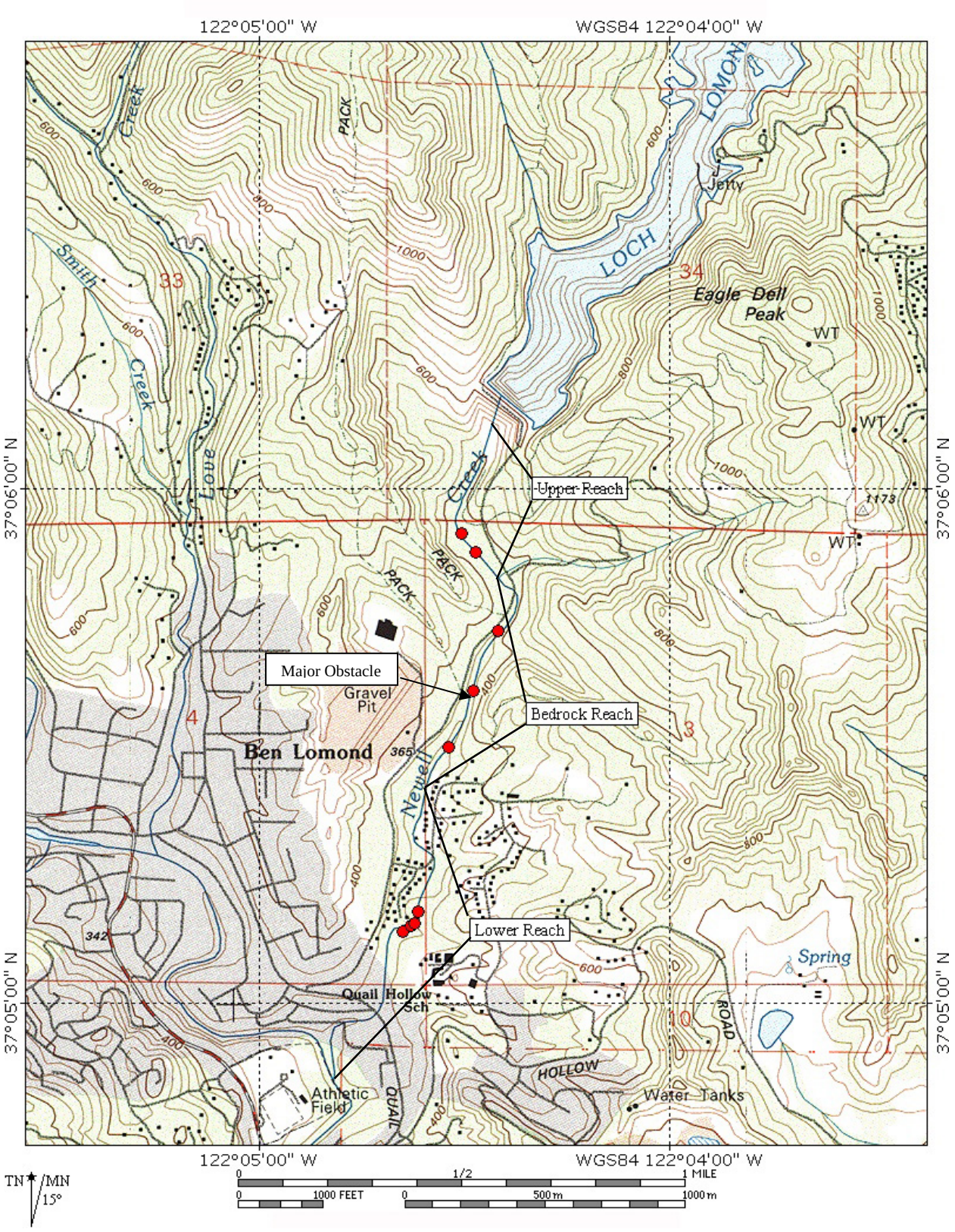


Figure 1. Lower Newell Creek study area (red dots indicate electrofishing sites)



Figure 2. Bedrock shelves in Lower Newell Creek



Figure 3. Bedrock shelf forming major obstacle to fish migration

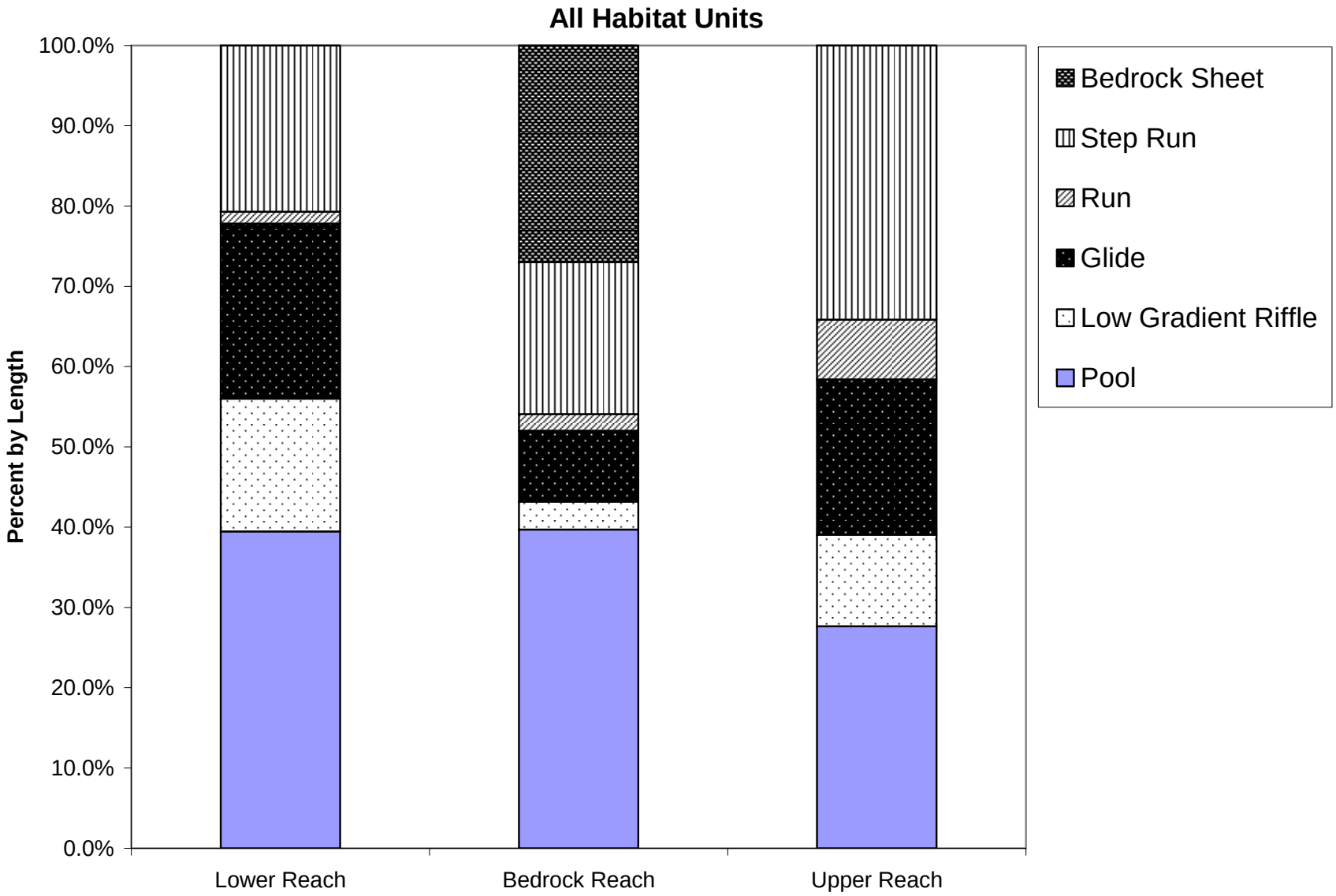


Figure 4. Proportional representation of habitat types by reach

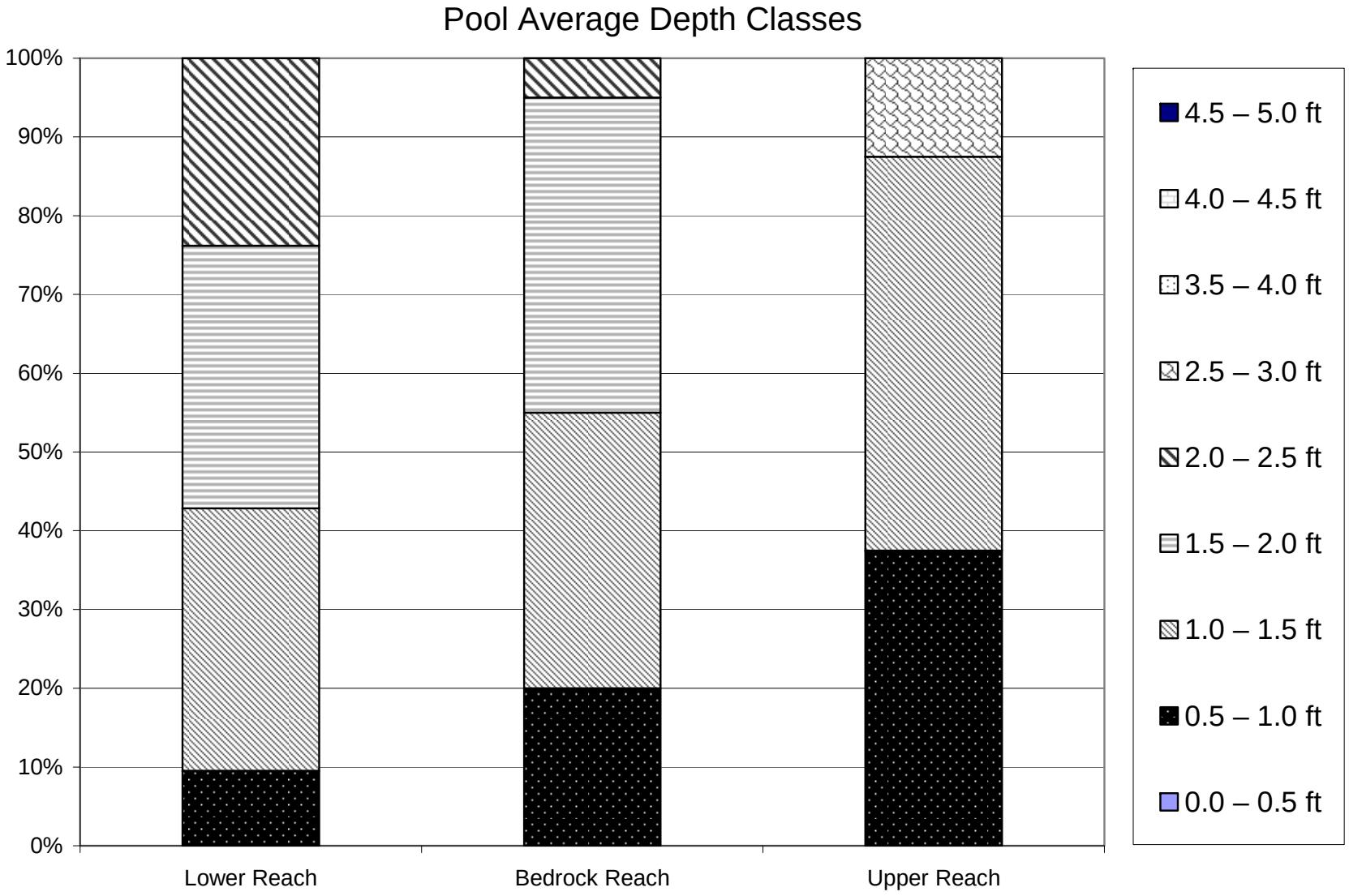


Figure 5. Pool average depth by reach

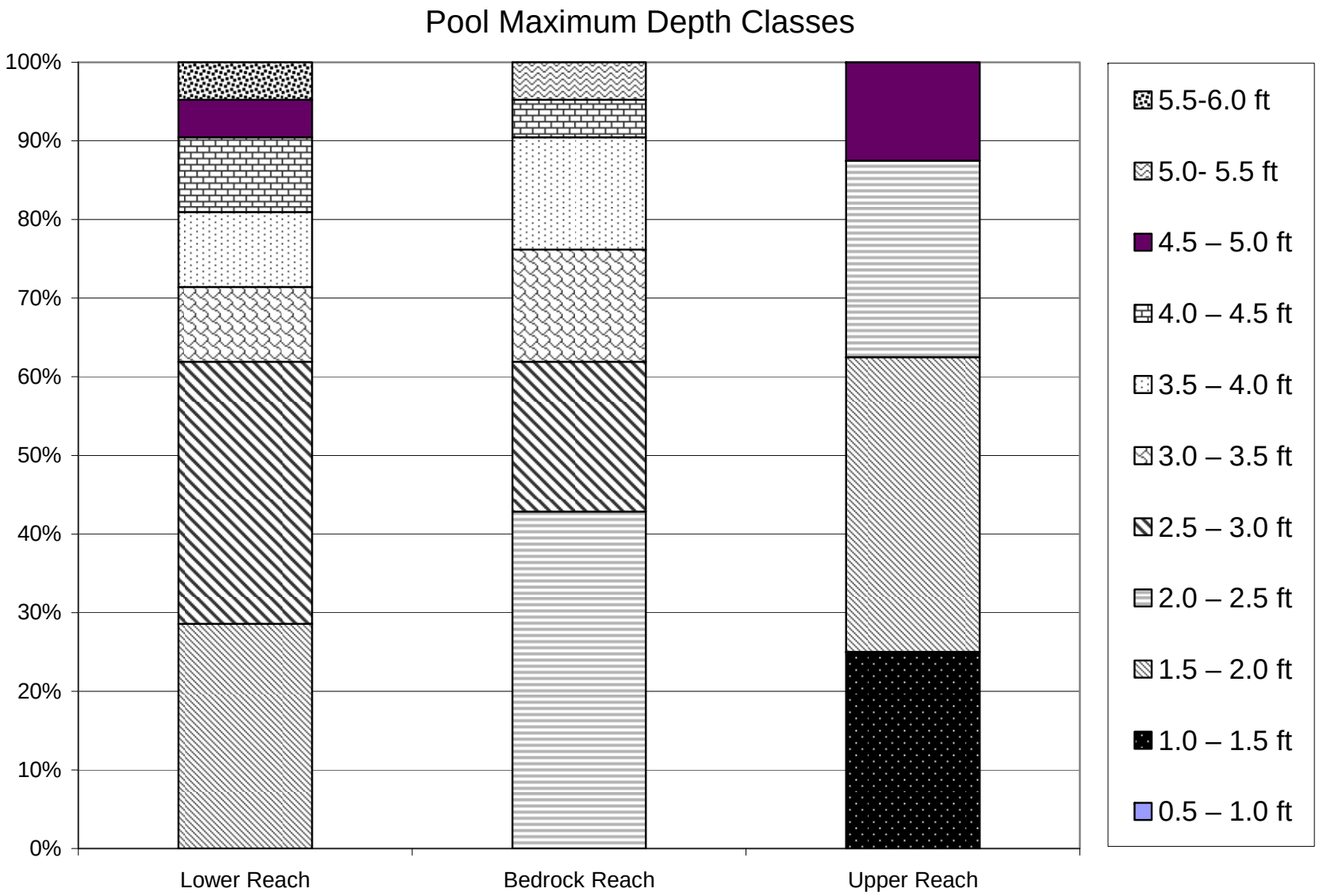


Figure 6. Pool maximum depth by reach

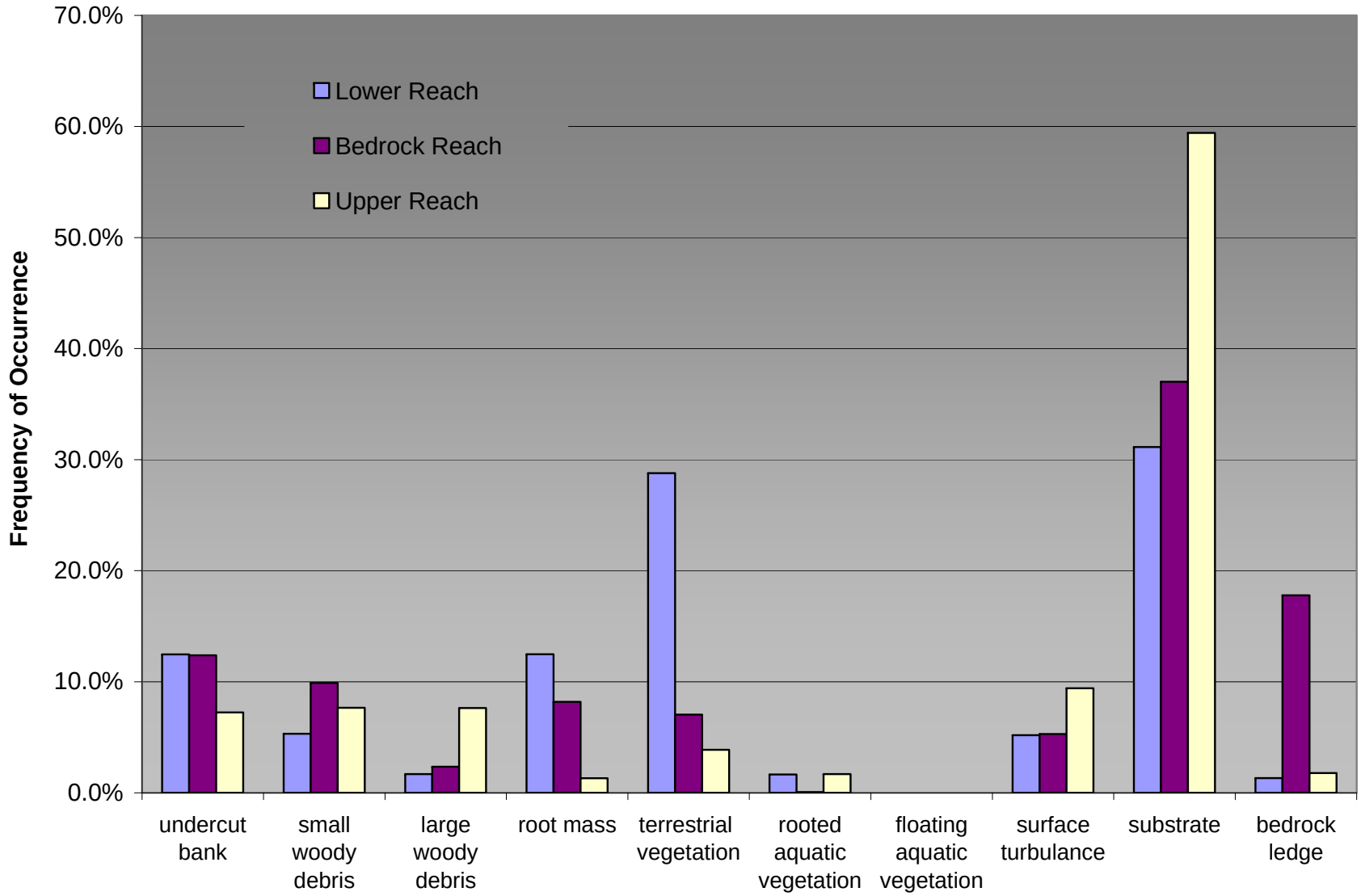


Figure 7. Frequency of occurrence of cover type by reach

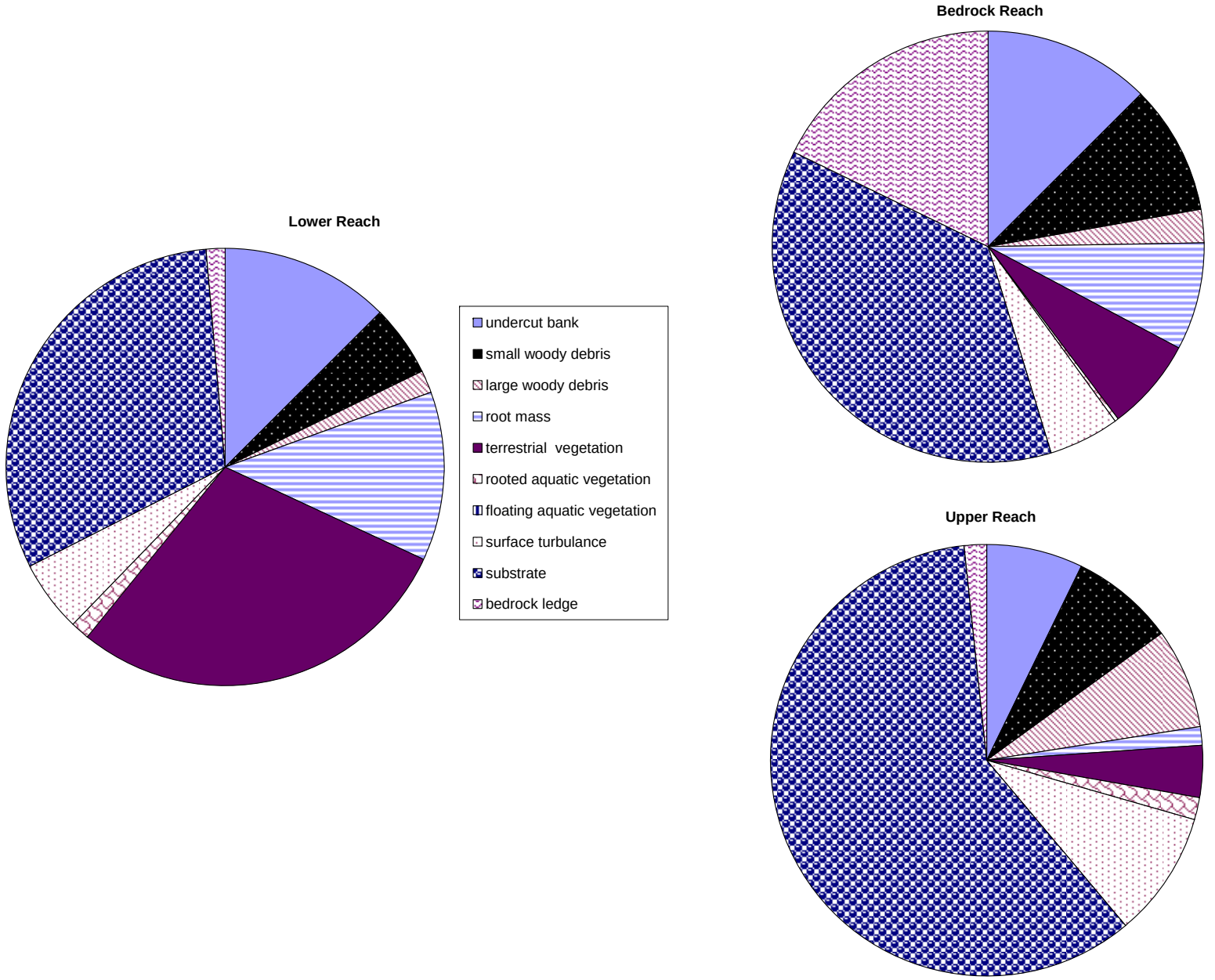


Figure 8. Relative extent of cover types

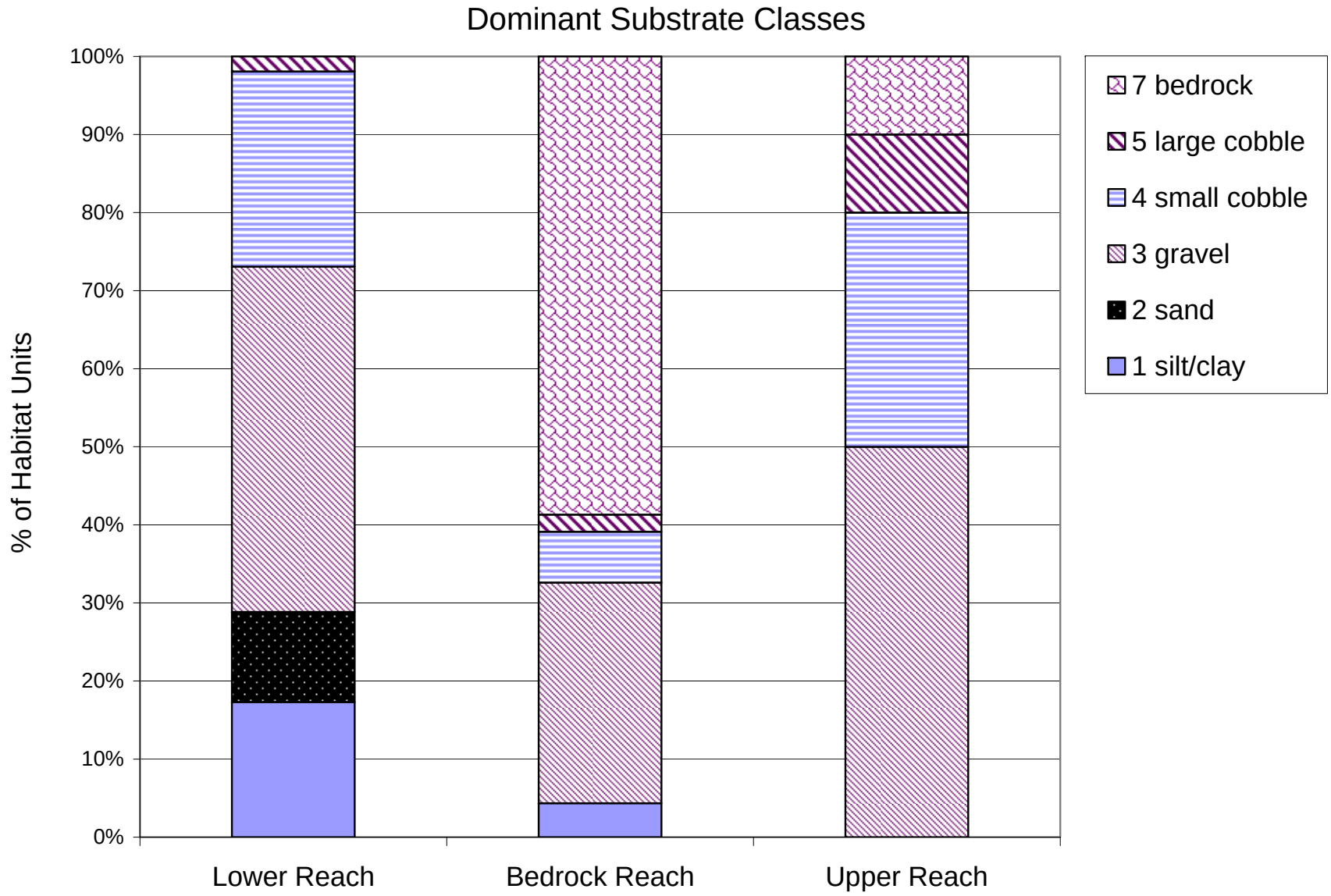


Figure 9. Dominant substrate by reach

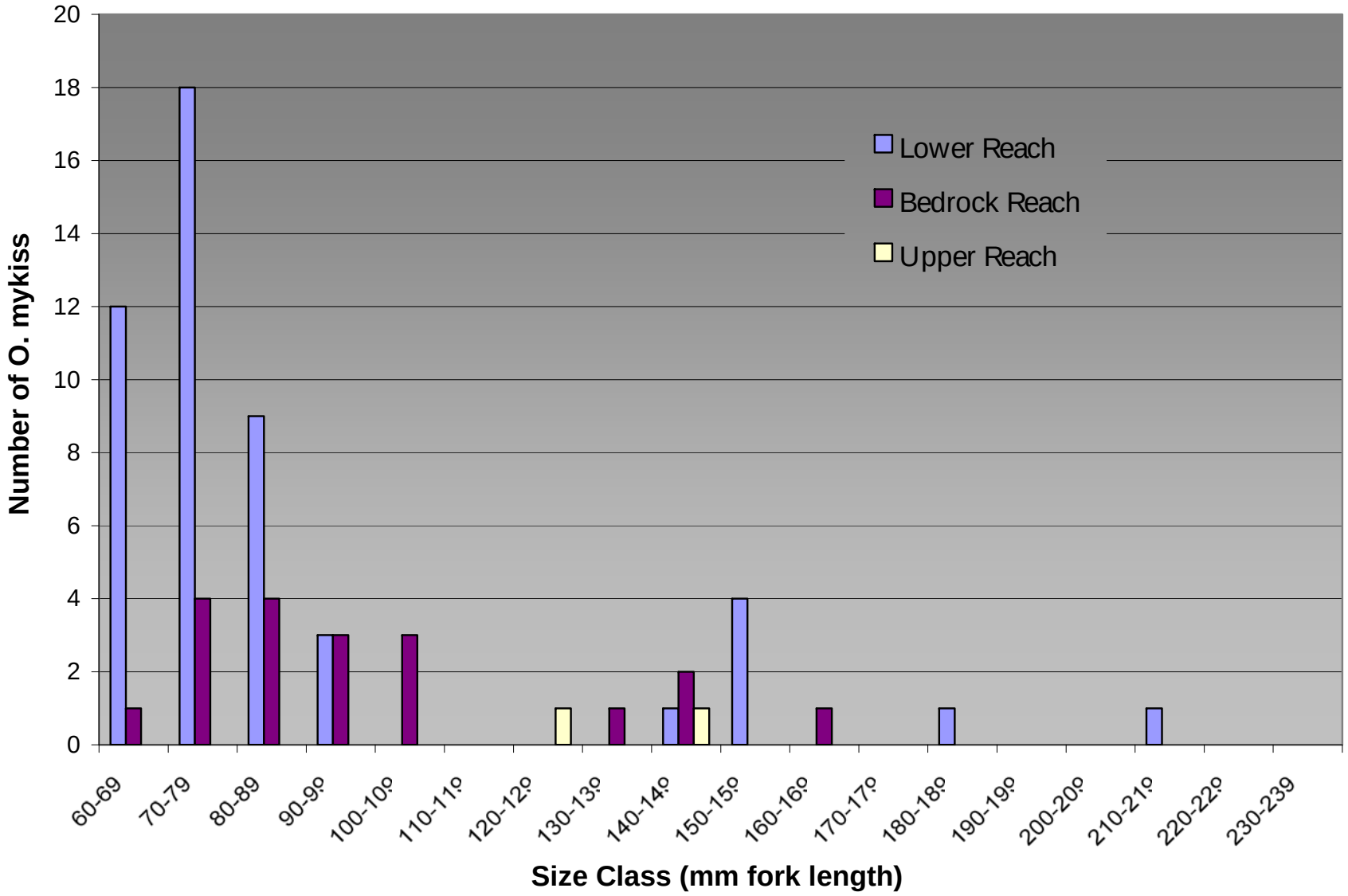
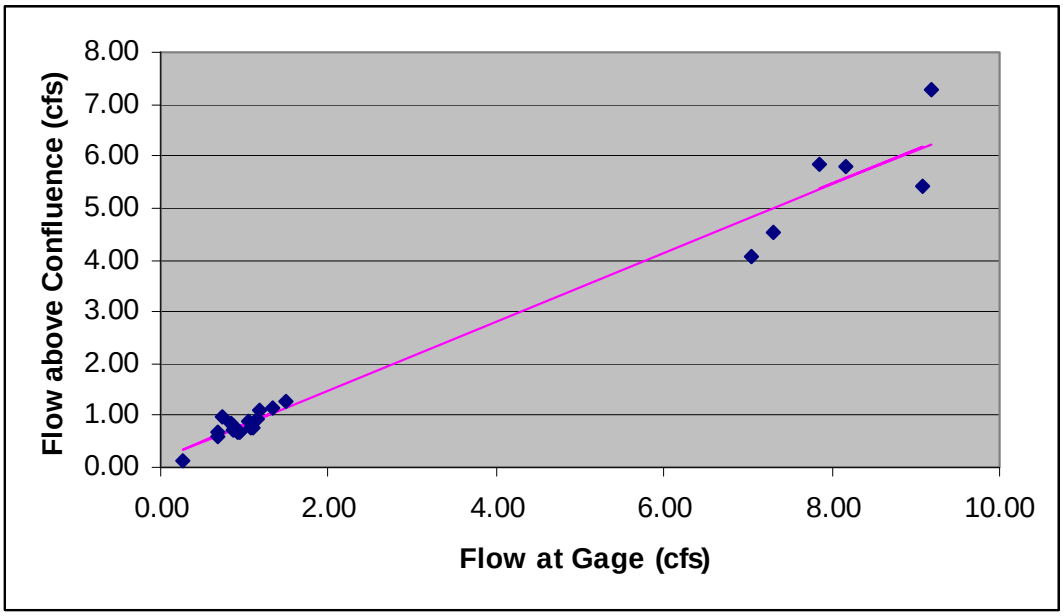


Figure 10. Size Distribution of *O. mykiss* by reach

Appendix D

Liddell Flow above West Branch Confluence

Data Source	Location	Date/Time	Flow at Gage (cfs)	Flow Above Confluence (cfs)
City		4/8/2003	1.18	1.09
City		5/22/2003	1.08	0.77
City		6/17/2003	0.84	0.83
City		7/22/2003	0.87	0.79
City		8/19/2003	0.95	0.68
City		9/23/2003	0.90	0.74
City		10/28/2003	1.15	0.91
City		11/18/2003	1.34	1.14
City		12/16/2003	1.10	0.77
City		5/20/2004	1.06	0.88
City		6/24/2004	0.85	0.73
City		7/21/2004	0.91	0.69
City		8/27/2004	0.68	0.67
City		9/22/2004	0.68	0.61
City		9/25/2007	0.26	0.15
Flow Study	LD R-6	10/25/06 14:05	0.73	0.98
Flow Study	LD R-6	12/14/06 13:35	1.48	1.29
Flow Study	LD R-4	2/12/07 14:38	7.05	4.07
Flow Study	LD S-3	2/12/07 10:34	7.30	4.54
Flow Study	LD R-6	2/12/07 13:08	9.08	5.43
Flow Study	LD-P2	2/12/07 11:55	8.18	5.78
Flow Study	LD S-4	2/12/07 11:08	7.86	5.86
Flow Study	LD R-5	2/12/07 13:59	9.18	7.29



LINEAR REGRESSION
SUMMARY OUTPUT

Regression Statistics	
Multiple R	0.985593
R Square	0.971394
Adjusted R Square	0.970032
Standard Error	0.378048
Observations	23

ANOVA

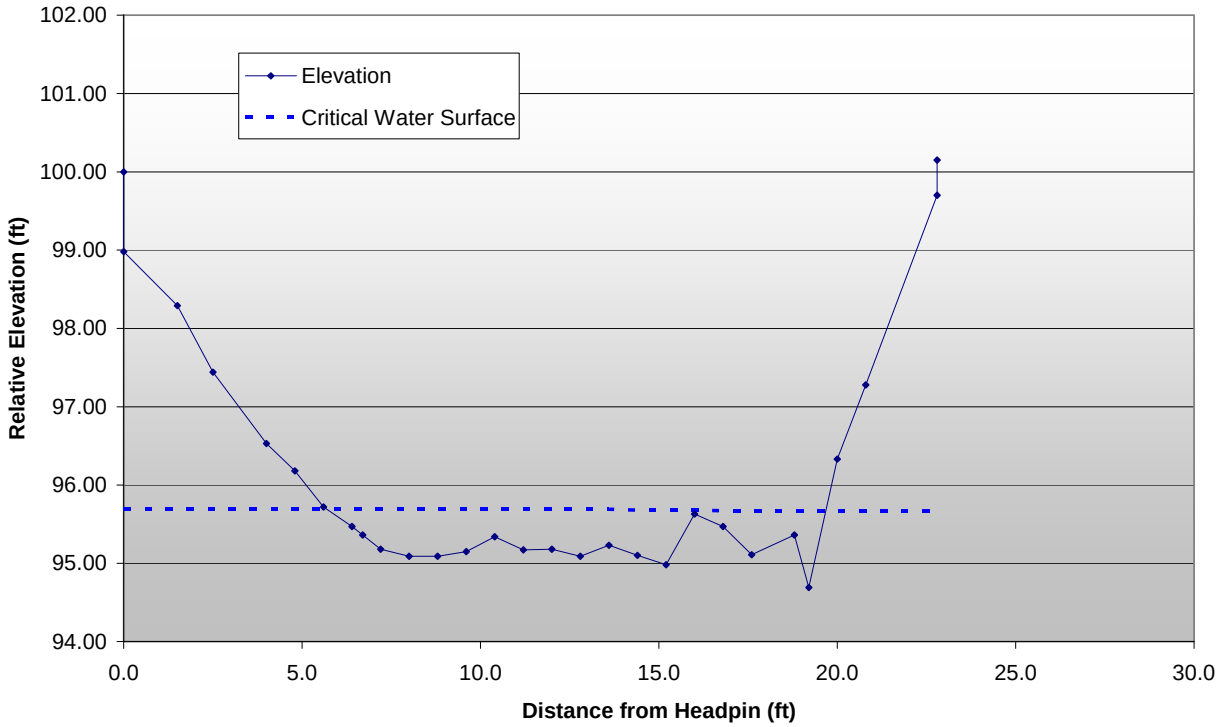
	df	*SS*	*MS*	*F*	*Significance F*
Regression	1	101.919	101.919	713.1187	1.08E-17
Residual	21	3.001323	0.14292		
Total	22	104.9204			

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*Lower 95.0%*	*Upper 95.0%*
Intercept	0.169407	0.105214	1.610108	0.122304	-0.0494	0.388212	-0.0494	0.388212
X Variable 1	0.661603	0.024775	26.70428	1.08E-17	0.610081	0.713126	0.610081	0.713126

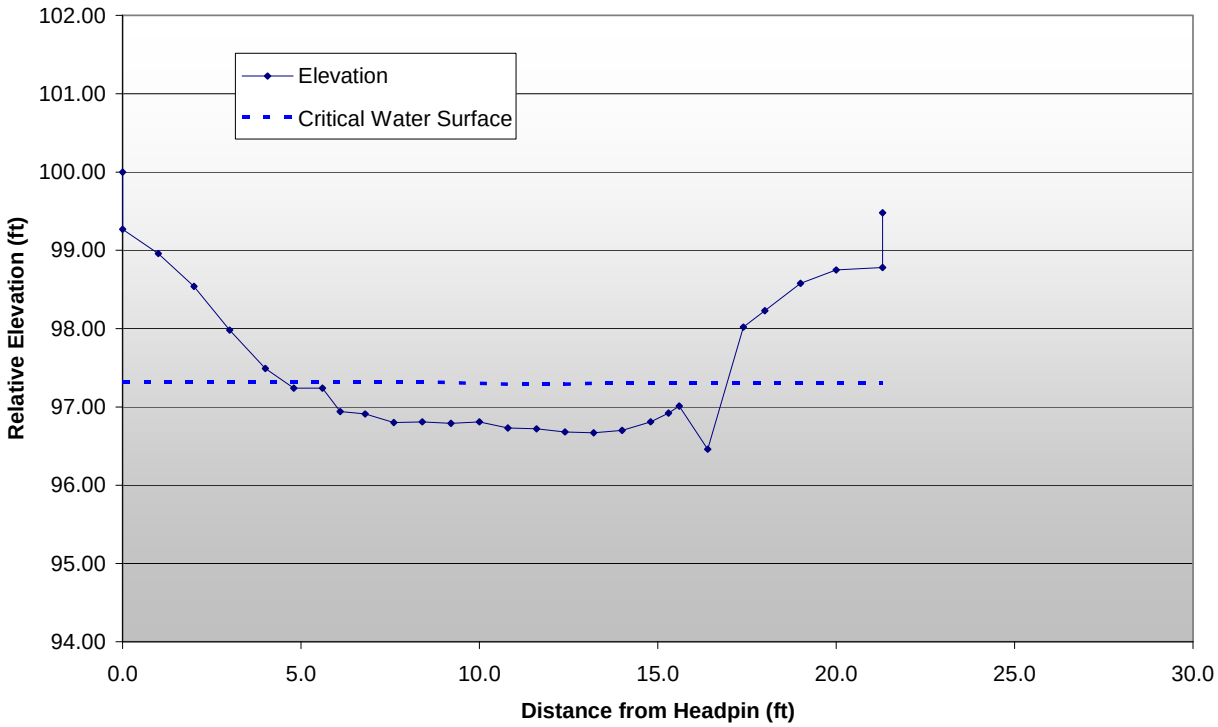
Appendix E

Critical Riffle Cross-sections

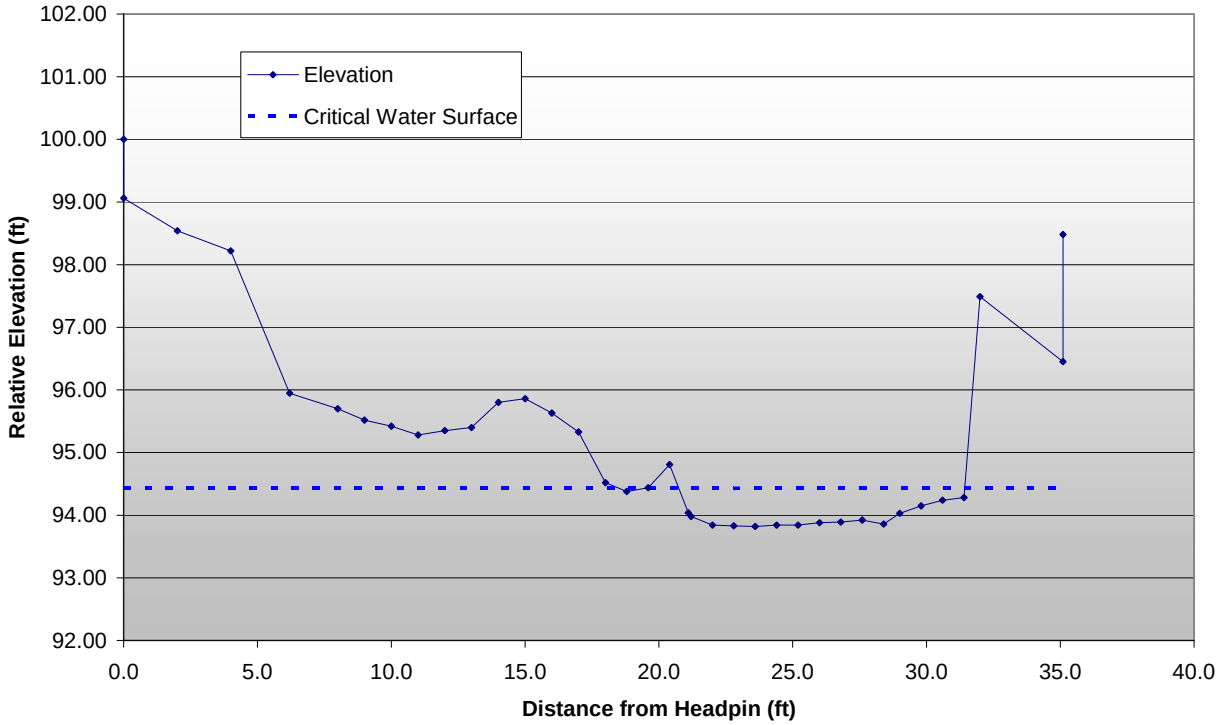
Liddell P-1



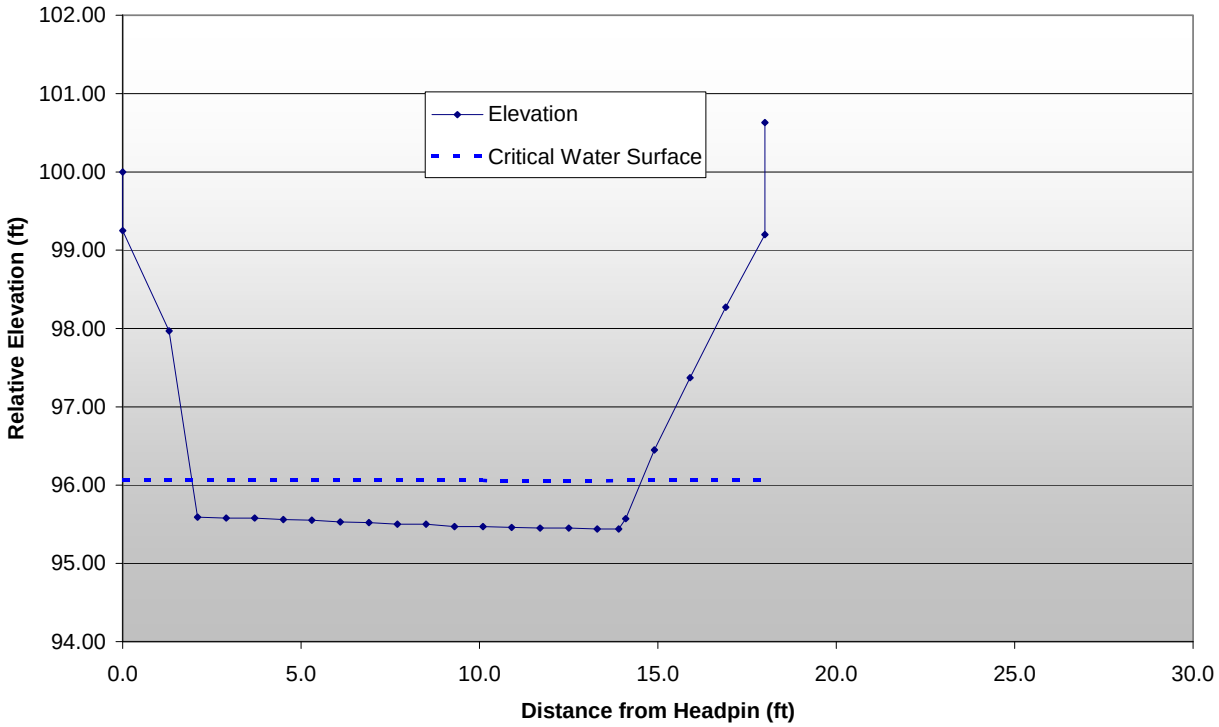
Liddell P-2



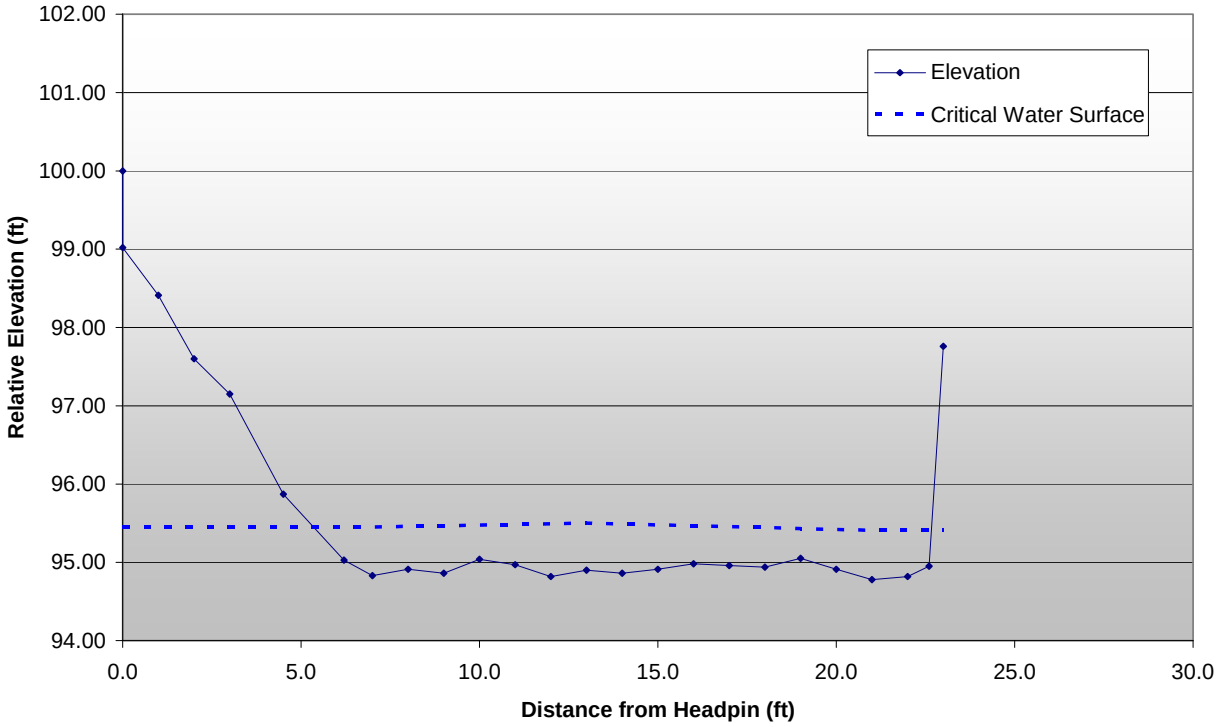
Liddell P-3


Elevation
Critical Water Surface
Relative Elevation (ft)
102.00
101.00
100.00
99.00
98.00
97.00
96.00
95.00
94.00
93.00
92.00
0.0
5.0
10.0
15.0
20.0
25.0
30.0
35.0
40.0
Distance from Headpin (ft)

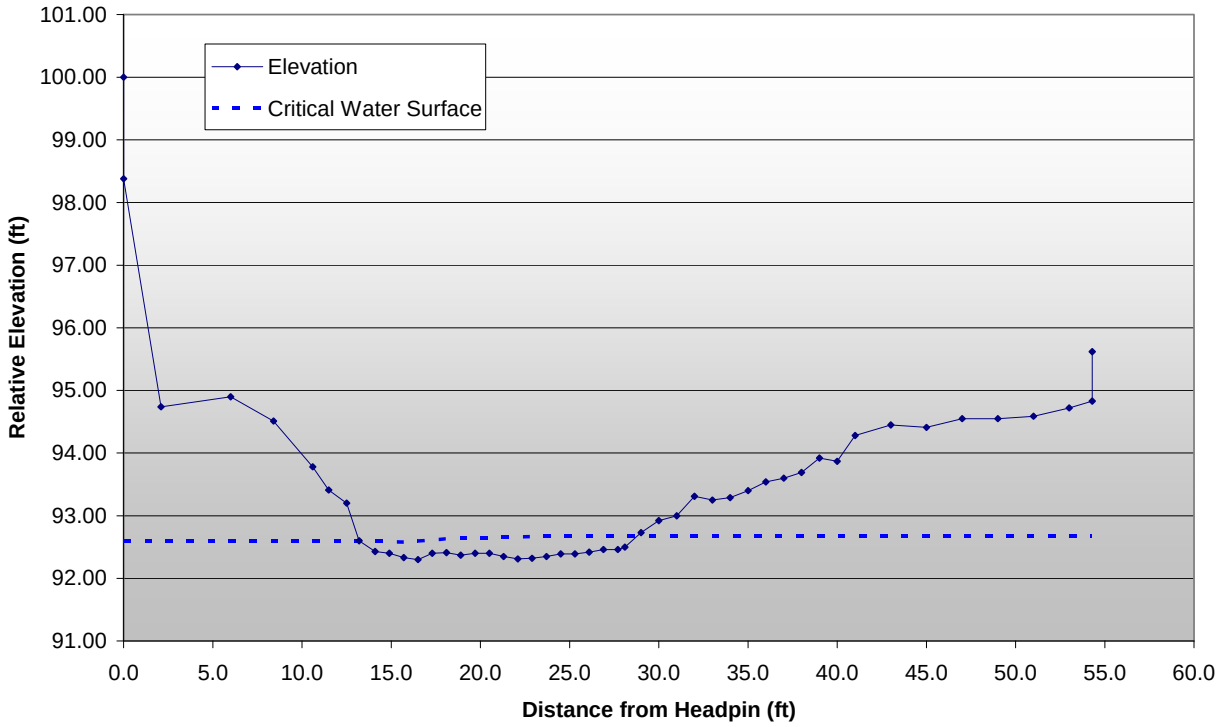
Laguna P-1



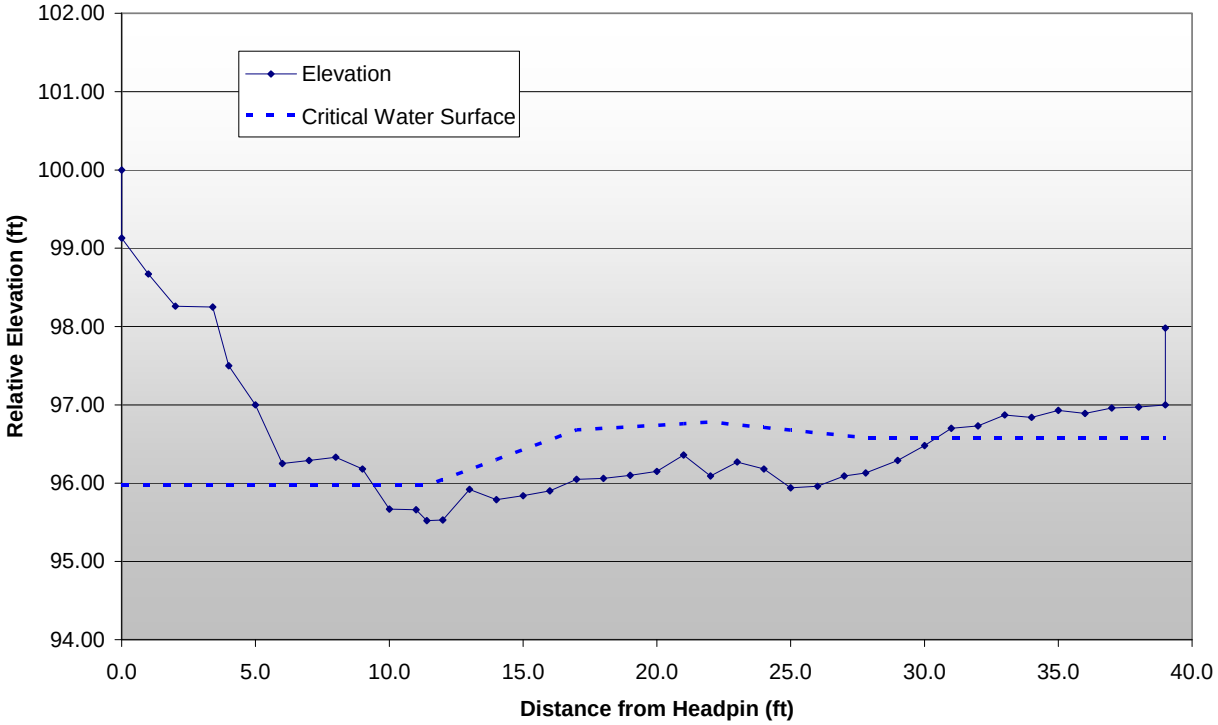
Laguna P-2



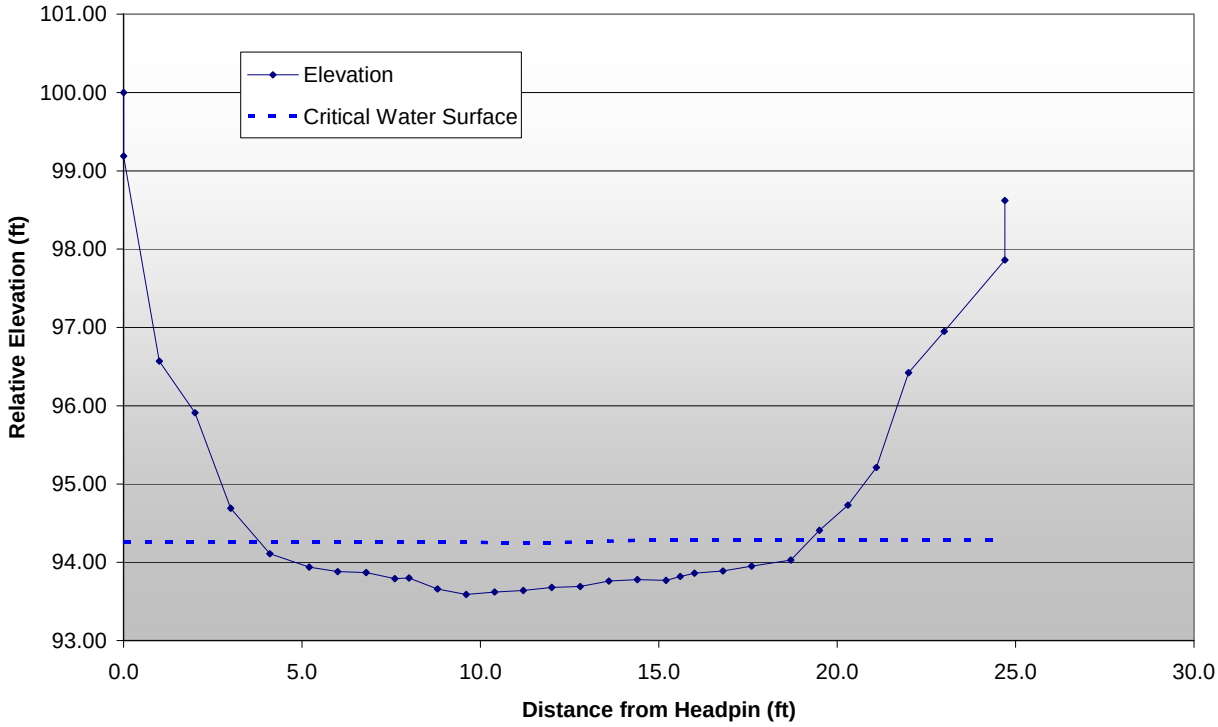
Laguna P-3



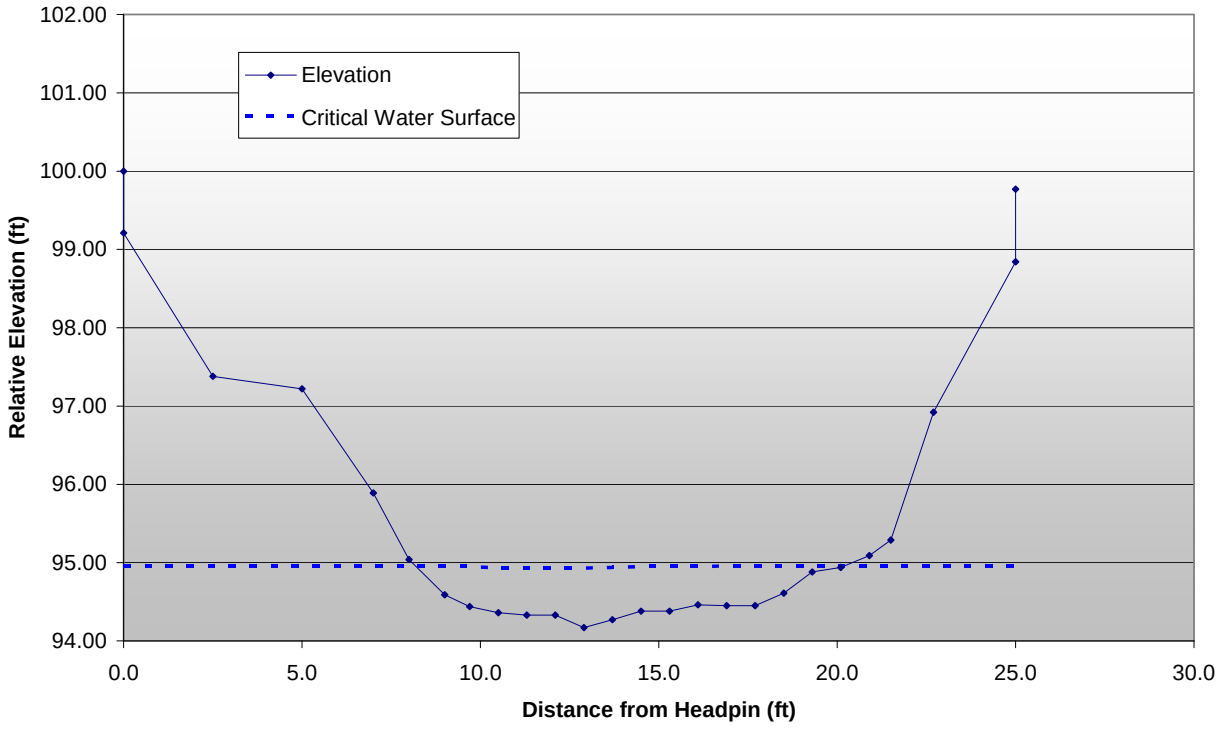
Laguna P-4

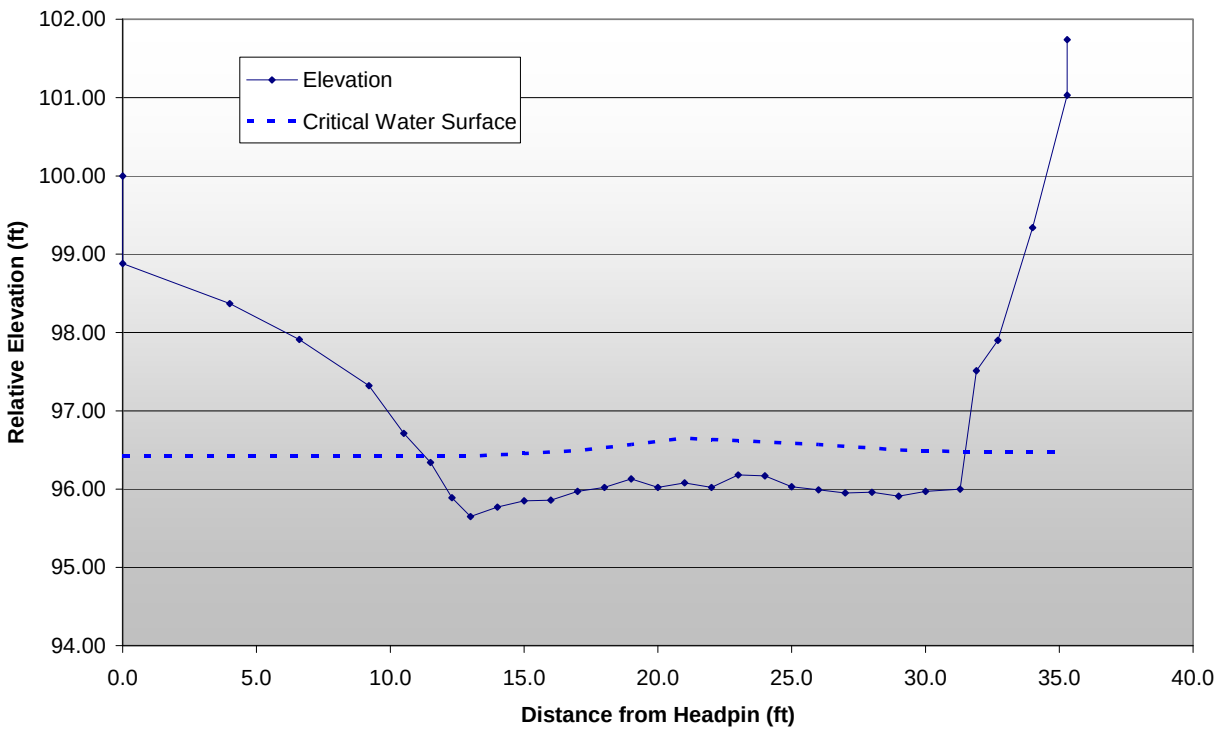


Majors P-1

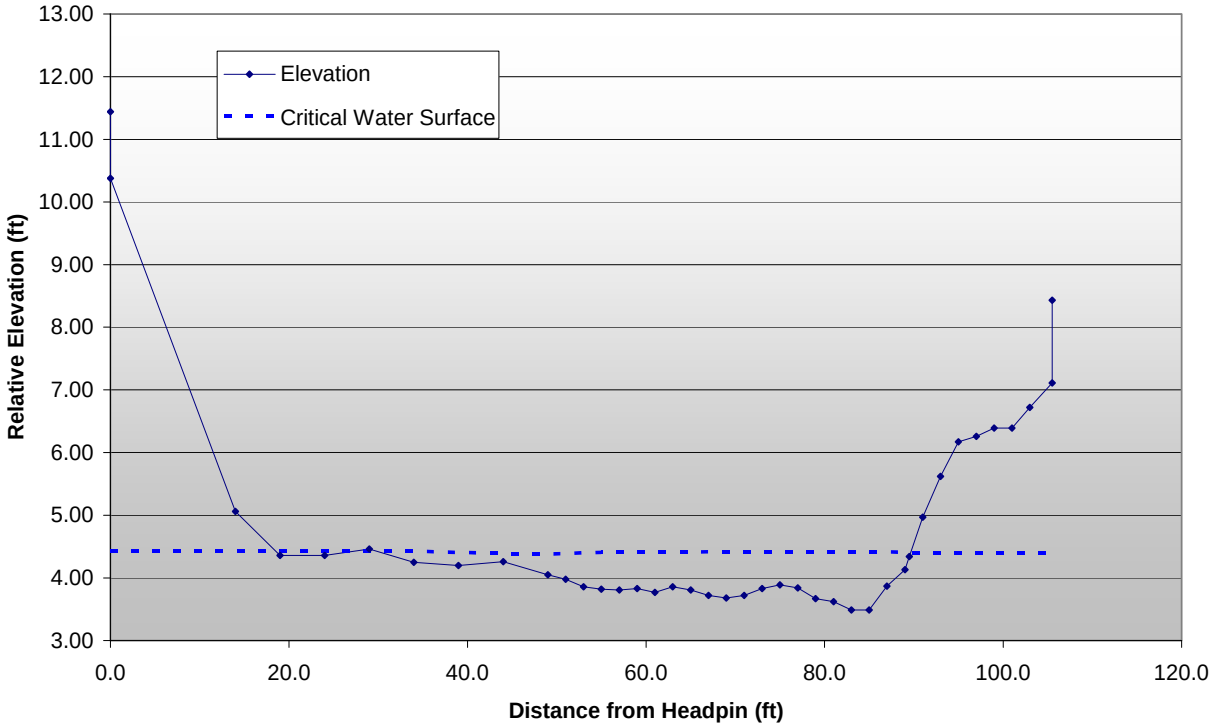


Majors P-2

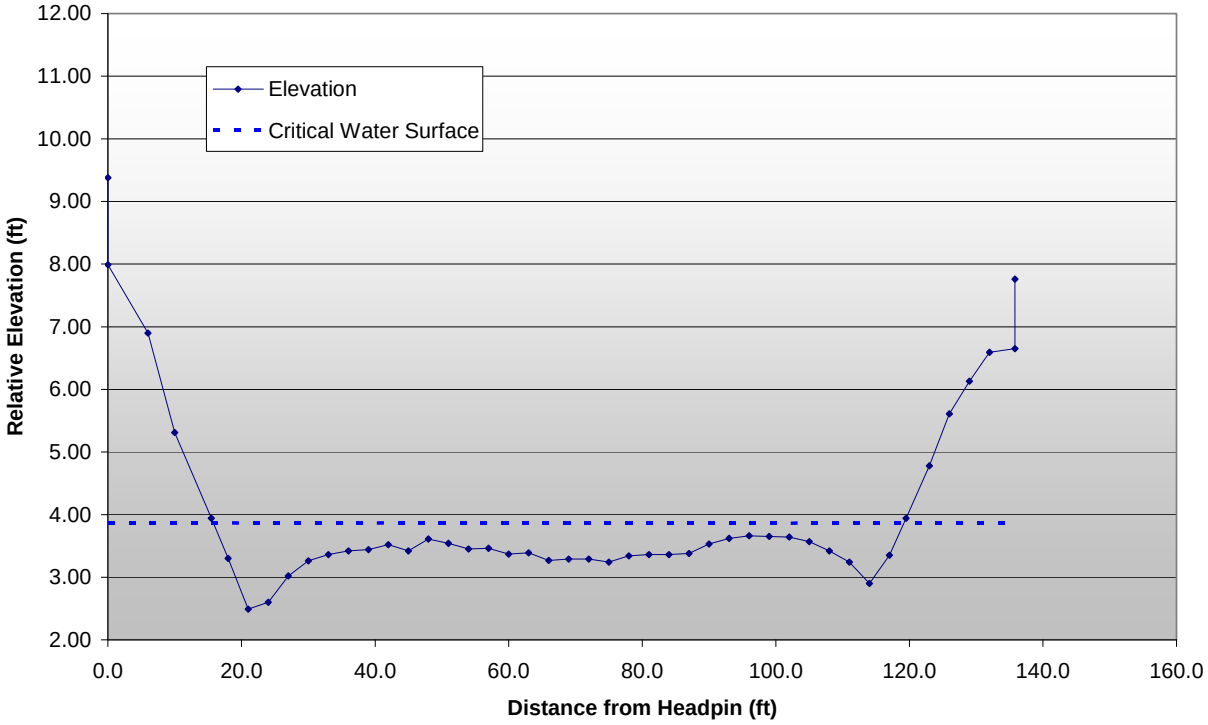



Majors P-3
Elevation
Critical Water Surface
Relative Elevation (ft)
102.00
101.00
100.00
99.00
98.00
97.00
96.00
95.00
94.00
0.0
5.0
10.0
15.0
20.0
25.0
30.0
35.0
40.0
Distance from Headpin (ft)

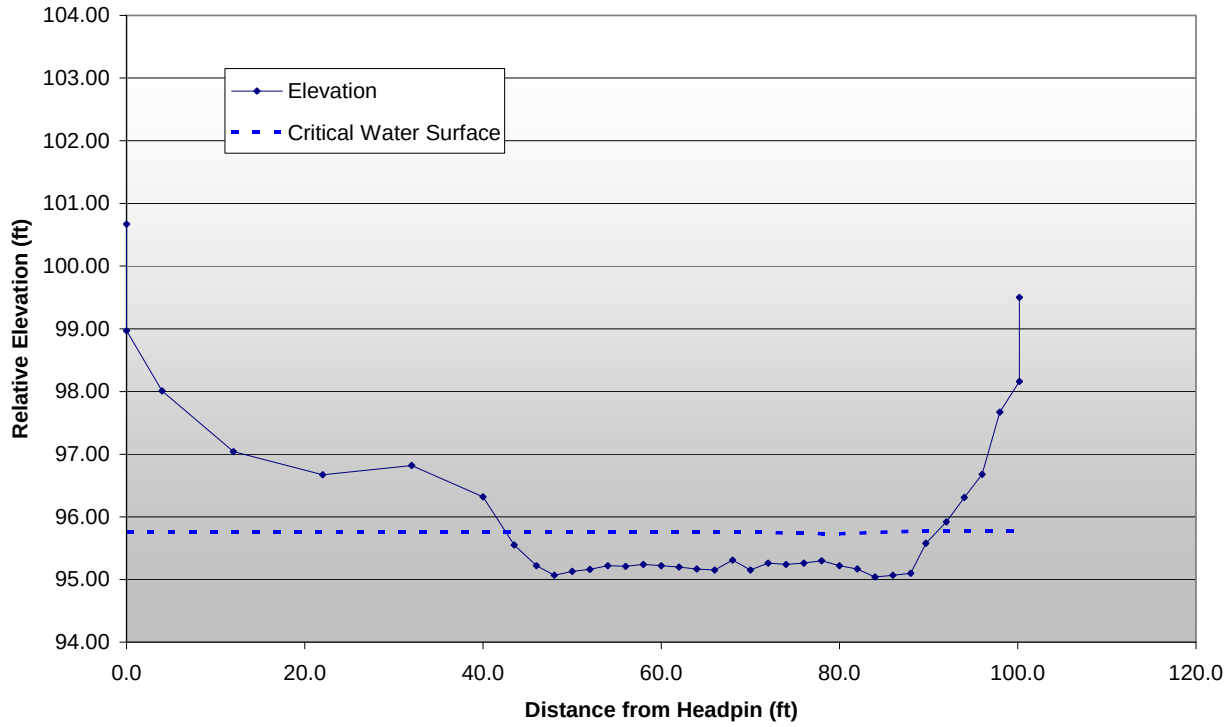
San Lorenzo P-1



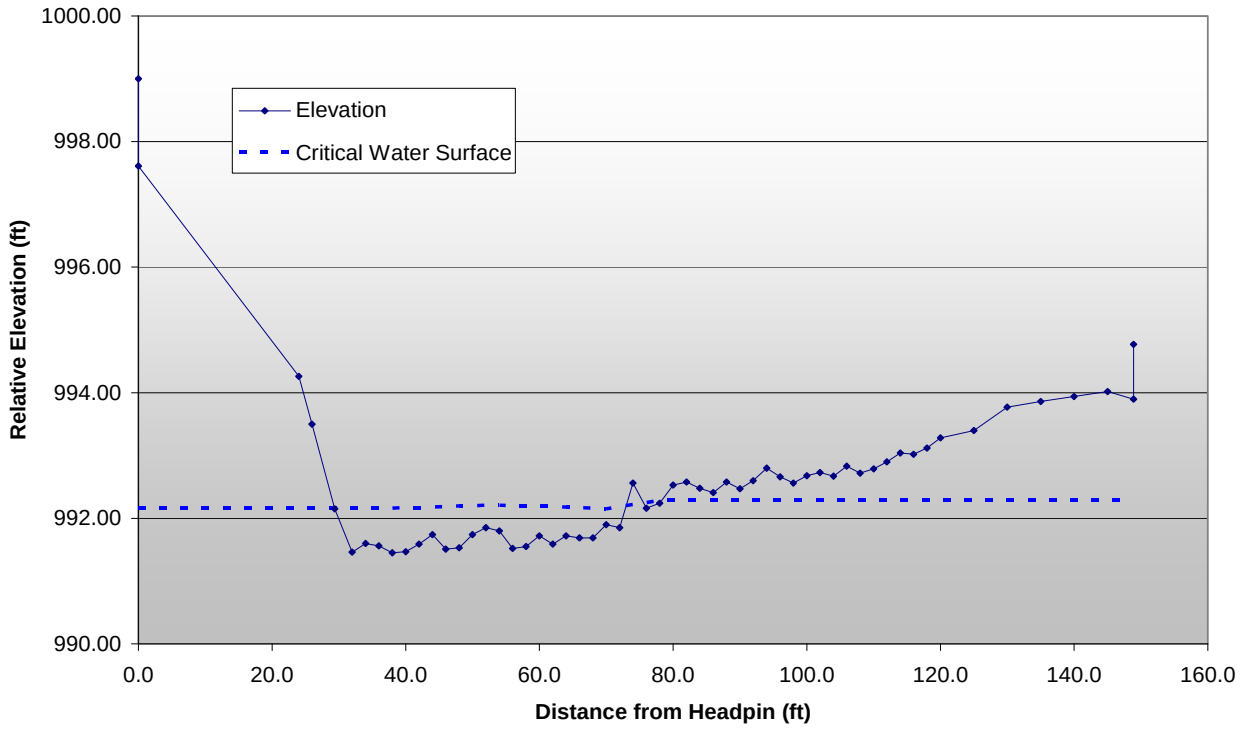
San Lorenzo P-2



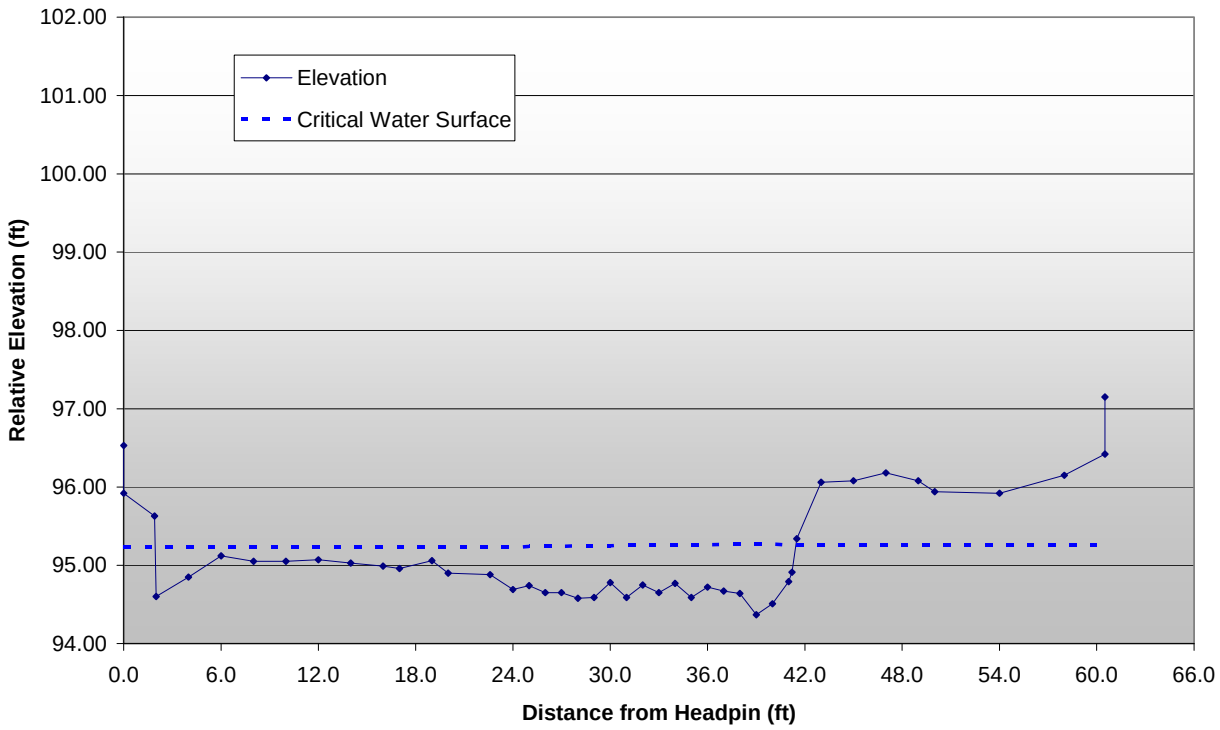
San Lorenzo P-3



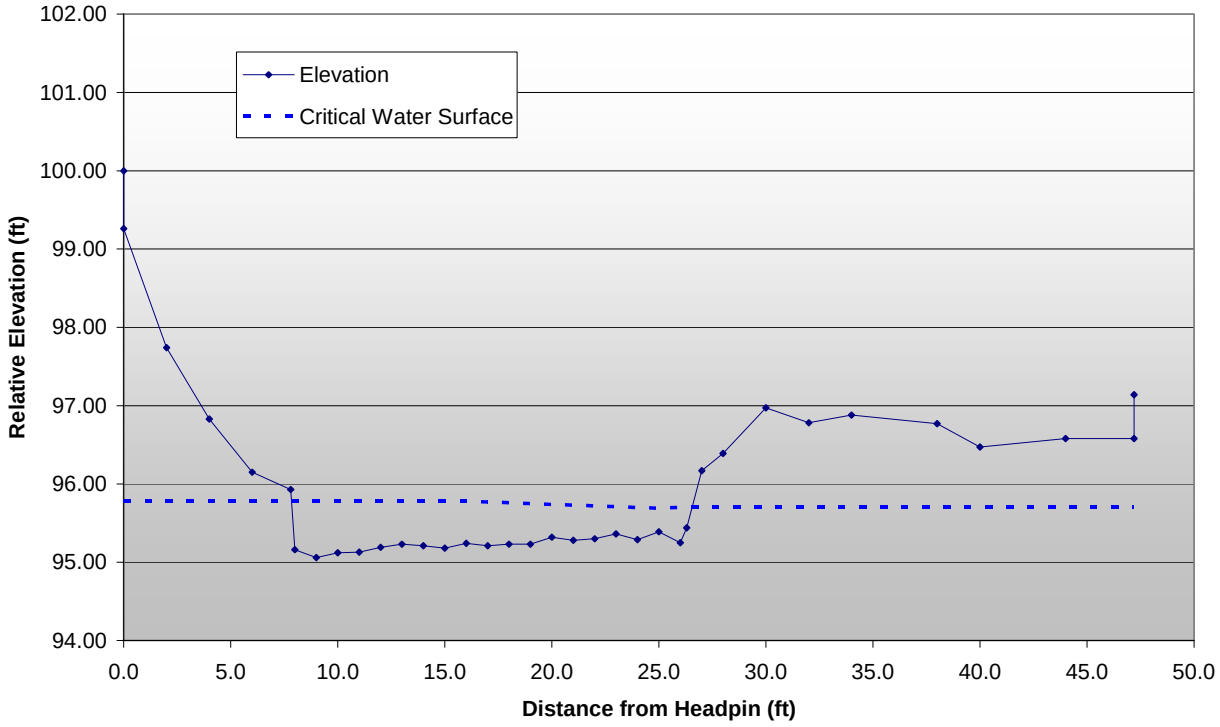
San Lorenzo P-4



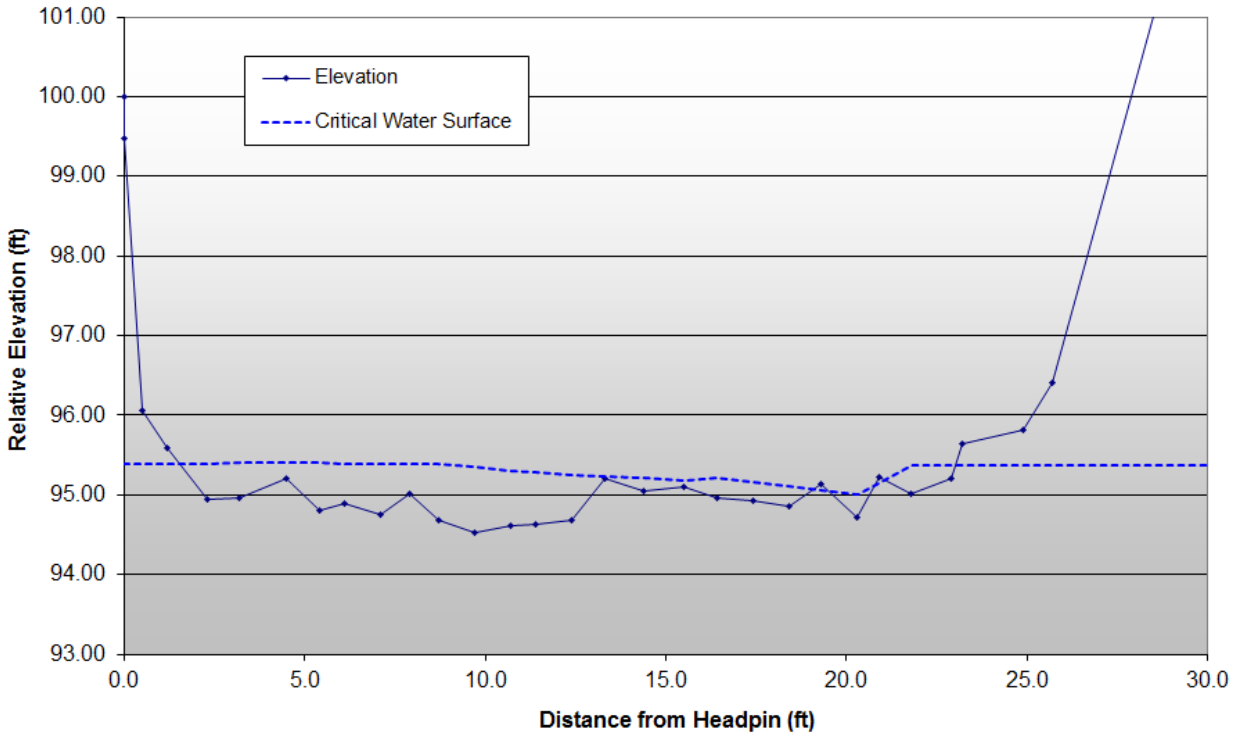
Newell P-1



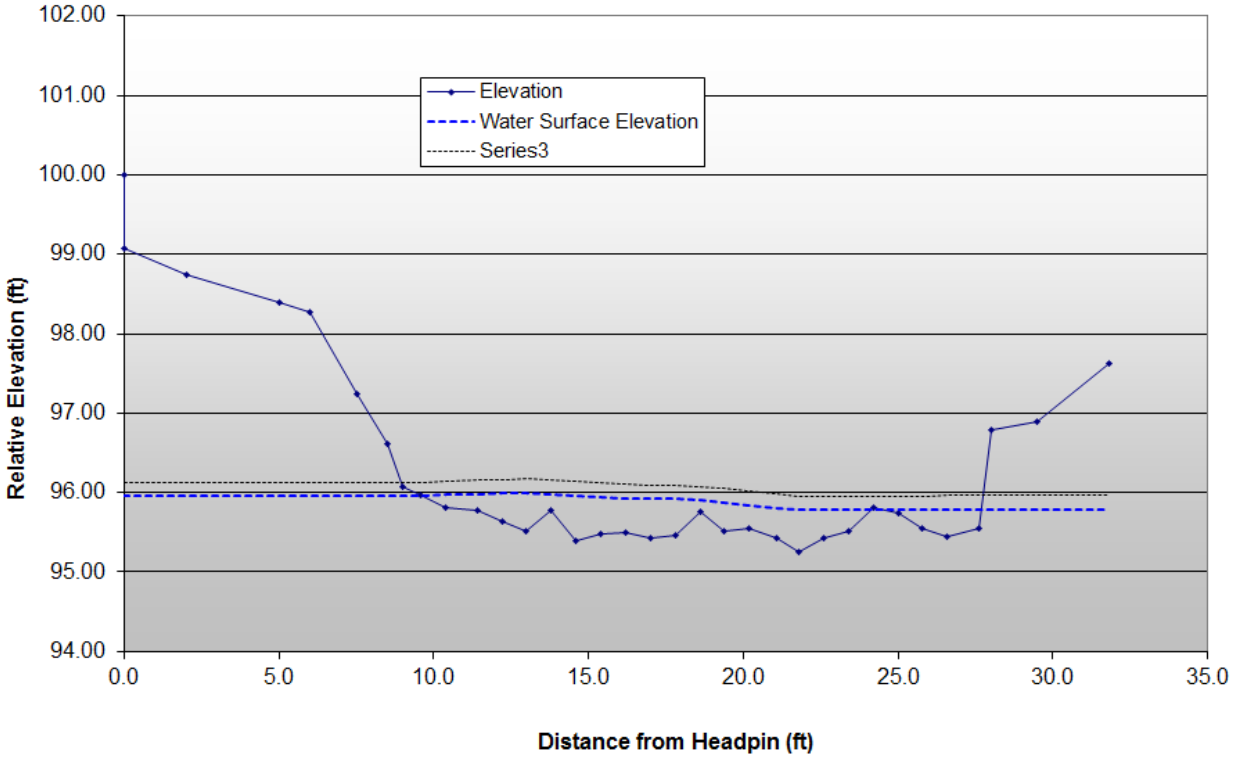
Newell P-2



Newell P-A1

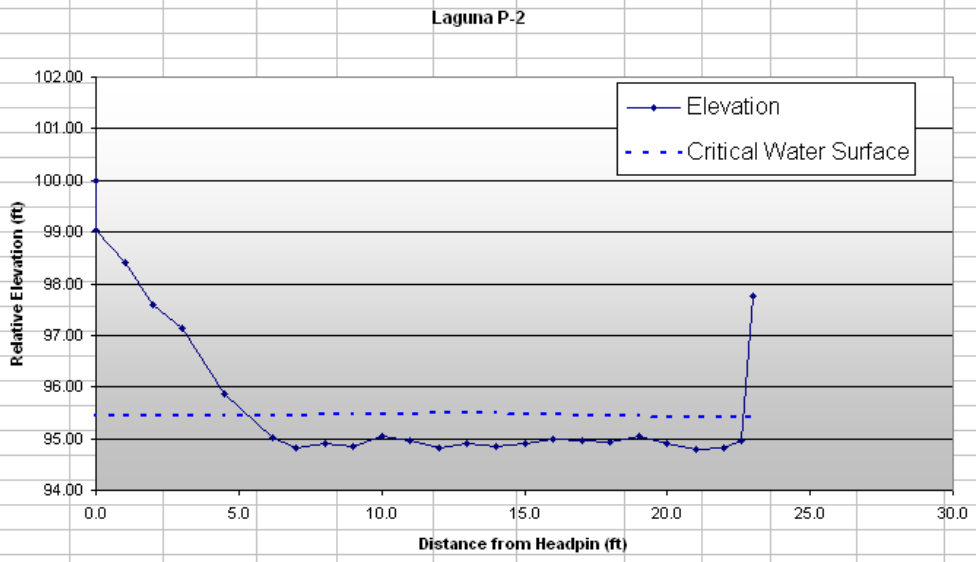


Newell P-A2

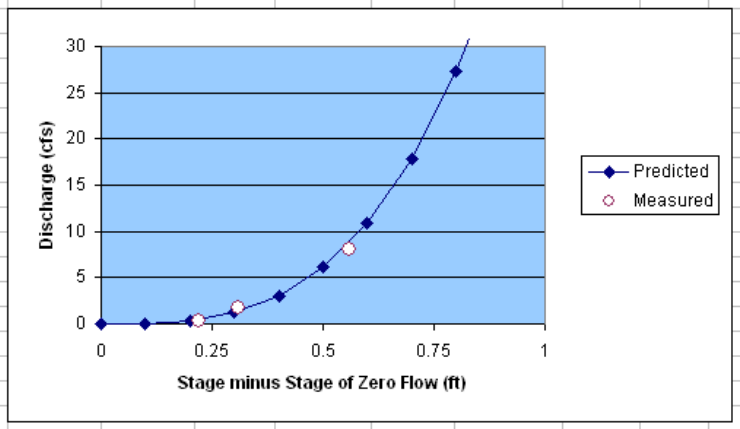


Appendix F

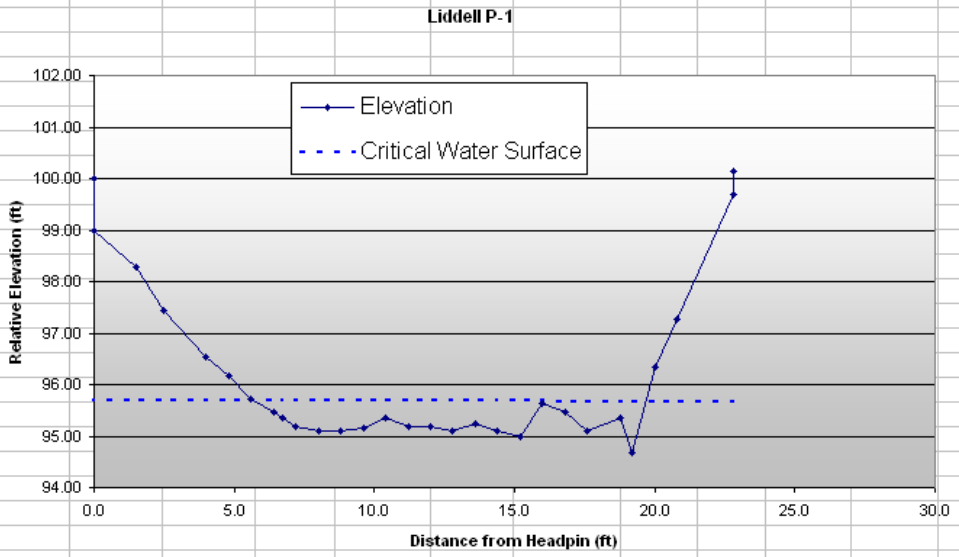
Analytical Data for Adult Extreme Critical Riffles



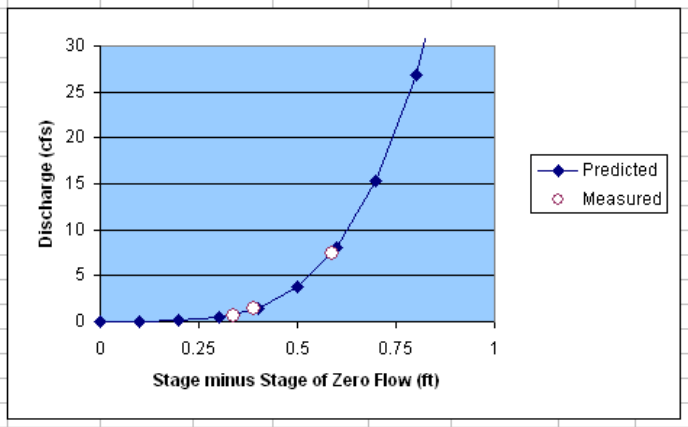
Date	Stage (ft)	Stage minus zero flow (ft)	Discharge (cfs)	Cross-Section nadir (ft)	Stage Zero Flow (ft)
17-Oct-06	95.00	0.22	0.39	94.78	94.78
12-Mar-07	95.09	0.31	1.75		
12-Dec-06	95.34	0.56	8.00		



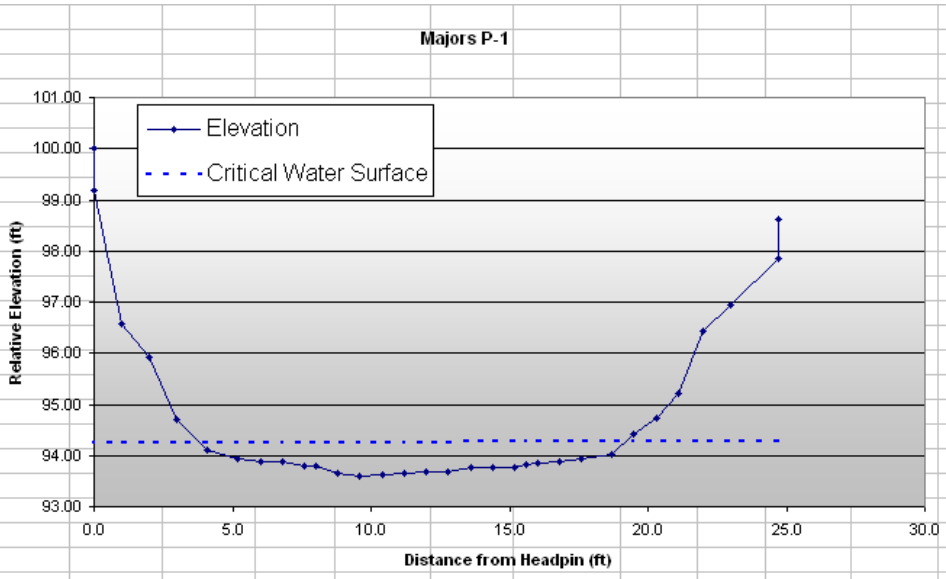
				Depth Criteria = 0.6 feet						
Stage (ft)	Stage Above Zero Flow (ft)	Discharge (cfs)	Wetted Width (ft)	Wetted Width >= Critical Depth (ft)	Percent >= Critical Depth	Longest Continuous Portion >= Critical Depth (ft)	Percent LCP		**Depth Criteria (ft)**	Stage for LCP = 10% of WW (ft)	Discharge (cfs)
94.98	0.2	0.3	13.7	0.0	0%	0.0	0%		**0.2**	95.05	0.9
95.08	0.3	1.2	17.5	0.0	0%	0.0	0%		**0.4**	95.25	5.0
95.18	0.4	3.0	17.5	0.0	0%	0.0	0%		**0.6**	95.45	15.5
95.28	0.5	6.1	17.5	0.0	0%	0.0	0%		**0.8**	95.65	35.5
95.38	0.6	10.9	17.5	1.0	6%	1.0	6%		**1**	95.85	68.5
95.45	0.67	15.5	17.5	5.9	34%	3.0	17%				
95.48	0.7	17.8	17.5	7.7	44%	4.0	23%				
95.58	0.8	27.2	17.5	13.7	79%	8.0	46%				
95.68	0.9	39.6	17.5	17.5	100%	17.5	100%				



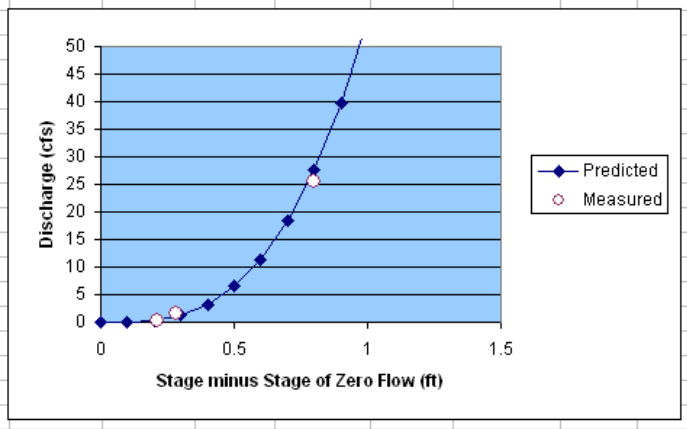
Date	Stage	Stage minus zero flow	Discharge	Cross-Section nadir	Stage Zero Flow
24-Oct-06	95.38	0.34	0.70	94.69	95.04
14-Dec-06	95.43	0.39	1.44		
12-Feb-07	95.63	0.59	7.35		



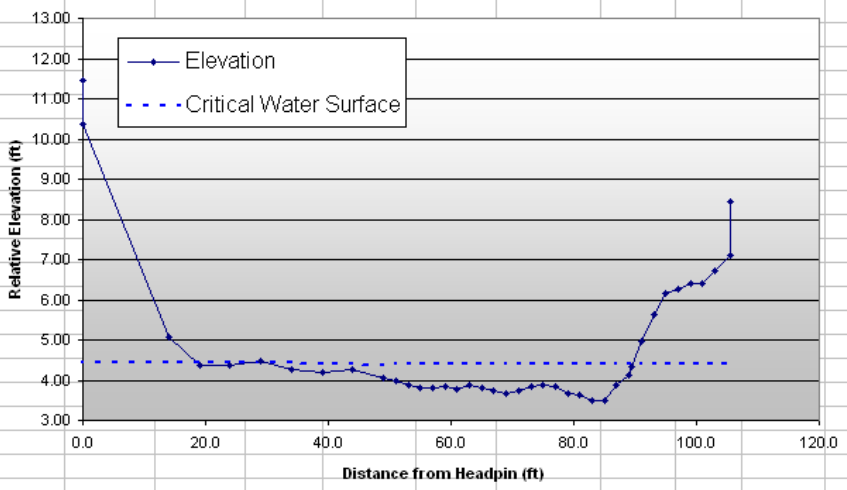
				Depth Criteria = 0.6 feet						
Stage (ft)	Stage Above Zero Flow (ft)	Discharge (cfs)	Wetted Width (ft)	Wetted Width >= Critical Depth (ft)	Percent >= Critical Depth	Longest Continuous Portion >= Critical Depth (ft)	Percent LCP	**Depth Criteria (ft)**	Stage for LCP = 10% of WW (ft)	Discharge (cfs)
95.14	0.1	0.0	5.6	0.0	0%	0.0	0%	**0.2**	95.29	0.2
95.24	0.2	0.1	9.5	0.0	0%	0.0	0%	**0.4**	95.49	2.4
95.34	0.3	0.4	9.5	0.6	6%	0.6	6%	**0.6**	95.69	11.3
95.44	0.4	1.5	11.5	0.6	5%	0.6	5%	**0.8**	95.89	34.6
95.54	0.5	3.8	12.8	0.6	5%	0.6	5%	**1**	96.09	84.0
95.64	0.6	8.1	12.8	1.4	11%	0.8	6%			
95.69	0.65	11.3	13.6	3.8	28%	1.6	12%			
95.74	0.7	15.4	14.4	5.6	39%	1.6	11%			
95.84	0.8	26.9	14.4	9.5	66%	4.8	33%			
95.94	0.9	44.0	14.4	10.3	71%	8.7	60%			



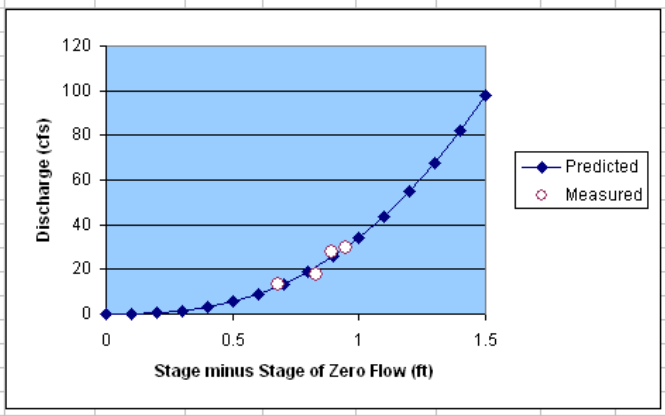
Date	Stage	Stage minus zero flow	Discharge	Cross-Section nadir	Stage Zero Flow
20-Oct-06	93.80	0.21	0.34	93.59	93.59
12-Dec-06	94.39	0.80	25.62		
8-Mar-07	93.87	0.28	1.56		



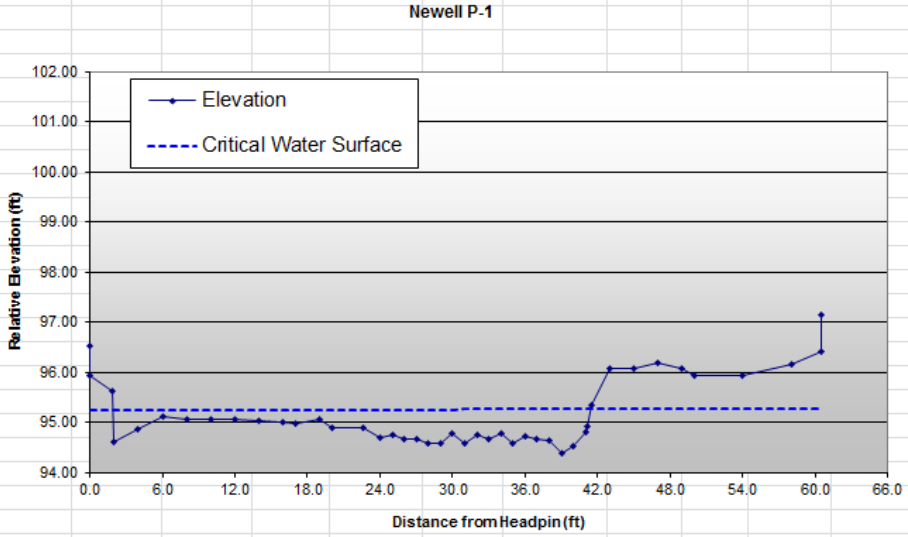
				Depth Criteria = 0.6 feet						
Stage (ft)	Stage Above Zero Flow (ft)	Discharge (cfs)	Wetted Width (ft)	Wetted Width >= Critical Depth (ft)	Percent >= Critical Depth	Longest Continuous Portion >= Critical Depth (ft)	Percent LCP	**Depth Criteria (ft)**	Stage for LCP = 10% of WW (ft)	Discharge (cfs)
93.69	0.1	0.0	3.2	0	0%	0	0%	**0.2**	93.85	0.9
93.79	0.2	0.4	7.0	0	0%	0	0%	**0.4**	94.09	6.5
93.89	0.3	1.3	11.6	0	0%	0	0%	**0.6**	94.26	16.0
93.99	0.4	3.3	13.5	0	0%	0	0%	**0.8**	94.46	35.9
94.09	0.5	6.5	14.5	0	0%	0	0%	**1**	94.66	67.9
94.19	0.6	11.4	15.6	0.8	5%	0.8	5%			
94.26	0.67	16.0	15.6	3.2	21%	3.2	21%			
94.29	0.7	18.3	15.6	4.8	31%	4.8	31%			
94.39	0.8	27.7	15.6	7.6	49%	7	45%			
94.49	0.9	39.8	16.4	11.6	71%	11.6	71%			



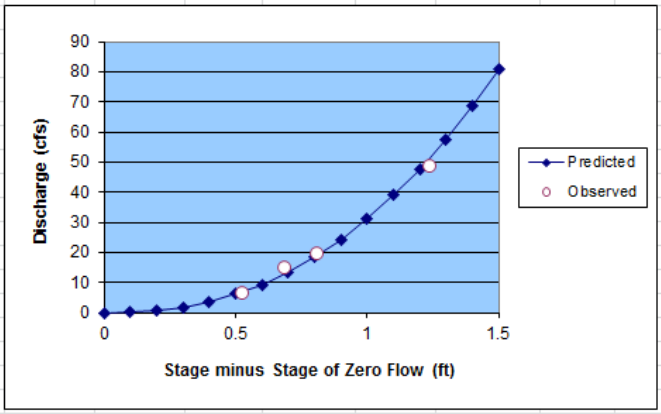
Date	Stage (ft)	Stage minus zero flow (ft)	Discharge (cfs)	Cross-Section nadir (ft)	Stage Zero Flow (ft)
12-Oct-05	4.34	4.34	18.00	3.49	3.51
20-Oct-05	4.19	4.19	13.00		
6-Dec-05	4.40	4.40	28.00		
6-Dec-05	4.46	4.46	30.00		



				Depth Criteria = 0.6 feet						
Stage (ft)	Stage Above Zero Flow (ft)	Discharge (cfs)	Wetted Width (ft)	Wetted Width >= Critical Depth (ft)	Percent >= Critical Depth	Longest Continuous Portion >= Critical Depth (ft)	Percent LCP	**Depth Criteria (ft)**	Stage for LCP = 10% of WW (ft)	Discharge (cfs)
3.71	0.2	0.5	14.0	0.0	0%	0.0	0%	**0.2**	3.67	0.3
3.81	0.3	1.5	20.0	0.0	0%	0.0	0%	**0.4**	4.1	8.6
3.91	0.4	3.1	36.0	0.0	0%	0.0	0%	**0.6**	4.4	25.2
4.01	0.5	5.6	38.0	0.0	0%	0.0	0%	**0.8**	4.6	42.7
4.11	0.6	9.0	41.5	4.0	10%	4.0	10%	**1**	4.8	66.2
4.21	0.7	13.5	47.8	6.0	13%	6.0	13%			
4.31	0.8	19.1	57.8	14.0	24%	8.0	14%			
4.40	0.89	25.2	68.8	20.0	29%	8.0	12%			
4.41	0.9	34.1	68.8	24.0	35%	10.0	15%			
4.51	1	43.7	73.8	36.0	49%	36.0	49%			
4.61	1.1	54.86	73.75	38.0	52%	38.0	52%			



Date	Stage (ft)	Stage minus zero flow (ft)	Discharge (cfs)	Cross-Section nadir (ft)	Stage Zero Flow (ft)
25-Feb-08	95.61	1.24	48.59	94.37	94.37
26-Feb-08	95.18	0.81	19.74		
27-Feb-08	95.06	0.69	15.01		
3-Mar-08	94.90	0.53	6.27		



				Depth Criteria = 0.6 feet						
Stage (ft)	Stage Above Zero Flow (ft)	Discharge (cfs)	Wetted Width (ft)	Wetted Width >= Critical Depth (ft)	Percent >= Critical Depth	Longest Continuous Portion >= Critical Depth (ft)	Percent LCP		**Depth Criteria (ft)**	Stage for LCP = 10% of WW (ft)	Discharge (cfs)
94.57	0.2	0.7	2.0	0.0	0%	0.0	0%		**0.2**	94.8	4.3
94.67	0.3	1.8	9.1	0.0	0%	0.0	0%		**0.4**	95.04	12.2
94.77	0.4	3.6	15.3	0.0	0%	0.0	0%		**0.6**	95.27	24.4
94.87	0.5	6.1	18.9	0.0	0%	0.0	0%		**0.8**	95.47	39.0
94.97	0.6	9.4	24.9	1.0	4%	1.0	4%		**1**	95.67	57.8
95.07	0.7	13.5	27.9	1.0	4%	1.0	4%				
95.17	0.8	18.5	39.4	2.0	5%	2.0	5%				
95.27	0.9	24.4	39.4	10.1	26%	4.0	10%				
95.37	1	31.2	40.3	16.3	40%	6.2	15%				
95.47	1.1	39.0	40.3	18.9	47%	17.8	44%				

Appendix G

WUA vs. Discharge Data

Table G-1. WUA vs. Discharge for Steelhead Spawning in Liddell Creek.

Simulated Flow	Equivalent Flow above West Branch	WUA below West Branch	WUA above West Branch	WUA combined	Percent of Peak WUA
1.0	0.83	540	358	898	15.7%
2.0	1.49	923	568	1491	26.1%
3.0	2.15	1305	812	2117	37.0%
4.0	2.82	1718	1094	2812	49.1%
5.0	3.48	2033	1385	3419	59.7%
6.0	4.14	2260	1702	3962	69.2%
7.0	4.8	2483	2012	4495	78.6%
8.0	5.46	2688	2285	4973	86.9%
8.5	5.79	2785	2409	5194	90.8%
9.0	6.12	2811	2509	5320	93.0%
9.5	6.45	2825	2600	5425	94.8%
10.0	6.79	2809	2690	5499	96.1%
10.5	7.12	2802	2770	5571	97.4%
11.0	7.45	2809	2828	5637	98.5%
11.5	7.78	2803	2881	5683	99.3%
12.0	8.11	2785	2923	5709	99.8%
13.0	8.77	2720	3002	5722	100.0%
14.0	9.43	2658	3061	5719	99.9%
15.0	10.09	2584	3087	5670	99.1%
16.0	10.76	2504	3085	5588	97.7%
17.0	11.42	2413	3068	5481	95.8%
18.0	12.08	2341	3027	5368	93.8%
19.0	12.74	2272	2958	5231	91.4%
20.0	13.4	2199	2866	5065	88.5%
21.0	14.06	2114	2778	4892	85.5%
23.0	15.39	1917	2576	4493	78.5%
25.0	16.71	1740	2404	4144	72.4%
27.0	18.03	1590	2213	3803	66.5%
29.0	19.36	1432	2055	3487	60.9%
31.0	20.68	1302	1921	3223	56.3%

Table G-2. WUA vs. Discharge for Coho Salmon Spawning in Liddell Creek.

Simulated Flow	Equivalent Flow above West Branch	WUA below West Branch	WUA above West Branch	WUA combined	Percent of Peak WUA
1.0	1.1	667	164	830	23.2%
2.0	1.7	1326	343	1669	46.6%
3.0	2.2	1763	506	2269	63.3%
4.0	2.8	2069	654	2723	76.0%
5.0	3.4	2241	792	3033	84.6%
6.0	3.9	2367	928	3295	91.9%
7.0	4.5	2459	1055	3514	98.0%
8.0	5.1	2432	1147	3579	99.8%
8.5	5.3	2405	1179	3585	100.0%
9.0	5.6	2377	1199	3576	99.7%
9.5	5.9	2351	1219	3570	99.6%
10.0	6.2	2330	1242	3572	99.7%
10.5	6.5	2287	1254	3541	98.8%
11.0	6.8	2237	1263	3500	97.6%
11.5	7.0	2177	1258	3434	95.8%
12.0	7.3	2130	1255	3386	94.4%
13.0	7.9	2038	1259	3298	92.0%
14.0	8.4	1907	1251	3158	88.1%
15.0	9.0	1807	1216	3024	84.3%
16.0	9.6	1734	1182	2916	81.3%
17.0	10.1	1662	1132	2794	77.9%
18.0	10.7	1585	1087	2672	74.5%
19.0	11.3	1517	1046	2563	71.5%
20.0	11.8	1438	1012	2450	68.4%
21.0	12.4	1354	981	2336	65.2%
23.0	13.5	1195	901	2096	58.5%
25.0	14.7	1060	812	1872	52.2%
27.0	15.8	919	727	1646	45.9%
29.0	16.9	806	640	1446	40.3%
31.0	18.0	689	592	1281	35.7%

Table G-3. WUA vs. Discharge for Steelhead and Coho Salmon Spawning in Laguna Creek.

Simulated Flow	Steelhead WUA	Percent of Peak	Coho WUA	Percent of Peak
0.2	296	4.7%	133	2.8%
0.5	459	7.3%	485	10.2%
0.6	489	7.8%	554	11.6%
2.0	1221	19.5%	1805	37.9%
2.1	1251	20.0%	1850	38.8%
4.0	2275	36.3%	3088	64.8%
6.0	3359	53.7%	3942	82.7%
8.0	4408	70.4%	4478	94.0%
8.9	4832	77.2%	4600	96.5%
10.0	5313	84.9%	4693	98.5%
12.0	5889	94.1%	4765	100.0%
14.0	6146	98.2%	4760	99.9%
16.0	6261	100.0%	4720	99.0%
18.0	6254	99.9%	4612	96.8%
18.5	6240	99.7%	4585	96.2%
20.0	6191	98.9%	4482	94.1%
22.0	6017	96.1%	4351	91.3%
24.0	5803	92.7%	4212	88.4%
26.0	5594	89.3%	4068	85.4%
28.0	5431	86.7%	3923	82.3%
30.0	5304	84.7%	3803	79.8%
32.0	5181	82.7%	3685	77.3%
34.0	5057	80.8%	3560	74.7%
36.0	4949	79.0%	3439	72.2%
38.0	4804	76.7%	3340	70.1%
40.0	4658	74.4%	3252	68.2%
42.0	4515	72.1%	3182	66.8%
44.0	4365	69.7%	3118	65.4%
46.0	4200	67.1%	3041	63.8%

Table G-4. WUA vs. Discharge for Steelhead and Coho Salmon Spawning in Majors Creek.

Simulated Flow	Steelhead WUA	Percent of Peak	Coho WUA	Percent of Peak
0.2	275	4.2%	26	0.5%
0.5	505	7.7%	456	8.6%
2.0	1390	21.1%	1751	33.1%
4.0	2232	33.8%	2631	49.8%
6.0	3055	46.3%	3398	64.3%
8.0	3854	58.4%	3996	75.7%
10.0	4582	69.4%	4534	85.8%
12.0	5250	79.6%	4945	93.6%
14.0	5813	88.1%	5207	98.6%
16.0	6285	95.3%	5282	100.0%
18.0	6548	99.3%	5124	97.0%
20.0	6598	100.0%	4861	92.0%
22.0	6432	97.5%	4547	86.1%
24.0	6168	93.5%	4173	79.0%
26.0	5913	89.6%	3804	72.0%
28.0	5674	86.0%	3466	65.6%
30.0	5472	82.9%	3189	60.4%
32.0	5328	80.7%	2937	55.6%
34.0	5169	78.3%	2748	52.0%
36.0	4951	75.0%	2601	49.3%
38.0	4710	71.4%	2474	46.8%
40.0	4457	67.6%	2362	44.7%
42.0	4236	64.2%	2266	42.9%
44.0	4037	61.2%	2171	41.1%
46.0	3847	58.3%	2091	39.6%

Table G-5. WUA vs. Discharge for Steelhead and Coho Salmon Spawning in Newell Creek.

Simulated Flow	Steelhead WUA	Percent of Peak	Coho WUA	Percent of Peak
1.00	917	8.5%	1069	11.8%
2.00	1534	14.1%	2741	30.3%
3.00	2331	21.5%	3875	42.8%
4.00	3191	29.4%	4743	52.4%
5.00	4057	37.4%	5440	60.1%
6.00	4909	45.2%	6032	66.6%
7.00	5695	52.5%	6505	71.8%
8.00	6392	58.9%	6901	76.2%
9.00	6941	63.9%	7217	79.7%
10.00	7422	68.4%	7488	82.7%
12.00	8217	75.7%	7968	88.0%
14.00	8870	81.7%	8380	92.6%
16.00	9441	87.0%	8759	96.7%
18.00	9912	91.3%	8947	98.8%
20.00	10315	95.0%	9054	100.0%
22.00	10639	98.0%	9047	99.9%
24.00	10805	99.5%	8974	99.1%
26.00	10855	100.0%	8872	98.0%
28.00	10846	99.9%	8650	95.5%
30.00	10692	98.5%	8383	92.6%
32.00	10453	96.3%	8054	89.0%
34.00	10153	93.5%	7713	85.2%
36.00	9794	90.2%	7375	81.5%
38.00	9379	86.4%	6989	77.2%
40.00	8900	82.0%	6598	72.9%
50.00	6705	61.8%	4778	52.8%
60.00	5218	48.1%	3527	39.0%
80.00	3626	33.4%	1729	19.1%
100.00	2317	21.3%	1024	11.3%
120.00	1364	12.6%	717	7.9%

Table G-6. WUA vs. Discharge for Steelhead Juvenile Rearing in Liddell Creek.

Simulated Flow	Equivalent Flow above West Branch	WUA below West Branch	WUA above West Branch	WUA combined	Percent of Peak WUA
0.10	0.24	762	623	1385	23.1%
0.25	0.33	954	688	1642	27.4%
0.50	0.5	1224	783	2007	33.6%
0.75	0.67	1429	859	2289	38.3%
1.00	0.83	1616	923	2539	42.4%
1.25	1	1779	987	2766	46.2%
1.50	1.16	1892	1046	2938	49.1%
1.75	1.33	1992	1107	3098	51.8%
2.00	1.49	2082	1162	3244	54.2%
2.25	1.66	2164	1219	3383	56.6%
2.50	1.82	2236	1272	3508	58.6%
2.75	1.99	2300	1327	3627	60.6%
3.00	2.15	2353	1379	3733	62.4%
3.25	2.32	2402	1432	3834	64.1%
3.50	2.49	2449	1483	3932	65.7%
3.75	2.65	2493	1530	4023	67.2%
4.00	2.82	2536	1577	4113	68.8%
4.50	3.15	2619	1664	4283	71.6%
5.00	3.48	2696	1748	4444	74.3%
5.50	3.81	2768	1831	4599	76.9%
6.00	4.14	2835	1907	4742	79.3%
6.50	4.47	2899	1979	4878	81.5%
7.00	4.8	2959	2049	5007	83.7%
8.00	5.46	3072	2180	5252	87.8%
9.00	6.12	3163	2290	5453	91.2%
10.00	6.79	3202	2370	5572	93.1%
12.00	8.11	3280	2486	5767	96.4%
14.00	9.43	3323	2567	5890	98.5%
20.00	13.4	3196	2730	5926	99.1%
28.00	18.69	3025	2957	5982	100.0%

Table G-7. WUA vs. Discharge for Coho Salmon Juvenile Rearing in Liddell Creek.

Simulated Flow	Equivalent Flow above West Branch	WUA below West Branch	WUA above West Branch	WUA combined	Percent of Peak WUA
0.10	0.24	2282	1477	3759	71.7%
0.25	0.33	2562	1566	4128	78.7%
0.50	0.5	2834	1701	4535	86.5%
0.75	0.67	3004	1790	4794	91.4%
1.00	0.83	3107	1865	4973	94.8%
1.25	1	3175	1906	5081	96.9%
1.50	1.16	3202	1936	5137	98.0%
1.75	1.33	3216	1967	5183	98.9%
2.00	1.49	3220	1995	5215	99.5%
2.25	1.66	3214	2019	5233	99.8%
2.50	1.82	3203	2040	5242	100.0%
2.75	1.99	3180	2063	5243	100.0%
3.00	2.15	3158	2079	5237	99.9%
3.25	2.32	3139	2095	5234	99.8%
3.50	2.49	3123	2102	5225	99.6%
3.75	2.65	3099	2103	5202	99.2%
4.00	2.82	3084	2103	5187	98.9%
4.50	3.15	3074	2097	5171	98.6%
5.00	3.48	3064	2096	5160	98.4%
5.50	3.81	3042	2108	5150	98.2%
6.00	4.14	3002	2127	5129	97.8%
6.50	4.47	2939	2143	5082	96.9%
7.00	4.8	2868	2162	5030	95.9%
8.00	5.46	2719	2214	4933	94.1%
9.00	6.12	2611	2263	4874	93.0%
10.00	6.79	2521	2322	4843	92.4%
12.00	8.11	2427	2421	4848	92.5%
14.00	9.43	2364	2515	4879	93.0%
20.00	13.4	2121	2758	4879	93.1%
28.00	18.69	1917	2847	4765	90.9%

Table G-8. WUA vs. Discharge for Steelhead and Coho Salmon Juvenile Rearing in Laguna Creek.

Simulated Flow	Steelhead WUA	Percent of Peak	Coho WUA	Percent of Peak
0.10	1474	21.6%	5088	80.9%
0.25	1721	25.2%	5401	85.9%
0.50	2060	30.2%	5687	90.4%
0.75	2358	34.5%	5861	93.2%
1.00	2628	38.5%	5990	95.3%
1.25	2870	42.0%	6087	96.8%
1.50	3086	45.2%	6166	98.1%
1.75	3283	48.1%	6220	98.9%
2.00	3460	50.7%	6245	99.3%
2.25	3625	53.1%	6267	99.7%
2.50	3776	55.3%	6279	99.9%
2.75	3910	57.3%	6284	100.0%
3.00	4037	59.1%	6287	100.0%
3.25	4157	60.9%	6280	99.9%
3.50	4269	62.5%	6267	99.7%
3.75	4374	64.1%	6239	99.2%
4.00	4474	65.5%	6204	98.7%
4.50	4662	68.3%	6130	97.5%
5.00	4841	70.9%	6052	96.3%
5.50	5002	73.3%	5967	94.9%
6.00	5150	75.4%	5883	93.6%
6.50	5284	77.4%	5805	92.3%
7.00	5406	79.2%	5732	91.2%
8.00	5613	82.2%	5596	89.0%
9.00	5785	84.7%	5443	86.6%
10.00	5944	87.1%	5267	83.8%
12.00	6190	90.7%	4899	77.9%
14.00	6385	93.5%	4603	73.2%
20.00	6717	98.4%	3908	62.2%
28.00	6828	100.0%	3411	54.3%

Table G-9. WUA vs. Discharge for Steelhead and Coho Salmon Juvenile Rearing in Majors Creek.

Simulated Flow	Steelhead WUA	Percent of Peak	Coho WUA	Percent of Peak
0.05	851	21.3%	3719	74.5%
0.25	1061	26.5%	4097	82.1%
0.50	1247	31.2%	4315	86.4%
0.75	1402	35.1%	4466	89.5%
1.00	1542	38.6%	4583	91.8%
1.25	1672	41.8%	4675	93.7%
1.50	1788	44.7%	4752	95.2%
1.75	1896	47.4%	4812	96.4%
2.00	1988	49.7%	4864	97.4%
2.25	2071	51.8%	4909	98.3%
2.50	2149	53.8%	4946	99.1%
2.75	2220	55.5%	4975	99.7%
3.00	2287	57.2%	4992	100.0%
3.50	2404	60.1%	4991	100.0%
4.00	2509	62.8%	4968	99.5%
4.50	2608	65.2%	4926	98.7%
5.00	2703	67.6%	4878	97.7%
5.50	2794	69.9%	4821	96.6%
6.00	2882	72.1%	4756	95.3%
6.50	2967	74.2%	4697	94.1%
7.00	3048	76.3%	4639	92.9%
7.50	3126	78.2%	4588	91.9%
8.00	3201	80.1%	4529	90.7%
9.00	3346	83.7%	4434	88.8%
10.00	3469	86.8%	4344	87.0%
12.00	3674	91.9%	4202	84.2%
14.00	3823	95.6%	4066	81.5%
16.00	3901	97.6%	3943	79.0%
18.00	3961	99.1%	3851	77.1%
20.00	3998	100.0%	3791	75.9%

Table G-10. WUA vs. Discharge for Steelhead and Coho Salmon Juvenile Rearing in the San Lorenzo River Downstream of Tait Street.

Simulated Flow	Steelhead WUA	Percent of Peak	Coho WUA	Percent of Peak
0	3220	23%	14691	89%
1	4122	29%	15340	93%
2	5024	35%	15990	97%
3	5821	41%	16280	99%
4	6506	46%	16432	100%
5	7108	50%	16490	100%
6	7636	54%	16461	100%
7	8118	57%	16373	99%
8	8558	60%	16289	99%
9	8947	63%	16210	98%
10	9295	66%	16120	98%
11	9604	68%	16034	97%
12	9892	70%	15945	97%
14	10400	73%	15771	96%
16	10828	76%	15596	95%
18	11215	79%	15436	94%
20	11570	82%	15286	93%
24	12201	86%	15031	91%
28	12735	90%	14833	90%
32	13191	93%	14613	89%
36	13538	95%	14376	87%
40	13803	97%	14126	86%
44	13996	99%	13894	84%
48	14107	99%	13677	83%
52	14110	99%	13503	82%
56	14101	99%	13355	81%
60	14125	100%	13227	80%
64	14166	100%	13123	80%
68	14184	100%	13044	79%
72	14169	100%	12992	79%

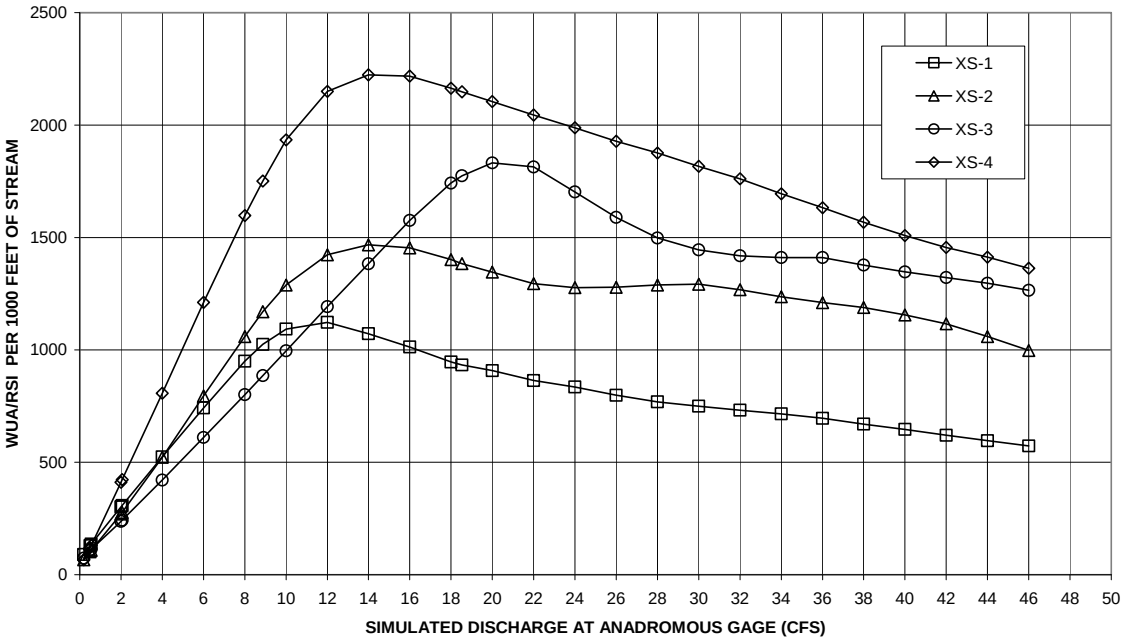
Table G-11. WUA vs. Discharge for Steelhead and Coho Salmon Rearing in Newell Creek.

Simulated Flow	Steelhead WUA	Percent of Peak	Coho WUA	Percent of Peak
0.10	2207	23.2%	8807	86.1%
0.20	2393	25.1%	9084	88.8%
0.30	2557	26.9%	9275	90.7%
0.40	2707	28.4%	9425	92.2%
0.50	2851	29.9%	9547	93.3%
0.60	2990	31.4%	9651	94.4%
0.70	3123	32.8%	9740	95.2%
0.80	3251	34.1%	9818	96.0%
0.90	3374	35.4%	9887	96.7%
1.00	3493	36.7%	9950	97.3%
1.50	4018	42.2%	10151	99.2%
2.00	4471	46.9%	10228	100.0%
3.00	5202	54.6%	10171	99.4%
4.00	5780	60.7%	10022	98.0%
5.00	6235	65.5%	9885	96.6%
6.00	6608	69.4%	9760	95.4%
7.00	6927	72.8%	9644	94.3%
8.00	7201	75.6%	9531	93.2%
9.00	7448	78.2%	9394	91.8%
10.00	7672	80.6%	9236	90.3%
12.00	8071	84.8%	8913	87.1%
14.00	8414	88.4%	8603	84.1%
16.00	8714	91.5%	8292	81.1%
18.00	8972	94.2%	8020	78.4%
20.00	9189	96.5%	7768	76.0%
22.00	9350	98.2%	7538	73.7%
24.00	9445	99.2%	7331	71.7%
26.00	9498	99.7%	7138	69.8%
28.00	9522	100.0%	6956	68.0%
30.00	9510	99.9%	6786	66.3%

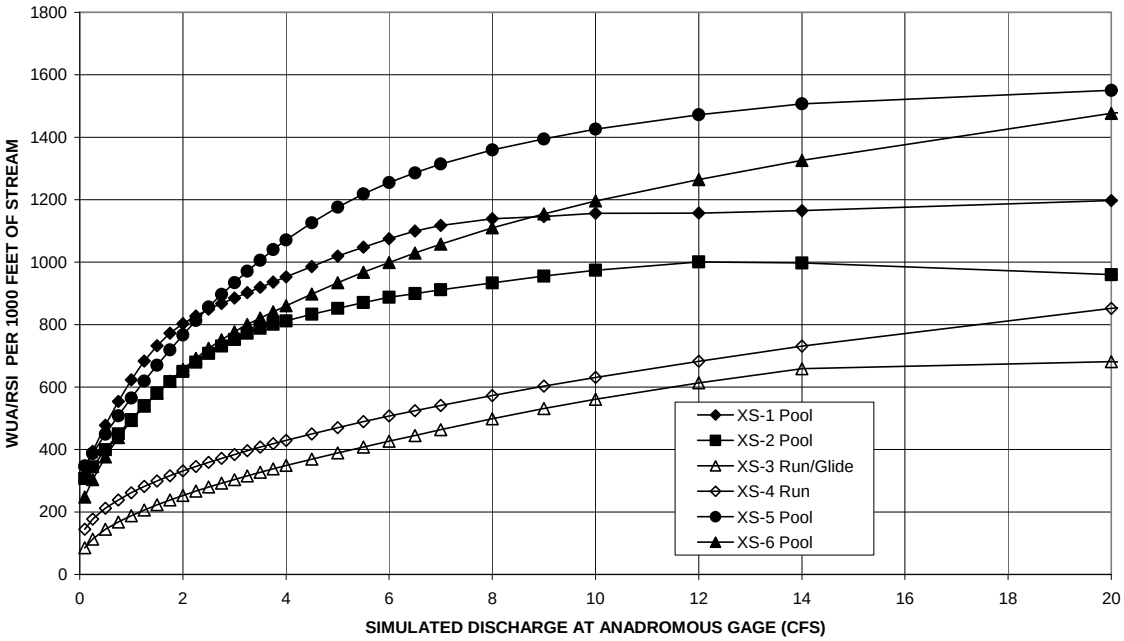
Appendix H

WUA vs. Discharge for Individual Study Transects

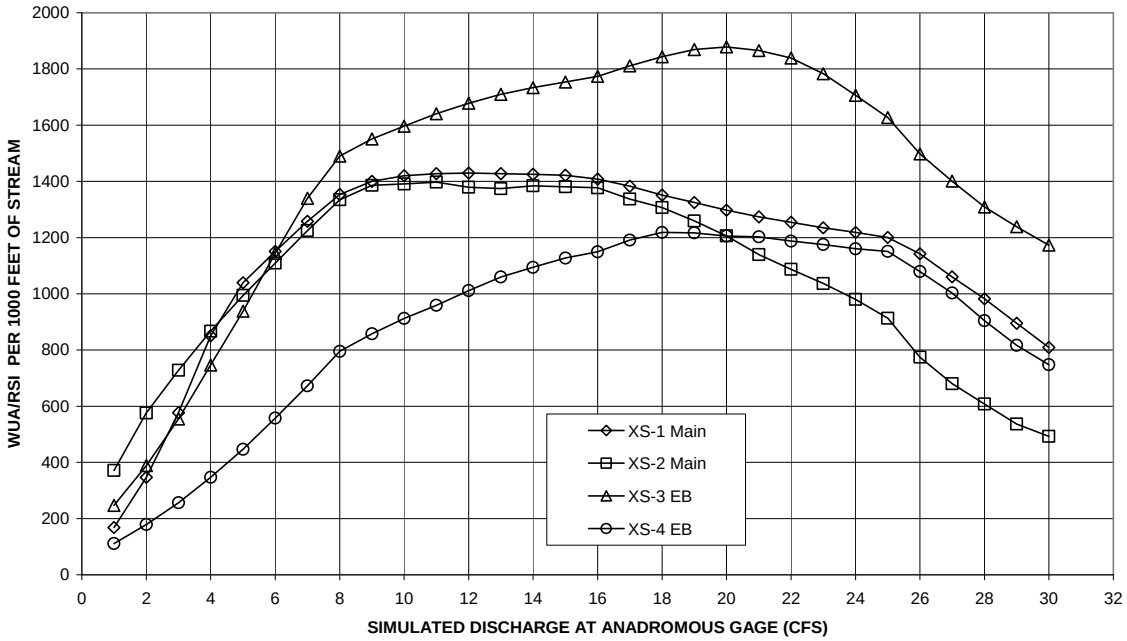
Laguna Creek
Steelhead Spawning



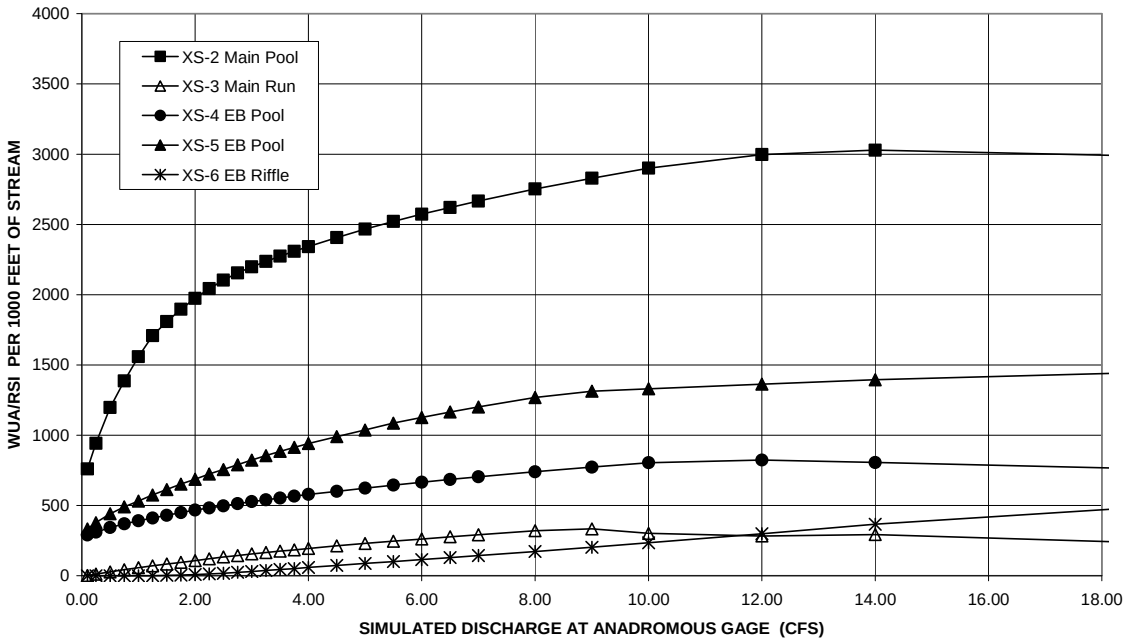
Laguna Creek
Steelhead Rearing



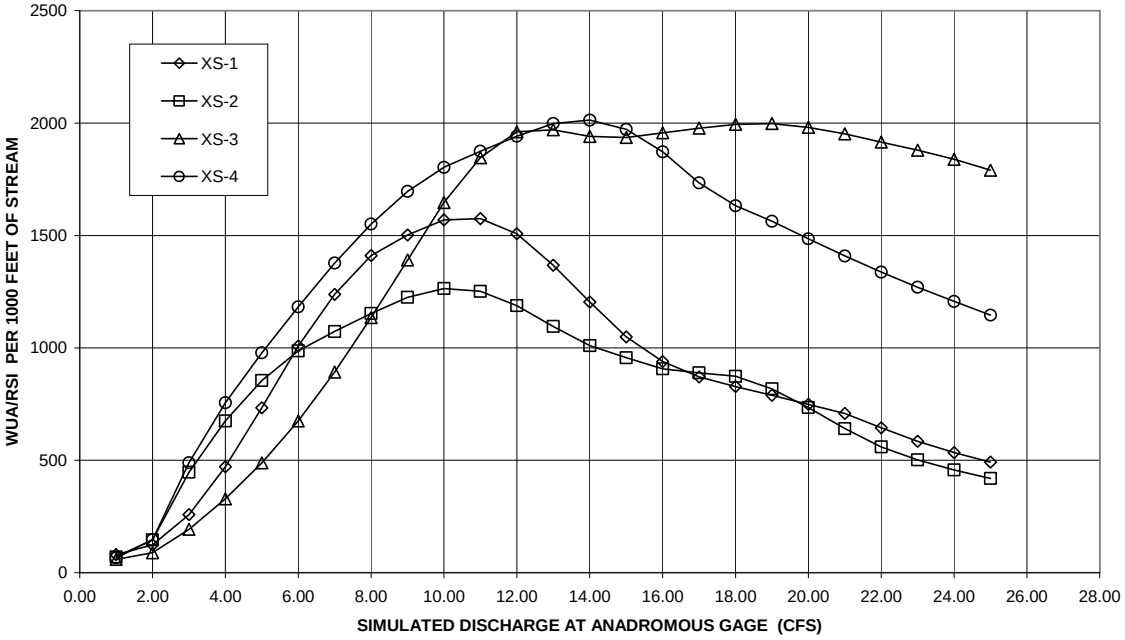
Liddell Creek
Steelhead Spawning



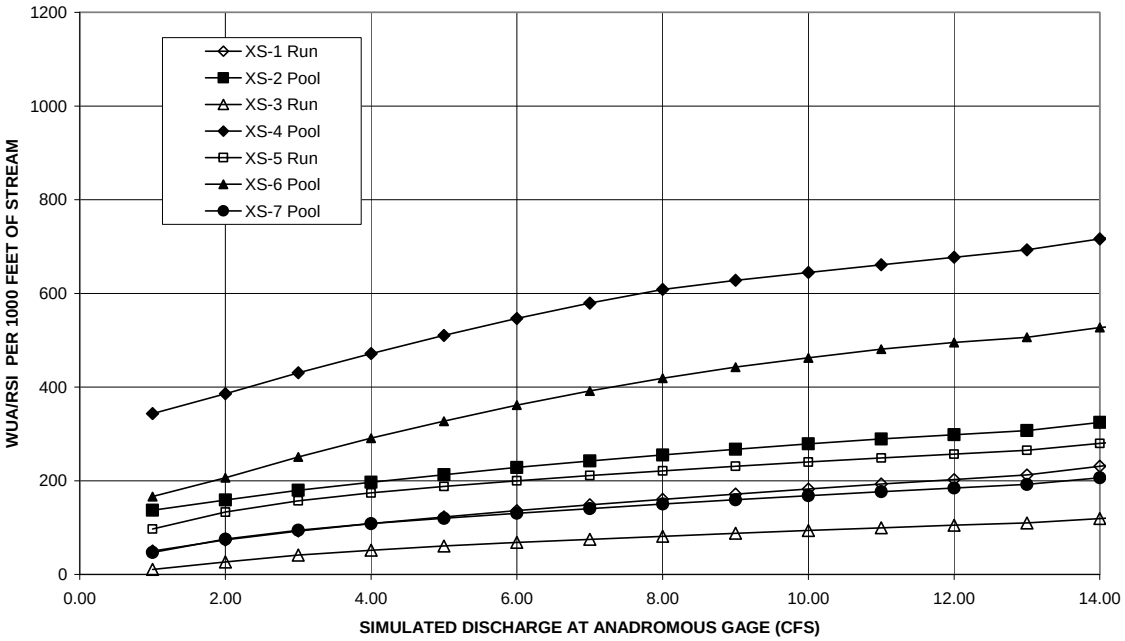
Liddell Creek
Steelhead Rearing



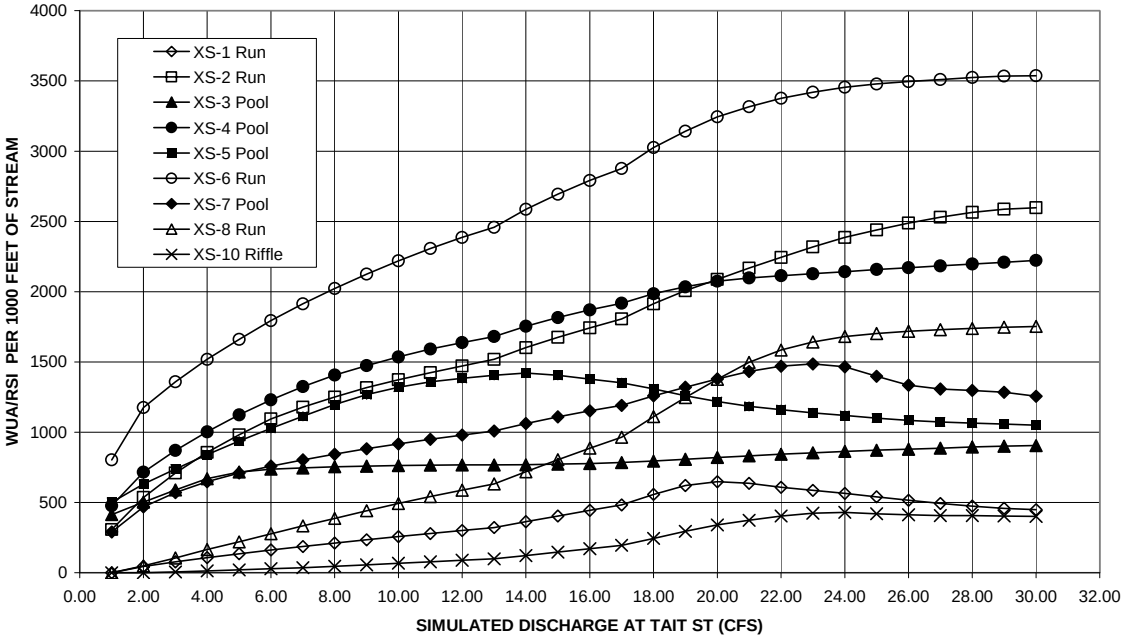
Majors Creek
Steelhead Spawning

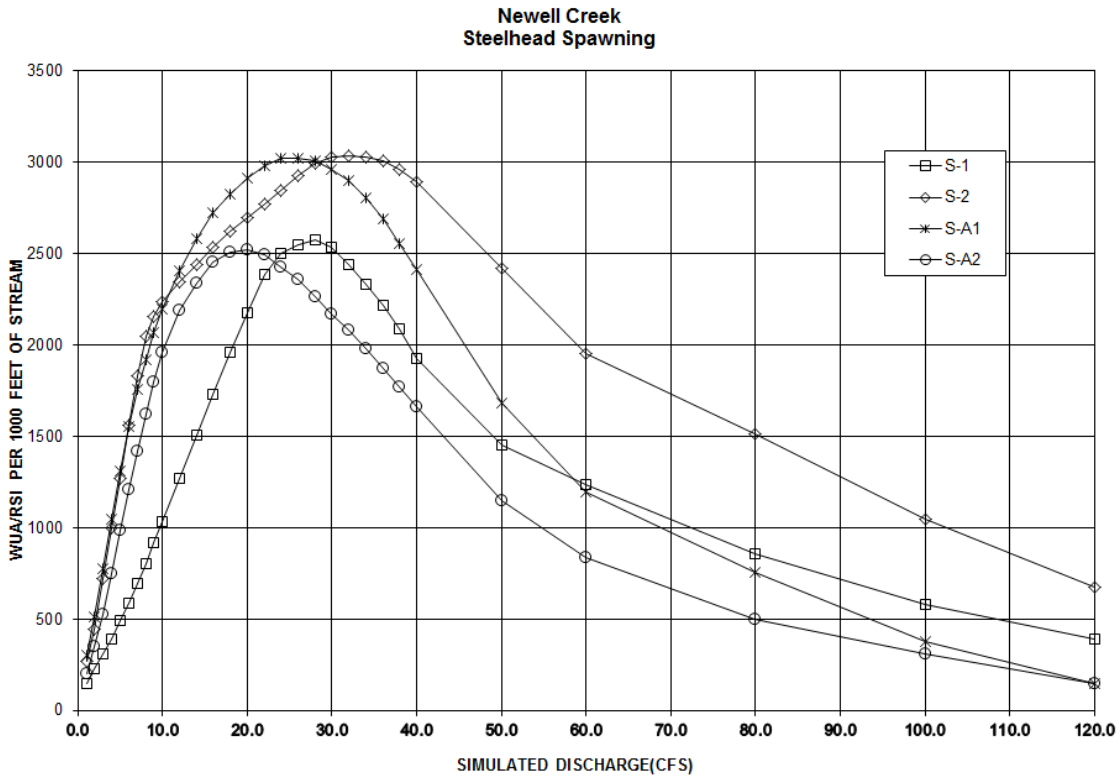


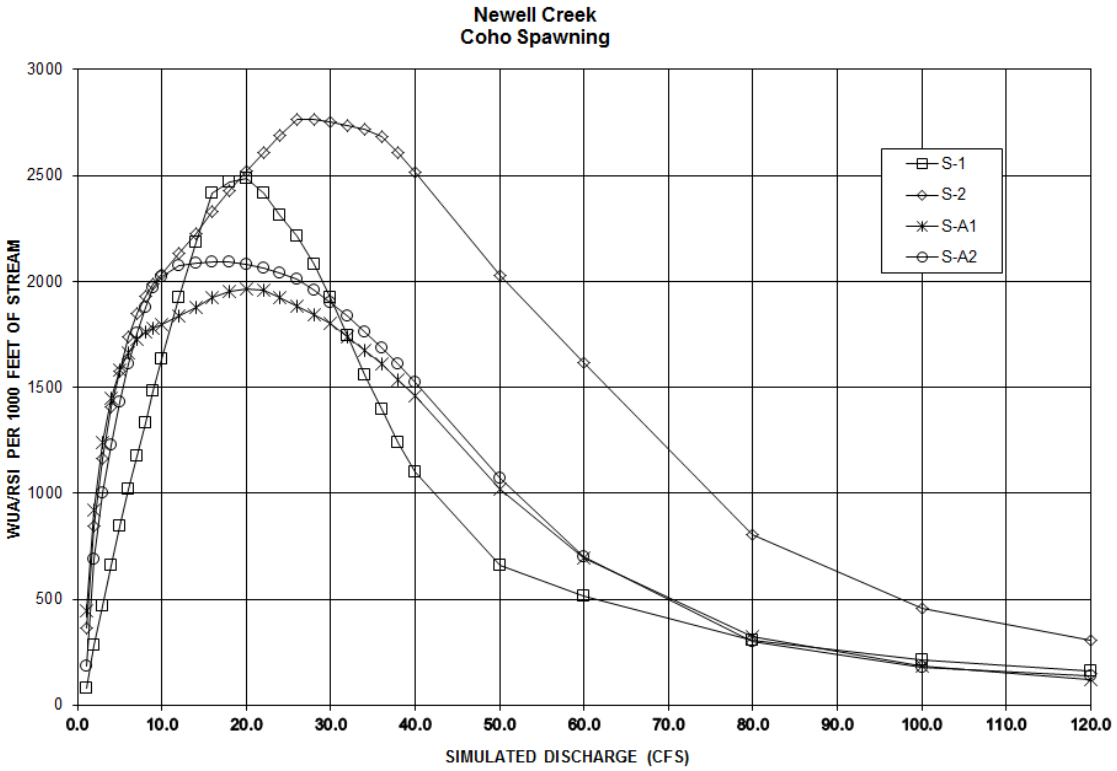
Majors Creek
Steelhead Rearing



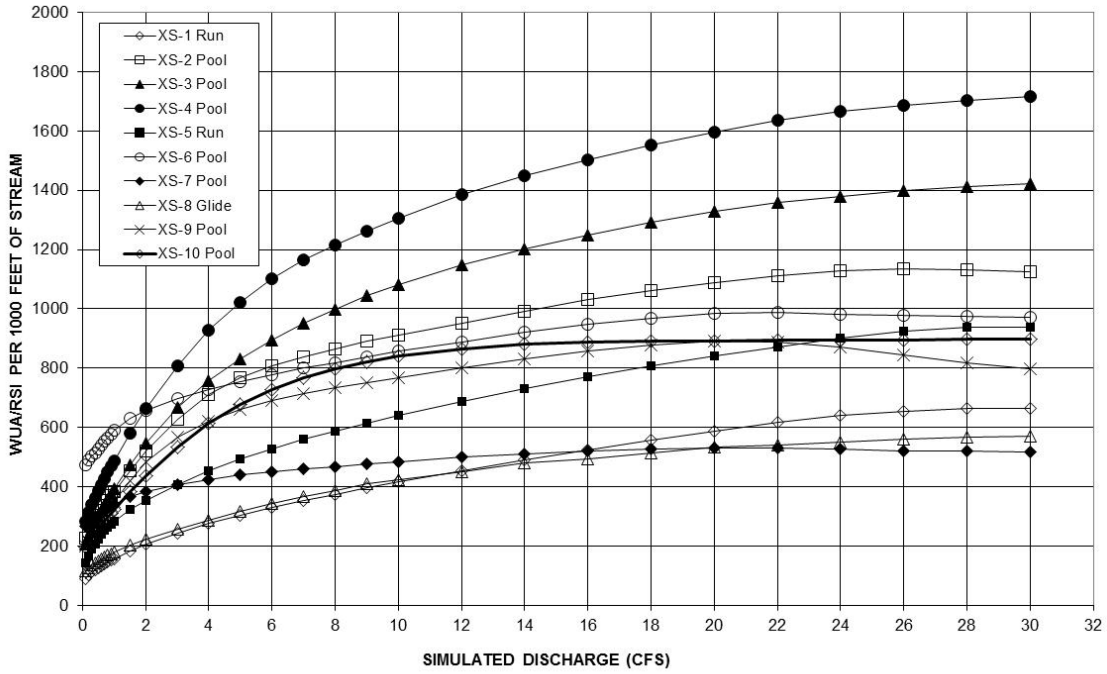
San Lorenzo River Downstream of Tait Street Diversion
Steelhead Rearing



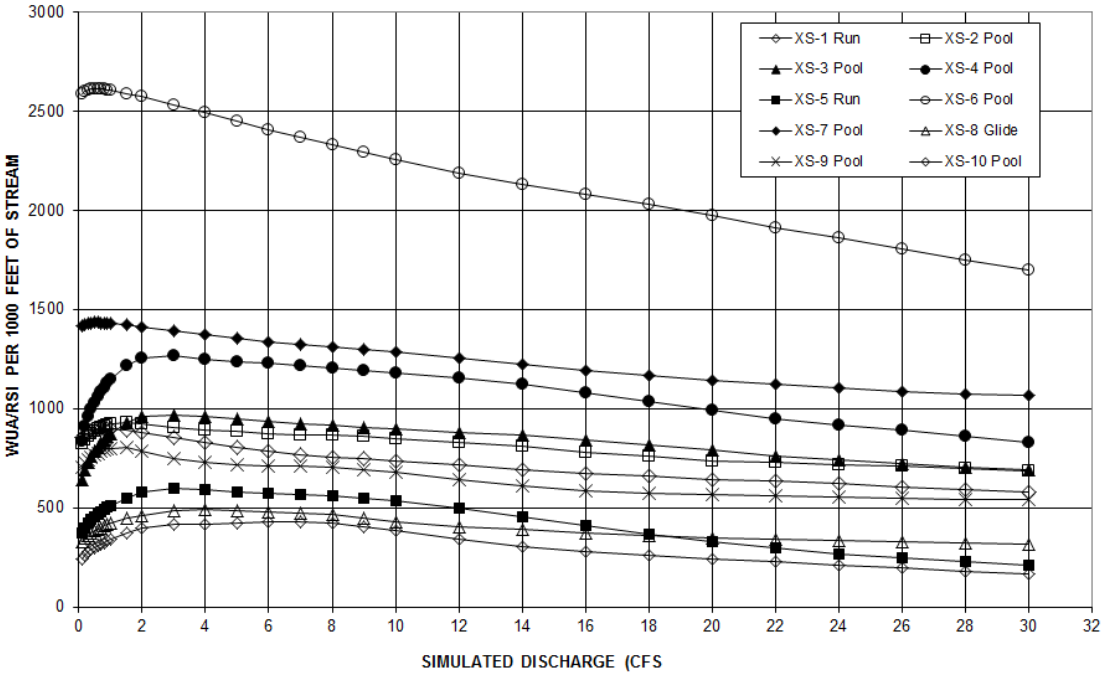

Newell Creek
Steelhead Spawning
WUA/RSI PER 1000 FEET OF STREAM
SIMULATED DISCHARGE(CFS)
S-1
S-2
S-A1
S-A2
0
500
1000
1500
2000
2500
3000
3500
0.0
10.0
20.0
30.0
40.0
50.0
60.0
70.0
80.0
90.0
100.0
110.0
120.0


Newell Creek
Coho Spawning
WUA/RSI PER 1000 FEET OF STREAM
SIMULATED DISCHARGE (CFS)
S-1
S-2
S-A1
S-A2
0
500
1000
1500
2000
2500
3000
0.0
10.0
20.0
30.0
40.0
50.0
60.0
70.0
80.0
90.0
100.0
110.0
120.0

Newell Creek
Steelhead Rearing



Newell Creek
Coho Rearing



Appendix 4: Felton Diversion Memoranda of Agreement

STATE OF CALIFORNIA
STATE WATER RESOURCES CONTROL BOARD

In the Matter of Application 23710 of City of Santa Cruz to Appropriate from San Lorenzo River in Santa Cruz County.	Decision 1406

DECISION APPROVING APPLICATION IN PART

City of Santa Cruz having filed Application 23710 for a permit to appropriate unappropriated water; protests having been received; the applicant and the remaining protestant having stipulated to proceedings in lieu of hearing as provided for by Title 23, California Administrative Code, Section 737; an investigation having been made by the State Water Resources Control Board pursuant to said stipulation; the Board, having considered all available information, finds as follows:

Substance of Application

1. Application 23710 is for a permit to appropriate 3,000 acre-feet per annum by offstream storage to be collected from September 1 of each year to June 1 of the succeeding year for municipal purposes from the San Lorenzo River in Santa Cruz County. The point of diversion is to be located within the SE¼ of NW¼, Section 22, T10S, R2W, MDB&M. The maximum rate of diversion to offstream storage will be 20 cubic feet per second (cfs).

Applicant's Project

2. Application 23710 is for the same amount of water covered by the applicant's Permit 16123 (Application 22318) and is not accumulative. The application was filed to obtain authority to increase the rate of diversion to offstream storage from 3,500 gallons per minute, approximately 8 cfs, to 20 cfs.

The applicant now holds License 9847 (Application 17913) to store 5,600 acre-feet in Loch Lomond Reservoir on Newell Creek which is an upper tributary of the San Lorenzo River. The water covered by Application 23710 and Permit 16123 (Application 22318) will be diverted from the San Lorenzo River at proposed Felton pumping station near the river's junction with Zayante Creek. The water will be pumped upstream approximately two miles into Loch Lomond Reservoir for later release into the same pipeline system for conveyance to the city.

Protests

3. A protest was filed by the Department of Fish and Game to protect the steelhead trout which utilize the San Lorenzo River for spawning, as a nursery area, and for migration to and from the ocean. A protest was also filed by California Trout, Inc., to protect the San Lorenzo stream system as a fishery resource and to protect the quality of the water in the system. This protest also questions the applicant's need for additional water storage in Loch Lomond Reservoir and raises questions as to the effect of the applicant's project on the environment and other matters.

Existence of Unappropriated Water

4. By its approval of Application 22318 (Permit 16123), the Board found that there was sufficient unappropriated water available in the San Lorenzo River to supply the applicant's project, and no protests were filed against Application 23710 alleging that this finding was incorrect.

Disposition of Protests

5. By agreement dated August 12, 1971, the Department of Fish and Game agreed to dismiss its protest provided certain minimum flows are maintained in the San Lorenzo River past the applicant's point of diversion for the preservation of fish and wildlife. It was agreed that from September 1 through September 30 the applicant shall bypass 10 cfs or the natural flow, whichever is less, and 20 cfs or the natural flow, whichever is less, from October 1 through May 31. Since this agreement was executed, the applicant has agreed to delete the month of September from its diversion season and to increase the minimum bypass in the San Lorenzo River during the month of October from 20 cfs to 25 cfs or the natural flow of the river, whichever is less (letter to board staff dated March 2, 1972; files on Application 23710). It also agreed that these further restrictions should apply to its Permit 16123 (Application 22318). Such flows are reasonably necessary and adequate to protect the San Lorenzo River as a fishery resource, and it is in the public interest that they be maintained.

6. The protest of California Trout, Inc., requests the Board to prohibit additional diversions to Loch Lomond Reservoir unless alleged damage to the fishery resource of the San Lorenzo River system by the applicant's project is mitigated by a fish planting program and by additional releases of water from Loch Lomond Reservoir. It also requests the Board to postpone storage of water under any permit issued pursuant to Application 23710 until the need for the water is demonstrated and alternate sources of water are found infeasible. Further, it is requested that any permit issued pursuant to Application 23710 expire after 25 years.

The applicant has authority to store the water covered by Application 23710 under its Permit 16123 (Application 22318) whether or not Application 23710 is approved. The Board has no authority to limit arbitrarily rights evidenced by a permit or license to a period of 25 years. The protestant has not produced evidence to show that the increase in the rate of diversion to offstream storage proposed by Application 23710, subject to the bypass provision previously discussed, will have an adverse effect upon the San Lorenzo River fishery resource. This increase in the rate of diversion will be the sole result of approval of Application 23710, except that the fishery resource will be better protected by eliminating diversions during the month of September and increasing the amount of water bypassed during the month of October from 20 cfs to 25 cfs. The standard permit terms concerning water quality which will be

included in the permit issued pursuant to Application 23710 will adequately protect the San Lorenzo River from any adverse effect upon the quality of the water resulting from the applicant's project. Other matters raised by this protestant are beyond the authority of this Board in acting upon Application 23710.

From the foregoing findings, the Board concludes that Application 23710 should be approved in part and that a permit should be issued to the applicant subject to the limitations and conditions set forth in the order following.

The records, documents, and other data relied upon in determining the matter are: Applications 17913, 22318 and 23710 and all relevant information on file therewith, particularly the report of field investigation made September 21, 1971.

ORDER

IT IS HEREBY ORDERED that Application 23710 be, and it is, approved in part, and that a permit be issued to the applicant subject to vested rights and to the following limitations and conditions:

1. The water appropriated shall be limited to the quantity which can be beneficially used and shall not exceed 3,000 acre-feet per annum by storage to be collected from October 1 of each year to June 1 of the succeeding year.

The total quantity of water diverted under this permit, together with that diverted under Permit 16123 (Application 22318), shall not exceed 3,000 acre-feet per annum.

The combined maximum rate of diversion to offstream storage under this permit and Permit 16123 (Application 22318) shall not exceed 20 cubic feet per second.

This permit does not authorize collection of water to storage outside the specified season to offset evaporation and seepage losses or for any other purpose.

2. For the protection of fish, no diversion shall be made during the month of October which depletes the flow of the stream to less than 25 cubic feet per second nor to less than 20 cubic feet per second during the period November 1 to the succeeding May 31. No water shall be diverted until the permittee has installed in the stream immediately below its point of diversion a staff gage, or other device satisfactory to the State Water Resources Control Board, showing the water levels which correspond to the above-mentioned flows in cubic feet per second. As a condition of continuing diversion, said measuring device shall be properly maintained.

The amount authorized for appropriation may be reduced in the license if investigation warrants.

4. Actual construction work shall begin on or before nine months from date of permit and shall thereafter be prosecuted

with reasonable diligence, and if not so commenced and prosecuted, this permit may be revoked.

5. Said construction work shall be completed on or before December 1, 1975.

6. Complete application of the water to the proposed use shall be made on or before December 1, 1980.

7. Progress reports shall be submitted promptly by permittee when requested by the State Water Resources Control Board until license is issued.

8. All rights and privileges under this permit, including method of diversion, method of use and quantity of water diverted, are subject to the continuing authority of the State Water Resources Control Board in accordance with law and in the interest of the public welfare to prevent waste, unreasonable use, unreasonable method of use or unreasonable method of diversion of said water.

9. The quantity of water diverted under this permit and under any license issued pursuant thereto is subject to modification by the State Water Resources Control Board, if, after notice to the permittee and an opportunity for hearing, the Board finds that such modification is necessary to meet water quality objectives in water quality control plans which have been or hereafter may be established or modified pursuant to Division 7 of the Water Code. No action will be taken pursuant to this

paragraph unless the Board finds that (1) adequate waste discharge requirements have been prescribed and are in effect with respect to all waste discharges which have any substantial effect upon water quality in the area involved, and (2) the water quality objectives cannot be achieved solely through the control of waste discharges.

10. Permittee shall allow representatives of the State Water Resources Control Board and other parties, as may be authorized from time to time by said Board, reasonable access to project works to determine compliance with the terms of this permit.

11. Permittee shall accord to the public, for the purpose of fishing, the right of access to the waters impounded in Loch Lomond Reservoir during the open season for the taking of fish subject to the regulations of the Fish and Game Commission.

12. In order to prevent degradation of the quality of water during and after construction of the project, prior to beginning of construction permittee shall file a report pursuant to Water Code Section 13260 and shall comply with any waste discharge requirements imposed by the California Regional Water Quality Control Board, Central Coast Region, or by the State Water Resources Control Board.

Adopted as the decision and order of the State Water Resources Control Board at a meeting duly called and held at Sacramento, California.

Dated: November 2, 1972

W. W. ADAMS
W. W. Adams, Chairman

RONALD B. ROBIE
Ronald B. Robie, Vice Chairman

E. F. DIBBLE
E. F. Dibble, Member

ABSENT
Roy E. Dodson, Member

MRS. CARL H. (JEAN) AUER
Mrs. Carl H. (Jean) Auer, Member

STATE OF CALIFORNIA
STATE WATER RESOURCES CONTROL BOARD

In the Matter of Application 23710 of City of Santa Cruz to Appropriate from San Lorenzo River in Santa Cruz County	)

ORDER GRANTING PETITION FOR
RECONSIDERATION OF DECISION 1406

On November 2, 1972, the State Water Resources Control Board adopted Decision 1406 in which the Board approved Application 23710 of the City of Santa Cruz (hereinafter referred to as "city").

On November 27, 1972, the city filed a petition for reconsideration of Decision 1406. The reconsideration requested concerns the 3,000 acre-feet per annum (total) limitation placed upon diversions under the permit issued pursuant to Application 23710 and Permit 16123 (Application 22318).

GOOD CAUSE APPEARING, IT IS HEREBY ORDERED that the petition for reconsideration of Decision 1406 filed by the city be, and it is, granted.

Adopted as the order of the State Water Resources Control Board at a meeting duly called and held at Sacramento, California.

Dated: December 21, 1972

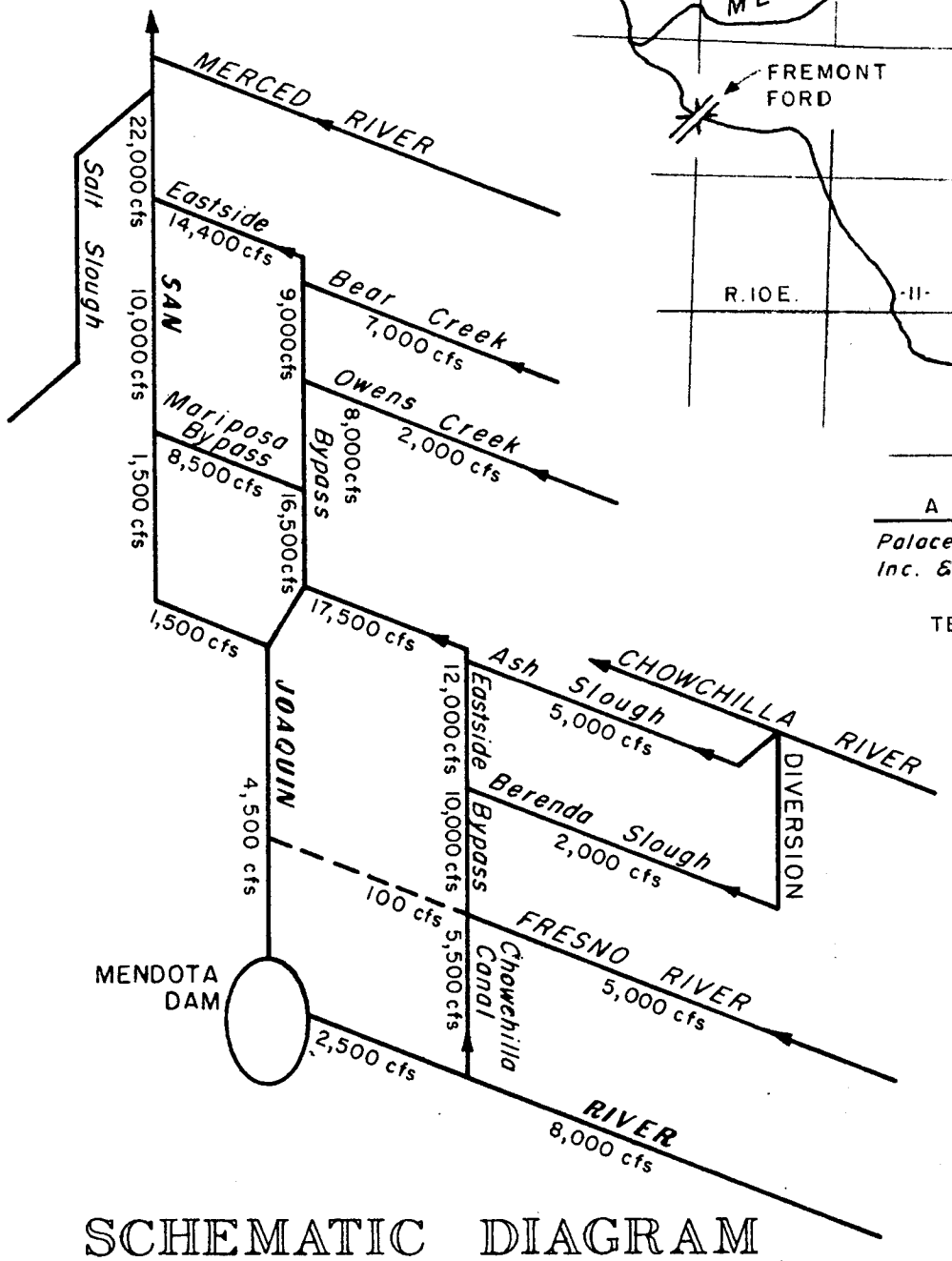
W. W. ADAMS
W. W. Adams, Chairman

RONALD B. ROBIE
Ronald B. Robie, Vice Chairman

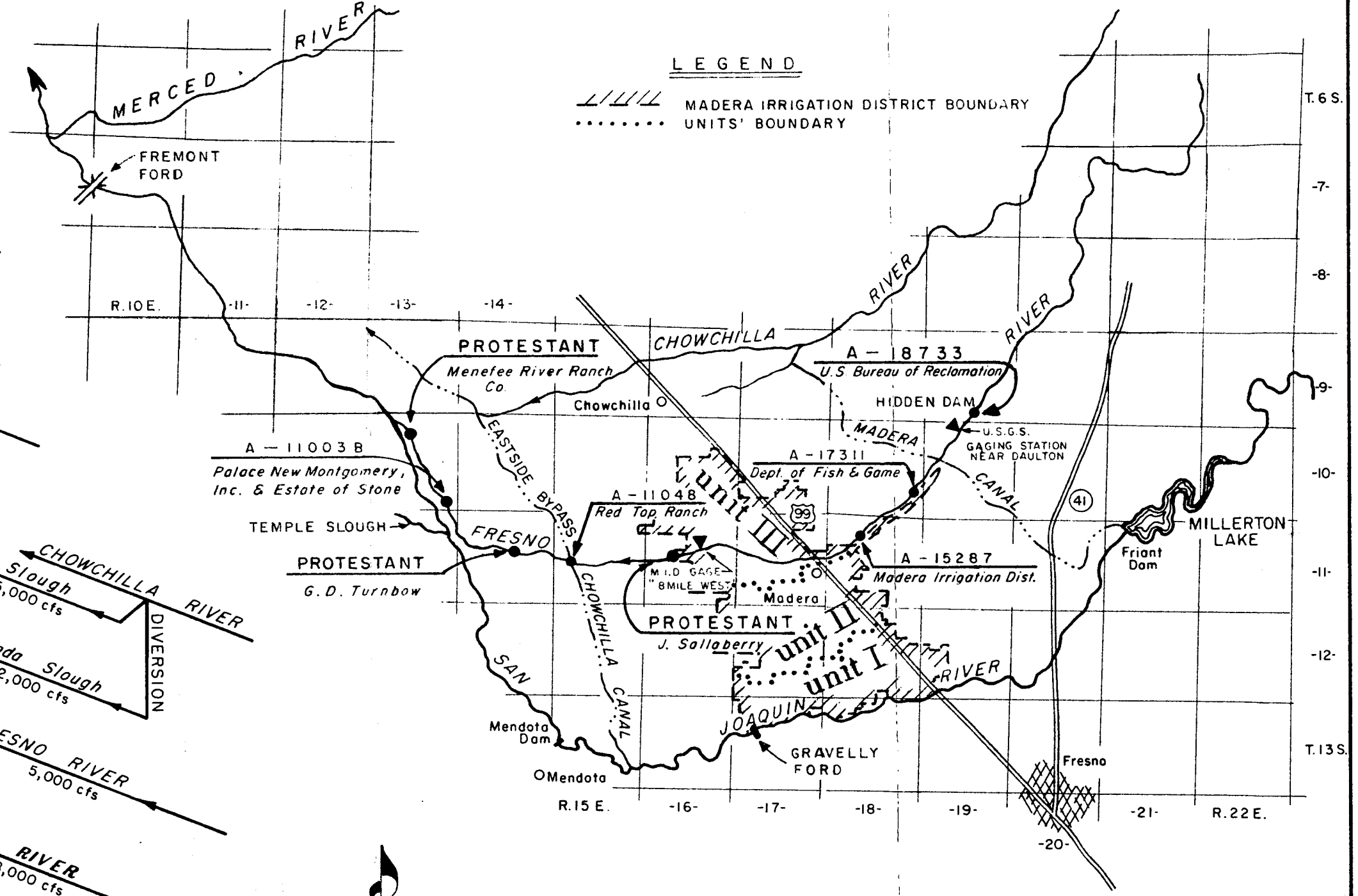
E. F. DIBBLE
E. F. Dibble, Member

ABSENT
Roy E. Dodson, Member

MRS. CARL H. (JEAN) AUER
Mrs. Carl H. (Jean) Auer, Member



SCHEMATIC DIAGRAM
LOWER SAN JOAQUIN RIVER FLOOD CONTROL PROJECT



MADERA CO.
M.D.B & M.

STATE OF CALIFORNIA
STATE WATER RESOURCES CONTROL BOARD

APPLICATION
18733

SCALE
0 6 12 MI.

DATE: 6/9/71	DRAWN: G.C.W.	CHECKED: M.G	DWG. 2883

FELTON DIVERSION FISH AND GAME MOA PROCEDURES

DATE	FLOW cfs	DAM	ACTION
NOVEMBER 1 TO JUNE 15	40 OR LESS	DEFLATED	INFLATE AIR BLADDERS UNDER DAM
		INFLATED	BY-PASS FLOW IS PASSING THROUGH FISH LADDER
NOVEMBER 1 TO MARCH 31	40 TO 2000	DEFLATED	NONE
	40 TO 300	INFLATED	BY-PASS FLOW IS PASSING THROUGH FISH LADDER
	300 OR MORE	DEFLATED	NONE
		INFLATED	OPEN SLIDE GATE 8 INCHES
	300 OR MORE FOR 5 DAYS IN A ROW AND FISH ARE HOLDING BELOW DAM	INFLATED	PARTIALLY DEFLATE DAM TO 4 FEET, CLOSE SLIDE GATE OVER NIGHT, RE-INFLATE DAM NEXT MORNING AS NEEDED

MEMORANDUM OF AGREEMENT
THE CALIFORNIA DEPARTMENT OF FISH AND GAME
AND THE CITY OF SANTA CRUZ
REGARDING THE OPERATION OF THE FELTON WATER DIVERSION

The California Department of Fish and Game ("DFG") and the City of Santa Cruz acting by and through its Water Department ("City") hereby enter into the following Memorandum of Agreement ("MOA").

RECITALS

A. The DFG is charged with the protection, management and enhancement of the fish and wildlife resources of the State of California.

B. The City diverts water for municipal and industrial use from the San Lorenzo River at the Felton Diversion Facility ("Facility" or "diversion facility"). This water is an integral component of the City's water supply. The Facility includes an inflatable rubber dam across the San Lorenzo River which is usually inflated during the winter months when streamflow and turbidity conditions are suitable for water diversion.

C. In 1994, DFG filed a complaint with the State Water Resources Control Board raising a number of concerns regarding potential impacts on fishery resources. The City and DFG met and worked cooperatively to evaluate these issues, and narrowed the unresolved issues to the following:

During the winter months, adult steelhead and coho salmon migrate upstream to spawn. When the dam is fully inflated, water is discharged through a fish ladder to provide upstream passage for steelhead and coho salmon. The DFG is concerned that under certain high flow conditions, water spilling over the fully inflated dam may reduce the effectiveness of the fish ladder attraction flows in assisting steelhead and coho salmon to locate the downstream entrance to the ladder. The DFG is also concerned that steelhead and salmon may have difficulty passing over the fully deflated Facility when winter streamflows are low and the City is not impounding or diverting water.

D. The City and DFG share the goal of amicable resolution of their differences in a manner which addresses both DFG's fishery concerns and the City's need for a safe and effective diversion facility. The City has therefore invested considerable effort and funds to address DFG's concerns by among other things collecting data, consulting with DFG, developing operational modifications to improve fishery conditions, and conducting a series of field studies which are described in the March 1996 Memorandum of Agreement ("Study MOA") between the City and DFG. As a result of this joint effort, DFG's outstanding concerns have been resolved, provided that the City modifies its operation of Felton Diversion as set forth in this MOA.

NOW, THEREFORE, IT IS AGREED THAT:

I. Felton Diversion Facility Operational Modifications.[1]

A. Low Streamflow Conditions. From November 1 through March 31 when the mouth of the San Lorenzo River is open and streamflow is 40 cubic feet per second (cfs) or less, and from April 1 through June 15 when the stream flow is 40 cfs or less, the City will operate the diversion facility in a manner consistent with the following:

1. When the dam is fully deflated, the City will inflate small air bladders beneath the deflated dam for the purpose of concentrating the streamflow near the center of the deflated dam. The small air bladders will be inflated to such a degree that the depth of flow within the zone of concentrated flow crossing the deflated dam is 8 inches or greater.[2]

2. When the City is diverting water, the dam will be inflated such that the by-pass flow is released through the fish ladder.

---

[1] The dam may also be inflated to allow operation of the fish trap in the fish ladder, a research project of the Monterey Bay Salmon and Trout Project (MBSTP) in coordination with the DFG. When the facility is being used solely for fish trapping, the operational provisions of this MOA shall not apply unless specifically agreed to in writing by the City, MBSTP and DFG.

[2] Field studies have demonstrated that this flow depth can be attained and that adult steelhead and salmon can readily jump and swim across the Felton Diversion Facility when it is in this operational mode.

B. Moderate Streamflow Conditions

From November 1 through March 31 when the mouth of the San Lorenzo River is open and streamflows are between 40 and 200 cfs the City will operate the diversion facility in a manner consistent with the following:

1. During the first one or two rainstorms of winter the dam remains fully deflated to facilitate flushing sediments and organic matter from the river channel. During this phase of winter operation migrating fish can readily pass (jump and swim) over the deflated dam.

2. When streamflows are between 40 and 200 cfs and the City is impounding or diverting water, the dam shall be inflated in which condition the existing fish ladder is operational.

C. High Streamflow Conditions

From November 1 through March 31 when the mouth of the San Lorenzo River is open and streamflows exceed 200 cfs, the City will operate the diversion facility in a manner consistent with the following:

1. During periods when the City is not impounding or diverting water and streamflows are between 200 cfs and 2,000 cfs, the rubber dam shall be fully deflated, thus providing adult fish the opportunity to jump and swim across the deflated dam.

2. When streamflows are between 200 cfs and 2,000 cfs and the City is impounding or diverting water, the rubber dam shall be inflated such that the fish ladder

is operational. When streamflow exceeds approximately 300 cfs, the slide gate shall be opened approximately 8 inches to increase attraction flow at the fish ladder entrance. In addition, when streamflows have equaled or exceeded 300 cfs for five consecutive days and adult steelhead or salmon are observed holding downstream of the dam, on the following day the dam shall be partially deflated and the slidegate closed by early evening and shall remain so overnight, thus providing adult steelhead and salmon the opportunity to jump and swim over the partially deflated dam. The facility may then be returned to the appropriate operational mode as determined by the City.

3. When streamflows exceed 2,000 cfs, the City may fully deflate the rubber dam, among other things to avoid damage. Under such streamflow conditions it is understood and agreed that upstream migration of steelhead and salmon is naturally interrupted, and high water velocities which may develop for short periods across the deflated dam will not adversely impact upstream migration.

II. General

A. The City will exercise reasonable judgment and care in its efforts to comply with the foregoing provisions, maintain the required minimum instream flows and a safe and effective operational diversion facility. If any issues or concerns arise while this MOA is in effect, both parties will make good faith efforts to resolve them directly and amicably in lieu of the DFG issuing a citation or instigating any administrative or judicial action.

B. There are presently several access points from which operations of the diversion facility can be observed. In the event that the existing access points become inadequate to permit periodic observations of the diversion facility operations pursuant to this MOA, and others do not become available, the City shall cooperate to provide reasonable access to DFG for such observations. The City may also make observations of fish passage pursuant to this MOA, but is under no obligation to do so.

C. The terms and conditions of this MOA may be amended at any time, provided such amendments are agreed to in writing by both parties to this MOA. This MOA shall be interpreted as having been drafted equally by both parties.

D. This MOA completely replaces and supersedes the Study MOA. This MOA shall take effect as provided below, and shall continue in effect until terminated by either party in a manner consistent herewith. This MOA may be terminated by either party. Said termination shall become effective six (6) months after the party not initiating the termination has been duly notified in writing.

E. This MOA satisfies Fish and Game Code Section 1601 et. seq. to the extent required by law. Should disagreements arise between staff level personnel of the City and of the DFG concerning the implementation of the terms hereof and those disagreements cannot be resolved by their respective management level supervisors, the issue will be elevated to the Director of the City Water Department and the DFG Regional Manager for resolution. If

resolution of the disagreements is not reached at this administrative level, the arbitration procedures specified in Section 1601 of the Fish and Game Code shall be initiated.

F. The City makes no admissions, directly or indirectly, by entering into this MOA or by the City's related conduct. The parties agree that neither the Study MOA, this MOA, nor the City's related conduct shall in any way be used against the City.

G. If this MOA is found to be in conflict with any other provision of law, the particular term or terms of the MOA found to be in conflict shall be void unless amended to comply with all appropriate local, state, and federal laws. In the event of any conflict or inconsistency between this MOA and any prior agreement between DFG and the City, this MOA shall prevail.

THIS MEMORANDUM OF AGREEMENT SHALL BE IN FULL FORCE AND EFFECT FROM THE DATE ALL PARTIES HAVE SIGNIFIED AGREEMENT BY SIGNATURE OF THE AUTHORIZED REPRESENTATIVE BELOW.

Date: 8-18-98

THE DEPARTMENT OF FISH AND GAME
The Resources Agency of California

By: Brian Hunter

Brian Hunter
Regional Manager

Appendix 5: Newell Creek Passage Synthesis

Newell Creek Limit of Anadromy

Prepared for:

City of Santa Cruz Water Department
Chris Berry, Project Manager
715 Graham Hill Road
Santa Cruz, CA 95060-1410

Prepared by:

Jeff Hagar, Hagar Environmental Science
Ezekiel Bean, City of Santa Cruz Water Department
Chris Berry, City of Santa Cruz Water Department

August 23, 2017

Summary

This report reviews and synthesizes the available information concerning the limit of anadromy and habitat quality for anadromous salmonids in Newell Creek. A bedrock chute downstream of Newell Creek Dam is judged to be a complete barrier to coho salmon (*Oncorhynchus kisutch*) and a temporal barrier and practical limit of anadromy for steelhead (*Oncorhynchus mykiss*). Additional barriers to steelhead migration upstream of Newell Creek Dam, not previously identified, are also documented.

Newell Creek Anadromous Reach Limit

There is a bedrock chute in Newell Creek approximately 1 mile upstream from the confluence of Newell Creek with the San Lorenzo River and approximately 0.7 miles downstream from Newell Creek Dam (Figures 1-3). The chute has long been considered a migration obstacle to migrating salmonids. Don Alley estimated that the falls is passable at flows in the range of 200 to 300 cfs (Alley, et al. 2004). The bedrock chute occurs in a longer section beginning about 0.85 miles upstream of the San Lorenzo River confluence that is dominated by bedrock substrate that occurs in frequent shelves or steps of a few inches to a few feet in height. These bedrock shelves also limit the ability of steelhead or coho salmon to migrate upstream and may make upstream areas inaccessible at certain flow levels. During reconnaissance surveys in May 2006 at a flow of about 5 cfs, minimum thalweg depth on many of these shelves was only 0.1 to 0.2 feet (Hagar, personal observation).

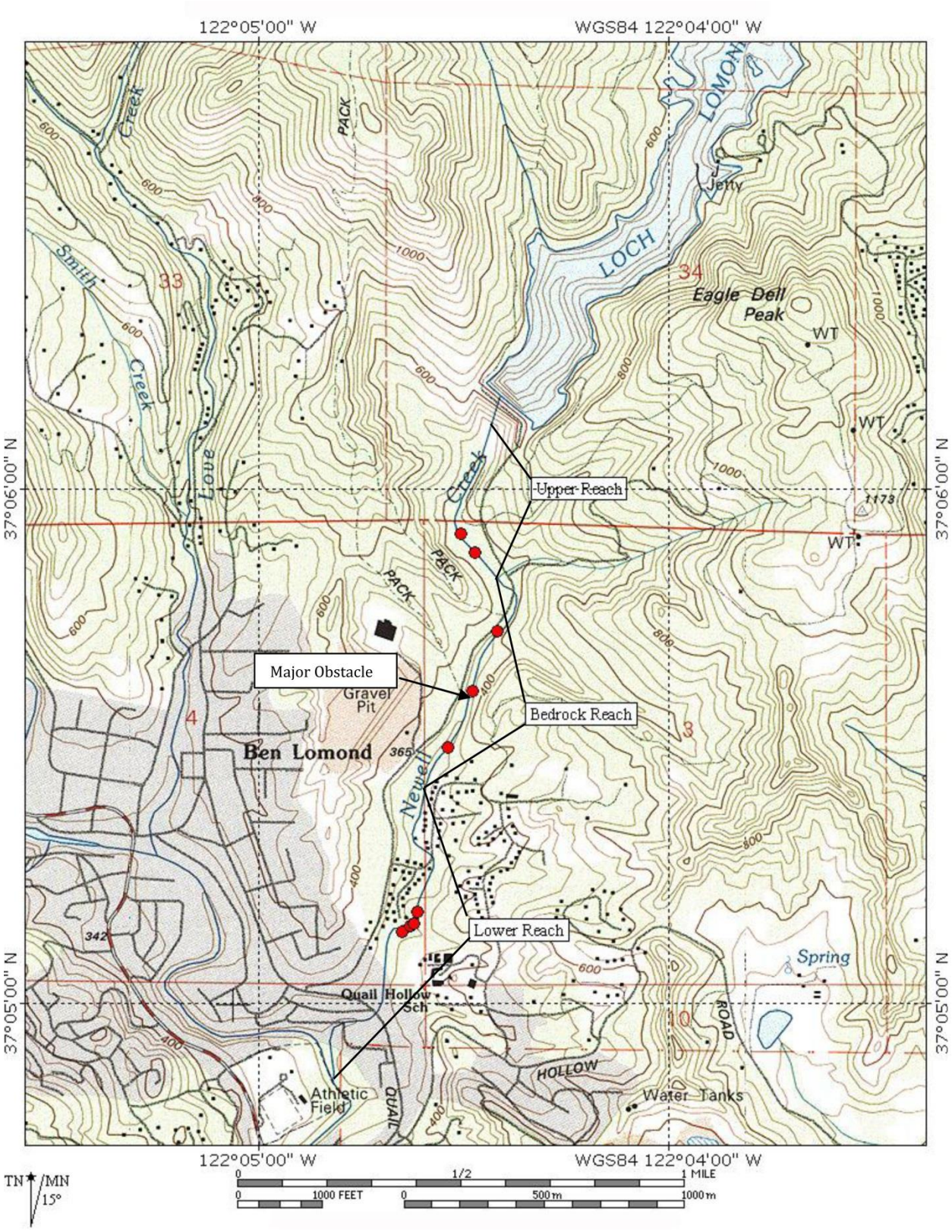


Figure 1. Lower Newell Creek (red dots are electrofishing sites).



Figure 2. Major migration obstacle 0.7 miles downstream of Newell Creek Dam, April 11, 2017, preliminary flow estimate about 18cfs (City of Santa Cruz preliminary gage data).



Figure 3. Major migration obstacle 0.7 miles downstream of Newell Creek Dam, April 11, 2017



Figure 4. Major migration obstacle 0.7 miles downstream of Newell Creek Dam, April 11, 2017.

Hydraulic Characteristics

The chute that is 0.7 miles downstream of Newell Creek Dam consists of a sloped bedrock ledge that rises a total of about 4.9 feet over a distance of about 27 feet. Even if a steelhead could leap from the relatively shallow pool at the base of the ledge, data presented in Powers and Orsborn (1985) indicates that the horizontal distance (27 feet) is too great for even a steelhead in prime condition (condition coefficient of 100%).

HES conducted more detailed measurements at the bedrock chute and a bedrock shelf (N P-3) about 0.8 miles downstream of the dam (HES 2014). HES noted the presence of potential passage routes on both banks (HES 2014), as follows:

"This obstacle is more complex than N P-3 with 3 distinct potential migration pathways. The center of the bedrock ledge is a relatively uniform chute with relatively constant slope and some portions approaching laminar flow. On the right side there is an overflow channel with two drops of 1.5 to 2 feet and shallow flow over relatively steep bedrock in the lower part. On February 25, 2008 at a flow of approximately 43 to 49 cfs, this channel was too shallow and had insufficient depth in the plunge pools to be passable. At higher flows this side may be passable. On the left side, the bedrock is more stepped forming a turbulent cascade with two small, shallow plunge pools. Although the plunge pools are quite small (about 2-3 feet in diameter) and have depths of only 1 to 1.5 feet, they may offer enough velocity reduction to allow fish to ascend this side of the ledge. On February 25, 2008 at a flow of 46 cfs the depth of flow along this pathway was too shallow in places to meet passage criteria. In addition, there was significant air entrainment in the highly turbulent flow along this pathway, reducing the fluid density and the propulsive force of a fishes swimming movements."

The central chute was analyzed in more detail. For short chutes velocity may be determined by the equation:

$$V_{SC} = (2gH)^{0.5} \qquad 1)$$

where V_{SC} is the velocity down a short chute, g is the acceleration due to gravity (32.2 fps^2), and H is the total vertical drop between two pools (Powers and Orsborn 1985). Using this equation, velocity in the steepest part of the cascade would be approximately 11 fps. While this is within the burst speed range for both steelhead and coho salmon, the turbulence in this cascade

presents difficulty by deflecting the fish from its course and causing excessive expenditure of energy to resist upwellings, eddies, entrained air, and vortices. Most of the fish's energy is utilized simply to maintain position and direction (Powers and Orsborn 1985).

The central chute in this obstacle is comparable to N P-3 but has a slightly steeper slope (17% compared to 12% at N P-3). The uneven face of this ledge is more difficult to survey for cross-sectional area, wetted perimeter, or mean depth. Due to the steeper slope, it is likely that higher levels of flow are required to meet a 0.6 foot depth criteria than the estimated 230 cfs required at N P-3. Assuming other channel variables are similar to N P-3 the increased slope at N P-4 alone would result in suitable passage depth (0.6 feet) at a flow of 204 to 327 cfs. This flow range would correspond to mean velocity estimates of 10 to 16 fps. Only a steelhead in top condition would be capable of ascending at the upper end of the velocity range. A coho salmon would likely be incapable of passing this obstacle, even at the lower velocity estimate.

In summary, HES concluded that an adult steelhead would not be able to leap the upper barrier and that its ability to swim over it (past the bedrock chute) would be limited by shallow depth of flow and high velocity, but may be possible for a fish in peak condition at a flow in the range of about 200 to 325 cfs. It is unlikely that adult coho salmon would be able to pass this obstacle at any flow (HES 2014). This is consistent with the previous assessment by Don Alley (Alley et al. 2004).

On April 11, 2017, a team of biologists representing NOAA Fisheries, CDFW, and the City of Santa Cruz conducted a site visit at the bedrock chute. The team confirmed the HES assessment although there were different opinions about the level of flow that might be needed for passage.

*Frequency of flows in the potential passage rang*e

If we assume that steelhead could indeed pass the bedrock chute at flow in the range of 200 to 325 cfs, it is possible to estimate how often flows at this level would occur. Simulated data (provided by Gary Fiske and Associates) for daily average flows below Loch Lomond (based on daily average inflow to Loch Lomond), were evaluated to determine frequency of flows in a suitable range that would exist in the absence of Loch Lomond. The natural flow in Newell Creek only rarely reaches levels suitable for passage of adult steelhead at this site. Daily average flow during the steelhead migration season (Dec through April) would be in the hypothetically suitable range 0.9% of the time of the time during the 1936 to 2014 hydrologic study period. In 41 of the 79 study years (52%), there would be no occurrence of flows in the suitable range. In 9 more years (an additional 11%), flow would be in the hypothetically suitable range for only one day. The greatest amount of time with hypothetically suitable flow

in any year was nine days and these were not consecutive but had a few brief events with any migration period lasting no more than two days.

Habitat conditions and Steelhead populations upstream of the barrier

Habitat conditions between the bedrock chute and the dam are not that good for steelhead. During habitat surveys conducted in 2007, it was found that the bedrock dominated reach (where the chute is located) and the upstream reach below Newell Creek Dam had markedly less instream cover and less potential spawning area than did the lower reach (Table 1). The uppermost reach had the least suitable habitat for *O. mykiss* including less extensive and shallower pools, less instream cover, and less potential spawning area. Abundance of O. mykiss in both visual surveys during the habitat assessment and in electrofishing surveys dropped off markedly in the upper half of the bedrock reach (beginning upstream of the bedrock chute) and in the uppermost reach (HES 2007).

Table 1. Population and Key Habitat Characteristics for Newell Creek Downstream of Loch Lomond (*Source*: HES 2007).

Reach	Habitat Unit	*O. mykiss* density (# per 100 ft.)	Reach Average *O. mykiss* density	% of Pools with max. depth >= 2 ft.	% of pools with >= 20% of unit with cover	Spawning area per 100 ft.
Lower	25	21	21	71	81	24
	26	85				
	26b	NA				
	29	21				
Bedrock[1]	55	29	15	100	29	13
	69	14				
	80	0				
Upper	105	5	2	38	13	10
	110	0				

[1] Double line indicates location of major migration obstacle.

The San Lorenzo River Salmonid Enhancement Plan (Alley et al. 2004) also evaluated the quality of habitat above the reservoir. The Plan considered the potential for restoring steelhead to the Newell Creek watershed upstream of Loch Lomond, specifically the possibility of transporting steelhead past Loch Lomond Reservoir to habitat in upper Newell Creek. Their conclusion was as follows:

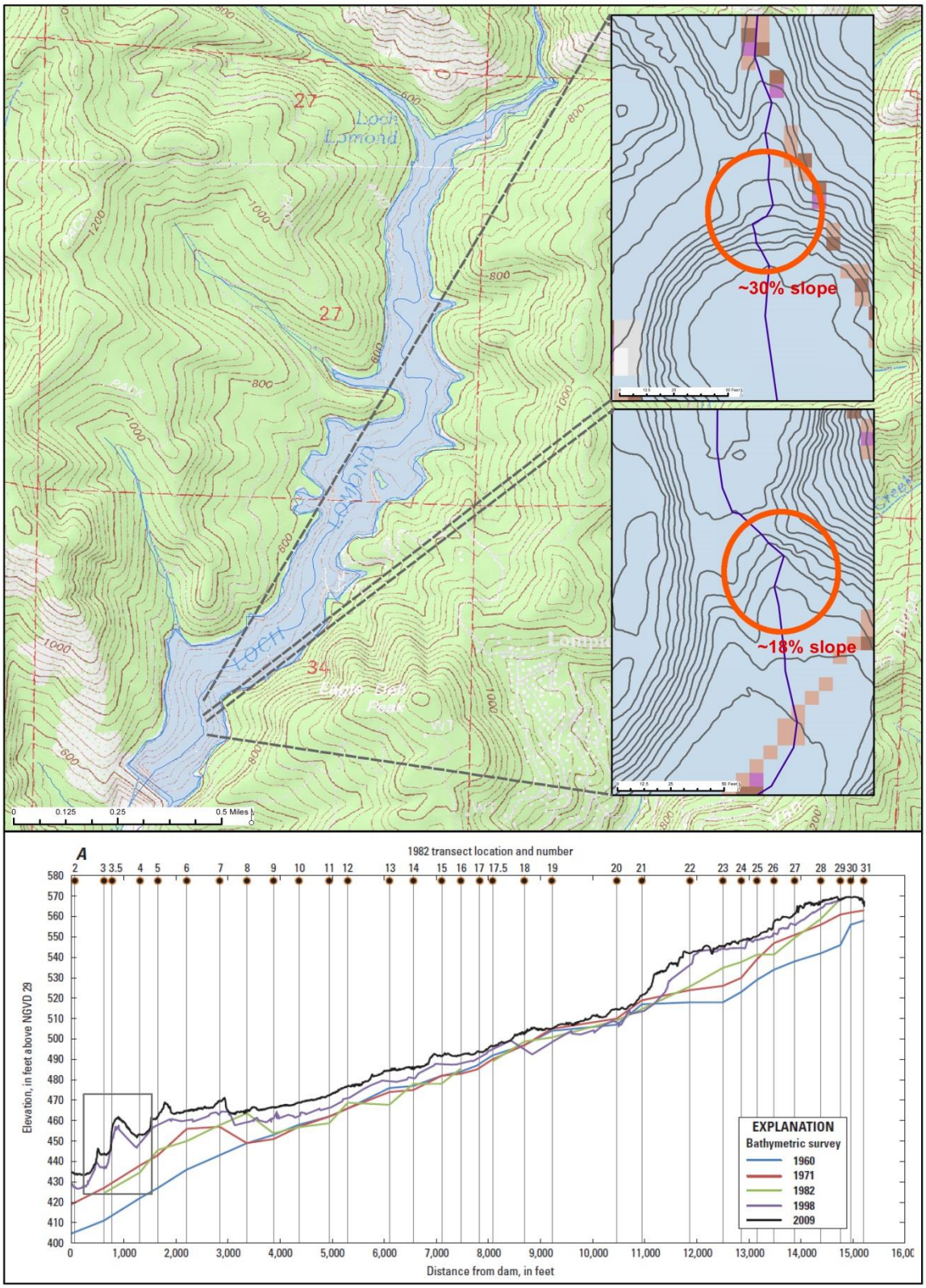
"Although the dam on Newell Creek is a complete barrier to steelhead migration, there would be little benefit in transporting adults above and providing smolt passage down past the dam. There is less than 2 miles of stream habitat for salmonids, which is of low quality due to relatively shallow pools, low baseflow and limited escape cover (Alley unpublished). Juvenile growth may be expected to be slow." (Alley et al. 2004 p.51).

If the bedrock chute is passable at certain flows, and if there is a sufficient amount of time when flows are in a passable range, the reach of Newell Creek above the site of Newell Creek Dam may have supported an anadromous run of steelhead. Construction of the dam may have resulted in loss of anadromous habitat above the dam. Bathymetry surveys of the reservoir were examined to determine whether any other obstacles to migration may have existed prior to construction of the Dam. The survey, completed in 2008 with a 2 foot contour interval, shows two steep sections of 18% and 30% gradient located 1700 feet and 2000 feet upstream of the fish release (the point where flow is released to Newell Creek from Loch Lomond). These locations seem to present even more severe obstructions than the bedrock chute 0.7 miles downstream of the dam. The lower feature has a 6 foot elevation gain over a 32 foot distance; the upper has an 8 foot elevation gain over a 26 foot distance. Separately or in combination, these features would have severely limited and likely precluded passage of steelhead and coho salmon to upstream habitat. The quality of habitat upstream of these obstacles, in the present inundation zone of Loch Lomond, is unknown. Habitat characterization downstream of the Dam and D.W. Alley habitat surveys in Newell Creek upstream of the reservoir, indicate relatively low quality habitat for salmonids. It would be reasonable to assume, in the absence of other information, that habitat in the inundation zone was of similar quality.

Conclusion

The bedrock chute 0.7 miles downstream of Newell Creek Dam precludes migration of steelhead the majority of the time and is judged a complete barrier to coho salmon. Although steelhead may be able to pass the chute during some isolated conditions (estimates are a window of flow from 200 to 325 cfs), the frequency of potential migration conditions is too low to support a consistent anadromous run. Therefore, the bedrock chute is considered the limit of anadromy for both coho salmon and steelhead. This is supported by observations of very few *O. mykiss* upstream of the chute compared to downstream reaches. Bathymetric surveys

indicate the presence of two additional steep gradient sections located between 1700 and 2000 feet upstream of the lower base of Newell Creek Dam that likely formed complete barriers to steelhead migration before construction of the Dam. Habitat quality between the chute and Newell Creek Dam is judged to be relatively poor for production of steelhead.



Top: Newell Creek Reservoir (USGS topographic map, 40' contours) showing historic path of Newell Creek, including pre-dam barriers (2' contours derived from 2008 bathemetric surveys; Sea Engineering Inc., 2009).
Bottom: Comparison of thalweg altitude for five bathymetric surveys (1960, 1971, 1982, 1998, and 2009), as compared with distance from the dam along the thalweg, Loch Lomond Reservoir, Santa Cruz County, California. Source: USGS Scientific Investigations Report 2011–5141.

Documents Cited

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HES, 2014. Assessment of Stream flow Effects on Migration, Spawning, and Rearing Habitat for Anadromous Salmonids in Streams Influenced by City of Santa Cruz Water Diversions Including Newell Creek. Prepared for City of Santa Cruz Water Department. Prepared by Hagar Environmental Science, Richmond, California. December 1, 2014.

Appendix 6: Loch Lomond Aquatic Pesticide Application Plan and Aquatic Pesticide Application General NPDES Permit

CORRECTION – 7/27/2016
Typographical Error – Changed Order Number From 2016-0074-EXEC to 2016-0073-EXEC

STATE WATER RESOURCES CONTROL BOARD
ORDER 2016-0073-EXEC

AMENDING

WATER QUALITY ORDER 2013-0002-DWQ
GENERAL PERMIT NO. CAG 990005
(AS AMENDED BY ORDERS 2014-0078-DWQ AND 2015-0029-DWQ)

STATEWIDE NATIONAL POLLUTANT DISCHARGE ELIMINATION SYSTEM PERMIT FOR RESIDUAL AQUATIC PESTICIDE DISCHARGES TO WATERS OF THE UNITED STATES FROM ALGAE AND AQUATIC WEED CONTROL APPLICATIONS

The State of California, Water Resources Control Board (hereafter State Water Board) finds:

1. The State Water Board is authorized to prescribe statewide general National Pollutant Discharge Elimination System (NPDES) permits for categories of discharges that involve the same or similar operations and the same or similar types of waste pursuant to the California Water Code section 13263(i).
2. On September 22, 1989, the U.S. Environmental Protection Agency (U.S. EPA) granted the State of California, through the State Water Board and the Regional Water Quality Control Boards, the authority to issue general NPDES permits pursuant to title 40 Code of Federal Regulations (C.F.R.) parts 122 and 123.
3. Section 122.28 of 40 C.F.R. provides for issuance of general permits to regulate a category of point sources if the sources involve the same or substantially similar types of operations; discharge the same type of waste; require the same type of effluent limitations or operating conditions; require similar monitoring; and are more appropriately regulated under a general order rather than individual permits.
4. On March 5, 2013, the State Water Board adopted Water Quality Order 2013-0002-DWQ (later amended by Orders 2014-0078-DWQ on May 20, 2014 and 2015-0029-DWQ on March 3, 2015), Statewide NPDES Permits for Residual Aquatic Pesticide Discharges to Waters of the United States from Algae and Aquatic Weed Control Applications (hereafter Weed Control Permit). The State Water Board amended Order 2013-0002-DWQ through Order 2014-0078-DWQ on May 20, 2014 and Order 2015-0029-DWQ on March 3, 2015. The Weed Control Permit covers the point source discharge of residual pesticides resulting from pesticide applications for aquatic weed control. The Weed Control Permit covers only pesticides that are approved for aquatic use by U.S. EPA and registered by the California Department of Pesticide Regulation (DPR) for aquatic applications in accordance with specific application rates
5. Section III.B of the Weed Control Permit provides delegation authority from the State Water Board to the Executive Director for the following actions:

a. Amend the permit to add new active ingredients currently registered by DPR for the control of aquatic weeds; and

b. Add Dischargers to the list of public agencies in permit Attachment G that have satisfactorily completed the California Environmental Quality Act (CEQA) process and been granted an exception from meeting receiving water limitations for pesticide active ingredients that are priority pollutants in accordance with section 5.3 of the State Water Board Policy for Implementation of Toxics Standards for Inland Surface Waters, Enclosed Bays, and Estuaries of California (SIP).

6. The discharge of residual aquatic pesticides with the following active ingredients is permitted with coverage under the Weed Control Permit: 2,4-D, acrolein, calcium hypochlorite, copper, diquat, endothall, fluridone, glyphosate, imazamox, imazapyr, penoxsulam, sodium carbonate peroxyhydrate, sodium hypochlorite, and triclopyr-based algaecides and aquatic herbicides, and adjuvants containing ingredients represented by the surrogate nonylphenol.

7. The State Water Board granted exceptions to public agencies and mutual water companies that met the criteria stated in SIP section 5.3 for short-term or seasonal exceptions from meeting the receiving water limitations for priority pollutants of acrolein and copper.

8. This item proposes the following amendments to the Weed Control Permit:

   a. Add the City of Sacramento, City of Poway, Helix Water District, San Diego County Water Authority, Santa Fe Irrigation District, and Sweetwater Authority to Attachment G which lists dischargers excepted from meeting receiving water limitations for acrolein or copper in accordance with SIP section 5.3. These agencies have satisfactorily completed the required CEQA process for exceptions to copper receiving water limits.

   b. Modify the SIP exception for Byron-Bethany Irrigation District (District) in Attachment G to add a SIP exception for copper to the District's current SIP exception for acrolein. Attachment G lists dischargers receiving exceptions to meeting receiving water limitations for acrolein or copper in accordance with SIP section 5.3. The District has satisfactorily completed the required CEQA process.

   c. Add the pesticide active ingredient flumioxazin. DPR approved the use of pesticide products containing this active ingredient for aquatic use in the state in 2014.

   d. Add the pesticide active ingredients hydrogen peroxide and peroxyacetic acid. DPR approved the use of pesticide products containing these active ingredients for aquatic use in the state in 2002.

9. Interested parties were invited to comment on the proposed permit amendments in response to the 30 day public notice of the amended permit issued on February 23, 2016. The Executive Director considered all comments received during the public notice period, and, where necessary, revised the proposed permit amendment accordingly prior to authorizing the amendments.

IT IS HEREBY ORDERED THAT:

Pursuant to the authority delegated by Water Code section 13267(f), Resolution 2002-0104, and Order 2015-0029-DWQ, Order 2013-0002-DWQ is hereby amended as shown in Attachment A.

6/30/16
Dated

Thomas Howard
Executive Director

Attachment A

STATE WATER RESOURCES CONTROL BOARD

1001 I STREET, SACRAMENTO, CALIFORNIA 95814

State Water Resources Control Board Pesticide Permit page
(https://www.waterboards.ca.gov/water_issues/programs/npdes/pesticides/)

WATER QUALITY ORDER 2013-0002-DWQ

(AS AMENDED BY ORDERS 2014-0078-DWQ, 2015-0029-DWQ, AND 2016-0073-EXEC)

GENERAL PERMIT NO. CAG990005

STATEWIDE GENERAL NATIONAL POLLUTANT DISCHARGE ELIMINATION SYSTEM (NPDES) PERMIT FOR RESIDUAL AQUATIC PESTICIDE DISCHARGES TO WATERS OF THE UNITED STATES FROM ALGAE AND AQUATIC WEED CONTROL APPLICATIONS

The following Dischargers may apply for coverage under this General Permit in compliance with the waste discharge requirements as set forth in this General Permit:

Table 1. Discharger Information

Dischargers	Any entity that discharges residual algaecides and aquatic herbicide and their degradation byproducts to waters of the United States* from algae and aquatic weed control applications.

Table 2. Administrative Information

This General Permit was adopted by the State Water Resources Control Board (hereinafter State Water Board) on:	March 5, 2013
This General Permit shall become effective on:	December 1, 2013
This General Permit shall expire on:	November 30, 2018
The U.S. Environmental Protection Agency (U.S. EPA) and the State Water Board have classified this discharge as a minor discharge.	

I, Jeanine Townsend, Clerk to the Board, do hereby certify that this General Permit with all attachments is a full, true, and correct copy of the General Permit adopted by the State Water Board on March 5, 2013.

AYE:

NAY:

ABSENT:

ABSTAIN:

Jeanine Townsend
Clerk to the Board

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I. DISCHARGE INFORMATION

Pesticide formulations may include “active ingredients” and “inert ingredients.”* Adjuvants***.** or surfactants may be added to the ingredients in the application equipment used in delivery of the pesticide. As part of the registration process of pesticides for use in California, U.S. EPA and the California Department of Pesticide Regulation (DPR) evaluate data submitted by registrants to ensure that a product used according to label instructions will cause no harm or adverse impact on non-target organisms that cannot be reduced or mitigated with protective measures or use restrictions. The Clean Water Act (CWA) section 301(a) broadly prohibits the discharge of any pollutant to waters of the United States, except in compliance with an NPDES permit. Residual
pesticides*. discharged into surface waters constitute pollutants within the meaning of the CWA even if the discharge is in compliance with the registration requirements of the Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA). Therefore, coverage under an NPDES permit is required.

The discharge of algaecides and aquatic herbicides and their residues to surface waters for algae and aquatic weed control throughout the State of California may pose a threat to existing and potential beneficial uses of waters of the United States if not properly controlled and regulated.

This General Permit regulates the discharge of aquatic pesticides* (algaecides and aquatic herbicides) used for algae and aquatic weed control to waters of the United States. These are algaecides and aquatic herbicides with registration labels that explicitly allow direct application to water bodies.

* An asterisk means the term is defined in Attachment A. This applies to all sections of this General permit.

II. PERMIT COVERAGE AND APPLICATION REQUIREMENTS

A. General Permit Coverage

Except for discharges on tribal lands that are regulated by a federal permit, this General Permit covers the point source* discharge to waters of the United States of residues resulting from pesticide applications using products containing 2,4-D, acrolein, calcium hypochlorite, copper, diquat, endothall, flumioxazin, fluridone, glyphosate, hydrogen peroxide, imazamox, imazapyr, penoxsulam, peroxyacetic acid, sodium carbonate peroxyhydrate, sodium hypochlorite, and triclopyr-based algaecides and aquatic herbicides, and adjuvants containing ingredients represented by the surrogate nonylphenol. This General Permit covers only discharges of algaecides, and aquatic herbicides that are currently registered for use in California, or that become registered for use and contain the above-listed active ingredients and ingredients represented by the surrogate of nonylphenol.

This General Permit does not cover agricultural storm water discharges or return flows from irrigated agriculture because these discharges are not defined as “point sources” and do not require coverage under an NPDES permit. This General Permit also does not cover other indirect or nonpoint source discharges from applications of algaecides and aquatic herbicides, including discharges of pesticides to land that may be conveyed in storm water or irrigation runoff.

As shown in Table 1, this General Permit becomes effective on December 1, 2013. To obtain coverage under this General Permit on or after that date, Dischargers must submit their application for coverage as set forth in Section II.C below, at least 90 days prior to their first pesticide application.

B. Discharger

A Discharger under this General Permit includes any entity involved in the application of algaecides and aquatic herbicides that results in a discharge of algaecides and aquatic herbicides and their residues and degradation byproducts to waters of the United States, and meets either or both of the following two criteria:

The entity has control over the financing for or the decision to perform algaecide and aquatic herbicide applications that result in discharges, including the ability to modify those decisions; or

The entity has day-to-day control of algaecide and aquatic herbicide applications or performs activities that are necessary to ensure compliance with this General Permit. For example, the entity is authorized to direct workers to carry out activities required by this General Permit or perform such activities themselves.

C. General Permit Application

To obtain authorization under this General Permit, Dischargers must submit to the State Water Board a complete application that consists of the following:

1. A Notice of Intent (NOI) shown as Attachment E, signed in accordance with the signatory requirements of the Standard Provisions in Attachment B;
2. An application fee. A fee is required only for new Dischargers. Dischargersenrolled under Order No. 2004-0009-DWQ and applying for coverage under this Permit will be billed during the regular billing cycle; and
3. An Aquatic Pesticide* Application Plan (APAP).

A Discharger proposing to apply algaecides and aquatic herbicides in multiple Water Board regions shall submit one NOI, one APAP, and one filing fee. The Discharger shall indicate in the NOI all the Water Board regions where applications are planned. The Discharger shall address all required elements of the APAP for all areas in the state where discharges are proposed.

Within 90 days of receipt of an application, the State Water Board's Deputy Director of the Division of Water Quality (Deputy Director) will either issue a Notice of Applicability (NOA) or deny the application. The NOA will specify the permitted algaecide and aquatic herbicide active ingredients that may be used, and any regionspecific conditions and requirements not stated in this General Permit. Any such region-specific conditions and requirements shall be enforceable. The Discharger is authorized to discharge starting on the date of the NOA.

Alternatively, the Deputy Director or a Regional Water Board Executive Officer may issue a Notice of Exclusion (NOE),[1] which either terminates the permit coverage or requires submittal of an application for an individual permit or alternative general permit.

D. Fees

The fee for enrollment under this General Permit shall be based on section 2200(b)(9) category 3 of title 23, California Code of Regulations, which is available at

[1] An NOE is a one-page notice that indicates and justifies why the Discharger or proposed Discharger is not eligible for coverage under this General Permit and states the reason why. This justification can include, but is not limited to, necessity to comply with a total maximum daily load or to protect sensitive water bodies. The NOE can also indicate that the coverage is denied if feasible alternatives to the selected pesticide application project are not analyzed.

http://www.waterboards.ca.gov/resources/fees/docs/fy1112fee_schdl_npdes_prmt.pdf and is payable to the State Water Board.

E. Terminating Coverage

To terminate permit coverage, a Discharger must submit a complete and accurate Notice of Termination (NOT) provided in Attachment F. The Discharger's authorization to discharge under this General Permit terminates on the day of the coverage termination letter issued by the Deputy Director. Prior to the termination effective date, the Discharger is subject to the terms and conditions of this General Permit and is responsible for submitting the annual fee and all reports associated with this General Permit.

A Discharger must submit an NOT when one of the following conditions occurs:

1. A new operator has taken over responsibility of the Discharger's algae or aquatic weed control activities covered under an existing NOA;
2. The Discharger has ceased all discharges from the application of algaecides and aquatic herbicide for which it obtained General Permit coverage and does not expect to discharge during the remainder of this General Permit term; or
3. The Discharger has obtained coverage under an individual permit or an alternative general permit for all discharges required to be covered by an NPDES permit.

III. FINDINGS

The Fact Sheet (Attachment D), which contains the background information and rationale for the requirements in this General Permit, is hereby incorporated into this General Permit and constitutes its findings. All other attachments (A, B, C, and E through G) are also incorporated into this General Permit.

THEREFORE, IT IS HEREBY ORDERED that this General Permit supersedes Order No. 2004-0009-DWQ except for enforcement purposes, and in order to meet the provisions contained in division 7 of the Water Code (commencing with § 13000) and regulations adopted thereunder, and the provisions of the CWA and regulations and guidelines adopted thereunder:

A. The Discharger shall comply with the requirements in this Order.

B. The Executive Director is authorized to amend this Order to add active ingredients that are registered by DPR for the control of aquatic weeds, and to grant exceptions pursuant to section 5.3 of the Policy for Implementation of Toxics Standards for Inland Surface Waters, Enclosed Bays, and Estuaries of California (SIP).

IV. DISCHARGE PROHIBITIONS

A. The discharge of residual algaecides and aquatic herbicides in a manner different from that described in this General Permit is prohibited.

B. The discharge of residual algaecides and aquatic herbicides shall not create a nuisance as defined in section 13050 of the California Water Code.

C. The discharge shall not cause, have a reasonable potential to cause, or contribute to an in-stream excursion above any applicable standard or criterion promulgated by U.S. EPA pursuant to section 303 of the CWA, or water quality objective adopted by the State or Regional Water Boards.

D. All pesticides are prohibited from the waters of the Lahontan Region (Region 6). The use of this permit is invalid in the Lahontan Region unless the discharger has requested a prohibition exemption from the Lahontan Water Board and the Lahontan Water Board has granted an exemption for the use of algaecides or aquatic herbicides.

V. EFFLUENT LIMITATIONS

A. The discharge of residual algaecides and aquatic herbicides must meet applicable water quality standards; and

B. Dischargers shall implement Best Management Practices (BMPs) when applying aquatic algaecides and aquatic herbicides. The BMPs must be provided in the APAP which is described in Section VIII.C below.

VI. RECEIVING WATER LIMITATIONS

The discharge shall not result in any of the following:

A. The discharge of residual algaecides and aquatic herbicides shall not cause or contribute to an exceedance of the following limitations in the receiving water:

Table 3. Receiving Water Limitations

Constituent/ Parameter	Beneficial Use [Reference Note 1 following Table 3] MUN, µ/L	Beneficial Use [Reference Note 1 following Table 3] WARM or COLD, µ/L	Beneficial Use [Reference Note 1 following Table 3] Other than MUN, WARM, or COLD, µ/L	Beneficial Use [Reference Note 1 following Table 3] All Designations	Basis
2, 4-D	70				U.S. EPA MCL
Acrolein [Reference Note 2 following Table 3]	320	21	780		U.S. EPA Water Quality Criteria, 1986.
Chlorine		Freshwater acute Criterion = 20 µ/L			U.S. EPA's Ambient Water Quality Criteria for Freshwater Aquatic Life Protection
Chlorine		Saltwater Acute Criterion =< 10 µ/L			California Ocean Plan
Copper [Reference Note 2 following Table 3				Dissolved Freshwater [Reference Note 3 following Table 3] Copper Chronic = 0.960exp{0.8545 [ln(hardness4)] – 1.702}	California Toxics Rule

Constituent/ Parameter	Beneficial Use [Reference Note 1 following Table 3] MUN, µ/L	Beneficial Use [Reference Note 1 following Table 3] WARM or COLD, µ/L	Beneficial Use [Reference Note 1 following Table 3] Other than MUN, WARM, or COLD, µ/L	Beneficial Use [Reference Note 1 following Table 3] All Designations	Basis
				[Reference Note 5 and 6 following Table 3] Dissolved Saltwater [Reference Note 3 following Table 3] Copper Chronic = 3.1 µg/L [Reference Note 5 and 6 following Table 3]	
Diquat	20				U.S. EPA MCL
Endothall	100				U.S. EPA MCL
Fluridone	560				U.S. EPA Integrated Risk Information System
Glyphosate	700				U.S. EPA MCL
Nonylphenol				Freshwater Chronic Criterion = 6.6 µg/L Saltwater Chronic Criterion = 1.7 µg/L	U.S. EPA National Recommended Ambient Water Quality Criteria

Constituent/ Parameter	Beneficial Use [Reference Note 1 following Table 3] MUN, µ/L	Beneficial Use [Reference Note 1 following Table 3] WARM or COLD, µ/L	Beneficial Use [Reference Note 1 following Table 3] Other than MUN, WARM, or COLD, µ/L	Beneficial Use [Reference Note 1 following Table 3] All Designations	Basis
Toxicity	Algaecide and aquatic herbicide applications shall not cause or contribute to toxicity in receiving water(s).	Algaecide and aquatic herbicide applications shall not cause or contribute to toxicity in receiving water(s).	Algaecide and aquatic herbicide applications shall not cause or contribute to toxicity in receiving water(s).	Algaecide and aquatic herbicide applications shall not cause or contribute to toxicity in receiving water(s).	Regional Water Boards' Basin Plans

Notes:

1. See Regional Water Boards' Water Quality Control Plans (Basin Plans) for beneficial use definitions.
2. Public entities and mutual water companies* listed in Attachment G are not required to meet these limitations in receiving waters during the exception period described in the APAP and Section VIII.C.10 below.
3. For waters in which the salinity is equal to or less than 1 part per thousand 95% or more of the time, the freshwater criteria apply. For waters in which the salinity is equal to or greater than 10 parts per thousand 95% or more of the time, saltwater criteria apply. For waters in which the salinity is between 1 and 10 parts per thousand, the applicable criteria are the more stringent of the freshwater or saltwater criteria.
4. For freshwater aquatic life criteria, waters with a hardness 400 mg/L or less as calcium carbonate, the actual ambient hardness of surface water shall be used. For waters with a hardness of over 400 mg/L as calcium carbonate, a hardness of 400 mg/L as calcium carbonate shall be used with a default Water-Effect Ratio of 1.
5. Values should be rounded to two significant figures.
6. This limitation does not apply to the Sacramento River and its tributaries above the State Highway 32 Bridge at Hamilton City. See Table III-1 of the Basin Plan for the Sacramento and San Joaquin River Basins for copper limitation

B. Dissolved Oxygen. Dissolved oxygen to be below the Regional Water Board Basin Plans' dissolved oxygen objectives for the receiving water.

C. Floating Material. Floating material to be present in the amounts that cause nuisance or adversely affect beneficial uses.

D. Settleable Substances. Settleable substances to be present in concentrations that result in the deposition of material that causes nuisance or adversely affects beneficial uses.

E. Suspended Material. Suspended material to be present in concentrations that cause nuisance or adversely affect beneficial uses.

F. Taste and Odors. Taste- or odor-producing substances to be present in concentrations that impart undesirable tastes or odors to fish flesh or other edible products of aquatic origin, or that cause nuisance, or otherwise adversely affect beneficial uses or domestic or municipal water supplies.

G. Toxic Pollutants. Toxic pollutants to be present in the water column, sediments, or biota in concentrations that adversely affect beneficial uses; that produce detrimental response in human, plant, animal, or aquatic life; or that bioaccumulate in aquatic resources at levels which are harmful to human health.

H. Color. Esthetically undesirable discoloration.

I. Aquatic Communities. Aquatic communities and populations, including vertebrates, invertebrates, and non-target plant species to be degraded.

VII. RECEIVING WATER MONITORING TRIGGERS

In the absence of Receiving Water Limitations, the Receiving Water Monitoring Triggers shown in Table 4 below will be used to assess compliance with the narrative receiving water toxicity limitation. However, exceeding the monitoring trigger does not constitute a violation of this General Permit as long as the Discharger performs the following actions: (1) initiates additional investigations for the cause of the exceedance; (2) implements additional BMPs to reduce the algaecide and aquatic herbicide residue concentration to be below the monitoring triggers in future applications; and (3) evaluates the appropriateness of using alternative products.

Table 4. Receiving Water Monitoring Triggers

Ingredient	Unit	Instantaneous Maximum Monitoring Trigger	Basis
Imazapyr	mg/L	11.2	U.S. EPA Office of Pesticides *Ecotoxicity Database*
Triclopyr Triethylamine	mg/L	13.0	U.S. EPA Office of Pesticides *Ecotoxicity Database*
Flumioxazin	mg/L	0.23	U.S. EPA Office of Pesticides *Ecotoxicity Database*

VIII. AQUATIC PESTICIDE USE REQUIREMENTS

A. Application Schedule

The Discharger shall provide a phone number or other specific contact information to all persons who request the Discharger's application schedule. The Discharger shall provide the requester with the most current application schedule and inform the requester if the schedule is subject to change. Information may be made available by electronic means, including posting prominently on a well-known website.

B. Public Notice Requirements

Every calendar year, at least 15 days prior to the first application of algaecide or aquatic herbicide, the Discharger shall notify potentially affected public agencies. The Discharger shall post the notification on its website if available. The notification shall include the following information:

1. A statement of the discharger's intent to apply algaecide or aquatic herbicide(s);
2. Name of algaecide and aquatic herbicide(s);
3. Purpose of use;
4. General time period and locations of expected use;
5. Any water use restrictions or precautions during treatment; and
6. A phone number that interested persons may call to obtain additional information from the Discharger.

C. Aquatic Pesticides Application Plan (APAP)

Dischargers shall submit an APAP at least 90 days before the expected day of permit coverage. The APAP shall contain, but not be limited to, the following elements sufficient to address each proposed treatment area:*

1. Description of the water system to which algaecides and aquatic herbicides are being applied;
2. Description of the treatment area in the water system;
3. Description of types of weed(s) and algae that are being controlled and why;
4. Algaecide and aquatic herbicide products or types of algaecides and aquatic herbicides expected to be used and if known their degradation byproducts, the method in which they are applied, and if applicable, the adjuvants and surfactants used;
5. Discussion of the factors influencing the decision to select algaecide and aquatic herbicide applications for algae and weed control;
6. If applicable, list the gates or control structures to be used to control the extent of receiving waters potentially affected by algaecide and aquatic herbicide application and provide an inspection schedule of those gates or control structures to ensure they are not leaking;
7. If the Discharger has been granted a short-term or seasonal exception under State Water Board Policy for Implementation of Toxics Standards for Inland Surface Waters, Enclosed Bays,*

and Estuaries of California (Policy) section 5.3 from meeting acrolein and copper receiving water limitations, provide the beginning and ending dates of the exception period, and justification for the needed time for the exception. If algaecide and aquatic herbicide applications occur outside of the exception period, describe plans to ensure that receiving water criteria are not exceeded because the Dischargers must comply with the acrolein and copper receiving water limitations for all applications that occur outside of the exception period;

8. Description of monitoring program;
9. Description of procedures used to prevent sample contamination from persons, equipment, and vehicles associated with algaecide and aquatic herbicide application;
10. Description of the BMPs to be implemented. The BMPs shall include, at the minimum:
    a. Measures to prevent algaecide and aquatic herbicide spill and for spill containment during the event of a spill;

b. Measures to ensure that only an appropriate rate of application consistent with product label requirements is applied for the targeted weeds or algae;

c. The Discharger's plan in educating its staff and algaecide and aquatic herbicide applicators on how to avoid any potential adverse effects* from the algaecide and aquatic herbicide applications;

d. Discussion on planning and coordination with nearby farmers and agencies with water rights diversion so that beneficial uses of the water (irrigation, drinking water supply, domestic stock water, etc.) are not impacted during the treatment period; and

e. A description of measures that will be used for preventing fish kill when algaecides and aquatic herbicides will be used for algae and aquatic weed controls.

11. Examination of Possible Alternatives. Dischargers should examine the alternatives to algaecide and aquatic herbicide use to reduce the need for applying algaecides and herbicides. Such methods include:

    a. Evaluating the following management options, in which the impact to water quality, impact to non-target organisms including plants, algaecide and aquatic herbicide resistance, feasibility, and cost effectiveness should be considered:

        i. No action;

        ii. Prevention;

        iii. Mechanical or physical methods;

        iv. Cultural methods;

        v. Biological control agents; and

        vi. Algaecides and aquatic herbicides;

    b. Using the least intrusive method of algaecide and aquatic herbicide application; and

    c. Applying a decision matrix concept to the choice of the most appropriate formulation.

D. APAP Processing, Approval, and Modifications

Upon receipt of an APAP, staff will post it on the State Water Board's website for a 30-day public comment period[2] and will distribute a notice via the State Water Board's Lyris list that an APAP has been posted. Staff will coordinate with Regional Water Board staff in reviewing the application package for

[2] See Waterkeeper Alliance, Inc. v. EPA, 399 F.3d 486 (2nd Cir. 2005).

completeness and applicability to this General Permit. If no comments are received and State and Regional Water Board staff deem the APAP complete, the Deputy Director will issue an NOA within five (5) working days of closure of the comment period. If comments are received, staff will work with Regional Water Board staff and the Discharger to address the comments to allow the Deputy Director to issue an NOA as expeditiously as possible. Permit coverage will begin when the Discharger receives the NOA.

Major changes to the APAP shall be submitted to the Deputy Director for approval. Examples of major changes include using a different product other than what is specified in the APAP, changing an application method that may result in different amounts of pesticides being applied, or adding or deleting BMPs.

E. Algaecide and Aquatic Herbicide Application Log

The Discharger shall maintain a log for each algaecide and aquatic herbicide application. The application log shall contain, at a minimum, the following information:

1. Date of application;
2. Location of application;
3. Name of applicator;
4. Type and amount of algaecide and aquatic herbicide used;
5. Application details, such as flow and level of water body, time application started and stopped, algaecide and aquatic herbicide application rate and concentration;
6. Visual monitoring assessment; and
7. Certification that applicator(s) followed the APAP.

IX. PROVISIONS

A. Standard Provisions

1. All Dischargers authorized to discharge under this General Permit shall comply with the Federal Standard Provisions included in Attachment B of this General Permit.
2. This General Permit does not authorize the discharge of residual algaecides and aquatic herbicides or their degradation byproducts to waters of the United States that are impaired by the active ingredient of the algaecides and herbicides used. Impaired waters are those waters not meeting water quality standards pursuant to section 303(d) of the CWA. California impaired waters are listed on: http://www.waterboards.ca.gov/water_issues/programs/tmdl/2010state_ir_reports /2010_combo303d.xls.

3. This General Permit does not authorize any take of endangered species. The discharge is prohibited from adversely impacting biologically sensitive or critical habitats, including, but not limited to, habitat of species listed under federal or state endangered species laws. To ensure that endangered species issues are raised to the responsible agencies, the State Water Board has notified the U.S. Fish and Wildlife Service, the National Marine Fisheries Service, and the California Department of Fish and Wildlife of this General Permit.
4. The State Water Board may use this General Permit to regulate the discharge of algaecides and aquatic herbicides and their residues to a surface water classified as Outstanding National Resource Waters or as a water body impaired by unknown toxicity only after the following conditions are satisfied: (1) the proposed project will comply with the limitations and discharge requirements specified in the General Permit; and (2) if required, the proposed algaecide and aquatic herbicide application qualifies for and has been granted a Basin Plan prohibition exception prior to discharge. The two bodies of water that are classified as Outstanding National Resource Waters in California are Lake Tahoe and Mono Lake.
5. The Discharger must follow all FIFRA pesticide label instructions and any Restricted Material Use Permits issued by a County Agricultural Commissioner.
6. All adjuvants used with the algaecides and aquatic herbicides must be labeled for aquatic use.
7. The Discharger must comply with effluent and receiving water limitations and must develop and implement an APAP.
8. To reduce the potential impacts to water quality, Dischargers shall implement the feasible alternatives to algaecide and aquatic herbicide use that are identified in the APAP.
9. All Dischargers authorized to discharge under this General Permit shall comply with discharge prohibitions and other requirements contained in Basin Plans, as implemented by the State and the nine Regional Water Boards.
10. All Dischargers authorized to discharge under this General Permit shall comply with the following provisions:

    a. After notice and opportunity for a hearing, this General Permit may be terminated or modified for cause, including, but not limited to:

        i. Violation of any term or condition contained in this General Permit;

ii. Obtaining this General Permit by misrepresentation or by failing to disclose fully all relevant facts;

iii. A change in any condition that requires either a temporary or permanent reduction or elimination of the authorized discharge; and

iv. A material change in the character, location, or volume of discharge (if applicable).

b. The provisions of this General Permit are severable. If any provision of this General Permit is found invalid, the remainder of this General Permit shall not be affected.

c. The Discharger shall maintain a copy of this General Permit and make it available at all times to operating personnel. Key operating personnel shall be familiar with its content.

d. Laboratories that perform sample analyses must be identified in all monitoring reports submitted to the State and Regional Water Boards.

e. All monitoring and analysis instruments and devices used by the Discharger to fulfill the prescribed monitoring program shall be properly maintained and calibrated based on manufacturer's recommendations to ensure their continued accuracy.

f. Each Discharger shall file with the State Water Board and the appropriate Regional Water Board technical reports on self monitoring* performed according to the detailed specifications contained in the Monitoring and Reporting Program attached to this General Permit.

g. The State and Regional Water Board are authorized to enforce the terms of this General Permit under provisions of the California Water Code, including, but not limited to, sections 13385, 13386, and 13387.

B. Monitoring and Reporting Program Requirements

The Discharger shall comply with the Monitoring and Reporting Program, and future revisions thereto, in Attachment C of this General Permit.

C. Special Provisions

1. Reopener Provisions

This General Permit may be reopened for modification and reissuance in accordance with the provisions contained in title 40 Code Federal Regulation (40 C.F.R.) section 122.62, and for the following reasons:

a. **Addition to the Public Entity List**. This General Permit may be reopened to modify Attachment G if any additional entity becomes qualified for a Policy section 5.3 exception.

b. **Addition of Aquatic Pesticide Active Ingredients**. This General Permit may be reopened to add additional algaecide and aquatic herbicide active ingredients if new active ingredients are registered by U.S. EPA and DPR.

c. **Acute and Chronic Toxicity**. If the State Water Board revises the Policy toxicity control provisions that would require new implementation procedures including the establishment of numeric chronic toxicity limitations, this General Permit may be reopened to include numeric acute and/or chronic toxicity receiving water limitations based on the new provisions.

d. **Receiving Water Limitations**. This General Permit may be reopened to add numeric Receiving Water Limitations for the residual algaecide and aquatic herbicides* exceeding the triggers if the additional investigation results show necessary.

e. **Endangered Species Act**. If U.S. EPA develops biological opinions regarding algaecides and aquatic herbicides included in this General Permit, this General Permit may be re-opened to add or modify Receiving Water Limitations/Monitoring Triggers for aquatic herbicides and algaecides and their residues of concern, if necessary.

f. This General Permit covers the application of pesticides that are based on active ingredients that are currently registered by DPR for the control of algae and aquatic weeds. When DPR registers a new active ingredient for algae and aquatic weed control, this General Permit needs to be reopened to add the new active ingredient to the permit before Dischargers may begin using the active ingredient. In addition, when DPR registers a new active ingredient that is also a priority pollutant and has been added to this General Permit, this General Permit may also be reopened to allow Dischargers to obtain an exception from meeting receiving water limitations for the priority pollutant in accordance with SIP section 5.3. It is very resource intensive to have the State Water Board amend this General Permit on a frequent basis. Thus, this General Permit contains a delegation from the State Water Board to the Executive Director to amend this General Permit for these two purposes.

2. **Change of Discharger**

In the event of any change in the Discharger that has obtained coverage under this General Permit, the previous Discharger shall notify the new Discharger of the existence of this General Permit by letter. A copy of the letter shall be immediately forwarded to the Deputy Director. After receipt of the letter, the Deputy Director will terminate the permit coverage to the previous Discharger. The new Discharger shall complete and submit to the

Deputy Director a revised NOI form (Attachment E), and any revisions to the APAP prepared by the previous control entity or a new APAP.

3. **Application Package**

   Dischargers who seek coverage under this General Permit shall file a complete application package at least 90 days before the expected date of algaecide and aquatic herbicide application. The application package shall include an NOI, APAP, and application fee. Enrolled Dischargers will be billed annually thereafter.

4. **Special Studies, Technical Reports, and Additional Monitoring Requirements**

   a. **Additional Investigation**

      Each Discharger must conduct additional investigations when the chemical monitoring shows exceedance of any receiving water limitation or monitoring trigger. The additional investigations shall identify corrective actions to eliminate exceedance of receiving water limitations or monitoring triggers caused by the algaecide and aquatic herbicide application. The investigation shall include, but not be limited to evaluating the need to implement one or more of the following actions: revising and improving the existing BMPs, revising the mode of application, using less toxic algaecide and aquatic herbicide products, or selecting alternative methods for algae and aquatic weed control.

   b. **Qualified Biologist Certification Following Project Completion**

      Upon completion of an algaecide and aquatic herbicide project, public entities and mutual water companies listed in Attachment G of this General Permit shall provide certification by a qualified biologist* that beneficial uses of receiving waters have been restored.

5. **Corrective Action**

   a. **Exceedance of Receiving Water Limitations or Monitoring Triggers.**

      If a Receiving Water Limitation in Table 3 or a Monitoring Trigger in Table 4 is exceeded in the Event or Post-Event sample, the Discharger shall perform the following actions: (1) initiate additional investigations for the cause of the exceedance, (2) implement appropriate BMPs to reduce the algaecide and aquatic herbicide concentration to be below the applicable receiving water limitation or monitoring triggers in future applications, and (3) evaluate the appropriateness of using alternative products.

   b. **Revision of Control Measures.**

If any of the following situations occur, the Discharger must review and, as necessary, revise the evaluation and selection of the control measures to ensure that the situation is eliminated and will not be repeated in the future:

i. An unauthorized release or discharge associated with the application of algaecides and aquatic herbicides (e.g., spill, leak, or discharge not authorized by this or another NPDES permit) occurs;

ii. The Discharger becomes aware, or the State Water Board concludes, that the control measures are not adequate/sufficient for the discharge to meet applicable water quality standards;

iii. Any monitoring activities indicate that the Discharger failed to:

a) Follow the label instructions for the product used;

b) Use the minimum amount of algaecide and aquatic herbicide product per application and optimum frequency of algaecide and aquatic herbicide applications that are necessary for an effective control program consistent with reducing the potential for development of resistance and the algaecide and aquatic herbicide product label requirements;

c) Perform regular maintenance activities to reduce leaks, spills, or other unintended discharges of algaecides and aquatic herbicides associated with the application of algaecides and aquatic herbicides covered under this General Permit; or

d) Maintain algaecide and aquatic herbicide application equipment in proper operating condition by adhering to any manufacturer's conditions and industry practices, and by calibrating, cleaning, and repairing such equipment on a regular basis to ensure effective algaecide and aquatic herbicide application and algae and aquatic weed control. The Discharger must ensure that the equipment's rate of algaecide and aquatic herbicide application is calibrated to deliver the minimum quantity of algaecides and aquatic herbicides that is needed to have an effective control program and is consistent with the algaecide and aquatic herbicide product label requirements.

c. **Corrective Action Deadlines**

If the Discharger determines that changes to the control measures are necessary to eliminate any situation identified above, the Discharger shall make such changes within 60 days. The Discharger shall take

the corrective action before any further discharge of the algaecides and aquatic herbicides and their residues will be allowed.

d. **Effect of Corrective Action**

The occurrence of a situation identified in Section C.5.b above may constitute a violation of this General Permit. Correcting the situation according to Corrective Action Section C.5.c above does not absolve the Discharger of liability for any original violation. However, failure to comply with any Corrective Action as required by Section C.5.c above constitutes an additional permit violation. The State and Regional Water Boards will consider the appropriateness and promptness of corrective action in determining enforcement responses to permit violations.

The State Water Board and the appropriate Regional Water Boards may impose additional requirements and schedules of compliance, including requirements to submit additional information concerning the condition(s) triggering corrective action or schedules and requirements more stringent than specified in this General Permit. Those requirements and schedules will supersede those in the Corrective Action Section above if such requirements conflict.

6. **Adverse Incident to Threatened or Endangered Species or Critical Habitat**

If the Discharger becomes aware of an adverse incident* to a federally-listed threatened or endangered species or its federally-designated critical habitat, that may have resulted from the Discharger's algaecides and aquatic herbicides application, the Discharger must immediately notify the National Marine Fisheries Service (NMFS) Santa Rosa office by phone at (707) 575-6050 in the case of an anadromous or marine species, or the U.S. Fish and Wildlife Service (FWS) at (916) 414-6600 in the case of a terrestrial or freshwater species. This notification must be made by telephone immediately when the Discharger becomes aware of the adverse incident and must include at least the following information:

a. The caller's name, telephone number, and e-mail address;

b. Applicator name and mailing address;

c. The name of the affected species;

d. How and when the Discharger became aware of the adverse incident;

e. Description of the location of the adverse incident;

f. Description of the adverse incident, including the U.S. EPA pesticide registration number for each product applied in the area of the adverse incident; and

g. Description of any steps that have been taken or will be taken to alleviate the adverse impact to the species.

Additional information on federally-listed threatened or endangered species and federally-designated critical habitat is available from NMFS website (www.nmfs.noaa.gov) for anadromous or marine species or FWS website (www.fws.gov) for terrestrial or freshwater species.

X. COMPLIANCE DETERMINATION

Compliance with receiving water limitations and monitoring triggers shall be determined through event and post-event monitoring results.

Attachment A – Definitions

Active Ingredient
Active ingredients are ingredients disclosed by manufacturers that yield toxic effects* on target organisms.

Adjuvants
Adjuvants are ingredients that are mixed with herbicides prior to an application event and are often trade secrets. These ingredients are chosen by the Discharger, based on site characteristics, and typically increase the effectiveness of pesticides on target organisms.

Adverse Incident
Adverse Incident means a situation where the Discharger observes upon inspection or becomes aware of in which:

- A person or non-target organism may have been exposed to an algaecide or aquatic herbicide residue; and
- The person or non-target organism suffered an adverse or toxic effect.

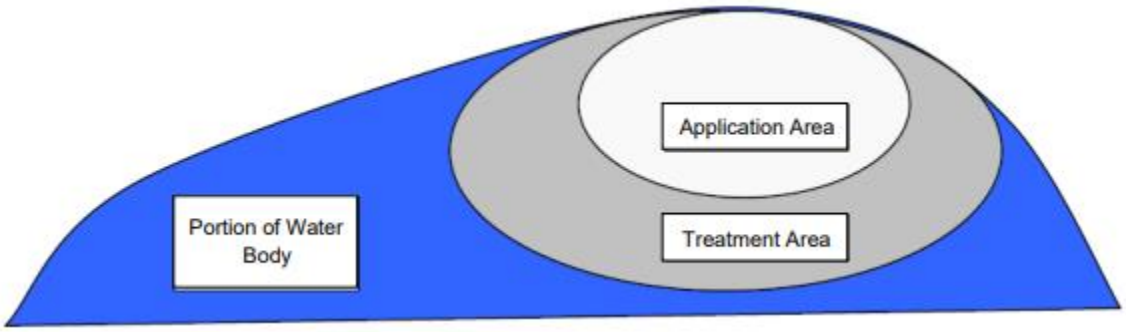
Adverse or Toxic Effect
An "adverse or toxic effect" includes any impact that occurs within waters of the United States on non-target organisms as a result of algaecide or aquatic herbicide residue discharge. Examples of these effects may include:

- Distressed or dead juvenile and small fishes
- Washed up or floating fish
- Fish swimming abnormally or erratically
- Fish lying lethargically at water surface or in shallow water
- Fish that are listless or nonresponsive to disturbance
- Stunting, wilting, or desiccation of non-target submerged or emergent aquatic plants
- Other dead or visibly distressed non-target aquatic organisms (amphibians, turtles, invertebrates, etc.)

An "adverse or toxic effect" also includes any adverse effects to humans (e.g., skin rashes) or domesticated animals that occur either directly or indirectly from a discharge to waters of the United States that are temporally and spatially related to exposure to an algaecide and aquatic herbicide residue (e.g., vomiting, lethargy).

Algae Control
Algae control means the treatment of filamentous algae, cyanobacteria (blue-green algae), or algal species that have the potential to affect human or environmental health.

Application Area
The application area is the area to which aquatic pesticides are directly applied.



Application Event
The application event is the time that introduction of the algaecide or aquatic herbicide to the treatment area takes place, not the length of time that the environment is exposed to the algaecide or aquatic herbicide.

Aquatic Pesticides
Aquatic pesticides in this General Permit are limited to algaecides and aquatic herbicides labeled for aquatic use to control aquatic weeds or algae.

Beneficial Uses
Beneficial uses of the waters of the state that may be protected against quality degradation include, but are not limited to, domestic, municipal, agricultural and industrial supply; power generation; recreation; aesthetic enjoyment; navigation; and preservation and enhancement of fish, wildlife, and other aquatic resources or preserves.

Coalition
Specifically refers to a monitoring coalition which is a collaborative monitoring partnership of dischargers to develop a monitoring plan that addresses the monitoring requirements of this General Permit. The Coalition's monitoring plan will be submitted for Coalition members in lieu of individual monitoring plans from each member.

Enclosed Bays
Enclosed Bays means indentations along the coast that enclose an area of oceanic water within distinct headlands or harbor works. Enclosed bays include all bays where the narrowest distance between the headlands or outermost harbor works is less than 75 percent of the greatest dimension of the enclosed portion of the bay. Enclosed bays do not include inland surface waters or ocean waters.

Estuaries
Estuaries means waters, including coastal lagoons, located at the mouths of streams that serve as areas of mixing for fresh and ocean waters. Coastal lagoons and mouths of streams that are temporarily separated from the ocean by sandbars shall be considered estuaries. Estuarine waters shall be considered to extend from a bay or the open ocean to a point upstream where there is no significant mixing of freshwater and seawater. Estuaries do not include inland surface waters or ocean waters.

Half-Life
Half-life is the time required for half of the compound introduced into an ecosystem to be eliminated or disintegrated by natural processes.

Inert Ingredients
Inert ingredients are additional ingredients and are often trade secrets; therefore, they are not always disclosed by the manufacturer.

Mutual Water Company
A mutual water company is defined in the Public Utilities Code, section 2725 as “[a]ny private corporation or association organized for the purpose of delivering water to its stockholders and members at cost, including use of works for conserving, treating, and reclaiming water."

Point Source
Any discernible, confined, and discrete conveyance, including but not limited to, any pipe, ditch, channel, tunnel, conduit, well, discrete fissure, container, rolling stock concentrated animal feeding operation, landfill leachate collection system, or vessel or other floating craft from which pollutants are or may be discharged. This term does not include return flows from irrigated agriculture or agricultural storm water runoff.

Priority Pollutants
Priority pollutants are listed within the California Toxics Rule in 40 Code of Federal Regulations, section 131.38(b)(1). Criteria to protect aquatic life and human health are set for priority pollutants in the California Toxics Rule.

Public Entity
Public entity includes the federal government or a state, county, city and county, city, district, public authority, or public agency.

Qualified Biologist
A qualified biologist is a biologist who has the knowledge and experience in the ecosystem where the algaecide or aquatic herbicide is applied so that he or she can adequately evaluate whether the beneficial uses of the receiving waters have been protected and/or restored upon completion of the algaecide and aquatic herbicide application project.

Receiving Waters
Receiving waters are waters of the United States anywhere outside of the treatment area at anytime and anywhere inside the treatment area after completion of the treatment event.

Representative Monitoring Location
To be considered "representative," at a minimum, a location must be similar in hydrology, algaecide or aquatic herbicide use, and other factors that affect the residual discharge to the areas being represented in that environmental setting.

Residual Algaecide and Aquatic Herbicide
Residual algaecide and aquatic herbicide are those portions of the pesticides that remain in the water after the application and its intended purpose (injury or elimination of targeted pests) have been completed.

Self Monitoring
Sampling and analysis performed by the Discharger or Coalition to determine compliance with the Permit. All laboratory analyses must be conducted by a laboratory certified by the California Department of Public Health.

Treatment Area
The treatment area is the area being treated by the algaecide or aquatic herbicide for algae and aquatic weed control and, therefore, the area being targeted to receive an appropriate rate of application consistent with product label requirements of algaecide or aquatic herbicide. It is the responsibility of the Discharger to define the treatment area for each specific algaecide and aquatic herbicide application.

Waters of the United States
1. All waters which are currently used, were used in the past, or may be susceptible to use in interstate or foreign commerce, including all waters which are subject to the ebb and flow of the tide;
2. All interstate waters, including interstate "wetlands;"
3. All other waters such as intrastate lakes, rivers, streams (including intermittent streams), mudflats, sand flats, "wetlands," sloughs, prairie potholes, wet meadows, playa lakes, or natural ponds the use, degradation, or destruction of which would affect or could affect interstate or foreign commerce including any such waters:
    a. Which are or could be used by interstate or foreign travelers for recreational or other purposes;
    b. From which fish or shellfish are or could be taken and sold in interstate or foreign commerce; or
    c. Which are used or could be used for industrial purposes by industries in interstate commerce.

4. All impoundments of waters otherwise defined as waters of the United States under this definition;
5. Tributaries of waters identified in items1 through 4 of this definition;
6. The territorial sea; and
7. "Wetlands" adjacent to waters (other than waters that are themselves wetlands) identified in paragraphs (1) through (6) of this definition. Waste treatment systems, including treatment ponds or lagoons designed to meet the requirements of CWA (other than cooling ponds as defined in 40 C.F.R. section 423.11(m) which also meet the criteria of this definition) are not waters of the United States. This exclusion applies only to manmade bodies of water which neither were originally created in waters of the United States (such as disposal area in wetlands) nor resulted from the impoundment of waters of the United States [See Note 1 of this Section.] Waters of the United States do not include prior converted cropland. Notwithstanding the determination of an area's status as prior converted cropland by any other federal agency, for the purposes of the Clean Water Act, the final authority regarding Clean Water Act jurisdiction remains with U.S. EPA.

Attachment B – Standard Provisions

I. STANDARD PROVISIONS – PERMIT COMPLIANCE (IF APPLICABLE)

A. Duty to Comply

1. The Discharger must comply with all of the conditions of this General Permit. Any noncompliance constitutes a violation of the CWA and the California Water Code and is grounds for enforcement action, for permit termination, revocation and reissuance, or modification; or denial of a permit renewal application. (40 C.F.R. §122.41(a).)
2. The Discharger shall comply with effluent standards or prohibitions established under section 307(a) of the CWA for toxic pollutants within the time provided in the regulations that establish these standards or prohibitions, even if this General Permit has not yet been modified to incorporate the requirement. (40 C.F.R. §122.41(a)(1).)

B. Need to Halt or Reduce Activity Not a Defense

It shall not be a defense for a Discharger in an enforcement action that it would have been necessary to halt or reduce the permitted activity in order to maintain compliance with the conditions of this General Permit. (40 C.F.R. §122.41(c).)

C. Duty to Mitigate

The Discharger shall take all reasonable steps to minimize or prevent any discharge in violation of this General Permit that has a reasonable likelihood of adversely affecting human health or the environment. (40 C.F.R. §122.41(d).)

D. Proper Operation and Maintenance

The Discharger shall at all times properly operate and maintain all facilities and systems of control (and related appurtenances) which are installed or used by the Discharger to achieve compliance with the conditions of this General Permit. Proper operation and maintenance also includes adequate laboratory controls and appropriate quality assurance procedures. (40 C.F.R. §122.41(e).)

E. Property Rights

1. This General Permit does not convey any property rights of any sort or any exclusive privileges. (40 C.F.R. §122.41(g).)
2. The issuance of this General Permit does not authorize any injury to persons or property or invasion of other private rights, or any infringement of state or local law or regulations. (40 C.F.R. §122.5(c).)

F. Inspection and Entry

The Discharger shall allow the Regional Water Board, State Water Board, United States Environmental Protection Agency (U.S. EPA), and/or their authorized representatives (including an authorized contractor acting as their representative), upon the presentation of credentials and other documents, as may be required by law, (40 C.F.R. §122.41(i); Water Code, §13383) to:

1. Enter upon the Discharger's premises where a regulated facility or activity is located or conducted, or where records are kept under the conditions of this General Permit;
2. Have access to and copy, at reasonable times, any records that must be kept under the conditions of this General Permit;
3. Inspect and photograph, at reasonable times, any facilities, equipment (including monitoring and control equipment), practices, or operations regulated or required under this General Permit; and
4. Sample or monitor, at reasonable times, for the purposes of assuring General Permit compliance or as otherwise authorized by the CWA or the Water Code, any substances or parameters at any location.

II. STANDARD PROVISIONS – PERMIT ACTION

A. General

This General Permit may be modified, revoked and reissued, or terminated for cause. The filing of a request by the Discharger for modification, revocation and reissuance, or termination, or a notification of planned changes or anticipated noncompliance does not stay any General Permit condition. (40 C.F.R. §122.41(f).)

B. Duty to Reapply

If the Discharger wishes to continue an activity regulated by this General Permit after the expiration date of this General Permit, the Discharger must apply for and obtain authorization as required by the new permit. (40 C.F.R. §122.41(b).)

C. Transfers

This General Permit is not transferable to any person except after notice to the State Water Board. The State Water Board may require modification or revocation and reissuance of the General Permit to change the name of the Discharger and incorporate such other requirements as may be necessary under the CWA and the Water Code. (40 C.F.R. §122.41(l)(3); §122.61.)

D. Continuation of this Permit

If this permit is not reissued or replaced prior to the expiration date, it will be administratively continued in accordance with 40 C.F.R. section 122.6 and remain in full force and effect.

III. STANDARD PROVISIONS – MONITORING

Samples and measurements taken for the purpose of monitoring shall be representative of the monitored activity. (40 C.F.R. §122.41(j)(1).)

Monitoring results must be conducted according to test procedures under 40 C.F.R. part 136 unless other test procedures have been specified in this General Permit. (40 C.F.R. §122.41(j)(4); §122.44(i)(1)(iv).)

IV. STANDARD PROVISIONS – RECORDS

A. Records Retention

The Discharger shall retain records of all monitoring information, including all calibration and maintenance records, copies of all reports required by this General Permit, and records of all data used to complete the application for this General Permit, for a period of at least three (3) years from the date of the sample, measurement, report or application. This period may be extended by request of the the State Water Board's Deputy Director of the Division of Water Quality (Deputy Director) at any time. (40 C.F.R. §122.41(j)(2).)

B. Records of monitoring information shall include:

1. The date, exact place, and time of sampling or measurements (40 C.F.R. §122.41(j)(3)(i).);
2. The individual(s) who performed the sampling or measurements (40 C.F.R. §122.41(j)(3)(ii).);
3. The date(s) analyses were performed (40 C.F.R. §122.41(j)(3)(iii).);
4. The individual(s) who performed the analyses (40 C.F.R. §122.41(j)(3)(iv).);
5. The analytical techniques or methods used (40 C.F.R. §122.41(j)(3)(v).); and
6. The results of such analyses. (40 C.F.R. §122.41(j)(3)(vi).)

C. Claims of confidentiality for the following information will be denied (40 C.F.R. §122.7(b).):

1. The name and address of any permit applicant or Discharger (40 C.F.R. §122.7(b)(1).); and
2. Permit applications and attachments, permits and effluent data. (40 C.F.R. §122.7(b)(2).)

V. STANDARD PROVISIONS – REPORTING

A. Duty to Provide Information

The Discharger shall furnish to the Regional Water Board, State Water Board, or U.S. EPA within a reasonable time, any information which the Regional Water Board, State Water Board, or U.S. EPA may request to determine whether cause exists for modifying, revoking and reissuing, or terminating this General Permit or to determine compliance with this General Permit. Upon request, the Discharger shall also furnish to the Regional Water Board, State Water Board, or U.S. EPA copies of records required to be kept by this General Permit. (40 C.F.R. §122.41(h); Wat. Code, §13267)

B. Signatory and Certification Requirements

1. All applications, reports, or information submitted to the Regional Water Board, State Water Board, and/or U.S. EPA shall be signed and certified in accordance with Standard Provisions – Reporting V.B.2, V.B.3, V.B.4, V.B.5, and V.B.6 below. (40 C.F.R. §122.41(k).)

2. For a corporation. By a responsible corporate officer. For the purpose of this section, a responsible corporate officer means: (i) A president, secretary, treasurer, or vice-president of the corporation in charge of a principal business function, or any other person who perfoms similar policy- or decision-making functions for the corporation, or (ii) the manager of one or more manufacturing, production, or operating facilities, provided, the manager is authorized to make management decisions which govern the operation of the regulated facility including having the explicit or implicit duty of making major capital investment recommendations, and initiating and directing other comprehensive measures to assure long term environmental compliance with environmental laws and regulations; the manager can ensure that the necessary systems are established or actions taken to gather complete and accurate information for permit application requirements; and where authority to sign documents has been assigned or delegated to the manager in accordance with corporate procedures.

3. For a partnership or sole proprietorship. By a general partner or the proprietor, respectively;

4. For a municipality, state, federal, or other public agency: All permit applications shall be signed by either a principal executive officer or ranking elected official. For purposes of this provision, a principal executive officer of a federal agency includes: (i) the chief executive officer of the agency, or (ii) a senior executive officer having responsibility for the overall operations of a principal geographic unit of the agency (e.g., Regional Administrators of U.S. EPA). (40 C.F.R. §122.22(a)(3).)

5. All reports required by this General Permit and other information requested by the Regional Water Board, State Water Board, or U.S. EPA shall be signed by a person described in Standard Provisions – Reporting V.B.1 above, or by a duly authorized representative of that person. A person is a duly authorized representative only if:

   a. The authorization is made in writing by a person described in Standard Provisions – Reporting V.B.1 above (40 C.F.R. §122.22(b)(1).);

   b. The authorization specifies either an individual or a position having responsibility for the overall operation of the regulated facility or activity or an individual or a position having overall responsibility for environmental matters for the company. (A duly authorized representative may thus be either a named individual or any individual occupying a named position.) (40 C.F.R. §122.22(b)(2).); and

   c. The written authorization is submitted to the Regional Water Board and State Water Board. (40 C.F.R. §122.22(b)(3).)

6. If an authorization under Standard Provisions – Reporting V.B.1 above is no longer accurate because a different individual or position has responsibility for the overall operation of the facility, a new authorization satisfying the requirements of Standard Provisions – Reporting V.B.1 above must be submitted to the Regional Water Board and State Water Board prior to or together with any reports, information, or applications, to be signed by an authorized representative. (40 C.F.R. §122.22(c).)

   Any person signing a document under Standard Provisions – Reporting V.B.1 or V.B.3 above shall make the following certification:

   "I certify under penalty of law that this document and all attachments were prepared under my direction or supervision in accordance with a system designed to assure that qualified personnel properly gather and evaluate the information submitted. Based on my inquiry of the person or persons who manage the system or those persons directly responsible for gathering the information, the information submitted is, to the best of my knowledge and belief, true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment for knowing violations." (40 C.F.R. §122.22(d).)

C. Monitoring Reports

1. Monitoring results shall be reported at the intervals specified in the Monitoring and Reporting Program (Attachment C) in this General Permit. (40 C.F.R. §122.22(l)(4).)

2. Monitoring results must be reported on a Self Monitoring* Report (SMR) form as agreed to by the Deputy Director and the Discharger.

3. If the Discharger monitors any pollutant more frequently than required by this General Permit using test procedures approved under 40 C.F.R part 136 or as specified in this General Permit, the results of this monitoring shall be included in the calculation and reporting of the data submitted in the SMR or a reporting form specified by the State Water Board. (40 C.F.R. §122.41(l)(4)(ii).)

4. Calculations for all limitations, which require averaging of measurements, shall utilize an arithmetic mean unless otherwise specified in this General Permit. (40 C.F.R. §122.41(l)(4)(iii).)

D. Compliance Schedules

Reports of compliance or noncompliance with, or any progress reports on, interim and final requirements contained in any compliance schedule of this General Permit, shall be submitted no later than 14 days following each schedule date. (40 C.F.R. §122.41(l)(5).)

E. Planned Changes

The Discharger shall give notice to the State and the Regional Water Board as soon as possible of any planned physical alterations or additions to the permitted activity or discharge. Notice is required under this provision (40 C.F.R. §122.41(l)(1)) only when the alteration or addition could significantly change the nature or increase the quantity of pollutants discharged. This notification applies to pollutants that are subject neither to effluent limitations in this General Permit nor to notification requirements under 40 C.F.R. section 122.42(a)(1).

F. Anticipated Noncompliance

The Discharger shall give advance notice to the State and Regional Water Boards of any planned changes in the permitted discharge or activity that may result in noncompliance with General Permit requirements. (40 C.F.R. §122.41(l)(2).)

G. Other Noncompliance

The Discharger shall report all instances of noncompliance not reported under Standard Provisions – Reporting V.C, V.D, and V.E above at the time monitoring reports are submitted. The reports shall contain the information listed in Standard Provision – Reporting V.F above. (40 C.F.R. §122.41(l)(7).)

H. Other Information

When the Discharger becomes aware that it failed to submit any relevant facts in a permit application, or submitted incorrect information in a permit

application or in any report to the State Water Board, Regional Water Board, or U.S. EPA, the Discharger shall promptly submit such facts or information. (40 C.F.R. §122.41(l)(8).)

VI. STANDARD PROVISIONS – ENFORCEMENT

The State and the Regional Water Boards are authorized to enforce the terms of this General Permit under several provisions of the Water Code, including, but not limited to, sections 13385, 13386, and 13387.

Attachment C – Monitoring and Reporting Program

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Attachment C – Monitoring and Reporting Program

Section 122.48 of title 40 of the Code of Federal Regulations (40 C.F.R. §122.48) requires that all NPDES permits specify monitoring and reporting requirements. California Water Code sections 13267 and 13383 also authorize the State Water Resources Control Board (the State Water Board) and the Regional Water Quality Control Board (Regional Water Board) to require technical and monitoring reports. This Monitoring and Reporting Program (MRP) establishes monitoring and reporting requirements which implement federal and California State laws and regulations.

This MRP is designed to address the two key questions shown below. It also encourages Dischargers to form monitoring coalitions with others doing similar applications within a given watershed or doing applications of similar environmental settings (flowing water and nonflowing water). The Coalition or Discharger may select sites representing worst case scenarios or high-use areas for each active ingredient in each environmental setting. If the Discharger elects in its Aquatic Pesticide Application Plan (APAP) to undertake monitoring and reporting through a Coalition, then the Coalition will prepare and implement an MRP (pursuant to this Attachment C) and act on behalf of the Discharger with respect to monitoring and reporting. Otherwise, the Discharger will prepare and implement an individual MRP.

Question No. 1: Does the residual algaecides and aquatic herbicides discharge cause an exceedance of receiving water limitations?

Question No. 2: Does the discharge of residual algaecides and aquatic herbicides, including active ingredients, inert ingredients, and degradation byproducts, in any combination cause or contribute to an exceedance of the “no toxics in toxic amount” narrative toxicity objective?

If the Discharger elects in its APAP to undertake monitoring and reporting through a Coalition, the APAP should reference and attach the Coalition’s monitoring plan.

I. GENERAL MONITORING PROVISIONS

A. Samples and measurements taken as required herein shall be representative of the nature of the monitored discharge. All samples shall be taken at the anticipated monitoring locations specified in the Discharger’s or Coalition’s APAP.

B. All laboratory analyses shall be conducted at a laboratory certified for such analyses by the California Department of Public Health in accordance with California Water Code section 13176. Laboratories that perform sample analyses shall be identified in all monitoring reports. The Discharger shall institute a Quality Assurance-Quality Control Program for any onsite field measurements such as electric conductivity, pH, turbidity, and temperature. A manual containing the steps followed in this program must be kept in the laboratory and shall be available for inspection by the State Water Board and the appropriate Regional Water Board staff. The Quality Assurance-Quality

Control Program must conform to United States Environmental Protection Agency (U.S. EPA) guidelines or to procedures approved by the State Water Board and the appropriate Regional Water Board.

C. All analyses shall be conducted in accordance with the latest edition of "Guidelines Establishing Test Procedures for Analysis of Pollutants," promulgated by the U.S. EPA in title 40 Code Federal Regulation (40 C.F.R.) 136 or equivalent methods that are commercially and reasonably available and that provide quantification of sampling parameters and constituents sufficient to evaluate compliance with applicable effluent limits and to perform reasonable potential analysis. Equivalent methods must be more sensitive than those specified in 40 C.F.R. 136 if the method is available in the 40 C.F.R. 136, and must be approved for use by the Regional Water Board Executive Officer.

Any procedures to prevent the contamination of samples as described in the monitoring program in the APAP shall be implemented.

D. Records of monitoring information shall include the following:

1. The date, exact place, and time of sampling or measurements;
2. The individuals who performed the sampling or measurements;
3. The dates analysis were performed;
4. The individuals who performed the analyses;
5. The analytical techniques or methods used; and
6. Results of analyses.

E. All monitoring instruments and devices used to fulfill the prescribed monitoring program shall be properly maintained and calibrated as necessary to ensure their accuracy.

F. Monitoring results, including noncompliance, shall be reported at intervals and in a manner specified in this MRP.

II. MONITORING LOCATIONS AND SAMPLE TYPES

A. Monitoring Locations

Each Discharger or Coalition shall establish monitoring locations specified in the APAP to demonstrate compliance with the receiving water limitations, discharge specifications, and other requirements in this General Permit. The number and location of samples shall be selected to answer the two key questions. A Discharger or Coalition may use representative monitoring locations* to characterize water quality for all waters of the United States within the Discharger's or Coalition's boundaries for each environmental setting (flowing water and non-flowing water). However, the Discharger or Coalition must provide justification for the selection of the representative monitoring locations. To be considered "representative," at a minimum, a location must be

similar in hydrology, algaecides and aquatic herbicides use, and other factors that affect the discharge of algaecides and aquatic herbicides and their residues to surface waters as a result of applications to the areas being represented in that environmental setting. Each Discharger or Coalition must provide technical justification and identify which areas are to be considered representative. Monitoring location information shall include a description of the treatment area, GPS coordinates if feasible, and algaecides and aquatic herbicides being applied. The specific monitoring locations initially identified as representative monitoring locations may be changed based on surveillance of the Discharger or Coalition.

B. Sample Types

The following monitoring is required for each sampling:

1. **Background Monitoring.** Background monitoring samples shall be collected upstream at the time of the application event* or in the application area* just prior to (up to 24 hours in advance of) the application event.
2. **Event Monitoring.** Event monitoring samples shall be collected immediately downstream of the treatment area in flowing waters or immediately outside of the treatment area in non-flowing waters, immediately after the application event, but after sufficient time has elapsed such that treated water would have exited the treatment area.
3. **Post-Event Monitoring.** Post-event monitoring samples shall be collected within the treatment area within one week after application or when treatment is complete.

III. RECEIVING WATER MONITORING REQUIREMENTS – SURFACE WATER

A. General Monitoring Requirements

The monitoring program described in the APAP shall be designed to answer the two key questions stated above. The monitoring program in the APAP shall describe the tasks and time schedules in which these two key questions will be addressed. Monitoring shall take place at locations that are being planned to be applied or may be applied as described in the Discharger's APAP.

The monitoring program described in the APAP must consider watershed specific attributes and waste constituents, based on the characteristics of applications within the Coalition's or Discharger's area, as well as the receiving water quality conditions. Developing the details of a monitoring design requires clearly defining several inputs to the design and then organizing these in a logical framework that supports effective decision making about indicators, monitoring locations, and monitoring frequency. The logical framework should describe:

1. The basic geographic and hydrographic features of the area, particularly application points and the pathways(s) of residue flows;
2. Algaecides and aquatic herbicides application practices and how they are distributed in space and time;
3. Relevant knowledge about the transport, fates, and effects of algaecides and aquatic herbicides, including best- and worst-case scenarios;
4. Description of the designated beneficial uses in each water body;
5. Relevant knowledge about the action of cumulative and indirect effects;
6. Mechanisms through which algaecides and aquatic herbicides applications could lead to designated use impacts, given the basic features of the area;
7. Known and potential impacts of algaecides and aquatic herbicides applications on water quality, ranked in terms of relative risk, based on factors such as magnitude, frequency and duration;
8. Sufficient number of sampling areas to assess the entire Discharger's or Coalition's area of influence; and
9. A description of sampling methods and a sampling schedule.

In conducting the receiving water sampling, a log shall be kept of the receiving water conditions throughout the reach bounded by the treatment area. Attention shall be given to the presence or absence of:

1. Floating or suspended matter;
2. Discoloration;
3. Bottom deposits;
4. Aquatic life;
5. Visible films, sheens, or coatings;
6. Fungi, slimes, or objectionable growths; and
7. Potential nuisance conditions.

Notes on receiving water conditions shall be summarized in the monitoring report.

B. Visual, Physical, and Chemical Monitoring Requirements

Monitoring shall take place at locations that are described and scheduled in the Coalition's or Discharger's APAP. Monitoring for all active ingredients must include frequent and routine monitoring on a pre-determined schedule, as summarized in the Table C-1 below:

Table C-1. Monitoring Requirements

Sample Type	Constituent/ Parameter	Units	Sample Method	Minimum Sampling Frequency	Same Type Requirement	Required Analytical Test Method
Visual	1. Monitoring area description (pond, lake, open waterway, channel, etc.) 2. Appearance of waterway (sheen, color, clarity, etc.) 3. Weather conditions (fog, rain, wind, etc.)	Not applicable	Visual Observation	[Reference Note 1 following Table C-1]	Background, Event and Post-event Monitoring	Not Applicable
Physical	1. Temperature [Reference Note 2 following Table C-1]	ºF	Grab [Reference Note 4 following Table C-1]	[Reference Note 5 following Table C-1]	Background, Event and Post-event Monitoring	[Reference Note 6 following Table C-1]
Physical	2. pH [Reference Note 3 following Table C-1]	Number	Grab [Reference Note 4 following Table C-1]	[Reference Note 5 following Table C-1]	Background, Event and Post-event Monitoring	[Reference Note 6 following Table C-1]

Sample Type	Constituent/ Parameter	Units	Sample Method	Minimum Sampling Frequency	Same Type Requirement	Required Analytical Test Method
Physical	3. Turbidity [Reference Note 3 following Table C-1]	NTU	Grab [Reference Note 4 following Table C-1]	[Reference Note 5 following Table C-1]	Background, Event and Post-event Monitoring	[Reference Note 6 following Table C-1]
Physical	4. Electric Conductivity [Reference Note 3 following Table C-1] @ 25°C	µmhos/cm	Grab [Reference Note 4 following Table C-1]	[Reference Note 5 following Table C-1]	Background, Event and Post-event Monitoring	[Reference Note 6 following Table C-1]
Chemical	1. Active Ingredient [Reference Note 7 following Table C-1]	µg/L	Grab [Reference Note 4 following Table C-1]	[Reference Note 5 following Table C-1]	Background, Event and Post-event Monitoring	[Reference Note 6 following Table C-1]
Chemical	2. Nonylphenol [Reference Note 8 following Table C-1]	µg/L	Grab [Reference Note 4 following Table C-1]	[Reference Note 5 following Table C-1]	Background, Event and Post-event Monitoring	[Reference Note 6 following Table C-1]

Sample Type	Constituent/ Parameter	Units	Sample Method	Minimum Sampling Frequency	Same Type Requirement	Required Analytical Test Method
Chemical	3. Hardness (if copper is monitored)	mg/L	Grab [Reference Note 4 following Table C-1]	[Reference Note 5 following Table C-1]	Background, Event and Post-event Monitoring	[Reference Note 6 following Table C-1]
Chemical	4. Dissolved Oxygen [Reference Note 2 following Table C-1]	mg/L	Grab [Reference Note 4 following Table C-1]	[Reference Note 5 following Table C-1]	Background, Event and Post-event Monitoring	[Reference Note 6 following Table C-1]

Notes:

1 All applications at all sites.

2 Field testing.

3 Field or laboratory testing.

4 Samples shall be collected at three feet below the surface of the water body or at mid water column depth if the depth is less than three feet.

5 Collect samples from a minimum of six application events for each active ingredient in each environmental setting (flowing water and non-flowing water) per year, except for glyphosate. If there are less than six application events in a year, collect samples during each application event for each active ingredient in each environmental setting (flowing water and non-flowing water). If the results of monitoring from six consecutive application events show concentrations that are less than the receiving water limitation/trigger for an active ingredient in an environmental setting, sampling

shall be reduced to one application event per year for that active ingredient in that environmental setting. To support a reduction in monitoring frequency, the six sampling events showing concentrations that are less than the receiving water limitation/trigger for an active ingredient must be consecutive and can span more than one year or application season. The reduction in monitoring frequency under this provision applies to all listed active ingredients including SIP listed active ingredients If the yearly sampling event shows exceedance of the receiving water limitation/trigger for an active ingredient in an environmental setting, then sampling shall return to six application events for that active ingredient in each environmental setting. For glyphosate, collect samples from one application event from each environmental setting (flowing water and non-flowing water) per year.

6 Pollutants shall be analyzed using the analytical methods described in 40 C.F.R. part 136.

7 2,4-D, acrolein, chlorine, dissolved copper, diquat, endothall, flumioxazin, fluridone, glyphosate, imazamox, imazapyr, penoxsulam, and triclopyr.

8 It is required only when a surfactant is used.

IV. REPORTING REQUIREMENTS

A. General Monitoring and Reporting Requirements

1. The Coalition or Discharger shall comply with all Standard Provisions (Attachment B) related to monitoring, reporting, and recordkeeping.
2. Upon written direction of the State Water Board or the Regional Water Board, the Coalition or Discharger shall submit information as specified.
3. The Coalition or Discharger shall report to the State Water Board and appropriate Regional Water Board any toxic chemical release data that are reported to the State Emergency Response Commission within 15 days of reporting the data to the Commission pursuant to section 313 of the "Emergency Planning and Community Right to Know Act" of 1986 (42 U.S.C. §11001 et. seq.).

B. Annual Information Collection

The Coalition or Discharger shall complete and retain all information on the previous reporting year beginning January 1 and ending December 31. When requested by the Deputy Director or Executive Officer of the applicable Regional Water Board, the Coalition or Discharger shall submit the annual information which must include the following:

1. An executive summary discussing compliance or violation of this General Permit and the effectiveness of the APAP to reduce or prevent the discharge of pollutants associated with algaecide and aquatic herbicide applications;
2. A summary of monitoring data, including the identification of water quality improvements or degradation as a result of the algaecide or aquatic pesticide application, if appropriate, and recommendations for improvements to the APAP [including proposed best management practices (BMPs)] and monitoring program based on the monitoring results. All receiving water monitoring data shall be compared to receiving water limitations and receiving water monitoring triggers;
3. Identification of BMPs currently in use and a discussion of their effectiveness in meeting the requirements in this General Permit;
4. A discussion of BMP modifications addressing violations of this General Permit;
5. A map showing the location of each treatment area;
6. Types and amounts of algaecides and aquatic herbicides used at each application event;*

7. Information on surface area and/or volume of treatment areas and any other information used to calculate dosage, concentration, and quantity of each algaecide and aquatic herbicide used;
8. Sampling results shall indicate the name of the sampling agency or organization, detailed sampling location information (including latitude and longitude or township/range/section if available), detailed map or description of each sampling area (address, cross roads, etc.), collection date, name of constituent/parameter and its concentration detected, minimum levels, method detection limits for each constituent analysis, name or description of water body sampled, and a comparison with applicable water quality standards, description of analytical QA/quality control plan. Sampling results shall be tabulated so that they are readily discernible; and
9. Summary of algaecide and aquatic herbicide application log.

C. Annual Report

The Coalition or Discharger shall submit to the Deputy Director and the appropriate Regional Water Board Executive Officer an annual report consisting of a summary of the past year's activities, and certify compliance with all requirements of this General Permit. If there is no discharge of algaecides and aquatic herbicides, their residues, or their degradation byproducts, the Coalition or Discharger shall provide the Deputy Director and the appropriate Regional Water Board Executive Officer a certification that algaecide and aquatic herbicide application activities did not result in a discharge to any water body. The annual report shall contain the following information:

1. An executive summary discussing compliance or violation of this General Permit and the effectiveness of the APAP; and
2. A summary of monitoring data, including the identification of water quality improvements or degradation as a result of the algaecide or aquatic pesticide application,
3. Dischargers shall submit the annual report according to the following schedule:

Table C-2. Reporting Schedule

Reporting Frequency	Reporting Period	Annual Report Due
Annual	January 1 through December 31	March 1

D. Electronic Reporting

At any time during the term of this General Permit, the State Water Board or the appropriate Regional Water Board may notify the Coalition or Discharger of the requirement to submit electronically Self Monitoring Reports (SMRs) using the State Water Board's California Integrated Water Quality System (CIWQS) Program (http://www.waterboards.ca.gov/ciwqs/index.html). Until such notification is given, the Coalition or Discharger shall submit hardcopy SMRs. The CIWQS website will provide additional directions for SMR submittal in the event there will be service interruption for electronic submittal.

The Coalition or Discharger shall report the results for all monitoring specified in this MRP in the SMR. The Coalition or Discharger shall submit annual SMRs including the results of all required monitoring using U.S. EPA-approved test methods or other test methods specified in this General Permit. If the Coalition or Discharger monitors any pollutant more frequently than required by this General Permit, the results of this monitoring shall be included in the calculations and reporting of the data submitted in the SMR.

E. Reporting Protocols

The Coalition or Discharger shall report with each sample result the applicable reported Minimum Level (ML) and the current Minimum Detection Limit, as determined by the procedure in 40 C.F.R. part 136.

The Coalition or Discharger shall report the results of analytical determinations for the presence of chemical constituents in a sample using the following reporting protocols:

1. Sample results greater than or equal to the reported ML shall be reported as measured by the laboratory (i.e., the measured chemical concentration in the sample).

2. Sample results less than the Report Limit, but greater than or equal to the laboratory's MDL, shall be reported as "Detected, but Not Quantified," or DNQ. The estimated chemical concentration of the sample shall also be reported.

   For the purposes of data collection, the laboratory shall write the estimated chemical concentration next to DNQ as well as the words "Estimated Concentration" (may be shortened to "Est. Conc."). The laboratory may, if such information is available, include numerical estimates of the data quality for the reported result. Numerical estimates of data quality may be percent accuracy (plus a percentage of the reported value), numerical ranges (low to high), or any other means considered appropriate by the laboratory.

3. Sample results less than the laboratory's MDL shall be reported as "<" followed by the MDL.

4. The Coalition or Discharger shall instruct laboratories to establish calibration standards so that the ML value (or its equivalent if there is differential treatment of samples relative to calibration standards) is the lowest calibration standard. At no time is the Coalition or Discharger to use analytical data derived from extrapolation beyond the lowest point of the calibration curve.

5. Multiple Sample Data: If two or more sample results are available, the Coalition or Discharger shall compute the arithmetic mean unless the data set contains one or more reported determinations of DNQ or "Not Detected" (ND). In those cases, the Coalition or Discharger shall compute the median in place of the arithmetic mean in accordance with the following procedure:

    a. The data set shall be ranked from low to high, ranking the reported ND determinations lowest, DNQ determinations next, followed by quantified values (if any). The order of the individual ND or DNQ determinations is unimportant.

    b. The median value of the data set shall be determined. If the data set has an odd number of data points, then the median is the middle value. If the data set has an even number of data points, then the median is the average of the two values around the middle unless one or both of the points are ND or DNQ, in which case the median value shall be the lower of the two data points where DNQ is lower than a value and ND is lower than DNQ.

6. The annual report shall comply with the following requirements:

    a. The Coalition or Discharger shall arrange all reported data in a tabular format. The data shall be summarized to clearly illustrate whether the algaecide and aquatic herbicide applications are conducted in compliance with effluent and receiving water limitations. The Coalition or Discharger is not required to duplicate the submittal of data that are entered in a tabular format within CIWQS. When electronic submittal of data is required and CIWQS does not provide for entry into a tabular format within the system, the Coalition or Discharger shall submit electronically the data in a tabular format as an attachment.

    b. The Coalition or Discharger shall attach a cover letter to the annual report that clearly identifies violations of the permit; discusses corrective actions taken or planned; and provides a time schedule for corrective actions. Identified violations must include a description of the requirement that was violated and a description of the violation.

    c. The annual report must be submitted to the State Water Board and the appropriate Regional Water Board, signed and certified as required by the Standard Provisions (Attachment B).

F. Other Reporting Requirements

1. Twenty-Four Hour Report

   The Coalition or Discharger shall report to the State Water Board and appropriate Regional Water Board any noncompliance, including any unexpected or unintended effect of an algaecide or aquatic herbicide use that may endanger health or the environment. Any information shall be provided orally within 24 hours from the time the Coalition or Discharger becomes aware of the circumstances and must include the following information:

   a. The caller's name and telephone number;

   b. Applicator name and mailing address;

   c. Waste Discharge Identification (WDID) number;

   d. The name and telephone number of a contact person;

   e. How and when the Coalition or Discharger become aware of the noncompliance;

   f. Description of the location of the noncompliance;

   g. Description of the noncompliance identified and the U.S. EPA pesticide registration number for each product the Discharger applied in the area of the noncompliance; and

   h. Description of any steps that the Coalition or Discharger has taken or will take to correct, repair, remedy, cleanup, or otherwise address any adverse effects.

   If the Coalition or Discharger is unable to notify the State and the appropriate Regional Water Board within 24 hours, the Coalition or Discharger must do so as soon as possible and also provide the rationale for why the Discharger was unable to provide such notification within 24 hours.

2. Five-Day Written Report

   The Coalition or Discharger shall also provide a written submission within five (5) days of the time the Discharger becomes aware of the noncompliance. The written submission shall contain the following information:

   a. Date and time the Coalition or Discharger contacted the State Water Board and the appropriate Regional Water Board notifying of the noncompliance and any instructions received from the State and/or Regional Water Board; information required to be provided in Section D.1 (24-Hour Reporting);

b. A description of the noncompliance and its cause, including exact date and time and species affected, estimated number of individual and approximate size of dead or distressed organisms (other than the pests to be eliminated);

c. Location of incident, including the names of any waters affected and appearance of those waters (sheen, color, clarity, etc);

d. Magnitude and scope of the affected area (e.g. aquatic square area or total stream distance affected);

e. Algaecide and aquatic herbicide application rate, intended use site (e.g., banks, above, or direct to water), method of application, and name of algaecide and herbicide product, description of algaecide and herbicide ingredients, and U.S. EPA registration number;

f. Description of the habitat and the circumstances under which the noncompliance activity occurred (including any available ambient water data for aquatic algaecides and aquatic herbicides applied);

g. Laboratory tests performed, if any, and timing of tests. Provide a summary of the test results within five days after they become available;

h. If applicable, explain why the Coalition or Discharger believes the noncompliance could not have been caused by exposure to the algaecides or aquatic herbicides from the Coalition's or Discharger's application; and

i. Actions to be taken to prevent recurrence of adverse incidents.

The State Water Board staff or Regional Water Board staff may waive the above required written report under this provision on a case-by-case basis if an oral report has been received within 24 hours.

Attachment D – Fact Sheet

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Attachment D– Fact Sheet

As described in Section III, Findings, of this General Permit, the State Water Resources Control Board (State Water Board) incorporates this Fact Sheet as findings of the State Water Board that support the issuance of this General Permit. This Fact Sheet includes the legal requirements and technical rationale that serve as the basis for the requirements of this General Permit.

This General Permit has been prepared under a standardized format to accommodate a broad range of discharge requirements for Dischargers in California.

I. PERMIT INFORMATION

A. Background

1. The Regulatory Background

In 1972, the Federal Water Pollution Control Act (also referred to as the Clean Water Act or CWA) was amended to provide that the discharge of pollutants to waters of the United States from any point source is effectively prohibited unless the discharge is in compliance with a National Pollutant Discharge Elimination System (NPDES) Permit.

On September 22, 1989, the U.S. Environmental Protection Agency (U.S. EPA) granted the State of California, through the State Water Resources Control Board (State Water Board) and the Regional Water Quality Control Boards (Regional Water Boards), the authority to issue general NPDES permits pursuant to title 40 Code of Federal Regulations (40 C.F.R.) 122 and 123.

Section 122.28 of 40 C.F.R. provides for issuance of general permits to regulate a category of point sources if the sources involve the same or substantially similar types of operations; discharge the same type of waste; require the same type of effluent limitations or operating conditions; require similar monitoring; and are more appropriately regulated under a general permit rather than individual permits.

On March 12, 2001, the Ninth Circuit Court of Appeals held that discharges of pollutants from the use of aquatic pesticides in waters of the United States require coverage under an NPDES permit. (*Headwaters, Inc. v. Talent Irrigation District).*[3] The *Talent* decision was issued just prior to the major season for applying aquatic pesticides.

Because of the serious public health, safety, and economic implications of delaying pesticide applications, in 2001 the State Water Board adopted Water Quality Order (Order) No. 2001-12-DWQ, Statewide General NPDES Permit for Discharges of Aquatic Pesticides to Waters of the

[3] 243 F.3d 526 (9th Cir., 2001).

United States on an emergency basis to provide immediate NPDES permit coverage for broad categories of aquatic pesticide use in California.

Order No. 2001-12-DWQ imposed requirements on any discharge of aquatic pesticides by public entities to waters of the United States in accordance with the Policy which establishes procedures for implementing water quality standards for priority pollutants* in NPDES permits. Section 5.3 of the State Water Board Policy for Implementation of Toxics Standards for Inland Surface Waters, Enclosed Bays, and Estuaries of California (Policy) allows for short-term or seasonal exceptions from its requirements for resource or pest management conducted by public entities or mutual water companies. In order to qualify for an exception from meeting priority pollutant standards, a public entity must fulfill the requirements listed in section 5.3 and the State Water Board must decide to grant the exception. Among other requirements, entities seeking an exception to complying with water quality standards for priority pollutants must submit documents in compliance with California Environmental Quality Act (CEQA).[4] Because of the emergency adoption of Order No. 2001-12-DWQ, the State Water Board invoked an exemption to the requirements of section 5.3 of the Policy and issued the permit incorporating a categorical exception to water quality standards for priority pollutants.

Order No. 2001-12-DWQ required that Dischargers develop a best management practices (BMPs) plan that minimizes adverse impacts to receiving waters and a monitoring and reporting plan that is representative of each type of aquatic pesticide application.

In August 2001, Waterkeepers Northern California (Waterkeepers) filed a lawsuit against the State Water Board challenging several aspects of Order No. 2001-12-DWQ. Major aspects of the challenge included the emergency adoption of the Order without compliance with CEQA and other exception requirements of the Policy; failure to address cumulative impacts; and failure to comply with the California Toxics Rule (CTR).[5]

In a settlement of the Waterkeepers' lawsuit, the State Water Board agreed to fund a comprehensive aquatic pesticide monitoring program that would assess receiving water toxicity caused by aquatic pesticides and alternatives for pesticide use. The State Water Board contracted with the San Francisco Estuary Institute (SFEI) to conduct the program. SFEI published the final report on February 5, 2004.

In November 2002, the Ninth Circuit issued another opinion concerning the need for an NPDES permit for pesticide application. (*League of*

[4] Cal. Pub. Resources Code § 21000 et. seq.
[5] 40 C.F.R. Section 131.38.

Wilderness Defenders v. Forsgren.[6]) In this case, the court held that the USDA Forest Service must obtain an NPDES permit before it sprays insecticides* from an aircraft directly into or over rivers as part of silviculture activities. The court found that the insecticides are pollutants under the CWA. The court also defined the exemption for silvicultural pest control from the definition of "point source" in U.S. EPA's regulations to be limited to pest control activities from which there is natural runoff.

Also in 2002, the Second Circuit issued an unpublished decision regarding the need for an NPDES permit for application of pesticides for mosquito control in federal wetland areas. (*Altman v. Town of Amherst.)* The lower court had dismissed a citizens' suit, holding that pesticides, when used for their intended purpose, do not constitute a "pollutant" for purposes of the CWA, and are more appropriately regulated under Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA). The appeals court vacated the trial court's decision and remanded the matter. In its unpublished decision, the Second Circuit expressed concern that: "[u]ntil the EPA articulates a clear interpretation of current law - among other things, whether properly used pesticides released into or over waters of the United States can trigger the requirements for NPDES permits - the question of whether properly used pesticides can become pollutants that violate the [Clean Water Act] will remain open."

Order No. 2001-12-DWQ expired on January 31, 2004. In 2004, it was replaced by two general permits: a vector control permit for larvicides (Order No. 2004-0008-DWQ) and a weed control permit (Order No. 2004-0009-DWQ). The State Water Board determined that adoption of these two permits was consistent with the Ninth Circuit decisions.

In 2005, the Ninth Circuit held that a pesticide that is applied consistent with FIFRA is not a "chemical waste" (*Fairhurst v. Hagener*),[7] but also stated that it would not change its decision in *Headwaters*. The court stated that whether an NPDES permit was required depends on whether there was any "residue or unintended effect" from application of the pesticide. In *Fairhurst*, the court found neither residue nor unintended effect was present. Therefore, the pesticide application at issue did not require an NPDES permit.

U.S. EPA's Final Rule: On November 20, 2006, U.S. EPA adopted a final regulation providing that NPDES permits are not required for pesticide applications as long as the Discharger follows FIFRA label instructions. According to the regulation, pesticides applied under the following two

[6] 309 F.3d 1181 (9th Cir., 2002).
[7] 422 F.3d 1146 (9th Cir., 2005).

circumstances are not pollutants and, therefore, are not subject to NPDES permitting requirements:

a. The application of pesticides directly to waters of the United States in order to control pests. Examples of such applications include applications to control mosquito larvae, aquatic weeds, or other pests that are present in waters of the United States; and

b. The application of pesticides to control pests that are present over waters of the United States, including near such waters, where a portion of the pesticides will unavoidably be deposited to waters of the United States in order to target the pests effectively; for example, when insecticides are aerially applied to a forest canopy where waters of the United States may be present below the canopy or when pesticides are applied over or near water for control of adult mosquitoes or other pests.

Lawsuits Against U.S. EPA's Final Rule: After U.S. EPA's new regulation was adopted in 2006, lawsuits were filed by both the pesticide industry and environmental groups in 11 of the 13 Circuits, including the Ninth Circuit Court, challenging U.S. EPA's Final Rule.

The National Cotton Council of America v. U.S. EPA:[8] The petitions for review were consolidated in the Sixth Circuit Court by an order of the Judicial Panel on Multidistrict Litigation.

On January 11, 2009, the Sixth Circuit Court of Appeals determined that U.S. EPA's Final Rule is not a reasonable interpretation of the CWA and vacated the Final Rule. U.S. EPA did not request reconsideration of the decision, but did file a motion for a two-year stay of the effect of the decision in order to provide agencies time to develop, propose, and issue NPDES general permits for pesticide applications covered by the ruling. On June 8, 2009, the Sixth Circuit granted the motion, such that the U.S. EPA exemption was to remain in place until April 9, 2011. Subsequently, U.S. EPA was granted an extension of the stay, which allowed the exemption to continue until October 31, 2011.

2. **Related Pesticide Regulation Information**

Pesticide formulations may include "active ingredients" and "inert ingredients." Adjuvants or surfactants may be added to the ingredients in the application equipment that is used in the delivery of the aquatic pesticide.

As part of the registration process of pesticides for use in California, U.S. EPA and the California Department of Pesticide Regulation (DPR)

[8] 553 F.3d 927 (6th Cir., 2009).

evaluate data submitted by registrants to ensure that a product used according to label instructions will cause no harm or adverse impact on non-target organisms that cannot be reduced or mitigated with protective measures or use restrictions. Registrants are required to submit data on the effects of pesticides on target pests (efficacy) as well as non-target effects. Data on non-target effects include plant effects (phytotoxicity), fish and wildlife hazards (ecotoxicity), impacts on endangered species, effects on the environment, environmental fate, degradation byproducts, leachability, and persistence. Requirements that are specific to use in California are included in many pesticide labels that are approved by U.S. EPA. Use must be reported to the County Agricultural Commissioner where required by law or by agreement with DPR.

The CWA, at section 301(a), broadly prohibits the discharge of any pollutant to waters of the United States, except in compliance with an NPDES permit. Since FIFRA is not necessarily as protective of water quality as the CWA, pesticides discharged into surface waters may constitute pollutants within the meaning of the CWA even if the discharge is in compliance with the registration requirements of FIFRA, thus, requiring coverage under a valid NPDES permit.

DPR and the County Agricultural Commissioners regulate the sale and use of pesticides in California. Pesticide applications subject to this General Permit must be consistent with permits issued by County Agricultural Commissioners and the pesticide label instructions approved by U.S. EPA under FIFRA. According to federal law, pesticide label language is under the sole jurisdiction of U.S. EPA. Label language and any changes thereto must be approved by U.S. EPA before the product can be sold in this country. DPR cannot require manufacturers to make changes on labels; however, DPR can refuse to register products unless manufacturers address unmitigated hazards by amending the pesticide label.

State regulations require that the County Agricultural Commissioners determine if a substantial adverse environmental impact will result from the proposed use of a restricted material. If the County Agricultural Commissioner determines that this is likely, the commissioner may deny the restricted pesticide use permit or may issue it under the condition that site-specific use practices be followed (beyond the label and applicable regulations) to mitigate potentially adverse effects. DPR conducts scientific evaluations of potential health and environmental impacts and provides commissioners with information in the form of suggested permit conditions. DPR’s suggested permit conditions reflect minimum measures necessary to protect people and the environment. County Agricultural

Commissioners use this information and its evaluation of local conditions to set site-specific limits in permits.

B. General Criteria

1. This General Permit serves as a general NPDES Permit for the discharge of residual algaecides and aquatic herbicides to surface waters as a result of algaecides and aquatic herbicides applications for algae and aquatic weed controls.
2. Dischargers who submit a complete application under this General Permit are not required to submit an individual permit application. The State Water Board's Deputy Director of the Division of Water Quality (Deputy Director) may request additional information or determine that a Discharger is not eligible for coverage under this General Permit and would be better regulated under an individual permit or other general NPDES permit adopted by the appropriate Regional Water Board. If the discharge becomes covered by an individual or another general permit, the applicability of this General Permit to the specified discharge will be immediately terminated on the effective date of the individual permit or coverage under the other general permit.

II. NOTIFICATION REQUIREMENTS

A. General Permit Application

To obtain authorization under this General Permit, Dischargers must submit to the State Water Board a complete application at least 90 days prior to their first application of the season. This is to allow posting of the Aquatic Pesticide Application Plan (APAP) for a 30-day comment period, staff to review APAP and respond to comments, and the Deputy Director to issue the Notice of Applicability (NOA). Following are the application information requirements:

1. A Notice of Intent (NOI shown as Attachment E) signed in accordance with the signatory requirements of the Standard Provisions in Attachment B;
2. An application fee. A fee is required only for new Dischargers. Dischargers that are enrolled under Order No. 2004-0009-DWQ and are applying for coverage under this Permit will be billed during the regular billing cycle; and
3. An APAP.

State Water Board staff will post the APAP on the State Water Board's website for 30 days for public review. In the meantime, the State and Regional Water Board staff will review the application package for completeness and applicability to this General Permit. After the application has been deemed complete, the Deputy Director will issue an NOA. The NOA will specify the permitted active ingredients of algaecides and aquatic herbicides that may be

used, and any Regional Water Board specific conditions and requirements not stated in this General Permit. Any such region-specific conditions and requirements shall be enforceable. The Discharger is authorized to discharge starting on the date of the NOA. If comments are received, staff will immediately work to resolve them in order to issue an NOA within 90 days of receipt of the application.

This General Permit specifices an effective date of December 1, 2013. The effective date is delayed because, with the impending start of the 2013 application season, Dischargers may be unable to comply with the requirement to submit their applications 90 days prior to their first pesticide application. The delay will allow enrollees under Water Quality Order No. 2004-0009-DWQ to have continued permit coverage throughout the 2013 application season while preparing their new application for coverage under this General Permit; new enrollees to prepare and submit their applications as well; and Water Boards' staff to process the applications and issue NOAs.

Alternatively, the Deputy Director may issue a Notice of Exclusion, which either terminates permit coverage or requires submittal of an application for an individual permit or alternative general permit.

B. Fee

The annual fee for enrollment under this General Permit, shall be based on Category 3 in section 2200(b)(9) of title 23, California Code of Regulations (Cal. Code Regs.). This category is appropriate because algaecide and aquatic herbicide applications incorporate BMPs to control potential impacts to beneficial uses, and this General Permit prohibits pollutant discharge associated with algaecide and aquatic herbicide applications from causing exceedance of CTR criteria or water quality objectives. Information concerning the applicable fees can be found at the State Water Board's Fee website (http://www.waterboards.ca.gov/resources/fees/docs/fy1112fee_schdl_npdes_prmt.pdf)

A Discharger proposing to apply algaecides and aquatic herbicides in multiple Water Board regions shall submit one NOI, one APAP, and one filing fee. The Discharger shall indicate in the NOI all the Water Board regions where applications are planned. The Discharger shall address all required elements of the APAP for all areas in the state where discharges are proposed.

C. Public Notification

The State Water Board has notified interested agencies and persons of its intent to prescribe waste discharge requirements in this General Permit and provided them with an opportunity to submit their written comments and recommendations.

III. DISCHARGE DESCRIPTION

This General Permit covers the point source discharge to waters of the United States of pesticide residues resulting from applications using products containing 2,4-D, acrolein, calcium hypochlorite, copper, diquat, endothall, flumioxazin, fluridone, glyphosate, hydrogen peroxide, imazamox, imazapyr, penoxsulam, sodium carbonate peroxyhydrate, peroxyacetic acid, sodium hypochlorite, and triclopyr-based algaecides and aquatic herbicides, and adjuvants containing ingredients represented by the surrogate nonylphenol. This General Permit covers only discharges of algaecides, aquatic herbicides, and adjuvants that are currently registered for use in California, or that become registered for use and contain the above-listed active ingredients and ingredients represented by the surrogate of nonylphenol.

A. Existing Discharge Description

As of January 11, 2013, there were 153 active enrollees under Water Quality Order No. 2004-0009-DWQ, Statewide General National Pollutant Discharge Elimination System Permit for the Discharge of Aquatic Pesticides for Aquatic Weed Control in Waters of the United States, General Permit No. CAG990005 (Order No. 2004-0009-DWQ). Most of the enrollees are local public agencies such as cities and irrigation, flood control, or reclamation districts. The other enrollees include six state of California agencies: the Departments of Boating and Waterways, Fish and Wildlife, Food and Agriculture, Parks and Recreation, Transportation, and Water Resources; a federal agency, U.S. Department of Fish and Wildlife Service; and a few private entities such as home owner associations and mobile home park owners.

The State Water Board granted exceptions to public agencies and mutual water companies that met the criteria stated in section 5.3 of the Policy for short-term or seasonal exceptions from meeting the receiving water limitations for priority pollutants of acrolein and copper.

Order No. 2004-0009-DWQ permits the discharge of aquatic pesticides with the following active ingredients: 2,4-D, acrolein, copper, diquat, endothall, fluridone, glyphosate, and triclopyr. The State Water Board reopened Order No. 2004-0009- DWQ after its adoption to add two more active ingredients: (1) imazapyr, a nonselective herbicide, for control of cordgrass and broadleaf weeds and other emergent aquatic species; and (2) sodium carbonate peroxyhydrate as an alternative to copper for algae control.*

B. Annual Report Review

State Water Board staff reviewed annual reports from 2004 through 2008[9] submitted under Order No. 2004-0009-DWQ. The data are summarized in Table D-1 below. As shown in Table D-1, all constituent concentrations from post-event application samples were below receiving water limitations except for the following: three exceedances each for acrolein and glyphosate and 82 exceedances for copper out of 288 monitoring events. For glyphosate, it is likely that the three exceedances were not the result of aquatic pesticide applications because the pre-application samples also showed exceedances and the remaining 151 sampling events showed no exceedance. For copper, 43 of the 82 exceedances were from public agencies or mutual water companies that were excepted from meeting priority pollutant limitations during the exception period. Thus, staff did not consider these exceedances as violations of the receiving water limitations. However, 39 of the exceedances were from entities that did not have a Policy exception. Therefore, staff considered these exceedances as true violations of the receiving water limitations.

Table D-1. Monitoring Data Summary, 2004-2008, Order No. 2004-0009-DWQ

Pollutant	Number of Samples	Number of Exceedance
2, 4-D	3	0
Acrolein	213	3
Copper	288	85
Diquat	17	0
Endothall	6	0
Fluridone	12	0
Glyphosate	154	3
Nonylphenol	53	0

[9] The data are submitted to the Regional Water Boards per Order No. 2004-0009-DWQ. When State Water Board staff started collecting data from the Regional Water Boards, the data available covered only this period.

Under Order No. 2004-0009-DWQ, the most commonly used aquatic pesticide products contained copper, acrolein, and glyphosate in descending order.

C. Receiving Water Description

The annual reports showed that most algae and aquatic weed control applications were performed in fresh inland surface waters such as lakes, ponds, flood control and drainage channels, or canals. Some applications were performed in coastal waters, marina lagoons, and slough with brackish water.

IV. APPLICABLE PLANS, POLICIES, AND REGULATIONS

The requirements contained in this General Permit are based on the applicable plans, policies, and regulations identified below.

A. Legal Authorities

This General Permit is issued pursuant to section 402 of the federal Clean Water Act (CWA) and implementing regulations adopted by the U.S. Environmental Protection Agency (U.S. EPA) and chapter 5.5, division 7 of the California Water Code, commencing with section 13370. It shall serve as an NPDES permit for point source discharges of residual algaecides and aquatic herbicides to surface waters. This General Permit also serves as WDRs pursuant to article 4, chapter 4, division 7 of the California Water Code (commencing with §13260).

This General Permit shall serve as a General NPDES permit for point source discharges of residues from algaecides and aquatic herbicide applications for algae and aquatic weed control. This General Permit also serves as general Waste Discharge Requirements pursuant to article 4, chapter 4, and division 7 of the California Water Code (commencing with §13260).

B. California Environmental Quality Act (CEQA)

Pursuant to California Water Code section 13389, State and Regional Water Boards are exempt from the requirement to comply with Chapter 3, Division 13 of the Public Resources Code when adopting NPDES permits.

C. State and Federal Regulations, Policies, and Plans

1. Water Quality Control Plans (Basin Plans)

The Regional Water Boards have adopted Basin Plans that designate beneficial uses, establish water quality objectives, and contain implementation programs and policies to achieve those objectives for all waters addressed through the plans. In addition, the Basin Plans implement State Water Board Resolution No. 88-63, which established state policy that all waters, with certain exceptions, should be considered suitable or potentially suitable for municipal or domestic supply. The Basin Plans identify typical beneficial uses as follows: municipal and domestic

supply, agricultural irrigation, stock watering, process supply, service supply, hydropower supply, water contact recreation, canoeing and rafting recreation, other non-contact water recreation,* warm freshwater aquatic habitat, cold freshwater habitat,* warm fish migration habitat, cold fish migration habitat, warm and cold spawning habitat, wildlife habitat, navigation, rare, threatened, or endangered species habitat, groundwater recharge,* and freshwater replenishment.

Requirements of this General Permit implement provisions contained in the applicable Basin Plans.

2. **National Toxics Rule (NTR) and California Toxics Rule (CTR)**

U.S. EPA adopted the NTR on December 22, 1992, and later amended it on May 4, 1995 and November 9, 1999. About 40 criteria in the NTR applied in California. On May 18, 2000, U.S. EPA adopted the CTR. The CTR promulgated new toxics criteria for California and, in addition, incorporated the previously adopted NTR criteria that were applicable in the state. The CTR was amended on February 13, 2001. These rules contain water quality criteria for priority pollutants.

3. **State Implementation Policy (Policy)**

On March 2, 2000, the State Water Board adopted the *Policy for Implementation of Toxics Standards for Inland Surface Waters, Enclosed Bays, and Estuaries of California* (Policy). The Policy became effective on April 28, 2000 with respect to the priority pollutant criteria promulgated for California by U.S. EPA through the NTR and to the priority pollutant objectives established by the Regional Water Board in the Basin Plans. The Policy became effective on May 18, 2000 with respect to the priority pollutant criteria promulgated by U.S. EPA through the CTR. The State Water Board adopted amendments to the Policy on February 24, 2005 that became effective on July 13, 2005. The Policy establishes implementation provisions for priority pollutant criteria and objectives and provisions for chronic toxicity control. Requirements of this General Permit implement the Policy.

Policy Exception

The Policy provides categorical exceptions allowing short-term or seasonal exceptions from meeting the priority pollutant criteria/objectives if it is determined to be necessary to implement control measures for resource or pest management conducted by public entities or mutual water companies to fulfill statutory requirements. The Policy specifically refers to vector or weed control, pest eradication, or fishery management as the basis for categorical exceptions. The exceptions are only granted to public entities or mutual water companies that have adequately provided the following information as required by the Policy:

a. A detailed description of the proposed action which includes the proposed method of completing the action;

c. A time schedule;

d. A discharge and receiving water monitoring plan that specifies monitoring prior to application events,* during application events, and after completion with the appropriate quality control procedures;

e. CEQA documentation including notifying potentially affected public and government agencies; and

f. Any necessary contingency plans.

The public entities and mutual water companies listed in Attachment G have met the above requirements before the issuance or during the term of the Order No. 2004-0009-DWQ.

The final Negative Declaration or Mitigated Negative Declarations (ND/MND) prepared by the public entities or mutual water companies have determined that the water quality impacts identified in the environmental assessments of the ND/MND from algaecide and aquatic herbicide applications are less than significant, and would not have a significant effect on the environment. The boards of each public entity and mutual water company*, as the lead agencies under CEQA, approved the final ND/MND. Therefore, each public entity or mutual water company is not required to meet priority pollutant criteria during the exception period.

During the issuance of the Order No. 2004-0009-DWQ, as required in section 15096 of the CEQA Guidelines, the State Water Board, as a Responsible Agency under CEQA, considered the ND/MND approved by the board of each public entity or mutual water company. The State Water Board found that the projects will have less than significant water quality impact if the Dischargers meet the requirements in this General Permit. Accordingly, the Policy 5.3 exception granted previously will continue to be valid under this Order.

Any Discharger not listed in Attachment G is required to meet all applicable priority pollutant criteria for receiving waters.

4. **Antidegradation Policy**

Section 131.12 of 40 C.F.R. requires that the state water quality standards include an antidegradation policy consistent with the federal policy. The State Water Board established California's antidegradation policy in State Water Board Resolution No. 68-16. Resolution No. 68-16 incorporates the federal antidegradation policy where the federal policy applies under federal law. Resolution No. 68-16 requires that existing water quality be maintained unless degradation is justified based on specific findings. The

Basin Plans implement, and incorporate by reference, both the state and federal antidegradation policies.

The permitted discharge must be consistent with the antidegradation provision of 40 C.F.R. section 131.12 and Resolution No. 68-16. The conditions of this General Permit require residual algaecide and aquatic herbicide discharges to meet applicable water quality objectives. Specifically, the General Permit sets receiving water limitations for 2,4-D, acrolein, chlorine, copper, diquat, endothall, fluridone glyphosate, and nonylphenol. It also sets receiving water monitoring triggers for imazapyr and triclopyr triethylamine (TEA).

The BMPs and other controls required pursuant to the General Permit constitute Best Available Technology Economically Achievable (BAT) and Best Conventional Pollutant Control Technology (BCT).

The General Permit requirements are protective of the broad range of beneficial uses set forth in basin plans throughout the state, constituting best control available consistent with the purposes of the algaecide and aquatic herbicide application in order to ensure that pollution or nuisance will not occur. The nature of pesticides is to be toxic in order to protect beneficial uses such as human health or long-term viability of aquatic life. For example, blue-green algae are bacteria that live in both fresh and marine waters. In California, certain forms of blue-green algae have been a particular problem in the Klamath River watershed and on the Central Coast. Blooms of these bacteria can poison livestock, wildlife, and humans; they can also damage drinking water sources. The use of an algaecide is one of the effective ways to control the harmful blooms of blue-green algae. Although algaecide application will temporarily degrade the water quality and result in short-term toxicity in the receiving water, it prevents the toxicities in the entire water body for a long period of time. While surface waters may be temporarily degraded; water quality standards and objectives will not be exceeded after project completion.

Another example of benefits of pesticide application is the control of aquatic weeds in flood control channels. Aquatic herbicides used to control emerging aquatic weeds in a flood control channel will effectively prevent full growth and bloom of aquatic weeds that may block the channel and cause flooding in the surrounding communities. Although the water quality is temporarily degraded while the herbicide is taking its effect in eliminating the weeds, the water quality will not be exceeded after the project is completed. In addition, the receiving water limitations and other requirements of this General Permit will ensure maintenance of the highest water quality consistent with maximum benefit to the people of the state.

Given the nature of a General Permit and the broad range of beneficial uses to be protected across the state, data analysis of specific water bodies is infeasible. While surface waters may be temporarily degraded, water quality standards and objectives will not be exceeded. The nature of pesticides is to be toxic in order to protect human health and water resources. However, compliance with receiving water limitations is required. Therefore, this General Permit is consistent with state and federal antidegradation policies.

5. **Endangered Species Act**

This General Permit does not authorize any act that results in the taking of a threatened or endangered species or any act that is now prohibited, or becomes prohibited in the future, under either the California Endangered Species Act (Fish and Game Code §2050 et. seq) or the Federal Endangered Species Act (16 U.S.C.A. §1531 et. seq). This General Permit requires compliance with effluent limitations, receiving water limitations, and other requirements to protect the beneficial uses of waters of the state. The Discharger is responsible for meeting all requirements of the applicable Endangered Species Act.

6. **Impaired Water Bodies on CWA 303(d) List**

This General Permit does not authorize the discharge of residual algaecides and aquatic herbicides and their degradation byproducts to waters of the United States that are impaired by the same active ingredients and their degradation byproducts. The links to California's impaired waters bodies are provided at http://www.waterboards.ca.gov/water_issues/programs/tmdl/integrated2010.shtm.

7. **Other Plans, Policies, and Regulations**

The State Water Board adopted the *Water Quality Control Policy for the Enclosed Bays and Estuaries of California*. The requirements within this General Permit are consistent with the policy.

8. **Delegation to Executive Director**

This General Permit covers the application of pesticides that are based on active ingredients that are currently registered by DPR for the control of algae and aquatic weeds. When DPR registers a new active ingredient for algae and aquatic weed control, this General Permit needs to be reopened to add the new active ingredient to the permit before Dischargers may begin using the active ingredient. In addition, when DPR registers a new active ingredient that is also a priority pollutant and has been added to this General Permit, this General Permit may also be reopened to allow Dischargers to obtain an exception from meeting receiving water

limitations for the priority pollutant in accordance with SIP section 5.3. It is very resource intensive to have the State Water Board amend this General Permit on a frequent basis. Thus, this General Permit contains a delegation from the State Water Board to the Executive Director to amend this General Permit for these two purposes. In cases of significant public controversy, the Executive Director may determine that any permit amendment otherwise subject to this section will be considered by the State Water Board.

V. RATIONALE FOR EFFLUENT LIMITATIONS AND DISCHARGE SPECIFICATIONS

Effluent limitations and toxic and pretreatment effluent standards established pursuant to sections 301 (Effluent Limitations), 302 (Water Quality Related Effluent Limitations), 304 (Information and Guidelines), and 307 (Toxic and Pretreatment Effluent Standards) of the CWA and amendments thereto are applicable to the discharge.

The control of pollutants discharged is established through effluent limitations and other requirements in NPDES permits. There are two principal bases for effluent limitations: (1) 40 C.F.R. section 122.44(a) requires that permits include applicable technology based limitations and standards; and (2) 40 C.F.R. section 122.44(d) requires that permits include water quality-based effluent limitations to attain and maintain applicable numeric and narrative water quality criteria to protect the beneficial uses of the receiving water where numeric water quality objectives have not been established.

The CWA mandates the implementation of effluent limitations that are as stringent as necessary to meet water quality standards established pursuant to state or federal law (33 U.S.C., §1311(b)(1)(C); 40 C.F.R. §122.44(d)(1)). NPDES permits must incorporate discharge limits necessary to ensure that water quality standards are met. This requirement applies to narrative criteria as well as to numeric criteria specifying maximum amounts of particular pollutants. Pursuant to 40 C.F.R. section 122.44(d)(1)(i), NPDES permits must contain limits that control all pollutants that "*are or may be discharged at a level which will cause, have the reasonable potential to cause, or contribute to an excursion above any state water quality standard, including state narrative criteria for water quality.*" Section 122.44(d)(1)(vi) of 40 C.F.R. further provides that *"[w]here a state has not established a water quality criterion for a specific chemical pollutant that is present in an effluent at a concentration that causes, has the reasonable potential to cause, or contributes to an excursion above a narrative criterion within an applicable State water quality standard, the permitting authority must establish effluent limits.*"

The CWA requires point source dischargers to control the amount of conventional, nonconventional, and toxic pollutants that are discharged into the waters of the United States. The control of pollutants discharged is established through effluent

limitations and other requirements in NPDES permits. There are two principal bases for effluent limitations: 40 C.F.R. section 122.44(a) requires that permits include applicable technology-based limitations and standards; and section 122.44(d) requires that permits include water quality-based effluent limitations to attain and maintain applicable numeric and narrative water quality criteria to protect the beneficial uses of the receiving water where numeric water quality objectives have not been established.

With respect to narrative objectives, the State Water Board must establish effluent limitations using one or more of three specified sources: (1) U.S. EPA's published water quality criteria; (2) a proposed state criterion (i.e., water quality objective) or an explicit state policy interpreting its narrative water quality criteria; or (3) an indicator parameter (i.e., 40 C.F.R. §122.44(d)(1)(vi)(A), (B) or (C)). Basin Plans contain a narrative objective requiring that: "*All waters shall be maintained free of toxic substances in concentrations that produce detrimental physiological responses in human, plant, animal, or aquatic life.*" Basin Plans require the application of the most stringent objective necessary to ensure that surface water and groundwater do not contain chemical constituents, discoloration, toxic substances, radionuclides, or taste and odor producing substances that adversely affect beneficial uses. Basin Plans state that material and relevant information, including numeric criteria, and recommendations from other agencies and scientific literature will be utilized in evaluating compliance with the narrative toxicity objective. Basin Plans also limit chemical constituents in concentrations that adversely affect surface water beneficial uses. Basin Plans further state that, to protect all beneficial uses, the Regional Water Board may apply limits more stringent than MCLs.

A. Discharge Prohibitions

1. The discharge of residual algaecides, residual aquatic herbicides, and their degradation byproducts in a manner different from that described in this General Permit is prohibited.

   This prohibition is based on 40 C.F.R. 122.21(a), "Duty to Apply," and California Water Code section 13260, which requires filing a Report of Waste Discharge before discharges can occur. Discharges not described in the NOI, and subsequently not discharged in the manner permitted by this General Permit, are prohibited.

2. The discharge of residual algaecides, residual aquatic herbicides, and their degradation byproducts shall not create a nuisance as defined in section 13050 of the California Water Code.

   This prohibition is based on California Water Code section 13050 for water quality control for achieving water quality objectives.

3. The discharge shall not cause, have a reasonable potential to cause, or contribute to an in-stream excursion above any applicable standard or

criterion promulgated by U.S. EPA pursuant to section 303 of the CWA, or water quality objective adopted by the State or Regional Water Boards.

This prohibition is based on CWA section 301 and California Water Code.

4. All pesticides are prohibited from the waters of the Lahontan Region (Region 6). The use of this permit is invalid in the Lahontan Region unless the discharger has requested a prohibition exemption from the Lahontan Water Board and the Lahontan Water Board has granted an exemption for the use of algaecides or aquatic herbicides.

   This prohibition is based on the Lahontan Water Board's region-wide waste discharge prohibition for pesticides in water with exemption criteria to allow certain uses of aquatic pesticides.

B. Effluent Limitations

1. Technology-Based Effluent Limitations

The intent of technology-based effluent limitations in NPDES permits is to require a minimum level of treatment of pollutants based on available treatment technologies while allowing the Discharger to use any available control technique to meet the limitations. For industrial and other non-municipal facilities, technology-based effluent limitations are derived by using: (1) national effluent limitations guidelines and standards established by U.S. EPA; or best professional judgment on a case-by-case basis in the absence of national effluent limitations guidelines and standards. In the case of pesticide applications, U.S. EPA has not developed guidelines and standards other than the requirement to follow the labels when applying pesticides. At this point, it is not appropriate to establish technology-based effluent limitations other than following the label when applying algaecides and aquatic herbicides.

Therefore, the effluent limitations contained in this General Permit are narrative and include requirements to develop and implement an APAP that describes appropriate BMPs, including compliance with all algaecide and aquatic herbicide label instructions, and to comply with numeric receiving water limitations and actions required if monitoring triggers are exceeded.

The BMPs required herein constitute BAT and BCT and will be implemented to minimize the area and duration of impacts caused by the discharge of algaecides and aquatic herbicides in the treatment area and to allow for restoration of water quality and protection of beneficial uses of the receiving waters to pre-application quality following completion of an application event.* In addition, for those enrollees that have been granted an exception to meeting receiving water limitations for acrolein and copper, in accordance with the Policy, this General Permit requires that

upon completion of a pesticide application project, the Discharger shall provide certification by a qualified biologist that the receiving water beneficial uses have been restored.

The development of BMPs provides the flexibility necessary to establish controls to minimize the area extent and duration of impacts caused by the discharge of algaecides and aquatic herbicides. This flexibility allows Dischargers to implement appropriate BMPs for different types of applications and different types of waters.

Much of the BMP development has been incorporated into the algaecide and aquatic herbicide regulation process by U.S. EPA, DPR, and County Agricultural Commissioners. The Dischargers must be licensed by DPR if such licensing is required for the algaecide and aquatic herbicide application project. The algaecide and aquatic herbicide use must be consistent with the algaecide and aquatic herbicide label instructions and any Restricted Material Use Permits issued by County Agricultural Commissioners.

U.S. EPA and DPR scientists review algaecide and aquatic herbicide labels to ensure that a product used according to label instructions will cause no harm (or “adverse impact”) on non-target organisms that cannot be reduced (or “mitigated”) with protective measures or use restrictions. Many of the label directions constitute BMPs to protect water quality and beneficial uses. Label directions may include: precautionary statements regarding toxicity and environmental hazards; directions for proper handling, dosage, application, and disposal practices; prohibited activities; spill prevention and response measures; and restrictions on type of water body and flow conditions.

A Restricted Material Use Permit issued by the County Agricultural Commissioner incorporates applicable suggested permit conditions from DPR and local site-specific conditions necessary to protect the environment. State regulations require that specific types of information be provided in an application to the County Agricultural Commissioners for a Restricted Material Use Permit. The County Agricultural Commissioners review the application to ensure that appropriate alternatives were considered and that any potential adverse effects are mitigated. The County Agricultural Commissioners also conduct pre-project inspections on at least five percent of projects.

This General Permit requires that Dischargers use BMPs when implementing control programs in order to mitigate effects to water quality resulting from algaecide and aquatic herbicide applications. Dischargers are required to consider alternative control measures to determine if there are feasible alternatives to the selected algaecide and aquatic herbicide

application project that could reduce potential water quality impacts. If the Discharger identifies alternative control measures to the selected algaecide and aquatic herbicide application project that could reduce potential water quality impacts and that are also feasible, practicable, and cost-effective, the Discharger shall implement the identified alternative measures. The selection of control measures that use nontoxic and less toxic alternatives is an example of an effective BMP.

2. **Water Quality-Based Effluent Limitations (WQBELs)**

a. **Scope and Authority**

Section 122.44(d)(1)(i) of 40 C.F.R. mandates that permits include effluent limitations for all pollutants that are or may be discharged at levels that have the reasonable potential to cause or contribute to an exceedance of a water quality standard, including numeric and narrative objectives within a standard. Where reasonable potential has been established for a pollutant, but there is no numeric criterion or objective for the pollutant, WQBELs must be established using: (1) U.S. EPA criteria under CWA section 304(a), supplemented where necessary by other relevant information; (2) an indicator parameter for the pollutant of concern; or (3) a calculated numeric water quality criterion, such as a proposed state criterion or policy interpreting the state's narrative criterion, supplemented with other relevant information, as provided in 40 C.F.R. section 122.44(d)(1)(vi).

The process for determining reasonable potential and calculating WQBELs when necessary is intended to protect the designated uses of the receiving water as specified in the Basin Plans, and achieve applicable water quality objectives and criteria that are contained in other state plans and policies, or any applicable water quality criteria contained in the CTR and NTR.

Section 122.44(k)(3) of 40 C.F.R. allows the use of other requirements such as BMPs in lieu of numeric effluent limits if the latter are infeasible. It is infeasible for the State Water Board to establish numeric effluent limitations in this General Permit because:

i. The application of algaecides and aquatic herbicides is not necessarily considered a discharge of pollutants according to the *National Cotton Council of America v. U.S. EPA*[10] and other applicable case law. The Sixth Circuit Court of Appeals ruled that residual pesticides associated with the application of pesticides at, over, or near water constitute pollutants within the meaning of

[10] 553 F.3d 927 (6th Cir., 2009)

the CWA and that the discharge must be regulated under an NPDES permit;

ii. This General Permit regulates the discharge of residual algaecides and aquatic herbicides used for algae and aquatic weed control to waters of the United States. These are algaecides and herbicides with registration labels that explicitly allow direct application to water bodies. In algaecides and aquatic herbicides applications to control pests, any algaecides and aquatic herbicides residue or degradation byproduct that is deposited in waters of the United States is a pollutant. However, at what point the algaecides and aquatic herbicides become a residue is not precisely known and varies depending on the type of algaecides and aquatic herbicides, application method and quantity, water chemistry, etc. Therefore, in the application of algaecides and aquatic herbicides, the exact effluent is unknown;

iii. It would be impractical to provide effective treatment of the algaecides and aquatic herbicides residue to protect water quality, given typically, algaecides and aquatic herbicides applications consist of numerous short duration intermittent algaecides and aquatic herbicides residue releases to surface waters from many different locations; and

iv. Treatment may render the algaecides and aquatic herbicides useless for algae and aquatic weed control.

Therefore, as stated in Technology-Based Effluent Limitations, Section V.B.1 above, the effluent limitations contained in this General Permit are narrative and include requirements to develop and implement an APAP that describes appropriate BMPs, including compliance with all algaecides and aquatic herbicides label instructions, and to comply with narrative receiving water limitations and triggers.

b. **Receiving Water Beneficial Uses**

Algaecide and aquatic herbicide applications for algae and aquatic weed control may potentially deposit residual algaecides and aquatic herbicides to surface waters. Beneficial uses of receiving waters are as follows: municipal and domestic supply, agricultural irrigation, agricultural stock watering, process water supply, service water supply, and hydropower supply, water contact recreation, canoeing and rafting recreation, other non-contact water recreation, warm freshwater aquatic habitat, cold freshwater aquatic habitat, warm fish migration habitat, cold fish migration habitat, warm and cold spawning habitat, wildlife habitat, navigation, groundwater recharge, and

freshwater replenishment. Requirements of this General Permit implement the applicable Basin Plans.

c. **Determining the Need for WQBELs**

Water quality standards include Regional Water Board Basin Plan beneficial uses and narrative and numeric water quality objectives, State Water Boardadopted standards, and federal standards, including the CTR and NTR, as well as antidegradation policies. The Basin Plans include numeric sitespecific water quality objectives and narrative objectives for toxicity, chemical constituents, and tastes and odors. The narrative toxicity objective states: "*All waters shall be maintained free of toxic substances in concentrations that produce detrimental physiological responses in human, plant, animal, or aquatic life.*" With regard to the narrative chemical constituent objective, the Basin Plans state that waters shall not contain chemical constituents in concentrations that adversely affect beneficial uses. At minimum, *"…water designated for use as domestic or municipal supply (MUN) shall not contain concentrations of chemical constituents in excess of the maximum contaminant levels (MCLs)*" in title 22 of CCR. The narrative tastes and odors objective states: "*Water shall not contain taste- or odor-producing substances in concentrations that impart undesirable tastes or odors to domestic or municipal water supplies or to fish flesh or other edible products of aquatic origin, or that cause nuisance, or otherwise adversely affect beneficial uses.*"

Federal regulations require effluent limitations for all pollutants that are or may be discharged at a level that will cause or have the reasonable potential to cause, or contribute to an in-stream excursion above a narrative or numerical water quality standard.

d. **Antidegradation Policy**

The permitted discharge is consistent with the antidegradation provisions of 40 C.F.R. section 131.12 and State Water Board Resolution No. 68-16. Compliance with these requirements will result in the use of best practicable treatment or control of the discharge. Due to the low volume of discharge expected from discharges regulated under this General Permit, the impact on existing water quality will be insignificant. Dischargers seeking authorization to discharge under this General Permit are required to demonstrate compliance with receiving water limitations during the application. If, however, the appropriate Regional Water Board, subsequent to review of any application, finds that the impact of a discharge will be significant, then authorization for coverage under this General Permit

will be denied and coverage under an individual permit will be required (including preparation of an antidegradation analysis).

VI. RATIONALE FOR RECEIVING WATER LIMITATIONS AND MONITORING TRIGGERS

A. Groundwater

[Not Applicable]

B. Surface Water

CWA section 303(a-c), requires states to adopt water quality standards, including criteria necessary to protect beneficial uses. Regional Water Boards adopted water quality criteria as water quality objectives in the Basin Plans. The Basin Plans state that *"[t]he numerical and narrative water quality objectives define the least stringent standards that the Regional Water Board will apply to regional waters in order to protect the beneficial uses."* The Basin Plans include numeric and narrative water quality objectives for various beneficial uses and water bodies. This General Permit contains receiving water limitations based on the Basin Plans' numerical and narrative water quality objectives for bio-stimulatory substances, chemical constituents, color, temperature, floating material, settleable substances, suspended material, tastes and odors, and toxicity. This General Permit also requires compliance with any amendment or revision to the water quality objectives contained in the Basin Plans adopted by Regional Water Boards subsequent to adoption of this General Permit.

Once algaecides and aquatic herbicides have been applied to a treatment area, the algaecide and aquatic herbicide product can actively control pests within the treatment area. The discharge of algaecides and aquatic herbicides, their residues, and their degradation byproducts from the applications to surface water must meet applicable water quality criteria and objectives. The receiving water limitations ensure that an application event* does not result in an exceedance of a water quality standard in the receiving water.

To protect all designated beneficial uses of the receiving water, the most protective (lowest) and appropriate (to implement the CTR criteria and WQOs in the Basin Plans) criteria should be selected as the permit limitation for a particular water body and constituent. In many cases, water quality standards include narrative, rather than numerical, water quality objectives. In such cases, numeric water quality limits from the literature or publicly available information may be used to ascertain compliance with water quality criteria.

Algaecide and aquatic herbicide formulations contain disclosed "active" ingredients that yield toxic effects* on target organisms and may also have toxic effects on nontarget organisms. Algaecide and aquatic herbicide active ingredients that do not contain pollutants for which there are applicable

numeric CTR criteria may still have toxic effects on receiving water bodies. In addition, the inactive or "inert" ingredients of algaecides and aquatic herbicides, which are trade secrets and have not been publicly disclosed, may also contain toxic pollutants or pollutants that could affect water quality.

DPR is responsible for reviewing toxic effects of product formulations and determining whether an algaecide or aquatic herbicide is suitable for use in California's waters. In this General Permit, inert ingredients are also considered on a constituent-byconstituent basis. U.S. EPA regulates pesticide use through strict labeling requirements in order to mitigate negative impacts to human health and the environment, and DPR environmental and medical toxicologists review toxicity data on formulations and can deny registration or work with registrants or County Agricultural Commissioners to impose additional requirements in order to protect human health or the environment.

U.S. EPA and DPR require that pesticides undergo toxicity testing and meet specific toxicity requirements before registering the pesticide for application to surface waters. U.S. EPA has found that the application of properly registered pesticides pose a minimal threat to people and the environment. In addition, the effects of these pesticides on water quality will be mitigated through compliance with FIFRA label requirements, application of BMPs, and monitoring.

Basin Plan water quality objectives to protect the beneficial uses of surface water and groundwater include numeric objectives and narrative objectives, including objectives for chemical constituents, toxicity, and tastes and odors. The toxicity objective requires that surface water and groundwater be maintained free of toxic substances in concentrations that produce detrimental physiological responses in humans, plants, animals, or aquatic life. The chemical constituent objective requires that surface water and groundwater shall not contain chemical constituents in concentrations that adversely affect any beneficial use or that exceed the MCLs set forth in title 22, Cal. Code Regs. The tastes and odors objective states that surface water and groundwater shall not contain taste- or odor-producing substances in concentrations that cause nuisance or adversely affect beneficial uses. The Basin Plans require the application of the most stringent objective necessary to ensure that surface water and groundwater do not contain chemical constituents, toxic substances, radionuclides, or taste and odor producing substances in concentrations that adversely affect domestic drinking water supply, agricultural supply, or any other beneficial use.

1. **Receiving Water Limitations**

   The instantaneous maximum receiving water limitations are based on promulgated water quality criteria such as those provided in the CTR, water quality objectives adopted by the State and Regional Water Boards

in their Basin Plans, water quality criteria adopted by the California Department of Fish and Wildlife, water quality standards such as drinking water standards adopted by U.S. EPA or the California Department of Public Health (CDPH), or U.S. EPA National Recommended Ambient Water Quality Criteria.

This General Permit provides receiving water limitations based on the lowest water quality criteria/objectives to protect all designated beneficial uses of the receiving water. The receiving water limitations in this General Permit are the same as those in Order No. 2004-0009-DWQ. The rationale for each limitation is summarized below.

Table D-2. Summary of Receiving Water Limitations

Constituent/ Parameter	Beneficial Use [Reference Note 1 following Table D-2] MUN, µ/L	Beneficial Use [Reference Note 1 following Table D-2] WARM or COLD, µ/L	Beneficial Use [Reference Note 1 following Table D-2] Other than MUN, WARM, or COLD, µ/L	Beneficial Use [Reference Note 1 following Table D-2] All Designations	Basis
2, 4-D	70				U.S. EPA MCL
Acrolein [Reference Note 2 following Table D-2]	320	21	780		U.S. EPA Water Quality Criteria, 1986.
Chlorine		Freshwater acute Criterion = 20 µ/L			U.S. EPA's Ambient Water Quality Criteria for Freshwater Aquatic Life Protection
Chlorine		Saltwater Acute Criterion =< 10 µ/L			California Ocean Plan
Copper				Dissolved Freshwater [Reference Note 3 following Table D-2]	California Toxics Rule

Constituent/ Parameter	Beneficial Use [Reference Note 1 following Table D-2] MUN, µ/L	Beneficial Use [Reference Note 1 following Table D-2] WARM or COLD, µ/L	Beneficial Use [Reference Note 1 following Table D-2] Other than MUN, WARM, or COLD, µ/L	Beneficial Use [Reference Note 1 following Table D-2] All Designations	Basis
[Reference Note 2 following Table D-2]				Copper Chronic = 0.960exp{0.8545 [ln(hardness4)] – 1.702} [Reference Note 5 and 6 following Table D-2] Dissolved Saltwater [Reference Note 3 following Table D-2] Copper Chronic = 3.1 µg/L [Reference Note 5 and 6 following Table D-2]	
Diquat	20				U.S. EPA MCL
Endothall	100				U.S. EPA MCL
Fluridone	560				U.S. EPA Integrated Risk Information System

Constituent/ Parameter	Beneficial Use [Reference Note 1 following Table D-2] MUN, µ/L	Beneficial Use [Reference Note 1 following Table D-2] WARM or COLD, µ/L	Beneficial Use [Reference Note 1 following Table D-2] Other than MUN, WARM, or COLD, µ/L	Beneficial Use [Reference Note 1 following Table D-2] All Designations	Basis
Glyphosate	700				U.S. EPA MCL
Nonylphenol				Freshwater Chronic Criterion = 6.6 µg/L Saltwater Chronic Criterion = 1.7 µg/L	U.S. EPA National Recommended Ambient Water Quality Criteria
Toxicity	Algaecide and aquatic herbicide applications shall not cause or contribute to toxicity in receiving water(s).	Algaecide and aquatic herbicide applications shall not cause or contribute to toxicity in receiving water(s).	Algaecide and aquatic herbicide applications shall not cause or contribute to toxicity in receiving water(s).	Algaecide and aquatic herbicide applications shall not cause or contribute to toxicity in receiving water(s).	Regional Water Boards' Basin Plans

Notes:

1. See Regional Water Boards' Water Quality Control Plans (Basin Plans) for beneficial use definitions.
2. Public entities and mutual water companies* listed in Attachment G are not required to meet these limitations in receiving waters during the exception period described in the APAP and Section VIII.C.10 below.
3. For waters in which the salinity is equal to or less than 1 part per thousand 95% or more of the time, the freshwater criteria apply. For waters in which the salinity is equal to or greater than 10 parts per thousand 95% or more of the time,

saltwater criteria apply. For waters in which the salinity is between 1 and 10 parts per thousand, the applicable criteria are the more stringent of the freshwater or saltwater criteria.

4. For freshwater aquatic life criteria, waters with a hardness 400 mg/L or less as calcium carbonate, the actual ambient hardness of surface water shall be used. For waters with a hardness of over 400 mg/L as calcium carbonate, a hardness of 400 mg/L as calcium carbonate shall be used with a default Water-Effect Ratio of 1.
5. Values should be rounded to two significant figures.
6. This limitation does not apply to the Sacramento River and its tributaries above the State Highway 32 Bridge at Hamilton City. See Table III-1 of the Basin Plan for the Sacramento and San Joaquin River Basins for copper limitation

Sodium hypochlorite, also known as liquid bleach, came into widespread use about 1930 for laundry, household, and general disinfecting uses. It is commercially available at strengths of five to 15 percent but is typically 10 percent or 12.5 percent available chlorine. It is more widely used than its dry counter part, calcium hypochlorite, due to its lower cost for transport, and is more easily handled.[11]

Chlorine is the only toxicant that results from the use of calcium hypochlorite and sodium hypochlorite-based pesticide products that are used to control algae and aquatic weeds. To protect all designated beneficial uses of the receiving water from chlorine residual, the most protective (lowest) and appropriate limitation for chlorine should be selected as the water quality limitation for a particular water body. The U.S. EPA National Recommended Ambient Water Quality Criteria for freshwater aquatic life and the California Ocean Plan water quality objectives for chlorine are applicable. U.S. EPA has recommended ambient water quality criteria of 11 µg/l as a continuous concentration (four-day average) and 19 µg/l as the maximum concentration (one-hour average) for freshwater aquatic life protection for chlorine. The California Ocean Plan Water Quality Objectives, which protect human health and marine aquatic life from constituents in marine waters of California, list 2 µg/l as the six month median, 8 µg/l as the daily maximum, and 60 µg/l as the instantaneous maximum for chlorine.

However, because of the lack of precision with current chlorine residual measuring instruments, it would be more appropriate to set the freshwater chlorine receiving water limitations to 10 µg/l as a monthly average and 20 µg/l as a daily maximum; a daily maximum of nondetect or <10 µg/l is appropriate to protect marine aquatic life.

The copper limitation in Order No. 2004-0009-DWQ was based on the CTR's Criteria Continuous Concentration (CCC) expressed in total recoverable concentration. This General Permit also uses CCC from the CTR as the basis of the copper limitations; however, the copper limitation is now expressed in dissolved concentration. Since the copper criterion in the CTR is expressed in dissolved concentration, the receiving water limitation must also be expressed in dissolved rather than total concentration since it is the dissolved portion of copper that is bioavailable to aquatic life.

Based on Policy section 5.3, this General Permit grants public entities and mutual water companies listed in Attachment G a short-term or seasonal exception from meeting receiving water limitations for acrolein and copper

[11] 11 G. C. White, Handbook of Chlorination, 2nd ed. (New York: Van Nostrand Reinhol Company Inc, 1986) 63-70.

during treatment. As a condition of the exception, this General Permit requires Dischargers to provide the length and justification of required exception periods in their APAPs. There is no discrete definition for short-term; but the intent is to allow the exception to apply during the treatment period. It is up to the Discharger to make this demonstration.

The receiving water dissolved oxygen limitation is based on the Regional Water Board Basin Plans' dissolved oxygen objectives.

2. **Receiving Water Monitoring Triggers**

In algaecide or aquatic herbicide applications, it is reasonable to conclude that some residual algaecides or aquatic herbicides will remain in the receiving waters. These residual algaecides or aquatic herbicides may cause toxicity to aquatic life. However, information regarding the specific amount of algaecide or aquatic herbicide residues (described below) in the receiving water as a result of direct applications for weed control is not adequate to develop receiving water limitations for these algaecides and aquatic herbicides. Therefore, this General Permit only contains Receiving Water Monitoring Triggers and/or monitoring requirements for these algaecides or aquatic herbicides. The monitoring triggers and monitoring data will be used to assess whether the discharges of these algaecide or aquatic herbicide residues have the reasonable potential to cause or contribute to an excursion of a water quality standard, including numeric and narrative objectives within a standard.

In the absence of adopted criteria, objectives, or standards, the State Water Board used U.S. EPA's Ambient Criteria for the Protection of Freshwater Aquatic Life (Ambient Water Quality Criteria) which are directly applicable as a regulatory level to implement narrative toxicity limitations included in all Regional Water Board Basin Plans. Where adopted criteria, objectives, standards, or Ambient Water Quality Criteria are unavailable, the State Water Board used data from U.S. EPA's Ecotoxicity Database to develop the Receiving Water Monitoring Triggers to protect all beneficial uses of the receiving water.

For constituents that do not have Ambient Water Quality Criteria, the Instantaneous Maximum Receiving Water Monitoring Trigger is based on one-tenth of the lowest 50 Percent Lethal Concentration (LC50) from U.S. EPA's Ecotoxicity Database. Using one-tenth of the lowest LC50 as the receiving water monitoring trigger is consistent with the Central Valley Regional Water Board's Basin Plan approach when developing the Daily Maximum Limitation for algaecides or aquatic herbicides that do not have water quality criteria.

This General Permit may be re-opened to add receiving water limitations to the algaecides or aquatic herbicides listed below if the monitoring

triggers are exceeded or the monitoring data indicate re-opening of the permit is appropriate. The following is a detailed discussion of toxicity data, applicable water quality criteria, and Receiving Water Monitoring Triggers, if applicable, for these algaecides or aquatic herbicides:

a. FlumioxazinFlumioxazin was first registered for aquatic use by U.S. EPA in 2010 and by DPR in 2014. Flumioxazin is a protoporphyrinogen oxidase (PPO) inhibitor which acts by initiating cell membrane disruption in algae (e.g. Filamentous, Blue-Green) and submersed (e.g. Eurasian watermilfoil, Curlyleaf pondweed) and floating (e.g Watermeal, Duckweed) aquatic plants. Flumioxazin is a contact herbicide that quickly degrades in water and plants. Flumioxazin must come in contact with the plant for optimal efficacy and is applied via foliar or surface spray or submersed injection. Flumioxazin does not accumulate in sediment. Flumioxazin degrades via hydrolysis with a half-life of 3.4 – 5.1 days at pH 5, 21.4-24.6 hours at pH 7, 14.6-22 minutes at pH 9.

   Staff obtained toxicity data for flumioxazin from U.S. EPA's Ecotoxicity Database to assess its toxicity to freshwater aquatic life. Table D-3 summarizes the toxicity data for flumioxazin below.

Table D-3. Toxicity Data Summary for Flumioxazin (CAS#103361-09-7)

Type of Organism	Study Length	Study Date	LC50 (mg/L)
Bluegill sunfish	96 h	1992	21
Sheepshead minnow	96 h	1992	4.7
Rainbow trout	96 h	1992	2.3
Rainbow trout	21 d	1992	2.4
Cell is intentionally left blank	Lowest LC/50 > 0.23	Cell is intentionally left blank	Cell is intentionally left blank

Ambient Water Quality Criteria are unavailable for flumioxazin. Table D-3 shows that one-tenth of the lowest LC50 to protect the most sensitive freshwater aquatic life for flumioxazin is greater than 0.23 mg/L.

Due to the absence of water quality criteria for flumioxazin and its toxicity to aquatic life as indicated in U.S. EPA's Ecotoxicity Database, this General Permit does not have a receiving water monitoring trigger for flumioxazin. However, this General Permit requires receiving water monitoring for flumioxazin to collect data, which will provide information whether the use of flumioxazin has water quality impacts.

b. Imazamox

Imazamox is a derivative of the active ingredient, ammonium salt of imazamox for the aquatic herbicide Clearcast, which DPR registered for use in California in October 2012. It is labeled for application to water for the control of submerged aquatic plants species and some emergent and floating species.

Imazamox is an herbicide that inhibits an enzyme in aquatic plants that is essential for the synthesis of three-branched chain amino acids.

Staff obtained toxicity data for imazamox from U.S. EPA's Ecotoxicity Database to assess its toxicity to freshwater aquatic life. However, U.S. EPA's Ecotoxicity Database contains toxicity data only for imazamox, but not for its salt. Table D-4 summarizes the toxicity data for imazamox below.

Table D-4. Toxicity Data Summary for Imazamox (CAS# 114311-32-9)

Type of Organism	Study Length	Study Date	LC50 (mg/L)
Mysid	96 h	1998	>100
Mysid	96 h	1998	>94.3
Bluegill sunfish	96 h	1994	>119
Rainbow trout	96 h	1994	>122
Sheephead mino	96 h	1998	>94.2
Sheephead mino	96 h	1998	>94.2
	Lowest LC50/10 > 9.4 mg/L		

Ambient Water Quality Criteria are unavailable for imazamox and imazamox salt. Table D-3 shows that one-tenth of the lowest LC50 to

protect the most sensitive freshwater aquatic life for imazamox is greater than 9.4 mg/l.

Due to the absence of water quality criteria for imazamox and its low toxicity to aquatic life as indicated in U.S. EPA's *Ecotoxicity Database*, this General Permit does not have a receiving water monitoring trigger for imazamox. However, this General Permit requires receiving water monitoring for imazamox to collect data, which will provide information on whether the use of imazamox has water quality impacts.

c. Imazapyr

The active ingredient imazapyr is marketed by the trade names Arsenal, Chopper, and Assault. Upon contact, imazapyr can interfere with DNA synthesis and cell growth of the plants. The target weed species are grasses, broad-leaves, vines, brambles, shrubs and trees, and riparian and emerged aquatics. The result of exposure is death of new leaves. It was first registered in the United States in 1984.

Imazapyr is a slow-acting amino acid synthesis inhibitor. It has an average water half-life* of four days with photodegradation as the primary form of degradation in water. Imazapyr acts more quickly and is less toxic than other low-volume herbicides. According to the San Francisco Estuary* Invasive Spartina Project's May 4, 2005 report titled *Use of Imazapyr Herbicide to Control Invasive Cordgrass (Spartina spp.) in the San Francisco Estuary,* imazapyr in water rapidly degrades via photolysis. The report further states that a number of field studies demonstrated that imazapyr rapidly dissipated from water within several days, and no detectable residues of imazapyr were found in either water or sediment within two months; in estuarine systems, dilution of imazapyr with the incoming tides contributes to its rapid dissipation, suggesting that imazapyr is not environmentally persistent in the estuarine environment and does not result in significant impacts to water quality. The report concludes that imazapyr herbicides can be a safe, highly effective treatment for control and eradication of non-native Spartina species in the San Francisco Estuary and offers an improved risk scenario over the existing treatment regime with glyphosate herbicides. On August 30, 2005, DPR registered imazapyr for aquatic application as an aquatic herbicide.

Toxicity data for imazapyr were obtained from U.S. EPA's *Ecotoxicity Database* to assess the toxicity of imazapyr to freshwater aquatic life. Tables D-5 and D-6 summarize the toxicity data for imazapyr and imazapyr salt.

Table D-5. Toxicity Data Summary for Imazapyr (CAS#81334-34-1)

Type of Organism	Study Length	Study Date	LC50 (mg/L)
Pink shrimp	96 h	1988	>189
Atlantic silverside	96 h	1988	>184
Bluegill sunfish	96 h	1983	>100
Bluegill sunfish	96 h	1983	>100
Channel catfish	96 h	1983	>100
Rainbow trout	96 h	1983	>100
Rainbow trout	96 h	1995	>110
	Lowest LC50/10 > 10		

Table D-6. Toxicity Data Summary for Imazapyr Isopropylamine Salt (CAS#81510-83-0)

Type of Organism	Study Length	Study Date	LC50 (mg/L)
Water flea	48 h	1984	350
Rainbow trout	96 h	1984	112
Bluegill sunfish	96 h	1984	>1000
	Lowest LC50/10 = 11.2		

Ambient Water Quality Criteria are unavailable for imazapyr and imazapyr salt. Tables D-5 and D-6 show that the lowest one-tenth of LC50 to protect the most sensitive freshwater aquatic life for imazapyr is 11.2 mg/l.

Due to its safe use in the environment and low toxicity to aquatic life as indicated in U.S. EPA's *Ecotoxicity Database*, this General Permit does not have a receiving water limitation for imazapyr. However, this General Permit contains a monitoring trigger of 11.2 mg/l based on one-tenth of the lowest LC50 from U.S. EPA's Ecotoxicity Database and requires receiving water monitoring to collect data, which will provide information on whether imazapyr has water quality impacts.

d. Penoxsulam

Penoxsulam is the active ingredient for Galleon SC, a selective systemic aquatic herbicide for management of freshwater aquatic vegetation in ponds, lakes, reservoirs, marshes, wetlands, non-irrigation canals, slow-moving water bodies, etc. Penoxsulam is a post-emergence acetolactate synthase (ALS) inhibitor developed by Dow AgroSciences to be used as a foliar spray on dry-seeded rice crops. The mode of action is to inhibit the acetolactate synthases enzyme in the target weed.

The U.S. EPA Pesticide Fact Sheet states that penoxsulam is expected to be very mobile, but not very persistent, in either aqueous or terrestrial environments. Penoxsulam exists almost exclusively in a disassociated state at pH values normally found in rice paddy water (averaging about eight), but not in terrestrial environments where lower pH values may be found. Penoxsulam degrades by two different transformation mechanisms, producing 13 different identified transformation products, 11 of which meet the criteria to be classified as major degradation byproducts,12 six of which reached peak concentrations at study termination, indicating a greater degree of persistence than penoxsulam and a potential to reach concentrations even greater than those reported at study termination. The results of the screening-level risk assessment suggest that penoxsulam will not pose a threat to aquatic or terrestrial animals, however, this conclusion must be tempered by the fact that testing has not been conducted on several major degradation byproducts.

Toxicity data for penoxsulam were obtained from U.S. EPA's *Ecotoxicity Database* to assess the toxicity of penoxsulam to freshwater aquatic life. Table D-7 summarizes the toxicity data for penoxsulam.

Table D-7. Toxicity Data Summary for Penoxsulam (CAS#219714-96-2)

Type of Organism	Study Length	Study Date	LC50 (mg/L)
Bluegill sunfish	96 h	2000	>103
Common carp fish	96 h	2001	> 101
Mysid	96 h	2000	>119
Rainbow trout	96 h	2002	>147

Type of Organism	Study Length	Study Date	LC50 (mg/L)
Rainbow trout	96 h	2000	>102
Scud	96 h	2000	>126
	Lowest LC50/10 > 10.1		

Ambient Water Quality Criteria are unavailable for penoxsulam. Table D-7 shows that the lowest one-tenth of LC50 to protect the most sensitive freshwater aquatic life for penoxsulam is greater than 10.1 mg/l.

Due to its safe use in the environment, low toxicity to aquatic life as indicated in U.S. EPA's *Ecotoxicity Database*, and lack of accurate toxicity value, this General Permit does not have a receiving water monitoring trigger. However, this General Permit requires receiving water monitoring to collect data, which will provide information on whether penoxsulam has water quality impacts.

e. Hydrogen Peroxide, Peroxyacetic Acid, and Sodium Carbonate Peroxyhydrate

Hydrogen peroxide, peroxyacetic acid, and sodium carbonate peroxyhydrate are contact herbicides that work by oxidizing critical cellular components of the target aquatic vegetation leading to death. When applied to water, peroxyacetic acid and sodium carbonate peroxyhydrate break down to water and oxygen. Sodium carbonate peroxyhydrate has been registered for aquatic use since early 2006. Hydrogen peroxide and peroxyacetic acid have been registered for aquatic use since 2002.

Use of these active ingredients in the aquatic environment is limited to contained, non-flowing waters as noted on product labels containing these active ingredients. These active ingredients can be highly toxic to fish and aquatic invertebrates at the higher application rates indicated on labels for products containing these active ingredients.

There are no LC50 toxicity data for peroxyacetic acid and sodium carbonate peroxyhydrate in U.S. EPA's *Ecotoxicity Database.* However, these active ingredients break down into hydrogen peroxide and their toxicity can be evaluated based on the toxicity of hydrogen peroxide. Staff obtained LC50 toxicity data for hydrogen peroxide from U.S. EPA's *Ecotoxicity Database* to assess it's toxicity to freshwater aquatic life. Table D-8 summarizes the LC50 toxicity data for hydrogen peroxide.

Table D-8. Toxicity Data Summary for Hydrogen Peroxide (CAS#7722-84-1)

Type of Organism	Study Length (hours)	Study Date	LC50 (mg/L)
Bluegill sunfish	0.5-96	1997	103-7250*
Rainbow trout	0.5-96	1997	45 - >12,000*
Rainbow trout	96	1992	93
Rainbow trout	0.5-2	1997	189-574
	LC50/10 >4.5		

* Toxicity is highly temperature dependent with higher toxicity at higher temperatures. Range of study temperatures = 7.35 °C to 21.5°C

Ambient Water Quality Criteria are unavailable for hydrogen peroxide, peroxyacetic acid, and sodium carbonate peroxyhydrate. Table D-8 shows that one-tenth of the lowest LC50 to protect the most sensitive freshwater aquatic life for hydrogen peroxide is greater than 4.5 mg/l.

Due to the absence of water quality criteria for hydrogen peroxide, peroxyacetic acid, and sodium carbonate peroxyhydrate and the relatively rapid breakdown of these compounds in water, this General Permit does not have receiving water triggers for these active ingredients.

f. Triclopyr Triethylamine (TEA) Salt

Triclopyr TEA is a systemic herbicide used to control broad-leaf weeds and woody plants.

U.S. EPA concluded in its re-registration document that triclopyr TEA is practically non-toxic to freshwater fish and aquatic invertebrates on an acute basis and triclopyr TEA is slightly toxic to practically non-toxic to estuarine/marine fish and invertebrates on an acute basis.

Triclopyr produces the metabolite or degradate 3,5,6-trichloro-2-pyridinol (TCP). Based on its analysis, U.S. EPA concludes that the existing uses of triclopyr are unlikely to result in acute or chronic dietary risks from TCP. Based on limited available data and modeling estimates, with less certainty, the U.S. EPA concluded that existing uses of triclopyr are unlikely to result in acute or chronic drinking water risks from TCP.

Toxicity data for triclopyr TEA were obtained from U.S. EPA's *Ecotoxicity Database* to assess the toxicity of triclopyr TEA to freshwater aquatic life. Table D-9 summarizes the toxicity data for Triclopyr TEA.

Table D-9. Toxicity Data Summary for Triclopyr TEA Salt (CAS#57213-69-1)

Type of Organism	Study Length	Study Date	LC50 (mg/L)
Bluegill sunfish	96 h	1978	891
Bluegill sunfish	96 h	1973	471
Fathead minnow	96 h	1978	947
Fathead minnow	96 h	1983	546
Fathead minnow	96 h	1983	279
Grass shrimp	96 h	1992	326
Inland Silverside fish	96 h	1989	**130**
Pink shrimp	96 h	1975	895
Rainbow trout	96 h	1973	240
Rainbow trout	96 h	1978	552
	Lowest LC50/10 = 13.0		

Ambient Water Quality Criteria are unavailable for triclopyr TEA. Table D-9 shows that the lowest one-tenth of LC50 to protect the most sensitive freshwater aquatic life for triclopyr TEA is 13 mg/l.

Due to its safe use in the environment and low toxicity to aquatic life as indicated in U.S. EPA's *Ecotoxicity Database*, this General Permit does not have a receiving water limitation for triclopyr TEA. However, this General Permit contains a monitoring trigger of 13.0 mg/l based on one-tenth of the lowest LC50 from U.S. EPA's *Ecotoxicity Database* and requires receiving water monitoring to collect data, which will provide information on whether triclopyr TEA has water quality impacts.

VII. RATIONALE FOR MONITORING AND REPORTING REQUIREMENTS

A. MRP Goals

Section 122.48 of 40 C.F.R. requires that all NPDES permits specify requirements for recording and reporting monitoring results. Water Code sections 13267 and 13383 authorize the State and Regional Water Boards to require technical and monitoring reports. The Monitoring and Reporting Program (MRP) in Attachment C of this General Permit establishes monitoring and reporting requirements to implement federal and state requirements.

The goals of the MRP are to:

1. Identify and characterize algaecide or aquatic herbicide application projects conducted by the Discharger;
2. Determine compliance with the receiving water limitations and other requirements specified in this General Permit;
3. Measure and improve the effectiveness of the APAP;
4. Support the development, implementation, and effectiveness of BMPs;
5. Assess the chemical, physical, and biological impacts on receiving waters resulting from algaecide or aquatic herbicide applications;
6. Assess the overall health and evaluate long-term trends in receiving water quality;
7. Demonstrate that water quality of the receiving waters following completion of resource or weed management projects are equivalent to pre-application conditions; and
8. Ensure that projects that are monitored are representative of all algaecide or aquatic herbicide and application methods used by the Discharger.

The MRP in the Attachment C of this General Permit is considered as baseline monitoring requirements. Monitoring plans proposed by Dischargers in their APAP must meet the minimum requirements prescribed in the MRP. Public entities and mutual water companies that have a Policy section 5.3 exception should comply with the MRP in this General Permit as well as monitoring plan proposed in their CEQA document where the two plans differ.

B. Effluent Monitoring

Pursuant to the requirements of 40 C.F.R. section 122.44(i), effluent monitoring is required for all constituents with effluent limitations. Effluent monitoring is necessary to assess compliance with effluent limitations, assess the effectiveness of the treatment process, and assess the impacts of the discharge on the receiving water and groundwater.

The application of pesticides for pest control is not necessarily considered a discharge of pollutants according to the *National Cotton Council of America v. U.S. EPA* decision and other applicable case law. The regulated discharge is the discharge of residual pesticides. At what point the pesticide becomes a residue is not precisely known. Therefore, in the application of pesticides, the exact effluent is unknown. Thus, the effluent monitoring requirement is not applicable for algaecide or aquatic herbicide applications.

C. Toxicity Testing Requirements

The State Water Board, pursuant to the Porter-Cologne Act and the federal CWA, customarily requires the Discharger to conduct toxicity monitoring. In fact, both Acts anticipate Discharger self monitoring. However, this General Permit does not require toxicity testing based on the 2004 toxicity study funded by the State Water Board and data collected from 2004 to 2008. The toxicity study found the following: (1) There was no toxicity with the use of 2,4-D, glyphosate, and triclopyr; (2) Toxicity testing was difficult for acrolein due to its volatility; (3) Results were inconclusive for diquat and fluridone; and (4) Peak copper concentrations did not exceed toxicity values. The monitoring data collected under Order No. 2004-0009-DWQ from 2004 to 2008 showed that all constituent concentrations from post-event application samples were below receiving water limitations except for the following: three exceedances each for acrolein and glyphosate and 82 exceedances for copper out of 288 monitoring events. For glyphosate, it is likely that the three exceedances were not the result of aquatic herbicide applications because the pre-application samples also showed exceedances and the remaining 151 samples showed no exceedance. For copper, 43 of the 82 exceedances were from public agencies or mutual water companies that were excepted from meeting priority pollutant limitations during the exception period. The Policy allows the exception. Thus, staff did not consider these exceedances as violations of the receiving water limitations. However, 39 of the exceedances were from entities that did not have a Policy exception. Although staff considered these exceedances as true violations of the receiving water limitations, staff is not aware of any long-term impacts from these exceedances. Long-term impacts from exceedances are likely not going to occur for the following reasons: (1) water quality criteria, which are used directly as receiving water limitations in this General Permit, have built-in factors of safety; (2) as shown in the 2004 toxicity study, the actual peak concentrations after applications of copper did not exceed toxicity values; and (3) the applications are short-term in duration. All of the foregoing information indicates that widespread acute ecosystem impacts will not occur from algaecide or aquatic herbicides applied according to their label instructions and requirements of this General Permit. Therefore, toxicity monitoring requirements are not necessary.

D. Receiving Water Monitoring

Receiving water monitoring is necessary to determine the impacts of the discharge on the receiving stream.

All forms of testing have some degree of uncertainty associated with them. The more limited the amount of test data available, the larger the uncertainty. The intent of this General Permit's sampling program is to select a number that will detect most events of noncompliance without requiring needless or burdensome monitoring.

Staff also used EPA's Technical Support Document for Water Quality-Based Toxics Control (TSD) to determine the appropriate number of samples that would be needed to characterize the impacts of the residual pesticide discharge from pesticide applications. Page 53 of the TSD recommends using a coefficient of variation (CV) 0.6 when the data set contains less than 10 samples. Table 3-1 of the TSD shows that with a CV of 0.6, the multiplying factors used to determine whether a discharge causes, has the reasonable potential to cause, or contributes to an excursion above a state water quality standard begin to stabilize when the sample number is six. Thus, this General Permit requires six samples per year for each active ingredient in each environmental setting (flowing water and non-flowing water) to characterize the effects of residual pesticide discharge from pesticide applications. However, after a Discharger or Coalition has provided results from six consecutive sampling events showing concentrations that are less than the receiving water limitation/trigger for an active ingredient in a specific environmental setting, sampling shall be reduced to one application event per year for that active ingredient in that environmental setting.

Similarly, this General Permit contains a reduced monitoring frequency of once per year (instead of six) at each environmental setting for glyphosate. The reduced monitoring frequency is based on staff’s review of available data from 2004 to 2008 that showed no exceedance of the permit limitation for glyphosate under Order No. 2004-0009-DWQ.

VIII. RATIONALE FOR AQUATIC PESTICIDE USE REQUIREMENTS

A. Application Schedule

The Discharger shall provide a phone number or other specific contact information for all persons who request the Discharger’s application schedule.

B. Application Notification Requirements

The Policy section 5.3, Categorical Exception, requires public agencies and mutual water companies that have been granted the short-term or seasonal exception for compliance with priority pollutant limitations to notify potentially affected public and government agencies of algaecide or aquatic herbicide application.

C. APAP

This General Permit contains narrative effluent limitations, which include implementing BMPs described in the APAP, which is a requirement of this General Permit. See Section VI, Rationale for Effluent Limitations and Discharge Specifications, for more detailed explanation of the need for an APAP.

D. APAP Processing, Approval, and Modifications

Upon receipt of a new or an amended APAP, staff will post it on the State Water Board's website. Major changes to the APAP shall be submitted to the Deputy Director for approval. Examples of major changes include using a different product other than what is specified in the APAP, changing an application method that may result in different amounts of algaecide or aquatic herbicides being applied, or adding or deleting BMPs. Since the APAP shall include ALL (1) the water bodies or water body systems in which algaecide or aquatic herbicides are being planned to be applied or may be applied to control algae and aquatic weeds and (2) the application areas and the target areas in the system that are being planned to be applied or may be applied, changes in monitoring locations are not considered major changes. However, these changes need to be reported in the annual report.

In preparing for the reissuance of the General Permit, staff will evaluate review periods and comments received during the life of this permit and look for efficiencies. Based on this information, staff will propose revisions to the public comment process for APAPs.

E. Aquatic Pesticide Application Log

An application log to record all algaecide or aquatic herbicide applications is necessary. This application log will help Dischargers and the Water Boards' staff to investigate any exceedance of receiving water limitations or receiving water monitoring triggers.

IX. RATIONALE FOR PROVISIONS

A. Standard Provisions

1. Standard Provisions in Attachment B

Standard Provisions, which apply to all NPDES permits in accordance with 40 C.F.R. section 122.41, and additional conditions applicable to specified categories of permits in accordance with 40 C.F.R. section 122.42, are provided in Attachment B. The Discharger must comply with applicable standard provisions and with those additional conditions that are applicable under 40 C.F.R. section 122.42.

Sections 122.41(a)(1) and (b) through (n) of 40 C.F.R. establish conditions that apply to all state-issued NPDES permits. These conditions must be

incorporated into the permits either expressly or by reference. If incorporated by reference, a specific citation to the regulations must be included in the General Permit. Section 123.25(a)(12) of 40 C.F.R. allows the state to omit or modify conditions to impose more stringent requirements. In accordance with 40 C.F.R. Section 123.25, this General Permit omits federal conditions that address enforcement authority specified in 40 C.F.R. section 122.41(j)(5) and (k)(2) because the enforcement authority under the California Water Code is more stringent. In lieu of these conditions, this General Permit incorporates by reference California Water Code section 13387(e).

2. Discharge to Impaired Water Bodies

Impaired water bodies are water quality limited segments listed under CWA 303(d) listings. The water bodies on these lists do not meet water quality standards, even if the discharge itself meets water quality standards. The Basin Plans state that "*Additional treatment beyond minimum federal standards will be imposed on dischargers to Water Quality Limit Segments. Dischargers will be assigned or allocated a maximum allowable load of critical pollutants so that water quality objectives can be met in the segment.*" The allocated loads are Discharger and receiving water specific. It is infeasible to assign a uniform load in a statewide general permit. Therefore, this General Permit does not authorize the discharge of active ingredients of algaecides or aquatic herbicides, their residues, and their degradation byproducts to water bodies that are already impaired due to the same product active ingredients, their residues, and their degradation byproducts.

B. Special Provisions

1. Reopener Provisions

The reopener provisions allow future modification to this General Permit in accordance with 40 C.F.R. section 122.62.

a. Addition to Policy Exception List in Attachment G

This General Permit may be reopened to add a public entity or a mutual water company which may not otherwise meet the receiving water limitations for acrolein and copper and meets the requirements for an exception from meeting those limitations, consistent with section 5.3 of the Policy.

b. Addition of Aquatic Pesticide Active Ingredients

This General Permit may be reopened to add newly registered algaecide or aquatic herbicide active ingredients so that Dischargers can be covered by this General Permit when they apply the algaecide or aquatic herbicide products with the new active ingredients.

c. Acute and Chronic Toxicity

When the State Water Board revises the Policy's toxicity control provisions that would require the establishment of numeric chronic toxicity limitations or other actions, this General Permit may be reopened to comply with those requirements.

d. Receiving Water Limitations

If monitoring data for residual pesticides show exceedance of monitoring triggers, the Discharger or Coalition shall conduct additional investigations to determine the cause of exceedance. At a minimum, the Discharger or Coalition shall evaluate its application methods, BMPs, and the appropriateness of using alternative products. As a result of the evaluation, this General Permit may be re-opened to add numeric Receiving Water Limitations for the residual pesticides exceeding the triggers.

e. Endangered Species Act

If U.S. EPA develops biological opinions regarding pesticides included in this General Permit, this General Permit may be re-opened to add or modify Receiving Water Limitations/Monitoring Triggers for residual pesticides of concern, if necessary.

2. **Special Studies, Technical Reports, and Additional Monitoring Requirements**

a. Additional Investigation

This General Permit requires Dischargers to conduct additional investigations if the monitoring results exceed the receiving water monitoring limitations. These investigations are necessary in order to address the exceedance caused by the algaecide or aquatic herbicide application and meet the General Permit's limitations and requirements including Basin Plans' narrative water quality objective of no toxics in toxic amount.

b. Qualified Biologist Certification Following Project Completion

The requirement is retained from Order No. 2004-0009-DWQ and is based on Policy section 5.3 exception.

3. **Corrective Action**

When receiving water limitations or triggers are exceeded, Dischargers are expected to assess the cause of exceedance and take appropriate actions as necessary to prevent recurrence of the problem.

X. COMPLIANCE DETERMINATION

This General Permit specifies that compliance be based on event and post-event sampling results. The event sample results will determine if exceedance occurred outside the Treatment Area* during treatment. Post-event samples will determine if exceedance occurred in the Application or Treatment Area after treatment. Since the minimum effective concentration and time needed to effectively kill or control target weeds or algae vary due to site specific conditions, such as flow, target species, water chemistry, and type of algaecides or aquatic herbicides, this General Permit allows Dischargers to determine when treatment is completed.

XI. PUBLIC PARTICIPATION

The State Water Board is considering the issuance of WDRs that will serve as a general NPDES permit for algaecide or aquatic herbicide applications. As a step in the WDR adoption process, the State Water Board staff has developed tentative WDRs. The State Water Board encourages public participation in the WDR adoption process.

A. Notification of Interested Parties

The State Water Board has notified interested agencies, parties, and persons of its intent to prescribe general WDRs for algaecide or aquatic herbicide applications and has provided them with an opportunity to submit their written comments and recommendations. Notification was provided to interested parties through specific mailings and publication in major newspapers throughout California. The State Water Board, in a public meeting, heard and considered all comments pertaining to discharges to be regulated by this General Permit. Details of the Public Hearing are provided in the Fact Sheet of this General Permit.

B. Written Comments

Interested persons were invited to submit written comments concerning this tentative WDR. Comments were due at the State Water Board offices by 12:00 noon on **August 21, 2012**. Seven comment letters were received.

C. Public Hearing and Meeting

The State Water Board held a public hearing on the tentative WDRs during its regular Board meeting on **August 7, 2012**. The State Water Board considered adoption of the WDRs at a public meeting on the following date, time, and location:

Date: **March 25, 2013**

Time: 9:00 a.m.

Location: State Water Resources Control Board

1001 I Street

Sacramento, CA 95814

Interested persons were invited to attend. At the public meeting, the State Water Board heard comments, if any, limited to changes on the draft General Permit.

Please be aware that dates and venues may change. The State Water Board's website address is www.waterboards.ca.gov where you can access the current agenda for changes in dates and locations.

D. Information and Copying

The tentative effluent limitations, receiving water limitations, and special provisions, comments received, and other information are on file and may be inspected at the address above at any time between 8:30 a.m. and 4:45 p.m., Monday through Friday. Copying of documents may be arranged through the State Water Board by calling (916) 379-9152.

E. Register of Interested Persons

Any person interested in being placed on the mailing list for information regarding this general WDR and NPDES permit should contact the State Water Board, reference the general WDR and NPDES permit, and provide a name, address, and phone number.

F. Additional Information

Requests for additional information or questions regarding this General Permit should be directed to NPDES_Wastewater@waterboards.ca.gov.

Attachment E – Notice of Intent

WATER QUALITY ORDER NO. 2013-0002-DWQ
GENERAL PERMIT NO. CAG990005

STATEWIDE GENERAL NATIONAL POLLUTANT DISCHARGE ELIMINATION SYSTEM (NPDES) PERMIT FOR RESIDUAL AQUATIC PESTICIDE DISCHARGES TO WATERS OF THE UNITED STATES FROM ALGAE AND AQUATIC WEED CONTROL APPLICATIONS

I. NOTICE OF INTENT STATUS (see Instructions)

Mark only one item

☐ A. New Applicator

☐ B. Change of Information: WDID # _____

☐ C. Change of ownership or responsibility: WDID# _____

II. DISCHARGER INFORMATION

A. Name _____

B. Mailing Address _____

C. City _____

D. County _____

E. State _____

F. Zip Code _____

G. Contact Person _____

H. Email address _____

I. Title _____

J. Phone _____

III. BILLING ADDRESS (Enter Information *only* if different from Section II above)

A. Name _____

B. Mailing Address _____

C. City _____

D. County _____

E. State _____

F. Zip Code _____

G. Email address _____

H. Title _____

I. Phone _____

IV. RECEIVING WATER INFORMATION

A. Algaecide and aquatic herbicides are used to treat (check all that apply):

☐ 1. Canals, ditches, or other constructed conveyance facilities owned and controlled by Discharger.

Name of the conveyance system: _____

☐ 2. Canals, ditches, or other constructed conveyance facilities owned and controlled by an entity other than the Discharger.

Owner's name: _____

Name of the conveyance system: _____

☐ 3. Directly to river, lake, creek, stream, bay, ocean, etc.

Name of water body: _____

B. Regional Water Quality Control Board(s) where application areas are located

(REGION 1, 2, 3, 4, 5, 6, 7, 8, or 9): Region _____

(List all regions where algaecide and aquatic herbicide application is proposed.)

V. ALGAECIDE AND AQUATIC HERBICIDE APPLICATION INFORMATION

A. Target Organisms:

_____

_____

B. Algaecide and Aquatic Herbicide Used: List Name and Active Ingredients

_____

_____

_____

C. Period of Application:

Start Date _____ End Date _____

D. Types of Adjuvants Used:

_____

_____

VI. AQUATIC PESTICIDE APPLICATION PLAN

A. Has an Aquatic Pesticide Application Plan been prepared and is the applicator familiar with its contents?

☐ Yes ☐ No

If not, when will it be prepared?_____

VII. NOTIFICATION

Have potentially affected public and governmental agencies been notified?

☐ Yes ☐ No

VIII. FEE

Have you included payment of the filing fee (for first-time enrollees only) with this submittal?

☐ Yes ☐ No ☐ NA

IX. CERTIFICATION

"I certify under penalty of law that this document and all attachments were prepared under my direction and supervision in accordance with a system designed to ensure that qualified personnel properly gather and evaluate the information submitted. Based on my inquiry of the person or persons who manage the system, or those persons directly responsible for gathering the information, the information submitted is, to the best of my knowledge and belief, true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine or imprisonment. Additionally, I certify that the provisions of the Order, including developing and implementing a monitoring program, will be complied with."

A. Printed Name:_____

B. Signature:_____ Date:_____

C. Title:_____

XI. FOR STATE WATER BOARD STAFF USE ONLY

WDID: Date NOI Received: Date NOI Processed:

Case Handler's Initial: Fee Amount Received: $ Check#:_____

☐ Lyris List Notification of Posting of APAP Date: Confirmation Sent

INSTRUCTIONS FOR COMPLETING THE NOTICE OF INTENT

WATER QUALITY ORDER 2013-0002-DWQ
GENERAL PERMIT CAG990005

STATEWIDE GENERAL NATIONAL POLLUTANT DISCHARGE ELIMINATION SYSTEM (NPDES) PERMIT FOR RESIDUAL AQUATIC PESTICIDE DISCHARGES TO WATERS OF THE UNITED STATES FROM ALGAE AND AQUATIC WEED CONTROL APPLICATIONS

These instructions are intended to help you, the Discharger, to complete the Notice of Intent (NOI) form for the Statewide General NPDES permit. **Please type or print clearly when completing the NOI form**. For any field, if more space is needed, submit a supplemental letter with the NOI.

Send the completed and signed form along with the filing fee and supporting documentation to the Division of Water Quality, State Water Resources Control Board. Please also send a copy of the form and supporting documentation to the appropriate Regional Water Quality Control Board (Regional Water Board).

Section I – Notice of Intent Status

Indicate whether this request is for the first time coverage under this General Permit or a change of information for the discharge already covered under this General Permit. Dischargers that are covered under Order No. 2004-0009-DWQ before effective date of this General Permit should check the box for change of information. For a change of ownership, please supply the eleven-digit Waste Discharge Identification (WDID) number for the discharge.

Section II – Discharger Information

Enter the name of the Discharger

Enter the street number and street name where correspondence should be sent (P.O. Box is acceptable).

Enter the city that applies to the mailing address given.

Enter the county that applies to the mailing address given.

Enter the state that applies to the mailing address given.

Enter the zip code that applies to the mailing address given.

Enter the name (first and last) of the contact person.

Enter the e-mail address of the contact person.

Enter the contact person's title

Enter the daytime telephone number of the contact person.

Section III – Billing Address

Enter the information **only** if it is different from Section II above.

A. Enter the name (first abd last) of the person who will be responsible for the billing.
B. Enter the street number and street name where correspondence should be sent (P.O. Box is acceptable).
C. Enter the city that applies to the mailing address given.
D. Enter the county that applies to the mailing address given.
E. Enter the state that applies to the mailing address given.
F. Enter the zip code that applies to the mailing address given.
G. Enter the e-mail address of the person responsible for billing.
H. Enter the title of the person responsible for billing.
I. Enter the daytime telephone number of the person responsible for billing.

Section IV – Receiving Water Information

Please be reminded that this General Permit does not authorize any act that results in the taking of a threatened or endangered species or any act that is now prohibited, or becomes prohibited in the future, under either the California Endangered Species Act (Fish and Game Code §2050 et. seq) or the Federal Endangered Species Act (16 U.S.C.A. §1531 et. seq). This General Permit requires compliance with effluent limitations, receiving water limitations, and other requirements to protect the beneficial uses of waters of the state. The Discharger is responsible for meeting all requirements of the applicable Endangered Species Act.

Additional information on federally-listed threatened or endangered species and federally-designated critical habitat is available from NMFS website (www.nmfs.noaa.gov) for anadromous or marine species or FWS website (www.fws.gov) for terrestrial or freshwater species.

A. Check all boxes that apply. At least one box must be checked
    1. Check this box if the application area is a canal, ditch, or other constructed conveyance system owned and controlled by the Discharger. Print the name of the conveyance system.
    2. Check this box if the application area is a canal, ditch, or other constructed conveyance system owned and controlled by an entity other than the Discharger. Print the name of the owner and the name of the conveyance system..

3. Check this box if the application area is to the river, lake, creek, stream, bay, ocean, etc. Print the name of the water body.

B. List all Regional Water Board numbers where pesticide application is proposed. Regional Water Board boundaries are defined in section 13200 of the California Water Code. The boundaries can also be found on our State Water Board website at http://www.waterboards.ca.gov/waterboards_map.shtml.

Regional Water Board Numbers	Regional Water Board Names
1	North Coast
2	San Francisco Bay
3	Central Coast
4	Los Angeles
5	Central Valley (Includes Sacramento, Fresno, Redding Offices)
6	Lahontan (South Lake Tahoe, Victorville offices)
7	Colorado River Basin
8	Santa Ana
9	San Diego

Section V – Algaecide and Aquatic Herbicide Application Information

A. List the appropriate target organism(s).

B. List the name and active ingredients of each algaecide and aquatic herbicide to be used.

C. List the start and end date of proposed algaecide and aquatic herbicide application event.

D. List the name(s) and type(s) of adjuvants that will be used.

The Discharger must submit a new NOI if any information stated in this section will be changed. If the Discharger plans to use an algaecide and aquatic herbicide product not currently covered under its Notice of Applicability (NOA), and the algaecide and aquatic herbicide product may be discharged to a water of the United States as a result of algaecide and aquatic herbicide application, the Discharger must receive a revised NOA

from the State Water Board's Deputy Director of the Division of Water Quality before using that product.

Section VI – Aquatic Pesticide Application Plan

The Coalition or Discharger must prepare and complete an Aquatic Pesticide Application Plan (APAP). The minimum contents of APAP are specified in the permit under Section VIII.C, Limitations and Discharge Requirements, of the General Permit. The Discharger must ensure that its applicator is familiar with the APAP contents before algaecide and aquatic herbicide application.
If an APAP is not complete at the time of application, enter the date by which it will be completed.

Section VII – Notification

Indicate if you have notified potentially affected public and governmental agencies, as required under item VIII.B of the General Permit.

Section VIII – Fee

The amount of Annual fee shall be based on Category 3 discharge specified in section 2200(b)(9) of title 23, California Code of Regulations. Fee information can be found at http://www.waterboards.ca.gov/resources/fees/docs/fy1112fee_schdl_npdes_prmt.pdf.

Check the YES box if you have included payment of the annual fee. Check the NO box if you have not included this payment. **NOTE:** You will be billed annually and payment is required to continue coverage.

Section IX– Certification

A. Print the name of the appropriate official. For a municipality, State, federal, or other public agency, this would be a principal executive officer, ranking elected official, or duly authorized representative. The principal executive officer of a federal agency includes the chief executive officer of the agency or the senior executive officer having responsibility for the overall operations of a principal geographic unit of the agency (e.g., Regional Administrator of U.S. EPA).
B. The person whose name is printed above must sign and date the NOI.
C. Enter the title of the person signing the NOI.

Attachment F – Notice of Termination

WATER QUALITY ORDER 2013-0002-DWQ
GENERAL PERMIT CAG990005

STATEWIDE GENERAL NATIONAL POLLUTANT DISCHARGE ELIMINATION SYSTEM (NPDES) PERMIT FOR RESIDUAL AQUATIC PESTICIDE DISCHARGES TO WATERS OF THE UNITED STATES FROM ALGAE AND AQUATIC WEED CONTROL APPLICATIONS

I. WASTE DISCHARGE IDENTIFICATION

WDID# _____

II. DISCHARGER INFORMATION

A. Name _____

B. Mailing Address _____

C. City _____

D. County _____

E. State _____

F. Zip Code _____

G. Contact Person _____

H. Email address _____

I. Title _____

J. Phone _____

III. BASIS FOR TERMINATION

_____

_____

_____

_____

_____

_____

IV. CERTIFICATION

"I certify under penalty of law that 1) I am not required to be permitted under this General Permit CAG990005; and 2) this document and all attachments were prepared under my direction and supervision in accordance with a system designed to ensure that qualified personnel properly gather and evaluate the information

submitted. Based on my inquiry of the person or persons who manage the system, or those persons directly responsible for gathering the information, the information submitted is, to the best of my knowledge and belief, true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine or imprisonment. Additionally, I understand that the submittal of this Notice of Termination does not release a pesticide applicator from liability for any violations of the Clean Water Act."

A. Printed Name:_____

B. Signature:_____ Date:_____

C. Title:_____

V. FOR STATE WATER BOARD USE ONLY

☐ Approved for Termination ☐ Denied and Returned to the Discharger

A. Printed Name:_____

B. Signature:_____

C. Date:_____

NOT Effective Date: _____

Attachment G – Exception List

LIST OF PUBLIC AGENCIES AND MUTUAL WATER COMPANIES GRANTED AN EXCEPTION PURSUANT TO STATE WATER RESOURCES CONTROL BOARD POLICY FOR IMPLEMENTATION OF TOXICS STANDARDS FOR INLAND SURFACE WATERS, ENCLOSED BAYS, AND ESTUARIES OF CALIFORNIA (POLICY)

The public entities and mutual water companies listed herein have prepared Initial Studies, Negative Declarations (ND), or Mitigated Negative Declarations (MND), and Notices of Determination for the discharge of algaecides and aquatic herbicides in accordance with the California Environmental Quality Act (CEQA (Public Resources Code § 21000 et seq.)) to comply with the exception requirements of section 5.3 of the Policy. The boards of each public entity or mutual water company, as the lead agencies under CEQA, approved the Final ND/MND and determined that the discharge of algaecides and aquatic herbicides in their respective projects would not have a significant effect on the environment. These public entities and mutual water companies have determined that the water quality or related water quality impacts identified in the environmental assessments of the ND/MND are less than significant.

In addition to submitting the CEQA documentation, these public entities and mutual water companies have also complied with the other exception requirements of section 5.3 of the Policy.

As required in section 15096 of the CEQA Guidelines, the State Water Resources Control Board (State Water Board), as a Responsible Agency under CEQA, considered the ND/MND approved by the board of each public entity or mutual water company and finds that the projects will have less than significant water quality impact if the waste discharge requirements in this General Permit are followed. Accordingly, the public entities and mutual water companies listed herein are hereby granted an exception pursuant to section 5.3 of the Policy.

1. Byron-Bethany Irrigation District
2. City of Antioch Department of Public Works
3. City of Sacramento
4. City of Poway
5. Contra Costa Water District
6. Contra Costa County Flood Control and Water Conservation District
7. Department of Food and Agriculture
8. Department of Water Resources
9. Fresno Irrigation District
10. Friant Water Users Authority

11. Glenn-Colusa Irrigation District
12. Helix Water District
13. James Irrigation District
14. Madera Irrigation District
15. Maine Prairie Water District
16. Marin Municipal Water District
17. Merced Irrigation District
18. Metropolitan Water District of Southern California
19. Modesto Irrigation District
20. Nevada Irrigation District
21. North Marin Water District
22. Oakdale Irrigation District
23. Placer County Water Agency
24. Potter Valley Irrigation District
25. Princeton-Cordora-Glenn Irrigation District
26. Provident Irrigation District
27. Reclamation District 108
28. Reclamation District 1000
29. Reclamation District 1004
30. San Diego County Water Authority
31. Santa Cruz Water Department
32. Santa Fe Irrigation District
33. Solano Irrigation District
34. South Feather Water and Power Agency
35. South Sutter Water District
36. Sweetwater Authority
37. Tehama Colusa Canal Authority
38. Turlock Irrigation District
39. Woodbridge Irrigation District
40. Yolo County Flood Control and Water Conservation District

Attachment E – Notice of Intent

WATER QUALITY ORDER NO. 2013-0002-DWQ
GENERAL PERMIT NO. CAG990005

STATEWIDE GENERAL NATIONAL POLLUTANT DISCHARGE ELIMINATION SYSTEM (NPDES) PERMIT FOR RESIDUAL AQUATIC PESTICIDE DISCHARGES TO WATERS OF THE UNITED STATES FROM ALGAE AND AQUATIC WEED CONTROL APPLICATIONS

I. NOTICE OF INTENT STATUS (see Instructions)

Mark only one item	A. New Applicator	B. ☑ Change of Information: WDID# **3 440206022**
	C. ☐ Change of ownership or responsibility: WDID# _____	

II. DISCHARGER INFORMATION

A. Name **City of Santa Cruz, Water Department**			
B. Mailing Address **715 Graham Hill Road**			
C. City **Santa Cruz**	D. County **Santa Cruz**	E. State **CA**	F. Zip **95060**
G. Contact Person **Lindsay Neun**	H. E-mail address lneun@cityofsantacruz.com	I. Title **Water Quality Manager**	J. Phone **831-420-5486**

III. BILLING ADDRESS (Enter Information ***only*** if different from Section II above)

A. Name			
B. Mailing Address			
C. City	D. County	E. State	F. Zip
G. E-mail address	H. Title	I. Phone	

IV. RECEIVING WATER INFORMATION

A. Algaecide and aquatic herbicides are used to treat (check all that apply):

1. ☐ Canals, ditches, or other constructed conveyance facilities owned and controlled by Discharger.
   Name of the conveyance system: _____
2. ☐ Canals, ditches, or other constructed conveyance facilities owned and controlled by an entity other than the Discharger.
   Owner's name: _____
   Name of the conveyance system: _____
3. ☑ Directly to river, lake, creek, stream, bay, ocean, etc.
   Name of water body: **Loch Lomond Reservoir**

B. Regional Water Quality Control Board(s) where treatment areas are located (REGION 1, 2, 3, 4, 5, 6, 7, 8, or 9): **Region 3**
(List all regions where algaecide and aquatic herbicide application is proposed.)

V. ALGAECIDE AND AQUATIC HERBICIDE APPLICATION INFORMATION

A. Target Organisms: **Algae**

B. Algaecide and Aquatic Herbicide Used: List Name and Active ingredients
Copper (Algimycin® PWF)
Hydrogen Peroxide/Dioxide (GreenClean Liquid 5.0®)
Peroxyacetic Acid (GreenClean Liquid 5.0®)
Sodium Carbonate Peroxyhydrate (PAK®27)

Note: Product names listed in parentheses are examples only and may change.

C. Period of Application: Start Date: **January 1** End date: **December 31, for the life of the permit**

D. Types of Adjuvants Used: **Aquatic labeled adjuvants such as Cygnet Plus®, as needed**

VI. AQUATIC PESTICIDE APPLICATION PLAN

Has an Aquatic Pesticide Application Plan been prepared and is the applicator familiar with its contents?
☑ Yes ☐ No

If not, when will it be prepared? _____

VII. NOTIFICATION

Have potentially affected public and governmental agencies been notified? ☑ Yes ☐ No

VIII. FEE

Have you included payment of the filing fee (for first-time enrollees only) with this submittal?
☐ YES ☐ NO ☑ NA

IX. CERTIFICATION

"I certify under penalty of law that this document and all attachments were prepared under my direction and supervision in accordance with a system designed to ensure that qualified personnel properly gather and evaluate the information submitted. Based on my inquiry of the person or persons who manage the system, or those persons directly responsible for gathering the information, the information submitted is, to the best of my knowledge and belief, true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine or imprisonment. Additionally, I certify that the provisions of the General Permit, including developing and implementing a monitoring program, will be complied with."

A. Printed Name: Chris Coburn

B. Signature: _____ **Date:** 3/19/21

C. Title: Deputy Director

XI. FOR STATE WATER BOARD STAFF USE ONLY

WDID:	**Date NOI Received:**	**Date NOI Processed:**
Case Handler's Initial:	**Fee Amount Received:** **$**	**Check #:**
☐ **Lyris List Notification of Posting of APAP**	**Date** _____	**Confirmation Sent** _____

City of Santa Cruz

WDID # 3 440206022

Aquatic Pesticide Application Plan (APAP)

For the

Statewide General National Pollutant Discharge Elimination System (NPDES) Permit for Residual Aquatic Pesticide Discharges to Waters of the United States from Algae and Aquatic Weed Control Applications

Water Quality Order No. 2013-0002-DWQ

General Permit # CAG990005

Revised March 1, 2021

Prepared for:
City of Santa Cruz
Water Department
715 Graham Hill Road
Santa Cruz, 95060
Contact: Lindsay Neun
(831) 420-5486

Prepared by:
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1615 5th Street, Suite A
Davis, CA 95616
Contact: Stephen Burkholder
(530) 757-0941

Submitted to:
State Water Resources Control Board
Attn: NPDES Wastewater Unit
1001 I Street, 15th Floor
Sacramento, CA 95814
Contact: Gurgan Chand
(916) 341-5780

Certification

"I certify under penalty of law that this document and all attachments were prepared under my direction or supervision in accordance with a system designed to ensure that qualified personnel properly gather and evaluate the information submitted. Based on my inquiry of the person or persons who manage the system or those persons directly responsible for gathering the information, the information submitted is, to the best of my knowledge and belief, true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment for knowing violations".

Signed and Agreed:

Chris Coburn
Deputy Director
Water Department
City of Santa Cruz

Stephen Burkholder
Pest Control Adviser # 153644
Senior Biologist
Blankinship & Associates, Inc.

Michael S. Blankinship
Licensed Professional Engineer (Civil) # 64112
Pest Control Adviser # 75890
Blankinship & Associates, Inc.

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Limitations

The services used to prepare this document were performed consistent with the agreement with the City of Santa Cruz and were rendered in a manner consistent with generally accepted professional consulting principles and practices using the level of care and skill ordinarily exercised by other professional consultants under similar circumstances at the same time the services were performed. No warranty, express or implied, is included. This document is solely for the use of our client. Any use or reliance on this document by a third party is not authorized and is at such party's sole risk.

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City of Santa Cruz
Aquatic Pesticide Application Plan

Statewide General National Pollutant Discharge Elimination System (NPDES) Permit for Residual Aquatic Pesticide Discharges to Waters of the United States from Algae and Aquatic Weed Control Applications
Water Quality Order No. 2013-0002-DWQ
General Permit # CAG990005
WDID # 3 440206022

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Aquatic Pesticide Application Plan

In March 2001, the State Water Resources Control Board (SWRCB) prepared Water Quality Order # 2001-12-DWQ which created Statewide General National Pollutant Discharge Elimination System (NPDES) Permit # CAG990003 for the discharges of aquatic herbicides to waters of the United States. The purpose of Order # 2001-12-DWQ was to minimize the areal extent and duration of adverse impacts to beneficial uses of water bodies treated with aquatic herbicides. The purpose of the general permit was to substantially reduce the potential discharger liability incurred for releasing water treated with aquatic herbicides into waters of the United States. The general permit expired January 31, 2004.

On May 20, 2004, the SWRCB adopted the statewide general NPDES Permit for Discharge of Aquatic Pesticides for Aquatic Weed Control in Waters of the United States # CAG990005. Dischargers were required to have coverage under the general permit to perform aquatic herbicide applications. In May 2009, the general permit expired, but was administratively continued until November 30, 2013.

The Statewide General NPDES Permit for Residual Aquatic Pesticide Discharges to Waters of the United States from Algae and Aquatic Weed Control Applications (herein referred to as the "Permit") was adopted on March 5, 2013 and became active on December 1, 2013 (SWRCB 2013). The Permit has been revised four times by Water Quality Orders since it was originally adopted by the SWRCB. The Permit expired on November 30, 2018 and has been administratively continued to allow dischargers to maintain coverage until a new permit is adopted. As such, the Permit is still active and enforceable. The Permit requires compliance with the following:

- The Policy for Implementation of Toxics Standards for Inland Surface Waters, Enclosed Bays, and Estuaries in California, a.k.a. the State Implementation Plan, or SIP (SWRCB 2005)
- The California Toxics Rule (CTR) (CTR 2000)
- Applicable Water Quality Objectives (WQOs) in the Regional Water Quality Control Board (RWQCB) Central Coastal Basin Plan (CCRWQCB 2019)

Coverage under the Permit is available to single dischargers and potentially to regional dischargers for releases of potential and/or actual pollutants to waters of the United States. Dischargers eligible for coverage under the Permit include public entities that conduct resource or pest management control measures, such as local, state, and federal agencies responsible for control of algae, aquatic weeds, and other organisms that adversely impact operation and use of drinking water reservoirs, water conveyance facilities, irrigation canals, flood control channels, detention basins and/or natural water bodies.

The Permit does not cover indirect or non-point source discharges, whether from agricultural or other applications of pesticides to land, that may be conveyed in storm water or irrigation runoff. The Permit only covers algaecides and aquatic herbicides that are applied according to label directions and that are registered for use on aquatic sites by the California Department of Pesticide Regulation (DPR).

The City of Santa Cruz Water Department (herein referred to as the "City") serves a suburban population of nearly 100,000 people situated in and around the City of Santa Cruz. The City of Santa Cruz is located on the Central-Northern California coast, south of San Francisco in Santa Cruz County and has a Mediterranean climate featuring wet, mild winters and warm, dry summers. The City's primary objective is to provide a safe, clean, and continuous supply of water for municipal and fire protection purposes to Santa Cruz and to the unincorporated surrounding areas.

The City owns and/or manages approximately 3,880 acres of land in the Santa Cruz Mountains around the Loch Lomond Reservoir, an impoundment of the Newell Creek Drainage. Refer to **Figure 1** and **Figure 2**. The reservoir is located 9 miles north of Santa Cruz, is about 2.5 miles long and has a maximum width of approximately 1,500 feet. It is fed by the Newell Creek drainage basin, which includes Newell Creek, extending three miles upstream of the reservoir and 2 miles downstream of the Newell Creek Dam to the San Lorenzo River. Loch Lomond Recreation Area was originally developed as a nature preserve and recreation area in the 1950's, and the reservoir was opened for public recreation in 1963 after the completion of the Newell Creek Dam two years earlier. The reservoir has been used as a source of water supply for the City of Santa Cruz since 1961. As part of the City's agreement for the completion of a dam, the entire area was open to the community for limited recreational activity, including hiking, boating, and fishing.

The Loch Lomond Reservoir has a surface area of approximately 175 acres and is up to 150 feet deep. The reservoir is situated in a largely undeveloped watershed. The reservoir experiences algae blooms during the late spring and summer months due to available nutrients, warm water temperatures, and abundant sunlight.

Blue-green algae, also known as cyanobacteria, can trigger complaints of adverse taste and/or odor in treated drinking water delivered to City customers when significant algae blooms are occurring in the reservoir. Additional complaints may be received regarding the appearance and adverse odor of water in Loch Lomond from reservoir users such as boaters or picnickers. Certain genera of cyanobacteria produce 2-methylisoborneol (MIB) and geosmin, which are taste and odor causing compounds that are difficult to remove from water during the treatment process.

Toxins produced by some cyanobacteria can be harmful to humans, fish, and other animals. Observation of toxin production has increased globally and in California. Some species identified in Loch Lomond have been known to produce toxins under some environmental conditions or in response to stressors. The factors that may influence toxin production in some cyanobacteria include algal density, temperature stress, nutrient availability, light availability or competition, and predation.

Metabolic products released by the algae react with chlorine during the treatment process to produce potentially carcinogenic disinfection by-products (DBPs). When a large algae population dies off the decomposition can deplete the available oxygen and lead to a fish kill, further damaging water quality. In order to prevent these problems and to provide customers with drinking water that meets State and Federal drinking water standards, routine monitoring of Loch Lomond is conducted to evaluate water quality and algal populations.

The City staff conducts routine water quality sampling in the reservoir to assess overall algae population status when blooms may occur. Species present at the surface and various water intake depths are generally identified and counted, and samples may be analyzed for chlorophyll-*a*. When populations of known nuisance genera (i.e., *Dolichospermum*, *Anabaena, Woronichinia, Lyngbya*, *Microcystis*, *Aphanizomenon*, etc.) are observed to be increasing, sampling frequency is increased. If algae counts and chlorophyll-*a* values show exponential growth, indicating that a bloom is imminent or occurring, an algaecide may be applied to prevent or lessen the impact of a cyanobacteria bloom.

The City has previously applied algaecides and aquatic herbicides using the SWRCB's 2004 Permit and the current 2013 Permit. Consistent with existing Permit requirements, the City has completed a Notice of

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Intent (NOI) and prepared an Aquatic Pesticide Application Plan (APAP), and a Notice of Applicability (NOA) has been received. Sampling and analysis has been performed and annual reports have been submitted to the SWRCB and Central Coast RWQCB. The revisions to the City's APAP are intended to better describe how the City approaches monitoring and reporting related to their use of algaecides to mitigate the impact of cyanobacteria blooms on drinking water customers and reservoir users.

Using Integrated Pest Management (IPM) techniques, the City intends to apply algaecides identified in the NOI submitted to the RWQCB. For the purposes of complying with the Permit, the City has created this APAP.

This APAP is a comprehensive plan developed by the City that describes the project, the need for the project, what may be done to reduce water quality impacts, and how those impacts will be monitored. Specifically, this APAP contains the following eleven (11) elements.

1. Description of the water system to which algaecides and aquatic herbicides are being applied;
2. Description of the treatment area in the water system;
3. Description of types of weed(s) and algae that are being controlled and why;
4. Algaecide and aquatic herbicide products or types of algaecides and aquatic herbicides expected to be used and if known their degradation byproducts, the method in which they are applied, and if applicable, the adjuvants and surfactants used;
5. Discussion of the factors influencing the decision to select algaecide and aquatic herbicide applications for algae and weed control;
6. If applicable, list the gates or control structures to be used to control the extent of receiving waters potentially affected by algaecide and aquatic herbicide application and provide an inspection schedule of those gates or control structures to ensure they are not leaking;
7. If the Discharger has been granted a short-term or seasonal exception under State Water Board Policy for Implementation of Toxics Standards for Inland Surface Waters, Enclosed Bays, and Estuaries of California (Policy) section 5.3 from meeting acrolein and copper receiving water limitations, provide the beginning and ending dates of the exception period, and justification for the needed time for the exception. If algaecide and aquatic herbicide applications occur outside of the exception period, describe plans to ensure that receiving water criteria are not exceeded because the Dischargers must comply with the acrolein and copper receiving water limitations for all applications that occur outside of the exception period;
8. Description of monitoring program;
9. Description of procedures used to prevent sample contamination from persons, equipment, and vehicles associated with algaecide and aquatic herbicide application;
10. Description of the Best Management Practices (BMPs) to be implemented. The BMPs shall include, at the minimum:

    10.1. Measures to prevent algaecide and aquatic herbicide spill and for spill containment during the event of a spill;

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10.2. Measures to ensure that only an appropriate rate of application consistent with product label requirements is applied for the targeted weeds or algae;

10.3. The Discharger's plan in educating its staff and algaecide and aquatic herbicide applicators on how to avoid any potential adverse effects from the algaecide and aquatic herbicide applications;

10.4. Discussion on planning and coordination with nearby farmers and agencies with water rights diversion so that beneficial uses of the water (irrigation, drinking water supply, domestic stock water, etc.) are not impacted during the treatment period; and

10.5. A description of measures that will be used for preventing fish kill when algaecides and aquatic herbicides will be used for algae and aquatic weed controls.

11. Examination of Possible Alternatives. Dischargers should examine the alternatives to algaecide and aquatic herbicide use to reduce the need for applying algaecides and herbicides. Such methods include:

    11.1. Evaluating the following management options, in which the impact to water quality, impact to non-target organisms including plants, algaecide and aquatic herbicide resistance, feasibility, and cost effectiveness should be considered:

        11.1.1. No action;

        11.1.2. Prevention;

        11.1.3. Mechanical or physical methods;

        11.1.4. Cultural methods;

        11.1.5. Biological control agents; and

        11.1.6. Algaecides and aquatic herbicides;

        If there are no alternatives to algaecides and aquatic herbicides, Dischargers shall use the minimum amount of algaecides and aquatic herbicides that is necessary to have an effective control program and is consistent with the algaecide and aquatic herbicide product label requirements.

    11.2. Using the least intrusive method of algaecide and aquatic herbicide application; and

    11.3. Applying a decision matrix concept to the choice of the most appropriate formulation.

This APAP is organized to address the aforementioned 1 through 11 elements.

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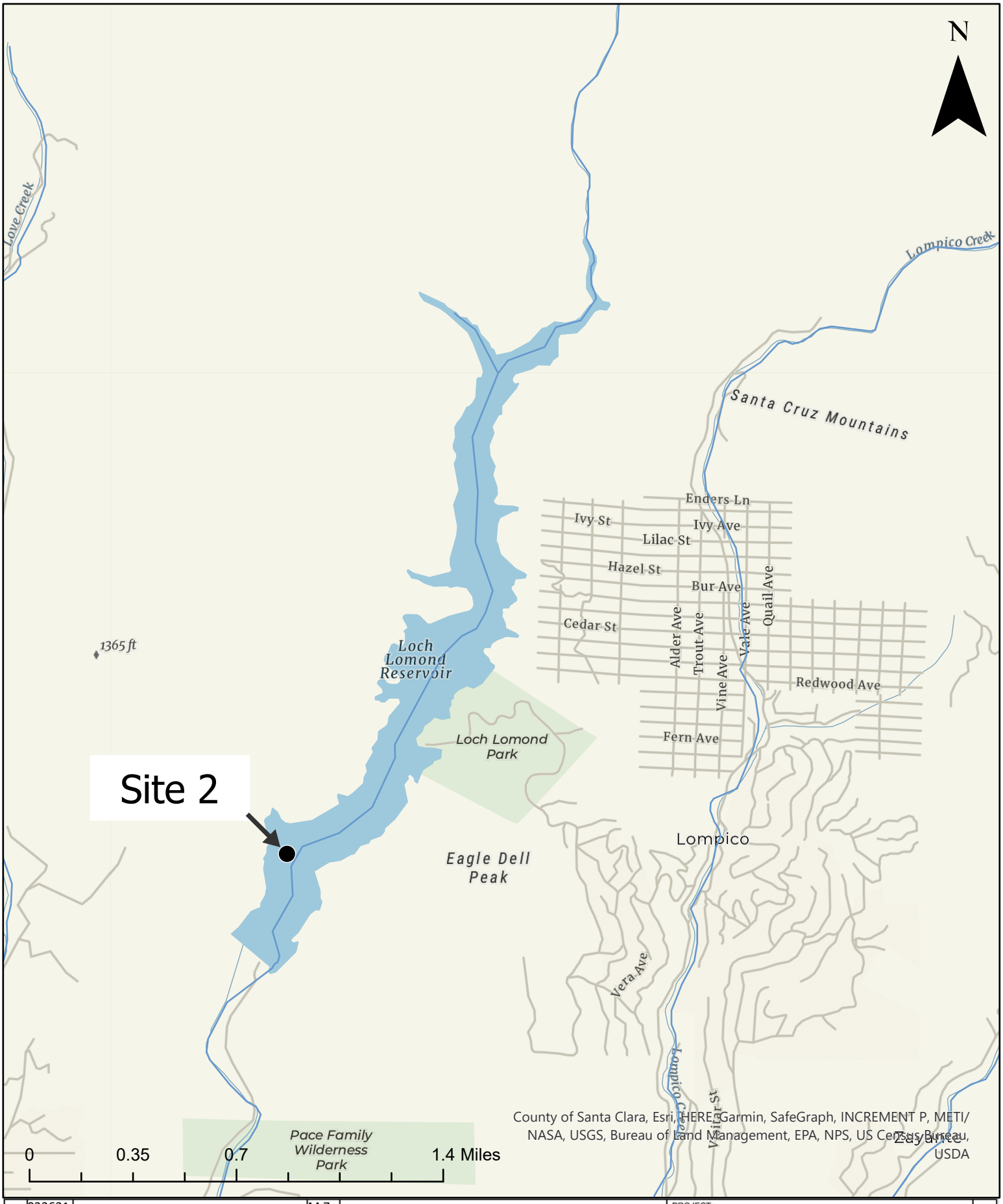
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PROJECT: City of Santa Cruz APAP

FIGURE: 1

DESCRIPTION: Project Location Map

DATE: Mar. 26, 2021



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FIGURE: 2

DESCRIPTION: Project Detail Map

DATE: Mar. 26, 2021

Element 1: Description of the Water System

The City owns, operates, and maintains Loch Lomond, a reservoir that supplies drinking water to the City of Santa Cruz. Loch Lomond is an impoundment of Newell Creek with a surface area of approximately 175 acres. Water flows into Loch Lomond from the surrounding watershed or is diverted from the San Lorenzo River and pumped into the reservoir via the Newell Creek Pipeline. Inflows fill the reservoir during winter months. During wet years, water may spill over the dam's spillway into Newell Creek; drought years may not result in sufficient rainfall to cause the reservoir to spill. The City delivers a minimum flow of 1 cubic foot per second (CFS) to Newell Creek throughout the year.

The water intake gates allow the City to select the depth from which water will be withdrawn from the reservoir and delivered to the Graham Hill Water Treatment Plant or released downstream to Newell Creek to meet the 1 CFS flow requirement. Maximum water surface elevation in the reservoir is 577.5 feet above mean sea level (AMSL). Intake depths are at 550 feet, 530 feet, 510 feet, 490 feet and 470 feet AMSL. The intake gates on the dam allow the City to take advantage of differences in water quality due to stratification and variable lake elevations. The intake depth used for water going to the treatment plant or downstream to Newell Creek is typically selected to maximize water quality going to the treatment plant and maintain cold water temperature in Newell Creek for native fish species. If the taste and odor issues are localized within a stratum of the reservoir, the City may be able to selectively withdraw water from a depth of the reservoir that is less impacted.

Refer to **Figure 1** and **Figure 2**.

Element 2: Description of the Treatment Area

The City may apply algaecides to Loch Lomond if treatment thresholds are met.

Element 3: Description of Weeds and Algae

Nuisance algae found in the reservoir include, but are not limited to: *Aphanizomenon*, *Anabaena, Woronichina, Dolichospermum*, *Lyngbya*, *Microcystis*, and *Oscillatoria*. The City routinely monitors for the types of algae present in the reservoir. Of the algae identified, some may produce MIB and geosmin, which are taste and odor causing compounds. The City may receive complaints of nuisance tastes and odors if blooms are not addressed early in growth cycle. Additionally, certain genus and species of algae identified in Loch Lomond have been known to produce toxins under some environmental conditions or in response to stressors.

The presence of algae in Loch Lomond may reduce water quality, create nuisance tastes and odors, and adversely impact drinking water treatment facilities.

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Element 4: Algaecides and Aquatic Herbicides Used, Known Degradation Byproducts, Application Methods and Adjuvants

Table 1 summarizes the algaecides that may be used by the City.

Table 1: Algaecides That May be Used

Herbicide	Application Method(s)	Adjuvant	Degradation Byproducts
Copper – Chelated	Handgun, boom sprayer, injection	As Needed	None, persists as various speciations of copper[1]
Copper Sulfate	Slug application, spreader, or via submersed burlap sack	Not Applicable	None, persists as various speciations of copper[1]
Hydrogen Peroxide[2]	Handgun, boom sprayer, injection	As Needed	O_2, H_2O
Peroxyacetic Acid	Handgun, boom sprayer, injection	As Needed	CO_2, O_2, H_2O
Sodium Carbonate Peroxyhydrate	Handgun, boom sprayer (liquid), or spreader (granules)	Not Applicable	CO_2, O_2, H_2O

[1] - USEPA 2009
[2] - Hydrogen Dioxide is a synonym for Hydrogen Peroxide and shares the same CAS number (CAS No. 772-84-1).

Historically, the City has not used adjuvants. As additional research on improved efficacy from use of aquatic-labeled adjuvants is published, the City may elect to use a penetrant to enhance algae control.

Algaecides may be applied to the reservoir using methods that target shallow littoral zones along shorelines, and/or the water column throughout the reservoir where, depending on where cyanobacteria are observed. An effective approach to treat algae blooms in Loch Lomond has been to apply algaecide throughout the surface area of the lake accessible by application boats, targeting the upper 10, 15, or 20 feet of the water column. Factors that influence the depth that will be treated include algae density, stage in bloom cycle, presence of known or suspected toxin producing algae, time of year, water temperature, wind, and thermal stratification of the reservoir.

All algaecide applications are made in accordance with the product label. For example, an application of liquid copper to Loch Lomond may be made by lowering weighted drop hoses into the water column and delivering a known amount of product to the application area to achieve the target concentration.

Element 5: Discussion of Factors Influencing Herbicide Use

Treatment of algae in Loch Lomond by the City is guided by the application of IPM. The IPM program and policy were recently reviewed and revised, and staff are familiar with the City's Pesticide Use Policy. One of the primary operational goals of the IPM program is to establish a general and reasonable set of control measures that not only aid in managing algae populations, but also address public health & safety, economic, legal, regulatory, and aesthetic requirements. An action threshold level is the point at which action should be taken to control algae before the water treatment plant's ability to produce high quality drinking water is significantly impacted; moreover, established action threshold levels may change based

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on public expectations. A central feature of IPM is to determine when control action is absolutely necessary and when it is not. The presence of some algae in the reservoir may be a sign of a well-balanced, flourishing ecosystem. City staff regularly conducts site scouting of the reservoir through water quality monitoring and evaluating algae populations throughout the year. Analytes and trends monitored related to algae treatment thresholds include temperature and dissolved oxygen, pH, turbidity, algae quantification and identification, chlorophyll-*a* and secchi depth.

Examples of when or how thresholds are met are when algae causes complaints of taste and odor issues in drinking water, potential toxins that could enter drinking water or expose reservoir users, or creates a nuisance to the public. Typical challenges associated with algae blooms are adverse impacts to water quality and nuisance tastes and odors.

If the population of algae in Loch Lomond equals or exceeds a threshold, a control method is implemented. Control methods considered include mechanical, cultural controls, biological, and/or chemical, consistent with the City's IPM techniques. Algaecide use may or may not be employed as a last resort control method and is considered a critical part of the IPM program. For algal blooms that are in progress and have exceeded a threshold, algaecides offer the most effective control.

Alternatively, the City's monitoring may indicate that algae populations are stable or naturally declining; in this case, no action would be taken. The City is not interested in stopping all algal growth or blooms, rather the focus is on preventing the production of taste and odor compounds, and algal toxins. The presence of non-problem algae may be beneficial as they are likely occupying an overlapping niche and directly competing with the problem algae species.

Algaecide application may also be made prior to threshold exceedance. For example, based on City's staff knowledge and observation of ambient quality conditions (e.g., nutrients, warming epilimnion, etc.) or algal density and predicted growth rate. The identification of some species of algae may reasonably be predicted to cause future problems. Accordingly, algae may be treated soon after detection and observation of significant increase in population numbers. Even though algae may not be an immediate problem at this phase, treating them before the bloom enters an exponential growth phase prevents their populations from reaching densities where adverse effects, like the production of MIB, geosmin or toxin would occur. An additional benefit from the application of IPM is that the total amount of algaecide needed is reduced. Generally, treating algae earlier in the growth cycle results in fewer controls needed and less total herbicide used. Selection of appropriate algaecide(s), adjuvant and rate of application is done based on the identification of the algae, its growth stage and the inclusion of that type of algae on the product label.

The selection of and decision to use an algaecide is based on the recommendation of a DPR-licensed Pest Control Adviser (PCA). The PCA considers a variety of control options that may include mechanical and/or cultural techniques that alone or in combination with algaecide use are the most efficacious and protective of the environment.

Evaluating alternative control techniques is part of the City's IPM approach; therefore, an alternative treatment may be selected. If appropriate, the City may elect to test new approaches as part of a test or pilot program. Examples of alternative control techniques include mechanical removal, and prevention of nutrient loading. A more detailed description of each of these is presented in **Element 10** and **Element 11** of this document. In general, alternative control techniques are more expensive, labor intensive, and less effective; however, they may be implemented as feasible.

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Element 6: Gates and Control Structures

Loch Lomond is an impoundment of Newell Creek formed by Newell Creek Dam. The dam has a fixed elevation spillway that can discharge water from Loch Lomond. The City has an array of intake gates on the dam used to bring water to the water treatment plant or for releases downstream to Newell Creek. The intake gates are at depths of 550 feet, 530 feet, 510 feet, 490 feet and 470 feet AMSL. On-going capital improvement projects at the reservoir include replacement and enhancement of the City's ability to draw water from specific elevations within the reservoir. This project is expected to be complete sometime in 2021-2022. The gates are subject to routine inspection, testing and maintenance to meet regulatory safety requirements.

The City uses Aquatic Herbicide Application Logs, as seen in **Figure 3**, to document conditions prior to and during applications of algaecides.

Element 7: State Implementation Policy (SIP) Section 5.3 Exception

The City has applied for and been granted a SIP Section 5.3 Exception for the use of copper. The City's exception period for applications of copper-containing algaecides is from April through September. These may be used on an as-needed basis during the exception period to control algae with the goal of minimizing taste and odor issues, and reducing impact of algal toxins in drinking water resulting from the presence of nuisance algae or aquatic vegetation in the City's reservoir.

The City does not anticipate using copper-containing products outside of the exception period.

Consistent with SIP exception requirements, after completion of copper applications for the year, a qualified biologist certifies that beneficial uses of receiving waters have been restored.

Element 8: Description of Monitoring Program

Attachment C of the Permit presents the Monitoring and Reporting Program (MRP). The MRP addresses two key questions:

> Question No. 1: Does the discharge of residual algaecides and aquatic herbicides cause an exceedance of the receiving water limitations?
>
> Question No. 2: Does the discharge of residual algaecides and aquatic herbicides, including active ingredients, inert ingredients, and degradation byproducts, in any combination cause or contribute to an exceedance of the "no toxics in toxic amount" narrative toxicity objective?

Attachment C of the Permit provides MRP guidelines that the City will use to meet the aforementioned goals.

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Figure 3: Aquatic Herbicide Application Log

CLEAN LAKES, INC.

AQUATIC WEED CONTROL
NPDES AQUATIC PESTICIDE APPLICATION LOG

Date of Application:	**Location:**		**App. Start Time:** **App. Stop Time:**	
Applicator Name:		**APAP Certification:**		
Discharge Gates or Control Structures				
Name	**Date Closed**	**Time Closed**	**Date Opened**	**Time Opened**
1.				
Calculations to Determine Opening and Closures:				

Application Details					
Plot Number	**Area (ac. or sq. ft.)**	**Average Depth**	**Product**	**Product Quantity**	**Concentration or Rate**

Figure 4: Aquatic Herbicide Field Monitoring & Sampling Form

City of Santa Cruz Water Quality Laboratory

CALIFORNIA WATER BOARDS State Water Resources Control Board, ELAP Cert. No. 1875
NPDES/APAP Aquatic Herbicide Field Monitoring & Sampling Form

DE:	NPDES/ APAP
AV:	
SV:	

Sample Type:	☐ Background	☐ Event Monitoring	☐ Post-Event Monitoring	**Date of Application:**	**Weather:**
Login Record File:				**Herbicide Applied:**	
				Event #:	

Date Collected/Rec'd	**Time Rec'd**	**Sampler**	**Location/GPS Coordinates**	**Thermometer ID/Cal.Date/ Correction Factor (°C)**

DO Meter *(select one)*	☐ **YSI 550A SN:**	
	☐ **YSI ProSolo ODO SN:**	*(Perform required Barometric Conversion below for instrument calibration)*
	Station Pressure: _____ inHg x 25.4= True Barometric Pressure: _____ mmHg per inHg	

Field Observations		
Location Conditions (*Please give a brief description if condition is present)*		
Condition	**Absent**	**Present**
Water flowing		
Floating or suspended matter		
Discoloration		
Bottom Deposits		
Aquatic Life		
Visible films, sheens, or coatings		
Fungi, slimes or objectionable growths		
Potential nuisance conditions		
Comments:		

Water Quality Samples Collected *(Please circle)*			
Dissolved Copper	General Physical	Hardness	Other:

Water Quality Characteristics

		Field Analysis		Date Analyzed:						
				Analyst(s):						
Standard Methods Reference		SM2550B		SM4500-H^+ B	SM2510B	SM2130B	SM2340C	SM2320B	SM2120B	SM2150B
TIME	**LOCATION**	**Temp (°C)**	**DO (mg/L)**	**pH (S.U.)**	**COND (µS/cm)**	**TURB (NTU)**	**HARD (mg/L)**	**ALK (mg/L)**	**COLOR (CU)**	**ODOR (TON)**

Chem Analyst Review:

Figure 4: Aquatic Herbicide Field Monitoring & Sampling Form

City of Santa Cruz Water Quality Laboratory

CALIFORNIA WATER BOARDS State Water Resources Control Board, ELAP Cert. No. 1875
NPDES/APAP Aquatic Herbicide Field Monitoring & Sampling Form

DE:	NPDES/ APAP
AV:	
SV:	

Definitions
Floating or suspended matter: Presence of floating and/or suspended material in concentrations that cause nuisance or adversely affect beneficial uses.
Discoloration: Presence of coloration that causes nuisance or adversely affects beneficial uses.
Bottom Deposits: Presence of bottom deposits in amounts that cause nuisance or adversely affect beneficial uses.
Aquatic Life: Presence of aquatic communities and populations, including vertebrates, invertebrates, and non-target plant species to be degraded.
Visible films, sheens, or coatings: Presence of oils, greases, waxes, or other materials in concentrations that result in a visible film or coating on the surface of the water or on objects in the water that cause nuisance, or that otherwise adversely affect beneficial uses.
Fungi, slimes or objectionable growths: Presence of fungi, slimes, or objectionable growth in concentrations that cause nuisance or otherwise adversely affect beneficial uses.
Potential nuisance conditions: Presence of an observed condition not listed (e.g. odor) that can potentially adversely affect beneficial uses.

8.2 Monitoring Locations and Frequency

For application of copper-containing algaecides or aquatic herbicides, the City will collect samples from a minimum of six application events for each active ingredient in each environmental setting per year. If there are less than six application events in a year for an active ingredient, the City will collect samples for each application event in each environmental setting (e.g., flowing water and non-flowing water).

Water quality sampling is required for applications of products that contain sodium carbonate peroxyhydrate, peroxyacetic acid, and/or hydrogen peroxide, however, no chemical analysis for the hydrogen peroxide class of active ingredients is needed. If applications of sodium carbonate peroxyhydrate, peroxyacetic acid, and/or hydrogen peroxide are made, the City will collect samples and complete sampling forms consistent with permit requirements. Samples will be analyzed for field parameters including pH, dissolved oxygen, temperature, turbidity and electrical conductivity.

If the results from six consecutive sampling events show concentrations that are less than the applicable receiving water limitation/trigger in an environmental setting, the City will reduce the sampling frequency for that active ingredient to one per year in that environmental setting (e.g., in the non-flowing water setting of Loch Lomond). If the annual sampling shows exceedances of the applicable receiving water limitation/trigger, the City will be required to return to sampling six applications the next year, and until sampling may be reduced again.

The City generally makes applications to treat pervasive planktonic algae blooms where the entire lake is the treatment area. Background and Post-Event monitoring samples are collected from the location identified as “Site 2” on **Figure 2**. After application, no treated water is expected to be discharged from the lake. No water is expected to be spilling over the spillway to Newell Creek, and water discharged from the fish release is below the thermocline, therefore the algaecide treated water should not leave the lake. As such, downstream receiving water samples, referred to as Event monitoring samples, may not be required.

If a partial lake application is made, sites will be chosen to represent the variations in treatment that occur, including algaecide or aquatic herbicide use, hydrology, and environmental setting, location of application, wind influence, water movement within the reservoir, and seasonal variations. The exact location(s) of sample site(s) will be determined after site scouting and a decision to make an aquatic herbicide application are made. **Figure 3** is the form used to document sampling.

8.2.1 Sample Locations

Sampling will include Background, Event, and Post-event monitoring as follows:

Background Monitoring: In static water, the background (BG) sample is collected in the treatment area, within 24 hours prior to the start of the application.

Event Monitoring: The Event sample for **non-flowing (static)** water is collected immediately outside the treatment area immediately after the application event, but after sufficient time has elapsed such that treated water would have exited the treatment area.

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The location and timing for the collection of the Event sample may be based on a number of factors including, but not limited to algae and aquatic weed density and type, flow rates, size of the treatment area and duration of treatment.

Post-event Monitoring: The post-event monitoring (Post) sample is collected within the treatment area within one week after the application, or when the treatment is deemed complete.

One full set of three samples (e.g., BG, Event and Post) will be collected during each treatment from the representative site(s) treated within the City according to the monitoring frequency and locations described earlier.

The Background and Post-Event Monitoring samples during a full lake treatment are anticipated to be collected from Site 2, located at approximately 37.10642°, -122.07142°.

See **Figure 3** for the field sampling form used.

8.3 Sample Collection

If the water depth is 6 feet or greater, the sample will be collected at a depth of 3 feet. If the water depth is less than 6 feet, the sample will be collected at the approximate mid-depth. As necessary, an intermediary sampling device (e.g., Van Dorn-style sampler or long-handled sampling pole) will be used. Sample scoopers are used to collect samples at the approximate desired sampling depth and used to fill clean sample bottles. Appropriate cleaning technique is discussed in Section 8.8.4.

8.4 Field Measurements

In conjunction with sample collection, temperature and dissolved oxygen will be measured in the field. Turbidity, electrical conductivity, and pH, are analyzed in the laboratory. Turbidity, pH, and conductivity meters are calibrated according to manufacturer's specifications and according to the City of Santa Cruz Water Quality Laboratory Quality Assurance Manual and Standard Operating Procedures. Meters undergo maintenance and/or calibration at the recommended frequency, and checked with a secondary standard prior to each use. Quarterly, dissolved oxygen meters are verified against a Winkler titration to demonstrate accuracy. Calibration and/or maintenance logs are maintained for all instruments.

8.5 Sample Preservation and Transportation

Samples may be collected directly into preserved containers, or collected in unpreserved containers, and preserved at the laboratory upon receipt if the analytical method requires preservation. Once a sample is collected and labeled it will immediately be placed in a dark, cold (~4° C) environment, typically a cooler with ice. Samples will be delivered to the laboratory as soon as practicable after sample collection.

8.6 Sample Analysis

Table 2 shows the constituents that each sample must be analyzed for.

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Table 2: Required Sample Analysis

Analyte	Method of Analysis	Reporting Limit	Hold Time (Days)	Container	Chemical Preservative
Temperature[1]	N/A	N/A	N/A	N/A	N/A
Dissolved Oxygen[1]	ASTM D888-09 (C)	N/A	1	N/A	N/A
Turbidity[2]	SM2130B	N/A	2	500/1000 mL HDPE	None
Electrical Conductivity[2]	SM2510B	N/A	28	500/1000 mL HDPE	None
pH[2]	SM4500-H+B	1-14	15 Minutes	500/1000 mL HDPE	None
Hardness[3]	SM2340C	4 mg $CaCO_3$/L	1 Day if unpreserved; 180 Days if preserved	250 mL HDPE	HNO_3
*Copper (dissolved)[3,4]	200.8	2.0 µg/L	1 Day if unpreserved; 180 Days if preserved	250 mL HDPE	HNO_3

Notes:
* Signifies algaecide or aquatic herbicide active ingredient. Chemical analysis is only required for the active ingredient(s) used in treatment.
Active ingredient analysis not required for algaecides and aquatic herbicides containing sodium carbonate peroxyhydrate, peroxyacetic acid, and/or hydrogen peroxide; field parameters must be measured and reported.
[1]Field measured.
[2]May be field or laboratory measured.
[3]Required for copper applications only.
[4]Per EPA 200.8, samples for dissolved copper should be filtered with a 0.45µm filter at the time of collection or as soon thereafter as practically possible.

8.7 Reporting Procedures

An annual report for each reporting period, from January 1 to December 31 will be prepared by March 1 of the following year and will be submitted to the Central Coast RWQCB and SWRCB. In years when no algaecides or aquatic herbicides are used, a letter stating no applications will be sent to the Central Coast RWQCB and SWRCB in lieu of an annual report.

The annual report will contain the following information as described in Attachment C of the Permit:

1. An Executive Summary discussing compliance or violation of the Permit and the effectiveness of the APAP; and
2. A summary of monitoring data, including the identification of water quality improvements or degradation as a result of algaecide or aquatic herbicide application.

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The City will collect and retain all information on the previous reporting year. When requested by the Deputy Director or Executive Officer of the Central Coast RWQCB, the City will submit the annual information collected, including:

1. An Executive Summary discussing compliance or violation of the Permit and the effectiveness of the APAP to reduce or prevent the discharge of pollutants associated with herbicide applications;
2. A summary of monitoring data, including the identification of water quality improvements or degradation as a result of algaecide or aquatic herbicide application, if appropriate, and recommendations for improvement to the APAP (including proposed BMPs) and monitoring program based on the monitoring results. All receiving water monitoring data shall be compared to applicable receiving water limitations and receiving water monitoring triggers;
3. Identification of BMPs and a discussion of their effectiveness in meeting the Permit requirements;
4. A discussion of BMP modifications addressing violations of the Permit;
5. A map showing the location of each treatment area;
6. Types and amounts of aquatic herbicides used at each application event during each application
7. Information on surface area and/or volume of treatment area and any other information used to calculate dosage, concentration, and quantity of each aquatic herbicide used;
8. Sampling results shall indicate the name of the sampling agency or organization, detailed sampling location information (including latitude and longitude or township/range/section if available), detailed map or description of each sampling area (address, cross roads, etc.), collection date, name of constituent/parameter and its concentration detected, minimum levels, method detection limits for each constituent analysis, name or description of water body sampled, and a comparison with applicable water quality standards, description of analytical QA/quality control plan. Sampling results shall be tabulated so that they are readily discernible; and
9. Summary of Aquatic Herbicide Application Logs (AHALs, **Figure 2**).

The City will report to the Central Coast RWQCB and SWRCB any noncompliance, including any unexpected or unintended effect of an algaecide or aquatic herbicide that may endanger health or the environment. The Twenty-Four Hour Report will be provided orally, by way of a phone call, to the SWRCB and Central Coast RWQCB within 24 hours from the time the City becomes aware of any noncompliance. The Twenty-Four Hour Report will include the following information:

1. The caller's name and telephone number;
2. Applicator name and mailing address;
3. Waste Discharge Identification (WDID) number;
4. How and when the City became aware of the noncompliance;
5. Description of the location of the noncompliance;
6. Description of the noncompliance identified and the USEPA pesticide registration number for each product the City or its contractor applied in the area of the noncompliance; and
7. Description of the steps that the City has taken or will take to correct, repair, remedy, cleanup, or otherwise address any adverse effects.

If the City is unable to notify the RWQCB and SWRCB within 24 hours, the City will do so as soon as possible and provide a rationale for why the City was unable to provide notification of noncompliance within 24 hours.

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In addition to the Twenty-Four Hour Report, the City will provide a written submission within five (5) days of the time the City becomes aware of the noncompliance if not waived by the RWRCB or SWRCB. The Five-Day Written Report will contain the following information:

1. Date and time the City contacted the State Water Board and the appropriate Regional Water Board notifying of the noncompliance and any instructions received from the State and/or Regional Water Board; information required to be provided in Section D.1 (24-Hour Reporting);
2. A description of the noncompliance and its cause, including exact date and time and species affected, estimated number of individual and approximate size of dead or distressed organisms (other than the pests to be eliminated);
3. Location of incident, including the names of any waters affected and appearance of those waters (sheen, color, clarity, etc.);
4. Magnitude and scope of the affected area (e.g. aquatic square area or total stream distance affected);
5. Algaecide and aquatic herbicide application rate, intended use site (e.g., banks, above, or direct to water), method of application, and name of algaecide and herbicide product, description of algaecide and herbicide ingredients, and U.S. EPA registration number;
6. Description of the habitat and the circumstances under which the noncompliance activity occurred (including any available ambient water data for aquatic algaecides and aquatic herbicides applied);
7. Laboratory tests performed, if any, and timing of tests. Provide a summary of the test results within five days after they become available;
8. If applicable, explain why the City believes the noncompliance could not have been caused by exposure to the algaecides or aquatic herbicides from the application; and
9. Actions to be taken to prevent recurrence of adverse incidents.

The Five-Day Written Report will be submitted within five (5) days of the time the City becomes aware of the noncompliance unless SWRCB staff or RWQCB staff waive the above described report if an oral report has been received within 24 hours.

8.8 Sampling Methods and Guidelines

The purpose of this section is to present methods and guidelines for the collection and analysis of samples necessary to meet the APAP objective of assessing adverse impacts, if any, to beneficial uses of water bodies treated with algaecides and aquatic herbicides.

This section describes the techniques, equipment, analytical methods, and quality assurance and quality control procedures for sample collection and analysis. Guidance for the preparation of this chapter included: NPDES Storm Water Sampling Guidance Document (USEPA 1992); Guidelines and Specifications for Preparing Quality Assurance Project Plans (USEPA 1980); Standard Methods for the Examination of Water and Wastewater, 22nd Edition (APHA 2012); and U.S. Geological Survey, National Field Manual for the Collection of Water Quality Data (USGS 1995).

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8.8.1 Sampling Techniques

City staff conduct routine monitoring consistent with the City of Santa Cruz Water Quality Laboratory Standard Operating Procedures (SOP) for all water quality monitoring conducted at Loch Lomond. The SOP is updated regularly to reflect new methods or techniques. As discussed in Section 8.3, if the water depth is 6 feet or greater the sample will be collected at a depth of 3 feet, if the water depth is less than 6 feet the sample will be collected at the approximate mid-depth. As necessary, an intermediary sampling device (e.g., Van Dorn-style sampler, sample scooper or long-handled sampling pole) will be used for locations that are difficult to access. Appropriate cleaning technique is discussed in Section 8.8.4.

During collection, the samples will be collected in a manner that minimizes the amount of suspended sediment and debris in the sample. Samples will be collected directly by the sample container or by an intermediary container in the event that the sample container cannot be adequately or safely used. Intermediary samplers will be polyethylene (plastic/HDPE), stainless steel or glass. Any container that will be reused between sites will be triple rinsed before collection of the next sample, see Section 8.8.4. Alternatively, disposable poly or glass intermediary sample containers can be used.

8.8.2 Sample Containers

Clean, empty sample containers with caps will be transported in ice chests. The containers will be certified clean by either the laboratory or the container supplier. To ensure data quality control, the sampler will utilize the appropriate sample container as specified by the laboratory for each sample type. Sample container type, holding time, and appropriate preservatives are listed in **Table 2**. Each container will be affixed with a label indicating a discrete sample number for each sample location.

8.8.3 Sample Preservation and Filtering

Samples may either be collected with bottles containing the correct preservative(s), or collected in unpreserved bottles and preserved upon receipt at the analytical lab. If filtration is required, it must be done prior to sample preservation. After collection, samples will be stored in a cooler with ice and transported to the analytical laboratory. Once at the laboratory samples will be analyzed or refrigerated at ≤ six (6) degrees Celsius. Samples requiring filtration (dissolved copper) are sent over night to a subcontracting laboratory for filtration and preservation. Refer to **Table 2** for details on method bottle requirements, filtration and hold times.

8.8.4 Sampling Equipment Cleaning

The City typically conducts water quality monitoring at multiple locations in Loch Lomond before, during and after application. Field parameter meters and sample collection equipment (e.g., Van Dorn-sampler) will be triple-rinsed with distilled water, and then rinsed once with the water being sampled prior to its first use at a new sample collection location.

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8.8.5 Sample Packing and Shipping

In general, pH, electrical conductivity and hardness will be analyzed in the City's Water Quality Laboratory (WQL) California Environmental Laboratory accreditation Program (CA-ELAP) Certificate # 1875. Dissolved copper samples will be analyzed by a CA-ELAP accredited subcontracting laboratory. All samples to be shipped or delivered to a subcontracting laboratory are to be packed and transported as soon as possible after collection to provide ample time for samples to be prepared and analyzed within the required holding time.

Ice will be included in coolers containing samples that require temperature control. Samples will be packaged for transport in the following manner:

1. Sample container labels will be checked for secure attachment to each sample container.
2. The sample containers will be placed in the cooler. If shipping glass bottles, place bubble-wrap, between sample containers to protect the sample containers from breakage during shipment and handling.
3. The Chain of Custody (COC) will be placed inside a plastic bag and placed inside the cooler. The COC will be filled out consistent with Section 8.9.4 with unique sample name, time and location, the sample collector, matrix type, the required analysis, number of containers, turn-around-time, and person(s) to which data will be reported.
4. The cooler will then be readied for pick-up by a courier.

8.9 Field Sampling Operations

8.9.1 Field Logbook

Datasheets/field forms must be maintained by to provide a record of sample location, significant events, observations, and measurements taken during sampling. Sample records are intended to provide sufficient data and observations to enable project team members to reconstruct events that occurred during the sampling and must be legible, factual, detailed, and objective. As appropriate and at the discretion of City staff, observations and measurements can be supplemented with pictures of site conditions at the time of sampling.

When recording observations in the field book, the sampling team will note the presence or absence of:

1. Floating or suspended matter;
2. Discoloration;
3. Bottom deposits;
4. Aquatic life;
5. Visible films, sheens, or coatings;
6. Fungi, slimes, or objectionable growths; and
7. Potential nuisance conditions.

See **Figure 4** for the forms to be used to record relevant field data when sampling.

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8.9.2 Alteration of Sampling Techniques

It is possible that actual field conditions may require a modification of the procedures outlined herein. Specifically, water levels, weather, other environmental parameters and/or safety hazards including stream flow in Newell Creek, rainfall, and potential presence of cyanotoxins may pose challenges to completion of monitoring. In such instances, variations from standard procedures and planned sampling locations and frequencies will be documented by means of appropriate entry onto the datasheets/field forms.

8.9.3 Flow Estimation

Flow estimation is generally not applicable to sampling in Loch Lomond. If required due to site conditions or for sampling that may need to be conducted in Newell Creek, the City will collect flow estimation measurements. City staff can retrieve discharge data and determine flows to and within the creek. If necessary, a flow meter calibrated according to the manufacturer's directions may be placed as close to the center of the creek or waterbody as possible and a reading taken in feet per second (ft/sec). Alternatively, a common floating object (ball, branch, leaf, etc.) may be placed as close to the center of the conveyance as possible and the time it travels a known distance will be estimated and represented in ft/sec. A minimum travel distance of approximately 25 feet or a travel time of up to 30 seconds will be used.

8.9.4 Chain-of-Custody (COC)

The COC record will be employed as physical evidence of sample custody. The sampler will complete a COC record to accompany each sample from the field to the laboratory. The COC will specify: time, date, location of sample collection, container type and total number, requested analysis, sampler name, required turn-around-time (if applicable), time and date of sample transaction between field and laboratory staff, preservative and filtration, if any, and name of receiving party at the laboratory.

Corrections to the COC will be made by drawing a line through, initialing, and dating the error, indicating the reason and entering the correct information. Erasures are not permitted.

Upon receipt of the samples, laboratory personnel will check to confirm that there is evidence of cooling and upon verification of the number and type of samples and the requested analysis, a laboratory representative will sign the COC, indicating receipt of the samples.

Upon sample delivery, the original copy will be left with the laboratory and a copy will be kept by the sampler, three-hole punched, and placed in the field logbook.

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8.9.5 Sample Label

The label will contain information on the specific project (e.g., City of Santa Cruz), the unique individual sample ID, the location (e.g., Loch Lomond Site #2 3' – BG), and the date and time the sample was collected.

Prior to sampling, a waterproof label will be filled out completely with indelible ink and will be affixed to the appropriate container.

8.9.6 Corrections to Documentation

Documents will not be destroyed or thrown away, even if they are illegible or contain inaccuracies that require a replacement or correction. If an error is made on a document used by an individual, that individual will make corrections by making a line through the error, date, initial and give reason for error and entering the correct information. The erroneous information will not be obliterated.

8.9.7 Document Control

A central file location will be established and used to store documentation such as the filed logbook and laboratory data. Staff tasked with monitoring or other Permit-related compliance work will familiarize themselves with the field forms, logbook and location of relevant documents like calibration logs and monitoring SOPs.

8.9.8 Sample Kit

Prior to departing to the field to collect samples, the following equipment will be prepared for use:

- Laboratory-supplied sampling bottles (one set for each sample to be collected plus spares, plus QA/QC samples, if applicable)
- Sample labels (one for each sample to be collected plus spares)
- Sharpie-type pen or other permanent, waterproof ink marker (indelible ink)
- Chain of Custody forms
- Dissolved Oxygen Meter
- Field logbook with field forms
- Deionized or distilled water
- blue ice packs
- Cooler for samples
- Intermediary sampling device (e.g., Van Dorn or sample scooper)
- Latex or nitrile gloves
- Rubber boots
- Camera/Smartphone

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8.10 Quality Assurance and Quality Control (QA/QC)

The purpose of quality assurance and quality control (QA/QC) is to assure and control the quality of data generated during sample collection and analysis as described earlier in this document. Quality assurance and quality control are measured in a variety of ways, as described below.

Refer to the City of Santa Cruz Water Quality Laboratory Quality Assurance Manual and method-specific standard operating procedures. The QA/QC manual contains detailed quality control parameters followed by City staff.

8.10.1 Data Reporting

The results of sampling and analysis will be summarized in the Annual Report. The data will be tabulated so that they are readily discernible.

Element 9: Procedures to Prevent Sample Contamination

Sample collection will not be done in close proximity to application equipment and preferably upwind. Sampling will be done in a manner that prevents contact with algaecide application equipment, containers, or personal protective equipment (PPE). Care will be taken by samplers to minimize contact with any treated water, vegetation, or application equipment.

In the event that sampling equipment will be used in more than one location, the equipment will be thoroughly cleaned, triple-rinsed uncontaminated water, and then rinsed once with the water being sampled prior to its first use at a new sample collection location, as described in Section 8.8.4. Gloves will be changed between sites.

Element 10: Description of BMPs

The City employs the following BMPs to ensure the safe, efficient and efficacious use of algaecides and aquatic herbicides.

10.1 Measures to Prevent Spills and Spill Containment in the Event of a Spill

Applicators take care when mixing and loading algaecides and adjuvants. All label language is followed to ensure safe handling and loading of algaecides. Application equipment is regularly checked and maintained to identify and minimize the likelihood of leaks developing or failure that would lead to a spill. Applications to Loch Lomond are made using boats; mixing and loading occurs at the boat launch with closed system when possible and if compatible with the product being applied. Spill and cleanup equipment will be kept in good working order and readily available at the mixing and loading site.

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If algaecides are spilled, they will be prevented from entering any waterbodies to the extent practicable. City and application contractor staff are trained to contain any spilled material and are familiar with the use of absorbent materials such as kitty litter, “pigs” and “pillows”. Spills will be cleaned up according to label instructions, and all equipment used to remove spills will be properly contained and disposed of or decontaminated, as appropriate. Applicators will report spills as required by City, county, state or federal policy and in a manner consistent with local, state and federal requirements.

10.2 Measures to Ensure Appropriate Use Rate

The following BMPs help ensure the appropriate algaecide and aquatic herbicide application rate is used.

10.2.1 Site Scouting

Prior to treatment, the City conducts extensive monitoring of water quality and algae in the reservoir. The City’s PCA and/or qualified City staff scout the reservoir to evaluate the extent to which algae thresholds have been exceeded. Thresholds are described in Element 5 and are generally based on complaints of taste and odor issues in drinking water, potential toxins that could enter drinking water or expose reservoir users, or creates a nuisance to the public.

If the reservoir is deemed to have exceeded a threshold, or a given algae population is anticipated to exceed a threshold based on known water quality, algal density, weather conditions, or other information, an algaecide application is considered. If the application can be made without negatively impacting the water quality, then an application is made.

10.2.2 Written Recommendations Prepared by PCA

Prior to application, a PCA licensed by DPR and/or qualified City staff scout the area(s) to be treated, makes a positive identification of pest(s) present, checks applicable product label(s) for control efficacy, and the PCA prepares a written recommendation, including rates of application, and any warnings or conditions that limit the application so that non-target flora and fauna are not adversely impacted. Licensed PCAs must complete 40 hours of continuing education every 2 years to stay licensed, and therefore are up-to-date on the latest techniques for pest control.

10.2.3 Applications Made According to Label

All algaecide applications are made according to the product label in accordance with regulations of the U.S. EPA, CalEPA, Cal OSHA, DPR, and the local Agricultural Commissioner. The City’s PCA and DPR-licensed Qualified Applicator Certificate (QAC) or Qualified Applicator License (QAL) holders regularly monitor updates and amendments to the label so that applications are in accordance with label directions. Licensed QALs and QACs must complete 20 hours of continuing education every 2 years to stay licensed, and therefore are up to date on the latest techniques for pest control.

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10.2.4 Applications Made by Qualified Personnel

As appropriate, consistent with applicable regulations, the City or its application contractor will utilize QALs, QACs or staff under the supervision of QALs or QACs to make applications or supervise applications recommended by the PCA. The City's application contractor has knowledge of proper equipment loading, nozzle selection, calibration, and operation so that spills are minimized, precise application rates are made according to the label, and only target plants are treated.

10.3 The Discharger's plan in educating its staff and herbicide applicators on how to avoid any potential adverse effects from the herbicide applications

See information above on the continuing education requirements of City or application contractor staff responsible for selection and application of algaecides and aquatic herbicides.

10.4 Application Coordination to Minimize Impact of Application on Water Users

At least 15 days prior to the first algaecide application of each year, the City will deliver a notification letter to the Santa Cruz Agricultural Commissioner, the California Department of Fish and Wildlife Bay-Delta Region, the US Fish and Wildlife Service, and the National Marine Fisheries Service. Any other affected public agencies or individuals will be added to the notification letter distribution list as they are identified. If required by the algaecide product label, water users potentially affected by any water use restrictions will be notified prior to an application being made. No farmers receive water directly from any of the potentially treated waterbodies.

10.5 Description of Measures to Prevent Fish Kills

It is important to acknowledge that the use of algaecides, even when used according to label instructions, may result in unavoidable fish kills. Nonetheless, measures will be taken to reduce the likelihood of fish kills as described below. Generally speaking, the concentration of residual algaecides (i.e., the concentration of the algaecide present after the treatment is complete) is not sufficiently high to result in fish kills. Low dissolved oxygen due to decomposition of decaying algae can adversely affect non-target species like fish.

10.5.1 Applications Made According to Label

All algaecide applications are made according to the product label in accordance with regulations of the USEPA, CalEPA, DPR, Cal OSHA and the local Agricultural Commissioner. Precautions on the product label to prevent fish kills will be followed. For example, limitations on the total water volume treated will be followed to prevent dead algae from accumulating and then decaying and subsequently depressing the dissolved oxygen (DO) level. Depressed DO may adversely impact fish populations.

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10.5.2 Written Recommendations Prepared by PCA

Prior to application, a PCA licensed by DPR, City and/or application contractor staff scouts the area to be treated, makes a positive identification of pest(s) present, checks applicable product label(s) for control efficacy, and in collaboration with City staff, the PCA prepares a written recommendation, including rates of application, and any warnings or conditions that limit the application so that fish are not adversely impacted.

10.5.3 Applications Made by Qualified Personnel

As appropriate, consistent with applicable regulations, the City and/or application contractor will utilize QALs, QACs or staff under the supervision of QALs or QACs to make applications or supervise applications recommended by the PCA. The City and/or application contractor have knowledge of proper equipment loading, calibration, and operation so that spills are minimized, precise product use rates are applied according to the label, and appropriate water concentration is achieved to control the target algae being treated.

Element 11: Examination of Possible Alternatives

11.1 Evaluation of Other Management Options

Evaluating alternative control techniques is part of the City's IPM approach and therefore alternative treatment measures are considered as part of the management options for algae control in Loch Lomond. Prior to making the decision to control algae with an algaecide, the City evaluates other available management options. These options are considered based on the impact to water quality, impact to non-targeted organisms like plants, fish or reptiles, potential efficacy, feasibility, and cost effectiveness. In general, alternative control techniques can be expensive, labor intensive, less effective, and cause temporary water quality degradation.

When the population of aquatic weeds equals or exceeds a threshold that could adversely affect drinking water quality or clog filters at treatment plants, management options are evaluated. Possible options that are considered may include additional sampling or investigation of the problem, implementing operational, mechanical, or cultural controls consistent with the City's IPM techniques.

11.1.1 No Action

As feasible, this technique is used. While no control action may be taken at this time, City staff conducts routine monitoring of the reservoir. The regular surveillance of conditions in Loch Lomond allow the City to monitor algae populations and inform decisions regarding thresholds where a control action may be needed. Prior to reaching a threshold, no control is considered.

The City is not interested in stopping all algal growth or blooms, but to focus on preventing the production of taste and odor compounds, or algal toxins. The presence of non-problem algae may be a benefit as they are likely occupying an overlapping niche and directly competing with the problem algae species.

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11.1.2 Prevention

Habitat Modification

Habitat modifying techniques that the City may consider include dredging, oxygenation or aeration, shading with dyes, and water mixing. In areas where sedimentation has significantly impacted the capacity of the water body, dredging can increase the water volume, reduce organic matter generated in the water body, and remove nutrient-containing sediment. Dredging would not provide a substantial benefit to reduced internal nutrient loading. It will be considered in the future for select areas if removal of sediment accumulation may help prevent nutrients available to fuel algal growth.

Aeration, oxygenation and mixing are methods that can mechanically add oxygen directly to the water, and can result in the reduction of nuisance algal growth. Aeration is currently used to reduce anoxia in the hypolimnion of Loch Lomond and provide water movement to discourage algal growth. The current compressor-based aeration system is scheduled to be upgraded to a hypolimnetic oxygenation diffuser system.

Another habitat modification technique that can be considered is shading the water column using non-toxic, inert dyes. The use of dyes works on algae by limiting their ability to photosynthesize when the dye is present but is not a long-term solution and is not typically feasible or applicable to waterbodies like Loch Lomond.

The City installed Solar Bees® in the reservoir to circulate water and reduce algal growth habitat as a trial from 2003 to 2005. The Solar Bees® are intended to prevent the water column from stratifying, increase flow within the lake, and suppress algal blooms. After years of hoping for success, City staff determined that the units were not effective at mitigating algal blooms in Loch Lomond. It was thought that the depth of narrow shape of the reservoir prevented the City from seeing a reduction in algal blooms or populations.

Native Species Establishment

No appropriate native plants or acceptable algae species are available that could be put in Loch Lomond to out-compete nuisance algae for nutrients in the water column without creating similar challenges.

11.1.3 Mechanical or Physical Methods

Mechanical Removal

Mechanical removal of algae in the City's reservoir is not feasible. While floating mats of filamentous algae or submersed aquatic weeds can be removed from the water column using methods like hand-pulling, use of motor-driven aquatic harvesters to pull up and remove vegetation or algal mats, aquatic weed-whacking or mowing, non-matted algae is too small to be controlled by mechanical removal. Mechanical harvesting can be used for minimal removal of algae but is only practical when there is a thick algal scum. Thick algal blooms are not likely in City's reservoir, and if they did occur, the drinking use would likely

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already be impaired. Additionally, this method has only been employed successfully in relatively small water bodies or in coves and embayments. Lastly, mechanical harvesting cannot be used for benthic algae, which are often the source of taste and odor compounds in the reservoir.

Reservoir covers limit algal production by limiting the light that is necessary for algal growth. Covering the City's reservoir with available technology is infeasible for many reasons, including its size and shape, ecosystem services and habitat benefits it provides, and to continue providing recreational opportunities to the community.

Alum, gypsum and lanthanum-modified bentonite have been used in some reservoirs, primarily in the Midwest and East, to limit algal growth by inactivating phosphorus, which is frequently the limiting nutrient. The City studied the use of these chemicals to help limit algal growth in its reservoir, but did not reach conclusive results regarding the effectiveness of either alum or gypsum. The City will continue to evaluate options to sequester nutrients.

Controlled Burns

This option is most suitable for some types of emergent and terrestrial weeds, and is not appropriate for control of algae. Additionally, controlled burns create air quality and significant wildfire concerns given the setting of Loch Lomond.

Grazing

This option is most suitable for emergent and terrestrial weeds, and is not suitable for algae. Impacts to water quality from animal feces, increases in turbidity, nutrients, and bank erosion, and impacts to desirable species make this option infeasible in some cases. The cost of hiring grazing animals is also generally more costly than chemical control alternatives. This option is not a suitable alternative control for algae within the reservoir.

Tilling or Discing

This option is not suitable for the control of aquatic or riparian vegetation because tilling or discing exposes erodible soils. This option is not a suitable alternative control within the reservoir.

Ultrasonic Control

Devices that emit ultrasonic waves at certain frequency to disrupt and/or kill algae cells. The City tested a unit from One SonicSolutions in 2011. The unit was mounted to a boat dock in a cover where algae was growing in the reservoir. The trial showed no significant difference in the test cove compared to other, untested coves. Therefore, the unit was removed after one trial season.

11.1.4 Cultural Methods

Non-herbicide cultural controls the City implements include withdrawing water from reservoir at varying depths at intake structures, or blending reservoir water with alternate water sources until taste and odor

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causing algae are no longer impacting the water. If these strategies are unavailable, an algaecide application may be necessary.

Cultural methods used to reduce the amount of algaecides used include modifying the timing of algaecide and non-chemical controls. The City may make algaecide applications before the density of algae is high enough to require higher algaecide application rates, amounts or additional applications to maintain target algae populations below threshold levels.

11.1.5 Biological Control Agents

There are no known biological control agents that can reliably and effectively control significant algal blooms. The option of introducing herbivorous fish such as triploid grass carp is not permitted by California Department of Fish and Wildlife, and these fish prefer to eat submersed aquatic plants, not algae.

Bio-manipulation utilizes various natural mechanisms that can reduce algae and involves modifying the ratio of prey and predator species present to increase predation on algae in the reservoir. The biological controls are typically done by top-down or bottom-up changes to the food-web structure aimed at increasing populations of algae-consuming zooplankton. Bio-manipulation may be more efficient when used in conjunction with other habitat modification methods. However, this technique is also very difficult to institute and maintain in large reservoirs. Additional challenges with environmental permitting and impacts to special status species make biomanipulation infeasible to implement in Loch Lomond.

11.1.6 Algaecides and Aquatic Herbicides;

After other alternatives have been evaluated, the application of algaecides and aquatic herbicides may be a viable option available in order to prevent an algal bloom from adversely affecting drinking water quality, or creating a nuisance to the public. Applications may be necessary when a population of aquatic weeds equals or exceeds a threshold under the IPM program. At Loch Lomond, copper-containing algaecides have proven to be very effective at reducing the target algae without adverse effects on non-target organisms. The City anticipates additional trials with the hydrogen peroxide and peroxyacetic acid-containing products.

In order to reduce the amount and impact, an algaecide application may also be made prior to reaching a threshold exceedance, as discussed in Element 5. Even though algae may not be an immediate problem at this phase, treating certain species before a significant bloom is underway reduces the amount of algaecide needed because the lower density of algae is easier to control, and there is less biomass to target. If an algaecide is selected as the control measure, the rate of application is calculated based on the identification of the algae, volume of water to be treated, and the appearance of that type of algae on the product label. The application may also include other control techniques that alone or in combination with chemical controls are the most efficacious and protective of the environment.

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11.2 Using the Least Intrusive Method of Aquatic Herbicide Application

The City may use a variety of application equipment, but applications are generally made using one to three boats. Boats may be used to apply algaecides by making broadcast applications using a spreader, handgun or submersed boom to apply granules or liquids. Combined with the need to hold, safely transport and properly apply algaecides, the methods used to apply algaecides to Loch Lomond are the least intrusive, feasible option.

Please refer to **Table 1** for application methods.

11.3 Applying a Decision Matrix Concept to the Choice of the Most Appropriate Formulation

As previously stated, a PCA and/or qualified City staff scout the area(s) to be treated, identifies the target algae(s) present, checks appropriate algaecide product label(s) for efficacy information, and then the PCA prepares a written recommendation. The written recommendation includes rates of application, and any warnings or conditions that limit the application.

The PCA may also recommend that an adjuvant be used to enhance the efficacy of the algaecide.

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Appendix 7: Example Historic Flood Control Biological Opinions

UNITED STATES DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
NATIONAL MARINE FISHERIES SERVICE
Southwest Region
501 West Ocean Boulevard, Suite 4200
Long Beach, California 90802-4213

AUG 19 2002

In Response Please Refer To:
151422SWR02SR8288:JMA

Mr. Calvin C. Fong
Chief, Regulatory Branch
Department of the Army
San Francisco District, Corps of Engineers
333 Market Street
San Francisco, California 94105-2197

Dear Mr. Fong:

This letter acknowledges the 17 June, 2002, receipt by the National Marine Fisheries Service (NOAA Fisheries) of your 13 June 2002 letter (File Number 26876S) requesting initiation of Section 7 consultation under the Endangered Species Act (ESA). The consultation concerns the possible effects of channel maintenance activities on the Lower San Lorenzo River, in the City of Santa Cruz, Santa Cruz County, California, to threatened Central California Coast (CCC) Evolutionarily Significant Unit steelhead trout (*Oncorhynchus mykiss*), threatened CCC ESU coho salmon (*Oncorhynchus kisutch*) and the Critical Habitat of CCC ESU coho salmon.

The project site is also located within an area identified as Essential Fish Habitat (EFH) for various life stages of CCC ESU coho salmon federally-managed under the Pacific Coast Salmon Fishery Management Plan. NMFS has evaluated the proposed project for potential adverse effects to EFH pursuant to Section 305(b)(2) of the Magnuson-Stevens Fisheries Act. For more information on EFH, see our website at "http://swr.nmfs.noaa.gov".

The City of Santa Cruz (the City) proposes, as part of a five year Corps Clean Water Act Section 404 Permit, to disk and loosen channel bottom sediments and on the lower San Lorenzo River in an effort to reduce flooding frequency by maintaining channel capacity. Disking will rip the roots of riparian vegetation on the dry in-channel sandbars. The lower San Lorenzo River is contained within recently raised levees that now provide the City with 100 year flood protection. The natural scour of the sandbars, as opposed to past dredging practices, will maintain the existing channel capacity. The City is disking dry sediment bars to a depth of approximately six inches to facilitate scour and removal during high winter flow events with a bulldozer between Highway 1 and the Water Street Bridge and a horse-drawn plow south of the Water Street Bridge. The channel ripping operation will be accomplished over a one to two week period

during late August to early October low-flow period. The channel ripping operation will cover a distance of approximately 4350 lineal feet between the Highway 1 and Soquel Avenue Bridges. Disking with the bulldozer will be confined to an area of about 150 lineal feet.

The City also proposes selective removal of riparian vegetation and to clean out storm drains flowing in the San Lorenzo River during the low flow period. Storm drain cleaning is a yearly maintenance activity for approximately ⅓ to ½ of the 18 storm drains.

The City originally proposed to install a low flow fish channel in order to provide summer rearing habitat for CCC ESU steelhead trout and other native fish. Portions of the lower San Lorenzo River are subject to braiding and form multiple shallow stream channels. During periods of lower than normal rainfall these braided channels form less than optimum habitat for native fish and potentially subject fish located in these channels to increased instream temperature and predation potential. To create the channel the City proposed to construct a log or sediment barrier upstream near the Highway 1 Bridge in order to funnel flows into a single channel. At the request of NOAA Fisheries, the City of Santa Cruz removed (documented in a letter from the City to NOAA Fisheries dated 7 August, 2002) this part of the project in order to facilitate the informal consultation process. NOAA Fisheries is concerned construction of a log or sediment barrier would lead to dewatered conditions downstream thus beaching and standing listed CCC ESU steelhead trout. The City may pursue this project separately in the future as part of a formal consultation.

Available information indicates the San Lorenzo River supports populations of CCC ESU steelhead trout, historically supported populations of CCC ESU coho salmon, and CCC ESU coho salmon Critical Habitat. To avoid or minimize impacts to this species, adverse modification of designated Critical Habitat, and; adverse impacts to EFH in the project area, the City of Santa Cruz has incorporated measures discussed above and the additional following measures into the project:

1. The work window is limited to late August and late October (15 October) during the summer low flow period (with possible time extensions to 31 October if weather permits).

2. Only dry sandbars will be ripped, no instream wetlands will be affected.

3. No refueling or equipment maintenance will be allow within the San Lorenzo River Channel.

4. No mechanical equipment will enter the wetted channel. The bulldozer will cross the San Lorenzo River channel at one of three preselected entry sites. Two of the sites will likely be completely dry at the time of operation, if the third location is used steel plates will be used to straddle the

channel in order to act as a bridge thus maintaining the live (wetted) channel (documented in an email from Ms. Donna Meyers from the City to Mr. Jonathan Ambrose of my staff, dated 14 August, 2002).

5. A five foot vegetative buffer will be maintained between the wetted channel and the sandbar areas proposed for ripping on.

6. A ten foot vegetative buffer will be maintained on the toe of the levee slope.

Based on the information available, I concur with your determination that this project may affect but is not likely to adversely affect threatened CCC ESU steelhead trout, CCC ESU coho salmon, designated Critical Habitat, or EFH. This concludes informal consultation for the project in accordance with 50 C.F.R. Section 402.14(b)(1) and EFH consultation in accordance with 50 CFR 600.920 for the City's San Lorenzo River. However, (1) if new information becomes available indicating CCC ESU steelhead trout or CCC ESU coho salmon may be adversely affected by the project in a manner not previously considered, (2) if the take avoidance and minimization measures listed above are not followed, or (3) if the project plans change, reinitiation of consultation will be required. In addition, at the onset and completion of construction activities it will necessary to inform Mr. Jonathan Ambrose, Protected Resources Division at (707) 575-6091. **This concurrence letter does not authorize the capture, movement, harassment, handling, or any other form of "take" of CCC ESU steelhead trout or CCC ESU coho salmon in the project area.**

If you have any questions, please contact Mr. Jonathan Ambrose at the number listed above.

Sincerely,

Mark Helvey

for Rodney R. McInnis
Acting Regional Administrator

cc: Jim Lecky - NOAA Fisheries
Gordon Liu - Corps, San Francisco
Donna Meyers - City of Santa Cruz
David Johnston - CDF&G, Monterey
John Gilchrist - John Gilchrist & Assoc.

UNITED STATES DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
NATIONAL MARINE FISHERIES SERVICE
Southwest Region
501 West Ocean Boulevard, Suite 4200
Long Beach, California 90802- 4213

DEC 11 2003

In Response Refer To:
151422SWR02SR8288:BLS

Colonel Michael J. Conrad, Jr.
United States Department of the Army
Sacramento District, Corps of Engineers
1325 J Street
Sacramento, California 95814-2922

Dear Colonel Conrad:

Enclosed is the National Marine Fisheries Service's (NOAA Fisheries) biological opinion (Enclosure 1) for the United States Army Corps of Engineers' (Corps) proposed construction of the San Lorenzo River bank stabilization project, located along the San Lorenzo River, in the City of Santa Cruz, Santa Cruz County, California. This biological opinion concludes the Corps' action is not likely to jeopardize the continued existence of threatened Central California Coast (CCC) Evolutionarily Significant Unit (ESU) steelhead (*Oncorhynchus mykiss*) and is not likely to adversely modify designated critical habitat for threatened CCC ESU coho salmon (*O. kisutch*). NOAA Fisheries expects the action will result in take of CCC ESU steelhead and therefore an incidental take statement is included with the biological opinion. The incidental take statement includes reasonable and prudent measures necessary and appropriate to minimize incidental take of CCC ESU steelhead.

In addition to the biological opinion, an Essential Fish Habitat (EFH) consultation is enclosed (Enclosure 2). The EFH consultation for Pacific coast salmon has determined that EFH will be only temporarily adversely affected, and in this case EFH recommendations are not necessary.

If you have any questions regarding this consultation please contact Mr. Bill Stevens of my staff at (707) 575-6016.

Sincerely,

Rodney R. McInnis
Acting Regional Administrator

Enclosures (2)

cc: Jim Lecky, NOAA Fisheries
Don Lash, Corps, Sacramento
Siobhan O'Neill, City of Santa Cruz Public Works Department
Joe Hall, City of Santa Cruz Redevelopment Agency

Enclosure 1

BIOLOGICAL OPINION

ACTION AGENCY:	Department of the Army, Corps of Engineers, Sacramento District
ACTION:	Construction of a Bank Stabilization Wall and Restoration of Wildlife Habitat Conditions Along the San Lorenzo River, Santa Cruz County, California.
CONSULTATION CONDUCTED BY:	National Marine Fisheries Service, Southwest Region
FILE NUMBER:	151422SWR02SR8288
DATE ISSUED:	DEC 11 2003

I. CONSULTATION HISTORY

On April 12, 2002, the National Marine Fisheries Service (NOAA Fisheries) met with the City of Santa Cruz and the United States Army Corps of Engineers (Corps) to discuss the proposed project and conduct a site review. Another meeting occurred on December 10, 2002, to discuss information necessary to initiate consultation pursuant to section 7(a)(2) of the Endangered Species Act (ESA) of 1973, as amended (16 U.S.C. 1531 *et seq.*) and how to minimize potential adverse impacts to listed salmonids and their habitat from the proposed action. Communications, including telephone calls and electronic mail, between NOAA Fisheries, the City of Santa Cruz, and the Corps resulted in identification of potential impacts to Central California Coast (CCC) Evolutionarily Significant Unit (ESU) steelhead (*Oncorhynchus mykiss*), CCC ESU coho salmon (*O. kisutch*), and designated critical habitat for threatened CCC ESU coho salmon from the proposed project. Impact minimization and conservation measures were developed to ensure the project was constructed in the manner considered least damaging to the environment and to minimize the effects to threatened CCC steelhead, CCC coho salmon, and designated critical habitat for CCC ESU coho salmon. Many of these measures were incorporated into the Corps' proposal and are referred to below in the *Description of the Proposed Action* section of this biological opinion.

On March 25, 2003, NOAA Fisheries received the Corps' March 20, 2003, draft Environmental Assessment (EA) and request for formal consultation pursuant to section 7(a)(2) of the ESA. The Corps determined the project may affect CCC ESU steelhead, CCC ESU coho salmon, and designated critical habitat for threatened CCC ESU coho salmon. On April 15, 2003, NOAA Fisheries informed the Corps that all of the information necessary to initiate formal consultation as outlined in the regulations governing interagency consultations (50 CFR 402.14) had not been

received. On June 11, 2003, NOAA Fisheries received the additional information and formal section 7 consultation was initiated. The Corps' August 22, 2003, second and final draft EA was received in our office on August 26, 2003.

During consultation, NOAA Fisheries determined that coho salmon were not likely to be adversely affected by the proposed project. This biological opinion analyzes the effects of the bank stabilization and habitat restoration project on threatened CCC steelhead and designated critical habitat for threatened CCC coho salmon. This biological opinion is based on the best scientific and commercial data available including information contained in the EA, the Corps' Project Description, other letters and electronic mails, field investigations, telephone conversations, and other sources of information. A complete administrative record of this consultation is on file at the NOAA Fisheries Santa Rosa Area Office.

II. DESCRIPTION OF THE PROPOSED ACTION

The Corps proposes to design and construct a bank stabilization wall and restore wildlife habitat along 900 feet of eroding river bank on the lower San Lorenzo River, in the City of Santa Cruz, Santa Cruz County, California. In addition, the existing maintenance road at the top of the bank would be rebuilt and restored for pedestrian, and emergency access. The street adjacent to the maintenance road will be replaced and improved. Construction is estimated to take approximately nine months and is scheduled to begin in April 2004. This action will enhance instream habitat conditions in the lower San Lorenzo River, stabilize the river bank, reduce erosion, and allow for the repairs to the maintenance road at the top of the riverbank.

A. Background

In response to severe flooding in 1938, 1941, and 1955, a Corps flood control project was completed in 1960 and designed to provide 100-year flood protection. Sediment deposition has reduced the capacity to about the 25-year level. Congressional authorization in 1986 and 1995 allowed for the modification of levees and habitat improvements to the San Lorenzo River, including: raising existing levees to the Federal Emergency Management Agency 100-year flood protection level, retrofitting and raising existing bridges, installing floodwalls, and revegetating the outer levee slopes with native riparian species to improve habitat. Construction on the San Lorenzo River Flood Control and Habitat Restoration Project began in 1999 and is scheduled for completion by 2003. On July 9, 1998, NOAA Fisheries provided its biological opinion on the Corps' San Lorenzo River Flood Control and Habitat Restoration Project that involved: (1) levee work, involving construction of levee crowns and land side levee slopes, and; (2) sediment removal from the active channel and reconfiguration of the fish passage low flow channel (NOAA Fisheries 1998). Bank erosion and scouring problems were not addressed as part of the flood control project. The City of Santa Cruz obtained Congressional authorization in 1999 which allowed for the design and construction of bank protection features (the proposed project) along a heavily scoured section of river.

B. Project Actions

The project site is along the west bank of the San Lorenzo River at the final bend of the river before the ocean. This reach extends from the Soquel Avenue Bridge to the Riverside Avenue Bridge. The Corps proposes to construct the wall away from the existing slope of the Purisima Shelf formation (a sandstone sedimentary sequence in the river bank), set back far enough to allow establishment of a natural slope and increase the area for in-channel vegetation. The height of the wall would range from approximately nine feet to 20 feet. Specifically, the Corps proposes to construct a soil-nail wall, which is a wall that relies on mechanical anchors and shot-crete to provide the force required to retain the riverbank.

The project also contains habitat enhancement components. At the base of the wall, the Corps will install the following habitat features: a log crib wall, root wad vanes, boulders, and in-stream vegetation. The main functions of these features are to enhance the formation of pools for fish habitat. The Corps will install the following habitat enhancement features: 1) approximately 119 linear feet (LF) of a one-tiered log crib structure and 261 LF of a two-tiered log crib structure along the base of the bank protection wall; 2) 50 LF of footer logs; 3) 76 LF of root wads; 4) 90 LF of log vanes, which will deflect and reduce flow velocities during high flow events; and 5) approximately 24 cubic yards of boulders that will anchor the log vanes and provide substrate for plant establishment. The Corps will use approximately 450 tons of river stone and sandy loam material to fill in the voids of the log crib structure to establish in-channel vegetation. In-channel planting includes species native to the San Lorenzo River watershed (most likely tree pole cuttings from the watershed and seedlings grown from local nurseries). The City of Santa Cruz, the non-Federal sponsor of this project, will be responsible for maintenance of the habitat and landscape features after the Corps completes construction[1].

In-channel construction would commence on May 1, 2004, with installation of a temporary water diversion structure that would be used to dewater the river adjacent to the site in order to facilitate in-channel work. In-channel work will be finished on October 31, 2004. Water diversion would be done at low tide to minimize the quantity of water to be diverted. The preliminary construction specifications call for use of a portable frame diversion system with an impermeable membrane such as a PortaDam™, with removal of water and relocation of fish conducted by a qualified fisheries biologist.

The PortaDam™ will be installed starting at the upstream end of the project site; allowing most water to flow out of the portion of the river to be enclosed. An approximate 30-foot wide swath of channel will be dewatered along 1,000 feet of river bank. Pumps will be used to incrementally draw down the water leaving only the deeper areas with standing water (pools). The pumps will be screened to exclude fish. Groundwater encountered during project activities will be filtered

[1]Maintenance needs cannot be accurately anticipated at this time and were not analyzed in this consultation.

before being pumped back into the river. A fisheries biologist will be on-site to capture any fish that may become stranded in the pools. Stranded fish will be captured with dip nets or seines, placed in a container with river water, and transferred into the flowing water of the San Lorenzo River. Nets may be used to guide fish into a specific location in order to capture the fish. This process should take approximately one to two days depending on the river flow at the time of construction.

Construction of a maintenance road and the improvement of a street are proposed as part of the bank stabilization project. At the top of the bank stabilization wall, the Corps will construct an eight- to ten-foot wide maintenance road and connect it to a downstream river maintenance road. The proposed maintenance road will parallel the Laurel Street Extension and continue along Third Street toward Riverside Avenue Bridge. The maintenance road project includes the construction of an overlook at the intersection of Laurel Street Extension and Third Street, protective railings, and overhead street lighting. Adjacent to the maintenance access road, the Corps will install a continuous three-foot wide vegetated strip consisting of native trees and shrubs along the entire length of the project. The trees will provide shade cover for the river and separate the street from the maintenance road. Finally, the Corps will replace and improve the Laurel Street Extension and Third Street, maintaining Laurel Street Extension's 13-foot one-way direction and Third Street's two-way (12-foot wide) lane direction.

Equipment to be used includes standard construction equipment such as graders, compactors, and haul trucks. Two areas have been designated as equipment and construction staging areas: the existing City of Santa Cruz permit parking lot on the northern end of the Laurel Street Extension and one lane of Third Street between Riverside Avenue and Laurel Street Extension.

C. Minimization and Conservation Measures

The following minimization and conservation measures for CCC steelhead were compiled by NOAA Fisheries from the draft EA developed for the project (Corps 2003) and discussions with the Corps. It is NOAA Fisheries' understanding the following general conditions will be applied to this project to minimize impacts to listed salmonids:

- In-channel construction will be restricted to May 1 through October 31.
- The initial diversion of water will be done during low tide and with incremental drawdowns.
- River flow in the main channel will not be disrupted at anytime during construction activities.
- Relocation of all trapped fish will be conducted by a qualified fisheries biologist.

- Pumps used to draw water out of the secured area will be installed with fish screens.

- The use of best management practices (*e.g.*, filtering groundwater before it is pumped back into the river, and prohibiting fueling, cleaning, or maintenance of equipment in or near the bed and banks of the river) will be implemented to reduce the probability of sediment and/or contaminated material from entering the river.

- No construction will be conducted within the wetted channel (aside from the containment barrier installation).

- Following in-stream operations, all equipment and materials will be removed from the San Lorenzo River.

- Erosion control methods (*e.g.*, a stormwater pollution prevention plan and revegetation upon completion of project construction) will be implemented during and after operations.

D. Action Area

The action area is defined by regulation as "all areas to be affected directly or indirectly by the Federal action and not merely the immediate area involved in the action" (50 CFR 402.02). As such, the action area of this biological opinion includes the immediate area of the project site, beginning with the active stream bed and banks within the containment barrier (*e.g.*, PortaDam™), the bank up to the road, including planting areas, and effects downstream of the containment barrier. The action area for this project is further defined as the 30-foot wide swath of channel that will be dewatered along 1,000 feet of river bank (30,000 square feet). The ultimate distance downstream of the project site where effects (*i.e.*, sedimentation and turbidity) may occur cannot be quantified. However, based on sedimentation and turbidity from similar projects in similar streams, NOAA Fisheries expects these effects will be minor.

III. DESCRIPTION AND STATUS OF THE SPECIES

This biological opinion analyzes the adverse effects of the proposed project on the following species and designated critical habitat:

- Threatened CCC ESU steelhead (62 FR 43937).
- Designated Critical Habitat for CCC ESU coho salmon (64 FR 24049).

Threatened CCC ESU coho salmon (61 FR 56138) are believed to be extirpated from the San Lorenzo River watershed at this time. This species therefore will not be considered in the effects analysis of this biological opinion.

A. Species Description

Because juvenile steelhead are expected to be rearing in the action area at the time of project activities, life history requirements during this life stage is discussed below in detail.

Spawning by adult steelhead may occur between December and June, but specific timing of spawning may vary a month or more among streams within a region. Shapovalov and Taft (1954) estimated hatching time of steelhead in Waddell Creek, Santa Cruz County, was from 25 to 35 days, emergence from the gravel began two to three weeks after hatching, and another two to three weeks was required to complete emergence. After emergence, steelhead fry utilize habitats with swift currents, moving gradually into deeper water as they grow. Older fry establish territories which they defend.

Juvenile steelhead require living space (different combinations of water depth and velocity), shelter from predators and harsh environmental conditions, food resources, and suitable water quality and quantity, for development and survival during summer and winter (Bjornn and Reiser 1991). Young-of-the-year (0+) and yearling steelhead generally use riffles and runs (*e.g.*, Roper *et al.* 1994) during much of a given year where these habitats exist. However, 0+ and older juveniles may seek cover and cool water in pools during the summer (Nielsen *et al.* 1994). Juvenile steelhead feed on a wide variety of aquatic and terrestrial insects, and emerging fry are sometimes preyed upon by older juveniles.

Streamside vegetation and cover are essential (Bjornn and Reiser 1991). Steelhead juveniles are usually associated with the bottom of the stream. In smaller California streams, the water levels may drop so low during the summer that pools become isolated and are the only viable rearing habitat. Daytime temperatures in summer rearing pools also may be near lethal levels; riparian shading and the presence of sub-surface, cold water seeps are often essential to maintain pool temperatures at tolerable levels. Because rearing juvenile steelhead reside in freshwater all year, adequate flow and temperature are important to the population at all times (California Department of Fish and Game (CDFG) 1997). In winter, juvenile steelhead become inactive and hide in any available cover, including gravel or woody debris.

Juvenile steelhead are affected by water temperature and dissolved oxygen (DO) levels. Water temperatures influence the growth rate, population density, swimming ability, ability to capture and metabolize food, and ability to withstand disease of these rearing juveniles. Dissolved oxygen levels of 6.5 to 7.0 milligrams per liter (mg/L) affected the migration and swimming performance of steelhead juveniles at all temperatures (Davis *et al.* 1963). Low DO levels decrease the rate of metabolism, swimming speed, growth rate, food consumption rate, efficiency of food utilization, affect normal behaviors, and ultimately reduce the survival rate of the

juveniles.

During rearing, suspended and deposited fine sediments can directly affect salmonids by abrading and clogging gills, and indirectly cause reduced feeding, avoidance reactions, destruction of food supplies, reduced egg and alevin survival, and changed rearing habitat (Reiser and Bjornn 1979). Larger juvenile salmon and trout appear to be little affected by ephemerally high concentrations of suspended sediments that occur during most storms (Cordone and Kelly 1961, Sorenson *et al.* 1977) but juvenile salmonids tend to avoid streams that are chronically turbid, such as those disturbed by human activities (Lloyd *et al.* 1987).

B. ESU Status and Trends

Steelhead abundance in the CCC ESU is low. Increases in stream water temperature and other habitat alterations over large areas in the ESU have led to shifts in fish communities favoring warm water species. Steelhead north of the Russian River (the largest river in the ESU located in Sonoma and Mendocino Counties, California) are still fairly abundant. However, streams impacted by urban development, typically support few, if any, steelhead. Nonetheless, this species remains more common than Chinook salmon (*O. tshawytscha*) and coho salmon in Northern California.

While there are no specific estimates of abundance at the population scale, steelhead numbers are substantially reduced from historical levels. A total of 94,000 adult steelhead were estimated to spawn in the rivers of this ESU in the mid-1960s, including 50,000 fish in the Russian River and 19,000 fish in the San Lorenzo River (Busby *et al.* 1996). The San Lorenzo River is the second largest river in the ESU. Based on the best data available NOAA Fisheries has estimated Russian River steelhead currently number about 7,000 fish, including hatchery fish which are currently not considered part of the listed population (Busby *et al.* 1996, NOAA Fisheries 1997a). San Lorenzo River steelhead are thought to number approximately 1,000 to 2,500 fish (Alley 2000), including hatchery fish, which are considered part of the listed population in this river. Abundance estimates for smaller coastal streams in the ESU indicate low but stable levels (NOAA Fisheries 1997a), with recent estimates for several streams (Lagunitas Creek (San Mateo County), Waddell Creek, Scott Creek, San Vincente Creek, Soquel Creek, and Aptos Creek (all in Santa Cruz County) of individual run sizes of 500 fish or less (62 FR 43937).

A positive indicator for the ESU is CCC steelhead have maintained a wide distribution throughout the area (62 FR 43937). Species with broad distributions are more likely to survive environmental fluctuations and stochastic events, even if they suffer local extirpation (Pimm *et al.* 1988). However, the West Coast Biological Review Team analyzed juvenile data that were collected at numerous sites in the ESU using a variety of methods. The data suggest an overall decline in juvenile abundance and the hypothesis that the ESU is stable or increasing can be statistically rejected, dependent on sampling conditions (NOAA Fisheries 2003).

In 1997 NOAA Fisheries identified past and present hatchery operations as the major threat to genetic integrity for steelhead in this ESU in (NOAA Fisheries 1997a). Hatcheries can cause adverse genetic impacts on wild fish populations, disease transmission, predation on wild fish, replacement rather than supplementation of wild stocks, and depletion of wild stocks to increase brood stocks (61 FR 56138). The two hatchery operations in the ESU are: (1) Don Clausen Fish Hatchery, which includes the hatchery and collection site on Dry Creek, tributary to the Russian River, Sonoma County, and the Coyote Valley Fish Facility, located on the East Fork of the Russian River, Mendocino County; and (2) Kingfisher Flat Hatchery (Monterey Bay Salmon and Trout Project), located on Big Creek, tributary to Scott Creek, Santa Cruz County. These hatchery operations have been improved to address genetic concerns. The stock has not had out-of-basin introductions in recent years, and hatchery fish are excluded from the broodstock. The current program goal of each hatchery is the restoration of local steelhead stocks.

C. Factors Responsible for Stock Declines: Changes to Habitat and Other Impacts

Threats to naturally reproducing steelhead are numerous and varied. Habitat degradation and destruction (CDFG 1998), natural stochastic events (*e.g.*, droughts, landslides and floods), ocean conditions (Beamish and Bouillion 1993, Beamish *et al.* 1997, Johnson 1988), alteration of stream flows (Chapman and Bjornn 1969, Berggren and Filardo 1993, 61 FR 56138), artificial propagation (Waples 1991, 1999, 61 FR 56138), predation by marine mammals (NOAA Fisheries 1999, Hanson 1993), and reduced marine-derived nutrient transport (Bilby *et al.* 1996, Bilby *et al.* 1998, Gresh *et al.* 2000) have played a role to varying degrees in the decline of steelhead populations. Among the most serious and ongoing threats to steelhead survival in this ESU are changes in hydrology and freshwater habitat degradation and loss (NOAA Fisheries 1996).

D. Coho Salmon Critical Habitat

The proposed project occurs in the San Lorenzo River, which contains designated critical habitat for threatened CCC ESU coho salmon. In designating critical habitat, NOAA Fisheries considers the following requirements of the species: (1) space for individual and population growth and for normal behavior; (2) food, water, air, light, minerals, or other nutritional or physiological requirements; (3) cover or shelter; (4) sites for breeding, reproduction, or rearing offspring; and, (5) in general, habitats that are protected from disturbance or are representative of the historic geographical and ecological distributions of this species (50 CFR 424.12(b)). In addition to these factors, NOAA Fisheries also focuses on known physical and biological features (primary constituent elements) within the designated area that are essential to the conservation of the species and that may require special management considerations or protection. These essential features may include, but are not limited to, spawning sites, food resources, water quality and quantity, and riparian vegetation.

The condition of CCC ESU coho salmon critical habitat, specifically its ability to provide for their conservation, has been degraded from conditions known to support viable salmonid

populations. NOAA Fisheries has determined present depressed population conditions are, in part, the result of the following human-induced factors affecting critical habitat: Logging, agricultural and mining activities, urbanization, stream channelization, dams, wetland loss, water withdrawals and unscreened diversions for irrigation.

Numerous studies have demonstrated land use activities associated with logging, road construction, urban development, mining, agriculture, and recreation have significantly degraded coho salmon critical habitat quantity and quality in the CCC coho salmon ESU. Impacts of concern include alteration of stream bank and channel morphology, alteration of water temperatures, loss of spawning and rearing habitat, fragmentation of habitat, loss of downstream recruitment of spawning gravels and large woody debris, degradation of water quality, removal of riparian vegetation resulting in increased stream bank erosion, increases in erosion entry to streams from upland areas, loss of shade (resulting in higher water temperatures) and loss of nutrient inputs (64 FR 50394, NOAA Fisheries 1996, 61 FR 56138).

E. Status of the Species in the San Lorenzo River

1. Overview

The San Lorenzo River is the primary municipal water source of the greater Santa Cruz area, with approximately 85,000 customers (60-80 percent of the City of Santa Cruz's supply; County of Santa Cruz 2000). Approximately 75,000 people live within the watershed and obtain water supply from smaller streams and groundwater basins within the watershed (County of Santa Cruz 2000). The San Lorenzo River watershed includes 80 miles of streams and is currently subject to numerous deleterious impacts including water diversions, summer dams, timber harvest, and urbanization.

Watersheds within the San Lorenzo River are sinuous and incised with many ridges and deep ravines. Slow downward soil movement and landslides are the natural erosional processes chiefly responsible for forming the topography of this area. Numerous faults cross the San Lorenzo Valley and pose a potential geologic hazard and contribute overall to sediment loading in the Santa Cruz Mountains (Balance Hydrologics, Inc. 1998).

2. Steelhead in the San Lorenzo River

Recent data for the San Lorenzo River watershed suggested this basin has a steelhead population smaller than 15 percent of the size it had 30 years previously. This basin was thought to have originally contained one of the two largest steelhead populations in the ESU (NOAA Fisheries 2003).

Since 1994, the County of Santa Cruz, the City of Santa Cruz, and the San Lorenzo Valley Water District have collaboratively funded surveys in the San Lorenzo River and its tributaries to ascertain population levels of steelhead. These surveys have been more rigorous than past efforts

and provide the best available estimate of year-to-year status of steelhead in the San Lorenzo River watershed. In 2002, estimated juvenile steelhead abundance extrapolated to the mainstem of the San Lorenzo River and all sampled tributaries was 168,278, the highest since 1998, which had similar abundance estimates (H.T. Harvey & Associates 2003).

In the summer of 2002, two sites (0a and 0b) in the San Lorenzo River nearest the project site (site 0a was approximately at the Water Street Bridge; 3,700 feet upstream of the upstream portion of the project site) were sampled and juvenile steelhead abundances were estimated (H.T. Harvey & Associates 2003). Total juvenile density at sampling sites 0a and 0b was 3.9/100 feet and 3.0/100 feet, respectively. All steelhead captured were ≥85 millimeters (mm) in length. Each summer a sandbar builds up at the mouth of the river, creating a lagoon. During late fall or early winter, the sandbar naturally breaches due to high river flows and storm-induced wave action. Two surveys conducted in the fall of 2002 from the mouth of the San Lorenzo River to the Water Street Bridge resulted in 51 steelhead (pre-beach seining) and 11 steelhead (post-breach seining). All steelhead captured were ≥85 mm in length. The trap nets failed to capture steelhead during either of the two sampling periods.

3. Anthropogenic Factors Affecting Species in the San Lorenzo River

A variety of factors, both anthropogenic and natural, have played a role in the decline of steelhead in the San Lorenzo River. Natural events, such as floods, droughts, and ocean productivity cycles, have depressed population numbers when these events occur. However, the more recent anthropogenic destruction and degradation of essential freshwater habitats have reduced the resiliency of steelhead populations to natural disturbances.

Excessive erosion, sedimentation, and turbidity (SCCPD 1979), diminished streamflows (SCCPD 1979, NOAA Fisheries 2001a, Denise Duffy & Associates, Inc. 1999) channelization (Mount 1995), and summer dams (NOAA Fisheries 2001b) have degraded steelhead spawning and rearing habitats and designated critical habitat for CCC coho salmon in the San Lorenzo River watershed. These effects caused by on-going activities such as urbanization and water diversions are expected to continue to occur in the San Lorenzo River.

The San Lorenzo River is located near the southern boundary of the CCC coho salmon ESU and the southernmost range of coho salmon in the western United States. Coho salmon used the San Lorenzo River for spawning and rearing. In 1954-55, the estimated adult coho salmon run in the San Lorenzo River ranged between 7,000 and 14,000 (State Water Resources Control Board 1982). This watershed's value as critical habitat is high for coho salmon, given its location near the southernmost extent of their range and the relatively large coho population it supported historically. Recovering coho salmon to the full extent of their former range will likely require restoring important components of critical habitat in the San Lorenzo River, such as spawning and rearing areas.

IV. ENVIRONMENTAL BASELINE

1. Aquatic Habitat Conditions in the Action Area

The project site is located along the west bank within the estuarine reach of the San Lorenzo River. This reach of the river consists of a single slack-water channel that has been heavily modified by encroachment, filling, fragmentation, levee construction, and rock lining of the lower estuary. The project area is located along a heavily scoured bank. At the bottom of the bank, a sandstone Purisima Shelf protrudes a few feet into the river channel. This rock formation was exposed as a result of river scouring. Several small resting pools of slow-moving water are below the shelf, but they have no cover elements for fish. Vegetation along the levee toe is maintained in a 10-foot buffer. A narrow one-way road adjacent to a vertical sandstone bluff is at the top of the river bank. This street is used by pedestrians, cyclists, and vehicular traffic. Part of the asphalt from this road overhangs the bank due to severe undercutting during high flow events.

The action area is influenced by the sandbar conditions at the mouth of the San Lorenzo River, approximately 3,700 feet downstream. During most summer and fall months, deep-water conditions occur due to development of a sandbar at the river mouth that allows the estuary to convert to freshwater. The sandbar closes the mouth of the river and forms a seasonal summer lagoon; in wetter years it appears that the sandbar self-breaches when the lagoon fills and spills over the sandbar. The sandbar across the mouth of the river forms naturally through wave action in late spring and summer. Typically, the sandbar forms during June and holds back water until November. In most years, flow levels in the river are lowest in May because the sandbar has not built up enough to hold back water to create a lagoon setting (Don Lash, Corps, pers. com., October 9, 2003). The City of Santa Cruz does not presently implement a sandbar management or breaching program for the mouth of the San Lorenzo River, but did so prior to 1995. Breaching activities were ceased following issues with public safety and natural resource (*e. g.*, steelhead) management.

2. Status of Steelhead in the Action Area

Steelhead adults and juveniles use the action area as a migration corridor and as rearing habitat, respectively. Adult steelhead are not expected to be present when the project is scheduled to occur based on the timing of adult migration (winter/spring). Although the project will occur in May when smolts are likely to be outmigrating; their presence on the project site is unlikely. Outmigrating smolts are expected to use the main flow area of the River, which does not run through the project area. Based on 14 seining samples each covering 100 feet of stream length (H.T. Harvey & Associates 2003), NOAA Fisheries estimates juvenile steelhead density in the San Lorenzo River between the mouth of the San Lorenzo River to the Water Street Bridge averages 4.4 steelhead per 100 feet of stream. The San Lorenzo River Bank Stabilization Project is situated nearly equidistant between the Water Street Bridge and the mouth of the river (approximately 3,700 feet from either). NOAA Fisheries estimates that no more than 44 juvenile

steelhead are likely to be present in the action area when the project occurs (4.4 steelhead per 100 feet multiplied by 10 for the 1,000-foot action area).

V. EFFECTS OF THE ACTION

The purpose of this section is to identify the direct and indirect effects of the proposed action on threatened CCC steelhead in the action area and designated critical habitat for threatened CCC coho salmon. Generally, the effects of the proposed action on steelhead and aquatic habitat, including designated coho salmon critical habitat, are those associated with temporarily diverting stream flow and dewatering work spaces to conduct in-channel construction activities and construct the containment barrier.

A. Turbidity and Sedimentation

Increased sedimentation and turbidity could result if fine sediment is contributed to the San Lorenzo River, or mobilized, during the proposed action. Substantial sedimentation rates could bury less mobile organisms (Ellis 1936, Cordone and Kelley 1961) that serve as a food source for many fish species, degrade instream habitat conditions (Cordone and Kelly 1961, Eaglin and Hubert 1993), infiltrate redds resulting in progressively lower egg survival (Tappel and Bjornn 1983, McNeil and Ahnell 1964, Reiser and White 1988, Tagart 1984), and cause reductions in fish abundance (Alexander and Hansen 1986, Berkman and Rabeni 1987) and growth (Crouse *et al.* 1991). Turbidity may cause indirect harm, injury or mortality to juvenile steelhead in the action area. High turbidity concentrations can result in fish mortality, reduce feeding efficiency, and decrease food availability (Berg and Northcote 1985, McLeay *et al.* 1983, Gregory and Northcote 1993, Velagic 1995).

The in-channel work proposed will likely cause increased levels of sedimentation and turbidity in the action area because the stream bed and banks will be disturbed. Although specific sedimentation and turbidity rates have not been estimated, NOAA Fisheries expects them to be low and temporary because: the Corps proposes to isolate the work space from flowing water; the in-channel work window will be limited, adequate erosion control measures will be employed at the time of the proposed action, and groundwater encountered during project activities will be filtered before being pumped back into the river. Consequently, sedimentation and turbidity are not expected to have adverse effects on steelhead. Habitat will be only temporarily disturbed, and project clean-up actions and winter flows are expected to return the creek bed and banks to conditions similar to those found in the action area prior to the project.

B. Maintenance Road Lighting

Salmonids are known to avoid high intensity light, and may be attracted to dim lights (Corps 2003). Lights placed along the planned maintenance will be oriented away from the River. Shields will also be placed on the light fixtures to further reduce the amount of light reaching

aquatic habitat. Therefore, NOAA Fisheries does not expect adverse effects to listed salmonids from the proposed lighting.

C. Fish Capture and Relocation

Juvenile steelhead within the project site will be captured following the installation of the containment barrier and relocated to adjacent suitable habitat. As described previously in the *Environmental Baseline* section, NOAA Fisheries does not expect more than 44 steelhead will need to be captured and relocated.

An effect of principal concern is mortality and injury to juvenile steelhead in the work area due to fish capture and relocation activities. Any fish relocation gear, whether passive (Hubert 1983) or active (Hayes 1983) has some associated risk to the fish, including stress, disease transmission, injury, or death.

Dip nets and/or seines will be used to capture and relocate juvenile steelhead. Small steelhead can be gilled in the mesh of a seine and scales and dermal mucus can be abraded by contacting the net. Juvenile steelhead can be suffocated if they are not quickly removed from the net after the net is removed from the water to process steelhead. Steelhead also can be crushed by the handler if the handler steps on the net. The risks to juvenile steelhead can be minimized if the handler carefully, quickly, and thoroughly removes all steelhead from the net and places them in bucket of water.

After juvenile steelhead are relocated, stress from crowding and increased competition for food in the relocation areas may occur. This stress and increased competition in the relocation areas will be minimal and temporary. Upon project completion, steelhead will be able to redistribute in the action area unimpeded.

Based on NOAA Fisheries prior experience with current relocation techniques and protocols to be used to conduct the fish capture and relocation activities, unintentional mortality of listed juvenile CCC steelhead expected from capture and handling procedures is not likely to exceed three percent of the fish subjected to handling, and can be reduced to near one percent with increased skill and experience of the fish relocation personnel. Despite these impacts, fish capture and relocation operations are expected to significantly minimize project impacts to steelhead by removing them from areas where they would have experienced high rates of injury and mortality. Based on the estimate of salmonid numbers given above, and a three percent mortality rate from dip netting and/or seining, NOAA Fisheries expects no more than two steelhead will be killed during fish capture and relocation activities.

D. Dewatering

Stream flow diversion and work space dewatering is expected to cause temporary loss, alteration, and reduction of aquatic habitat within the action area. Stream flow diversions could harm

individual steelhead by concentrating or stranding them in residual wetted areas (Cushman 1985) before they are relocated, or causing them to move to adjacent habitats (Clothier 1953, 1954, Kraft 1972, Campbell and Scott 1984). Steelhead could be killed or injured if crushed beneath the containment barrier during installation, though direct mortality is expected to be minimal because of the small number of steelhead in the action area. During installation of the containment barrier, a fisheries biologist will remain in the river to net and rescue any additional fish that may have become stranded throughout the dewatering process.

Steelhead which avoid capture in work spaces will die during dewatering activities. However, because the affected space is small and the number of steelhead which avoid capture likely few, the number of steelhead subject to mortality via stranding will be few. NOAA Fisheries expects the juvenile steelhead stranding rate associated with dewatering for this project will be less than the unintentional mortality rate from capturing and handling procedures (three percent). Based on the estimates of salmonid numbers given above, NOAA Fisheries expects no more than one steelhead to be killed as a result of stranding during dewatering activities.

Benthic (*i.e.*, bottom dwelling) aquatic macroinvertebrates may be temporarily lost or their abundance reduced when individual organisms are stranded or when creek habitats are dewatered (Cushman 1985). Effects to aquatic macroinvertebrates resulting from stream flow diversions and dewatering will be temporary because construction activities will be relatively short-lived, and rapid recolonization (about one to two months) of disturbed areas by macroinvertebrates (Cushman 1985, Thomas 1985, Harvey 1986) is expected following rewatering. In addition, the effect of macroinvertebrate loss on juvenile steelhead is likely to be negligible because food from upstream sources (via drift) would be available downstream of the dewatered areas since stream flows will be maintained outside of the checkdam. Based on the foregoing, the loss of aquatic macroinvertebrates as a result of dewatering activities is not expected to adversely effect steelhead.

E. In-Channel Habitat Structures

A single-tier crib wall, two-tier crib wall, footer logs, and root wad vanes with boulders will be placed in the dewatered channel and attached to the bank stabilization wall. Vegetation will be planted and the river bank slope will be restored to existing grade. As a result of these activities, emergent and riparian vegetation will be enhanced, local river flow velocities will be reduced, sediment/pool formation will be enhanced, and in-stream cover and habitat diversity will be increased. NOAA Fisheries expects these effects to be beneficial and long-lasting to CCC steelhead and designated critical habitat for CCC coho salmon.

F. Interrelated and Interdependent Actions

An interrelated action is an activity that is part of a larger action and depends on the larger action for its justification. An interdependent action is an activity that has no independent utility apart from the action under consultation (50 CFR 402.02). There are no known interrelated or

interdependent actions associated with the Corps constructing the bank stabilization project.

VI. CUMULATIVE EFFECTS

Cumulative effects include the effects of future State, tribal, local or private actions that are reasonably certain to occur in the action area considered in this biological opinion. Future Federal actions unrelated to the proposed action are not considered in this section because they require separate consultation pursuant to section 7 of the ESA. Other than the on-going activities described above in the *Environmental Baseline* section, NOAA Fisheries is unaware of future State, tribal, local, or private actions reasonably certain to occur that will affect the action area.

VII. INTEGRATION AND SYNTHESIS OF EFFECTS

The San Lorenzo River Bank Stabilization Project will result in the dewatering of approximately 30,000 square feet of the San Lorenzo River. Steelhead present in the area to be dewatered will be subject to capture and relocation. A few juvenile steelhead (no more than three) will likely be killed as a result of relocation and dewatering activities.

Although the population of steelhead in the San Lorenzo River is considerably depressed from historical numbers, NOAA Fisheries does not believe the loss of three juvenile steelhead will appreciably reduce the number, distribution, or reproduction of steelhead in the San Lorenzo River. The project has no long term detrimental impacts on steelhead habitat and will not restrict the amount of juvenile rearing space in future years. Beneficial effects to steelhead habitat are expected. Based on the estimated 1,000 to 2,500 adult steelhead in the San Lorenzo River, a one-time loss of three juvenile steelhead rearing in the action area during project construction is unlikely to have a detectable effect on this population's abundance or viability because the remaining population is large enough to be resilient to this small, one-time, loss. Spawning in subsequent years is expected to produce enough juveniles to repopulate any habitat areas that may become vacant by the loss of three juveniles. As noted, the survival chances of juveniles in these areas in future years are likely to improve. Thus, survival and recovery of this population, or the ESU in general, is not likely to be appreciably reduced.

The effects of the project will result in temporary impacts (*i.e.*, dewatering and loss of macroinvertebrates) to critical coho salmon habitat. These impacts will last no more than a few weeks based on the impact minimization measures and conservation measures proposed. The area of the channel disturbed for the instream work is expected to return to pre-project conditions following project completion. The effects of placing in-channel habitat structures are expected to be beneficial and long-lasting to CCC steelhead and designated critical habitat for CCC coho salmon.

VIII. CONCLUSION

After reviewing the best available scientific and commercial information, the status of CCC steelhead, the environmental baseline for the action area including the condition of CCC coho salmon critical habitat, the effects of the proposed San Lorenzo River Bank Stabilization Project, and cumulative effects, it is NOAA Fisheries' biological opinion that the proposed project is not likely to jeopardize the continued existence of CCC steelhead, nor is it likely to destroy or adversely modify designated coho salmon critical habitat.

IX. INCIDENTAL TAKE STATEMENT

Section 9 of the ESA and Federal regulation pursuant to section 4(d) of the Act prohibit the take of endangered and threatened species, respectively, without special exemption. Take is defined as to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture or collect, or to attempt to engage in any such conduct. Harm is further defined by NOAA Fisheries as an act which actually kills or injures fish or wildlife. Such an act may include significant habitat modification or degradation which actually kills or injures fish or wildlife by significantly impairing essential behavioral patterns, including breeding, spawning, rearing, migrating, feeding, or sheltering. Incidental take is defined as take that is incidental to, and not the purpose of, the carrying out of an otherwise lawful activity. Under the terms of section 7(b)(4) and section 7(o)(2), taking that is incidental to and not intended as part of the agency action is not considered to be prohibited taking under the Act provided that such taking is in compliance with the terms and conditions of this incidental take statement.

The measures described below are nondiscretionary, and must be undertaken by the Corps for the exemption in section 7(o)(2) to apply. The Corps has a continuing duty to regulate the activity covered by this incidental take statement. If the Corps (1) fails to assume and implement the terms and conditions or (2) fails to require its designees to adhere to the terms and conditions of the incidental take statement, the protective coverage of section 7(o)(2) may lapse. In order to monitor the impact of incidental take, the Corps must report the progress of the actions and its impact on the species to NOAA Fisheries as specified in the incidental take statement. (50 CFR §402.14(I)(3)).

A. Amount or Extent of Take

NOAA Fisheries anticipates incidental take of CCC steelhead is likely to occur as a result of implementation of the proposed project. The best available information has been used to estimate the number of CCC steelhead likely to be taken is 44.

NOAA Fisheries anticipates the following take is likely to occur:

1. No more than 43 juvenile steelhead will be captured and relocated from the work area.

2. Based on the number of juvenile steelhead captured (43) and a three percent mortality rate from dip netting and/or seining, NOAA Fisheries would expect only two juvenile steelhead to be killed during capture and relocation activities.

3. Based on NOAA Fisheries' best judgement of the number of juvenile steelhead that will remain on site after steelhead relocation activities, NOAA Fisheries would expect only one juvenile steelhead to be killed as a result of stranding during dewatering activities.

B. Effect of the Take

In the accompanying biological opinion, NOAA Fisheries determined this level of anticipated take is not likely to result in jeopardy to CCC steelhead and the project is not likely to result in the destruction nor adverse modification of CCC coho salmon critical habitat.

This incidental take statement is based on implementation of the proposed San Lorenzo River Bank Stabilization Project as described in the Description of the Proposed Action section of this biological opinion, including impact minimization and conservation measures incorporated into the project design. Failure to implement the project as proposed (including relevant conservation measures) or implementation of the project in a manner that causes an effect to listed species, or designated critical habitat not considered in this opinion may cause coverage of section 7(o)(2) to lapse and require reinitiation of consultation to ensure compliance with section 7(a)(2) of the ESA.

C. Reasonable and Prudent Measures

The following reasonable and prudent measures are necessary and appropriate to minimize take of threatened CCC steelhead. The results of the effect analysis in this biological opinion provide the basis for the reasonable and prudent measures.

1. The Corps shall implement measures to reduce and monitor steelhead injury and mortality associated with dewatering and fish relocation activities.

2. The Corps shall implement minimization and conservation measures that will avoid and minimize impacts to CCC steelhead.

3. The Corps shall report to NOAA Fisheries activities associated with minimizing and monitoring effects of the proposed action on steelhead.

D. Terms and Conditions

In order to be exempt from the take prohibitions of the ESA, the Corps must comply with the following non-discretionary Terms and Conditions, which implement the Reasonable and Prudent Measures described above and outline reporting/monitoring conditions.

The following Terms and Conditions implement Reasonable and Prudent Measure No. 1.

1. Captured fish shall be kept in cool, shaded, aerated water (*e.g.*, plastic bucket) protected from noise or jostling any time they are not in the stream and fish shall not be removed from this water except for (1) collection of genetic material (see below) and (2) when released.

2. Fish capture activities shall be conducted by a NOAA Fisheries-approved biologist. Contact NOAA Fisheries (see below) for approval procedures.

3. Fish shall not be overcrowded into buckets, allowing approximately six cubic inches per 0+ individual and more for larger/older fish.

4. Make every effort not to mix 0+ with larger salmonids, or other potential predators, that may consume the smaller salmonids.

5. A copy of this biological opinion shall be kept on-site for the duration of the project.

The following Term and Condition implements Reasonable and Prudent Measure No. 2.

1. Fish screens on pumps shall be implemented according to NOAA Fisheries' *Fish Screening Criteria for Anadromous Salmonids* (NOAA Fisheries 1997b).

The following Terms and Conditions implement Reasonable and Prudent Measure No. 3.

1. Notify NOAA Fisheries one week prior to capture activities in order to provide an opportunity to attend. Call Bill Stevens at (707) 575-6016, or e-mail at William.Stevens@noaa.gov

2. Provide a written monitoring report to NOAA Fisheries within 90 working days following the completion of the proposed action. The report shall include the number of CCC steelhead killed or injured during the proposed action; the number and size (in millimeters) of steelhead captured and removed; any effect of the proposed action on steelhead not previously considered; and, photographs taken before, during, and after the activity from photo reference points. All data relating to steelhead shall be submitted to the Santa Rosa NOAA Fisheries office at 777 Sonoma Avenue, Room 325, Santa Rosa, California, 95404-6528, Attention: Bill Stevens.

3. If more than three listed salmonids are killed, injured, or found dead or injured, the project permitee shall contact NOAA Fisheries Biologist Bill Stevens by phone immediately at (707) 575-6016. If Mr. Stevens cannot be reached, the

Santa Rosa NOAA Fisheries Office will be contacted at (707) 578-8555. The purpose of the contact is to review the activities resulting in take and to determine if additional protective measures are required. All steelhead mortalities must be retained, placed in an appropriately sized whirl-pak or zip-lock bag, labeled with the date and time of collection, fork length, location of capture, and frozen as soon as possible. Frozen samples must be retained until specific instructions are provided by NOAA Fisheries.

4. For all steelhead captured, genetic tissue data shall be collected. The following information shall be part of the Genetic Tissue Collection Data:

Collection Date
Collection Location (County, River, Exact location on river)
Collector Name
Collector Affiliation/Phone
Sample ID Number
Species Tissue Type
Condition
Fork Length (mm; in order to facilitate measurements, fish may be anesthetized.)
Sex (M, F, Unk.)
Adipose Fin Clip? (Y or N)
Tag? (Y or N)
Notes/Comments

Genetic tissue shall be collected according to the following protocols:

a. Live fish: Cut a three millimeter (mm) square clip from tail fin using clean scissors and place sample in a piece of dry blotter/filter paper (*e.g.*, Whatman brand). Return steelhead to aerated bucket to recover. Fold blotter paper over for temporary storage. Samples must be air-dried as soon as possible (do not wait more than eight hours). Air-drying inside takes about 24 hours; air-drying in the sun is much quicker. When blotter/filter paper is dry to the touch, place it and sample into a clean envelope labeled with Sample ID Number. Seal envelope.

b. Live fish (alternate method): Cut a three mm square clip from tail fin using clean scissors and store the clip in a small (*e.g.*, two milliliter) vial filled with pure ethanol. Return steelhead to aerated bucket to recover. Sample must be fully immersed in ethanol. Ethanol dissolves all

inks, so make sure vials are well sealed and outside is dry. Label with Sample ID Number.

c. Carcasses: Either a three mm square clip from the operculum or tail fin, or alternately, complete scales (20-30) should be removed and placed on a piece of dry blotter/filter paper (*e.g.*, Whatman brand). Fold blotter paper over for temporary storage. Samples must be air-dried as soon as possible (do not wait more than eight hours). When tissue/paper is dry to the touch, place into a clean envelope labeled with Sample ID Number. Seal envelope

d. Additional guidelines:

Never cut adipose fin.
Each sample must be stored in a separate tube or envelope.
Each sample must be clearly labeled with the Sample ID Number.
Samples may be sent surface mail.
Samples are for scientific research. Please take care in their collection.

5. The Genetic Tissue Collection Data shall be provided to the Salmonid Genetic Repository, NOAA Fisheries Science Center, 110 Shaffer Road, Santa Cruz, California, 95060. Please contact Dr. Carlos Garza at (831) 420-3903 with questions or for additional instructions.

6. All non-salmonid aquatic vertebrates will be collected and relocated during electrofishing activities.

X. CONSERVATION RECOMMENDATIONS

Section 7(a)(1) of the ESA directs Federal agencies to utilize their authorities to further the purposes of the ESA by carrying out conservation programs for the benefit of endangered and threatened species. Conservation recommendations are discretionary agency activities to minimize or avoid adverse effects of a proposed action on listed species or critical habitat, to help implement recovery plans, or to develop information.

1. NOAA Fisheries recommends the Corps develop plans to address the impacts of summer dams in the San Lorenzo River watershed on salmonids.

2. NOAA Fisheries recommends the Corps work with the City of Santa Cruz, other agencies, and stakeholders to develop and implement a program for protection and restoration of salmon and steelhead habitat in the San Lorenzo River.

3. NOAA Fisheries recommends the Corps work with the City of Santa Cruz to develop a City-wide plan on how to minimize impacts to riparian habitats on projects permitted by the Corps.

In order for NOAA Fisheries to be kept informed of actions minimizing or avoiding adverse effects or benefitting listed species or their habitats, NOAA Fisheries requests notification of the implementation of any conservation recommendations.

XI. REINITIATION NOTICE

This concludes formal consultation on the actions outlined in the project proposal. As provided in 50 CFR 402.16, reinitiation of formal consultation is required where discretionary Federal agency involvement or control over the action has been retained (or is authorized by law) and if: (1) the amount or extent of incidental take is exceeded; (2) new information reveals effects of the action that may affect listed species or critical habitat in a manner or to an extent not previously considered in this opinion; (3) the action is subsequently modified in a manner that causes an effect to the listed species or critical habitat not considered in this opinion; (4) a new species is listed or critical habitat designated that may be affected by the action; or (5) the measures outlined above and included in the project proposal are not fully implemented. In instances where the amount or extent of incidental take is exceeded, formal consultation shall be reinitiated immediately.

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Enclosure 2

MAGNUSON-STEVENS FISHERY CONSERVATION AND MANAGEMENT ACT ESSENTIAL FISH HABITAT CONSULTATION

I. INTRODUCTION

The Magnuson-Stevens Fishery Conservation and Management Act (MSFCMA), as amended by the Sustainable Fisheries Act of 1996 (Public Law 104-267), established requirements for Essential Fish Habitat (EFH) descriptions in Federal fishery management plans and to require Federal agencies to consult with the National Marine Fisheries Service (NOAA Fisheries) on activities that may adversely affect EFH. Essential Fish Habitat for Pacific Coast salmon has been described in Appendix A, Amendment 14 to the Pacific Coast Salmon Fishery Management Plan. The San Lorenzo River bank stabilization project constructed by the U.S. Army Corps of Engineers (Corps) affects the San Lorenzo River, which has been designated EFH for salmon.

Only species managed under a Federal fishery management plan are covered under the MSFCMA. Coho salmon and Chinook salmon are managed under Federal fishery management plans, whereas steelhead are not managed. Therefore, these EFH Conservation Recommendations address only coho salmon and do not address steelhead. No recommendations are presented for Chinook salmon EFH because Chinook salmon are not present and do not use the San Lorenzo River watershed.

II. LIFE HISTORY AND HABITAT REQUIREMENTS

The life history of coho salmon in California has been well documented by Shapovalov and Taft (1954) and Hassler (1987). In contrast to the life history patterns of other anadromous salmonids, coho salmon in California generally exhibit a relatively simple 3-year life cycle (Shapovalov and Taft 1954, Hassler 1987). Adult salmon typically begin the freshwater migration from the ocean to their natal streams after heavy late-fall or winter rains breach the sand bars at the mouths of coastal streams (Sandercock 1991). Delays in river entry of over a month are not unusual (Salo and Bayliff 1958, Eames *et al.* 1981). Migration continues to March, generally peaking in December and January, with spawning occurring shortly after returning to the spawning grounds (Shapovalov and Taft 1954).

Coho salmon are typically associated with small to moderately-sized coastal streams characterized by heavily forested watersheds; perennially-flowing reaches of cool, high-quality water; dense riparian canopy; deep pools with abundant overhead cover; instream cover consisting of large, stable woody debris and undercut banks; and gravel or cobble substrates.

Female coho salmon choose spawning sites usually near the head of a riffle, just below a pool, where water changes from a laminar to a turbulent flow and there is small to medium gravel

substrate. The flow characteristics of the location of the redd usually ensure good aeration of eggs and embryos, and flushing of waste products. The water circulation in these areas also facilitates fry emergence from the gravel. Preferred spawning grounds have nearby overhead and submerged cover for holding adults; water depth of 10-54 centimeters (cm); water velocities of 20-80 cubic meters per second (cm/s); clean, loosely compacted gravel (1.3-12.7 cm diameter) with less than 20 percent fine silt or sand content; cool water (4-10 degrees Celsius [°C]) with high dissolved oxygen (8 milligrams per liter [mg/l]); and an intergravel flow sufficient to aerate the eggs. The lack of suitable gravel often limits successful spawning in many streams.

Each female builds a series of redds (nests), moving upstream as she does so, and deposits a few hundred eggs in each. Fecundity of coho salmon is directly proportional to female size; coho salmon may produce deposit from 1,000-7,600 eggs (reviewed in Sandercock 1991). Briggs (1953) noted a dominant male accompanies a female during spawning, but one or more subordinate males also may engage in spawning. Coho salmon may spawn in more than one redd and with more than one partner (Sandercock 1991). Coho salmon are semelparous (they spawn once and then die). The female may guard a nest for up to two weeks (Briggs 1953).

The eggs generally hatch between four to eight weeks, depending on water temperature. Survival and development rates depend on temperature and dissolved oxygen levels within the redd. According to Baker and Reynolds (1986), under optimum conditions, mortality during this period can be as low as 10 percent; under adverse conditions of high scouring flows or heavy siltation, mortality may be close to 100 percent. McMahon (1983) found that egg and fry survival drops sharply when fines make up 15 percent or more of the substrate. The newly-hatched fry remain in the gravel from two to seven weeks until emergence from the gravels (Shapovalov and Taft 1954). Upon emergence, fry seek out shallow water, usually along stream margins. As they grow, they often occupy habitat at the heads of pools, which generally provide an optimum mix of high food availability and good cover with low swimming cost (Nielsen 1992). Chapman and Bjornn (1969) determined that larger parr tend to occupy the head of pools, with smaller parr found further down the pools. As the fish continue to grow, they move into deeper water and expand their territories until, by July and August, they are in the deep pools. Juvenile coho salmon prefer well shaded pools at least 1 meter deep with dense overhead cover; abundant submerged cover composed of undercut banks, logs, roots, and other woody debris; preferred water temperatures of 12-15°C (Brett 1952, Reiser and Bjornn 1979), but not exceeding 22-25°C (Brungs and Jones 1977) for extended time periods; dissolved oxygen levels of 4-9 mg/l; and water velocities of 9-24 cm/sec in pools and 31-46 cm/sec in riffles. Water temperatures for good survival and growth of juvenile coho salmon range from 10-15°C (Bell 1973, McMahon 1983). Growth is slowed considerably at 18°C and ceases at 20°C (Stein *et al.* 1972, Bell 1973).

Preferred rearing habitat has little or no turbidity and high sustained invertebrate forage production. Juvenile coho salmon feed primarily on drifting terrestrial insects, much of which are produced in the riparian canopy, and on aquatic invertebrates growing in the interstices of the substrate and in the leaf litter in the pools. As water temperatures decrease in the fall and winter

months, fish stop or reduce feeding due to lack of food or in response to the colder water, and growth rates slow down. During December-February, winter rains result in increased stream flows and by March, following peak flows, fish again feed heavily on insects and crustaceans and grow rapidly.

In the spring, as yearlings, juvenile coho salmon undergo a physiological process, or smoltification, which prepares them for living in the marine environment. They begin to migrate downstream to the ocean during late March and early April, and out migration usually peaks in mid-May, if conditions are favorable. Emigration timing is correlated with peak upwelling currents along the coast. Entry into the ocean at this time facilitates more growth and therefore greater marine survival (Holtby *et al.* 1990). At this point, the smolts are about 10-13 cm in length. After entering the ocean, the immature salmon initially remain in nearshore waters close to their parent stream. They gradually move northward, staying over the continental shelf (Brown *et al.* 1994). Although they can range widely in the north Pacific, movements of coho salmon from California are poorly known.

III. PROPOSED ACTION

The Corps proposes to design and construct a bank stabilization wall and restore wildlife habitat along 900 feet of eroding river bank on the lower San Lorenzo River, in the City of Santa Cruz, Santa Cruz County, California. In addition, the existing maintenance road at the top of the bank would be rebuilt and restored for pedestrian, and emergency access. The street adjacent to the maintenance road will be replaced and improved. Construction is estimated to take approximately nine months and is scheduled to begin in April 2004. This action will enhance instream habitat conditions in the lower San Lorenzo River, stabilize the river bank, reduce erosion, and allow for the repairs to the maintenance road at the top of the riverbank.

IV. EFFECTS OF THE PROJECT ACTION

Effects of the proposed project on salmon EFH are those associated with the implementation of a bank stabilization project on the San Lorenzo River as described in the preceding biological opinion. In the action area in the San Lorenzo River (approximately 30,000 square feet), EFH is temporarily adversely affected by this project due to habitat degradation, sedimentation, turbidity, and loss of macroinvertebrates from construction activities. Ultimately, habitat effects of the proposed project are expected to be beneficial to EFH. The Corps will install root wad vanes, boulders, and in-stream vegetation to create pools for fish habitat at the project site.

V. CONCLUSION

After reviewing the effects of the San Lorenzo River bank stabilization project, NOAA Fisheries believes the project action, as proposed, will adversely affect the EFH of coho salmon in the San Lorenzo River. However, these adverse effects will be minor and temporary. NOAA Fisheries has determined that coho salmon have been extirpated from the San Lorenzo River and will not be impacted by adverse effects from this project. If coho salmon are restored to the river, they may benefit from the habitat improvements resulting from this project. Therefore no EFH recommendations are provided.

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UNITED STATES DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
NATIONAL MARINE FISHERIES SERVICE
Southwest Region
501 West Ocean Boulevard, Suite 4200
Long Beach, California 90802- 4213

JUL 16 2004

In response refer to:
151422SWR02SR6273:BLS

Lieutenant Colonel Michael McCormick, District Engineer
United States Department of the Army
San Francisco District, Corps of Engineers
333 Market Street, 8th Floor
San Francisco, California 94105-2197

Dear Colonel McCormick:

Enclosed is the National Marine Fisheries Service's (NOAA Fisheries) biological opinion (Enclosure 1) for the United States Army Corps of Engineers' (Corps) proposed permitting of the City of Santa Cruz Public Works Department to perform maintenance and sediment removal within the concrete flood control channel of Branciforte Creek, in the City of Santa Cruz, Santa Cruz County, California (Corps File Number 26875S). This biological opinion concludes the Corps' action is not likely to jeopardize the continued existence of threatened Central California Coast (CCC) Evolutionarily Significant Unit (ESU) steelhead (*Oncorhynchus mykiss*), and is not likely to adversely modify designated critical habitat for threatened CCC ESU coho salmon (*O. kisutch*). NOAA Fisheries expects the action will result in take of CCC ESU steelhead, and, therefore, an incidental take statement is included with the biological opinion. The incidental take statement includes reasonable and prudent measures necessary and appropriate to minimize incidental take of CCC ESU steelhead.

In addition to the biological opinion, NOAA Fisheries has evaluated the proposed project for potential adverse effects to Essential Fish Habitat (EFH) pursuant to section 305(b)(2) of the Magnuson-Stevens Fishery Conservation and Management Act. The EFH consultation for Pacific coast salmon (Enclosure 2) has determined that EFH will be only temporarily adversely affected, and in this case EFH recommendations are not necessary.

If you have any questions regarding this consultation, please contact Mr. Bill Stevens of the Santa Rosa Area Office at (707) 575-6066.

Sincerely,

Rodney R. McInnis
Regional Administrator

Enclosures (2)

cc:

Jim Lecky, NOAA Fisheries, Long Beach
Andrew Muss, Corps, San Francisco
Siobhan O'Neill, City of Santa Cruz Public Works Department, Santa Cruz
Robert Floerke, California Department of Fish and Game, Yountville
Diane Noda, U.S. Fish and Wildlife Service, Ventura

Enclosure 1

BIOLOGICAL OPINION

ACTION AGENCY: Department of the Army, Corps of Engineers, San Francisco District

ACTION: Permitting the City of Santa Cruz Public Works Department to Perform Maintenance and Sediment Removal Activities Within the Concrete Flood Control Channel of Branciforte Creek, Santa Cruz County, California.

CONSULTATION CONDUCTED BY: National Marine Fisheries Service, Southwest Region

FILE NUMBER: 151422SWR02SR6273

DATE ISSUED: JUL 16 2004

I. CONSULTATION HISTORY

On May 6, 2002, as requested by the City of Santa Cruz Public Works Department (City), the National Marine Fisheries Service (NOAA Fisheries) provided comments on the City's California Environmental Quality Act Initial Study and Mitigated Negative Declaration for flood control channel maintenance on Branciforte Creek, located in the City of Santa Cruz, Santa Cruz County, California. Branciforte Creek is a tributary to the San Lorenzo River and supports Federally threatened Central California Coast (CCC) Evolutionarily Significant Unit (ESU) steelhead (*Oncorhynchus mykiss*) and is designated critical habitat for threatened CCC ESU coho salmon (*O. kisutch*).

On June 17, 2002, we received the United States Army Corps of Engineers' (Corps) June 13, 2002, request for consultation pursuant to section 7(a)(2) of the Federal Endangered Species Act (ESA) of 1973, as amended (16 U.S.C. 1531 *et seq.*). The consultation would evaluate the effects of the Corps' permitting the City to perform maintenance and sediment removal activities within the concrete flood control channel of Branciforte Creek (Project) on CCC steelhead and designated critical habitat for CCC coho salmon. Through communications with the City and the Corps, NOAA Fisheries requested, and was granted, additional time to respond to the Corps' request.

On February 26, 2003, NOAA Fisheries received the Corps' February 21, 2003, second request for consultation. The Corps determined the proposed project may affect, but was not likely to adversely affect CCC steelhead. NOAA Fisheries did not concur with this determination and on March 25, 2003, informed the City that additional information was necessary to initiate formal

consultation on the Project. On September 23, 2003, NOAA Fisheries received the additional information from the Corps and formal section 7 consultation was initiated. NOAA Fisheries expected to provide the Corps our biological opinion no later than February 5, 2004.

In January 2004, the consultation was delayed due to additional information that became available, conflicts in scheduling site visits, and an expected change in the project description. On February 3, 2004, NOAA Fisheries requested an extension of the consultation period until an updated project description was received. Site visits were conducted on January 15, 2004 (NOAA Fisheries, Corps, California Department of Fish and Game [CDFG], City), and February 12, 2004 (Corps and the City) to clarify the project description.

On May 20, 2004, NOAA Fisheries received an updated project description from the City which was adequate to initiate formal section 7 consultation. NOAA Fisheries confirmed this with the Corps on June 9, 2004.

During consultation, NOAA Fisheries determined coho salmon were not likely to be adversely affected by the proposed project. This biological opinion analyzes the effects of the maintenance and sediment removal activities within the concrete flood control channel of Branciforte Creek on threatened CCC steelhead and designated critical habitat for threatened CCC coho salmon. This biological opinion is based on the best scientific and commercial data available including information contained in the Corps' Project Description, the City's permit application, the City's Negative Declaration for Branciforte Creek Flood Control Channel Maintenance, other letters and electronic mail, field investigations, telephone conversations, and other sources of information. A complete administrative record of this consultation is on file at the NOAA Fisheries Santa Rosa Area Office.

II. DESCRIPTION OF THE PROPOSED ACTION

The Corps proposes to authorize the maintenance and sediment removal activities in Branciforte Creek under the Department of the Army Nationwide Permit 31 (Maintenance of Existing Flood Control Projects) pursuant to section 404 of the Clean Water Act. The City would be permitted to remove accumulated sediment and vegetation in order to maintain the designed footprint and contour of the channel and restore flood capacity. Removal of sediment and vegetation will occur throughout an estimated 3,100 linear feet of Branciforte Creek, between Hubbard Street pedestrian bridge and Ocean Street bridge, in the City of Santa Cruz, Santa Cruz County, California. The City's sediment and vegetation removal activities would be permitted for two years, beginning in the summer of 2004, and continuing through the summer of 2005. Annual project activities will require approximately 21 working days to remove an estimated 5,800 cubic yards of material.

A. Background

Section 6 of the Flood Control Act of 1938 authorized and directed the Secretary of War "to cause preliminary examinations and surveys for flood control including floods aggravated by or due to tidal effect" for several creeks and rivers within the U.S., including the San Lorenzo River. In 1953, a preliminary examination and survey of the San Lorenzo River authorized by the Flood Control Act of 1938 was completed (Corps 1994). As a result of the examination and survey, the recommended plan included "flood-confining levees and floodwalls along the river, together with minor enlargement (dredging) of the channel and removal of certain obstructions to flow, and the improvement of Branciforte Creek by straightening and paving its channel." The "General Design Memorandum, San Lorenzo River Flood Control Project - May 1957" (Corps 1994) provided detailed design of the project authorized by the Flood Control Act of 1954. The basic features of the San Lorenzo River Flood Control Project are composed of a mainstem unit - San Lorenzo River - and a tributary unit - Branciforte Creek (Corps 1994). Construction of the mainstem unit of the San Lorenzo River Flood Control Project was completed in 1959, and the Branciforte Creek flood control channel portion was constructed in 1957-1959.

The Corps has required the City to obtain a separate permit for activities proposed to occur in Branciforte Creek or in the San Lorenzo River. However, the Corps will be writing one operations and maintenance manual (manual) for activities in Branciforte Creek and the San Lorenzo River which will replace the existing manual written in 1962. The Corps plans to complete the manual in 2005 and will request formal consultation pursuant to section 7(a)(2) of the ESA with NOAA Fisheries regarding its implementation. NOAA Fisheries intends that the biological opinion on the Corps' manual will supplement or supercede this existing biological opinion. Furthermore, the City is currently in the discussion stage with the regulatory agencies regarding a Habitat Conservation Plan. It is possible flood control and channel maintenance activities may be included in the list of covered activities.

The Branciforte Creek flood control channel portion of the San Lorenzo River Flood Control Project begins at the confluence with the San Lorenzo River and extends approximately one mile up Branciforte Creek. The flood control channel was designed to convey a 125-year flood event, estimated at 8,400 cubic feet per second (cfs). Accumulated silt, debris, and vegetation have reduced the capacity to 1,800-3,500 cfs, a 58-79% reduction from design capacity. The channel is a fully-lined rectangular concrete channel with 13- to 20-foot high vertical side walls and a 35-foot wide bottom.

A fish passage channel was constructed in the center of the channel to concentrate flow and facilitate passage for fish during low-flow periods. The fish passage channel is trapezoidal with a four-foot top width, one-foot bottom width, and one-foot depth extending from approximately 500 feet above the San Lorenzo River confluence to the upstream end of the flood control channel. The fish passage channel was constructed to accept baffle plates perpendicular to stream flow at 50- and 100-foot intervals. Channel sedimentation has restricted installation of these plates. Based on a site inspection, NOAA Fisheries recommended the City keep the fish

passage channel free of sediment and not install the plates. This recommendation conforms to the Corps' maintenance measure that "[all] sand or other obstructions shall be removed from the fish channel" (Corps 1962).

As part of a maintenance agreement between the Corps and the City (Corps 1962), the City is required to maintain the channel at its design capacity, including keeping the channel free of any obstructions, vegetation, silt or debris that might cause flooding problems during high flows. As such, the City has maintained the flood channel regularly since 1959. However, from approximately 1998 to Spring 2002, the City did not remove sediment and vegetation from the channel because they did not have a California Department of Fish and Game (CDFG) Streambed Alteration Agreement (SAA). Subsequently, debris, silt, and vegetation accumulated in the channel, which: (1) caused some localized flooding, and (2) provided habitat for steelhead. The Corps has sent a letter annually to the City recommending the City to return the channel to its design grade to ensure adequate channel capacity (E. Behn, Corps, pers. comm., December 4, 2003).

As described in the *Consultation History* section above, we received the Corps' initial request for consultation on June 17, 2002. On September 13, 2002, CDFG provided the City with a SAA and the City conducted sediment and vegetation removal activities in the dry portions of the channel above the ordinary highwater mark and without discharging fill into the waters of the U. S. Sediment and vegetation removal activities did not occur in 2003.

B. Project Actions

The City proposes to remove sediment and vegetation during the low-flow period (late summer-early fall) when stream flow is generally confined to the fish passage channel. Sediment and vegetation removal activities within the fish passage channel may be conducted in a different manner than activities within the concrete flood control channel.

1. Maintenance of fish passage channel

In order to remove sediment from the fish passage channel, the City intends to modify a piece of heavy equipment (*e.g.*, small tractor, bulldozer or skidsteer) with a v-shape plow or excavator bucket. The heavy equipment can enter the concrete flood control channel from an existing maintenance road at the upstream end of the flood control channel, or it can be lowered into the channel by a crane located on the maintenance road. The heavy equipment will drive down the center of the fish passage channel with the v-shaped plow pushing the sediment up and out onto the concrete flood control channel and/or use a bucket. Sediment that is removed from the fish passage channel is expected to be flushed from the concrete flood control channel with the onset of winter rains and the subsequent high stream flows. Other types of heavy equipment that may be used in this activity are excavators, draglines, loaders, and dump trucks.

The size of the maintenance area may require that the removal of sediment from the fish passage channel be addressed in sections. For example, depending on the amount of work needed, sediment removal activities would proceed in increments of approximately 50- to 1,000-foot sections. Fish capture and relocation activities and water diversion activities (described below) may be implemented in order to: (1) minimize impacts to CCC steelhead, and (2) facilitate the removal of sediment from the fish passage channel.

The City proposes an "adaptive management" approach in determining how fast sediment fills the fish passage channel following winter flows and what ramifications may occur from sedimentation. The City intends to work closely with the regulatory agencies on what approach is best to ensure the fish passage channel functions as designed. Conditions in the fish passage channel (*e.g.*, amount of sediment present) at the time the maintenance is proposed may dictate the best approach for fish channel maintenance.

2. Maintenance of concrete flood control channel

Two methods of channel cleaning may be used, both of which may require fish capture, and relocation activities and water diversion activities (described below). Both methods are intended to remove sediment in the concrete flood control channel. The accumulation of sediment has diverted flows from the smaller low-flow fish passage channel in the bottom of the flood control channel.

1. A front-end loader will proceed from upstream to downstream. The equipment would proceed down an existing ramp to the dry channel bed and then to the clean-up site. All in-channel equipment will be operated on the dry channel bottom, either to the right or left of the low-flow channel. Elevated wood platforms would be used at locations where equipment must cross the low-flow channel. Debris will be loaded into small dump trucks or containers and transferred to the City landfill. Alternatively, the vegetation will be removed and the silt deposits left in place to be carried out by high stream flows.

2. A small crane or tractor with an arm and bucket will be used to extract sediment and vegetation in the dry channel from various access points on the existing maintenance road above the channel. This method is the City's preferred alternative and would be used at locations where it is not possible to get equipment access to a removal site via the stream channel. Debris will be loaded into small dump trucks or containers and transferred to the City landfill. Alternatively, the vegetation will be removed and the silt deposits left in place to be carried out by high stream flows.

Some of the accumulated sediments and vegetation are located in a reach of the creek that contains the summer lagoon with water backed up from the San Lorenzo River (during most summers, a sandbar forms at the mouth of the San Lorenzo River, closing the mouth and forming a lagoon behind the sandbar. This condition will be described in more detail later in the *Environmental Baseline* section of this biological opinion). These deposits and vegetation would

only be removed when the lagoon is not in place *(i.e.*, when a sandbar did not form at the mouth of the San Lorenzo River) or when the sandbar has been breached.

3. Fish capture and relocation

Fish capture and relocation activities will be conducted as follows: a block net will be placed at the upstream and downstream ends of scheduled work area; the block nets, or other fish exclusion devices, will be kept in place for the duration of sediment and vegetation removal activities, including overnight. A biologist and/or appropriate City staff will walk upstream from the downstream net with a seine. Fish will be captured, placed in a bucket, and released by a biologist upstream of the concrete flood control channel.

If water is present the following morning in the area from where fish were captured, each morning prior to sediment and vegetation removal activities, a visual survey of block-netted area will be conducted. This survey will begin at downstream block net, walking upstream. If any fish are observed, fish will be captured and relocated upstream of the concrete flood control channel. Electrofishing may be used where necessary and appropriate. Genetic material from listed salmonids will be collected, as per NOAA Fisheries request. Upon completion of fish capture and removal activities, water diversion measures will be implemented.

4. Water diversion

The City will divert stream flow around the work area using cofferdams consisting of sandbags, hay bales, clean gravel, rubber, polypropylene or other appropriate material. In some cases, a bypass channel or detention basin may be appropriate to isolate a work area. Piping and pumping may also be used depending on the size (*i.e.*, length) of the work area and the amount of water that needs to be diverted.

Water in the concrete flood-control channel and/or in the fish passage channel will be addressed by the City's "adaptive management" approach. The City intends to work closely with the regulatory agencies on which approach is best to implement dependent upon water depth present at the time maintenance is proposed. As mentioned above, water levels in the action area may be extremely low, or the San Lorenzo River may be backed up all the way up the concrete flood-control channel through the primary maintenance area.

5. Rock diffusers

The Corps' Readiness Branch has suggested the City replace rocks displaced from the invert (*i.e.*, the upstream end) of the concrete flood control channel with new rocks. The rocks are meant to act as diffusers to prevent further erosion and prevent possible damage to the base of the concrete flood control channel. If the City decides to follow this suggestion, the City anticipates this process occurring in the following manner:

Eight granite rocks (five 18-inch and three 30-inch-diameter) will be placed in the natural channel (*i.e.*, immediately upstream of the concrete flood control channel) against the lip or abutment of the concrete flood control channel to protect the concrete. The rocks will not block fish access to the fish passage channel as the rocks will be at the same elevation, or lower than the elevation, of the concrete flood control channel abutment.

The rocks will be pressure washed prior to their installation in order to prevent turbidity. The rocks will be placed in the creek with a crane parked on the maintenance road. The larger rocks will be placed against the abutment and the smaller rocks will be placed directly in front of the larger rocks forming a gradual ramp into the existing fish passage channel. A biologist will be on-site during this activity. The City anticipates this activity would need to re-occur if many of the rocks are displaced as a result of high stream flows, erosion, *etc.* The City typically removes any rocks found in the flood control channel as part of its maintenance activities.

6. Drainage hole maintenance

The concrete flood control channel contains drainage holes which the Corps has determined are outside their jurisdiction as the drainage holes are above the ordinary high water mark. The drainage holes require periodic cleaning and will be accomplished in the following manner:

A vacuum truck will be parked on the maintenance road above the drainage holes and a hose will be lowered into the channel. The hose will connect to the drainage holes which will be vacuumed out. The in-channel areas adjacent to the drainage holes will be sandbagged to prevent any spillage from escaping from the hose into the concrete flood control channel.

C. Minimization and Conservation Measures

The following minimization and conservation measures for CCC steelhead were compiled by NOAA Fisheries from the City's Negative Declaration for Branciforte Creek Flood Control Channel Maintenance and from discussions with the Corps and the City. It is NOAA Fisheries' understanding the following general conditions will be applied to this project by the City to minimize impacts to listed salmonids:

- In-channel activities will be restricted to July 1 through October 31.
- Capture and relocation of fish will be conducted by a qualified fisheries biologist.
- The use of best management practices (*e.g.*, equipment used will not be refueled in or adjacent to the stream channel and all heavy equipment will be operated from the dry channel bed or top of bank) will be implemented to reduce the probability of contaminated material from entering Branciforte Creek.

D. Action Area

The action area is defined by regulation as "all areas to be affected directly or indirectly by the Federal action and not merely the immediate area involved in the action" (50 CFR §402.02). As such, the action area of this biological opinion includes the immediate area of the project site, beginning with the active concrete channel bed and banks, access roads, and effects downstream. The action area for this project is further defined as the 35-foot wide swath of channel where activities will occur along approximately 3,100 linear feet of flood control channel (108,500 square feet). The action area also includes approximately 200 square feet of the natural channel and bank of Branciforte Creek where rocks will be placed (approximately 20 feet along the bank where the width is approximately 10 feet). The ultimate distance downstream of the project site where effects (*i.e.*, sedimentation and turbidity) may occur cannot be quantified. However, based on sedimentation and turbidity from similar projects in similar streams, NOAA Fisheries expects these effects will be minor, and unlikely to adversely affect steelhead.

III. DESCRIPTION AND STATUS OF THE SPECIES

This biological opinion analyzes the adverse effects of the proposed project on the following species and designated critical habitat:

- Threatened CCC ESU steelhead (62 FR 43937).
- Designated critical habitat for CCC ESU coho salmon (64 FR 24049).

Threatened CCC ESU coho salmon (61 FR 56138) are deemed to be extirpated from the San Lorenzo River watershed at this time. This species, therefore, will not be considered in the effects analysis of this biological opinion.

A. Species Description

Because juvenile steelhead are expected to be rearing in the action area at the time of project activities, life history requirements during this life stage are discussed below in detail.

Spawning by adult steelhead may occur between December and June, but specific timing of spawning may vary a month or more among streams within a region. Shapovalov and Taft (1954) estimated hatching time of steelhead in Waddell Creek, Santa Cruz County, was from 25 to 35 days, emergence from the gravel began two to three weeks after hatching, and another two to three weeks was required to complete emergence. After emergence, steelhead fry utilize habitats with swift currents, moving gradually into deeper water as they grow. Older fry establish territories which they defend.

Juvenile steelhead require living space (different combinations of water depth and velocity), shelter from predators and harsh environmental conditions, food resources, and suitable water quality and quantity, for development and survival during summer and winter (Bjornn and Reiser 1991). Young-of-the-year (0+) and yearling steelhead generally use riffles and runs (*e.g.*, Roper *et al.* 1994) during much of a given year where these habitats exist. However, 0+ and older juveniles may seek cover and cool water in pools during the summer (Nielsen *et al.* 1994). Juvenile steelhead feed on a wide variety of aquatic and terrestrial insects, and emerging fry are sometimes preyed upon by older juveniles.

Streamside vegetation and cover are essential (Bjornn and Reiser 1991). Steelhead juveniles are usually associated with the bottom of the stream. In smaller California streams, the water levels may drop so low during the summer that pools become isolated and are the only viable rearing habitat. Daytime temperatures in summer rearing pools also may be near lethal levels; riparian shading and the presence of sub-surface, cold water seeps are often essential to maintain pool temperatures at tolerable levels. Because rearing juvenile steelhead reside in freshwater all year, adequate flow and temperature are important to the population at all times (CDFG 1997). In winter, juvenile steelhead become inactive and hide in any available cover, including gravel or woody debris.

Juvenile steelhead are affected by water temperature and dissolved oxygen (DO) levels. Water temperatures influence the growth rate, population density, swimming ability, ability to capture and metabolize food, and ability to withstand disease of these rearing juveniles. Dissolved oxygen levels of 6.5 to 7.0 milligrams per liter (mg/L) affected the migration and swimming performance of steelhead juveniles at all temperatures (Davis *et al.* 1963). Low DO levels decrease the rate of metabolism, swimming speed, growth rate, food consumption rate, efficiency of food utilization, affect normal behaviors, and ultimately reduce the survival rate of juveniles.

During rearing, suspended and deposited fine sediments can directly affect salmonids by abrading and clogging gills, and indirectly cause reduced feeding, avoidance reactions, destruction of food supplies, reduced egg and alevin survival, and changed rearing habitat (Reiser and Bjornn 1979). Larger juvenile salmon and trout appear to be little affected by ephemerally high concentrations of suspended sediments that occur during most storms (Cordone and Kelly 1961, Sorenson *et al.* 1977) but juvenile salmonids tend to avoid streams that are chronically turbid, such as those disturbed by human activities (Lloyd *et al.* 1987).

B. ESU Status and Trends

In this opinion, NOAA Fisheries assesses the status of the CCC steelhead ESU by examining four types of information, all of which help to understand a population's ability to survive. These population viability parameters are: abundance, growth rate, spatial structure, and diversity (McElhaney *et al.* 2000). Factors responsible for the current status of the ESU are also described.

While there are no specific estimates of abundance at the population scale, CCC steelhead numbers are substantially reduced from historical levels.. A total of 94,000 adult steelhead were estimated to spawn in the rivers of this ESU in the mid-1960s, including 50,000 fish in the Russian River[1] and 19,000 fish in the San Lorenzo River (Busby *et al.* 1996). Recent estimates for the Russian River are on the order of 4,000 fish (NOAA Fisheries 1997). Abundance estimates for smaller coastal streams in the ESU indicate low but stable levels (NOAA Fisheries 1997), with recent estimates for several streams (Lagunitas Creek, Waddell Creek, Scott Creek, San Vincente Creek, Soquel Creek, and Aptos Creek) of individual run sizes of 500 fish or less (62 FR 43937).

Overall, the abundance of the CCC steelhead ESU has declined precipitously, from an estimated 94,000 returning adults in the 1960s to estimates less than 5,350 in recent times (Busby *et al.*1996, NOAA Fisheries 1997). These numbers indicate over a 94 percent decline in the population of steelhead spawning in the ESU. Absent information indicating a recent upward trend in numbers ESU wide, NOAA Fisheries assumes that the overall population growth rate may continue to be negative. For more detailed information on the population trend of CCC steelhead, see Busby *et al.* 1996, NOAA Fisheries 1997, and NOAA Fisheries 2003a.

CCC steelhead have maintained a wide distribution throughout the ESU. Presence/absence data show that in a subset of streams sampled in the CCC region, most contain steelhead (NOAA Fisheries 1997). Of streams in the ESU for which there is current presence/absence data on steelhead, 218 of 264 streams currently support some juveniles (including the Russian River). Species with broad distributions are more likely to survive environmental fluctuations and stochastic events, even if they suffer local extirpation (Pimm *et al.* 1988). Many streams in and around the San Francisco Bay region, however, no longer support steelhead.

The interbasin transfer of hatchery steelhead has persisted in various locations and at various times within the CCC ESU (NOAA Fisheries 1997). This has likely affected the genetic composition of existing stocks. Although some genetic research is being done on CCC steelhead, little information is available to assess the diversity of the species.

While CCC steelhead have experienced significant declines in abundance and long-term population trends suggest a negative growth rate, they have maintained a wide distribution throughout the ESU. This suggests that, while there are significant threats to the population, they possess a resilience that is likely to slow their decline. In the recent document titled *Preliminary conclusions regarding the updated status of listed ESUs of West Coast salmon and steelhead*, the biological review team concluded that steelhead in the CCC steelhead ESU remain "likely to become endangered in the foreseeable future" (NOAA Fisheries 2003a).

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[1]The Russian River, which is the largest watershed in the ESU, once boasted steelhead runs ranked as the third largest in California, behind only the Klamath and Sacramento Rivers.

C. Factors Responsible for Stock Declines: Changes to Habitat and Other Impacts

Threats to naturally reproducing steelhead are numerous and varied. Habitat degradation and destruction (CDFG 1998), natural stochastic events (*e.g.*, droughts, landslides, and floods), ocean conditions (Beamish and Bouillion 1993, Beamish *et al.* 1997, Johnson 1988), alteration of stream flows (Chapman and Bjornn 1969, Berggren and Filardo 1993, 61 FR 56138), artificial propagation (Waples 1991, 1999, 61 FR 56138), predation by marine mammals (NOAA Fisheries 1999, Hanson 1993), and reduced marine-derived nutrient transport (Bilby *et al.* 1998, Gresh *et al.* 2000), have played a role to varying degrees in the decline of steelhead populations. Among the most serious and ongoing threats to salmonid survival in this ESU are changes in hydrology, and freshwater habitat degradation and loss. Increases in stream water temperature and other habitat alterations over large areas in the ESU have led to shifts in fish communities favoring warm water species.

In 1997 NOAA Fisheries identified past and present hatchery operations as the major threat to genetic integrity for steelhead in this ESU (NOAA Fisheries 1997a). Hatcheries can cause adverse genetic impacts on wild fish populations, disease transmission, predation on wild fish, replacement rather than supplementation of wild stocks, and depletion of wild stocks to increase brood stocks (61 FR 56138). Four artificial propagation programs are considered part of this ESU (69 FR 33102): (1) Don Clausen Fish Hatchery Captive Broodstock Program in Sonoma County; (2) Scott Creek/Kingfisher Flats Conservation Program in Santa Cruz County; (3) Scott Creek Captive Broodstock Program in Santa Cruz County; and (4) Noyo River Fish Station egg-take Program in Mendocino County, though operations have ceased. These hatchery operations have been improved to address genetic concerns. The stock has not had out-of-basin introductions in recent years, and hatchery fish are excluded from the broodstock. The current program goals of these operations include the restoration of local steelhead stocks.

D. Coho Salmon Critical Habitat

The proposed project occurs in Branciforte Creek, which contains designated critical habitat for threatened CCC ESU coho salmon. The condition of CCC ESU coho salmon critical habitat, specifically its ability to provide for the conservation of coho salmon, has been degraded from conditions known to support viable salmonid populations. NOAA Fisheries has determined present depressed population conditions are, in part, the result of the following human-induced factors affecting critical habitat: logging, agricultural and mining activities, urbanization, stream channelization, dams, wetland loss, water withdrawals, and unscreened diversions for irrigation.

Numerous studies have demonstrated land use activities associated with logging, road construction, urban development, mining, agriculture, and recreation have significantly degraded coho salmon critical habitat quantity and quality in the CCC coho salmon ESU. Impacts of concern include alteration of stream bank and channel morphology, alteration of water temperatures, loss of spawning and rearing habitat, fragmentation of habitat, loss of downstream recruitment of spawning gravels and large woody debris, degradation of water quality, removal

of riparian vegetation resulting in increased stream bank erosion, increases in erosion entry to streams from upland areas, loss of shade (resulting in higher water temperatures), and loss of nutrient inputs (64 FR 50394, NOAA Fisheries 1996, 61 FR 56138).

Branciforte Creek is located near the southern boundary of the CCC coho salmon ESU and the southernmost range of coho salmon in the western United States. Coho salmon used Branciforte Creek for spawning and rearing. In 1954-55, the estimated adult coho salmon run in the San Lorenzo River ranged between 7,000 and 14,000 (State Water Resources Control Board 1982). The San Lorenzo River watershed's value as critical habitat is high for coho salmon, given its location near the southernmost extent of their range and the relatively large coho population it supported historically. Recovering coho salmon to the full extent of their former range will likely require restoring important components of critical habitat in Branciforte Creek, such as spawning and rearing areas.

E. Status of the Species in the San Lorenzo River and Branciforte Creek

1. Overview

The San Lorenzo River is the primary municipal water source of the greater Santa Cruz area with approximately 85,000 customers (60-80 percent of the City's supply; County of Santa Cruz 2000). Approximately 75,000 people live within the watershed and obtain water supply from smaller streams and groundwater basins within the watershed (County of Santa Cruz 2000). The San Lorenzo River watershed is currently subject to numerous deleterious impacts including water diversions, summer dams, timber harvest, and urbanization. Unless current water supplies are augmented, the City of Santa Cruz will be unable to meet average annual demands in normal rainfall years, and the City of Santa Cruz Water Department recognizes that existing water supplies are inadequate to meet the health and safety needs of its current users in drought conditions (Swanson Hydrology & Geomorphology *et al.* 2002).

Watersheds within the San Lorenzo River are sinuous and incised with many ridges and deep ravines. Slow downward soil movement and landslides are the natural erosional processes chiefly responsible for forming the topography of this area. Numerous faults cross the San Lorenzo Valley and pose a potential geologic hazard and contribute overall to sediment loading in the Santa Cruz Mountains (Balance Hydrologics, Inc. 1998).

2. Steelhead in the San Lorenzo River and Branciforte Creek

Recent data for the San Lorenzo River watershed suggest this basin has a steelhead population smaller than 15 percent of the size it had 30 years previously. This basin was thought to have originally contained one of the two largest steelhead populations in the ESU (NOAA Fisheries 2003a).

Available information suggests that steelhead numbers in Branciforte Creek have declined similarly to the overall ESU and San Lorenzo River declines (Titus *et al.* 2002, CDFG 1996), although specific information on historic population levels within the creek are not available. Titus *et al.* (2002) and CDFG (1996) documented declines in instream habitat values in Branciforte Creek due to a variety of anthropogenic-induced factors. Recent information on juvenile abundance (post-1955) does exist for Branciforte Creek (Titus *et al.* 2002, Alley 2000, 2001, 2002, H.T. Harvey & Associates 2003). However, some information is qualitative, making it difficult to quantify the rate of recent decline in steelhead populations at the watershed level (*i.e.*, San Lorenzo River steelhead population) and local level (*i.e.*, Branciforte Creek's local steelhead population).

Since 1994, the County of Santa Cruz, the City of Santa Cruz, and the San Lorenzo Valley Water District have collaboratively funded surveys in the San Lorenzo River and its tributaries to ascertain population levels of steelhead. These surveys have been more rigorous than past efforts and provide the best available estimate of year-to-year status of steelhead in the San Lorenzo River watershed. Since 1998, two sites in Branciforte Creek have been sampled, and juvenile steelhead abundances have been estimated (Alley 2000, 2001, 2002, H.T. Harvey & Associates 2003). Estimated reach densities of total juvenile steelhead density in Branciforte Creek (1998-2002) from the nearest sample site to the action area - approximately 2.5 miles upstream - ranged from 29.0 to 68.0 juvenile steelhead per 100 feet.

In 2002, estimated juvenile steelhead abundance extrapolated to the mainstem of the San Lorenzo River and all sampled tributaries was 168,278, the highest since 1998, which had similar abundance estimates (H.T. Harvey & Associates 2003). Annual estimates of total juvenile steelhead produced in Branciforte Creek (Alley 2000, 2001, 2002, H.T. Harvey & Associates 2003) ranged from 10,682 in 2002 to 16,621 in 1998.

Branciforte Creek above the concrete flood control channel contains 10.5 miles of salmonid spawning and rearing habitat, and an additional 8 miles of habitat are available in three major tributaries to Branciforte Creek (CDFG, unpublished data, 2002). Vegetation, primarily willows (*Salix* spp.), in the concrete flood-control channel had not been removed between approximately 1998 and Spring 2002 and provided habitat for juvenile steelhead, as at least 100 juveniles were observed by NOAA Fisheries in the lower reach. Vegetation was removed in late summer/early fall 2002 and subsequent field visits comprised of ocular estimations conducted by NOAA Fisheries resulted in no steelhead observations. Three sites totaling 1,132 feet within the concrete flood-control channel were sampled for steelhead on August 19, 2003. Four juvenile steelhead (two pre-smolts) were captured at one site while zero steelhead were captured at the other two sites (Hagar Environmental Science 2003).

3. Anthropogenic Factors Affecting Species in Branciforte Creek

A variety of factors, both anthropogenic and natural, have played a role in the decline of steelhead in Branciforte Creek. Natural events, such as floods, droughts, and ocean productivity

cycles, have depressed population numbers when these events occur. However, the more recent anthropogenic destruction and degradation of essential freshwater habitats have reduced the resiliency of steelhead in Branciforte Creek to natural disturbances.

Excessive erosion, sedimentation, and turbidity (SCCPD 1979), diminished streamflows (SCCPD 1979, NOAA Fisheries 2001a, Denise Duffy & Associates, Inc. 1999) and channelization (Mount 1995) and summer dams (NOAA Fisheries 2001b) have degraded steelhead spawning and rearing habitats and designated critical habitat for CCC coho salmon in the San Lorenzo River watershed. These effects caused by on-going activities such as urbanization and water diversions, are expected to continue to occur in Branciforte Creek and the San Lorenzo River.

IV. ENVIRONMENTAL BASELINE

1. Aquatic Habitat Conditions in the Action Area

Branciforte Creek is a tributary to the San Lorenzo River which discharges to Monterey Bay at the City of Santa Cruz. A portion of Branciforte Creek has been channelized for flood control. The flood control channel was built through the existing Branciforte Creek valley from the confluence with the San Lorenzo River to 5,200 feet upstream. The flood control channel receives runoff from Carbonera Creek and the mainstem of Branciforte Creek which have a combined drainage area of 17.2 square miles. The confluence of Carbonera and Branciforte Creeks is approximately 0.25 miles upstream from the upper end of the flood-control reach.

The 5,200-foot flood-control channel is trapezoidal (mostly rectangular) in shape, lined with concrete. The width of the flood-control channel is 35 feet, and the wall varies in height from 13 to 20 feet. Habitat within the concrete flood-control channel consists of the low-flow channel and riffles, runs, glides, and corner scour pools that occur within the sediment deposits that lay on top of the concrete bottom (Gilchrist 2002). The concrete channel, when kept cleared of vegetation and sediment, provides little-to-no rearing habitat for salmonids due to high flow velocities, lack of instream cover, and high summer temperatures (CDFG 2002), though rearing juvenile and steelhead smolts were observed in August 2003 (Hagar Environmental Science 2003). NOAA Fisheries does not expect salmonids use the concrete channel for spawning due to the limitations described, and lack of spawning gravels. This area is primarily used as a migratory corridor to the salmonid spawning and rearing habitat upstream in Branciforte Creek and its tributaries. On August 19, 2003, flow was estimated at 1.5 cfs and velocity was approximately 1 foot per second (Hagar Environmental Science 2003).

From the upstream end of the concrete flood control channel downstream to approximately the Water Street Bridge (approximately 1,900 feet), the gradient is relatively high and generally very little sediment accumulates. Downstream from the Water Street Bridge the gradient decreases. Vegetation within the channel consists of yellow willow (*Salix lasiandra*), arroyo willow (*S.*

lasiolepis), white alder (*Alnus rhombifolis)*, acacia (*Acacia decurrens*), cattail (*Typha domingensis*), French broom (*Genista monspessulanus*), and Kikuyu grass. In many parts of the channel, silt, debris, and vegetation in the fish passage channel have pushed the creek out of the fish passage channel toward the east or west bank wall.

Vegetation above the top of the concrete flood control channel consists largely of ornamental trees and shrubs planted on private property (*i.e.*, in residences' backyards). Species above Water Street include redwood (*Sequoia sempervirens*), acacia, pines (*Pinus* spp.), *Eucalyptus* spp., and other ornamentals. On the east bank below Water Street native trees such as California bay (*Umbelluaria californica*), buckeye (*Aesculus californica*), and coast live oak (*Quercus agrifolia*) are interspersed with non-native blackwood and green wattle acacia. Some of the trees and large shrubs above the concrete flood control channel are overhanging, providing some shade to stream flows during summer months.

The lower portion of the San Lorenzo River is comprised of an estuarine reach. During winter months, the sandbar at the mouth of the San Lorenzo River is open and the river is subject to tidal exchange. In the summer months, the combined effect of declining river flows and the creation of a sandbar by summer wave action can result in sandbar closure. During a closed-bar condition at the mouth, the San Lorenzo River backs up through the action area. Within the action area, this situation produces deep, slack water habitat. Under an open-bar condition, stream flow is typically confined to the fish passage channel. Rapid changes between conditions as a result of a closed-bar or open-bar results in a high frequency of disturbance in the action area with very little response time for steelhead to react to the new hydrologic regime.

2. Status of Steelhead in the Action Area

Steelhead are present within the concrete flood-control channel. Adults and juveniles use the action area as a migration corridor and juveniles may use the action area as rearing habitat when suitable conditions exist (*i.e.*, when debris, silt, and vegetation accumulate in the channel). Three sites totaling 1,132 feet within the concrete flood-control channel were sampled for steelhead on August 19, 2003. Four juvenile steelhead - including two smolts - were captured at one site while zero steelhead were captured at the other two sites (Hagar Environmental Science 2003). Adult steelhead are not expected to be present when the project is scheduled to occur based on the shallow depths at the project site and the timing of adult migration (winter/spring). NOAA Fisheries estimates juvenile steelhead density in the concrete flood-control channel averages approximately 1 steelhead per 283 feet of stream (four juvenile steelhead per 1,132 feet of stream divided by four). NOAA Fisheries estimates that no more than 11 juvenile steelhead (3,100-foot action area divided by 283 feet of stream) are likely to be present in the action area when project activities occur.

3. Previous formal consultations in Branciforte Creek

a. Widening of Branciforte and Carbonera Creek Bridges on U.S. Route 1

On November 14, 2001, NOAA Fisheries issued our biological opinion to the Federal Highway Administration on this project (NOAA Fisheries 2001a). Adverse effects to listed species were limited to the immediate footprint of the project area and temporary impacts from construction activities were localized at the project sites. Most project related impacts were expected to be of limited scope and duration, and were expected to have no long term effects on the survival of the listed species, either within the Branciforte and Carbonera Creek drainages, the San Lorenzo River watershed, or at the ESU level. Long-term construction impacts were expected to be limited to the actual footprint of the work pads, the widened bridges due to Emeline Street off ramp structures, revegetated areas, low flow channel, and areas where stream bank integrity was expected to be enhanced. The areas of the channels disturbed for the instream work were expected to revert to a more natural condition than existed due to incorporation of boulder enhanced low flow channel and removal of sac concrete slope protection. This project has not yet occurred.

b. Market Street Bridge Scour Repair Project

On September 4, 2003, NOAA Fisheries issued our biological opinion to the Corps on this project (NOAA Fisheries 2003b). Impacts from the scour repair were expected to be localized at the project site, of limited scope and duration, and were expected to have no long-term effects on the survival of the listed species within the Branciforte Creek drainage, the San Lorenzo River watershed, or at the ESU level. The area of the channel disturbed for the instream work was expected to revert to a more natural condition than existed due to the scour repair and removal of obsolete concrete chunks. Based on post-project information provided to NOAA Fisheries, this project was completed as proposed, and impacts to listed species and aquatic habitats were as anticipated.

V. EFFECTS OF THE ACTION

The purpose of this section is to identify the direct and indirect effects of the proposed action on threatened CCC steelhead in the action area and designated critical habitat for threatened CCC coho salmon. Generally, the effects of the proposed action on steelhead and aquatic habitat, including designated coho salmon critical habitat, are those associated with performing maintenance of the flood-control channel, including removing sediment and vegetation from the channel.

A. Sediment Removal

Increased sedimentation and turbidity could result if fine sediment is contributed to Branciforte Creek, or mobilized, during the proposed action. Substantial sedimentation rates could bury less mobile organisms (Ellis 1936, Cordone and Kelley 1961) that serve as a food source for many fish species, degrade instream habitat conditions (Cordone and Kelly 1961, Eaglin and Hubert 1993), and cause reductions in fish abundance (Alexander and Hansen 1986, Berkman and Rabeni 1987) and growth (Crouse *et al.* 1991). Turbidity may cause indirect harm, injury or mortality to juvenile steelhead in the action area. High turbidity concentrations can result in fish mortality, reduce feeding efficiency, and decrease food availability (Berg and Northcote 1985, McLeay *et al.* 1983, Gregory and Northcote 1993, Velagic 1995).

The proposed sediment and vegetation removal activities will affect the physical and biological environment of the action area. Cofferdams will be used to temporarily divert flows in Branciforte Creek and dewater the work areas. Dewatering activities will affect approximately 3,100 linear feet of Branciforte Creek. The stream flow diversion structures will be in place for a maximum duration of four months (July 1 through October 31), though likely will only require 21 days. These temporary structures in the stream may hinder movement of steelhead between areas upstream and downstream of the work areas. However, the cofferdams will be placed such that stream flow will go around the dewatered area and will allow for juvenile steelhead to pass.

The operation of the cofferdams and water diversions are not expected to adversely affect steelhead movements in Branciforte Creek because few steelhead are likely to be moving through the concrete channel during the work period (July 1 through October 31). The work period is outside the migratory period of both adult and juvenile steelhead. Adult steelhead migrate upstream during the winter months and post-spawned adults will return downstream immediately following spawning in the late winter and early spring. Adult steelhead are not expected to be present in the action area during the proposed work period and not expected to be directly affected by sediment and vegetation removal activities. The movements of a few juvenile steelhead may be affected temporarily, but because stream flow and passage around the cofferdams will be provided, this temporary impact is unlikely to affect the fitness of individual fish.

Most steelhead smolts outmigrate between February and April, though two smolts were captured in the action area in August 2003 (Hagar Environmental Science 2003). During the work period, few juvenile steelhead are expected to be in the concrete channel due to poor habitat conditions. Steelhead spawning in Branciforte Creek occurs upstream of the concrete channel, as does higher quality summer rearing habitat.

Any effects as a result of an increase in turbidity and/or sedimentation are not likely to adversely steelhead or their habitat in the action area, as these effects are expected to be minimal and temporary. The City proposes to isolate the work areas from flowing water and the in-channel work window will be limited. Steelhead will be relocated upstream prior to channel maintenance

activities. Sediment that is mobilized will be flushed downstream following the first rainfall event.

B. Riparian Vegetation Removal

The removal of vegetation within the concrete flood control channel - primarily willows and cattails - could result in increased stream temperatures. Riparian vegetation moderates stream temperatures by providing canopy which shades the water and reduces the amount of insolation (*i.e.*, direct solar radiation) that reaches the water surface (Beschta 1991, Hetrick *et al.* 1998). Listed species may be harmed when stream temperatures are elevated to such an extent that they result in behavioral and/or physiological responses, which in turn, result in decreases to the individual's ability to survive.

Stream side vegetation provides habitat for terrestrial insects, which are important food for salmonids. This vegetation also directly provides organic material to the stream, which makes up about 50 percent of the stream's nutrient energy supply for the food chain (Cummins 1974). Detritus from incoming terrestrial plants is a principal source of food for aquatic invertebrates that eventually become food for fish (Minshall 1967). Removal of stream side vegetation can, therefore, affect the diet of fish by reducing production of both terrestrial and aquatic insects (Chapman and Demory 1963).

The removal of vegetation within the concrete flood control channel will reduce the amount of cover available for steelhead. The importance of cover to fish is well documented. For instance, when stream cover is reduced, a decline in salmonid abundance is often a consequence (Boussu 1954).

Riparian vegetation removal may result in increased stream temperatures, reduce the amount of available food, and decrease the quality of habitat. However, few juvenile steelhead use the action area as rearing habitat and likely do so only because vegetation and sediment were allowed to accumulate because channel maintenance activities did not occur. Steelhead habitat was degraded with the creation of the concrete channel in 1959 and implementation of channel maintenance activities will result in little-to-no habitat for steelhead.

Adults use the action area as a migratory corridor, and NOAA Fisheries does not expect the quality of adult steelhead migration habitat will be reduced as a result of sediment and vegetation removal activities.

C. Fish Capture and Relocation

Juvenile steelhead within the project site will be captured following the installation of the containment barrier and relocated to adjacent suitable habitat upstream of the concrete flood control channel. As described previously in the *Environmental Baseline* section, NOAA Fisheries does not expect more than 11 steelhead will need to be captured and relocated.

An effect of principal concern is mortality and injury to juvenile steelhead in the work area due to fish capture and relocation activities. Any fish relocation gear, whether passive (Hubert 1983) or active (Hayes 1983) has some associated risk to the fish, including stress, disease transmission, injury, or death.

Dip nets and/or seines will be used to capture and relocate juvenile steelhead. Small steelhead can be gilled in the mesh of a seine and scales and dermal mucus can be abraded by contacting the net. Juvenile steelhead can be suffocated if they are not quickly removed from the net after the net is removed from the water to process steelhead. Steelhead also can be crushed by the handler if the handler steps on the net. The risks to juvenile steelhead can be minimized if the handler carefully, quickly, and thoroughly removes all steelhead from the net and places them in bucket of water.

Electrofishing may be used where necessary and appropriate. Electrofishing can kill both juvenile and adult fish (Reynolds 1983, Zeigenfuss 1995, Habera *et al.* 1996, Nordwall 1999). The amount of unintentional mortality attributable to electroshocking may vary widely depending on the equipment used, the settings on the equipment, ambient conditions, and the expertise and experience of the personnel. The effects to fish from electroshocking can be severe and may include death, spinal injuries, burns, hemorrhaging, and physiological stress. Long-term effects of electroshocking on both juveniles and adult salmonids are not well understood. Though chronic effects may occur, it is assumed most impacts from electroshocking occur at time of sampling.

After juvenile steelhead are relocated, stress from crowding and increased competition for food in the relocation areas may occur. This stress and increased competition in the relocation areas will be minimal and temporary. Upon project completion, steelhead will be able to redistribute in the action area unimpeded.

Based on NOAA Fisheries' prior experience with current relocation techniques and protocols to be used to conduct the fish capture and relocation activities, unintentional mortality of listed juvenile CCC steelhead expected from capture and handling procedures is not likely to exceed three percent of the fish subjected to handling, and can be reduced to near one percent with increased skill and experience of the fish relocation personnel. Despite these impacts, fish capture and relocation operations are expected to significantly minimize project impacts to steelhead by removing them from areas where they would have experienced high rates of injury and mortality. Based on the estimate of salmonid numbers given above, and a three percent mortality rate from dip netting and/or seining, NOAA Fisheries expects that at most one steelhead will be killed during fish capture and relocation activities.

D. Dewatering

Stream flow diversion and work space dewatering is expected to cause temporary loss, alteration, and reduction of aquatic habitat within the action area. Stream flow diversions could harm

individual steelhead by concentrating or stranding them in residual wetted areas (Cushman 1985) before they are relocated, or causing them to move to adjacent habitats (Clothier 1953, 1954, Kraft 1972, Campbell and Scott 1984). Steelhead could be killed or injured if crushed beneath the containment barrier during installation, though direct mortality is expected to be minimal because of the small number of steelhead in the action area. During installation of the containment barrier, a fisheries biologist will remain in the flood control channel to net and rescue any additional fish that may have become stranded throughout the dewatering process.

It is unlikely that steelhead which initially avoid capture in work spaces will die during dewatering activities. Due to the concrete bottom of the flood control channel and lack of escape cover, any steelhead that initially avoid capture will be easily observed near the completion of the dewatering process, captured, and relocated. NOAA Fisheries does not expect any steelhead will be killed as a result of stranding during dewatering activities.

Benthic (*i.e.*, bottom-dwelling) aquatic macroinvertebrates may be temporarily lost or their abundance reduced when individual organisms are stranded or when creek habitats are dewatered (Cushman 1985). Effects to aquatic macroinvertebrates resulting from stream flow diversions and dewatering will be temporary because construction activities will be relatively short-lived, and rapid recolonization (about one to two months) of disturbed areas by macroinvertebrates (Cushman 1985, Thomas 1985, Harvey 1986) is expected following rewatering. In addition, the effect of macroinvertebrate loss on juvenile steelhead is likely to be negligible because food from upstream sources (via drift) would be available downstream of the dewatered areas since stream flows will be maintained outside of the checkdam. Based on the foregoing, the loss of aquatic macroinvertebrates as a result of dewatering activities is not expected to adversely effect steelhead.

E. Interrelated and Interdependent Actions

An interrelated action is an activity that is part of a larger action and depends on the larger action for its justification. An interdependent action is an activity that has no independent utility apart from the action under consultation (50 CFR §402.02). There are no known interrelated or interdependent actions associated with the Corps permitting maintenance and sediment removal activities within the concrete flood control channel of Branciforte Creek.

VI. CUMULATIVE EFFECTS

Cumulative effects include the effects of future State, tribal, local or private actions that are reasonably certain to occur in the action area considered in this biological opinion. Future Federal actions unrelated to the proposed action are not considered in this section because they require separate consultation pursuant to section 7 of the ESA. In addition to the on-going activities described above in the *Environmental Baseline* section, the City of Santa Cruz is proceeding with an ocean desalination project as their current water system relies primarily on

surface water supplies. When properly located and planned accordingly, ocean desalination can be an environmentally safe alternative that avoids or minimizes impacts to Federally listed salmonids. Limiting the use of surface water as a source of water supply is important for the recovery of listed species. An expected benefit of a regional desalination project would be using desalinated seawater to replace water withdrawals from coastal streams.

VII. INTEGRATION AND SYNTHESIS OF EFFECTS

Channel maintenance activities in Branciforte Creek Flood Control Channel will result in the dewatering of 3,100 linear feet of Branciforte Creek. Steelhead present in the areas to be dewatered will be subject to capture and relocation. One steelhead may be killed as a result of fish capture and relocation activities.

Impacts from the channel maintenance activities will be localized at the project site, will be of limited scope and duration, and are expected to have no long-term effects on the survival of the listed species within the Branciforte Creek drainage, the San Lorenzo River watershed, or at the ESU level.

Although the population of steelhead in Branciforte Creek is considerably depressed from historical numbers, NOAA Fisheries does not believe the loss of a few juvenile steelhead will appreciably reduce the number, distribution, or reproduction of steelhead in Branciforte Creek. Maintaining the concrete flood control free of sediment and vegetation is expected to preclude many juvenile steelhead from rearing in the action area, which has generally been the case between 1959 and 1998.

As described in the *Status of the Species in the San Lorenzo River and Branciforte Creek* section of this biological opinion, data suggests the San Lorenzo River watershed basin has a steelhead population smaller than 15 percent of the size it had 30 years previously, and steelhead numbers in Branciforte Creek have declined similar to the overall ESU and San Lorenzo River declines. NOAA Fisheries believes it is reasonable to conclude that steelhead densities in Branciforte Creek where the channel is now lined with concrete were higher before the flood control channel was constructed. Some steelhead habitat is created in the concrete flood control channel when channel maintenance activities do not occur. Thus, the steelhead carrying capacity of Branciforte Creek was reduced with the creation of the concrete flood control channel and remains reduced with on-going channel maintenance activities.

NOAA Fisheries does not expect that sustaining the reduced carrying capacity of the habitat in the action area due to channel maintenance activities will appreciably reduce the likelihood of steelhead survival and recovery in Branciforte Creek, the San Lorenzo River, or the ESU. Branciforte Creek above the concrete flood control channel contains 10.5 miles of salmonid spawning and rearing habitat, and an additional 8 miles of habitat are available in three major tributaries to Branciforte Creek (CDFG, unpublished data, 2002). Steelhead spawning in

Branciforte Creek occurs upstream of the concrete channel, as does higher quality summer rearing habitat. As described earlier, the downstream end of the concrete flood control begins at the confluence with the San Lorenzo River. In 2002, estimated juvenile steelhead abundance extrapolated to the mainstem of the San Lorenzo River and all sampled tributaries was 168,278, the highest since 1998, which had similar abundance estimates (H.T. Harvey & Associates 2003). There are no known projects expected to occur in Branciforte Creek similar to the construction of a 5,200-foot concrete-lined channel. Further, the City of Santa Cruz is in the discussion stage with the regulatory agencies regarding a Habitat Conservation Plan. Thus, Branciforte Creek is unlikely to experience habitat modification in the future similar to what occurred with the construction of the Branciforte Creek Flood Control Channel.

Keeping sediment free from the fish passage channel will improve juvenile passage through the concrete flood control channel to rearing habitat upstream and downstream of the concrete flood control channel. Based on the approximate 10,000 to 16,000 juvenile steelhead in Branciforte Creek, a one-time loss of one juvenile steelhead rearing in the action area during channel maintenance activities is unlikely to have a detectable effect on this population's abundance or viability because the remaining population is large enough to be resilient to this small, one-time, loss. Spawning in subsequent years is expected to produce enough juveniles to repopulate any habitat area that may become vacant by the loss of one juvenile, though less habitat will be available as a result of channel maintenance activities. Thus, survival and recovery of this population, or the ESU in general, is not likely to be appreciably reduced.

The effects of the project will result in temporary impacts to critical coho salmon habitat, as well as the longer term impacts discussed above. Increased sedimentation and turbidity, stream flow diversion, and resultant loss of aquatic macroinvertebrates are short-term effects. These impacts are expected to last no more than a few weeks based on the impact minimization measures and conservation measures proposed. The sustained reduction in carrying capacity is unlikely to reduce the value of CCC coho salmon critical habitat in Branciforte Creek because the value of any habitat that forms in the concrete flood control channel via the accumulation of sediment and vegetation is limited, and much larger areas of higher value habitat exist in the Creek and San Lorenzo River watershed.

VIII. CONCLUSION

After reviewing the best available scientific and commercial information, the status of CCC steelhead, the environmental baseline for the action area including the condition of CCC coho salmon critical habitat, the effects of the proposed maintenance and sediment removal activities within the concrete flood control channel of Branciforte Creek, and cumulative effects, it is NOAA Fisheries' biological opinion that the proposed project is not likely to jeopardize the continued existence of CCC steelhead, nor is it likely to destroy or adversely modify designated coho salmon critical habitat.

IX. INCIDENTAL TAKE STATEMENT

Section 9 of the ESA and Federal regulation pursuant to section 4(d) of the ESA prohibit the take of endangered and threatened species, respectively, without special exemption. Take is defined as to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture or collect, or to attempt to engage in any such conduct. Harm is further defined by NOAA Fisheries as an act which actually kills or injures fish or wildlife. Such an act may include significant habitat modification or degradation which actually kills or injures fish or wildlife by significantly impairing essential behavioral patterns, including breeding, spawning, rearing, migrating, feeding, or sheltering. Incidental take is defined as take that is incidental to, and not the purpose of, the carrying out of an otherwise lawful activity. Under the terms of section 7(b)(4) and section 7(o)(2), taking that is incidental to and not intended as part of the agency action is not considered to be prohibited taking under the ESA provided that such taking is in compliance with the terms and conditions of this incidental take statement.

The measures described below are nondiscretionary, and must be undertaken by the Corps for the exemption in section 7(o)(2) to apply. The Corps has a continuing duty to regulate the activity covered by this incidental take statement. If the Corps (1) fails to assume and implement the terms and conditions or (2) fails to require its designees to adhere to the terms and conditions of the incidental take statement, the protective coverage of section 7(o)(2) may lapse. In order to monitor the impact of incidental take, the Corps must report the progress of the actions and its impact on the species to NOAA Fisheries as specified in the incidental take statement (50 CFR §402.14(I)(3)).

This incidental take statement is based on implementation of the proposed project as described in the *Description of the Proposed Action* section of this biological opinion, including impact minimization and conservation measures incorporated into the project design. Failure to implement the project as proposed (including relevant conservation measures) or implementation of the project in a manner that causes an effect to listed species, or designated critical habitat not considered in this opinion may cause coverage of section 7(o)(2) to lapse and require reinitiation of consultation to ensure compliance with section 7(a)(2) of the ESA.

A. Amount or Extent of Take

Based on estimated juvenile steelhead densities in the action area, NOAA Fisheries anticipates incidental take of CCC steelhead is likely to occur as a result of implementation of the proposed project. During dewatering and fish relocation activities, all juvenile steelhead present will be subjected to capture and related stresses. With direct relocation mortality rates (*i.e.*, as a result of electrofishing) ranging up to three percent and the unlikely potential for many steelhead to be left in dewatered areas since the action area has a concrete bottom, NOAA Fisheries expects one steelhead will be killed during relocation and dewatering activities. The area directly disturbed by flood control channel maintenance activities will be approximately 108,500 square feet. All juveniles present in that area between July 1 and October 31 will captured. No incidental take of

adult steelhead is anticipated for this project.

B. Effect of the Take

In the accompanying biological opinion, NOAA Fisheries determined this level of anticipated take is not likely to result in jeopardy to CCC steelhead and the project is not likely to result in the destruction nor adverse modification of CCC coho salmon critical habitat.

C. Reasonable and Prudent Measures

The following reasonable and prudent measures are necessary and appropriate to minimize take of threatened CCC steelhead. The results of the effect analysis in this biological opinion provide the basis for the reasonable and prudent measures.

1. The Corps shall implement measures to reduce and monitor steelhead injury and mortality associated with dewatering and fish relocation activities.

2. The Corps shall implement minimization and conservation measures that will avoid and minimize impacts to CCC steelhead.

3. The Corps shall report to NOAA Fisheries activities associated with minimizing and monitoring effects of the proposed action on steelhead.

D. Terms and Conditions

In order to be exempt from the take prohibitions of the ESA, the Corps must comply with the following non-discretionary Terms and Conditions, which implement the Reasonable and Prudent Measures described above.

The following Terms and Conditions implement Reasonable and Prudent Measure No. 1.

1. Captured fish shall be kept in cool, shaded, aerated water (*e.g.*, plastic bucket) protected from noise or jostling any time they are not in the stream and fish shall not be removed from this water except for (1) collection of genetic material (see below) and (2) when released.

2. Fish capture activities shall be conducted by a NOAA Fisheries-approved biologist. Contact NOAA Fisheries (see below) for approval procedures.

3. If electrofishing is used to capture fish, the backpack electrofisher will be set as follows:

	Initial settings	Maximum settings
Voltage	100 V (Volts)	400 V
Pulse width	500 µs (microseconds)	5 ms (milliseconds)
Pulse rate	30 Hz (Hertz)	70 Hz

4. No electrofishing shall occur if water conductivity is greater than 350 µS/cm (microSiemens per centimeter) when instream water temperatures exceed 18°C. Only direct current (DC) shall be used.

5. A minimum of three passes with the electrofisher will be utilized to ensure maximum capture probability of steelhead within the area proposed for dewatering.

6. All captured steelhead will be processed and released prior to conducting a subsequent electrofishing pass.

7. All captured fish will be allowed to recover from electrofishing before being returned to the stream.

8. Fish shall not be overcrowded into buckets, allowing approximately six cubic inches per 0+ individual and more for larger/older fish.

9. Make every effort not to mix 0+ with potential predators that may consume the smaller salmonids.

10. A copy of this biological opinion shall be kept on-site for the duration of the project.

The following Term and Condition implements Reasonable and Prudent Measure No. 2.

1. Fish screens on pumps shall be implemented according to NOAA Fisheries' *Fish Screening Criteria for Anadromous Salmonids* (NOAA Fisheries 1997b).

2. In order to prevent rocks placed within the natural channel of Branciforte Creek (immediately upstream of the concrete flood control channel) becoming displaced and causing fish passage impediments in the fish passage channel, rocks placed shall be sized appropriately to minimize the likelihood of becoming displaced.

The following Terms and Conditions implement Reasonable and Prudent Measure No. 3.

1. Notify NOAA Fisheries one week prior to capture activities in order to provide an

opportunity to attend. Call NOAA Fisheries Biologist Bill Stevens at (707) 575-6066, or e-mail at William.Stevens@noaa.gov.

2. Provide a written monitoring report to NOAA Fisheries within 90 working days following the completion of the proposed action. The report shall include the number of CCC steelhead killed or injured during the proposed action; the number and size (in millimeters) of steelhead captured and removed; any effect of the proposed action on steelhead not previously considered; and photographs taken before, during, and after the activity from photo reference points. All data relating to steelhead shall be submitted to the Santa Rosa NOAA Fisheries Office at 777 Sonoma Avenue, Room 325, Santa Rosa, California, 95404-6528, Attention: Bill Stevens.

3. If more than two listed salmonids are killed, injured, or found dead or injured, the project permitee shall contact NOAA Fisheries Biologist Bill Stevens by phone immediately at (707) 575-6066. If Mr. Stevens cannot be reached, the Santa Rosa NOAA Fisheries Office will be contacted at Federal Relay 1-866-377-8642 ([707] 578-8555). The purpose of the contact is to review the activities resulting in take and to determine if additional protective measures are required. All steelhead mortalities must be retained, placed in an appropriately sized whirl-pak or zip-lock bag, labeled with the date and time of collection, fork length, location of capture, and frozen as soon as possible. Frozen samples must be retained until specific instructions are provided by NOAA Fisheries.

4. For all steelhead (if any) captured for relocation, genetic tissue data will be collected. The following information shall be part of the Genetic Tissue Collection Data:

Collection Date
Collection Location (County, River, Exact location on river)
Collector Name
Collector Affiliation/Phone
Sample ID Number
Species Tissue Type
Condition
Fork Length (mm; in order to facilitate measurements, fish may be anesthetized.)
Sex (M, F, Unk.)
Adipose Fin Clip? (Y or N)
Tag? (Y or N)
Notes/Comments

If the City collects genetic tissue, it shall be collected according to the following protocols:

a. Live fish: Cut a three millimeter (mm) square clip from tail fin using clean scissors and place sample in a piece of dry blotter/filter paper (e.g., Whatman brand). Return steelhead to aerated bucket to recover. Fold blotter paper over for temporary storage. Samples must be air-dried as soon as possible (do not wait more than eight hours). Air-drying inside takes about 24 hours; air-drying in the sun is much quicker. When blotter/filter paper is dry to the touch, place it and sample into a clean envelope labeled with Sample ID Number. Seal envelope.

b. Live fish (alternate method): Cut a three mm square clip from tail fin using clean scissors and store the clip in a small (e.g., two milliliter) vial filled with pure ethanol. Return steelhead to aerated bucket to recover. Sample must be fully immersed in ethanol. Ethanol dissolves all inks, so make sure vials are well sealed and outside is dry. Label with Sample ID Number.

c. Carcasses: Either a three mm square clip from the operculum or tail fin, or alternately, complete scales (20-30) should be removed and placed on a piece of dry blotter/filter paper (e.g., Whatman brand). Fold blotter paper over for temporary storage. Samples must be air-dried as soon as possible (do not wait more than eight hours). When tissue/paper is dry to the touch, place into a clean envelope labeled with Sample ID Number. Seal envelope.

d. Additional guidelines:

Never cut adipose fin.
Each sample must be stored in a separate tube or envelope.
Each sample must be clearly labeled with the Sample ID Number.
Samples may be sent surface mail.
Samples are for scientific research. Please take care in their collection.

5. The Genetic Tissue Collection Data shall be provided to the Salmonid Genetic Repository, NOAA Fisheries Science Center, 110 Shaffer Road, Santa Cruz, California, 95060. Please contact Dr. Carlos Garza at (831) 420-3903 with questions or for additional instructions.

X. CONSERVATION RECOMMENDATIONS

Section 7(a)(1) of the ESA directs Federal agencies to utilize their authorities to further the purposes of the ESA by carrying out conservation programs for the benefit of endangered and threatened species. Conservation recommendations are discretionary agency activities to minimize or avoid adverse effects of a proposed action on listed species or critical habitat, to help implement recovery plans, or to develop information.

1. NOAA Fisheries recommends the Corps develop plans to address the impacts of summer dams in the San Lorenzo River watershed on salmonids.

2. NOAA Fisheries recommends the Corps work with the City of Santa Cruz, other agencies, and stakeholders to develop and implement a program for protection and restoration of salmon and steelhead habitat in the San Lorenzo River watershed.

3. NOAA Fisheries recommends the Corps work with the City of Santa Cruz to develop a City-wide plan on how to minimize impacts to riparian habitats on projects permitted by the Corps.

In order for NOAA Fisheries to be kept informed of actions minimizing or avoiding adverse effects or benefitting listed species or their habitats, NOAA Fisheries requests notification of the implementation of any conservation recommendations.

XI. REINITIATION NOTICE

This concludes formal consultation on the actions outlined in the project proposal. As provided in 50 CFR §402.16, reinitiation of formal consultation is required where discretionary Federal agency involvement or control over the action has been retained (or is authorized by law) and if: (1) the amount or extent of incidental take is exceeded; (2) new information reveals effects of the action that may affect listed species or critical habitat in a manner or to an extent not previously considered in this opinion; (3) the action is subsequently modified in a manner that causes an effect to the listed species or critical habitat not considered in this opinion; (4) a new species is listed or critical habitat designated that may be affected by the action; or (5) the measures outlined above and included in the project proposal are not fully implemented. In instances where the amount or extent of incidental take is exceeded, formal consultation shall be reinitiated immediately.

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Enclosure 2

MAGNUSON-STEVENS FISHERY CONSERVATION AND MANAGEMENT ACT ESSENTIAL FISH HABITAT CONSULTATION

Maintenance and Sediment Removal Activities Within the Concrete Flood Control Channel of Branciforte Creek, Santa Cruz County, California.

I. INTRODUCTION

The Magnuson-Stevens Fishery Conservation and Management Act (MSFCMA), as amended by the Sustainable Fisheries Act of 1996 (Public Law 104-267), established requirements for Essential Fish Habitat (EFH) descriptions in Federal fishery management plans and to require Federal agencies to consult with the National Marine Fisheries Service (NOAA Fisheries) on activities that may adversely affect EFH. EFH for Pacific Coast salmon has been described in Appendix A, Amendment 14 to the Pacific Coast Salmon Fishery Management Plan. As described below in the *Proposed Action* section of this EFH consultation, the proposed activities of the City of Santa Cruz Public Works Department (City) permitted by the U.S. Army Corps of Engineers (Corps) affect Branciforte Creek, which has been designated EFH for salmon.

Only species managed under a Federal fishery management plan are covered under the MSFCMA. Coho salmon and Chinook salmon are managed under Federal fishery management plans, whereas steelhead are not managed. Therefore, these EFH Conservation Recommendations address only coho salmon and do not address steelhead. No recommendations are presented for Chinook salmon EFH because Chinook salmon are not present and do not use Branciforte Creek.

II. LIFE HISTORY AND HABITAT REQUIREMENTS

The life history of coho salmon in California has been well documented by Shapovalov and Taft (1954) and Hassler (1987). In contrast to the life history patterns of other anadromous salmonids, coho salmon in California generally exhibit a relatively simple 3-year life cycle (Shapovalov and Taft 1954, Hassler 1987). Adult salmon typically begin the freshwater migration from the ocean to their natal streams after heavy late-fall or winter rains breach the sand bars at the mouths of coastal streams (Sandercock 1991). Delays in river entry of over a month are not unusual (Salo and Bayliff 1958, Eames et al. 1981). Migration continues to March, generally peaking in December and January, with spawning occurring shortly after returning to the spawning grounds (Shapovalov and Taft 1954).

Coho salmon are typically associated with small to moderately-sized coastal streams characterized by heavily forested watersheds; perennially-flowing reaches of cool, high-quality

water; dense riparian canopy; deep pools with abundant overhead cover; instream cover consisting of large, stable woody debris and undercut banks; and gravel or cobble substrates.

Female coho salmon choose spawning sites usually near the head of a riffle, just below a pool, where water changes from a laminar to a turbulent flow and there is small to medium gravel substrate. The flow characteristics of the location of the redd usually ensure good aeration of eggs and embryos, and flushing of waste products. The water circulation in these areas also facilitates fry emergence from the gravel. Preferred spawning grounds have nearby overhead and submerged cover for holding adults; water depth of 10-54 centimeters (cm); water velocities of 20-80 cubic meters per second (cm/s); clean, loosely compacted gravel (1.3-12.7 cm diameter) with less than 20 percent fine silt or sand content; cool water (4-10 degrees Celsius [°C]) with high dissolved oxygen (8 milligrams per liter [mg/l]); and an intergravel flow sufficient to aerate the eggs. The lack of suitable gravel often limits successful spawning in many streams.

Each female builds a series of redds (nests), moving upstream as she does so, and deposits a few hundred eggs in each. Fecundity of coho salmon is directly proportional to female size; coho salmon may produce deposit from 1,000-7,600 eggs (reviewed in Sandercock 1991). Briggs (1953) noted a dominant male accompanies a female during spawning, but one or more subordinate males also may engage in spawning. Coho salmon may spawn in more than one redd and with more than one partner (Sandercock 1991). Coho salmon are semelparous (they spawn once and then die). The female may guard a nest for up to two weeks (Briggs 1953).

The eggs generally hatch between four to eight weeks, depending on water temperature. Survival and development rates depend on temperature and dissolved oxygen levels within the redd. According to Baker and Reynolds (1986), under optimum conditions, mortality during this period can be as low as 10 percent; under adverse conditions of high scouring flows or heavy siltation, mortality may be close to 100 percent. McMahon (1983) found that egg and fry survival drops sharply when fines make up 15 percent or more of the substrate. The newly-hatched fry remain in the gravel from two to seven weeks until emergence from the gravels (Shapovalov and Taft 1954). Upon emergence, fry seek out shallow water, usually along stream margins. As they grow, they often occupy habitat at the heads of pools, which generally provide an optimum mix of high food availability and good cover with low swimming cost (Nielsen 1992). Chapman and Bjornn (1969) determined that larger parr tend to occupy the head of pools, with smaller parr found further down the pools. As the fish continue to grow, they move into deeper water and expand their territories until, by July and August, they are in the deep pools. Juvenile coho salmon prefer well shaded pools at least 1 meter deep with dense overhead cover; abundant submerged cover composed of undercut banks, logs, roots, and other woody debris; preferred water temperatures of 12-15°C (Brett 1952, Reiser and Bjornn 1979), but not exceeding 22-25°C (Brungs and Jones 1977) for extended time periods; dissolved oxygen levels of 4-9 mg/l; and water velocities of 9-24 cm/s in pools and 31-46 cm/s in riffles. Water temperatures for good survival and growth of juvenile coho salmon range from 10-15°C (Bell 1973, McMahon 1983). Growth is slowed considerably at 18°C and ceases at 20°C (Stein *et al.* 1972, Bell 1973).

Preferred rearing habitat has little or no turbidity and high sustained invertebrate forage production. Juvenile coho salmon feed primarily on drifting terrestrial insects, much of which are produced in the riparian canopy, and on aquatic invertebrates growing in the interstices of the substrate and in the leaf litter in the pools. As water temperatures decrease in the fall and winter months, fish stop or reduce feeding due to lack of food or in response to the colder water, and growth rates slow down. During December-February, winter rains result in increased stream flows and by March, following peak flows, fish again feed heavily on insects and crustaceans and grow rapidly.

In the spring, as yearlings, juvenile coho salmon undergo a physiological process, or smoltification, which prepares them for living in the marine environment. They begin to migrate downstream to the ocean during late March and early April, and out migration usually peaks in mid-May, if conditions are favorable. Emigration timing is correlated with peak upwelling currents along the coast. Entry into the ocean at this time facilitates more growth and, therefore, greater marine survival (Holtby *et al.* 1990). At this point, the smolts are about 10-13 cm in length. After entering the ocean, the immature salmon initially remain in nearshore waters close to their parent stream. They gradually move northward, staying over the continental shelf (Brown *et al.* 1994). Although they can range widely in the north Pacific, movements of coho salmon from California are poorly known.

III. PROPOSED ACTION

The Corps proposes to authorize the maintenance and sediment removal activities in Branciforte Creek under the Department of the Army Nationwide Permit 31 (Maintenance of Existing Flood Control Projects) pursuant to section 404 of the Clean Water Act. The City would be permitted to remove accumulated sediment and vegetation in order to maintain the designed footprint and contour of the channel, and restore flood capacity. Removal of sediment and vegetation will occur throughout an estimated 3,100 linear feet of Branciforte Creek, between Hubbard Street pedestrian bridge and Ocean Street bridge, in the City of Santa Cruz, Santa Cruz County, California. The City's sediment and vegetation removal activities would be permitted for two years, beginning in the summer of 2004, and continue in 2005. Annual project activities will require approximately 21 working days to remove an estimated 5,800 cubic yards of material.

IV. EFFECTS OF THE PROJECT ACTION

Effects of the proposed project on salmon EFH are those associated with the maintenance and sediment removal activities in the concrete flood control channel in Branciforte Creek as described in the preceding biological opinion. In the action area in Branciforte Creek (approximately 108,500 square feet), EFH is temporarily adversely affected by this project due to sedimentation, turbidity, and loss of macroinvertebrates from project activities.

V. CONCLUSION

After reviewing the effects of the maintenance and sediment removal activities in Branciforte Creek, NOAA Fisheries believes the project action, as proposed, will adversely affect the EFH of coho salmon in Branciforte Creek. However, these adverse effects will be minor and temporary. NOAA Fisheries has determined that coho salmon have been extirpated from Branciforte Creek and will not be impacted by adverse effects from this project. Therefore, no EFH recommendations are provided.

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UNITED STATES DEPARTMENT OF COMMERCE
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In response refer to:
2007/07793:DHW

MAY 05 2008

Lieutenant Colonel Craig W. Kiley
District Engineer
U.S. Department of the Army
San Francisco District, Corps of Engineers
1455 Market Street
San Francisco, California 94103-1398

Dear Colonel Kiley:

This document transmits the NOAA's National Marine Fisheries Service (NMFS) biological opinion (Enclosure 1) based on our review of the City of Santa Cruz Department of Public Work's proposed San Lorenzo River Gravity Outlet Valve Replacement Project and Channel Maintenance Activities in the City of Santa Cruz, Santa Cruz County, California and its effects on threatened Central California Coast (CCC) steelhead (*Oncorhynchus mykiss*) Distinct Population Segment (DPS), endangered Central California Coast (CCC) coho salmon (*O. kisutch*) Evolutionary Significant Unit (ESU), and designated critical habitat for CCC steelhead and CCC coho salmon in accordance with section 7 of the Endangered Species Act of 1973, as amended (16 U.S.C. 1531 *et seq.*). In addition, this letter transmits the result of NMFS' Essential Fish Habitat (EFH) consultation pursuant to section 305(b)(2) of the Magnuson-Stevens Fishery Conservation and Management Act (MSA) (Enclosure 2).

Endangered Species Act Consultation

NMFS concludes in the biological opinion that the proposed action will not jeopardize the continued existence of CCC steelhead nor adversely modify designated critical habitat for CCC steelhead and CCC coho salmon. Repeated surveys in the San Lorenzo River and its tributaries have not found the presence of juvenile coho salmon. Therefore, NMFS did not evaluate any project effects on the CCC coho salmon ESU in this biological opinion. However, we anticipate that take of listed CCC steelhead DPS as a result of the valve replacements will occur, and therefore, an incidental take statement with non-discretionary terms and conditions is included.

Essential Fish Habitat Consultation

The projects are located within an area identified as EFH for coho salmon managed with the Pacific Salmon Fishery Management Plan (FMP) under the Magnuson-Stevens Fishery Conservation and Management Act (MSA). NMFS has evaluated the proposed projects for adverse effects to EFH pursuant to Section 305 (b)(2) of the MSA. Potential adverse effects to

EFH from the proposed projects include an increase in suspended sediment concentrations during construction activities, which can result in higher than normal turbidity levels.

Maintenance and construction activities associated with the projects, such as channel ripping and the placement and removal of cofferdams, are expected to increase the concentration of suspended sediments within the water column. Effects of suspended sediment are expected to be minimal due to Best Management Plans incorporated into the project description, and the short duration and small area associated with construction and maintenance activities. In addition, the enclosed biological opinion also contains non-discretionary terms and conditions that will minimize adverse effects to EFH. Therefore, NMFS has not provided EFH Conservation Recommendations for this project.

If you have any questions about this section 7 and EFH consultation, or if you require additional information, please contact Mr. Dave Walsh at (707) 575-6016.

Sincerely,

Rodney R. McInnis
Regional Administrator

Enclosures (2)

cc: Jane Hicks, ACOE
Russ Strach, NMFS
Korie Schaeffer, NMFS
Siobhan O'Neill, Chris Cave, City of Santa Cruz Department of Public Works
Gary Kittleson, Kittleson Environmental Consulting
Holly Costa, Army Corps of Engineers
Copy to file: 141522SWR2007SR00550

Enclosure 1

BIOLOGICAL OPINION

ACTION AGENCY: U.S Army Corps of Engineers (Corps), San Francisco District

ACTION: Issuance of a Clean Water Act Section 404 permit and Section 10 Rivers and Harbors Act permit for the San Lorenzo River Channel Maintenance Activities and the San Lorenzo River Gravity Outlet Valve Replacement Project in Santa Cruz County, California.

CONSULTATION CONDUCTED BY: National Marine Fisheries Service, Southwest Region

TRACKING NUMBER: SWR/2007/07793

DATE ISSUED: May 5th, 2008

I. CONSULTATION HISTORY

NOAA's National Marine Fisheries Service (NMFS) will be reporting the results of consultation on two separate project activities in this biological opinion; both occurring within the San Lorenzo River. The former is San Lorenzo River Maintenance Activities (maintenance activities) that have been performed in the past and require a NMFS' consultation, as per the U.S. Army Corps of Engineers' (Corps) regulations, every two years, and the latter is the San Lorenzo River Gravity Outlet Valve Replacement Project (valve replacement(s)), which is slated for one construction season and will require dewatering and relocation of fish.

A. Past Consultations with NMFS

On July 17, 1997, August 9, 1999, August 19, 2002, and January 11, 2006, NMFS completed informal consultation with the Corps for the maintenance activities. The Corps made a "may affect/not likely to adversely affect" determination for the maintenance activities impacts on endangered Central California Coast (CCC) coho salmon (*Oncorhynchus kisutch*) Evolutionary Significant Unit (ESU), threatened CCC steelhead (*O. mykiss*) Distinct Population Segment (DPS), and CCC coho salmon habitat with which NMFS concurred.[1] The Corps' last two-year permit to the City of Santa Cruz Department of Public Works (City) expired in 2007. These maintenance activities consist of channel ripping and thinning prescriptions to promote scour in the river channel for flooding control. All the work for this project was performed in dry portions of the channel.

[1] Critical habitat for steelhead was under evaluation during this time period.

B. Present Consultation with NMFS

By letter dated February 20, 2007, the Corps requested initiation of consultation pursuant to section 7 of the Endangered Species Act (ESA) of 1973, as amended (16 U.S.C 1531 *et seq.*) with NMFS for the maintenance activities and the valve replacements to be conducted in Santa Cruz County, California. At the time, the Corps determined the valve replacements may affect, but were not likely to adversely affect threatened CCC steelhead DPS, endangered CCC coho salmon ESU, and their respective designated critical habitat. The valve replacements included the proposal to capture and relocate listed salmonids.

Based on conversations with NMFS staff who reminded the Corps that capturing listed salmonids triggers formal consultation, the Corps revised their determination to may affect, likely to adversely affect CCC coho salmon, CCC steelhead, and their respective designated critical habitat on March 21, 2007. On April 24, 2007, NMFS received Kittleson Environmental Consulting's April 23, 2007, *Supplemental Fisheries Impact Assessment and Estimate of Potential Incidental Take of Listed Fish Species* for the valve replacements (Kittleson Environmental Consulting is a consultant for the City of Santa Cruz Department of Public Works). Based on our review of this document and Kittleson Environmental Consulting's January 24, 2007, *Biotic Assessment and Suggested Mitigation Measures* for the valve replacements, formal consultation was initiated.

On January 9, 2008, NMFS staff met with the City of Santa Cruz Department of Public Works staff to further discuss and view the locations of the valve replacements and maintenance activities in the San Lorenzo River.

Telephone and electronic communications with Corps representatives and the applicant, and other sources of information were considered in the biological opinion. A complete administrative record of this consultation is on file in the NMFS Santa Rosa Area Office.

II. DESCRIPTION OF THE PROPOSED ACTION

The Corps proposes to authorize, pursuant to Section 404 of the Clean Water Act of 1972 (33 U.S.C. 1344) and Section 10 of the Rivers and Harbors Act (33 U.S.C. 403), the City to replace five to six of the original 1960-era slide/flap gates at the levee system gravity outlet sites (outlet sites) on the San Lorenzo River.[2] The original outfall gates, used to discharge the City's storm flows into the San Lorenzo River, have outlived their service life and will be replaced with updated outflow valves. This portion of the San Lorenzo River flows through downtown Santa Cruz and is leveed. The Nationwide Permit #7: Outfall Structures and Maintenance, would be valid for two years. Construction is estimated to take approximately three months and is scheduled to begin in May 2008 and finish in July 2008 to take advantage of low river flows and possible open lagoon conditions.

[2] In 1959, the Corps constructed a flood control channel on the lower 2.5 miles of the San Lorenzo River to protect the City of Santa Cruz from flooding.

The Corps proposes to authorize, pursuant to Section 404 of the Clean Water Act of 1972 (33 U.S.C. 1344) and Section 10 of the Rivers and Harbors Act (33 U.S.C. 403), the City to disk the channel bottom sediments (channel ripping) and to thin the riparian habitat in an effort to reduce flooding frequency by maintaining channel capacity. The Nationwide Permit #31: Maintenance of Existing Flood Control Facilities, would be valid for two years. The channel ripping and riparian thinning operations will be accomplished over a one to two week period between August 1 and October 15, over the two-year permit in 2008 and 2009; conducting one channel ripping treatment per year and only during the low-flow period in the San Lorenzo River (with possible extension to October 31, weather permitting).

A. Description of the Proposed Work

1. Maintenance Activities

Maintenance activities will be performed in accordance with the Corps' guidelines for the Treatment of Vegetation within Local Flood-Damage-Reduction Systems (Corps 2007). The guidelines include selective removal of riparian vegetation that could possibly undermine the stability of the levees. Riparian vegetation thinning prescriptions will vary by reach and retain a five-foot vegetated buffer between the wetted channel and the sandbar areas to be ripped, and a 10-foot vegetated buffer on the toe of the levee slopes. Willows up to three inches in diameter at breast height (dbh) and alders up to six inches dbh will be retained and thinned to favor overhanging cover to the low-flow channel. Both hand thinning and mechanized thinning techniques will be employed.

Disking (down to six inches deep) will be used for ripping the roots of riparian vegetation on the dry in-channel islands. Only dry islands will be ripped. Mechanical equipment will not enter wetted channels. A bulldozer will cross the river at one of three pre-selected sites; two of these sites will be dry at the time of the operation. If the third site is used, the City proposes installing a temporary crossing consisting of a culvert with gravel fill (crossing) to provide access for heavy equipment to reach the in-channel islands. Approximately 20-to- 40 cubic yards of gravel and a culvert will be placed in a side channel at this location.

Prior to the placement of materials, blocknets will be placed upstream and downstream of the crossing to move all fish from the area. The two blocknets will be placed together then slowly moved in separate directions (one moving upstream and one moving downstream) for a sufficient distance to move fish from the area. This area is a side channel on the east side of an island. The main channel in the reach runs on the west river bank, on the opposite side of the island. After channel ripping activities are complete, the crossing will be removed from the area. Any flowing water in the area will pass through culverts, sized at a minimum of 12 inches in diameter. The culverts will be placed in the smaller of the channels for a maximum of ten days, based on previous experience managing vegetation on the mid-channel island, although five days is the likely duration. The method used for channel ripping of the mid-channel islands is selective, occurring only in dry area to loosen large vegetative roots. Although the total distance of the maintenance activities covers approximately 4,350 lineal feet between the Highway 1 and Soquel Avenue bridges, the actual area of channel ripping will occur along approximately from 1,000 to 2,000 lineal feet.

2. Valve Replacements

The proposed action includes light construction within and around the six outlet sites.[3] One outlet site will be repaired at a time. The outlet sites are submerged in the main channel or in standing water at the toe of the levee and have been affected by accumulated sediments. Activities at each outlet site will consist of a constructed cofferdam, dewatering of concrete apron structures, removal of sediment from existing concrete apron surfaces, excavation of existing rip-rap levee slopes around the existing outfall structures, and the installation of a modern outflow valve. Dewatering will be required at each outlet site to isolate the work area from the river during construction. Aquatic species will be captured and relocated from the six outlet sites during the incremental water drawdowns within the cofferdams. Water will be slowly pumped from the cofferdam in small increments, then stopped for fish to be captured and relocated. The pumps will be installed with fish screens and standing water within the cofferdam will be pumped onto the adjacent riprap slopes. The pumped water will eventually reenter the river after percolating through the riprap bank slope. This process will continue until the cofferdam has been completely dewatered and free of fish. The outlet site, located near a bank stabilization wall, will require the relocation and dewatering activities to be performed simultaneously due to difficulties with creating a watertight seal between the cofferdam and the wall. Each cofferdam will enclose an approximately 20-foot by 20-foot area around each outlet site and will require seven days to dewater the area to completion. Cofferdams will be constructed from wood, sand bags, and plastic sheets, depending on the site conditions and depth of standing water and/or potential tidal influence.

A total of 120-linear feet of creek bank will be affected by the valve replacements; however, the actual area of disturbance will be limited to 20-foot lengths since each outlet site will be dewatered one at a time. The total estimated cumulative area of stream to be dewatered is approximately 2,400 square feet or 0.055 acres. The most upstream outlet site is located near the Water Street Bridge and most downstream outlet site is located near the Riverside Bridge.

C. Best Management Plans (BMPs)

The following BMPs will be incorporated:

1. containment of site runoff throughout construction activities;
2. installation of temporary erosion and sedimentation control devices;
3. location of equipment and spoils in designated staging areas;
4. control of the water release in dewatered areas to minimize turbidity; and
5. maintain construction equipment in proper operating condition to prevent leaks of oil or grease.

[3] The biological assessment assumes that there will be funding to complete construction at five of the outlet sites, however, NMFS has considered all six outlet sites in this biological opinion in order to assess impacts to listed salmonids should funding become available for work at the sixth outlet site before construction commences.

D. Description of the Action Area

The action area includes all areas affected directly and indirectly by the project. The action area for this project is located in the San Lorenzo watershed between the Highway 1 Bridge and the mouth of the San Lorenzo River – a distance of approximately two miles. In addition, the action area extends up into and through the riparian zones of both banks for a total width of approximately 70 feet. The bankfull channel bottom of the San Lorenzo River at the locations where the maintenance and valve replacement activities will occur is approximately 50 feet in width. There is perennial flow within the action area. NMFS determined from the site visit on January 9, 2008, that the locations in the river for relocated fish would be no more than 100 feet from the dewatered outlet sites.

III. STATUS OF THE SPECIES AND CRITICAL HABITAT

This biological opinion analyzes the effects of the proposed maintenance activities and valve replacements on threatened CCC steelhead (62 FR 43937) DPS, their designated critical habitat (70 FR 52487), and designated critical habitat for CCC coho salmon (64 FR 24049) ESU.

In 2005, sampling efforts in Bean Creek (a tributary of the San Lorenzo River) found two adult coho salmon and was the first evidence of successful spawning for this species since 1981 (D.W. Alley and Associates 2005). The 1981 observations were in Zayante Creek (a tributary of the San Lorenzo River) and also in the San Lorenzo River (Smith 1982).

These observations, however, do not justify a stable coho salmon population within the San Lorenzo watershed. At the present time the CCC coho salmon ESU is not supported by the San Lorenzo River (Smith 1982, Alley *et al.* 2004), and is also considered to be extirpated from this river system (Jon Ambrose, NMFS, personnel communication, March 17, 2008).

It is unlikely that any remnant coho salmon would utilize the action area during the valve replacements (occurring in May through July) or the maintenance activities (late summer) due to poor habitat conditions in the action area and the would likely remain in the higher quality habitats of the upper reaches and tributaries of the San Lorenzo River. Therefore, adverse effects to CCC coho salmon are not expected for channel maintenance and valve replacement activities. Impacts to CCC coho salmon are not considered further in this biological opinion.

A. Steelhead Description and Life History

Steelhead are anadromous fish, spending some time in both fresh- and saltwater. The older juvenile and adult life stages occur in the ocean, until the adults ascend freshwater streams to spawn. Eggs (laid in gravel nests called redds), alevins (gravel dwelling hatchlings), fry (juveniles newly emerged from stream gravels), and young juveniles all rear in freshwater until they become large enough to migrate to the ocean to finish rearing and maturing to adults.

General reviews for steelhead in California document much variation in life history (Shapovalov and Taft 1954, Barnhart 1986, Busby *et al.* 1996, McEwan 2001). Although variation occurs in

coastal California, steelhead usually live in freshwater for two years, then spend one or two years in the ocean before returning to their natal stream to spawn. Steelhead may spawn one to four times over their life. Steelhead typically immigrate to freshwater between October and April, peaking in January and February and emigrate to sea between February and early May. Given the proposed in-channel construction period – May to July – and the life history of steelhead, only juvenile steelhead and late migrating steelhead smolts are likely to be present in the action area during valve replacements and channel maintenance activities. The steelhead smolts, however, would likely remain in the main channels and not be found in the side channel area that is designated for dewatering.

Steelhead fry rear in edgewater habitats and move gradually into pools and riffles as they grow larger. Cover is an important habitat component for juvenile steelhead, both as a velocity refuge and as a means of avoiding predation (Shirvell 1990, Meehan and Bjornn 1991). Steelhead, however, tend to use riffles and other habitats not strongly associated with cover during summer rearing more than other salmonids. Young steelhead feed on a wide variety of aquatic and terrestrial insects, and emerging fry are sometimes preyed upon by older juveniles. Rearing steelhead juveniles prefer water temperatures of 7.2-14.4 degrees Celsius (°C) and have an upper lethal limit of 23.9°C (Barnhart 1986, Bjornn and Reiser 1991). They can survive in water up to 27°C with saturated dissolved oxygen conditions and a plentiful food supply. Fluctuating diurnal water temperatures also aid in survivability of salmonids (Busby *et al.* 1996).

B. Status of the Species

In this biological opinion, NMFS assessed the status of CCC steelhead by examining four types of information, all of which help to understand a population's ability to survive. These population viability parameters are: abundance, population growth rate, spatial structure, and diversity (McElhaney *et al.* 2000). While there is insufficient information to evaluate these population viability parameters in a quantitative sense, NMFS has used existing information to determine the general condition of the DPS. Factors responsible for the current status of the DPS are also described.

Historically, approximately 48 populations of steelhead existed in the CCC steelhead DPS (Bjorkstedt *et al.* 2005). Many of these populations (about 20) were independent, or potentially independent, meaning they had a high likelihood of surviving for 100 years absent anthropogenic impacts. The remaining populations were dependent upon immigration from nearby CCC steelhead DPS populations to ensure their viability (Bjorkstedt *et al.* 2005, McElhaney *et al.* 2000).

While historical and present data on abundance are limited, CCC steelhead numbers are substantially reduced from historical levels. A total of 94,000 adult steelhead were estimated to spawn in the rivers of this DPS in the mid-1960s, including 50,000 fish in the Russian River - the largest population within the DPS (Busby *et al.* 1996). Recent estimates for the Russian River are on the order of 4,000 fish (NMFS 1997). San Lorenzo River steelhead are thought to number approximately 1,000 to 2,000 fish (Alley 2000) including hatchery fish which are considered part of the listed population in the river. Abundance estimates for smaller coastal streams in the DPS indicate low but stable levels with recent estimates for several streams (Lagunitas, Waddell,

Scott, San Vincente, Soquel, and Aptos creeks) of individual run sizes of 500 fish or less (62 FR 43937). For more detailed information on trends in CCC steelhead abundance, see: Busby *et al.* 1996, NMFS 1997, and Good *et al.* 2005.

Some loss of genetic diversity has been documented and attributed to previous among-basin transfers of stock and local hatchery production in interior populations in the Russian River (Bjorkstedt *et al.* 2005). Reduced population sizes and fragmentation of habitat in San Francisco streams has likely also led to loss of genetic diversity in these populations.

CCC steelhead have experienced serious declines in abundance, and long-term population trends suggest a negative growth rate. This indicates the DPS's may not be viable in the long term. DPS populations that historically provided enough steelhead strays to support dependent populations may no longer be able to do so, placing dependent populations at increased risk of extirpation. However, because CCC steelhead have maintained a wide distribution throughout the DPS, roughly approximating the known historical distribution, CCC steelhead likely possess a resilience that is likely to slow their decline relative to other salmonid species in worse condition. The most recent status review concludes that steelhead in the CCC steelhead DPS remain "likely to become endangered in the foreseeable future" (Good *et al.* 2005). On January 5, 2006, NMFS issued a final determination that the CCC steelhead DPS is a threatened species, as previously listed (71 FR 834).

C. Status of the Critical Habitat

In designating critical habitat, NMFS considers the following requirements of the species: (1) space for individual and population growth, and for normal behavior, (2) food, water, air, light, minerals, or other nutritional or physiological requirements, (3) cover or shelter, (4) sites for breeding, reproduction, or rearing offspring and generally, and (5) habitats that are protected from disturbance or are representative of the historic geographical and ecological distributions of this species (50 CFR 424.12(b)). In addition to these factors, NMFS also focuses on known physical and biological features (primary constituent elements or "PCEs") within the designated area that are essential to the conservation of the species and may require special management considerations or protection. These essential features may include, but are not limited to, spawning sites, food resources, water quality and quantity, and riparian vegetation.

Critical habitat for coho salmon is defined as: "all waterways, substrate, and adjacent riparian zones (in an ESU/DPS) below longstanding, naturally impassable barriers (*i.e.*, natural waterfalls in existence for at least several hundred years) (64 FR 24049)." NMFS has excluded from critical habitat designation all tribal lands in northern California and areas above certain dams blocking access to historical habitats of listed salmonids. Waterways include estuarine areas and tributaries. Riparian areas are defined as "the area adjacent to a stream that provides the following functions: shade, sediment, nutrient, or chemical regulation, stream bank stability, and input of large woody debris (LWD) or organic matter" (64 FR 24049). In other words, riparian areas are those areas that produce physical, biological, and chemical features that help to create stream habitat for salmonids.

Critical habitat for the CCC steelhead DPS is described as the "width of the stream channel defined by the ordinary high-water line as defined by the Corps in 33 CFR 329.11" (FR 69 71880). Riparian areas were excluded because their inclusion without a specific lateral extent in coho salmon critical habitat (see above) has resulted in difficulty for Federal agencies in determining the specific acreage of critical habitat across landscapes.[4] Activities in riparian areas may impact CCC steelhead critical habitat, because the "quality of aquatic habitat within stream channels is intrinsically related to the adjacent riparian zones..." (69 FR 71880).

1. CCC Coho Salmon Critical Habitat

On May 5, 1999, NMFS designated critical habitat for the CCC coho salmon ESU (64 FR 24049). The designation includes all accessible reaches of rivers between Punta Gorda and the San Lorenzo River in Santa Cruz County, California; this designation also includes two rivers entering San Francisco Bay: Arroyo Corte Madera Del Presidio and Corte Madera Creek.

The condition of CCC coho salmon critical habitat, specifically its ability to provide for their conservation, has been degraded from conditions known to support viable salmonid populations. NMFS has determined that present depressed population conditions are, in part, the result of the following human-induced factors affecting critical habitat[5]: logging, agricultural and mining activities, urbanization, stream channelization, dams, wetland loss, and water withdrawals and unscreened diversions for irrigation.

Numerous studies have demonstrated that land use activities associated with logging, road construction, urban development, mining, agriculture, and recreation, have significantly degraded coho salmon critical habitat quantity and quality in the CCC coho salmon ESU. Impacts of concern include alteration of stream bank and channel morphology, alteration of water temperatures, loss of spawning and rearing habitat, fragmentation of habitat, loss of downstream recruitment of spawning gravels and LWD, degradation of water quality, removal of riparian vegetation resulting in increased stream bank erosion, increases in erosion entry to streams from upland areas, loss of shade (higher water temperatures), and loss of nutrient inputs (61 FR 56138).

Depletion and storage of natural river and stream flows have drastically altered natural hydrologic cycles in many of the streams in the ESU. Alteration of flows results in migration delays, loss of suitable habitat due to dewatering and blockage, stranding of fish from rapid flow fluctuations, entrainment of juveniles into poorly screened or unscreened diversions, and increased water temperatures harmful to salmonids (61 FR 56138).

[4] NMFS chose not to provide a lateral extent in riparian areas to avoid under or over estimating the actual extent of riparian habitat essential to aquatic habitat (69 FR 71880).

[5] Other factors, such as over-fishing and artificial propagation, have also contributed to the current population status of these species. All these human-induced factors have exacerbated the adverse effects of the natural environmental variability from such factors as drought and poor ocean conditions.

2. CCC Steelhead Critical Habitat

On September 2, 2005, NMFS designated critical habitat for the CCC steelhead DPS. The designation includes nearly all steelhead-inhabited reaches of rivers between Russian River southward to and including Aptos Creek, as well as drainages of San Francisco and San Pablo Bay eastward to, but excluding the Sacramento-San Joaquin Delta. Major coastal watersheds occupied by this DPS include the Russian River, Lagunitas Creek, and San Lorenzo River.

In designating critical habitat, NMFS identified several factors potentially responsible for adversely affecting habitat for this DPS. Assessment of CCC steelhead designated critical habitat is included in NMFS (2005), which addresses critical habitat for several salmonid species including CCC steelhead. In general forestry, urban and rural residential development, water development, flood control, and agricultural activities have contributed to excessive sedimentation, low woody debris abundance and recruitment, elevated water temperature, chemical toxicity, and atypical stream hydrology throughout the streams designated as critical habitat for the CCC steelhead DPS. These factors likely limit production and recovery of the CCC steelhead DPS. Numerous anthropogenic migration barriers (dams and culverts) in the streams of the CCC steelhead DPS impede access to potential habitat, affect sediment transport, and affect water flow and temperature.

3. Conservation Value of Critical Habitat

NMFS created Critical Habitat Analytical Review Teams (CHART) to describe and assess potential critical habitat for CCC steelhead (NMFS 2005). The CHART identified 46 occupied CALWATER Hydrologic Sub-Areas (HSAs) within the freshwater and estuarine range of the DPS. Fourteen HSAs were rated low, 13 were rated medium, and 19 were rated high in conservation value. Essential features of spawning, rearing, and migration are contained in approximately 1,832 miles of occupied stream habitat within these HSAs.

The San Lorenzo River is included in the San Lorenzo HSA as critical habitat for CCC steelhead. The NMFS CHART rated the San Lorenzo HSA as having high conservation value to CCC steelhead (NMFS 2005). Because quality of habitat was only one of the rating factors used to determine conservation value, and habitat quality was considered at the geographic scale of an HSA, specific stream reaches within an HSA may, or may not, contain high quality of habitat, regardless of the HSAs overall rating for conservation value.

Although the CHART did not review critical habitat value for CCC coho salmon, the conservation value of coho salmon critical habitat throughout the San Lorenzo River HSA is likely "High" due to generally good habitat conditions found throughout the watershed, and by comparison to the generally poor habitat conditions found in some neighboring watersheds, and the high degree of isolation experienced by CCC coho salmon populations throughout the ESU.

4. Critical Habitat Trend

With the listing of these salmonid species and the designation of critical habitat, the provisions of the Federal ESA took effect to prevent Federal actions from authorizing, funding, or carrying out

actions that would jeopardize the long-term survival and recovery of the species and/or taking actions that would adversely modify critical habitat. In addition, both the State and Federal government are providing funding for habitat restoration projects in this ESU and DPS. However, Federal agency actions affect only a subset of many of the critical habitat areas and/or elements. Funding for restoration has been increased since the late 1990s, but it may not affect a significant portion of degraded critical habitat for several decades. Thus, it is unknown whether State management of land use, Federal agency responsibilities under the ESA, and State/Federal restoration efforts are likely to reverse the overall trend of continued habitat degradation in the near future.

D. Status of the Species and Habitat in the San Lorenzo River Watershed

1. Status of Species

Johnson (1964) estimated there were 20,000 adults in the San Lorenzo River before 1965. Recent data for the San Lorenzo River watershed suggested this basin has a steelhead population smaller than 15 percent (< 3,000) of the size it had 30 years previously. This basin was thought to have originally contained one of the two largest steelhead populations in the ESU (NMFS 2003).

Since 1994, the County of Santa Cruz, the City of Santa Cruz, and the San Lorenzo Valley Water District have collaboratively funded surveys in the San Lorenzo River and its tributaries to ascertain population levels of steelhead. These surveys have been more rigorous than past efforts and provide the best available estimate of year-to-year status of steelhead in the San Lorenzo River watershed. In 2002, estimated juvenile steelhead abundance extrapolated to the mainstem of the San Lorenzo River and all sampled tributaries was 168,278, the highest since 1998, which had similar abundance estimates (H.T. Harvey & Associates 2003). Two of these sample sites, near the Water Street Bridge, were sampled and juvenile steelhead abundances were estimated at 3.0/100- to- 3.9/100 feet, with all captured steelhead measuring ≥85 millimeters (mm) in length.

2. Factors Affecting Steelhead, and Steelhead and Coho Salmon Critical Habitat, in the San Lorenzo River

A variety of factors, both anthropogenic and natural, have played a role in the decline of steelhead and coho salmon in the San Lorenzo River watershed. Natural events, such as floods, droughts, and ocean productivity cycles, have depressed population numbers when these events occur. However, the more recent anthropogenic destruction and degradation of essential freshwater habitats have reduced the resiliency of these populations to natural disturbances.

Excessive erosion, sedimentation, and turbidity (Santa Cruz County Planning Department (SCCPD) 1979), diminished streamflows (SCCPD 1979, NMFS 2001a, Denise Duffy & Associates, Inc. 1999) channelization (Mount 1995), and summer dams (NMFS 2001b) have degraded designated critical habitat for CCC steelhead and coho salmon with losses of PCEs for spawning and rearing throughout the San Lorenzo River. These effects caused by on-going

activities such as urbanization and water diversions are expected to continue to occur in the San Lorenzo River.

3. Watershed Importance for Coho Salmon

The San Lorenzo River is located near the southern boundary of the CCC coho salmon ESU and the southernmost range of coho salmon in the western United States. Coho salmon used the San Lorenzo River for spawning and rearing. In 1954-55, the estimated adult coho salmon run in the San Lorenzo River ranged between 7,000 and 14,000 (State Water Resources Control Board 1982). This watershed's value as critical habitat is high for coho salmon, given its location near the southernmost extent of their range and the relatively large coho population it supported historically. Recovering coho salmon to the full extent of their former range will likely require restoring important components of critical habitat in the San Lorenzo River, such as spawning and rearing areas.

IV. ENVIRONMENTAL BASELINE

The environmental baseline includes the past and present impacts of all Federal, State, or private actions and other human activities in the action area, the anticipated impacts of all proposed Federal projects in the action area that have already undergone formal or early section 7 consultation, and the impact of State or private actions which are contemporaneous with the consultation in process.

The action area is heavily urbanized, and drains the City's stormwater runoff in the alluvial floodplain section of the 138-square-mile San Lorenzo watershed. The San Lorenzo River suffers from poor water quality, loss of connectivity with its historic flood plain, loss of native riparian habitat, and reduced stream flows due to water extraction for increased urban uses. Many of the channels running along the east bank of the river are braided; forming multiple shallow stream channels that provide less than optimum habitat for native fish and potentially subject them to increased instream temperatures and predation. The main channel runs near the west bank of the river and moves closer to the middle of the river downstream, passing under the street bridges and away from the outlet sites, where the valve replacements are to occur. The main channel composition downstream provides adequate depths and riffle/pool habitat access for steelhead juveniles and smolts in this area just upstream of the Water Street Bridge before reaching the grade break between from river reach to estuarine reach. Aquatic habitats in the San Lorenzo River have deteriorated considerably from historic conditions (Santa Cruz Planning Department 1979) due to increased rates of sediment input (two to four times background levels) (Swanson Hydrology 2001) into the river. The high rates of sediment input have impaired salmonid spawning, feeding, and rearing habitats by burying spawning gravels and disrupting invertebrate (salmonid prey items) life cycles.

The major modification to the San Lorenzo River over the past 50 years is the levee on the lower 2.5 miles that has channelized the reach and contributed to the loss of habitat complexity in the action area. The City was responsible for maintenance of the levee, after its completion in 1959, and did so by annually dredging the channel bottom 5-8 feet below sea level and removing

vegetation along the banks (City of Santa Cruz 2003). The channel ripping applications have replaced the dredging for achieving flood control and maintaining the existing channel capacity. The levee height was also increased by an additional two feet in the early 2000's to provide the City with 100-year flood protection. Presently the San Lorenzo River is receiving attention from state and local governments with the intentions of restoring the river for fish and wildlife; and local governments, along with water purveyors, are also managing the conflicting needs of urban water use with wildlife protection.

A. Previous Consultations Completed in the Action Area

1. San Lorenzo River Channel Maintenance Activities

On July 17, 1997, August 9, 1999, August 19, 2002, and January 11, 2006, NMFS completed informal consultations with the Corps (San Francisco District) for San Lorenzo River Channel Maintenance activities. On July 17, 1997, NMFS concurred with the Corps that the maintenance activities may affect, but were not likely to adversely affect CCC steelhead or CCC coho salmon. On August 9, 1999, NMFS concurred with the Corps that the maintenance activities may affect, but were not likely to result in the destruction or adverse modification of proposed critical habitat for CCC steelhead or designated critical habitat for CCC coho salmon. On August 19, 2002, and January 11, 2006, NMFS concurred with the Corps that the maintenance activities may affect, but were not likely to adversely affect CCC steelhead, CCC coho salmon, and designated critical habitat for both species, as well as Essential Fish Habitat (EFH) under the Pacific Coast Salmon Fishery Management Plan.

2. San Lorenzo River Bank Stabilization Project

On December 11, 2003, NMFS issued a biological opinion to the Corps (Sacramento District) for their construction of the San Lorenzo River Bank Stabilization Project. In the biological opinion, NMFS concluded that the bank stabilization project would not jeopardize listed salmonids or adversely modify their critical habitats. The Corps designed and constructed a bank stabilization wall and restored wildlife habitat along 900-feet of eroding river bank on the lower San Lorenzo River. This action enhanced instream habitat conditions in the lower San Lorenzo River; stabilizing the river bank, and reducing erosion. The project required the capture and relocation of juvenile steelhead. The Incidental Take Statement for this project anticipated 43 juvenile steelhead would be captured and relocated, with a three percent mortality associated with capture and relocation activities. The EFH consultation for Pacific salmon determined that EFH would only be temporarily adversely affected, and in this case, EFH recommendations were not necessary.

Initial fish capture and relocation activities began on May 11, 2004. In June 2004, unanticipated events occurred at the active project site which resulted in the incidental take exceeding numbers authorized in the biological opinion and the need for an additional fish relocation action at the work site. Therefore, on June 29, 2004, NMFS issued a non-jeopardy, non-adverse modification supplemental biological opinion to the Corps (Sacramento District). The supplemental biological opinion concluded that the capture and relocation of additional steelhead would not result in jeopardy to listed steelhead, nor adversely modify their critical habitat. The

supplemental biological opinion also provided a new incidental take statement which anticipated the capture and relocation of juvenile steelhead based on the size of the area to be dewatered as a surrogate for the relatively small number of steelhead that would need relocation.

B. Status of the Species and Habitat in the Action Area

1. Status of Steelhead in the Action Area

Steelhead adults and juveniles use the action area as a migration corridor and as rearing habitat, respectively. Adult steelhead are not expected to be present when the valve replacements are scheduled to occur based on the timing of adult migration (winter/spring). The valve replacements are slated for May when some late migrating steelhead smolts may still be in the area. However, their presence at any of the valve replacement sites is unlikely, because based on steelhead migration preferences in water depth and attraction flows NMFS expects these outmigrating steelhead smolts will use the main channel running near the middle of the river when swimming downstream, and hold in the adjacent pools of the main channel (where the relocated fish will be placed) rather than meander out to the banks and use the scoured pool areas near the outlet sites. Maintenance activities will commence in the summer when only juvenile steelhead are expected in the area. Based on 14 seining samples each covering 100 feet of stream length, the estimated juvenile steelhead density in the San Lorenzo River between the mouth of the San Lorenzo River to the Water Street Bridge averaged 4.4 steelhead per 100 feet of stream (H.T. Harvey & Associates 2003). The City has also used this estimate to predict an incidental take of 4.4 steelhead for five outlet sites having a combined length of 100 feet, from Highway 1 downstream to the river mouth, and also predicted that one steelhead would be encountered at each dewatered site. NMFS has adjusted this estimate to 5.3 steelhead per 120 feet to include the additional dewatered site.

2. Aquatic Habitat Conditions in the Action Area

The action area is influenced by the sandbar conditions at the mouth of the San Lorenzo River. During most summer and fall months, deep-water conditions occur due to development of a sandbar; forming a lagoon at the river mouth that converts to freshwater. The San Lorenzo River lagoon has been reduced in size due to urban encroachment by the City of Santa Cruz and channelization practices. This alteration and subsequent degradation of critical habitat in the lagoon has also likely reduced salmonid carrying capacity. The sandbar closes the mouth of the river and forms a seasonal summer lagoon; in wetter years it appears that the sandbar self-breaches when the lagoon fills and spills over the sandbar. The sandbar across the mouth of the river forms naturally through wave action in late spring and summer. Typically, the sandbar forms during June and holds back water until November. In most years, water levels in the river are lowest in May because the sandbar has not built up enough to hold back water to create a lagoon setting (Don Lash, Corps, personnel communication, October 9, 2003) which is when valve replacements activities are usually proposed within the San Lorenzo River. The current rain year (2007 – 2008) is below the average compared with the past years, having current rain levels below 100% of average throughout the state.[6] Higher flows keep the mouth of the San

[6] As of April 23, 2008.

Lorenzo River from closing and forming the lagoon which would be less common to occur in a dry year.

Salmonid habitat in the vicinity of the outfall structures is generally poor for a variety of reasons. The outfall structures have concrete aprons, and the area is periodically maintained by removing sediment, there is little emergent vegetation or cover, the river substrate is sandy or comprised of organic detritus, and the vicinity is littered with solid waste and garbage. Salmonid habitat within the channel maintenance activities provides a migration corridor to more suitable habitat upstream.

V. EFFECTS OF THE PROPOSED ACTION

In general, the effects of the action are associated with dewatering of portions of aquatic habitat, temporary increases in turbidity levels, and reduction in riparian vegetation. These impacts, their associated effects on steelhead and salmonid critical habitat, as well as the beneficial impacts of the valve replacement project, are described in detail below.

A. Sedimentation and Turbidity Increases

As described above, the San Lorenzo River experiences higher sediment input compared with recorded historic levels. The precise levels are currently evaluated by the U.S. Geologic Survey's efforts to gauge the sediment transport flowing from upstream (Siobhan Nolen, personal communication, City of Santa Cruz, 2008). During the maintenance activities, temporarily high levels of turbidity are expected from substrate disturbances during: the installation of the temporary culvert crossing to access the mid-channel island at the third maintenance site, and the channel ripping; both of which will leave behind loosened substrate in the channel.

Research with salmonids has shown that high turbidity concentrations can: reduce feeding efficiency, decrease food availability, reduce dissolved oxygen in the water column, result in reduced respiratory functions, reduce tolerance to diseases, and also cause fish mortality (Berg and Northcote 1985, Gregory and Northcote 1993, Velagic 1995, Waters 1995). Mortality of very young coho salmon and steelhead fry due to increased turbidity has been reported by Sigler *et al.* (1984). Even small pulses of turbid water will cause salmonids to disperse from established territories (Waters 1995), which can displace fish into less suitable habitat and/or increase competition and predation, decreasing chances of survival.

For the valve replacements activities, NMFS anticipates that increases in sediment and turbidity in aquatic habitat in the action area will occur during the proposed ground disturbances from excavation, construction of cofferdams, removal of the old gravity outflow valves, and the installation of the new valves. The ultimate distance downstream of the cofferdams effects (*i.e.*, sedimentation, turbidity, and steelhead relocation activities) cannot be precisely quantified. However, NMFS expects these effects to be minor, because the workspace will be dewatered and no vehicles or heavy equipment will work in wetted channels outside of the coffer dams.

Although ripping activities in side channel areas will be performed in the dry, sediment, and turbidity may result when flows enter these areas during the first few late fall or winter storm events. The amount of sediment and turbidity mobilized by streamflow in the ripped areas cannot be precisely quantified. Observations made by City staff indicate that the water clarity does not visibly change when flow from the ripped areas is added to the sediment load moving down from reaches and tributaries farther up in the watershed (S. Nolen, 2008). The City's use of an adaptive management approach to selectively choose islands for channel ripping also minimizes the amount of sediment disturbance and in conjunction with BMPs. NMFS expects the added sediment load will be minimized.

Therefore, NMFS anticipates that rearing juvenile steelhead downstream of the action area may be affected by short-term increases in turbidity caused during the construction of the cofferdams, dewatering, and following early storm events. NMFS does not anticipate pulses of turbidity from the proposed project will reach lethal levels. However, pulses of increased turbidity may result in juvenile steelhead temporarily vacating preferred habitat, including some individuals inhabiting the lagoon, and/or temporarily reducing their feeding efficiency. Due to the timing of project impacts (summer and during the first higher flow events), only low numbers of juvenile steelhead are anticipated to be affected. The minimal and temporary nature of the turbidity levels are not expected to have a detectable impact on the survival of individual fish in the action area. For example, NMFS expects the temporary duration of turbidity from valve replacement work will allow any juvenile steelheads displaced from preferred habitat to return well before any reduction in feeding has reduced their survival chances.

B. Fish Relocation Activities

1. Maintenance Activities

NMFS expects that moving fish with block nets out of the area where the temporary culvert will be installed will be successful because: 1) few fish are likely to be present, and 2) no cover is available for them to avoid the movement of the nets. Steelhead are more likely to utilize the main channel on the west bank than the limited habitat in the side channels found along the east bank. The crossing reach between the east bank and the mid-channel sandbar is devoid of suitable pools that could be used for rearing. The habitat available consists of shallow water without large enough substrate or other cover elements such as woody debris or live trees that could provide hiding places for steelhead to avoid block net movement.

2. Valve replacements

Fish relocation efforts will take place in between the incremental drawdowns of standing water within the cofferdams. No dewatering or removal and relocation of fish will occur prior to May 2007. The outlet site near the Water Street Bridge will require concurrent dewatering and fish removal efforts because of poor sealing conditions between the cofferdam wall and the bank stabilization wall constructed in 2004.

Each 2-to-5 foot band of aquatic habitat at the outlet sites consist of a deep pool with a silt/sand substrate and little habitat complexity. This condition makes the collection of steelhead a

thorough and efficient process that will result in minimal stress to fish. The higher salinity concentrations of the lower five pools will negate the use of an electrofisher, therefore, all collection of fish will be made with seines and dip nets.

NMFS assumes that the population of steelhead in the action area to be 5.3 fish for every 120-linear feet of river, or approximately one fish for each 20-linear feet of dewatered outlet site. This estimate is based on the size of the habitat, the number of outlet sites, and the numbers of fish visually observed from H.T. Harvey and Associate survey efforts (adjusted to 5.3 fish/120 feet for the six outlet sites where the valve replacements will occur). A qualified fishery biologist will take appropriate precautions during fish relocation activities to minimize adverse affects to the juvenile steelhead. Captured fish are planned to be moved to a nearby pool with suitable and comparable habitat that will be located no more than 100 feet from each outlet site.

3. Adverse Effects to Steelhead from Relocation Efforts

Relocated fish may endure stress from crowding at the relocation sites and increased competition for available resources such as food and habitat. Some of the fish at the relocation sites may leave the site, and move either upstream or downstream that have greater availability of habitat and less fish density. As each fish moves, competition remains either localized to a small area or quickly diminishes as fish disperse. NMFS cannot accurately estimate the number of fish adversely affected by competition, but does not believe this impact will cascade through the creeks' watershed population of steelhead based on the small area that will likely be affected. The survival chances of individual fish are unlikely to be adversely affected.

Fish relocation efforts are expected to minimize project impacts to steelhead by removing them from areas where they would have experienced high rates of injury and mortality. Fish will be relocated to areas that possess similar habitat and water quality parameters (*e.g.*, temperature) to their original locations, and will be distributed appropriately to prevent overcrowding.

C. Dewatering

1. Maintenance Activities

The flow along the east bank of the mid-channel island will be channeled through a culvert during the maintenance activities and is not expected to inhibit movement for salmonids in the area. The high-flow channel along the west bank of the mid-channel island is the preferred passage by steelhead through this reach and will remain open. The maintenance timeframe on the mid-channel island is expected to last less than one week for each year in the permit, during which time the culvert and gravel bar will remain in place. The water level in this reach of the San Lorenzo River is expected to be much lower than those levels at the outflow sites. Based on the lack of habitat complexity and flow in the footprint of the 20-foot length culvert, NMFS staff concluded that no more than one juvenile steelhead is expected in the area at the time of the gravel bar installation. At the request of U.S. Fish and Wildlife Service, the City will remove all culvert and gravel bar materials upon completion of the ripping activities (Gary Kittleson, personal communication, 2008).

2. Valve Replacements

A cofferdam will be in place at one of the six outlet sites over the duration of the valve replacement activities at that site, which will result in a temporary and periodic net habitat loss of 400 square feet for each dewatered site. Constructing one cofferdam at a time is intended to disperse project impacts over time, rather than concentrating them during one time period.

Temporary cofferdams will be installed in order to dewater the outlet site and will remove water through incremental drawdowns using pumps installed with fish screens. Standing water within the cofferdam will be pumped onto adjacent rip-rap slopes along the river banks. Eventually the water pumped from the cofferdam will percolate through the rip-rapped bank slopes and return into the river. These activities with the mentioned BMPs for dewatering minimize fish stranding and loss within the confines of the cofferdam and will not result in any harm to salmonids passing outside of the cofferdam where flow will neither impede nor interrupt their movement.

Streamflow diversion and work space dewatering is expected to cause a temporary loss, alteration, and reduction of aquatic habitat within the action area. Stream flow diversions could harm individual steelhead by concentrating or stranding them in residual wetted areas (Cushman 1985) before they are relocated, or causing them to move to adjacent habitats (Clothier 1953, Clothier 1954, Kraft 1972, Campbell and Scott 1984).

Benthic macroinvertebrates may be temporarily lost or their abundance reduced when individual organisms are stranded or when creek habitats are dewatered (Cushman 1985). Effects to macroinvertebrates resulting from stream flow diversions and dewatering will be temporary because construction activities will be relatively short-lived, and rapid recolonization (about one to two months) of disturbed areas by macroinvertebrates (Cushman 1985, Thomas 1985, Harvey 1986) is expected following rewatering. In addition, the effect of macroinvertebrate loss on juvenile steelhead is likely to be negligible because food from upstream sources (via drift) would be available downstream of the dewatered areas since stream flows will be maintained outside of the cofferdam. Based on the foregoing, the loss of aquatic macroinvertebrates as a result of dewatering activities is not expected to adversely affect steelhead.

Steelhead that failed to be relocated from the outlet site will die during dewatering activities. For the combined dewatering activities NMFS anticipates no more than one juvenile steelhead will be killed as a result of stranding or crushing during dewatering activities.[7] This is due to the size of the area affected, prior to relocation efforts, and the low numbers of steelhead expected to be present within the action area. A qualified fishery biologist will be on site to remove and relocate all juvenile steelhead that may become stranded during the dewatering drawdowns.

D. Loss of Riparian Vegetation from Maintenance Activities

Part of the City's maintenance prescription includes removal and thinning of riparian vegetation within the action area. The historic riparian vegetation in this reach was eradicated as part of the levee construction by the Corps, and the City has maintained the area to prevent the

[7] This estimate is based on projects with similar scenarios that were analyzed by NMFS, where a 3% mortality rate was determined.

accumulation of sediment and further aggregation of vegetation into the wetted channel. Through restoration and maintenance efforts made by the City, a small concentration of riparian vegetation persists in the action area that contributes to shading and lowering water temperatures.

There are future restoration plans in and around the action area that will result in the plantings of new riparian vegetation along the levee and the river banks. Maintaining a five-foot vegetated buffer between the wetted channel and the sandbar areas and another ten-foot buffer on the toe of the levee slopes aids in bank stabilization, while providing shade and cover to migrating and rearing steelhead. The thinning prescriptions are not expected to reduce the value of the critical habitat in the action area since the BMPs will provide buffered areas along the islands and the levee toe that will provide channel shading and habitat refuge.

E. Beneficial Effects from the Maintenance Activities and Valve Replacements

1. Maintenance Activities

The channel maintenance portion of this activity is required to encourage scour and reduce flooding frequency. As the San Lorenzo River flow recedes during the late spring months, a braided stream channel tends to form between Highway 1 and Soquel Avenue because of a low stream gradient and channel sediment accumulation. The growth of vegetation in the channel dissipates the flows and inhibits scour, contributing to the development of braded channel conditions between the levees. These braded channels dissipate summer flows across several shallower channels with resulting higher water temperatures. The annual clearing of excess sediment and vegetation, through maintenance activities, reduces the amount of braded channels in the area. This is likely to increase pool depths. Water temperature may also improve, although improvement is likely to be limited because temperatures in nearby non-braded channel areas are relatively high.

2. Valve Replacements

Replacing the levee slide/flap gates at each outflow site with updated valves will eliminate the possibility of trapping steelhead. The current gates that have been in service since the levee construction in 1959 are rusted open and leak from the sand accumulation in the outfall apron structures. The replacement valves are a "pinch" type that are tapered at the outflow end and are engineered to open and shut at specific stormwater water pressure behind the levee. When stormwater pressure is high, the valves open and allow stormwater through the levee into the river. The outward water pressure and the pinch design of the valve end prevent any material, including fish, from flowing in reverse through the valves and out of the river. Once the water pressure behind the levee drops, the valve closes shut. The replacement valves are of 100% elastomer construction, making them practically maintenance free with a long operation life span, making repair and maintenance needs minimal.

E. Interrelated and Interdependent Activities

NMFS does not anticipate any interdependent or interrelated actions associated with the proposed action.

VI. CUMULATIVE EFFECTS

Cumulative effects include the effects of future State, tribal, local, or private actions that are reasonably certain to occur in the action area considered in this biological opinion. Future Federal actions that are unrelated to the proposed action are not considered in this section because they require separate consultation pursuant to section 7 of the ESA. Impacts from urbanization, such as increased runoff from new areas of impervious surfaces, and sediment and turbidity associated with road repair and construction, are likely to continue to occur in the action area. The pace of such development fluctuates based on economic conditions, and has currently slowed. In recent years, additional aquatic habitat protections have been applied by State and Federal agencies when developing projects. Based on these factors, NMFS concludes that the level of habitat degradation in the action area resulting from cumulative effects is expected to remain fairly constant or somewhat reduced during the next several years after the channel maintenance and valve replacement activities are implemented.

VII. INTEGRATION AND SYNTHESIS OF EFFECTS

The maintenance activities will result in the removal of sediment and vegetation to encourage scour and reduce flooding frequency. The disking process will rip root systems from the islands in select areas of the lower San Lorenzo River using adaptive management approach. The work will be conducted during the summer low-flow period between August 1 and October 15 in 2008 and 2009, and have one channel ripping application for each year. One area in the river may require a crossing made from gravel with a 12-inch culvert. All steelhead will be moved from the area, using block nets, prior to the crossing installation. Small pulses of turbidity are expected as a result of the gravel installation and removal and also during the first storm events of the following season. The turbidity levels are undetectable from the other turbidity sources moving through the watershed and should not cause long term impacts to steelhead or habitat.

The valve replacements will update the existing gravity outlet valves with modern day valves that will require less maintenance and prohibit the entrainment of fish. The related construction for the valve replacements will result in the dewatering of approximately 2,400 square feet (120 linear feet) of the San Lorenzo River. An estimated 5.3 juvenile steelhead are expected to be encountered at all six outlet sites being dewatered and will be subject to capture and relocation. No more than one juvenile steelhead is likely to be killed as a result from the combined dewatering activities. Any late migrating steelhead smolts continuing through the action area into May would be using the main channel and are not be likely to be encountered in the small confined outlet sites that are located along the river banks. Turbidity levels will likely increase from the building and removal of cofferdams but is expected to be temporary without having adverse effects on steelhead.

The population of steelhead in the San Lorenzo River is considerably depressed from historical numbers. The valve replacements are engineered to prevent backflow and will have no long term detrimental impacts on steelhead habitat and will not restrict the amount of juvenile rearing space in future years. Beneficial effects to steelhead passage and rearing habitats are expected from the channel maintenance and valve replacement projects. Based on the estimated 1,000 to 2,500 adult steelhead in the San Lorenzo River and the relocation efforts of qualified biologists using NMFS approved techniques, a loss of one juvenile steelhead is unlikely to have a detectable effect on this population's abundance or viability in future years because the remaining population is large enough to be resilient to this small, one-time loss. Spawning in subsequent years is expected to produce enough juveniles to repopulate any habitat areas that may become vacant by the loss of these fish. As noted, the survival chances of juveniles in these areas in future years are likely to improve. Thus, survival and recovery of this population, or the DPS in general, is not likely to be appreciably reduced.

The attributes for the PCEs in the designated critical habitat for CCC steelhead and CCC coho salmon include water and water quality, foraging habitat, natural cover including large substrate and aquatic vegetation, and migratory corridors free of obstructions. CHART's overall conservation value for the San Lorenzo HSA was determined as high, although the habitat conditions in the action area are generally poor, consisting of migration corridors that are marginal; primarily due to elevated stream temperatures and management for flood control. Overwinter and outmigration habitat conditions are also poor because the channel lacks habitat complexity and velocity refuge.

The effects from the maintenance activities will be temporary and result in higher turbidity levels. The effects from the valve replacements will result in temporary impacts (*e.g.*, turbidity increase, dewatering, and loss of macroinvertebrates) to critical steelhead and coho salmon habitat. These impacts will last no more than a few weeks based on the impact minimization measures and conservation measures proposed. The area of the channel disturbed for the instream work is expected to return to pre-project conditions following completion of construction. The effects from the maintenance activities and valve replacements are expected to be beneficial and long-lasting to CCC steelhead and designated critical habitat for CCC steelhead and CCC coho salmon.

VIII. CONCLUSION

After reviewing the best available scientific and commercial information, the current status of the species and critical habitat, the environmental baseline for the action area, the effects of the proposed action and the cumulative effects, it is NMFS' biological opinion that the San Lorenzo River Valve Replacement Project and Channel Maintenance Activities are not likely to jeopardize the continued existence of the CCC steelhead DPS.

After reviewing the best available scientific and commercial information, the current status of critical habitat, the environmental baseline for the action area, the effects of the proposed action and the cumulative effects, it is NMFS' biological opinion that the San Lorenzo River Valve

Replacement Project and Channel Maintenance Activities are not likely to destroy or adversely modify designated critical habitat for CCC steelhead or CCC coho salmon.

IX. INCIDENTAL TAKE STATEMENT

Section 9 of the ESA and Federal regulation pursuant to section 4(d) of the ESA prohibit the take of endangered and threatened species, respectively, without special exemption. Take is defined as to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture or collect, or to attempt to engage in any such conduct. Harm is further defined by NMFS as an act which actually kills or injures fish or wildlife. Such an act may include significant habitat modification or degradation which actually kills or injures fish or wildlife by significantly impairing essential behavioral patterns, including breeding, spawning, rearing, migrating, feeding, or sheltering. Incidental take is defined as take that is incidental to, and not the purpose of, the carrying out of an otherwise lawful activity. Under the terms of section 7(b)(4) and section 7(o)(2), taking that is incidental to and not the purpose of the agency action is not considered to be prohibited taking under the ESA provided that such taking is in compliance with the terms and conditions of this incidental take statement.

The measures described below are nondiscretionary, and must be undertaken by the Corps, the City, and their designees for the exemption in section 7(o)(2) to apply. The Corps and the City have a continuing duty to regulate the activity covered by this incidental take statement. If the Corps or the City: (1) fails to assume and implement the terms and conditions, or (2) fails to require any designee to adhere to the terms and conditions of the incidental take statement through enforceable terms that are added to any permit, grant document, or contract, the protective coverage of section 7(o)(2) may lapse. In order to monitor the impact of incidental take, the Corps or the City must report the progress of the action and its impact on the species to NMFS as specified in the incidental take statement (50 CFR §402.14(i)(3)).

A. Amount or Extent of Take

Incidental take of threatened CCC steelhead juveniles during construction for the valve replacements is expected to occur due to dewatering and subsequent fish relocation efforts during the construction season. The majority of this take will be non-lethal take. Some injury and mortality of juvenile steelhead is anticipated as fish are collected by seining, dip netting, and other relocation-related activities. It is anticipated that most fish will be removed from the outlet sites with these collection methods prior to dewatering activities and, therefore, based on the results from past surveys and valve replacement activities, it is estimated that no more than a total of 5.3 juvenile steelhead will be found and relocated during the dewatering at all outlet sites. One juvenile steelhead could be injured or killed if stranded in the dewatered zone and perish as a result of crushing or desiccation. It is anticipated that no fish will be taken as a result of the crossing placement due to proper blocknetting technique if conducted for both or either year during the 2008-2009 maintenance activities. This activity will be conducted in a low-flow channel that fish are not expected to use.

B. Effect of the Take

In the accompanying biological opinion, NMFS determined that this level of anticipated take is not likely to result in jeopardy to CCC steelhead.

C. Reasonable and Prudent Measures

Pursuant to section 7(b)(4) of the ESA, the following reasonable and prudent measures are necessary and appropriate to minimize incidental take of threatened CCC steelhead:

1 . Measures shall be taken to minimize injury and mortality to listed salmonids from fish relocation activities.

2. Prepare and submit a report to document effects of construction and relocation activities and performance.

D. Terms and Conditions

In order to be exempt from the prohibitions of section 9 of the ESA, the City and their designee(s) must comply with the following terms and conditions, which implement the reasonable and prudent measures described above. These terms and conditions are nondiscretionary.

Monitoring requirements are included below, as per 50 CFR 402.12(i)(3): "In order to monitor the impacts of incidental take, the Federal agency or any applicant must report the progress of the action and its impact on the species to the Service [NMFS] as specified in the incidental take statement."

The following terms and conditions implement Reasonable and Prudent Measure 1.

1. The City shall provide NMFS with a "Dewatering and Fish Relocation Plan" for review 30 days prior to the start of dewatering and fish relocation activities. This plan shall outline cofferdam construction, dewatering, and fish relocation methods. The plan shall be submitted to NMFS Santa Rosa Area Office (see address below).

2. The City shall retain a qualified biologist with expertise in the areas of anadromous salmonid biology, including handling, collecting, and relocating salmonids; salmonid/habitat relationships; and biological monitoring of salmonids. The City shall ensure that all biologists working on the valve replacements are qualified to conduct fish collections in a manner which minimizes potential risks to listed salmonids. Electrofishing, if used, shall be performed by a qualified biologist and conducted according to the "NOAA Fisheries Guidelines for Electrofishing Waters Containing Salmonids Listed under the Endangered Species Act", June 2000. A Statement of Qualifications for all biologists who will be employed on the valve replacements shall be provided to NMFS for review 30 days prior to any dewatering and fish relocation activities.

3. The biologist shall monitor the construction site during placement and removal of cofferdams and channel diversion-related activities to ensure that any adverse effects to salmonids are minimized. The biologist shall be on site during all dewatering events to ensure that all listed salmonids are captured, handled, and relocated safely. The biologist shall notify NMFS biologist Dave Walsh (707) 575-6016 or dave.walsh@noaa.gov, one week prior to relocation activities in order to provide an opportunity for NMFS staff to observe the activities.

4. Listed salmonids shall be handled with extreme care and kept in water to the maximum extent possible during relocation activities. All captured fish shall be kept in cool, shaded, aerated water protected from excessive noise, jostling, or overcrowding any time they are not in the stream and fish shall not be removed from this water except when released. To avoid predation, the biologist shall have at least two containers and segregate young-of-year salmonids from older salmonids and other potential aquatic predators. Captured salmonids shall be relocated, as soon as possible, to a location at least 100 feet downstream of the outlet site which has suitable habitat conditions, and which allows for maximum survival of the transported salmonids.

5. Pumps used to dewater the outlet site shall be equipped with screens that meet the following NMFS fish screening criteria:

a. perforated plate: screen openings shall not exceed 3/32 inches (2.38mm), measured in diameter;
b. woven wire: screen openings shall not exceed 3/32 inches (2.38 mm measured diagonally);
c. screen material shall provide a minimum of 27% open area; and
d. approach velocity shall not exceed 0.33 feet per second.

6. The City shall provide NMFS with an annual summary report within 90 days of the completion of fish relocation and monitoring the valve replacement activities. The report shall include the methods used during the fish relocation and monitoring efforts, location, number and species captured, number of mortalities by species, and other pertinent information related to the monitoring and fish relocation activities. Reports shall be submitted to the NMFS Santa Rosa Area Office (see address below).

<u>The following terms and conditions implement Reasonable and Prudent Measure 2</u>.

1. The City shall provide written notification to NMFS at least fourteen days prior to commencement of in-channel crossing construction and removal. Written notification shall be sent to the NMFS Santa Rosa Area Office (see address below).

2. The City or their contractors shall allow any NMFS employee(s) or any other person(s) designated by NMFS, to accompany field personnel to visit the valve replacement and maintenance activities locations while the construction and activities are being carried out.

All reports or plans required for the above terms and conditions shall be sent to:

NMFS Santa Rosa Area Office
Supervisor, Protected Resources Division
Southwest Region
National Marine Fisheries Service
777 Sonoma Avenue, Room 325
Santa Rosa, California 95404

X. REINITIATION NOTICE

This concludes formal consultation on the proposed San Lorenzo River Gravity Outlet Valve Replacement Project and Channel Maintenance Activities. As provided in 50 CFR §402.16, reinitiation of formal consultation is required where discretionary Federal agency involvement or control over the action has been retained (or is authorized by law) and if: (1) the amount or extent of incidental take is exceeded; (2) new information reveals effects of the action that may affect listed species or critical habitat in a manner or to an extent not previously considered; (3) the identified action is subsequently modified in a manner that causes an effect to listed species or critical habitat that was not considered in the biological opinion; or (4) a new species is listed or critical habitat designated that may be affected by the identified action. In instances where the amount or extent of incidental take is exceeded, formal consultation shall be reinitiated immediately.

XI. CONSERVATION RECOMMENDATIONS

Section 7(a)(1) of the ESA directs Federal agencies to utilize their authorities to further the purposes of the ESA by carrying out conservation programs for the benefit of the threatened and endangered species. Conservation recommendations are discretionary measures suggested to minimize or avoid adverse effects of a proposed action on listed species, to minimize or avoid adverse modification of critical habitat, or develop additional information.

1. NMFS recommends the Corps work with the City of Santa Cruz to develop a city-wide plan on how to further minimize the turbidity impacts on salmonids from placing gravel bar crossings in the San Lorenzo River watershed, or design alternative free-spanning crossings that do not make contact with the stream bed.

2. NMFS recommends the Corps work with the City of Santa Cruz, other agencies, and stakeholders to develop and implement a program for protection and restoration of salmon and steelhead habitat in the San Lorenzo River.

3. The City has indicated that there will be a need to replace more valves along the levees in upcoming years. NMFS recommends the Corps work with the City of Santa Cruz to develop a city-wide plan on how to further minimize impacts to riparian habitats for any future valve replacements that will be permitted by the Corps.

In order for NMFS to be kept informed of actions minimizing or avoiding adverse effects or benefitting listed species or their habitats, NMFS requests notification of the implementation of any conservation recommendations.

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B. Personal Communications

Jon Ambrose, Fishery Biologist, NMFS, 2008.

Gary Kittleson, Kittleson Environmental Consulting, 2008.

Don Lash, Army Corps of Engineers, October 9, 2003.

Siobhan O'Neil, City of Santa Cruz, April 24, 2008.

Enclosure 2

The San Lorenzo River Gravity Outlet Valve Replacement Project and San Lorenzo River Channel Maintenance activities in Santa Cruz County, California.

Magnuson-Stevens Fishery Conservation and Management Act (MSA) Essential Fish Habitat Comments

EFH Consultation

As described in the above effects analysis, NMFS has determined that the proposed action would adversely affect EFH for Federally-managed coho within the Pacific Salmon FMP. However, the anticipated adverse effects are so minimal in nature that no EFH Conservation Recommendations are necessary to avoid, minimize, mitigate, or otherwise offset the adverse effects to EFH. This concludes EFH consultation for the City of Santa Cruz Department of Public Work's proposed San Lorenzo River Gravity Outlet Valve Replacement Project and Channel Maintenance Activities to be conducted in the City of Santa Cruz, Santa Cruz County, California. Pursuant to 50 CFR 600.920(l), the Corps must reinitiate EFH consultation with NMFS if the proposed action is substantially revised in a way that may adversely affect EFH or other fish and wildlife resources, or if new information becomes available that affects the basis for NMFS' EFH Conservation Recommendations.

Appendix 8: Hydrologic, Water Supply, and Fisheries Habitat Effects Modeling

Hydrologic, Water Supply, and Fisheries Habitat Effects Modeling

1.0 OVERVIEW

Appendix 8, Hydrologic, Water Supply, and Fisheries Modeling provides information about the models used for the City of Santa Cruz (City) Anadromous Salmonid Habitat Conservation Plan (ASHCP).

Evaluation of long-term hydrologic variability in the City's drinking water source watersheds, looking back as well as forward, is fundamental to understanding the City's effects on habitat of special-status aquatic species (specifically, Central California Coast steelhead (*Oncorhynchus mykiss*) (steelhead) and Central California Coast coho (*Oncorhynchus kisutch*) (coho)which are anadromous salmonids) and options for their recovery as well as the long-term reliability of the City's water supply.[1] The City has long sponsored the United States Geological Survey (USGS) Big Trees and Santa Cruz gages on the San Lorenzo River and utilizes them to assist with seasonal supply planning and operation of the Felton Diversion, which has existing instream flow and other operational constraints dictated by the flow at the Big Trees gage. However, the City intensified its effort in 2003 during development of the ASHCP with the installation of additional stream gages and initiation of related habitat evaluations. Concurrent with that, the City was also adopting the Confluence® water supply model to evaluate options for improving water supply reliability. Over time, the modeling of the effects of City water operations on coho and steelhead habitat and on water supply reliability enabled the City, the California Department of Fish and Wildlife (CDFW), and the National Marine Fisheries Service (NMFS) to develop a set of "Conservation Flows" for the ASHCP.[2] The Conservation Flows strike a balance between water supply reliability and fisheries habitat. Consistent with the City's adopted Water Supply Augmentation Strategy, the City has evaluated its ability to meet supply reliability and fisheries conservation goals with modifications of its water rights. The modeling clearly demonstrated that the City cannot meet its water supply reliability goals without modification of its water rights and that these changes are necessary to enable long term provision of the Conservation Flows needed for the ASHCP. This overview provides a summary of the three distinct models used to develop and evaluate the Conservation Flows for the ASHCP.

[1] The City owns and operates a water system that diverts and serves water both within the City limits and outside of those limits. References to the City's water system, rights and supplies therefore refer to areas both inside and outside of the City limits.

[2] In the City's petitions for changes to water rights, the Conservation Flows are called "Agreed Flows" in recognition that they were developed through negotiations with NMFS and CDFW. The Conservation Flows and the Agreed Flows are identical.

2.0 SUMMARY OF MODELS

There are three distinct but interrelated models that the City has used in the effort to develop and evaluate the ASHCP:

- Hydrologic Model (Appendix 8-1) - A hydrologic model that develops the available daily flows in the North Coast streams (specifically Laguna, Liddell, and Majors Creeks), the San Lorenzo River, and Newell Creek available for supply once the Conservation Flows are met.
- Water Supply Model (Appendix 8-2) - The Confluence® water supply model, which utilizes available streamflows (generated by the Hydrologic Model) in a particular scenario (e.g., the Conservation Flows) and with many other system operating assumptions, to evaluate potential operations of the City's water system and the resulting water supply reliability and to calculate the resulting flow left instream for fish habitat.
- Fisheries Habitat Effects Model (Appendix 8-3) - A fisheries habitat effects model that evaluates the fisheries habitat effects of the residual streamflows left instream after municipal supply demands are met in the Water Supply Model, consistent with the minimum streamflows required in a particular scenario, to develop flow-based metrics of habitat effects.

The following is a brief summary of each of these modeling components. Figure 1 provides a flow chart that illustrates how the models work together.

Hydrologic Model

As discussed in Appendix 8-1, this model was developed by Balance Hydrologics, Inc. in order to better understand the long-term hydrologic variability in the City's drinking water source streams to provide the foundation for fisheries conservation and supply reliability planning. Developing a long-term record suitable for supply reliability and biological effects evaluation was enabled by utilizing the long-term record at the USGS Big Trees gage and other stream gages, but also required installation of 10 additional stream gages to better understand effects of City operations, hydrologic dynamics as they relate to availability of anadromous salmonid habitat under different City operations scenarios, and future water supply reliability predictions. Fundamental to this effort was an evaluation of locally downscaled climatic predictions and their effects on future, changed hydrologic dynamics, and subsequently, anadromous salmonid habitat viability and water supply reliability.

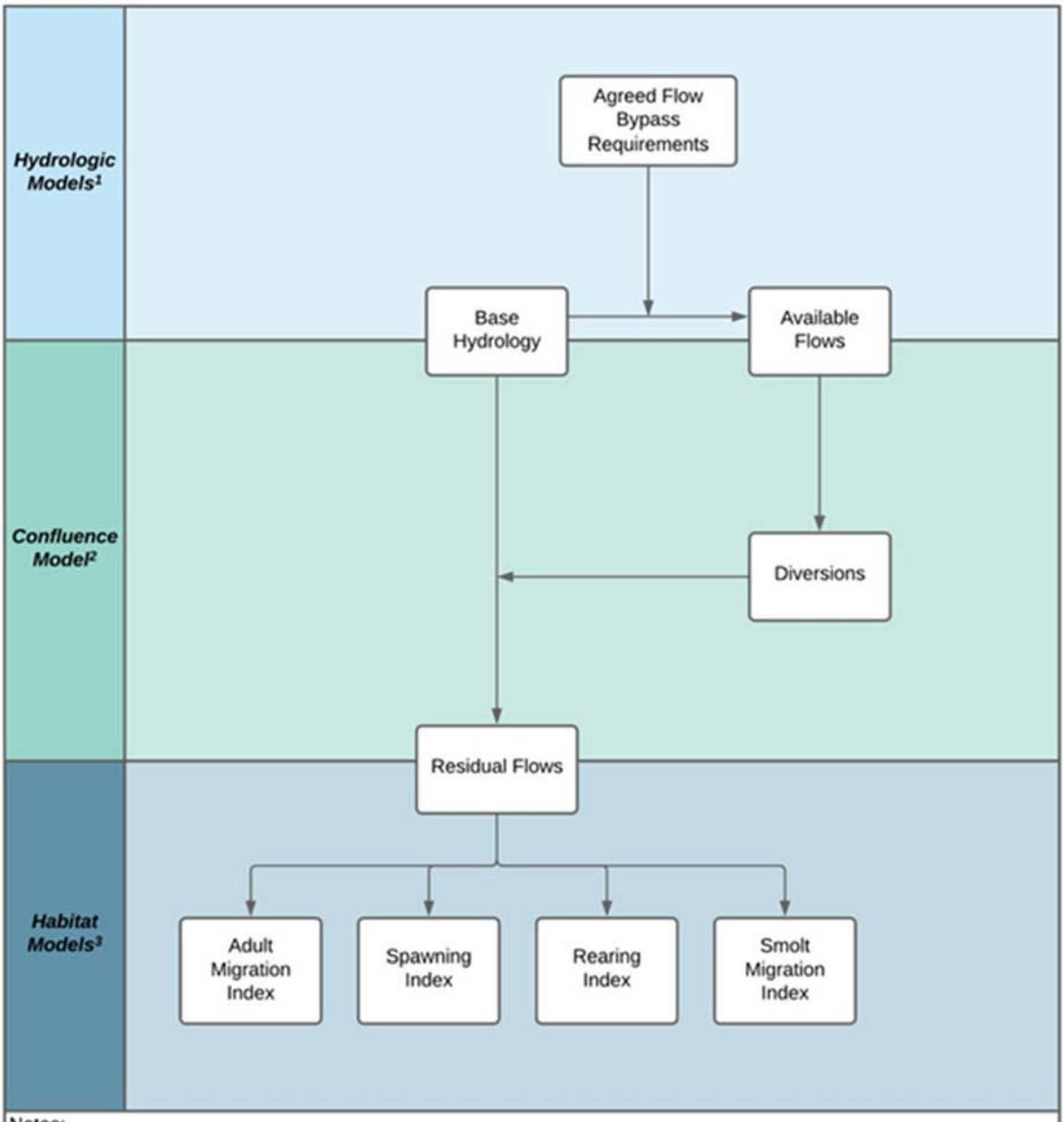
This model developed daily flows available for diversion and/or storage over a multi-year historical period of record and for plausible climate change conditions.

Water Supply Model

As discussed in Appendix 8-2, this model was developed by Gary Fiske and Associates, Inc. Confluence® is a model designed to simulate the operation of water systems to assist water supply agencies to evaluate and compare supply and infrastructure alternatives. The model can accommodate a wide variety of water supplies, storage facilities, infrastructure, and operating constraints including, but not limited to, raw water quality and instream flow needs. The model enables water suppliers to focus on the results that are most important to their decision-making. or that are needed to fulfill legal or regulatory requirements, including different representations of:

- Water supply reliability
- Water demands including instream flow needs or other environmental demands
- Source-specific production
- Surface water and groundwater storage levels
- Treatment and transmission throughput

Figure 1. Flow Chart of Hydrologic, Water Supply, and Fisheries Habitat Models



Notes:

1. The Hydrologic Models apply the Agreed Flow bypass requirements to the Base Hydrology (using historical or climate change hydrology) to determine Available Flows for diversion at each of the City's diversion points.
2. The Available Flows are used in the Confluence Model to generate simulated Diversions. The Diversions are subtracted from the Base Flows to generate the Residual Flows remaining downstream of the diversion points.
3. The Habitat Models use the Residual Flows to develop the various fish habitat indices. Residual Flows represent the amount of streamflow left in the stream after Diversions, assuming diversion is possible after the Agreed Flow bypass requirements are met. Residual Flow may be different than the Agreed Flow bypass requirements if there is more flow in the stream than needed by the Diversions or if flow is less than the Agreed Flow bypass requirements with no diversion.

Confluence® used the available daily flows to assess the impacts on system operations and water supply reliability of different water rights and infrastructure alternatives, and produced residual streamflows after City diversions, which are input to the fisheries effects modeling.

Fisheries Habitat Effects Model

As discussed in Appendix 8-3, the fisheries habitat effects model was developed by Hagar Environmental Science to evaluate habitat conditions in City drinking water source streams under a variety of instream flow conditions. Effects analysis was based on determining flow/habitat relationships in streams from which the City diverts water using several standard methods. Flow/habitat relationships were used to evaluate potential habitat effects across a wide variety of hydrologic conditions to better understand the City's past, present, and future effects on coho and steelhead. The effects analysis was primarily focused on the influence of the City's water system operations on instream flows and the related habitat effects.

The following appendices describe each of these models and modeling results in detail. All three of the models are required to evaluate the Baseline and the ASHCP.

3.0 SCENARIOS MODELED

The scenarios modeled in this appendix include the following:

- Baseline: Conditions at the time the City developed the ASHCP (2018). The baseline is used in evaluations conducted under the California Environmental Quality Act (CEQA) to support the City's decision whether to adopt the ASHCP but is not used in the ASHCP to evaluate effects.
- ASHCP: All water rights modifications, including addition of Conservation Flows as the minimum bypass flows, and water supply augmentation components of the ASHCP.

Additional description of the Baseline and ASHCP are provided below. Detailed modeling assumptions for each scenario are included in Table 1 and described in more detail in Appendix 8-2.

Baseline

The Baseline represents City water rights, water supply operations, and bypass flows that were in place at the time the ASHCP was developed. The City's existing pre-1914 appropriative water

rights authorize diversions from several North Coast streams and the City's post-1914 appropriative water rights allow diversions from Newell Creek and the San Lorenzo River under existing water rights licenses and permits. Water supply operations under the Baseline consider existing infrastructure capacities, as shown in Table 1 and described in more detail in Appendix 8-2. Bypass flows under the Baseline are defined by the interim bypass flow agreement between the City and CDFW which was included in the April 30, 2018 Tolling Agreement between CDFW and the City. All other conditions are based on those existing in 2018.

ASHCP

Activities included in the ASHCP are described in detail in ASHCP Chapter 3, Covered Activities. The ASHCP includes proposed modifications to the City's existing water rights to improve flexibility in operation of the City's water system to better use limited water resources, while enhancing stream flows for local anadromous fisheries. The ASHCP also includes water supply augmentation components and surface water diversion improvements that could result after the water rights modifications are approved.

The elements of this strategy that the City may implement to ensure sufficient water supply to implement the ASHCP include:

- An extension of time to perfect the City's Felton Diversion water rights
- Alignment of all City's water rights place of use (POU) designation
- Flexibility in use of City's San Lorenzo River water rights points of diversion (POD)
- Addition of direct diversion to the City's Felton and Newell Creek water rights
- Improvements to the Graham Hill Water Treatment Plant that will enable more use of turbid winter high flows.
- Development of underground storage rights for diverted high winter flows.
- Designation of "Conservation Flows" for the City's San Lorenzo River and North Coast water rights

These changes will enable better use of high winter flows in the San Lorenzo River (primarily diverted from the Tait Street Diversion) to assist recharge of regional aquifers and enable supply reliability.

The modeling of the ASHCP accounts for the proposed water rights modifications, proposed water supply augmentation, and surface water diversion improvements, as applicable, as well as infrastructure improvements that have independent utility and would be implemented in the

future regardless of the ASHCP, as identified in Table 1 and described in more detail in Appendix 8-2.

TABLE 1: MODELING ASSUMPTIONS FOR BASELINE AND ASHCP

MODELING COMPONENT	MODELING ASSUMPTIONS	
	Baseline	**ASHCP**
DEMANDS		
City Service Area	3,200 mgy	3,200 mgy
North Coast Agriculture	40 mgy	40 mgy
HYDROLOGY		
Historical Hydrologic	1937-2015	1937-2015
Record	2020-2070	2020-2070
Climate Change	CMIP-5 MOD	CMIP-5 MOD
Hydrologic Record	2018 Interim Bypass Flows	Conservation Flows
DISPATCH OF SUPPLIES IN MODELING		
Source Dispatch Order to Meet City Demand	1. North Coast 2. Tait Diversion 3. Tait Wells 4. Beltz Wells 5. Surface water storage	1. North Coast 2. Tait Diversion 3. Tait Wells 4. Felton 5. Beltz Wells 6. Surface water and groundwater storage operated in parallel
North Coast Potential End Uses	1. Agricultural Demands 2. City Demands	1. Agricultural Demands 2. City Demands 3. GW Storage 4. Transfers
Tait Potential End Uses	City Demands	1. City Demands 2. GW Storage 3. Transfers
Felton Potential End Uses	Surface storage	1. City Demands 2. Surface storage 3. GW Storage 4. Transfers

MODELING COMPONENT	MODELING ASSUMPTIONS	
	Baseline	**ASHCP**
Beltz Wells Potential End Uses	City Demands	City Demands
Loch Lomond Potential End Uses (and ASR Potential End Uses for Proposed Project and Alt 2)	City Demands	City Demands
DIVERSION CAPACITIES		
Liddell	2.47 cfs	2.47 cfs
Laguna	6.27 cfs	6.27 cfs
Majors	2.09 cfs	2.09 cfs
Tait	11.52 cfs	27.85 cfs
Felton	12.40 cfs	13.70 cfs
WATER RIGHTS (maximum diversion rate)		
North Coast	No limit	No limit
Felton	Jan-May; Oct-Dec 20.0 cfs Jun-Aug 0 Sep 7.8 cfs	Shared water right: Jan-May; Oct-Dec 32.2 cfs Jun-Aug 12.2 cfs Sep 20.0 cfs[3]
Tait	12.2 cfs in all months	
WATER TREATMENT CAPACITY (mgd)		
Graham Hill WTP	16.5 mgd	18.0 mgd

[3] This manner of modeling the way that diversions at Tait and Felton would interact in the Proposed Project reasonably replicates how the two facilities would operate with proposed changes to the City's current water rights for those facilities. The City's proposed changes to those rights, however, would not involve adding Felton as a point of diversion on the City's licenses for the Tait Diversion. The City therefore would not divert water at Felton during the period of each year when the Felton Permits do not authorize diversions. Permit 16123 only authorizes diversions at Felton from September 1 through June 1. Permit 16601 only authorizes diversions there from October 1 to June 1.

MODELING COMPONENT	MODELING ASSUMPTIONS	
	Baseline	**ASHCP**
OTHER KEY OPERATING CONSTRAINTS		
North Coast	Turbidity	Turbidity
Felton	Turbidity, First Flush, Pump limitations, Reservoir elevations	Turbidity, First Flush
Tait	Turbidity	Turbidity
WELL EXTRACTION CAPACITIES (native groundwater)		
Beltz	0.8 mgd Apr - Nov in all water years	0.8 mgd Apr - Nov in all water years
Beltz 12	0.3 mgd May - Aug in critically dry years	0.3 mgd May - Aug in critically dry years
Tait Wells	1.28 mgd May - Dec 0.78 mgd Jan - Apr	1.28 mgd May – Dec 0.78 mgd Jan - Apr
LOCH LOMOND RESERVOIR		
Max/usable capacity	2,810 mg/1,740 mg	2,810 mg/1,740 mg
Allowable diversion months	Sept - Jun	Sept - Jun
Daily Instream Release	1.00 cfs	1.00 cfs
Annual San Lorenzo Valley Entitlement	102.1 mg	102.1 mg
AQUIFER STORAGE & RECOVERY		
Storage Capacity	N/A	3,000 mg
Aquifer Losses	N/A	20%
Injection Capacity	N/A	Historic 4.5 mgd; Climate Change 5.5 mgd
Extraction Capacity	N/A	Historic 8.0 mgd; Climate Change 7.0 mgd
Injection Season	N/A	Nov – Apr

MODELING COMPONENT	MODELING ASSUMPTIONS	
	Baseline	**ASHCP**
Extraction Season	N/A	May - Oct
Hydrologic condition restriction	N/A	No injection in Hydrologic Condition-5 months
WATER TRANSFERS		
Maximum monthly transfer	N/A	Neighbor agency groundwater demands
Hydrologic condition restriction	N/A	No transfer in Hydrologic Condition-4 & Hydrologic Condition-5 months

Appendix 8-1

Baseflow Hydrology and Climate Change Affects Modeling

1.0 INTRODUCTION AND BACKGROUND

This document provides a general overview of the hydrologic model used to complete historical and climate change (CC) analysis in support of the City of Santa Cruz (City) Water Supply Planning (WSP) efforts, as well as evaluation of the City Anadromous Salmonid Habitat Conservation Plan (ASHCP) (see Chapter 3 of the ASHCP for a full description of the Covered Activities included in the ASHCP). Modeling work for the WSP occurred during the time period 2008–2018, referred to as the WSP analysis period, and modeling completed in support of the ASHCP occurred from 2014–2020. During the WSP analysis period, the hydrologic modeling tools and approaches evolved and were updated numerous times due to active discussions with the regulatory agencies involved in the WSP negotiations, and in order to incorporate more hydrologic observations into the model framework. We refer to the model framework as the Base Hydrology Model.

The Base Hydrology Model uses a combination of measured and modelled daily streamflows to represent the historical hydrology of the region. Rivers and streams represented in the model are a part of the City water supply system and provide habitat for coho salmon (coho) and steelhead trout (steelhead). We refer to these streams as Source Streams (Figure 1):

a. San Lorenzo River at Big Trees Station and Tait Street Station;

b. Liddell Creek–Upper Station and Anadromous Station;

c. Majors Creek–Upper Station and Anadromous Station;

d. Laguna Creek–Upper Station and Anadromous Station; and

e. Newell Creek–Upper Station and Anadromous Station.

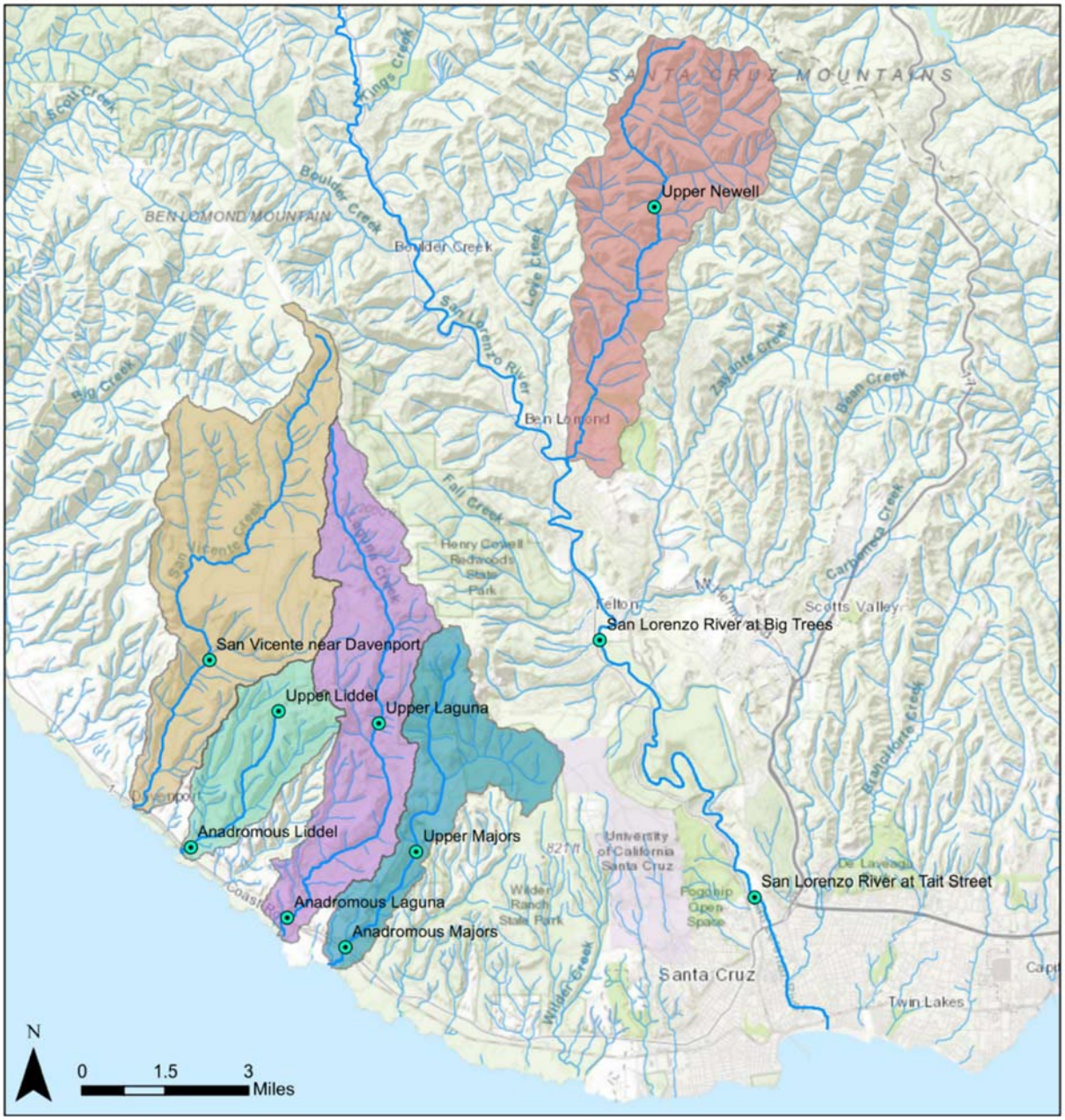


Figure 1: Source Streams and Gaging Station Locations

In the case of Laguna, Majors and Newell Creeks, the “Upper" Stations are located upstream of points of water supply diversions owned and maintained by the City. The Upper Liddell Creek station occurs downstream of the City’s diversion at Liddell Spring. In contrast, all “Anadromous" Stations are downstream of diversion points within the reaches of anadromy of coho salmon and steelhead trout (Figure 1). More specifically, Anadromous stations correspond to locations on Laguna, Majors, Liddell, and Newell Creeks where upstream migration of anadromous fish is limited due to migrational barriers, or other limiting factors (Appendix 8-3).

2.0 OVERVIEW OF THE BASE HYDROLOGY MODEL

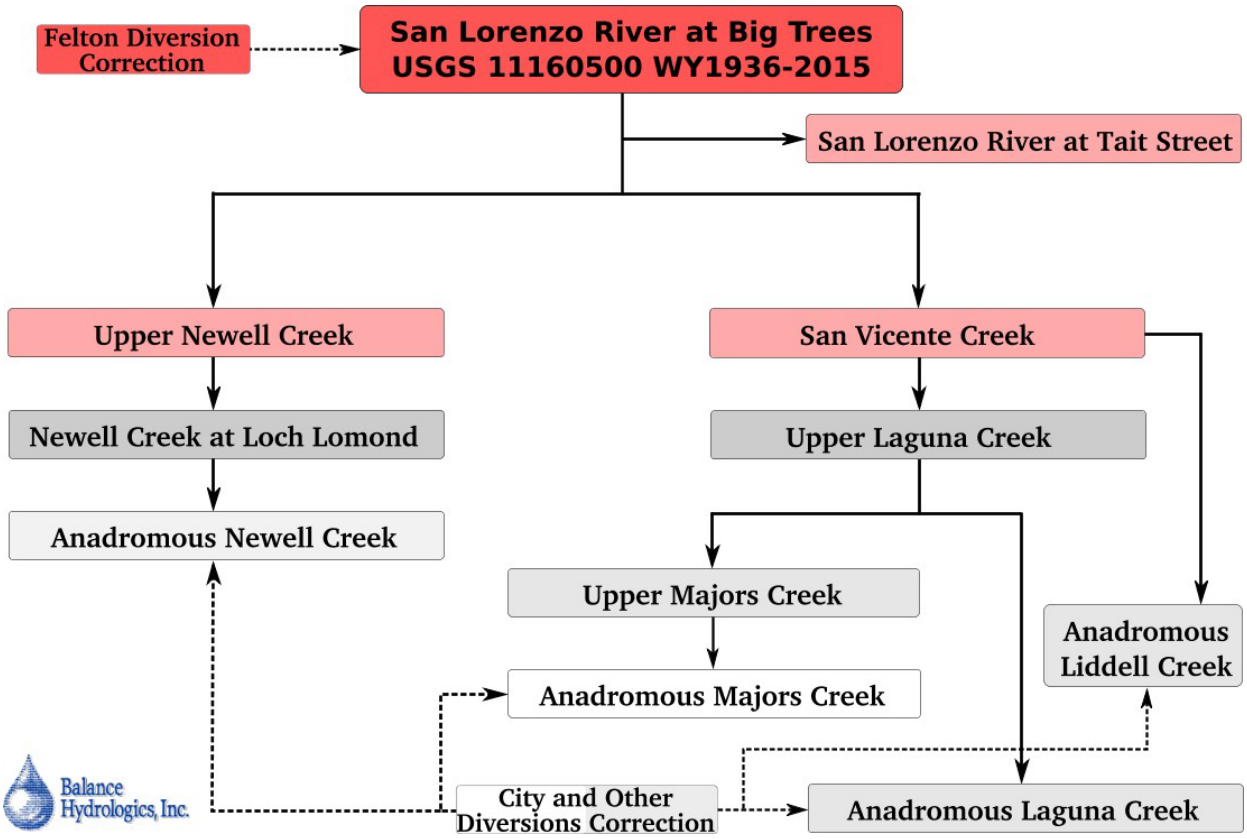


Figure 2: Workflow of the Base Hydrology Model. The diagram illustrates how the regression relationships provided within Appendix A are applied within the model. Lines between boxes indicate application of the specified set of regression relationships between the two indicated stations. All daily streamflows for the historical analysis period WY1936-2015 are derived from the USGS Big Trees published records. Dashed lines indicate that the flow corrections are estimates.

The basic purpose of the Base Hydrology Model is to partition modelled daily flow at points of diversion between water supply (Appendix D-2) and target instream flows for the various life stages of coho and steelhead (see Appendix 8-3 for a description of instream flow rule requirements, specifically referred to as the Conservation Flows). In general, the Conservation Flows vary by source stream, and according to five hydrologic categories calculated for the San Lorenzo River at Big Trees gage (Big Trees) (Table 1): critically dry, dry, average, wet and very wet (Figure 3). The five hydrologic categories are partitioned between the quintile statistics (i.e., 20%, 40%, 60% and 80%) for annual flows at Big Trees. For example, critically dry conditions

correspond to total annual flows that are less than the 20th–percentile flow condition for the Big Trees period of record (Figure 3). See Appendix 8-3 for more information on the statistical hydrologic categories, and how they are applied within the ASHCP instream flow rules.

Streamflow is modelled at the daily time step for multiple reasons. First, daily streamflow provides a reasonable measure of basic habitat conditions for coho and steelhead because daily streamflow can be directly linked with field measurements of habitat suitability (Appendix 8-3). Second, the water supply system model used to evaluate water supply reliability for the City operates at the daily time step since water use generally fluctuates daily (Appendix 8-2). Last, we cannot reliably model streamflow at time scales smaller than daily, and the monthly time step is too coarse for analysis purposes. Next, we describe the model in more detail.

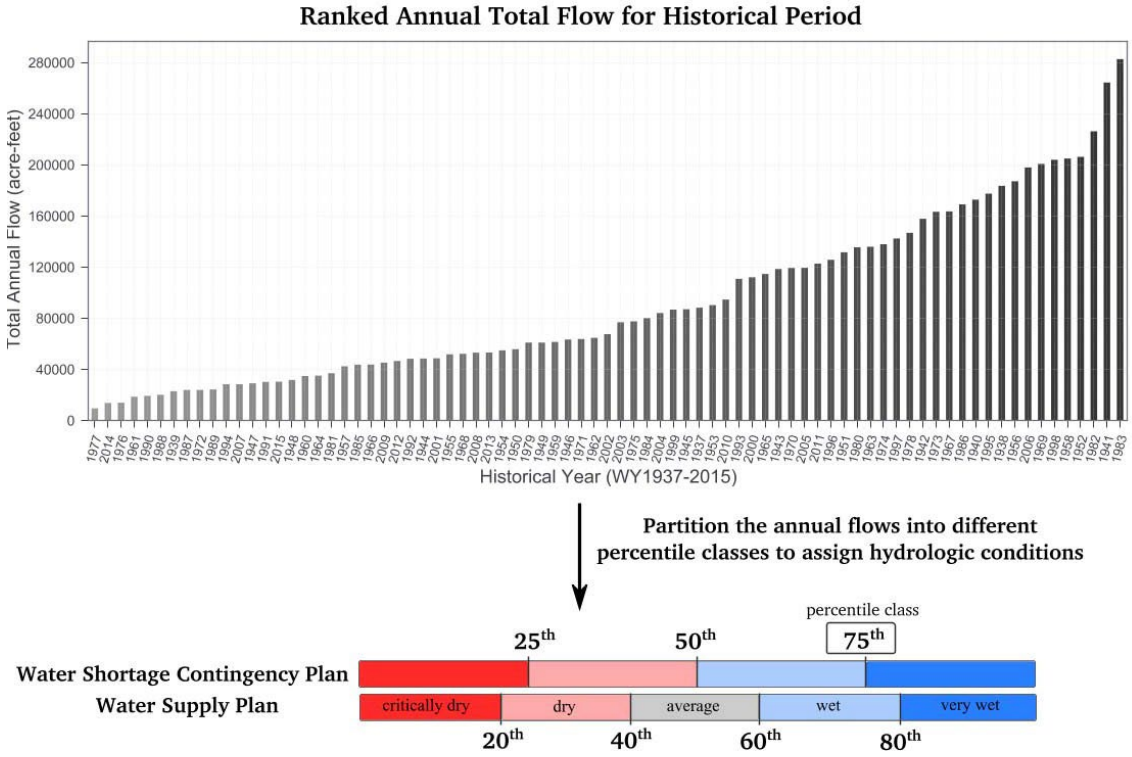


Figure 3: Graphic describing the five hydrologic categories used for the Water Supply Plan, and to evaluate the Proposed Project. The ranked annual total flow is for the Big Trees gage. The Water Shortage Contingency Plan categories were used for previous water supply planning undertaken by the City (City of Santa Cruz Water Department, 2009), and are shown for reference purposes only.

The San Lorenzo River at Big Trees (Big Trees) hydrologic record serves as the control point of the Base Hydrology Model. We selected the Big Trees record as the model control point for a few reasons. First, it is the longest running regional stream gaging station, operated by the

United States Geological Survey (USGS) since October 1936 and continuing to the present day. Second, the San Lorenzo River is a primary water supply source for the City. For the purposes of the WSP, the Base Hydrology Model simulates daily historical flow conditions in each source stream for the historical period October 1936–September 2015 (historical analysis period). Following standard convention, we refer to the historical analysis period as Water Years 1936-2015 (WY1936-2015). A water year runs from October 1 of one calendar year, to September 30 of the following year. For example, WY1950 begins on October 1, 1949 and ends September 30, 1950. The historical analysis period ends in September 2015 because it was necessary to stop adding data at some point in order to reach consensus on an overall conservation strategy. September 2015 was also a reasonable stopping point in the analysis data set because it followed three years of severe drought, and WY2015 is one of the driest years of local records.

Streamflow modeling occurs with regression models constructed from available gaged daily flow records. In general, daily streamflows for non-measurement periods are estimated at all source stream stations based on the Big Trees daily flow record. The specific gaging records and associated measurement periods used to develop the Base Hydrology Model and the regression relationships are provided in Table 1.

Table 1: List of Gaging Records used in the Base Hydrology Model

Station	Time Period
1. San Lorenzo River at Big Trees (USGS Gage 11160500)	October 1936–September 2015
2. San Lorenzo River at Tait Street (USGS Gage 11161000)	October 1987–September 2015
3. Laguna Creek near Davenport (USGS Gage 11161590)	October 1969–September 1976
4. Laguna Creek upstream of Laguna Dam (City and Balance Hydrologics)	October 2003–present
5. Laguna Creek at Highway 1 (City and Balance Hydrologics)	October 2003–present
6. Majors Creek near Davenport (USGS Gage 11161570)	October 1969–September 1976
7. Majors Creek upstream of Majors Dam (City and Balance Hydrologics)	October 2004–present
8. Majors Creek at Highway 1 (City and Balance Hydrologics)	October 2004–present
9. Liddell Creek near Bonny Doon (City and Balance Hydrologics)	October 2003–present
10. Liddell Creek at Highway 1 (City and Balance Hydrologics)	October 2004–present
11. San Vicente Creek near Davenport (USGS Gage 11161800)	October 1969–September 1985
12. Newell Creek upstream of Loch Lomond Dam (City and Balance Hydrologics)	October 2003–present
13. Anadromous Newell Creek (City and Balance Hydrologics)	October 2003–present

Each station in Table 1 is a modeling node in the Base Hydrology Model. We use the former USGS San Vicente Creek station daily records within the model because it provides the best basis of correlation for Laguna Creek (Figure 1). Streamflows between San Vicente and Laguna Creeks correlate because the upper watershed drainage basins include significant areas of Karst. Karst landscapes include underground drainage systems due to the dissolution of bedrock such as

limestone or marble. Marble bedrock occurs in both the San Vicente and Laguna Creek basins. Note though that San Vicente Creek is not a water supply source for the City of Santa Cruz.

The regression relationships used to estimate daily flows during non-measurement periods within the Base Hydrology Model are provided in Tables A1 and A2 (Appendix A). The regression relationships were first developed in 2010 and were re-examined and revised in 2015 following three years of drought. A re-examination of the regression models resulted in changes to models for Tait Street, Liddell, Laguna and Majors Creeks (Table 1). In all cases, changes made to the regression models reflect the need to better simulate daily flows during low flow months and periods of drought. Water supply and instream habitat conditions for coho and steelhead are most challenged during these times. The regression relationships are executed within a MathWorks MATLAB script, developed specifically for the WSP.

2.1 Calculation of Daily Flows

The Big Trees record of daily flow for the historical analysis period is read into the Base Hydrology Model. The script then computes daily flows at all other stations according to the workflow shown in Figure 2, and for the historical analysis period WY1936-2015. Color changes to the station names in Figure 2 indicate that the basis of mean flow calculation changes (Tables A1 and A2). For example, Big Trees is used to calculate the daily flow record at San Vicente Creek for the historical analysis period. Then in turn, the daily flow record for San Vicente Creek is used to calculate flows at Upper Laguna Creek over the same period (Figure 2). Although our modeling strategy may propagate errors, the results are satisfactory because the Base Hydrology Model is able to reproduce the observed hydrologic trends over the historical analysis period (discussed in more detail in the paragraphs that follow).

Table 2: Summary Information for Inter-basin Model Calibration

Mean daily flow for calibration period			
Stream	**Obs (cfs-days)**	**Sim. (cfs-days)**	**Rel. error (%)**
Laguna (11161590)	4.82	5.02	4.3
Majors (11161570)	4.24	4.30	1.50
Liddell (Upper)	4.28	4.24	1.7
Tait (11161000)	144.3	140.2	2.7

General notes on the table: 1. Calibration period varies. See Figure 4.
2. Relative error = (S im. − Obs.)/Obs.

In the course of computing the daily flow records according to Figure 2, flow corrections are made to Big Trees and all anadromous stations in order to account for upstream flow diversions:

- San Lorenzo River at Big Trees: Record of diversion at Felton;
- San Lorenzo River at Tait: Record of diversion at Tait and Felton;
- Anadromous Laguna Creek: Record of North Coast production + 0.25 cubic feet per second;
- Anadromous Majors Creek: Record of North Coast production + 0.194 cubic feet per second; and
- Anadromous Liddell Creek: Record of diversion at Liddell Spring.

The application of flow corrections to affected gages for times when data is available means that daily flow records used in the Base Hydrology Model are assumed to represent quasi-unimpaired flow conditions. Despite the application of flow corrections, daily flows used in the model may not fully account for all upstream water extractions from source streams, tributaries and shallow ground water which directly influence instream flows. We also do not consider other watershed conditions that could influence instream flows that we could not possibly detect through gaging record analysis. City records of water supply production, flow release tests and gaging station records for stations located immediately downstream of City diversions on Laguna, Majors and Liddell Creeks are the basis for the corrections applied in the model. A comparison between gaged and modelled streamflows for Laguna, Majors and Liddell Creeks, as well as the San Lorenzo River at Tait Street is shown in Figure 4. The calibration period differs across the stations and is shown as the x-axes of Figure 4.

The overall reliability of the Base Hydrology Model is reasonable for Upper Laguna, Upper Majors, Upper Liddell and Tait Street (Figure 4). Relative errors of the model for each of these

four stations is <5% when comparing mean daily streamflows over the respective calibration periods (Table 2). A suitably calibrated model is expected to have a relative error < 10% (Elsner and others, 2010).

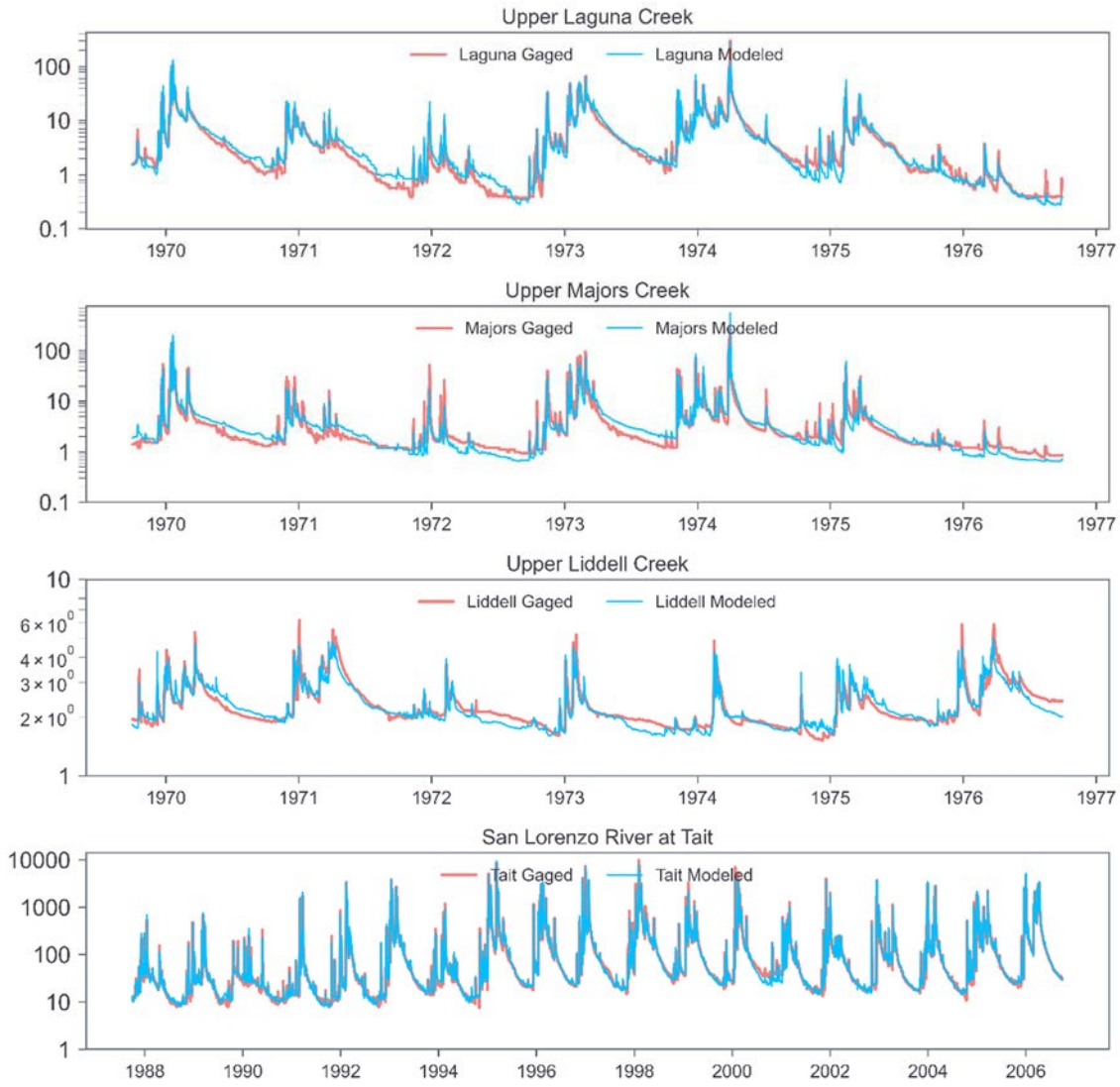


Figure 4: Comparisons between gaged and modelled daily streamflows. Modelled streamflows were calculated according to the regression relationships provided in Appendix A.

2.2 Why a Regression Basis for the Base Hydrology Model?

The City has previously used a physically based watershed scale hydrologic model for its Integrated Water Management Planning (IWMP) projects (City of Santa Cruz Water Department 2009). In 2006 we evaluated output from the IWMP against gaging records for Laguna, Majors and Liddell Creeks. The comparison revealed that the IWMP-derived flows generally have a wet bias [i.e more streamflow] relative to measurements made during summertime low flow periods, periods of drought, intra-storm periods and recessional flow periods (Figure 5). A wet bias during these conditions was difficult to accept because of the challenges faced by instream habitat conditions as well as water supply availability during low flow periods. This circumstance, coupled with the City's desire to examine numerous instream flow and water supply scenarios, prompted the project team to adapt and build a hydrology model for the source streams using available gaging records as the model basis.

The simplicity of the Base Hydrology Model provides two advantages. First, we can efficiently evaluate different instream flow rules or water supply scenarios (it takes less than 1 minute to run a simulation once the input files are built), and second, the model is built using observations of streamflow (corrected with available data) within all source streams. In support of the WSP and the ASHCP, the Base Hydrology Model has been used to evaluate more than 50 different scenarios.

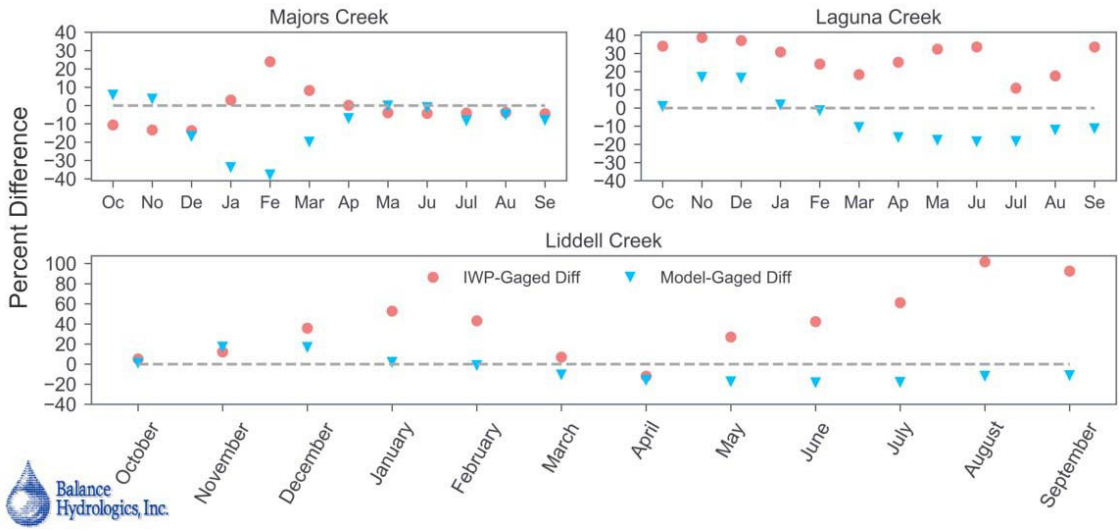


Figure 5: Percent difference between IWMP modelled flows and associated gaged flows (IWP-Gaged Diff), and regression modelled flows and associated gaged (Model-Gaged Diff) flows. Values represent monthly averages calculated over the gaging period of records (Table 1).

2.3 Limitations and Assumptions for Base Model

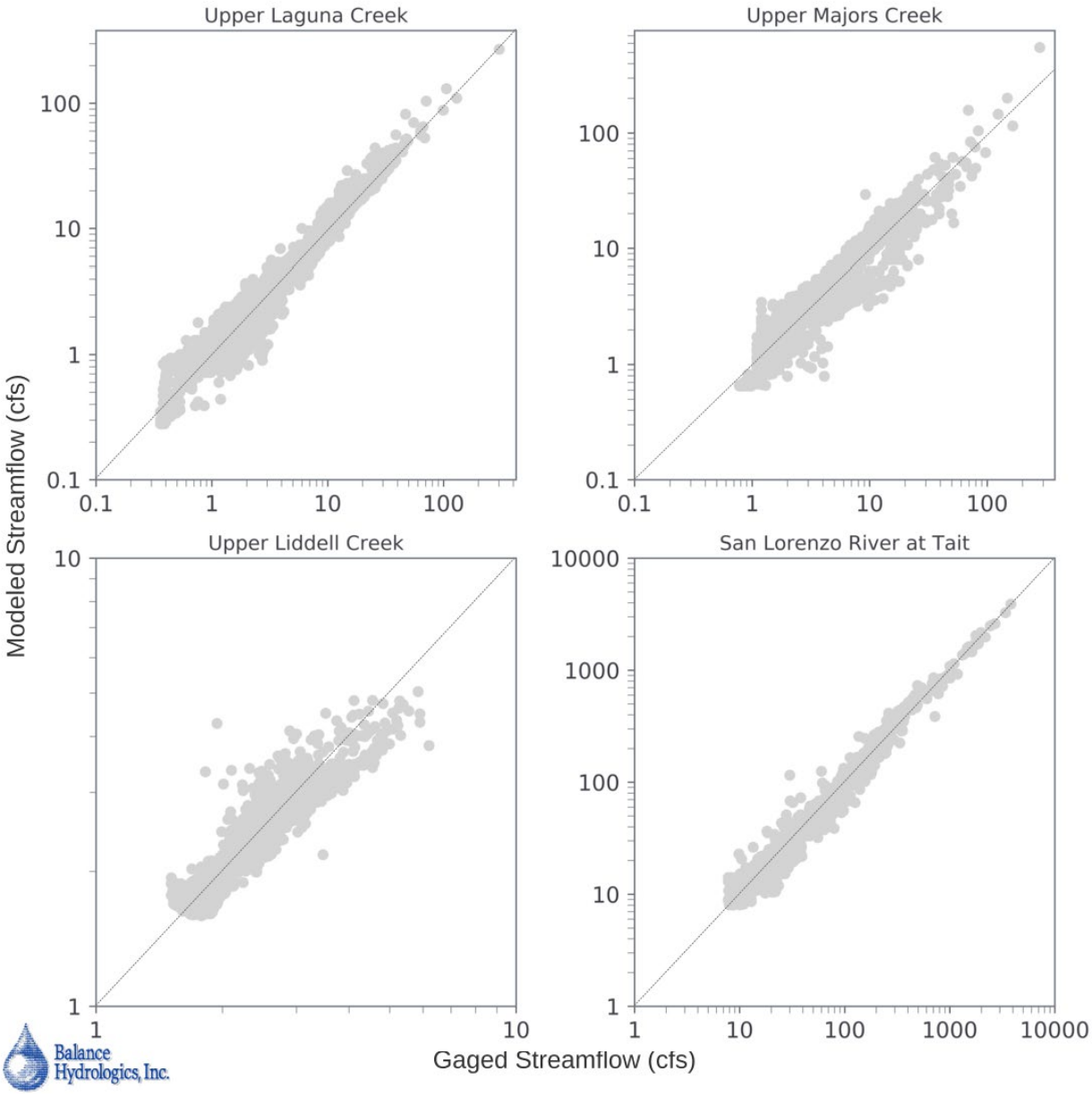


Figure 6: Comparison between gaged and modelled streamflows for Upper Laguna, Upper Majors, Upper Liddell and the San Lorenzo River at Tait Street. The data for Laguna and Majors Creek spans WY1970-76; the data for Liddell Creek spans WY2003-09, and the data for Tait spans WY1987-06. Similar results occur for Laguna and Majors Creek for the more recent period for which gaging records exist (Table 1). 1:1 lines shown for reference.

The Base Hydrology Model is constructed with regression relationships that have been identified in order to model low flow periods to a level acceptable to the City and regulatory agencies. The

regression relationships can, for example, track changes in flow reported within applicable gaging records (Figure 4), and in general provide an improvement over flow records developed as a part of the IWMP (Figure 5). However, in some cases the regression relationships do not reproduce summertime flows reported, for example, at the USGS Laguna Creek near Davenport station during WY1972 (Figure 4). Model departures from summertime gaged flows in WY1972 exist because the regression relationships do not capture all of the variance present in the historical data. This is expected given our approach. Nonetheless, the model does capture the magnitude of the drought summertime flows during WY1976. This outcome reflects our general goal since we understand WY1976 was a critically dry year, and for such conditions water supply and instream habitat are most challenged.

The Base Hydrology Model is used to compile and calculate daily streamflow records for Laguna, Majors, Liddell and Newell Creeks, and for the San Lorenzo River at Tait for the period WY1936-2015. As a result, daily flow records for a majority of the water years within the historical analysis period are calculated using the regression relationships (compare historical analysis period against available gaging records in Table 1). Consequently, we assume that the inter-basin and intra-basin flow conditions captured by the years of overlapping gaging records are consistent with conditions during correlated years. We have no reasonable way to examine this assumption. However, the Big Trees record suggests that general land use practices and other activities that could affect runoff production have not changed considerably during the historical analysis period, which by extension we assume for the other basins as well. Last, based on the distribution of gaged vs. modelled flows (Figure 6) we assume that the regression relationships reflect the average, or most probable range of streamflow conditions in the source streams for any given set of precipitation, soil saturation and groundwater conditions, etc.

3.0 OVERVIEW OF BASE HYDROLOGY MODEL APPLICATION TO POTENTIAL CLIMATE CHANGE CONDITIONS

Climate change (CC) work for the City WSP has been ongoing since 2008. In our first step we incorporated CC into the WSP planning process. This involved a substantial literature review to gain an understanding of CC science for, in particular, California. An outgrowth of this led Balance to contact Ed Maurer at Santa Clara University to seek expert guidance on how to set up a simplified analysis for the WSP using CC information. Guidance and suggestions resulted in the development of a water balance model (WBM), which serves as the basis for the CC modeling reported here. We run the WBM with CC data acquired through Cal–Adapt for the period WY2020–70 (CC analysis period).

At the time our CC work was getting started, the Cal–Adapt program (https://cal-adapt.org/about/)was in the early stages of implementation. The development of Cal–Adapt was in part motivated by then California Governor Schwarzenegger's November 2008 Executive Order S-13-08, which specifically asked the Natural Resources Agency to identify how state agencies can respond to CC. In essence, Cal–Adapt is a hub for climate change data relevant to adaptation planning in California. In more recent years however, Cal–Adapt has also grown to offer web-based analysis of CC data available via the Cal–Adapt website. In the remainder of this technical memorandum, we review our approach to the WSP CC analysis, and the data sets we used to complete the work.

3.1 Development of Projected CC Streamflows

Development of projected CC streamflows for the WSP follows three main steps, with intermediate work completed in between each step (Figure 7).

Step 1: The Water Balance Model (WBM)

The first step focuses on development of the WBM, specified as:

Equation (1)

$$Q = P + B - Et_o - R.$$

The WBM is a water accounting statement which specifies that streamflow (Q) is the difference between additions and losses to the water budget. Additions in this case are the upstream contributing watershed average precipitation (P) and baseflow (B); losses are the upstream contributing watershed average potential evapotranspiration (Et_o) and groundwater recharge (R). All terms in Equation 1 are expressed in units of feet per day, and streamflow is calculated with units of cubic feet per second, summed at the monthly time step (cfs-days). The step from units of feet per day to streamflow is achieved by multiplying the water balance result over the upstream drainage basin area. Precipitation is provided directly through the CC projections and differs depending on the projection that is used.

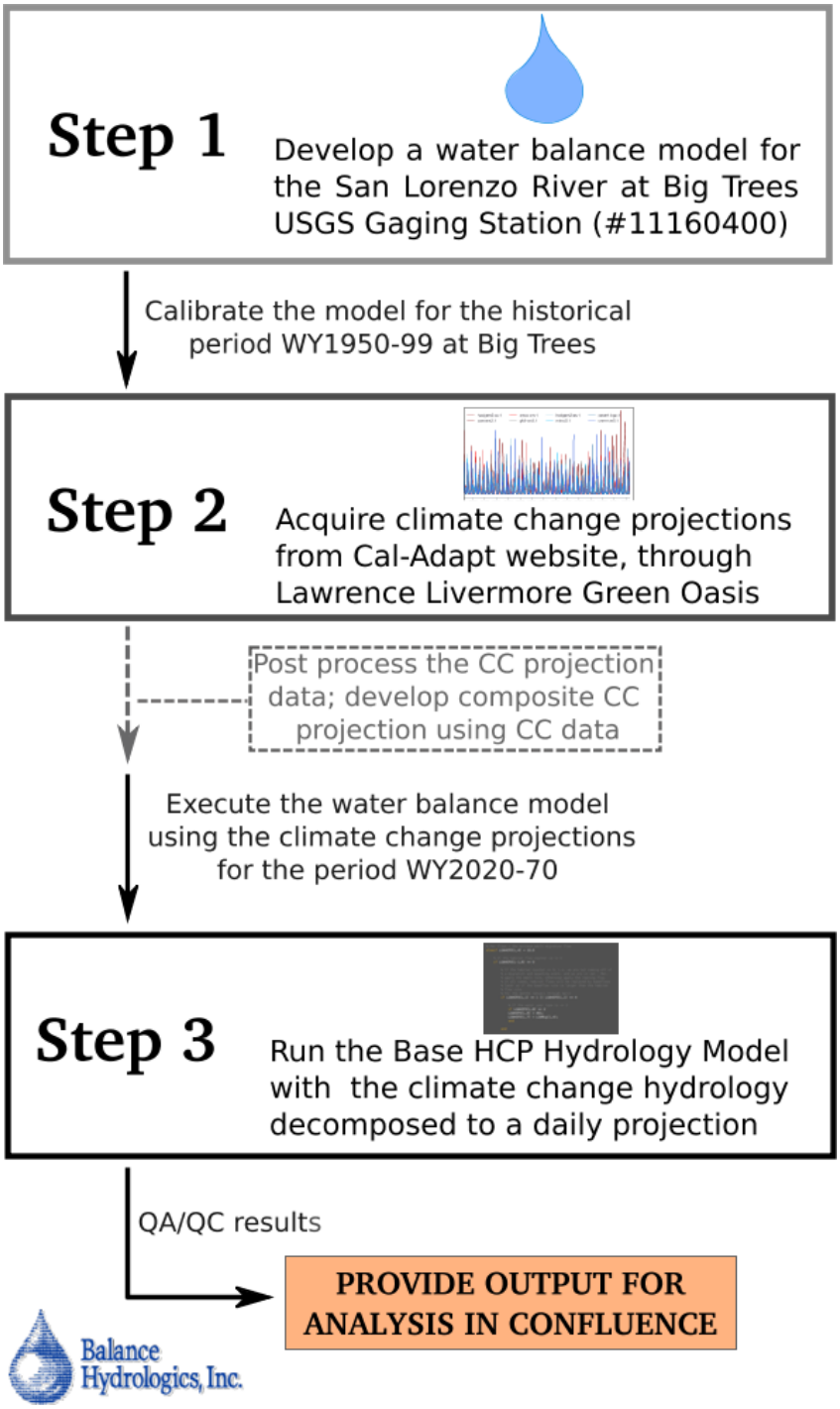


Figure 7: Steps followed to apply climate change projections to the Base Hydrology Model. The steps are discussed in the main text.

In contrast, baseflow is a calculated quantity, which we approximate as a backward-looking function that tracks the general wetness conditions:

Equation (2)

$$B = \left(\sum_{j=t-1}^{j=t-6} P \right) * Co_s * K_b.$$

Summation occurs over the prior five months average daily rainfall, Co_s is the carry-over-storage of shallow groundwater and K_b is the estimated proportion of the prior months' precipitation and carry-over storage available as baseflow. K can take values between 0 and 1, and here has a value of 0.099. Testing indicates that the WBM is sensitive to K values > 0.0999, and relatively insensitive to values much less than 0.099. We calculate the carry-over-storage as a departure of recent precipitation trends from the analysis period average:

Equation (3)

$$Co_s = \frac{\frac{1}{10}\left(\sum_{j=t}^{j=t-10} P\right)}{\overline{P}}.$$

The historical analysis period average precipitation $\overline{P}$ is 0.0102 feet per day. Potential evapotranspiration is calculated according to the adjusted Blaney-Criddle equation:

Equation (4)

$$Et_o = pr([0.75 * \overline{T}\,] + 0.5),$$

where pr is the average proportion of daylight hours for the Santa Cruz region (37.5 degrees north latitude) and $\overline{T}$ is the contributing watershed average monthly air temperature in degrees centigrade. The adjusted Blaney-Criddle equation produces an Et_o curve that rises to a maximum during the late summer months and achieves a minimum during the early winter months of December and January. See the following website for more details regarding the Blaney-Criddle equation: http://www.fao.org/3/s2022e/s2022e07.htm.

Recharge is calculated as a monthly apportioning function:

Equation (5)

$$R = \frac{P_m}{\left(\sum_{m=1}^{m=12} P_{m,n}\right)} * K_r.$$

The subscript *m* is the present month in the present water year, and *n* is the present water year in the data set. The term K_r is a constant annual recharge amount that here has a value of 0.328 feet per year, based on estimates we developed using hydrologic records at Liddell Spring. Equation 5 distributes K_r based on the present month's proportion of the water year total precipitation. This approach likely underestimates recharge in wet years and overestimates it in dry years. However, fixing K_r to a constant value yields WBM performance that is acceptable, as we will discuss further in the next section. Second, our approach to use of a fixed K_r value also avoids more sophisticated approaches that would require data that is not readily available.

Last, it is important to highlight that the WBM is primarily dependent on monthly precipitation, as well as average monthly air temperature (Equations 1–5). These dependencies provide the opportunity to apply the WBM to evaluate how future plausible climate conditions of precipitation and air temperature may affect monthly streamflow totals in the Santa Cruz region. Next, we discuss how the WBM was calibrated in order to produce plausible estimates of monthly streamflow at Big Trees.

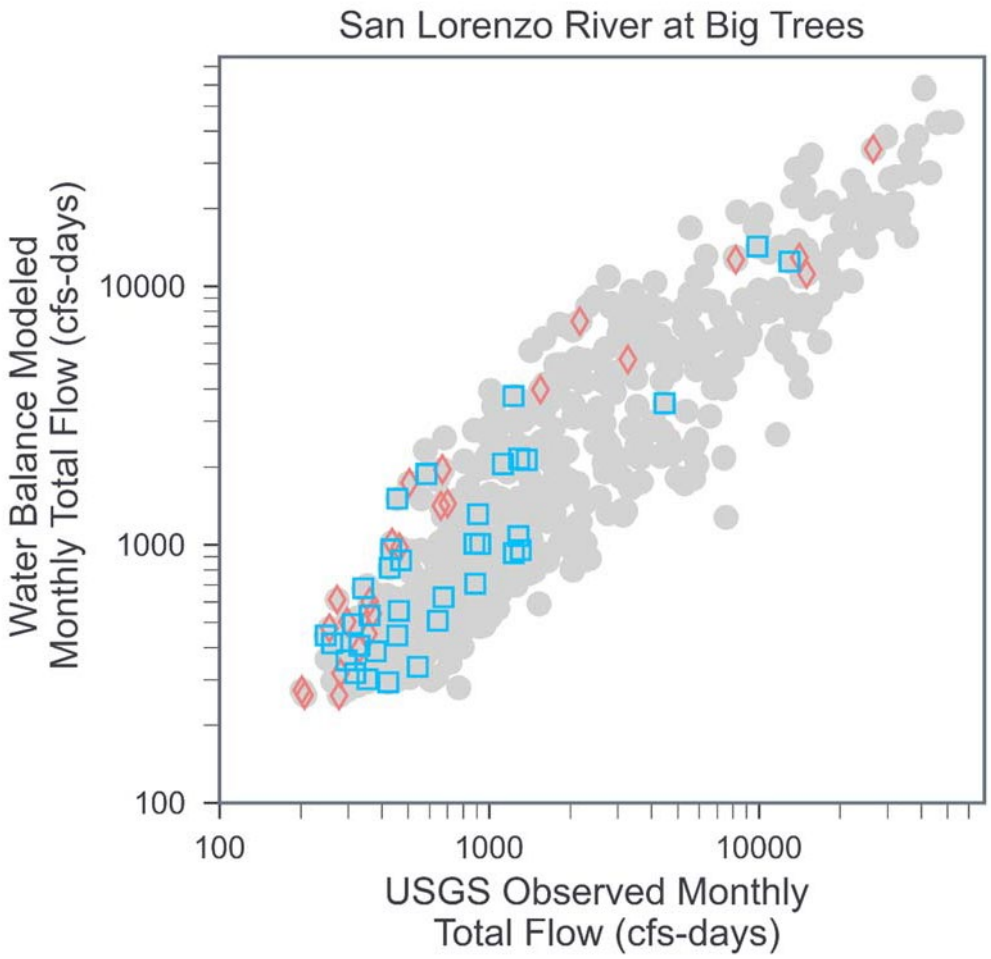


Figure 8: USGS observed monthly total streamflow vs. modelled monthly total streamflow using the Water Balance Model. The red diamonds cover the WY1976-77 drought, and the blue squares cover the WY1989-91 drought. 1:1 line shown for reference.

Water Balance Model Calibration

The WBM (Equations 1–5) is calculated using local gridded climatological data (Maurer and others, 2002) available through Cal–Adapt for the period WY1950-2000. We use gridded climatological data because it is available at the same spatial resolution as the CC projection data. As a result, the WBM is constructed and used with data that are spatially consistent. The calculated WBM monthly total streamflows are then plotted against the associated observed data reported for Big Trees. Best fit lines between the two data sets provide the calibration curves for the WBM. The goal of the calibration process is to use Equations 1–5 to predict monthly total

streamflow at Big Trees as best we can given the limitations of the WBM. In particular, we seek good model performance for dry or drought years. To achieve the best approximation of drought conditions with the WBM, we treat the recharge (R) and baseflow (B) terms of Equation 1 as fitting parameters. This means we tested different ways of calculating both terms until we minimized misfit between observed and modelled, and reasonably reproduced dry and drought streamflows. Once satisfied with the WBM performance, we use the calibration curves to transform the WBM streamflows to magnitudes which occur within the observed range of streamflows at Big Trees (Figures 8 and 9). The calibrated WBM performs as expected with respect to testing against the observed streamflow record at Big Trees, and successfully approximates flow magnitudes during the driest months on record for the period WY1950–2000 (Figures 8 and 10). Outside of the driest months, there is a clear linear correlation between observed and modelled flows, and the calibrated WBM calculates a majority of Big Trees flows within a factor 2 and less of the observed flows (Figure 9). In more detail, roughly 70% of modelled flows are within a factor 0.6–1.5 of observed flows (Figure 9). Beyond these specific results, the overall skill of the WBM is reasonable, with a relative error < 1% when comparing monthly mean streamflows over the calibration period (Table 3). As mentioned above, a suitably calibrated model is expected to have a relative error < 10% (Elsner and others, 2010). The model is capable of capturing observed year-to-year fluctuations and trends from wet to dry, and all the other climatological combinations (Figure 10). This result indicates the WBM can track how climatological conditions drive year-to-year fluctuations in streamflow, which makes intuitive sense given how the model is constructed (Equations 1–5).

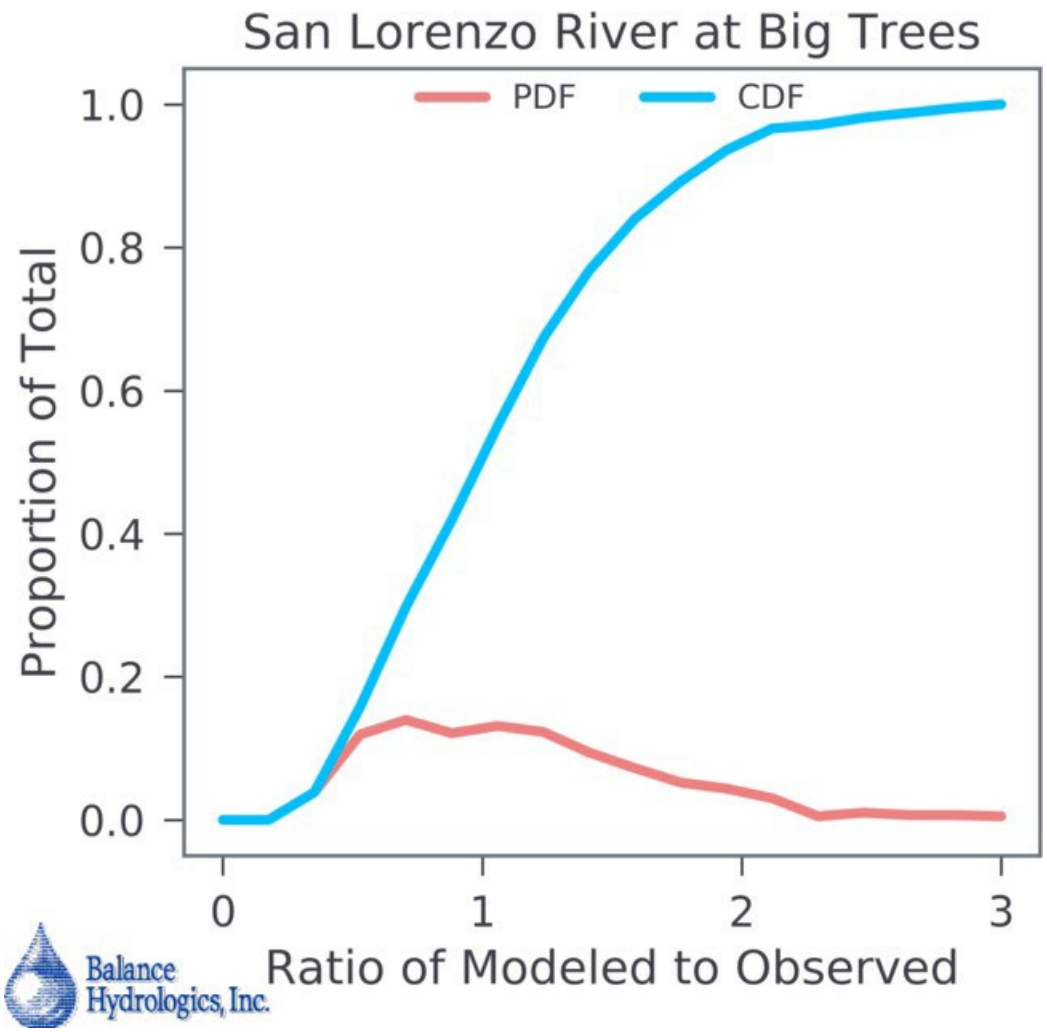


Figure 9: Probability distributions of the ratio of modelled to observed streamflows at Big Trees for the period WY1950-2000. Modelled streamflows were calculated with the Water Balance Model (Equations 1–4) and the calibration curves. PDF stands for the probability distribution function, and CDF for the cumulative distribution function.

Table 3: Summary Information for Water Balance Model Calibration

Monthly mean for calibration period			
San Lorenzo River	**Obs (cfs-days)**	**Sim. (cfs-days)**	**Rel. error (%)**
Big Trees (11160500)	4028.4	4026.9	0.03

General notes on the table: 1. Calibration period WY1950–2000.
2. Relative error = (Sim. − Obs.)/Obs.

It is important to point out that the WBM does not contain a change of storage term, which would be typical for mass balance statements. We do not include a change of storage term because we do not know how groundwater storage within the study area changes over the period WY1950–2000 (i.e., the calibration period), and consequently, we cannot constrain storage fluctuations under future plausible climates. We address the model shortcoming with respect to groundwater storage through our approaches to estimate the baseflow and recharge terms of Equation 1. Additional model limitations are presented at the end of this section.

Step 2: Acquire Climate Change Projections

All CC projections used as a part of the WSP analysis were acquired via the Cal-Adapt website (Figure 7). Projected climate data have a monthly time step and include precipitation, minimum air temperature and maximum air temperature. Values for each of these three climate parameters represent spatial averages over model grid cells which contribute runoff to the Big Trees gaging station. The spatial resolution of the different CC projections used in the WSP planning process varied and is discussed in the following sections for each projection.

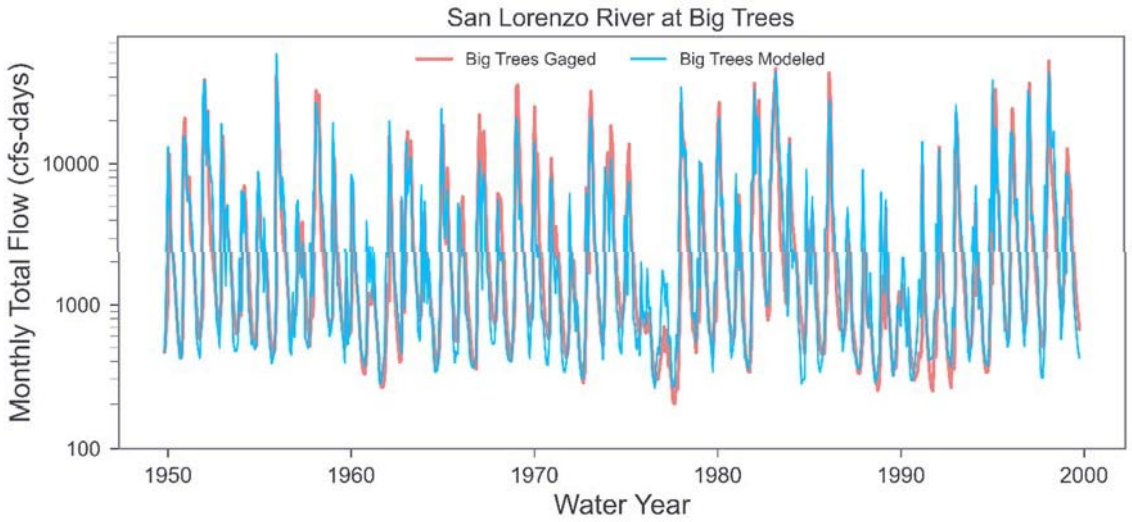


Figure 10: Comparison of observed and modelled monthly total streamflow for the Big Trees station for the period WY1950–2000. Modelled streamflows were calculated with the Water Balance Model (Equations 1–4) and the calibration curves.

CC Projection 1

The first CC projection used in the WSP planning process is the CMIP3 GFDL2.1 A2 data set (Projection 1), downscaled from Global Climate Model (GCM) simulations to grid cells with a spatial resolution of 1/8°. This resolution roughly equates to model grids that measure 7.4x7.4 square miles. Downscaling was performed by others and occurred following the Bias Correction and Spatial Disaggregation procedure (BCSD) (Wood and others, 2004). The abbreviation parts of the data set name include important information about the projection:

- CMIP: Stands for the Coupled Model Intercomparison Project (see https://pcmdi.llnl.gov/mips/ for more information about CMIP in general);
- 3: The number 3 stands for the third phase of the collaborative effort;
- GFDL: The abbreviation GFDL stands for the Geophysical Fluid Dynamics Laboratory;
- 2.1: The number 2.1 refers to the GFDL Global Climate Model (GCM) version 2.1; and
- A2: The abbreviation refers to the emissions scenario.

CMIP3 and all other CMIP phases are numerical experiments completed to help climate scientists carry out basic research using GCMs. CMIP3 was specifically completed in support of developing the Fourth Assessment Report (AR4) of the Intergovernmental Panel on Climate Change (IPCC) (IPCC, 2007). The IPCC is administered under the auspices of the World

Meteorological Organization, a specialized agency of the United Nations Environment Program. We selected this particular projection from among several available at the time through Cal–Adapt because the A2 emissions scenario projected large average temperature increases in the range of 2–5.4°C (IPCC, 2007) by 2090–2099, relative to 1980–1999 temperatures. Increases of local temperatures over time reduces streamflow for any given precipitation event due to higher evapotranspirative losses (Equation 4). Consequently, this means less instream water for coho salmon and steelhead trout, and less streamflow available for water supply.

The Projection 1 precipitation data was post-processed because after initial inspection it was noted that the data set is wet, and quite wet when compared to the historical period record (Figure 11). It is known that the BCSD downscaling process may introduce a wet bias into modelled data relative to the historic calibration period record (Stratus Consulting, 2015). Therefore, an alternative approach was used to develop the projected precipitation and air temperature records. The Projection 1 data set downloaded from Cal–Adapt was adjusted according to the Delta method (Stratus Consulting, 2015; Hamlet and Lettenmaier, 1999), which was termed the transient record. The transient record preserves the distribution of events present in the raw projected CC data set (i.e., the variability of the raw GFDL2.1 A2 record) but scales it according to recorded monthly rainfall depths and air temperature magnitudes reported for the Santa Cruz region (NOAA and CDEC CRZ Station). The transient precipitation record is drier than the Projection 1 record but preserves the year–to–year variability of the unadjusted data (Figure 11). The transient air temperatures are warmer than the Projection 1 record. Combined, the transient monthly precipitation, minimum air temperature and maximum air temperature records were used as the Projection 1 data set in the WSP planning analysis.

CC Projection 2

The second CC projection used in the WSP planning process represents a statistical combination of four different downscaled GCMs produced as a part of CMIP5 (Projection 2). The CMIP5 experiment is the basis of the Fifth Assessment Report (AR5) of the IPCC, which was carried out with new emissions scenarios known as Representative Concentration Pathways (RCP) (IPCC, 2014). We used projections developed with RCP8.5, which represents the radiative forcing at year 2100, with units of Watts/square meter. The emissions scenario RCP8.5 represents very high Green House Gas (GHG) emissions as understood at the time when AR5 was completed. In contrast to Projection 1, Projection 2 data were downscaled to a spatial resolution of 1/16°, or grids that measure roughly 3.8x3.8 square miles. CMIP5 data available via Cal–Adapt were downscaled two different ways and used selected data that were specifically downscaled using the BCSD approach, consistent with Projection 1.

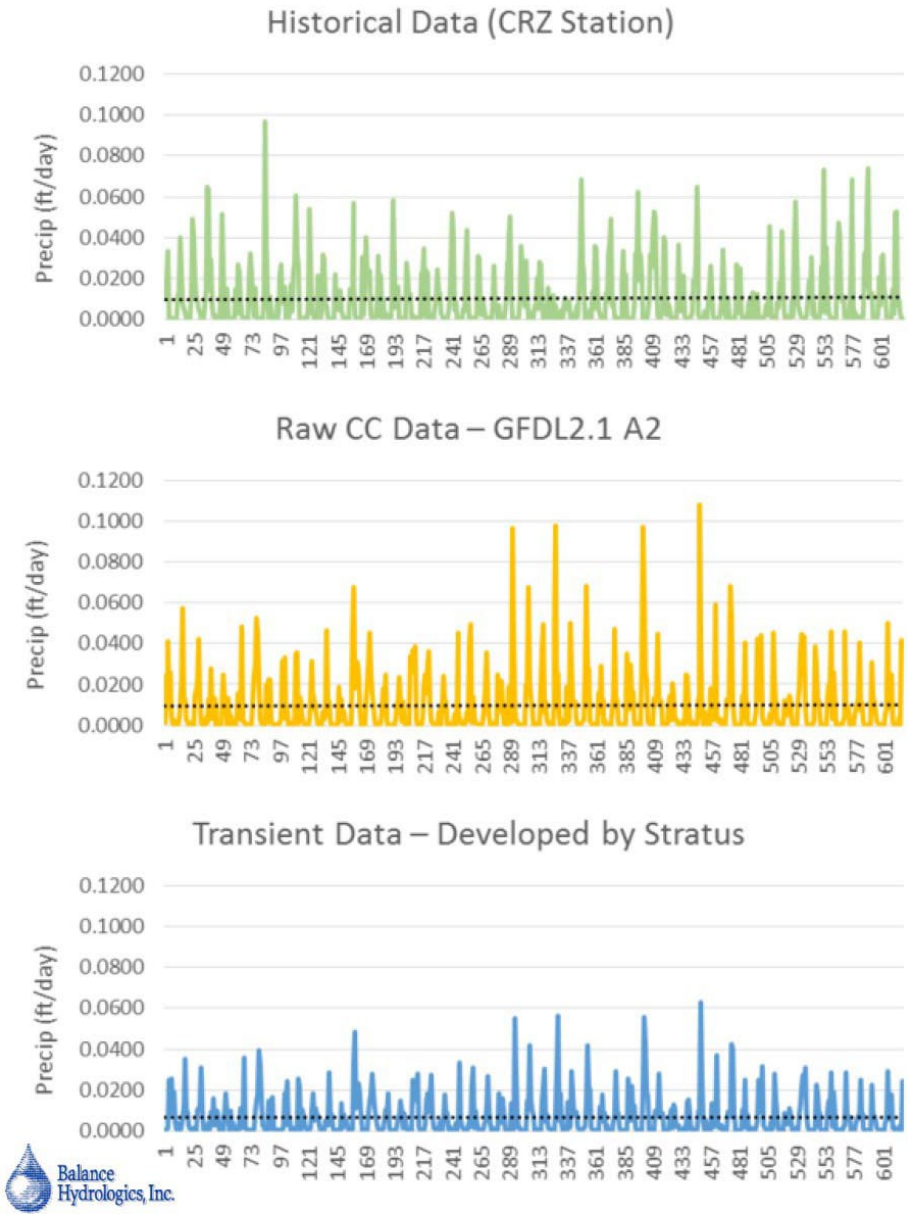


Figure 11: Precipitation data for the Santa Cruz region. Each data set covers a 50-year time span, and the x-axis of each plot is expressed in months since start of record – 1950 for historical data and 2020 for CC data. The monthly total precipitation totals were divided by the number of days in each month to yield precipitation in feet per day (y-axis). The transient data set was developed by Stratus Consulting.

Cal–Adapt and its partners made 10 different specific projections available as a part of the CMIP5 data set. After weeks of testing, four out of the ten individual projections were used as the basis for calculating the statistical CC projection (recall from Projection 1 that the abbreviation for each model cited next conveys important information about each source):

- ACCESS1-0.1.rcp85: Australian Community Climate and Earth System Simulator 1
- CCSM4.1.rcp85: Community Climate System Model 4
- HadGEM2-CC.1.rcp85: Hadley Global Environment Model 2 – Carbon Cycle
- CanESM2.1.rcp85: Canadian Earth System Model 2.1

The four chosen data sets that we used to build Projection 2 are on average moderate in terms of precipitation when compared to all ten models available for planning use (Figure 12). However, even though these four CC projections are moderate as defined by departures from the cumulative mean across all 10 models, the chosen data sets contain quite dry and wet conditions when compared to historical conditions. This point will be clear when we present the precipitation record for Projection 2 below.

At this point we have four different monthly CC projections to use for water supply planning under Projection 2. We decided that rather than chose one of the four projections, we would build upon the four and develop a statistical CC projection. We choose this approach for Projection 2 because it is not possible to predict future climate.

The strategy used here to develop a statistical CC projection with the four identified times series involves a stochastic modeling technique, illustrated schematically in Figure 13. The stochastic approach requires the assumption that the four moderate climate projections approximately capture the expected range of monthly and annual precipitation (and air temperature trends) totals for the CC analysis period. The expected range assumption permits us to numerically expand the records of monthly precipitation (and air temperature) for the four moderate models to monthly arrays that are > 4 in size. Here, we chose 100 equally incremented values within the range set by the four projection minimum and maximum values for each month of the CC analysis period. As a result, the sample size of future plausible climate conditions increases from 4 to 100 for any given month in the CC analysis period.

Expanding the projection sample size from 4 to 100 inclusive samples is analogous to assuming that a relatively large number N of GCMs would yield, after sampling, a downscaled distribution of climate projections that would approach the distribution defined by the 100 equally incremented values across all months of the CC analysis period. For relatively dry conditions, the 100 equally incremented values differ by approximately 1 millimeter/month (mm/month). This difference increases to roughly 4 mm/month for progressively wetter conditions. Although 100 future plausible climates may be a small sample size, it does serve the purpose of reducing our reliance on only 4 projections of future climate. The more critical issue, however, is how the sequence of month-to-month, or year-to-year climate might vary in the future.

Our goal is to develop a CC projection that reflects the general consensus among California climate scientists of more pronounced droughts, more severe floods and warming temperatures for the central coastal region of the State (Swain and others, 2018). We address this goal through use of percentile statistics (e.g., 10th, 20th, etc. percentiles), and add the requirement that the statistics are robust. For example, if we calculate the various percentile statistics for the 4 moderate climate projections and compare these to statistics for the expanded sample of 100, it is no surprise that there are differences, some of which are substantial. This raises the issue of sample size and uncertainty. To overcome this difficulty, we randomly subsample (with replacement) the monthly arrays of 100 monthly values of precipitation and air temperature until change of the percentile statistics approaches zero. This occurs when the total number of time series > 5,000, and here, we produced 10,000 randomly constructed CC time series of precipitation and air temperature.

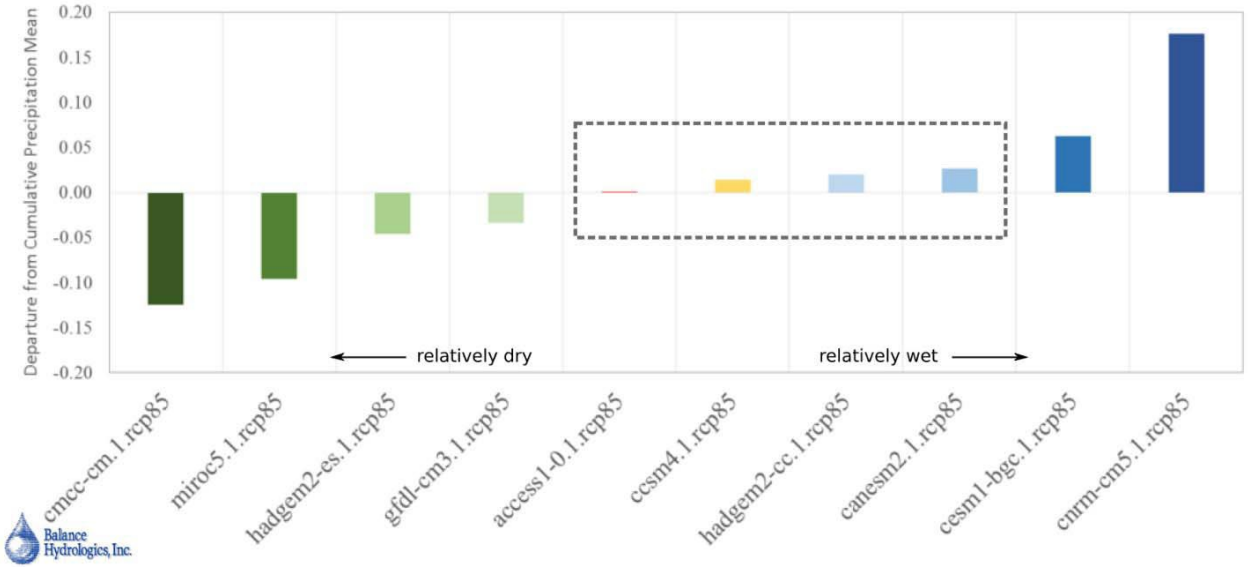


Figure 12: Model specific departure from the cumulative precipitation mean for all ten downscaled CMIP5 climate projections of precipitation over the CC analysis period. The plot provides an indication of which projected data sets are relatively dry, relatively wet and comparable to the cumulative mean across the projection data sets. The four models used to build Projection 2 are indicated by the dashed box.

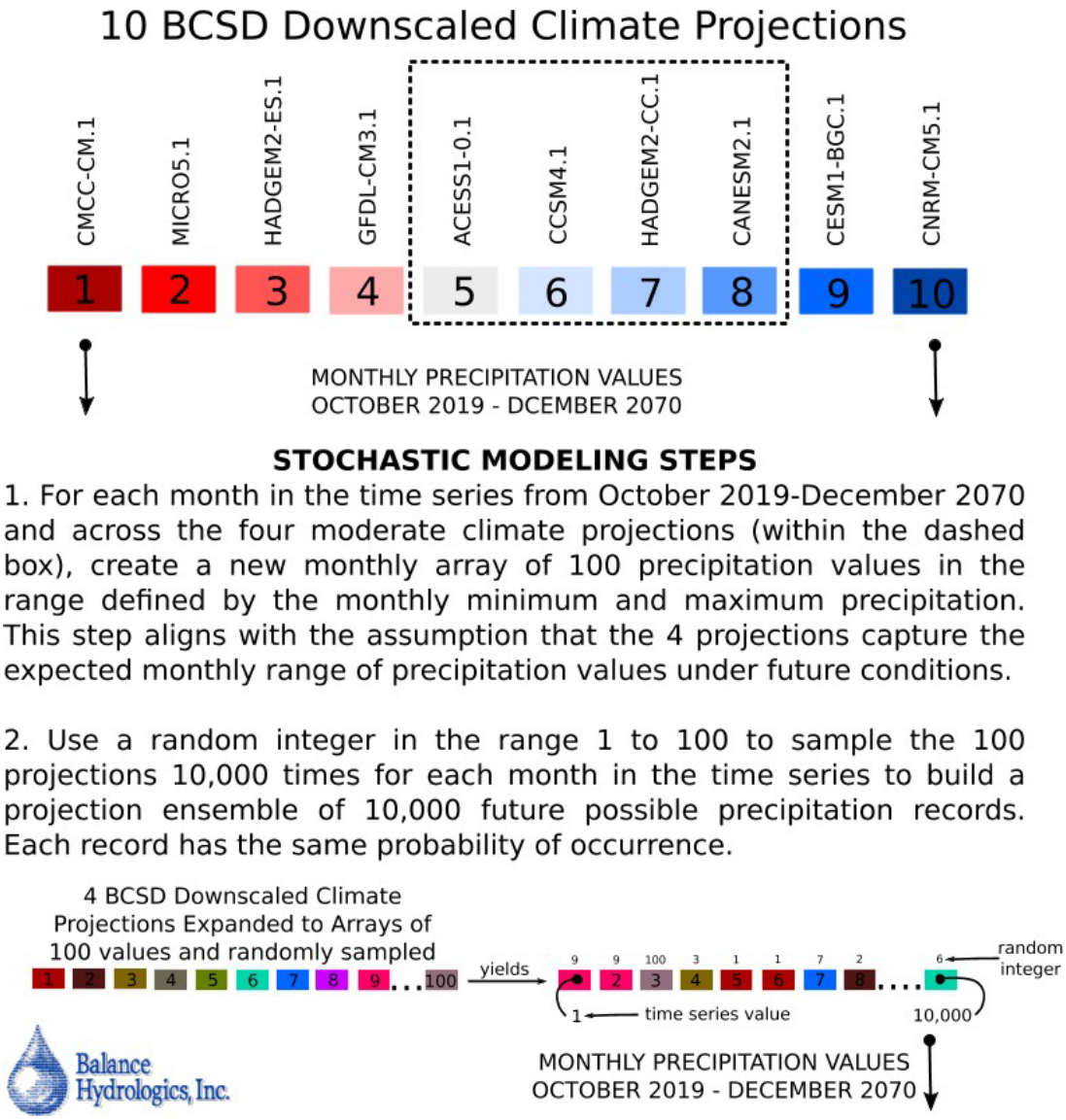


Figure 13: Schematic of the stochastic modeling workflow used to develop climate projections of precipitation and air temperature with a population of 100 samples. This population is randomly subsampled 10,000 times to develop a statistically stationary distribution of precipitation and air temperature.

We calculated percentile statistics for each month of the CC analysis period using the 10,000 different monthly values for precipitation and air temperature. We also calculated percentile statistics for annual conditions. Next, we drew from the underlying annual percentile statistics in a manner which tracks overall dry, average and wet periods (Figure 14), as well as cool, average and hot conditions. After several rounds of testing, we selected the 10th percentile for dry and cool conditions, the 50th percentile for average conditions, and the 75th percentile for wet and

hot conditions. Next, we needed to determine whether a future year (and the months of that year) was dry (cool), average or wet (hot).

We used the expected range magnitude relative to the median value to determine if any given year of the CC analysis period was likely to exhibit average vs. dry, or wet conditions. We choose three general rainfall conditions in order to keep things simple yet adjust model calculations based on clear differences in rainfall. Recall, the expected range magnitude is the difference between the maximum and the minimum for the four chosen CC projections. If the expected range was larger than the median value for any given year, that year was deemed most likely to exhibit dry or wet conditions. On the other hand, if the expected range was less than the median value for any given year, that year was deemed most likely to exhibit conditions of the central tendency.

The decision to select the 10th vs. 75th percentile value was determined by comparing the 50th percentile precipitation for each associated year vs. the 50th percentile for all years of the CC analysis period across all 10,000 samples. Years with values less than the CC analysis period 50th percentile value were considered dry, and the 10th percentile was selected. Years with values greater than the projection period 50th percentile value were considered wet, and the 75th percentile value was selected. This manner of record construction means that years, rather than months were selected to be dry, normal or wet. We chose the annual basis to guide record construction in order to be consistent with how we develop daily hydrographs from the monthly data (discussed in the subsequent section), and because the project team has a higher confidence in annual projections of climate variables.

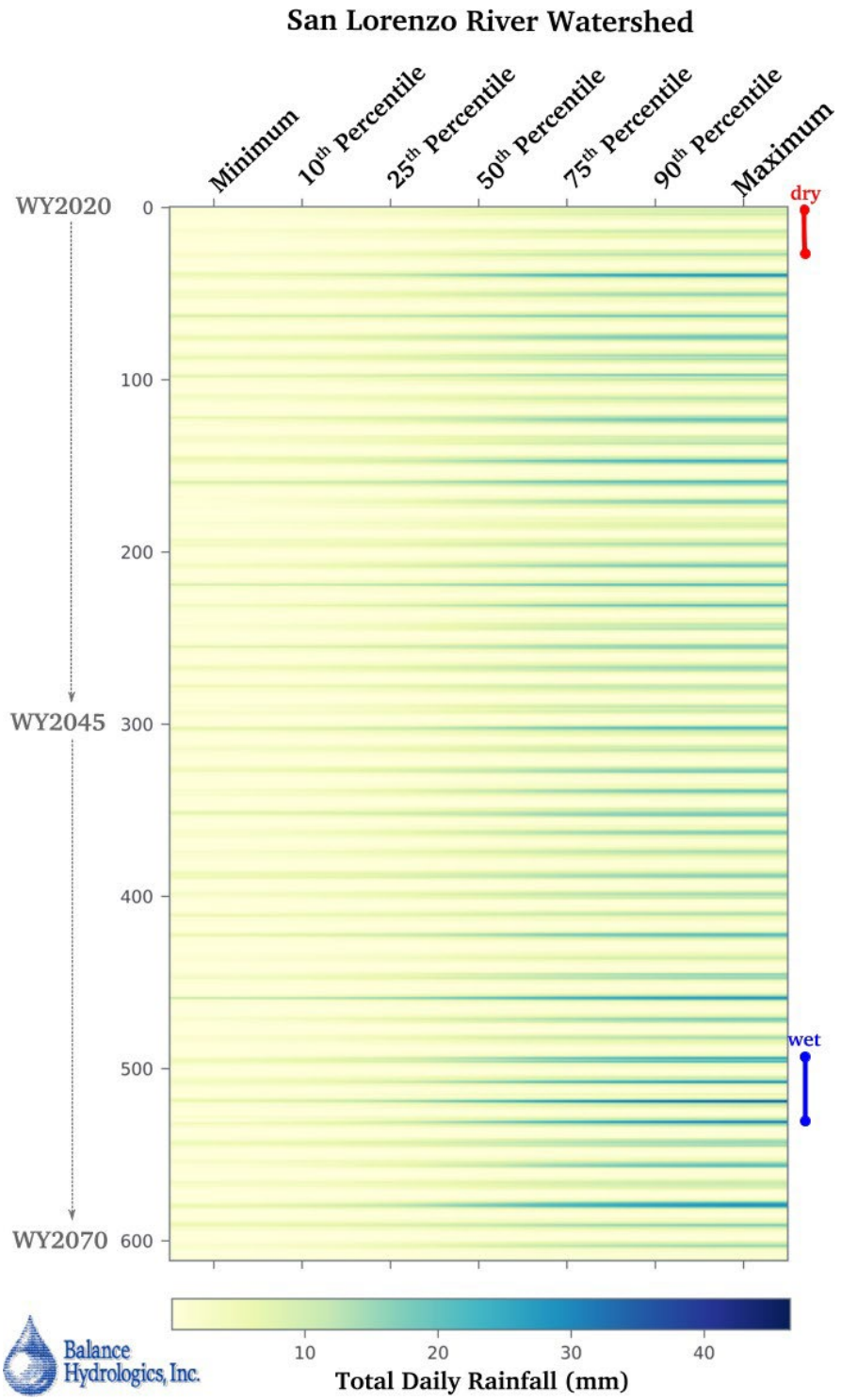


Figure 14: Heat map of population statistics for Projection 2 developed with the stochastic sampling (Figure 13). The y-axis plots how the statistics shown on the x-axis vary from month to month over the CC analysis period. Darker blue colors indicate relatively wet periods, and stronger yellow colors indicate dry periods. An example wet and dry period are indicated.

The Projection 2 precipitation time series contains a range of values that are generally consistent with the range of historical observations (Figure 15). However, the Projection 2 record qualitatively displays increased year to year variability relative to historical conditions, as well as consecutive years of relatively large and small precipitation totals. For example, WY2020–22 are as dry as the WY76-77 drought but contain a third relatively dry year. On the other hand, WY2061–64 are as wet, and slightly wetter, compared to WY1956, but contain four relatively wet years in a sequence as opposed to one single wet year. This means that Projection 2 is generally consistent with previous work that suggests the central coast of California will have drier dry periods, wetter wet periods, and increased year-to-year variability that reflects abrupt switches between dry and wet conditions, and vice versa (Swain and others, 2018).

The Projection 2 precipitation time series also reflects the dry and wet trends of the overall statistics drawn from the sample of 10,000 plausible climate conditions (cf. Figures 14 and 15), which is a function of the four CC projections we choose to use. The Projection 2 maximum air temperature shows a steady increasing trend over the CC analysis period, as expected (Figure 16). However, the magnitude of temperature increase is low relative to most estimates. This result means that projected streamflow could attain lower values under Projection 2 (Equation 4) if we sampled to produce a warmer air temperature trend. We choose not to pursue this path, however, because Projection 3 was developed to reflect more severe climate conditions through much warmer air temperatures (discussed in the next section).

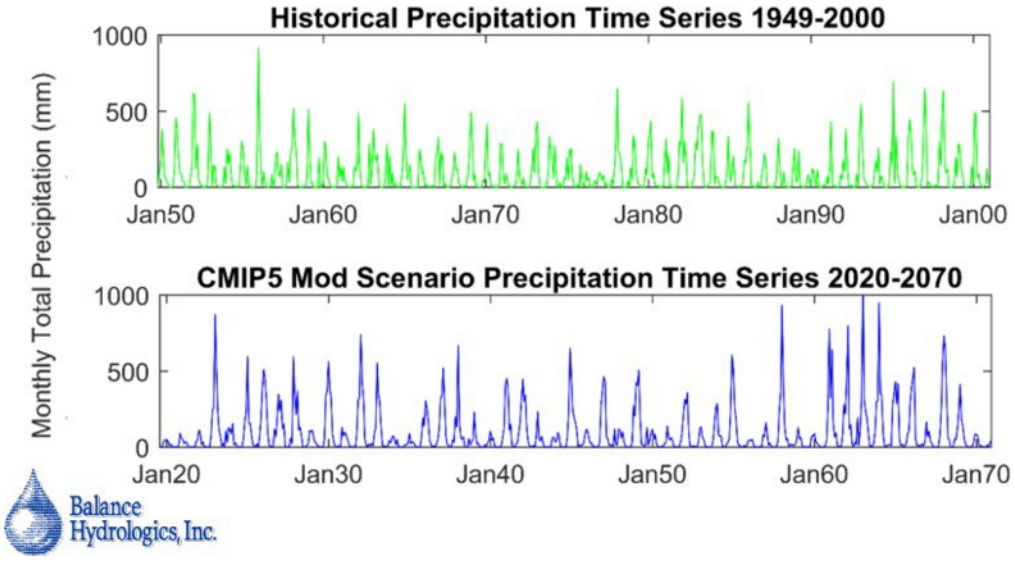


Figure 15: Comparison of an historical period observed precipitation for Santa Cruz vs. the Projection 2 precipitation developed using the stochastic modeling approach.

CC Projection 3

The Projection 3 CC data set was developed as part of the Mid–County Groundwater Basin Sustainability Plan (King and Tana, 2016). The Projection 3 approach makes use of the historical climatology for the period WY1977–2016 as a catalog which is sampled to develop a random sequence of annual conditions weighted by air temperature. The catalog approach has been used elsewhere in the Santa Cruz region and in other parts of California (Metropolitan Water District of Southern California, 2016; Young, 2016). Air temperature weighting was specifically used in order to produce a future climate condition which has a warming air temperature trend consistent with regional expectations from CC research (Swain and others, 2018).

The original climate catalog was used to develop a record for the period WY2016–69. However, we removed data for the period WY2016–19, and added one year of data at the end of the time series in order to line the time series up with the CC analysis period. The raw climate catalog is a just sequence of years (e.g., 1977, 2015, 1998...) of observed climate conditions. As a result, we used the historical climatology associated with the specific climate catalog sequence to construct the monthly precipitation and air temperature records of Projection 3 that are run through the WBM. See (King and Tana, 2016) for more details.

Comparison of Projections 1–3 and Historical Gridded Climate Conditions

We compare and contrast historical and projected climate conditions by plotting departures of monthly total precipitation and average air temperature, relative to historical averages for the period 1950–2000 (Figure 17). Furthermore, we focus the comparison on the winter months of December–March because that is when most precipitation falls. Monthly climate conditions can fall within one of four quadrants relative to historical averages: dry and cool, wet and cool, dry and warm, and wet and warm (top plot of Figure 17). Use of this type of quadrant plot makes comparison across climate conditions straightforward.

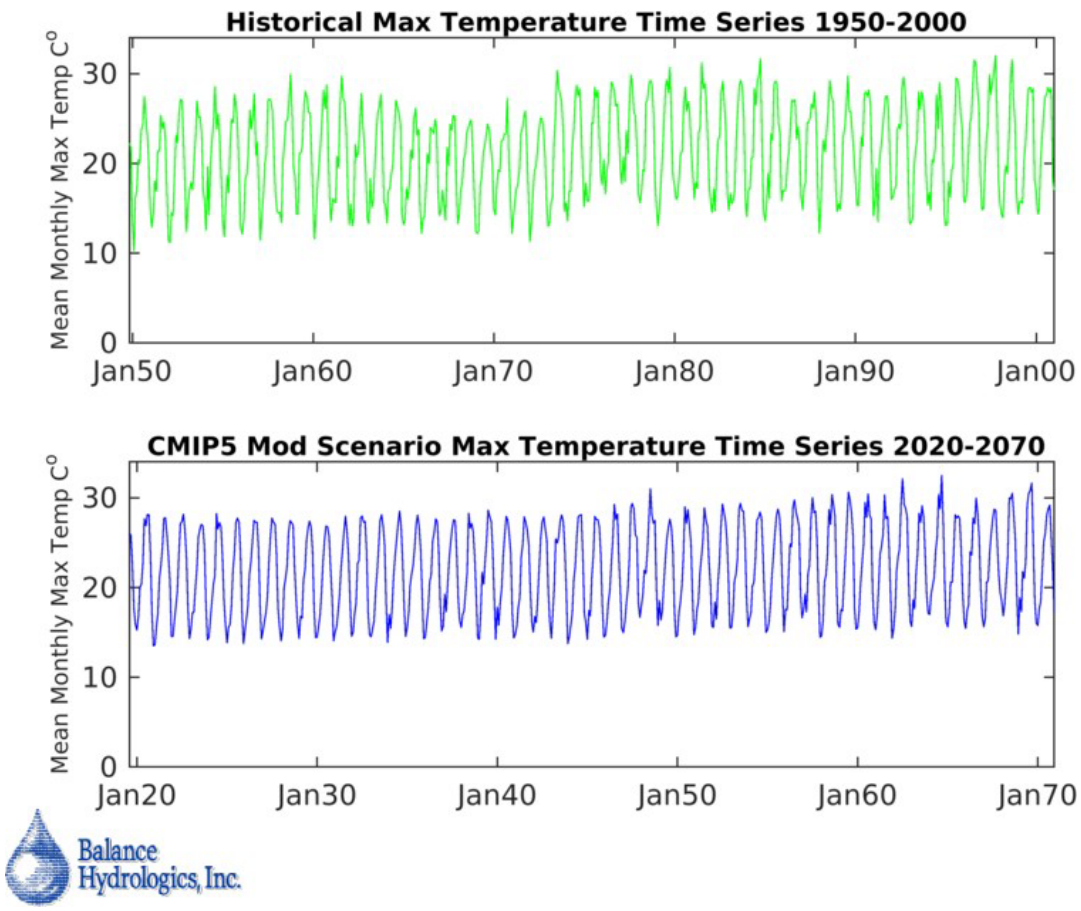


Figure 16: Comparison of an historical period observed maximum air temperature for Santa Cruz vs. the Projection 2 maximum air temperature developed using the stochastic modeling approach.

The Gridded Historical precipitation distribution (Maurer and others, 2002) is left skewed, with a greater proportion of months that have less rainfall than the average. Consequently, there were fewer gridded years that were wet relative to the average, but wet years departed more strongly from the average, as shown by probability density contours that extend beyond a value of 2. Dry and wet months were both cool and warm, relative to average gridded conditions. Furthermore, monthly air temperature departures approach a normal distribution, in contrast to precipitation.

The winter month conditions of CC Projections 1–3 differ from the historical distributions of precipitation and air temperature (lower right–hand 3 plots of Figure 17). Projection 1 is in general drier and warmer than historical average conditions, which was mentioned earlier in this section (Figure 11). In contrast to Historical Gridded and Projections 2 and 3, the distributions of precipitation and air temperature of Projection 1 approach normal distributions over the CC analysis period. This highlights that Projection 1 lacks the increased rainfall variability that climate scientists expect for Central California but reflects the rise of average air temperature

(Swain and others, 2018). As a result, water supply planning with Projection 1 is understood to reflect dry and warm conditions.

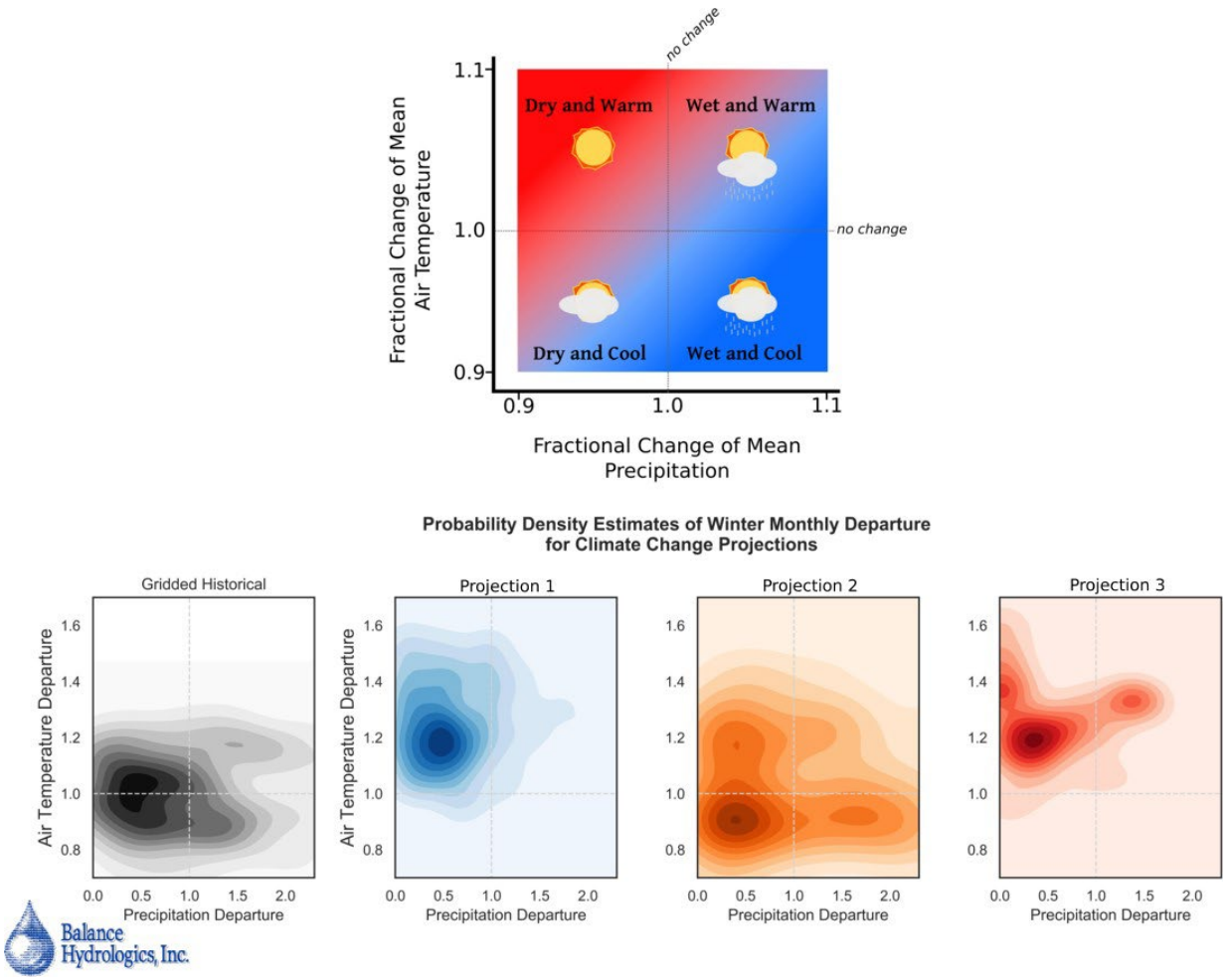


Figure 17: Summary of winter months climate conditions for the three CC projections used in WSP planning analysis. The top plot is a conceptual map that shows how different climate conditions can be understood relative to the historical gridded average annual precipitation and air temperature (coordinates of [1,1] in the plot). The bottom four plots show probability density estimates for the distributions of monthly total precipitation and monthly average air temperature over the months December–March for the historical analysis period and the three CC projection data sets. The probability density estimates provide a quick way to visually understand differences between the four data sets. Density estimates calculated using the SciPy python library.

Projection 2 exhibits a more variable future climate in terms of precipitation and air temperature, compared to Gridded Historical and Projections 1 and 3 (Figure 17). As discussed earlier, this was the intent of Projection 2. There are a concentration of winter months with cool and dry conditions, warm and dry, and cool and wet. However, there are fewer months that are warm

and wet. The cooler underlying temperature trend of Projection 2 is evident in the distribution of temperatures relative to the historical average gridded condition. Nonetheless, Projection 2 does contain winter months that are warmer than historical average gridded conditions, consistent with expectations (Figure 17). Water supply planning with Projection 2 is understood to reflect more variable conditions in terms of precipitation, but air temperatures are generally cool.

Projection 3 is similar to Projection 1, but with a greater proportion of winter months that are wet and warm. Projection 3 also contains winter months that are the driest and warmest of any CC projection used for WSP (Figure 17). Compared to Projection 2, however, precipitation has less overall variability. Consequently, water supply planning with Projection 3 is understood to reflect somewhat severe dry and warm climate conditions. Overall, CC Projections 1–3 provide a wide range of future conditions relative to the historical gridded climate. Most importantly, this wide range of conditions yields a strong basis to test how projected instream flow conditions perform relative to historical conditions (Appendices 1b and 1c).

Step 3: Run the Base Hydrology Model

Develop Daily Streamflow records

We developed daily streamflow projections at Big Trees in two different ways using the monthly streamflows of Projections 1–3. In the first method we averaged daily streamflow across all months of the historical analysis period at Big Trees. This step yielded an average daily streamflow hydrograph for each of the 12 months in a water year. We then summed the average daily streamflow for each month and used the sums to calculate the proportion of flow for each day of each month of the water year calendar. These daily flow proportions were then used to distribute the Projection 1 total monthly streamflows at Big Trees, resulting in a projected daily streamflow hydrograph for the CC analysis period.

The daily streamflow hydrograph for Projection 1 was post-processed to smooth abrupt and unreasonable changes in flow that occurred between days within the CC analysis period, at month-to-month transitions, and at the end of each water year (i.e., September 30th). Where applied, smoothing of the daily flow record was done with a zero-order forward and reverse digital filter. This means that the location of any given peak in time is not affected, but its amplitude is adjusted based on the nature of flows forward and backward in time from any particular position, based on a specified filtering length and computed flow differences. This particular filter has the advantage of matching initial conditions well. The smoothing filter length was chosen to minimize the sum of differences between the corrected and the filtered record (< 0.1% difference in total flow). It is important to point out that even though Projection 1 data were smoothed, the operation did not result in the loss of peak flow events, etc. that result

from precipitation events. The first approach yielded reasonable daily flow hydrographs for each year. However, it has the disadvantage of using a single hydrograph shape for each future year, and it requires data filtering to produce a smoothly varying flow condition at monthly and water year transitions.

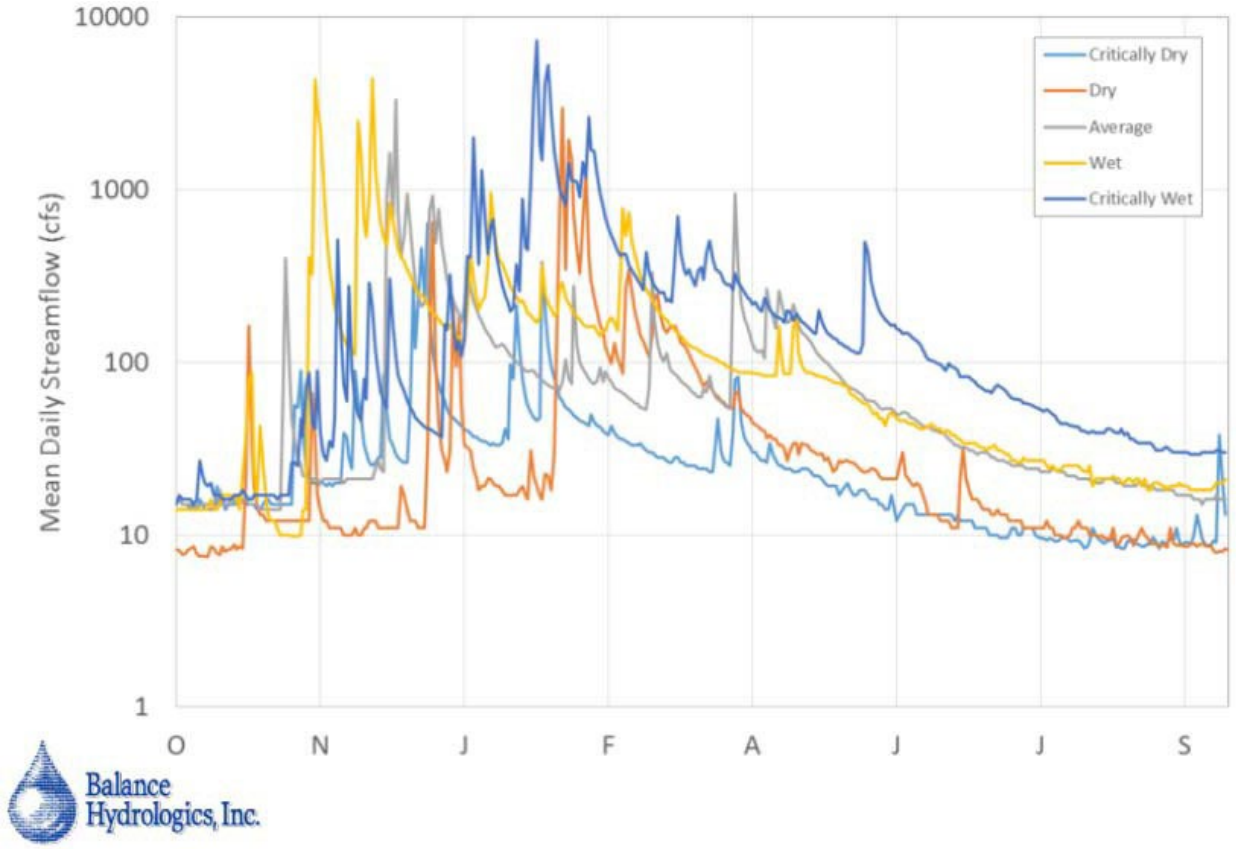


Figure 18: Characteristic annual hydrographs for critically dry, dry, average, wet and very wet total annual flow conditions at Big Trees.

For Projections 2 and 3 we applied a second and improved method to develop projected daily streamflows, after additional work carried out over the span of about a year indicated improvements to the daily records was possible. We borrowed from the climate catalog approach (King and Tana, 2016; Young, 2016) and identified characteristic annual hydrographs for the five different hydrologic categories calculated for the Big Trees gage (presented within Section 1 above and discussed in Appendix 8-3 in relation to instream flow rules): critically dry, dry, average, wet and very wet (Figure 18). We applied each characteristic hydrograph to the projections based on the annual hydrologic characteristic of each future year in Projections 2 and 3. For example, if WY2042 was a very wet year, we decomposed the projected monthly flow at Big Trees into an annual hydrograph by scaling the total 2042 annual flow over the very wet characteristic hydrograph. In order to compare model results between the historical and CC

analysis periods, the 5-category hydrologic conditions were calculated for the historical analysis period, and then used as the hydrologic basis for the CC period. This is equivalent to using the historical conditions as the reference through which to understand how CC may affect hydrologic conditions at the annual time scale.

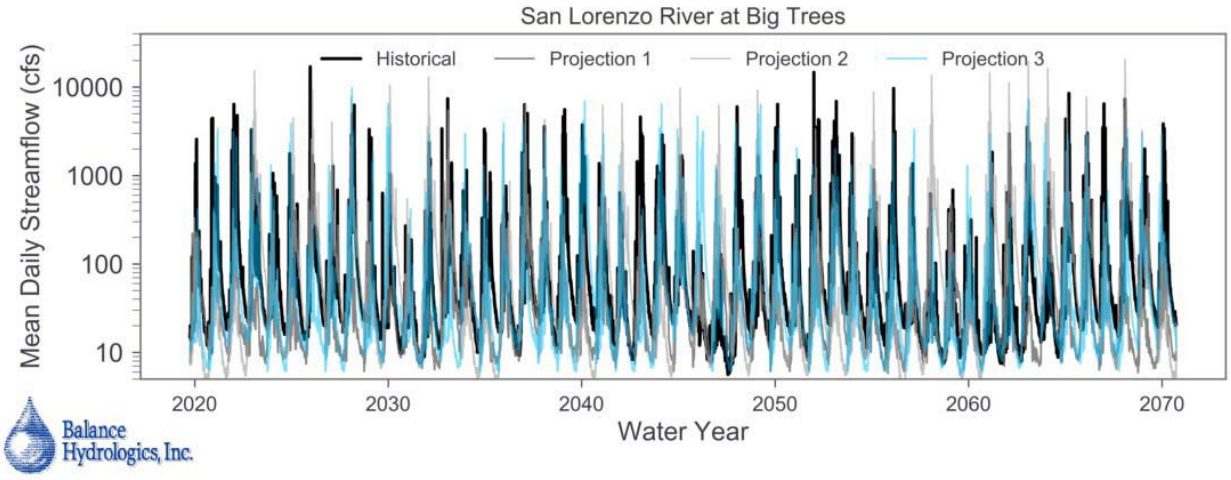


Figure 19: Summary of the daily streamflow hydrographs at Big Trees for the historical period WY1950-2000 observed streamflows, and the Projections 1–3 for the CC analysis period. Note that in this case the historical record does not correspond to gridded climate conditions (Maurer and others, 2002).

The second approach, namely the one that we used for Projections 2 and 3, has the advantage of using multiple hydrograph shapes that are classified according to dryness and wetness conditions (City of Santa Cruz Water Department, 2009), and the resulting time series only require filtering at the water year transitions to produce smoothly varying flows. In both cases nonetheless, we have no way to assess the skill of the decomposition approach because we are using CC projections made at the monthly time step. As a result, the daily hydrographs represent one outcome out of a very large possible number of future outcomes. The daily hydrographs for Projections 1–3 for the CC analysis period are shown in Figure 19. The historical observed hydrograph at Big Trees for WY1950–2000 is shown for reference.

Run the Base Hydrology Model

The daily streamflow records for Projections 1–3 at Big Trees are loaded into the Base Hydrology Model to develop CC hydrology for all source streams of the City. Daily flows for all source streams are then evaluated against instream flow rules (Appendix 8-3), and remaining flows are apportioned to water supply availability (Appendix 8-2).

3.2 Limitations and Assumptions for CC Analysis

Many assumptions were made to apply the Base Hydrology Model to CC analysis. Here we review some important ones. First and foremost, the analysis we have completed is intended as a means to evaluate changes in streamflow under future conditions, and primarily in terms of drought conditions and baseflows. We chose this focus because it is during these times that water supply and instream habitat conditions are most challenged. Furthermore, the collective approaches taken to yield projections of future daily streamflows was done in order to make useful comparisons to observed historical conditions, and between differing CC projections. As a result, our projections of daily streamflow for the three CC conditions should not be interpreted as predictions of future streamflows.

Second, we assume that the CC conditions represented by Projections 1–3 offer plausible future conditions for the Santa Cruz region. Specifically, Projections 1–3 provide a reasonable basis for testing how the instream flow rules might affect habitat conditions and water supply availability under a changed future climate. This assumption is based on the range of future conditions represented by Projections 1–3 (Figure 17).

An additional and important assumption of our work is that hydrograph shapes and day-to-day distributions of flows observed in the past are reasonable bases to project daily flows in the future. We could have used daily flows produced in the process of downscaling climate models to the local scale. However, these flows were shown to over-estimate summertime and drought streamflows. Because of the sensitivity of coho salmon and steelhead trout under these conditions, this option was not pursued in favor of the WBM (Chartrand, 2018).

Third, we assume that the WBM as set up for climate change analysis in support of the WSP and the Draft Environmental Impact Report will apply to CC conditions in the future. This assumption may turn out to be inaccurate if, for example, stands of redwoods within the source stream watersheds transition to a drier climate forest composition, because forest composition affects the watershed water budget. Last, we did not have a reasonable way to constrain instream conditions for the CC analysis period due to potential future operations of the Felton diversion, or the present water right required bypass flow on the San Lorenzo River. We note these two points because San Lorenzo River flow diversions due to the Felton diversion and the Pre-existing legal bypass are added to gaged streamflows within the historical analysis period to develop the associated estimates of unimpaired streamflows, which is the basis of the Base Hydrology Model. As a result, and based on the best available information, we set the Felton diversion [see Appendix 8-2 for details] to zero for the CC analysis period, and applied the Pre-existing legal bypass based on the historical data.

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Appendix A: Regression Models Used in Base Hydrology Model

In the tables that follow, a number of abbreviations are used: H.C.-hydrologic condition; CD-critically dry; D-dry; A-average; W-wet; VW-very wet; BT-San Lorenzo River at Big Trees USGS 11160500.

Table A1: Regression Relationships used in Base Hydrology Model for Upper Stations

Station	Regression Relationships	
San Vicente SV [11]	**Months**	**All Flows**
	Nov. - Apr.	$SV = 0.1025 * BT^{0.9161} + 0.65$
	May - Oct.	$SV = 1.0^{-7} * BT^{3} - 2.056^{-4} * BT^{2} + 0.1382 * BT - 0.750$
Upper Laguna LG [4]	**H.C.**	**SV flows < 1 cfs**
	CD and D	$LG = 0.4043 * SV^{0.1109}$
	A	$LG = 0.5796 * SV^{0.0957}$
	W	$LG = 0.7551 * SV^{0.088}$
	VW	$LG = 1.0225 * SV^{0.0528}$
	H.C.	**SV flows >= 1 and < 20 cfs**
	CD and D	$LG = 0.3987 * SV^{1.1047}$
	A	$LG = 0.5452 * SV$
	W	$LG = 0.748 * SV^{0.8944}$
	VW	$LG = 1.019 * SV^{0.7931}$
	H.C.	**SV flows >= 20 cfs**
	All	$LG = 0.5452 * SV$
Upper Majors MJ [4]	**H.C.**	**LG flows < 1 cfs**
	CD and D	$MJ = 0.4455 * LG + 0.5257$
	A	$MJ = 0.5574 * LG + 0.6361$
	W	$MJ = 0.6148 * LG + 8721$
	VW	$MJ = 0.6148 * LG + 8721$
	H.C.	**MJ flows >= 1 and < 10 cfs**
	CD and D	$MJ = 0.9577 * LG^{0.7601}$
	A	$MJ = 1.1947 * LG^{6766}$
	W	$MJ = 1.4873 * LG^{0.581}$
	VW	$MJ = 1.4873 * LG^{0.581}$
	H.C.	**LG flows >= 10 cfs**
	All	$MJ = 0.2225 * LG^{1.3962}$
Upper Liddell LD [9]	**H.C.**	**LG flows < 4 cfs**
	-	$LD = 1.8414 * LG^{0.1325}$
	H.C.	**LG flows >= 4 cfs**
	-	$LD = 1.5252 * LG^{0.2727}$
Upper Newell NL [12]	**Months**	**All Flows**
	Oct.-Sept.	$NL = 0.00906 * BT^{1.2484}$

General notes on the table:
1. Number in [] refers to the stations listed in Table 1.
2. Flows at Loch Lomond Dam calculated as: *LLD=NL**(8.25/4.81)

Table A2: Regression Relationships used in Base Hydrology Model for Anadromous Stations

Station	Regression Relationships	
Anadromous Laguna ALG [5]	**WY1936-69 and WY1986-15**	
	Months	**LG flows <= 30 cfs**
	Oct. - Mar.	$ALG = -0.02370 * LG^2 + 1.72551 * LG + 0.16774$
	-	**LG flows > 30 cfs**
	Oct. - Mar.	$ALG = (LG - 15) * 2$
	-	**All Flows**
	Apr. - June	$ALG = -0.00498 * LG^2 + 1.3233 * LG - 0.0730$
	-	**All Flows**
	July - Sept.	$ALG = -0.0063 * LG^2 + 1.2436 * LG - 0.0906$
Anadromous Laguna ALG [5]	**WY1970-85**	
	Months	**All Flows**
	Oct. - Mar.	$ALG = 0.3247 * LG^{1.4939}$
	-	**LG flows <= 30 cfs**
	Apr. - June	$ALG = -0.002 * LG^3 + 0.1046 * LG2 - 0.1339 * LG$
	-	**LG flows > 30 cfs**
	Apr. - June	$ALG = 0.3247 * LG^1.4939$
	-	**All Flows**
	July - Sept.	$ALG = 0.0415 * LG^{2.1328}$
Anadromous Majors AMJ [8]	**WY1936-69 and WY1986-15**	
	Months	**All Flows**
	Oct. - Sept.	$AMJ = 0.9248 * MJ^{1.0961}$
Anadromous Majors AMJ [8]	**WY1970-85**	
	Months	**All Flows**
	Oct. - Sept.	$AMJ = 1.1863 * MJ - 1.1052$
Anadromous Liddell ALD [10]	**Months**	**All Flows**
	Oct. - Sept.	$ALD = 0.44 * SV + LD$
Anadromous Newell ANL [13]	**Months**	**All Flows**
	Oct. - Sept.	$ANL = 1.147 * LLD$
San Lorenzo Tait Street [9]	**All Months**	**BT flows < 30 cfs**
	-	Tait = $0.94378 * BT^{1.0558}$
	All Months	LG flows > 30 cfs
	-	Tait = $1.1689 * BT^{0.9928}$

General notes on the table: 1. Number in [] refers to the stations listed in Table 1.

Appendix 8-2

Water Supply Modeling

THE CONFLUENCE MODEL

Confluence® is a model designed to simulate the operation of water supply systems to assist water supply agencies in evaluating and comparing water supply and infrastructure alternatives. The model allows simulations using a daily or monthly time step and can accommodate a wide variety of surface water and groundwater supplies, storage facilities, infrastructure, operating constraints, and flow regimes. The model produces a wide variety of outputs in both graphical and tabular form to enable water suppliers to focus on the results that are most important to their decision-making or that are needed to fulfill legal or regulatory requirements, including different representations of:

- Water supply reliability
- Water demands
- Source-specific production
- Surface water and groundwater storage levels
- Treatment and transmission throughput
- Fixed and variable costs

The data underlying all model outputs is easily exported to Microsoft Excel to further customize needed calculations and presentations.

A key driver of the simulations is the daily streamflows available for diversion, which constrain the potential diversion volumes for each day of the hydrologic period of record. The model can simulate system operations over the entire record or any subset of that record. Modeling runs can include single or multiple simulations depending on the questions being addressed.

Model inputs for system components are entered through an interactive schematic of the water supply system. A simple system schematic for the City of Santa Cruz (City) water system[1] is shown in Figure 1. For each source, storage facility, or treatment plant, the operating and infrastructure constraints associated with that system component (including the relevant set of available flows) can be edited from the "live" schematic by the modeler. In addition, the capacities, line losses, pumping costs, and other parameters associated with each portion of the transmission system are specified, which impose other constraints on system operations.

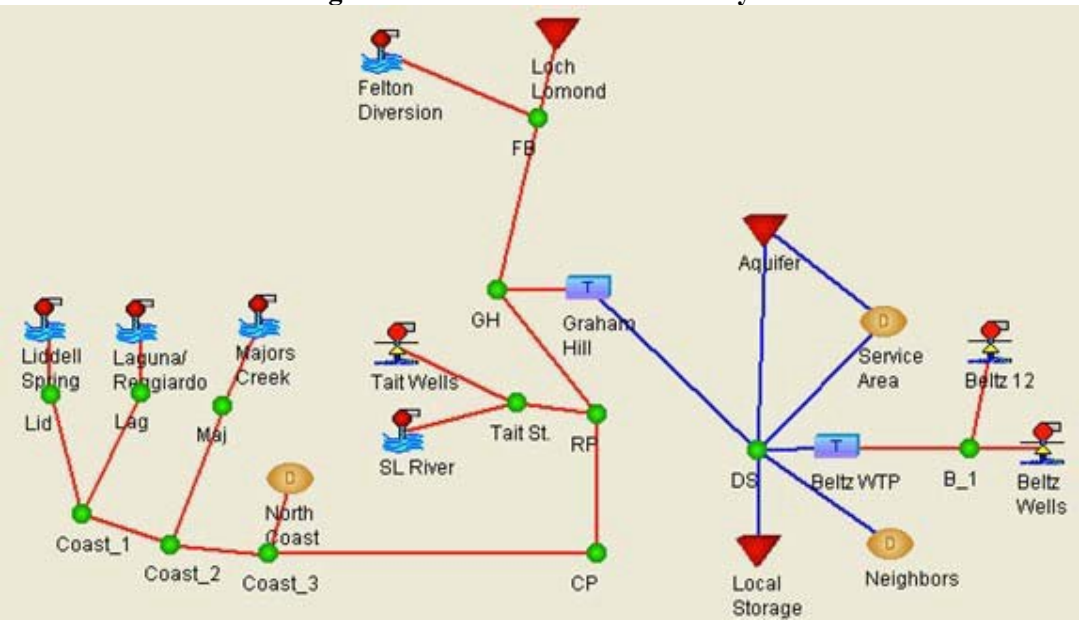
[1] The City owns and operates a water system that diverts and serves water both within the City limits and outside of those limits. References to the City's water system, rights and supplies therefore refer to areas both inside and outside of the City limits.

For each time step, the way the system is dispatched is determined by shadow prices assigned by the user to each supply source and each zone of surface water or groundwater storage. The simulation dispatches the system in increasing order of cost, as determined by these shadow prices and any other variable operating costs (e.g., pumping or treatment costs) associated with using each supply source. The supply source with the lowest combined cost is dispatched first, followed by the next highest cost, etc. The shadow prices assigned to storage zones are used to regulate the drawdown of surface water and groundwater storage.

Other model inputs include:

- The specification of the simulation parameters, including the flow years that are to be sampled and the operating years for which the simulation is to be run.
- The forecast of annual and monthly system demands.
- The specific outputs that are desired.

Figure 1. Confluence Santa Cruz System Schematic



Legend:

- Demand node
- Connection node
- Surface water diversion
- Groundwater extraction wells
- Storage
- Water treatment plant

USE OF CONFLUENCE IN SANTA CRUZ

History

Beginning with the City's Integrated Water Plan (IWP),[2] which was initially completed in 2003, the City has used Confluence to guide many key water resource planning efforts, including analyses of the potential impacts of climate change, assessments of potential water transfers to neighboring agencies, support for the City's 2015 Urban Water Management Plan,[3] and numerous evaluations of the impacts of potential supply, infrastructure and/or operational changes. In recent years, Confluence supported the City's Water Supply Advisory Committee

[2] Gary Fiske & Associates. 2003. City of Santa Cruz Integrated Water Plan, Draft Final Report. June 2003.
[3] City of Santa Cruz. 2016. City of Santa Cruz 2015 Urban Water Management Plan. Prepared by the City of Santa Cruz, Water Department. August 2016.

(WSAC), as it engaged in an extended evaluation of many potential future water supply and infrastructure alternatives. Since 2008, Confluence has provided modeling support to evaluate and refine the numerous options considered by the City, the California Department of Fish and Wildlife (CDFW), the National Oceanic and Atmospheric Administration (NOAA), and the National Marine Fisheries Services (NMFS), to develop an Anadromous Salmonid Habitat Conservation Plan (ASHCP). This effort resulted in the development of minimum bypass flow requirements (Conservation Flows) to balance the habitat needs of anadromous species and the reliability of water supplied to City customers.

Application of Confluence to the Santa Cruz Water Rights Project

Modeling Approach

Confluence was used to model scenarios reflecting the Baseline and the ASHCP, all of which are described in the Appendix 8 Overview. In all cases, the goal of the model simulation is to maximize water supply reliability for City customers consistent with the relevant assumptions for each scenario. For example, for the Proposed Project, those assumptions include implementation of the Conservation Flows. Specifically, the objective is to minimize peak-season water shortages during the worst multi-year drought in the hydrologic record.

For all model runs, the first constraint on system operations is the daily available flows. As described in Appendix 8-3, available flows for City diversions reflect the agreements reached in the City's ASHCP. The projected available flows can reflect historical conditions or projected conditions of climate change.

Modeling Logic without Groundwater Storage (Baseline)

The lack of groundwater storage for the Baseline results in an inability to eliminate the worst-drought shortage. Loch Lomond Reservoir is operated to minimize the magnitude of this shortage. Following are the key modeling steps, which are identical to those used in prior SCWD Confluence modeling.

1. Iteratively simulate the operation of the system for the worst multi-year drought and the three years of the hydrologic record prior to that drought.[4] Beginning the simulation 3

[4] For the CMIP5 climate change projection, described in Appendix 8-1, the worst drought occurs in the first 3 years of the hydrologic record. The 3 prior years were set at the average available flows over the record.

years prior to the beginning of the drought enables the drought to begin with a Loch Lomond Reservoir storage volume reflecting the prior wetter years.

2. Each iteration will adjust Loch Lomond Reservoir's rule curves and the number and costs of blocks of remaining demand that the reservoir must attempt to serve. The goal of these iterations is to regulate the reservoir drawdown so that the usable storage volume is exhausted at the end of the final month (October) of the drought, but no sooner. This will minimize the remaining water supply shortage.
3. With these rule curves and demand blocks, simulate the system over the entire hydrologic record.

Modeling Logic with Groundwater Storage (Proposed Project)

The Proposed Project includes ASR injection to and extraction from underground storage. The surface water and groundwater storage volumes are operated conjunctively[5] to minimize the ASR infrastructure required to achieve the reliability goal, to eliminate the worst-drought shortage. The modeling steps are as follows:

1. Iteratively simulate the operation of the system for the worst multi-year drought and the three years of the hydrologic record prior to that drought. In addition to enabling Loch Lomond Reservoir to start the drought with a storage volume reflecting the prior wetter years, this also reflects the assumption of a 3-year pre-drought fill period for groundwater storage. The storage zones and rule curves for Loch Lomond Reservoir and the underground storage are set to jointly fill and draw down both storage facilities.
2. Each iteration will adjust the ASR injection and extraction capacities to ultimately find the minimum infrastructure needed to eliminate the worst-drought shortage. The proper groundwater injection and extraction capacities are the minimum levels that will draw down the usable storage volumes of both Loch Lomond Reservoir's surface storage and the underground storage to zero at the end of the multi-year drought.
3. With these ASR injection and extraction capacities, simulate the system operation over the entire hydrologic record.

At the conclusion of the simulations of the Baseline and Proposed Project, the resulting daily diversions and Loch Lomond Reservoir fill and drawdown volumes are combined with the natural flows (prior to ASHCP bypass requirements) and any tributary inflows downstream of the diversions to calculate the daily anadromous-reach flows across the hydrologic record in each

[5] Conjunctive use refers to a range of actions and projects that provide for the coordinated management of surface water and groundwater supplies to increase total supplies and enhance water supply reliability.

stream. These results are provided as input to the fisheries effects modeling, described in Appendix 8-3.

Key Assumptions

As discussed, the use of Confluence to support the development and evaluation of the Proposed Project builds upon the many years of application of Confluence to the City's system. Over those years, model capabilities were continuously updated, and assumptions refined to better represent the actual operation of the system. Tables 1 through 5 lay out the key assumptions that underlie the model runs for the Baseline and Proposed Project.

Baseline Assumptions

Table 1. Key Modeling Assumptions for the Baseline

CATEGORY	COMPONENT	ASSUMPTION
DEMANDS	City Service Area	3,200 mgy
	North Coast Agriculture	40 mgy
HYDROLOGY	Historical Hydrologic Record	1937-2015
	Climate Change Hydrologic Record	2020-2070
	Climate Model	CMIP-5 MOD
	Flow Rules	interim bypass requirements effective in 2018
DISPATCH OF SUPPLIES	Source Dispatch Order to Meet SCWD Demand	1. North Coast 2. Tait Diversion 3. Tait Wells 4. Beltz Wells 5. Surface water storage
	North Coast Potential End Uses	1. Agricultural Demands 2. City Demands
	Tait Potential End Uses	City Demands
	Felton Potential End Uses	Surface storage at Loch Lomond Reservoir
	Beltz Wells Potential End Uses	City Demands

CATEGORY	COMPONENT	ASSUMPTION
	Loch Lomond Potential End Uses	City Demands
DIVERSION CAPACITIES	Liddell	2.47 cfs
	Laguna	6.27 cfs
	Majors	2.09 cfs
	Tait	11.52 cfs
	Felton	12.40 cfs
WATER RIGHTS (maximum diversion rate)	North Coast	No Limit when minimum flows are met
	Felton	Jan-May; Oct-Dec 20.0 cfs Jun-Aug 0 Sep 7.8 cfs
	Tait	12.2 cfs in all months
WATER TREATMENT PLANT CAPACITY (mgd)	Graham Hill WTP	16.5 mgd
OTHER KEY OPERATING CONSTRAINTS	North Coast	Turbidity
	Felton	Turbidity, First Flush, Pump limitations, Reservoir elevations
	Tait	Turbidity
WELL EXTRACTION CAPACITIES (Native Groundwater)	Beltz Live Oak	0.8 mgd Apr - Nov in all water years
	Beltz 12	0.3 mgd May - Aug in critically dry years
	Tait Wells	1.28 mgd May-Dec; 0.78 mgd Jan-Apr

CATEGORY	COMPONENT	ASSUMPTION
LOCH LOMOND	Max/usable capacity	2,810 mg/1,740 mg
	Allowable diversion months	Sept-Jun
	Daily Instream Release	1.00 cfs
	Annual San Lorenzo Valley	102.1
AQUIFER STORAGE & RECOVERY	Storage Capacity	N/A
	Aquifer Losses	N/A
	Injection Capacity	N/A
	Extraction Capacity	N/A
	Injection Season	N/A
	Extraction Season	N/A
	Hydrologic condition restriction	N/A
WATER TRANSFERS	Maximum monthly transfer	N/A
	Hydrologic condition restriction	N/A

Following are brief discussions of the Baseline assumptions laid out in Table 1.

- Demands. The assumptions represent the City's best estimates of the magnitudes of long-term unconstrained annual demands. "Unconstrained demands" are those that would be expected to be realized in the absence of voluntary or mandatory drought-related curtailments as described in the City's 2009 Water Shortage Contingency Plan [City of Santa Cruz 2009). These annual demands are allocated across calendar months based on customer demand patterns. These assumptions are identical to those used in recent SCWD system modeling, including the WSAC process, and the ASHCP.
- Hydrology. The 79-year historical and the 51-year climate change periods of record are again consistent with recent modeling efforts. The CMIP-5 MOD climate change projection is described above in Appendix 8-1 and was used in the ASHCP process. The available flows in the Baseline are per the interim bypass requirements effective in 2018, described in Appendix 8-3.
- Dispatch of Supplies. In each daily time step, the simulation dispatches the supply sources in this order to meet that day's demands. The North Coast sources are assigned the lowest shadow prices and are thus dispatched first. The available North Coast supply first serves North Coast agricultural demands, and the remaining available North Coast supply goes to the Graham Hill Water Treatment Plant (GHWTP) to serve SCWD

demands. Available supplies from the Tait Diversion and the Tait wells are then dispatched to the GHWTP to serve SCWD demands. If there remains unserved demand, the available Beltz Well supplies are dispatched. The final source to be dispatched to the GHWTP to serve SCWD demands, which is only used if the other sources are unable to serve that day's demand, is the Loch Lomond Reservoir.

For the Baseline, the places of use for all the supplies are consistent with existing water rights.

- Diversion and Treatment Constraints. In any daily time step of the simulation, actual diversions are constrained by many factors. The first of these is the physical diversion capacities, which are displayed in the Table 1. (The capacity shown for Felton is the assumed capacity of the Felton Booster Pump Station, which is somewhat less than the 13.7 cfs physical capacity of the diversion itself.) In addition, diversions may be constrained by water rights, the current magnitudes of which are also displayed in Table 1. Other operating constraints include:
    - Excess turbidity. If the water at the relevant diversion facility is determined to be too turbid on any day to either be treated at GHWTP or, in the case of Felton, to be stored in Loch Lomond Reservoir that diversion is shut off for that day. Confluence turbidity constraints are a function of the precipitation on the current day and recent past days. The constraints are designed to approximate the current treatment capabilities at GHWTP or the current turbidity limits for water placed into Loch Lomond Reservoir for storage.
    - Additional Felton Diversion constraints. Diversions from Felton are also limited by several other factors:
        - First flush. The City currently does not divert from Felton Diversion in the fall until after there have been sufficient flows to "flush" solids and other contaminants that have accumulated in the San Lorenzo River over the dry season. The specific modeled constraint is that diversions cannot begin until there have been two days of flow at the Big Trees gage that are at least 100 cfs.
        - Pumping limitations. The current configuration of the Felton Diversion pumps allows diversions only at several discrete levels up to and including the maximum 13.7 cfs. These discrete pumping levels are reflected in the model assumptions, and further constrain diversions at Felton Diversion.
        - Loch Lomond Reservoir elevations. The current transmission from Felton Diversion to Loch Lomond Reservoir is hydraulically constrained, so that the rate at which water can be moved decreases as the reservoir's elevation

increases. Of course, if Loch Lomond Reservoir is spilling, no water can be diverted from Felton Diversion to the reservoir.

- Water Treatment Plant. The GHWTP capacity is assumed to be 16.5 mgd.
- Well Extraction Capacities. Table 1 displays the assumed well extraction capacities for the Beltz wells as well as the Tait wells.
- Loch Lomond Reservoir. The assumed maximum storage capacity of the reservoir is 2,810 mg. Of this, 70 mg is assumed to be inaccessible for drawdown. In addition, 1,000 mg is assumed to be reserved to insure against a possible future drought, which is longer and/or more severe than what has been experienced in the past. This leaves 1,740 mg usable storage volume. This usable storage capacity is filled and drawn down as described above. Other key Loch Lomond Reservoir operating constraints are also displayed in Table 1.

It is worth repeating that all assumptions have been refined over the years to ensure that the model simulates as closely as possible the manner in which City currently operates its water system.

Project Assumptions

Table 2. Key Modeling Assumptions for the ASHCP

CATEGORY	COMPONENT	ASSUMPTION
DEMANDS	City Service Area	3,200 mgy
	North Coast Agriculture	40 mgy
HYDROLOGY	Historical Hydrologic Record	1937-2015
	Climate Change Hydrologic Record	2020-2070
	Climate Model	CMIP-5 MOD
	Flow Rules	Conservation Flows

CATEGORY	COMPONENT	ASSUMPTION
DISPATCH OF SUPPLIES	Source Dispatch Order to Meet City Demand	1. North Coast 2. Tait Diversion 3. Tait Wells 4. Felton 5. Beltz Wells 6. Surface water and groundwater storage operated in parallel
	North Coast End Uses	1. Agricultural Demands 2. City Demands 3. GW Storage 4. Transfers
	Tait Potential End Uses	1. City Demands 2. GW Storage 3. Transfers
	Felton Potential End Uses	1. City Demands 2. Surface storage 3. GW Storage 4. Transfers
	Beltz Wells End Uses	City Demands
	Loch Lomond & ASR End Uses	City Demands[6]
DIVERSION CAPACITIES	Liddell	2.47 cfs
	Laguna	6.27 cfs
	Majors	2.09 cfs
	Tait	27.85 cfs
	Felton	13.70 cfs

[6] The Proposed Project includes the expansion of the Newell Creek/Loch Lomond water-right license's (License 9847) place of use to include neighboring agencies and the full boundaries of local groundwater basins. Transfers under that license into that expanded area are likely to be rare.

CATEGORY	COMPONENT	ASSUMPTION
WATER RIGHTS (maximum diversion rate)	North Coast	No Limit when Conservation Flows
	Felton & Tait	Shared water right: Jan-May; Oct-Dec 32.2 cfs Jun-Aug 12.2 cfs Sep 20.0 cfs
WATER TREATMENT PLANT CAPACITY (mgd)	Graham Hill WTP	18 mgd
OTHER KEY OPERATING CONSTRAINTS	North Coast	Turbidity
	Felton	Turbidity, First Flush
	Tait	Turbidity
WELL EXTRACTION CAPACITIES (Native Groundwater)	Beltz Live Oak	0.8 mgd Apr - Nov in all water years
	Beltz 12	0.3 mgd May - Aug in critically dry years
	Tait Wells	1.28 mgd May-Dec; 0.78 mgd Jan-Apr
LOCH LOMOND	Max/usable capacity	2,810 mg/1,740 mg
	Allowable diversion months	Sept-Jun
	Daily Instream Release	1.00 cfs
	Annual San Lorenzo Valley Entitlement	102.1 mg

CATEGORY	COMPONENT	ASSUMPTION
AQUIFER STORAGE & RECOVERY	Storage Capacity	3,000 mg
	Aquifer Losses	20%
	Injection Capacity	Hist 4.5 mgd; Clim Chg 5.5 mgd
	Extraction Capacity	Hist 8.0 mgd; Clim Chg 7.0 mgd
	Injection Season	Nov-Apr
	Extraction Season	May-Oct
	Hydrologic condition restriction	No injection in Hydrologic Condition-5 months
WATER TRANSFERS	Maximum monthly transfer	Neighbor agency groundwater demands
	Hydrologic condition restriction	No transfer in Hydrologic Condition-4 & Hydrologic Condition-5 months

Following are brief discussions of the key differences between the modeling assumptions for the Proposed Project, as laid out in Table 2 and those for the Baseline.

- Hydrology. The available flows for diversions in the Proposed Project are determined by the Conservation Flow rules.
- Dispatch of Supplies. The final step of the dispatch includes the joint drawdown of the surface water from Loch Lomond Reservoir storage and ASR groundwater storage. In addition, the water rights changes included in the Proposed Project, discussed below, expand the potential destinations for the supplies from particular sources. Table 2 shows the order of destinations to which each source is dispatched.
- Diversion Constraints. The Tait Diversion capacity is assumed to be upgraded to match the upgraded treatment plant capacity. The current Felton Booster Pump Station constraints are assumed to be removed, so the capacity shown for the Felton Diversion is the physical capacity of the diversion itself. Other operating constraints that differ from the Baseline include:
    - Excess turbidity. Because of the assumed improvements at GHWTP, the number of days of turbidity shutoffs are assumed to be halved for the Felton and Tait Diversions.
    - Additional Felton Diversion constraints. Assumed improvements to the Felton pumps eliminate the discrete pumping limitations of the Baseline. Likewise, improvements to the Felton Booster Pump Station and transmission to Loch

Lomond Reservoir are assumed to remove the hydraulic constraints so the capacity to move water to the reservoir no longer depends on the reservoir elevation.

- Water Rights. The Proposed Project shares the current water rights at Felton and Tait, and the places of use for those diversions are expanded so that either can divert water to the SCWD service area, to ASR injection, and to neighboring agencies. Likewise, the Proposed Project expands the allowed places of use for the North Coast diversions.
- Water Treatment Plant. The GHWTP is assumed to be upgraded to a capacity of 18 mgd. The upgrades are also assumed to enable more turbid water to be treated.
- Well Extraction Capacities. The Beltz and Tait well capacities to extract native groundwater are supplemented by the assumed ASR well extraction capacities discussed below.
- ASR. Based on preliminary groundwater modeling, the groundwater storage capacity is assumed to be 3 billion gallons. A 20% loss factor is also assumed, so that for each 100 gallons injected, only 80 gallons are available for extraction. The volumes in groundwater storage are assumed to drawn down jointly with Loch Lomond Reservoir. Table 2 shows the assumed injection and extraction capacities. Injections are constrained in the modeling to the months of November-April; extractions are modeled to occur in May-October. Finally, no injection is permitted in months for which the Big Trees flow falls in the lowest quintile (Hydrologic Condition 5). See Appendix 8-3 for a description of the Hydrologic Conditions.)
- Water Transfers. Transfers only occur when available streamflows on any day exceed the volumes that can be delivered to all other points of use. Transfers are limited by the combined estimated groundwater demands of Soquel Creek Water District, Scotts Valley Water District, and San Lorenzo Valley Water District. Central Water District demands are assumed to be within these other districts demands because Central is relatively small. Transfers cannot occur in months for which the Big Trees flow falls in the lowest two quintiles (Hydrologic Conditions 4 and 5).

Key Model Outputs

As discussed above, there is a large array of potential model outputs. Following are charts that illustrate a subset of those outputs that provide key comparisons between the Baseline and Proposed Project. Results will first be shown for historical flows and then for climate change.

Historical Flows

For historical flows, the ASR injection and extraction capacities needed to achieve the water supply reliability goal (zero worst-drought peak-season shortage) for the Proposed Project are 4.5 mgd and 8.0 mgd, respectively. With these capacities, Figures 2 and 3 compare the total annual diversions from the San Lorenzo River.

Figure 2. Annual Felton Diversions: Historical Flows

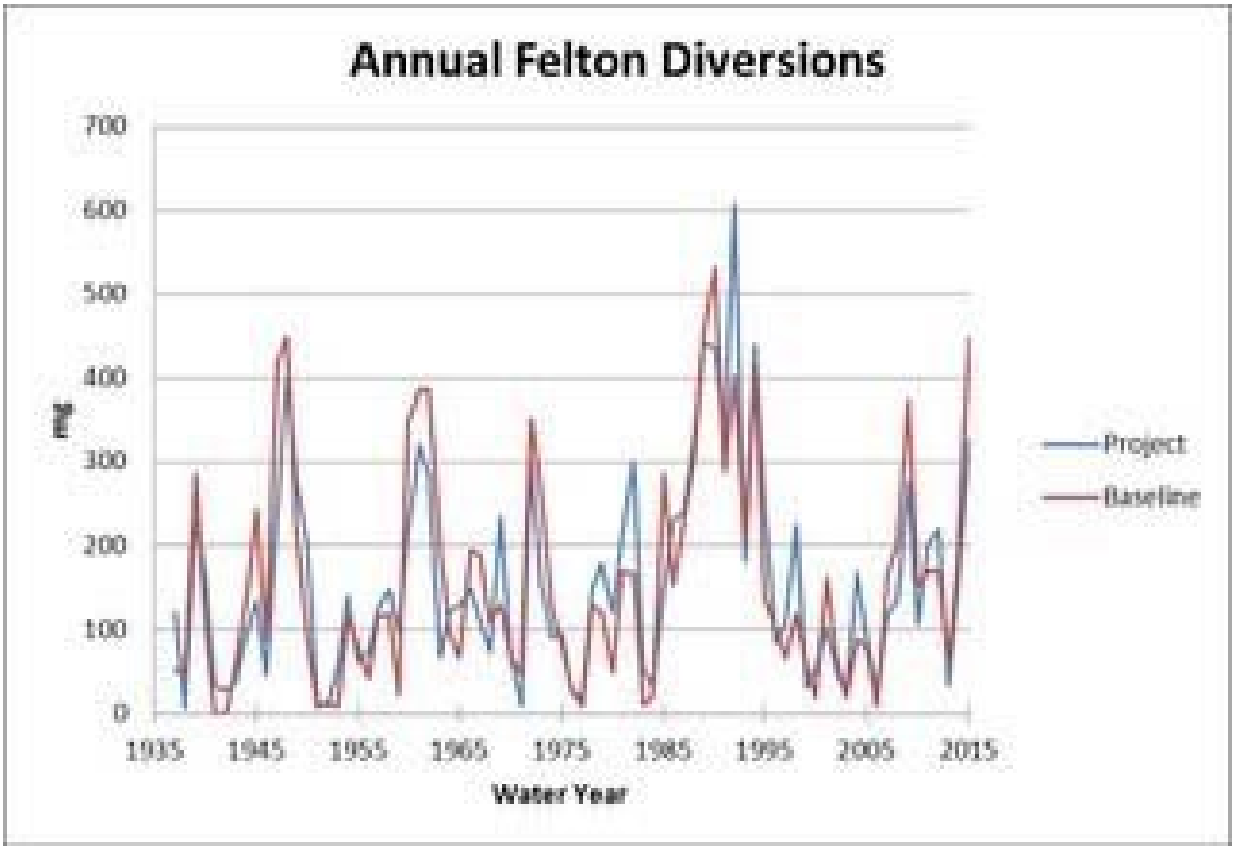


Figure 3. Annual Tait Diversions: Historical Flows

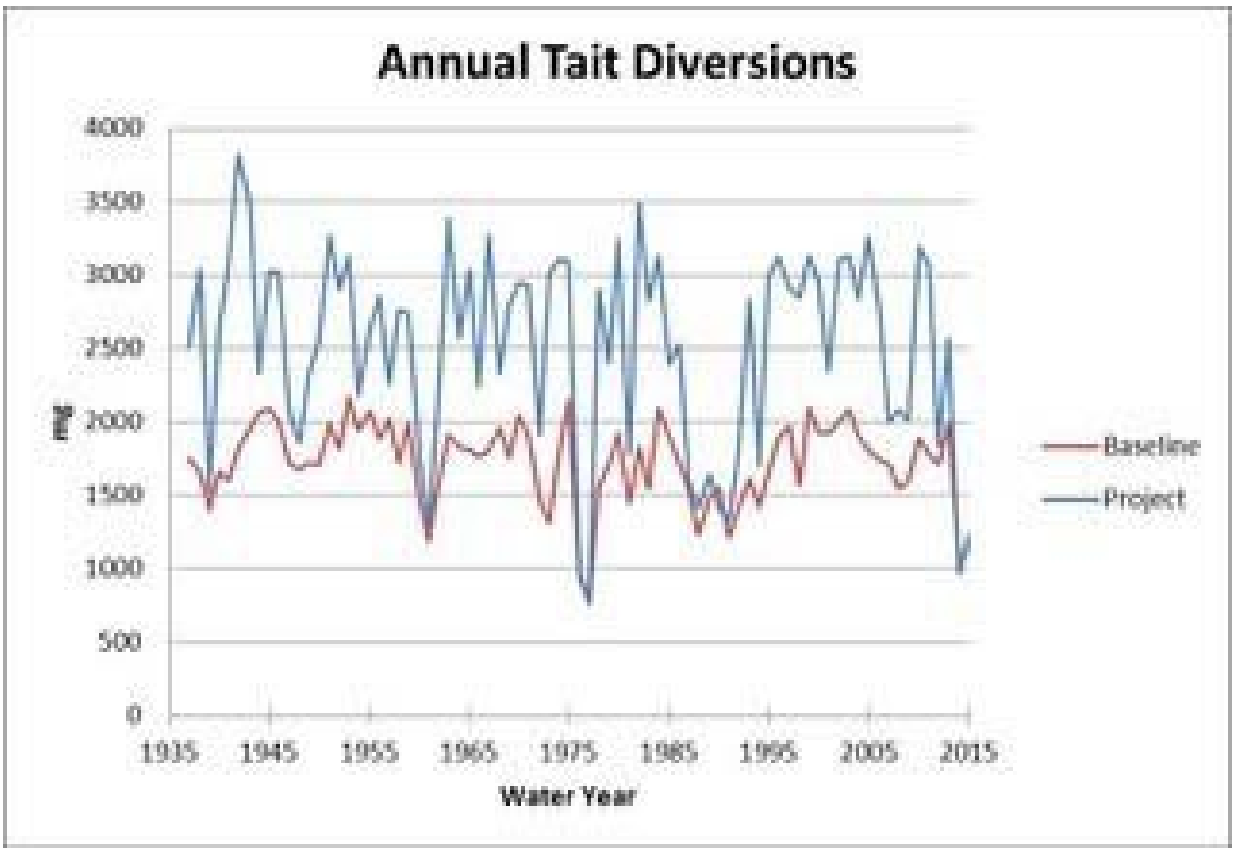


Figure 4 compares North Coast annual diversions. The slight variations are due to the small differences between the interim bypass flows effective in 2018 and the Conservation Flows.

Figure 4. Annual Diversions from the North Coast: Historical Flows

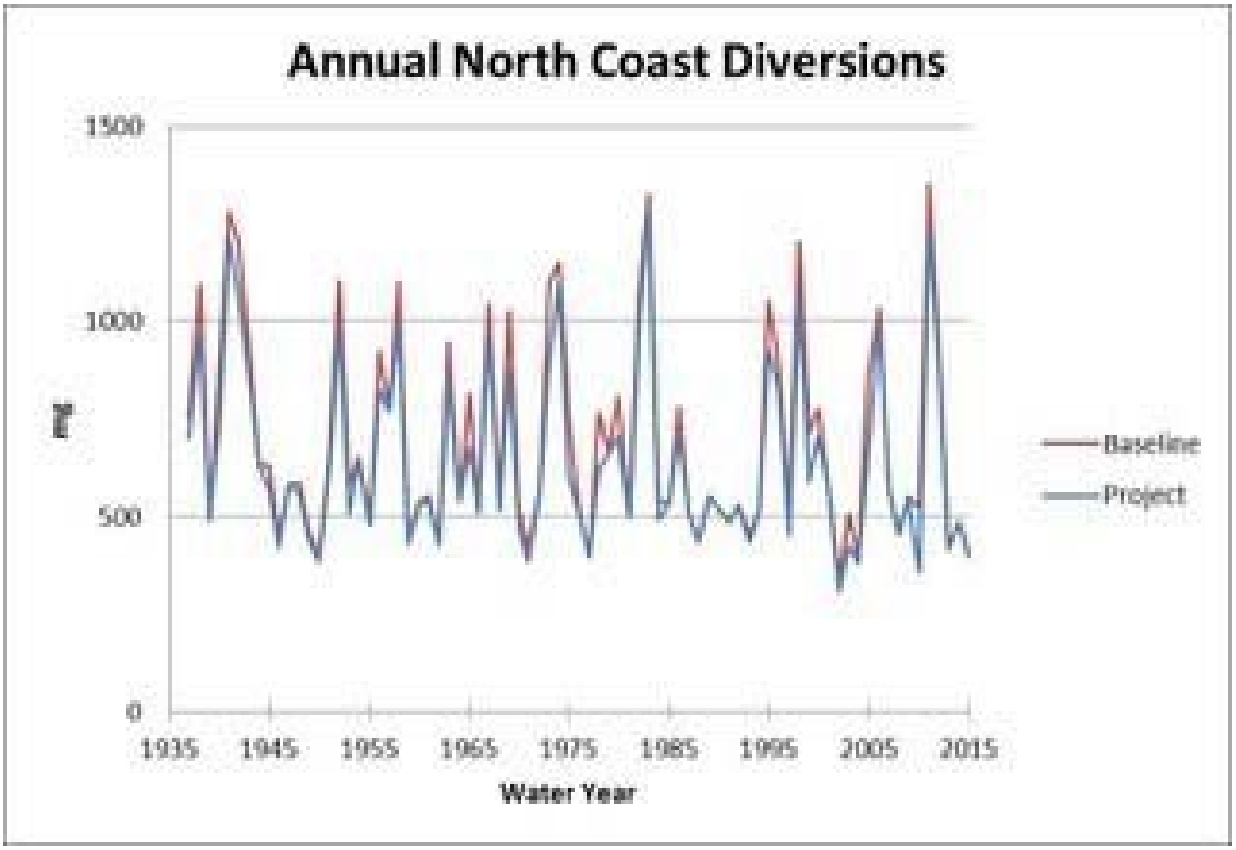


Figure 5 compares the annual ASR injection and extraction volumes for the Proposed Project and Alternative 2. (Recall that the extraction volumes reflect the assumed 20% aquifer losses.)

Figure 5. Annual ASR Injection and Extraction Volumes: Historical Flows

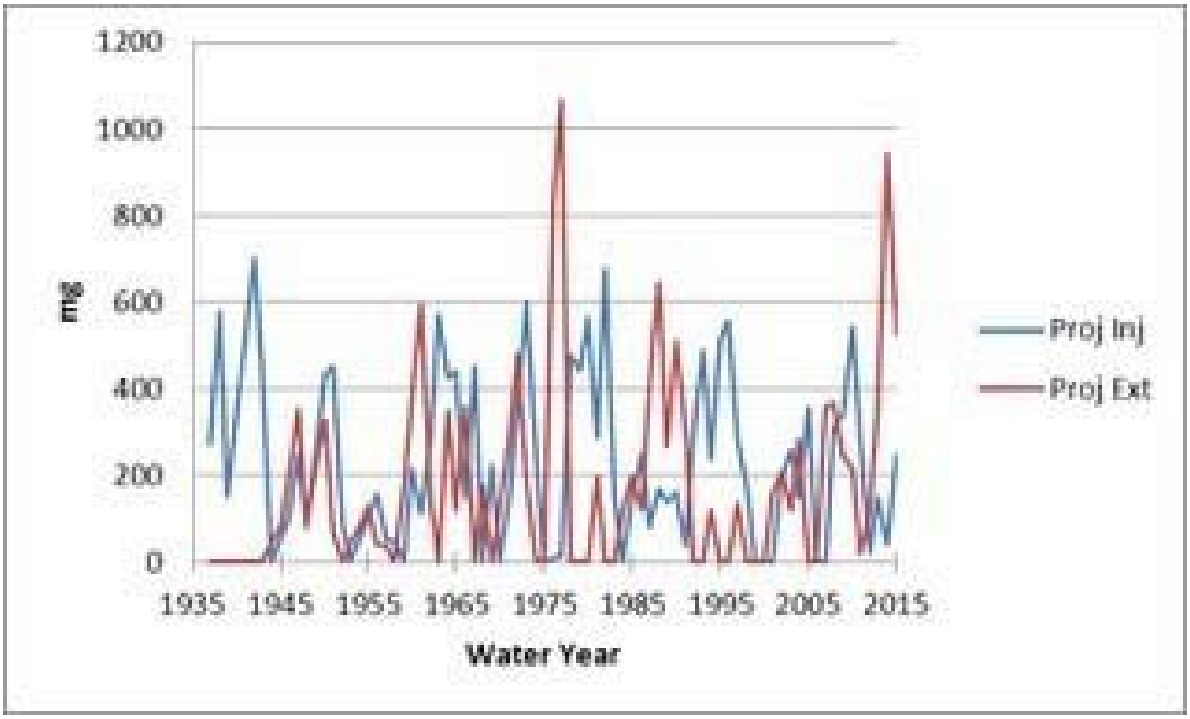


Figure 6 compares the resulting peak-season shortages across the hydrologic record. The large shortage during the worst (1976-77) drought in the Baseline is apparent. Consistent with the water supply reliability goal, that shortage is eliminated by the Proposed Project's ASR infrastructure. The Proposed Project also eliminates lesser shortages in other dry periods.

Figure 6. Peak-Season Shortages: Historical Flows

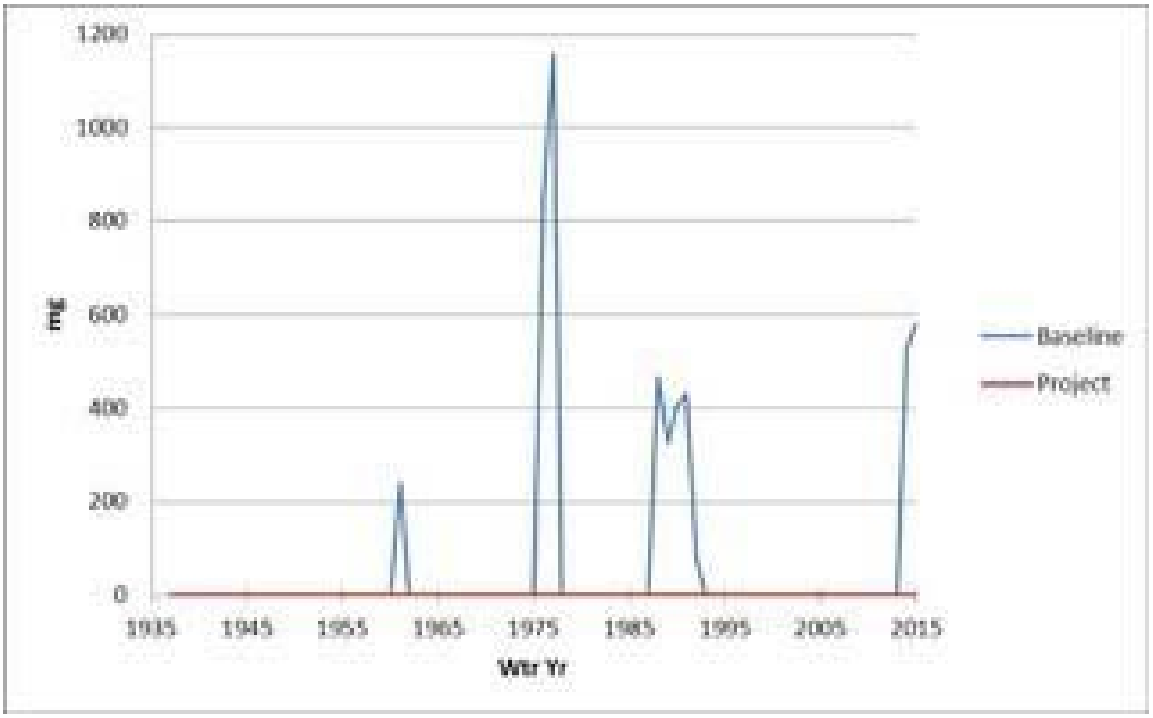
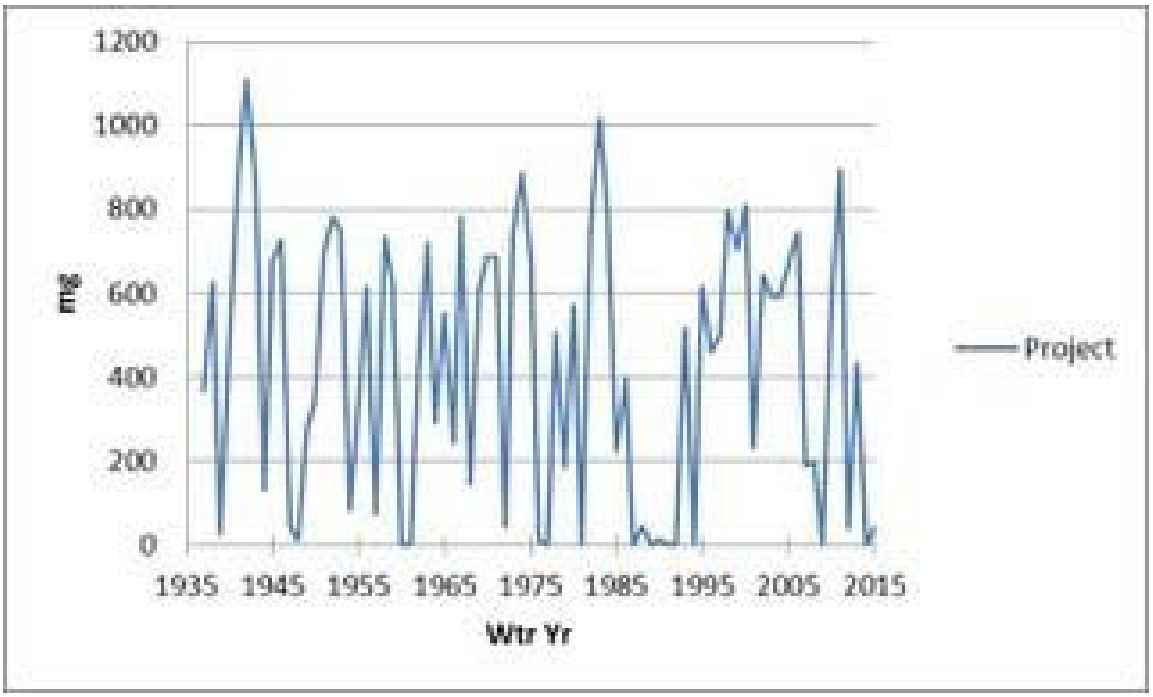


Figure 7 compares the annual volumes transferred to neighboring agencies.

Figure 7. Annual Water Transfer Volumes: Historical Flows



Figures 8 and 9 show exceedance curves for end-of-April (beginning of dry season) usable storage volumes, including Loch Lomond Reservoir and ASR.

Figure 8. End-of-April Usable Loch Lomond Reservoir Storage: Historical Flows

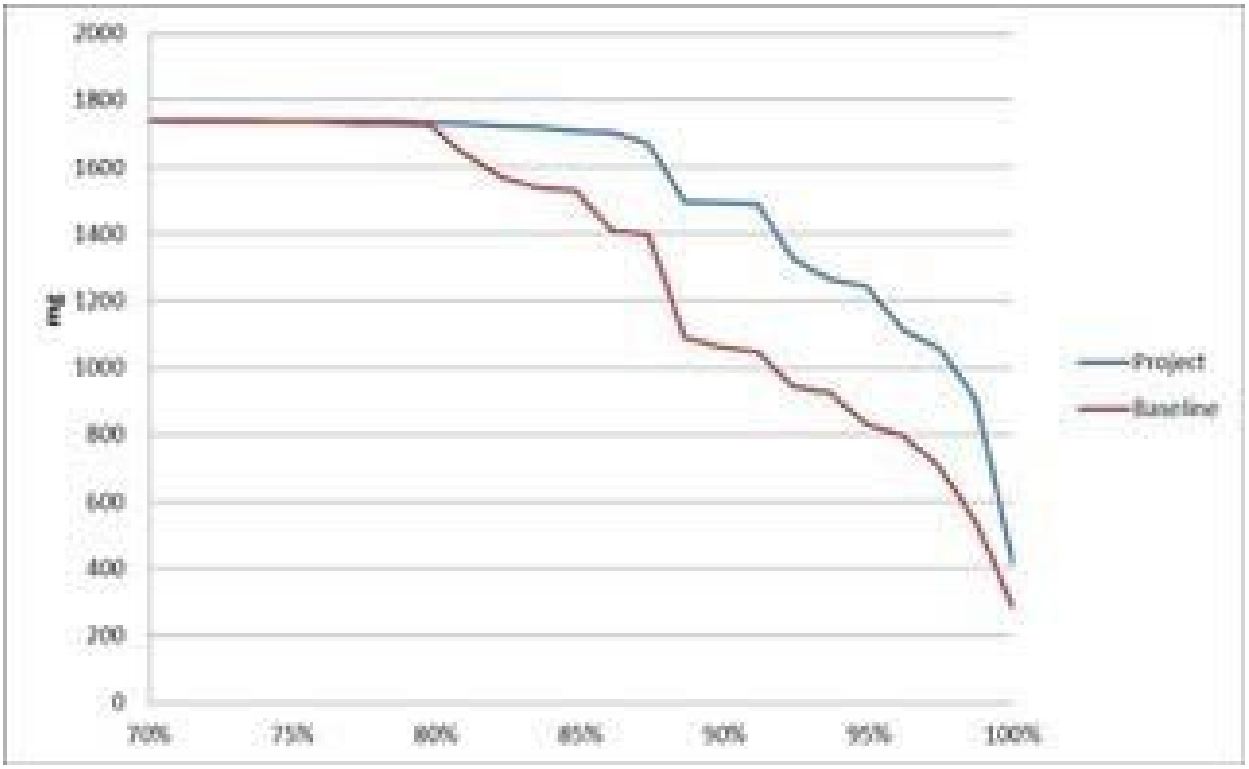
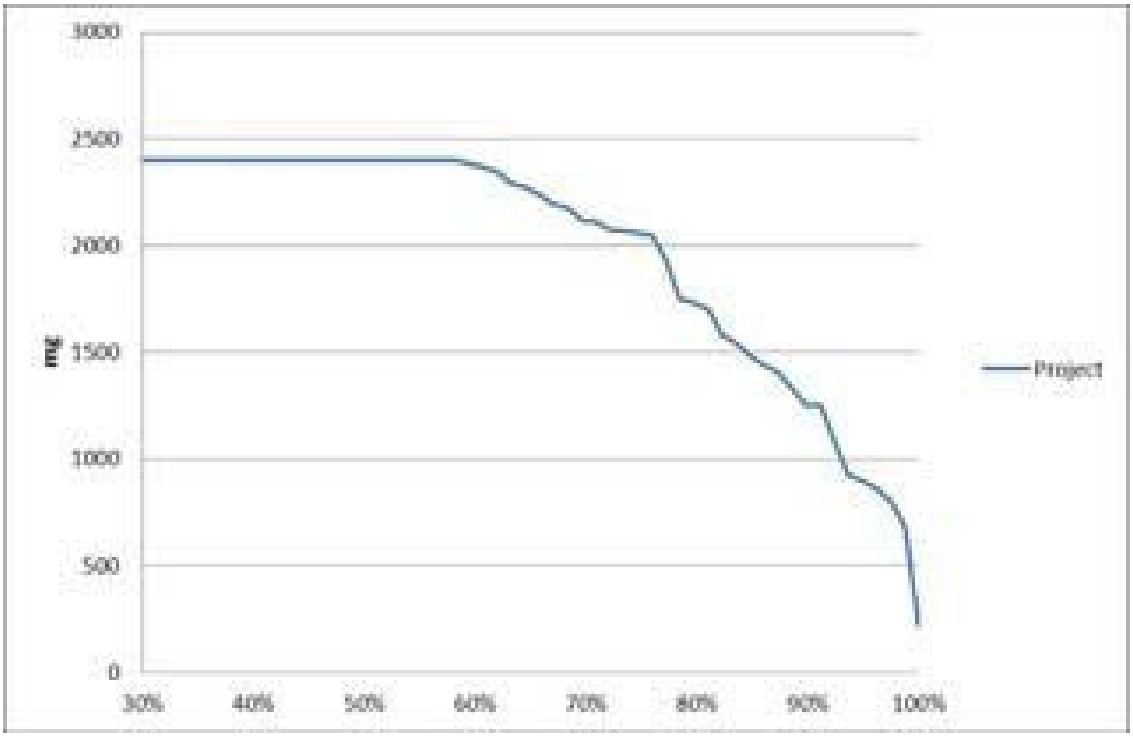


Figure 9. End-of-April Usable Aquifer Storage: Historical Flows



Climate Change

For CMIP-5 climate change flows, the ASR injection and extraction capacities needed to achieve the water supply reliability goal (zero worst-drought peak-season shortage) for our Proposed Project are 6.0 mgd and 7.0 mgd respectively. The following charts compare the Baseline and Proposed Project.

Figure 10. Annual Diversions from San Lorenzo River: Climate Change

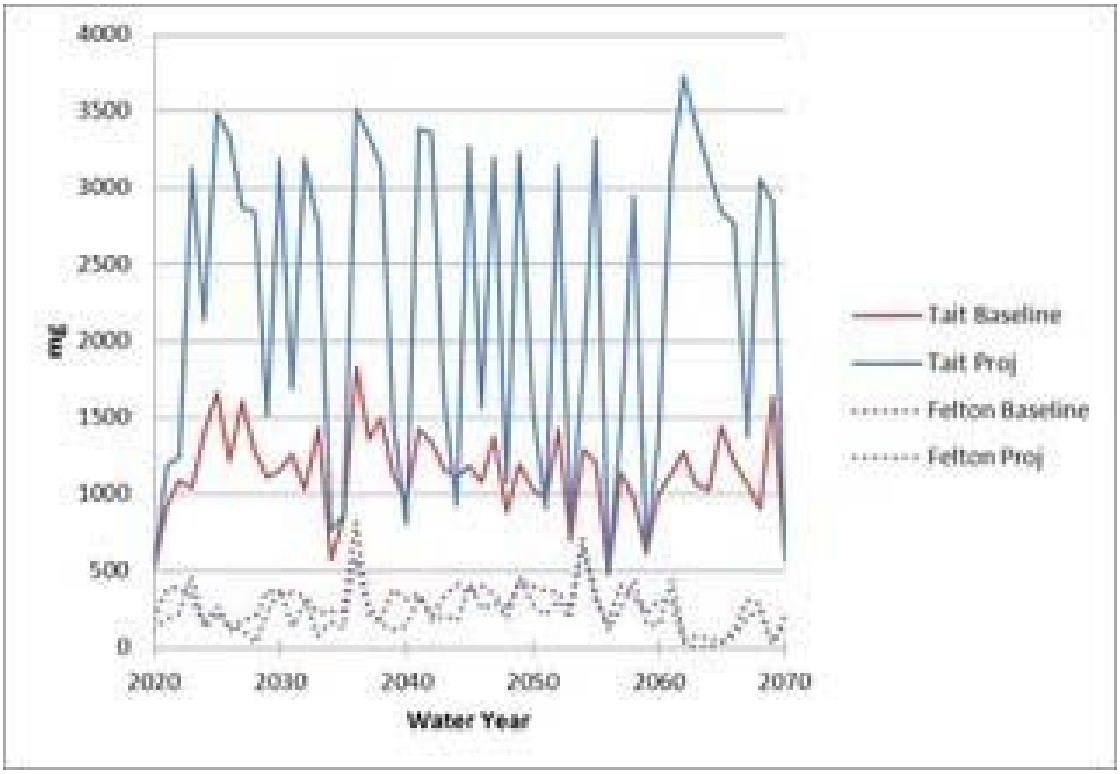


Figure 11. Annual Diversions from the North Coast: Climate Change

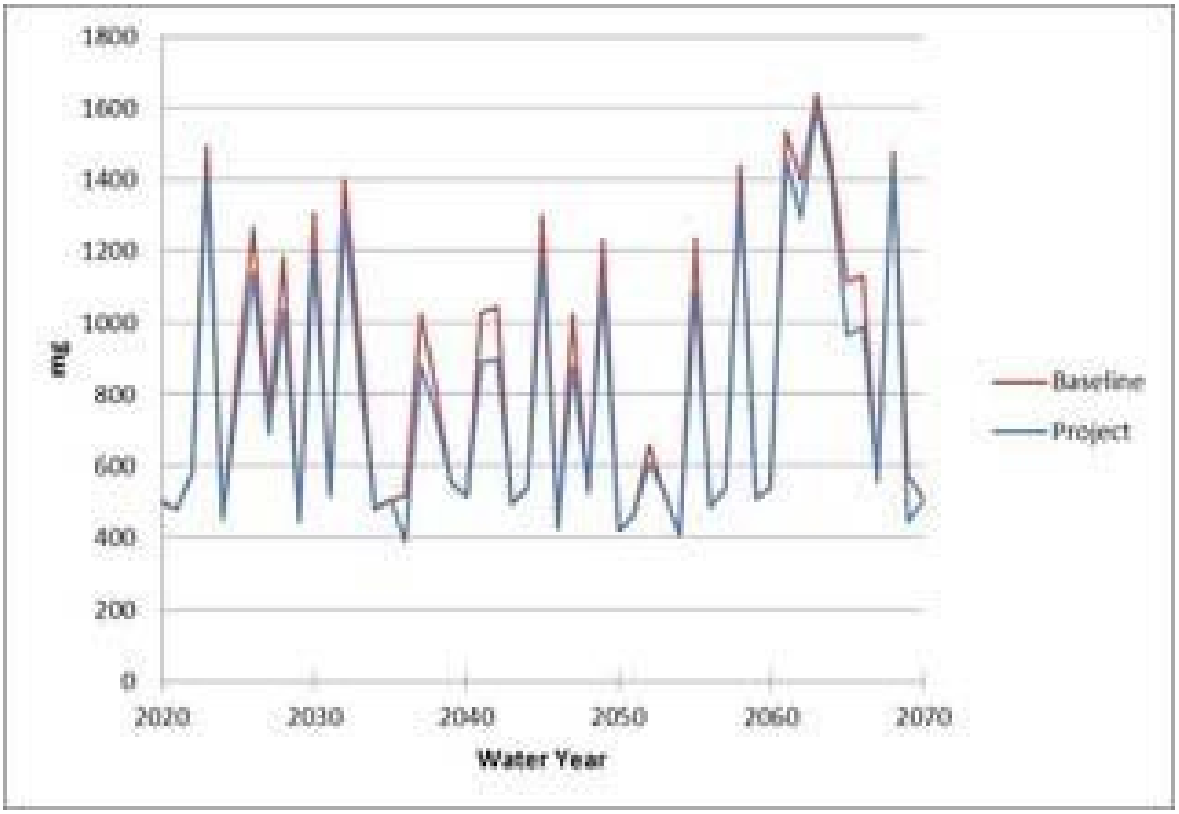


Figure 12. Annual Project ASR Injection and Extraction Volumes: Climate Change

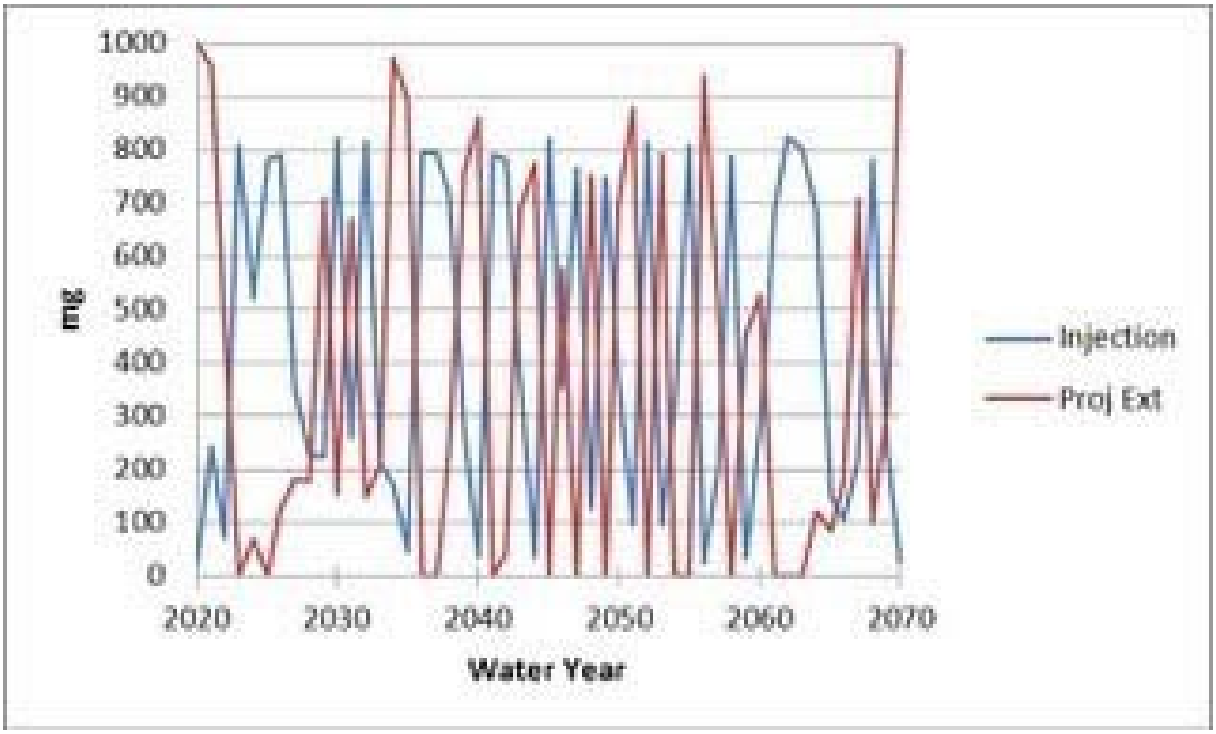


Figure 13. Peak-Season Shortages: Climate Change

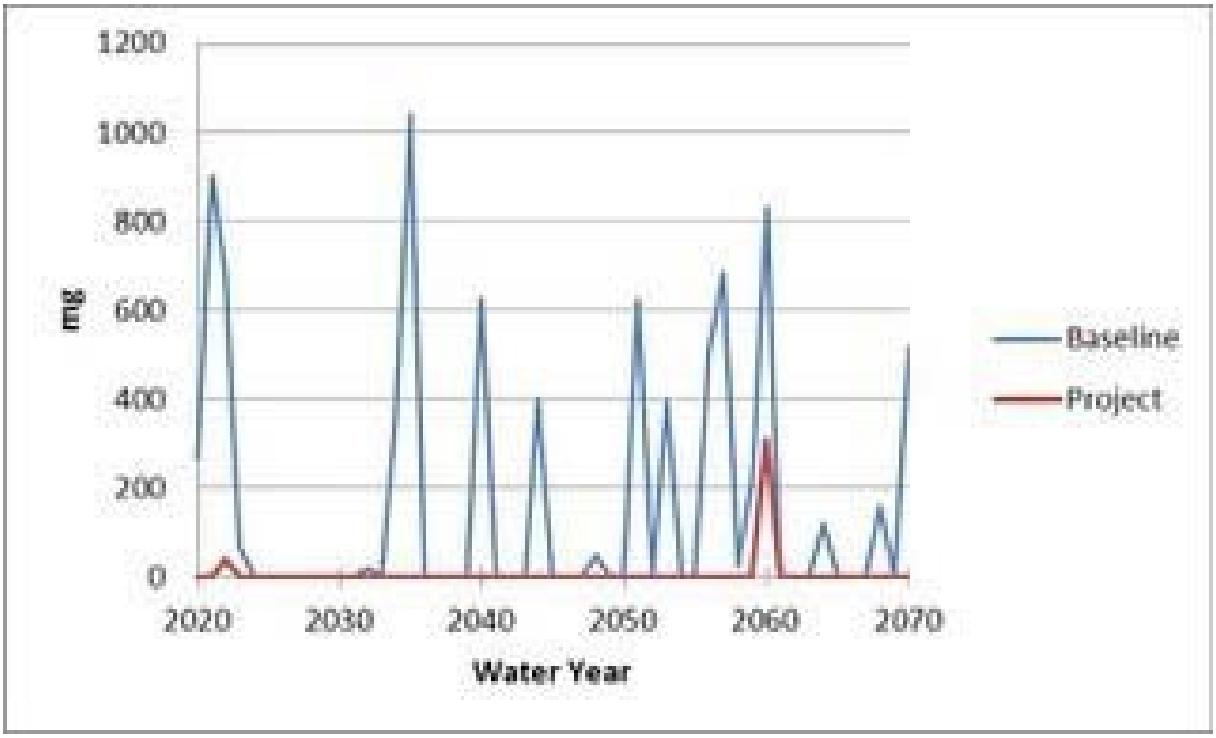


Figure 14. Annual Project Water Transfer Volumes: Climate Change

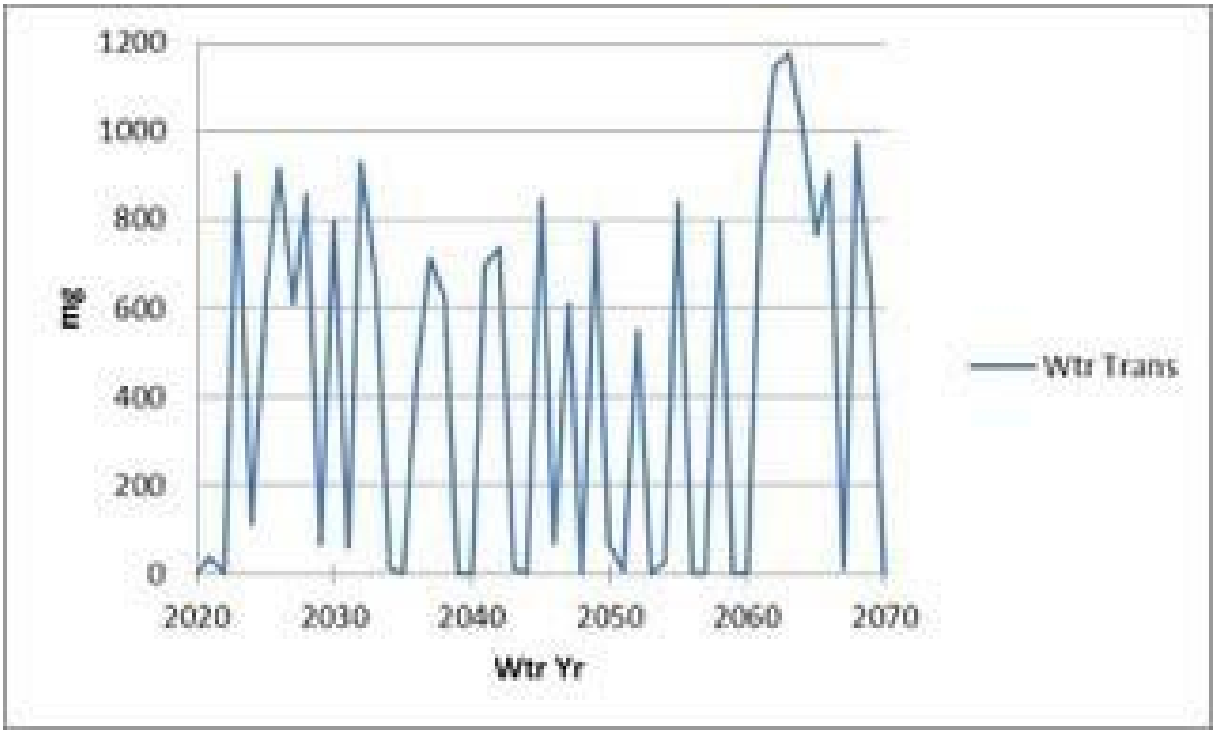


Figure 15. End-of-April Usable Loch Lomond Storage: Climate Change

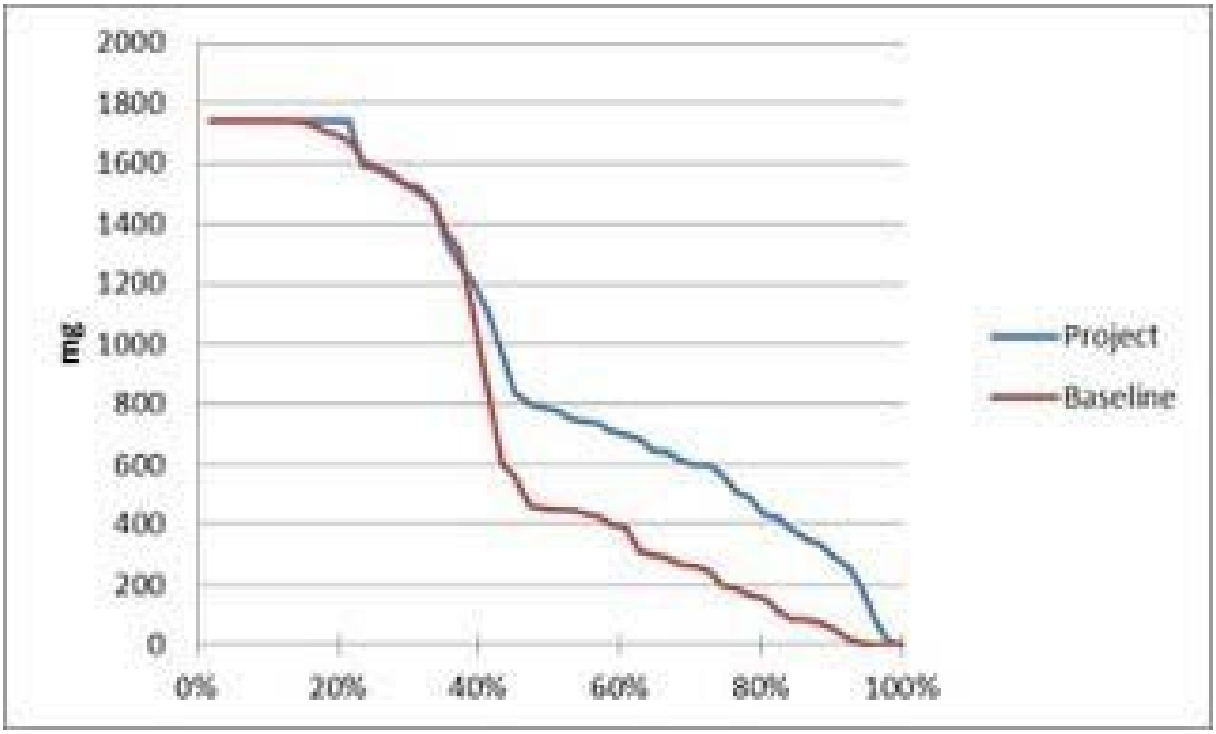
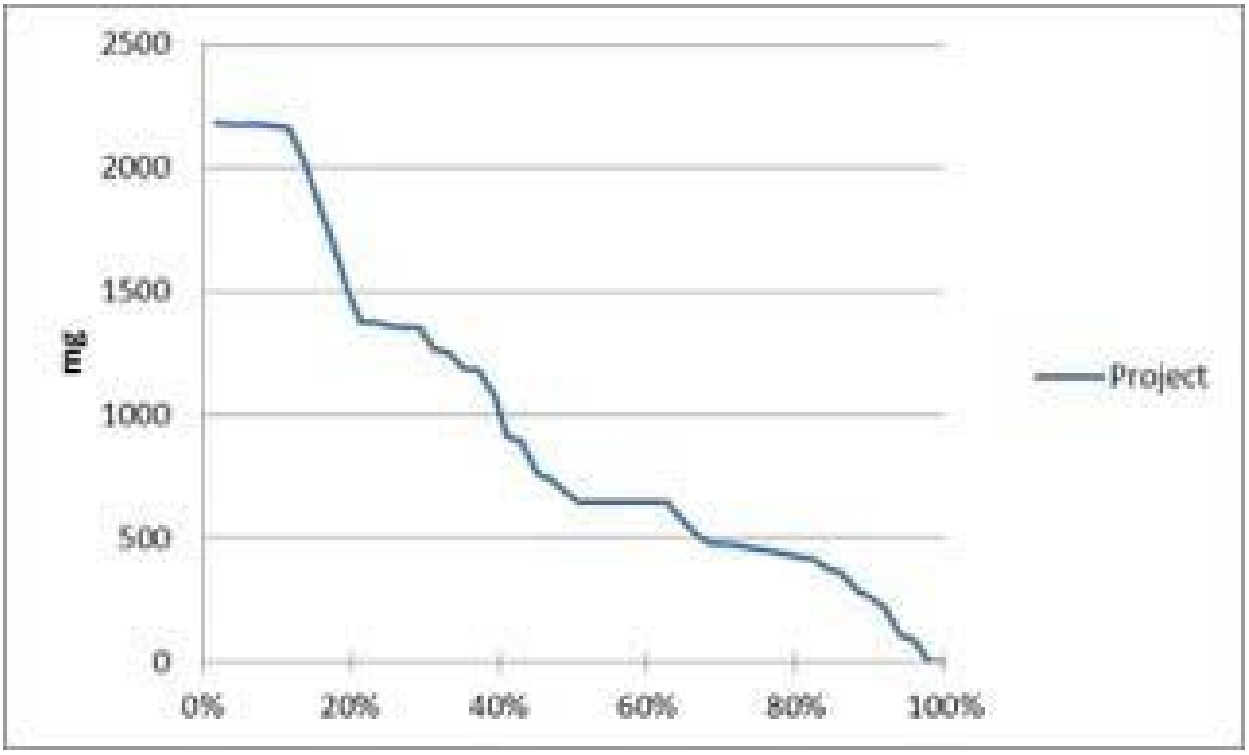


Figure 16. End-of-April Usable Aquifer Storage: Climate Change



Appendix 8-2 – Attachment 1

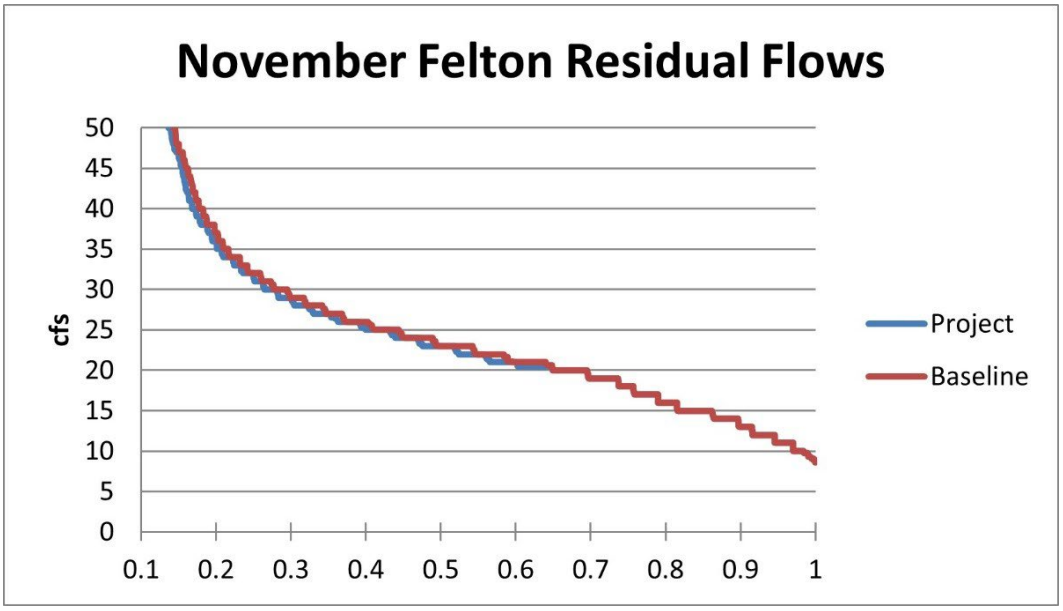
Residual Flow Exceedance Curves

This attachment contains the modeled exceedance curves and associated data for the monthly residual flows in the anadromous reaches below each of City's six diversions. The daily residual flows are defined as follows:

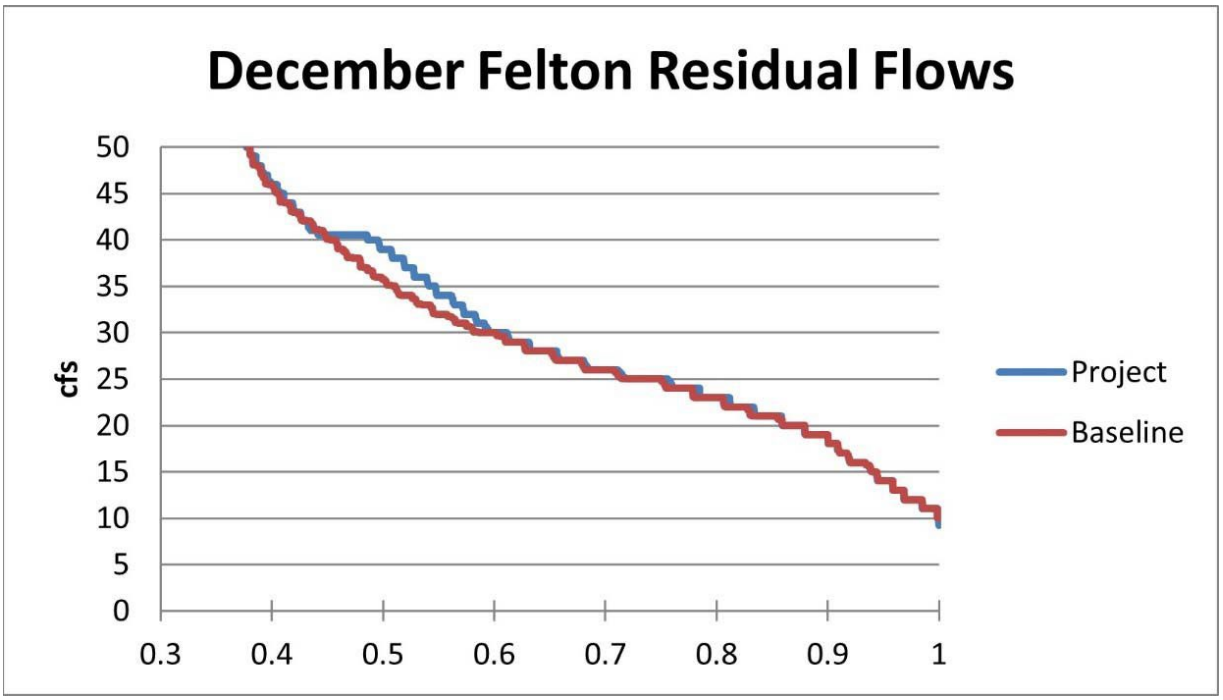
Natural streamflow - Diversion volume + Tributary inflows below point of diversion

The charts all show the exceedance probabilities for flows up to 50 cfs.

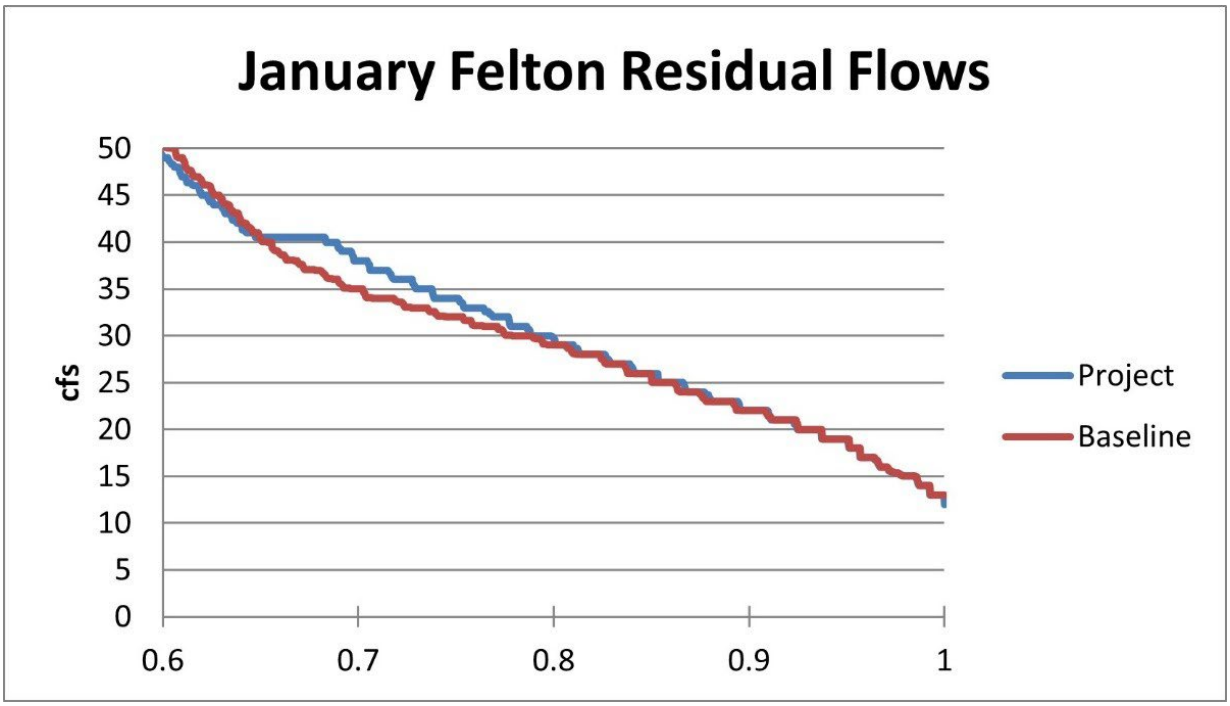
FELTON DIVERSION



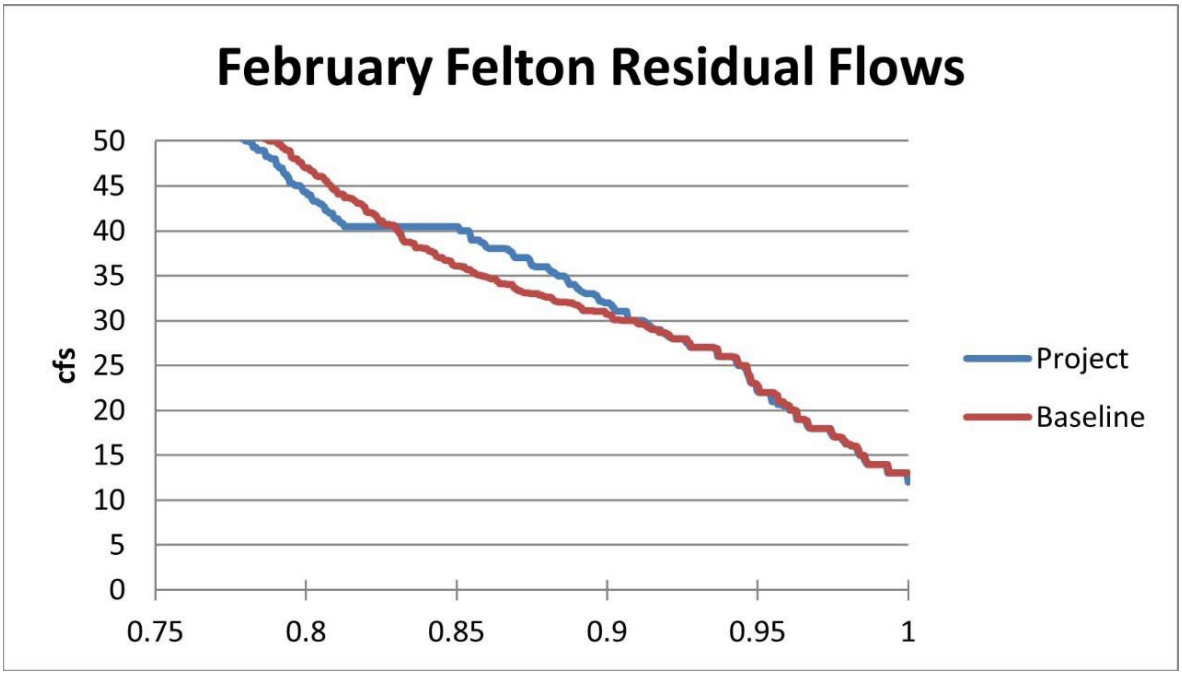
Percentile	ASHCP	Baseline
10%	72	73
20%	36	37
30%	29	29
40%	25	26
50%	23	23
60%	21	21
70%	19	19
80%	16	16
90%	13	13
100%	9	9



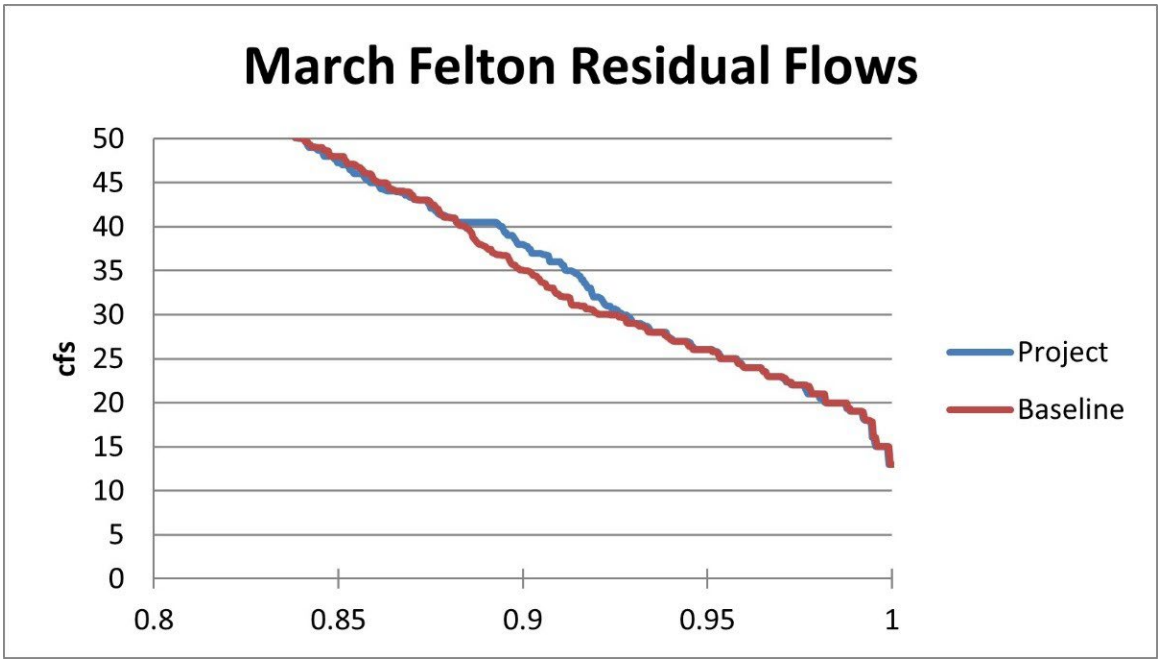
Percentile	ASHCP	Baseline
10%	358	358
20%	133	139
30%	71	73
40%	46	46
50%	39	36
60%	30	30
70%	26	26
80%	23	23
90%	18	18
100%	9	9



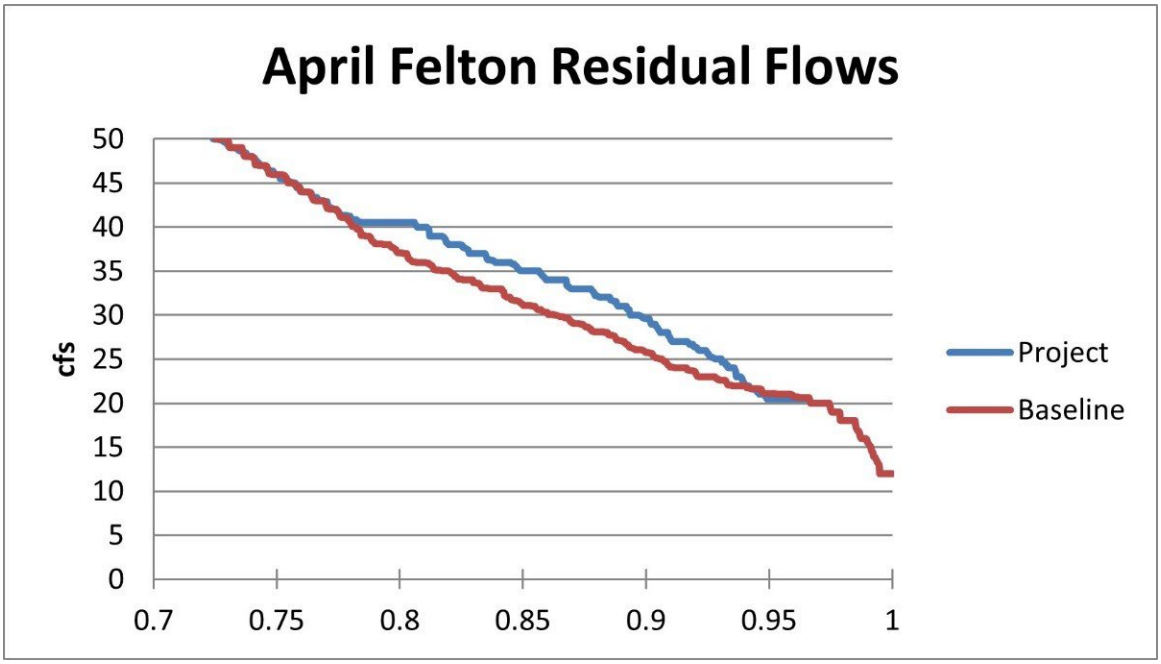
Percentile	ASHCP	Baseline
10%	708	708
20%	337	337
30%	202	203
40%	123	123
50%	75	76
60%	49	51
70%	38	35
80%	30	29
90%	22	22
100%	12	12



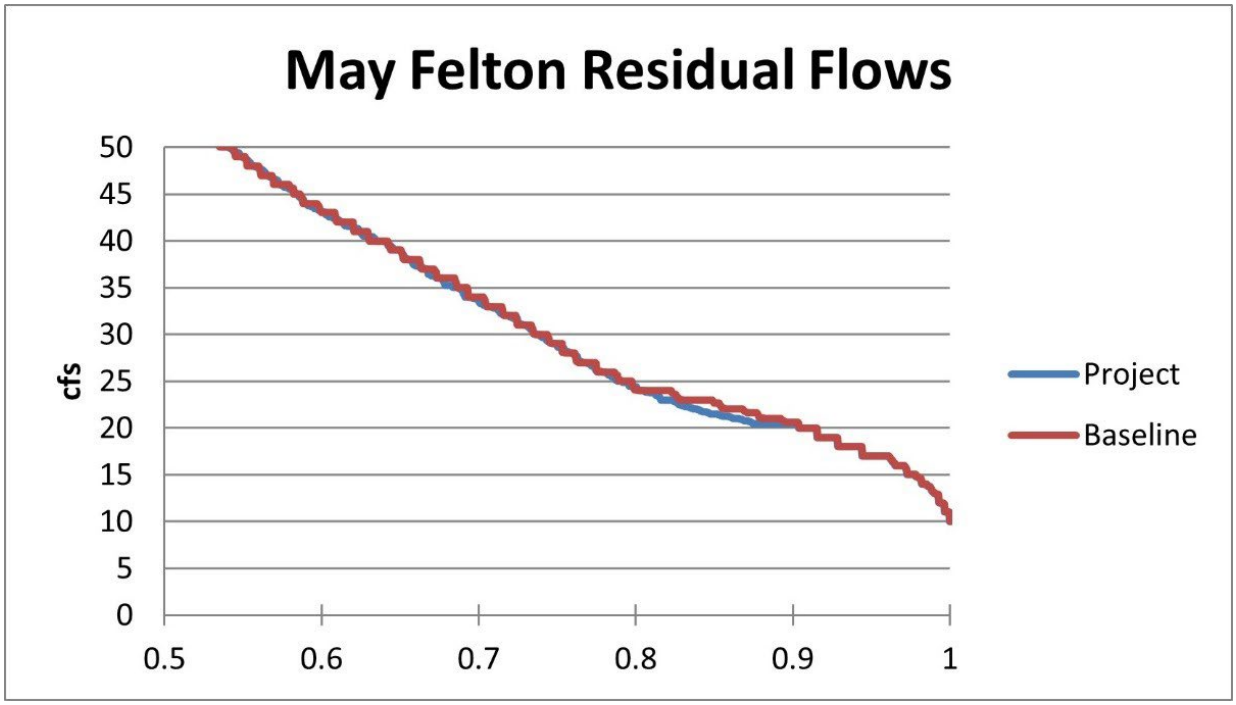
Percentile	ASHCP	Baseline
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20%	486	493
30%	303	304
40%	204	205
50%	146	146
60%	106	106
70%	76	76
80%	44	47
90%	32	31
100%	12	12



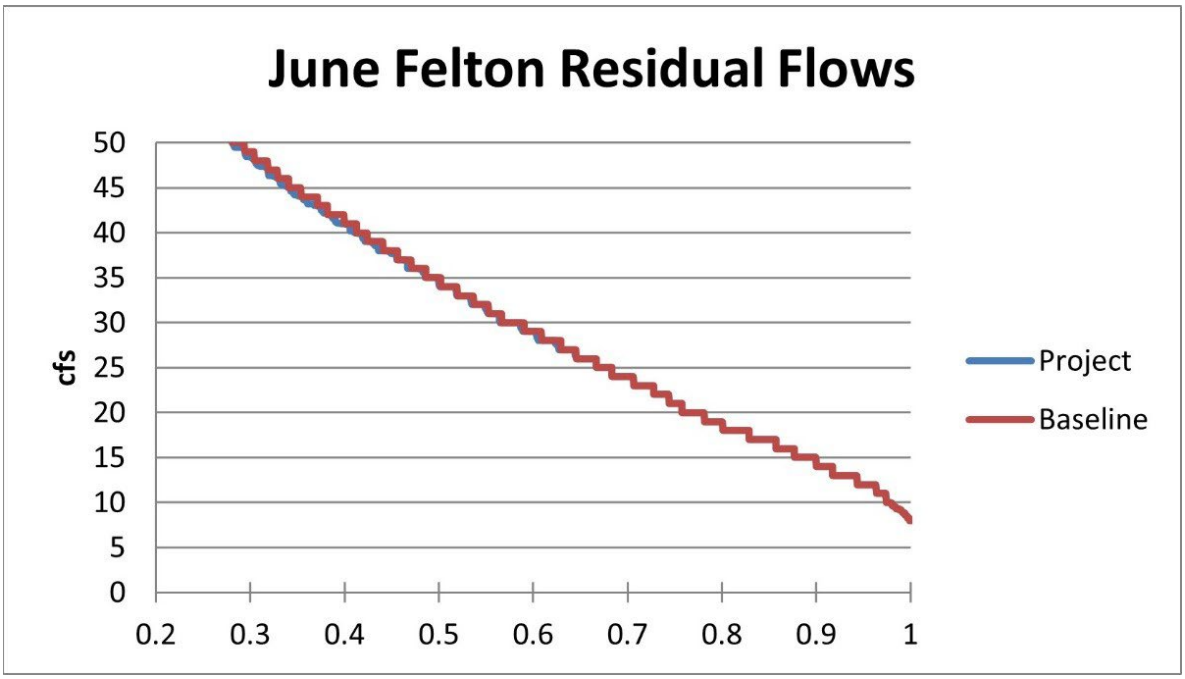
Percentile	ASHCP	Baseline
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30%	276	277
40%	196	195
50%	144	144
60%	105	105
70%	79	79
80%	58	58
90%	38	35
100%	13	13



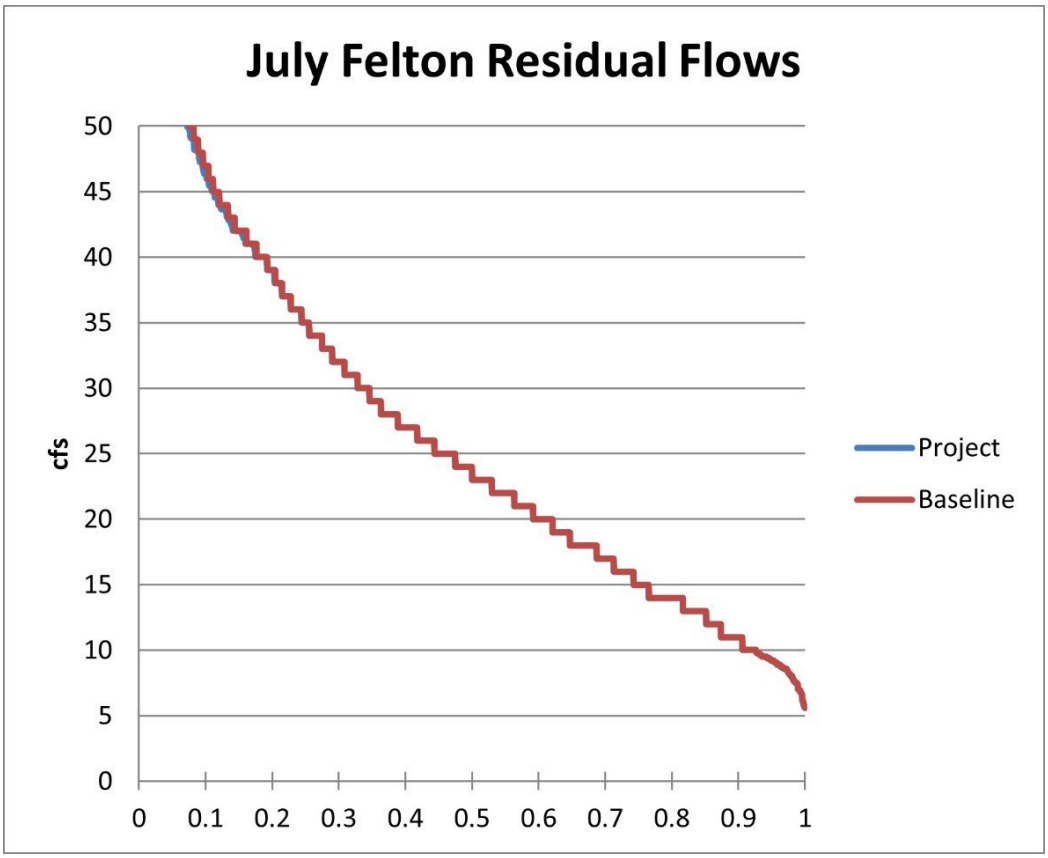
Percentile	ASHCP	Baseline
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30%	157	158
40%	114	114
50%	87	87
60%	68	68
70%	54	54
80%	41	37
90%	30	26
100%	12	12



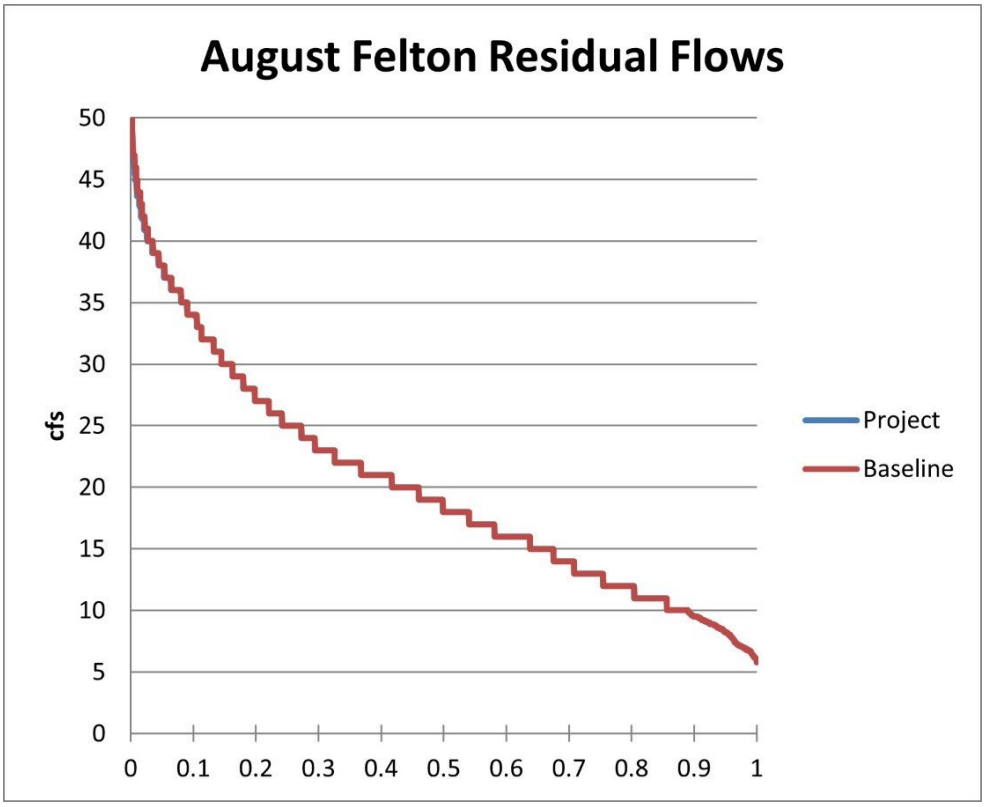
Percentile	ASHCP	Baseline
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20%	99	99
30%	80	80
40%	68	67
50%	54	54
60%	43	43
70%	34	34
80%	24	24
90%	21	21
100%	10	10



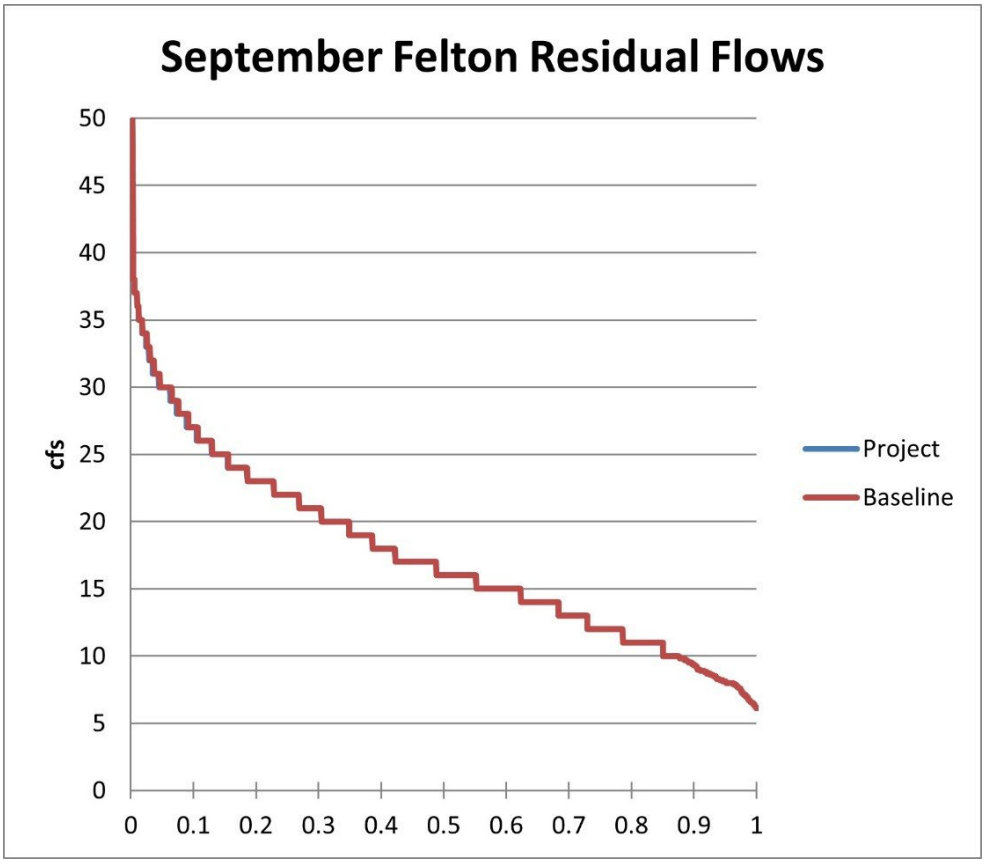
Percentile	ASHCP	Baseline
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20%	59	59
30%	48	49
40%	41	41
50%	35	35
60%	29	29
70%	24	24
80%	19	19
90%	14	14
100%	8	8



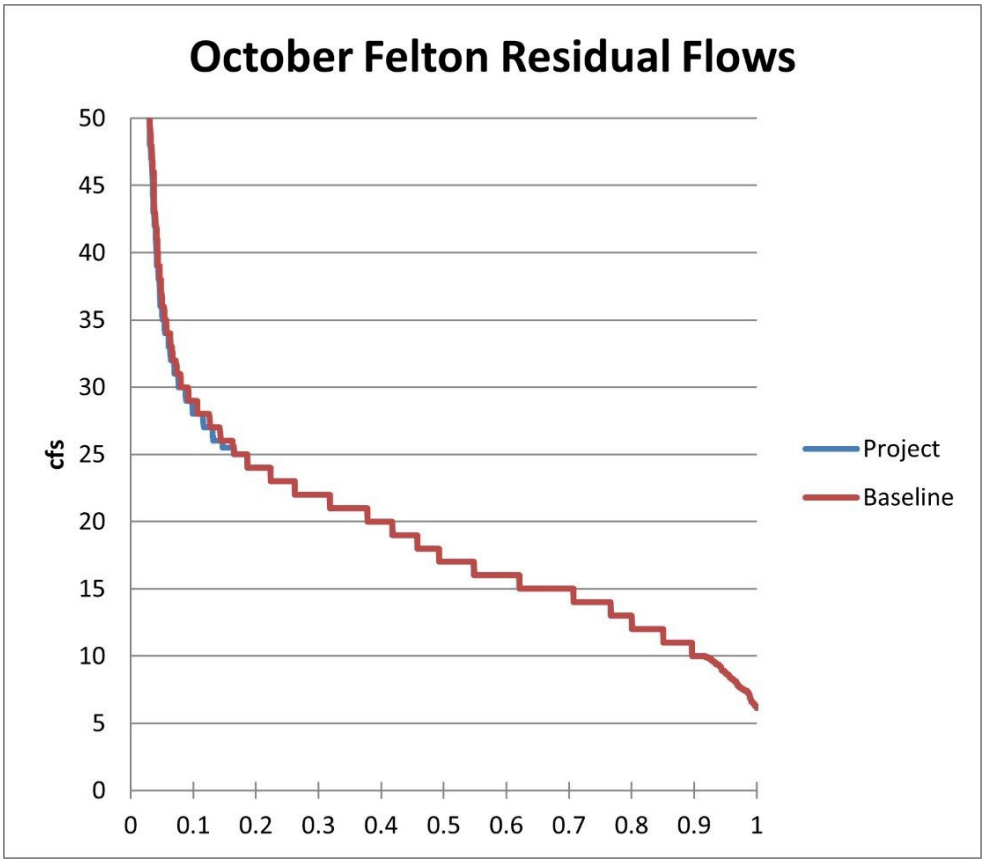
Percentile	ASHCP	Baseline
10%	46	47
20%	39	39
30%	32	32
40%	27	27
50%	23	23
60%	20	20
70%	17	17
80%	14	14
90%	11	11
100%	6	6



Percentile	ASHCP	Baseline
10%	34	34
20%	27	27
30%	23	23
40%	21	21
50%	18	18
60%	16	16
70%	14	14
80%	12	12
90%	10	10
100%	6	6

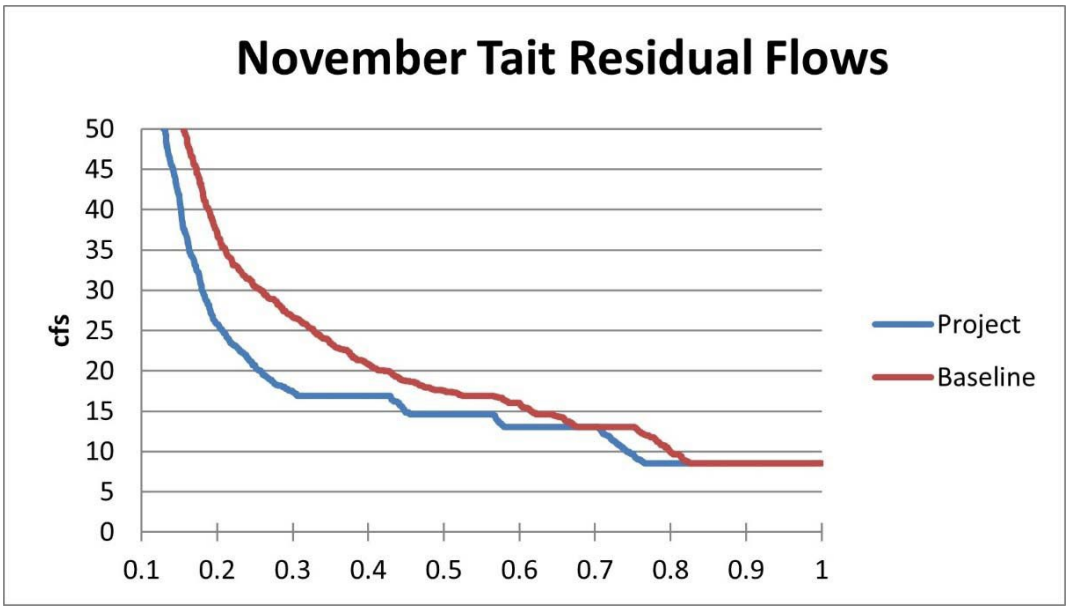


Percentile	ASHCP	Baseline
10%	27	27
20%	23	23
30%	21	21
40%	18	18
50%	16	16
60%	15	15
70%	13	13
80%	11	11
90%	9	9
100%	6	6

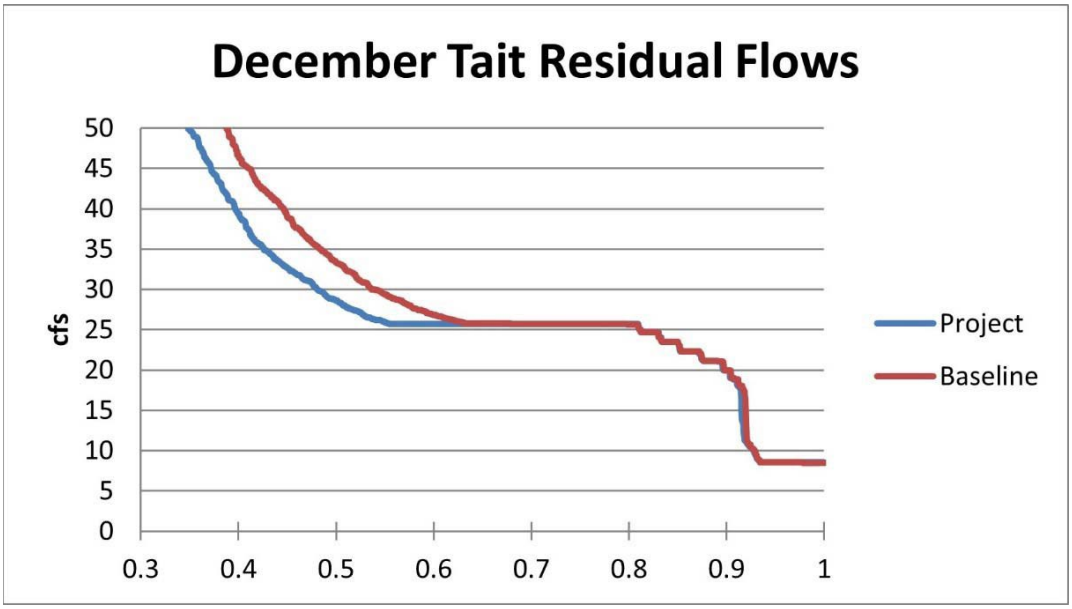


Percentile	ASHCP	Baseline
10%	28	29
20%	24	24
30%	22	22
40%	20	20
50%	17	17
60%	16	16
70%	15	15
80%	13	13
90%	10	10
100%	6	6

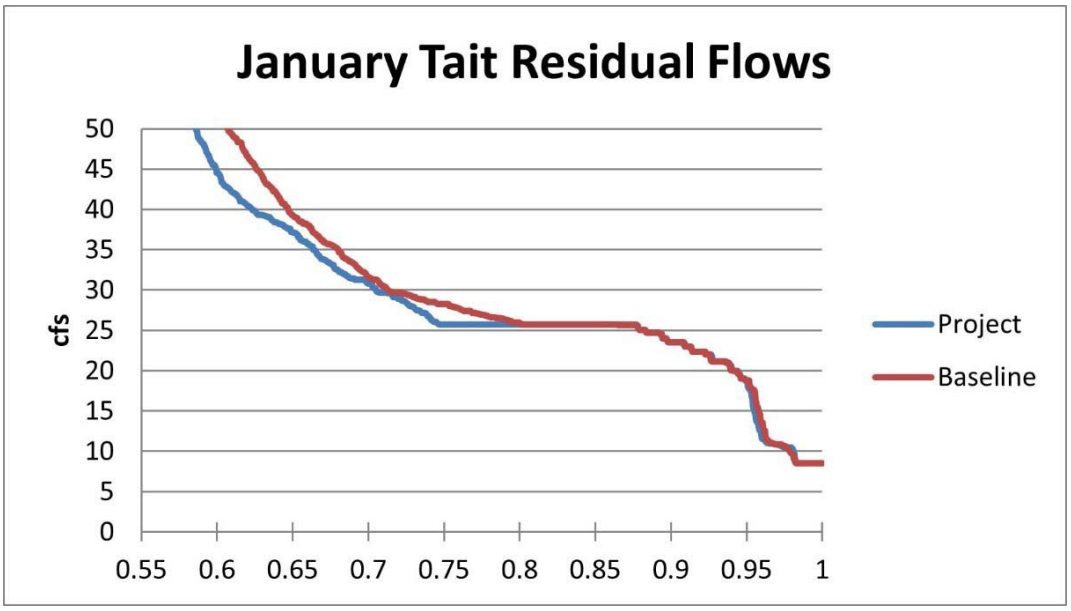
TAIT DIVERSION



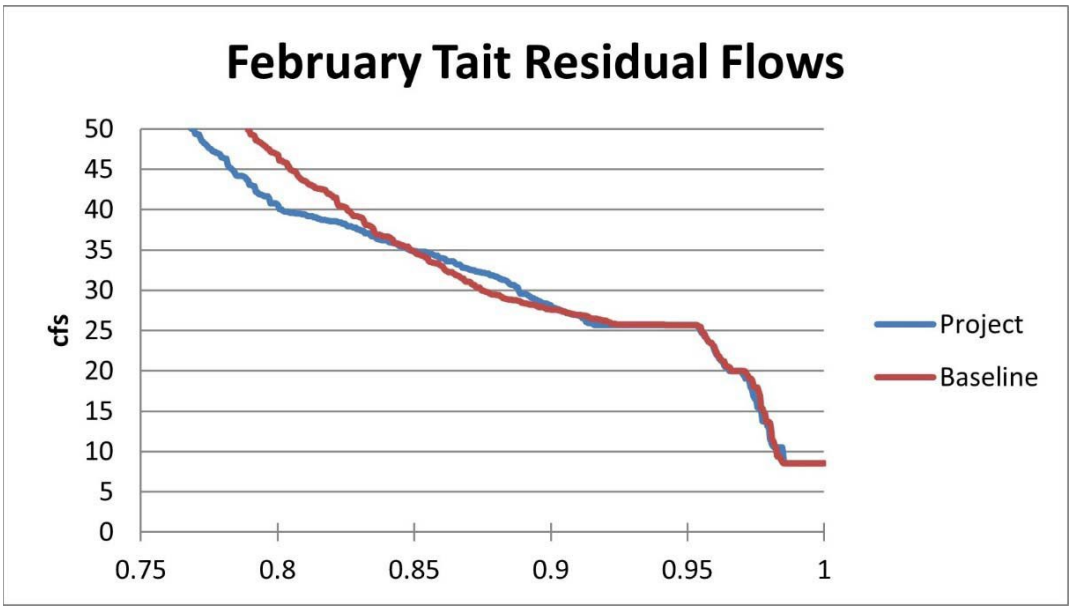
Percentile	ASHCP	Baseline
10%	73	84
20%	26	37
30%	17	27
40%	17	21
50%	15	18
60%	13	16
70%	13	13
80%	9	10
90%	9	9
100%	8	8



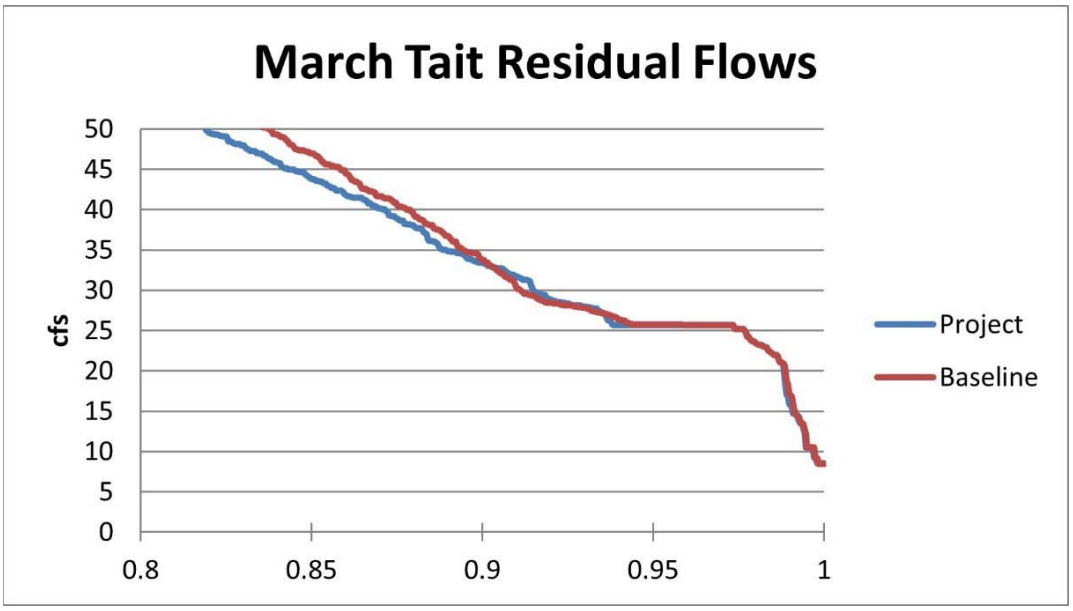
Percentile	ASHCP	Baseline
10%	394	399
20%	145	157
30%	70	80
40%	39	46
50%	29	33
60%	26	27
70%	26	26
80%	26	26
90%	20	20
100%	8	8



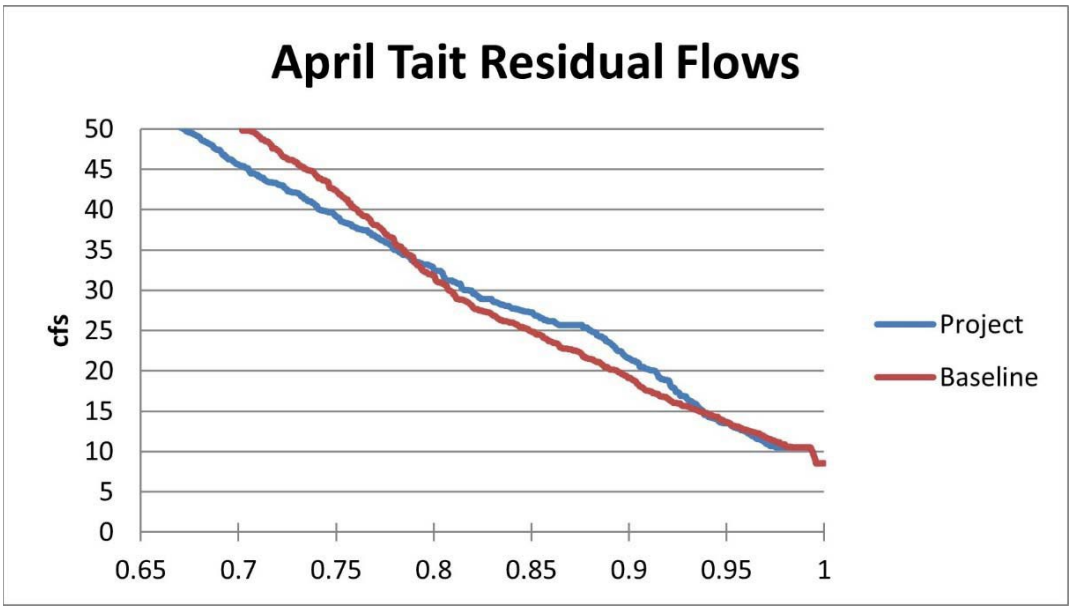
Percentile	ASHCP	Baseline
10%	791	796
20%	377	388
30%	211	222
40%	125	132
50%	76	82
60%	45	52
70%	31	32
80%	26	26
90%	23	23
100%	9	8



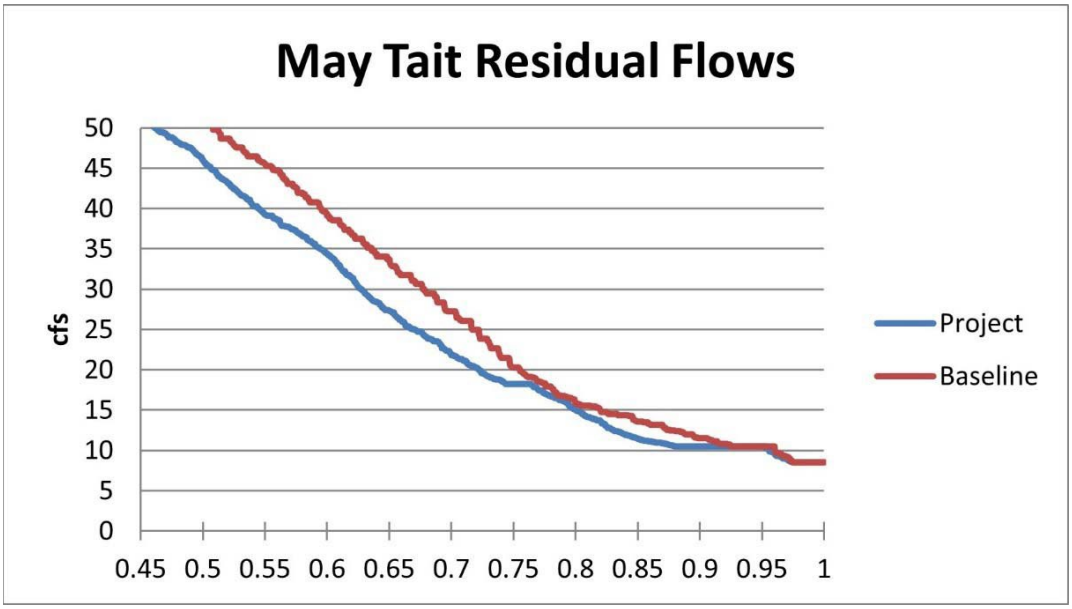
Percentile	ASHCP	Baseline
10%	977	985
20%	540	550
30%	324	330
40%	212	219
50%	146	152
60%	105	112
70%	73	77
80%	41	46
90%	28	28
100%	8	8



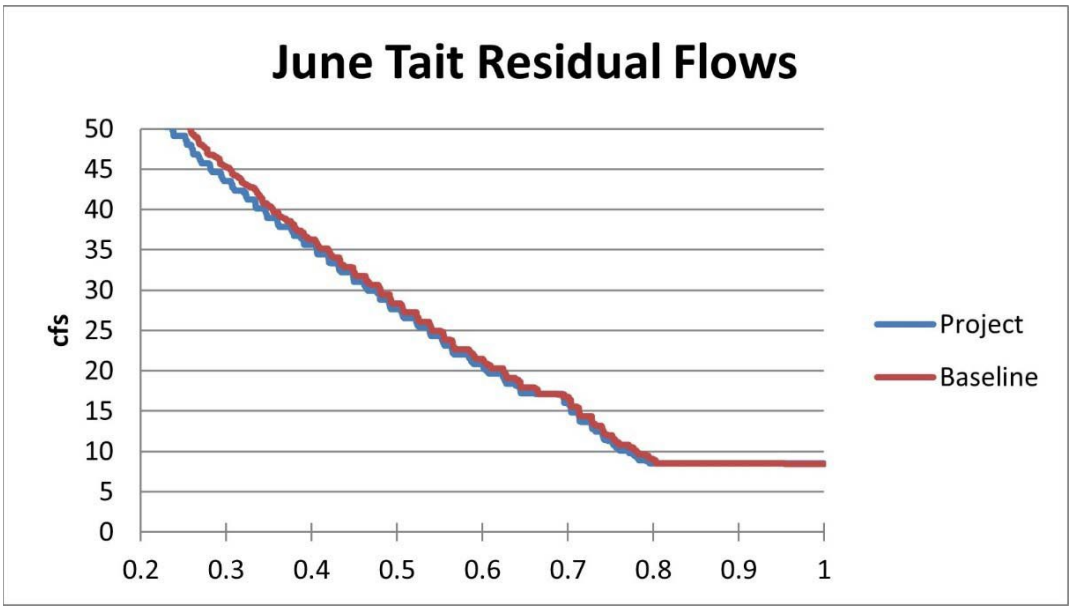
Percentile	ASHCP	Baseline
10%	671	682
20%	432	440
30%	293	297
40%	204	211
50%	145	152
60%	103	110
70%	77	82
80%	54	59
90%	33	34
100%	9	8



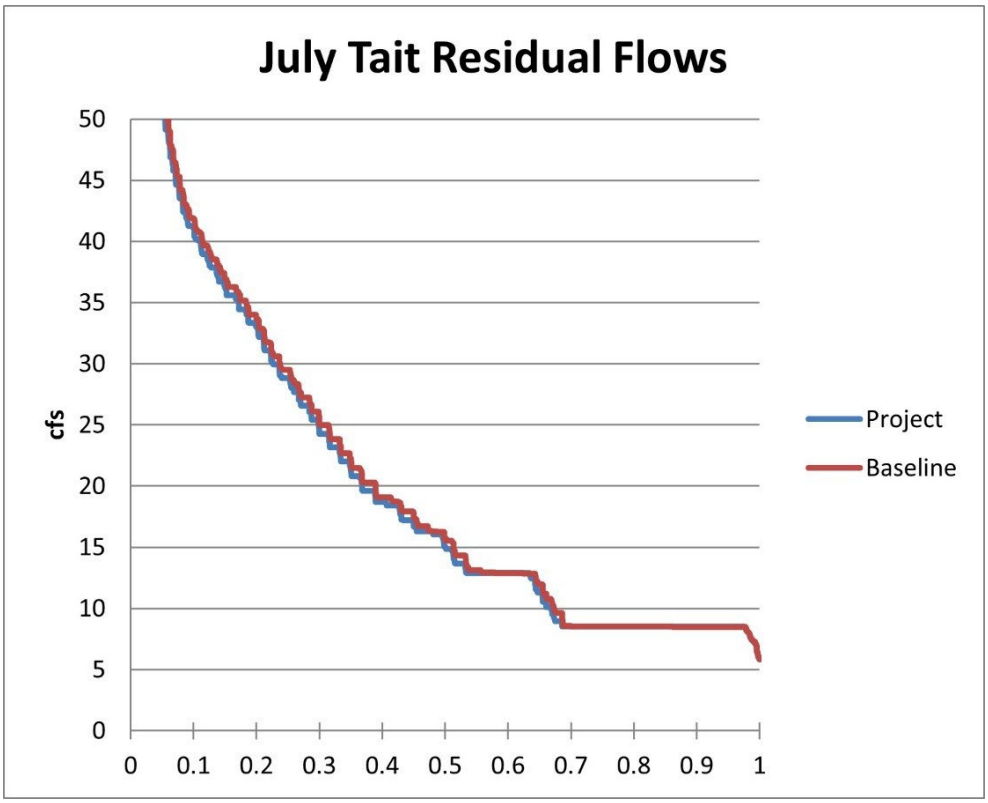
Percentile	ASHCP	Baseline
10%	372	386
20%	221	233
30%	154	169
40%	113	123
50%	82	90
60%	63	67
70%	46	51
80%	33	32
90%	22	19
100%	9	8



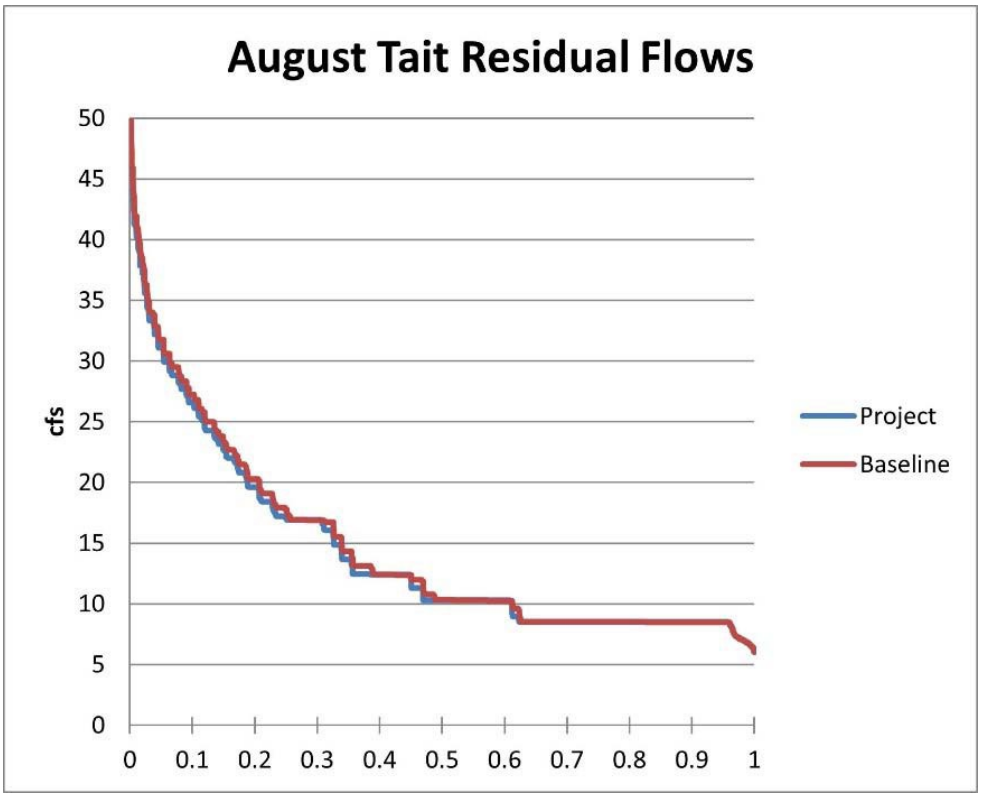
Percentile	ASHCP	Baseline
10%	143	151
20%	96	105
30%	73	81
40%	59	67
50%	46	51
60%	34	39
70%	22	27
80%	15	16
90%	11	11
100%	8	8



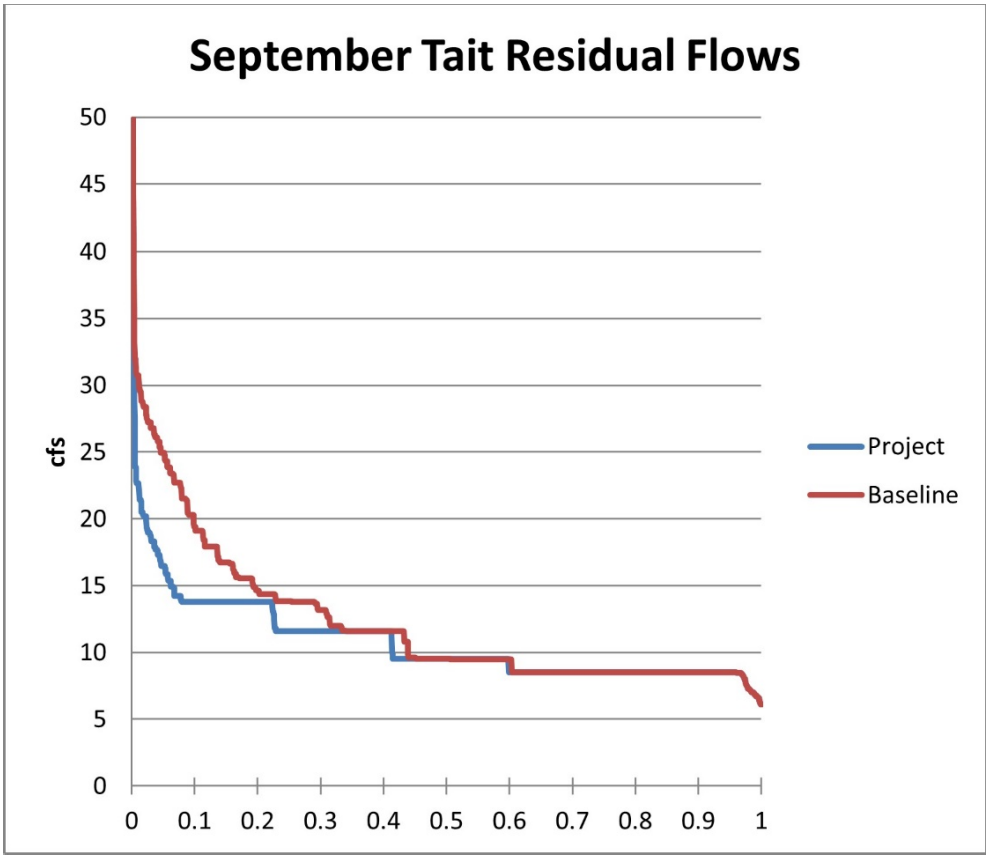
Percentile	ASHCP	Baseline
10%	71	75
20%	55	57
30%	43	45
40%	36	36
50%	28	28
60%	21	22
70%	16	17
80%	9	9
90%	9	9
100%	8	8



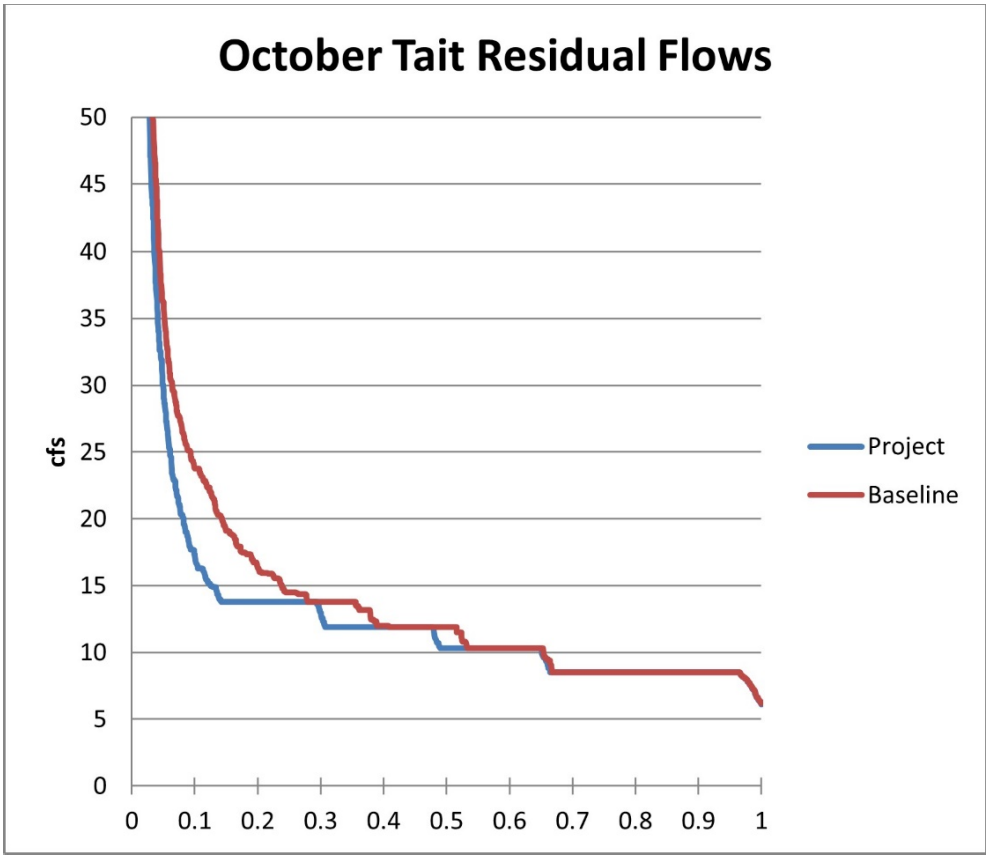
Percentile	ASHCP	Baseline
10%	41	42
20%	33	34
30%	24	25
40%	19	19
50%	15	16
60%	13	13
70%	9	9
80%	9	9
90%	9	8
100%	6	6



Percentile	ASHCP	Baseline
10%	27	27
20%	20	20
30%	17	17
40%	12	12
50%	10	10
60%	10	10
70%	9	9
80%	9	9
90%	9	8
100%	6	6

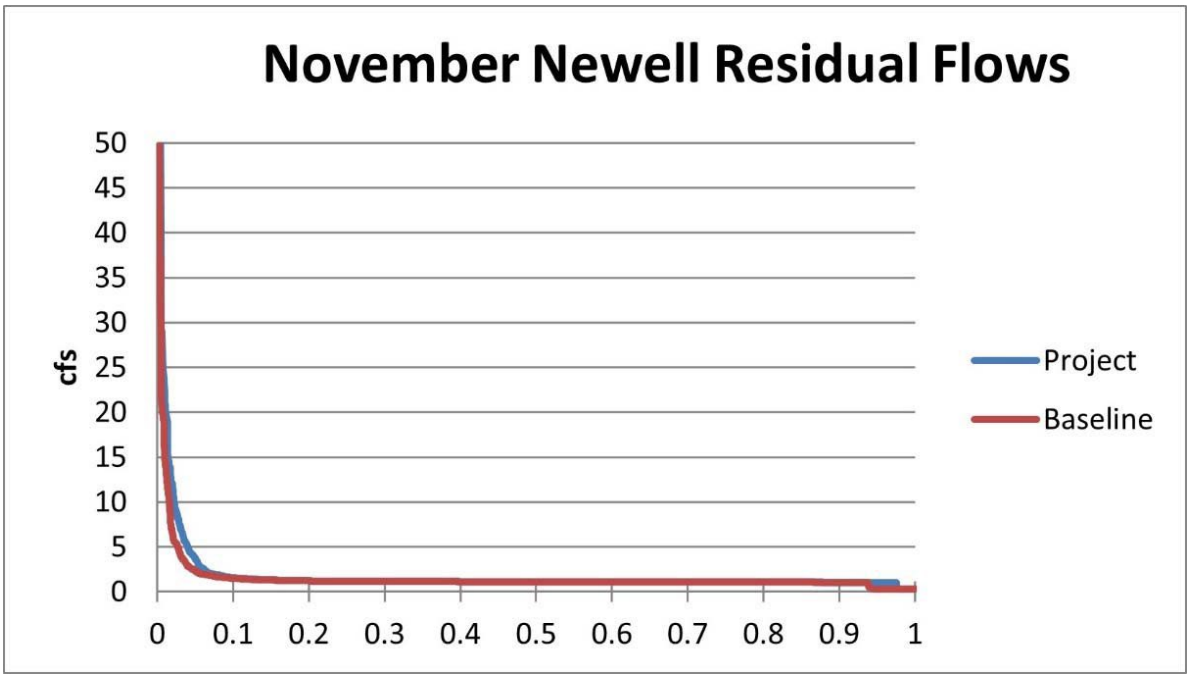


Percentile	ASHCP	Baseline
10%	14	19
20%	14	15
30%	12	13
40%	12	12
50%	10	10
60%	9	9
70%	9	9
80%	9	9
90%	9	8
100%	6	6

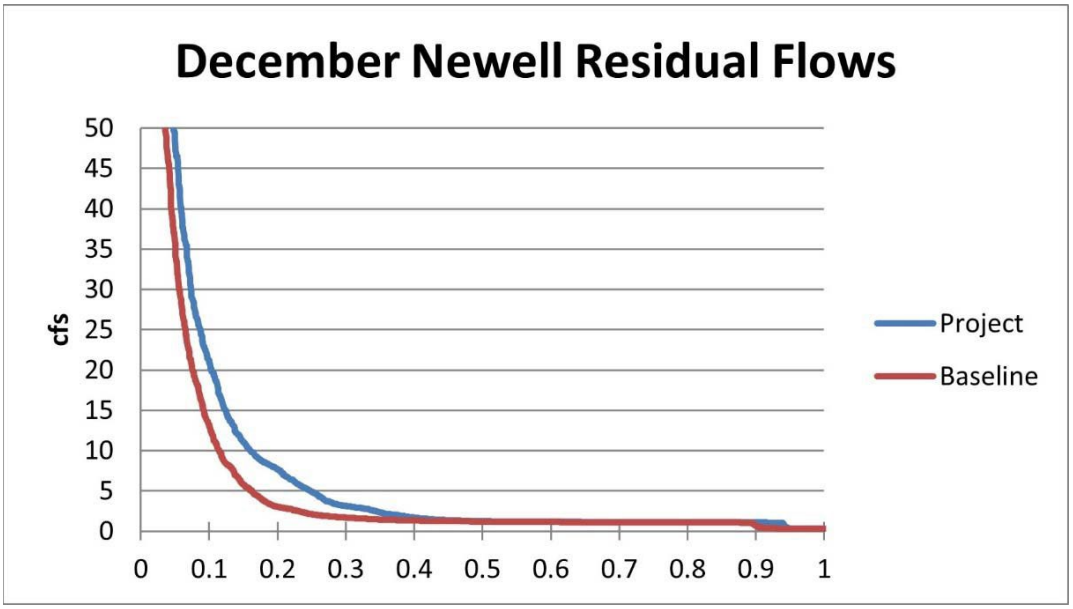


Percentile	ASHCP	Baseline
10%	17	24
20%	14	16
30%	13	14
40%	12	12
50%	10	12
60%	10	10
70%	9	9
80%	9	8
90%	9	8
100%	6	6

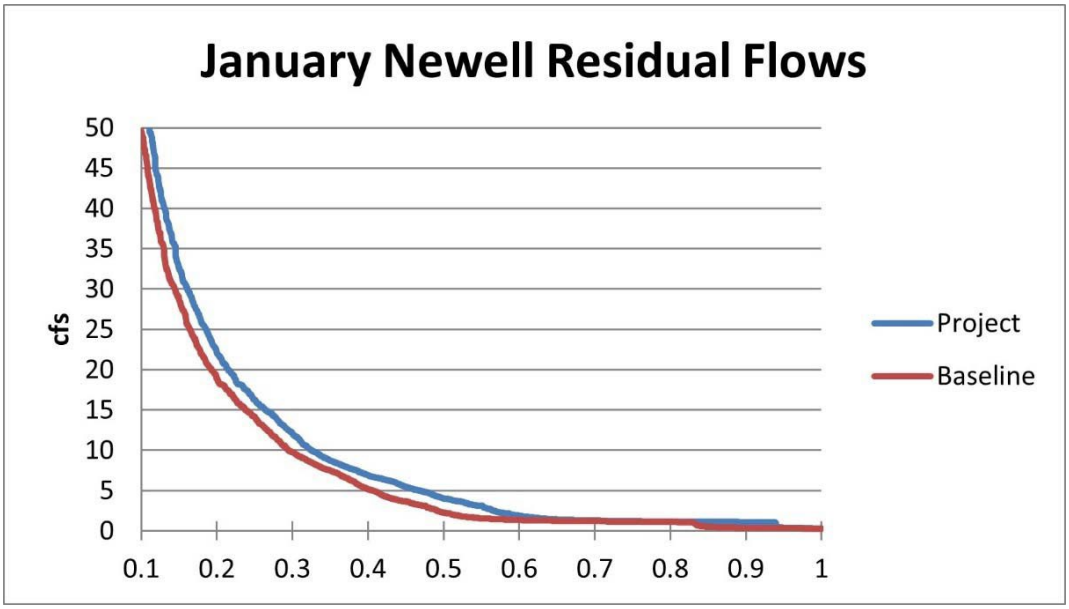
NEWELL CREEK



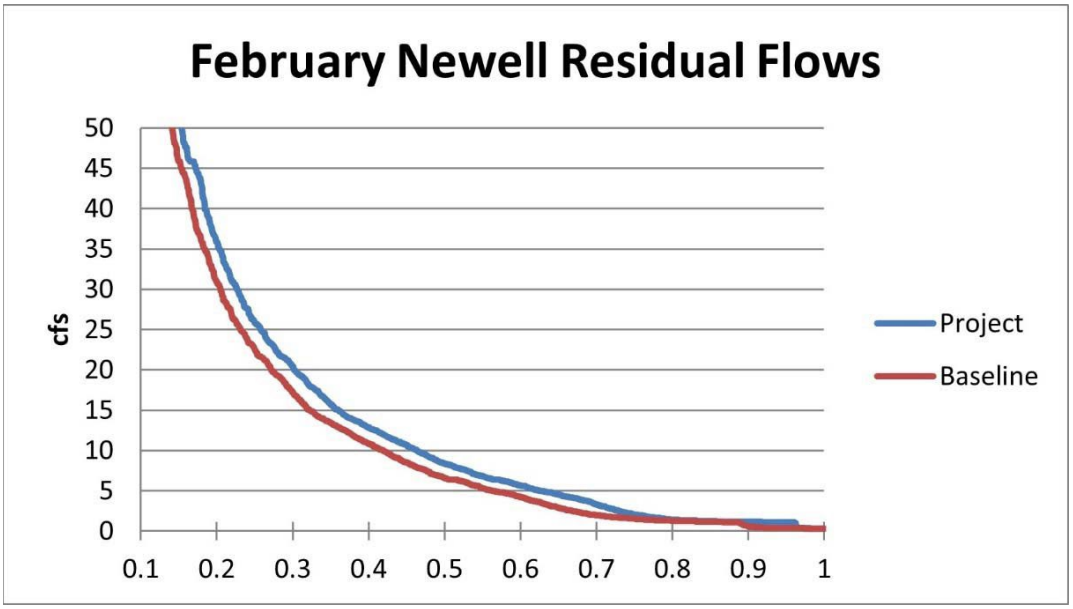
Percentile	ASHCP	Baseline
10%	2	2
20%	1	1
30%	1	1
40%	1	1
50%	1	1
60%	1	1
70%	1	1
80%	1	1
90%	1	1
100%	0	0



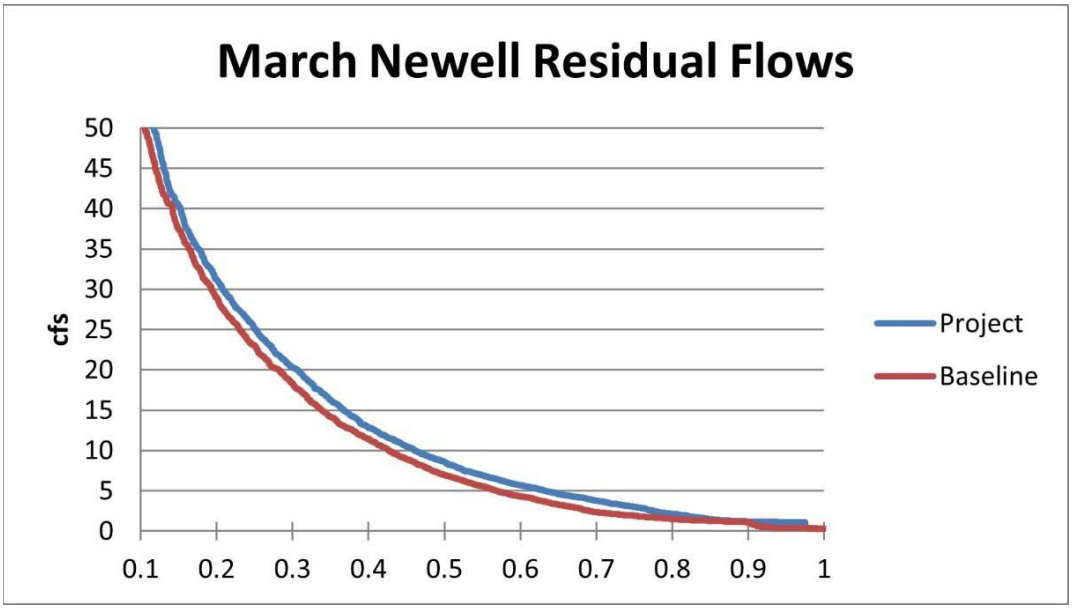
Percentile	ASHCP	Baseline
10%	21	13
20%	8	3
30%	3	2
40%	2	1
50%	1	1
60%	1	1
70%	1	1
80%	1	1
90%	1	1
100%	0	0



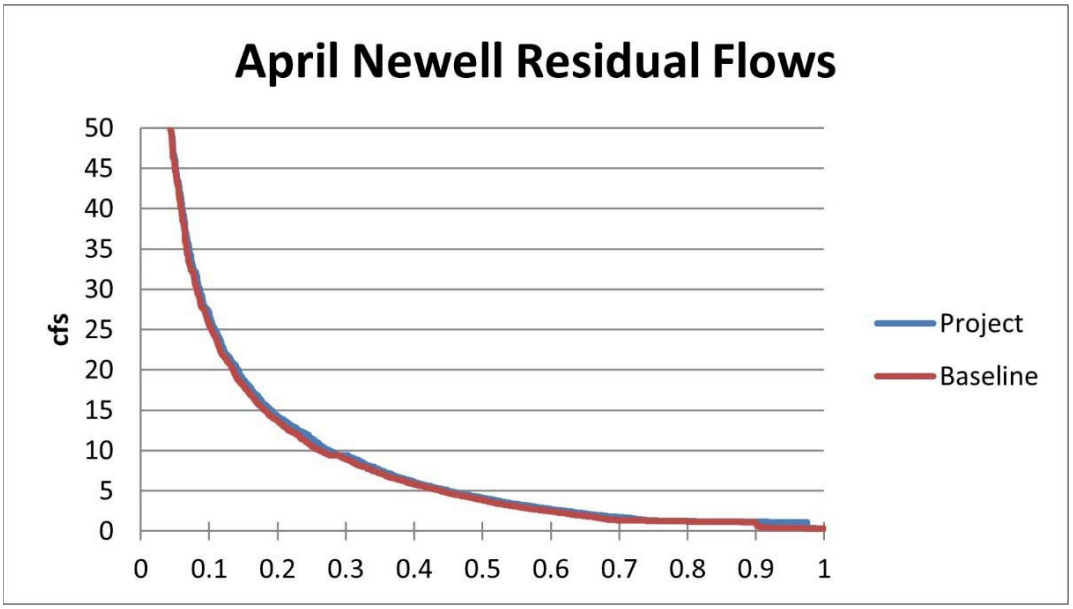
Percentile	ASHCP	Baseline
10%	55	49
20%	22	19
30%	12	10
40%	7	5
50%	4	2
60%	2	1
70%	1	1
80%	1	1
90%	1	0
100%	0	0



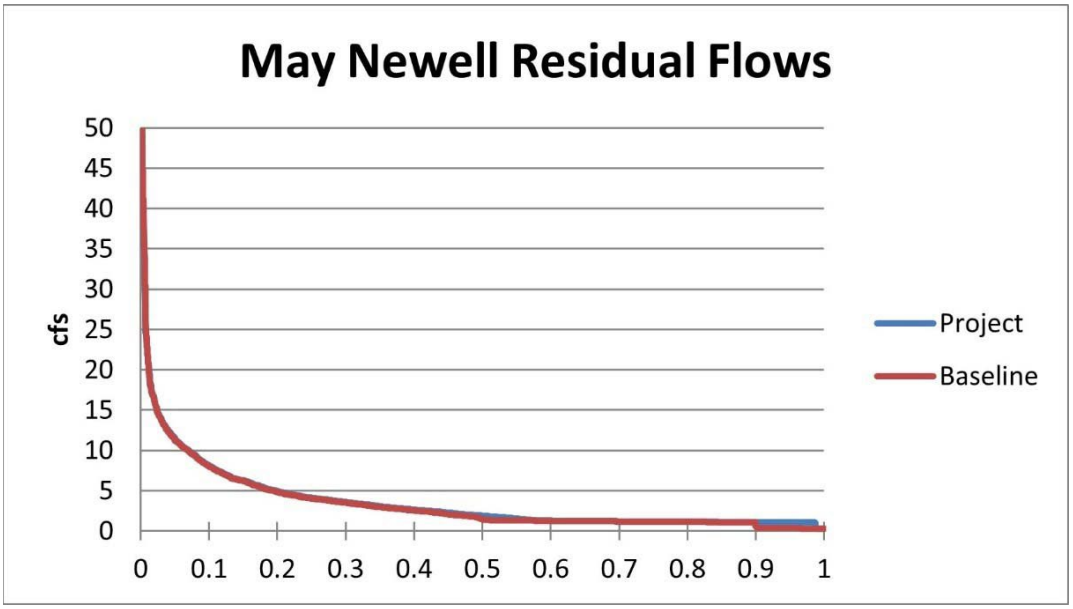
Percentile	ASHCP	Baseline
10%	78	72
20%	36	31
30%	20	17
40%	13	11
50%	8	7
60%	6	4
70%	3	2
80%	1	1
90%	1	1
100%	0	0



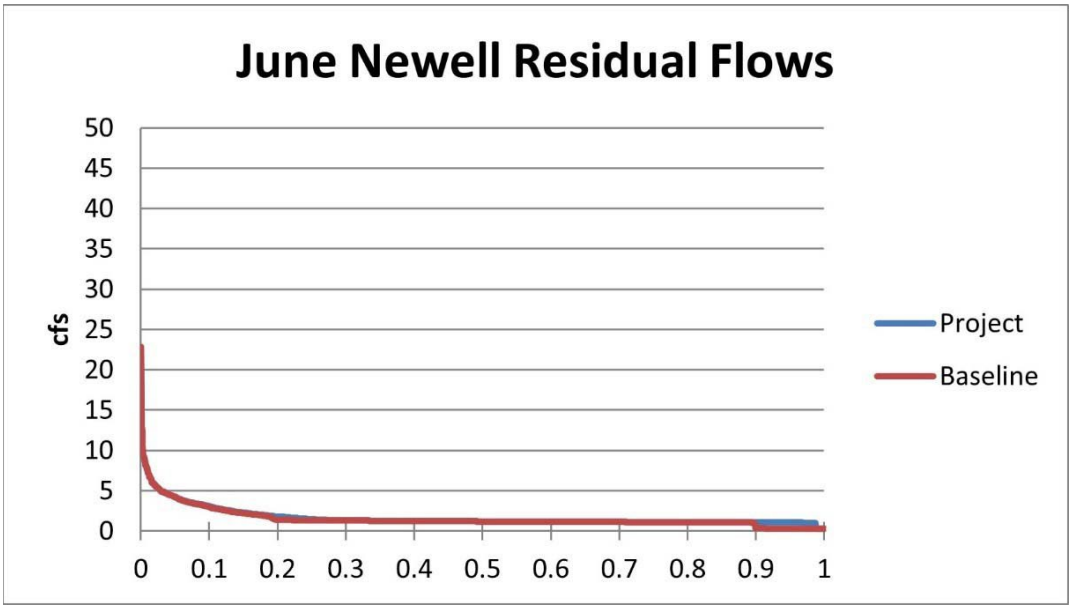
Percentile	ASHCP	Baseline
10%	53	50
20%	31	29
30%	20	18
40%	13	11
50%	9	7
60%	6	4
70%	4	2
80%	2	2
90%	1	1
100%	0	0



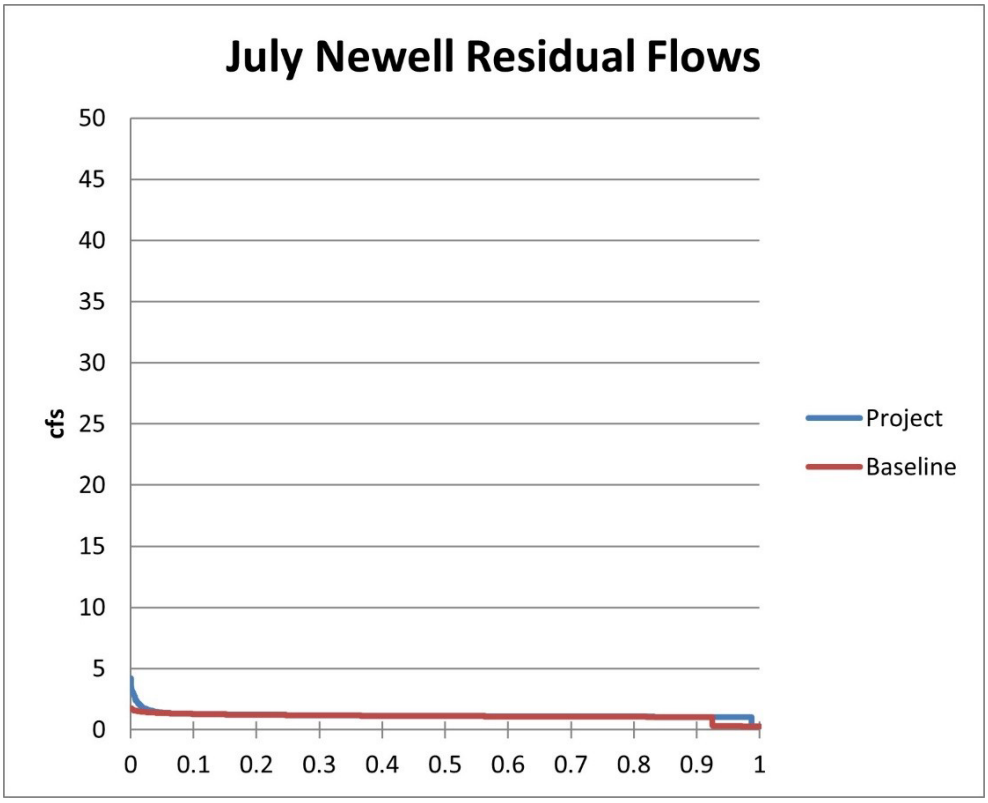
Percentile	ASHCP	Baseline
10%	27	26
20%	14	14
30%	9	9
40%	6	6
50%	4	4
60%	3	2
70%	2	1
80%	1	1
90%	1	1
100%	0	0



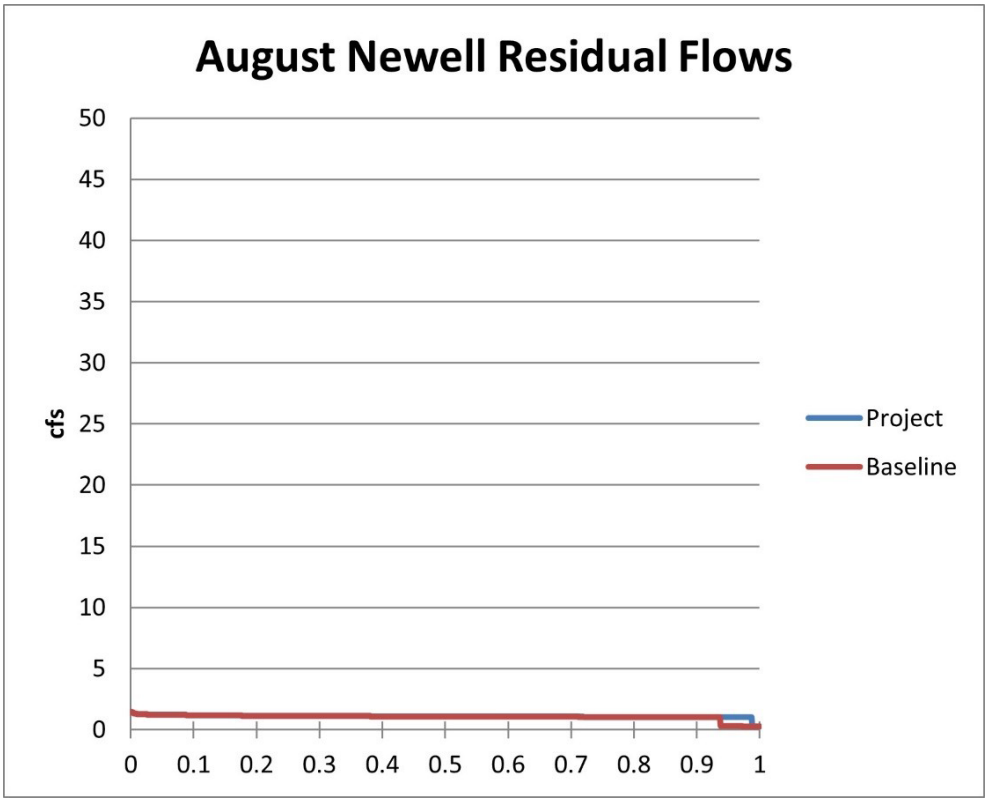
Percentile	ASHCP	Baseline
10%	8	8
20%	5	5
30%	4	4
40%	3	3
50%	2	1
60%	1	1
70%	1	1
80%	1	1
90%	1	1
100%	0	0



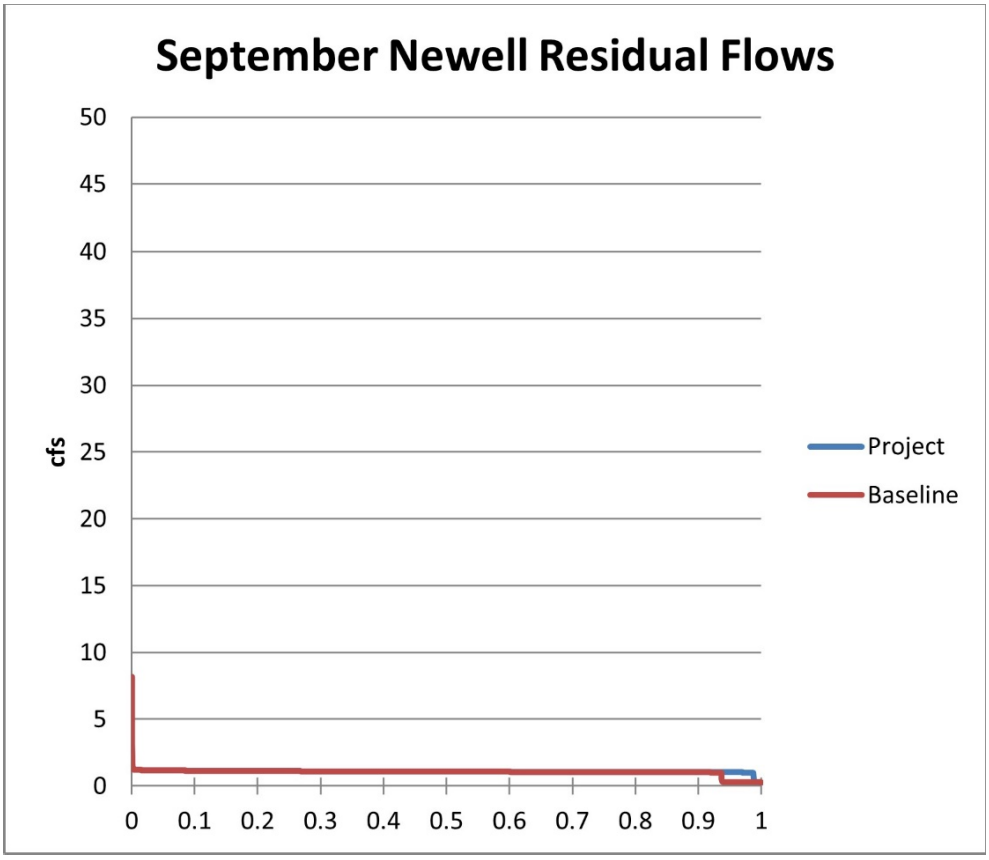
Percentile	ASHCP	Baseline
10%	3	3
20%	2	1
30%	1	1
40%	1	1
50%	1	1
60%	1	1
70%	1	1
80%	1	1
90%	1	0
100%	0	0



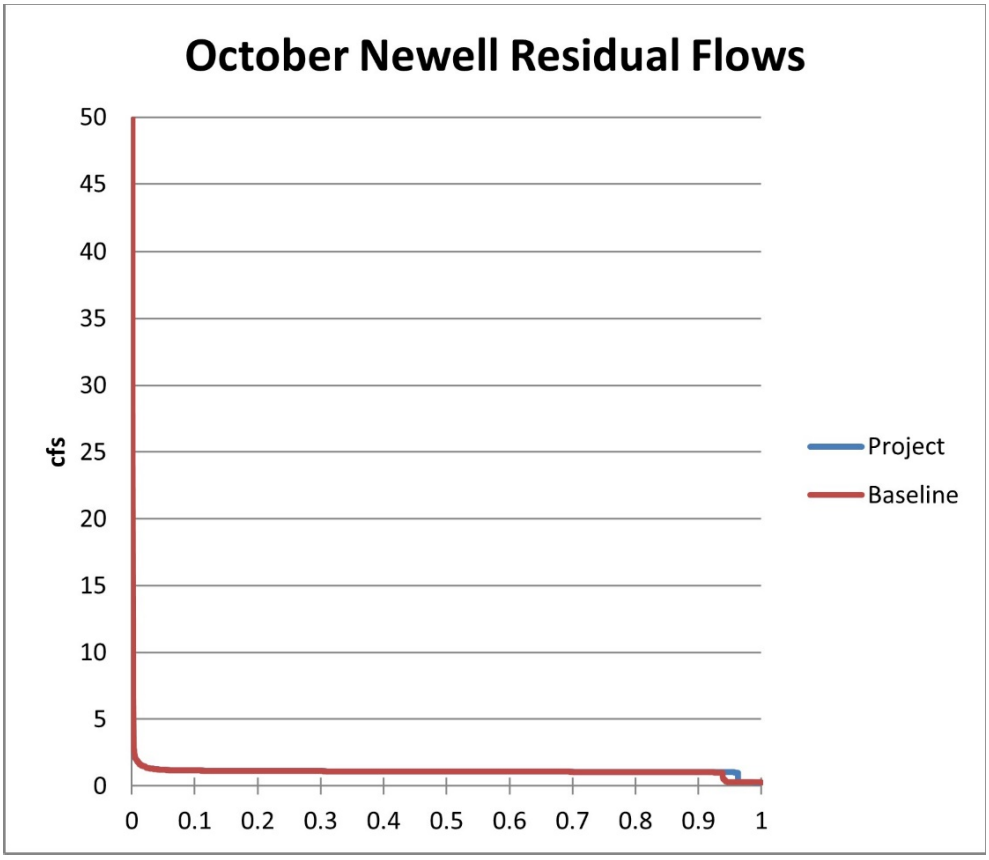
Percentile	ASHCP	Baseline
10%	1	1
20%	1	1
30%	1	1
40%	1	1
50%	1	1
60%	1	1
70%	1	1
80%	1	1
90%	1	1
100%	0	0



Percentile	ASHCP	Baseline
10%	1	1
20%	1	1
30%	1	1
40%	1	1
50%	1	1
60%	1	1
70%	1	1
80%	1	1
90%	1	1
100%	0	0

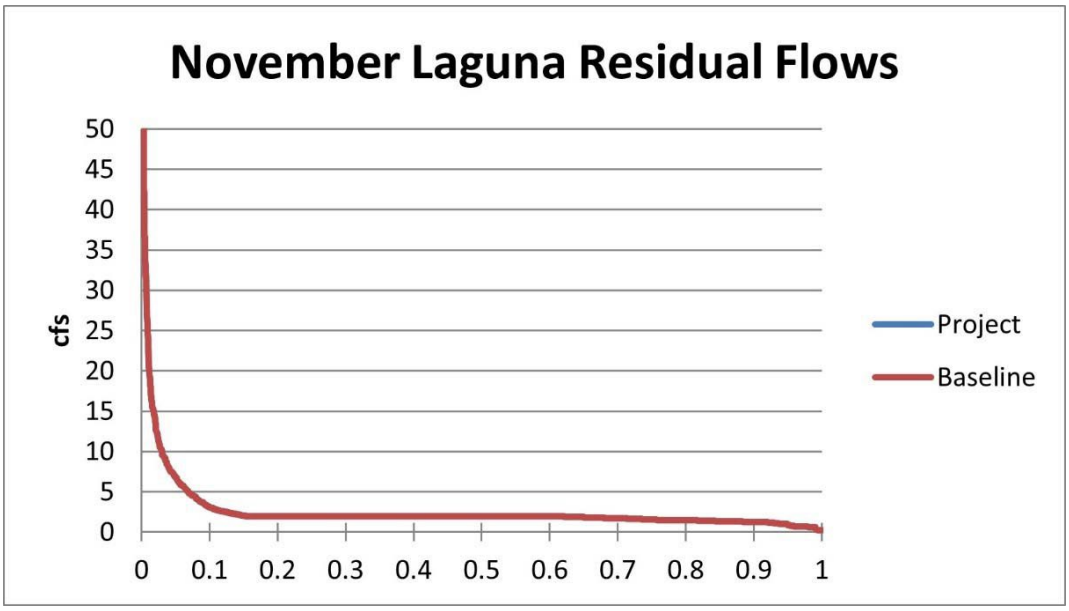


Percentile	ASHCP	Baseline
10%	1	1
20%	1	1
30%	1	1
40%	1	1
50%	1	1
60%	1	1
70%	1	1
80%	1	1
90%	1	1
100%	0	0

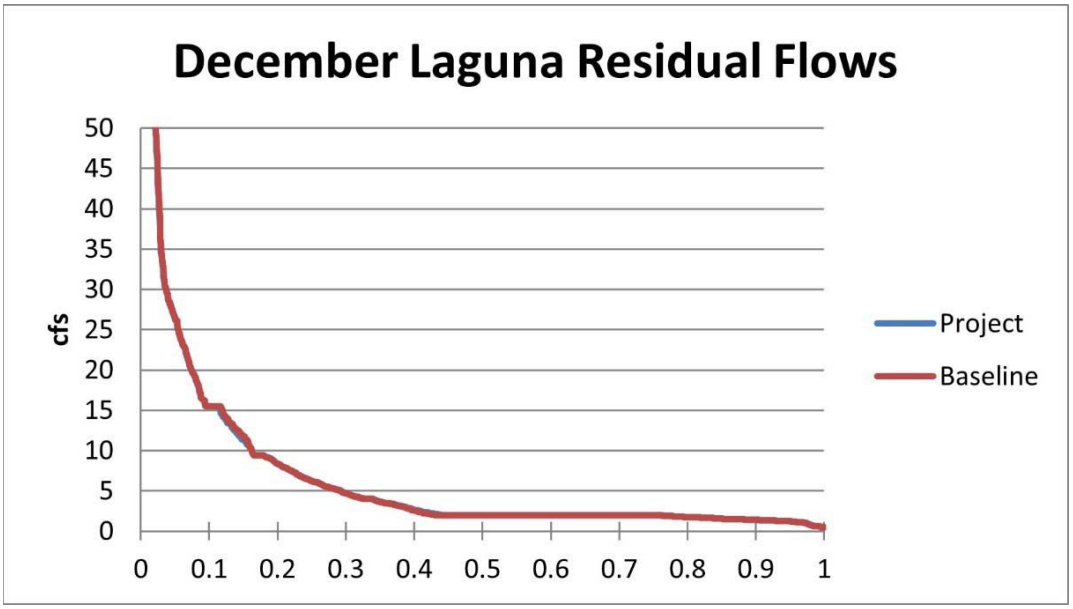


Percentile	ASHCP	Baseline
10%	1	1
20%	1	1
30%	1	1
40%	1	1
50%	1	1
60%	1	1
70%	1	1
80%	1	1
90%	1	1
100%	0	0

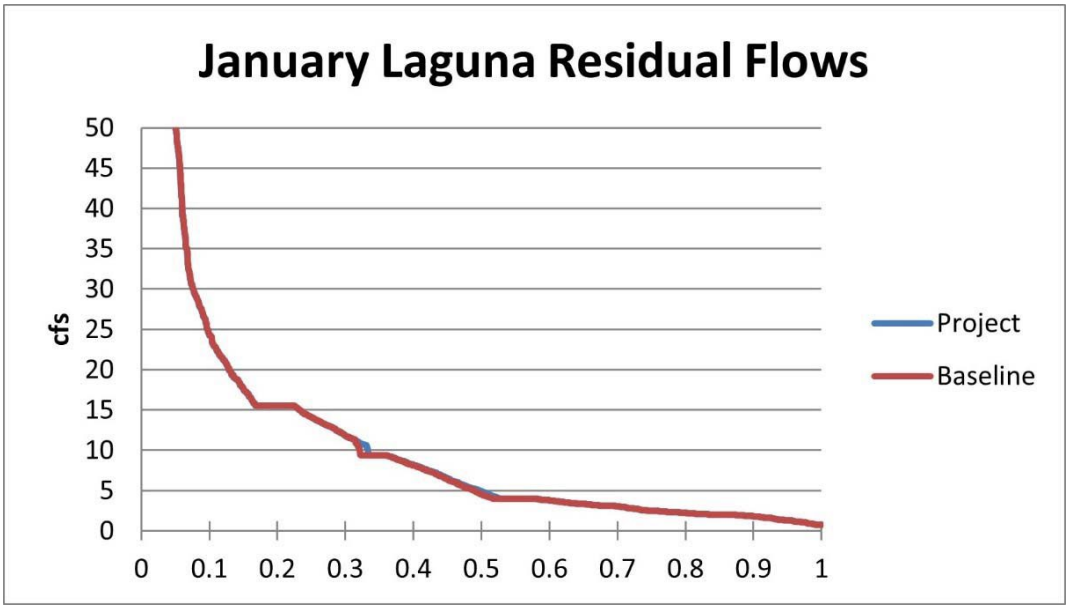
LAGUNA



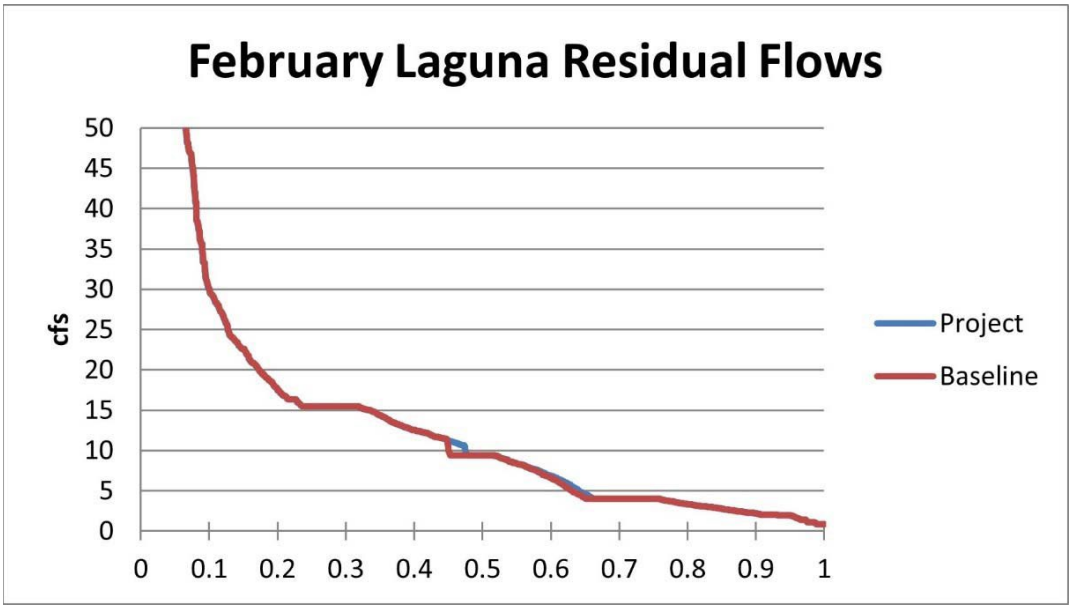
Percentile	ASHCP	Baseline
10%	3	3
20%	2	2
30%	2	2
40%	2	2
50%	2	2
60%	2	2
70%	2	2
80%	1	1
90%	1	1
100%	0	0



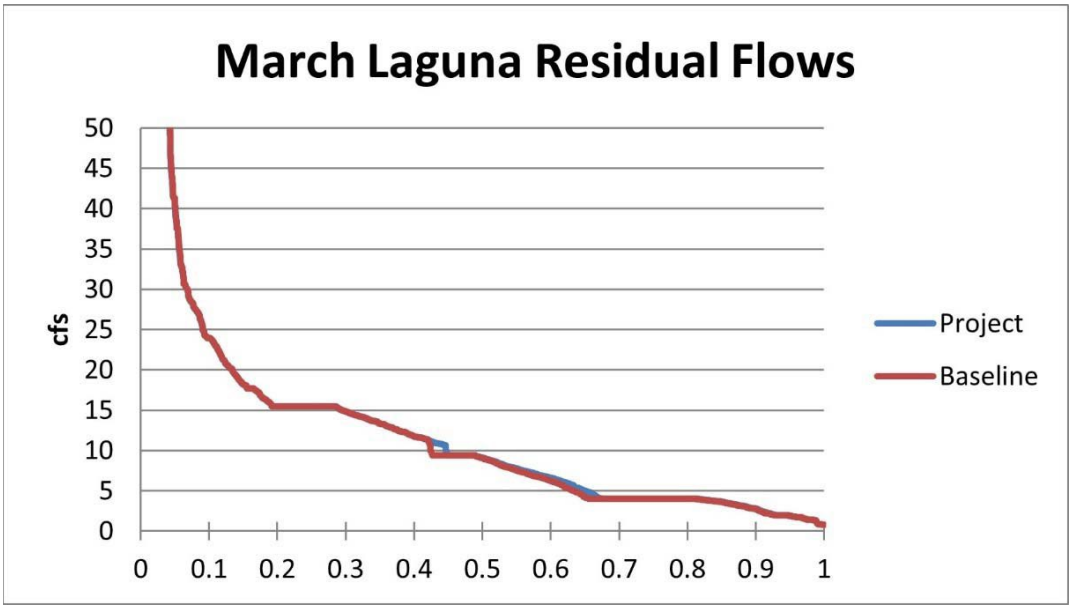
Percentile	ASHCP	Baseline
10%	16	16
20%	8	8
30%	5	5
40%	3	3
50%	2	2
60%	2	2
70%	2	2
80%	2	2
90%	1	1
100%	0	0



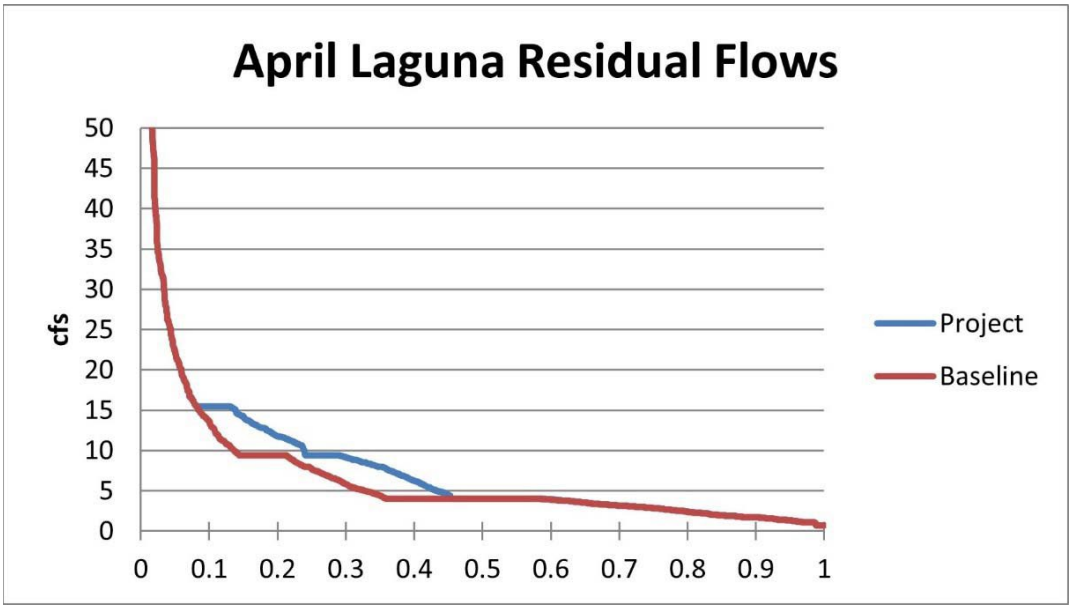
Percentile	ASHCP	Baseline
10%	24	24
20%	16	16
30%	12	12
40%	8	8
50%	5	5
60%	4	4
70%	3	3
80%	2	2
90%	2	2
100%	1	1



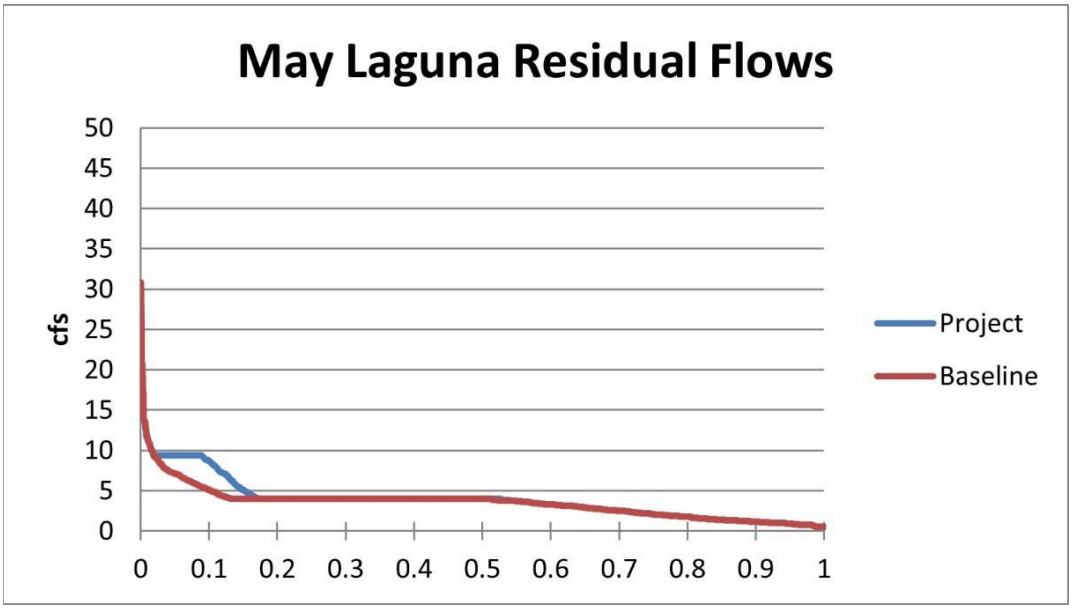
Percentile	ASHCP	Baseline
10%	30	30
20%	17	17
30%	15	15
40%	13	13
50%	9	9
60%	7	7
70%	4	4
80%	3	3
90%	2	2
100%	1	1



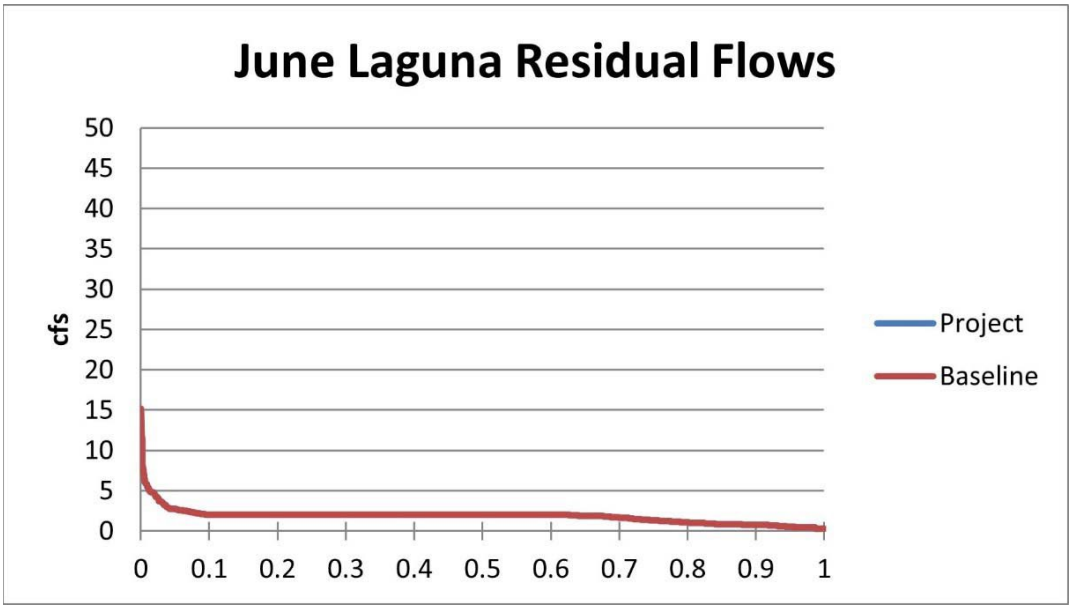
Percentile	ASHCP	Baseline
10%	24	24
20%	16	16
30%	15	15
40%	12	12
50%	9	9
60%	7	6
70%	4	4
80%	4	4
90%	3	3
100%	1	1



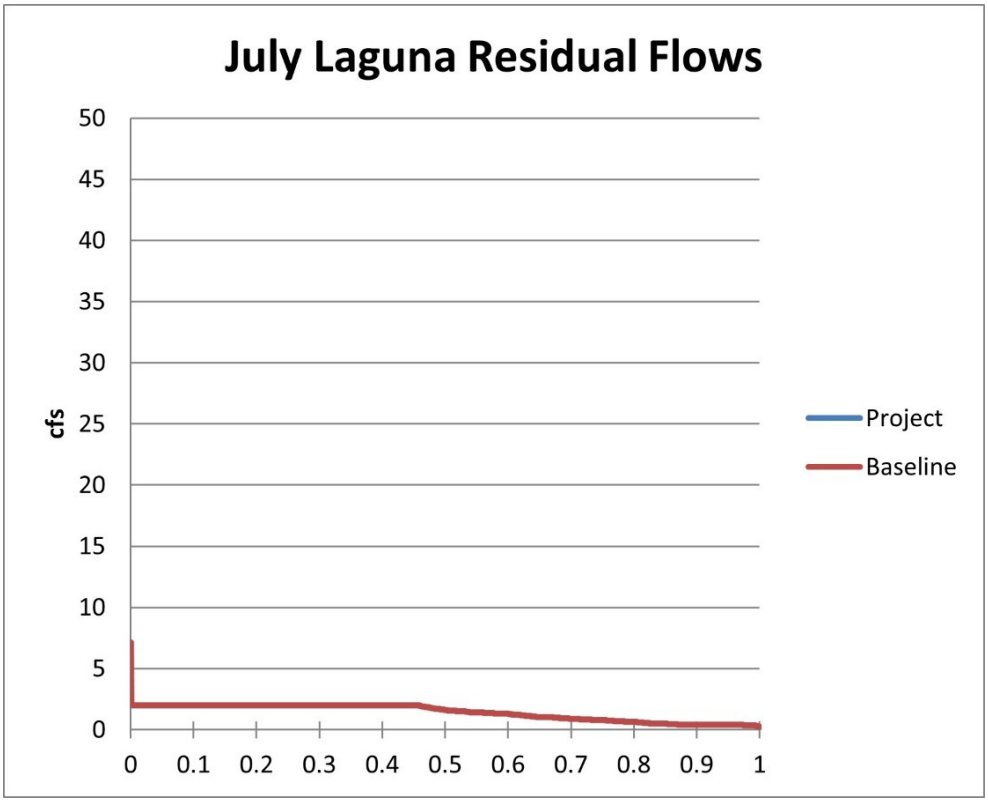
Percentile	ASHCP	Baseline
10%	16	14
20%	12	9
30%	9	6
40%	6	4
50%	4	4
60%	4	4
70%	3	3
80%	2	2
90%	2	2
100%	1	1



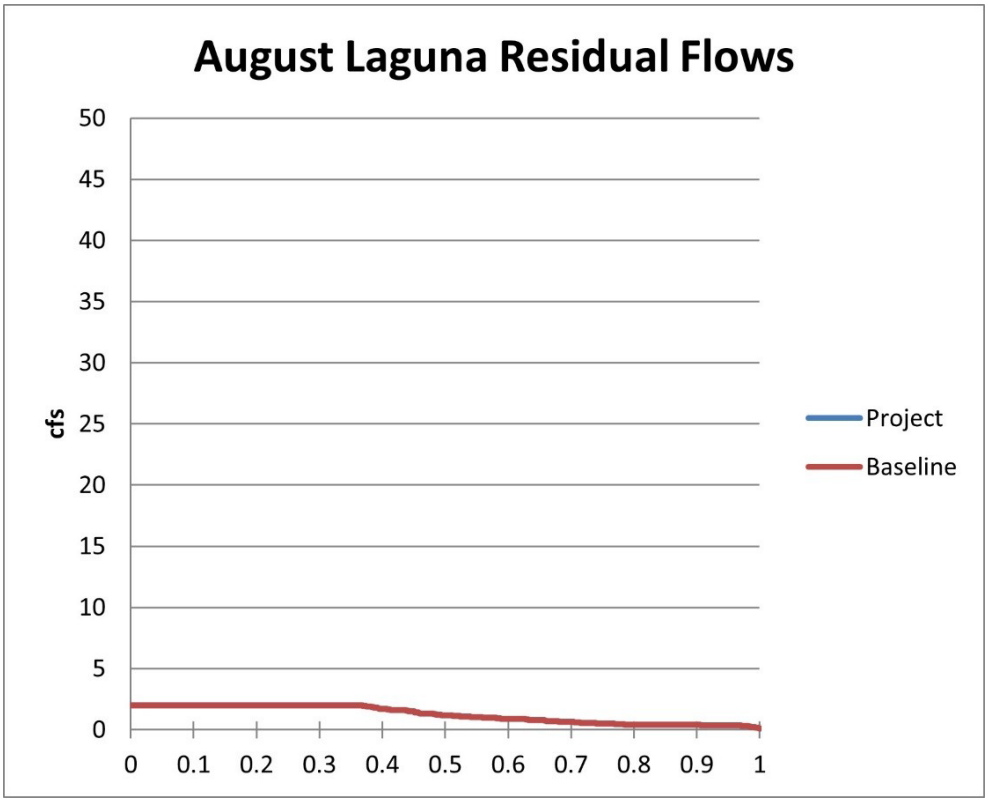
Percentile	ASHCP	Baseline
10%	9	5
20%	4	4
30%	4	4
40%	4	4
50%	4	4
60%	3	3
70%	3	3
80%	2	2
90%	1	1
100%	0	0



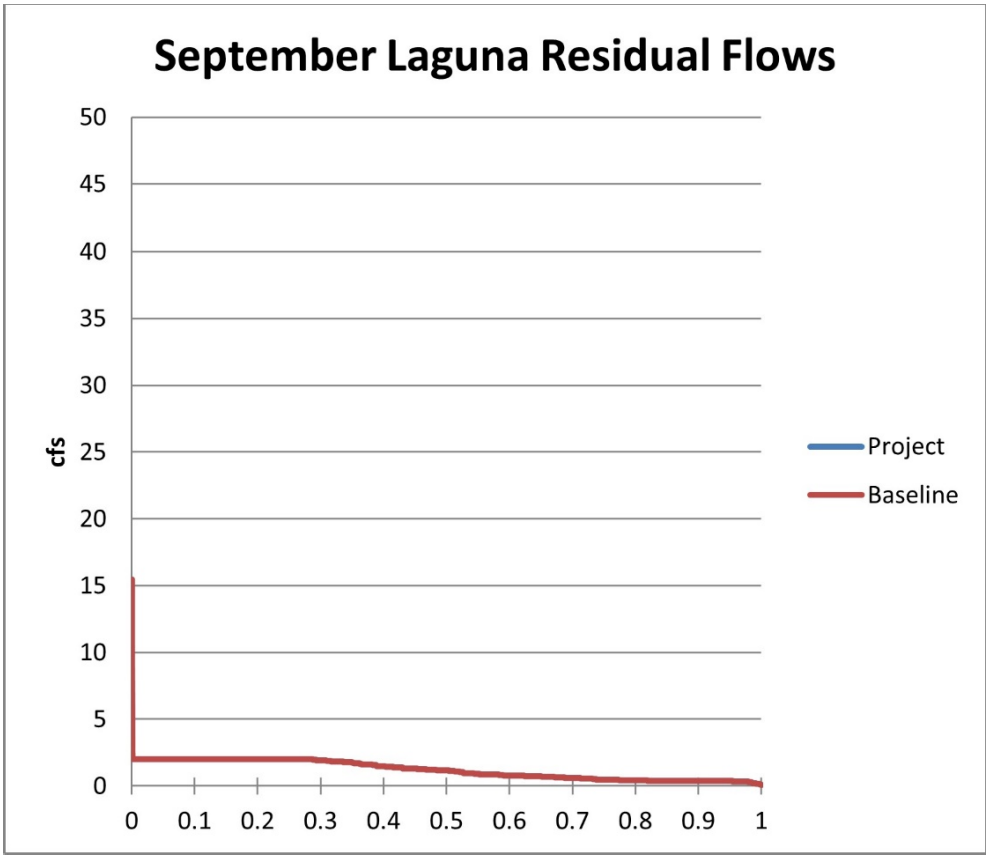
Percentile	ASHCP	Baseline
10%	2	2
20%	2	2
30%	2	2
40%	2	2
50%	2	2
60%	2	2
70%	2	2
80%	1	1
90%	1	1
100%	0	0



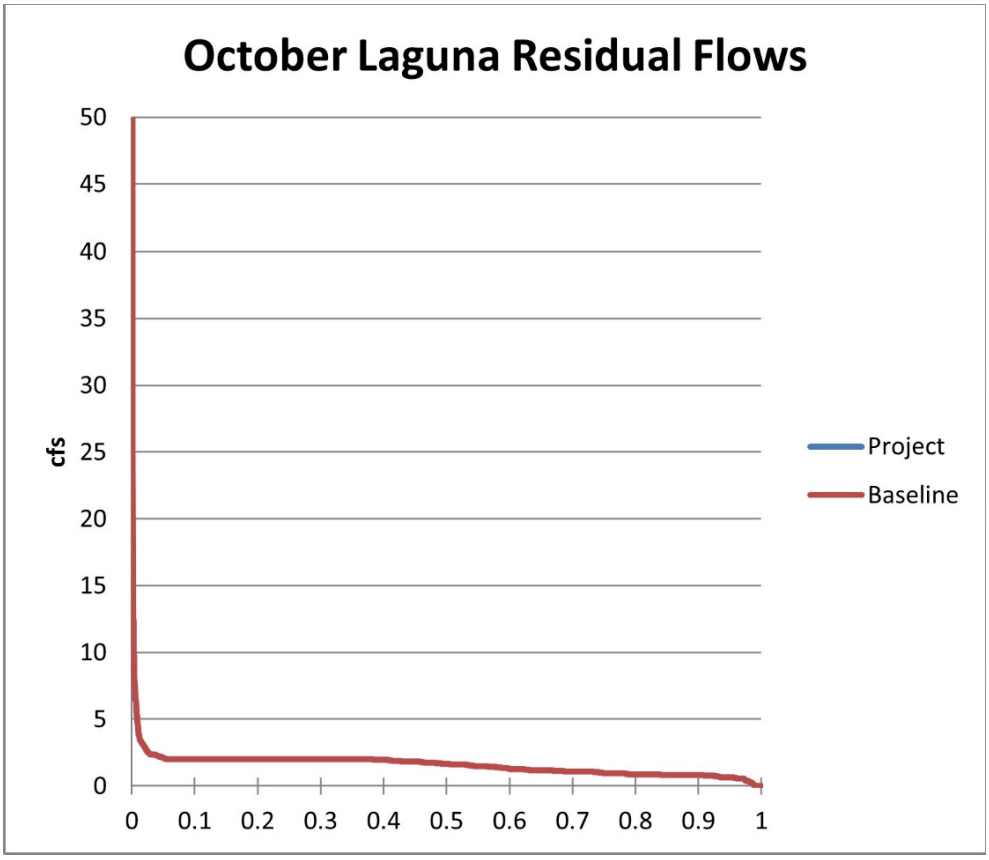
Percentile	ASHCP	Baseline
10%	2	2
20%	2	2
30%	2	2
40%	2	2
50%	2	2
60%	1	1
70%	1	1
80%	1	1
90%	0	0
100%	0	0



Percentile	ASHCP	Baseline
10%	2	2
20%	2	2
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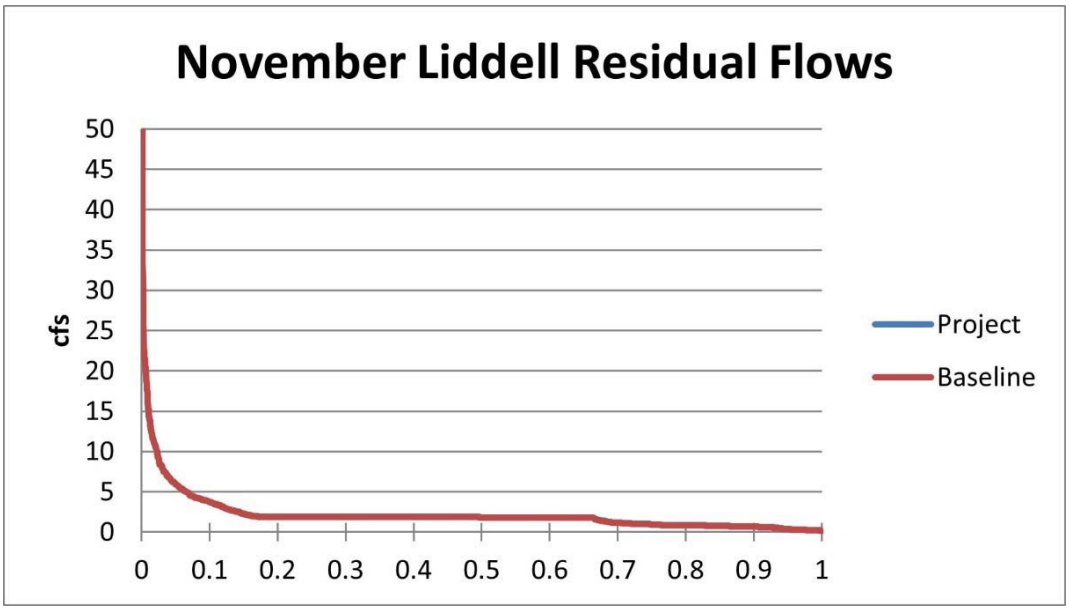


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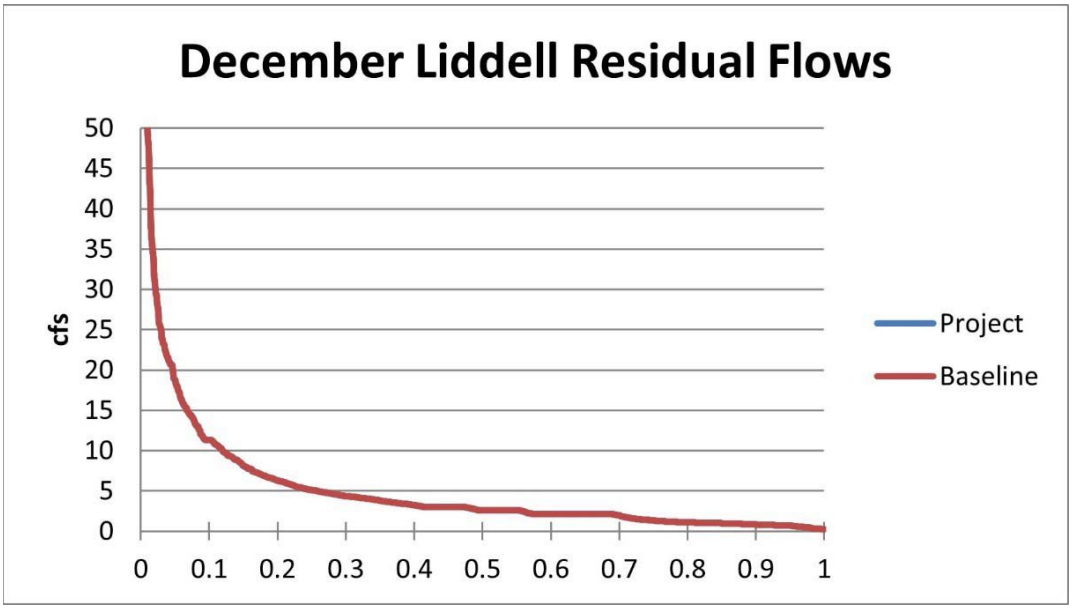


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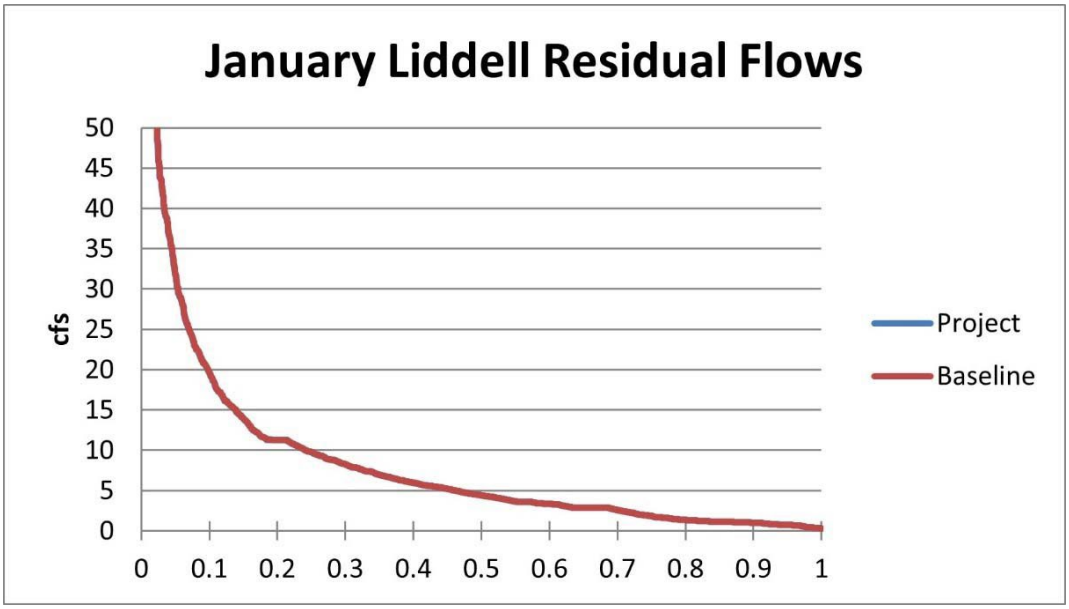
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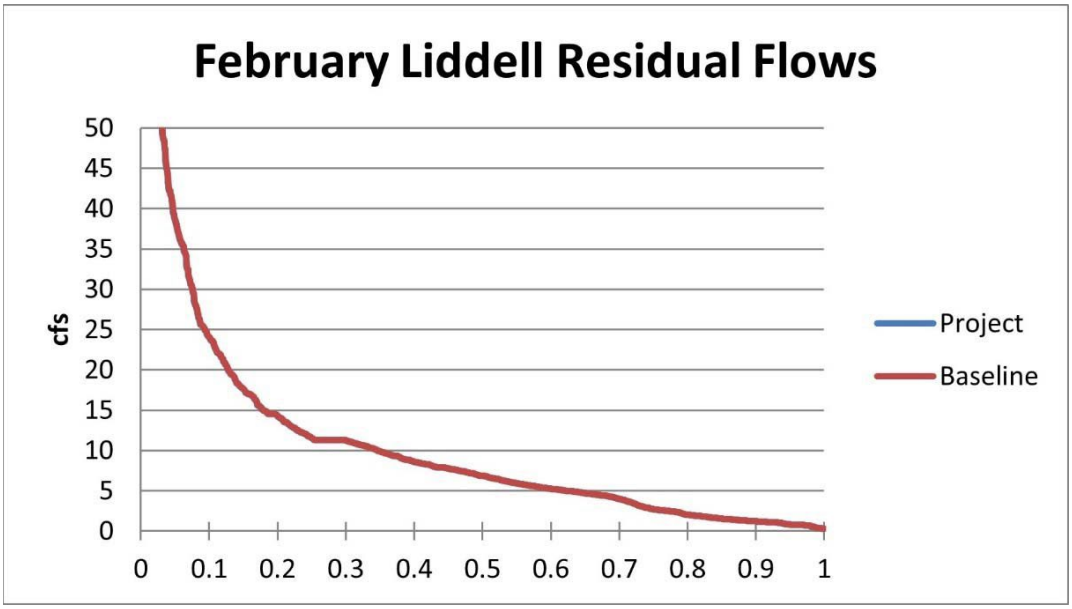
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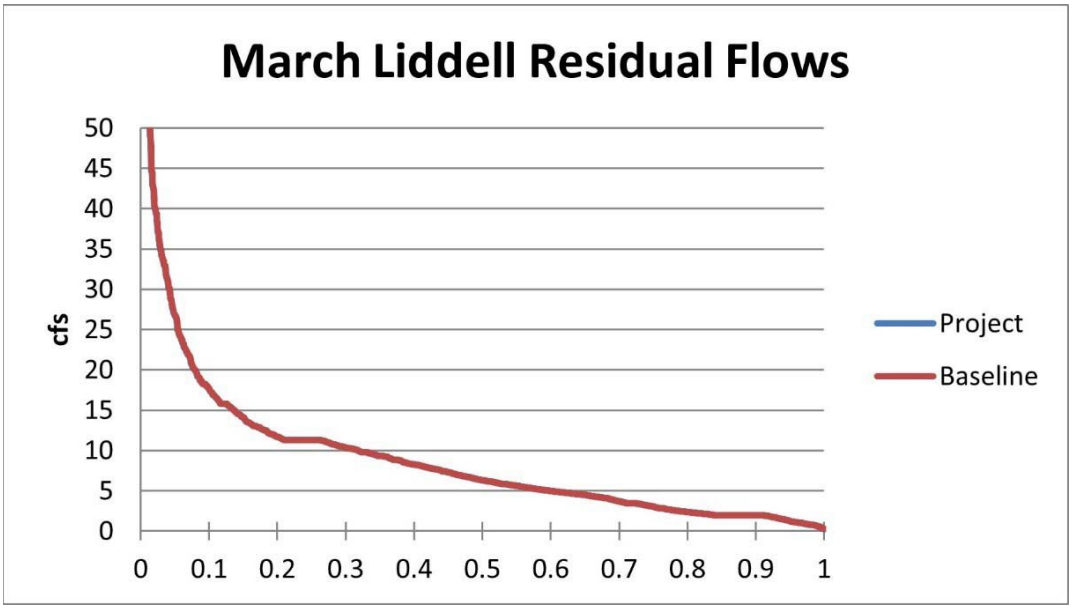
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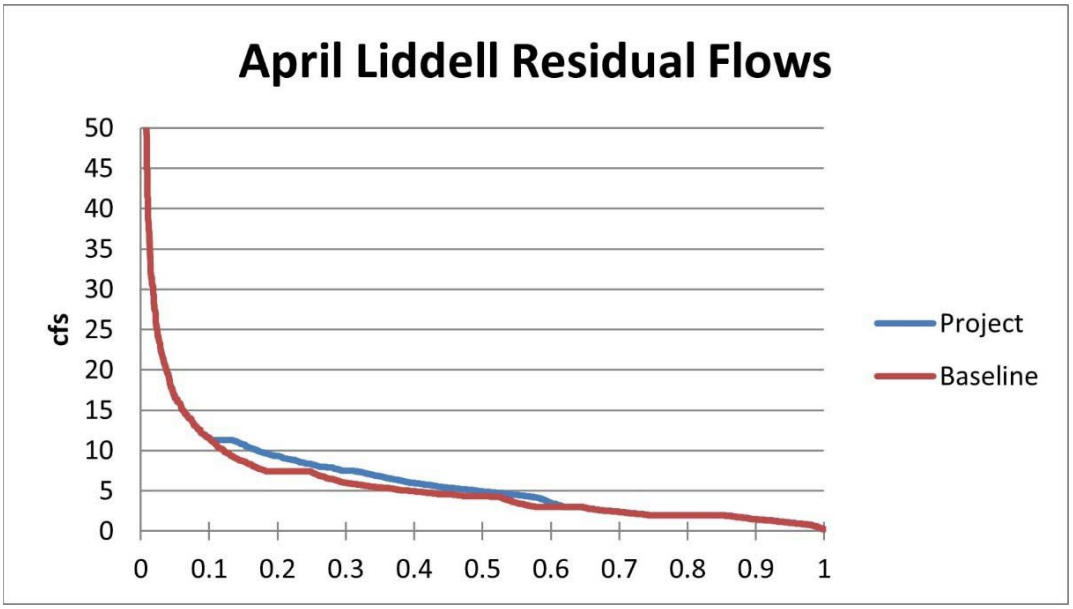
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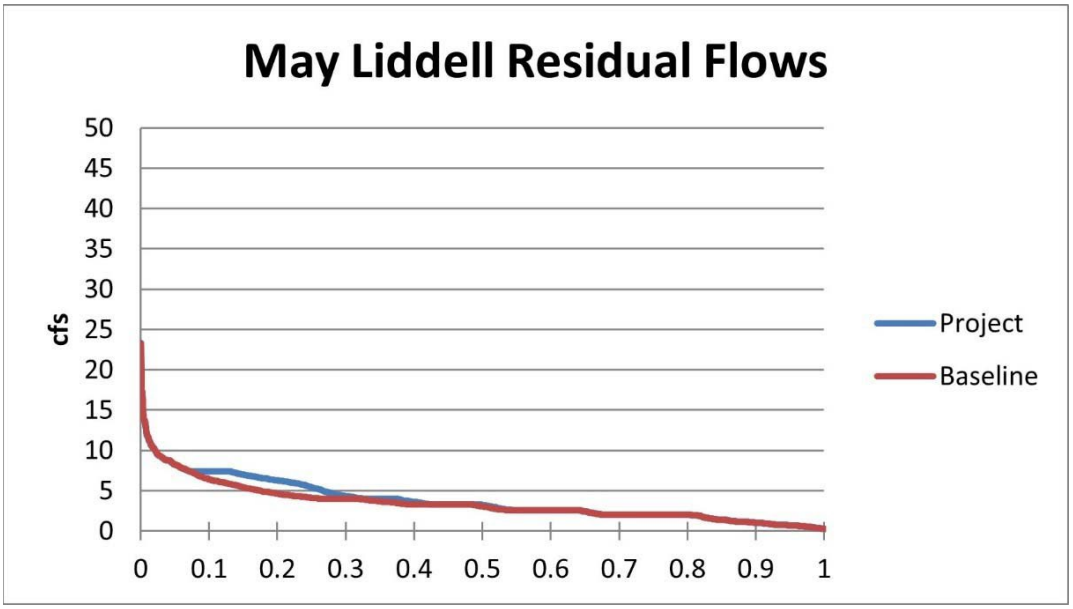
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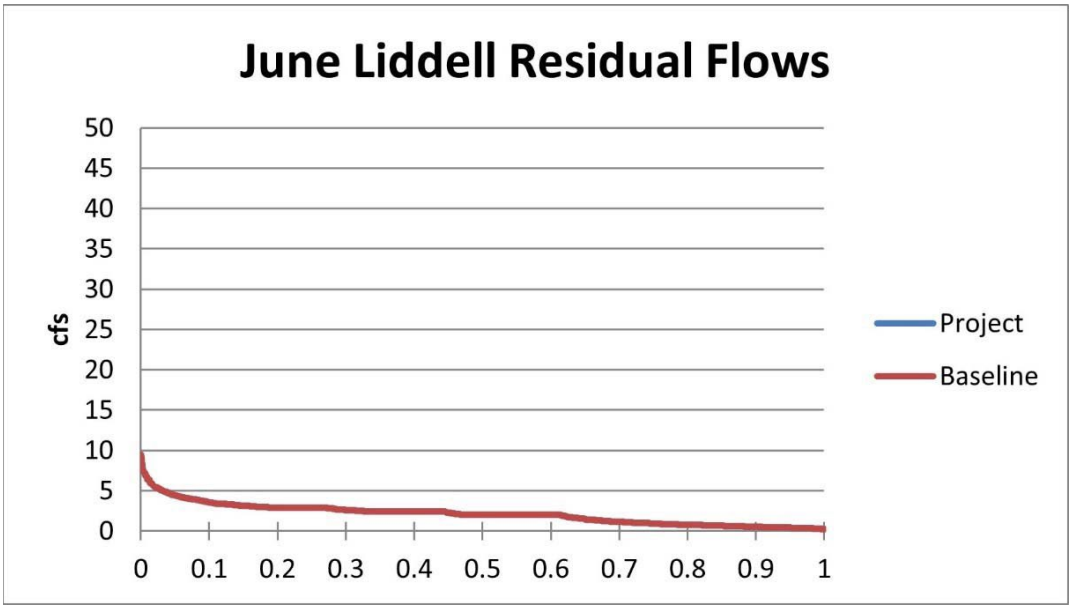
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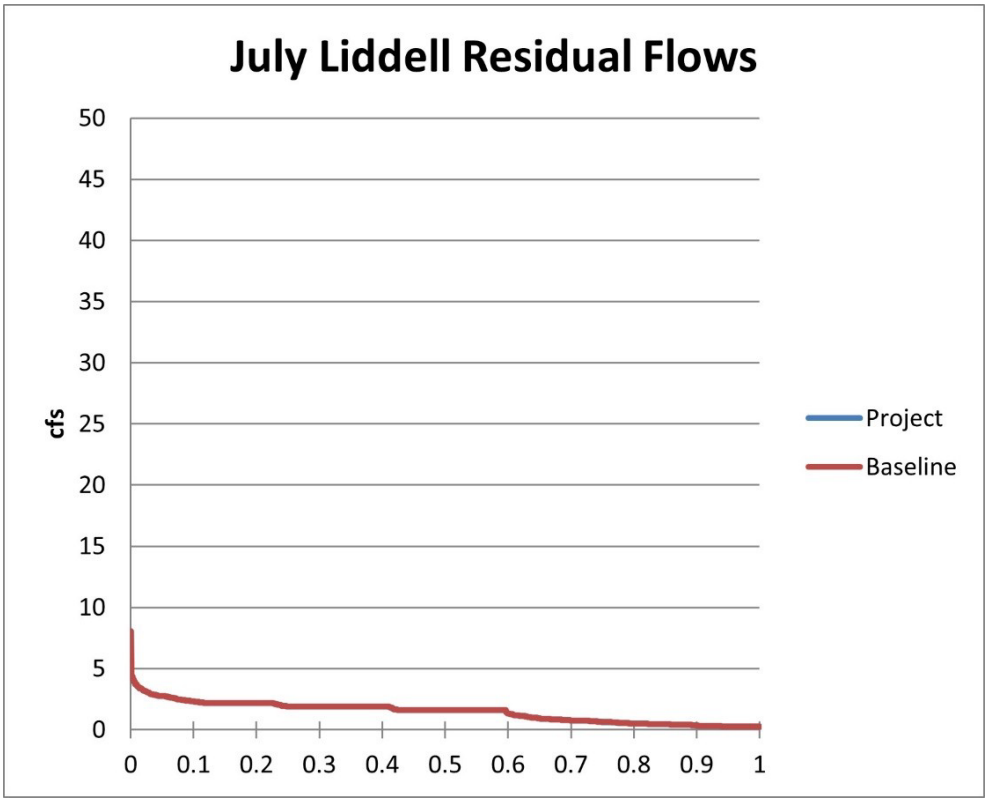
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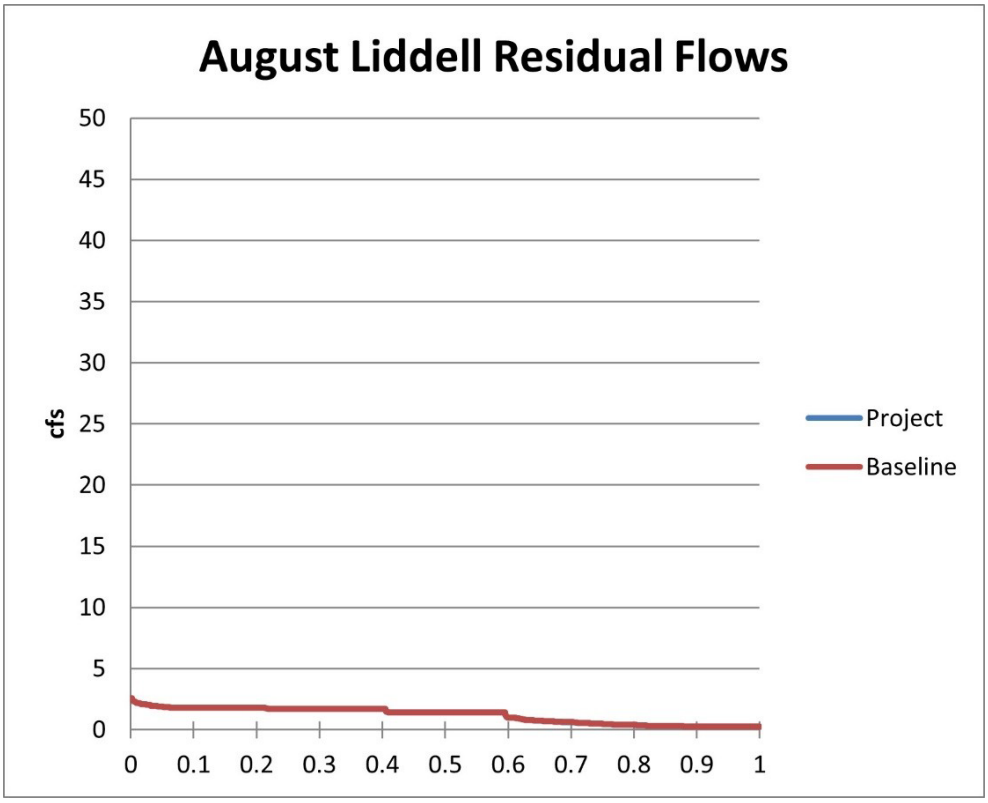
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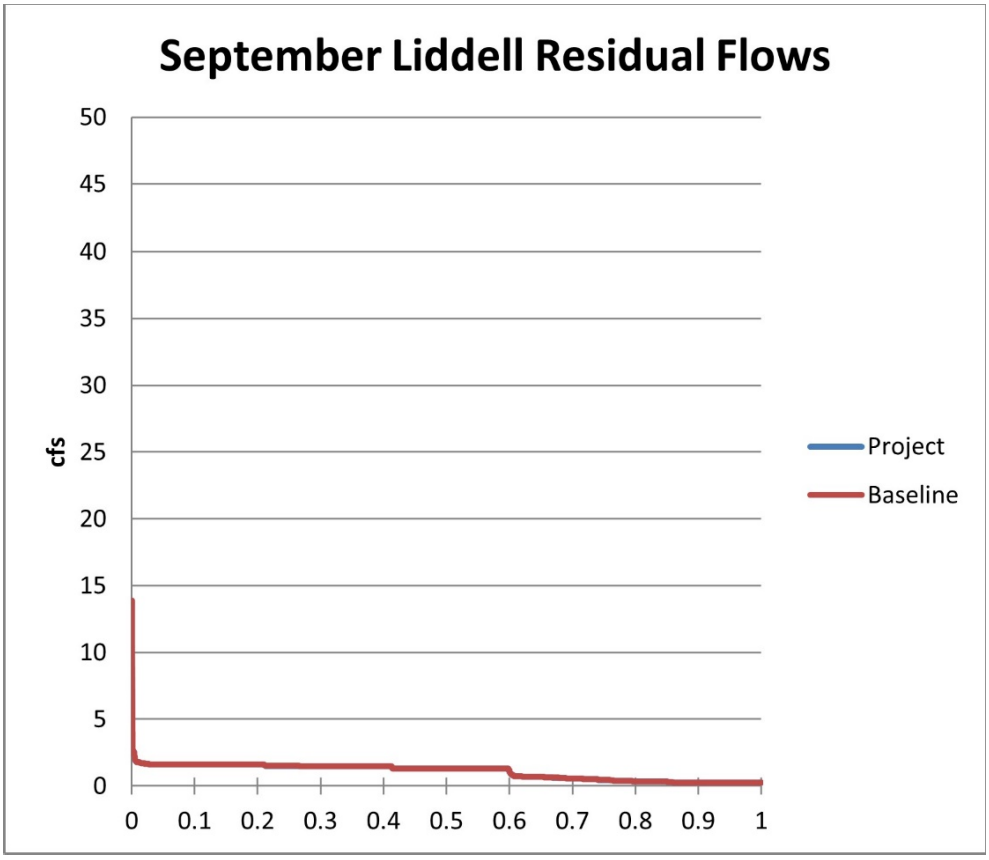
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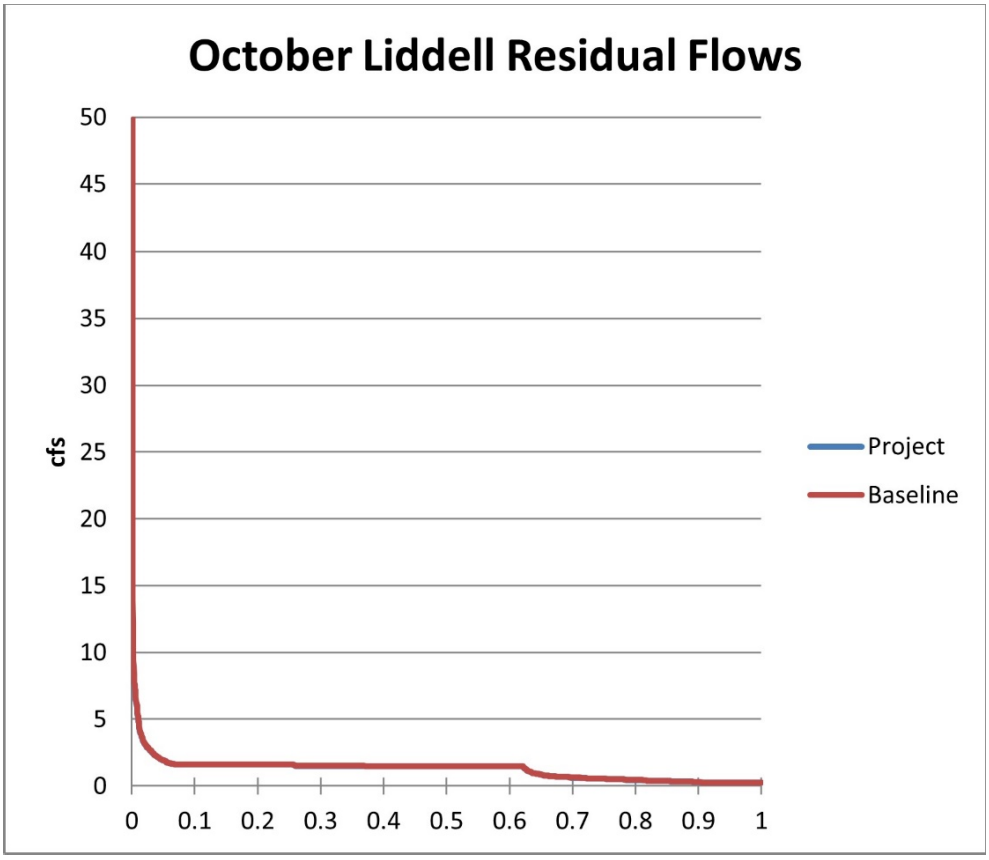
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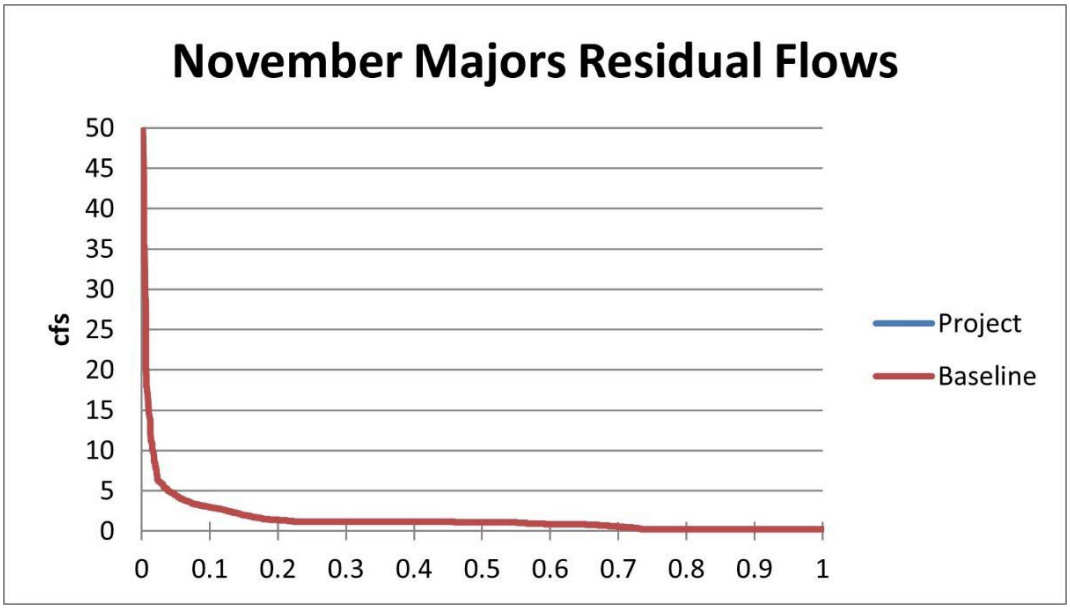


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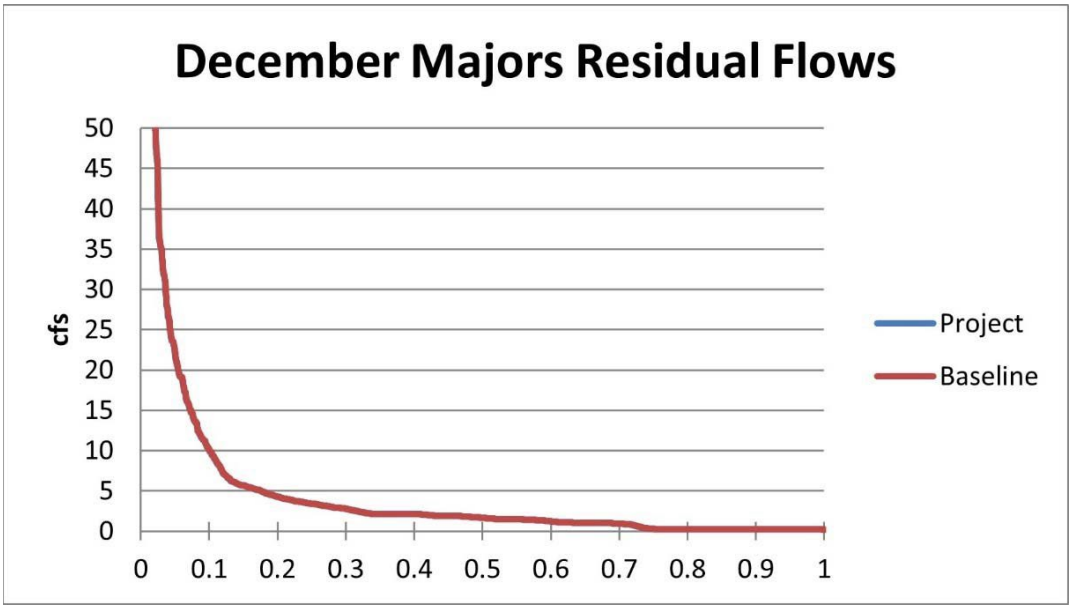


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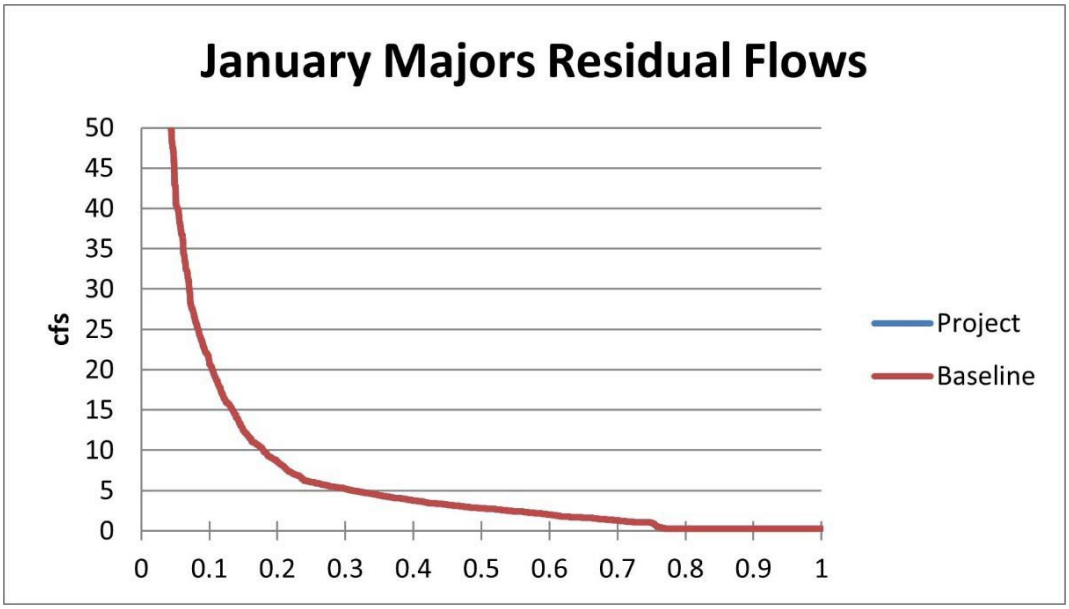
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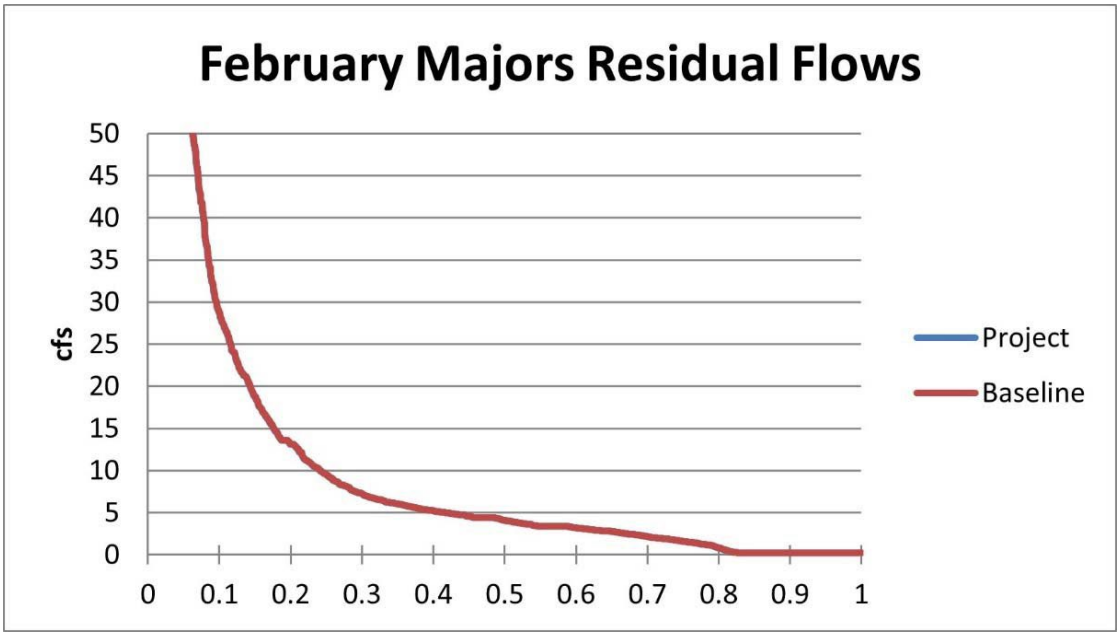
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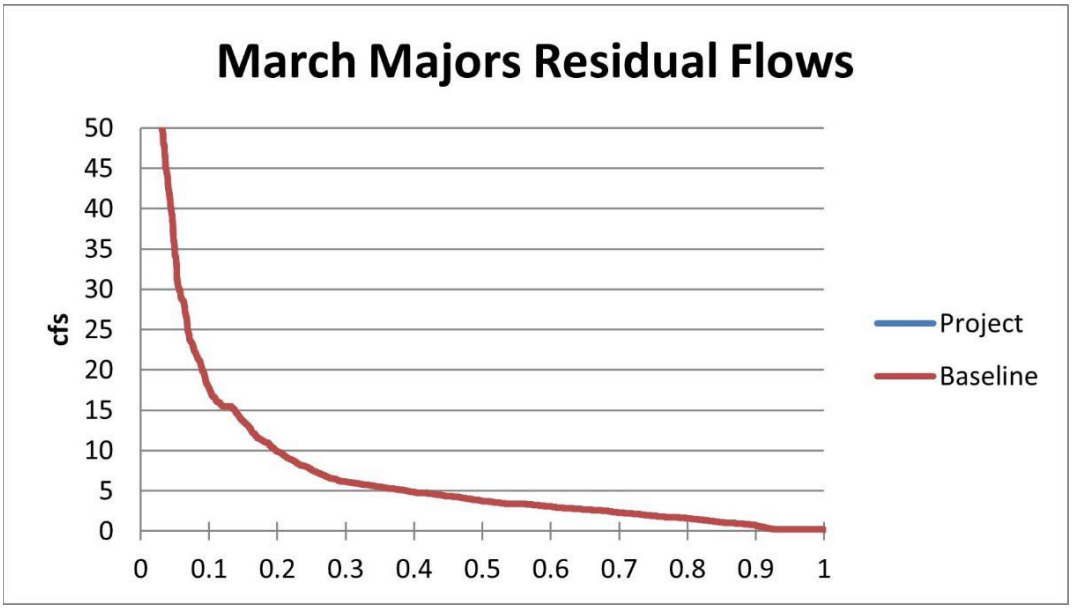
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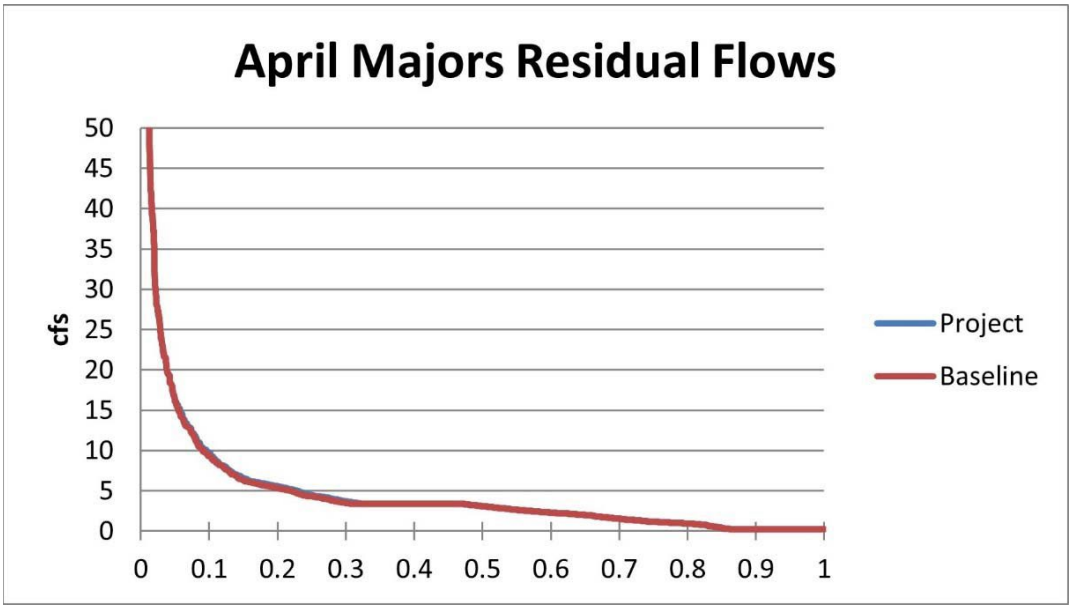
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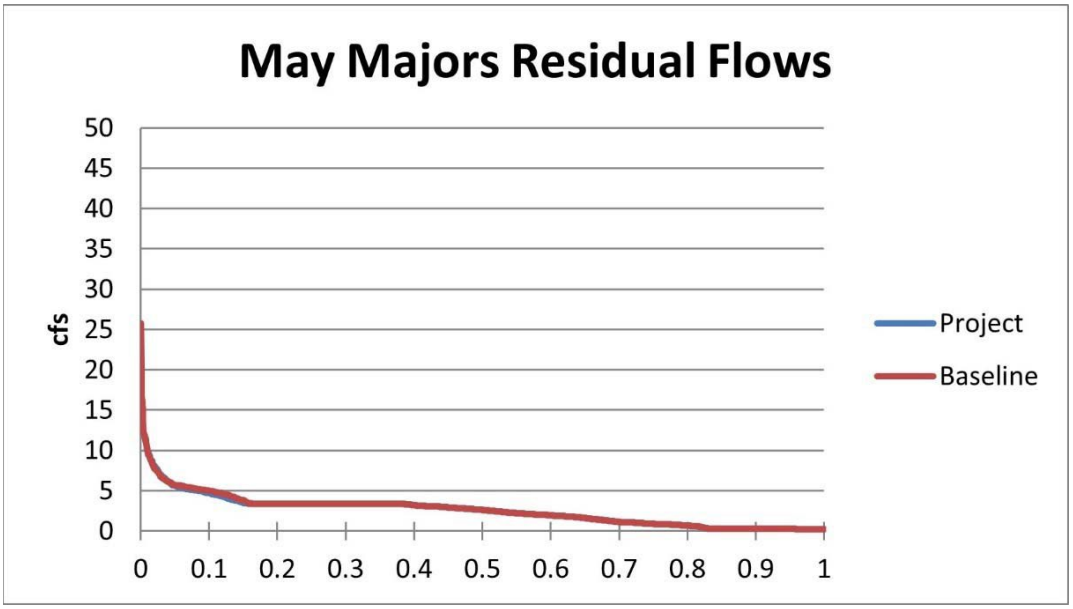
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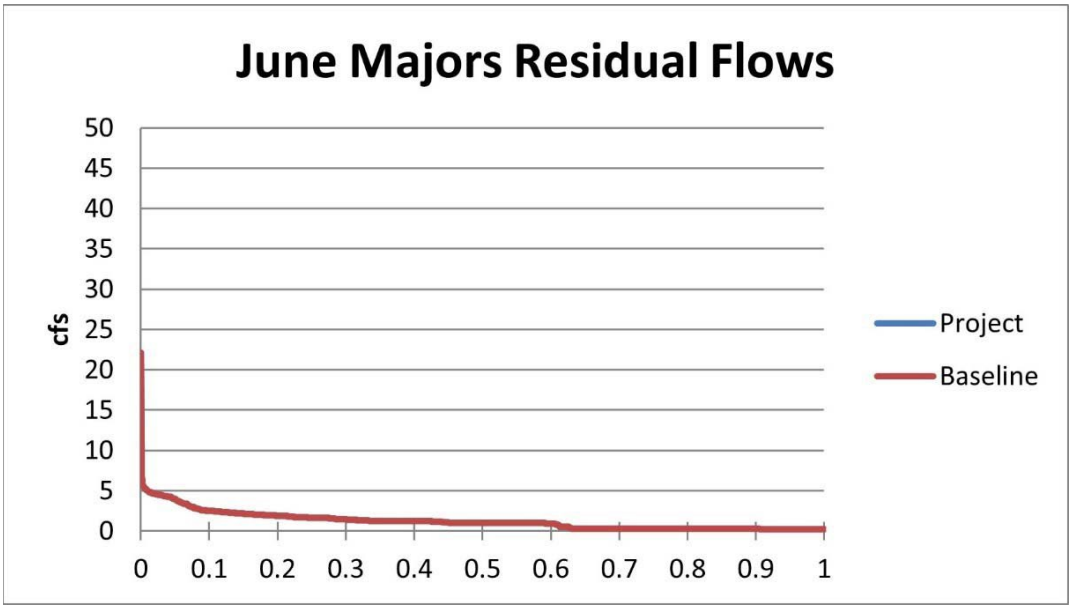
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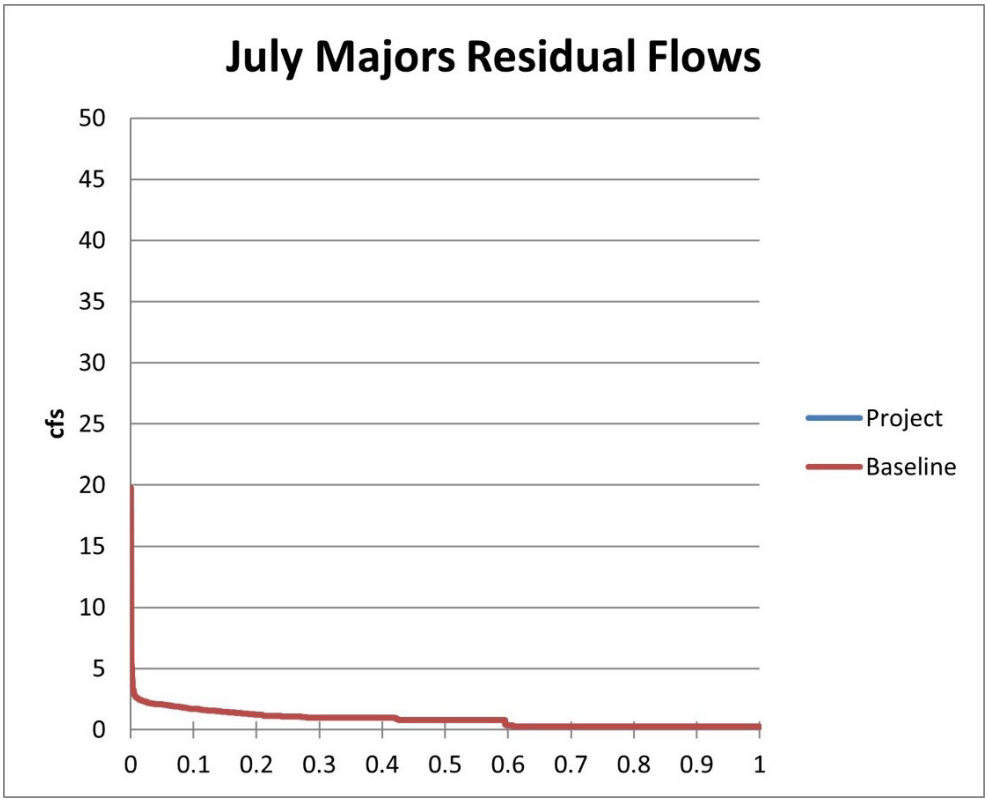
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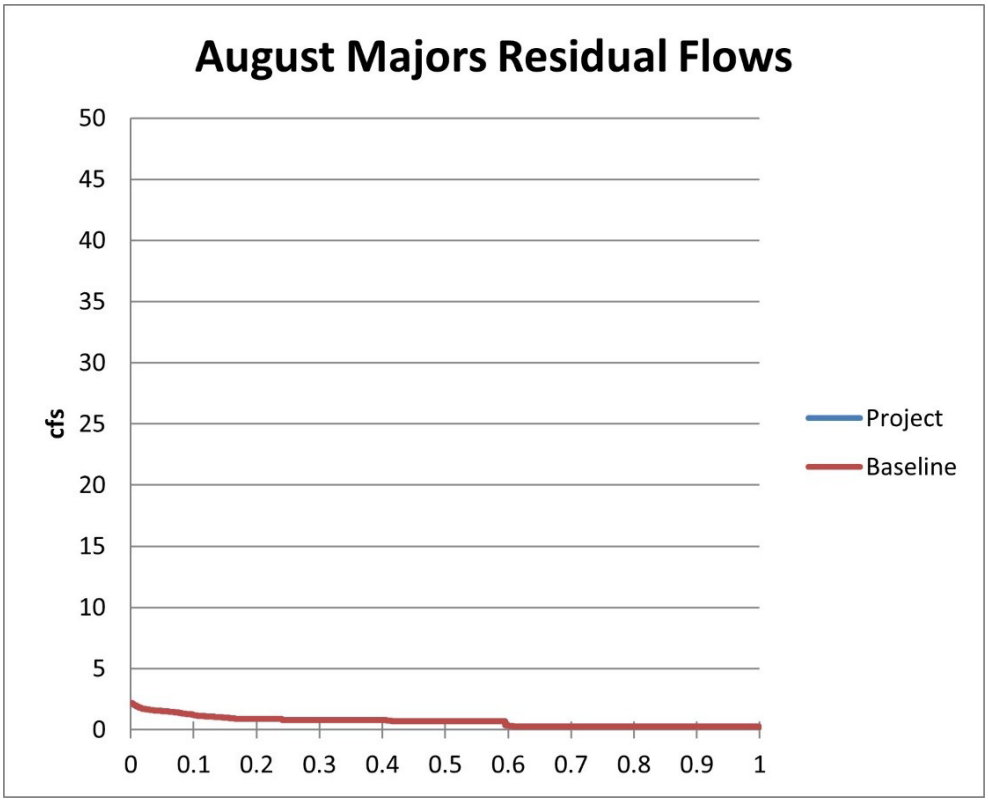
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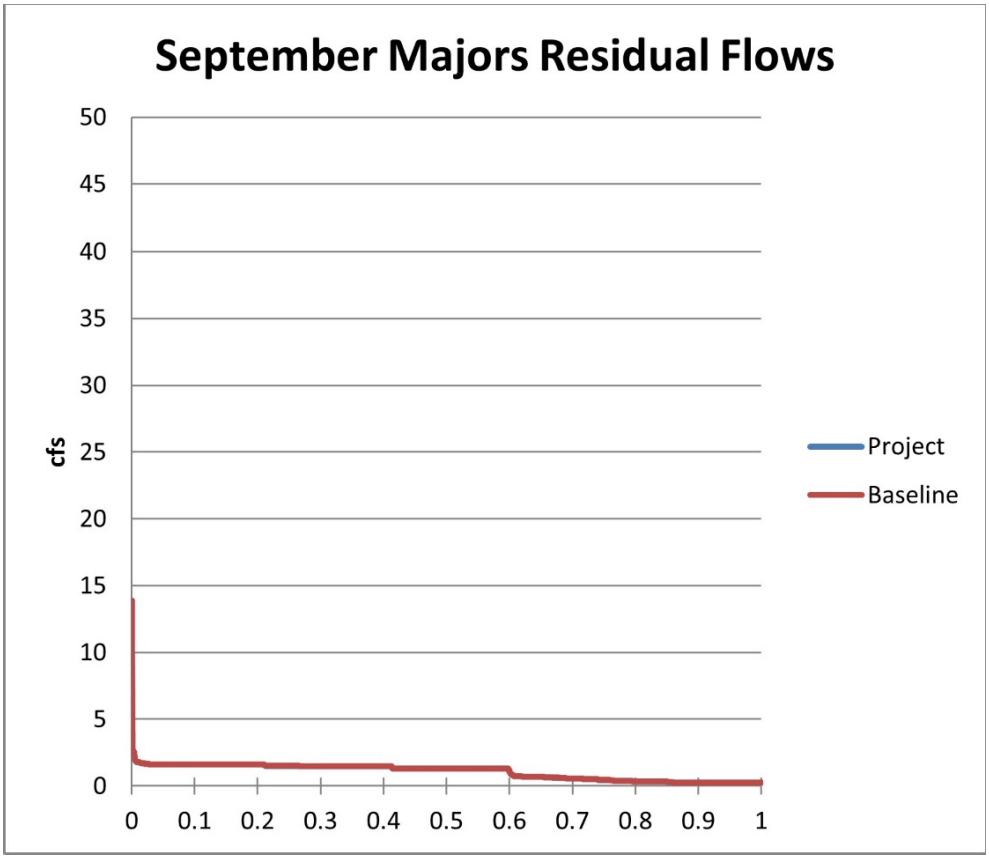
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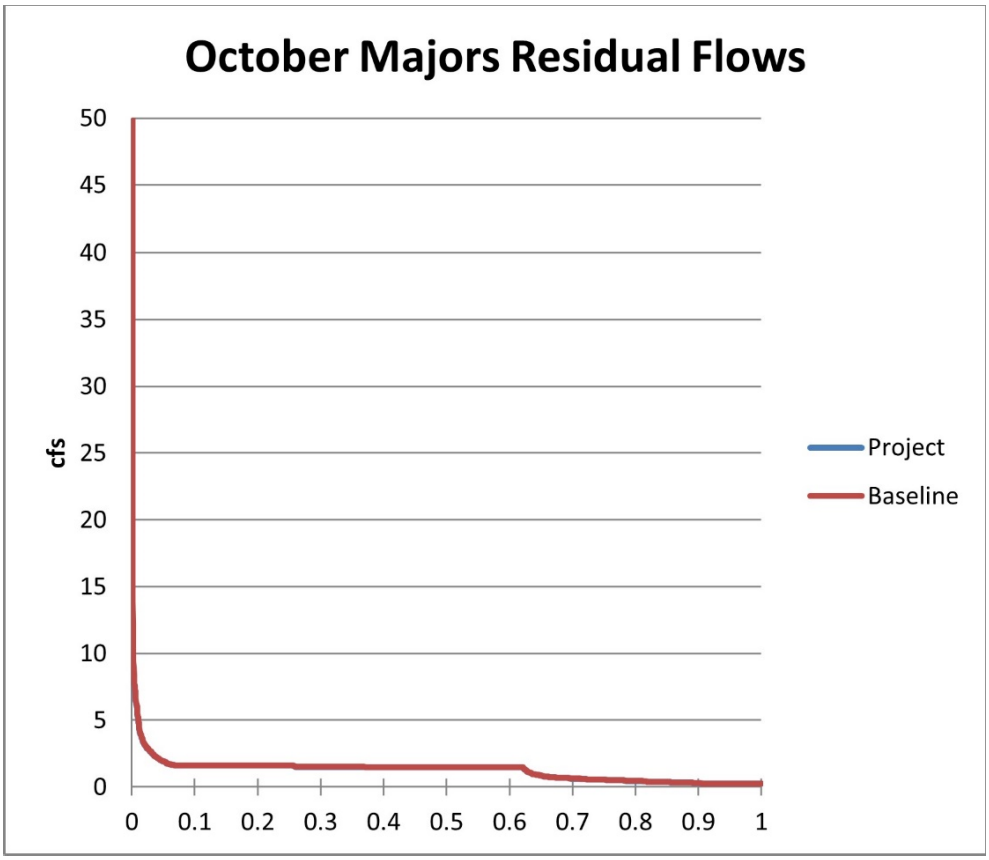
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Appendix 8-3

Steelhead and Coho Salmon Habitat Modeling

1.0 PURPOSE

This document provides a description of the methodology and results of habitat modeling conducted to evaluate the effects of the Santa Cruz Water Rights Project (Proposed Project) on habitat for Central California Coast steelhead (steelhead) (*Oncorhynchus mykiss*) and Central California Coast coho salmon (coho) (*Oncorhynchus kisutch*) due to changes in streamflows.

2.0 INTRODUCTION AND BACKGROUND

Operation of diversions for the City's water system involves potential effects on salmonid populations inhabiting the streams that also serve as the City's water supply sources. The objective of this analysis has been to provide a means of linking streamflow to habitat values for steelhead and coho inhabiting stream reaches influenced by City water supply operations. The methodology is based on the 79-year daily streamflow database developed by Balance Hydrologics (see Appendix 8-1) and uses modeled daily residual streamflows,[1] that are output from the Confluence model (see Appendix 8-2). The information, tools, and methods were developed as a collaborative process involving the City and its consultants, representatives of the National Marine Fisheries Service, and representatives of the California Department of Fish and Wildlife over a multi-year period beginning in 2005 as part of the development of the pending ASHCP.

The City operates three diversions from North Coast streams (Liddell Spring, Laguna Creek/Reggiardo Creek, and Majors Creek), diversions from the San Lorenzo River at the Felton Diversion and the Tait Diversion, and diversion from Newell Creek at Loch Lomond Reservoir.[2] Only the Felton Diversion (CDFW 1998) and Newell water rights have required bypass flows currently. A major objective of developing the ASHCP has been to identify opportunities to minimize the effect of the City's diversions on steelhead and coho by managing diversion operations to meet in-stream flow levels to support salmonid habitat in coordination with City water supply functions. Toward this end, the City has negotiated long-term minimum bypass flow requirements (Conservation Flows) with CDFW and NMFS as part of the ASHCP process. As both the California Department of Fish and Wildlife (CDFW) and the National Marine Fisheries Service (NMFS) have tentatively agreed on the bypass flow requirements, the City has committed to implement the Conservation Flows as part of the Proposed Project regardless of the

[1] Residual streamflow is the amount of streamflow left in the stream after diversion, assuming diversion is possible after the applicable minimum bypass flows are met. Residual streamflow may be different than the applicable minimum bypass flows if there is more flow in the stream than needed by the diversion or if flow is less than the agreed bypass with no diversion.
[2] The name of the dam that impounds Newell Creek, forming Loch Lomond Reservoir, is Newell Creek Dam.

final outcome of the ASHCP process. The Conservation Flows are described in the ASHCP and are the minimum bypass flows.

3.0 METHODOLOGY

3.1 Analytical Tools

There are many components of an aquatic system that potentially influence the suitability of habitat for each life stage of steelhead and coho. During the freshwater portion of their life history, these species are dependent on flowing waters and they are uniquely adapted to the Mediterranean seasonal hydrologic pattern and dynamic annual precipitation variability influencing streams flowing from the Central California coast. The major factor linking the City's water supply activity and the suitability of habitat for salmonids is alteration of the magnitude and timing of instream flows. Therefore, development and evaluation of bypass flows focused on physical habitat parameters related to flows and was supported by existing analytical tools including the Physical Habitat Simulation Model (PHABSIM) component of the Instream Flow Incremental Methodology (Bovee et al. 1998, see following Section 3.1.1), the Critical Riffle or Thompson Method (Bjornn and Reiser 1991; Thompson 1972; CDFW 2013), the Powers and Orsborn method (Powers and Orsborn 1985), and R2 (Berry 2016). These methods are summarized below and described in more detail in HES (2014).

Habitat conditions for steelhead and coho are also influenced by water temperature. As described further in Section 3.15, effects of the Proposed Project and alternatives on water temperature are limited to operation of Loch Lomond Reservoir. Modeling of water temperature was not conducted but City records for reservoir water temperature profiles and reservoir spill were evaluated to assess potential effects.

Other habitat components such as benthic macro-invertebrate food sources, substrate characteristics, channel features, riparian vegetation, human disturbance, predation, disease, etc. are potentially important but were not incorporated directly in the analytic structure because either there is not an apparent, quantifiable direct linkage between the Proposed Project and a given habitat component, or there is not sufficient knowledge to evaluate or quantify linkages. Other components are considered qualitatively based on expert judgment in relation to the Proposed Project.

3.1.1 Analysis of Spawning and Rearing Habitat Using PHABSIM

The PHABSIM method assesses habitat conditions by measuring hydraulic conditions at representative cross sections and constructing computer models to predict changes in suitability of habitat with discharge. The model output includes an index representing habitat suitability based on depth and velocity conditions. For spawning, the suitability index also incorporates substrate size characteristics. The PHABSIM analysis was conducted in 2005 through 2010 by Hagar Environmental Science (HES) in coordination with a technical team representing CDFW, NMFS, and the City.

PHABSIM study sites were selected by walking the stream and identifying locations where conditions were generally favorable for either spawning or rearing of steelhead or coho. Spawning transects were generally near the transition areas between a pool-tail and the head of a riffle where substrate and velocity conditions favor spawning. Some transects were also placed in run type habitat or in deeper riffles where suitable substrate occurred. Rearing transects were located in pool, flatwater, or deeper riffle habitat roughly in proportion to the abundance of each type. Habitat type composition was based on information in ENTRIX (2004) for North Coast Streams; HES (2007) for Newell Creek; and a 2005 HES survey of the Lower San Lorenzo River (HES 2014). Sites were selected to cover the range of variability in factors such as stream width, cross-section depth, and substrate conditions. Sites were located close to access wherever possible. One or more transects were marked perpendicular to the flow at each site to cover the range of conditions at individual sites.

Data Collection and Pre-processing

The PHABSIM study required collection of channel geometry and hydraulic data including an elevation profile, depth and velocity cross-sections, and water surface elevation (stage) at each study site across a range of flows that bracketed the suitable range for a given life-stage. Cross-sections were selected and initial surveys were conducted during low-flow conditions since channel features and substrate conditions are more easily observed at that time. Initial transect data collection included an elevation cross-section (channel geometry) and substrate code for stations at intervals sufficient to describe the habitat and provide a maximum number of data points for hydraulic modeling. Substrate particle size classes and relative abundance were characterized at each measurement point on the transect using the Bovee substrate coding system (Bovee 1978). Water stage data were collected at each cross-section to serve as the low flow point for stage/discharge relationships. One transect in each study area was selected for flow estimation and a depth and velocity set was collected for this purpose. The flow transect was usually one of the passage or spawning transects since they were generally placed in more

suitable locations for flow measurement. Flow measurements were supplemental to the City's 15-minute gage data for each stream (HES 2014).

Subsequent data collection required collection of a high flow velocity set (velocity at each station) at the upper end of the model range of flows and a series of stage/discharge measurements over the range of flows to be modeled. These data were collected during storm runoff periods (HES 2014).

Stage measurements were correlated with flow to develop a stage/discharge relationship for each transect location. Flow corresponding to each stage measurement was estimated using either the City gage data, site measured flow, or a correlation of site measured flow with City gage data (HES 2014).

Hydraulic Model Development and Calibration

The data collected were used to develop a hydraulic simulation under the PHABSIM framework which was used to simulate depths and velocities in streams under varying stream flow conditions. Simulated depth and velocity data were then used to calculate the physical habitat index, either with or without substrate information. First, water surface elevations were predicted for each transect using the IFG-4 component of the PHABSIM model. The IFG-4 method uses an empirical log/log regression formula of stage and discharge (flow) based on the measured data to determine water surface elevations across a series of simulation flows. Each cross section was treated independently of all others in the data set. A minimum of three stage-discharge measurement pairs were used to calibrate the stage-discharge relationship.

Water velocities were calculated using the "one-flow" technique which uses a single set of measured velocities and depths to estimate the Manning's n value on an individual cell basis along a transect. The high flow velocity and depth data were used for this purpose whenever possible so that measured values were available for the maximum number of cells on each transect. At the simulated discharges, the model uses Manning's formula and these previously derived Manning's n values together with the projected depth to predict velocities. A velocity calibration was performed to determine the adequacy of velocity simulations and adjustments were made where needed and justified (HES 2014).

Habitat Suitability Criteria

Hydraulic parameters (depth and velocity) and substrate values are linked to habitat value through application of habitat suitability criteria (HSC) that describe the relative suitability of water depth, water velocity, and stream substrate, to the fish species being evaluated. For the

ASHCP, existing HSC data developed on the Trinity River by the U.S. Fish and Wildlife Service were used (Hampton 1997). The Trinity River HSC were used because they were considered the best quality criteria available within a reasonable geographic distance from the North Coast streams, the San Lorenzo River, and Newell Creek. The Trinity River HSC were developed by direct observation and measurement of depth and velocity at locations used by spawning steelhead and coho and rearing juveniles. Suitability criteria for spawning substrates were taken from Bovee (1978) due to a lack of data from Hampton (1997).

Habitat Index Simulation

Habitat index simulation is the process that combines hydraulic estimates of velocity and depth (i.e., the results of the hydraulic simulation) with the suitability values for those attributes (i.e., the habitat suitability criteria) to weight the area of each cell along a transect at the simulated flow. The weighted values for all cells are summed to give a single habitat index, called weighted usable area or relative suitability index (WUA/RSI). The WUA/RSI index of aquatic habitat suitability describes the incremental relationship between physical habitat and stream discharge. Hydraulic and habitat index modeling were conducted using PHABSIM Version 3.0 (Riverine Habitat Simulation, Payne 1994).

3.1.2 Analysis of Flows for Migration Passage Using Critical Riffle Analysis

This method identifies sites that are exceptionally wide and shallow (critical riffles) as limiting to fish migration and establishes the level of flow that meets minimum migration criteria for depth of flow at these sites (HES 2014). The migration passage flow assessment is based on standards developed in the fisheries literature (Thompson 1972; Bjornn and Reiser 1991; CDFW 2013). These standards assume that there must be sufficient depth over the shallowest riffles for the target species to swim upstream with its body completely covered.

The critical riffle analysis was conducted from 2005 through 2010 and used a methodology attributed to Thompson (1972). Thompson's method entails identifying a series of shallow riffles that potentially affect fish passage, establishing transects across the shallowest locations, and then determining, for each transect, the flow at which a minimum depth criterion is maintained across at least 25% of the total channel width and a contiguous minimum width of 10% of the channel. Thompson (1972) recommends a minimum passage depth criterion of 0.6 feet for adult steelhead, although other depth criteria have been used depending on specific site conditions and objectives. This basic methodology has been widely adapted and modified since its introduction as a proposed method in 1972.

In this analysis, the Technical Team (NMFS, CDFW, City of Santa Cruz and consultants) agreed on minimum passage depth criteria (critical depths) of 0.6 feet for migrating adults and 0.3 feet for smolts. Factors to consider in choosing a depth or width criteria are the number, length, and difficulty of critical passage points; distance from the ocean; and size and condition of the fish. In each of the study streams where the critical riffle analysis was used, the reach between the mouth and the upper limit of the anadromous reach is quite short (from 0.7 to 1.6 miles) and generally has low gradient. Riffles make up a relatively small portion of the habitat in each stream (ENTRIX 2004; HES 2007) and other obstructions are infrequent. The riffles are relatively short and interspersed with pools with good cover characteristics, including undercut banks and roots. Therefore, migrating adults should be in good condition at each of the critical passage locations and fatigue from having to pass many obstacles over great distances should not be an issue. Given swimming speeds cited previously, high velocity was not a factor at any of the identified passage sites.

Site Selection and Field Data Collection

Three to four critical riffles were identified during an initial walk-through of the anadromous reach of each of the North Coast streams during the fall of 2006. Critical passage locations in the San Lorenzo River downstream of the Tait Diversion were identified during a habitat survey conducted in October 2005 and critical passage locations were identified in Newell Creek downstream of Newell Creek Dam/Loch Lomond Reservoir during the fall of 2007 and during the winter of 2009-2010 (HES 2014). A single transect was placed along the shallowest cross-section of each riffle and marked with head pins for location of future measurements. Transects incorporated the shallowest portion on the probable route a migrating salmonid would follow. Streambed elevations were measured at regular intervals along a survey tape and tied to a reference elevation at each transect (one of the head pins). Water surface elevations were also measured at both sides of the channel and at the thalweg (deepest point on the cross-section), including the time of each measurement. Water surface elevation measurements were repeated at each transect under varying flow conditions during the following winter and early spring. Flow associated with water surface elevations or velocity transects was determined from site measurements or estimated from the 15-minute gage record maintained by the City in the anadromous reach of the North Coast streams and in Newell Creek below Newell Creek Dam, and the USGS gage in the San Lorenzo River at the Tait Diversion.

Data Analysis

Cross-section data were entered in a spreadsheet configured to allow determination of the critical water surface elevation at which depth criteria were met. Each measurement point on the cross-section represented a cell with boundaries extending halfway to both adjacent measurement

points. Depth of each cell was calculated for any given water surface level as the water surface elevation minus the bed elevation. A depth criterion (i.e., 0.6 feet for adults or 0.3 feet for smolts) was set for each iteration of the spreadsheet and both the total width of cells meeting that depth criteria as well as the longest contiguous group of cells meeting the criteria were tallied and compared to the total wetted width corresponding to that stage. A stage was selected for which 25% of the wetted channel width and a contiguous portion totaling at least 10% of the wetted width had a depth equal to or greater than the criteria value. A stage/discharge relationship was estimated for each transect using the field stage measurements and discharge data. The stage/discharge relationship was used to calculate the flow required to meet critical water surface elevations at each cross-section. This was the minimum migration flow at the cross-section.

For each reach where passage was evaluated, a flow window was defined with suitable conditions for adult migration. The lower threshold was defined by the cross-section with passage criteria met at the lowest flow and the upper threshold was defined by the cross-section with the highest flow required to meet passage criteria. This is a departure from the standard method (which uses the average value of the transects) but was requested by CDFW as a buffer against potential error in the method. This provides a protected "window" for migration passage with diversion halted when the lower threshold is reached and not resumed until flows exceed the upper threshold. The amount of flow in excess of the upper threshold is available for diversion. If flow drops below the lower threshold, either spawning, rearing, or smolt migration flows would then be governing.

3.1.3 Analysis of Passage at Bedrock Sheets in Newell Creek Using Powers and Orsborn

Two bedrock sheets that are passage obstacles upstream of Rancho Rio Bridge in Newell Creek were more complex than the critical riffles and were assessed using methods described by Powers and Orsborn (1985). Both obstacles were analyzed as chutes, using the Powers and Orsborn terminology, since they were relatively uniform in cross-section with steep but relatively constant slope. These bedrock sheets present an obstacle to migrating salmonids due to the very shallow depth of flow and high flow velocity. Both had shallow entrances (downstream end) and negative exit slopes (the bed slope at the top of the chute is downward in the upstream direction). The shallow depth at the base of the chute precludes steelhead from jumping so, in order to pass the obstacle, they must swim up it. At each site a bed cross-section and profile were surveyed. Water surface and spot velocity measurements were made at different flow levels. Water velocity and depth were calculated for a range of flow conditions using the Manning's Equation. The Manning's Equation predicts mean velocity from wetted

width, cross-sectional area, bed slope, and an empirical roughness coefficient (the Manning's coefficient). Cross-sections were also placed through the hydraulic control below each chute and a stage/discharge relationship developed at each control to determine the water surface elevation below each chute for given flows. This affects the length of the chute that must be negotiated by a migrating fish.

For each cross-section, the stage allowing passage was calculated for a range of depth criteria between 0.3 and 0.6 feet. This part of the analysis used criteria as described previously for evaluation of critical riffles (i.e., the criteria depth is achieved across 25% of the wetted channel width and at least a contiguous portion equaling 10% of the wetted channel width). Because the Manning's Equation is sensitive to the choice of roughness coefficient, minimum and maximum velocity (and corresponding flow estimates) were calculated. For this analysis we used Manning's coefficient values of 0.025 and 0.040 as minimum and maximum values consistent with smooth rock substrate.

The analysis assumes that adult steelhead require a depth of flow at least equal to their body depth in order for the fish to make full use of its propulsive power. Steelhead body depth was assumed to be between 0.4 and 0.6 feet. Steelhead are assumed to have burst speeds of 13.7 to 26.5 feet per second (fps) and coho are assumed to have burst speeds of 10.6 to 21.5 fps (Powers and Orsborn 1985). It is assumed that burst speed can be maintained for an estimated 5 to 10 seconds (Powers and Orsborn 1985). Maximum speed for passing an obstacle was assumed to be a percentage of burst speed depending on fish condition. Condition coefficients were 100% for fish fresh out of salt water or still a long way from spawning areas, 75% for fish in the river a short time and still migrating upstream (good condition), and 50% for fish in the river a long time and close to the spawning grounds (poor condition) after Powers and Orsborn (1985). The distance from the mouth of the San Lorenzo River to Newell Creek is relatively short (about 14 miles) and migrating steelhead or coho should be able to reach the barrier location within a few days of entering freshwater. Therefore, fish would be assumed to be in relatively good condition and a condition coefficient of 75% to 100% would be appropriate. The distance a fish can swim at an obstacle is computed as:

$$LFS = ((VF*c) - VW) * TF \quad (1)$$

where LFS is the length a fish can swim, VF is the fish swimming velocity, c is the coefficient of condition, VW is the water velocity, and TF is the time to fatigue.

For short chutes velocity may be determined by the equation:

$$V_{SC} = (2gH)^{0.5} \quad 2)$$

where V_{SC} is the velocity down a short chute, g is the acceleration due to gravity (32.2 fps^2), and H is the total vertical drop between two pools (Powers and Orsborn 1985).

Formulas 1 and 2 were used with the preceding assumptions to estimate the length a fish can swim and the velocity of water through the chute at a flow meeting the passage depth criteria. If the length a fish could swim is greater than the length of the chute and if the velocity is less than the fish's burst swimming speed over that distance, then the chute is passable at that flow. An upper level of flow beyond which passage is not possible can also be calculated as the flow at which LFS becomes less than the chute length.

3.1.4 Analysis of Passage in the San Lorenzo River Downstream of the Felton diversion Using the R2 Method

PHABSIM studies were not conducted in the San Lorenzo River between the Felton Diversion and Tait Diversion as part of the ASHCP since operation of the City's diversion was subject to a previous agreement with CDFW (CDFW 1998) and evaluation of the effects of water rights changes indicated little effect on flows (ENTRIX 2006). As development of the ASHCP progressed and as the need for facilities improvements and water rights changes to meet supply under agreed bypass flows became better developed, the ASHCP technical team identified the need for increased focus on effects of Felton operations on streamflow and instream habitat resulting from increased use of the facility. In late 2016 the ASHCP technical team decided to evaluate adult passage requirements in this reach via a desktop method utilized by CDFW (the R2 method, developed by R2 Resource Consultants) and to correlate it with other adult passage sites where physical datum is available to evaluate comparability instead of initiating new instream flow studies (Berry 2016). Further, it was agreed that adult migration is usually the life stage requiring the most flow, so other life stages would be protected as well (Berry 2016).

The R2 assessment was developed to provide an estimate of bypass flow that would be protective of anadromous salmonid spawning habitat and upstream passage in as many streams as possible based on measures of channel size expressed in terms of drainage area and mean annual flow (R2 Resource Consultants 2008). The analysis used the following formula provided by CDFW (Gray 2016).

$$Q_{fp} = 19.3\ Q_m\ D_{min}^{2.1}\ DA^{-0.72} \quad 3)$$

where Q_{fp} is the minimum fish passage flow (cfs), Q_m is mean annual flow (cfs), D_{min} is minimum passage depth criterion (feet), and DA is drainage area (square miles).

Results of the R2 analysis were also compared to a critical passage study in the San Lorenzo River gorge using the Powers and Orsborn methodology, surveys at other sites using the Thompson method, observations of movement of large juvenile steelhead in the San Lorenzo River and estimates of passage flow requirements by local fishery biologists in the San Lorenzo Watershed Management Plan (Berry 2016).

3.1.5 Analysis of Effects of the Project on Water Temperature

Steelhead are generally expected to survive and grow well at temperatures up to about 19°C to 21°C if food is abundant. Temperatures of 19°C or less is considered optimal under most conditions (Bidgood and Berst 1969, Hokanson et al. 1977, Smith and Li 1983, Armour 1991, see also HES 2014 for a summary of these findings). Steelhead may actually grow faster at higher temperatures if food is abundant (Smith and Li 1983) but at temperatures in excess of 21°C, increased mortality may offset the benefits of increased growth rates at the population level Hokanson et al. 1977 (see HES 2014 for discussion of temperature suitability). Temperatures of 25°C to 26°C are generally considered lethal (Bidgood and Berst 1969, Hokanson et al. 1977).

The north coast streams (Liddell, Laguna, and Majors Creeks) have water temperature conditions which are relatively cool due to marine influence and relatively dense, intact riparian canopies (City of Santa Cruz 2021). Temperature monitoring data collected by the City indicate temperature conditions in these streams are within the range of tolerance for both steelhead and coho rearing juveniles and near optimal in many cases (City of Santa Cruz 2021). The City diversions on the North Coast do not create conditions that influence water temperature (i.e., large storage facilities, removal of riparian shading vegetation, or alteration of subsurface flows). The San Lorenzo River and its tributaries extend further inland than the North Coast streams and water temperature is warmer. Water temperature is suitable for steelhead at all monitoring locations but increases with distance downstream from Newell Creek and is near the upper range of suitability during the seasonal thermal maximum period and in the lower San Lorenzo River from above Tait Street Diversion to the lagoon (City of Santa Cruz 2021). Coho require cooler temperature than steelhead, and temperature is relatively warm for coho except in the tributaries and upper mainstem and in Newell Creek downstream of Loch Lomond Reservoir (City of Santa

Cruz 2021). Coho do not presently maintain viable populations in the San Lorenzo River and its tributaries where the City has its water supply operations.

The existing required release of 1 cfs from Newell Creek Dam is from the lower levels of the Loch Lomond Reservoir and is colder than ambient stream temperatures during the summer and warmer than ambient during the winter. The fish release is typically between 11°C and 14°C. As a result, temperature in Lower Newell Creek below the dam is warmer than Upper Newell Creek, above the dam, during winter and spring and cooler in the summer by up to 4°C on average (City of Santa Cruz 2021). Warmer water in winter and spring can enhance salmonid growth rates if food resources are sufficient. The cooling influence in summer may maintain temperature in a more suitable range during excessively warm conditions but may depress growth rates at other times. The effect would be strongest closest to the dam since there is equilibration with environmental conditions with distance downstream (e.g., air temperature, insolation, subsurface flows). The cooling influence in summer can extend downstream as far as the San Lorenzo River and at these times the flow from Newell Creek can reduce temperature in the main stem .by about 1°C (City of Santa Cruz 2021, HES 2014b).

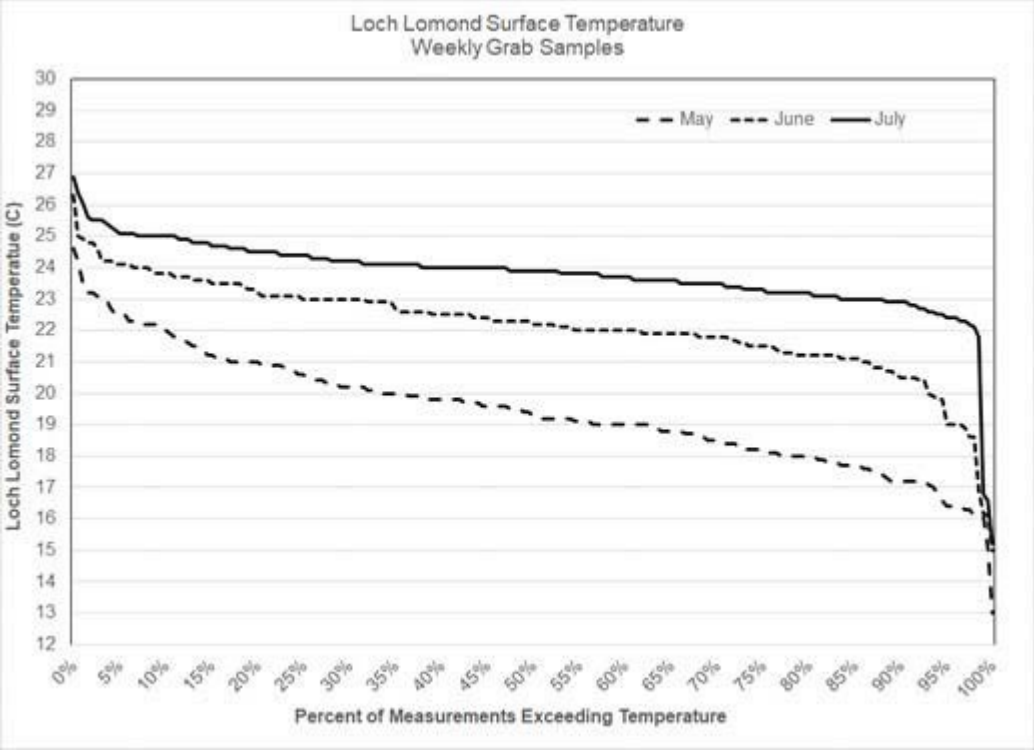
Operation of the reservoir (required 1 cfs release and reservoir spill) has the potential to influence water temperature in Newell Creek downstream of the dam and in the San Lorenzo River downstream of the Newell Creek confluence. The effect of the 1 cfs release is generally beneficial, particularly during the late summer and during dry years, when stream temperature is highest and may limit habitat suitability for steelhead, and particularly for coho.

During periods when the reservoir spills, water from the surface of the reservoir flows down the spillway and mixes with the fish release downstream of the dam. Since spill is from the reservoir surface, it can be warmer than the fish release during the warmer parts of the year. However, the majority of spill occurs during or after precipitation events in the winter when Loch Lomond temperature is cool. The period when temperature effects are most likely is during the spring and early summer (May through July) when the lake surface is warming and there is still a potential for spill, at least in wetter years when storage is high.

Temperature monitoring data collected by the City indicate that surface water temperatures in Loch Lomond Reservoir closest to the spillway can reach levels that are potentially harmful to steelhead and coho. Sub-optimal temperatures (21°C or greater) have occurred 98% of the time in July, 85% of the time in June, 19% of the time in May, and only 1% of the time in April (Figure 1). Surface temperatures in the City monitoring data have never been recorded above 18.3°C in March. Potentially lethal levels have also been recorded (25°C or higher) in June and

July, although the frequency of such occurrence is low in June (less than 1% of readings).[3] Frequency of reservoir surface temperature of 25°C or higher in July has been observed 11% of the time. These data may slightly underestimate the frequency of temperature in the unsuitable range since it is generally recorded mid-morning while peak temperature usually occurs in the mid to late afternoon.

Figure 1: Loch Lomond Surface Temperature Measured by Weekly Grab Sample from 1987 to 2020

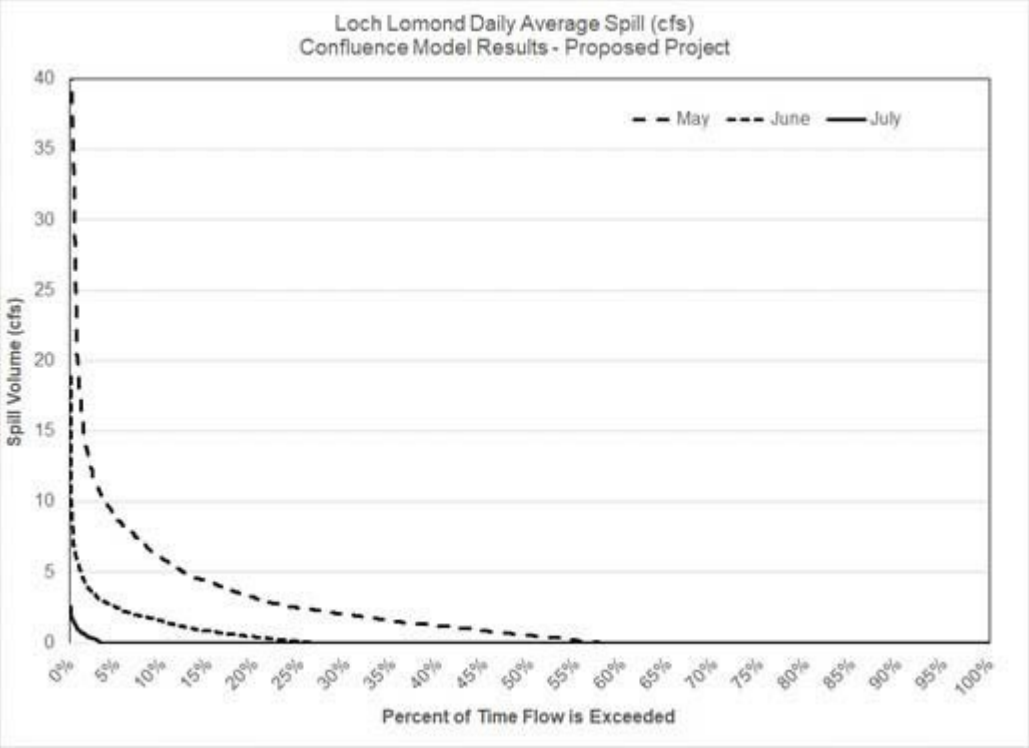


The effect of warm reservoir spills is moderated by the frequency, volume, and timing of spill; possible additional warming (during the day) or cooling (at night) as water flows down the spillway; and mixing with the cooler water from the fish release below the dam. Data collected by the City were evaluated to better understand the potential and magnitude of this effect. At times when the spill is warmest, later in the spring, the amount of spill tends to be declining and it is diluted to a greater degree by the colder fish release. Daily spill volumes estimated by the Confluence model for the Proposed Project using the historical hydrological record (1937-2015) indicate that spill would occur about 58% of the time in May, 27% of the time in June, and 3% of

[3] Data are in the form of surface grab samples measured once per week, usually mid-morning, collected since 1987.

the time in July (Figure 2). Maximum spill amounts would be 77 cfs in May, 19 cfs in June, and 2.5 cfs in July. The model results predict two days in August during the entire record when spill would occur and a maximum spill of 0.20 cfs. No spill was predicted to occur in September, or October. The highest spill amount for May is a result of data from 1983, which was a very wet year, the second wettest in the hydrologic record. The reservoir was spilling continuously from mid-November 1982 and storms in late April resulted in increased spill through early May of up to 77 cfs. Spill declined to 15 cfs by mid-May and continued dropping until it ceased on August 2. It is likely that reservoir temperature was moderated during this period by cool air temperature and overcast conditions typical during storm passage. Late season storms, such as occurred in 1957, 1996, 1998, 1995, and 1941, were responsible for the majority of high spill events in May that are evident in the Confluence model results. Similar to the 1983 data, these events are likely associated with relatively cool reservoir temperatures. Absent late season storms in May, spill amount is rarely in excess of 16 cfs.

Figure 2: Loch Lomond Daily Average Spill from Confluence Model Results for the Proposed Project



The effect of warm spill from the reservoir is offset by cold water released through the fish release. In May, the warmest surface temperature in the City database is 24.6°C. If 16 cfs is flowing over the spillway at that temperature, a simple mass/energy balance would predict that the resulting flow in Newell Creek downstream of the spillway would be 23.9°C after mixing

with a flow of 1 cfs from the fish release at 12°C. Increasing the fish release to 6.5 cfs would result in a temperature of 21°C. An upgrade to the Newell Creek Dam outlet structure, currently under construction, will allow for significantly higher releases. During June, the Confluence model predicts much lower spill levels. The highest spill amount for June was modeled at 19 cfs but this was the result of a late season storm in the historic hydrologic record for 2011 representing a single day of the record. In all other model years, predicted spill in June was 10 cfs or less and only exceeded 5 cfs about 1% of the time. The amount of cold release to cool this level of spill to 21°C or less (~3 cfs), is well within the capacity of the fish release, even at the maximum observed June reservoir surface temperature of 26.3°C. For July, the maximum spill in the model results is 2.5 cfs and the maximum temperature in the City monitoring data for July is 26.9°C. Under these conditions a flow of 2 cfs through the fish release at 12°C would be sufficient to lower the resulting temperature to less than 21°C.

Limited temperature data available in Newell Creek downstream of the dam suggests that the effect of the spill on water temperature below the dam can be substantial but appears not to exceed suitable levels for rearing steelhead or coho under the Baseline. During 2019, the reservoir was spilling for most of the period from early February through late June. Maximum water temperature recorded below the dam[4] in April was 20.3°C when the reservoir was spilling at approximately 5 cfs or less. The average daily temperature below the dam, however, was never higher than 18.1°C in April. The reservoir was spilling at no more than 2 cfs in June 2019 and maximum recorded water temperature downstream reached 19.1°C. Average daily temperatures were below 17°C during June and declined to less than 12°C by the time spill ceased near the end of the month.

Temperature increases due to spill are likely to influence temperature conditions in the San Lorenzo River downstream of Newell Creek. There is a limited amount of temperature data for the San Lorenzo River at the Newell Creek confluence (Figure 3). These data indicate that water temperature approaches 20°C during peak summer warming and that Newell Creek appears to have a slight cooling influence during the summer (1°C or less) and a very slight warming influence in winter. The only datapoint potentially influenced by spill is May 9, 2019.

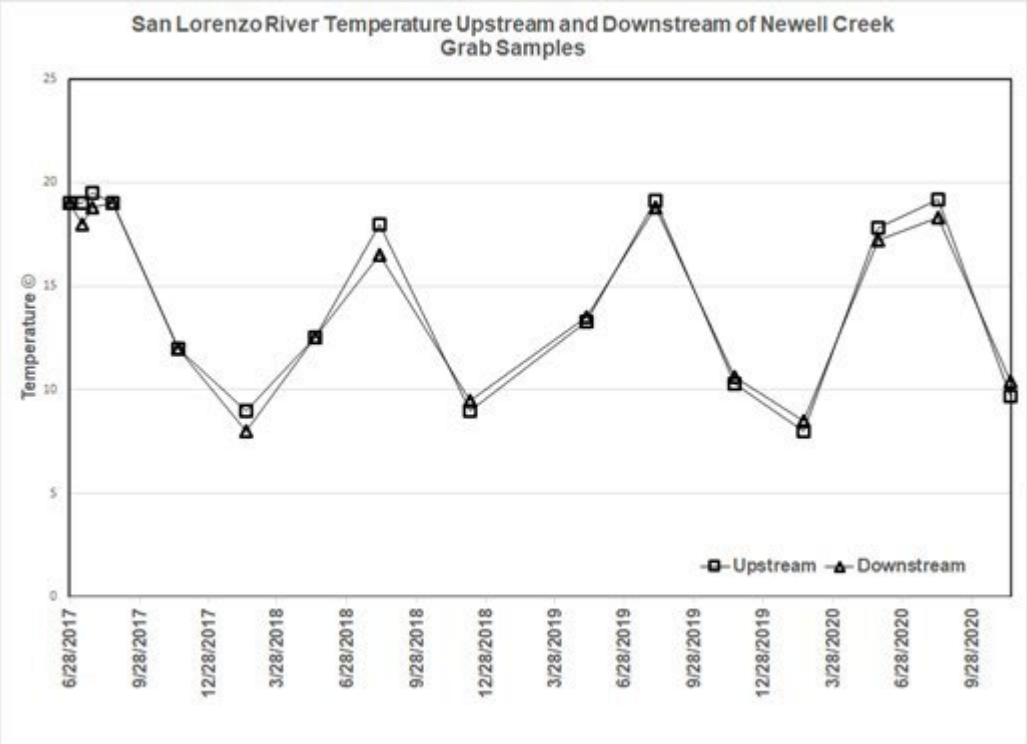
Streamgage and reservoir elevation data indicate that the reservoir was spilling at a low volume (1 cfs or less) and temperature data records for Newell Creek below the dam show a value of 14 to 14.1°C bracketing the time temperatures were recorded in the San Lorenzo River. This is consistent with the observation of 13.3°C upstream of the Newell/San Lorenzo confluence and 13.5°C downstream of the confluence. Maintaining water temperature of 21°C or less below

[4] Temperature, reflecting both the fish release and reservoir spill, is continuously recorded by the City at the stream gage downstream of the dam at a 15-minute recording interval. Data has been collected since July 2017.

Newell Creek dam during periods of spill should also minimize any thermal effects in the San Lorenzo River.

Increased frequency of spill in April and May with associated warmer temperatures may actually be beneficial for rearing steelhead (and coho if present) as long as the temperature is still within the suitable range. Salmonids grow faster at warmer temperatures within the suitable range with adequate food supply. Increased spill in June may also be beneficial as long as it does not result in temperature above the suitable level.

Figure 3: San Lorenzo River Temperature Upstream and Downstream of Newell Creek, 2017-2020



3.2 Analytical Framework, Model Structure, and Biological Parameters

The methodology takes its structure from the salmonid life cycle and is focused on quantifiable relationships between important aspects of the life cycle that are influenced by streamflow. The habitat models address the effect of flow modification on four key life-history elements: migration of adults from river mouth to upstream spawning areas; deposition and incubation of eggs in the streambed; rearing of juveniles to smolt stage; and downstream migration of smolts

to the stream mouth. These elements were selected because they represent key aspects of the species' life history that are potentially influenced by alteration of streamflows by the City. The development of models for each of these four key elements is summarized below and is more fully described in HES (2014).

Adult Migration

The relationship between flow and passage criteria (depth) was evaluated in the stream reaches below five of the City diversions (Liddell, Laguna, Majors, Tait Diversion, and Newell Creek downstream of Newell Creek Dam) by application of the results of the critical riffle analysis. Thresholds for adult migration passage are presented in Table 1.

A different method was used to evaluate adult migration through the San Lorenzo River between the Felton Diversion and the Tait Diversion. As described previously, adult passage requirements in this reach were analyzed using a desktop method provided by CDFW (R2) and correlation with other adult passage sites where physical data were available. This method generates a single value for minimum flow meeting migration requirements downstream of the Felton Diversion (Table 1).

Table 1: Parameter values (flow in cfs) and timing used in effects analysis

Location	Adult Migration Threshold (Min-Max Flow in cfs)	Spawning	Incubation (Minimum Flow in cfs)	Rearing	Smolt Migration Threshold (Minimum Flow in cfs)
	Timing				
	Dec-Mar/Apr	Dec-May	Jan-May	All	Jan-May
Laguna Creek	10.6-15.5	Fig. 1a	4.0	Fig. 2a	3.8
Liddell Creek	4.9-11.3	Fig. 1b	2.0	Fig. 2b	2.0
Majors Creek	9.0-16.0	Fig. 1c	2.9	Fig. 2c	3.4
San Lorenzo R. @ Tait	17.0-25.2	NA[5]	NA[13]	Fig. 2d	10.0
San Lorenzo R.@ Felton	40.0	Fig. 1d	20.0	Fig. 2e	20.0
Newell Creek	11.4-24.4	Fig. 1e	1.0	Fig. 2f	8.3

[5] No spawning occurs in this reach.

Spawning and Incubation

The relationship between flow and spawning habitat quality was assessed in the anadromous reaches of study streams by collecting data to calibrate a PHABSIM model. Salmonid spawning habitat is well-modeled with PHABSIM since salmonids have quite specific preferences for type of substrate, water depth, and flow velocity and tend to select locations that have hydraulic features that are relatively easy to model. Spawning habitat value is expressed in units of WUA per unit length of stream which accounts for both the areal extent and suitability of habitat. The analysis generates a curve of WUA vs. discharge (flow) that, in general, has zero value at low levels of discharge, rises to an optimum level at some intermediate flow, and decreases at higher flows (Figure 4).

Juvenile Rearing

The relationship between flow and rearing habitat quality was described in study streams through application of the PHABSIM model. Diversions throughout the year have the potential to alter habitat conditions for rearing salmonids in the study streams. The suitability of rearing habitat, as with spawning habitat, is expressed as WUA per unit length of stream (Figure 5). Curves of rearing WUA vs. discharge in this application of the model were more variable than the spawning curves. For steelhead the curves show an increase in habitat suitability from low values at lower flows, an increase to higher levels as flows increase and a gradual flattening of the curve (Figure 5). For coho the curves are relatively flat with higher values at minimum flows than steelhead, a low peak at lower discharge than steelhead, and a gradual decline at higher discharge levels.

Smolt migration

Diversion during the spring, particularly during April and May, may potentially reduce passage opportunities for steelhead and coho smolts at critical passage locations in the anadromous reaches of streams. The relationship between flow and passage criteria (depth) was evaluated in the anadromous reaches of study streams by application of the critical riffle analysis using the same sites, channel data, and hydraulic data as for adult passage; only the depth criteria were altered for evaluation of smolt passage. Thresholds for smolt migration determined by this method are shown in Table 1.

Use of Habitat Models to Evaluate the ASHCP

Evaluation of the ASHCP involves linkage of the hydrologic database, the Confluence operations model, and a suite of habitat models. Using a schedule of bypass flows developed in

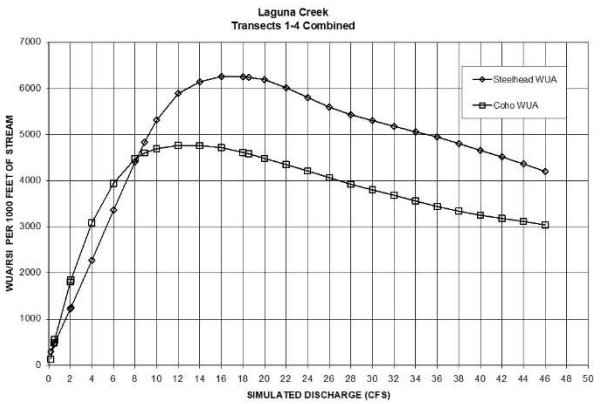
the ASHCP process that are considered protective of anadromous salmonids (the Conservation Flows), the hydrologic record is conditioned by reserving the Conservation Flows and calculating the amount of flow available for diversion on a daily basis (the available flows). The Confluence model then uses the available flows as input to determine daily diversions from each source (see Appendix 8-2). Depending on supply needs, the Confluence model may divert the entire amount or some portion of the available flows. The Confluence model output includes the amount of flow left in the stream after diversion for City supply. These are the residual flows. The residual flow is either the Conservation Flow for that time period, the Conservation Flow plus whatever amount is not needed for City supply, or the natural streamflow if the available flow is zero and diversion is precluded. The habitat models use the residual flows rather than the Conservation Flow as the basis for effects analysis since this is what would actually be in the stream and often reflects flows that are in excess of City supply needs, particularly during winter high flow periods and during wetter years.

The habitat models are constructed as linked spreadsheets for each of the six diversion points. Each spreadsheet takes input as daily time-series for up to six flow scenarios. Flow scenarios are the residual flows output from the Confluence model (see Appendix 8-2). Each flow scenario has a series of habitat values calculated for each relevant life-stage in each reach. Daily values of migration potential for adults or smolts are calculated based on parameter values in Table 1 as a binary parameter (1 for suitable or 0 for not suitable). WUA for spawning and/or rearing are calculated on a daily timestep with reference to WUA vs. discharge curves (Figures 4 and 5). Figure 4 shows how spawning habitat changes with flow in each of the stream reaches affected by City diversions. As flow (discharge, x-axis) increases, habitat value for spawning (WUA, y-axis) increases rapidly from very low levels at zero flow to a peak and then declines more gradually at higher flows. For example, in Laguna Creek the spawning habitat index peaks at a flow of about 16 cfs for steelhead and about 12 cfs for coho (Figure 4a). Figure 5 shows how rearing habitat changes with flow. In general, the rearing habitat index for steelhead increases from low levels at zero flow and then increases more slowly, remains constant, or declines slightly at higher flows, depending on the stream reach. For coho, the rearing habitat index is higher at zero flow[6], reaches a peak at relatively low flows and declines at higher flows (Figures 5a and 5f). The daily flow from the Confluence model output of residual flows at each diversion point determines the habitat index value for each life stage. The habitat index may be either the WUA value for spawning or rearing or the number of days with suitable conditions for migration of adult or smolt life stages. Index values for each flow scenario are summarized (averages or counts) and tabulated and graphed.

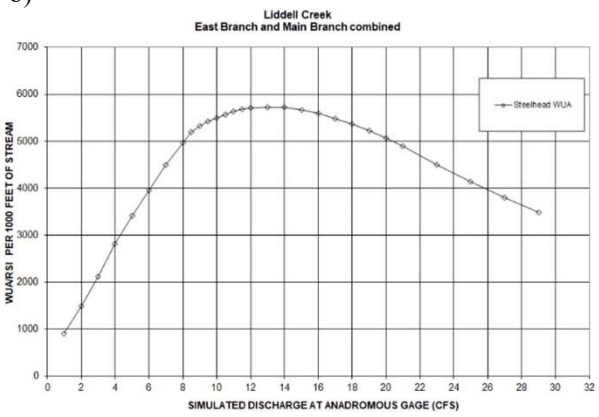
[6] Juvenile Coho prefer lower velocities such as occur in pools. Suitable habitat can occur in residual pools with little or no surface flow.

Figure 4: Spawning Habitat Suitability vs. Flow Functions for Steelhead and Coho Used in Effects Analyses

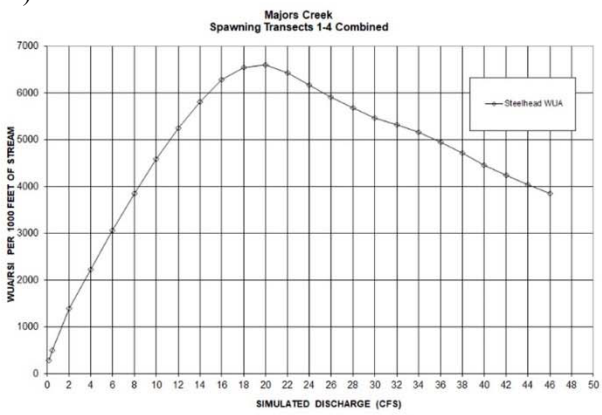
a)



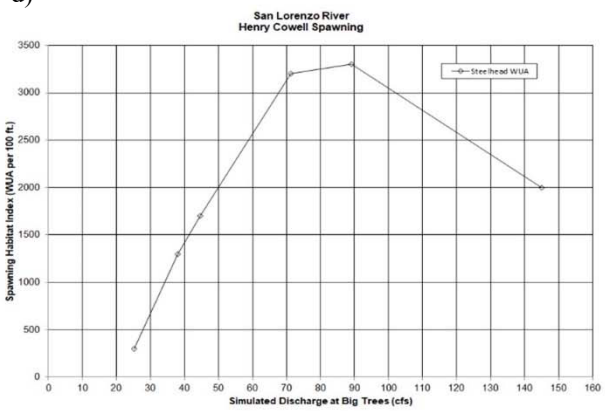
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e)

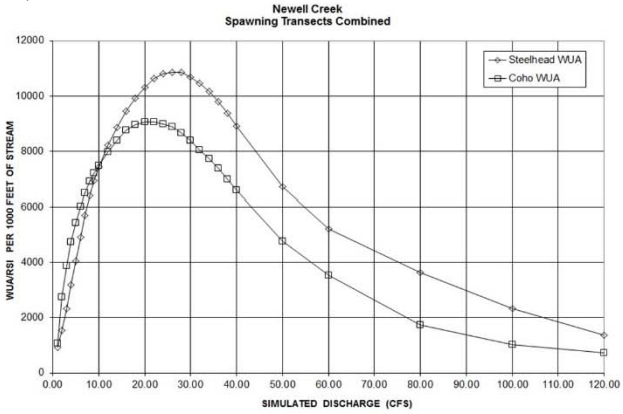


Figure 5: Rearing Habitat Suitability vs. Flow Functions for Steelhead and Coho used in Effects Analyses

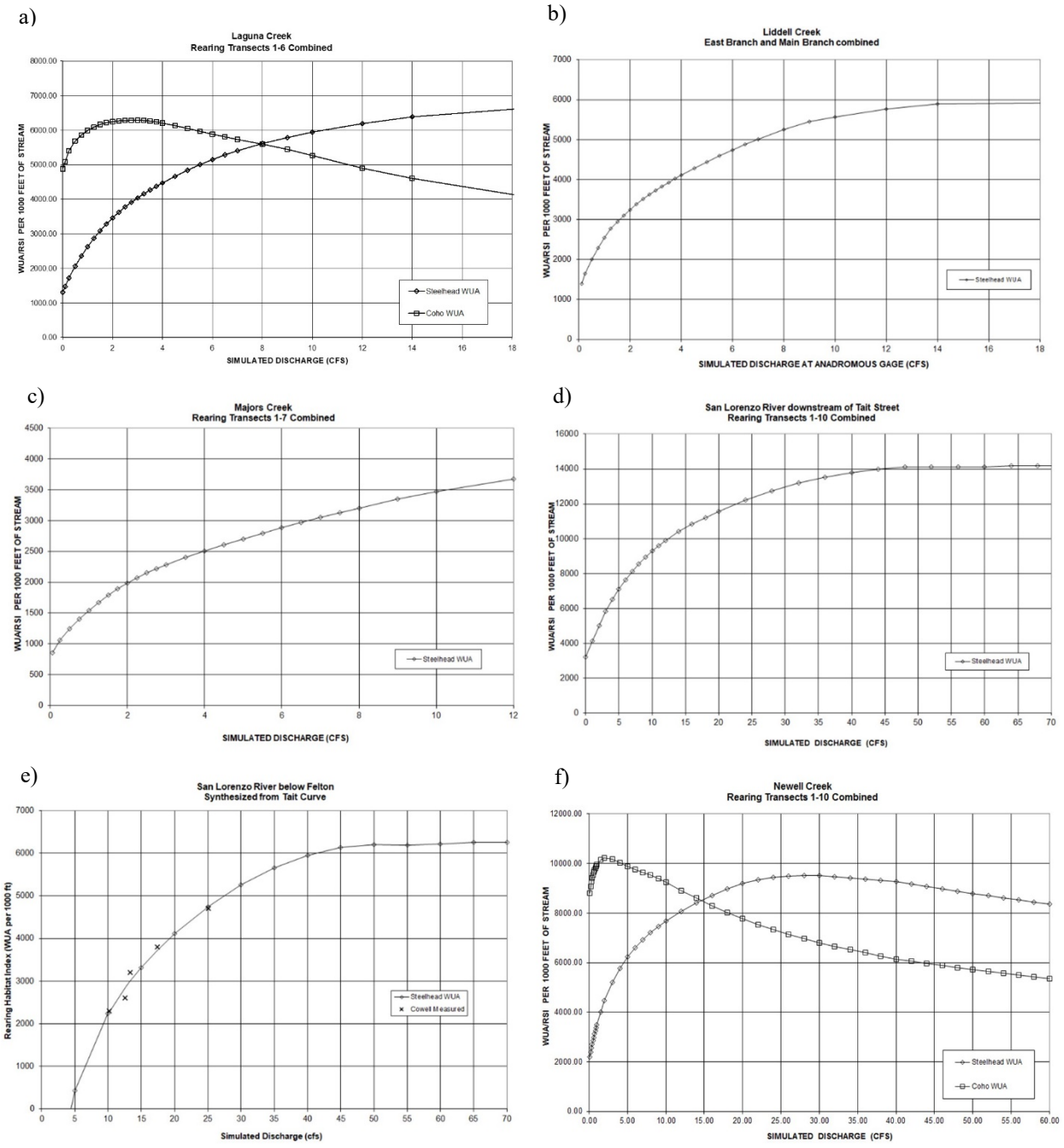


Table 2: Comparison of Interim Bypass Flows and Conservation Flows.

Location/Life Stage	Interim Bypass Flows (Baseline)	Conservation Flows (ASHCP)
Laguna Creek Adult Migration Spawning/Incubation Rearing Smolt Migration	No required bypass in April None required in December	Bypass required in April in 0-60% hydrologic exceedance conditions (HCs) Bypass required in December
Liddell Creek Adult Migration Spawning/Incubation Rearing Smolt Migration	No required bypass in April None required in December	Bypass required in April in 0-60% HCs Bypass required in December
Majors Creek Adult Migration Spawning/Incubation Rearing Smolt Migration	No required bypass in April None required in December	Bypass required in April in 0-60% HCs Bypass required in December
San Lorenzo River @ Tait Adult Migration Spawning/Incubation Rearing Smolt Migration	No required bypass in April	Bypass required in April in 0-60% HCs
San Lorenzo River @ Felton Adult Migration Spawning/Incubation Rearing Smolt Migration	Minimum bypass 20 cfs Nov 1-May 31 10 cfs September, 25 cfs October, No diversion July-Aug	Minimum bypass 40 cfs Dec-Apr when flow without diversion would occur at this level, 40 cfs for 14 days following potential migration event 20 cfs Nov 1-May 31, 10 cfs September, 25 cfs October, No diversion July-Aug
Newell Creek Adult Migration Spawning/Incubation Rearing Smolt Migration	1 cfs minimum bypass	1 cfs minimum bypass, 0.25 cfs during low Loch Lomond storage

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Appendix 9: Rationale for Determining Minimum Instream Flow Targets

Rationale for Determining Minimum Instream Flow Targets

Background and Overview

Minimum bypass flow requirements have been developed as part of the City's Habitat Conservation Plan for anadromous species (ASHCP) in order to minimize the effect of diversions on habitat conditions for steelhead and coho salmon. Flow reductions, particularly during the summer low-flow season, represent one of the City's major effects on steelhead and coho salmon in the ASHCP planning area. There are currently no instream or bypass flow requirements for the Tait Street or North Coast diversions.

Bypass flows were developed through an iterative process that considered both the habitat values of instream flows as well as the ability of the City to meet its water supply obligations. Instream flow alternatives were modeled using the City's water supply operations model (Confluence® Model) to understand the effect of various flow alternatives on the City's water supply obligations. The City also developed a series of fisheries habitat-based models to analyze the effect that the various flow alternatives would have on covered species habitat (Appendix 8). This process was the combined effort of a technical working group convened by the City beginning in 2005 and composed of resource agency personnel representing NMFS and CDFW, City staff, and consultants.

The City submitted a proposal for instream bypass flows and other conservation measures in June 2012 to the technical working group (City of Santa Cruz 2012). CDFW responded to this proposal with comments and proposed modifications to the flow proposal (CDFW 2012). The City worked to resolve comments provided by CDFW and completed modeling studies of several iterations of the CDFW proposal that were ultimately codified as DFG-5. In 2014, the City Council convened a Water Supply Advisory Committee (WSAC) to engage a multi-disciplinary, stakeholder-driven process that would advise the Council on future water supply development. Based on the information developed through field studies and iterative model runs, the Water Supply Advisory Committee (WSAC) convened by the City recommended that the City adopt the flow alternative that was the most protective of the covered species (the CDFW proposal known as DFG-5) and develop a new water supply that would make it practicable for the City to provide the flows for Covered Species while meeting its water supply obligations.

The City's objective is to use available water supplies to restore natural flow regimes at times and locations where it will have the most beneficial effects on steelhead and coho salmon production. In order to meet this objective, priorities were established for the different streams and life-stages influenced by City diversions. Priorities were

determined based on factors including the amount of habitat and size of populations influenced by each diversion; diversion capacity compared to streamflow levels; and responsiveness to flow increases in comparison to other potentially limiting factors.

All of the streams in the ASHCP Planning Area currently support steelhead. The San Lorenzo River potentially supports coho salmon. The Coho Recovery Plan (NMFS 2010) does not consider Laguna Creek, Liddell Creek, and Majors Creek as potential habitat for coho salmon under current conditions. However, since coho have been observed on several occasions in Laguna Creek since 2005, Laguna Creek is considered potential coho habitat for the purposes of this ASHCP.

Of the North Coast streams, Laguna Creek was given highest priority since it has the greatest length of anadromous habitat influenced by City diversion; it is the only one with a functional lagoon system; it has experienced the largest proportional flow diversion; and it has supported production of coho in recent years. Liddell Creek was given the lowest priority since the City diversion influences only a portion of the potential anadromous habitat; base flows are generally higher in the anadromous reach due to augmentation from the West Branch, the Middle Branch, and basin hydrology; there is no lagoon; and there is a high level of fine particles in the substrate that diminish habitat quality and potentially limit the benefits of any flow augmentation.

Steelhead populations in the North Coast streams are relatively small due to the short lengths of anadromous habitat. Based on rearing densities of smolt-sized steelhead in snorkel surveys and stream length, it is estimated that each stream currently produces in the range of 150 to 400 smolts annually (Table 1). Electrofishing data collected in 2009 indicate that these numbers could actually be somewhat higher, possibly by a factor of two (HES 2011). Laguna Creek lagoon has the potential to produce on the order of 828 smolts, based on population estimates in 2014 (HES 2015). Using estimates of adult return rates of 3% for stream-reared fish and 8.3% for estuary-reared steelhead (Shapovalov and Taft 1954; Bond 2006) yield estimates of adult populations of less than half a dozen for Liddell and Majors Creeks and about 80 for Laguna Creek, of which over 80% would be from the lagoon. Even if stream densities were 3 to 4 times higher, these would still be very small populations.

Table 1: Steelhead Production Estimates in North Coast Streams

	Anadromous Reach Length (miles)	Percent Pools by length[1]	Density of Smolt-size Stream Steelhead (# per 100 feet) [1]	Population Estimate for Stream Smolts	Fall Lagoon Population Estimate for Smolts[2]	Potential Adult Returns of Stream Smolts	Potential Adult Returns of Lagoon Smolts	Potential Total Adult Return
Liddell	1.16	0.33	7.2	146		4		4
Laguna	1.43	0.63	8.3	395	828	12	69	81
Majors	0.7	0.72	5.5	146		4		4

[1] City of Santa Cruz snorkeling data.

[2] Based on fall 2014 abundance (HES 2015).

Rearing densities of smolt-sized fish in Newell Creek averaged about 13.7 per 100 feet of stream during population surveys conducted from 1994 to 2019 (Santa Cruz County Environmental Health 2020). If these fish were all anadromous, this would result in an estimate of about 615 smolts in the 0.85 miles of most productive habitat in the anadromous reach. Using the same 3% return rate, this would result in an estimated return of about 18 adult steelhead, on average, depending on ocean conditions and many other factors.

The San Lorenzo River lagoon has the potential to produce a large number of steelhead smolts. In 2005, NMFS estimated that there were 4,000-6,000 smolts rearing in the lagoon over the summer months (2ND Nature 2006). This was the highest estimate between 2004 and 2016. In spring 2017, there were an estimated 3600 steelhead juveniles in the lagoon and monthly estimates of catch per unit effort doubled to tripled through September (HES 2018). In 2019 there were an estimated 12,141 juveniles in the lagoon in June and 14,105 in September (HES 2020). These estimates likely represent the maximum rearing capacity of the lagoon under present conditions. Using Bond's estimate of 8.3% return rates for estuary-reared steelhead, this would potentially result in maximum returns of approximately 300-1100 adult steelhead in addition to those from production in the mainstem and tributaries[1].

This analysis, while somewhat hypothetical, indicates the relative importance of the San Lorenzo River and Laguna Creek, particularly the lagoon habitat, in supporting steelhead populations in the ASHCP area and the relatively small contribution of Newell Creek and

[1] To put this estimate in context, estimates of adult steelhead returns to the San Lorenzo River summarized from various sources by D.W. Alley & Associates (2005) range from around 300 to 3000 during discreet periods between the mid-1930s and 2004 when estimates were made.

the other North Coast streams. While coho salmon are extirpated from the San Lorenzo River and North Coast streams, the river is a focus of recovery efforts by NMFS. The lower San Lorenzo River and some of its tributaries may play important roles in the recovery strategy for Central California Coast coho salmon (NMFS 2010).

Development of Bypass Flows

Assessment of flows needed to support steelhead and coho salmon populations in each stream is based on measures of habitat quantity and quality as a surrogate for measures of fish abundance, since an approach involving the latter is generally unsupported by available technical information and accepted analytical procedures. In contrast, the relationship between flow and habitat for spawning, rearing, and passage in each stream can be explored through habitat modeling using the Physical Habitat Simulation (PHABSIM) model of the Instream Flow Incremental Methodology (Bovee et al. 1998) and other analytical techniques. Application of the PHABSIM model, along with other existing information, provided the basis for evaluating instream flow scenarios to improve habitat conditions for steelhead and coho salmon (HES 2014).

Development of proposed flow targets is based on the following goals for habitat conditions in priority streams:

1. Year round rearing base flows meeting an average of at least 80% of habitat value that would occur in the absence of City diversion in Laguna Creek and 60-80% in the San Lorenzo River downstream of Tait Street. Minimum inflow of 8 cfs to San Lorenzo River Lagoon. Base flows resulting in slight improvement over existing conditions in Liddell and Majors Creeks. Flows complying with existing agreements in Newell Creek and San Lorenzo River below Felton, including no diversions from June through August.
2. Flow meeting minimum migration criteria for adult steelhead and coho whenever it would occur in the absence of City diversion during the adult migration period in December through March (relaxed in Liddell and Majors Creeks in 60-100% exceedance hydrologic conditions).
3. Flow meeting 80% of peak habitat for spawning for 14 days after the end of migration periods (relaxed in Liddell and Majors Creeks in 60-100% exceedance hydrologic conditions).
4. Flow maintaining wetted width of channel at spawning sites following most recent spawning period and during incubation and pre-emergence period (relaxed in Liddell and Majors Creeks in 60-100% exceedance hydrologic conditions).
5. Flow meeting minimum migration criteria for smolts during smolt emigration period (March-May). This is relaxed to bypass flow on 3 consecutive days in

very dry conditions (80-100% hydrologic condition) in the San Lorenzo River and in dry and very dry conditions (60-100% exceedance hydrologic conditions) in Liddell and Majors Creeks.

6. Prescribed ramping rates to minimize potential for stranding from flow reductions when there is a reduction in bypass requirement and/or diversions come back on-line.

The bypass flow schedules are designed to be driven by the natural hydrograph, which varies significantly from year to year. The flow schedules are different for different hydrologic conditions (very dry, dry, normal, wet, very wet) that are determined on a month-by-month basis by reference to the historical record of the Big Trees stream gage. For each hydrologic condition, there is a base level of flow supporting juvenile rearing that varies from month to month based on the natural pattern of higher wet-season base flows and lower dry-season flows. During the months of December through May, this rearing base flow can be interrupted at any time (on a daily basis) by actual hydrologic conditions in the form of storm flows. If storm flows are high enough to allow for adult migration, this triggers migration flows which will be sustained as long as they naturally occur. As flows drop below the migration threshold, a progression of flows for spawning and incubation are triggered.

This precise system is very flexible in order to harmonize with the natural hydrograph, but involves many moving parts and very detailed attention to the City's water diversion rates. The advantage is that appropriate flows are provided for habitat exactly when and in the amounts that they are most beneficial and would be naturally available. This can also be beneficial from the perspective of the City's supply activity; diversions are curtailed only during those periods when they are providing actual benefits to the instream resources, leaving flows available for diversion at other times. Periods when flows are in excess of the needs of anadromous species are defined by the hydrograph and signal when extra water can be diverted for storage with minimal effect on habitat. It was essential to test the bypass flow requirements in the City's water supply model (Confluence®) to ensure that supply needs could still be met.

Definition of Hydrologic Categories

Due to the extreme range of seasonal and inter-annual flow variation occurring in ASHCP streams and the inability to predict flow conditions from month to month during the wet season, the bypass flows are specified on a month-by-month basis for each of five different hydrologic exceedance conditions. The hydrologic conditions (HC) are based on the record of cumulative daily average flow at the Big Trees gage on the San Lorenzo River. Cumulative water-year flow was calculated for each month in the record (water-years 1937-2015) and sorted from lowest to highest (Table 2). This record was split into

five equal parts representing a range of exceedance categories from 100% (flow exceeded 100% of the time) to 0% (flow never exceeded). This results in five HC classes for very dry, dry, normal, wet, and very wet conditions as HC 5, 4, 3, 2, and 1, respectively). Hydrologic condition limits by month are shown in Table 2. Over time, and particularly with changing climate conditions, frequency of occurrence in each Category may diverge from historical frequencies.

Operationally, the hydrologic category is determined each month based on the cumulative water year flow at Big Trees for the preceding month. This approach is not intended to replace, and is not incompatible with, the forecasting model used by the City, which is based on four year-types with a determination made in March for the current water-year. Rather, it provides an additional tool for dealing with the complexity of species habitat needs. Using the water-year type to define bypass flow requirements would mean that the water-year type is undefined until March and there would be no basis for provision of bypass flows during the important and dynamic winter months. Bypass flows based on the previous seasons runoff result in the potential for in-stream flows that can be too low in wetter winters following a dry year (negatively impacting habitat), or too high in dryer winters following a wetter year (negatively impacting City supply). Although bypass flows are determined based on the HC system, results are still presented by water-year type for consistency with other City programs. The hydrologic condition changes from month to month while the water year applies to a complete annual cycle. Each water year may be composed of months having a variety of hydrologic conditions. For example, a wet water year may start with a dry fall and early winter with HC-4 or HC-5 from October through January, then have a very wet February ending in HC-2 or HC-3 and a wet March ending in HC-1 or 2.

Table 2: Hydrologic Condition Limits for End of Month Cumulative Daily Flow (cfs) for Water Year at San Lorenzo River Big Trees Gage, Period of Record 1 October, 1936 to 30 September 2015*

Hydrologic Condition Limits* (End of Month Cumulative Daily Flow from October 1 in cfs)					
	Category 5 80-100 %	Category 4 60-80%	Category 3 40-60%	Category 2 20-40%	Category 1 0-20%
Oct	<=459	460 to 539	540 to 709	710 to 875	>875
Nov	<=1186	1187 to 1497	1498 to 1827	1828 to 2485	>2485
Dec	<=2397	2398 to 3134	3135 to 5642	5643 to 10196	>10196
Jan	<=4322	4323 to 8456	8457 to 16694	16695 to 28019	>28019
Feb	<=8442	8443 to 16368	16369 to 29140	29141 to 42995	>42995
Mar	<=13004	13005 to 22948	22949 to 35371	35372 to 57968	>57968
Apr	<=14203	14204 to 24491	24492 to 39487	39488 to 67884	>67884
May	<=15448	15449 to 25279	25280 to 41659	41660 to 71412	>71412
Jun	<=16005	16006 to 26116	26117 to 43123	43124 to 73420	>73420
Jul	<=16364	16365 to 26819	26820 to 44073	44074 to 74718	>74718
Aug	<=16653	16654 to 27355	27356 to 44799	44800 to 75591	>75591
Sep	<=16978	16979 to 27843	27844 to 45398	45399 to 76368	>76368

* Hydrologic condition limits are set by the historical record period as indicated. These limits will be applied over the life of the ASHCP to maintain consistency with effects analyses. Over time, and particularly with changing climate conditions, frequency of occurrence in each Category may diverge from historical frequencies.

Flow targets were tailored to achieve habitat benefits across the full range of hydrologic conditions in each year type (Figure 1). In any month, the bypass flow is driven by the active life stage having the highest flow requirement. Rearing baseflows are provided when other life stages are not controlling, such as before the occurrence of flow at the migration level in Figure 1. Natural flow that exceeds the level at which migration is possible triggers the migration flow bypass, as occurs on February 9 in Figure 1. Adult migration flows are presented as an upper and lower threshold with diversion halted when the lower threshold is reached and not resumed until natural flows exceed the upper threshold or recede below the lower threshold. Only the amount of flow in excess of the upper threshold is available for diversion. If flow drops below the lower threshold, the life stage with the next highest flow requirement would determine the minimum bypass level. Spawning flows are provided for a period of 14 days following the last occurrence of a migration flow. Incubation flows are provided for a period of 60 days following the last spawning flow or until May 31st, whichever occurs first (Figure 1). Flow in excess of the bypass amount is available for diversion. When the bypass flow exceeds the natural

flow, diversion is curtailed, as happens in Figure 1 for very brief periods as the hydrograph recedes from the upper migration threshold to the lower; at the end of the 14 day spawning period; and just before incubation flows end on May 31. These general provisions may be relaxed in specific circumstances as described below.

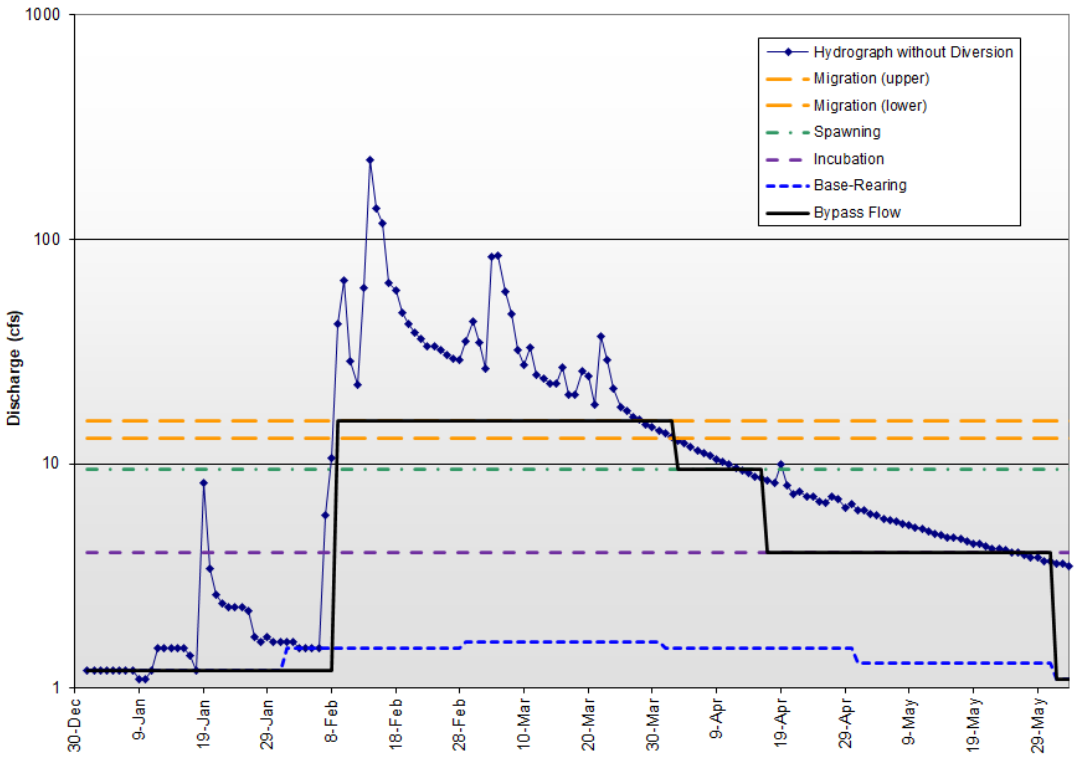


Figure 1: Schematic of Hydrograph Showing how Bypass Flows are Determined by the Natural Hydrograph, Salmonid Life Stage Timing, and Flow Requirements.

Flow Targets by Life Stage

Development of the instream flow targets started with a rearing base flow to be provided to support the rearing juvenile life stage during times when streams are not influenced by recent precipitation. The rearing base flow is the default flow when higher flow is not proposed for a particular life stage, for example, during the late summer when only rearing is occurring or during the winter if storms have not created conditions suitable for migration and spawning. Rearing base flow proposals were developed based on naturally occurring hydrologic characteristics (data developed by Balance Hydrologics), field observations, and professional opinion and were supported by PHABSIM modeling results. The late spring/early summer period was favored over the later summer for increased stream flows consistent with the natural hydrograph and the assumption that

this is a critical time period for rearing success (Harvey & Stanley Associates, Inc. 1982). Studies in Santa Cruz County streams in the early 1980s indicated that the importance of stream flow appears to be in the spring when these fish show a large increase in size (Harvey & Stanley Associates, Inc. 1982). It is not necessarily the low late summer/fall flows in Santa Cruz County streams that limits density of smolt-sized steelhead, but is instead the amount of adequate cover such as pool development, undercut banks, and unembedded cobble (Harvey & Stanley Associates, Inc. 1982).

Flow bypasses during the December through May time period are designed to protect adult migration, spawning, incubation, and smolt emigration. In order for upstream migration of adults to occur, the mouth of the stream must be open. It is assumed that flow at a level sufficient to meet minimum migration levels is also sufficient to open the mouth in project streams. The available area for lagoon development at the mouth of Laguna Creek is relatively small and is virtually non-existent at Liddell and Majors Creeks. Based on size alone, it would be expected that relatively little inflow is needed to open the mouth and that the first major storm of winter may provide sufficient inflow for that purpose in combination with wave erosion of the beach at that time of year. This is also true for the San Lorenzo River lagoon where storms result in high runoff and storm flows can be significantly greater than the City's diversion capacity. Since the City diversions are not operated during the initial phases of storm runoff (HES 2012), the potential effect of diversion operations on opening of the mouths is avoided.

When City diversions resume operations following storm peaks, there is the potential to limit migration periods by truncating the recession limb of storm hydrographs. Once the mouth has opened and flows have exceeded minimum passage levels, impacts to migration flows in priority streams are avoided by limiting diversions to maintain a flow window for migration whenever those flows would occur in the absence of City diversions. Minimum passage flow windows were determined from field studies as further described below (HES 2014). Adult migration flows are provided from December through April. Adult migration flows are triggered after the stream mouth opens and anytime thereafter when daily average flow (absent City diversion) is at or exceeds minimum adult migration flows for one day. In lower-priority streams, adult migration bypass flows may be relaxed during dry or critically dry periods (60-80% or 80-100% hydrologic conditions).

Minimum migration flows were estimated at critical riffles. The migration passage flow assessment is based on standards developed in the fisheries literature. These standards assume that there must be sufficient depth over the shallowest riffles for the target species to swim upstream with its body completely covered. Specifically, the critical depth must occur across 25% of the wetted channel width and across a contiguous section comprising 10% of the wetted channel width (Thompson 1972, Bjornn and Reiser 1991, CDFW 2013). The critical depths used in this analysis are 0.6 feet for adult steelhead and

0.3 feet for steelhead smolts. The flow meeting the passage criteria at each of several critical riffles was determined from field measurements (HES 2014).

There are numerous sources of error in the method including measurement of flow and associated rating curve, measurement of channel features and placement of cross-sections, and assumptions about depth required for steelhead passage. For example, it is assumed that adult steelhead need a depth of 0.6 feet to migrate with their backs in water but in fact they may be able to pass an obstacle with only 0.5 feet of depth or less and their backs partially exposed. In addition, there is likely a minimum of at least 5-10% error in estimation of the flow that provides a depth of 0.6 feet. If fish can migrate at flows lower than the minimum flow estimate, resuming diversions when flows drop to lower levels could impair passage. Some sort of buffer is desirable. Therefore, the flow meeting passage criteria at the least critical cross-section was used as the lower migration flow threshold and the flow meeting passage criteria at the most critical cross-section was used as the upper migration threshold. This provides a protected "window" for migration passage with diversion halted when the lower threshold is reached and not resumed until flows exceed the upper threshold. Only the amount of flow in excess of the upper threshold is available for diversion. If flow drops below the lower threshold, the life stage with the next highest flow requirement would determine the minimum bypass level.

After a passage event has occurred, impacts from City diversions in priority streams are avoided or minimized by maintaining flow in the anadromous reach sufficient for spawning and embryo incubation. Spawning flows are provided from December through May, covering both the steelhead and coho salmon spawning periods. Results of the PHABSIM analysis were used to determine the flow that provides 80% of the peak spawning habitat for each stream. This is the spawning flow target and it is in place for a period of 14 days following the last occurrence of a migration flow. If streamflow falls below the minimum migration level during the 14-day period, the natural streamflow is provided (i.e., there is no diversion). After 14 days, and assuming no additional migration events, flow requirements would target protection of incubating eggs and developing fry. Analysis of PHABSIM data was used to determine the level of flow needed for incubation to maintain wetted conditions across the channel at spawning cross-sections in each stream. This level of flow is provided for a period of 60 days following the last spawning flow or until May 31st, whichever occurs first. If streamflow falls below the incubation level during this period then the natural streamflow is provided (i.e., there is no diversion). The period for embryo incubation is January through May. In lower-priority streams, spawning and incubation bypass flows may be relaxed during December and in dry or critically dry periods (60-80% or 80-100% hydrologic conditions).

Smolts migrate downstream, primarily in March, April and May, and City diversions potentially limit migration periods by reducing flow below levels needed by smolts to

pass critical riffles and other migration obstacles. Minimum passage flow estimates for smolts were developed at each of the critical passage locations using depth criteria appropriate for smolts (HES 2014). Impacts of City diversions are avoided or minimized by bypassing the smolt migration minimum, or natural flow if less than the minimum, during the smolt migration period (January through May). During dry periods (80-100% hydrologic conditions) bypasses for smolt migration may be reduced to 3 consecutive days per week in lower priority streams.

Multiple life stages may be present at any given time and each life stage has different optimum flow levels. The flow target at any given time would be the target for the life stage present at that time with the highest flow requirement. For example, during the spring period, smolt migration and rearing can occur simultaneously and the flow target will be the higher of the two, usually smolt migration. Rearing habitat value will therefore be somewhat elevated when flows for smolt migration are provided.

The transition between flow levels is also important. When a diversion is initiated after being inactive or is increased, there is a potential for rapid change in flow that could lead to stranding of salmonid fry and other aquatic life. To avoid or minimize this potential effect, the City will incorporate SOPs for operation of all its diversions to limit flow reductions such that change in stage is no greater than 0.16 feet per hour when fry may be present (January 15 through May 31) and no greater than 0.3 feet per hour at other times (NMFS 2007). A flow reduction schedule will be developed for each diversion such that the change in diversion rate does not exceed the change in stage criteria. The point of reference for stage change will be the anadromous gage in each stream.

Minimum bypass flow targets are presented as minimum flows that represent a floor for City diversions such that diversions would not reduce flow below these levels. The effect of diversion limitation must be assessed through hydrologic modeling, not simply by evaluating the minimum flow proposals. Actual flows are often substantially higher than maximum diversion rates so flow in the anadromous reach is often substantially higher than the proposed flows.

Specific Considerations by Stream Reach

Tait Street Diversion and Wells

The primary potential effects on steelhead and coho salmon from the Tait Street Diversion are related to deterioration of migration and rearing habitat from reduction in stream flow. There is no suitable spawning habitat downstream of the Tait Street Diversion for either steelhead or coho. Rearing habitat is present for steelhead but is too warm for coho. The San Lorenzo River Lagoon provides critical rearing habitat for juvenile steelhead.

The San Lorenzo River has a high priority for restoration. It is a large watershed with extensive anadromous habitat with approximately 26 miles of anadromous habitat in the

mainstem and 57 miles in the tributaries (ENTRIX, Inc. 2004b). The San Lorenzo River supports steelhead and potentially supports coho salmon. Although the lagoon is highly altered from pre-development conditions and the habitat is significantly degraded, it is still important for rearing juvenile steelhead (HES 2012).

Minimum rearing flow in the San Lorenzo River downstream of Tait Street will be 8 cfs in the two driest hydrologic conditions. This is about 60% of the maximum habitat index for steelhead rearing in the riverine reach (HES 2014), and 90% of the minimum lagoon inflow that would occur with no diversion at Tait Street. Prior to implementation of ASHCP bypass flows, minimum inflow to the lagoon was as low as 1 cfs. Bypass flows up to 18.5 cfs are specified for normal, wet, and very wet hydrologic categories based on historical hydrologic patterns.

Adult migration flows would be provided in December through March with a lower flow threshold of 17 cfs and an upper threshold is 25.2 cfs based on critical riffle analysis (HES 2014). There is no spawning habitat downstream of Tait Street for either steelhead or coho salmon so spawning and incubation flows are not provided.

Smolt migration flows are provided in January through May in 0-80% hydrologic conditions (hydrologic conditions 1-4), and for at least 3 consecutive days per week in 80%-100% conditions (hydrologic condition 5). The smolt migration minimum is 10 cfs.

Tributaries contribute additional flow below the diversion though this contribution is limited, particularly in the dry season. These include Pogonip Creek, Branciforte Creek, Pasatiempo Creek, Arroyo de San Pedro Regaldo, and Ocean Villa Creek.

The TAC agreed to the following modifications to preserve storage in Loch Lomond Reservoir. This was considered important for meeting bypass flow goals to maintain rearing habitat in the lagoon as well as to preserve supply during drought conditions:

- If storage levels in Loch Lomond fall below levels indicated below (MG), adult migration flows in the San Lorenzo River may be reduced to 3 consecutive days per week.
    - Dec- 1900
    - Jan- 2000
    - Feb- 2100
    - Mar- 2200
- Further, if storage levels in Loch Lomond fall below the following levels (MG), adult migration flows in San Lorenzo may be reduced to 5 consecutive days after each storm event that exceeds 17 cfs.
    - Dec- 1600
    - Jan- 1700
    - Feb- 1800

    - Mar- 1900
- If the City determines that conditions will require diversion of stored water from Loch Lomond Reservoir that cannot be offset by diversions at Felton, or from Liddell and Majors Creeks, the City may further reduce smolt outmigration requirements at the Tait Street Diversion provided that: (a) drought has been officially declared; and (b) this reduction in smolt outmigration opportunities will not reduce smolt migration more than one full day/week in the lower San Lorenzo River system or there is evidence from the San Lorenzo River or neighboring watersheds (i.e. Scott Creek) indicating that smolt migration is no longer occurring.

Laguna/Reggiardo Creek Diversion

Laguna Creek was given a high priority for restoration. It is the largest watershed and has the longest reach of anadromous habitat of all the North Coast streams where the City diverts water. It also has a nearly intact lagoon system that is very productive for steelhead. All life stages of steelhead are supported in Laguna Creek and there is potential for all life stages of coho salmon (HES 2012).

Minimum rearing flow in Laguna Creek is 2 cfs at all times. Adult migration, spawning, and incubation flow requirements are provided in all hydrologic conditions. Adult migration flows would be provided in December through March in dry and driest hydrologic conditions and through April in normal wet and very wet hydrologic conditions. The migration flow window lower flow threshold is 11.3 cfs and the upper threshold is 15.5 cfs.

Spawning flows are provided January through May in all hydrologic conditions. The spawning flow target in Laguna Creek is 9.4 cfs, which provides 80% of peak habitat index for steelhead spawning and 97% of the peak for coho salmon. Incubation flows are provided in January through May in all hydrologic conditions. The incubation flow in Laguna Creek is 4.0 cfs. Incubation flows are provided for 60 days after the last spawning day or until May 30, whichever is earliest.

Smolt migration flows in Laguna Creek are provided in January through May in 0-80% hydrologic conditions (hydrologic conditions 1-4), and for at least 3 consecutive days per week March, April, and May in 80%-100% conditions (hydrologic condition 5). The smolt migration minimum is 3.8 cfs.

Liddell Spring Diversion

Restoration of flow in Liddell Creek was given lower priority than Laguna Creek and the San Lorenzo River due to limited productive capacity for steelhead, relatively short anadromous length, and relatively small size of the diversion relative to Laguna Creek

and the San Lorenzo River. All life stages of steelhead are supported in Liddell Creek. Productive capacity for steelhead is limited due to excessive amounts of fine sediment and lack of a functional lagoon (HES 2012).

Minimum rearing flow in Liddell Creek would be 0.25 cfs in the two driest year categories (80-100% and 60-80%) and higher in the three wetter year categories. A flow of 0.25 cfs provides approximately 27% of the maximum habitat index for steelhead rearing in the reach (HES 2014).

Adult migration, spawning, and incubation flow requirements are relaxed in dry and critically dry years (60-100% hydrologic conditions). Adult migration flows would be provided in December through April in 0%-60% hydrologic conditions. Spawning flows are provided December through May in 0%-60% hydrologic conditions. Incubation flows are provided January through May for 60 days after the last spawning day or until May 30, whichever is earliest.

Smolt migration flows in Liddell Creek are provided in January through May in 0-60% (hydrologic conditions 1-3), and for 3 consecutive days per week in March, April, and May during 60%-100% conditions (hydrologic conditions 4 and 5). If the City determines that conditions will require diversion of stored water from Loch Lomond Reservoir that cannot be offset by diversions at Felton, additional water may be diverted from Liddell Creek by modifying smolt outmigration flow requirements to three days every two weeks.

Majors Creek Diversion

Restoration of flow in Majors Creek was given lower priority than Laguna Creek and the San Lorenzo River due to the short anadromous reach length (0.6 miles) and lack of a developed lagoon (HES 2012). It also has a relatively small diversion relative to Laguna Creek and the San Lorenzo River. All life stages of steelhead are potentially supported in Majors Creek.

Minimum rearing flow in Majors Creek would be 0.25 cfs in the two driest year categories (80-100% and 60-80%) and higher in the three wetter year categories. A flow of 0.25 cfs equates with approximately 27% of the maximum WUA for rearing juvenile steelhead occurring in Majors Creek.

Adult migration, spawning, and incubation flow requirements are relaxed in dry and critically dry years (60-100% hydrologic conditions). Adult migration flows would be provided in December through April in 0%-60% hydrologic conditions. The City practice of closing the diversion during storm periods to avoid turbidity minimizes the effect of the diversion on stormflows and avoids potential effects to adult steelhead migration.

Smolt migration flows in Majors Creek are provided in January through May in 0-60% conditions (hydrologic conditions 1-3), and for 3 consecutive days per week in March, April, and May during 60%-100% conditions (hydrologic conditions 4 and 5). If the City determines that conditions will require diversion of stored water from Loch Lomond Reservoir that cannot be offset by diversions at Felton, additional water may be diverted from Majors Creek by modifying smolt outmigration flow requirements to three days every two weeks.

Newell Creek Diversion

Newell Creek supports all life stages of steelhead and potentially supports all life stages of coho. Restoration of flow in Newell Creek was given lower priority than Laguna Creek and the San Lorenzo River. The anadromous reach length is relatively short and habitat conditions in the majority of the anadromous reach are degraded due to close residential development on both sides of the creek (HES 2012). Providing flow for migration and spawning would severely constrain storage in the reservoir and increase reliance on other diversions. Adult migration, spawning, incubation, and smolt migration bypass flows have not been specified for Newell Creek however flows sufficient for these uses occurs during periods of reservoir spill, which occurs in all but the driest winters. Minimum bypass flow of 1 cfs is provided at all times per existing agreements. An exception year minimum of 0.25 cfs would be provided when storage is low.

PHABSIM model results indicate that the habitat suitability index for rearing steelhead at 0.25 cfs is 70% of the value at 1.0 cfs (HES 2014). The City, in consultation with NMFS and CDFW, implemented a release of 0.2 cfs during recent drought conditions from February 2014 to February 2016 under a Temporary Urgency Change Petition with the State Water Resources Control Board. The 0.2 cfs flow level (68% of the habitat index at 1.0 cfs flow) provided reasonable habitat conditions during that period based on observations made by the City Water Department and reviewed by NMFS and CDFW (Chris Berry, personal communication to Jeff Hagar, 2014). Hydrologic model results indicate that natural flow (without the reservoir) would be less than 0.4 cfs the majority of the time that the exception minimum would be in place (Confluence model results "*Resid Flows No Div rev 10-03-17")*.

Hydrologic modeling indicates that the operation of the reservoir results in a slight reduction in median flows through the anadromous reach (compared to reservoir inflows) during the early part of the rearing period (spring) in wet, normal and dry years, and an augmentation of median flows during the latter part of the rearing period due to the 1 cfs minimum release. Flow augmentation is highest (begins earlier) in dry years, and lowest in wet years. During critical dry years, the 1 cfs release requirement augments the natural flow throughout the rearing period and essentially doubles the flow downstream of the dam relative to median reservoir inflow from July through October. The instream flow

requirement also results in flow augmentation in the main stem San Lorenzo River downstream of Newell Creek, although the proportional increase is much smaller.

San Lorenzo River Diversion at Felton

The San Lorenzo River downstream of Felton potentially supports all life stages of steelhead and coho though spawning potential is likely limited for both species and rearing is limited for coho by warm summer temperatures. The Felton Diversion operates according to two Memoranda of Agreement (MOAs) signed with the California Department of Fish and Wildlife (Agreement Between City of Santa Cruz and State of California Department of Fish and Wildlife for Stream flow Maintenance and Operation of Fishway at Felton Diversion Project on San Lorenzo River for the Protection and Preservation of the Fish and Wildlife Resources, 1971; and Memorandum of Agreement between California Department of Fish and Wildlife and the City of Santa Cruz Regarding Operation of the Felton Water Diversion, 1998). These agreements minimize the effects of the Felton Diversion and the City would continue to operate in compliance with them under the ASHCP.

The maximum rate of withdrawal for October 1 to May 31 is 20 cfs with a minimum bypass flow of 25 cfs for October and 20 cfs for the period November 1 through May 31. In September, the diversion rate is 3500 gpm with a 10 cfs bypass requirement – although diversion in September is often not possible or is unnecessary. The Felton Diversion does not operate in the summer months of June through August. Under the ASHCP the minimum bypass will be increased to provide 40 cfs for adult migration in December through April whenever natural flow would occur at this level in the absence of a diversion. The 40 cfs minimum bypass flow for migration will be extended for spawning in December through April for 14 days after potential passage events (i.e., 40 cfs flow and mouth of the river is open). The 40 cfs winter bypass flow is based on the R2 method (Berry 2016) and is consistent with data and recommendations provided in Ricker and Butler (1979) and HES (2014).

Conclusion

Bypass recommendations were developed to balance instream habitat value with water supply needs under an extremely variable hydrologic system. The resulting bypass flow schedules are tailored to conditions in any given water year type with maximum efficiency in rapidly adjusting to changing circumstances. This allows for a more natural tracking of streamflows with salmonid habitat needs and lifecycle periodicity without jeopardizing water supply needs and while clearly defining periods when excess flows are available for diversion. Bypass flows defined through this process result in projected habitat conditions that are a significant improvement over existing levels and approach levels that would occur in the absence of City diversions in key areas. Thorough testing

with the City's operations model verified that this system is capable of delivering full supplies under revised water rights and improved water supply infrastructure.

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Appendix 10: Pipeline Repair and Flushing Standard Operating Procedures

PROCEDURE	7102-01
EFFECTIVE	03/16/06
SUPERSEDES	11/01/04

STANDARD OPERATING PROCEDURE NO. 7102-01
Superchlorinated Potable Water Discharges

Purpose

This Standard Operating Procedure (SOP) describes the procedures to be followed when flushing any part or portion of the Santa Cruz Water Department's (SCWD) distribution system and free chlorine residual exceeds 2 parts per million (ppm). (ppm = mg/L) This includes water discharged during flushing activities associated with line disinfections.

Flushing of super-chlorinated water is required prior to laboratory testing to determine bacteriological quality after disinfection.

Disinfection of water mains is addressed in SOP No. 7102-03.

Dechlorination of discharges of low-chlorinated water with a chlorine residual less than 2 ppm is addressed in SOP No. 7102-02.

Discharges Requiring Dechlorination

All discharges from the distribution system must be treated to ensure chlorine residual does not reach waters of the State. Waters of the State include streams, rivers, ponds, lagoons and oceans. Discharges to be super-dechlorinated are those generated in the course of disinfection.

Scope of this Procedure

This procedure addresses manual super-dechlorination of SCWD-generated potable water discharges with free chlorine residual exceeding 2 ppm. Water with free chlorine residual exceeding 2 ppm requires dechlorination such that chlorine does not reach waters of the State and cause damage to plant and animal life. This SOP applies primarily to the dechlorination of water that has been injected with chlorine to disinfect new water mains.

This SOP does not give instructions for making up dechlorinating solution or determining appropriate feed rates. See manufacturer's instructions for dechlorination solution application.

Changes to Procedure

This formal procedure has been revised. Any previously released informal procedures are no longer acceptable and should be replaced with this SOP. Any suggestions or ideas pertaining to this procedure as well as informal or older procedures should be forwarded to the Engineering division to be reviewed.

This procedure may evolve over time as new dechlorination chemicals or methods become available that make dechlorination of potable water discharges quicker and/or easier.

Changes to Procedure, cont.

Note that references to existing interdepartmental SOPs related to this topic are made throughout this SOP.

Impacts of Flushing and Dechlorination

- Environmental: Flushing at high velocities can erode soil and cause instability, uproot vegetation and cause drainage problems.
- Fish and Wildlife / Endangered Species: Chlorine in concentrations exceeding 0.05 ppm kills nitrifying bacteria and other aquatic life. Spikes of ammonia and nitrite, through gill necrosis, result in respiratory failure, suffocation, etc.
- Wastewater Treatment Plant: High doses of chlorine kill nitrifying bacteria and can cause certain unit treatment processes to fail, resulting in potential contamination of effluent discharging to the receiving water.
- Degradation/Capacity Reduction of Storm/Sanitary Sewer: Prolonged contact with high concentrations of chlorine may cause corrosion in cast iron pipe. Further, large discharges may exceed pipe capacity such that normal flows are restricted.

These concerns should be evaluated prior to each discharge and impacts should be minimized as prescribed by regulations.

Priority of Dechlorination Relative to Other Jobsite Tasks

For any job involving flushing or dechlorination, jobsite tasks should be prioritized in order of the following concerns.

1. Worker Health and Safety (e.g., don safety gear, set up traffic control, identify any site contamination concerns).
2. Public Health & Safety (e.g., stop flows from breaks that are impeding traffic or threatening homes or businesses, operate valves as necessary to prevent contamination of mains and minimize number of customers out of water).

Environmental Protection (e.g., set up dechlorination and/or sediment control equipment as necessary, ensure trench spoils are disposed of properly).

Flushing Equipment

The following equipment is needed for flushing:

Hydrant Flushing:

- 2 ½" Hydrant adaptor fitting by 2" male end cam-lock fitting.
- 2" Fire hose with cam-lock fittings.
- 2 ½" Hydrant adaptor fitting with hose bib sampling port.
- Pitot tube.
- Pipe wrench.
- Hydrant wrench.
- Various valve keys.

Blowoff Flushing:

- 2" Blowoff assembly with hose bib sampling port.
- 2" Fire hose with cam-lock fittings.
- Pipe wrench.
- Pitot tube.
- Various valve keys.

Dechlorination Equipment

The following equipment is needed for dechlorination when following this procedure:

- Super dechlorinating unit.
- Super dechlorination solution (ascorbic acid).
- LPD-250 Diffuser
- Diffuser tablets (sodium sulfite)
- Personal Protective Equipment
- Analytical equipment for measuring temperature, free chlorine residual concentration and turbidity. (As described in "Measuring Equipment" below.)
- Lab sampling bottles – 1 general physical (GP) bottle and 2 small sterile Bact bottles for each sampling station, labeled per "Field Chlorination Report".
- Deionized (DI) water.

Note that the LPD-250 diffuser equipment is capable of dechlorinating up to 4 ppm in free chlorine concentration.

Chemical Handling & PPE Requirements

When handling solid or liquid chlorine, use clean rubber or leather gloves and a respirator if in an enclosed area. Do not inhale vapors from closed container (upon opening). Diffusers with tablets (new or used) should be stored in vehicles in secondary containment to prevent particles of sodium sulfite from being deposited directly onto vehicle, tool or other surfaces.

See the Production Division's SOP 7106-IV-4 for handling of dry and liquid chlorine products.

First Aid

See MSDS for specific chemical to determine best course of action:

Eye Contact: Immediately flush eyes with large amounts of water for at least 15 minutes holding lids apart to ensure flushing of entire eye surface. Seek medical attention.

Skin Contact: Wash thoroughly with soap and water.

Inhalation: Remove person from contaminated area to fresh air. If breathing has stopped, resuscitate. Seek medical attention.

Ingestion: Induce vomiting. Seek medical attention.

WARNING!

Some work units that will be using sodium sulfite (LPD-250 Diffuser) for dechlorination also use calcium hypochlorite (HTH) or sodium hypochlorite to disinfect water distribution system mains or appurtenances. These two (2) chemicals can react when mixed in the presence of water. The reaction can produce heat and both hydrogen and chlorine gas, creating both a potentially toxic and explosive/flammable atmosphere. Should the chemicals become mixed, staff should immediately evacuate to a safe area and contact the fire department (911). These chemicals and associated mixing and dispensing equipment must be kept segregated from each other at all times.

PROCEDURE

This procedure includes instruction for dechlorination and flushing for chlorinated water mains through a hydrant or blow off.

- **Notification**

Get permission of City or County Public Works Departments to use sanitary sewer for water disposal. In the City, inform the Wastewater Mains Supervisor in the Water Dept. and Wastewater Mains Field Crew Leader in Public Works, via email. Provide date, location, rough quantity, and main size to be flushed. In the County, inform Santa Cruz County Sanitation Dispatch at 464-5462 with date, location, and estimated quantity of water to be flushed.

- **Preparation**

Direct flushing-water away from traffic, pedestrians, underground utility vaults, watercourses and private lands. Check that travel path of water is clear of hazardous contaminants such as puddles of gas, oil, paint thinners, etc. Take measures necessary to prevent sediment, debris, spilled auto fluids, etc., from entering the sanitary sewer or storm drain. (Reference SOP No. 7105-01.)

- **Backflow Protection**

Where possible isolate new main from the distribution system through a temporary connection between the feed line and the new main utilizing a double check valve assembly with appropriate fittings. If a backflow prevention assembly cannot be incorporated, appropriate timing of supply valve and blow off operation must be coordinated to ensure that a backflow situation does not occur.

- **Dechlorination/ Flushing**

Note that for superchlorinated water, the super-dechlorinating unit with ascorbic acid solution is to be used. In addition, the LPD-250 diffuser with sodium sulfite tablets may be used once free chlorine concentration has dropped to 2 ppm or less.

Refer to equipment manuals for specific instruction on use of the dechlorinating systems.

1. Connect super-dechlorination system to a fire hose attached to hose bib assembly on a fire hydrant or blowoff. Position dechlorinating unit at end of hose such that it discharges into a storm drain or sanitary sewer inlet. Restrain dechlorinator to ensure stability at high flow rate. Connect dechlorinating solution feed assembly with appropriate solution concentration and feed rate per manufacturer's instructions.
2. Open water feed line after partially opening blow off valve or hydrant.
3. Obtain an initial water sample from hose bib in glass quart bottle. Check chlorine concentration using a diluted sample and colorimeter. An appropriate amount of sample is 5 mL of deionized water (DI) (to the fill line on the colorimeter's sample tube) to one (1) drop of sample water from the glass quart bottle (20 drops = 1 mL). Add one (1) DPD Free Chlorine Reagent Pillow. Cover and shake the sample tube. (Ensure that hands remain free of any dechlorinating solution.) If a pink or red color remains, use the colorimeter to determine the approximate free chlorine concentration. (Multiply by 100 to account for the sample's dilution.)

Record initial chlorine residual in the appropriate section on the "*Field Chlorination Report."*

Begin flushing by further opening the hydrant/blow off valve slowly until a flow rate of 2.5ft/s is obtained. (Calculate or use standard tables to determine appropriate flow in gpm and use pitot gauge to substantiate in field.) Sample water being discharged after the dechlorinator to ensure that free chlorine concentration is being reduced to zero using "Method of Measurement" below.

4. Bathe hose bib in superchlorinated water and disinfect nozzle with propane torch for a minimum of 30 seconds.
5. Sample water discharged before dechlorination equipment through hose bib and test using the method described in step no. 3 to ensure that free chlorine concentration is being reduced to system residual (0.5 – 1.0 ppm). When chlorine residual can no longer be detected using a diluted sample, transfer 5mL of sample water taken with the glass quart bottle to the sample tube and add one (1) DPD Free Chlorine Reagent pillow. Cover and shake the sample tube. If a pink or red color remains, use the colorimeter to directly read the approximate concentration of the chlorine. Absence of color indicates that there is no detectable chlorine present.

• Dechlorination/ Flushing, cont.

6. If initial batch of super dechlorination solution (ascorbic acid) is near completion and free chlorine concentration is at 2 ppm or less, super dechlorinator may be replaced with LPD-250 diffuser with sodium sulfite tablets. Otherwise, add more ascorbic acid solution and continue. Opening and closing appropriate valves (slowly to prevent water hammer) to maintain isolation of new main while swapping dechlorinators (or while mixing new batch of ascorbic acid solution) will aid in achieving a thorough scour and flush, while preventing backflow.
7. Periodically sample water discharged through dechlorination equipment and test using "Method of Measurement" below to ensure that free chlorine concentration is being reduced to zero ppm. Adjust feed rate or add tablets as necessary to completely remove chlorine.
8. At this point, begin checking turbidity using the Hach Portable Turbidimeter. Verify calibration of turbidimeter with the standards. Fill glass sample bottles to line at top of bottle and wipe dry outside with KimWipes. Gently tilt bottle to expel air bubbles. Test samples until turbidity is close to a standard set by the Water Quality Control Lab (≤0.5 NTU).
9. Confirm chlorine concentration using a sample with the colorimeter (direct read this value). Chlorine level should be between 0.5 and 1 ppm.
10. At each sample point, take a General Physical sample, filling to neck of the bottle. Carefully fill two (2) small, sterile Bact test sample bottles (two (2) per sample point) to the 100-mL line and cap immediately. Take additional samples if contamination is suspected. Record sample identification on "*Field Chlorination Report."*
11. Close valve to hydrant or blowoff and water feed line. Disassemble dechlorination equipment.
12. Estimate the amount of water flushed. Record on *"Field Chlorination Report."*
13. Submit *"Field Chlorination Report"* as well as samples to SCWD Water Quality Lab within one (1) hour of sampling. Transport samples in an insulated cooler with ice packs.

Method of Measurement

Free chlorine is measured by adding DPD Free Chlorine Reagent pillow to a sample of a given discharge. If a pink or red color develops when reagent is added to the sample, chlorine is present. This is known as colorimetric analysis. Absence of color indicates there is no detectable chlorine present.

Turbidity is measured utilizing the Hach Portable Turbidimeter, which operates on the nephelometric principle of turbidity measurement. This instrument

Method of Measurement, cont.

measures the degree of cloudiness by means of transmitted light. See manufacturer's manual for complete instructions.

Measuring Equipment

DPD Free Chlorine Reagent Pillows, manufactured by HF Scientific, Inc., are used to dispense the reagent into the sample. Utilize the clear, clean sample tubes included in the Hach Colorimeter kit to analyze the water. Transfer 5 mL of sample water taken with the glass quart bottle to the sample tube (fill to line, measure from bottom of meniscus) and add one (1) DPD Free Chlorine Reagent pillow (for 5mL sample).

Cover and shake the sample tube. If a pink or red color remains, use the colorimeter to directly read the approximate concentration. Absence of color indicates that there is no detectable chlorine present. The target chlorine concentration is 0.5 ppm, with an acceptable range of 0.5 to 1.0 ppm.

The Hach Portable Turbidimeter is used to measure turbidity. Verify calibration using the standards. Scratches, fingerprints, or condensation on the bottles will affect the readings. Wipe bottles carefully with Kimwipes, using silicon oil if bottles are scratchy. Line up diamond on bottle with instrument's orientation mark. Close cover. Press READ in AUTO RANGE mode.

Fill sample bottle to white line, cap, and wipe with Kimwipe. Gently rotate bottle to remove air bubbles. If turbidity >0.5 NTU, continue to flush. If turbidity remains over 0.5 NTUs for over an hour, stop flushing and continue procedure with note to lab about high turbidity level.

Attention!

Any activity resulting in a shutdown requires sampling of the water to verify that the turbidity is less than 0.5 NTU and the chlorine residual is between 0.5 and 1 ppm before putting main back in service. (Or to levels comparable to historical system parameters in the area.) If the main is dewatered or the residual pressure drops below 5 psi, the requirements above must be met and samples must be taken to the SCWD Water Quality Lab.

Regulating Agencies

- USEPA
- US Fish and Wildlife
- California Department of Health
- California Department of Fish and Game
- Central Coast RWQCB
- City of Santa Cruz
- NOAA Fisheries

Applicable Regulations

- Clean Water Act Sections 309, etc.
- Endangered Species Act Sections 9 and 11
- California Water Code Sections 13300-13361
- California Fish and Game Code Sections 5650 and 2050
- City of Santa Cruz Municipal Code
- California Code of Regulations, Title 22, Section 64421

Attachments

- MSDS, Sodium Sulfite
- MSDS, Ascorbic Acid
- Field Chlorination Report

References

- ANSI/AWWA C651-99 Standard for Disinfecting Water Mains
- AWWA Research Foundation Guidance Manual for Disposal of Chlorinated Water (2001)
- State of California RWQCB Water Quality Control Plan for the Central Coastal Basin (September, 1994)

PROCEDURE	7102-02
EFFECTIVE	03/16/06
SUPERSEDES	11/01/04

STANDARD OPERATING PROCEDURE NO. 7102-02
Low-Chlorine Potable Water Discharges

Purpose

This Standard Operating Procedure (SOP) describes the procedures to be followed when flushing any part or portion of the Santa Cruz Water Department's (SCWD) distribution system and free chlorine residual is less than or equal to 2 parts per million (ppm). (ppm = mg/L) This includes water discharged during flushing activities, hydrant testing, and main breaks.

The main objectives for planned water main flushing are sediment removal; taste and odor control; control of color, high turbidity, low chlorine residuals, or bacterial growth; corrosion control; or response to customer complaint(s).

Dechlorination of discharges of superchlorinated water with chlorine residual exceeding 2 ppm is addressed in SOP No. 7102-01.

Sediment control (i.e. pumping a trench to a drain inlet) is addressed in SOP No. 7105-01.

Discharges Requiring Dechlorination

All discharges from the distribution system must be treated to ensure the chlorine residual does not reach waters of the State. These include streams, rivers, ponds, lagoons and oceans. Discharges to be dechlorinated include those generated in the course of performing any of the following:

- Main or hydrant flushing (for any purpose).
- Hydrant testing.
- Main dewatering (for any purpose).
- Any other activity requiring discharge of chlorinated water (other than exempt discharges as defined below).

Exempt Discharges

The following discharges are exempt from the dechlorination requirement described in this SOP:

- Discharges of raw, untreated water with no chlorine residual.
- Discharges of non-chlorinated groundwater.
- Discharges less than 1000 gallons.
- Unplanned discharges at unstaffed locations (e.g., main breaks, broken fire hydrant, and reservoir overflow).
- Trench dewatering during distribution system maintenance and construction activities. (Reference SOP No. 7105-01 for sediment control.)

Scope of this Procedure

This procedure addresses manual dechlorination of SCWD-generated potable water discharges with free chlorine residual of 2 ppm or less. Dechlorination of discharges of superchlorinated water with a free chlorine residual of greater than 2 ppm are addressed in SOP 7102-01.

The specifications do not give instructions for making up dechlorinating solution or determining appropriate feed rates. See manufacturer's instructions for dechlorination solution application.

Changes to Procedure

This formal procedure has been revised. Any previously released informal procedures are no longer acceptable and should be replaced with this SOP. Any suggestions or ideas pertaining to this procedure as well as informal or older procedures should be forwarded to the Engineering division to be reviewed.

This procedure may evolve over time as new dechlorination chemicals or methods become available that makes dechlorination of potable water discharges quicker and/or easier.

Note that references to existing interdepartmental SOPs related to this topic are made throughout this SOP.

Impacts of Flushing and Dechlorination

- Environmental: Flushing at high velocities can erode soil and cause instability, uproot vegetation and cause drainage problems.
- Fish and Wildlife / Endangered Species: Chlorine in concentrations exceeding 0.05 ppm kills nitrifying bacteria and other aquatic life. Spikes of ammonia and nitrite, through gill necrosis, result in respiratory failure, suffocation, etc.
- Wastewater Treatment Plant: High doses of chlorine kills nitrifying bacteria and can cause certain unit treatment processes to fail, resulting in potential contamination of effluent discharging to the receiving water.
- Degradation/Capacity of Storm/Sanitary Sewer: Prolonged contact with high concentrations of chlorine may cause corrosion in cast iron pipe. Further, large discharges may exceed pipe capacity such that normal flows are restricted.

These concerns should be evaluated prior to each discharge and impacts should be minimized as prescribed by regulations.

Priority of Dechlorination Relative to Other Jobsite Tasks

For any job involving flushing or dechlorination, jobsite tasks should be prioritized in order of the following concerns.

1. Worker Health and Safety (e.g., don safety gear, set up traffic control, identify any site contamination concerns).
2. Public Health & Safety (e.g., stop flows from breaks that are impeding traffic or threatening homes or businesses, operate valves as necessary to prevent contamination of mains and minimize number of customers out of water).
3. Environmental Protection (e.g., set up dechlorination and/or sediment control equipment as necessary, ensure trench spoils are disposed of properly).

Flushing Equipment

The following equipment is needed for flushing:

Hydrant Flushing:

- 2 ½" Hydrant adaptor fitting by 2" male end cam-lock fitting
- 2" Fire hose with cam-lock fittings
- 2 ½" Hydrant adaptor fitting with hose bib sampling port
- Pitot tube
- Pipe wrench
- Hydrant wrench
- Various valve keys

Blowoff Flushing:

- 2" Blowoff assembly with hose bib sampling port
- 2" Fire hose with cam-lock fittings
- Pipe wrench
- Pitot tube
- Various valve keys

Dechlorination Equipment

The following equipment is needed for dechlorination when following this procedure:

- LPD-250 Diffuser with tablet chamber.
- Diffuser tablets (sodium sulfite).
- Personal Protective Equipment (i.e. respirator, goggles and rubber gloves).
- Analytical equipment for measuring temperature, free chlorine residual concentration, and turbidity. (As described in "Measuring Equipment" below.)
- Lab sampling bottles – 1 general physical (GP) bottle and 2 small sterile Bact bottles for each sampling station, labeled per "Field Chlorination Report".

Note that the LPD-250 diffuser equipment is capable of dechlorinating up to 4 ppm in free chlorine concentration.

Chemical Handling & Personal Protective Equipment Requirements

Diffusers with tablets (new or used) should be stored in vehicles in secondary containment to prevent particles of sodium sulfite from being deposited directly onto vehicle, tools or other surfaces.

See the Production Division's SOP 7106-IV-4 for handling of dry and liquid chlorine products.

First Aid

See MSDS for specific chemical to determine best course of action:

Eye Contact: Immediately flush eyes with large amounts of water for at least 15 minutes holding lids apart to ensure flushing of entire eye surface. Seek medical attention.

Skin Contact: Wash thoroughly with soap and water.

Inhalation: Remove person from contaminated area to fresh air. If breathing has stopped, resuscitate. Seek medical attention.

Ingestion: Induce vomiting. Seek medical attention.

WARNING!

Some work units that will be using sodium sulfite (LPD-250 Diffuser) for dechlorination also use calcium hypochlorite (HTH) or sodium hypochlorite to disinfect water distribution system mains or appurtenances. These two chemicals can react when mixed in the presence of water. The reaction can produce heat and both hydrogen and chlorine gas, creating both a potentially toxic and explosive/flammable atmosphere. Should the chemicals become mixed, staff should immediately evacuate to a safe area and contact the fire department (911). These chemicals and associated mixing and dispensing equipment must be kept segregated from each other at all times.

PROCEDURE

This procedure includes instructions for flushing and dechlorination when hydrant flushing, hydrant flow testing or main dewatering through a hydrant or blowoff.

- **Notification**

Give 48-hour notice, using door hangers, to areas that will be affected by flushing, particularly to certain categories of customers who are seriously affected by flushing (e.g., laundries and dialysis patients). Notification of flushing as part of the department's flushing program shall be given via a newspaper ad.

Internal notification of all planned flushing shall be given to all divisions of the Water Department.

Get permission of City or County Public Works Departments to use sanitary sewer for water disposal. In the City, inform the Wastewater Mains Supervisor in the Water Dept. and Wastewater Mains Field Crew Leader in Public Works, via email. Provide date, location, rough quantity, and main size to be flushed.

- **Notification (continued)**

In the County, inform Santa Cruz County Sanitation Dispatch at 464-5462 with date, location, and estimated quantity of water to be flushed.

- **Preparation**

Direct flushing-water away from traffic, pedestrians, underground utility vaults, watercourses and private lands. Check that travel path of water is clear of hazardous contaminants such as puddles of gas, oil, paint thinners, etc. Take measures necessary to prevent sediment, debris, spilled auto fluids, etc., from entering the sanitary or storm sewer. (See SOP 7105-01.)

- **Dechlorination**

Dechlorination is accomplished by the addition of sodium sulfite tablets to the discharge flow. For main flushing, hydrant flow testing or main dewatering through a blowoff, a dechlorinating diffuser assembly is typically used. For the diffuser, tablets are placed inside a chamber of the flow-through diffuser attached to the discharge face of the diffuser. The diffuser is then connected to a hose bib assembly attached to the hydrant or blowoff. As the discharged water flows over and around the tablets, chemical is released as the water contacts the tablets, reacting with and destroying the chloramines. Refer to equipment manuals for specific instruction on use of the diffuser.

- **Flushing & Testing**

1. Obtain a water sample from a hose bib sample port or at a home in the area to be flushed. Perform a turbidity and chlorine test (as described in SOP No. 7102-03) before starting the flush. This will provide you with target levels of the surrounding area. If the area is experiencing low chlorine levels (<0.2 mg/L) contact the Water Quality Manager. Record levels on "*Field Chlorination Report"* (attached).
2. Connect hose bib sampling assembly to hydrant or blow off. Connect fire hose then diffuser (full of tablets) to sampling assembly with diffuser positioned over storm drain, gutter, or sanitary sewer inlet.
3. Slowly operate the appropriate valves to isolate the water main or area to be flushed to prevent water hammer.
4. Begin the flushing by opening the hydrant or blow off valve slowly until a desired flow is obtained. Measure flow rate with a pitot tube and note length of time. Record on "*Field Chlorination Report."*
5. Monitor the supply of tablets in the diffuser tablet chamber periodically to ensure that there are adequate tablets available to complete the flushing. Add tablets as needed.
6. Continue to flush the water, sampling and testing until turbidity is close to a standard set by the Water Quality Control Lab, usually ≤0.5 NTU. Record on "*Field Chlorination Report"*.
7. Confirm chlorine concentration using a sample with the colorimeter. Chlorine level should meet or exceed the target level of the surrounding area (between 0.5 and 1 ppm). Record on "*Field Chlorination Report."*

- **Flushing & Testing, cont.**

8. If the main is dewatered or the residual pressure drops below 5 psi, bacteriological samples need to be drawn at each sample point. Disinfect hose bib nozzle with propane torch for a minimum of 30 seconds. Take one (1) GP sample, filling to neck of the bottle. Carefully fill two (2) small, sterile Bact test sample bottles (two (2) per sample point) to the 100-mL line and cap immediately. Take additional samples if contamination is suspected. Record sample identification on "*Field Chlorination Report."*
9. Close valve to hydrant or blowoff and disassemble dechlorination equipment. Reopen all previously closed valves.
10. Estimate the flow rate and amount of water flushed. Record on *"Field Chlorination Report."*
11. Submit *"Field Chlorination Report"* as well as samples to lab within one (1) hour of sampling. Transport samples in insulated cooler with ice packs.

Method of Measurement

Free chlorine is measured by adding DPD Free Chlorine Reagent pillow to a sample of a given discharge. If a pink or red color develops when reagent is added to the sample, chlorine is present. This is known as colorimetric analysis. Absence of color indicates there is no detectable chlorine present.

Turbidity is measured utilizing the Hach Portable Turbidimeter, which operates on the nephelometric principle of turbidity measurement. This instrument measures the degree of cloudiness by means of transmitted light. See manufacturer's manual for complete instructions.

Measuring Equipment

DPD Free Chlorine Reagent Pillows, manufactured by HF Scientific, Inc., are used to dispense the reagent into the sample. Utilize the clear, clean sample tubes included in the Hach Colorimeter kit to analyze the water. Transfer 5 mL of sample water taken with the glass quart bottle to the sample tube and add one (1) DPD Free Chlorine Reagent pillow (for 5mL sample).

Cover and shake the sample tube. If a pink or red color remains, use the colorimeter to directly read the approximate concentration. Absence of color indicates that there is no detectable chlorine present. The target chlorine concentration is 0.5 ppm, with an acceptable range of 0.5 to 1.0 ppm.

The Hach Portable Turbidimeter is used to measure turbidity. Verify calibration using the standards. Scratches, fingerprints, or condensation on the bottles will affect the readings. Wipe bottles carefully with Kimwipes, using silicon oil if bottles are scratchy. Line up diamond on bottle with instrument's orientation mark. Close cover. Press READ in AUTO RANGE mode.

Measuring Equipment, cont.

Fill sample bottle to white line, cap, and wipe with Kimwipe. Gently rotate bottle to remove air bubbles. If turbidity >0.5 NTU, continue to flush. If turbidity remains over 0.5 NTUs for over an hour, stop flushing and continue procedure with note to lab about high turbidity level.

Regulating Agencies

- USEPA
- US Fish and Wildlife
- California Department of Health
- California Department of Fish and Game
- Central Coast RWQCB
- City of Santa Cruz
- NOAA Fisheries

Applicable Regulations

- Clean Water Act Section 309, etc.
- Endangered Species Act Sections 9 and 11
- California Water Code Sections 13300-13361
- California Fish and Game Code Sections 5650 and 2050
- City of Santa Cruz Municipal Code
- California Code of Regulations, Title 22, Section 64421

Attachments

- MSDS, Sodium Sulfite
- MSDS, Ascorbic Acid
- Field Chlorination Report

References

- ANSI/AWWA C651-99 Standard for Disinfecting Water Mains
- AWWA Research Foundation Guidance Manual for Disposal of Chlorinated Water (2001)
- State of California RWQCB Water Quality Control Plan for the Central Coastal Basin (September, 1994)

Appendix 11: Sediment Control During Open Channel Water Discharges Standard Operating Procedures

PROCEDURE	7105-01
EFFECTIVE	8/30/02
SUPERSEDES	

STANDARD OPERATING PROCEDURE NO. 7105-01
Sediment Control During Open Channel Water Discharges

Purpose

This standard operating procedure SOP describes procedures to be used to minimize the transport of sediment to storm drains or receiving waters during open channel discharges containing sediment or having the potential to entrain sediments to satisfy the requirements of the Regional Water Quality Control Board and to protect the environment.

Scope of this Procedure

This procedure is not intended to cover all erosion control or sedimentation situations, but does apply to dewatering and related sediment control at SCWD work sites. Larger projects with sediment control needs should follow guidelines of the City's Urban Water Runoff Program.

Discharges Requiring Sediment Control

The sediment control procedures described herein must be used for all discharges from trenches during main or service break repair activities and any other Department activities that involve open channel discharges to the storm drain system or "receiving" waters with potential to mobilize and transport significant concentrations of sediment.

Exempt Discharges

The following discharges are exempt from these sediment control requirements:

- Unplanned discharges at unstaffed locations (e.g., reservoir overflows, main or service breaks prior to arrival of repair crew).
- Discharges to land – Any discharges to land that are absorbed into the ground and involve minimal or no runoff to storm sewers or receiving waters.
- Discharges of clean water along a clean flow path.
- Discharges within closed conduits.

Overview of Sediment Control Procedures

Sediment control is accomplished through implementation of several Best Management Practices (BMPs) including 1) use of vacuum truck to eliminate discharge, 2) filtration with pea gravel bags before discharge to storm drain, and 3) overland filtration. Residual sediment should be shoveled and either used as fill[1], or hauled off-site for appropriate disposal. Success of these procedures will depend on appropriate implementation.

Roles and Responsibilities

- Distribution Crew Leader is responsible for:
  - Determining method of dewatering
  - Contacting Water Resources Management staff for consultation and monitoring.
- Water Resources Management is responsible for:
  - Monitoring,
  - Determining necessity of further procedures for environmental protection.
  - Consultation with regulatory agencies (RWQCB, DFG, others as appropriate)[2].

[1] In areas of potential soil contamination (gasoline, etc.) refer to draft SOP #7105-02 for more information before determining appropriate course of action. This procedure for working with contaminated soils has yet to be developed.

[2] Reporting required as follows: Any discharge to surface waters requires notification to RWQCB within **24 hours.** Report to DFG should be made **in writing** within 14 days of beginning of **emergency** work. All dewatering work that is not emergency work should not involve any discharge to surface waters and therefore does not require a discharge permit but may require consultation with DFG, USFWS, etc. regarding biotic issues. See Attachment 1– Sample Notification Letter.

PROCEDURE	7105-01
EFFECTIVE	8/30/02
SUPERSEDES	

STANDARD OPERATING PROCEDURE NO. 7105-01
Sediment Control During Open Channel Water Discharges

Impacts of Sedimentation

Sedimentation (the result of discharge of soil laden water to surface, or "receiving" waters) causes degradation of aquatic habitat through filling pools and spawning gravels, limits respiration of aquatic life, and enriches receiving waters with nutrients; thereby increasing incidence of algae blooms.

Priority of Sediment Control Relative to Other Jobsite Tasks

For any activity involving dewatering and sediment control, jobsite tasks should be prioritized in order of the following concerns:

1. Worker Health and Safety (e.g. don safety gear, set up traffic control, identify any site contamination concerns).

2. Public Health & Safety (e.g., stop dewatering sediment control if flows into traffic are causing a hazard, or if delays in dewatering are resulting in an inability to repair a leaking main and ability to provide water).

3. Environmental Protection (e.g., set up dechlorination and/or sediment control equipment as necessary, ensure trench spoils are disposed of properly).

Sediment Control Equipment

- Turbidity Meter
- Data sheets (example: Attachment 3)
- Vacuum Truck
- Pea gravel bags
- Pea Gravel
- Flat Blade Shovel
- Container for residual sediment disposal
- Pump
- Screening for pump intake (if dewatering in presence of aquatic life)
  - 1/4 inch mesh on screening required for sites with aquatic life present[3].
- Straw and Seed[4]

Changes to Procedure

This is a formal procedure. Any previously released informal procedures are no longer acceptable and should be replaced with this SOP. This procedure may evolve over time as new sediment control technology or methods become available that make sediment control quicker, easier or more effective.

Related SOPs

Please reference SOPs # 7102-01-01, 7102-02 and 7102-04 for dechlorination and 7105-02[5] for contaminated soil disposal procedures.

[3]Sites with potential aquatic life present require consultation with Water Resources Management staff and possibly presence of a qualified biologist before work can be initiated. Any site on the North Coast requires consultation with Water Resources Management staff before initiation of work. Water Resources Management staff will consult with regulatory agencies before initiation of any work if possible in cases with aquatic life present. Tail gate meetings with biologist will be held at the beginning of every work day at such sites. Biologist has authority, within reason and with deference to Dept. priorities as stated in this SOP, to direct dewatering work such that impacts to aquatic life are minimized.

[4] Straw should be rice or barley straw. Seed should consist of a mix of red clover and barley or local native mix to be determined at time of application in consultation with Water Resources Management Section.

[5] This procedure for working with contaminated soils has yet to be developed.

PROCEDURE	7105-01
EFFECTIVE	8/30/02
SUPERSEDES	

STANDARD OPERATING PROCEDURE NO. 7105-01
Sediment Control During Open Channel Water Discharges

Scenario	Procedure
1. Dewatering in vegetated, rural setting.	1. Ascertain that aquatic life is not present in ponded water *(for example repairs of leaks on the North Coast*[5] *require consultation with Water Resources Management staff before dewatering or other work can begin).* 2. Screen pump with ¼ inch mesh if frogs or fish are present. If they are not present, screening is not required. 3. Locate end of discharge pump hose into pea-gravel filled filter fabric bag for energy dissipation for discharge overland. Discharge should not cause erosion or transport sediment to <u>any</u> nearby surface waterbody. Discharge should be as far from nearest waterbody as possible and located on flat, well vegetated ground if possible. 4. Pump as necessary, ascertaining that discharge water is not eroding soil and that sediment is settling out of discharge water before entering any surface water. 5. Collect samples upstream and downstream in receiving waters throughout procedure if work site is near any surface water body. Document turbidity and discharge volume.[6] 6. Follow up with straw/seed soil stabilization as necessary immediately following completion of work, or prior to the end of the day if the U.S. Weather Service forecast is a "chance" (30% or more) of rain before the next day, and prior to weekend or other shutdown periods during winter months (October 15 – April 15).
2. Dewatering trench in a paved, urban setting *with* vacuum truck available.	1. Call Public Works to secure vacuum truck for end-hauling of water to wastewater treatment plant. 2. No further action required for dewatering if no discharge exists.
3. Dewatering trench in a paved, urban setting *without* vacuum truck available.	1. Remove debris (sediment, branches, garbage, etc.) from discharge flow path. If the discharge is caused by a main or service break and there is surface flow, isolate the main or service prior to excavation if it is appropriate to do so based on standard main or service break repair procedures. Once the surface flow is stopped, remove all sediment and debris from the flow path. If there is surface flow and debris is present, remove debris if it can be removed without causing it to become entrained in the flow. For breaks where there is no surface flow (street is dry) or for main dewatering or other clean water discharges, inspect the flow path between the flow source and discharge location (the storm drain or receiving water the flow will discharge to). Remove any debris or accumulated sediment from the flow path. 2. Place pea gravel bags in flow path and around nearest downslope storm drain[7]. Beware of safety issues related to ponded water on pavement and place traffic cones around perimeter of ponded water. 3. Begin pumping. 4. Check pea gravel bags periodically to ensure they are staying in place and performing their function. If the sediment has built up behind pea gravel bags, remove sediment as necessary if an opportunity occurs (flow has temporarily ceased). Do not attempt to remove sediment during discharge. Do not allow accumulated sediment to enter storm drain. 5. Collect sample(s) of water being discharged to storm drain throughout the process

[6] See Attachment 2– Map
[7] See Attachment 3 – Data Sheet.
[8]See Attachment 4 – Pea Gravel Bag Dam Layout

PROCEDURE	7105-01
EFFECTIVE	8/30/02
SUPERSEDES	

STANDARD OPERATING PROCEDURE NO. 7105-01
Sediment Control During Open Channel Water Discharges

	(after it has drained through pea gravel bags) and document estimated discharge volume and turbidity. 6. Conclude pumping, when discharge is complete, allow any water that is ponded behind the pea gravel bags to drain, then shovel as much sediment as possible into backhoe bucket or other available container. Hose down remaining sediment on pavement ensuring that flow of this cleanup water drains to pea gravel bags at downslope stormdrain. When hosing is complete, allow any water that is ponded behind the pea gravel bags to drain. Retrieve all equipment and store in appropriate field vehicle(s). Haul residual sediment off-site for disposal or use as fill on-site. Empty the sediment and debris from the backhoe bucket or container into the dump truck if available. Otherwise, the sediment may be 1) spread out on an appropriate unpaved ground locally, if an appropriate location exists, 2) transported to a City facility and deposited on an appropriate unpaved surface, if an appropriate location exists, 3) added to open trench spoils bins, or disposed of in a dumpster. Non-sediment debris must be disposed of in a dumpster or garbage can.[9]
Regulatory Agencies	• Central Coast Regional Water Quality Control Board (RWQCB) • United States Environmental Protection Agency (USEPA) • United States Fish and Wildlife Service (USFWS) • National Marine Fisheries Services (NMFS) • California Department of Fish and Game (DFG) • Santa Cruz County Planning • City of Santa Cruz
Applicable Regulations	• Federal Clean Water Act • County of Santa Cruz Water Quality Ordinance • California Water Code • Endangered Species Act
Attachments	1. Sample Agency Notification Letter 2. Map 3. Data Sheet 4. Pea Gravel Bag Layout
References	• EBMUD Environmental Compliance Manual • Central Coast Basin Plan

[9] In areas of potential soil contamination (gasoline, etc.) refer to SOP #7105-02 (yet to be developed) for more information before determining appropriate course of action.

Attachment 1 – Sample Notification Letter

PROCEDURE	7105-01
EFFECTIVE	8/30/02
SUPERSEDES	

Watershed Resources Management – 715 Graham Hill Rd.- Santa Cruz, CA 95060

Ms. Regulator
123 Old Logging Road Way
Santa Rosa, CA 90666

September 19, 2001

Dear Regulator,

Thank you for your consideration of our emergency repair work on the City's North Coast water main during the week of July 30 – August 3, 2001. This work was precipitated by a significant leak in the north coast raw water main and was necessary to maintain drinking water supply to the City from the north coast sources. In brief, this work included pumping of ponded water from the leaking pipeline and groundwater that seeped into a hole (which had been excavated by the leak) approximately 10 ft. across and 10 feet deep, excavation and replacement of the failed section of pipeline and filling of the hole. This repair work occurred in the riparian zone on the east side of Old Dairy Gulch just south of Highway 1 on, and in the vicinity of, the City's pipeline easement through APN 00-001-045. The City hired Green Construction to complete this repair. As you requested, I have compiled the following information regarding this work.

- July 30, 2001: 6,000 gallons of water pumped from the hole by the Santa Cruz Water Department (SCWD) and discharged into vegetation such that sediment would settle out. Discharge was dissipated by directing discharge into strawbale staked into crotch of mature willow tree.

- July 31, 2001: 2,000 gallons of water pumped from hole by Green Construction and discharged into vegetation such that sediment would settle out. Discharge was dissipated by directing discharge into strawbale staked into crotch of mature willow tree.

- August 1, 2001: 4,000 gallons of water pumped from hole by Green Construction and discharged into vegetation such that sediment would settle out.

- At approximately 7:30 am on this day I encountered Green Construction discharging turbid water pumped from the hole directly to Old Dairy Gulch and informed them that this was unacceptable. The foreman immediately moved the discharge line to a site with vegetative filter capacity. As Green Construction crews had only been on site for approximately half an hour at that point and the discharge was occurring at 400 gallons/hour, no more than 200 gallons of turbid water was discharged directly to the creek. Discharge was dissipated by directing discharge into strawbale staked into crotch of mature willow tree.

- August 2, 2001: 1,600 gallons of water pumped from hole by Green Construction and discharged into vegetation 100 feet from Old Dairy Gulch on 1-3% slope such that sediment would settle out. Discharge was dissipated by directing discharge into strawbale staked into crotch of mature willow tree.

- All water pumped from the hole was turbid. This suspended sediment was composed of native material deposited by the creek in the riparian zone of this low gradient reach of Old Dairy Gulch. Though discharge water surely still had some fines suspended when it entered creek, deposition of the bulk of the suspended sediment in the vegetation at the discharge point was successful. Discharged water appeared clear as it passed from the riparian vegetation into the creek.

Attachment 1 is documentation of biological surveys and work related to California Red Legged Frogs performed by Rana Aurori – the wildlife biologist who was retained by the City to assist us with this project. Attachment 2 is data collected during the project characterizing water quality of the discharge, and environmental conditions of the site upstream and downstream of the point of discharge. Attachment 3 illustrates the plan for restoration of the site disturbed by this work. The property owner's botanist, Danthonia Californica, has approved this plan. Attachment 4 is the project site location map. Finally, we are in the process of obtaining necessary permits for this work from the County of Santa Cruz as well as other relevant agencies.

Thank you again for your consideration. If you have any questions please feel free to call me at 420-5483.

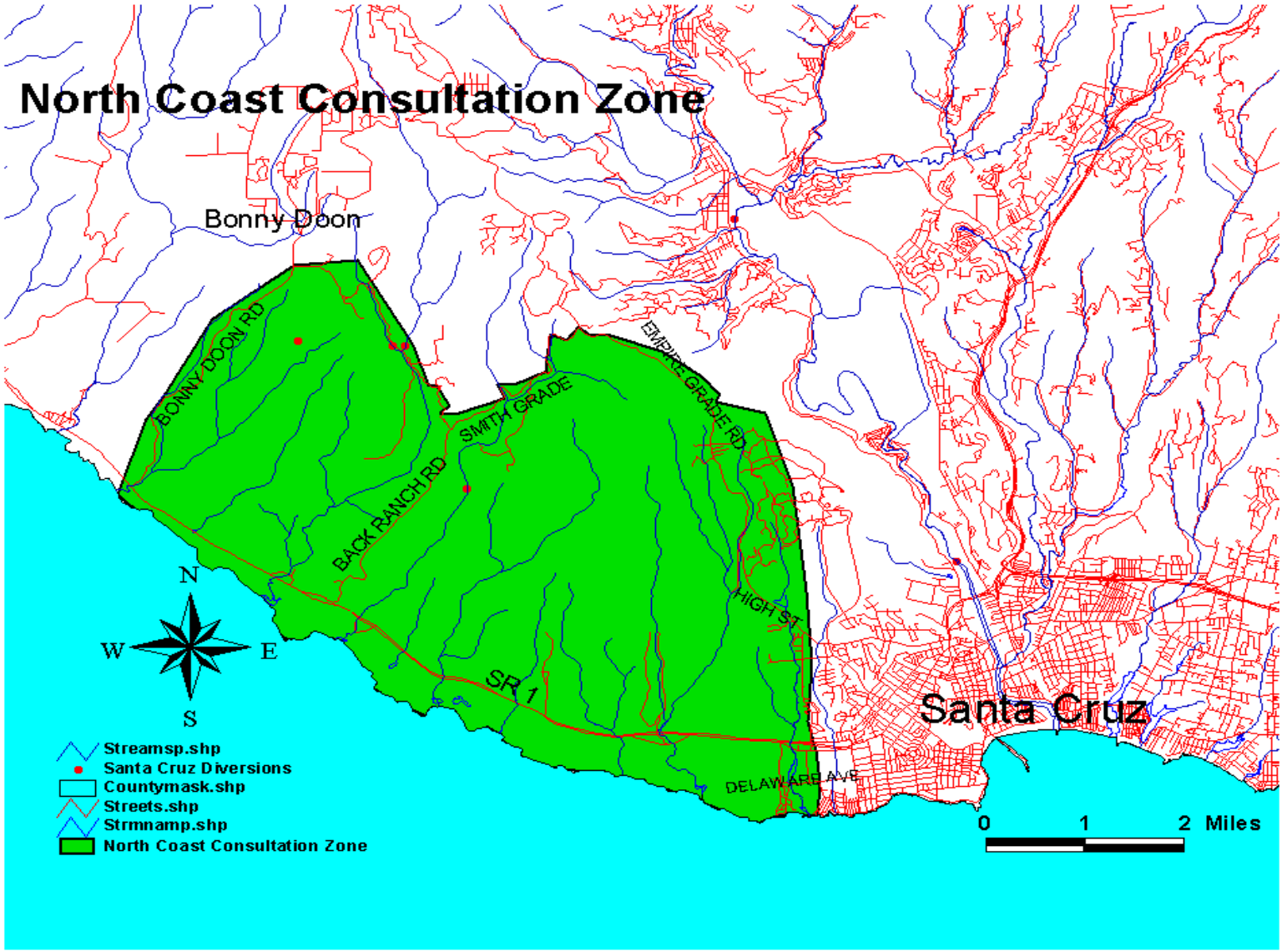
Sincerely,

SCWD Water Resources Manager

cc: read file, SCWD Operations Manager,USFWS, DFG, NMFS, RWQCB, SCCO Planning

PROCEDURE	7105-01
EFFECTIVE	8/30/02
SUPERSEDES	

Attachment 2 – Map



Attachment 3 – Data Sheet

PROCEDURE	7105-01
EFFECTIVE	8/30/02
SUPERSEDES	

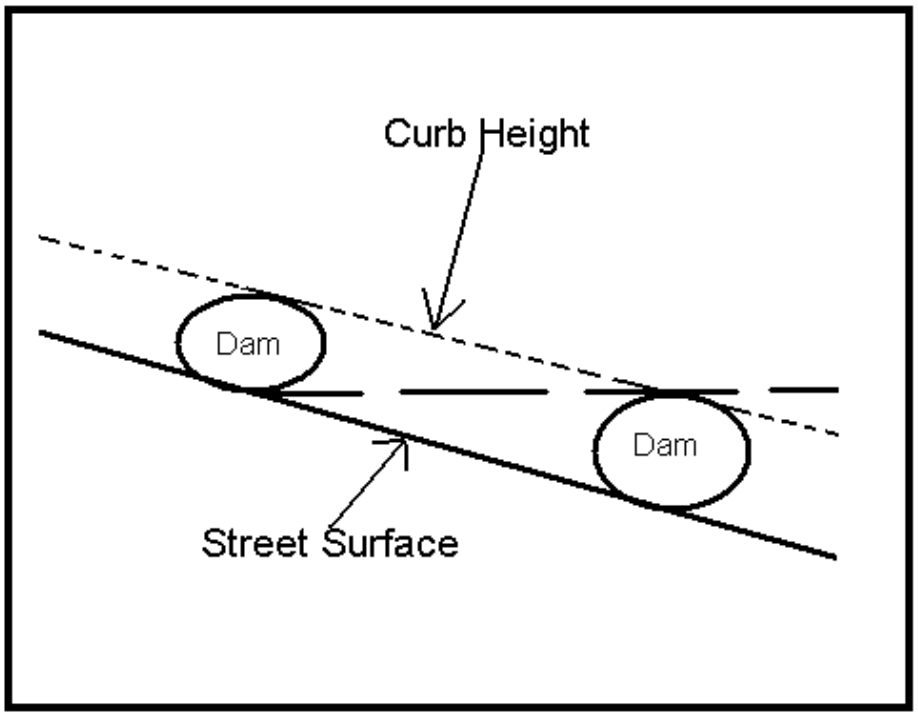
DEWATERING DATA	DESCRIPTION	UNITS	LIMIT	SAMPLE
	Chlorine residual	mg/l	0	
	Turbidity	NTU	1. Where natural turbidity is between 0 and 50 units, increases shall not exceed 20 percent. 2. Where natural turbidity is between 50 and 100 units, increases shall not exceed 10 units. 3. Where natural turbidity is greater than 100 units, increases shall not exceed 10 percent.	
Discharge	pH	NA	6.5-8.5	
	Temperature	Degrees Celsius		
	Volume	gallons		
	Chlorine residual	mg/l	0	
	Turbidity	NTU	See above	
Upstream	pH	NA	6.5-8.5	
	Temperature	Degrees Celsius		
	Presence of aquatic life?	Y/N		
	Presence of visible sheens, films, discoloration?	Y/N		
	Presence of erosion or sediment transport or % embeddedness	Y/N or %		
	Chlorine residual	mg/l	0	
	Turbidity	NTU	See above	
Downstream	pH	NA	6.5-8.5	
	Temperature	Degrees Celsius		
	Presence of aquatic life?	Y/N		
	Presence of visible sheens, films, discoloration?	Y/N		
	Presence of erosion or sediment transport or % embeddedness	Y/N or %		
Date: Time: Sampler's Initials:		Notes:		Weather:

Attachment 4 – Pea Gravel Bag BMP

PROCEDURE	7105-01
EFFECTIVE	8/30/02
SUPERSEDES	



Pea gravel bags dams surrounding storm drain inlet. Discharge should be interrupted and settled sediment removed before it is transported over dams into storm drain.



Pea gravel bag dams place in path of water flow to storm drain inlet. Dam spacing dependent on slope (i.e. in order to achieve orientation as above must be placed more closely together on steep slopes).

Appendix 12: Drinking Water Discharge General NPDES Permit

STATE WATER RESOURCES CONTROL BOARD
1001 I Street, Sacramento, California 95814
http://www.waterboards.ca.gov/water_issues/programs/npdes

ORDER WQ 2014-0194-DWQ
GENERAL ORDER NO. CAG140001

STATEWIDE NATIONAL POLLUTANT DISCHARGE ELIMINATION SYSTEM (NPDES) PERMIT FOR DRINKING WATER SYSTEM DISCHARGES TO WATERS OF THE UNITED STATES

Discharges from drinking water systems to surface waters in California are subject to waste discharge requirements as set forth in this Order, and as authorized by a Notice of Applicability issued by the Deputy Director of Water Quality (Deputy Director). Definitions for the purpose of this Order are included in Attachment A. Key definitions are as follows:

Table 1. Key Definitions for the Purpose of this Order

Drinking Water System[1]	A system with 1000[2] connections or greater that are regulated by the State Water Board Division of Drinking Water or a local county department of health, with the primary purpose of transmitting, treating and distributing safe drinking water. Drinking water systems include state owned/operated facilities such as parks, campgrounds, and rest areas [1] *This Order applies to community water systems as defined in Attachment A of this Order. This Order does not apply to non-community water systems or non-transient water systems as defined in Attachment A of this Order.* [2] *Systems with fewer than 1000 connections that discharge to waters of the United States have the option to enroll in this Order. Non-enrollment does not exempt dischargers from Clean Water Act requirements.*
Drinking Water System Discharge	Short-term or seasonal discharges from a drinking water system of water that has been dedicated for drinking water purposes
Water Purveyor	Any entity that discharges from a drinking water system, including water purveyors, wholesalers, distributors, districts, municipalities, private companies, and other entities that own or operate a community drinking water system
Discharger	A water purveyor that is authorized to discharge under this Order through an approved Notice of Applicability issued by the Deputy Director of Water Quality
Waters of the United States	Generally refers to surface waters, as defined for the purposes of the federal Clean Water Act. For the purpose of this Order, the terms “surface water,” and “receiving water” are interchangeably used to mean “waters of the United States,” unless noted otherwise

Table 2. Administrative Information

This Order was adopted by the State Water Board on November 18, 2014:
This Order shall become effective on February 26, 2015 (100 days after the adoption date of this Order)
This Order shall expire on February 25, 2020

CERTIFICATION

I, Jeanine Townsend, Clerk to the Board, do hereby certify that this Order with all attachments is a full, true, and correct copy of the Order adopted by the State Water Board on November 18, 2014.

AYE:	Chair Felicia Marcus Vice Chair Frances Spivy-Weber Board Member Tam M. Doduc Board Member Steven Moore Board Member Dorene D'Adamo
NAY:	None
ABSENT:	None
ABSTAIN:	None

Jeanine Townsend
Clerk to the Board

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I. SCOPE OF STATEWIDE GENERAL ORDER AND REQUIRED REGULATORY COVERAGE

This Order is a National Pollutant Discharge Elimination System (NPDES) general permit that authorizes discharges from drinking water systems, as defined on Page 1 of this Order. This Order provides regulatory coverage for short-term or seasonal planned and emergency (unplanned) discharges resulting from a water purveyor's essential operations and maintenance activities undertaken to comply with the federal Safe Drinking Water Act, the California Health and Safety Code, and the State Water Board's Division of Drinking Water permitting requirements for providing reliable delivery of safe drinking water.

Planned discharges include regularly scheduled, automated, or non-regularly scheduled activities that must take place to comply with mandated regulations and that the water purveyor knows in advance will result in a discharge to surface water. Emergency discharges include unplanned discharges that occur due to facility leaks, system failures, operational errors, or catastrophic events for which the water purveyor is not aware of the discharge until after the discharge has commenced. Planned and emergency discharges may occur directly, through a constructed storm drain or through another conveyance system, to waters of the United States (U.S.).

The Federal Water Pollution Control Act (also referred to as the Clean Water Act) section 402 requires that a discharge of any pollutant or combination of pollutants to surface waters that are deemed waters of the U.S., with certain exceptions, be regulated by a NPDES permit. (For the purpose of this Order, the terms "waters of the United States [or U.S.]", "surface waters" and "receiving waters" are used interchangeably unless noted otherwise.) On September 22, 1989, the U.S. Environmental Protection Agency (U.S. EPA) granted the State of California, through the State Water Resources Control Board (State Water Board) and the Regional Water Quality Control Boards (Regional Water Boards), the authority to issue NPDES permits pursuant to title 40 Code of Federal Regulations parts 122 and 123.

Discharges of a pollutant from a drinking water system, regardless of the size of the system, are required to be regulated by an NPDES permit if the discharges flow into a water of the U.S. Title 40 Code of Federal Regulations part 122.28 provides for issuance of general permits to regulate a category of dischargers if they involve the same or substantially similar types of operations; discharge the same type of waste; require the same type of effluent limitations or operating conditions; require similar monitoring; and are more appropriately regulated under a general order rather than individual orders. Discharges from drinking water systems that result from mandated activities to protect public health are of substantially similar types of operations, discharging the same type of waste.

This Order requires all water purveyors in California with drinking water system discharges to waters of the U.S. as described in Section I.B of this Order, except those water purveyors that meet the exception criteria identified in section I.A of this Order, to obtain NPDES regulatory coverage through enrollment in this statewide NPDES General Order. The water purveyor shall submit an application package to the State Water Board in accordance with section II.C.1 *Application Package Requirements* any time after the effective date of the permit but no later than **September 1, 2015**.

A. Water Purveyors NOT Required to Enroll in This Order

Water purveyors that meet any of the following criteria, items 1 through 6, are NOT required to submit an application package to obtain coverage through enrollment in this particular statewide NPDES General Order; this Order is, however, available for water purveyors that meet the criteria of items 1 through 3 below and choose to enroll. (This Order does not exempt any water purveyor from federal Clean Water Act requirements to obtain NPDES regulatory coverage for its discharges to waters of the U.S.) By **September 1, 2015**, water purveyors that meet any one of the items 2 through 5 below shall submit to the State Water Board a Notice of Non-Applicability form (see Attachment B-2) that certifies NPDES regulatory coverage from this Order is not required. A water purveyor with multiple community water systems in California need only submit one Notice of Non-Applicability for its systems that meet the same criterion.

1. The drinking water system has fewer than 1000 connections that deliver drinking water to end users. (This does not include water wholesalers as defined in Attachment A that deliver water to other drinking water systems); or

2. The water purveyor discharges solely to a municipal separate storm sewer system(s) (MS4) and has an established local agreement with the MS4 permittee to discharge into its system(s),

   AND

   The corresponding Regional Water Board Executive Officer provides written confirmation to the State Water Board Deputy Director that the local agreement provides sufficient regulation of the subject drinking water system discharges through an existing MS4 NPDES permit; or

3. The water purveyor is an MS4 permittee, or co-permittee, named on a State Water Board or a Regional Water Board issued MS4 permit that also authorizes discharges from drinking water systems, and all drinking water system discharges solely discharge into its own MS4 system; or

4. The water purveyor's discharge is regulated under an existing individual site-specific NPDES permit issued by the Regional Water Board because: (1) the discharge from the system is outside of the scope of this low threat Order, and/or (2) a Total Maximum Daily Load (TMDL) was adopted and the Regional Water Board determined that TMDL-specific permit requirements for its drinking water system(s) discharges are appropriate because those discharges may contribute to the impairment of the water body; or

5. All discharges from the drinking water system do not discharge to a water of the U.S.; or

6. The discharge is exempt from the legal requirement to obtain an NPDES permit under federal law.

After review, a Notice of Non-Applicability Approval by the State Water Board's Deputy Director of Water Quality (Deputy Director) may be issued. If the Notice of Non-Applicability is not complete or the discharge is deemed ineligible, the Deputy Director will send a response letter to the applicant outlining: (1) the missing information that deems the Notice of Non-Applicability incomplete, or (2) why the described discharge is not eligible and thus the water purveyor must obtain coverage under this Order. The State Water Board will provide the water purveyor **60 days from the date of the response letter** to provide State Water Board staff the items necessary to complete the Notice of Non-Applicability or to submit a complete application package in accordance with section II.C of this Order.

B. Discharges Authorized Under This Order

This Order authorizes drinking water system discharges (as defined on Page 1) resulting from a water purveyor's essential operations and activities undertaken to comply with the federal Safe Drinking Water Act, the California Health and Safety Code, and the State Water Board's Division of Drinking Water permitting requirements. Discharges authorized by this Order are composed solely of water that is dedicated by drinking water facilities for the primary purpose of providing safe and reliable drinking water. Additionally, discharges authorized under this Order are determined to not adversely affect or impact beneficial uses of the receiving waters when properly managed through best management practices. Such discharges include, but are not limited to, discharges from supply wells, transmission systems, water treatment facilities, water distribution systems, and storage facilities. Any discharges that are likely to cause or contribute to an exceedance of a water quality objective other than those granted an exception under the State Water Board Resolution 2014-0067, will not be authorized under this Order.

This Order authorizes single discharges at one identified location and multiple simultaneous discharges at multiple locations. Authorized discharges to waters of the U.S. may include, but are not limited to, the following discharges:

1. Planned Discharges Due To:

a. Groundwater supply well flushing or pump-to-waste.
b. Groundwater well development, rehabilitation, and testing.
c. Groundwater monitoring for purpose of supply well development, rehabilitation and testing.
d. Trench dewatering of drinking water during planned repairs.
e. Transmission system installation, cleaning, and testing.
f. Water treatment plant operations (excluding filter backwash that is discharged to a water of the U.S).
g. Distribution system storage tank or reservoir releases.
h. Distribution system dewatering, flushing, and pressure testing.
i. Fire flow / fire hydrant testing.
j. Meter testing.

k. Automated water quality analyzers operations.
l. Pressure relief valves.
m. Unscheduled activities that must be undertaken to comply with mandates of the Federal Drinking Water Act and California Health and Safety Code.

2. Emergency (Unplanned) Discharges Due To:

a. Emergency drinking water system failures and repairs including transmission and distribution system failures and repairs.
b. Trench dewatering due to an emergency failure.
c. Operation errors.
d. Catastrophic events.

C. Discharges Not Authorized Under This Order

The State Water Board does not authorize any of the following discharges to waters of the U.S. under this Order:

1. Discharges that are not within the scope of this Order as described in section I and/or are not authorized by a Notice of Applicability issued by the Deputy Director of Water Quality (Deputy Director); or

2. Discharges to a water of the U.S. with a total maximum daily load (TMDL) that prescribes a waste load allocation to a water purveyor, where the Deputy Director determines that the requirements of this Order are not consistent with the assumptions and requirements of the TMDL and thus compliance with this Order is not sufficient for the water purveyor to comply with the imposed TMDL requirements; or

3. Discharges from new drinking water systems (not an expansion of an existing system) into a Clean Water Act section 303(d)-listed impaired water body that is impaired for a constituent that exists in the new discharge at a concentration greater than the criteria used to establish the impairment of the water body, and for which a regional water board has issued an individual permit that addresses the TMDL requirements; or

4. Direct discharges into areas designated by the State Water Board as Areas of Special Biological Significance (ASBS).

II. PERMIT COVERAGE AND APPLICATION REQUIREMENTS

A. Permit Coverage

This Order provides regulatory coverage to water purveyors with existing and potential authorized discharges as set forth in section I.B to waters of the U.S. from a community drinking water system that does not adversely affect or impact beneficial uses of the

receiving water. Permit coverage may include discharges from work conducted by contractors on behalf of the water purveyor.

B. Permit Effective Date

This Order becomes effective **February 26, 2015**, 100 days after the adoption date of this Order. Any time after the effective date but no later than **September 1, 2015**, all water purveyors that do not meet the criteria of section I.A. of this Order shall submit a complete application package in accordance with the following section II.C.

C. Application Package Requirements

To obtain regulatory coverage under this Order, a water purveyor must submit to the State Water Board a complete application package that includes all the following items. A water purveyor with multiple drinking water systems in California need only submit one complete application package (with individual Notice of Intent forms for each of its drinking water systems) and obtain one Notice of Applicability for regulatory coverage of all its systems that discharge to waters of the U.S.

1. **Notice of Intent.** A completed Notice of Intent form for each of its drinking water systems (shown as Attachment B1 of this Order), signed and certified in accordance with section V.B., *Signatory and Certification Requirements*, of Attachment D – Standard Provisions.

2. **Application Package Fee.** A fee payable to the State Water Board in accordance with California Code of Regulations, title 23, or subsequent fee regulations updates. The current fee schedule is available at the following website: http://www.waterboards.ca.gov/resources/fees

   Only one fee is required for an application package requesting coverage for multiple drinking water systems.

3. **Site Information.**
   a. A site schematic showing the following items:
      i. The general location of the community drinking water facilities and/or the boundaries of the water purveyor's service area(s); and
      ii. The general location of groundwater supply wells and/or any discharge locations to surface waters; and
      iii. General identification of the portion of the community water system that discharges within a 300-foot conveyance distance from the receiving water(s) and/or within a 300-foot radius of the receiving water(s).
   b. Names of all named receiving water bodies and/or major downstream water bodies.

c. A description of the multiple uses of the water prior to surface water discharge or beneficial reuse that the discharges will serve (i.e. ground water recharge, irrigation).

d. Reason(s) that the discharge water cannot be utilized for multiple uses or beneficial reuse. (Refer to section VI. MULTIPLE USES OR BENEFICIAL REUSE, below)

4. **Total Maximum Daily Loads (TMDL) Constituent-specific Application Package Supplement** (applicable for discharges into waters of the U.S. identified in section III. K of the Fact Sheet). A supplement to the application requirements listed above shall include the following items:

   i. **Laboratory Analysis of TMDL-specific constituent(s).** (The laboratory analysis shall be conducted by a laboratory certified by the Environmental Laboratory Accreditation Program (ELAP).) The application package supplement shall include a laboratory analysis sheet(s) indicating the concentration of the applicable TMDL specific constituent(s) in the drinking water system discharge at the point of discharge. The monitoring and analysis shall be conducted in accordance with title 40 Code of Federal Regulations part 136. The water purveyor shall submit the following items for the application supplement to be deemed complete:

      a) A minimum of two samples representative of the drinking water system discharge that contains or has the potential to contain the greatest concentration or level of constituent/parameter associated with the TMDL constituent/parameter. The samples shall be taken at a location after the appropriate treatment or controls are implemented for the constituent associated with the TMDL; and

      b) The estimated minimum and maximum discharge volume per discharge event; and

      c) The estimated average discharge volume from the system per year. The estimated volumes may be based on historical data.

   ii. **TMDL-specific Best Management Practices.** Description of site-specific best management practices that properly treat and/or control corresponding TMDL constituents in the discharge to a concentration or level less than the water purveyor's applicable TMDL-specific permit requirement (s) as set forth in Attachment G, if any.

The supplemental analytical information will be used to confirm that the discharge does not contribute to the specific impairment of the TMDL-related waterbody(ies) and that the requirements in this Order are sufficient to ensure compliance with the specific TMDLs.

D. State Water Board Notice of Applicability

After the water purveyor's application package is deemed complete, the Deputy Director will issue a Notice of Applicability. Regulatory coverage for the planned and emergency

discharges that occur within the areas identified in the application package commences with the date of issuance of a Notice of Applicability to the water purveyor. If the submitted application package is not complete in accordance with previous section II.C., or the discharge is deemed ineligible for coverage under this Order, the Deputy Director will send a response letter to the applicant outlining: (1) the missing information that renders the application package incomplete, or (2) why the described discharge is not eligible for coverage under this Order. The water purveyor will have **60 days from the date of the response letter** to provide State Water Board staff the items necessary to complete the application package.

E. Permit Coverage Termination

1. **Termination of Existing Regional Water Board Permit Coverage.** Upon the issuance of the NOA in accordance with this Order, the State Water Board expects the applicable Regional Water Board to terminate regulatory coverage under an existing non-MS4 Regional Water Board NPDES permit for discharges within the scope of this Order.

2. **Termination of Statewide Permit Coverage or Revocation of Notice of Non-Applicability.** The Deputy Director may terminate coverage or revoke a Notice of Non-Applicability Approval (NONAA) under this Order for any of the specified causes, and require application for coverage under an individual or other NPDES permit as set forth in title 40 Code of Federal Regulations part 122.28(b)(3). Causes for permit coverage termination or NONAA revocation include, but are not limited to, the following:
   a. Violation of any term or condition of this Order; or
   b. Misrepresentation or failure to disclose all relevant facts in obtaining permit coverage or non-applicability status under this Order, or
   c. Written request from a Discharger to terminate enrollment because discharge has ceased or that the permit is no longer needed.

   Annual permit fees will be assessed by the State Water Board up to the date of written termination notification from the State Water Board to the Discharger, or the date of a termination request letter from the Discharger to the State Water Board, whichever is applicable.

3. **Qualified Biologist Certification Following Project Completion.** Upon completion of the project, the Discharger shall provide certification by a qualified biologist that beneficial uses of the receiving waters have been restored. For drinking water system discharges, completion of the project is when the water purveyor ceases discharges from its drinking water system under this Order, or when the State terminates NPDES permit coverage for the discharge(s).

F. Permit Transfer

A change in ownership of the facilities authorized to discharge through coverage under this Order requires the current owner to provide written notice to the State Water Board

at least 30 days in advance of transfer of ownership. The Deputy Director may determine that the new owner must submit an application package to seek coverage under this Order if the nature or location(s) of the discharge(s) have changed from the application package on file.

III. FINDINGS

The State Water Board finds the following:

A. Legal Authorities. This Order serves as statewide Waste Discharge Requirements (WDRs) pursuant to California Water Code article 4, chapter 4, division 7 (commencing with § 13260). This Order is also issued pursuant to federal Clean Water Act (CWA) section 402 and implementing regulations adopted by the U.S. EPA, and the California Water Code, chapter 5.5, division 7 (commencing with § 13370). This Order shall serve as a statewide general NPDES permit for point source discharges from single or multiple discharge points to surface waters, storm drains, and other storm water conveyances leading to waters of the U.S.

B. Background and Rationale for Requirements. The Fact Sheet (Attachment F) contains background information and rationale for the requirements in this Order, and is hereby incorporated into and constitutes findings for this Order. Attachments A through E, G, and H are also incorporated into this Order.

C. Termination of Existing Coverage Under Similar Regional Water Board Orders. The State Water Board's intention in the issuance of this statewide NPDES Permit is to provide consistent and efficient regulation of discharges from drinking water systems statewide. To provide such consistency, the State Water Board intends that existing regulatory coverage under an existing non-MS4 Regional Water Board NPDES permit for discharges regulated under this Order will be terminated by the applicable regional water board upon issuance of the Notice of Applicability to a water purveyor per the terms of this Order.

D. Threat and Complexity of Discharge.
When mitigated through implementation of appropriate management practices, treatment and/or controls, discharges from community water systems, as defined under this Order, pose no adverse effects or impacts to beneficial uses of the receiving waters. In accordance with the State Water Board fee regulations, the discharges that are regulated under this general NPDES Permit require minimal or no additional treatment systems to meet limits and pose no significant threat to water quality and therefore are of low threat and low complexity.

E. State Implementation Policy. As adopted in March 2000, and amended in February 2005, the *Policy for Implementation of Toxics Standards for Inland Surface Waters, Enclosed Bays, and Estuaries of California* (State Implementation Policy or SIP) establishes implementation provisions for priority pollutant criteria, and objectives and provisions for chronic toxicity control. Section 5.3 of the SIP allows for the granting of a categorical exception for drinking water system activities conducted to fulfill statutory requirements mandated by federal and state regulations.

F. California Ocean Plan. In 1972, the State Water Board adopted the Water Quality Control Plan for Ocean Waters of California (hereinafter Ocean Plan), as amended. The latest Ocean Plan amendment became effective on August 19, 2013. The Ocean Plan is applicable, in its entirety, to point source discharges to the ocean waters of the State. To protect the beneficial uses of ocean water, the Ocean Plan establishes water quality objectives and a program of implementation. Requirements of this Order implement the Ocean Plan and are applicable to those discharges directly into the Ocean or indirectly via a storm water system that drains into the Ocean near the location of discharge. This Order does not authorize direct discharges into Areas of Special Biological Significance (ASBS).

Section III.J of the Ocean Plan allows the State Water Board to grant an exception where the State Water Board determines that the exception will not compromise protection of the ocean waters or beneficial uses and the public interest will be served.

G. Exception Resolution. On November 18, 2014, the State Water Board adopted a Resolution approving an exception to the State Implementation Policy and the Ocean Plan to water purveyors statewide for discharges from drinking water systems from complying with specified priority pollutant criteria and ocean plan objectives. As provided in Resolution 2014-0067, the State Water Board granted an exception per section 5.3 of the State Implementation Policy to water purveyors statewide, for planned and emergency discharges to inland surface waters, enclosed bays and estuaries. Similarly, as provided in Resolution 2014-0067, the State Water Board granted water purveyors with drinking water system discharges to the ocean, other than direct discharges into ASBS, an Ocean Plan exception for compliance with specified Ocean Plan objectives. As further discussed in the Fact Sheet (Attachment F), the State Water Board finds that in accordance with the requirements of the SIP and Ocean Plan, discharges from drinking water systems qualify for an exception of the State Implementation Policy and Ocean Plan per Resolution 2014-0067.

H. California Environmental Quality Act. Under Water Code section 13389, this action to adopt an NPDES permit is exempt from the provisions of Chapter 3 of the California Environmental Quality Act (CEQA), (commencing with section 21100) of Division 13 of the Public Resources Code.

Additionally, pursuant to CEQA, Public Resources Code section 21100 et seq., on November 18, 2014 the State Water Board adopted Resolution 2014-0067 approving a Mitigated Negative Declaration for excepting the type of discharges as covered under this Order from specified requirements of the State Implementation Policy and the California Ocean Plan.

I. Total Maximum Daily Load (TMDL) Implementation. A review of Regional Water Board TMDLs found that, as of the adoption date of this Order, only the Los Angeles Regional Water Board and the San Diego Regional Water Board have TMDLs that either directly apply waste load allocations to, or may indirectly imply that waste load allocations are applicable to, the discharges from drinking water systems regulated under this General Order. None of these TMDLs established waste load allocations that apply exclusively to discharges from drinking water systems. These TMDLs are

applicable to the discharges from drinking water systems authorized under this Order and are therefore implemented by this Order.

This Order requires TMDL-related sampling of discharges from drinking water systems identified in a TMDL. If a Regional Water Board determines that any of these TMDLs, or any newly approved TMDLs, establish requirements that should be implemented through TMDL-specific permit requirements for the discharges from drinking water systems that are authorized under this Order, the Regional Water Board may issue permit(s) for those discharges, with coverage under this Order subsequently terminated. Alternatively, if further TMDLs are adopted that address pollutants that are likely to be in discharges from drinking water systems, and allocate waste loads specifically to water purveyors regulated under this Order, the State Water Board may consider adding additional TMDL-specific permit requirements to Attachment G of this Order in a subsequent permit amendment or renewal.

J. Notification of Interested Parties. State and Regional Water Board staffs have conducted eight stakeholder meetings statewide, and numerous other informal communications, and have notified prospective water purveyors and interested agencies and persons of the intent to issue this statewide NPDES permit and prescribe these statewide waste discharge requirements. The State Water Board provided an opportunity for all interested parties to submit written comments and testimony.

K. Consideration of Public Comment. The State Water Board, in an August 5, 2014 public hearing, heard and considered public comments pertaining to the draft Order. The State Water Board also considered all written public comments submitted by the public comment due date of August 19, 2014, prior to adopting this Order. The Fact Sheet (Attachment F) provides details regarding the public notice and public hearing.

THEREFORE, IT IS HEREBY ORDERED that, in order to meet the provisions contained in California Water Code, Division 7 (commencing with section 13000) and regulations adopted thereunder, and the provisions contained in the Clean Water Act and regulations and guidelines adopted thereunder, a water purveyor shall comply with the requirements of this Order. Water purveyors that have obtained coverage under this Order shall comply with the requirements in sections IV. through VII. (Discharge Specifications and Effluent Limitations, Receiving Water Limitations, Multiple Uses or Beneficial Uses Provisions, and Compliance Determination), Attachments D and E (Standard Provisions and Monitoring and Reporting Program) of this Order, and Attachment G (TMDL-related requirements) as applicable.

IV. DISCHARGE SPECIFICATIONS AND EFFLUENT LIMITATIONS (ONLY APPLICABLE TO DISCHARGES THAT ENTER A WATER OF THE U.S.)

For purposes of this Order, references to “discharge(s)” mean discharge(s) that may occur directly, through a constructed storm drain, or through other conveyance system, to waters of U.S. The Discharger shall comply with the following discharge specifications and effluent limitations.

A. Specification for Implementation of Best Management Practices

1. The Discharger shall implement best management practices (BMPs) that treat or control pollutants from its discharges to maintain compliance with this Order. Implementation of BMPs includes proper management, and routing of discharges to control the pollutants of concern. The Discharger shall properly manage planned discharges and implement proven BMPs provided by professional associations or institutes such as the American Water Works Association, to protect beneficial uses of the receiving water body(ies). For emergency discharges, the Discharger shall implement BMP procedures as soon as feasible while concurrently protecting public health and safety. Attachment C of this Order provides example BMPs.

   At minimum, the Discharger shall implement BMPs for planned discharges to achieve the following performance measures:

   i. Prevent aquatic toxicity by using dechlorination chemical additions, implementing equivalent proven dechlorination methods, and/or assuring that the chlorine in the discharge dissipates naturally; such that the level of chlorine in the discharge is less than 0.019 mg/L prior to entering a receiving water.

   ii. Prevent riparian erosion and hydromodification by implementing flow dissipation, erosion control, and hydromodification-prevention measures; and

   iii. Minimize sediment discharge, turbidity and color impacts by implementing sediment, turbidity, erosion and color control measures.

2. For Groundwater Supply Well Operations, the Discharger shall implement treatment systems or BMPs for all groundwater well development, rehabilitation, or operation discharges to waters of the U.S. to ensure these discharges:
   (1) Do not cause or contribute to an exceedance of the receiving water limitation for turbidity in Section V.G. of this Order, and
   (2) Comply with a turbidity action level of 100 Nephelometric Turbidity Units (NTUs) or less in the discharge. An exceedance of the turbidity numeric action level of 100 NTU is not a violation of this Order, but any exceedance does require that the Discharger take action to modify, change or enhance BMPs when the turbidity level is greater than 100 NTU, until the turbidity level is 100 NTU or less.

3. The Discharger shall implement quality assurance and quality control protocol to assure best management practices, monitoring, and reporting are effective, valid, and in compliance with this Order. The Discharger shall train all personnel operating the drinking water system and responding to emergency discharges to assure the quality assurance and quality control protocol is properly implemented.
4. For planned discharges, BMPs shall be implemented prior to and during discharges that enter a water of the U.S. For planned discharges from pressure relief valves (*i.e.*, due to testing or maintenance) and unchlorinated pump-to waste wells, BMPs

shall be implemented unless infeasible (e.g., inaccessible, inadequate space). For emergency discharges, BMPs shall be implemented as soon as feasible following assurance that public safety, property, and infrastructure are protected.

5. In fulfilling the requirements of this section, the Discharger may implement the example BMPs contained in Attachment C, or proven BMPs per updated approved guidance established by industry experts, professional associations, or entities (e.g. *2014 Edition of the BMP Manual for Drinking Water System Releases* published by the California-Nevada Section of the American Water Works Association).
6. The Discharger shall maintain a documented log of all BMPs implemented for its different types of discharges that enter a water of the U.S., and make it available to State and Regional Water Board staff upon request.
7. The Discharger shall modify BMPs as necessary to maintain compliance with the requirements of this Order. If monitoring results or other available information demonstrate that the discharge is not in compliance, the Discharger shall determine the source of non-compliance, and develop and implement new or revised BMPs as necessary. As part of this process, the Discharger shall validate the effectiveness of any new or revised BMPs to achieve the requirements of this Order. All non-compliance and corresponding corrective actions to address non-compliance shall be reported to the State Water Board in the annual report, as required in the Monitoring and Reporting Program (Attachment E) of this Order. A log documenting the additional or revised BMPs shall be made available upon request by staff of the State and/or Regional Water Board.

B. Effluent Limitations

1. All Discharges of Superchlorinated Water:

a. The total chlorine residual concentration in the discharge shall not exceed 0.019 mg/L.

b. A field monitoring result with a total residual chlorine concentration greater than or equal to 0.1 mg/L shall be deemed out of compliance with a chlorine effluent limitation.

2. All Planned Discharges directly into, or within 300 feet of, Inland Surface Waters, Enclosed Bays, and Estuaries

a. The total chlorine residual concentration in the discharge shall not exceed 0.019 mg/L.
b. A field monitoring result with a total residual chlorine concentration greater than or equal to 0.1 mg/L shall be deemed out of compliance with a chlorine effluent limitation.

3. All Planned Discharges directly into, or within 300 feet of, Ocean Waters

a. The total chlorine residual concentration in the discharge shall not exceed 0.008 mg/L.
b. A field monitoring result with a total residual chlorine concentration greater than or equal to 0.1 mg/L shall be deemed out of compliance with a chlorine effluent limitation.

c. The turbidity concentration in the discharge shall not exceed 225 NTU at any time.

V. RECEIVING WATER LIMITATIONS

Receiving water limitations are based on water quality objectives contained in Regional Water Quality Control Board Basin Plans and State Water Board water quality control plans, including the Ocean Plan, and policies, and are a required part of this Order. Drinking water system discharges to the receiving water that are authorized to discharge under this Order shall not cause or contribute to the exceedance of a water quality objective or standard in the receiving water, other than water quality objectives or standards for parameters that have been granted an exception under the State Water Board Resolution 2014-0067 and are not part of a TMDL, and at minimum shall not cause or contribute to an occurrence of the following in the receiving water:

A. pH. The pH level to be outside the range of the pH receiving water objective in a corresponding Regional Water Board basin plan.

B. Chemical Constituents. Chemical constituents to be present in concentrations that adversely affect beneficial uses.

C. Floating Material and Trash. Floating material, debris or trash to be present that cause nuisance or adversely affect beneficial uses.

D. Sediment and Total Suspended Solids. The sediment load and total suspended solids discharge rate of surface waters to be altered in such a manner as to cause nuisance or adversely affect beneficial uses.

E. Toxicity. Toxic substances to be present, individually or in combination, in concentrations that produce detrimental physiological responses in human, plant, animal, or aquatic life.

F. Hydromodification. Velocity and/or volume of discharge to modify the existing physical characteristics of a water body.

G. Turbidity. Turbidity concentrations to exceed corresponding Regional Water Board basin plan water quality objectives for turbidity.

VI. MULTIPLE USES OR BENEFICIAL REUSE

The discharge to surface waters may be considered wasteful when it is feasible for the water to be used prior to discharge. The State Water Board strongly encourages all water purveyors to put all or part of the discharge water to multiple uses or a beneficial reuse prior to discharge into surface water. Because of the high quality of the discharge water addressed in this Order, discharges authorized under this Order that are put to multiple use or beneficial reuse are not required to be monitored and generally not required to obtain any other waste discharge requirements if the water that would otherwise be discharged is instead collected and reused for landscape irrigation, agricultural irrigation or other uses in

a manner that augments the existing water supply, or if the discharge is directly or indirectly discharged to: (1) storm water capture basin(s), (2) low impact development features, or (3) other groundwater-recharge system(s).

VII. PROVISIONS

A. Standard Provisions

The Discharger shall comply with all Standard Provisions in Attachment D.

B. Monitoring and Reporting Program Requirements

The Discharger shall comply with the Monitoring and Reporting Program requirements in Attachment E.

C. Special Provisions

1. Reopener Provisions

The State Water Board may modify or reopen this Order prior to its expiration date in any of the following circumstances:

a. If present or future investigations demonstrate that the discharges governed by, and in compliance with, this Order cause adverse impacts on water quality or beneficial uses of the receiving waters;

b. If State Water Board precedential decisions, new policies, new laws, or new regulations are adopted;

c. To include specific implementation provisions in Attachment G for any existing or newly adopted TMDLs;

d. If an administrative or judicial decision on a separate NPDES permit or Waste Discharge Requirements addresses requirements applicable to discharges authorized in this Order; and/or

e. As otherwise authorized by law.

D. Noncompliance

Noncompliance with any requirement of this Order may be subject to enforcement action by the State Water Board and/or Regional Water Board as authorized under the Porter Cologne Water Quality Control Act (Water Code Section 13000), consistent with the State Water Board's enforcement policy.

VIII. COMPLIANCE DETERMINATION FOR PLANNED DISCHARGES

Compliance with the final effluent limitations contained in Section IV.B of this Order will be determined as specified below:

A. Permit Compliance for Planned Discharges only

Compliance with applicable effluent limitations, BMP implementation requirements, receiving water limitations, monitoring, notification, and reporting requirements of the permit constitutes compliance with this Order. Due to the infeasibility of a Discharger to self-monitor compliance with receiving water limits in distant receiving water bodies (for discharges into drainage conveyance systems), non-compliance with receiving water limitations for indirect discharges will be determined based on additional site-specific information made available to the Water Boards indicating that drinking water system discharges caused or contributed to the exceedance of the receiving water limitations and adversely impacted beneficial uses.

B. General

Compliance with effluent limitations shall be determined using monitoring and reporting protocols defined in the Monitoring and Reporting Program of this Order. For purposes of reporting and administrative enforcement by the State and/or Regional Water Boards, the Discharger shall be deemed out of compliance with the effluent limitations if the constituent concentration or level is greater than the effluent limitation and greater than or equal to the minimum level (ML, also known as the Reporting Level (RL)) of properly calibrated in-field monitoring equipment.

C. Total Residual Chlorine

Handheld chlorine measuring devices that are U.S. EPA-approved are appropriate to measure residual chlorine in the field for compliance determination. The minimum level of a hand-held chlorine meter used to determine compliance with the total chlorine residual effluent limitations is 0.1 mg/L or lower. A discharge monitoring result with a total residual chlorine concentration greater than or equal to 0.1 mg/L shall be deemed out of compliance with a chlorine effluent limitation. Due to other possible interferences of these handheld devices, if readings are false positives, these will not be evaluated for compliance if explanation of cause of false positive is provided.

ATTACHMENT A – DEFINITIONS

Adverse Effect or Adverse Impact to Beneficial Uses of a Receiving Water Body
A detrimental effect upon water quality or beneficial uses of a receiving water body caused by a discharge or loading of a pollutant or pollutants.

Authorized Discharge
Any discharge that is authorized pursuant to this National Pollutant Discharge Elimination System (NPDES) permit and meets the requirements and conditions set forth in this Order.

Basin Plan
The Water Quality Control Plan(s) adopted by a Regional Water Quality Control Board. A Basin Plan designates beneficial uses, establishes water quality objectives, and contains implementation programs and policies to achieve water quality objectives for all waters of the Basin.

Beneficial Uses
The existing or potential uses of receiving waters in the permit area as designated by a Regional Water Board basin plan or other water quality control plan.

Best Management Practices (BMPs)
Methods, measures, or practices designed and selected to reduce or eliminate the discharge of pollutants to surface waters from point and nonpoint source discharges. BMPs include structural and nonstructural controls, and operation and maintenance procedures, which can be applied before, during, and/or after pollution producing activities.

Community Water System
A public water system for the provision of water for human consumption through pipes or other constructed conveyances that has 15 or more service connections or regularly serves at least 25 individuals daily at least 60 days out of the year.

Drinking Water System
A system regulated by the State Water Resources Control Board Division of Drinking Water or a local county department of health, with the primary purpose of conveying, treating, storing and distributing safe drinking water to at least 15 service connections used by yearlong residents or regularly serves at least 25 year around residents of the area served by the system.

Deputy Director
The Deputy Director of Water Quality for the State Water Resources Control Board or any person(s) delegated by the Deputy Director to serve as acting Deputy Director.

Direct Discharge
Any discharge that enters a Water of the U.S. without first traveling via a storm drain or any other constructed conveyance system.

Discharger
Any water purveyor named in this Order as being responsible for permit requirements within its jurisdiction. A discharger to this Order includes a public or private water purveyor, wholesaler, or district, or a contractor working on behalf of the water purveyor, wholesaler or district.

Drinking Water System Discharges
Release of flows from drinking water intakes, transmission, storage, pumping, treatment and distribution systems including flows due to: (1) system failures and pressure releases, (2) system development, testing and maintenance that is performed to comply with the federal Safe Drinking Water Act, the California Health and Safety Code, and State Water Board Division of Drinking Water permit requirements.

Emergency Discharge
A discharge due to a sudden unexpected occurrence involving a clear and imminent danger, demanding immediate action to prevent or mitigate loss of, or damage to, life, health, property, or essential public services, including the provision of drinking water supplies in accordance with applicable drinking water statutes and regulations.

Estuaries
Surface waters, including coastal lagoons, located at the mouths of streams that serve as areas of mixing for fresh and ocean waters. Estuarine waters shall be considered to extend from a bay or the open ocean to a point upstream where there is no significant mixing of fresh water and seawater.

Enclosed Bays
Enclosed bays are hydrological indentations along the coast that enclose an area of oceanic water within distinct headlands or harbor works. Enclosed bays include all bays where the narrowest distance between the headlands or outermost harbor works is less than 75 percent of the greatest dimension of the enclosed portion of the bay.

Impaired Water Body
A water body that is currently listed on the Clean Water Act section 303(d) list.

Indirect Discharge
Any discharge that enters a Water of the U.S. by first traveling via a storm drain or any other constructed conveyance system.

Inland Surface Waters
All surface waters of the state that do not include the ocean, enclosed bays, or estuaries.

Low Impact Development (LID)
A storm water management and land development strategy that emphasizes water conservation and the use of on-site natural features integrated with engineered, small-scale hydrologic controls to more closely reflect pre-development hydrologic functions.

Method Detection Limit (MDL)
Minimum concentration of a substance that can be measured and reported with 99 percent confidence that the analyte concentration is greater than zero, as defined in in 40 C.F.R. part 136, Attachment B, revised as of July 3, 1999.

Minimum Level (ML) and Reporting Level (RL)
The minimum level (ML) means the concentration at which a properly calibrated monitoring system gives a recognizable signal and acceptable calibration point. The ML is the concentration in a sample that is equivalent to the concentration of the lowest calibration standard analyzed by a specific monitoring procedure, assuming that all the method specified sample weights, volumes, and processing steps have been followed. A reporting level (RL) is the ML for reporting and compliance determination included in this Order.

MS4 Operator
The MS4 Operator is the entity responsible for the operation of its local municipal separate storm sewer system subject to an MS4 NPDES Permit.

Monitoring Well
Specialized wells in which the depth to groundwater can be measured and samples of ground water can be collected for analysis for the purpose of managing drinking water aquifers and/or to fulfill requirements mandated by the federal Safe Drinking Water Act and the California Health and Safety Code.

Non-community Water System
A water system that is not a community water system, as defined in this attachment. A non-community water system is a water system that generally serves less than 15 service connections used by yearlong residents or does not regularly serve at least 25 year around residents with the water system's service area.

Not Detected (ND)
Sample results less than the properly calibrated monitoring equipment's MDL.

Non-transient Water System
A water system that is not a community water system, as defined in this attachment, and that regularly serves at least 25 of the same persons over six months per year. Non-transient water systems are regulated by the State Water Board Division of Drinking Water.

National Pollutant Discharge Elimination System (NPDES)
The national program for issuing, modifying, revoking and reissuing, terminating, monitoring and enforcing permits, and imposing and enforcing pretreatment requirements, under Clean Water Act sections 307, 402, 318, and 405.

Pollutants
Substances defined in Clean Water Act section 502(6) (33 U.S.C. § 1362(6)), and incorporated by reference into Water Code section 13373.

Pollution Prevention
Any action that causes a net reduction in the use or generation of a hazardous substance or other pollutant that is discharged into water and includes, but is not limited to, input change, operational improvement, production process change, and product reformulation (as defined in Water Code section 13263.3). Pollution prevention does not include actions that merely shift a pollutant in discharge water from one environmental medium to another environmental medium, unless clear environmental benefits of such an approach are identified to the satisfaction of the State Water Board or Regional Water Board.

Receiving Water
The term receiving water is used interchangeably with the term waters of the U.S.

Superchlorinated Water
Water that is dosed with chlorine in order to adequately sanitize and disinfect drinking water system facilities

Supply Well
A groundwater well that is installed, operated, maintained and/or rehabilitated in accordance with the federal Safe Drinking Water Act and the California Health and Safety Code to pump ground water for the primary purpose of delivering drinking water to a municipality or community.

Transmission Systems
Transmission systems include pipes, pumps, canals, pump houses, and other components used to move water from the point of origin to storage reservoirs, treatment facilities, and distribution systems. Transmission systems do not have connections to serve end users.

Water Purveyor
Any entity that discharges from a drinking water system, including water purveyors, wholesalers, distributors, districts, municipalities, private companies, and other entities that own or operate a community drinking water system.

Water Wholesaler
An entity that provides potable water to a person, political subdivision, or municipality that is not the ultimate consumer of the service.

Waters of the State
Any surface water or groundwater, including saline waters, within boundaries of the state.

Waters of the United States (U.S.)
Generally refers to surface waters, as defined for the purposes of the federal Clean Water Act.

ATTACHMENT B1 – NOTICE OF INTENT

STATE WATER RESOURCES CONTROL BOARD TO APPLY FOR REGULATORY COVERAGE UNDER ORDER WQ 2014-0194-DWQ, NPDES NO. CAG140001 FOR DRINKING WATER SYSTEM DISCHARGES TO WATERS OF THE U.S.

1. DRINKING WATER SYSTEM OWNER[1]

Name			Number of Connections:_____
State Water Board Division of Drinking Water Drinking Water System No.:_____ (If Applicable - Conceptual Letter Approval – System No.:_____)			
Mailing Address			
City	State	ZIP	Phone
Contact Person			
Signature:[2]			Date:

2. APPLICANT (IF DIFFERENT FROM SYSTEM OWNER)

Name			
Mailing Address			
City	State	ZIP	Phone
Contact Person			
Signature:[2]			Date:

3. WATER SUPPLIERS (IF APPLICABLE)

Name			
Mailing Address			
City	State	ZIP	Phone
Contact Person			
Signature:[2]			Date:

4. BILLING ADDRESS

Name			
Mailing Address			
City	State	ZIP	Phone
Contact Person			

[1] If additional property owners are involved, provide the information in a supplementary letter.

[2] By signing this notice of intent, you are certifying under penalty of perjury that the information provided in this application and in any attachments is true and accurate to the best of your knowledge. By signing this Notice of Intent, you agree to closely monitor and stop the discharge if there is any violation of Order WQ 2014-0194-DWQ or impact to receiving water beneficial uses.

5. PLANNED DISCHARGE INFORMATION

Identify the type of facilities that will have drinking water system discharge (all that apply)

☐	Intake and/or Transmission Facilities	☐	Distribution Systems
☐	Storage Tanks and/or Reservoirs	☐	Supply Wells
☐	Water Treatment Facilities	☐	Other (explain below)

List and description of other discharges.

Are the discharges existing discharges as of the adoption date of this Order)? _____

If not, identify the new discharges that are proposed to take place prior to the expiration date of this Order?

List any additives to the drinking water not affiliated with drinking water treatment, their purpose, and quantity: (For example, algaecides, anticorrosion agents, etc.)

6. MULTIPLE WATER USE OR BENEFICIAL USE OPTIONS

Is using a portion of the discharge for irrigation, groundwater infiltration/recharge or other use a viable option?	☐ Yes	☐ No
Is land disposal of a portion of your discharge a viable option?	☐ Yes	☐ No

Provide a brief description of the discharge (or portion thereof), that is collected and applied for irrigation or other beneficial reuse. If no multiple water use options of any portion of your discharge are viable, explain why (attach additional sheet as necessary).

7. **RECEIVING WATER INFORMATION (provide on separate sheet if necessary)** *Note that identification of receiving waters does not necessarily constitute a formal finding that any specific water body is a water of the U.S.*

Name of all named receiving water bodies and/or major downstream water bodies:		
Circle the Regional Water Quality Control Board(s) where receiving water body (ies) is/are located: REGION 1, 2, 3, 4, 5, 6, 7, 8, or 9 (See Attachment H for identification of the various regions)		
Are any of the receiving water bodies receiving drinking water system discharges listed on the current 303d list[1] for a constituent in your discharge?[1]	☐ Yes	☐ No
If Yes, then list the water bodies on the 303d list, the constituent causing the impairment:		
Does/Do the receiving water body(ies) have applicable waste load allocations identified in Section K of the Fact Sheet or TMDL-related requirements in Attachment G? If yes, the following items must be attached to this form for the application package to be deemed complete: a. Laboratory Analysis and estimated volume of your discharge per section II.C.1.d.i. of this Order b. If applicable, a description of the additional best management practices, including applicable treatment or controls that will be implemented to comply with TMDL-related requirements per section II.C.1.d.ii. of this Order	☐ Yes	☐ No

[1] See http://www.waterboards.ca.gov/water_issues/programs/tmdl/ for current Clean Water Act section 303(d) listing.

8. BEST MANAGEMENT PRACTICES (CHECK ALL THAT APPLY)

☐ Best Management Practices (BMPs) are being implemented by trained personnel of the subject drinking water system(s) and an instruction copy of the BMPs are available to all personnel and available at the water purveyor's main office(s) upon State or Regional Water Board staff request.

Date that implementation of BMPs commenced for the above identified Drinking Water System:

_____

If not, provide date BMPs will be implemented and available. (Date must be within 6 months of the effective date of this Order.) _____

9. APPLICATION FEE

☐ Provide the appropriate applicable fees. Information on applicable fees can be found at http://www.waterboards.ca.gov/resources/fees/ Checks shall be made payable to the State Water Resources Control Board.

I certify under penalty of law that this document and all attachments were prepared under my direction or supervision in accordance with a system designed to assure that qualified personnel properly gather and evaluate the information submitted. Based on my inquiry of the person or persons who manage the system or those persons directly responsible for gathering the information, the information submitted is, to the best of my knowledge and belief, true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment for knowing violations.

_____ _____

Signature Date

ATTACHMENT B2 – NOTICE OF NON-APPLICABILITY

STATE WATER RESOURCES CONTROL BOARD

CERTIFYING NON-APPLICABILITY OF REGULATORY COVERAGE UNDER ORDER WQ 2014-0194-DWQ, NPDES NO. CAG140001

1. DRINKING WATER SYSTEM OWNER

Name			State Board Division of Drinking Water Drinking Water System Permit No.:
Mailing Address			
City	State	ZIP	Phone
Contact Person			
Signature:			Date:

2. WATER PURVEYOR (IF DIFFERENT FROM ABOVE)

Name			
Mailing Address			
City	State	ZIP	Phone
Contact Person			
Signature:			Date:

3. REASON FOR NON-APPLICABILITY: (check one that applies and complete information)

Discharges from the above system(s):

☐ Are regulated by a separate individual NPDES Permit issued by a Regional Water Board to address site-specific discharges outside the scope of this Order or a Total Maximum Daily Load (TMDL) –related water quality impairments:

Regional Water Board Order No. _____NPDES Permit No._____

☐ Are covered under a local agreement with an municipal sewer storm system (MS4) permittee (Attach a copy of agreement and acknowledgement by the corresponding Regional Water Board)

☐ Are from a drinking water system owned/operated by an (MS4) permittee or co-permittee named on an existing Water Board NPDES Permit and <u>all</u> discharges flow into the same regulated storm drain system.

Provide Order No. _____NPDES Permit No._____

☐ Do not discharge to a water of the U.S. or a conveyance that drains to a water of the U.S.

I certify under penalty of law that this document and all attachments were prepared under my direction or supervision in accordance with a system designed to assure that qualified personnel properly gather and evaluate the information submitted. Based on my inquiry of the person or persons who manage the system or those persons directly responsible for gathering the information, the information submitted is, to the best of my knowledge and belief, true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment for knowing violations.

_____ _____

Signature Date

ATTACHMENT C – EXAMPLE BEST MANAGEMENT PRACTICES (BMPs)

The Discharger shall implement BMPs to comply with the requirements of this Order, to protect the beneficial uses of the receiving waters and to prevent erosion or hydromodification caused by drinking water system discharges. Required BMPs include but are not limited to the proven practices established by the American Water Works Association, or other professional associations or institutes, in accordance with updated available technology. Dischargers shall implement BMPs comparable to the following example procedures and measures to achieve compliance.

I. Example BMP Procedures

A. Chlorinated Water Discharges

All chlorinated water shall be dechlorinated chemically or naturally. Filter bags, filter rolls and fabric filters, shall be used to remove any sand, silt or debris from entering the surface water or storm drain system.

B. Superchlorinated Water Discharges

All superchlorinated water shall be dechlorinated at the point of discharge directly into a surface water or the point of discharge into any storm water conveyance system. Filter bags or rolls, or equivalent, shall be used to remove any sand, silt or debris from entering the surface water or storm drain system.

C. Facility Drainage Discharges

All discharges from transmission, treatment, storage and distribution facility draining for cleaning and maintenance shall be dechlorinated. Filter bags, filter rolls and fabric filters shall be used to remove sediment prior to discharging to surface waters or storm drains.

D. Groundwater Supply Well Discharges

During flushing, rehabilitation, or development of water supply wells, multi-baffled settling tanks, or equivalent, shall be used if necessary to remove large particles and to reduce turbidity. If further management is needed to reduce solids after settling, the Discharger shall filter the water implementing a filter-bag filtration system, or equivalent practice, before discharging to achieve a turbidity threshold that is in compliance with this Order.

II. Example BMP Measures

A. Sediment and Erosion Control

Sediment and erosion control BMPs that assess and prevent potential impacts to receiving waters, at discharge points and downstream reaches.

1. **Receiving Waters.** The Discharger shall identify methods for locating discharge points and receiving waters to determine appropriate sediment and erosion control measures.

2. **Sediment Control.** Sediment control practices shall be used to filter and trap sediment particles, and prevent them from reaching storm drains or receiving waters. Sediment control practices to control sedimentation discharge and buildup in receiving waters include:

   (a) Straw wattles and gravel bags may be placed in a flow pathway and around storm drain inlets;

   (b) Plastic sheets may be used to line a trench and flow pathway to prevent water contact with soil;

   (c) Check dams may be constructed to dissipate flow energy and minimize the potential for discharges to dislodge soil; and

   (d) A storm water swale, if available nearby to the point of discharge that has sufficient capacity for the discharge.

   (e) Discharge to an open field or turf to remove sand and/or silt or larger particles prior to surface water discharge.

3. **Erosion Controls.** Erosion control practices shall be used to protect soil surfaces at discharge points and receiving waters. Erosion control practices shall be used to prevent re-suspension of ambient sediment within a receiving water, and shoreline erosion and streambed scour. Such controls shall minimize the energy of discharges by managing flow velocities and volumes, and shall be appropriately designed so that the discharge does not exceed the hydraulic capacity of the receiving water at the point of discharge and areas downstream of the discharge point. The following measures may be used to control erosion in receiving waters:

   (a) Construct check dams to slow down the flow;

   (b) Install flow diffusers at discharge point;

   (c) Fashion discharge flow path with as little slope as possible; and

   (d) Decrease discharge flow rates and duration.

B. Dechlorination

The following types of dechlorination methods, or equivalent, to remove chlorine:

1. Dechlorinating Diffuser – The dechlorinating diffuser connects directly to a discharge nozzle (e.g., to a fire hydrant or fire hose) and contains a chamber that houses dechlorination agent. Some diffusers feature a siphon for dechlorinating agent tablets or a solution to dechlorinate the water.

2. Dechlorination Mats – These mats are used to facilitate effective contact between the flow and dechlorinating agent during dechlorination. For dechlorination of discharges from trenches during main breaks, the tablets are placed inside synthetic mesh fabric pockets sewn together in a grid or line. The dechlorinating mats are laid across the flow path or over the storm water conveyance system.

As the discharged water contacts the tablets, dechlorinating agent is released and chlorine is inactivated.

3. Broadcast Dechlorination – Dechlorination granules are spread over an area, such as pavement, where chlorinated water is flowing toward a storm water conveyance system inlet. As the discharged water contacts the tablets, dechlorinating agent is released and chlorine is inactivated.

4. Chemical Injection Metering Pump – Occasionally, a dechlorination agent is injected into a discharge pipe, such as a tank drain, to dechlorinate the water before entering the storm water system.

Addition of dechlorination chemicals shall be managed to ensure the dechlorination agent does not adversely affect or impact beneficial uses of the receiving waters.

C. Copper and Zinc Management

A Discharger that applies copper-based herbicides or zinc-based corrosion inhibitors to its water shall implement BMP measures to eliminate or reduce copper and zinc concentrations in its discharges to the extent feasible, including but not limited to the following:

1. Record keeping of where, when and how much zinc or copper is used to treat water that has the potential to be discharged to a surface water.

2. Implementation of BMPs that eliminate planned discharges and minimize emergency discharges to surface water bodies from occurring within 48 hours of applying copper-based herbicides or zinc-based corrosion inhibitors.

3. Implementation of BMPs to eliminate or reduce to the extent feasible the use of copper-based herbicides or zinc-based corrosion inhibitors by using less toxic agents or other methods in place of copper-based herbicides or zinc-based corrosion inhibitors.

D. Training

All personnel using, operating and maintaining all facilities and equipment shall be properly trained to implement BMPs to discharges when conducting mandated operational and maintenance activities. The Discharger's staff and/or contractors shall be properly trained to understand permit compliance needs and perform the required monitoring, notification and reporting.

E. Equipment and Supplies

Equipment and sampling meters shall be inspected, maintained and calibrated per manufacturer instructions and specifications.

ATTACHMENT D – STANDARD PROVISIONS

I. STANDARD PROVISIONS – PERMIT COMPLIANCE

A. Duty to Comply

1. The Discharger shall comply with all of the conditions of this Order. Any noncompliance constitutes a violation of the Clean Water Act (CWA) and the California Water Code (Water Code) and is grounds for a potential enforcement action, permit termination, revocation and reissuance, or modification; or denial of a permit renewal application. (40 C.F.R. § 122.41(a).)

B. Need to Halt or Reduce Activity Not a Defense

It shall not be a defense for a permittee in an enforcement action that it would have been necessary to halt or reduce the permitted activity in order to maintain compliance with the conditions of this Order. (40 C.F.R. § 122.41(c).)

C. Duty to Mitigate

The Discharger shall take all reasonable steps to minimize or prevent any discharge in violation of this Order that has a reasonable likelihood of adversely affecting human health or the environment. (40 C.F.R. § 122.41(d).)

D. Proper Operation and Maintenance

The Discharger shall at all times properly operate and maintain all facilities and systems of treatment and control (and related appurtenances) which are installed or used by the Water Purveyor to achieve compliance with the conditions of this Order. Proper operation and maintenance also includes adequate laboratory controls and appropriate quality assurance procedures. This provision includes the operation of backup or auxiliary facilities or similar systems that are installed by a Water Purveyor only when necessary to achieve compliance with the conditions of this Order. (40 C.F.R. § 122.41(e).)

E. Property Rights

1. This Order does not convey any property rights of any sort or any exclusive privileges. (40 C.F.R. § 122.41(g).)

2. The issuance of this Order does not authorize any injury to persons or property or invasion of other private rights, or any infringement of state or local law or regulations. (40 C.F.R. § 122.5(c).)

F. Inspection and Entry

The Water Purveyor shall allow State and/or Regional Water Board staff, United States Environmental Protection Agency (U.S. EPA), and/or their authorized representatives

(including an authorized contractor acting as their representative), upon the presentation of credentials and other documents, as may be required by law, to (40 C.F.R. § 122.41(i); Water Code section 13383):

1. Enter upon the Discharger's premises where a regulated facility or activity is located or conducted, or where records are kept under the conditions of this Order (40 C.F.R. § 122.41(i)(1));

2. Have access to and copy, at reasonable times, any records that must be kept under the conditions of this Order (40 C.F.R. § 122.41(i)(2));

3. Inspect and photograph, at reasonable times, any facilities, equipment (including monitoring and control equipment), practices, or operations regulated or required under this Order (40 C.F.R. § 122.41(i)(3)); and

4. Sample or monitor, at reasonable times, for the purposes of assuring Order compliance or as otherwise authorized by the CWA or the Water Code, any substances or parameters at any location. (40 C.F.R. § 122.41(i)(4).)

II. STANDARD PROVISIONS – PERMIT ACTION

A. General

This Order may be modified, revoked and reissued, or terminated for cause. The filing of a request by the Discharger for modification, revocation and reissuance, or termination, or a notification of planned changes or anticipated noncompliance does not stay any Order condition. (40 C.F.R. § 122.41(f).)

B. Duty to Reapply

If the Discharger chooses to continue a discharge regulated by this Order after the expiration date of this Order and after the State Water Board has reissued this Order, the Discharger shall apply for and obtain new permit coverage as required by the new Order. (40 C.F.R. § 122.41(b).)

C. Transfers

This Order is not transferable to any person except after notice to the State Water Board. The State Water Board may require modification or revocation and reissuance of the Order or Notice of Applicability to change the name of the Discharger and incorporate such other requirements as may be necessary under the CWA and the Water Code. (40 C.F.R. § 122.41(l)(3) and 122.61.)

III. STANDARD PROVISIONS – MONITORING

A. Samples and measurements taken for the purpose of monitoring shall be representative of the monitored activity. (40 C.F.R. § 122.41(j)(1).)

B. If applicable, monitoring results shall be conducted according to test procedures under 40 Code of Federal Regulations part 136. (40 C.F.R. § 122.41(j)(4) and 122.44(i)(1)(iv).)

IV. STANDARD PROVISIONS – RECORDS

A. Records Retention

The Discharger shall retain records of all monitoring information, including all calibration and maintenance records and all original strip chart recordings for continuous monitoring instrumentation, copies of all reports required by this Order, and records of all data used to complete the application for this Order, for a period of at least three (3) years from the date of the sample, measurement, report or application. This period may be extended by request of the State Water Board's Division of Water Quality Deputy Director at any time. (40 C.F.R. § 122.41(j)(2).)

B. Records of monitoring information shall include:

1. The date, exact place, and time of sampling or measurements (40 C.F.R. § 122.41(j)(3)(i));

2. The individual(s) who performed the sampling or measurements (40 C.F.R. § 122.41(j)(3)(ii));

3. The date(s) sampling and monitoring were performed (40 C.F.R. § 122.41(j)(3)(iii));

4. The individual(s) who performed the analyses (40 C.F.R. § 122.41(j)(3)(iv)); and

5. The results of such monitoring. (40 C.F.R. § 122.41(j)(3)(vi).)

C. Claims of confidentiality for the following information will be denied (40 C.F.R. § 122.7(b)):

1. The name and address of any permit applicant or Discharger (40 C.F.R. § 122.7(b)(1)); and

2. Permit applications and attachments, permits and monitoring data. (40 C.F.R. § 122.7(b)(2).)

V. STANDARD PROVISIONS – REPORTING

A. Duty to Provide Information

The Discharger shall furnish to the State Water Board or the United States Environmental Protection Agency (U.S. EPA) within a reasonable time, any information which the State Water Board or U.S. EPA may request to determine whether cause exists for modifying, revoking and reissuing, or terminating this Order or to determine compliance with this Order. Upon request, the Discharger shall also furnish to the State Water Board, a Regional Water Board or U.S. EPA copies of records required to be maintained by this Order. (40 C.F.R. § 122.41(h) and Wat. Code, §§ 13267, 13383.)

B. Signatory and Certification Requirements

1. All applications, reports, or information submitted to the State Water Board, and/or U.S. EPA shall be signed and certified in accordance with Standard Provisions – Reporting sections V.B.2 through V.B.7, below. (40 C.F.R. § 122.41(k).)

2. For a corporation, a responsible corporate officer shall sign all permit applications. For the purpose of this section, a responsible corporate officer means: (i) A president, secretary, treasurer, or vice-president of the corporation in charge of a principal business function, or any other person who performs similar policy- or decision-making functions for the corporation, or (ii) the manager of one or more manufacturing, production, or operating facilities, provided, the manager is authorized to make management decisions which govern the operation of the regulated facility including having the explicit or implicit duty of making major capital investment recommendations, and initiating and directing other comprehensive measures to assure long term environmental compliance with environmental laws and regulations; the manager can ensure that the necessary systems are established or actions taken to gather complete and accurate information for permit application requirements; and where authority to sign documents has been assigned or delegated to the manager in accordance with corporate procedures. (40 C.F.R. § 122.22(a)(1).)

3. For a partnership or sole proprietorship, a general partner or the proprietor shall sign all permit applications, respectively. (40 C.F.R. § 122.22(a)(2).)

4. For a municipality, State, federal, or other public agency, all permit applications shall be signed by either a principal executive officer or ranking elected official. For purposes of this provision, a principal executive officer of a federal agency includes: (i) the chief executive officer of the agency, or (ii) a senior executive officer having responsibility for the overall operations of a principal geographic unit of the agency (e.g., Regional Administrators of U.S. EPA). (40 C.F.R. § 122.22(a)(3).).

5. All reports required by this Order and other information requested by the State Water Board, a Regional Water Board or U.S. EPA shall be signed by a person described in Standard Provisions – Reporting V.B.2 above, or by a duly authorized representative of that person. A person is a duly authorized representative only if:

a. The authorization is made in writing by a person described in Standard Provisions – Reporting V.B.2 above (40 C.F.R. § 122.22(b)(1));

b. The authorization specifies either an individual or a position having responsibility for the overall operation of the regulated facility or activity such as the position of plant manager, operator of a well or a well field, superintendent, position of equivalent responsibility, or an individual or position having overall responsibility for environmental matters for the company. (A duly authorized representative may thus be either a named individual or any individual occupying a named position.) (40 C.F.R. § 122.22(b)(2)); and

c. The written authorization is submitted to the State Water Board. (40 C.F.R. § 122.22(b)(3).)

6. If an authorization under Standard Provisions – Reporting V.B.3 above is no longer accurate because a different individual or position has responsibility for the overall operation of the facility, a new authorization satisfying the requirements of Standard Provisions – Reporting V.B.3 above shall be submitted to the State and Regional Water Board prior to or together with any reports, information, or applications, to be signed by an authorized representative. (40 C.F.R. § 122.22(c).)

7. Any person signing a document under Standard Provisions – Reporting V.B.2 or V.B.3 above is making the following certification:

"I certify under penalty of law that this document and all attachments were prepared under my direction or supervision in accordance with a system designed to assure that qualified personnel properly gather and evaluate the information submitted. Based on my inquiry of the person or persons who manage the system or those persons directly responsible for gathering the information, the information submitted is, to the best of my knowledge and belief, true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment for knowing violations." (40 C.F.R. § 122.22(d).)

C. Monitoring Reports

1. Monitoring results shall be reported at the intervals specified in the Monitoring and Reporting Program in Attachment E of this Order.

2. If the Discharger monitors any pollutant more frequently than required by this Order using test procedures approved under 40 Code of Federal Regulations part 136, the results of this monitoring shall be included in the calculation and reporting of the data to the State Water Board. (40 C.F.R. § 122.41(l)(4)(ii).)

D. Twenty-Four Hour Reporting

1. The Discharger shall report any noncompliance that may endanger health or the environment to the Regional Water Board. Any information shall be provided orally within 24 hours from the time the Discharger becomes aware of the circumstances.

A written submission shall also be provided to the applicable regional water quality control board within five (5) days of the time the Discharger becomes aware of the circumstances. The written submission shall contain a description of the noncompliance and its cause; the period of noncompliance, including exact dates and times, and if the noncompliance has not been corrected, the anticipated time it is expected to continue; and steps taken or planned to reduce, eliminate, and prevent reoccurrence of the noncompliance. (40 C.F.R. § 122.41(l)(6)(i).)

2. The State Water Board or a Regional Water Board may waive the above-required written report under this provision on a case-by-case basis if an oral report has been received within 24 hours. (40 C.F.R. § 122.41(l)(6)(iii).)

E. Anticipated Noncompliance

The Discharger shall give advance notice to the appropriate Regional Water Board or State Water Board of any planned changes in the permitted facility or activity that may result in noncompliance with General Order requirements. (40 C.F.R. § 122.41(l)(2).)

F. Other Noncompliance

The Discharger shall report all instances of noncompliance not reported under Standard Provisions – Reporting V.C and V.D above at the time monitoring reports are submitted. The reports shall contain the information listed in Standard Provision – Reporting V.D above. (40 C.F.R. § 122.41(l)(7).)

G. Other Information

When the Water Purveyor becomes aware that it failed to submit any relevant facts in a permit application, or submitted incorrect information in a permit application or in any report to the Regional Water Board, State Water Board, or U.S. EPA, the Water Purveyor shall promptly submit such facts or information. (40 C.F.R. § 122.41(l)(8).)

VI. Standard Provisions – Enforcement

The State and Regional Water Board are authorized to enforce the terms of this permit under several provisions of the Water Code, including, but not limited to, sections 13385, 13386, and 13387.

ATTACHMENT E – MONITORING AND REPORTING PROGRAM

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ATTACHMENT E – MONITORING AND REPORTING PROGRAM

Discharges from drinking water systems, as authorized by this Order, shall be properly managed to not adversely affect or impact beneficial uses of a receiving water body. The purpose of the monitoring and reporting requirements contained in the following Monitoring and Reporting Program is to provide information demonstrating that management practices are properly implemented to protect surface water quality. The objective of the monitoring is to validate that the management practices are performing properly to maintain compliance with this Order and protect receiving waters from adverse impacts to beneficial uses.

Title 40 Code of Federal Regulations part 122.48 requires that all National Pollutant Discharge Elimination System (NPDES) permits specify monitoring and reporting requirements. California Water Code sections 13267 and 13383 also authorize the State Water Resources Control Board (State Water Board) and a Regional Water Quality Control Board (Regional Water Board) to require technical and monitoring reports. This Monitoring and Reporting Program establishes monitoring and reporting requirements, which implement the federal and State of California regulations.

Dischargers authorized under this Order shall comply with all Standard Provisions in Attachment D related to monitoring, reporting and recordkeeping.

I. GENERAL MONITORING PROVISIONS

A. Samples and measurements taken as required herein shall be representative of the nature of the monitored discharge after implementation of best management practices (BMPs). All samples shall be taken at the monitoring locations specified below and, unless otherwise specified, before the discharge flow joins or is diluted by any other waste stream or body of water.

B. Chemical analyses that require laboratory testing are not required in this Order (with the exception of application requirements for discharge into a water body with already established TMDL requirements identified in Section K of the Fact Sheet and/or TMDL-related requirements prescribed to the water purveyors listed in Attachment G). The Discharger shall conduct onsite field measurements for pH, turbidity, and total chlorine residual per quality assurance and quality control (QA/QC) protocol that conform to U.S. EPA guidelines, or procedures approved by the American Water Works Association or other professional drinking water industry association.

C. The Discharger shall maintain sufficient resources, including trained personnel and properly calibrated and maintained field instruments to adequately perform all field measurements required in this Order. Onsite field measurements shall be performed using handheld devices by trained personnel acting on the Discharger's behalf. A manual containing the proper operating procedures for all onsite field monitoring equipment, shall be maintained onsite or at the water purveyor's office, and shall be available for inspection by State or Regional Water Board staff.

D. Appropriate field meter devices shall be selected consistent with accepted scientific practices and used to ensure the accuracy and reliability of measurements of monitored discharges. All devices shall be properly maintained and calibrated per manufacturer instructions and as necessary to ensure their continued accuracy.

II. MONITORING REQUIREMENTS FOR PLANNED DISCHARGES

A. Event Monitoring Requirements for Superchlorinated, Well development and/or rehabilitation, and Large Volume Discharges.

The Discharger shall monitor all superchlorinated discharges, all discharges from well development and/or rehabilitation activities, and individual discharges greater than 325,850 gallons (one acre-foot) for the constituents specified in Table E-1 and per the frequency specified in Table E-2.

Table E-1. Event Monitoring of Superchlorinated Discharges, Well Development and/or Rehabilitation, and Individual Discharge Events Greater than 325,850 Gallons

Parameter	Units	Sampling [2]	Sample Type
Chlorine, Total Residual [1,3,4]	mg/L	1/Event	Grab[1]
Volume	Gallons	1/Event	Estimate [5]
pH [6]	Standard Units	1/Event	Grab
Turbidity	NTU	1/Event	Visual Estimate
Turbidity for Well Development and/or Rehabilitation Only[1]	NTU	1/Event	Grab[1]

[1] A handheld field meter shall be used, provided the meter utilizes a U.S. EPA-approved algorithm/method and is calibrated and maintained in accordance with the manufacturer's instructions. The Discharger shall maintain a calibration and maintenance log for each meter used for monitoring required by this Monitoring and Reporting Program.
[2] Sampling shall take place downstream of management practices, as feasible.
[3] Total chlorine residual shall be monitored with a method sensitive to and accurate at a minimum level of 0.1 mg/L. False positives are acceptable if explanation of the cause is included.
[4] Total Chlorine Residual monitoring is not required of non-chlorinated discharges.
[5.] Calculated estimate using available meter reading information or visual estimate.
[6] pH monitoring is required for superchlorinated discharges only.

Table E-2. Event Frequency Requirements for Superchlorinated Discharges, Well Development and/or Rehabilitation Discharges to a Water of the U.S., and Discharges Greater than 325,850 Gallons

Duration of Discharge	Sampling Requirements
Less than 20 minutes	One sample is required during the first 10 minutes of the discharge.
20 minutes to 60 minutes	One sample is required during the first 10 minutes of the discharge, plus a second sample is required within the last 10 minutes of the discharge.
Greater than 60 minutes	One sample is required within the first 10 minutes, a second sample is required within the next 50 minutes, and a third sample is required approximately within the last 10 minutes of the discharge or as close to the end of the discharge as is feasible.

B. Annual Representative Monitoring Requirements

This Order allows discharges of similar nature to be monitored on a representative basis. Representative monitoring is the use of monitoring results of one water quality monitoring sample to represent other discharges expected to have the same water quality. A representative monitoring measurement must represent discharges of similar nature, meaning discharges that have all the following items in common:

(a) The same general water source (ground water or surface water of similar water quality), and

(b) The same water treatment, and

(c) The same type of implemented BMPs.

The Discharger shall monitor all planned discharges not listed in Section II.A above, using representative monitoring, as previously defined in this section, for the constituents specified in Table E-3 and per the frequency specified in Table E-4.

Table E-3. Annual Representative Monitoring Requirements

Parameter	Units	Sampling[2]	Sample Type[2]
Chlorine, Total Residual [3,4]	mg/L	1/Year	Grab[1]
Volume	Gallons	1/Year	Estimate [5]
Turbidity	NTU	1/Year	Visual Estimate

[1] A handheld field meter shall be used, provided the meter utilizes a U.S. EPA-approved algorithm/method and is calibrated and maintained in accordance with the manufacturer's instructions. The Discharger shall maintain a calibration and maintenance log for each meter used for monitoring required by this Monitoring and Reporting Program.
[2] Sampling shall take place downstream of management practices, as feasible.
[3] Total chlorine residual shall be monitored with a method sensitive to and accurate at a minimum level of 0.1 mg/L. False positives are acceptable if explanation of the cause is included.
[4] Total Chlorine Residual monitoring is not required of non-chlorinated discharges.
[5] Calculated estimate using available meter reading information or visual estimate.

Table E-4. Annual Representative Monitoring Frequency Requirements

Duration of Discharge	Sampling Requirements
Less than 20 minutes	One sample is required during the first 10 minutes of the discharge.
20 minutes to 60 minutes	One sample is required during the first 10 minutes of the discharge, plus a second sample is required within the last 10 minutes of the discharge.
Greater than 60 minutes	One sample is required within the first 10 minutes, a second sample is required within the next 50 minutes, and a third sample is required approximately within the last 10 minutes of the discharge or as close to the end of the discharge as is feasible.

In its annual report, the Discharger shall:

(a) Submit a copy of its site schematic submitted in its application for enrollment with labeled representative monitoring locations, and

(b) Identify the portions of its system that the representative monitoring results represent, and
(c) Identify all changes in its representative monitoring locations that have occurred during the monitoring-year.

C. Annual Discharge Volume Monitoring Requirements

The Discharger shall keep:
(a) A record of the number of direct discharges to a water of the U.S. that is greater than 50,000 gallons, during each calendar year,
(b) An estimate of the total volume discharged to surface water during each calendar year, and
(c) An estimate of the total volume of discharge water directed to a reuse or beneficial use in accordance with section VI. of this Order.

D. Monitoring Not Required

Monitoring is not required for any discharges that:
(a) Do not ultimately reach a water of the U.S., and
(b) Are put to multiple uses or beneficial reuse, in accordance with section VI. of the Order, prior to surface water discharge.

E. Increase in Monitoring Requirements

The Deputy Director may increase the monitoring or frequency at any time to ensure the protection of beneficial uses of the receiving water. Any requirement for increased monitoring will be based on site-specific data or information that indicates a site-specific discharge threatens to cause or contribute to an exceedance of a receiving water quality criteria or objective.

III. RECEIVING WATER MONITORING REQUIREMENTS DURING NON-COMPLIANCE WITH THIS ORDER

The receiving water must be monitored for all direct planned discharges that do not comply with the requirements contained in section IV of the Order and the discharge potentially causes or contributes to an adverse effect or impact to beneficial uses. Receiving water monitoring shall be conducted during or immediately after the Discharger became aware of a non-compliant discharge that adversely effects or impacts beneficial uses of the receiving water. The Discharger shall monitor the point of confluence of the discharge and the receiving water. If the receiving water presents hazards to the monitoring personnel, visual monitoring shall be conducted using telephoto lenses and binoculars. If further hazards exist beyond such measures, monitoring is not required, and the hazards shall be documented in the corresponding monitoring report.

Receiving water monitoring shall consist of digital photographs and documentation of observed effects and impacts the discharge has on the receiving water body including the presence or absence of:

a. Erosion;

b. Floating or suspended matter;

c. Discoloration;

d. Impact on aquatic life;

e. Visible films, sheens, or coatings; and

f. Potential nuisance conditions.

Photographs and documented observations of the receiving water conditions shall be included in the annual monitoring report, and made available to State and Regional Water Board staff upon request.

Receiving water monitoring is not required for emergency discharges.

IV. POST-NOTIFICATION OF EMERGENCY OR NON-COMPLIANT DISCHARGES THAT ADVERSELY EFFECT OR IMPACT BENEFICIAL USES

Within 24 hours of the Discharger becoming aware of an adverse effect(s) or impact on beneficial uses of the receiving water body due to non-compliance with this Order, or due to a system failure or emergency involving a discharge from its drinking water system, the Discharger shall notify the corresponding Regional Water Board and the MS4 operator if applicable, and shall confirm this notification in writing within five days.

The notification shall include all of the following:

a. The location and extent of non-compliance or emergency discharge;

b. The cause of the non-compliance or emergency discharge;

c. The date, time and expected duration of the non-compliance or emergency discharge;

d. The estimated volume of discharge;

e. The applicable receiving water body; and

f. The corrective actions taken (or being taken) to prevent future non-compliance or repair the system failure.

V. PRE-NOTIFICATION OF LARGE PLANNED DISCHARGES GREATER THAN ONE ACRE-FOOT (325,850 GALLONS)

Three (3) days prior to initiation of a planned discharge (or retroactively within 24-hours after the Discharger is informed to conduct an urgent planned discharge) of a volume equal to or greater than one acre-foot (325,850 gallons), the Discharger shall notify the MS4 operator if applicable, and the appropriate Regional Water Board and provide:

a. The start date of discharge

b. The location of discharge and the applicable receiving water

c. The estimated volume of discharge, and

d. The reasons for discharge

VI. REPORTING AND RECORDKEEPING REQUIREMENTS

A. Self-Monitoring Report Requirements

1. Self-monitoring reports including compliant and non-compliant discharge monitoring information shall be maintained in the Discharger's main office and made available upon request of State and Regional Water Board staff.

2. Monitoring periods and reporting for all required monitoring shall be completed according to the schedule in Table E-5 below. Each discharge event that meets the conditions in section II and Table E-1 of this MRP shall be monitored.

Table E-5. Monitoring Periods and Reporting Schedule

Sampling Frequency	Monitoring Period	Record Keeping Due Date
1/Event or Year	January 1 thru December 31	1 March

3. The Discharger shall arrange and summarize any reported numerical data in a tabular format. When electronic submittal of data is required and CIWQS does not provide for entry into a tabular format within the system, the Discharger shall electronically submit the data in a tabular format as an attachment.

4. If no discharge occurred during the reporting period, the monitoring report shall report that there was no discharge.

5. Authorized Dischargers shall maintain the results for all monitoring specified in this Monitoring and Reporting Program and as specified in this Order. If a Discharger monitors any pollutant more frequently than required by this Order, the results of this monitoring shall be included in the self-monitoring report.

B. REPORTING REQUIREMENTS TO STATE WATER BOARD

1. Dischargers shall report to the State Water Board any toxic chemical release data it reports to the State Emergency Response Commission within 15 days of reporting the data to the Commission pursuant to section 313 of the "Emergency Planning and Community Right to Know Act" of 1986.

2. By March 1 of every year, all non-compliant discharge monitoring information contained in the Discharger's self-monitoring report for the past calendar year shall be submitted to the State Water Board annually and shall include all non-compliant monitoring results required in this Monitoring and Reporting Program. All non-compliant discharge monitoring information shall be accompanied by the corrective actions the Discharger has taken to return the discharge to compliance. Dischargers shall also submit the annual discharge volume monitoring requirements specified in section II.C of this Attachment.

3. The Discharger shall attach a cover letter to the SMR. The information contained in the cover letter shall clearly identify discharge events of non-compliance with the permit; discuss corrective actions taken or planned; and the proposed time schedule for corrective actions. Identified non-compliance shall include a description of the requirement that was violated and a description of the violation.

4. Monitoring reports shall be submitted to the State Water Board, signed and certified as required by the Standard Provisions (Attachment D), to the address listed below:

   State Water Resources Control Board
   Division of Water Quality
   NPDES Permitting Unit
   1001 I Street, 15th Floor
   Sacramento, CA 95814

5. At any time during the term of this permit, the Deputy Director may notify authorized Dischargers to electronically submit monitoring reports using the State Water Board's California Integrated Water Quality System (CIWQS) Program Web site (http://www.waterboards.ca.gov/ciwqs/index.html). Until such notification is given, each Discharger shall submit a hard copy of its monitoring reports. Subsequent guidance will be provided to the Discharger upon the Deputy Director's notification for electronic submittal of reports. (Direction and guidance for electronic SMR submittals is currently available on the CIWQS Web site at http://www.waterboards.ca.gov/water_issues/programs/ciwqs/chc_npdes.shtml

ATTACHMENT F – FACT SHEET

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This Fact Sheet includes the legal requirements and technical rationale that serve as the basis for the requirements of this Order. As described in section III.B of the Order, the State Water Board incorporates this Fact Sheet as its findings supporting the issuance of the Order.

I. PERMIT INFORMATION

A. Background

Water wholesalers and purveyors are responsible for developing water supplies and providing drinking water to their communities and customers in accordance with statutory requirements of the federal Safe Drinking Water Act and the California Health and Safety Code. Mandatory system-development and system-maintenance activities often result in surface water discharges, either via storm drain systems or other conveyance systems, or directly to a surface water body.

The Federal Water Pollution Control Act (also referred to as the Clean Water Act) section 402 requires that a discharge of any pollutant or combination of pollutants to surface waters that are waters of the United States, with certain exceptions, be regulated by a National Pollutant Discharge Elimination System (NPDES) permit. (For the purpose of this Order, the terms “waters of the United States”, “surface waters” and “receiving waters” are used interchangeably unless noted otherwise.) On September 22, 1989, the U.S. Environmental Protection Agency (U.S. EPA) granted the State of California, through the State Water Resources Control Board (State Water Board) and the Regional Water Quality Control Boards (Regional Water Boards), the authority to issue general NPDES permits pursuant to title 40 Code of Federal Regulations parts 122 and 123.

Discharges to waters of the U.S. required to be regulated with an NPDES permit, in accordance with the Clean Water Act, include discharges of pollutants from drinking water systems. The Clean Water Act does not include an exemption from federal regulation based on volume or flow of discharge; therefore, all sizes of drinking water systems, including very small systems with small volumes of surface water discharges, are required to be regulated with an NPDES permit. Many drinking water system discharges in California that enter waters of the U.S. (either directly or via a storm water conveyance system) are unregulated. The systems that are regulated are permitted with Regional Water Quality Control Board (Regional Water Board) permits.

The State Water Board recognizes that although the quality of the discharges from different locations within a system (raw water, potable water, chlorinated water, etc.) varies, the set of discharges from the different systems throughout the state are fairly uniform. The discharges are of water that must be discarded as water purveyors conduct similar mandatory activities to assure the water that is ultimately delivered is safe for drinking and other potable uses.

Although the discharges are similar in nature, they are regulated differently throughout the state. Some are not regulated at all. Others are regulated by various Regional Water Boards permits, depending on the region the system is located. Some Regional

Water Boards regulate the raw and potable drinking water discharges using region-wide low threat-type general NPDES permits that regulate a broad range of constituents through differing regulatory approaches. Other Regional Water Board general permits do not address the constituents of concern from these types of discharges, and/or contain requirements that are not feasible for water purveyors to comply without creating obstacles to the proper operation of drinking water systems. The following table illustrates more detail on part of the Regional Water Boards' differing regulatory approaches for discharges from drinking water systems:

Table F-1. Differences in Existing Regional Water Boards' Permit Requirements

Region	Effluent Limitations[0]										
	Chlorine Residual (mg/L)	Settleable Solids (ml/L)	pH (standard units.)	TDS (mg/L)	BOD_5 (mg/L)	Ammonia	Turbidity (Nep Turbidity Units)	O&G (mg/L)	Temp (˚F)	Priority Pollutant	Acute Toxicity
1	0.11[1] and 0.019[2]	0.1	6.5[3] and 8.5[4]	BPO[17]	--	--	--	--	--	--	--
2[5]	--	--	--	--	--	--	--	--	--	--	--
3	0.02	--	--	BPO[17]	--	--	--	--	--	MCLs	--
4	0.1[6]	0.3[6] and 0.1[7]	6.5[3] and 8.5[4]	150[6] and 50[7]	30[6] and 20[7]	--	150[6] and 50[7]	15[6] and 10[7]	86 ˚F	--	90% Survival
5	0.11[1] and 0.019[2]	0.1[6]	[8]6.5 - 8.5 [9]7.5 – 9.5 [10]6.5 – 8.3	--	[11]30[6], 15[12], and 10[7]	--	--	--	--	MCLs	--
6[14]	0.003[4] and 0.002[13]	--	BPO[17]	--	--	BPO[17]	--	--	--	--	--
7	0.11[1] and 0.019[2]	0.2	6.0[3] and 9.0[4]	--	55 and 95	--	75	25	--	--	--
8	0.1[6]	--	6.5[3] and 8.5[4]	BPO[17]	75[6, 15]	--	--	15	--	--	--
9	0.1[16]	--	6.0[3] and 9.0[4]	--	--	--	--	--	--	--	--

0. TDS=Total Dissolved Solids, BOD5=5-day Biochemical Oxygen Demand, O&G=Oil and Grease, Temp=Temperature
1. 4-day Average
2. 1-hour Average
3. minimum value
4. maximum value
5. Region 2 recently issued a tentative individual NPDES Permit for public review and comment
6. Daily Maximum
7. Monthly Average
8. 6.5 minimum and 8.5 maximum for discharges to Sacramento/San Joaquin River Basins
9. 7.5 minimum and 9.5 maximum for discharges to Goose Creek
10. 6.5 minimum and 8.3 maximum for discharges to Tulare Lake Basin
11. Same effluent limits for Total Suspended Solids (TSS)
12. Weekly Average

13. Median value of daily measurements
14. Also has effluent limits for bacteria and dissolved oxygen based on the basin plan objective
15. TSS only
16. 90 percentile of all samples during discharge
17. Basin Plan Objective
18. Region 1 - North Coast Region, 2 - San Francisco Bay Region, 3 - Central Coast Region, 4 - Los Angeles Region, 5 - Central Valley Region, 6 - Lahontan Region, 7 - Colorado River Region, 8 - Santa Ana Region, 9 - San Diego Region

Additionally, most large and small municipalities have Municipal Separate Storm Sewer System (MS4) NPDES permits for discharge of storm water to waters of the United States (U.S.). Some MS4 permit holders (permittees) allow drinking water system discharges to enter their storm water systems as authorized non-storm water discharges, typically through established local agreements. Other MS4 permittees do not allow such discharges to enter their storm water systems unless the State Water Board or Regional Water Board separately regulates those discharges prior to entering the system.

Title 40 Code of Federal Regulations part 122.28 provides for issuance of general permits to regulate a category of point sources if the sources: (1) involve the same or substantially similar types of operations; (2) discharge the same type of waste; (3) require the same type of effluent limitations or operating conditions; (4) require similar monitoring; and (5) are more appropriately regulated under a general order rather than individual orders. Thus:

1. This Order issues NPDES Permit No. CAG140001 with the intent to provide consistent and efficient regulatory coverage and requirements for drinking water system discharges statewide that have a low threat to water quality when properly mitigated through implementation of best management practices.
2. This Order authorizes drinking water system discharges of water that is dedicated to drinking water facilities for the primary purpose of providing safe and reliable drinking water including, but not limited to treatment facilities, storage and distribution systems, transmission systems, and water supply and monitoring wells in drinking water aquifers. Owners or operators of drinking water systems that apply for coverage under this Order and that are issued a Notice of Applicability are hereinafter referred to as “dischargers”. For the purposes of this Order, references to “discharger” or “permittee” in applicable federal and State laws, regulations, plans, and policy are considered equivalent to references to the Dischargers herein.

   Regulatory coverage under this Order serves as authorization for the Discharger to discharge water from its drinking water system(s) to waters of the United States (U.S.) either directly into waters of the U.S. or via other conveyance, including through a municipal storm sewer system. Coverage under this Order does not authorize discharges into a municipal storm water system. The municipal storm water system owner/operator has authority to allow these non-storm water discharges into the system. A municipal storm water system owner/operator retains authority to impose further conditions, restrictions or limitations, above and beyond the requirements of this Order, on water purveyors, as a condition for discharging into the system.

B. Water Purveyors NOT Required to Enroll in This Order

All water purveyors that have discharges to waters of the U.S. as described in this Order require an NPDES permit to discharge. The State Water Board is not mandating that small systems of less than 1,000 service connections enroll in this Order. However, the State Water Board strongly encourages water purveyors with small systems to obtain the regulatory coverage under this Order to comply with the Clean Water Act. The State Water Board recognizes that some water purveyors have obtained regulatory coverage through MS4 permits, or, due to their discharge contributing to an impairment managed by a previously-adopted Total Maximum Daily Load, the discharge must be regulated by a separate individual NPDES permit.

The State Water Board issues statewide NPDES permits for the regulation of storm water discharges from small communities and non-traditional entities. Regional Water Quality Control Boards issue NPDES permits for the regulation of storm water from large (non-small) municipalities. These storm water orders may authorize non-storm water discharges from fire hydrant flushing, operation, maintenance, or testing of potable water systems, and groundwater dewatering systems, similar to discharges covered under this Order. The State Water Board will not require a water purveyor that holds a local agreement with a municipal storm water permittee to obtain regulatory coverage under this Order provided the corresponding Regional Water Board acknowledges in writing that the local agreement demonstrates coverage under the municipal storm water permit.

This Order requires that, **by September 1, 2015**, water purveyors that meet the criteria **below** submit a Notice of Non-Applicability form (Attachment B2) certifying, in accordance with section V.B., *Signatory and Certification Requirements*, of Attachment D – Standard Provisions, that regulatory coverage from this Order is not required.

- The water purveyor discharges solely to a municipal separate storm sewer system(s) (MS4) and has an established local agreement with the MS4 permittee to discharge into its system(s), **AND** the corresponding Regional Water Board Executive Officer provides written confirmation to the State Water Board Deputy Director of Water Quality that the local agreement provides sufficient regulation of the subject drinking water system discharges through an existing MS4 NPDES permit; or
- The water purveyor is an MS4 permittee, or co-permittee, named on a State Water Board or a Regional Water Board issued MS4 permit that also authorizes discharges from drinking water systems, and all drinking water system discharges solely discharge into its own MS4 system.

Also by **September 1, 2015**, this Order requires water purveyors that meet the criteria **below** to submit a Notice of Non-Applicability form (Attachment B2) certifying, in accordance with section V.B., *Signatory and Certification Requirements*, of Attachment D – Standard Provisions, that regulatory coverage from this Order is not required.

- The water purveyor is regulated under an existing NPDES permit issued by the Regional Water Board because a Total Maximum Daily Load (TMDL) was adopted and the Regional Water Board determined that TMDL-specific permit requirements for its drinking water system(s) discharges are appropriate because those discharges may contribute to the impairment of the water body.

Also by **September 1, 2015**, this Order allows water purveyors that meet the criteria **below** the option of submitting a Notice of Non-Applicability form (Attachment B2) certifying, in accordance with section V.B., *Signatory and Certification Requirements*, of Attachment D – Standard Provisions, that regulatory coverage from this Order is not required.

- All discharges from the drinking water system do not discharge to a water of the U.S.

A water purveyor with multiple drinking water systems in California need only submit one Notice of Non-Applicability for its systems that meet the same criterion.

After review of each submitted Notice of Non-Applicability, the State Water Board's Deputy Director of Water Quality (Deputy Director) will either issue 1) a Notice of Non-Applicability Approval or 2) a response letter to the applicant outlining: (a) the missing information that deems the Notice of Non-Applicability incomplete, or (b) why the described discharge is not eligible and thus the water purveyor must obtain coverage under this Order. The water purveyor will have **60 days from the date of the response letter** to submit the items necessary to complete the Notice of Non-Applicability or to submit a complete application package in accordance with section II.C of this Order. A notice may be issued to a water purveyor that holds a drinking water system permit through the State Water Board Division of Drinking Water, and that has not submitted a Notice of Non-Applicability (or an application package for enrollment, as explained later in this Fact Sheet) by September 1, 2015, if that purveyor discharges from its drinking water system to a water of the U.S.

Drinking water systems that serve less than 1,000 connections that serve end users (this does not include water wholesalers), maintain the option to enroll in this Order and are not required to submit the Notice of Non-Applicability form.

C. Facilities and Discharges Covered Under this Order

This Order covers discharges from drinking water systems that qualify as a "community water system" as defined in the California Health and Safety Code, and wholesalers of water to community water systems. Community water systems provide daily drinking water for at least 15 service connections and at least 25 individuals at least 60 days each year. Community water systems must comply with the California Health and Safety Code per the California Code of Regulations titles 17 and 22. Title 17 ensures that water delivered by community water systems is wholesome and potable. Title 22 contains potable water standards, including the primary and secondary maximum contaminant levels (MCLs), and requires monitoring and reporting on surface water and groundwater drinking water sources.

Community water systems authorized to discharge under this Order include the following facilities:

1. **Transmission Systems.** Transmission systems are the pipes, pumps, canals, pump houses, and other components used to move water from the point of origin to storage reservoirs, treatment facilities, and distribution systems. Transmission systems do not have connections to serve end users. Above ground and underground pipes generally range in diameter from 24 inches to 90 inches. Some facilities are open channels. The water in transmission systems may or may not meet standards for human consumption.

2. **Distribution and Storage Systems.** Distribution systems are the pipes and associated pumps, valves, hydrants, storage facilities and other structures that distribute and store potable water from treatment plants, wells, reservoirs, and transmission systems to end users. Distribution pipes generally range in diameter from 2 inches to 24 inches.

3. **Wells in Drinking Water Aquifers.** Drinking water supply wells are installed in borings advanced into the ground to extract groundwater for use as drinking water. These types of wells are typically 12 inches to 36 inches in diameter. Monitoring wells are also in borings advanced into the ground to gage the depth to groundwater for drinking water aquifer management purposes such as groundwater overdraft protection. In addition monitoring wells serve as access points to sample the aquifer to characterize the water quality and to detect contaminants such as bacteria before the contaminant reaches the water supply. Monitoring wells are typically 12 inches or less in diameter. Discharges from water supply and monitoring wells occur during well development, maintenance (including flushing), rehabilitation, and sampling. This Order covers discharges from wells in unpolluted drinking water aquifers, and discharges from polluted drinking water aquifers that are properly treated to not cause or contribute to an adverse effect or impact to beneficial uses of the receiving waters.

4. **Water Treatment Plant or Facility.** Water treatment facilities treat water to the quality that is suitable for potable drinking water in accordance with the federal Safe Drinking Water Act, California Health and Safety Code and the State Water Board Division of Drinking Water permitting requirements. Water treatment systems range from large treatment plants to small treatment facilities including well head treatment apparatuses.

D. Discharge Description

This Order provides regulatory coverage for planned and emergency discharges. Planned discharges are part of a water purveyor's essential activities to comply with the federal Safe Drinking Water Act, the California Health and Safety Code, and State Water Board Division of Drinking Water permitting requirements for providing reliable and safe drinking water. Planned discharges include scheduled and unscheduled discharges that take place under the control of the Discharger to comply with regulatory mandates. Emergency discharges occur due to system failures and emergencies. This Order serves as a general

NPDES permit for the discharge to waters of the U.S. of surface water or groundwater that may be altered by chlorine, corrosion inhibiting agents, algaecides, or addition of other chemicals, but that does not adversely affect or impact beneficial uses of the receiving waters.

E. Discharger's Activities

This Order covers discharges that are essential to comply with the federal Safe Drinking Water Act, the California Health and Safety Code, and State Water Board Division of Drinking Water permitting requirements for providing reliable and safe drinking water. Discharges from these activities described in detail below are intermittent, short-term or seasonal in nature.

1. **Maintenance and Repair.** Facility maintenance and repairs occur frequently (e.g., multiple times a day) at different locations within a system. Discharges may be necessary when dewatering the repair or maintenance site. Underground facilities require excavation for access, and dewatering is necessary to prevent flooding. The resulting "trench dewatering" discharges are usually turbid because the discharge velocity may be high enough to dislodge and transport sediment from trenches and pits. Discharges may also be necessary to maintain positive water pressure within the drinking water system. Positive pressure may be necessary during repair and replacement of pipes, valves, and other components to prevent sediment, debris, and microorganisms from entering the system.
2. **System Flushing.** Flushing portions of a system may be necessary to replace stagnant water when demand is low, or to remove poor quality drinking water. Flushing may also be needed to respond to consumer complaints. Fire hydrants serve as access portals for flushing water distribution systems. Flushing can also occur from other valves or standpipe connections. Flushing may be part of routine operations, and can occur daily, weekly, monthly, or annually based on seasonal water use or known water quality trends. New system facilities or facilities that are periodically taken out of service for maintenance or in response to low water demands may necessitate flushing with super-chlorinated water prior to full operation.
3. **Pipeline, Tunnel, and Reservoir Drainage.** Occasionally, pipelines, tunnels, and reservoirs must be taken out of service for maintenance, such as inspections, repairs, and upgrades. Planned discharges may occur as often as once per year or as infrequently as once every 20 years. These facilities may also be drained in emergency circumstances due to unanticipated drinking water quality concerns.
4. **Groundwater Pumping.** The most common type of discharge from a supply well is well "blow-off" or purging water from the well. Well blow-off is required to reactivate a well after it has been out of service, to purge the system to collect a monitoring sample, or to purge the system when monitoring indicates that the water supply does not meet drinking water quality requirements. Discharges from water supply wells also occur as a result of well maintenance, such as unclogging a filter screen from sediment and mineral build-up.

F. Types of Discharges from Discharger's Activities

This Order covers planned and emergency discharges that occur daily throughout the State. Planned discharges are a part of the Discharger's essential activities, described in part in the previous section of this Fact Sheet. Emergency discharges occur when pipelines or other infrastructure break or leak, valves malfunction, or other unanticipated events occur, such as noncompliance with drinking water standards or hydraulic releases necessary to prevent pipeline rupture. Planned and emergency discharges may include, but are not limited to the following:

1. **Planned Discharges include discharges from:**
    a. Water treatment plant operations (excluding filter backwash that is discharged to a water of the U.S.)
    b. Distribution system storage tanks
    c. Distribution system dewatering, flushing, and pressure testing
    d. Fire flow/fire hydrant testing
    e. Meter testing
    f. Automated water quality analyzers
    g. Pressure relief valves
    h. Groundwater supply well flushing
    i. Groundwater well development, rehabilitation, and testing.
    j. Groundwater monitoring for purpose of supply well development, rehabilitation, and testing.
    k. Transmission system installation, cleaning, and testing.
2. **Emergency Discharges include discharges from:**
    a. Emergency system repairs, including transmission system failure or leaks, and distribution system pipe breaks.
    b. Trench dewatering.
    c. Catastrophic events.

G. Water Treatment Methods and Additives

This Order covers discharges to waters of the U.S. of surface water or groundwater that may be altered by chlorine, corrosion-inhibiting or algaecides agents containing metals such as zinc and copper, or other chemicals but that do not adversely affect or impact beneficial uses of the receiving water when properly managed. For disinfection, water purveyors treat their water with chlorine to comply with California Code of Regulations title 22 or to control microbial growth that can lead to corrosion. Chlorine removal, (also referred to as dechlorination) and its effectiveness depends in part on chemical dose and contact time. Discharger's disinfection and dechlorination processes may include, but are not limited to the following:

1. **Disinfection Treatment Methods.**
   a. **Chlorination.** Most dischargers use chlorine to disinfect their drinking water in accordance with California Code of Regulations, title 22, or to control microbial growth that can lead to corrosion. Chlorine reacts with organic matter and pipe materials (such as iron). As a result, the total chlorine residual decreases following chlorine treatment as water flows throughout the distribution system, making a system vulnerable to bacterial regrowth. Dischargers manage the lack of adequate chlorine concentrations in the distribution system by occasionally flushing water from dead end areas or other parts of their system with new water that has a sufficient chlorine residual concentration. Dischargers may also use booster stations to inject additional chlorine.
   b. **Chloramination.** Some Dischargers prefer chloramine over chlorine. Chloramine forms when chlorine and ammonia combine. Chloramine's disinfection power is one-hundredth that of free chlorine, but chloramine is also more stable and less reactive. Chloramine is also more persistent when released into the environment. Chloramine provides longer-lasting, more reliable protection against bacterial regrowth.
   c. **Super-chlorination.** Some treatment processes require superchlorinated treatment of the drinking water. Superchlorination is necessary when disinfecting new facilities, when returning facilities to service after taking them offline, and when contamination is detected. Superchlorinated water typically has a total chlorine residual concentration greater than 4.0 mg/L.

2. **Dechlorination Treatment Methods.** During planned discharges, flows may be connected to devices that add dechlorinating chemicals prior to discharge. During emergency discharges, dissolving pellets or mesh bags containing the dechlorinating chemicals may be placed in the path of the flow.

H. Example Drinking Water Discharge Characteristics

The following table illustrates the typical characteristics of the types of discharges covered by this Order. This table is not inclusive of all potential discharges:

Table F-1. Typical Characteristics of Drinking Water System Discharges

Facility and Discharge Category [1]	Planned or Emergency	Flow Rate (gpm) [2]	Duration [2]	Frequency [2]	Total Residual Chlorine (mg/L) Or Turbidity (NTU) [2]
Transmission Systems					
Dewatering for new construction, maintenance, or inspection [3]	Planned	200 to 3,500	2 hours to 21 days	Once per year to 20 years	0.8 to 2.5 mg/L
Disinfecting of new construction	Planned	200 to 1,350	2 hours to 14 days	Upon start-up	10 to 50 mg/L
Maintenance or construction	Planned	50 to 200	2 to 10 minutes	Once per year to 20 years	0.8 to 2.5 mg/L
Aqueduct dewatering	Planned	250 to 50,000	1 to 2 days	Once per 2 to 10 years	0.8 to 2.5 mg/L
Disinfecting (new pipeline or storage facility after repair) [4]	Both	Up to 3,500	1 hour to 21 days	Upon initial use	25 to 200 mg/L
Water pipeline breaks, pipeline diameter > 24 inches (includes trench dewatering)	Emergency	5 to 3,500	30 minutes to 2 day		0.8 to 2.5 mg/L
Storage Facilities					
Drain valve testing	Planned	5 to 300	60 to 120 minutes	Once per 5 to 10 years	0.8 to 2.5 mg/L
Reservoir rehabilitation pipe flushing	Planned	Varies	Varies		0.8 to 2.5 mg/L
Tank and reservoir draining for maintenance	Planned	200 to 1,350	1 to 14 days	2 per year to 1 per 5 years	0.8 to 2.5 mg/L
Reservoir overflow	Emergency	Varies	Varies	Varies	0.8 to 2.5 mg/L
Distribution Systems					
Standpipe cleaning	Planned	500 to 2,000	1 to 2 days		0.8 to 2.5 mg/L
Water meter field testing	Planned	50 to 1,000	30 to 60 minutes		0.8 to 2.5 mg/L
Dead-end pumping	Both	200 to 2,000	30 minutes to 1 hour	4 to 12 per year	0.8 to 2.5 mg/L
Line flushing through a hydrant	Both	700 to 1,600	≤10 to 60 minutes	1 to 3 per year per hydrant	0.8 to 2.5 mg/L
Distribution system maintenance or pipe breaks, pipeline diameter < 24 inches (includes trench dewatering)	Both	5 to 1,350	10 to 60 minutes		0.8 to 2.5 mg/L

Facility and Discharge Category [1]	**Planned or Emergency**	**Flow Rate (gpm)** [2]	**Duration** [2]	**Frequency** [2]	**Total Residual Chlorine (mg/L) Or Turbidity (NTU)** [2]
Water quality management and water quality sampling (e.g., for bacteria; metals; taste; odor; etc.)	Both	100 to 15,000	5 minutes to several hours	1 to 50 (for management); up to 5,000+ events per year (for sampling)	0.8 to 2.5 mg/L
Unauthorized hydrant opening	Emergency	500 to 1,000	60 minutes to 8 hours		0.8 to 2.5 mg/L
Groundwater Well Operations					
Water supply well development	Planned	500 to 5,000	15 to 40 hours	Upon start-up	500 to 25,000 NTU
Water supply well rehabilitations	Planned	500 to 3,500	7 days	As-needed; up to 4 per year	500 to 20,000 NTU
Monitoring well sampling	Planned	15-60	20 minutes to 3 hours per well	Semi-annual or as needed	500 to 5000 NTU
Water supply well disinfection		500 to 3,500	30 minutes to 24 hours	As needed	$\leq$ 200 mg/L
Monitoring well development	Planned	15-60	3-8 hours	Semi-annual or as needed	500 to 25,000 NTU
Discharge by water supply well ("blow-off") for reactivation or monitoring	Both	500 to 3,500	30 minutes to 24 hours	Up to 4 per year (planned); or more frequently for emergency circumstances	500 to 20,000 NTU

Unit Abbreviations:

gpm = gallons per minute

mg/L = milligrams per liter

Footnotes:

[1] Source: Tikkanen, Maria, John Schroeter, Lawrence Y.C. Leong, and Rajagopalon Ganesh, 2001. Guidance Manual for the Disposal of Chlorinated Water. Denver, CO. AWWA Research Foundation and American Water Works Association; with modifications by the Alameda County Water District, Alameda County and San Jose Water Company, Santa Clara County, 2013.

[2] Milligrams per liter or Nephelometric Turbidity Units prior to implementation of best management practice. The data presented are typical ranges; actual conditions may vary outside of these ranges.

[3] This information does not apply to raw unaltered water.

[4] The processes to disinfect water pipelines and storage facilities use different chlorination methods, which have different chlorine contact times. Chlorinated water is dechlorinated before discharge under planned operations.

I. Example Discharges, Potential Threat to Receiving Water and Corresponding Permit Requirements.

As shown above, discharges to waters of the U.S. from the discharger's essential activities may have the potential to impact the receiving water. The threat to water

quality is from toxicity of chlorination or metal-containing agents, loading of solids, large volume discharges, and discharges having high velocities. This Order contains permit requirements specifically targeted to protect the beneficial uses of the receiving water from impacts due to these threats, as shown in the following examples:

1. Direct discharge to inland surface waters, enclosed bays and estuaries
Threat: Toxicity to aquatic life; Potential adverse impact on beneficial uses due to:
(1) concentrations of chemical constituents, (2) sediment and turbidity loading from discharge water and erosion, and (3) hydromodification.

Applicable Permit Requirements:
section IV.A Best Management Practices specifications,
section IV.C.1. Total chlorine effluent limitation,
section VI. Receiving water limitations,
Attachment E., section II. Monitoring requirements,
Attachment E., section VII. Reporting and record-keeping requirements.

2. Discharge to a municipal storm water system where the discharge travels less than 300 feet from the point of discharge into the storm drain system to the receiving water body; if the length of the storm drain conveyance is unknown, the distance shall be a direct 300 feet to a water of the U.S.

Threat: Toxicity to aquatic life; Potential adverse impact on beneficial uses due to:
(1) concentrations of chemical constituents, (2) sediment, debris, trash and turbidity loading from discharge water and street scouring, and (3) hydromodification.

Applicable Permit Requirements:
section IV.A Best Management Practices specifications,
section IV.C.1. Total chlorine effluent limitation,
section VI. Receiving water limitations,
Attachment E., section II. Monitoring requirements,
Attachment E., section VII. Reporting and record-keeping requirements.

3. Discharge to a municipal storm water system where: (1) the discharge travels more than 300 feet, or (2) the receiving water body outside of a 300-foot radius of the location of discharge into the storm drain.

Threat: Potential adverse impact on beneficial uses due to: (1) sediment, debris, trash and turbidity loading from discharge water and street scouring, and (2) hydromodification.

Applicable Permit Requirements:
section IV.A Best Management Practices specifications,
section VI. Receiving water limitations,
Attachment E., section II. Monitoring requirements,
Attachment E., section VII. Reporting and record-keeping requirements.

4. Discharges of superchlorinated, supply well water due to development and rehabilitation, and large volume discharge, either directly or via a storm water system, to waters of the U.S.

Threat: Toxicity to aquatic life. Potential adverse impact on beneficial uses due to:

(1) concentrations of chemical constituents, (2) sediment, debris, trash and turbidity loading from discharge water and street scouring, and

(3) hydromodification.

Applicable Permit Requirements:

section IV.A Best Management Practices specifications,
section IV.B.1. Final total chlorine effluent limitation,
Attachment E., section II. Event Monitoring Requirements for Superchlorinated,
Attachment E., section VII. Reporting Requirements.

5. Discharges from portions of the drinking water system that:

(1) Directly discharge into or discharge to a storm water conveyance system that conveys the discharge into:

i. Storm water capture basin(s),

ii. Low impact development features, or

iii. Other groundwater-recharge system(s); and

(2) Are collected and used for landscape irrigation and/or other beneficial reuse.

Threat: No threat to water of the U.S. or water of the state.

Applicable Permit Requirements: Reporting only. No effluent limits or monitoring requirements. No further waste discharge requirements necessary.

J. Discharge Points and Receiving Waters

Although drinking water system discharges potentially occur along any point of the system alignment, and may occur concurrently, the discharges are considered “point source discharges” – discharges of a pollutant from a distinct point source, as defined more fully in title 40 Code of Federal Regulations part 122.2, to a water of the U.S. Discharges flow directly into receiving waters or indirectly to receiving waters via storm drains and other conveyance systems. Discharges into creeks, rivers, lakes, enclosed bays, estuaries, and the ocean occur throughout the State. The application package for coverage under this Order requires the water purveyor to identify the receiving waters for its discharges. If the system discharges into numerous small tributaries prior to discharging into a major water body, the application only requires a general description of the immediate receiving water bodies and the name of the major downstream water body(ies).

II. NOTIFICATION REQUIREMENTS

A. General Order Application

Dischargers enrolling for coverage under this General Order are required to submit a complete application package, including a Notice of Intent (NOI), Attachment B1 of this Order any time after the effective date of the Permit but no later than **September 1**, **2015**. A water purveyor with multiple community water systems need only submit one complete application package, containing individual NOIs for each of its water systems and obtain one Notice of Applicability for regulatory coverage of all its systems that discharge to waters of the U.S. The application package must include all of the following items to be deemed complete:

1. A Notice of Intent for each community water system, including general information about the water purveyor and the existing or proposed discharge(s).

2. A site map that identifies:
a. The boundaries of the water purveyor's service areas,
b. The general location of the drinking water system,
c. The approximate general location of groundwater supply wells, and
d. The general identification of the portion of the community water system that discharges within a 300-foot conveyance distance from the receiving water(s) and/or within a 300-foot radius of the receiving water(s).

The intent of the site map is to provide general information regarding where the discharges are originating and their locations relative to receiving waters. The site map is part of the application package. Regulatory coverage applies to discharges identified in the application package. By providing boundaries of service areas and/or approximate locations of facilities, regulatory coverage of all potential discharges is included in the Notice of Applicability.

3. An application fee payable to the State Water Board that shall be in accordance with California Code of Regulations, title 23, or subsequent fee regulations updates. The current fee schedule is available at http://www.waterboards.ca.gov/resources/fees.

4. Evaluation of multiple water use or beneficial reuse options, or the reason(s) that the discharge water cannot be placed for multiple uses or beneficial uses, as encouraged by the State Water Board in accordance with Article X, section 2 of the California Constitution, and Water Code section 100 (prohibition of the waste or unreasonable use of water). Pursuant to these state policies, the State Water Board strongly encourages discharges of water from drinking water systems to be captured for multiple uses prior to surface water discharge, or to be routed to groundwater infiltration facilities. Therefore, to obtain coverage under this Order, a water purveyor is required to evaluate its water reuse options. These options include:

a. Discharging into a storm water system that employs low impact development practices or flows into storm water capture basins to recharge groundwater.

b. Collecting and using the water for landscape or agricultural irrigation or other appropriate uses in lieu of potable drinking water supply.

Discharges to land from drinking water systems that do not drain to waters of the U.S. do not need authorization to discharge under an NPDES permit. Discharges to groundwater may require waste discharge requirements issued by the State and/or Regional Water Boards. As an incentive to promote multiple uses of drinking water system discharges, the State Water Board generally will not require separate waste discharge requirements or monitoring for discharges otherwise regulated under this Order that are beneficially reused because they are intermittent and of relatively-good quality (not including waste that threatens ground water quality). A water purveyor must estimate the quantity of water discharged from its system that is beneficially reused, and report it in the annual report. If the entire drinking water system does not discharge to waters of the U.S., NPDES permit coverage is not needed.

5. Receiving water information, including names of receiving water bodies and major downstream water bodies.

6. For applicable discharges into waters of the U.S. identified in section III.K of this Fact Sheet, a TMDL constituent-specific supplement to the application package that includes: a) laboratory analysis of TMDL-specific constituents listed in section III.K, and b) TMDL-specific Best Management Practices to address the constituents.

B. State Water Board Notice of Applicability or Ineligibility for Coverage Under this Order

After the water purveyor's application package is deemed complete, the State Water Board's Deputy Director of Water Quality (Deputy Director) will issue a Notice of Applicability (NOA). Regulatory coverage for the planned and emergency discharges that occur within the areas identified in the application package commences with the date of issuance of a Notice of Applicability to the water purveyor. If the submitted application package is not complete in accordance with this Order, or the discharge is deemed ineligible for coverage under this Order, the Deputy Director will send a response letter to the applicant outlining: (1) the missing information that renders the application package incomplete, or (2) why the described discharge is not eligible for coverage under this Order. The water purveyor has **60 days from the date of the response letter** to provide State Water Board staff the items necessary to complete the application package.

C. Permit Coverage Termination

1. **Termination of Existing Regional Water Board Permit Coverage.** Upon the issuance of the NOA in accordance with this Order, the State Water Board expects the applicable Regional Water Board to terminate regulatory coverage under an existing non-MS4 Regional Water Board NPDES permit for discharges newly

regulated under this Order. The State Water Board expects all Regional Water Board permit coverage of drinking water systems that are not separately regulated due to site-specific TMDL requirements to be terminated within one year of the Adoption Date of this Order.

2. **Termination of Statewide Permit Coverage or Revocation of Notice of Non-Applicability.** The Deputy Director may terminate coverage or revoke a Notice of Non-Applicability Approval (NONAA) under this Order for any of the specified causes, and require application for coverage under an individual or other NPDES permit as set forth in title 40 Code of Federal Regulations part 122.28(b)(3). Causes for permit coverage termination or NONAA revocation include, but are not limited to, the following:
   a. Violation of any term or condition of this Order; or
   b. Misrepresentation or failure to disclose all relevant facts in obtaining permit coverage or non-applicability status under this Order; or
   c. Written request from a Discharger to terminate enrollment because discharge has ceased or that the permit is no longer needed.

   Annual permit fees will be assessed by the State Water Board up to the date of written termination notification from the State Water Board to the Discharger, or the date of a termination request letter from the Discharger to the State Water Board, whichever is applicable.

D. Permit Transfer

A change in ownership of the facilities authorized to discharge through coverage under this Order requires the current owner to provide written notice to the State Water Board at least 30 days in advance of transfer of ownership. The Deputy Director may determine that the new owner must submit an application package to seek coverage under this Order if the nature or location(s) of the discharge(s) have changed from the application package on file.

III. APPLICABLE PLANS, POLICIES, AND REGULATIONS

The requirements contained in this Order are based on the applicable plans, policies, and regulations identified in the Findings in section III of this Order. This section provides supplemental information, where appropriate, for the plans, policies, and regulations relevant to the discharge.

A. Legal Authorities

This Order serves as Waste Discharge Requirements pursuant to California Water Code article 4, chapter 4, division 7 (commencing with § 13260). This Order is also issued pursuant to federal Clean Water Act (CWA) section 402 and implementing regulations adopted by U.S. EPA, and California Water Code chapter 5.5, division 7 (commencing with § 13370). It shall serve as an NPDES permit for point source

discharges from multiple discharge points to surface waters, storm drains, and other conveyances leading to surface waters.

B. State Implementation Policy

The *Policy for Implementation of Toxics Standards for Inland Surface Waters, Enclosed Bays, and Estuaries of California* (State Implementation Policy or SIP) establishes implementation provisions for priority pollutant criteria, and objectives and provisions for chronic toxicity control. However, section 5.3 of the SIP allows the State Water Board to grant categorical exceptions from meeting priority pollutant criteria/objectives for discharges from drinking water systems conducted by the owners or operators to fulfill statutory requirements mandated by the federal Safe Drinking Water Act and the California Health and Safety Code. The California Toxics Rule contains criteria for 126 priority pollutants that may be present in these drinking water systems discharges. In many cases, discharges from drinking water systems do not comply with all of the applicable priority pollutant criteria (such as for the protection of aquatic life) since potable and treated drinking water are only required to comply with maximum contaminant levels (MCLs) for the protection of public health. A review of the 126 priority pollutants found that there are priority pollutant criteria that are more stringent than the established MCLs.

The planned and emergency drinking water systems discharges covered under this Order are in accordance with the exception granted by the State Water Board through Resolution 2014-0067, allowing water purveyors an exception to comply with priority pollutant criteria for the priority pollutants that have an applicable California Toxic Rule (CTR) criterion more stringent than its corresponding MCL, or do not have an adopted pollutant-specific MCL. The exception was granted in accordance with the requirements set forth in Section 5.3 of the State Implementation Policy.

C. California Ocean Plan

In 1972, the State Water Board adopted the Water Quality Control Plan for Ocean Waters of California (hereinafter Ocean Plan), as amended. The latest Ocean Plan amendment became effective on August 19, 2013. The Ocean Plan is applicable, in its entirety, to point source discharges to the ocean waters of the State. To protect the beneficial uses of ocean water, the Ocean Plan establishes water quality objectives and a program of implementation. Requirements of this Order implement the Ocean Plan and are applicable for those discharges entering directly into the Ocean or indirectly via a storm water system that drains into the Ocean near the location of discharge. This Order does not authorize direct discharges into Areas of Special Biological Significance (ASBS).

Section III.J of the Ocean Plan allows the State Water Board to grant an exception to specified Ocean Plan requirements where the State Water Board determines that the exception will not compromise protection of beneficial uses of ocean waters and the public interest will be served. In many cases, discharges from drinking water systems due to

mandated activities do not comply with all of the established Ocean Plan objectives (such as for protection of aquatic life or human health based on more stringent carcinogenic objectives) since these discharges are only required to comply with MCLs for the purpose of public health and safety. A review of the Ocean Plan pollutant water quality objectives shows that there are a number of pollutants that may occur in mandated drinking water system discharges, with Ocean Plan objectives that are more stringent than the MCLs. State Water Board Resolution 2014-0067 granted an Ocean Plan exception to water purveyors for the pollutants that have an Ocean Plan objective more stringent than its corresponding MCL or do not have an adopted pollutant-specific MCL. The exception was granted in accordance with the Ocean Plan exception requirements.

D. California Environmental Quality Act (CEQA).

Under Water Code section 13389, this action to adopt an NPDES permit is exempt from the provisions of Chapter 3 of CEQA, (commencing with section 21100) of Division 13 of the Public Resources Code.

Pursuant to CEQA, Public Resources Code section 21100 et seq., on November 18, 2014 the State Water Board adopted Resolution 2014-0067 approving a Mitigated Negative Declaration (MND) for exceptions from specified requirements of the State Implementation Policy and California Ocean Plan for statewide discharges resulting from mandated activities required by the federal Safe Drinking Water Act and California Health and Safety Code. The MND concludes that discharges from drinking water systems have less than significant impact to the environment with appropriate mitigation incorporated. This Order implements Resolution 2014-0067 and establishes appropriate mitigation requirements for discharges authorized under this Order.

E. Regional Water Boards' Water Quality Control Plans

The Regional Water Boards have adopted Water Quality Control Plans (hereinafter Basin Plans) that designate beneficial uses, establish water quality objectives, and contain implementation programs and policies to achieve those objectives. In addition, the Basin Plans implement State Water Board Resolution No. 88- 63, which established state policy that all waters, with certain exceptions, should be considered suitable or potentially suitable for municipal or domestic supply. The Basin Plans identify typical beneficial uses as follows: municipal and domestic supply, agricultural irrigation, stock watering, process supply, service supply, hydropower supply, water contact recreation, canoeing and rafting recreation, other non-contact water recreation, warm freshwater aquatic habitat, cold freshwater habitat, warm fish migration habitat, cold fish migration habitat, warm and cold spawning habitat, wildlife habitat, navigation, rare, threatened, or endangered species habitat, groundwater recharge, and freshwater replenishment. Requirements of this Order implement provisions contained in the applicable Basin Plans.

F. Antidegradation Policy

Section 131.12 of 40 C.F.R. requires that state water quality standards include an antidegradation policy consistent with the federal policy. The State Water Board established California's antidegradation policy in State Water Board Resolution 68-16. Resolution 68-16 incorporates the federal antidegradation policy where the federal policy applies under federal law. Resolution 68-16 requires that existing high water quality be maintained unless degradation is justified based on specific findings. The State Water Board and Regional Water Board's Water Quality Control Plans implement, and incorporate by reference, both the state and federal antidegradation policies. The permitted discharges must be consistent with the antidegradation provision of section 131.12 and State Water Board Resolution 68-16.

Given the nature of a general permit and the broad range of beneficial uses to be protected across the state, it is not feasible to analyze each surface water body in the state to determine which water bodies are of high quality for the constituents in the discharges authorized by this Order. The State Water Board finds that, due to the intermittent, seasonal and temporary characteristics of these discharges, the impact on existing surface water quality from these discharges will be insignificant, as further explained in the MND approved by the State Water Board in Resolution 2014-0067. While surface waters may be temporarily degraded and there may be temporary excursions above water quality objectives in the immediate vicinity of these discharges, any such impacts to surface water quality that may occur are consistent with the maximum social and economic benefit of the people of the state, provided that the discharges comply with this Order. The discharges are a necessary consequence of providing safe, clean, affordable, and accessible drinking water to the people of the state in accordance with the state policy declared in Water Code section 106.3, subdivision (a), and the discharges are mandated by drinking water laws and regulations. The BMPs required under this Order constitute best practical treatment and control of these discharges. Therefore the discharges permitted under this Order are consistent with the antidegradation provision of section 131.12 and the State Water Board Resolution 68-16.

G. Anti-Backsliding Requirements

Sections 402(o)(2) and 303(d)(4) of the CWA and title 40 Code of Federal Regulations part 122.44(l) prohibit backsliding in NPDES permits. These anti-backsliding provisions require that effluent limitations in a reissued permit must be as stringent as those in the previous permit, with some exceptions in which limitations may be relaxed. This Order is a new statewide NPDES permit that regulates discharges from community drinking water systems statewide. Some of these same discharges are currently regulated under existing Regional Water Board NPDES permits. Some of these same discharges are not regulated at all. This Order, when implemented, will provide consistent regulatory requirements that apply to discharges from drinking water systems statewide. The following existing Regional Water Board NPDES permits regulate discharges from community drinking water systems, among other types of discharges, and were used to

guide the development of this Order. Existing NPDES permits' effluent limitations and requirements in these Regional Water Board permits were analyzed for the purpose of analyzing backsliding.

The San Francisco Bay Regional Water Board Permit (Order R2-2009-0033) is a general permit applicable only to surface water treatment facilities for potable supply discharges for either long term or short term. The short term discharges include limits for TSS, settleable matter, pH, total chlorine residual, total trihalomethanes (TTHMs), zinc, and acute toxicity. The treatment of any surface waters to make them suitable for drinking includes filtration and disinfection. This treatment is expected to remove any BOD, TSS or settleable matter present in the surface water. For the other effluent limits of TTHMs and zinc, the discharges would be in compliance with MCLs for TTHMs as required by the federal Safe Drinking Water Act, the California Health and Safety Code, and the State Water Board's Division of Drinking Water permitting requirements. In addition, pursuant to the SIP and Ocean Plan exceptions, the discharges covered under this Order are not required to comply with zinc objectives. Therefore, there is no need to establish TSS, TTHMs and zinc effluent limitations, nor an effluent limitation for pH.

The Los Angeles Regional Water Board Permit (Order R4-2003-0108) is a general permit for discharges of groundwater from potable water supply wells to surface waters and it includes limits of TSS, turbidity, BOD, settleable solids, chlorine residual, pH, TTHMs, Methyl tertiary butyl ether (MTBE) and a list of 15 volatile organic compounds (VOCs) that are also considered priority pollutants, PCBs, and various limits for TDS, Sulfate, Chloride, Boron and Nitrogen applicable per watershed/stream reach. Groundwater that is suitable for drinking water purposes receives natural or well-head treatment so it is not expected to have BOD, TSS, or settleable solids. For this reason and as previously discussed, there is no need to impose limits for BOD, TSS, settleable solids, pH, and TTHMs. In the case of PCBs and the 15 VOCs, as these are priority pollutants that are granted exceptions, it is not necessary to establish limits for these pollutants. With regards to the limits for TDS, Sulfate, and chloride, compliance with the federal Safe Drinking Water Act, the California Health and Safety Code, and the State Water Board's Division of Drinking Water permitting requirements, should result in compliance with the TDS, sulfate, and chloride limits, so there is no need to impose the same limitations in this Order. With regards to nitrogen, compliance with the nitrate MCL should ensure compliance with the nitrogen limitations. During the effective period of R4-2003-0108 there were no issues of non-compliance with the boron limitations. This is new information to justify that there is no reasonable potential to exceed the boron limits. Therefore, there is no need to impose a boron limitation.

The Central Valley Regional Water Board Permit (Order R5-2013-0074) is a general permit applicable to dewatering activities and other types of low threat discharges to surface waters including discharges from drinking water systems. It includes limitations for Biochemical Oxygen Demand (BOD), Total Suspended Solids (TSS), settleable solids, pH, and total chlorine residual. Since this Permit applies to a large set of what the Central Valley Water Board considered low threat discharges, it established a wide range of effluent limitations to ensure protection of beneficial uses.

This statewide Order and its requirements are specifically applicable to drinking water systems that discharge either groundwater and/or surface water that have/has received treatment per state regulations. As previously discussed, treated surface water and groundwater suitable for drinking water purposes are not expected to have BOD, TSS, or settleable solids. In addition, sedimentation and erosion control BMPs are required to be implemented to prevent the discharges authorized by this Order from carrying sediment and causing soil erosion that would add TSS and settleable solids in their discharge prior to entering a storm drain or receiving water directly. It is therefore unnecessary to establish effluent limits for BOD, TSS, or settleable solids in this Order.

Community drinking water systems are required to maintain a pH of 7.0 in their distribution systems as part of their corrosion control treatment plans (40 C.F.R. section 141.82(f)). For all other community systems that do not need to maintain a corrosion control plan, it is expected that they will have no issues with pH levels because they have no issues with corrosion of their systems. Including an effluent limitation for pH in this Order would unnecessarily regulate those systems that are already required to comply with a 7.0 pH level and force other community drinking water systems to add additional chemicals prior to discharging, which in turn may add salts and other pollutants that may cause water quality impacts. Therefore, it is unnecessary to include an effluent limitation for pH in this Order.

The San Diego Regional Water Board Permit (Order R9-2010-0003) is a general permit for discharges of hydrostatic test water and potable water to surface waters and storm drains or other conveyance systems. It establishes limits for total chlorine residual and pH. As previously discussed there is no need to include an effluent limit for pH.

This statewide Order requires that discharges be managed by the use of multiple BMPs, and also contains effluent limitations for chlorine residual and turbidity and receiving water limitations for pH, chemical constituents, sediment and total suspended solids, and toxicity, among other requirements. This Order does not include specific effluent limitations for BOD, TSS, settleable solids or settleable matter, pH, TTHMs, zinc, acute toxicity, MTBE, 15 priority pollutants VOCs, PCBs, TDS, sulfate, chloride, boron and nitrogen, which are included in some of the comparable Regional Water Board permits, as described above. To the extent that this Order may impose less stringent limitations than those contained in the existing Regional Water Board permits, applicable exceptions to the anti-backsliding prohibition that are supported by the analysis above include: waters in attainment, where permit requirements are consistent with antidegradation (§ 303(d)(4)(B)); new information available (§ 402(o)(2)(B)(i)); and events beyond dischargers' control (§ 402(o)(2)(C)), due to the mandatory or emergency nature of the discharges. All requirements under this Order, when implemented, will increase the regulatory requirements over drinking water system discharges on a statewide basis. The effluent limitations for chlorine residual and numerical threshold of 100 NTU for turbidity in this Order are as stringent as the Regional Water Board permits. Effluent limits in broader Regional Board General Permits for discharges to inland waters, enclosed bays and estuaries consist of monthly averages of 50 NTU or 75 NTU. The 100 NTU numerical threshold in this Order is an instantaneous numeric action level that requires further implementation of BMPs when

exceeded. An instantaneous action level of 100 NTU for applicable discharges that are short term and intermittent is as protective, if not more protective, than a monthly average of 50 NTU or 75 NTU.

H. Monitoring and Reporting Requirements

Title 40 Code of Federal Regulations part 122.48, requires that all NPDES permits specify requirements for recording and reporting monitoring results. Section 13267 and section 13383 of the Water Code authorize the regional boards to require technical and monitoring reports. The Monitoring and Reporting Program (MRP) in this Order establishes monitoring, recordkeeping, notification, and reporting requirements to implement State and federal requirements. This MRP is provided in Attachment E.

To address the cost of compliance to dischargers and the cost of implementation to the Water Boards, the monitoring and reporting requirements in this Order are designed to provide necessary information for the discharger to make informed decisions regarding implementation of best management practices, and for the reporting of information that has pertinent value to the protection of water quality. This Order implements representative monitoring requirements, allowing one monitoring sample to represent the quality of other repetitive discharges that are similar in nature. Discharges that are considered to be similar in nature include those that have the following elements in common: (1) the same general water supply, (2) undergo the same water treatment, and (3) are managed through the same series of best management practices. This Order additionally requires annual monitoring and reporting of non-compliant discharges, mandatory recordkeeping, Regional Water Board notification of high volume discharges, reporting of estimated annual volumes discharged to surface water and reporting of the estimated volume of water put to multiple uses prior to surface water discharge or routed to ground water infiltration.

I. Endangered Species Act

This Order does not authorize any act that results in the taking of a threatened or endangered species or any act that is now prohibited, or becomes prohibited in the future, under either the California Endangered Species Act (Fish and Game Code § 2050 et. seq) or the Federal Endangered Species Act (16 U.S.C.A. § 1531 et. seq). This Order requires compliance with effluent limitations, receiving water limitations, and other requirements to protect the beneficial uses of waters of the state. The Discharger is responsible for meeting all requirements of the applicable Endangered Species Act.

J. Impaired Water Bodies on CWA 303(d) List

Under section 303(d) of the 1972 CWA, states, territories, and authorized tribes are required to develop lists of water quality limited segments. The waters on these lists do not meet water quality standards, even after discharges of point sources of pollution have installed the minimum required levels of pollution control technology. On

October 11, 2011, U.S. EPA gave final approval to California's 2010 section 303(d) List of Water Quality Limited Segments. The Basin Plans reference this list of Water Quality Limited Segments (WQLSs), which are defined as "…*those sections of lakes, streams, rivers or other fresh water bodies where water quality does not meet (or is not expected to meet) water quality standards even after the application of appropriate limitations for point sources* (40 C.F.R. part 130.2(j))." The Basin Plans also state, "*Additional treatment beyond minimum federal standards will be imposed on dischargers to [WQLSs]. Dischargers will be assigned or allocated a maximum allowable load of critical pollutants so that water quality objectives can be met in the segment*." Impaired waters are those waters not meeting quality standards pursuant to section 303(d) of the CWA, thus do not support beneficial uses. States must also prioritize the water bodies on the list and develop action plans, called total maximum daily loads (TMDLs) to improve the water quality. California impaired waters, as approved by the State Water Board, are listed on http://www.waterboards.ca.gov/water_issues/programs/tmdl/2010state_ir_reports/2010_combo303d.xls.

This Order does not authorize discharges from new drinking water systems (not an expansion of an existing system) into an impaired water body that is impaired for a constituent that exists in the new discharge at a concentration greater than the criteria used to establish the impairment of the water body.

K. Applicable Total Maximum Daily Loads (TMDLs) with Waste Load Allocations (WLAs) to Water Purveyors

TMDLs in California are developed either by the Regional Water Boards or by U.S. EPA. TMDLs developed by Regional Water Boards are designed as Basin Plan amendments and include implementation provisions. TMDLs developed by U.S. EPA typically contain the total load and load allocations required by section 303(d), but do not contain comprehensive implementation provisions. This stems from the fact that U.S. EPA authorities related to implementation of nonpoint source pollution control measures are generally limited to education and outreach as provided by CWA section 319. TMDLs are currently required for all waters and pollutants on the 303(d) list. TMDLs must consider and include allocations to both point sources and nonpoint sources of listed pollutants. Although the abbreviation stands for "Total Maximum Daily Load," the limitations contained in a TMDL may be other than "daily load" limits. There also can be multiple TMDLs on a particular water body, or there can be one TMDL that addresses numerous pollutants. The basis for grouping pollutants into one TMDL is typically whether or not there can be a common analytical approach to the assessment or a common management response to the impairment.

A review of Regional Water Board TMDLs found that, as of the adoption date of this Order, only the Los Angeles Regional Water Board and the San Diego Regional Water Board have existing (previously adopted) TMDLs in their basin plans that may indirectly imply that waste load allocations are applicable to the discharges from drinking water systems regulated under this General Order. In many of the existing TMDLs, waste

load allocations apply to general categories of discharges (such as “other NPDES discharges”, “general NPDES discharges” or “minor NPDES discharges”) that indirectly include discharges from drinking water systems.

The State Water Board is required to ensure that the effluent limits in this Order are “consistent with the assumptions and requirements of any available waste load allocation for the discharge.” (40 C.F.R. § 122.44(d)(1)(vii)(B).) Although these TMDLs apply to the discharges that are authorized under this Order, none of the TMDLs or supporting staff reports indicate that the discharges from drinking water systems authorized under this Order are significant sources of the relevant pollutants. Based on the data that is currently available, and due to the high quality and intermittent and short-term nature of the discharges from drinking water systems authorized under this Order, it is unlikely that these discharges contribute to the impairment of the TMDL-related water bodies. The State Water Board has determined that the intermittent, short-term and seasonal discharges regulated under this Order do not contribute to the impairment, and requirements more stringent than those included in this Order will not contribute to the actions needed to address the impairment. Therefore, it is consistent with the assumptions and requirements of the waste load allocation in these TMDLs for this Order to not include any TMDL-specific effluent limitations. However, due to the existing language in the TMDLs identified in this section, the State Water Board is requiring laboratory sampling to be included in the application process of this Order, to confirm that pollutants in the subject drinking water system discharges are not at levels that are contributing to the existing impairment. The State Water Board is also requiring that applicants describe and implement applicable TMDL pollutant-specific management practices to reduce the subject pollutant concentration to the maximum extent possible. The data submitted will be evaluated on a case by case basis and in consultation with Regional Board staff. The evaluation will be based on specific factors such as the amount of discharge, duration of discharge, type of pollutant, and consideration of the applicable established Waste Load Allocations for each TMDL to determine whether the conditions of this Order address the applicable TMDL requirements.

If the Deputy Director determines that any of these TMDLs, or any newly approved TMDLs, establish waste load allocations that should be implemented through TMDL-specific permit requirements for the discharges from drinking water systems that are authorized under this Order, the water purveyor will be required to enroll in this Order and maintain enrollment unless and until the Regional Water Board issues an individual or general permit for those discharges contributing to the impairment. Alternatively, if further TMDLs are adopted that address pollutants that are likely to be in discharges from drinking water systems, and allocate waste loads specifically to water purveyors regulated under this Order, the State Water Board may consider adding additional TMDL-specific permit requirements to Attachment G of this Order in a subsequent permit amendment or renewal.

To facilitate a water purveyor’s identification of an applicable TMDL in the Los Angeles and San Diego regions, the following table has been provided to identify the receiving water bodies and corresponding pollutants for which an applicant must provide an application supplement, in accordance with Section II.C.4 of this Order. The table

below includes only the TMDL-specific constituents that may pertain to drinking water discharges and/or additional pollutants the discharges assimilate as they flow into receiving waters. A summary providing general information regarding each TMDL adopted by U.S. EPA or the Regional Water Boards for the Los Angeles and San Diego regions that are applicable to the discharges from drinking water systems authorized under this Order, is provided following the table.

Table F-2. Los Angeles Regional Water Boards' 303(d) list Waterbodies and applicable TMDL-specific constituents

TMDL WATERBODY	TMDL CONSTITUENT
Ballona Creek	Copper Lead Zinc
Ballona Creek Estuary	Cadmium Copper Lead Silver Zinc TSS Chlordane DDTs DDD Total PCBs
Ballona Creek, Ballona Estuary and Sepulveda Channel	Total Coliform E. coli
Calleguas Creek	Boron Total Dissolved Solids Sulfate Chloride Chronic Toxicity Unit (TU_c) Chlorpyrifos Diazinon Chlordane 4,4-DDD 4,4,-DDE 4,4,-DDT Dieldrin PCBs Toxaphene
Calleguas Creek, Reach 1, 2, 3, 4, 5, 9, 10, 11, 12, and 13	Copper Nickel
Calleguas Creek, Reach 4 and 5	Selenium

Colorado Lagoon	Chlordane Dieldrin Lead Zinc PAHs PCBs DDT
Dominguez Channel	Toxicity
Dominguez Channel and Torrance Lateral	Copper Lead Zinc
Dominguez Channel Estuary	PAHs Chlordane Dieldrin
Dominguez Channel Estuary and Greater Harbor Waters	Copper Lead Zinc 4-4-DDT Total PCBs
Compton Creek	Copper Lead
Echo Lake	Total Nitrogen Total Phosphorus
El Dorado Park Lake	Total Nitrogen Total Phosphorus Mercury
Lake Calabasas	Total Nitrogen Total Phosphorus
Lincoln Lake	Total Nitrogen Total Phosphorus
Long Beach City Beaches and the Los Angeles River Estuary	Total Coliform
Los Angeles Harbor	Total Coliform

Los Angeles River	Nitrate-nitrogen Nitrite-nitrogen Nitrate-nitrogen + nitrite-nitrogen Cadmium Copper Lead Zinc E. coli
Los Angeles River above LA-Glendale WRP	Ammonia
Los Angeles River below LA-Glendale WRP	Ammonia
Los Angeles River Reach 1	Copper Lead
Los Angeles River Reach 2 and Arroyo Seco	Copper Lead
Los Angeles River Reach 3 above LA- Glendale WRP and Verdugo	Copper Lead
Los Angeles River Reach 3 below LA- Glendale WRP	Copper Lead
Los Angeles River Reach 4	Copper Lead
Los Angeles River Reach 5,6 and Bell Creek	Copper Lead Selenium
Los Angeles River Burbank Western Channel, above WRP	Copper Lead
Los Angeles River Burbank Western Channel, below WRP	Copper Lead
Los Angeles River tributaries	Ammonia
Los Cerritos Channel	Copper Lead Zinc
Macado Lake	Total PCB DDD (all congeners) DDE (all congeners) DDT (all congeners) Total DDT Chlordane Dieldrin

Malibu Creek	E. coli
Malibu Creek Lagoon	Total Coliform
Marina Del Rey Mothers Beach and Back Basins	Total Coliform
Park Lake, Peck Rd	Total Nitrogen Total Phosphorus
Rainbow Creek	Total Nitrogen Total Phosphorus
Rio Hondo Reach 1	Copper Lead Zinc
San Gabriel River Estuary	Copper
San Gabriel River, Reach 1	Copper
San Gabriel River, Reach 2	Lead
San Gabriel River, Coyote Creek	Copper Lead Zinc
San Gabriel River, San Jose Creek, Reach 1 and 2	Selenium
Santa Clara River	Total Coliform E. coli
Santa Clara River, Reach 7	Ammonia as Nitrogen Nitrate plus Nitrite as Nitrogen
Santa Clara River, Reach 3	Ammonia as Nitrogen Nitrate plus Nitrite as Nitrogen
Santa Fe Dam Park Lake	Total Nitrogen Total Phosphorus
Santa Monica Bay	Total Coliform
Upper Santa Clara River, Reach 3	Chloride
Upper Santa Clara River, Reaches 4B, 5 and 6	Chloride
Ventura Coastal (Miscellaneous)	Total Coliform
Ventura River	Total Nitrogen Total Phosphorus

Table F-3. San Diego Regional Water Boards' 303(d) list Waterbodies and applicable TMDL-specific constituents

TMDL WATERBODY	POLLUTANT
Alisa Hydrologic Subarea	Total Coliform
Chollas Creek	Copper Lead Zinc
Chollas Hydrologic Subarea	Total Coliform
Dana Point Hydrologic Subarea	Total Coliform
Lower San Juan Hydrologic Subarea	Total Coliform
Miramar Reservoir Hydrologic Subarea	Total Coliform
Mission San Diego Hydrologic Subarea & Santee Hydrological Subarea	Total Coliform
Rainbow Creek	Total Nitrogen Total Phosphorus
San Clemente Hydrologic Subarea	Total Coliform
San Dieguito Hydrologic Subarea	Total Coliform
San Joaquin Hills Hydrologic Subarea & Laguna Hills Hydrologic Subarea	Total Coliform
San Marcos Hydrologic Subarea	Total Coliform
San Luis Rey Hydrologic Subarea	Total Coliform
Scripps Hydrologic Subarea	Total Coliform
Tecolote Hydrologic Subarea	Total Coliform

Summary of Los Angeles Region Water Quality Control Board TMDLs

The following is a summary of TMDLs in the Los Angeles region that have waste load allocations for general NPDES discharge categories, followed by a general description. Table F-2 in this section lists the 303(d) list water bodies and TMDL-specific constituents. These TMDLs have been adopted by the Regional Water Board, and approved by the State Water Board and/or the U.S. EPA under Clean Water Act section 303(c), prior to the adoption date of this Order. This Order solely implements the requirements of existing TMDLs; this Order does not modify an existing TMDL or basin plan language. Further detailed information on the summary of listed TMDLs below, as adopted by the Regional Water Quality Control Boards or U.S. EPA, can be found at the following websites:

http://www.waterboards.ca.gov/losangeles/water_issues/programs/tmdl/
or
http://epa.gov/region09/water/tmdl/final.html

1. Total Maximum Daily Load for Nitrogen, Phosphorus, Mercury, Trash, Organochlorine Pesticides and Polychlorinated Biphenyls (PCBs) in the Los Angeles Area Lakes

U.S. EPA established TMDLs in the following nine lakes in the Los Angeles region, for the following pollutants:

- Peck Road Park Lake: nitrogen, phosphorus, chlordane, DDT, dieldrin, PCBs, trash
- Lincoln Park Lake: nitrogen, phosphorus, trash
- Echo Park Lake: nitrogen, phosphorus, chlordane, dieldrin, PCBs, trash
- Lake Calabasas: nitrogen, phosphorus
- El Dorado Park Lakes: nitrogen, phosphorus, mercury
- Legg Lakes (North, Center and Legg): nitrogen, phosphorus
- Puddingstone Reservoir: nitrogen, phosphorus, chlordane, DDT, PCBs, mercury, dieldrin
- Santa Fe Dam Park: nitrogen, phosphorus
- Lake Sherwood: mercury

The NPDES permits in the watersheds draining to the impaired lakes include municipal separate storm sewer system (MS4) permits, a California Department of Transportation (Caltrans) storm water permit, general construction storm water permits, general industrial storm water permits, and a general NPDES permit. Other than the MS4 and Caltrans storm water permits, there are no major individual NPDES permits in the watersheds draining to the impaired lakes. Sources of pollutants include discharges of potable water used to maintain lake levels.

2. Total Maximum Daily Load for Chloride in the Upper Santa Clara River

Chloride levels in Reach 3 of the Santa Clara River exceed the water quality objective (WQO) of 80 mg/L for chloride in Reach 3 established in the Water Quality Control Plan, Los Angeles Region (Basin Plan). U.S. EPA established a TMDL for Reach 3. There are two major point sources that discharge into Reach 3, the Santa Paula and Fillmore Water Reclamation Plants. Minor point source discharges to Reach 3 include:

- storm water regulated under the NPDES municipal stormwater permit
- runoff from construction sites regulated under the statewide construction general NPDES permit,
- storm water regulated under the Caltrans statewide NPDES permit,
- runoff from industrial sites regulated under the statewide industrial facility general NPDES permit, and
- dewatering operations regulated under NPDES permits

In addition, elevated chloride concentrations are causing impairments of the water quality objective of 100 mg/L in Reach 5 (EPA 303(d) list Reach 7) and Reach 6 (EPA 303(d) list Reach 8) of the Santa Clara River (SCR). These reaches were on the 1998 and 2002 Clean Water Act (CWA) 303(d) lists of impaired water bodies as impaired due to chloride. The objectives for these reaches were set to protect all beneficial uses; agricultural beneficial uses have been determined to be most sensitive, and not currently attained at the downstream end of Reach 5 (EPA 303(d) list Reach 7) and Reach 6 (EPA 303(d) list Reach 8) in the Upper Santa Clara River (USCR). Irrigation of salt sensitive crops such as avocados, strawberries, and nursery crops with water containing elevated levels of chloride results in reduced crop yields. Chloride levels in groundwater in Piru Basin underlying the reach downstream of Reach 5 are also rising.

3. Total Maximum Daily Load for Bacteria in the Santa Monica Bay

Many of the beaches along Santa Monica Bay (SMB) were listed on the California's 1998 section 303(d) List, due to impairments for coliform or for beach closures associated with bacteria generally. The Los Angeles Regional Board adopted TMDLs to address bacteriological water quality impairments for 44 beaches along Santa Monica Bay located in Los Angeles County, California. WLA(s) are expressed as the number of sample days at a shoreline monitoring site that may exceed the following single sample numeric targets:

- Total coliform density shall not exceed 10,000/100ml.
- Fecal coliform density shall not exceed 400/100ml
- Enterococcus density shall not exceed 104/100ml
- Total coliform density shall not exceed 1000/100 ml if the ratio of fecal-to-total coliform exceeds 0.1.

With the exception of isolated sewage spills, storm water runoff conveyed by storm drains and creeks is the primary source of elevated bacterial indicator densities to the SMB beaches during wet weather. Waste load allocations are expressed as allowable exceedance days because the bacterial density and frequency of single sample exceedances are the most relevant to public health protection. All responsible jurisdictions and responsible agencies (local agencies that are responsible for discharges from a publicly owned treatment works to the SMB watershed or directly to the Bay, permittees or co-permittees on a municipal storm water permit, the California Department of Transportation, and other agencies that have jurisdiction over a beach adjacent to SMB) within a subwatershed are jointly responsible for complying with established allowable number of exceedance days.

4. Total Maximum Daily Load for Nutrients in the Los Angeles River

Reaches of the Los Angeles River and its tributaries were listed as impaired for nitrogen compounds (ammonia, nitrate, and nitrate) and related effects such as

algae, pH, odor, and scum on the 2002 303(d) list. These reaches were listed because numeric and narrative water quality objectives for nitrogen compounds and related effects were exceeded, thereby impairing warm, freshwater, and wildlife habitats, and recreation beneficial uses.

The principal source of nitrogen compounds to the Los Angeles River is discharges from the Donald C. Tillman Water Reclamation Plant (WRP), the Los Angeles-Glendale WRP, and the Burbank WRP. During dry weather period, the major POTWs contribute 84.1% of the total dry weather nitrogen load. Urban runoff, storm water, and groundwater discharge may also contribute nitrate loads. Further evaluation of these sources is set forth in the Implementation Plan

Concentration based WLAs for nitrogen compounds are allocated to minor point sources enrolled under NPDES or WDR permits including but not limited to Tapia Water Reclamation Plant (WRP), Whittier Narrows WRP, Los Angeles Zoo WRP, industrial and construction storm water, and municipal storm water and urban runoff from municipal separate storm sewer systems (MS4s). The WLA(s) are listed by receiving water and established as the applicable one-hour and thirty-day average effluent limitations at the point of discharge.

5. Total Maximum Daily Load for Nutrients in the Santa Clara River

Discharge of wastes containing nitrite, nitrate and ammonia to the Santa Clara River causes exceedances of water quality objectives for ammonia, nitrate and nitrite established in the Basin Plan. The Santa Clara River is listed as impaired by ammonia in Reach 3 and by nitrate plus nitrite in Reach 7 on the 2002 303(d) list of impaired water bodies. Reach 8 of the Santa Clara River is included on the State Monitoring List for organic enrichment/dissolved oxygen, which may be caused by excessive nitrogen. Nitrate and nitrate are biostimulatory substances that can cause eutrophic effects such as low dissolved oxygen and algae growth. Excessive ammonia can cause aquatic life toxicity.

The principal source of ammonia, nitrite, and nitrate to the Santa Clara River is discharges from the Saugus and Valencia Water Reclamation Plants (WRPs) and the Fillmore and Santa Paula Publicly Owned Treatment Works (POTWs). Agricultural runoff, storm water discharge and groundwater discharge may also contribute nitrate loads. Further evaluation of these sources is set forth in the Implementation Plan.

Concentration-based waste loads are allocated to major point sources of ammonia and nitrate+nitrite in Reach 3, which include the Fillmore and Santa Paula POTWs; concentration-based waste loads are allocated to major point sources of ammonia and nitrite+nitrate in Reaches 7 and 8, which include the Valencia and Saugus WRPs. Concentration-based waste loads are also allocated to municipal, industrial and construction storm water sources regulated under NPDES permits and minor discharges enrolled under NPDES or WDR permits. The allocations for minor point sources are based on the water quality

objectives for ammonia, nitrite, nitrate and nitrite plus nitrate. The WLAs are established as one-hour and thirty day average concentrations.

6. Total Maximum Daily Load for Bacteria in the Marina del Rey Mothers Beach and Back Basins

Elevated bacterial indicator densities are causing impairment of the water contact recreation (REC-1) beneficial use at Marina del Rey Harbor (MdRH) Mothers' Beach and back basins. Dry-weather urban runoff and storm water conveyed by storm drains are the primary sources of elevated bacterial indicator densities to MdRH Mothers' Beach and back basins during dry and wet-weather. As of December 2002, there were seven dischargers located within the Marina del Rey watershed. These dischargers were issued general NPDES permits, general industrial and/or general construction storm water permits. The bacteria loads associated with these discharges are largely unknown, since most do not monitor for bacteria. However, these discharges are not expected to be a significant source of bacteria.

The Los Angeles County MS4 and Caltrans storm water permittees and co-permittees are assigned waste load allocations (WLAs) expressed as the number of daily or weekly sample days that may exceed the single sample targets identified under "Numeric Target" at a monitoring site. Waste load allocations are expressed as allowable exceedance days because the bacterial density and frequency of single sample exceedances are the most relevant to public health protection.

According to the TMDL, discharges from general NPDES permits, general industrial storm water permits and general construction storm water permits are not expected to be a significant source of bacteria.

7. Total Maximum Daily Load for Bacteria in the Los Angeles Harbor

Elevated bacterial indicator densities are causing impairment of the water contact recreation (REC-1) beneficial use of Inner Cabrillo Beach and the potential REC-1 uses of the Main Ship Channel in the Los Angeles Harbor.

Dry-weather urban runoff and storm water conveyed by storm drains are major sources of elevated bacterial indicator densities to Inner Cabrillo Beach and the Main Ship Channel during dry and wet-weather. As of March 2004, there are 15 active individual and 15 active general, NPDES permits for discharges to the Inner or Outer Los Angeles Harbor including the Terminal Island Treatment Plant. While the fecal coliform counts in the wastewater field indicate a contribution of bacteria to the Harbor by the Terminal Treatment Plant, the wastewater field is sufficiently diluted and the bacterial densities are so much lower in the Harbor than the high bacterial densities and exceedances at the sites at Cabrillo Beach and in the Main Ship Channel that it appears that the

Treatment Plant is not a significant source of bacteria to the Beach or to the Ship Channel.

Waste load allocations are expressed as allowable exceedance days because the bacterial density and frequency of single sample exceedances are the most relevant to public health protection. According to the TMDL, discharges from general NPDES permits, general industrial storm water permits and general construction storm water permits are not expected to be a significant source of bacteria.

8. Total Maximum Daily Load for Bacteria in Malibu Creek and Lagoon

Elevated bacterial indicator densities are causing impairment of the water contact recreation (REC-1) beneficial use at Malibu Creek, Lagoon, and adjacent beach. Fecal coliform bacteria may be introduced from a variety of sources including storm water runoff, dry-weather runoff, onsite wastewater treatment systems, and animal wastes. Waste Load Allocations (WLAs) are expressed as the number of daily sample days that may exceed the single sample limits as identified under "Numeric Target." WLAs are expressed as allowable exceedance days because the bacterial density and frequency of single sample exceedances are the most relevant to public health protection.

The responsible jurisdictions and responsible agencies are the County of Los Angeles, County of Ventura, the cities of Malibu, Calabasas, Agoura Hills, Hidden Hills, Simi Valley, Westlake Village, and Thousand Oaks; Caltrans, and the California Department of Parks and Recreation. The responsible jurisdictions and responsible agencies include the permittees and co-permittees of the municipal storm water (MS4) permits for Los Angeles County and Ventura County, and Caltrans. In addition, according to the TMDL, discharges from Tapia WWRF and effluent irrigation, and general construction storm water permits are not expected to be a significant source of bacteria.

9. Total Maximum Daily Load for Metals in the Los Angeles River

Segments of the Los Angeles River and its tributaries are on the Clean Water Act section 303(d) list of impaired waterbodies for copper, cadmium, lead, zinc, aluminum and selenium. The metals subject to this TMDL are toxic pollutants, and the existing water quality objectives for the metals reflect national policy that the discharge of toxic pollutants in toxic amounts be prohibited. When one of the metals subject to this TMDL is present at levels exceeding the existing numeric objectives, then the receiving water is toxic. The beneficial uses impaired by metals in the Los Angeles River and its tributaries are those associated with aquatic life and water supply, including wildlife habitat, rare, threatened or endangered species, warm freshwater habitat, wetlands, and groundwater recharge.

There are significant differences in the sources of metals loadings during dry weather and wet weather. During dry weather, most of the metals loadings are in the dissolved form. The three major publicly owned treatment works (POTWs) that discharge to the river (Tillman WRP, LA-Glendale WRP, and Burbank WRP) constitute the majority of the flow and metals loadings during dry weather. The storm drains also contribute a large percentage of the loadings during dry weather because although their flows are typically low, concentrations of metals in urban runoff may be quite high. The remaining portion of the dry weather flow and metals loadings represents a combination of tributary flows, groundwater discharge, and flows from other permitted NPDES discharges within the watershed.

TMDLs are developed for reaches on the 303(d) list and for reaches where recent data indicate additional impairments. Addressing the impairing metals throughout the Los Angeles River watershed will ensure that the metals do not contribute to an impairment elsewhere in the watershed. Metals allocations are therefore developed for upstream reaches and tributaries that drain to impaired reaches. These TMDLs address wet- and dry-weather discharges of copper, lead, zinc and selenium and wet-weather discharges of cadmium.

Impairments related to cadmium only occur during wet weather. Impairments related to selenium are confined to Reach 6 and its tributaries. Dry-weather impairments related to zinc only occur in Rio Hondo Reach 1. The aluminum listing was based on water quality objectives set to support the municipal water supply beneficial use (MUN). MUN is a conditional use in the Los Angeles River watershed. The United States Environmental Protection Agency (U.S. EPA) has determined that TMDLs are not required for impairments of conditional uses.

10. Total Maximum Daily Load for Metals in Ballona Creek

Ballona Creek is on Clean Water Act Section 303(d) list of impaired waterbodies for dissolved copper, dissolved lead, total selenium, and dissolved zinc and Sepulveda Canyon Channel is 303(d) listed for lead. TMDLs are developed for reaches on the 303(d) list and metal allocations are developed for tributaries that drain to impaired reaches. Recent data indicates that selenium is not present at levels exceeding existing numeric targets and is not impairing the designated beneficial uses. Therefore a TMDL for selenium is not included. This TMDL address dry- and wet-weather discharges of copper, lead, and zinc in Ballona Creek and Sepulveda Canyon Channel.

There are significant differences in the sources of copper, lead, and zinc loadings during dry weather and wet weather. During dry weather, most of the metals loadings are in the dissolved form. Storm drains convey a large percentage of the metals loadings during dry weather because although their flows are typically low, concentrations of metals in urban runoff may be quite high. During dry years, dry weather loadings account for 25-35 percent of the annual metals loadings. Additional sources of dry weather flow and metals loading include groundwater

discharge and flows from other permitted NPDES discharges within the watershed. During wet weather, most of the metals loadings in Ballona Creek are in the particulate form and are associated with wet-weather storm water flows.

Concentration-based dry- and wet-weather waste load allocations are assigned to the minor NPDES permits and general non-storm water NPDES permits that discharge to Ballona Creek or its tributaries.

11. Total Maximum Daily Load for Toxic Pollutants in the Ballona Creek Estuary

Ballona Creek Estuary (Estuary) is on the Clean Water Act Section 303(d) list of impaired water bodies for cadmium, copper, lead, silver, zinc, chlordane, DDT, PCBs, PAHs and toxicity in sediments. Urban storm water has been recognized as a substantial source of metals. Numerous researchers have documented that the most prevalent metals in urban storm water (i.e., copper, lead, zinc, and to a lesser degree cadmium) are consistently associated with suspended solids. Because metals are typically associated with fine particles in storm water runoff, they have the potential to accumulate in estuarine sediments where they may pose a risk of toxicity.

TMDLs are developed for cadmium, copper, lead, silver, zinc, chlordane, DDT, and PCBs within the sediments of the Ballona Creek Estuary. WLAs are assigned to point sources for the Ballona Creek watershed. A grouped mass-based waste load allocation is developed for the storm water permittees (Los Angeles County MS4, Caltrans, General Construction and General Industrial permittees) by subtracting the load allocations from the total loading capacity.

Sediment based waste load allocations are assigned to minor NPDES permits and general non-storm water NPDES permits that discharge to Ballona Creek or its tributaries. The Los Angeles Water Board implements an approach for compliance for these waste load allocations by establishing a total suspended solids (TSS) effluent limitation together with a concentration-based limit for the each specific TMDL pollutant.

12. Total Maximum Daily Load for Toxicity in Calleguas Creek

Discharge of wastes containing chlorpyrifos, diazinon, other pesticides and/or other toxicants to Calleguas Creek, its tributaries and Mugu Lagoon cause exceedances of water quality objectives for toxicity established in the Basin Plan. Source analysis determined that agricultural and urban uses are the largest sources of chlorpyrifos and diazinon in the watershed.

A waste load of 1.0 TUc is allocated to the major point sources (POTWs) discharging to the Calleguas Creek Watershed. Minor sources include NPDES

permittees other than wastewater treatment plants, and urban storm water co-permittees (MS4s) discharging to the Calleguas Creek watershed.

A WLA of 1.0 TUc is allocated to minor point sources. In addition, WLAs for acute and chronic toxicity for diazinon and chloropyrifos are allocated to the minor point sources.

13. Total Maximum Daily Load for Organochlorine (OC) Pesticides and Polychlorinated Biphenyls (PCBs) in Calleguas Creek

Eleven of fourteen reaches in the Calleguas Creek Watershed (CCW) were identified on the 2002 303(d) list of water-quality limited segments as impaired due to elevated levels of organochlorine (OC) pesticides and/or polychlorinated biphenyls (PCBs) in water, sediment and/or fish tissue. Additionally, Mugu Lagoon was listed as impaired for sedimentation/siltation. OC pesticides and PCBs can bioaccumulate in fish tissue and cause toxicity to aquatic life in estuarine and inland waters. Siltation may transport OC Pesticides and PCBs to surface waters and impair aquatic life and wildlife habitats.

Monitoring data from major NPDES discharges and land use runoff were analyzed to estimate the magnitude of OC pesticides and PCBs loads to Calleguas Creek, its tributaries and Mugu Lagoon. The largest source of OC pesticides in the listed waters is agricultural runoff. Most PCB residues are due to past use of PCBs as coolants and lubricants in transformers, capacitors, and other electrical equipment. Atmospheric deposition is also a potential source of PCBs. Urban runoff and POTWs are minor sources of OC pesticides and PCBs.

14. Total Maximum Daily Load for Toxics in the Marina del Rey Harbor

The back basins of Marina del Rey Harbor are on the Clean Water Act Section 303(d) list of impaired water bodies for chlordane, copper, lead, zinc, PCBs, DDT, dieldrin, sediment toxicity and a fish consumption advisory. Review of available data during the development of this TMDL indicated that dieldrin and DDT are no longer causes of impairment. The following designated beneficial uses are impaired by chlordane, copper, lead, zinc, PCBs, and toxicity: water contact recreation (REC1); marine habitat (MAR); wildlife habitat (WILD); commercial and sport fishing (COMM); and shellfish harvesting (SHELL).

Urban storm water has been recognized as a substantial source of metals. Numerous researchers have documented that the most prevalent metals in urban storm water (i.e., copper, lead, and zinc) are consistently associated with suspended solids. Because metals are typically associated with fine particles in storm water runoff, they have the potential to accumulate in marine sediments where they may pose a risk of toxicity. Similar to metals, the majority of organic constituents in storm water are associated with particulates.

Waste load allocations (WLA) are assigned to point sources for the Marina del Rey watershed. A grouped mass-based waste load allocation is developed for the storm water permittees (Los Angeles County MS4, Caltrans, General Construction and General Industrial) by subtracting the load allocations from the total loading capacity. Sediment concentration-based waste load allocations are developed for other point sources in the watershed.

15. Total Maximum Daily Load for Bacteria in Ballona Creek, the Ballona Estuary, and the Sepulveda Channel

Elevated bacterial indicator densities are causing impairment of the water contact recreation (REC-1) beneficial use designated for Ballona Estuary and Sepulveda Channel, limited water contact recreation (LREC) designated for Ballona Creek Reach 2, and non-contact recreation (REC-2) beneficial uses of Ballona Creek Reach 1.

The major contributors of flows and associated bacteria loading to Ballona Creek and Estuary are dry- and wet-weather urban runoff discharges from the storm water conveyance system. Run-off to Ballona Creek is regulated as a point source under the Los Angeles County MS4 Permit, the Caltrans Storm Water Permit, and the General Construction and Industrial Storm Water Permits. In addition to these regulated point sources, the Ballona Estuary receives input from the Del Rey Lagoon and Ballona Wetlands through connecting tide gates.

The Los Angeles County MS4 and Caltrans storm water permittees and co-permittees are assigned waste load allocations (WLAs) expressed as the number of daily or weekly sample days that may exceed the single sample targets equal to the TMDLs established for the impaired reaches.

Waste load allocations are expressed as allowable exceedance days because the bacterial density and frequency of single sample exceedances are the most relevant to public health protection. According to the TMDL, discharges from general NPDES permits, general industrial storm water permits and general construction storm water permits are not expected to be a significant source of bacteria.

16. Total Maximum Daily Load for Metals in the Calleguas Creek Watershed

Three of fourteen reaches in the Calleguas Creek Watershed (CCW) including Revolon Slough, Lower Calleguas Creek – Reach 2, and Mugu Lagoon are identified on the 2002 Clean Water Act Section 303(d) list of water-quality limited segments as impaired due to elevated levels of metals and selenium in water. The 303(d) listings, which were approved by the State Water Resources Control Board in February 2003, require the development of Total Maximum Daily Loads (TMDLs) to establish the maximum amount of pollutants a water body can receive without exceeding water quality standards.

Significant sources of metals and selenium include urban runoff, agricultural runoff, groundwater seepage, and POTW effluent. For mercury, open space was also a significant source. Sources were also analyzed as a function of wet and dry weather. Higher loads were delivered during wet weather for all constituents, due to the association between metals and particulate matter.

In the case of copper, nickel, and selenium, waste load allocations (WLAs) were developed for both wet and dry-weather. The dry-weather WLAs apply to days when flows in the stream are less than the 86th percentile flow rate for each reach. The wet-weather WLAs apply to days when flows in the stream exceed the 86th percentile flow rate for each reach. Annual mass loads of mercury in suspended sediment were developed according to low, medium, and high annual flow categories. Final WLAs were established for POTWs, permitted storm water dischargers, and for all other NPDES dischargers.

17. Total Maximum Daily Load for Salts in the Calleguas Creek Watershed

Eleven of fourteen reaches in the Calleguas Creek Watershed (CCW) are identified on the 2002 Clean Water Act Section 303(d) list of water quality limited segments as impaired due to elevated levels of boron, chloride, sulfate, or total dissolved solids (TDS) (these constitutions are commonly referred to as salts). Sources of salts in the watershed include water supply (water imported from the State Water Project or Freeman Diversion and deep aquifer groundwater pumping), water softeners that discharge to publicly owned treatment works (POTWs), POTW treatment chemicals, atmospheric deposition, pesticides and fertilizers, and indoor water use (chemicals, cleansers, food, etc.). Salts that are transported during dry weather to the surface water are quantified via the following mechanisms: groundwater pumping, groundwater exfiltration, POTWs, dry weather urban and agricultural runoff. Wet weather loadings from each of these sources have the potential to be significant, but tend to be lower in concentration and do not occur during the critical conditions for salts. Wet weather loads are significant from the perspective of transporting stranded salts off the watershed.

The TMDL includes WLAs for five POTWs, permitted storm water dischargers, and all other NPDES dischargers. Concentration-based WLAs are assigned to all other NPDES dischargers based on the Basin Plan objectives.

18. Total Maximum Daily Load for Bacteria in the Harbor Beaches of Ventura County

Elevated bacteria indicator densities are causing impairment of the water contact recreation (REC-1) beneficial use at Kiddie Beach and Hobie Beach. Kiddie and Hobie Beach are referenced in the Staff Report as the Harbor Beaches of Ventura County. Bacteria sources in the Harbor Beaches of Ventura County include anthropogenic and non-anthropogenic sources and point and non-point sources. Each of these sources contributes to the elevated levels of bacteria

indicator densities at the Harbor Beaches of Ventura County during dry- and wet-weather.

WLAs are expressed as allowable exceedance days. According to the TMDL, discharges from general NPDES permits, general industrial storm water permits and general construction storm water permits are not expected to be a significant source of bacteria.

19. Total Maximum Daily Load for OC Pesticides, Polycyclic Aromatic Hydrocarbons (PAHs), Polychlorinated Biphenyls (PCB), and Metals in the Colorado Lagoon

Colorado Lagoon is identified on the 1998, 2002, and 2006 Clean Water Act Section 303(d) lists of water quality limited segments as impaired due to elevated levels of OC pesticides, PCBs, sediment toxicity, PAHs, and metals in fish tissue and sediment. The point sources of OC pesticides, PCBs, PAHs, and metals discharged to Colorado Lagoon are urban runoff and storm water discharges from MS4s and the California Department of Transportation (Caltrans).

Mass-based WLAs for MS4 permittees including the City of Long Beach, Los Angeles County Flood Control District, and Caltrans are allocated to the five major storm drain outfalls that currently discharge to the lagoon. Concentration-based WLAs for sediment are also assigned to these mentioned permittees. For all other point sources such as minor NPDES permits, other storm water and non-storm water permittees, sediment concentration-based WLAs are also assigned.

20. Total Maximum Daily Load for Bacteria in the Santa Clara River

Elevated bacterial indicator densities are causing impairment of the water contact recreation (REC-1) beneficial use designated for the Santa Clara River (SCR) Estuary and Reaches 3, 5, 6, and 7. Recreating in waters with elevated bacterial indicator densities has long been associated with adverse human health effects. The significant contributors of bacteria loading to the SCR and Estuary are dry- and wet-weather urban runoff discharges from the storm water conveyance system.

General NPDES permits, individual NPDES permits, the Statewide Industrial Stormwater General Permit, the Statewide Construction Activity Storm Water General Permit, and the Statewide Stormwater Permit for Caltrans Activities are assigned WLAs of zero (0) allowable exceedance days of the single sample targets for both dry and wet weather and no exceedances of the geometric mean targets.

Discharges from general NPDES permits, general industrial storm water permits and general construction storm water permits are not expected to be a significant source of bacteria.

21. Total Maximum Daily Load for Toxics in Machado Lake

Machado Lake is identified on the 1998, 2002, 2006, and 2008 Federal Clean Water Act Section 303(d) lists of impaired water bodies due to chlordane, DDT, dieldrin, Chem A, and PCBs in fish tissue. Chem A (the abbreviation for 'chemical group A') is a suite of bio-accumulative pesticides that includes chlordane and dieldrin. The 1998 303(d) listing (and subsequent listings) for Chem A was predominately based on fish tissue concentrations of chlordane and dieldrin; there was only minimal detection of other Chem A pollutants in 1983 and 1984. Chlordane and dieldrin have been recently detected in fish tissue, while other Chem A pollutants have not been detected in 25 years. Therefore, this TMDL only addresses the Chem A pollutants (chlordane and dieldrin) that are causing impairment.

Because of potential harm to human health and the environment, the use of these pollutants has been banned for many years; however, the physiochemical properties of the pollutants cause them to persist in the environment. These pollutants, bound to soil particles, are easily transported with surface runoff to water bodies. Contaminated sediments accumulate in the receiving water bodies and aquatic organisms are exposed to the toxic pollutants. Sediment toxicity has been documented at Machado Lake, and it is likely that pesticides and PCBs contribute to the toxic condition of the sediments. Moreover, all of these pollutants biomagnify as they move up the food chain, thereby increasing concentrations in higher trophic-lever aquatic organisms and wildlife.

22. Total Maximum Daily Load for Bacteria in the Los Angeles River

General NPDES permits, individual NPDES permits, the Statewide Industrial Storm Water General Permit, the Statewide Construction Activity Storm Water General Permit, and WDR permittees in the Los Angeles River Watershed are assigned WLAs of zero (0) days of allowable exceedances of the single sample target for both dry and wet weather.

Discharges from general NPDES permits, general industrial storm water permits and general construction storm water permits are not expected to be a significant source of bacteria. Therefore, the WLAs for these discharges are zero (0) days of allowable exceedances for all three time periods and for single sample limits.

23. Total Maximum Daily Load for Metals and Toxics in the Los Angeles and Long Beach Harbors

The waters of Dominguez Channel and the Greater Los Angeles and Long Beach Harbor area are impaired by heavy metals and organic pollutants. These water bodies are included on the State’s Clean Water Act 303(d) impaired waters list for one or more of the following pollutants: cadmium, chromium, copper, mercury, lead, zinc, chlordane, dieldrin, toxaphene, DDT, PCBs, certain PAH compounds, benthic community effects and toxicity. These impairments exist in

one or more environmental media—water, sediment, or tissue. Impairments in fish tissue are for DDT, PCBs, toxaphene, chlordane and dieldrin. Beneficial uses designated in these waters to protect aquatic life include the marine habitat use (MAR) and rare, threatened or endangered species habitat use (RARE). In addition, the estuaries (EST) are recognized as areas for spawning, reproduction and/or early development (SPWN), migration of aquatic organisms (MIGR), and wildlife habitat (WILD). Dominguez Channel also has an existing designated use of warm freshwater habitat (WARM) and the Los Angeles River Estuary has the designated use of wetland habitat (WET). Beneficial uses associated with human use of these waters include recreational use for water contact (REC1), non-contact water recreation (REC2), industrial service supply (IND), navigation (NAV), commercial and sport fishing (COMM), and shellfish harvesting (SHELL).

24. Total Maximum Daily Load for Algae, Eutrophic Conditions and Nutrients in the Ventura River and its Tributaries

The Ventura River Estuary and Reaches 1 and 2 are on the Clean Water Act (CWA) section 303(d) list as impaired for algae and eutrophic conditions. San Antonio Creek and Cañada Larga are on the CWA section 303(d) list as impaired for nitrogen and dissolved oxygen, respectively. Recent data confirm these impairments and demonstrate additional impairments for low dissolved oxygen in the Estuary, San Antonio Creek, and Reaches 1-4. The algae and nutrient related impairments are caused by excessive loading of nutrients, particularly nitrogen and phosphorus, to Ventura River and its tributaries. The water quality impairments due to eutrophication and increased nutrient loading occur during the dry season when algae growth primarily occurs. For purposes related to this TMDL, the dry season is defined as occurring from May 1 to September 30.

Waste load allocations addressing point and non-point sources of nutrients are assigned to discharges to the Ventura River watershed**.**

25. Total Maximum Daily Load for Metals in the San Gabriel River

Segments of the San Gabriel River and its tributaries are on the Clean Water Act section 303(d) list of impaired water bodies for copper, lead, zinc, and selenium. The constituents subject to this TMDL are toxic pollutants, and the existing water quality objectives for these constituents reflect national policy that the discharge of toxic pollutants in toxic amounts be prohibited. When one of the constituents subject to this TMDL is present at levels exceeding the existing numeric objectives, then the receiving water is toxic. The beneficial uses impaired by metals and selenium in the San Gabriel River and its tributaries are those associated with aquatic life and water supply, including wildlife habitat, rare, threatened or endangered species, warm freshwater habitat, wetlands, and groundwater recharge.

TMDLs are developed for reaches on the 303(d) list and for reaches where recent data indicate additional impairments. Addressing the impairing metals and selenium throughout the San Gabriel River watershed will ensure that they do not contribute to impairments elsewhere in the watershed. Metals and selenium allocations are therefore developed for upstream reaches and tributaries that drain to impaired reaches.

These TMDLs address dry-weather impairments of copper in the estuary and selenium in San Jose Creek Reach 1 and wet-weather impairments of lead in San Gabriel River Reach 2 and copper, lead, and zinc in Coyote Creek.

26. Total Maximum Daily Load for Metals in the Los Cerritos Channel

Los Cerritos Channel was included on the 1998, 2002 and 2006 California 303(d) lists as an impaired water body for copper, zinc, and lead. (Regional Board, 1998 and California State Water Resources Control Board, 2002 and 2006.)

The NPDES permits in the Los Cerritos Channel Freshwater Watershed include municipal separate storm sewer system (MS4) permits, the California Department of Transportation (Caltrans) storm water permit, general construction storm water permits, general industrial storm water permits, minor NPDES permits, and general NPDES permits.

Concentration based waste load allocations are established for minor NPDES permits and general non-storm water permits that discharge to the Los Cerritos Channel to ensure that these discharges do not contribute to exceedances of the California Toxic Rule criteria. The waste load allocation for these metals is based on dry and wet weather flows.

27. Total Maximum Daily Load for Indicator Bacteria in the Long Beach City Beaches and Los Angeles River Estuary

General NPDES permits, individual NPDES permits, the Statewide Industrial Storm Water General Permit, the Statewide Construction Activity Storm Water General Permit, the Statewide General Waste Discharge Requirements for Sanitary Systems, and the Vessel General Permit in the Long Beach City Beaches Watershed are assigned WLAs of zero (0) days of allowable exceedances for all time periods for the single sample targets and no exceedances of the 30-day geometric mean targets because they are not expected to be a significant source of indicator bacteria.

San Diego Regional Board TMDLs

Continuing the listing from above, the following is a summary of the TMDLs in the San Diego region that have waste load allocation for general NPDES discharge categories, followed by a general summary. Further detailed information on the already adopted

TMDLs can be found at the following website:

http://www.waterboards.ca.gov/sandiego/water_issues/programs/tmdls/index.shtml

28. Total Maximum Daily Load for Metals in Chollas Creek

Chollas Creek was placed on the Clean Water Act (CWA) section 303(d) List of Water Quality Limited Segments (List of Water Quality Limited Segments) in 1996 for the metals copper, lead, and zinc. Storm water samples from Chollas Creek collected between 1994 and 2003 periodically exceeded California Toxics Rule (CTR) water quality criteria for copper, lead, and zinc, dissolved copper, lead and zinc concentrations in Chollas Creek violate numeric water quality criteria for copper, lead, and zinc promulgated in the California Toxics Rule, and the narrative objective for toxicity. Concentrations of these metals in Chollas Creek threaten and impair the designated beneficial uses of warm freshwater habitat (WARM), and wildlife habitat (WILD). For Chollas Creek, essentially all metals sources (point and nonpoint) are discharged through municipal separate storm sewer systems (MS4) that are regulated under waste discharge requirements (WDRs), NPDES Permits. The point source discharges that could affect Chollas Creek are the MS4 discharges, storm water discharges from industrial sites, and discharges of extracted groundwater. All point source discharges to Chollas Creek will be required to achieve this WLA.

This TMDL establishes concentration-based WLAs set equal to 90 percent of the numeric water quality objectives for copper, lead, and zinc, as defined in the California Toxics Rule. Because the concentration of these metals resulting in toxic effects varies significantly with hardness, the resulting WLAs are hardness dependent.

29. Total Maximum Daily Load for Total Nitrogen and Total Phosphorus in Rainbow Creek

Nitrate, total nitrogen, and total phosphorus concentrations in Rainbow Creek exceed the inorganic chemicals nitrate and biostimulatory substances water quality objectives. These exceedances threaten to unreasonably impair the municipal supply (MUN), warm freshwater habitat (WARM), cold freshwater habitat (COLD), and wildlife habitat (WILD) beneficial uses of Rainbow Creek. Excessive nutrient levels in Rainbow Creek promote the growth of algae in localized areas, creating a nuisance condition, that unreasonably interferes with aesthetics and contact and non-contact water recreation (REC1, REC2) and threatens to impair WARM, COLD and WILD beneficial uses. State highways, agricultural fields and orchards, commercial nurseries, residential and urban areas, and septic tank disposal systems contribute to increased nutrient levels in Rainbow Creek as a result of storm water runoff, irrigation return flows, and ground water contributions to the creek.

WLAs for the discharge of total nitrogen and total phosphorus into Rainbow Creek were established. Identified dischargers of total nitrogen and total phosphorus loading include Caltrans, County of San Diego and nonpoint sources. The TMDL provides WLAs of 2 percent of the total annual TMDL for both total nitrogen and total phosphorus for additional point sources, however the TMDL Implementation Action Plan does not provide for the assignment of WLAs to unidentified point source discharges, effectively resulting in the prohibition of discharges of total nitrogen and total phosphorus into Rainbow Creek.

30. Total Maximum Daily Load Indicator Bacteria in Twenty Beaches and Creeks in the San Diego Region for Direct Discharges Only

Bacteria densities in the Pacific Ocean at various beach and coastal creek mouth segments (referred to hereafter as "beaches") exceed water quality objectives (WQOs) for indicator bacteria. Bacteria densities in ocean water at these beaches unreasonably impair and threaten to impair the water quality needed to support the contact water recreation (REC-1) designated beneficial use. Bacteria densities in the waters of Aliso Creek, San Juan Creek, Tecolote Creek, Forrester Creek, the (lower) San Diego River, and Chollas Creek exceed WQOs for indicator bacteria. Bacteria densities in these creeks unreasonably impair and threaten to impair the water quality needed to support REC-1. The federal Clean Water Act requires the establishment of Total Maximum Daily Loads (TMDLs) for pollutants that exceed the WQOs needed to support designated beneficial uses, i.e., that cause or contribute to exceedances of state "water quality standards".

Unidentified point sources have not been assigned WLAs, which is equivalent to being assigned a WLA of zero. No discharges of bacteria are expected or allowed from unidentified point sources under the dry or wet weather TMDLs.

IV. RATIONALE FOR DISCHARGE SPECIFICATIONS AND EFFLUENT LIMITATIONS

The Clean Water Act (CWA) requires point source dischargers to control the amount of conventional, non-conventional, and toxic pollutants discharged into waters of the United States. The control of pollutants discharged during drinking water system discharge events is established primarily through required Best Management Practices specifications established to require water purveyors to implement a minimum level of pollutant control through best management practices that are proven to be effective in the water supply industry. Numeric effluent limitations are established for chlorine in circumstances where the water discharged from a drinking water system poses an immediate threat to aquatic life with receiving waters. There are two principal bases for effluent limitations: 40 C.F.R. section 122.44(a) requires that permits include applicable technology-based limitations and standards, and 40 C.F.R. section 122.44(d) requires that permits include water quality-based effluent limitations to attain and maintain applicable water quality objectives and criteria to protect the beneficial uses of receiving waters.

A. Applicable Objectives and Criteria

This Order authorizes discharges to inland surface waters, enclosed bays, estuaries and the ocean, statewide. The water quality objectives and criteria applicable to these receiving waters are contained in the corresponding Basin Plan(s), other water quality control plans, and policies, such as the State Implementation Plan and the California Ocean Plan, that implement federal and state water quality objectives.

1. **Regional Boards Basin Plans Objectives.** Basin Plans specify various narrative and numeric water quality objectives, including the maximum contaminant levels (MCLs) in California Code of Regulations, title 22. Typical narrative objectives most relevant to this Order are listed below:

   a. **Toxicity.** The toxicity objective typically states, "All waters shall be maintained free of toxic substances in concentrations that are lethal to or that produce other detrimental responses in aquatic organisms." U.S. EPA water quality criteria were used to translate this objective with respect to chlorine. U.S. EPA's recommended 1-hour average acute criterion for chlorine is 0.019 mg/L and its 4-day average chronic criterion is 0.011 mg/L (the acute or chronic criteria are not to be exceeded more than once every three years on average in any single location).

   b. **pH.** The pH objective in basin plans vary; some objectives are fixed numeric objectives while others provide a numeric range such as *"the pH shall not to be depressed below 6.5 nor raised above 8.5. This encompasses the pH range usually found in waters. Controllable water quality factors shall not cause changes greater than 0.5 units in normal ambient pH levels."*

   c. **Sediment.** Sediment objectives in basin plans vary; however, the basin plans typically provide a narrative objective such as, *"The suspended sediment load and suspended sediment discharge rate of surface waters shall not be altered in such a manner as to cause nuisance or adversely affect beneficial uses."*

   d. **Settleable Material.** The settleable material objectives in basin plans vary; however, the basin plans typically provide a narrative objective such as, *"Waters shall not contain substances in concentrations that result in the deposition of material that cause nuisance or adversely affect beneficial uses."*

   e. **Suspended Material.** The suspended material objectives in basin plans vary; however, the basin plans typically provide a narrative objective that typically states, *"Waters shall not contain suspended material in concentrations that cause nuisance or adversely affect beneficial uses."*

   f. **Turbidity.** The turbidity objectives in basin plans vary; some objectives are fixed numeric objectives while others provide a narrative objective such as, *"Waters shall be free of changes in turbidity that cause nuisance or adversely affect beneficial uses. Increases from normal background light penetration or turbidity*

relatable to waste discharge shall not be greater than 10 percent in areas where natural turbidity is greater than 50 NTU."

2. **California Toxic Rule (CTR) Criteria.** The CTR specifies numeric aquatic life and human health criteria for numerous priority pollutants. Some human health criteria are for consumption of "water and organisms" and others are for consumption of "organisms only." The criteria applicable to "water and organisms" apply to many receiving waters subject to this Order because they are potential drinking water sources with the municipal and domestic supply (MUN) beneficial use. In accordance with Resolution 2014-0067, this Order implements a SIP exception to the CTR criteria for a number of priority pollutants on the basis that these discharges are less than significant with mitigation, and that mandated activities to protect public safety and health are held paramount.

3. **Ocean Plan Water Quality Objectives.** The Ocean Plan specifies in Table 1 of the Ocean Plan numeric water quality objectives for the protection of Marine Aquatic Life and Human Health (Carcinogens and non-carcinogens) for numerous priority pollutants. In accordance with Resolution 2014-0067, this Order implements an exception to the Ocean Plan water quality objectives for a number of priority pollutants on the basis that these discharges are less than significant with mitigation, and that mandated activities to protect public safety and health are held paramount.

4. **Sediment Quality Objectives.** The *Water Quality Control Plan for Enclosed Bays and Estuaries – Part 1, Sediment Quality* contains a narrative water quality objective: "Pollutants in sediments shall not be present in quantities that, alone or in combination, are toxic to benthic communities in bays and estuaries of California." This objective is to be implemented by integrating three lines of evidence: sediment toxicity, benthic community condition, and sediment chemistry. The policy requires that if the Water Board determines that a discharge has reasonable potential to cause or contribute to an exceedance of this objective, it is to impose the objective as a receiving water limit.

B. Technology-Based Effluent Specifications and Effluent Limitations

CWA section 301(b) and 40 C.F.R. section 122.44 require that permits include conditions meeting technology-based requirements at a minimum, and any more stringent effluent limitations necessary to meet water quality standards. The CWA requires U.S. EPA to develop effluent limitations guidelines (ELGs), and standards representing application of best practicable treatment control technology (BPT), best available technology economically achievable (BAT), best conventional pollutant control technology (BCT), and best available demonstrated control technology for new sources (NSPS). CWA section 402(a)(1) and 40 C.F.R. section 125.3 authorize the use of Best Professional Judgment to derive technology-based requirements and effluent limitations on a case-by-case basis when ELGs are unavailable.

1. Technology-Based Best Management Practices Effluent Specifications

This Order does not establish technology-based effluent limitations because U.S. EPA has not established ELGs for the types of discharges this Order authorizes. Moreover, data necessary to develop technology-based effluent limitations on a case-by-case basis for each water body in California, using Best Professional Judgment, are unavailable. The State Water Board finds that the technology-based effluent limitations in Regional Water Board Basin Plans apply to discharges that are continuous in nature and contain "wastes". This statewide Order regulates intermittent and seasonal discharges of drinking water that are short-term, and in and of themselves do not contain the degree of "waste" contained in municipal or industrial wastewater or storm water. Therefore technology-based effluent limitations are not included.

The State Water Board finds that technology is available to control solids in drinking water system discharges, and chemical constituents such as chlorine and other chemical agents added to the water supply source, treatment, and distribution process. Therefore numeric and narrative technology-based best management practices specifications are included in this Order. Attachment C of this Order provides example of such BMPs.

To assure that implemented BMPs are effective, this Order requires:

- Dischargers to assure that quality assurance and quality control protocol is implemented to assure best management practices, monitoring, and reporting are effective, valid, and in compliance with this Order. A Discharger shall train all personnel operating the drinking water system and responding to emergency discharges to assure the quality assurance and quality control protocol is properly implemented.
- For planned discharges, a Discharger shall implement BMPs prior to and during discharges that enter a water of the U.S. For planned but unscheduled or automated discharges from pressure relief valves and unchlorinated pump-to waste wells, BMPs shall be implemented unless infeasible (e.g., inaccessible, inadequate space). For emergency discharges, the BMPs shall be implemented as soon as feasible following assurance that public safety, property, and infrastructure are protected.
- In fulfilling the requirements of this section, the Discharger may implement the example BMPs contained in Attachment C, or proven BMPs per updated approved guidance established by industry experts, professional associations, or entities (e.g. *2014 Edition of the BMP Manual for Drinking Water System Releases* published by the California-Nevada Section of the American Water Works Association).
- The Discharger shall maintain a documented log of all BMPs implemented for its different types of discharges that enter a water of the U.S, and make it available to State and Regional Water Board staff upon request.

- The Discharger shall modify its BMPs as necessary to maintain compliance with the requirements of this Order. If monitoring results or other available information demonstrates that the discharge is not in compliance, the Discharger shall determine the source of non-compliance, and develop and implement new or revised BMPs as necessary. As part of this process, the Discharger shall validate the effectiveness of any new or revised BMPs to comply with the requirements of this Order. All non-compliance and corresponding corrective actions to address non-compliance are required to be reported to the State Water Board in the annual report, as required in the Monitoring and Reporting Program (Attachment E) of this Order. A log documenting the additional or revised BMPs shall be made available upon request by staff of the State and/or Regional Water Board.

2. **Toxicity (Chlorine and other chemical agents).** This Order translates the narrative toxicity objective with respect to chlorine by using U.S. EPA's water quality criteria for chlorine. Water distribution systems are usually chlorinated to meet the minimum total chlorine residual requirements in California Code of Regulations, title 22. According to the most recent Annual Consumer Confidence Reports from various water agencies, the typical average total chlorine residual concentration in a distribution system is about 2.0 mg/L, which is roughly 100 times U.S. EPA's acute water quality criterion of 0.019 mg/L. However, chlorine in water discharges can dissipate from volatilization and reaction with dirt and organic matter on streets and storm drain systems. Based on the analysis in section IV.C. below, reasonable potential for toxicity exists only for superchlorinated waters and other chlorinated waters that are in closer proximity to receiving waters (within 300 feet). For all other discharges, this Order establishes narrative technology-based specifications, specifying that proven management practices must be implemented to treat or control pollutants from its discharges to maintain compliance with this Order.

   At minimum, this Order requires that dischargers properly manage all planned discharges and implement proven dechlorination or chemical-control BMPs provided by professional associations or institutes such as the American Water Works Association, to assure that beneficial uses of the receiving water body(ies) are not adversely affected or impacted. Such BMPs include natural dissipation of chlorine in the discharge prior to it reaching the surface water body. For emergency discharges, the Discharger shall implement BMP procedures as soon as feasible while concurrently protecting public health and safety. Attachment C of this Order provides example of such dechlorination BMPs.

   Copper and zinc are known constituents in chemical agents used for to control algae in water supplies and control corrosion in drinking water facilities. Management practices proven to control copper and other metals during pesticide applications are not the same management practices needed to control these metals in drinking water system discharges. Although the State Water Board has granted a regulatory exception to CTR constituents including copper and zinc, the State Water Board expects dischargers to implement BMPs to reduce metals concentrations to the best

extent possible. Attachment C of this Order provides example BMPs for copper and zinc concentration reduction specifically in drinking water system discharges.

3. Solids (Sediment, Settleable Material, Suspended Material, Debris, and Turbidity)

Various discharges from drinking water systems may contain sediment as follows:

- Sediment accumulates at the dead ends of distribution systems during periods of low water demand. The sediment within a system must be flushed periodically.
- Raw transmitted water may contain sediment due to naturally occurring minerals and organic debris.
- Trench dewatering can result in relatively high sediment loads, depending on soil type, flow rate and duration, and excavation size.
- Discharges from new well development and inactive well rehabilitation may have high sediment loads due to drilling mud, cuttings, and removal of solids from the bottom of the well and around the screen casing.

Discharges can also contribute to sediment loading, solids loading and erosion within receiving waters due to high flows and volumes. Such discharges can dislodge sediment and transport it to receiving waters, or destabilize and erode shorelines or other natural receiving water features.

At minimum, this Order requires that dischargers implement BMP for planned discharges to:

- Prevent riparian erosion and hydromodification by implementing flow dissipation, erosion control, and hydromodification-prevention measures; and
- Minimize sediment discharge, turbidity and color impacts by implementing sediment, turbidity, erosion and color control measures.

For groundwater supply well operations, this Order requires dischargers to implement treatment systems or BMPs for all groundwater well development, rehabilitation, or operation discharges to waters of the U.S. to assure these discharges:

- Do not cause or contribute to an exceedance of the receiving water limitation for turbidity in Section V.G. of this Order, and
- Comply with a turbidity action level of 100 Nephelometric Turbidity Units (NTUs) or less in the discharge. An exceedance of the turbidity numeric action level of 100 NTU is not a violation of this Order, but any exceedance does require the Discharger take action to modify, change, or enhance BMPs when the turbidity level is greater than 100 NTU, until the turbidity level is 100 NTU or less.

4. **Instream Sediment Quality.** Pollutants in some receiving water sediments may be present in quantities that alone or in combination are toxic to benthic communities. Efforts are underway to identify stressors causing such conditions. Due to the relative clean nature of potable water, it is unlikely that these discharges contribute to sediment toxicity. However, to date there is no evidence either way; therefore, the State Water Board cannot draw a definitive conclusion about reasonable potential for these discharges to cause or contribute to exceedances of the sediment quality objectives.

C. Water Quality Based Effluent Limitations

1. Scope and Authority

This Order contains water quality-based effluent limitations (WQBELs) that implement water quality objectives and criteria that protect beneficial uses. CWA section 301(b) and 40 C.F.R. section 122.44(d) require that permits include limitations more stringent than federal technology-based requirements where necessary to achieve applicable water quality standards. According to 40 C.F.R. section 122.44(d)(1)(i), permits must include effluent limitations for all pollutants that are or may be discharged at levels that have a reasonable potential to cause or contribute to an exceedance of a water quality standard, including numeric and narrative objectives within a standard. Where reasonable potential has been established for a pollutant, but there is no numeric criterion or objective, WQBELs must be established using: (1) U.S. EPA criteria guidance under CWA section 304(a), supplemented where necessary by other relevant information; (2) an indicator parameter for the pollutant of concern; or (3) a calculated numeric water quality criterion, such as a proposed state criterion or policy interpreting a narrative criterion, supplemented with relevant information (40 C.F.R. § 122.44[d][1][vi]). The process for determining reasonable potential and calculating WQBELs is intended to establish effluent limitations for discharges to comply with applicable water quality objectives established to protect designated beneficial uses of receiving waters.

2. Need for Water Quality Based Effluent Limitations (Reasonable Potential Analysis)

Assessing whether a pollutant has reasonable potential to exceed a water quality objective or criterion is the fundamental step in determining whether a water quality based effluent limitation is required. As explained below, this Order finds reasonable potential for toxicity due to the chlorinated drinking water system discharges.

a. **Analysis for Numeric Objectives and Promulgated Criteria.** The State Implementation Plan (SIP), section 1.3 sets forth the method used in this Order for assessing whether a pollutant has reasonable potential to exceed a numeric water quality objective or promulgated criterion. The analysis begins with identifying the maximum effluent concentration (MEC) observed for each pollutant based on available effluent concentration data and the ambient background concentration (B). The SIP, section 1.4.3 states that ambient

background concentrations are either the maximum ambient concentration observed or, for water quality objectives intended to protect human health, the arithmetic mean of observed concentrations. There are three triggers in determining reasonable potential and the need for a numeric effluent limitation:

- Trigger 1 is activated if the maximum effluent concentration is greater than or equal to the lowest applicable water quality objective (MEC $\geq$ water quality objective).

- Trigger 2 is activated if the ambient background concentration observed in the receiving water (B) is greater than the water quality objective (B > water quality objective) *and* the pollutant is present in any effluent sample.

- Trigger 3 is activated if a review of other information indicates that a WQBEL is needed to protect beneficial uses.

The Ocean Plan provides a similar method for assessing reasonable potential as described in Appendix V of the Ocean Plan.

Water in drinking water systems is required to comply with maximum contaminant levels (MCLs) per state regulations; therefore for pollutants that have MCLs more stringent than the CTR or Ocean Plan water quality objectives, this Order finds those priority pollutants do not have reasonable potential to exceed a water quality objective. However for the remaining priority pollutants for which the MCL is not the most stringent applicable water quality objective, an exception to those objectives has been granted through Resolution 2014-0067.

b. Analysis for Toxicity due to Chlorine. This Order translates the narrative toxicity objective with respect to chlorine by using U.S. EPA's water quality criteria for chlorine. Water distribution systems are usually chlorinated to meet the minimum total chlorine residual requirements in California Code of Regulations title 22. According to the most recent Annual Consumer Confidence Reports from various water agencies, the typical average total chlorine residual concentration in a distribution system is about 2.0 mg/L, which is roughly 100 times U.S. EPA's acute water quality criterion of 0.019 mg/L. However, chlorine in water discharges can dissipate from volatilization and reaction with dirt and organic matter on streets and storm drain systems. Based on the analysis below, reasonable potential for toxicity exists only for superchlorinated waters and other chlorinated waters that are in closer proximity to receiving waters (within 300 feet). Therefore this Order contains numeric chlorine water quality based effluent limitations for superchlorinated discharges and chlorinated water discharged within 300 feet of a surface water body.

Numeric effluent limitations are not included in this Order for sediment, settleable material, and suspended material, as there is no readily available means to translate the sediment, settleable material, and suspended material objectives into numeric WQBELs appropriate for the many receiving waters that could be affected by the discharges covered by this Order. This Order controls sediment,

settleable material, and suspended material through BMPs as discussed above in this fact sheet.

All 126 priority pollutants in the California Toxic Rule and pollutants with Ocean Plan water quality objectives have also been considered. The pollutants with MCLs as the most stringent water quality objective have shown no reasonable potential because these discharges are already required to comply with MCLs per state regulations and State Water Board Division of Drinking Water permits. For the remaining pollutants, a categorical SIP and Ocean Plan exception has been granted, therefore there is no reasonable potential since the exceptions lead to no applicable numeric criteria for these discharges.

3. Calculation of Water Quality Based Effluent Limitations (WQBELs)

Regulations at 40 C.F.R. section 122.44(k)(3) require numeric WQBELs unless numeric WQBELs are infeasible. This Order imposes numeric WQBELs for total residual chlorine because it is feasible and necessary to calculate numeric WQBELs for this toxic pollutant in order to protect beneficial uses in the receiving water bodies. Field chlorine meters are readily available and used to measure chlorine in drinking water system discharges, therefore it is feasible to collect representative total residual chlorine concentration data to determine compliance.

The total chlorine residual WQBEL established in this Order for discharges to inland surface waters, enclosed bays and estuaries is 0.019 mg/L based on U.S. EPA's acute water quality criterion for chlorine, which is expressed as a one-hour average. The total chlorine residual WQBEL established in this Order for discharges to the ocean is 0.008, mg/L based on the Ocean Plan criteria for chlorine. The numeric WQBELs for total residual chlorine are applicable to: (1) all superchlorinated discharges, and (2) chlorinated discharges located within 300 feet of a receiving water body.

According to a controlled field study conducted by East Bay Municipal Utilities District (EBMUD), when dechlorination BMPs are properly implemented, the total chlorine residual concentration in chlorinated discharges is fully neutralized within 200 feet to concentrations below a minimum level of 0.1 mg/L (Tikkanen et. al, 2001, *Guidance Manual for Disposal of Chlorinated Water*). The study analyzed samples from nine fire hydrants discharging at varying flow rates and treated with dechlorination BMPs within the EBMUD jurisdiction. Similarly, the Santa Clara Valley Urban Runoff Pollution Prevention Program (SCVURPPP) analyzed samples from ten fire hydrants discharging at varying flow rates and treated with dechlorination BMPs in the Cities of Palo Alto, San Jose and Sunnyvale. Based on the SCVURPPP study, eight of the discharge events monitored achieved full neutralization (to concentrations below 0.1 mg/L) by 160 feet. The two remaining discharge events spiked above the minimum level of 0.1 mg/L, but ultimately achieved full neutralization within 425 feet. The spike in concentration was suspected to be due to turbidity interference.

Based on these data and adding an additional safety factor due to the immediate toxicity to aquatic life from chlorine, the State Water Board determines that discharges where dechlorination BMPs (chemically or naturally) have been properly implemented that are more than 300 feet from a receiving water body do not pose a reasonable potential to exceed the applicable total residual chlorine water quality objective. Thus, the numeric WQBEL is not applicable to such discharges.

The turbidity numeric WQBEL established in this Order for discharges to the ocean is 225 NTU based on the Ocean Plan criteria for turbidity. The numeric WQBELs for turbidity is applicable to all discharges located within 300 feet of the ocean. These discharges pose a reasonable potential to cause exceedance of ocean turbidity water quality objective due to high solids levels in drinking water systems discussed in detail above in this fact sheet.

V. DISCHARGES NOT AUTHORIZED BY THIS ORDER

This Order implements the regulatory exceptions granted to water purveyors by Resolution 2014-0067. Requirements in this Order are designed for discharges described in the corresponding Mitigated Negative Declaration (attached to Resolution 2014-0067) that, when properly mitigated through the implementation of BMPs, monitoring, and reporting, do not pose a significant threat to the environment. .

Discharges not authorized by this Order include:

- Discharges other than those authorized in the Notice of Applicability issued by the Deputy Director of Water Quality; or
- Discharges to a water of the U.S. with a total maximum daily load (TMDL) that prescribes a waste load allocation to a water purveyor, where the Deputy Director determines that the requirements of this Order are not consistent with the assumptions and requirements of the TMDL, and thus compliance with this Order is not sufficient for the water purveyor to comply with the imposed TMDL requirements; or
- Discharges from new drinking water systems (not an expansion of an existing system) into an impaired water body that is impaired for a constituent that exists in the new discharge at a concentration greater than the criteria used to establish the impairment of the water body; or
- Direct discharges into areas designated by the State Water Board as Areas of Special Biological Significance (ASBS).

VI. RATIONALE FOR RECEIVING WATER LIMITATIONS

The receiving water limitations in this Order are established in accordance with federal and State water quality standards per the CWA and regulations adopted thereunder, and

narrative and numeric water quality objectives in the Regional Water Boards' Basin Plans and State Water Board water quality control plans and policies.

VII. RATIONALE FOR MONITORING AND REPORTING REQUIREMENTS

Title 40 Code of Federal Regulations part 122.48 requires that all NPDES permits specify requirements for recording and reporting monitoring results. Water Code sections 13267 and 13383 authorize the Regional Water Board to require technical and monitoring reports. The Monitoring and Reporting Program (Attachment E) of this Order, establishes monitoring, recordkeeping and reporting requirements to implement federal and state requirements. The following provides the rationale for the monitoring and reporting requirements contained in Attachment E of this Order.

A. Effluent Monitoring

Pursuant to the requirements of title 40 Code of Federal Regulations part 122.44(i)(2), reporting of effluent monitoring is required for all constituents with effluent limitations and specifications. Effluent monitoring is necessary to assess compliance with effluent limitations and specifications, assess the effectiveness of the implemented BMPs and treatment process (where applicable), and to assess the impacts of the discharge on the receiving water.

Effluent monitoring requirements have been established in this Order to provide: (1) the Discharger with necessary information to make informed decisions regarding the implementation of effective management practices, and (2) the State Water Board to determine compliance with effluent specifications and limitations. Required effluent monitoring includes event monitoring and representative monitoring as follows:

1. **Event Monitoring.** This Order requires monitoring of all superchlorinated discharges, all discharges from well development and rehabilitation activities, and individual discharge events that are greater than 325,850 gallons (one acre-foot). The Discharger shall monitor all such events per the sample types and frequencies specified in Attachment E.

2. **Annual Representative Monitoring.** This Order allows discharges of similar nature to be monitored on a representative basis. Representative monitoring is the use of monitoring results of one water quality monitoring sample to represent other discharges expected to have the same water quality. A representative monitoring measurement must represent discharges of similar nature, meaning discharges that have all the following items in common:

   (i) The same general water source (ground water or surface water of similar water quality), and

   (ii) The same water treatment, and

(iii) The same type of implemented BMPs.

The Discharger shall monitor all planned discharges not defined as events (Item 1. above) using representative monitoring per the sample types and frequencies specified in Attachment E. In its annual report, the Discharger shall:

(a) Submit a copy of its site schematic submitted in its application for enrollment with labeled representative monitoring locations, and
(b) Identify the portions of its system in which the representative monitoring results represent, and
(c) Include any changes in its representative monitoring locations that have occurred during the monitoring-year, as applicable.

3. Annual Discharge Volume Monitoring Requirements

This Order requires the Discharger to monitor and keep record of:
(a) The number of direct discharge to a water of the U.S that is greater than 50,000 gallons, during each calendar year,
(b) An estimate of the total volume discharged to surface water during each calendar year, and
(c) An estimate of the total volume of discharge water directed to a reuse or beneficial use in accordance with section VI. of this Order.

4. Monitoring Not Required

This Order does not establish monitoring requirements for any discharges that: (a) do not ultimately reach a water of the U.S., (b) are implemented for multiple uses or routed to a beneficial reuse, in accordance with section V. of the Order, prior to surface water discharge, or (c) are emergency discharges.

B. Receiving Water Monitoring

This Order requires visual receiving water monitoring for all direct planned discharges that do not comply with the requirements contained in section IV of the Order, and that may potentially adversely affect or impact beneficial uses of the receiving waters. Receiving water monitoring shall be conducted during or immediately after the Discharger became aware of a non-compliant discharge that adversely effects or impacts beneficial uses of the receiving water. The Discharger shall monitor the point of confluence of the discharge and the receiving water. If the receiving water presents hazards to the monitoring personnel, visual monitoring shall be conducted using telephoto lenses and binoculars. If further hazards exist beyond such measures, monitoring is not required, and the hazards shall be documented in the corresponding monitoring report.

C. Post-Notification Requirements

Within 24 hours of the Discharger becoming aware of an adverse effect(s) or impact on beneficial uses of the receiving water body due to non-compliance with this Order, or

due to a system failure or emergency involving a discharge from its drinking water system, the Discharger shall notify the corresponding Regional Water Board and the MS4 operator, and the Discharger shall confirm this notification in writing within five days. The notification shall include all of the following:

1. The location and extent of non-compliance or emergency discharge;
2. The cause of the non-compliance or emergency discharge;
3. The date, time and expected duration of the non-compliance or emergency discharge;
4. The estimated volume of discharge;
5. The applicable receiving water body; and
6. The corrective actions taken (or being taken) to prevent future non-compliance or repair the system failure.

D. Pre-Notification Requirements

Three (3) days prior to initiation of a planned discharge (or retroactively within 24-hours after the Discharger is informed to conduct an urgent planned discharge) of a volume equal to or greater than one acre-foot (325,850 gallons), the Discharger shall notify the MS4 operator, if applicable, and the appropriate Regional Water Board and provide:

1. The start date of discharge
2. The location of discharge and the applicable receiving water
3. The estimated volume of discharge, and
4. The reasons for discharge

E. Reporting and Recordkeeping Requirements

1. This Order requires the Discharger to maintain self-monitoring reports, including compliant and non-compliant discharge monitoring information, in its main office and to make those reports available upon request of State and Regional Water Board staff.

2. Monitoring periods and reporting for all required monitoring shall be completed according to the schedule in Attachment E.

3. The Order requires the Discharger to arrange and summarize any reported numerical data in a tabular format.

4. If a Discharger monitors any pollutant more frequently than required by this Order, the results of this monitoring shall be included in the self-monitoring report.

5. The Order requires the Discharger to report to the State Water Board any toxic chemical release data it reports to the State Emergency Response Commission within 15 days of reporting the data to the Commission pursuant to section 313 of the "Emergency Planning and Community Right to Know Act" of 1986.

6. This Order requires the Discharger to report, by March 1 of every year, all non-compliant discharge monitoring information contained in the Discharger's self-monitoring report for the past calendar year. All non-compliant discharge monitoring information shall be accompanied by the corrective actions the Discharger has taken to return the discharge to compliance. Identified non-compliance must include a description of the requirement that was violated and a description of the violation.

7. The Discharger is required to attach a cover letter to the report that clearly identifies discharge events of non-compliance with the permit; discuss corrective actions taken or planned; and the proposed time schedule for corrective actions.

F. Increase in Monitoring Requirements

The Deputy Director may modify the monitoring and reporting requirements at any time to ensure the protection of the beneficial uses of the receiving water. The modified requirements will be based on site-specific data or information indicating that a site-specific discharge threatens to cause or contribute to an exceedance of a receiving water quality criteria or objective.

At any time during the term of this permit, the Deputy Director may notify authorized Dischargers to electronically submit monitoring reports using the State Water Board's California Integrated Water Quality System (CIWQS) Program Web site (http://www.waterboards.ca.gov/ciwqs/index.html). Until such notification is given, each Discharger shall submit a hard copy of its monitoring reports. Subsequent guidance will be provided to the Discharger upon the Deputy Director's notification for electronic submittal of reports. (Direction and guidance for electronic SMR submittals is currently available on the CIWQS Web site at http://www.waterboards.ca.gov/water_issues/programs/ciwqs/chc_npdes.shtml

VIII. RATIONALE FOR PROVISIONS

A. Standard Provisions

Standard Provisions, which apply to all NPDES permits in accordance with 40 Code of Federal Regulations part 122.41, and additional conditions applicable to specified categories of permits in accordance with 40 Code of Federal Regulations part 122.42, are provided in Attachment D. The discharger must comply with all standard provisions and with those additional conditions that are applicable under 40 Code of Federal Regulations part 122.42.

Title 40 Code of Federal Regulations part 122.41(a)(1) and (b) through (n) establish conditions that apply to all State-issued NPDES permits. These conditions must be incorporated into the permits either expressly or by reference. If incorporated by reference, a specific citation to the regulations must be included in the Order. Title 40 Code of Federal Regulations part 123.25(a) allows the state to omit or modify conditions to impose more stringent requirements. In accordance with

40 Code of Federal Regulations part 123.25, this Order omits federal conditions that address enforcement authority specified in 40 Code of Federal Regulations part 122.41(j)(5) and (k)(2) because the enforcement authority under the Water Code is more stringent. In lieu of these conditions, this Order incorporates by reference Water Code section 13387(e).

B. Special Reopener Provisions

The reopener provisions in this Order provide an explanation of the State Water Board authority to reopen this Order in accordance with 40 Code of Federal Regulations part 122.62. For example, the State Water Board is developing a Proposed Total Residual Chlorine and Chlorine-Produced Oxidants Policy of California, which when adopted is intended to establish consistent standards and implementation procedures for regulating chlorine statewide. This provision is the avenue by which the State Water Board may reopen this Order to include a revised reporting level to determine compliance with effluent limitations for total residual chlorine if a statewide policy for total residual chlorine is adopted during the term of this Order.

IX. PUBLIC PARTICIPATION

The State Water Board adopted this Order that serves as a statewide general NPDES permit for low threat discharges from drinking water systems on November 18, 2014. State Water Board staff developed the draft Order using input from water purveyors and other interested parties over the course at least two years. The language and requirements in the draft order were developed to eliminate, where possible, unnecessary interference with mandated activities to protect public health. State Water Board staff held nine stakeholder meetings statewide and other verbal correspondences to incorporate the most crucial concerns related to small systems, and the feasibility and cost of permit compliance. The State Water Board encouraged public participation at the August 5, 2014 public hearing, the October 21, 2014 workshop meeting and the November 18, 2014 adoption meeting for this item.

A. Notification of Interested Parties

The State Water Board notified interested agencies, parties, and persons of its intent to consider adoption of this general Order for low threat discharges from drinking water systems and provided them with an opportunity to submit their written comments and recommendations. Notification was provided to interested parties through specific mailings, distribution through the Water Board Lyris Email System and through publication in the following newspapers for the following communities:

- Inter-City Express - Alameda County
- Tahoe Daily Tribune - Alpine County
- Fresno Bee - Fresno County
- Imperial Valley Press - Imperial County
- Los Angeles Daily Journal - LA County
- Orange County Recorder - Orange County

- Daily Recorder - Sacramento County
- San Diego Commerce - San Diego County
- New Times - San Luis Obispo County
- Record Searchlight - Shasta County
- Sonoma County Herald - Sonoma County

B. Public Comments

A draft Order was issued for public comment and review on June 6, 2014. Interested persons were invited to submit written comments concerning the draft Order. A revised draft Order was issued on July 3, 2014, mainly incorporating TMDL implementation language to the previously issued draft Order. For State Water Board staff and the State Water Board to be fully responsive and consider public comments, all comments were required to be submitted to the State Water Board by noon on August 19, 2014.

C. Public Hearing

The State Water Board held a public hearing on the draft Order during its regular Board meeting on the following date and time and at the following location:

Date:	August 5, 2014
Time:	9:00 a.m.
Location:	California Environmental Protection Agency Headquarters Office 1001 I Street, 2nd Floor Sacramento, CA 95814

Interested persons were invited to attend. At the public hearing, the State Water Board heard testimony pertinent to the subject discharges, and this Order. Oral testimony was heard; however, for accuracy of the record, important testimony was required to be submitted in writing.

The State Water Board considered comments that were provided orally at the public hearing, and in writing in accordance with the public notice issued for this Order, for the development of the final draft permit. Due to the numerous changes to the draft permit, a subsequent public workshop was held on October 21, 2014, and further oral comments were heard as the final draft permit was considered for adoption on November 18, 2014.

All pertinent dates, documents and agendas were kept updated and accessible on the NPDES Program Page of the State Water Board website at the following web address: http://www.waterboards.ca.gov/water_issues/programs/npdes/.

D. Waste Discharge Requirements

This Order serves as statewide Waste Discharge Requirements (WDRs) pursuant to California Water Code, article 4, chapter 4, division 7 (commencing with § 13260). This Order is also issued pursuant to federal Clean Water Act (CWA) section 402 and implementing regulations adopted by the U.S. Environmental Protection Agency

(U.S. EPA), and California Water Code chapter 5.5, division 7 (commencing with § 13370). This Order shall serve as a statewide general NPDES permit for point source discharges from single or multiple discharge points to surface waters, storm drains, and other storm water conveyances leading to waters of the U.S.

Due to the drought conditions and the State of California water conservation goals, the State Water Board strongly encourages water purveyors with a discharge authorized under this Order to place the discharge water to multiple uses prior to surface water discharge, or to a beneficial reuse. The multiple use or beneficial reuse of the discharges authorized under this Order generally does not require coverage under waste discharge requirements if the discharge is collected and reused for landscape irrigation or other uses in a manner that augments the existing supply, or if the discharge is directly or indirectly discharged to:

- Storm water capture basin(s),
- Low impact development features
- Other groundwater-recharge system(s), or

Discharges from drinking water systems to land that do not drain to waters of the U.S. do not need authorization to discharge under an NPDES permit. Although discharges to groundwater may require waste discharge requirements issued by the State and/or Regional Water Boards, as an incentive to promote multiple uses of drinking water system discharges, the State Water Board generally will not require waste discharge requirements or monitoring for such drinking water system discharges that are beneficially reused rather than discharged to a water of the U.S. A water purveyor must estimate and report in its annual report, the quantity of water that would otherwise have been discharged but is used multiple times or is beneficially reused for this provision to apply.

E. Register of Interested Persons

Any person interested in being placed on the mailing list for information regarding this Order must register on the Drinking Water Systems Discharge Permit lyris listing at http://www.waterboards.ca.gov/resources/email_subscriptions/swrcb_subscribe.shtml, by selecting 'Water Quality Topics', then selecting 'Drinking Water Systems Discharges'.

F. Additional Information

Requests for additional information or questions regarding this Order should be directed to Ms. Diana Messina, staff of the State Water Board, at diana.messina@waterboards.ca.gov.

ATTACHMENT G – WATER BODIES WITH TOTAL MAXIMUM DAILY LOADS (TMDLs) AND WASTE LOAD ALLOCATIONS (WLAs) TO WATER PURVEYORS

As of the adoption date of this Order, no already-adopted TMDLs have established WLAs that apply exclusively to discharges from drinking water systems regulated under this Order. Due to the nature of the discharges authorized under this Order, it is unlikely that these discharges contribute to the impairment of the TMDL-related water bodies; therefore existing TMDL-related requirements that include WLAs to general categories of discharges are not applicable.

This Attachment is reserved for the State Water Board to include additional permit requirements in a subsequent permit renewal to implement future TMDLs that:

1) address pollutants likely to be in discharges from drinking water systems, and

2) allocate waste loads specifically to water purveyors regulated under this Order.

ATTACHMENT H - MAP OF THE REGIONAL WATER QUALITY CONTROL BOARDS

To find the Regional Water Board for a particular location, click on the map or enter a street address at the following website:*http://www.waterboards.ca.gov/waterboards_map.shtml#rwqcbs*

Or click on the map below:



Appendix 13: Changed Circumstances Response Actions

Appendix 13 - Changed Circumstances Response Actions

General Activity	Sub-Activity	Routine Covered Activity	Changed Circumstances Activity[1]
Reservoir Operations	• Woody Debris Removal on Reservoir Face	• 10 cubic yards of < 10-inch diameter/8-foot long wood removed annually	Fire: 2 additional annual events in up to 5 years Flood: 2 additional annual events in up to 5 years
Water Diversion Sediment Management	• Laguna Diversion sediment removal • Majors Diversion sediment removal	• Excavation of up to 3 yards per event up to 1-3x/year. Valve operations. • Excavation of 5-10 cubic yards per event up to 1-3x/year. Valve operations. • Excavation of 5-10 cubic yards per event up to 1-3x/year. Valve operations.	Fire: 2 additional annual events diversions in up to 5 years Flood: 2 additional annual events at diversions in up to 5 years
Fish Ladder and Screen Maintenance	• Felton Diversion debris and sediment removal • Tait Street Diversion debris and sediment removal	• 1-3 x/year up to a yard of sediment and woody material needs to be removed from the ladder. • 1-3x/year up to a yard of sediment and woody material needs to be removed from intake.	Fire: 2 additional annual events at both diversions in up to 5 years Flood: 2 additional annual events at both diversions in up to 5 years
Dewatering of Creeks for Maintenance and Repairs for any projects requiring in-channel work when channels are not dry	• Fish capture and relocation • Vegetation removal	• Dewatered stream reaches can range from approximately 20-200 feet at 1-10 sites for 1-4 weeks in any given year.	Fire: 2 additional dewatering events in up to 5 years Flood: 2 additional dewatering events in up to 5 years

[1] Actions implemented to address changed circumstances are expected to be within the scope of the standard covered activities and are therefore cross-referenced with the associated covered activity in the table above.

General Activity	Sub-Activity	Routine Covered Activity	Changed Circumstances Activity[1]
Flood Control Maintenance	• Debris/Obstruction Removal • Flood Control Sediment Management/Removal	• 1-3x/year in wet water years up to 100 cubic yards of material. • Removal of approximately 2 cubic yards of sediment per drainage structure/annually or biannually for up to 30 drainage structures.	Flood: Debris/obstruction removal – up to 2 additional annual events in up to 5 years Flood Control Sediment Mgt/Rem – up to 2 more annual events at all structures in up to 5 years

Appendix 14: Take Associated with Dewatering Activities

Appendix 14 - Summary of anticipated injury or mortality from dewatering activities by covered activity type.

General Activity	No. of Events over HCP Term	Steelhead juveniles			Coho salmon juveniles		
		Fish captured for relocation per event (per HCP Term)	Unintentional injury or mortality/ Event (Per HCP Term)		Fish captured for relocation per event (per HCP Term)	Unintentional injury or mortality/ Event (Per HCP Term)	
			Capture/ Relocation [1]	Dewatering[2]		Capture/ Relocation	Dewatering
Maintenance and Repair at Felton and Tait St Diversions	4	150[3] (600)	5 (20)	3 (12)	Not expected[4]	--	--
Changed Circumstances - Maint at Felton and Tait St Div	20	150 (3000)	5 (100)	3 (60)	Not Expected	-	-
Habitat Restoration and Management	30	150[5] (4500)	5 (150)	3 (90)	75[6] (750)	2 (20)	2 (20)
Changed Circumstances - dewatering and fish relocation for Habitat Restoration and Maintenance	20	150 (3000)	5 (100)	3 (60)	75 (525)	2 (14)	2 (14)
Branciforte Creek FCC Sediment Management/ Removal	6	62[7] (372)	2 (12)	2 (12)	Not Expected[8]	--	--
Changed Circumstances- Branciforte Creek FCC Sediment Management/ Removal	10	62 (620)	5 (50)	3 (30)	Not Expected	-	-
Max Over HCP Term for All Activities		**12092**	**432**	**264**	**1275**	**34**	**34**
Max Per Event		**150**	**5**	**3**	**75**	**2**	**2**

[1] NMFS estimates 3 percent of fish captured and relocated could be injured or killed
[2] NMFS estimates 2 percent of the number of fish encountered during capture and relocation could be injured and killed during dewatering
[3] Assuming an average density of 50 steelhead per 100 feet of stream and 300 feet of stream will be affected per event. Two events at each facility over the term of the permit.
[4] No coho have been observed in the mainstem San Lorenzo River downstream of the Felton Diversion in annual juvenile salmonid surveys in recent years and even if coho become re-established in the San Lorenzo River they are more likely to be found rearing in the tributaries.
[5] The average areal extent will involve 300 feet of stream channel that requires dewatering. Average density of rearing juvenile steelhead is assumed to be 50 per 100 feet of stream.
[6] Some of these activities could occur in the tributaries where rearing coho may be present. Average densities are expected to be very low in the near term, but effects could occur if coho become re-established in the Plan Area. Under such future conditions coho may be found at up to one-third of the project locations, likely at densities not more than half those of rearing steelhead (25 fish per 100 feet). The average areal extent will involve 300 feet of stream channel that requires dewatering.
[7] The population density in the upper portion is estimated at 2 steelhead per 100 feet of FCC. If it is assumed that sediment removal is conducted three times over the term of the HCP for the 3,100-foot lower and middle portions (6 events at 3,100 linear feet) where sediment accumulates.
[8] The San Lorenzo and Branciforte FCCs do not provide suitable habitat for coho and juvenile coho are not expected to be found there.

Appendix 15: Take Associated with Monitoring

Appendix 15 - Proposed annual monitoring of CCC steelhead and CCC coho salmon in the San Lorenzo River (including Newell Creek, Zayante Creek, and Mountain Charlie Creek), Liddell Creek, Laguna Creek, and Majors Creek.

Line	Species	Origin	Life Stage	Number Captured	Number Killed	Action	Observe or Collect Method	Procedures	Details
1	CCC Steelhead	Natural	Adult	3,000	5	Capture/Mark, Tag, Sample Tissue/Release Live Animal	Weir or Fish Ladder Trap	Anesthetize; Tag, PIT, Floy, Acoustic, Radio (External/Internal); Tissue Sample, Fin, Opercle, Scale	Adult Abundance
2	CCC Steelhead	Natural	Adult	15	0	Observe/Harass	Snorkel/Dive surveys		
3	CCC Steelhead	Natural	Juvenile	5,500	0	Observe/Harass	Snorkel/Dive surveys		Juvenile Abundance – Riverine
4	CCC Steelhead	Natural	Juvenile	3,680	74	Capture/Handle/ Release Animal	Electrofishing, Backpack		Juvenile Abundance – Riverine
5	CCC Steelhead	Natural	Juvenile	2,500	75	Capture/Mark, Tag, Sample Tissue/Release Live Animal	Electrofishing, Backpack	Anesthetize; Tag, PIT; Tissue Sample, Fin, Opercle, Scale	Juvenile Abundance – Riverine
6	CCC Steelhead	Natural	Juvenile	8,700	174	Capture/Mark, Tag, Sample Tissue/Release Live Animal	Seine, Beach		Juvenile Abundance – Lagoons
7	CCC Steelhead	Natural	Juvenile	4,000	120	Capture/Mark, Tag, Sample Tissue/Release Live Animal	Seine, Beach	Anesthetize; Tag, PIT; Tissue Sample, Fin, Opercle, Scale	Juvenile Abundance – Lagoons
8	CCC Coho Salmon	Natural and Listed Hatchery	Adult	200	2	Capture/Mark, Tag, Sample Tissue/Release Live Animal	Weir or Fish Ladder Trap	Anesthetize; Tag, PIT, Floy, Acoustic, Radio (External/Internal); Tissue Sample, Fin, Opercle, Scale	Adult Abundance
9	CCC Coho Salmon	Natural and	Juvenile	1,100	0	Observe/Harass	Snorkel/Dive surveys		Juvenile Abundance – Riverine

		Listed Hatchery							
10	CCC Coho Salmon	Natural and Listed Hatchery	Juvenile	1,200	24	Capture/Handle/ Release Animal	Electrofishing, Backpack		Juvenile Abundance – Riverine
11	CCC Coho Salmon	Natural and Listed Hatchery	Juvenile	300	9	Capture/Mark, Tag, Sample Tissue/Release Live Animal	Electrofishing, Backpack	Anesthetize; Tag, PIT; Tissue Sample, Fin, Opercle, Scale	Juvenile Abundance – Riverine
12	CCC Coho Salmon	Natural and Listed Hatchery	Juvenile	100	2	Capture/Handle/ Release Animal	Seine, Beach		Juvenile Abundance – Lagoons
13	CCC Coho Salmon	Natural and Listed Hatchery	Juvenile	100	3	Capture/Mark, Tag, Sample Tissue/Release Live Animal	Seine, Beach	Anesthetize; Tag, PIT; Tissue Sample, Fin, Opercle, Scale	Juvenile Abundance – Lagoons