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Technical Memorandum

Conceptual-Level Cost Comparison of Water Supply Alternatives

April 17, 2013

Prepared for

City of Santa Cruz and
Soquel Creek Water District
scwd² Desalination Program

K/J Project No. 0868005*05

Executive Summary

This analysis provides a conceptual-level cost comparison of water supply alternatives for the City of Santa Cruz (City) and Soquel Creek Water District (District) to meet their supplemental water supply objectives.

City and District Objectives for a Supplemental Water Supply

According to the City Integrated Water Plan (IWP, 2005), the City's supplemental water supply objective is a project that can provide up to 2.5 million gallons per day (mgd) of potable water during dry and critically dry years. As part of the District Integrated Resources Plan (IRP, 2006, 2012), the District's supplemental water supply objective is a project that can provide an estimated average of 1.3 mgd (1,500 AFY) and up to 2.5 mgd (2,800 AFY) of potable water every year for at least 20 years to protect and recover over-drafted aquifers. The combined objective is to provide up to 2.5 million gallons per day (mgd) and 2,800 acre-feet per year (AFY) of supplemental potable water supply collectively for the City and District.

Water Supply Alternatives Considered

The water supply alternatives considered herein include the proposed Regional Seawater Desalination Project for the **scwd²** Desalination Program and other water supply alternatives that have been studied as part of or subsequent to the City and District Integrated Water Plans. The alternatives are listed below and described in more detail in this technical memorandum, the project environmental impact report and in the referenced technical studies.

- Regional Desalination Project
- City-Only Desalination Project
- District-Only Desalination Project
- Regional Recycled Water for Irrigation
- Indirect Potable Reuse - Groundwater Recharge
- Direct Potable Reuse - Reservoir Augmentation in Loch Lomond Reservoir
- Direct Potable Reuse - Direct Blending into the Source Water for the Graham Hill WTP
- Recycled Water Exchange with North Coast Agriculture
- Winter-time Water Transfers from the City to Neighboring Agencies

Summary of Conceptual Costs and Potable Water Production

Table 1 and Figure 1 provide a summary of the conceptual level annual new potable water supply volumes, capital costs, operations and maintenance (O&M) costs, and the annualized unit water costs for the different alternatives. The planning level conceptual costs of the alternatives presented are based on information and costs developed in technical studies conducted by the City and District as part of their integrated water plans and the **scwd²** Desalination Program, and supplemented with cost estimates from similar projects and professional experience. All costs are conceptual and order of magnitude type costs and intended to be used for comparison purposes between alternatives.

Table 1: Summary of Water Supply Alternatives – Costs and New Potable Water Supply Amounts

	Regional Desalination Project	City-Only Desalination Project	District-Only Desalination Project	Regional Recycled Water for Irrigation	Indirect Potable Reuse (IPR) Using Groundwater Recharge	Direct Potable Reuse (DPR) using Reservoir Augmentation	Direct Potable Reuse (DPR) blended before Graham Hill WTP	Agriculture Water Exchange with North Coast Agriculture	Winter-Time Surface Water Transfers
Water Supply Amounts									
Assumed Average Annual Water Produced (AFY) (1)	1,500	470	1,500	1,200	Up to 1,000	1,500	1,500	1,200	740
Assumed Maximum New Water Supply (AFY) (1)	2,800	2,800	2,800	1,200	Up to 1,000	2,800	2,800	1,200	740
City Max New Potable Water Supply (AFY)	2,800	2,800	0	950	0	0	0	0	0
District Max New Potable Water Supply (AFY)	2,800	0	2,800	250	0	0	0	0	0
Total Viable New Water Supply to Meet Objectives (AFY)	**2,800** (2)	**2,800**	**2,800**	**250** (3)	**0** (4)	**0** (5)	**0** (5)	**0** (6)	**0** (7)
Conceptual Costs									
Project Management (mil $)	$5	$5	$5	$5	$7	$7	$7	$5	$3
Ocean Intake (mil $)	$27	$27	$20	-	-	-	-	-	-
Treatment Plant (mil $)	$69	$69	$68	$30	$37	$50	$50	$30	$30
Conveyance (pipes, pumps, storage, brine) (mil $)	$10	$3	$10	$60	$56	$64	$52	$46	$10
Groundwater Wells (mil $)	-	-	-	-	$37	-	-	$11	-
Permitting/Studies (mil $)	$4	$4	$4	$5	$7	$10	$10	$6	$5
Total Capital Expenditures (mil $)	**$115**	**$108**	**$107**	**$100**	**$144**	**$131**	**$119**	**$98**	**$48**
City Capital Cost (mil $)	*$68*	*$108*	*$0*	*$59*	*$0*	*$77*	*$70*	*$58*	-
District Capital Cost (mil $)	*$47*	*$0*	*$107*	*$41*	*$144*	*$54*	*$49*	*$40*	*$24*
Scotts Valley Capital Cost (mil $)	-	-	-	-	-	-	-	-	*$24*
Range of Annual O&M (mil $/yr)	**$3.3 to $3.8**	**$1.5 to $3.8**	**$2.6 to $3.8**	**$1.0**	**$2**	**$1.6 to $2.2**	**$1.5 to $2**	**$0.7**	**$0.7**
City Annualized Unit Cost ($/AF)	$2,600 - $3,500	$3,300 - $5,200	$0	$3,300	$0	$2,200 - $2,500	$2,000 - $2,300	$3,100	$0
District Annualized Unit Cost ($/AF)	$2,200 - $3,100	$0	$3,300 - $3,700	$2,500	$9,400	$1,700 - $2,000	$1,600 - $1,900	$2,300	$4,500
Scotts Valley Annualized Unit Cost ($/AF)	-	-	-	-	-	-	-	-	$4,000
Total Project Annualized Unit Cost ($/AF) (8)	**$3,500 - $4,300**	**$3,300 - $5,200**	**$3,300 - $3,700**	**$5,100**	**$9,400**	**$3,100 - $3,400**	**$2,900 - $3,200**	**$5,500**	**$4,200**

(1) Some alternatives considered in this exercise do not meet the supplemental supply objectives and are not viable due to significant regulatory or other restrictions as noted. However, for the purpose of comparing unit costs, average and maximum water produced were assumed for alternatives that are not viable. See the discussion of each alternative for more information on assumed water supply amounts.

(2) Depending on operational agreements, the City or District could receive up to 2,800 AFY new potable water supplies.

(3) Because the City would significantly restrict irrigation in a drought, the 950 AFY for irrigation from a regional recycled water project would not "free up" and provide new potable supplies for the City during a drought. Therefore, the new potable water supply to meet City and District objectives is approximately 250 AFY of supply for the District.

(4) IPR using groundwater recharge is not practical for the District or City because 1) it requires blending recycled water with surface or groundwater prior to injection and both surface and groundwater supplies are already limited; 2) injection wells are required to be located a prescribed distance away from any public or private drinking water well which is difficult due to the thousands of wells within Soquel-Aptos area groundwater basin; and, 3) local geography and limitations are not conducive to percolation/blending ponds.

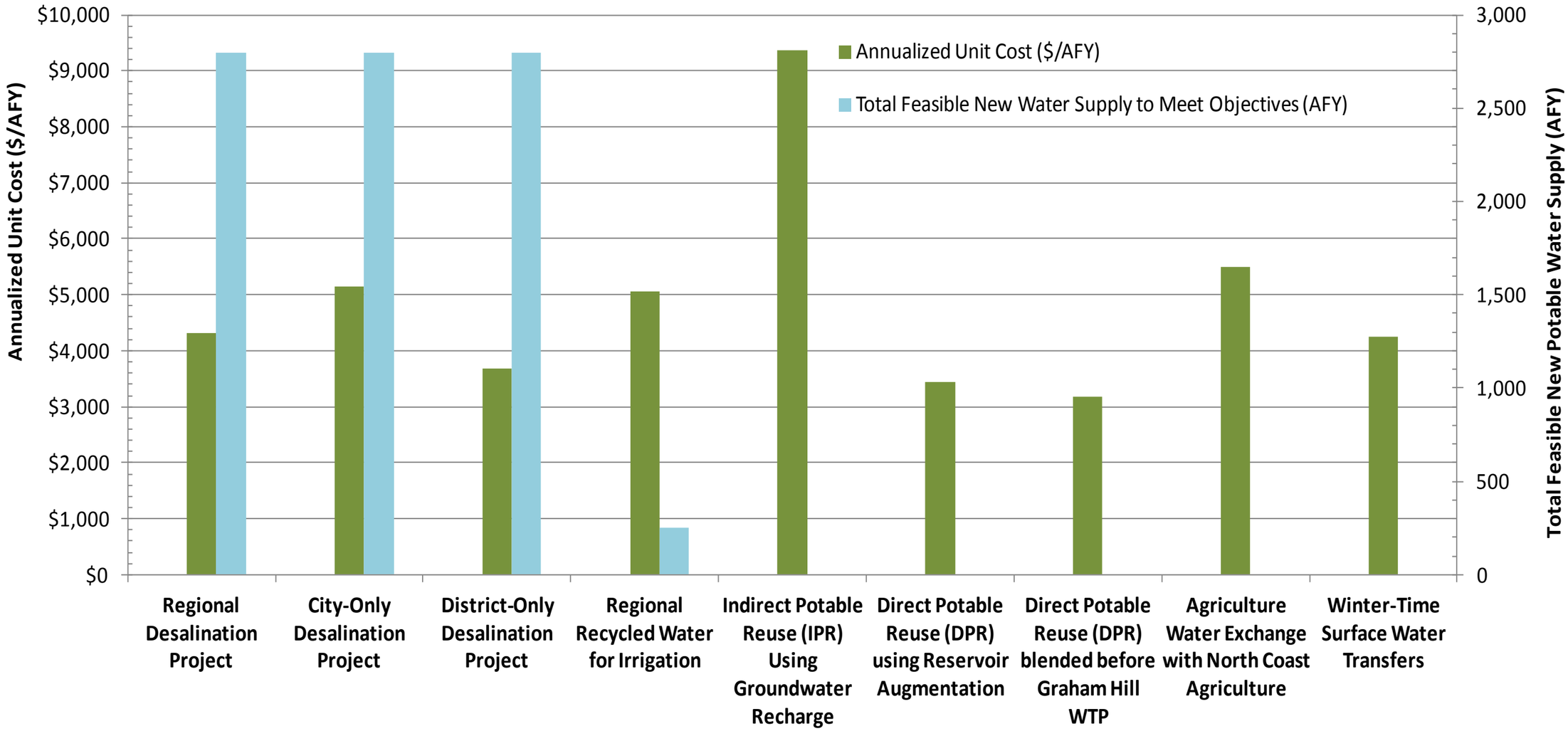
(5) While this alternative could provide up to 2,800 AFY of new water supply, DPR is not currently permitted and would face significant regulatory and public perception challenges. Therefore this alternative does not provide new potable water supplies for the City and District, within the timeframe of the project.

(6) While there could theoretically be ~1,140 AFY of groundwater available from north coast basins, State Parks has ruled out a water exchange and local organic growers do not want recycled water.

(7) Approximately 740 AFY of City winter water could be available for transfer to neighboring water agencies: 400 AFY could go to Scotts Valley; 340 AFY to District requires change in water supply permit. Water rights change could take 20 years so new water to District is not viable in the project timeframe. Exchange water back to the City not likely until Scotts Valley groundwater recovers.

(8) Annualized water cost includes capital and O&M costs for the life of the project. The range represents operation at maximum assumed production capacity (low end of unit cost range) and average annual assumed production capacity (high end of unit cost range). The Total Project Annualized Cost represents the Total Annualized Capital Expenditures plus the Range of Annual O&M. The City and District Annualized Unit Cost represents their proportion of the Total Annualized Capital Costs (59% for City and 41% for District) plus the Range of Annual O&M based on their assumed maximum and average water supply. The City and District annualized unit costs do not add up to the total project annualized unit costs because the distribution of capital costs is not proportional to the distribution of water supply used to calculate annualized cost.

Figure 1 Comparison of Annualized Costs and New Potable Water Supplies



Section 1: City and District Objectives for a Supplemental Water Supply

This section provides a brief description of the overall objectives of a supplemental water project for the City of Santa Cruz (City) and Soquel Creek Water District (District), and the potential water supply alternatives considered to meet the objectives.

City Supplemental Water Supply Objectives

The City relies primarily on surface water runoff that is captured in reservoirs or withdrawn through stream diversions. The City also has several groundwater wells that seasonally supply about 5 percent of its water supply. The City water supply facilities include:

- Surface water storage in Loch Lomond Reservoir (Newell Creek Dam and diversion from San Lorenzo River in Felton).
- Surface diversion on the San Lorenzo River in Santa Cruz.
- Surface diversions from three coastal streams and a natural spring (i.e., North Coast sources).
- Groundwater from the Live Oak Wells.

The City system relies on surface runoff from local rainfall and groundwater infiltration. No water is purchased from state or federal sources or otherwise imported to the region from outside the Santa Cruz area. The strong reliance on surface water to provide nearly all of its water supply is the primary threat to the City water system. Stream flows vary for a number of reasons including seasonal variations, drought, and potential long term impacts from climate change. The City is also in negotiations with state and federal fisheries agencies to reduce use of surface water for protection of endangered species in the San Lorenzo and north coast sources.

If the City were faced with drought conditions similar to the 1977 drought, the City would not have enough water to meet current demands; drought-related curtailment has historically been estimated to be as high as 45 percent. Even with ongoing conservation efforts and up to 15 percent water-use restrictions during drought, additional water supplies are needed to meet potable water needs for public health and safety, economic stability, and provide water for protection of endangered species.

The City Integrated Water Plan (IWP, 2005) provides a flexible, phased approach for providing a reliable high-quality supply of water while ensuring protection of public health and safety. The City IWP includes the following primary components:

- **Conservation**: Permanently reduce customer demand for water and increase water use efficiency to obtain the greatest public benefit from available supplies.

- **Curtailment**: Further reduce water use by up to 15 percent through temporary water restrictions during times of drought. Significantly curtail irrigation use during drought.
- **Supplemental Supply**: Evaluate a small regional 2.5 mgd desalination plant to provide supplemental water during drought and to help protect coastal aquifers.

The evaluation of recycled water has also played an important role in adding more diversification to the agencies' water portfolios.

Therefore, as part of the City IWP, the City's supplemental water supply objective is a project that can provide up to 2.5 mgd of new potable water during dry and critically dry years.

District Supplemental Water Supply Objectives

Similar to the City, no water supply for the District is purchased from state or federal sources or imported to the region from outside the Santa Cruz area. The District obtains 100 percent of its water supply from groundwater aquifers within the Soquel-Aptos Groundwater Management area via production wells. The groundwater aquifers are located within two geologic formations that underlie the District service area, the Purisima Formation and the Aromas Red Sands aquifer. The Purisima Formation provides the majority of the District's annual water needs. These aquifers provide groundwater to the District as well as other municipal utilities (such as the City, Central Water District, and the City of Watsonville), small mutual water districts or companies, and private well owners. The primary threat to the District water supply is over-drafting of the aquifers and the subsequent potential for seawater intrusion. The basin currently is in a state of overdraft, and the cumulative impact of pumping in excess of sustainable yields will eventually lead to seawater intrusion and to potential contamination of the groundwater basin.

The District has practiced groundwater management for over 25 years and continually monitors for changes in water quality and groundwater levels. The District needs to find a supplemental water supply that will permit them to reduce pumping from the over-drafted groundwater aquifers and naturally allow the coastal groundwater levels to rise and thereby prevent seawater intrusion.

The District's 2012 IRP Update is a long-term water plan that offers a diversified strategy emphasizing water-use efficiency through demand management (e.g. conservation efforts), groundwater management, and supplemental supply development. This report serves as a roadmap through 2030 for maintaining water supply reliability for the District's customers and protecting the local environment by establishing water supply planning objectives to recover the groundwater basin and maintain protective levels.

Therefore, as part of the District IRP, the District's supplemental water supply objective is a project that can provide an average of 1.3 mgd (1,500 AFY) and up to 2.5 mgd (2,800 AFY) of new potable water every year, for at least 20 years, to recover and protect over-drafted aquifers.

Section 2: Water Supply Alternatives Considered

The water supply alternatives considered herein include the proposed Regional Seawater Desalination Project for the **scwd²** Desalination Program and other water supply alternatives that have been studied as part of or subsequent to the City and District Integrated Water Plans. This section provides a brief description of the following supplemental water projects that have been considered and evaluated for the City and District:

- Regional Desalination Project
- City-Only Desalination Project
- District-Only Desalination Project
- Regional Recycled Water for Irrigation
- Indirect Potable Reuse - Groundwater Recharge
- Direct Potable Reuse - Reservoir Augmentation in Loch Lomond Reservoir
- Direct Potable Reuse - Direct Blending into the source water for the Graham Hill WTP
- Recycled Water Exchange with North Coast Agriculture
- Winter-time Water Transfers from the City to Neighboring Agencies

This section also provides the assumptions that are used to develop the conceptual costs of the alternatives, in terms of capital expenditures, annual operations and maintenance (O&M) costs and annualized costs. An annualized capital cost is calculated based on a project life of 30 years and an interest rate of three percent. The annualized capital cost is added to the annual O&M costs to estimate the total cost per year to construct and operate the project over the life of the project.

For each alternative, the amount of potable water supply that could be provided by each alternative is described in terms of the following:

- Assumed average Annual Water Produced = the amount of water that could be produced under average operating conditions. However, some alternatives considered in this exercise are not viable due to significant regulatory or other restrictions, as noted, and do not meet the objectives. For the purpose of comparing unit costs, average and maximum water produced were assumed for alternatives that are not viable.
- Assumed Maximum Annual Water Supply = the maximum amount of water that could be produced. However, some alternatives considered in this exercise are not viable due to significant regulatory or other restrictions, as noted, and do not meet the objectives. For the purpose of comparing unit costs, average and maximum water produced were assumed for alternatives that are not viable.
- Total Viable New Water Supply to Meet Objectives = the additional supplemental potable water supply available as a result of the project. This number is zero for alternatives that are not viable.

The annualized unit cost of water is calculated as the sum of the annualized capital costs plus O&M costs, divided by the annual production of the project. A range of annualized water costs has been provided by dividing the annualized costs by the maximum water production (resulting in a lower annualized unit cost) and the average water production (resulting in a higher annualized unit cost). The annualized unit costs for the City and District are also shown for alternatives where the capital costs of the project are shared. Because the capital costs are shared, the individual unit costs are lower than the total project annualized cost; however, the sum of the individual unit costs does not equal the total project annualized cost, because of the differences and ranges of the operations costs.

The conceptual costs of the alternatives presented are based on information and costs developed in technical studies conducted by the City and District as part of their integrated water plans and the **scwd²** Desalination Program, and supplemented with cost estimates from similar projects and professional experience. Table 2 presents a summary of standard cost estimating level descriptions, accuracy and recommended contingencies based on the development level of the project. These data were compiled from the Association for the Advancement of Cost Engineering (AACE).

Table 2: Standard AACE Cost Estimating Guidelines

Cost Estimate Class[(a)]	Project Level Description	Estimate Accuracy Range	Recommended Estimate Contingency
Class 5	Planning	-30 to +50%	30 to 50%
Class 4	Conceptual (1 to 5% Design)	-15 to +30%	25 to 30%
Class 3	Preliminary (10 to 30% Design)	-10 to +20%	15 to 20%
Class 2	Detailed (40 to 70% Design)	-5 to +15%	10 to 15%
Class 1	Final (90 to 100% Design)	-5 to +10%	5 to 10%

Notes:

(a) Association for the Advancement of Cost Engineering, 1997. International Recommended Practices and Standards.

The proposed alternatives have been developed to a planning level, with conceptual design criteria, conceptual site locations and pipeline routes and a basic understanding of project alternative elements and limitations. Therefore, the costs are intended to be used for comparison purposes between alternatives, and the level of accuracy for the capital and operating cost estimates presented should be considered to represent a Class 5 estimate with an estimate accuracy contingency of -30 to +50 percent.

Regional Desalination Project

The City and District have partnered, forming the **scwd²** Task Force, to evaluate the **scwd²** Regional Desalination Project. The regional desalination project proposes a seawater desalination facility on the Westside of Santa Cruz that would provide up to 2.5 mgd (and potentially up to 2,800 AFY) of potable water as a supplemental water supply for both the City and the District. The desalination facility would typically provide water to the District every year to help reduce groundwater withdrawals of the over-drafted Soquel-Aptos aquifer to prevent seawater intrusion. The desalination facility would provide potable water to the City during drought periods and provide operational flexibility for surface water reductions required to protect endangered species.

Detailed project concepts, descriptions and preliminary level costs for the regional desalination project are provided in the "**scwd²** Regional Desalination Facility Preliminary Design Report" (CDM Smith, 2012). A brief listing of the regional desalination project elements and assumptions for this technical memorandum are provided below.

Regional Desalination Project Elements and Assumptions:

- Project provides up to 2.5 mgd (2,800 AFY) of potable drinking water.
- Potable water would be delivered to City and pumped to District via an intertie pipeline.
- Ocean intake and facility pretreatment are sized for approximately 7 mgd of source water to produce 2.5 mgd of drinking water. Facility has space to be expanded to 4.5 mgd.
- Facility would be located on the Westside of Santa Cruz.
- Intake assumed to be a screened ocean intake. Brine would be blended with existing wastewater plant ocean outfall.
- Project would not contribute to additional greenhouse gas emissions for the City or District.
- Facility would typically operate at 1.3 mgd to provide water to the District, and up to 2.5 mgd to provide water to the City in accordance with project operating agreements.

Summary of Regional Desalination Project Potable Water Production and Conceptual Costs

Because the desalination facility produces water that meets potable drinking water regulations, and the project provides up to 2,800 AFY for both the City and the District, this alternative meets the supplemental potable water supply objectives of the City and District.

The conceptual level project capital cost of approximately $115 million would be shared by the City and District. . The preliminary ownership and operations agreement between the City and the District appropriate the cost for the project as follows; the City would pay 59-percent of the project capital cost ($68 million) and the District would pay 41-percent ($47 million).

The average annual operating costs are presented based on the range of average annual water production from the facility producing 1.3 mgd (1,500 AFY). The maximum annual water production from the facility would be 2.5 mgd (2,800 AFY).

The regional desalination project would be operated according to the preliminary operations agreement between the City and the District, to provide up to 2.5 mgd (2,800 AFY) to the City, the District, or a portion to both. The total project annualized unit cost is between $3,500/AFY and $4,300/AFY. Because the City and District would share the capital cost of the facility and the operating costs would be shared the agency's depending on the water use by each agency, the individual agency annualized unit cost is lower, and in a range of $2,200 to $3,500 per AF.

Potential DPR Pilot System at the Regional Desalination Facility

With recent regulatory developments and community interest in Direct Potable Reuse (DPR), an important opportunity exists to study the feasibility of incorporating DPR into the water supply portfolios of the City and District in the future. A small DPR pilot system could be constructed at the proposed Desalination Facility and operated to provide California Department of Public Health (CDPH) with information to assist in their development of DPR regulatory criteria, and to demonstrate the ability of the treatment process to produce safe drinking water.

The DPR Pilot Study could include construction of a small scale advanced recycled water treatment pilot system, located within the footprint of the proposed **scwd**^{2} Regional Seawater Desalination Project. The pilot equipment could be run by the desalination plant operators and testing could take place over a period of several years. The construction cost of the DPR Pilot Study could add approximately $2 million (less than 2-percent) to the cost of the proposed **scwd**^{2} Regional Seawater Desalination Project. Construction and operation of a DPR pilot system as part of the proposed project would have lower capital and operating costs than a stand-alone DPR Pilot Study program.

A DPR Pilot Study as part of the proposed **scwd**^{2} Regional Seawater Desalination Project would not produce any additional potable water supply, but would provide information for the public and regulators and could be the first phase in a longer-term evaluation and potential implementation of DPR as an additional supplemental water supply for the City and District. Therefore, while this concept is worth noting, unit costs for this alternative were not calculated.

City-Only Desalination Project

The City-only desalination project would be a seawater desalination facility on the Westside of Santa Cruz that would provide up to 2.5 mgd of potable water as a supplemental water supply for the City only. The desalination facility would provide potable water to the City during drought periods and provide operational flexibility for surface water reductions required to protect endangered species.

For the City-only desalination project, the project concepts, descriptions and preliminary level costs for the project would be similar to those provided for the Regional Desalination Project. A brief listing of the City-only desalination project elements and assumptions for this technical memorandum are provided below.

City-Only Desalination Project Elements and Assumptions:

- Project provides up to 2.5 mgd of potable drinking water.
- Potable water would be delivered to City only. There would be no pumping or intertie pipeline to District.
- Ocean intake and facility pretreatment are sized for approximately 7 mgd of source water to produce 2.5 mgd of drinking water. Facility has space to be expanded to 4.5 mgd.
- Facility would be located on the Westside of Santa Cruz.
- Intake assumed to be a screened ocean intake. Brine would be blended with existing wastewater plant ocean outfall.
- Facility would typically operate 2 years out of 7 years, at up to 2.5 mgd to provide water to the City during drought periods.

Summary of City-Only Desalination Project Potable Water Production and Conceptual Costs

The City-only desalination project would be operated to provide up to 2.5 mgd to the City. Because the desalination facility produces water that meets potable drinking water regulations, the project meets the supplemental potable water supply objectives of the City. This project does not provide water to the District and does not meet the supplemental water supply objectives of the District.

The City would own and operate the desalination facility for the City's use, and therefore, the conceptual level project capital cost of approximately $108 million would be financed by the City. The capital cost of the City-only desalination project is slightly less than the regional desalination project because the District intertie pipeline would not be required.

For the purposes of developing an annual operations cost for comparison, the City average annual operating costs are based on the anticipated water allocations during a seven year period with five normal years (0 mgd produced) and two drought years (1.25 to 2.5 mgd produced). Based on this assumed operations, the City production averages out to approximately 470 AFY over the full seven year period.

The range of annualized water cost, $3,300/AFY to $5,200/AFY, is higher than for the regional desalination project because it would produce less water, on average, than the regional project and because the project would be funded by the City alone.

District-Only Desalination Project

The District-only desalination project is assumed to be a seawater desalination facility on the Westside of Santa Cruz that would provide up to 2.5 mgd (and potentially up to 2,800 AFY) of potable water as a supplemental water supply for the District only. Water would be pumped to the District through an intertie pipeline. While a location for a District only desalination facility, and intake and brine disposal pipeline alignments could potentially be developed in the District service area, significant additional studies and costs would be required, therefore it is assumed that a facility would be located on the Westside of Santa Cruz. The desalination facility would provide

potable water to the District every year to reduce groundwater pumping and help recover the aquifer and protect it from seawater intrusion.

Based on the 2012 Integrated Resources Plan Update by the District, this alternatives was placed in "reserve" for potential future consideration should the **scwd²** Desalination Project be no longer considered.

For the District-only desalination project, the project concepts, descriptions and preliminary level costs for the project would be similar to those provided in the Regional Desalination Project. A brief listing of the District-only desalination project elements and assumptions for this technical memorandum are provided below.

District-Only Desalination Project Elements and Assumptions:

- Project could provide an average of approximately 1.3 mgd (1,500 AFY) and potentially up to 2.5 mgd (2,800 AFY) of potable drinking water
- Potable water would be delivered to District only, through pumping and an intertie pipeline to District.
- Ocean intake and facility pretreatment are sized for approximately 7 mgd of source water to produce 2.5 mgd of drinking water. Facility does not have space to be expanded.
- Intake and conveyance pipelines do not have expansion capability.
- Facility would be located on the Westside of Santa Cruz.
- Intake assumed to be a screened ocean intake. Brine would be blended with existing wastewater plant ocean outfall.
- Facility would typically operate at 1.3 mgd (1,500 AFY) to provide water to the District only.

Summary of District-Only Desalination Project Potable Water Production and Conceptual Costs

The District-only desalination project could be operated to provide up to 2.5 mgd (2,800 AFY) to the District. Because the desalination facility produces water that meets potable drinking water regulations, the project meets the supplemental potable water supply objectives of the District. This project does not provide water to the City and does not meet the supplemental water supply objectives of the City.

The District would own and operate the desalination facility for the District's use, and therefore, the conceptual level project capital cost of approximately $107 million would be financed by the District. The capital cost of the District-only desalination project is slightly less than the regional desalination project; while the conveyance system would be more costly, the project would not be designed for potential future increase in capacity.

The average annual operating costs are presented based on the average annual water production from the facility of 1.3 mgd to the District.

The range of annualized water cost, $3,300/AFY to $3,700/AFY is close to that of the regional desalination project because the District-only desalination facility would produce a similar amount of water on average. Also, the District-only annualized water cost is more than the District's water cost for the regional project because the project would be funded by the District alone.

Regional Recycled Water for Irrigation

This alternative considers the regional use of recycled water for landscape irrigation to reduce the demand on the City and District potable supply systems. Secondary effluent from the City of Santa Cruz wastewater treatment plant (WWTF) could be treated with coagulation, filtration, partial desalination, and disinfection to meet California Title 22 requirements for unrestricted irrigation use. Under this scenario, the new treatment processes could be located at the WWTF. The recycled water supply could be pumped to large irrigation customers with large landscapes in the City and District service areas through a new distribution network of purple pipes and related improvements.

For the regional recycled water for irrigation project, the project concepts, descriptions and preliminary level costs for the project are summarized in this technical memorandum based on technical studies for the City IWP (Carollo 2000, 2002) and District IRP (Black & Veatch, 2005, 2009), and are comparable to recycled water for irrigation project costs for Redwood City and Monterey County. A brief listing of the regional recycled water for irrigation project elements and assumptions for this technical memorandum are provided below.

Regional Recycled Water Project Elements and Assumptions:

- Project could provide approximately 1,200 AFY of recycled water to meet large irrigation demands in City and District areas. (950 AFY to City Area; 250 AFY to District Area)
- Recycled water treatment includes coagulation, filtration, partial desalination, and disinfection to meet California Title 22 for unrestricted irrigation use.
- The advanced recycled water treatment facility could be located at the WWTF, the feasibility of which has not yet been determined.
- Source water from Santa Cruz wastewater plant effluent. Brine would be blended with existing wastewater plant ocean outfall.
- New, dedicated recycled water ("purple pipe") distribution system piping, storage tanks and pump stations are required to supply large irrigation users in City and District areas.

Summary of Regional Recycled Water for Irrigation Project Potable Water Production and Conceptual Costs

The regional recycled water for irrigation project could be operated to provide up to approximately 1,200 AFY of recycled water to large irrigation users the City and District areas. In normal years this would offset approximately 950 AFY of potable water use for the City. However, in drought years, the City IWP already assumes that irrigation use would be significantly restricted. While parks and golf courses could stay green during a drought, the City would not have additional

potable water supply as a result of the regional recycled water for irrigation project. Therefore, this does not meet the supplemental potable water supply objectives of the City.

Recycled water to the District area could provide approximately 250 AFY of recycled water for irrigation. This could reduce the District's shortfall of 1,500 AFY to approximately 1,250 AFY, an amount that would still be needed from another source to reduce groundwater pumping. Therefore, this does not meet the supplemental potable water supply objectives of the District.

For this technical memorandum, the conceptual level project capital cost of approximately $100 million is assumed to be shared by the City and District. Similar to the agreement for cost sharing of a regional desalination project, the City is assumed to pay 59-percent of the project capital cost ($59 million) and the District is assumed to pay 41-percent ($41 million).

The capital cost of the regional recycled water treatment facility is less than the regional desalination project because the overall recovery of the recycled water plant would be higher, only a part of the effluent would require reverse osmosis desalting, and the materials of construction do not need to resist the corrosivity of seawater. However, the cost of the conveyance system for the regional recycled water project would be significant. The new distribution system is estimated to require over 20 miles of dedicated recycled water main and lateral pipelines, and at least two system storage tanks and pump stations.

The average annual operating costs include treatment and pumping of 1.1 mgd of recycled water, on average, to the large irrigation customers in the City and District areas. The operating costs are lower than a desalination facility because the overall recovery of the recycled water plant would be higher, the energy for treatment would be lower, and the average annual flow would be lower.

The total project annualized water cost, $5,100/AFY, is higher than for the regional desalination project due to the relatively high project costs and the lower average annual production.

Indirect Potable Reuse – Groundwater Recharge

This alternative considers the regional use of highly treated recycled water for injection into the groundwater basin to provide a supplemental groundwater supply for the City and District potable supply systems. This concept, known as Indirect Potable Reuse (IPR), was reviewed for its feasibility for both the City and the District to help replenish the over-drafted Soquel-Aptos area groundwater basins (Kennedy/Jenks 2010, 2013). Overall, a groundwater recharge project would face significant challenges due to the lack of available blending water, the complex basin geology, avoiding the high number of private and municipal wells, and regulatory restrictions and uncertainties. Therefore, this alternative was considered not viable to meet the supplemental potable water supply objectives of the City and District. However, for purposes of providing a comparative cost estimate in this technical memorandum, the IPR-groundwater project is assumed to be able to produce up to 1,000 AFY.

While the final regulations for IPR-groundwater recharge are not complete, the California Department of Public Health (CDPH) is working with agencies on a case-by-case basis to evaluate IPR projects. Secondary effluent from the City of Santa Cruz wastewater treatment plant could be treated with an advanced water treatment process including coagulation, filtration, full desalination, advanced oxidation and ultraviolet light, and disinfection. The advance recycled water treatment facility would be a similar size to the regional desalination facility and would be located on the Westside of Santa Cruz to be near the wastewater plant effluent supply. The recycled water supply would be pumped to a series of injection wells in the District service area through a new distribution network of purple pipes and related improvements. Injection, monitoring and extraction wells would be built to operate the system and recover the injected recycled water.

For the IPR-groundwater recharge alternative, the project concepts, descriptions and preliminary level costs for the project are summarized in this technical memorandum based on technical studies for the City IWP (Carollo 2000 and 2002) and District IRP (Black & Veatch, 2005, 2009), and white papers (Kennedy/Jenks 2010, 2013). Preliminary cost estimates are comparable to IPR-groundwater recharge project costs for Santa Clara Valley Water District and Orange County Water District. A brief listing of the IPR-groundwater recharge project elements and assumptions for this technical memorandum are provided below.

IPR-Groundwater Recharge Project Elements and Assumptions:

- Advanced recycled water treatment includes coagulation, microfiltration, full desalination, advanced oxidation and ultraviolet light, and disinfection to meet expected CDPH requirements for IPR.
- The advanced recycled water treatment facility would be located on the Westside of Santa Cruz.
- Source water from Santa Cruz wastewater plant effluent. Brine would be blended with existing wastewater plant ocean outfall.
- New, dedicated recycled water ("purple pipe") distribution system piping, storage tanks and pump stations are required to deliver recycled water to District areas.
- A network of injection, monitoring and extraction wells would be required.
- For every 1mgd of recycled water injecting into the groundwater basin, the IPR project could require up to 1 mgd of blending water. The injection wells and underground geology would then need to be able to handle a total injection of 2 mgd of water.

Summary of IPR-Groundwater Recharge Project Potable Water Production and Conceptual Costs

A groundwater recharge project for the District would face significant challenges due to the lack of available blending water, the complex basin geology, avoiding the high number of private and municipal wells, and regulatory restrictions and uncertainties. Therefore, IPR-groundwater recharge is considered not viable and would not meet the District's supplemental potable water supply objective.

Because the City's groundwater extraction area is relatively small and constrained, and for the reasons stated above, it is assumed that injection and additional extraction water will not be viable for the City. Therefore, this alternative does not meet the supplemental potable water supply objectives of the City.

For this technical memorandum, the conceptual level project capital cost of approximately $144 million is assumed to be financed by the District since that is where the benefit would be realized. The capital cost of the IPR advanced recycled water treatment plant ($37M) is less than the treatment plant for the regional desalination project ($69M) because the overall recovery of the recycled water plant would be higher, the materials of construction do not need to resist the corrosivity of seawater, and the design capacity would be lower. However, the cost of the conveyance system and well system for the IPR-groundwater recharge project would be significant. The new distribution system is estimated to require approximately 20 miles of dedicated recycled water main and lateral pipelines, at least two system storage tanks and pump stations, and a network of injection, monitoring and additional extraction wells.

The average annual operating cost includes treatment and pumping of the recycled water up to the injection wells in the District area for the assumed average annual flow, which is assumed to be the same as the maximum potential flow. The operating costs are lower than a desalination facility because the overall recovery of the advanced recycled water plant would be higher, and the energy for treatment would be lower.

The annualized water cost, $9,400/AFY, is higher than for the regional desalination project because of the relatively high costs for new conveyance pipelines plus injection, monitoring and extraction wells, and the lower amount of assumed water supply.

Direct Potable Reuse - Reservoir Augmentation in Loch Lomond

This alternative considers the use of highly treated recycled water for introduction and blending in the City's Loch Lomond Reservoir to provide a supplemental water supply for the City and District potable supply systems. This concept could fall under either Indirect Potable Reuse (IPR) or Direct Potable Reuse (DPR) depending upon the percent of recycled water added to the reservoir compared with the existing source water, and the residence time in the reservoir. Although reservoir augmentation could be an IPR type project, the City's Loch Lomond Reservoir is too small to meet the anticipated CDPH requirements for an IPR-reservoir augmentation project (Kennedy/Jenks, 2013). Therefore, this alternative considers a DPR-reservoir augmentation project with Loch Lomond Reservoir.

DPR is currently not permitted in California and CDPH has not developed any conditional regulations for DPR projects. As a result, a DPR project is considered to be not viable in the timeframe of the Project, given that DPR projects are not permitted, the CDPH has not evaluated or conditionally approved any DPR projects, conditional approval, demonstration testing and implementation would likely take a decade or more, and DPR faces significant public perception

challenges. Therefore, this alternative was considered not viable to meet the supplemental potable water supply objectives of the City and District. However, for purposes of providing a comparative cost estimate in this technical memorandum, the DPR-Reservoir Augmentation in Loch Lomond project is assumed to be able to produce up to 2,800 AFY.

Secondary effluent from the City of Santa Cruz wastewater treatment plant would be treated with an advanced water treatment process including coagulation, filtration, full desalination, advanced oxidation and ultraviolet light, and disinfection. For DPR projects, an engineered buffer (such as a monitored storage tank), would likely be required by CDPH to allow for wastewater treatment process variability, reliability and other unknowns, providing additional time to allow time for corrective action in the event that the product water does not meet all regulatory requirements prior to introduction into the potable supply (WateReuse 2011). The advance recycled water treatment facility would be a similar size to the regional desalination facility and would be located on the Westside of Santa Cruz to be near the wastewater plant effluent supply. The recycled water supply would be pumped via a new pipeline to Loch Lomond Reservoir for blending and storage.

Blended recycled water and reservoir water would be transported down to the City's Graham Hill Water Treatment Plant (GHWTP) via the existing Newell Creek pipeline. The blended water would be treated through the existing GHWTP and enter the City's potable water distribution system. Water would be pumped to the District via a new intertie pipeline.

For the DPR-reservoir augmentation project, the project concepts, descriptions and preliminary level costs for the project are summarized in this technical memorandum based on white papers developed by Kennedy/Jenks (2010, 2013). A brief listing of the DPR-reservoir augmentation project elements and assumptions for this technical memorandum are provided below.

DPR-Reservoir Augmentation Project Elements and Assumptions:

- Advanced recycled water treatment includes coagulation, microfiltration, full desalination, advanced oxidation and ultraviolet light, disinfection and a monitored storage buffer, to meet potential CDPH requirements for DPR.
- The advanced recycled water treatment facility would be located on the Westside of Santa Cruz.
- Source water would be from Santa Cruz wastewater plant effluent. Brine would be blended with existing wastewater plant ocean outfall.
- New, dedicated recycled water ("purple pipe") pipeline and pump station to deliver the water up to Loch Lomond.
- Blended recycled water and reservoir water would be treated at GHWTP.
- Potable water would be delivered to City and pumped to District via an intertie pipeline.
- Project assumed to provide up to 2.5 mgd (2,800 AFY) of potable drinking water.

Summary of DPR-Reservoir Augmentation Project Potable Water Production and Conceptual Costs

For purposes of providing a comparative cost estimate in this technical memorandum, the DPR-Reservoir Augmentation in Loch Lomond project is assumed to be able to produce up to 2,800 AFY. However, a DPR project is considered to be not viable in the timeframe of the Project, given that DPR projects are not permitted, the CDPH has not evaluated or conditionally approved any DPR projects, conditional approval, demonstration testing and implementation would likely take a decade or more, and DPR faces significant public perception challenges. Therefore, this alternative was considered not viable to meet the supplemental potable water supply objectives of the City and District.

For this technical memorandum, the conceptual level project capital cost of approximately $131 million is assumed to be shared by the City and District. Similar to the agreement for cost sharing of a regional desalination project, the City is assumed to pay 59-percent of the project capital cost ($77 million) and the District is assumed to pay 41-percent ($54 million).

The capital cost of the DPR advanced recycled water treatment plant ($50M) is less than the treatment plant for the regional desalination project ($69M) because the overall recovery of the advanced recycled water plant would be higher and the materials of construction do not need to resist the corrosivity of seawater. However, the cost of the new approximately 16 mile pipeline up to Loch Lomond would be significant.

The average annual operating costs include treatment and pumping of the recycled water up to Loch Lomond. The operating costs are lower than a desalination facility because the overall recovery of the advanced recycled water plant would be higher, and the energy for treatment would be lower. Operating costs include additional energy requirements to pump the recycled water up to Loch Lomond Reservoir.

The range of total project annualized water cost, $3,100/AFY to $3,400/AFY, is lower than for the regional desalination project due to the lower operating and energy costs.

Direct Potable Reuse – Blending Before the GHWTP

This alternative considers the use of highly treated recycled water for introduction and blending in source water to the City's GHWTP to provide a supplemental water supply for the City and District potable supply systems. This concept, known as DPR was reviewed for its viability for both the City and the District (Kennedy/Jenks, 2013). DPR is currently not permitted in California and CDPH has not developed any conditional regulations for DPR projects. As a result, a DPR project is considered to be not viable in the timeframe of the Project, given that DPR projects are not permitted, the CDPH has not evaluated or conditionally approved any DPR projects, conditional approval, demonstration testing and implementation would likely take a decade or more, and DPR faces significant public perception challenges. Therefore, this alternative was considered not viable to meet the

supplemental potable water supply objectives of the City and District. However, for purposes of providing a comparative cost estimate in this technical memorandum, the DPR-Blending before the GHWTP project is assumed to be able to produce up to 2,800 AFY.

Secondary effluent from the City of Santa Cruz wastewater treatment plant would be treated with an advanced water treatment process including coagulation, filtration, full desalination, advanced oxidation and ultraviolet light, and disinfection. For DPR projects, an additional engineered buffer would likely be required by CDPH to allow for wastewater treatment process variability, reliability and other unknowns. An additional engineered buffer may be a highly monitored water storage facility that would allow time for corrective action in the event that the product water does not meet all regulatory requirements prior to introduction into the potable supply (WateReuse 2011). The advanced recycled water treatment facility would be a similar size to the regional desalination facility and would be located on the Westside of Santa Cruz to be near the wastewater plant effluent supply. The recycled water supply could be pumped via a new pipeline to an existing raw water pipeline upstream of the inlet to the GHWTP for blending with the other surface water sources. The blended water would be treated through the existing GHWTP and enter the City's potable water distribution system. Water would be pumped to the District via a new intertie pipeline.

For the DPR-Blending before the GHWTP project, the project concepts, descriptions and preliminary level costs for the project are summarized in this technical memorandum based on white papers by Kennedy/Jenks (2013). A brief listing of the DPR-Blending before the GHWTP project elements and assumptions for this technical memorandum are provided below.

DPR-Blending Before the GHWTP Project Elements and Assumptions:

- Advanced recycled water treatment includes coagulation, microfiltration, full desalination, advanced oxidation and ultraviolet light, disinfection and monitored storage, to meet potential CDPH requirements for DPR.
- The advanced recycled water treatment facility and monitored storage would be located on the Westside of Santa Cruz.
- Source water from Santa Cruz wastewater plant effluent. Brine would be blended with existing wastewater plant ocean outfall.
- New, dedicated recycled water ("purple pipe") pipeline and pump station to deliver the water up to a raw water pipeline upstream of the inlet of the GHWTP.
- Blended recycled water and surface water would be treated at GHWTP.
- Potable water would be delivered to City and pumped to District via an intertie pipeline.
- For the purposes of providing comparative cost estimates, Project assumed to provide up to 2.5 mgd (2,800 AFY) of potable drinking water.

Summary of DPR-Blending Before the GHWTP Project Potable Water Production and Conceptual Costs

For purposes of providing a comparative cost estimate in this technical memorandum, the DPR-Blending before the GHWTP project is assumed to be able to produce up to 2,800 AFY. However, a

DPR project is considered to be not viable in the timeframe of the Project, given that DPR projects are not permitted, the CDPH has not evaluated or conditionally approved any DPR projects, conditional approval, demonstration testing and implementation would likely take a decade or more, and DPR faces significant public perception challenges. Therefore, this alternative was considered not viable to meet the supplemental water supply objectives of the City and District.

For this technical memorandum, the conceptual level project capital cost of approximately $119 million is assumed to be shared by the City and District. Similar to the agreement for cost sharing of a regional desalination project, the City is assumed to pay 59-percent of the project capital cost ($70 million) and the District is assumed to pay 41-percent ($49 million).

The capital cost of the DPR advanced recycled water treatment facility ($50 million) is less than the regional desalination treatment facility ($69 million) because the overall recovery of the advanced recycled water plant would be higher and the materials of construction do not need to resist the corrosivity of seawater. The project cost is less than DPR using reservoir augmentation because conveyance and discharge into Loch Lomond Reservoir would not be required. However, the cost of this DPR alternative still requires up to 14 miles of new pipeline and pumping facilities to convey the advanced treated recycled water to the inlet to the GHWTP.

The average annual operating costs include treatment and pumping of the recycled water into the raw water before the GHWTP. The operating costs are lower than a desalination facility because the overall recovery of the advanced recycled water plant would be higher, and the energy for treatment would be lower. Operating costs include additional energy requirements to pump the recycled water up to GHWTP.

The range of annualized water cost, $2,900/AFY to $3,200/AFY, is lower than for the regional desalination project due to the lower operating and energy costs.

Recycled Water Exchange with North Coast Agriculture

This alternative proposes using recycled water for agricultural irrigation through an exchange in which the City would provide recycled water to North Coast growers in all years, and in return, the City would obtain access to the grower's coastal groundwater basin to use as a reserve supply in drought years. Several major issues emerged with this recycled water concept, including: (1) uncertainty about the amount of groundwater available in a multi-year drought; (2) unwillingness of State Parks (the major landowner) to permit groundwater pumping for the water exchange;

and (3) opposition by local organic growers (Gary Fiske & Associates, 2003). Therefore, this alternative is not viable to meet the objectives of the City and District. However, for purposes of providing a comparative cost estimate in this technical memorandum, the recycled water exchange project is assumed to be able to produce up to 1,200 AFY.

For the recycled water exchange with North Coast agriculture project, the project concepts, descriptions and preliminary level costs for the project are summarized in this technical memorandum based on technical studies for the City IWP (Carollo 2000), (Gary Fiske & Associates, 2003). A brief listing of the regional recycled water for irrigation project elements and assumptions for this technical memorandum are provided below.

Recycled Water Exchange with North Coast Agriculture Project Elements and Assumptions:

- Project would provide recycled water to meet agricultural irrigation demands for north coast agricultural areas. In return, approximately 400 million gallons per year (1,200 AFY) of groundwater could be provided to City during droughts.
- Recycled water treatment includes coagulation, filtration, partial desalination, and disinfection to meet California Title 22 for unrestricted irrigation use.
- Recycled Water Treatment facility could be located at the Santa Cruz WWTF.
- Source water from Santa Cruz wastewater plant effluent. Brine would be blended with existing wastewater plant ocean outfall.
- New, approximately 5 mile dedicated recycled water ("purple pipe") distribution system piping, storage tanks and pump stations would be required to supply large irrigation users on North Coast.
- New groundwater wells, groundwater treatment and pump stations, and water transfer piping to deliver the potable water to the City system.
- Groundwater would be delivered to the City and pumped to the District through an intertie pipeline. The District may need to obtain water rights to receive this water.

Summary of Recycled Water Exchange Project Potable Water Production and Conceptual Costs

For the purposes of this technical memorandum, the exchange of recycled water for agriculture groundwater is assumed to provide up to approximately 1,200 AFY of water per year. However, because the State Parks, the major landowner in the North Coast area groundwater basin, is unwilling to consider the groundwater exchange project, and local growers are unwilling to use recycled water, this alternative project is not viable and would not provide potable water to meet the supplemental potable water supply objectives of the City and District.

For this technical memorandum, the conceptual level project capital cost of approximately $98 million is assumed to be shared by the City and District. Similar to the agreement for cost sharing of a regional desalination project, the City is assumed to pay 59-percent of the project capital cost ($58 million) and the District is assumed to pay 41-percent ($40 million).

The capital cost of the recycled water treatment facility ($30 million) is less than the regional desalination treatment facility ($69 million) because the overall recovery of the recycled water plant would be higher, only a part of the effluent would require reverse osmosis desalting and the

materials of construction do not need to resist the corrosivity of seawater. However, the cost of the recycled water conveyance system and the groundwater facilities would be significant.

The average annual operating costs include treatment and pumping of the recycled water up to the large irrigation customers on the North Coast, and treatment and pumping of groundwater back to the City and District. The operating costs are lower than a desalination facility because the overall recovery of the recycled water plant would be higher, and the energy for treatment would be lower.

The annualized water cost, $5,500/AFY, is higher than for the regional desalination project because this alternative has a relatively high capital cost and would produce less water.

Winter-Time Surface Water Transfers from the City to Neighboring Agencies

This alternative proposes treating excess surface water in the San Lorenzo River through the City's GHWTP in the winter, and sending the water to neighboring water agencies to offset groundwater pumping. The GHWTP would need to be upgraded to handle the additional winter-time water capacity and more challenging winter-time water quality. The "excess" surface water available to be treated depends on the amount of winter-time rain and runoff, the demands of City customers, and the requirements to leave water in the river for the protection of endangered species. The ability to send the excess water to neighboring water agencies depends on whether the neighboring agencies are located within the watershed boundaries, and if they have water rights to the surface water in the San Lorenzo River watershed. The neighboring water agencies considered in the water transfers alternative include Scotts Valley Water District, San Lorenzo Valley Water District, and the Soquel Creek Water District.

For the winter-time surface water transfer project, the project concepts, descriptions and preliminary level costs for the project are summarized in this technical memorandum based on technical studies for the City IWP (Carollo, 2000) and the County of Santa Cruz (Ricker, 2011). A brief listing of the water transfer project elements and assumptions for this technical memorandum are provided below.

Winter-Time Surface Water Transfers Project Elements and Assumptions:

- Project could treat excess winter-time water of approximately 740 AFY for transfer.
- Approximately 400 AFY could go to Scotts Valley and San Lorenzo Valley Water Agencies (collectively referred to as Scotts Valley) which are within the watershed boundaries of the San Lorenzo River.
- The Soquel Creek Water District, which is outside the watershed boundaries, would need to obtain water rights for the San Lorenzo River and then approximately 340 AFY could go to the District.
- Improvements to the GHWTP pretreatment, washwater and solids handling could be required to treat the larger volumes and more challenging water quality conditions for winter-time surface water transfers.

- Potable water would flow into the City distribution system and be pumped to neighboring agencies.
- New intertie pipelines and pump stations would be provided to Scotts Valley agencies.
- New intertie pipelines and pump stations would be provided to District.
- Because of the over-draft condition of the neighboring water agency's groundwater basins, the City is not expected to receive water back from the agencies (Ricker, 2011).

Summary of Winter-Time Surface Water Transfer Project Potable Water Production and Conceptual Costs

For the purposes of this technical memorandum, the transfer of winter-time water from the City to the District groundwater is assumed to provide up to approximately 340 AF of water per year for the District. This could reduce the District's shortfall of 1,500 AFY to approximately 1,160 AFY, an amount that would still be needed from another source to reduce groundwater pumping. However, the Soquel Creek Water District does not have current water rights on the San Lorenzo River, and the City's water rights do not permit sending San Lorenzo surface water to the District on a full-time basis. The current time-frame to obtain new water rights in California is approximately 20 years, although inquiries are being made as to whether or not there may be some mechanism to more rapidly allow conjunctive use water transfers on an interim basis. This alternative project does not provide water to meet the supplemental water supply objectives of the District, in the timeframe of the proposed project.

Based on the County studies of the water transfer concept (Ricker, 2011), the major benefit is to the neighboring water agencies. Because the groundwater basins for the Scotts Valley, San Lorenzo Valley Water District, and Soquel Creek Water District are currently over-drafted, and those agencies are challenged to meet their current demands, the City is not expected to be able to receive exchange water back from these agencies in drought. Therefore, this alternative project does not provide water to meet the supplemental water supply objectives of the City.

For this technical memorandum, the conceptual level project capital cost of approximately $48 million is assumed to be shared by Scotts Valley and the District.

The capital cost of the improvements to the GHWTP and intertie pipelines is less than the regional desalination project, as is the operations costs for this alternative. However, the total project annualized unit water cost of $4,200 is high due to the relatively small amount of water supply. The annualized unit water cost for the District is even higher due to the smaller amount of water that could be delivered to the District.

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