Appendices Only

City of Santa Cruz

Final
Santa Cruz Regional Recycled Water Facilities Planning Study

June 2018

Kennedy/Jenks Consultants

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FINAL
City of Santa Cruz Regional Recycled Water Facilities Planning Study

6 June 2018

Prepared for

City of Santa Cruz
212 Locust Street, Suite C
Santa Cruz, CA 95060

K/J Project No. 1668007.00

Note to Reader:

The Draft RWFPS was submitted to the SWRCB in September 2017, representing the City of Santa Cruz's decisions based on the understanding of regional projects, regulatory requirements and water supply conditions at that time. There have been and continue to be developments that influence the City's pursuit of recycled water, such as the Soquel Creek Water District finalizing aspects of their recycled water program and other regulatory milestones related to indirect and direct potable reuse. The City recognizes that some of the information in this document is no longer current, and that as regional projects and regulations evolve, future opportunities for reuse may also evolve. The City is committed to tracking the state of regulations and regional reuse programs in the future.

Acknowledgments

Funding for this plan has been provided in full or in part through an agreement with the State Water Resources Control Board. The contents of this document do not necessarily reflect the views and policies of the State Water Resources Control Board, nor does mention of trade names or commercial products constitute endorsement or recommendation for use.

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List of Appendices

<u>TMs developed to support RWFPS include:</u>

TM #1a Evaluation of Treatment Requirements for Recycled Water in California (Trussell, 2017)
TM #1b Evaluation of Treatment Facilities (Trussell, 2017)
(TM #1a and #1b are included in Appendix A)
TM #2a Beltz Wellfield Area Injection Well Capacity and Siting Study
TM #2b Santa Margarita Basin Injection Well Capacity and Siting Study
(TM #2a and #2b are included in Appendix C)
TM #3 Surface Water Augmentation (Included in Appendix D)
TM #4 Streamflow Augmentation (Included in Appendix E)

** Meeting agendas and presentations from the kick-off, workshops and webinars are available through the City.

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Appendix A: Regulatory Requirements and Treatment

This appendix includes a summary of recycled water regulations and treatment for reuse and includes the following:

A.1 TM #1a Evaluation of Treatment Requirements for Recycled Water in California (Trussell, 2017)

A.2 Recycled Water Uses Allowed in California (EBMUD, 2013)[15]

A.3 TM #1b Evaluation of Treatment Facilities (Trussell, 2017)

A.4 PTG X-500 Pasteurization System – Proposal for Santa Cruz's WWTP

15 https://www.ebmud.com/files/7614/3173/1139/recycled-water-uses-allowed-in-california-2013_0.pdf

Appendix A.1

TM #1A EVALUATION OF TREATMENT REQUIREMENTS

Date: September 12, 2017 *(revised draft)*
November 18, 2016 (*revised draft*)
October 20, 2016 (*initial draft*)

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Subject: Evaluation of Treatment Requirements for Recycled Water in California

1 - INTRODUCTION

California faces a number of important water resource challenges, including a historic drought. The State is no stranger to such challenges, however, and through its history has promoted several innovations to enhance water supply, treatment, and conservation. Over the course of the last five decades, California has been a leader in the field of water reuse, opening doors to new sources of water as traditional sources grow increasingly scarce. The history and experience gained since the first water reuse projects in California have informed utilities, regulators, and engineers on how best to protect public health while providing local, reliable sources of non-potable and potable water.

This technical memorandum (TM) provides information for the Santa Cruz Regional Recycled Water Facilities Planning Study (RWFPS) on (a) the different types of water reuse in practice or under development, (b) the history and current status of regulatory development, (c) the treatment processes used to satisfy the regulatory requirements, and (d) the challenges and opportunities associated with pursuing the different types of water reuse.

2 - TYPES OF WATER REUSE

California currently allows multiple forms of water reuse both for non-potable and potable applications. This section provides an overview of the spectrum of uses, encompassing both existing projects and regulations as well as proposed and future types.

2.1 Non-Potable Reuse

The forms of non-potable reuse that are permitted in California vary based on (1) the degree of treatment required and (2) the intended use of the recycled water (CDPH 2014b). As a general rule, when more treatment is provided, the final use of the water is less restricted. The following sections briefly describe the types of non-potable reuse and their potential uses. The discussion progresses from the lowest level of treatment (with the highest restrictions) to the highest level of treatment (with the lowest restrictions), per the regulatory classifications (CDPH 2014b):

- Undisinfected secondary recycled water
- Disinfected secondary – 23 recycled water
- Disinfected secondary – 2.2 recycled water
- Disinfected tertiary recycled water

2.1.1 Undisinfected Secondary Recycled Water

The first type of water suitable for non-potable reuse is undisinfected secondary recycled water. The regulations set minimum treatment requirements, namely, that the recycled water be oxidized, which is defined as water with stabilized organic matter that contains dissolved oxygen and is nonputrescible (CDPH 2014b). This is typically satisfied through a secondary treatment providing aerobic, biological treatment. Disinfection is not required for this type of water.

The lack of filtration and disinfection elevates the risks associated with this type of water. The uses for this type of recycled water are limited to applications where the general public cannot come into contact with the water, either through on-site exposure or through edible products. Examples of appropriate uses include: (a) irrigation of crops and pastures intended for animals that do not produce milk for human consumption, (b) orchards and vineyards provided the water does not touch the consumable portions, and (c) non-food-bearing trees (CDPH 2014b).

2.1.2 Disinfected Secondary–23 Recycled Water

"Disinfected secondary–23 Recycled Water" receives its name from the degree of disinfection provided, as measured by the concentration of total coliform bacteria remaining after disinfection. Water meeting these criteria may not exceed a median most probable number (MPN) of 23 total coliform bacteria per 100 milliliters (mL) of water based on results from the previous 7 days. The total coliform bacteria may also not exceed 240 MPN per 100 mL in more than one sample from any 30-day period. As with undisinfected recycled water, this classification of water also requires oxidation (i.e., secondary treatment) prior to disinfection (CDPH 2014b). The reduction of total coliform bacteria through disinfection allows this type of recycled water to be used in slightly less restrictive applications. The goal of the regulations is still to maintain separation of the water and the general public; however, some additional uses are permitted such as irrigation of (a) cemeteries, (b) restricted access golf courses, (c) and pastures intended for animals that produce milk for human consumption (CDPH 2014b).

2.1.3 Disinfected Secondary – 2.2 Recycled Water

Disinfected secondary – 2.2 Recycled Water requires a higher degree of disinfection compared to the '23' classification. The median total coliform concentration from the previous 7 days of sampling must be less than or equal to an MPN of 2.2 per 100 mL, and no more than one sample may exceed an MPN of 23 per 100 mL in a 30-day period (CDPH 2014b). This classification of non-potable recycled water permits additional uses with more human contact. Most notably, this includes irrigation of food crops as long as the consumable part does not contact the water.

2.1.4 Disinfected Tertiary Recycled Water

The unrestricted application of recycled water requires oxidation, coagulation, filtration and disinfection. This classification, called Disinfected Tertiary Recycled Water, requires compliance with specific monitoring for both filtration and disinfection. The filtration step must meet the following specifications:

- The filtration rate shall not exceed 5 gpm/ft^2 or shall not exceed 2 gpm/ft^2 if using a traveling bridge automatic backwash filter.
- The filter effluent turbidity shall not exceed an average of 2 NTU in a 24-hour period, 5 NTU more than 5% of the time within a 24-hour period, and 10 NTU at any time.

If using membrane technology (including microfiltration, ultrafiltration, nanofiltration, or reverse osmosis), the effluent turbidity must comply with more stringent requirements. The following turbidity requirements may not be exceeded:

- 0.2 NTU more than 5% of the time within a 24-hour period, and
- 0.5 NTU at any time.

Coagulant addition is required unless (1) the filter effluent turbidity remains less than 2 NTU, (2) the influent turbidity is continuously measured, (3) the influent turbidity does not exceed 5 NTU for more than 15 minutes and never exceeds 10 NTU, and (4) the ability to add coagulant is available if needed, or the recycled water can be diverted during periods when it does not comply with conditions (1) – (3).

The stricter disinfection requirements associated with Disinfected Tertiary Recycled Waters are meant to provide protection not only against bacterial pathogens, but also viruses. The regulations require a chlorine “CT” dose (i.e., the product of the chlorine concentration “C” and residence time “T”) to be no less than 450 mg-min/L at all times. The system must also demonstrate that the modal contact time of the disinfection basin is at least 90 minutes during peak dry weather design flow (CDPH 2014b). Other types of disinfection technology may be used, including ultraviolet irradiation, if they can be demonstrated to provide equivalent levels of virus control. The final disinfected effluent must also maintain the following total coliform levels: (1) median value less than 2.2 MPN per 100 mL, (2) no more than one sample above 23 MPN per 100 mL over a 30-day period, and (3) lower than 240 MPN per 100 mL at all times.

Disinfected tertiary recycled water can be used without restrictions, including for the irrigation of food crops regardless of whether it contacts the consumable portion. It can also be used to irrigate parks, playgrounds, and school yards (CDPH 2014b).

A summary of the non-potable reuse options is shown in Figure 2.1.

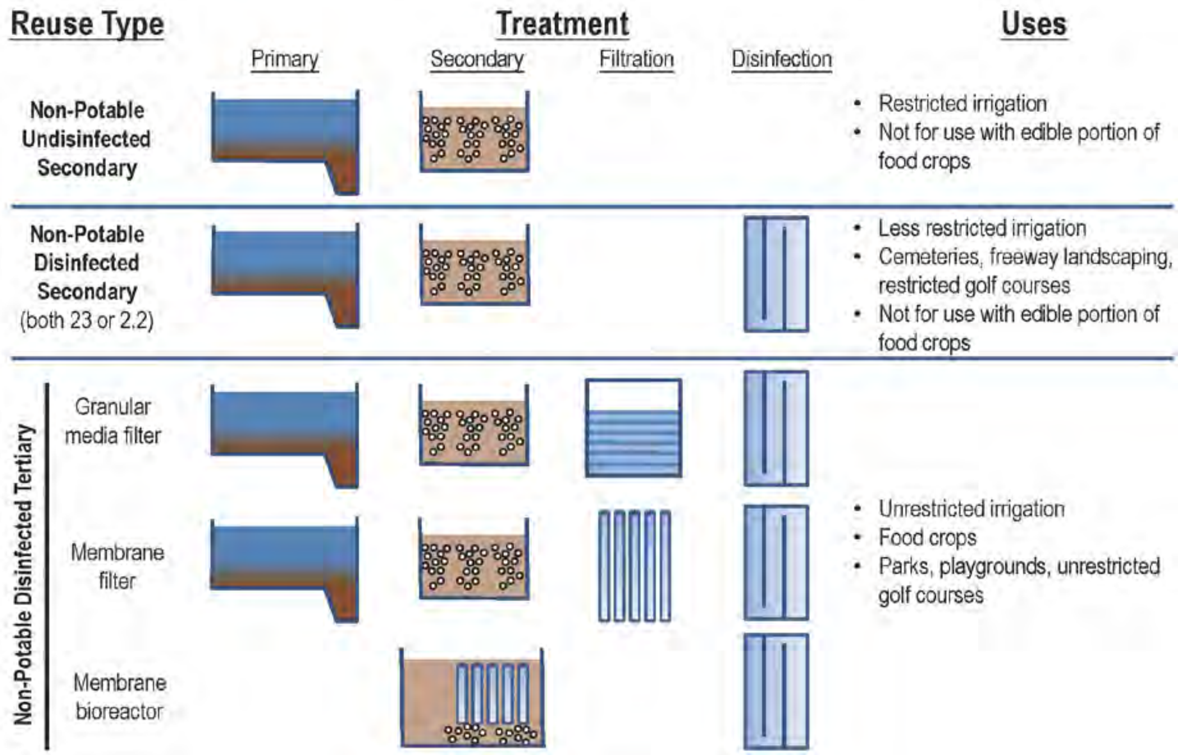

Figure 2.1 – Non-potable reuse options and associated treatments

2.2 Potable Reuse

The range of options for potable reuse is shown in Figure 2.2. One way to differentiate the various forms is based on the degree of separation—both in time and space—between the treatment of water and its ultimate consumption by the public. Viewed through this lens, the different forms of potable reuse lie along a spectrum of varying degrees of "directness." In general, as the form of potable reuse becomes more direct, additional treatment is added to maintain the reliability and robustness that is lost when the degree of separation becomes smaller. This concept is depicted in Figure 2.2; the level of treatment starts with tertiary treatment for groundwater recharge via surface spreading, and moves to Full Advanced Treatment (FAT) for groundwater recharge via injection, where FAT is the treatment of the entire flow of water through both reverse osmosis (RO) and an advanced oxidation process (AOP). The degree of treatment increases progressively to FAT +++ when the water is delivered directly to consumers. The additional forms of treatment will be discussed further in this TM.

Groundwater recharge, also referred to as Groundwater Replenishment Reuse (GRR) currently represents the most indirect form of potable reuse. By requiring the passage and retention of reuse effluents in an aquifer, GRR provides the highest degree of spatial and temporal separation between treatment and consumption. The presence of an environmental buffer characterizes this form of treatment as *indirect* potable reuse (IPR). The other form of IPR is Surface Water Augmentation (SWA), which utilizes an alternative environmental buffer—a reservoir. Projects that meet the regulatory requirements for aquifers and reservoirs both fall under the IPR umbrella.

Direct potable reuse (DPR) projects are defined by the absence of a significant environmental buffer. The most direct form of DPR—Treated Water Augmentation—introduces advanced treated effluents directly into the distribution system. These projects do not benefit from passage through an environmental buffer or a downstream drinking water treatment plant. DPR projects also have significantly reduced time to detect and respond to failures or compromises in treatment prior to distribution. As this response time decreases and projects become more direct, different strategies are needed to ensure public health protection.

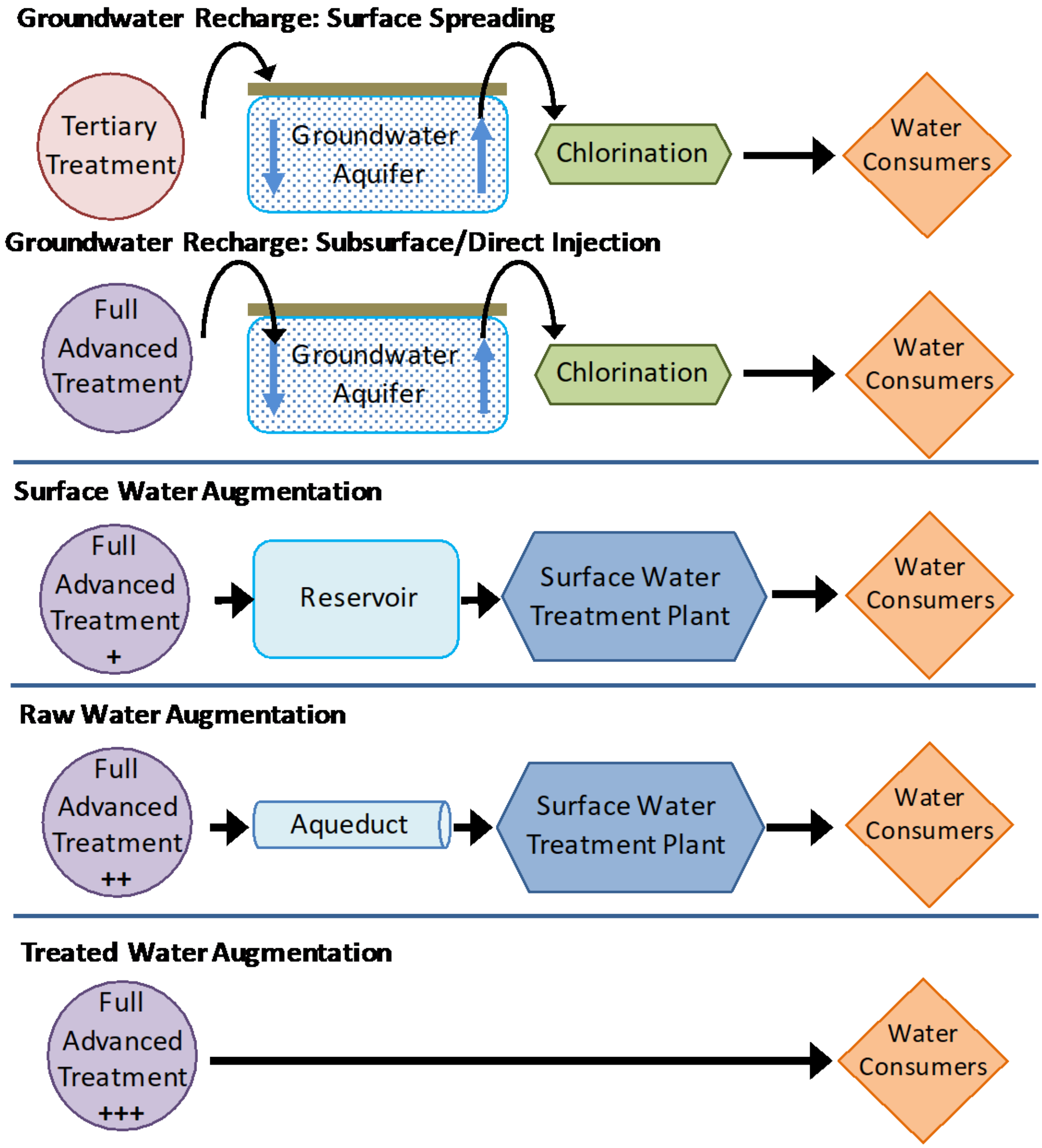

Figure 2.2 - Types of Potable Reuse

The following sections describe the features of each type of potable reuse, and how they can be developed to provide equal protection of public health.

2.2.1 *Groundwater Replenishment Reuse (GRR)*

GRR requires the use of a drinking water aquifer between the advanced treatment of wastewater and consumption by the public. GRR is further categorized into two sub-types: surface spreading and subsurface injection (Figure 2.3). For surface spreading, GRR regulations require that secondary effluents receive a minimum of tertiary filtration and disinfection before application of the recharge water to a spreading area (CDPH 2014a). As the water percolates through the soil to the groundwater aquifer, further control and attenuation of contaminants is provided through soil aquifer treatment (SAT).

Subsurface (or direct) injection projects introduce water directly into the aquifer through injection, and thereby bypass the potential for further treatment through SAT. Accordingly, higher degrees of treatment are required at the advanced water treatment facility (AWTF) to ensure that equivalent qualities of water are extracted and distributed. To provide the same degree of treatment as surface spreading, full advanced treatment of secondary effluent prior to injection is required (see Section 3.2.1.2).

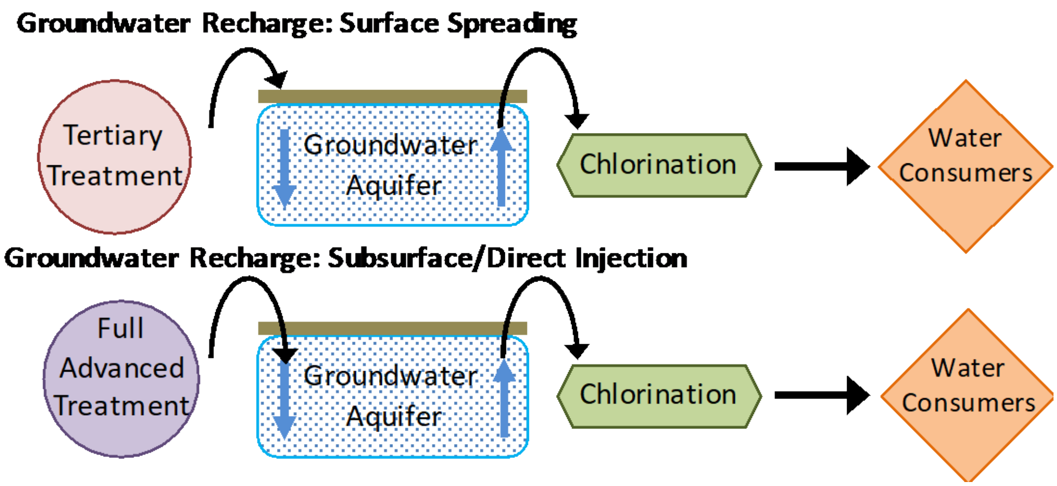

Figure 2.3 - GRR options: surface spreading and subsurface injection

2.2.2 *Surface Water Augmentation (SWA)*

SWA is a type of IPR that involves the introduction of advanced treated effluent into a surface water reservoir, which serves as an environmental buffer. After passage through the reservoir, additional treatment is required at a downstream surface water treatment plant (Figure 2.4). The use of the reservoir provides benefits for public health protection, including (1) mixing and dilution of contaminants, as well as (2) time to detect and respond to treatment excursions or failures. Uniform regulations for SWA are currently being developed by the State Water Resources Control Board's Division of Drinking Water (DDW). Draft SWA regulations were released for public comment on July 21, 2017. After the public comment period ends in September, 2017, further modifications may be made prior to adoption. It is anticipated that the SWA regulations will be adopted by the end of 2017. Because the regulations are not yet finalized, there remains some uncertainty about what will be required for such projects, but a number of requirements—including treatment, reservoir size, mixing, and dilution—are included in the draft regulations and are anticipated in the final regulation as well (see Section 3.2.2).

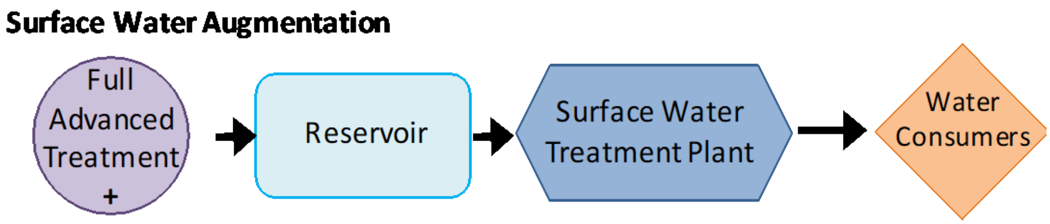

Figure 2.4 – Surface water augmentation

2.2.3 Direct Potable Reuse

DPR provides little or no buffer between advanced treatment of wastewater and consumption. Per the Water Code, DPR comprises the "planned introduction of recycled water either directly into a public water system…or into a raw water supply immediately upstream of a water treatment plant." The Draft DPR Feasibility Report recognized a range of possible types of DPR projects (SWRCB 2016). While a number of names have been used to describe the various forms of DPR, the industry has recently settled on two denominations, as defined in California Assembly Bill 574:

1. A project delivering recycled water directly to a surface water treatment plant or a surface water reservoir, with the reservoir providing no benefits. Herein referred to as **"Raw Water Augmentation."**
2. A project delivering finished water to a public water system's distribution system. Herein referred to as **"Treated Water Augmentation."**

Figure 2.5 shows the two forms of DPR project types schematically.

At the most direct end of the DPR spectrum, "Treated Water Augmentation" projects discharge advanced treated water directly into the distribution system with significantly reduced time to respond to failures. In "Raw Water Augmentation," advanced treated water flows through aqueducts (and potentially small reservoirs that do not meet the SWA specifications) that may provide retention time but not the significant degrees of dilution provided by SWA. In addition, the water undergoes further treatment at the surface water treatment plant. Regardless of the type of DPR, the primary challenge is to ensure public health is reliably protected. To accomplish this, it is likely that future regulations will require increasingly more stringent degrees of advanced treatment as we move to more and more direct forms of DPR. This topic is further discussed in Section 3.2.3.

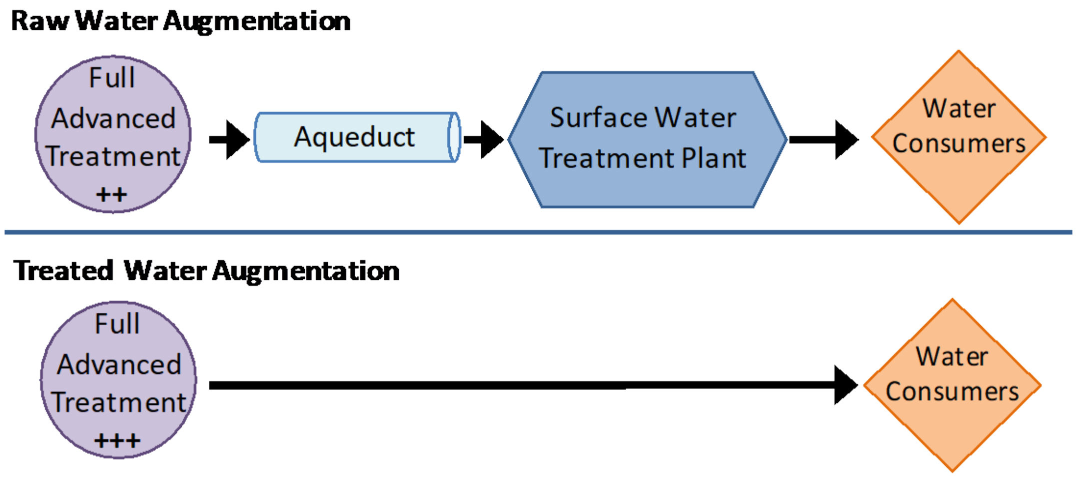

Figure 2.5 – The two forms of direct potable reuse

3 - REGULATORY REQUIREMENTS: PAST, PRESENT, FUTURE

The production, discharge, distribution, and use of recycled water are subject to federal, state, and local regulations; the primary objectives of which are to protect public health. Regulatory requirements apply for non-potable and potable uses of recycled water.

3.1 Non-Potable Reuse Regulatory Requirements

Recycled water quality requirements for a given project depend on the regulatory requirements, which set a minimum standard plus any additional customer requirements for the end uses. For example, though removal of total dissolved solids (TDS, a measure of salinity) is not required for recycled water by regulations, it may be desirable depending on the end use and the concentration of TDS in the source water.

There are no federal regulations governing water reuse in the United States, thus regulations (or guidelines) for recycled water are developed and implemented at the state government level.

In the State of California, recycled water requirements are administered by the State Water Resource Control Board (SWRCB) - Division of Drinking Water (DDW), formerly under California Department of Public Health (CDPH), and individual Regional Water Quality Control Boards (RWQCBs). The regulatory requirements for recycled water projects in California are contained in Title 22 and Title 17 of the California Code of Regulations (CCR)[1]:
DDW regulates the treatment, quality, and use of recycled water, as well as the proper separation of recycled water and drinking water systems. Title 22 stipulates the levels of treatment for different uses of recycled water, permissible types of reuse, and minimum recycled water quality

[1] State requirements for production, discharge, distribution, and use of recycled water are contained in the California Water Code, Division 7-Water Quality, Sections 1300 through 13999.16 (Water Code); the California Administrative Code, Title 22-Social Security, Division 4 Environmental Health, Chapter 3-Reclamation Criteria, Sections 60301 through 60475 (Title 22); and the California Administrative Code, Title 17-Public Health, Chapter 5, Subchapter 1, Group 4-Drinking Water Supplies, Sections 7583 through 7630 (Title 17).

requirements (as discussed in Section 2.1). Water meeting these standards is considered safe for non-drinking purposes. Routine monitoring is required to ensure that the intended quality is consistently being produced. In addition to recycled water uses and treatment requirements, Title 22 addresses sampling and analysis requirements at the treatment plant, preparation of an engineering report prior to production or use of recycled water, general treatment design requirements, reliability requirements, and alternative methods of treatment.

The focus of Title 17 is protection of drinking (potable) water supplies through control of cross-connections[2] with potential contaminants, including non-potable water supplies such as recycled water. Title 17, Group 4, Article 2 - Protection of Water System, Table 1, specifies the minimum backflow protection required on the potable water system for situations in which there is potential for contamination to the potable water supply. Title 17 specifies the minimum backflow protection on the potable water system for situations in which there is potential for contamination to the potable water supply. In conjunction with local health agencies, DDW reviews and approves final onsite (customer) system plans for cross-connection control in accordance with Title 17, and inspects each system prior to operation. Backflow prevention and cross-connection testing would be performed for each site in accordance with DDW requirements before the recycled water supply is connected to that site.

The SWRCB adopted a Water Reclamation Requirements for Recycled Water Use (General Order) on June 7, 2016 in an effort to streamline the use of non-potable recycled water in drought[3]. New recycled water distribution and use will be covered under this General Order. Wastewater treatment facilities that intend to produce recycled water for reuse must obtain a separate coverage under a separate Regional Water Quality Control Board permit.

3.2 Potable Reuse Regulatory Requirements

The first potable reuse project in California is the surface spreading GRR project at Los Angeles County Sanitation District's (LACSD) Montebello Forebay. When this project began in 1962, there were no regulations governing GRR. The first draft regulations were published in 1976, a year before Water Factory 21 at Orange County Water District (OCWD) became the first subsurface injection GRR project. These two pioneering projects were instrumental in helping regulators understand the risks and control tools needed for reliable, safe potable reuse. They played a large role in guiding the final GRR regulations, which were published in June, 2014. GRR is the only form of potable reuse currently in practice in California, with seven projects providing approximately 200 mgd of potable reuse water.

The adoption of the final regulations in 2014 has provided agencies interested in GRR with clear regulatory guidance. The completion of this regulation was motivated by legislative action, namely California Senate Bill 918 (SB 918), which mandated that the GRR regulations be finalized by December, 2013. SB 918 also set out two additional potable reuse goals, namely: (1)

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[2] A cross-connection is an unprotected actual or potential connection between a potable water system used to supply water for drinking purposes and any source or system containing unapproved water or a substance that is not or cannot be approved as safe, wholesome, and potable, which in this case will be recycled water. By-pass arrangements, jumper connections, removable sections, swivel or changeover devices, or other devices through which backflow could occur, shall be considered to be cross-connections

[3] Order WQ 2016-0068-DDW http://www.waterboards.ca.gov/board_decisions/adopted_orders/water_quality/2016/wqo2016_0068_ddw.pdf

to develop uniform criteria for SWA by December, 2016, and (2) to assess the feasibility of developing future regulations for DPR by December, 2016. As of October, 2016, DDW has completed the GRR regulations, with the goals for SWA regulations and the DPR feasibility analysis to be largely on schedule. The content and requirements of these three forms of potable reuse—groundwater replenishment reuse, surface water augmentation, and direct potable reuse—are discussed in the following sections.

3.2.1 Groundwater Replenishment Reuse (GRR)

The two forms of GRR included in the final regulations are surface spreading and subsurface injection (Articles 5.1 and 5.2). Through the Regional RWFPS, the City of Santa Cruz has determined that space limitations and hydrogeologic conditions constrain any GRR project to subsurface injection. The focus of this section, therefore, is on regulations related to subsurface injection projects.

3.2.1.1 History of GRR through Subsurface Injection

OCWD began operating Water Factory 21 in 1976 in an effort to diversify the District's water supply and become less reliant on imported water. The use of subsurface injection—the first project of its kind—was chosen to mitigate seawater intrusion into the local groundwater basin. Because groundwater injection bypasses the benefits of soil aquifer treatment (SAT), it was determined that additional treatment would be required at the AWTF to provide an equivalent level of public health protection. Water Factory 21 provided valuable insight for the design of treatment facilities engaging in subsurface injection, and led to the future regulatory requirement for full advanced treatment, i.e., the full flow of water passing through both reverse osmosis and an advanced oxidation process. In 2008, the Groundwater Replenishment System (GWRS) replaced Water Factory 21, increasing recycled water production to 70 mgd utilizing MF, RO and UV/H_2O_2 to treat secondary effluent. The capacity of this facility was recently expanded to produce 100 mgd, with potential future plans for further expansion to 130 mgd.

3.2.1.2 Regulations for GRR

The regulations for GRR through surface spreading and subsurface injection are different due to the loss of SAT when the water is injected directly. However, the major requirements designed to ensure high water quality and protection of public health are the same, and are summarized in Table 3-1.

Table 3-1 – Overview of 2014 DDW Groundwater Replenishment Reuse Regulations

Requirement	Description
Public hearing	Required for the initial permit and whenever there is a proposal to increase the maximum recycled municipal wastewater contribution
Laboratory analysis	Must be performed by certified labs approved by DDW using DDW-approved drinking water methods
Regulated chemicals	For the applied recycled municipal wastewater, quarterly monitoring of constituents with maximum contaminant levels (MCLs) and annual monitoring of constituents with secondary MCLs is required
Diluent water	Diluent water quality must not exceed a primary MCL, a secondary MCL or an unregulated constituent notification level (NL), with additional requirements for diluent waters that are not DDW-approved source waters
Additional monitoring	Additional chemical and contaminant monitoring requirements for recycled municipal wastewater and downgradient groundwater monitoring wells including quarterly monitoring of priority pollutants and other chemicals DDW specifies based on review of the engineering report, as well as unregulated constituents with notification levels (NLs)
Operations plan	Operation Optimization Plan must be submitted to DDW prior to startup, which identifies and describes operations & maintenance, monitoring, and analytical methods for the groundwater replenishment reuse project (GRRP) to meet the requirements of the groundwater replenishment regulations
Reporting	Annual report must be submitted to DDW within six months of the end of each calendar year
Retention time	Retention time in the aquifer appears with regard to two aspects of the regulations. The first relates to pathogen removal (or treatment), while the second relates to the time to identify treatment failures and take actions to assure protection of public health. The response retention time can be established initially through modeling or with an intrinsic tracer, but a tracer study must be initiated within three months of operation. The retention time will be no less than two months for groundwater injection, and no less than six months for spreading.

As previously noted, the treatment requirements differ for surface spreading and subsurface injection projects. Spreading projects must only meet the Title 22 requirements for disinfected tertiary waters (i.e., oxidation, filtration and disinfection) followed by SAT at the spreading basin (see Section 2.1.4). Injection projects must use FAT, with most facilities following the GWRS treatment model using MF, RO and UV/H_2O_2. Because the treatment requirements for subsurface injection are more stringent than surface spreading, water that has been treated through a FAT train can be used for both injection and spreading.

The GRR regulations focus on minimizing the acute risk to public health associated with the presence of pathogens. Requirements for pathogen control include 12-log reduction of enteric virus, 10-log reduction of *Giardia* cysts, and 10-log reduction *Cryptosporidium* oocysts. These requirements must be met through multiple barriers. For each type of pathogen, a minimum of three treatment processes must be used, with each providing at least 1.0-log, but no more than 6-logs, of pathogen removal credit. For subsurface injection, the full log removal requirement for *Giardia* cysts and *Cryptosporidium* oocysts must be accomplished at the treatment plant. Virus removal can be accomplished through a combination of treatment at the AWTF and subsurface attenuation, where a 1.0-log removal of virus credit is awarded for each month the water spends in the aquifer.

Chronic and acute risks to public health associated with chemical contaminants are also addressed in the GRR regulations. Total nitrogen, for example, must be sampled twice weekly with any exceedances above 10 mg/L as N requiring additional action. Initially, RO was considered to be completely effective at removing all pathogens and chemicals; however, with improving analytical methods, trace organic compounds have been detected in RO permeate. This gave rise to the required advanced oxidation process following RO. Performance requirements for RO involve demonstrating minimum levels of salt rejection, and ensuring permeate TOC remains within specified limits.[4]

To demonstrate AOP performance, the regulations allow one of two methods to be used. In the first, the AOP process must be demonstrated to provide minimum removals of a suite of constituents from nine different chemical classes. The second, and more commonly pursued, option is to demonstrate the ability of the AOP process to provide 0.5-log reduction of 1,4-dioxane (CDPH 2014a). 1,4-dioxane was selected because it serves as an indicator of the low molecular weight, uncharged constituents that have been shown to pass through RO. Studies have shown that processes that reduce 1,4-dioxane levels will also be effective at removing a wide diversity of additional contaminants of emerging concern (CECs). The most common AOP used in existing GRR projects is ultraviolet light (UV) with hydrogen peroxide.

A list of all existing GRR projects in California is provided in Table 3-2.

[4] The RO membranes must achieve minimum and average sodium chloride rejections of 99.0% and 99.2%, respectively. Initial RO permeate TOC must be less than 0.25 mg/L and not exceed 0.5 mg/L over the long term, based on a 20-week running average of all TOC results and the average of the last four TOC results.

Table 3-2 – Ongoing GRR Projects in California

Potable Reuse Project	Start-Up	Potable Reuse Type	Current Treatment	Capacity (mgd)
Montebello Forebay (LACSD)	1962	Spreading	• Biological • Granular media filtration • Disinfection	44
Groundwater Replenishment System (OCWD)	1978	Spreading (*Orange County Forebay*) Injection (*Talbert Gap Barrier*)	• Biological • MF • RO • UV/H_2O_2	100
West Coast Basin Barrier (West Basin)	1992	Injection	• Biological • MF • RO • UV/ H_2O_2	18
Chino Basin (IEUA)	2005	Spreading	• Biological • Granular media filtration • Disinfection	19
Alamitos Barrier (WRD AWTF)	2005	Injection	• Biological • MF • RO • UV/ H_2O_2	8
Dominguez Gap (Terminal Island)	2006	Injection	• Biological • MF • RO • Disinfection	5
Cambria Community Services District (temporary project)	2015	Injection	• Biological • MF • RO • UV/ H_2O_2	0.22
TOTAL				**194**

3.2.2 Surface Water Augmentation

As noted previously, SB 918 mandated the development of surface water augmentation (SWA) regulations by the end of 2016. Unlike the GRR regulations that were developed based on 50 years of project experience, there has been a relatively short amount of time to complete the SWA regulations, with no full-scale operating experience to guide the process. Given the challenges and the expedited timeline of this task, a State Expert Panel was appointed to advise DDW on public health issues and any other scientific and technical matters relevant to regulatory development.

DDW released draft SWA regulations for public comment on July 21, 2017 including a number of provisions that were recommended by the Expert Panel (DDW 2017). Further modifications may be made prior to the adoption of the regulations once the public comment period closes in September, 2017. The following discussion provides an overview of the provisions most relevant to an agency that is considering implementing a SWA project.

3.2.2.1 Treatment Criteria

Unlike the GRR regulation, the draft SWA regulation allows pathogen credits to be achieved at both the AWTF and the DWTF. The regulations require post-reservoir treatment at a surface water treatment plant, which provides a minimum 4/3/2 log reduction of virus, *Giardia,* and *Cryptosporidium*, respectively, per the Surface Water Treatment Rule. The remaining credits must be achieved at the AWTF, with the regulations specifying three levels of treatment based on the degree of dilution and the retention time provided by the reservoir:

- The first option pertains to projects that provide at least 100-to-1 dilution of the advanced treated water in the reservoir. For these projects, the total amount of treatment required is 12/10/10 for virus, *Giardia*, and *Cryptosporidium*, meaning that a minimum of 8/7/8 must be achieved through the AWTF (assuming the DWTF will provide 4/3/2). The treatment must be provided by at least two separate treatment processes, each achieving at least a 1-log reduction with no more than 6-log credit for any process.
- The second option pertains to projects that provide at least 10-to-1 dilution of the advanced treated water in the reservoir. As a result of the reduced dilution in the reservoir, an additional log of treatment is needed at the advanced treatment facility, bringing the minimum AWTF requirements to 9/8/9 for an overall total log removal requirement of 13/11/11. The treatment must be provided by at least three separate treatment processes, each achieving at least a 1-log reduction with no more than 6-log credit for any process.
- Furthermore, if the retention time drops below 120 days, at least one additional $\log_{10}$ reduction of pathogens will be required. The State Board also reserves the right to require additional treatment for any project seeking an alternative to the minimum theoretical reservoir retention time requirement of 180 days.

3.2.2.2 Dilution Criteria

One of the main benefits of the reservoir is its ability to provide dilution, which provides a buffer against contaminants in the event of a discharge of off-spec water. The dilution and mixing criteria in the draft SWA regulation requires that the volume of water withdrawn from the reservoir contains no more than:

- 1%, by volume, of recycled municipal wastewater that was delivered to the reservoir during any 24-hour period, or
- 10%, by volume, of recycled municipal wastewater that was delivered to the surface water reservoir during any 24-hour period, with the recycled municipal wastewater delivered having been subjected to an additional treatment process producing no less than a 1-log reduction of enteric virus, *Giardia* cysts, and *Cryptosporidium* oocysts

These dilution requirements must be verified through the use of hydrodynamic modeling of the reservoir. No pathogen log removal credits will be given for time spent or dilution achieved in the reservoir.

3.2.2.3 Theoretical Retention Time Criteria

The final major reservoir criterion is the theoretical retention time, defined in the draft regulation as the total volume (V) in the reservoir at the end of a month divided by the total flow out of the reservoir during that month (Q). The draft regulations specify that the initial theoretical retention time (V/Q) may be no less than 180 days, but that project sponsors may apply for alternative minimum theoretical retention times as low as 60 days (DDW 2017). Such projects would still need to meet minimum dilution requirements, and would have to provide additional treatment of at least 1-log reduction per pathogen for any project proposing a retention time less than 120 days.

Table 3-3 – Summary of draft Surface Water Augmentation Regulations (July, 2017 draft)

Chapter 3. Article 5.3. Indirect Potable Reuse: Surface Water Augmentation		
Section	Title	Description
§60320.301	General Requirements	Includes development of plan between water recycling agency and public water system; demonstration of "technical, managerial, and financial" capability; compliance
§60320.302	Advanced Treatment Criteria	Requirements for full advanced treatment; process monitoring; demonstration testing; reporting
§60320.304	Lab analyses	Laboratory requirements for analysis of chemicals, both those with MCLs and those without
§60320.306	Wastewater Source Control	Requirements for source control program
§60320.308	Pathogenic Microorganism Control	Requirements for virus, *Giardia*, and *Cryptosporidium* reduction through the advanced treatment process; options for alternative levels of treatment
§60320.312	Regulated Contaminants and Physical Characteristics Control	Requirements for monitoring of various groups of regulated chemical contaminants; response to exceedances; monitoring
§60320.320	Additional Chemical and Contaminant Monitoring	Requirements for additional chemical testing and reporting, including Notification Levels and other contaminants of concern
§60320.322	SWSAP Operation Plan	Identifies plan requirements including operations, maintenance, analytical methods, monitoring, training, and reporting
§60320.326	Augmented Reservoir Monitoring	Monitoring requirements at the reservoir, including sampling locations and frequency
§60320.328	Reporting	Includes results of monitoring, operations summary, responses to failure events
§60320.330	Alternatives.	Permits use of alternatives that provide equivalent or better protection of public health; requirements for approval of alternatives
Chapter 17. Article 9. Indirect Potable Reuse: Surface Water Augmentation		
Section	Title	Description
§64668.10	General requirements & Definitions	Includes definitions, permit requirements, and other elements related to Article 5.3, Chapter 3; requirements for reservoir
§64668.20	Public Hearings	Requirements for public interaction, including meetings, web-accessible information, and customer notifications
§64668.30	SWSAP Augmented Reservoir Requirements	Requirements for reservoir as approved surface water supply; retention time requirements; tracer study and modeling requirements; dilution requirements

3.2.3 Direct Potable Reuse

Despite the fact that there are no existing regulations or applications in California, DPR is currently the subject of much industry interest. SB 918's final mandate required DDW to assess the feasibility of developing uniform regulations for DPR, setting a deadline for this analysis of December 2016. This goal inspired a significant industry research effort related to DPR, since many knowledge gaps exist related to the design, performance and safety provided by a potential DPR system. The research effort included studies on treatment and monitoring, source control and engineered storage, public acceptance and economic analyses. WateReuse Research Foundation (WRRF), WateReuse California, Water Research Foundation (WRF) and other international partners have focused significant resources on these topics.

The main research need cited by the Expert Panel in their feasibility analysis centered on the question of DPR safety (Olivieri et al. 2016). Because the most important goal of any potable reuse project is the protection of public health, the key factor in assessing DPR feasibility is to understand how consistently a DPR system could protect public health. DPR is unique in the absence of an environmental buffer (e.g., aquifer or reservoir) to provide dilution and time to respond to discharges of off-spec water. WRRF Project 14-12, entitled "Demonstrating Redundancy and Monitoring to Achieve Reliable Potable Reuse (WRRF 14-12)," was created to address the question of DPR reliability using a 1.5-mgd demonstration plant designed and built at the City of San Diego's North City Water Reclamation Plant and operated over a 12-month period. The data and experience from this project, and many others, have provided DDW with insight on the ability to implement DPR safely (Pecson et al. 2017).

The State Expert Panel recently completed its final report and concluded that it is feasible to create uniform regulations for DPR in California (Olivieri et al. 2016). On September 8, 2016 DDW released a draft report on the feasibility of developing statewide regulations for direct potable reuse of recycled water summarizing the Panel recommendations and its own conclusions. They have identified several knowledge gaps that must be filled before uniform regulations can be adopted. The timeline for developing these regulations is unclear; more specificity may be provided in DDW's final report to the legislature. Although substantial work and time is still required to prepare the regulations, general strategies and design ideas are taking shape.

3.2.3.1 Treatment

Regardless of the type of potable reuse, public health protection is the principal goal. In general, public health protection is achieved through a combination of elements, including treatment, monitoring, dilution, and storage. There are many different ways potable reuse elements can be combined to ensure reliability. For example, decreases in storage and retention time can be compensated with higher degrees of treatment. This fact is supported by the GRR regulations, which allow for shorter aquifer storage times (down to 2 months) if higher degrees of treatment are provided. Likewise, in the draft SWA regulations, pathogen removal requirements are higher, *i.e.* 13/11/11 or higher, if lower levels of dilution are provided, compared to the 12/10/10 required with more dilution. Given the reduced time to respond to failures, DPR projects will need to provide additional safeguards such as higher levels of treatment, more frequent monitoring, and more rigorous response protocols.

The State Expert Panel reviewed the performance and public health protection provided by the DPR treatment train in WRRF 14-12 and determined it was protective of public health. The Expert Panel did not, however, specify minimum LRV requirements for pathogen control, only that the WRRF 14-12 treatment train was protective. Despite the absence of specific LRV requirements for DPR, it is possible to bookend the range of likely values. For example, it is probable that the LRV requirements for DPR will be more stringent than those for SWA given DPR's lack of an environmental barrier. To date, the highest level of treatment required by the draft SWA regulations is 13/11/11 (see Section 3.2.2.1). At the upper end, the Expert Panel has concluded that a train consisting of O_3, BAC, MF/UF, RO, UV/AOP, and free chlorine was suitable for the most direct form of DPR, i.e., Treated Water Augmentation. The median LRV for the DPR treatment train was 20/19/16. Future regulations will likely require LRVs in between these two sets of values, with progressively more stringent requirements placed on the more direct forms of reuse Table 3-4.

Table 3-4 – Anticipated LRV requirements for pathogen removal in future DPR regulations.

	Virus	*Giardia*	*Cryptosporidium*
Treatment Requirements	13-20	11-19	11-16

Based on draft Surface Water Augmentation regulations and State Expert Panel report on DPR.

3.2.3.2 Source Control

Enhancements in source control will also be a likely component of future DPR regulations. The lack of dilution and response time will place higher requirements on the quality of final effluents from DPR facilities. Unlike IPR projects that benefit from both time and dilution in the environment, DPR will have less capacity to buffer out contaminant peaks. Accordingly, the high quality of the source water (i.e., wastewater) will need to be more tightly ensured, including through strategies such as enhanced source control.

3.2.3.3 Monitoring

Currently, on-line, continuous surrogate monitoring is practiced for all of the pathogen barriers at the AWTF in IPR projects. The need for continuous monitoring is linked to the acute threat of pathogens, because even short periods of treatment failure may lead to adverse public health outcomes. The time between treatment and consumption can be limited, meaning that agencies have little time to enact failure response strategies in the event of a treatment failure. Accordingly, the high-frequency pathogen monitoring practiced in IPR will undoubtedly carry over into DPR as well.

The Expert Panel also recommended that additional surveys of pathogen concentrations in raw wastewater be undertaken. Prior to potable reuse there was a concerted effort to separate wastewater from drinking water, so wastewaters were not evaluated as potable sources. As a result, there are very few studies on the levels of drinking water pathogens—i.e., virus, *Giardia*, and *Cryptosporidium*—in wastewaters (Rose et al. 2004). These risks need to be better characterized in order to ensure that the DPR treatment requirements can reduce these concentrations down to acceptable levels for public health.

Pathogens are not the only contaminants that may require additional monitoring in DPR. The Expert Panel also recommended research to further characterize and control chemical contaminants. Monitoring requirements include the use of high-frequency TOC meters to identify the passage of any chemical peaks through a treatment train, as well as continued vigilance for emerging chemicals of concern (CECs) that may be discovered in the future.

3.2.3.4 Other requirements

In addition to defining the design elements that will ensure DPR is protective of public health, significant institutional changes will also need to occur for it to be successfully implemented. The existing water treatment framework keeps drinking water and wastewater treatment entities separate, with little to no communication between them. In a system with DPR, wastewater will be treated at an AWTF and either sent directly to the DWTF or sent directly to water consumers. This fundamentally alters the current framework, as the AWTF would essentially be a drinking water source, meaning it must comply with the drinking water code.

An important aspect of drinking water treatment is the management and preservation of the source water. In the context of potable reuse, the sewershed of a wastewater treatment plant becomes a drinking water source; thus, the importance of what ends up in the wastewater becomes apparent, as does the need for sewershed management. To implement this concept, a new layer of regulatory development may be required for DPR to update management practices of wastewater collection. Management of operators and staff at the wastewater and drinking water facilities will also be impacted, as different skills and certification requirements exist for the two entities. As these entities become more closely linked, additional time and resources will be required to educate operators on wastewater, drinking water, and advanced water treatment.

Another important consideration for the success of DPR in California is the public's opinion of the practice. A recent survey conducted in San Diego County provided feedback that the community was resistant to the idea, indicating that more communication between the public and local municipalities regarding the safety and benefits of the concept are needed (Millan et al. 2015). Efforts to communicate the concepts of DPR are increasing; examples include more development of demonstration facilities by several municipalities, and the development of communication plans for the state and local level.

The challenges associated with DPR described in this section will vary depending on the degree of directness; however, the emphasis of all projects will remain on providing protection equal to or greater than that provided by conventional drinking water. Public outreach will remain an important aspect of the success of potable reuse projects, regardless of the type of DPR, or even the type of indirect potable reuse. The success of GRR in California and the public's acceptance of those projects is a testament that with communication and outreach, the public can accept this new source of water.

4 - TREATMENT PROCESSES AND CREDITS

This section describes the treatment processes used in water reuse applications, and the credits that have been awarded for past projects. The purpose of this section is to provide information to understand how multiple unit processes can be combined to meet the treatment requirements of different reuse scenarios.

The State Water Board allocates treatment credits—calculated as log reduction values or LRVs—on a case-by-case basis for each project. Factors that may influence the LRV that is credited for a given unit process include the type of monitoring provided and the performance of the unit process are also discussed in this section.

4.1 Wastewater Treatment

The State Board allows wastewater treatment facilities to receive pathogen LRV credits. In the absence of site-specific information on pathogen removal performance, agencies can utilize literature data to propose to DDW LRV values that might be assigned to their facilities. Typically, these credits are conservative to account for the lack of site-specific pathogen information. The data collected by Rose et al. (2004) on pathogen concentrations in raw and secondary effluents have been the primary source of information for crediting. Two recent IPR projects used the data set to gain LRV credits of 2/2/1 for virus, *Giardia*, and *Cryptosporidium*, respectively, based on their use of activated sludge processes with long solids retention times (SRT). Subsequent permitting efforts have argued that long SRTs do not correlate with higher pathogen removal performance, decreasing the current crediting to 1.9/0.8/1.2 (see Olivieri et al. (2016) for additional discussion)[5].

Credits have also been assigned for tertiary treatment processes, particularly for non-potable applications. Studies completed in the 1960s showed that 5-logs of virus inactivation could be achieved through tertiary filtration and chlorine disinfection with a CT dose of 450 mg-min/L (reviewed in Williams (2015)). Facilities that meet the treatment requirements for both filtration and disinfection with chlorine do not need to further demonstrate virus control through direct monitoring (CDPH 2014b). Alternative forms of disinfection are allowed under the regulation; however, those processes need to demonstrate that the disinfection process alone can provide 5-logs of virus inactivation. UV has been approved as an alternative process for a number of projects based on the requirements outlined in the NWRI Manual (NWRI and Water Research Foundation 2012). Ozonation and pasteurization have also received conditional approval.

4.2 Membrane Filtration

In potable reuse settings, the primary goal of the membrane filtration is to provide pre-treatment for the RO, and to remove suspended particulate matter, *Giardia* cysts and *Cryptosporidium* oocysts. Membrane filtration can be accomplished with both microfiltration and ultrafiltration, which provide a physical barrier with nominal pore sizes of approximately 0.1 and 0.01 μm, respectively. The pathogen LRV credits for membrane filtration has been more consistent across potable reuse projects, with all projects receiving 4-log credits for both *Giardia* and *Cryptosporidium*, and most receiving 0-log credits for virus, OCWD's GWRS being an exception. The framework outlined in EPA's Membrane Filtration Guidance Manual has been used to guide the crediting process (EPA 2005). The Guidance Manual requires both (1) a continuous, indirect measurement of process performance (typically accomplished through on-line monitoring of filtrate turbidity), along with (2) a periodic, direct integrity test (DIT), such as a pressure decay test. Using existing technology, the DIT is typically only sensitive enough to demonstrate 4-log removal of the larger protozoan pathogens—*Giardia* and *Cryptosporidium*—but cannot quantify virus removal. Consequently, most projects receive 0-logs of virus removal credit in the absence of other data. As the first applicant under the new regulation, OCWD did receive some virus credit for MF in the GWRS based on the submittal of full–scale data on coliphage removal.

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[5] The study by Rose et al. (2004) focused only on the pathogen removal performance of conventional activated sludge processes; the performance of trickling filters and other fixed film processes remains poorly understood. Consequently, no credits have been approved for a facility using a fixed-film process.

Membrane filtration may also be used for tertiary filtration in non-potable applications. For these applications, membrane filters must only comply with turbidity requirements to satisfy the treatment requirements (see Section 2.1.4). When used with chlorine disinfection meeting the rest of the Title 22 requirement for non-potable reuse, compliance is granted.

4.3 Membrane Bioreactors

Membrane bioreactors (MBR) are currently used in non-potable applications in California, but have thus far not been utilized for potable reuse. For non-potable reuse, the MBRs must comply with the turbidity limits previously described to meet the filtration requirements (Section 2.1.4). MBRs themselves are not assigned pathogen removal credits in non-potable reuse, but can be used in conjunction with an approved disinfection process to meet the 5-log virus removal requirements.

The main challenge in translating MBRs into potable reuse applications is that they have difficulty meeting the direct integrity testing requirements of the EPA's Membrane Filtration Guidance Manual (EPA 2005). Despite the similarities between the membranes used in MBRs and in membrane filtration, MBR systems have not yet been developed with the capacity to perform the pressure decay tests that are needed to quantify protozoa removal performance (see Section 4.2). New systems are under development to address this issue, but no MBRs have yet been credited for pathogen removal credit in California. Given this limitation, all existing facilities utilizing the full advanced treatment train have selected membrane filtration to achieve the 4-log removal credit for *Giardia* and *Cryptosporidium*.

4.4 Reverse Osmosis

The LRV credits that have been assigned to RO in the existing IPR projects range from 1.0 to 2.0-logs for all three pathogen groups. The variation in treatment credits is related to the sensitivity of the surrogate that is monitored to determine performance. Surrogates with lower sensitivity, such as electroconductivity, may only be able to demonstrate 1-log of removal. TOC can be more sensitively measured, and therefore has been credited with 1.5 to 2.0 logs of pathogen removal, depending on the specifics at the particular site. In both cases, the removal of dissolved constituents—based on either TOC or electroconductivity—serves as a surrogate to estimate the removal of pathogens.

The actual performance of RO in terms of pathogen removal is likely to be significantly higher than 2 logs, and research is currently underway to identify new surrogates that can demonstrate RO performance closer to what is actually being achieved. These new frameworks may offer the opportunity to extend RO log credits to values as high as 3.0 to 3.5.

4.5 UV and Advanced Oxidation Processes

UV is an effective form of disinfection for all three pathogen groups. The design of advanced oxidation processes (AOP) typically requires UV doses (500 to 1,000 mJ/cm^2) in great excess of those needed for disinfection alone (50 mJ/cm^2 for 5-log reduction in RO permeate in the NWRI manual and 186 mJ/cm^2 for a 4-log reduction in the EPA LT2ESWTR). Consequently, all existing UV systems have been credited with the maximum LRV of 6 logs when operated in AOP mode under conditions where the influent to the UV unit has a UV transmittance (UVT) that meets the design requirements for the UV unit (generally UVT > 95%).

4.6 Ozone

No permitted projects have utilized ozone as a pathogen barrier for potable reuse, so there are no direct permitting precedents for this form of disinfection. In drinking water systems, pathogen inactivation credit has been assigned based on the ozone dose provided using the EPA CT tables that relate dose to inactivation (EPA 2003). WRRF 14-12 is currently assessing the inactivation of *Crypto* in recycled water contexts to verify that the drinking water CT tables also apply in recycled water settings. Based on preliminary results, it is likely that the existing CT tables will apply, providing a permitting pathway for ozone disinfection in potable reuse. The City of San Diego is pursuing a SWA project using ozone (and BAC) as pre-treatment to a full advanced treatment train. Ozone LRV credits are being sought for all three pathogen groups in that project.

4.7 Biological Activated Carbon

Biological activated carbon (BAC) has also not been used in a full-scale potable reuse project in California to date, but is currently being pursued for the City of San Diego's SWA project. Like ozone, a crediting framework for BAC will need to be developed for pathogen LRVs. A significant research effort would likely have to be made to receive credit for this process. There may be an opportunity for the use of precedent based on the removal credits received for direct filtration in the surface water treatment rules, but this has yet to be explored in depth[6].

4.8 Chlorine Disinfection

Free chlorine disinfection can be implemented to provide virus and *Giardia* credits at multiple places in a potable reuse treatment train. EPA's drinking water CT tables link the surrogate parameter, namely free chlorine CT, to pathogen inactivation credits. These tables should also apply for many locations in the AWTF treatment train, particularly at addition points downstream of RO. Recent studies have shown virus inactivation to exceed 6-logs in UF filtrate (Pecson et al. *submitted*).

These regulations assign a 5-log virus credit for processes coupling filtration with a chlorine CT of 450 mg-min/L. Recently, a number of agencies have sought approval for free chlorine disinfection of tertiary recycled water for non-potable reuse, including LACSD and Padre Dam Municipal Water District. Free chlorine disinfection is possible in nitrified effluents that have converted most or all of the ammonia nitrogen into nitrate. This nitrification step is critical to prevent the reaction of free chlorine and ammonia into combined chlorine, which is a much less potent disinfectant. CT values as low as 9 mg-min/L have been permitted to achieve the 5-log virus disinfection requirement, a 50-fold decrease compared to the default requirement of 450 mg-min/L (Huitric et al. 2014).

4.9 Pasteurization

Pasteurization is an alternative form of disinfection being considered by the City. Further details are provided in Appendix A.4 of the RWFPS.

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[6] The original SWTR gives a removal credit of 2/2/1 (*Cryptosporidium*/*Giardia*/virus) for direct filtration when the turbidity of each individual filter is monitored, and the turbidity is < 0.3 NTU 95% of the time and always below 1 NTU.

4.10 Summary of Unit Treatment Processes and Credits

A probable range of LRVs for a given unit process is provided in Table 4-1 . This table can be used as a guide for planning purposes, however, it should be recognized that the State Water Board allocates treatment credits on a case-by-case basis for each project based on monitoring provided and the performance of the unit process.

Table 4-1 – Summary of Potential LRV Credits for Unit Treatment Processes

	Virus	*Giardia*	*Cryptosporidium*
Wastewater Treatment			
Through Tertiary Filtration[a]	0–2	0–2	0–1.2
MBR[b]	Unknown	Unknown	Unknown
Membrane Filtration[c]	0–4	4	4
Reverse Osmosis[d]	1.5 - 3.5	1.5 - 3.5	1.5 - 3.5
UV and AOP	6	6	6
Ozone[e]	1-6	1-6	1-3
BAC[f]	Unknown	Unknown	Unknown
Chlorine	1-6	1-3	0
Surface Water Treatment Plant	4	3	2

[a] See Section 4.1 and Olivieri et al. (2016)
[b] MBRs have not been credited for pathogen removal performance in potable reuse in California (Section 4.3)
[c] Protozoa removal based on EPA (2005). See Section 4.2 for discussion of virus removal credits.
[d] Most potable reuse facilities receive between 1 and 2 LRV credit, though options for higher credits are being pursued (Section 4.4).
[e] None of the permitted potable reuse projects utilize ozone disinfection, though projects under development will pursue ozone credit.
[f] While removal credits for BAC may be attainable, none of the existing or planned projects in California are seeking LRV credit for this process.

5 - PERSPECTIVES FOR POTABLE REUSE

The previous discussion demonstrates the wide range of potable reuse scenarios, and the growing acceptance—from the industry, regulators, and the public—to allow an increasingly more diverse range of options. Nevertheless, there are benefits and risks of pursuing different forms of reuse. From a regulatory perspective, GRR is the only form of potable reuse with finalized regulations. The benefit of these regulations is that they provide clarity and guidance on the requirements for the design, operation, and permitting of a project. Furthermore, the industry has over 50 years of experience with GRR projects, making this form of reuse the most “known” quantity. A diversity of projects has been or are currently under development, providing information on the ability of different treatment trains to satisfy the requirements. The need for large groundwater aquifers, however, makes this form of reuse difficult or unattainable for many locations in the State.

SWA will expand the geographic distribution of California potable reuse, opening opportunities for projects in areas without adequate aquifers. This is particularly evident in the San Diego County region, where agencies have access to reservoirs but not suitable aquifers. Final regulations have not been completed, though the release of the draft regulation in July, 2017, has offered clarity on the future requirements. Unlike the long history of GRR, SWA does not benefit from any experience with existing projects. Two SWA projects are currently being pursued in the San Diego County region—at the City of San Diego and Padre Dam—and the experience of these projects should provide valuable insight into the challenges of SWA. Previously, one of the key questions was where the draft regulation would draw the line between SWA and DPR. The Expert Panel recommended that SWA allow for “gap” projects with theoretical V/Q between 4 and 2 months. DDW’s draft includes a default retention time requirement of 180 days, but does include a provision for alternative minimum retention times no less than 60 days.

DPR has the greatest potential to expand the geographic distribution of potable reuse, since it can uncouple projects from the need for an environmental buffer. DPR may also lead to significant reductions in project costs by eliminating the need for infrastructure to transport water to and from the buffer (Tchobanoglous et al. 2011). Nevertheless, there are no regulations for DPR—in draft or final form—though the State Expert Panel has concluded that it is feasible to develop such regulations. DDW has cautiously endorsed this conclusion as well, though they state that multiple hurdles will need to be cleared before such regulations can be developed. In particular, they would like an additional research effort be completed to fill in the knowledge gaps cited in their report (SWRCB 2016). The absence of regulations, however, does not mean that DPR projects cannot proceed. DDW has repeatedly stated their regulatory authority to permit DPR projects on a case-by-case basis. The State Board’s report makes clear that they would like such projects to advance slowly and in a phased approach, starting with the least direct form of DPR (Raw Water Augmentation) and moving slowly and methodically toward Treated Water Augmentation.

6 - SUMMARY OF NON-POTABLE AND POTABLE REUSE

There are many factors that should be considered in evaluating non-potable and potable reuse opportunities. Table 6-1 provides a summary of the types of water reuse discussed in this TM, and pros and cons associated with each type.

Table 6-1 - Summary of Pros and Cons of Water Reuse Options for the City of Santa Cruz

Non-Potable Reuse	**Pros**	**Cons**
Undisinfected Secondary	• Requires no modifications to the Santa Cruz Wastewater Treatment Facility	• Restricted end uses • Does not provide a new source of potable water for the City
Disinfected – 23 Secondary	• Requires only the implementation of disinfection at the SCWTF	• Restricted end uses • Does not provide a new source of potable water for the City
Disinfected – 2.2 Secondary	• Requires only the implementation of disinfection at the SCWTF	• Somewhat restricted end uses • Does not provide a new source of potable water for the City
Disinfected Tertiary	• Unrestricted end uses for non-potable applications	• Does not provide a new source of potable water for the City
Indirect Potable Reuse	**Pros**	**Cons**
GRR through Surface Spreading	• Requires the least amount of above-ground treatment for potable reuse • Has been in practice in CA for over 50 years • General public perception is o.k. • Finalized and well-defined regulations exist	• Requires large land area for surface spreading • Requires access to drinking water aquifer large enough to meet project demands • Does not remove all CECs
GRR through Subsurface Injection	• Requires less land area than spreading • Has been in practice in CA for over 40 years • Finalized and well-defined regulations exist • Does remove all CECs	• Requires additional treatment beyond what is required for surface spreading: RO and UV/AOP • Requires access to drinking water aquifer large enough to meet demand needs
Surface Water Augmentation	• Offers an alternative to communities without access to an aquifer • Draft regulations nearly complete • Multiple projects currently being pursued in CA • Does remove all CECs	• No existing project in operation today in California • Requires access to drinking water reservoir that meets dilution requirements • Regulations are not finalized • Public perception is less certain
Direct Potable Reuse	**Pros**	**Cons**
Raw Water Augmentation	• Most similar to SWA and therefore easier to implement than more direct types • Offers an alternative to communities without access to an aquifer or reservoir that meets dilution/retention time requirements • Does remove all CECs	• No existing project in operation today in California • Feasibility is currently being evaluated • Regulations are not expected in the near future • Public perception is less certain
Treated Water Augmentation	• Offers an alternative to communities without access to any form of engineered or environmental buffer • Potentially lower costs due to reduced infrastructure needs • Greatest potential for wide geographic distribution • Does remove all CECs	• Shortest response times will necessitate strict requirements for treatment, monitoring, failure response, etc. • No existing project in operation today in California • Feasibility is currently being evaluated • Regulations are not expected in the near future • Likely years away from project implementation • Public perception is less certain

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Recycled Water Uses Allowed[1] in California

Use of Recycled Water	Treatment Level: Disinfected Tertiary Recycled Water	Disinfected Secondary – 2.2 Recycled Water	Disinfected Secondary – 23 Recycled Water	Undisinfected Secondary Recycled Water
Irrigation of:				
Food crops where recycled water contacts the edible portion of the crop, including all root crops	**Allowed**	Not Allowed	Not Allowed	Not Allowed
Parks and playgrounds	**Allowed**	Not Allowed	Not Allowed	Not Allowed
School yards	**Allowed**	Not Allowed	Not Allowed	Not Allowed
Residential landscaping	**Allowed**	Not Allowed	Not Allowed	Not Allowed
Unrestricted-access golf courses	**Allowed**	Not Allowed	Not Allowed	Not Allowed
Any other irrigation uses not prohibited by other provisions of the California Code of Regulations	**Allowed**	Not Allowed	Not Allowed	Not Allowed
Food crops, surface-irrigated, above-ground edible portion, and not contacted by recycled water	**Allowed**	**Allowed**	Not Allowed	Not Allowed
Cemeteries	**Allowed**	**Allowed**	**Allowed**	Not Allowed
Freeway landscaping	**Allowed**	**Allowed**	**Allowed**	Not Allowed
Restricted-access golf courses	**Allowed**	**Allowed**	**Allowed**	Not Allowed
Ornamental nursery stock and sod farms with unrestricted public access	**Allowed**	**Allowed**	**Allowed**	Not Allowed
Pasture for milk animals for human consumption	**Allowed**	**Allowed**	**Allowed**	Not Allowed
Non-edible vegetation with access control to prevent use as a park, playground or school yard	**Allowed**	**Allowed**	**Allowed**	Not Allowed
Orchards with no contact between edible portion and recycled water	**Allowed**	**Allowed**	Not Allowed[2]	Not Allowed[2]
Vineyards with no contact between edible portion and recycled water	**Allowed**	**Allowed**	Not Allowed[2]	Not Allowed[2]
Non food-bearing trees, including Christmas trees not irrigated less than 14 days before harvest	**Allowed**	**Allowed**	**Allowed**	**Allowed**
Fodder and fiber crops and pasture for animals not producing milk for human consumption	**Allowed**	**Allowed**	**Allowed**	**Allowed**
Seed crops not eaten by humans	**Allowed**	**Allowed**	**Allowed**	**Allowed**
Food crops undergoing commercial pathogen-destroying processing before consumption by humans	**Allowed**	**Allowed**	**Allowed**	**Allowed**
Ornamental nursery stock, sod farms not irrigated less than 14 day before harvest	**Allowed**	**Allowed**	**Allowed**	**Allowed**
Supply for impoundment:				
Non-restricted recreational impoundments, with supplemental monitoring for pathogenic organisms	**Allowed[3]**	Not Allowed	Not Allowed	Not Allowed
Restricted recreational impoundments and publicly-accessible fish hatcheries	**Allowed**	**Allowed**	Not Allowed	Not Allowed
Landscape impoundments without decorative fountains	**Allowed**	**Allowed**	**Allowed**	Not Allowed
Supply for cooling or air conditioning:				
Industrial or commercial cooling or air conditioning involving cooling tower, evaporative condenser, or spraying that creates a mist	**Allowed[4]**	Not Allowed	Not Allowed	Not Allowed
Industrial or commercial cooling or air conditioning not involving cooling tower, evaporative condenser, or spraying that creates a mist	**Allowed**	**Allowed**	**Allowed**	Not Allowed

Recycled Water Uses Allowed[1] in California

(continued)

Use of Recycled Water	Treatment Level: Disinfected Tertiary Recycled Water	Disinfected Secondary – 2.2 Recycled Water	Disinfected Secondary – 23 Recycled Water	Undisinfected Secondary Recycled Water
Other uses:				
Groundwater recharge	**Allowed** under special case-by-case permits by RWQCBs[5]			
Flushing toilets and urinals	**Allowed**	Not Allowed	Not Allowed	Not Allowed
Priming drain traps	**Allowed**	Not Allowed	Not Allowed	Not Allowed
Industrial process water that may contact workers	**Allowed**	Not Allowed	Not Allowed	Not Allowed
Structural fire fighting	**Allowed**	Not Allowed	Not Allowed	Not Allowed
Decorative fountains	**Allowed**	Not Allowed	Not Allowed	Not Allowed
Commercial laundries	**Allowed**	Not Allowed	Not Allowed	Not Allowed
Consolidation of backfill material around potable water pipelines	**Allowed**	Not Allowed	Not Allowed	Not Allowed
Artificial snow making for commercial outdoor uses	**Allowed**	Not Allowed	Not Allowed	Not Allowed
Commercial car washes, not heating the water, excluding the general public from washing process	**Allowed**	Not Allowed	Not Allowed	Not Allowed
Industrial process water that will not come into contact with workers	**Allowed**	**Allowed**	**Allowed**	Not Allowed
Industrial boiler feedwater	**Allowed**	**Allowed**	**Allowed**	Not Allowed
Non-structural fire fighting	**Allowed**	**Allowed**	**Allowed**	Not Allowed
Backfill consolidation around non-potable piping	**Allowed**	**Allowed**	**Allowed**	Not Allowed
Soil compaction	**Allowed**	**Allowed**	**Allowed**	Not Allowed
Mixing concrete	**Allowed**	**Allowed**	**Allowed**	Not Allowed
Dust control on roads and streets	**Allowed**	**Allowed**	**Allowed**	Not Allowed
Cleaning roads, sidewalks, and outdoor work areas	**Allowed**	**Allowed**	**Allowed**	Not Allowed
Flushing sanitary sewers	**Allowed**	**Allowed**	**Allowed**	**Allowed**

This summary is prepared from the December 2, 2000-adopted Title 22 Water Recycling Criteria and supersedes all earlier versions. Prepared by Bahman Sheikh and edited by EBMUD Office of Water Recycling, who acknowledge this is a summary and not the formal version of the regulations referenced above.

[1] Refer to the full text of the December 2, 2000 version of Title 22: California Code of Regulations, Chapter 3 Water Recycling Criteria. This chart is only an informal summary of the uses allowed in this version, with the exception of orchards and vineyards noted as "Not Allowed[2]" on page 1 and explained below.

[2] Per California Department of Public Health letter of January 8, 2003 to California Regional Water Quality Control Boards.

[3] Allowed with "conventional tertiary treatment." Additional monitoring for two years or more is necessary with direct filtration.

[4] Drift eliminators and/or biocides are required if public or employees can be exposed to mist.

[5] Refer to Groundwater Recharge Guidelines, available from the California Department of Public Health.

2013

Appendix A.3

TM #1B TREATMENT FACILITY EVALUATION

Date: September 12, 2017 *(revised draft)*
June 22, 2017 *(initial draft)*

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Subject: Considerations for Treatment Facilities for Santa Cruz Recycled Water Facilities Planning Study (RWFPS)

1 - INTRODUCTION

The City of Santa Cruz ("the City") is developing the Santa Cruz Regional Recycled Water Facilities Planning Study (RWFPS) to explore opportunities to develop a local or regional recycled water program as part of their water supply portfolio. Through the RWFPS, the City and its partners have identified a list of potential recycled water alternatives including both (1) non-potable uses to meet irrigation and commercial/industrial demands, and (2) potable uses to recharge local groundwater aquifers, augment surface waters, or directly supplement the drinking water system. A description of the treatment requirements for each alternative, organized by type of reuse, is provided in Table 1. Section 8 in the RWFPS provides a more detailed description of each alternative.

Trussell Technologies, Inc. (Trussell Tech) developed a Technical Memorandum ("TM 1A"), Evaluation of Treatment Requirements, outlining (a) the types of water reuse in practice or under development in California, (b) the history and status of regulatory development, (c) the treatment processes used to satisfy the regulatory requirements, and (d) the challenges and opportunities associated with pursuing the different types of water reuse (Trussell Technologies 2016).

The following TM 1B provides more specific information for each of the City's RWFPS alternatives including potential candidate treatment trains and a high-level planning estimate of the associated costs and site layout requirements. The goal of TM 1B is to provide additional information that supports the ongoing evaluation of alternatives for recycled water treatment and use in Santa Cruz.

Treatment considerations for the recommended project are discussed in Section 9 of the RWFPS.

Table 1 – Summary of Proposed Alternative Projects for the RWFPS

Alternative Project	Product Water Flow (mgd : AFY)[1]	Level of Treatment/Type of Reuse
Non-Potable Reuse		
Alt 1a	0.25 : 282	Disinfected tertiary supply for local reuse
Alt 1b	0.74 : 824	Maximized disinfected tertiary supply for local reuse
Alt 2	0.12 : 139	Decentralized disinfected tertiary supply for local reuse at UC Santa Cruz
Alt 3b	2.2 : 2,454	• Disinfected tertiary supply for local reuse • Disinfected tertiary for SqCWD GRR
Potable Reuse – Groundwater Recharge		
Alt 3d	1.4 : 1,544	• Advanced treated water supply for local non-potable reuse • Advanced treated water for SqCWD GRR
Alt 3e	3.4 : 3,824	• Advanced treated water supply for local reuse – GRR and NPR • Advanced treated water for SqCWD GRR
Alt 4a	2.1 : 2,389	Advanced treated water supply for local GRR and non-potable reuse
Alt 4b	2.0 : 2,240	Decentralized advanced treated water supply for local GRR and non-potable reuse
Potable Reuse – Surface Water Augmentation/Streamflow Augmentation		
Alt 5	3.2 : 1,777	Advanced treated water supply for reservoir augmentation in Loch Lomond Reservoir
Alt 6	3.2 : 1,777	Advanced treated water supply for streamflow augmentation in San Lorenzo River
Direct Potable Reuse		
Alt 7	3.2 : 1,777	Advanced treated water supply for blending at Graham Hill WTP
Potable Reuse – Regional Groundwater Recharge		
Alt 8a	5.0 : 5,600	Advanced treated water supply for regional GRR to serve the City, Scotts Valley, Soquel Creek and San Lorenzo Valley
Alt 8b	3.7 : 4,144	Maximized advanced treated water supply for regional GRR

[1] These flows represent the average annual production of recycled water from the treatment facility. For alternatives 3 and 8 the annual amount of recycled water beneficially reused by the City is less.

1.1 General Assumptions for Costs and Layouts

Thirteen alternatives are discussed in this TM 1B, including four options for non-potable reuse and nine options for potable reuse. High-level estimates of capital and operation and maintenance (O&M) costs were developed for each potable reuse alternative based on real and estimated costs from several existing or developing water reuse facilities throughout California. To determine costs for the varying product water flows and facility capacities, economies of scale were considered for costs such as ancillary equipment, skid racks, and plumbing. These estimates were also compared to the WateReuse Research Foundation's estimates for advanced treatment trains (Snyder 2012). The capital and O&M cost estimates for the non-potable reuse alternatives were developed based on detailed cost estimates for proposed and existing non-potable reuse facilities in California, as well as an adaptation of the methods described in the *Cost Estimating Manual for Water Treatment Facilities* (McGivney and Kawamura 2008).

Facility layout estimates for the non-potable reuse alternatives were developed based on the designs of five existing and proposed reuse facilities in California, and the designs of four additional facilities were compared to estimate the layout requirements for the potable reuse alternatives[1].

Given that the project alternatives are in the early planning stage, it was necessary to make several assumptions when developing the estimates for capital and O&M costs, and the facility layout requirements presented in this TM 1B. The following sections describe the general assumptions that pertain to all the alternatives included in this analysis. Further detail on any additional assumptions specific to each of the alternatives is provided in Sections 2 and 3.

1.1.1 Siting and Layout

To date, the City and its partners have not determined the final location for the additional treatment facilities associated with the 13 alternatives. Options for siting include development (1) at the Santa Cruz Wastewater Treatment Facility (WWTF), (2) at external locations near the WWTF, and (3) at satellite locations. Given this uncertainty, conservative layout assumptions were used, i.e., efforts were not made to minimize facility footprints or fit them into specific site constraints. This approach was selected to provide the most direct comparison of the various project options being explored. The City may also elect to conduct a more comprehensive siting analysis following this study to provide a more detailed assessment of cost, environmental, social, engineering and operational considerations related to facility siting.

1.1.2 Equipment, Facilities, and Labor

The cost estimates represent the direct costs for the listed treatment processes plus a 30% construction and estimating contingency. The estimate does not include other mark-ups, such as those for (1) general conditions, (2) contractor overhead and profit, and (3) sales tax.

For O&M costs, labor costs were estimated based on typical labor rates at potable reuse facilities in Southern California, and include all the agency costs for the staff including salary and other non-salary items, benefits, etc.

The following aspects of the design *were* included in the capital cost estimates:

- Ancillary treatment components such as pumps and clear wells
- Connecting plumbing between treatment processes

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[1] Non-potable reuse facilities evaluated in the estimates included (a) a 2 MGD water recycling facility in San Mateo County, (b) a 3.75 MGD water recycling facility in Riverside County, (c) a 3 MGD and (d) 5 MGD water recycling facility in San Diego County, and (e) a 1 MGD MBR facility in Los Angeles County. Potable reuse facilities include two facilities in San Diego County, one in Los Angeles County, and one in Monterey County.

- Equipment costs

The following facilities *were not* included in the estimates:

- Administrative building
- Additional power sub-station
- Pumping or piping outside of the treatment area
- Feed/product water storage tanks
- Unit process buildings
- Site preparation
- Taxes, mobilization/demobilization, contractor overhead and profit (OH&P)

Additional detail about how these costs were integrated into the alternatives evaluation is provided in Appendix G of the RWFPS.

When considering membrane processes in the various alternatives, the systems were sized to produce the desired final effluent flow assuming typical recoveries for membrane filtration (MF) and reverse osmosis (RO), namely 90% MF recovery and 75% RO recovery. It should be noted that there are a range of MF and RO recoveries that could be explored during piloting and design to increase efficiency.

2 - RECYCLED WATER FOR NON-POTABLE REUSE (NPR)

The City is considering non-potable reuse alternatives to meet the irrigation, commercial and industrial demands of the local community. As discussed in TM 1A, there are several types of non-potable reuse that vary based on the level of treatment provided and the intended use of the recycled water (Trussell Technologies 2016). In general, as the degree of treatment increases, the uses for the water produced become less restricted. The value of the investment in a reuse facility can increase if the product water can be applied to a wide variety of uses, as it opens the door for more potential customers. After considering prospective users in the community, the City has moved forward with project alternatives that provide enough treatment to be classified by the Title 22 Code of Regulations[2] as unrestricted-use recycled water.

The alternatives being considered for non-potable reuse include 1a, 1b, 2, and 3b. These alternatives would be classified as “disinfected tertiary recycled water,” and therefore must be compliant with the associated regulations for that classification, as outlined in TM 1A (CDPH 2014, Trussell Technologies 2016). To be considered tertiary disinfected recycled water, secondary effluent must undergo tertiary filtration with either granular media filtration (GMF) or membrane filtration, followed by disinfection. A treatment system consisting of primary influent followed by a membrane bioreactor (MBR) and disinfection can also meet the requirements for tertiary disinfected recycled water if the filter effluent complies with the turbidity limits for MF systems per the regulations (CDPH 2014).

[2] State requirements for production, discharge, distribution, and use of recycled water are contained in the California Water Code, Division 7-Water Quality, Sections 1300 through 13999.16 (Water Code); the California Administrative Code, Title 22-Social Security, Division 4 Environmental Health, Chapter 3-Reclamation Criteria, Sections 60301 through 60475 (Title 22)

As discussed in TM 1A, disinfection requirements include protection against bacterial pathogens and viruses. The Division of Drinking Water (DDW) specifies the use of chlorine disinfection with a "CT" dose (the product of the chlorine concentration "C" and residence time "T") of 450 mg-min/L, as well as a modal contact time of 90 minutes (CDPH 2014). Alternative forms of disinfection, such as ultraviolet light (UV), ozone, and pasteurization are also accepted by DDW if they show equivalent virus inactivation. For the project alternatives that would have facilities at the WWTF (1a, 1b and 3b), chlorine disinfection is recommended. Because these facilities could provide water for diverse uses at locations of varying distance from the Santa Cruz WWTF, it is beneficial to maintain a chlorine residual throughout the distribution system. The chlorine residual would serve to inhibit biofilm and microbial growth in the distribution system, and may also benefit recycled water users that require a residual for their application, such as industrial cooling water. Project Alternative 2 is a decentralized plant with the recycled water destined for use at nearby facilities. Given the potential footprint constraints with a satellite facility, UV disinfection was selected.

In addition to providing the greatest flexibility for non-potable recycled uses, disinfected tertiary recycled water would also serve as a higher-quality feed water for an advanced water treatment facility (AWTF), which is considered for alternative 3b. Improved feed water quality to the membrane filter (MF), the first treatment process at the proposed AWTF facilities, has been shown to significantly improve operation of the MF (Tchobanoglous et al. 2015). This leads to more consistent operation of the facility and a more efficient MF process. Although tertiary filtration greatly improves water quality, it would not replace the MF treatment system at the AWTF.

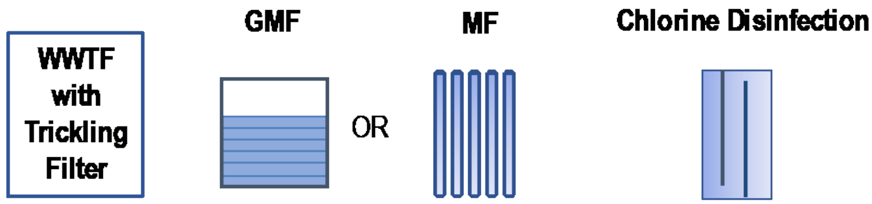
The following sections discuss the alternative non-potable trains: (1) GMF with chlorine disinfection, (2) MF with chlorine disinfection, and (3) MBR with UV disinfection.

2.1 Disinfected Tertiary Facility - Alternatives 1a, 1b and 3b Facility Layout and Cost Estimates

Alternatives 1a, 1b and 3b would include GMF or MF with chlorine disinfection. The different options would adhere to the same Title 22 regulations and have the same water quality goals, but each alternative would produce a different amount of recycled water, as shown in Table 2.

- Alternative 1a is the smallest of the three, producing 0.25 mgd of product water. Due to its size, the existing tertiary filtration system could be used, with minor additions as described in the report "Producing Tertiary Disinfected Recycle Water at the Santa Cruz Wastewater Treatment Facility" (Trussell Technologies 2015), herein referred to as the Title 22 Concept Design. Therefore, the estimated capital cost for this alternative only includes the addition of a disinfection system.
- Alternatives 1b and 3b would require a new filtration system to produce the desired amount of product water: 1.3 mgd and 2.4 mgd, respectively.

Figure 1 shows the proposed treatment train and the requirements for compliance with the non-potable recycled water regulations. Additional detail about these requirements can be found in TM 1A.



	Regulatory Requirements for Title 22 Compliance		

Title 22 Treatment and Water Quality Requirements	Produces an "oxidized wastewater" per Title 22 Regulations	Achieves GMF filtration requirements:
		• Filtration rate ≤ 5gpm/ft²
		• Filter effluent not to exceed:
		  • 2 NTU avg. in 24-hr period
		  • 5 NTU > 5% of time
		  • 10 NTU at any time
		or
		Achieves MF filtration requirements:
		• Filter effluent not to exceed:
		  • 0.2 NTU > 5% of time
		  • 0.5 NTU at any time
			Achieves disinfection requirements:
			• CT of 450 mg-min/L
			• 90-min modal contact time
			and
			• Effluent coliform levels:
			  • 7-day median < 2.2 MPN/100mL
			  • No more than 1 sample > 23 MPN/100mL in 30-day period
			  • < 240 MPN/100mL at all times

Figure 1 - Regulatory requirements and proposed treatment train and for Centralized NPR Alternatives 1a, 1b, and 3b

For alternatives 1b and 3b, filtration could be achieved with GMF, which would consist of dual media filter beds and the ancillary equipment needed to operate the system, such as a backwash water storage and feed system, waste equalization basin, and air scour system. Prior to the filters, coagulant would be injected into a rapid-mix chamber followed by flocculation. Filter pre-treatment may be necessary for efficient filter operation and performance.

As an additional option, MF could replace GMF for alternatives 1b and 3b. A potential benefit of an MF system is that, in general, an MF system can have a smaller footprint compared to GMF. However, this difference is realized to a greater extent with larger facilities, since the ancillary equipment takes up a progressively smaller percentage of the footprint as facility size increases. That said, the estimated footprint for the MF system at the WWTF is essentially equivalent to the GMF footprint due both to (a) the small capacity of the system, and (b) the anticipated low flux rates through the MF using a trickling filter effluent as feed water.

For treatment plants with conventional activated sludge, the MF system can achieve fluxes between 25 and 35 gallon-ft^2/day (gfd). The higher fluxes are often associated with the improved water quality linked to facilities providing biological nutrient removal (BNR). Existing potable reuse facilities have demonstrated that the use of trickling filter effluent as a feed water can significantly impact the performance of the MF system. For this reason, it was assumed that a conservative flux rate of 20 gfd would be appropriate when using trickling filter effluent. The lower flux rate translates to higher membrane surface area requirements to produce the same amount of product water.

The disinfection system for alternatives 1b and 3b would consist of injection of sodium hypochlorite into a rapid-mix chamber followed by a concrete serpentine contact basin designed to maximize the plug flow nature of the hydraulics. The basin would provide a minimum of 90 minutes of modal contact time and a CT of 450 mg-min/L, as specified by the regulations. The disinfection system for alternative 1a assumes implementation of the design concept outlined in the Title 22 Concept Design (Trussell Technologies 2015).

High-level estimates for capital costs, operation and maintenance (O&M) costs, and facility layout requirements are shown in Table 2. The following assumptions were made when determining these estimates:

- The GMF/MF and disinfection facilities would be located at the WWTF
- O&M cost estimates were established for granular media filtration only, as this was the more likely alternative of the two given the challenges associated with membrane filtration of trickling filter effluent.
- Product water storage was not accounted for in the costs or site layout estimates.
- For alternative 1a, the WWTF's existing filters could be used (as was assumed for the Title 22 Concept Design).
- The flux rate through the MF membranes was assumed to be 20 gfd.

Table 2 - Facility Layout and Cost Estimates for Centralized NPR Alternatives 1a, 1b, and 3b

Alternative:	**1a**		**1b**		**3b**	
Product Water (mgd)	0.25		0.74		2.2	
Footprint (sf)	3,600		3,600 (GMF) 4,400 (MF)		9,900 (GMF) 9,600 (MF)	
Unit Process	**Unit Cost ($/gpd capacity)**	**Cost, $M**	**Unit Cost ($/gpd capacity)**	**Cost, $M**	**Unit Cost ($/gpd capacity)**	**Cost, $M**
Granular Media Filtration	--	--	$3.74	$2.77	$2.10	$4.63
Membrane Filtration	--	--	$4.10	$3.03	$3.07	$6.76
Disinfection with Chlorine	$2.17	$0.54	$2.06	$1.52	$1.71	$3.76
Total Capital ($M)	**$0.5**		**$4.3 (GMF) $4.6 (MF)**		**$8.4 (GMF) $10.5 (MF)**	
O&M Type	**Unit Cost**	**Cost, $M/yr**	**Unit Cost**	**Cost, $M/yr**	**Unit Cost**	**Cost, $M/yr**
Chemicals	$46/AF	$0.01	$46/AF	$0.04	$46/AF	$0.11
Electrical	309 kwh/MG	$0.01	269 kwh/MG	$0.01	264 kw/MG	$0.04
Equipment	$7/AF	$0.002	$6/AF	$0.005	$6/AF	$0.01
Labor	0.5 FTE/yr	$0.09	1.0 FTE/yr	$0.13	1.0 FTE/yr	$0.39
Total O&M ($M/yr)	**$0.11**		**$0.19**		**$0.55**	

2.2 Membrane Bioreactor (MBR) Facility - Alternative 2

MBRs are currently being used for non-potable reuse in California, and have been proven to be a reliable technology for the application. The combined biological treatment and membrane filtration helps to maintain a low and consistent effluent turbidity that meets the regulatory requirements for disinfected tertiary recycled water, and provides an excellent water quality for disinfection. The biological treatment is achieved with a suspended growth system that uses a high mixed liquor suspended solids concentration. Membrane filtration is done using either an MF or ultra-filtration (UF) membrane. If this alternative is selected, the membrane chosen would need to demonstrate compliance with the turbidity regulations for tertiary disinfected recycled water, either with pilot testing or at startup.

In determining estimates for the costs and footprint area (Table 3), it was assumed that two parallel aerobic basins with initial anoxic zones would be used for biological treatment. The aerobic zones of the basins would be aerated with fine bubble diffusers lining the bottom of each basin. The effluent streams from the basins would remain separate and flow into two parallel MF filters. All ancillary equipment to operate the system is also included in the estimates.

The use of an alternative form of disinfection, achieved with a UV reactor system, is included in this alternative to minimize the space requirements for disinfection. Because this would be a decentralized water reuse project, the overall layout may be constrained due to siting limitations. In addition, since the water would only be utilized onsite or near the place of treatment; the requirements for maintaining a chlorine residual in the distribution system may be less stringent. To qualify as an alternative form of disinfection, the UV system selected for the project must have been demonstrated to achieve 5 logs of virus inactivation and maintain coliform levels below the required limits, as discussed in TM 1A (Trussell Technologies 2016).

Figure 2 shows the proposed treatment train for Alternative 2. The Title 22 treatment and water quality requirements are also included. Additional detail about these requirements can be found in TM 1A.

	Regulatory Requirements for Title 22 Compliance	

Title 22 Treatment and Water Quality Requirements	Produces an "oxidized wastewater" per Title 22 Regulations
	
	Achieves MF filtration requirements:
	• Filter effluent not to exceed:
	  • 0.2 NTU > 5% of time
	  • 0.5 NTU at any time
		Meets alternative disinfection requirements:
		• Demonstrate 99.999% (5-log) reduction of virus
		and
		• Effluent coliform levels:
		  • 7-day median < 2.2 MPN/100mL
		  • No more than 1 sample > 23 MPN/100mL in 30-day period
		  • < 240 MPN/100mL at all times

Figure 2 - Regulatory requirements and proposed treatment train and for Decentralized NPR Alternative 2

Table 3 - Facility Layout and Cost Estimates for Decentralized NPR Alternative 2

Alternative:	**2**	
Product Water (mgd)	0.12	
Footprint (sf)	2,200	
Unit Process	**Unit Cost ($/gpd capacity)**	**Cost, $M**
MBR	$44.23	$5.31
Disinfection with UV	$2.04	$0.24
Total Capital ($M)	**$5.6**	
O&M Type	**Unit Cost**	**Cost, $M/yr**
Chemicals	$27/AF	$0.004
Electrical	1592 kwh/MG	$0.01
Equipment	$87/AF	$0.01
Labor	0.5 FTE/yr	$0.09
Total O&M ($M/yr)	**$0.12**	

3 - RECYCLED WATER FOR POTABLE REUSE

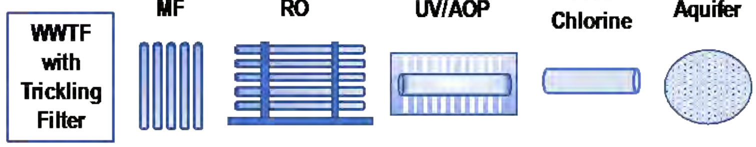
The City is considering potable reuse alternatives to supplement drinking water sources through groundwater replenishment reuse (GRR), surface water augmentation (SWA), streamflow augmentation or direct potable reuse (DPR) with raw water blending at Graham Hill Water Treatment Plant (WTP). There are six GRR alternatives, including one project (4b) that utilizes an MBR in the place of conventional treatment, and two regional projects (8a, 8b) that include coordination with Scotts Valley Water District (SVWD), SqCWD and San Lorenzo Valley Water District. There is one alternative each for SWA, streamflow augmentation, and DPR.

As discussed previously, the final location of the AWTF has not been determined for this alternatives analysis as there are various options available, including at the Santa Cruz WWTF or at an offsite location. While these decisions can be incorporated at later phases of the project, it should be noted that the siting of these facilities would have potentially impact water quality and treatability. In general, it is beneficial to have the AWTF located closer to the WWTF due to the logistics of keeping the water quality stable through the pipelines between the facilities. This would need to be weighed against the benefits of an off-site location, which may have more space available and therefore lower layout constraints.

3.1 Groundwater Recharge Project Facility – Alternatives 3d, 3e, 4a, 8a, 8b

The alternative projects that provide groundwater replenishment assume direct injection of recycled water into the subsurface. Alternatives 3d, 3e, 4a, 4b, 8a, and 8b are all groundwater replenishment reuse projects (GRRP) that would provide a high level of treatment prior to injection into a local aquifer.

As described in TM 1A, the treatment required for a GRRP is full advanced treatment (FAT). Typical facilities complying with the FAT requirements employ MF, RO, and UV/peroxide for advanced oxidation to achieve the 12/10/10 log inactivation of virus/*Giardia*/*Cryptosporidium*, respectively. Treatment must also provide a high degree of chemical contaminant removal. This treatment approach is recommended for the GRRP alternatives. Figure 3 shows the proposed treatment train for these alternatives. The typical log-removal value (LRV) credits awarded for each process are included in the figure, as well as the regulatory requirement of total LRV for GRR projects. More specific information about the regulations that govern GRR can be found in TM 1A (Trussell Technologies 2016).



	WWTF with Trickling Filter	MF	RO	UV/AOP	Free Chlorine	Aquifer	TOTAL	REQUIRED
	Anticipated Pathogen Log Removal Credits							
Virus:	--	0	1.5 - 3.5	6	1 - 6	2 - 6	12* – 21.5	12
Giardia:	--	4	1.5 - 3.5	6	1 - 3	--	12.5 – 16.5	10
Cryptosporidium:	--	4	1.5 – 3.5	6	0	--	11.5 – 13.5	10

* Assumes unit processes would be combined to achieve the minimum LRV requirements

Figure 3 – Proposed treatment train for GRRP alternatives 3d, 3e, 4a, 8a, and 8b with typical LRV credits and regulatory requirements

For all GRRP alternatives, it was assumed that at least two months of retention time would be achieved between injection into the aquifer and withdrawal. The regulations specify that 1 log of virus credit – calculated as log reduction values or LRVs – would be awarded for each month the water is held in the aquifer; therefore, the shorter the retention time, the more treatment is required prior to injection to achieve the required 12 log total virus inactivation. In addition to virus control, shorter retention times may also require stricter monitoring and tighter control of acute contaminants such as nitrate, nitrite, and perchlorate (Pecson et al. 2016).

Based on preliminary estimates of aquifer capacity and hydraulics, the proposed injection areas for both the Santa Cruz- and SqCWD-led GRRPs are assumed to have the capacity to allow for a minimum of six months of retention time prior to withdrawal. As a contingency, if the retention time is shorter, free chlorine disinfection was included in the estimates for cost and layout requirements in this TM 1B. The free chlorine would be injected as the water leaves the AWTF, and would complete the required amount of contact time to achieve 5 logs of virus inactivation as it travels to the injection site. Compliance monitoring would be executed at the injection well. In addition to pathogen control, chemical contaminants such as total nitrogen, NDMA, and 1,4-dioxane must also be controlled, as discussed in TM 1A (Trussell Technologies 2016). These requirements would be met for all the alternatives with RO and UV/peroxide prior to injection.

A primary assumption for the assessment of cost and layout requirements for all the GRRP alternatives (excluding the MBR option 4b) was that the existing secondary treatment would remain unchanged, and would be a suitable feed water for the AWTF. This approach would comply with the regulations and minimize changes to the existing wastewater treatment system, but would likely impact the operation and design of the AWTF. As discussed previously, trickling filter effluent is known to be more difficult to treat with MF systems; accordingly, the cost estimate assumed lower flux rates than a similar system preceded by a conventional activated sludge system. A flux rate of 20 gfd was assumed when determining the capital and O&M cost estimates, as well as the estimate of site layout requirements. Conventional activated sludge treatment with BNR improves total organic carbon (TOC) removal, lowers turbidity, controls nutrient levels, provides consistent water quality, and minimizes contaminants of emerging concern (CECs) (Tchobanoglous et al. 2015).

As discussed previously, the lack of tertiary filtration may also impact AWTF performance. In the absence of tertiary filtration prior to the MF system, the AWTF may be more susceptible to plant upsets such as the occurrence of Red Worms, or Bloodworms, which have the tendency to clog the strainers that precede the MF system. Multiple facilities in California have experienced similar issues when using secondary (vs. tertiary) water as their feed.

Although there are significant benefits to having conventional activated sludge and tertiary treatment prior to the AWTF, there are several GRR projects throughout California utilizing secondary effluents—including trickling filter effluents—as their AWTF feed water. In developing the treatment trains for alternatives 3d, 3e, 4a, 8a, and 8b, considerations were made to account for the lower quality of the feed water to maintain compliance with all regulations.

Alternatives 8a and 8b are proposed to include up to 20% tertiary disinfected effluent from Scotts Valley Water Reclamation Facility (WRF). Despite blending with a higher quality tertiary effluent, it is not anticipated that the water quality would improve so significantly as to noticeably improve operation and maintenance of the proposed AWTF. Therefore, the same MF flux rates were assumed for the capital and O&M cost estimates and facility layout requirements for Alternatives 8a and 8b as were used for the other GRRP alternatives.

Table 4 shows a summary of the high-level estimates of GRRP capital cost, O&M cost, and facility layout requirements. Each of these alternatives consists of an MF, RO, UV/AOP, post treatment, and free chlorine disinfection. All ancillary equipment required for these treatment processes was also included in the estimates.

Table 4 - Facility Layout and Cost Estimates for GRRP Alternatives 3d, 3e, 4a, 8a, 8b

Alternative:	**3d**		**3e**		**4a**		**8a**		**8b**	
Product Water (mgd)	1.4		3.4		2.1		5.0		3.7	
Footprint (sf)	22,000		41,000		29,000		56,000		44,000	
Unit Process	**Unit Cost ($/gpd capacity)**	**Cost, $M**	**Unit Cost ($/gpd capacity)**	**Cost, $M**	**Unit Cost ($/gpd capacity)**	**Cost, $M**	**Unit Cost ($/gpd capacity)**	**Cost, $M**	**Unit Cost ($/gpd capacity)**	**Cost, $M**
MF	$3.66	$5.27	$2.84	$9.65	$3.13	$6.57	$2.63	$13.16	$2.72	$10.06
RO	$5.38	$7.74	$4.17	$14.18	$4.86	$10.20	$3.87	$19.35	$4.21	$15.59
UV/AOP	$0.93	$1.35	$0.73	$2.47	$0.80	$1.68	$0.67	$3.36	$0.73	$2.68
Post Treatment and Chemical Handling	$1.20	$1.73	$1.20	$4.08	$1.20	$2.52	$1.20	$6.00	$1.20	$4.44
Free Chlorine	$0.16	$0.23	$0.16	$0.55	$0.16	$0.34	$0.16	$0.81	$0.16	$0.60
Total Capital ($M)	**$16.3**		**$30.9**		**$21.3**		**$42.7**		**$33.4**	
O&M Type	**Unit Cost**	**Cost, $M/yr**	**Unit Cost**	**Cost, $M/yr**	**Unit Cost**	**Cost, $M/yr**	**Unit Cost**	**Cost, $M/yr**	**Unit Cost**	**Cost, $M/yr**
Chemicals	$101/AF	$0.16	$101/AF	$0.38	$101/AF	$0.24	$101/AF	$0.56	$101/AF	$0.42
Electrical	3520 kwh/MG	$0.37	2908 kwh/MG	$0.72	3138 kw/MG	$0.48	2755 kwh/MG	$1.01	2847 kw/MG	$0.77
Equipment	$214/AF	$0.35	$177/AF	$0.67	$195/AF	$0.46	$167/AF	$0.94	$175/AF	$0.72
Labor	3.0 FTE/yr	$0.49	6.0 FTE/yr	$1.01	4.0 FTE/yr	$0.69	8.0 FTE/yr	$1.47	7.0 FTE/yr	$1.16
Total O&M ($M/yr)	**$1.37**		**$2.79**		**$1.86**		**$3.98**		**$3.07**	

3.2 Groundwater Recharge Project with an MBR

As discussed previously, MBRs are currently used effectively for non-potable reuse in California; however, they have not been utilized for potable reuse in the state so far. This is primarily due to the lack of pathogen removal credits awarded to MBRs per existing regulations. The membranes used in MBR systems are designed such that it is not possible to perform direct integrity testing requirements as outlined in the EPA's Membrane Filtration Guidance Manual (EPA 2005). These tests, specifically pressure decay tests, are the only way to quantify protozoa removal performance that is currently accepted in the regulations. Therefore, MBR systems have not received LRV credits in California.

Alternative ways to quantify pathogen removal through an MBR membrane are being reviewed by DDW. The Australian Water Recycling Center for Excellence has a framework for assigning pathogen removal credit to MBR systems, and DDW has indicated that they may be willing to accept this framework for California in the future (WaterSecure 2017). A brief synopsis of the regulations is included in this TM to provide context for comparing this alternative to the other GRRP options.

3.2.1 Australia's Framework for MBR Pathogen Removal Credit

Australia's framework for MBR pathogen removal crediting outlines a 3-tiered approach to awarding credit (WaterSecure 2017):

- **Tier 1** consists of default, conservative LRVs based on historical MBR performance data. The LRVs also have default operating conditions that must be maintained to receive the credit.
- **Tier 2** involves more rigorous testing of the system to first determine the worst-case (and most conservative) site-specific operating conditions, and then determine the minimum LRVs achieved during those conditions. Through this approach, both the LRVs and operating conditions would be determined, and may or may not be different than those permitted for Tier 1.
- **Tier 3** is currently a hypothetical approach until further research is conducted, and includes the development of a correlation between measurable, online parameters and pathogen removal performance.

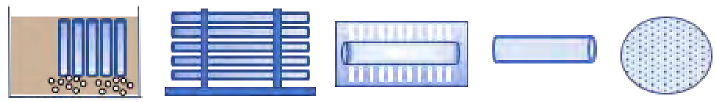
Australia's guidelines to achieve Tier 1 credit specify the operating conditions shown in Table 5, which apply only to submerged MBR systems operated within their design specifications and with a nominal pore size of 0.04 – 0.1 μm (WaterSecure 2017).

Table 5 – Tier 1 MBR Operating Conditions and LRVs

Parameter	Operating Range	
	Min	Max*
Bioreactor pH	6	8
Bioreactor dissolved oxygen (mg/L)	1	7
Bioreactor temperature (C)	16	30
Solids retention time (d)	11	--
Hydraulic retention time (h)**	6	--
Mixed Liquor suspended solids (g/L)	3	--
Transmembrane pressure (kPa)	3	--
Flux ($L/m^2/h$)	--	30
Turbidity (NTU)	--	0.2
Pathogen Type	**Default LRV**	
Virus	1.5	
Giardia/*Cryptosporidium*	2	
Bacteria	4	
* The '--' denotes no limit ** Hydraulic retention time as calculated based on total influent volume from the last 24 hours of operation		

3.3 Groundwater Recharge Project Facility with MBR – Alternative 4b

As described for the non-potable reuse application with MBR (Alternative 2), Alternative 4b was assumed to have an MBR with two parallel aerobic basins, using an initial anoxic zone and MF filters for solids separation. All ancillary equipment to operate the system is also included in the estimates. Table 6 includes the capital, O&M and site layout estimates for this alternative. This alternative considers an AWTF with an MBR, RO, UV/AOP, post treatment, and free chlorine disinfection. Similar to the other GRRP alternatives, the chlorine disinfection CT would be achieved in the pipeline from the AWTF to the injection wells. Figure 4 shows the proposed treatment train for Alternative 4b, and includes the anticipated LRV credits awarded to each process as well as the regulatory requirements for overall treatment for a GRR project.



	MBR	RO	UV/AOP	Free Chlorine	Aquifer	TOTAL	REQUIRED
	Anticipated Pathogen Log Removal Credits						
Virus:	1.5*	1.5 - 3.5	6	1 - 6	2 - 6	12 – 23	12
Giardia:	2*	1.5 - 3.5	6	1 - 3	--	10.5 – 14.5	10
Cryptosporidium:	2*	1.5 – 3.5	6	0	--	10^ – 11.5	10

* Estimated LRV credit based on Australia's framework for MBR pathogen removal crediting - Tier 1
^ Assumes unit processes would be combined to achieve the minimum LRV requirements

Figure 4 - Proposed treatment train for Alternative 4b including typical LRV credits for each process and regulatory requirements for GRR projects

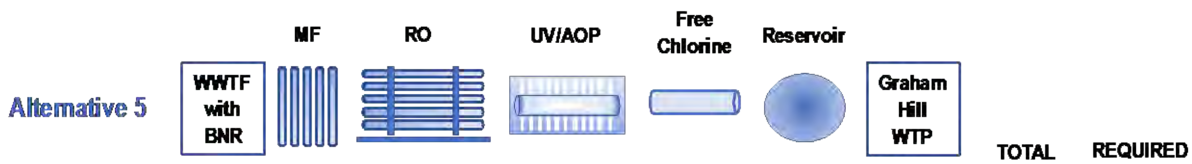
The system would still be required to achieve 12/10/10 of virus, *Giardia*, and *Cryptosporidium* LRVs to satisfy all requirements for a GRR project with a minimum of two months retention time in the ground. If DDW adopts similar guidelines to those of Australia, the Tier 1 approach would give an LRV of 2 for *Giardia*/*Cryptosporidium* in comparison to the 4 LRVs awarded when using a conventional MF. This 2 LRV deficit is assumed to be covered for *Giardia* by the inclusion of free chlorine, which can achieve up to 1-3 LRV credits. To maintain 10 LRV credits for *Cryptosporidium*, the RO system would need to be operated such that an LRV of 2 can be demonstrated.

Table 6 - Facility Layout and Cost Estimates for GRRP with MBR Alternative 4b

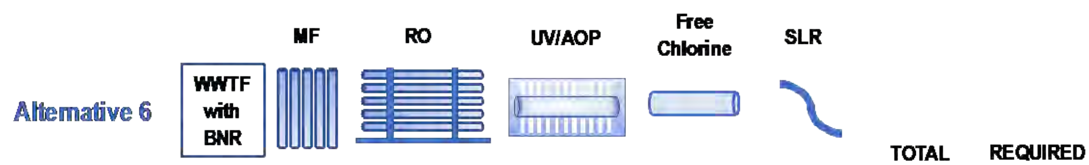
Alternative:	**4b**	
Product Water (mgd)	2.0	
Footprint (sf)	49,000	
Unit Process	**Unit Cost ($/gpd capacity)**	**Cost, $M**
MBR	$15.07	$30.14
RO	$4.19	$8.38
UV/AOP	$0.75	$1.50
Post Treatment and Chemical Handling	$1.20	$2.40
Free Chlorine	$0.16	$0.33
Total Capital ($M)	**$42.7**	
O&M Type	**Unit Cost**	**Cost, $M/yr**
Chemicals	$101/AF	$0.23
Electrical	4898 kwh/MG	$0.72
Equipment	$195/AF	$0.44
Labor	5.0 FTE/yr	$0.81
Total O&M ($M/yr)	**$2.19**	

3.4 Surface Water and Streamflow Augmentation Facility – Alternatives 5 and 6

The City is considering both SWA and streamflow augmentation to increase local sources of drinking water. Alternative 5 would include an AWTF with the product water flow being discharged into Loch Lomond Reservoir. This project would fall into the potable reuse category of SWA, where the treated effluent must comply with multiple requirements, including both dilution and retention time requirements in the reservoir prior to treatment at a drinking water plant. Alternative 6 would include the same AWTF, but with the product water discharging into the San Lorenzo River to compensate for higher river withdrawals upstream. Figure 5 shows the proposed treatment trains for these alternatives, and includes typical LRV credits awarded to each process. The regulatory requirement for total LRV credits at the AWTF is also included for Alternative 5. There is no existing regulatory requirement or established criteria for streamflow augmentation.



Alternative 5	WWTF with BNR	MF	RO	UV/AOP	Free Chlorine	Reservoir	Graham Hill WTP	TOTAL	REQUIRED
	Anticipated Pathogen Log Removal Credits								
Virus:	--*	0	1.5 - 3.5	6	1 - 6	--	4	13^ – 19.5	13
Giardia:	--*	4	1.5 - 3.5	6	1 - 3	--	3	15.5 – 19.5	11
Cryptosporidium:	--*	4	1.5 – 3.5	6	0	--	2	13.5 – 15.5	11



Alternative 6	WWTF with BNR	MF	RO	UV/AOP	Free Chlorine	SLR	TOTAL	REQUIRED
	Anticipated Pathogen Log Removal Credits							
Virus:	--*	0	1.5 - 3.5	6	1 - 6	--	8.5 – 15.5	n/a
Giardia:	--*	4	1.5 - 3.5	6	1 - 3	--	12.5 – 16.5	n/a
Cryptosporidium:	--*	4	1.5 – 3.5	6	0	--	11.5 – 13.5	n/a

* LRV credit of 1 – 2 logs possible for each pathogen with upgrade to BNR secondary wastewater treatment

^ Assumes unit processes would be combined to achieve the minimum LRV requirements

Figure 5 - Proposed treatment train for SWA and streamflow augmentation alternatives 5 and 6 with typical LRV credits for each process and regulatory requirements for SWA

TM 1A discussed the most recent draft SWA regulations from June 2015 (NWRI 2015, Trussell Technologies 2016), which has yet to be updated. Therefore, the treatment requirements for Alternative 5 would adhere to the regulations discussed in TM 1A. It was assumed that if the water treatment is suitable for reservoir augmentation, it would also be suitable for streamflow augmentation, proposed for Alternative 6. The water produced through the treatment train at the proposed AWTF would be a high clarity, well oxygenated water that is low in nutrients and organics. Although Alternatives 5 and 6 would discharge into different surface water bodies, it was assumed that the same water quality standards would apply to both receiving waters. Therefore, the proposed AWTF treatment processes would be the same for both alternatives.

An important distinction between the GRRP alternatives and the SWA and DPR alternatives is the proposed pre-treatment for the AWTF feed water. As discussed in Section 3.1, it was assumed for the GRRP alternatives analysis that the existing wastewater treatment at Santa Cruz WWTF would be sufficient for the AWTF feed water. In contrast, it is recommended that the feed water be fully nitrified and filtered for an AWTF providing water for SWA or DPR. The State Expert Panel appointed to advise DDW on decisions relating to DPR recommended that wastewater treatment include biological nutrient removal (BNR) prior to an AWTF (Olivieri et al. 2016). At this time, the potable recycled water projects in California considering SWA are planning to provide nitrified (and partially denitrified) feed water to the AWTF, i.e., SWA projects for both the City of San Diego and at Padre Dam Municipal Water District. Therefore, it is conservative and appropriate to plan for an updated secondary wastewater treatment process in addition to the cost and layout estimates presented in this TM.

For example, the San Lorenzo River has a TMDL of 1.5 mg/L nitrate as N. Meeting the discharge limits for the San Lorenzo River and Loch Lomond Reservoir may be important drivers for improved secondary wastewater treatment, as the nitrogen removal through the AWTF alone may not be sufficient to achieve the TMDL for the proposed receiving waters. A nitrification/denitrification process at the WWTF could provide further control of nutrients that, in conjunction with the AWTF, may allow for discharge into both the reservoir and river.

High-level estimates for capital costs, operation and maintenance (O&M) costs, and facility layout requirements are shown in Table 7. Both alternatives assume the same treatment train: MF, RO, UV/AOP, post treatment, and free chlorine. As was proposed for the GRRP alternatives, the contact time for free chlorine disinfection would be achieved in the pipeline from the AWTF to the reservoir. This would require measurement of the chlorine residual near the reservoir for reporting purposes, and then dechlorination prior to discharge into the reservoir. The following assumptions were made when determining these estimates:

- Nitrified feed water would be available for the AWTF. Costs and layout requirements associated with producing nitrified feed water were not included in this assessment.
- LRV of 13/11/11 for virus/*Giardia*/*Cryptosporidium* would be achieved through the combined treatment at the AWTF and the Graham Hill WTP; a minimum of 9/8/9 would be achieved at the AWTF in compliance with the draft SWA regulations
- Product water storage costs and layout requirements were not included in this estimate.
- The proposed receiving waters (San Lorenzo River and Loch Lomond Reservoir) have the same water quality requirements, and so the same degree of treatment at the AWTF would be sufficient for both waters.
- A minimum of 10:1 dilution would be achieved in Loch Lomond Reservoir
- A 6-month V/Q would be achieved in Loch Lomond Reservoir

Table 7 - Facility Layout and Cost Estimates for SWA and Streamflow Augmentation Alternatives 5 and 6

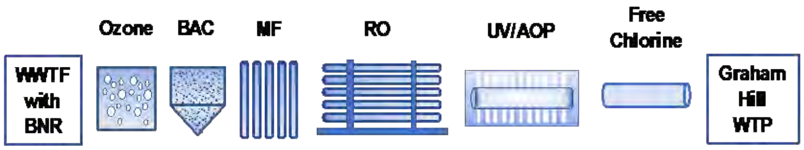
Alternative:	**5**		**6**	
Product Water (mgd)	3.2		3.2	
Footprint (sf)	39,000		39,000	
Unit Process	**Unit Cost ($/gpd capacity)**	**Cost, $M**	**Unit Cost ($/gpd capacity)**	**Cost, $M**
MF	$2.75	$8.80	$2.75	$8.80
RO	$4.30	$13.76	$4.30	$13.76
UV/AOP	$0.16	$0.52	$0.16	$0.52
Post Treatment and Chemical Handling	$1.20	$3.84	$1.20	$3.84
Free Chlorine	$0.75	$2.40	$0.75	$2.40
Total Capital ($M)	**$29.3**		**$29.3**	
O&M Type	**Unit Cost**	**Cost, $M/yr**	**Unit Cost**	**Cost, $M/yr**
Chemicals	$101/AF	$0.36	$101/AF	$0.36
Electrical	3061 kwh/MG	$0.72	3061 kwh/MG	$0.72
Equipment	$186/AF	$0.67	$186/AF	$0.67
Labor	5 FTE/yr	$0.95	5 FTE/yr	$0.95
Total O&M ($M/yr)	**$2.69**		**$2.69**	

3.5 Direct Potable Reuse Facility – Alternative 7

The City is considering one alternative for Direct Potable Reuse, Alternative 7. This option would consist of the highest degree of advanced treatment of all the alternatives, and assumes the final effluent would be mixed with raw water entering the Graham Hill WTP. Because this is the most direct form of potable reuse being considered by the City, the most stringent treatment requirements regarding pathogen and chemical contaminant control would apply.

The current state of regulation development for DPR in California was discussed in TM 1A. Although there are no existing regulations, the feasibility of the practice is still being assessed, with a major focus on the question of DPR safety and protection of public health. The State Expert Panel has concluded that it is feasible to create uniform regulations for DPR in California (Olivieri et al. 2016). DDW has provided a final report on the feasibility of DPR to the legislature, with recommendations for additional research to be conducted to add to existing knowledge on the safety and reliability of the practice (SWRCB 2016).

Due to the uncertainty of the treatment requirements for DPR, the AWTF proposed for Alternative 7 is conservative, providing a range of LRVs of >13-20/>11-19/>11-16 for virus/*Giardia*/*Cryptosporidium*. This facility, would consist of ozone, BAC, MF, RO, UV/AOP, post treatment, and free chlorine disinfection, and has been shown to provide superior public health protection (Pecson et al. 2017). As was the case for SWA, BNR would proceed the AWTF. Figure 6 shows the proposed treatment train for Alternative 7 as well as typical LRV credits awarded to each treatment process. Because the regulatory requirements for total LRV credits through treatment are not defined, a range of values is included in the figure.



	WWTF with BNR	Ozone	BAC	MF	RO	UV/AOP	Free Chlorine	Graham Hill WTP	TOTAL	REQUIRED
	Anticipated Pathogen Log Removal Credits									
Virus:	--*	1 - 6	--	0	1.5 - 3.5	6	1 - 6	4	13.5 – 25.5	>13 – 20^
Giardia:	--*	1 - 6	--	4	1.5 - 3.5	6	1 - 3	3	16.5 – 25.5	>11 – 19^
Cryptosporidium:	--*	1 - 3	--	4	1.5 – 3.5	6	0	2	14.5 – 18.5	>11 – 16^

* LRV credit of 1 – 2 logs possible for each pathogen with upgrade to BNR secondary wastewater treatment

^ LRV requirements are not established for DPR, but minimum requirements will likely be > than draft SWA requirements

Figure 6 - Proposed treatment train for DPR Alternative 7 with typical LRV credits for each process, as well as estimated regulatory requirements

The high-level estimates for capital and O&M costs, and facility layout requirements are shown in Table 8. The following assumptions were made in determining these estimates:

- Nitrified feed water would be available for the AWTF. Costs and layout requirements associated with producing nitrified feed water were not included in this assessment.
- LRV of >13-20/>11-19/>11-16 for virus/*Giardia*/*Cryptosporidium* would be achieved through treatment at the AWTF
- Product water storage costs and layout requirements were not included in this estimate.

Table 8 - Facility Layout and Cost Estimates for DPR Alternative 7

Alternative:	7	
Product Water (mgd)	3.2	
Footprint (sf)	46,000	
Unit Process	**Unit Cost ($/gpd capacity)**	**Cost, $M**
Ozone Disinfection	$1.56	$4.99
BAC	$2.60	$8.32
MF	$2.12	$6.78
RO	$4.42	$14.14
UV/AOP	$0.52	$1.67
Post Treatment and Chemical Handling	$0.57	$1.82
Free Chlorine	$0.16	$0.52
Total Capital ($M)	**$38.3**	
O&M Type	**Unit Cost**	**Cost, $M/yr**
Chemicals	$116/AF	$0.42
Electrical	4863 kwh/MG	$1.14
Equipment	$183/AF	$0.66
Labor	7 FTE/yr	$1.28
Total O&M ($M/yr)	**$3.49**	

4 - SUMMARY

A summary of all the alternatives presented in this TM 1B can be found in Table 9, including high-level estimates for capital costs, yearly O&M costs, and facility layout estimates. The project options for both non-potable and potable reuse vary in product water capacity as well as treatment technologies, with varying impact on costs and layout requirements. For example, the difference between choosing an MF versus granular media filtration for non-potable reuse (Alternatives 1b and 3b) has a marginal impact on cost and layout requirements, but the cost and layout differences between an MF and MBR for a GRR project (i.e. Alternatives 4a vs 4b) are substantial. Regardless of the various options for treatment technologies, all the alternatives were evaluated to include process trains that either comply with existing regulations, or would likely comply with future regulations based on the latest available information.

Table 9 – Summary of Facility Layout and Cost Estimates

Alternative		Capital Cost ($M)	O&M Cost ($M/yr)*	Facility Layout Estimate (sf)
Name	**Product Water (mgd)**			
Non-Potable Reuse				
Alt 1a	0.25	$0.5	$0.11	3,600
Alt 1b	0.74	$4.3 (GMF) $4.6 (MF)	$0.19	3,600 (GMF) 4,400 (MF)
Alt 2	0.12	$5.6	$0.12	2,200
Alt 3b	2.2	$8.4 (GMF) $10.5 (MF)	$0.55	9,900 (GMF) 9,600 (MF)
Potable Reuse – Groundwater Recharge				
Alt 3d	1.4	$16.3	$1.37	22,000
Alt 3e	3.4	$30.9	$2.79	41,000
Alt 4a	2.1	$21.3	$1.86	29,000
Alt 4b	2.0	$42.7	$2.19	49,000
Potable Reuse – Surface Water Augmentation/Streamflow Augmentation				
Alt 5	3.2	$29.3	$2.69	39,000
Alt 6	3.2	$29.3	$2.69	39,000
Direct Potable Reuse				
Alt 7	3.2	$38.3	$3.49	46,000
Potable Reuse – Regional Groundwater Recharge				
Alt 8a	5.0	$42.7	$3.98	56,000
Alt 8b	3.7	$33.4	$3.07	44,000
Notes: *O&M costs were only estimated for GMF; O&M costs associated with MF were not considered				

5 - REFERENCES

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Appendix A.4

X-500 Pasteurization System
Proposal for Santa Cruz's WWTP

Pasteurization Technology Group

2306 Merced St.

San Leandro, CA 94577

(510) 357-0562

Proposal

PTG would like to offer to the City of Santa Cruz, its Title 22 Certified 500,000 gallon per day, skid mounted disinfection system for $48,000.00. This unit cost over $350,000 to build originally, but since it has been operated by both Ventura Water and Melbourne Water over the past 6 years, the price is being drastically reduced. The system will have been upgraded and refurbished, prior to delivery to the City of Santa Cruz and PTG guarantees the performance of this equipment.

This unit consumes approximately 25.0 BTU/ gallon of water to be disinfected. At a water flow rate of 0.25MGD, this system will consume about 6,250,000 BTU of natural gas per day. At current natural gas rates of approximately $5.00/ MBTU it will use about $31.25 per day to operate.

The system also has remote monitoring capability built into the Control Software for easy plant operation and can be adapted to existing Santa Cruz SCADA software.

PTG will train and support the installation of the equipment so that the Santa Cruz staff are able to operate the system safely and efficiently.

Process Overview

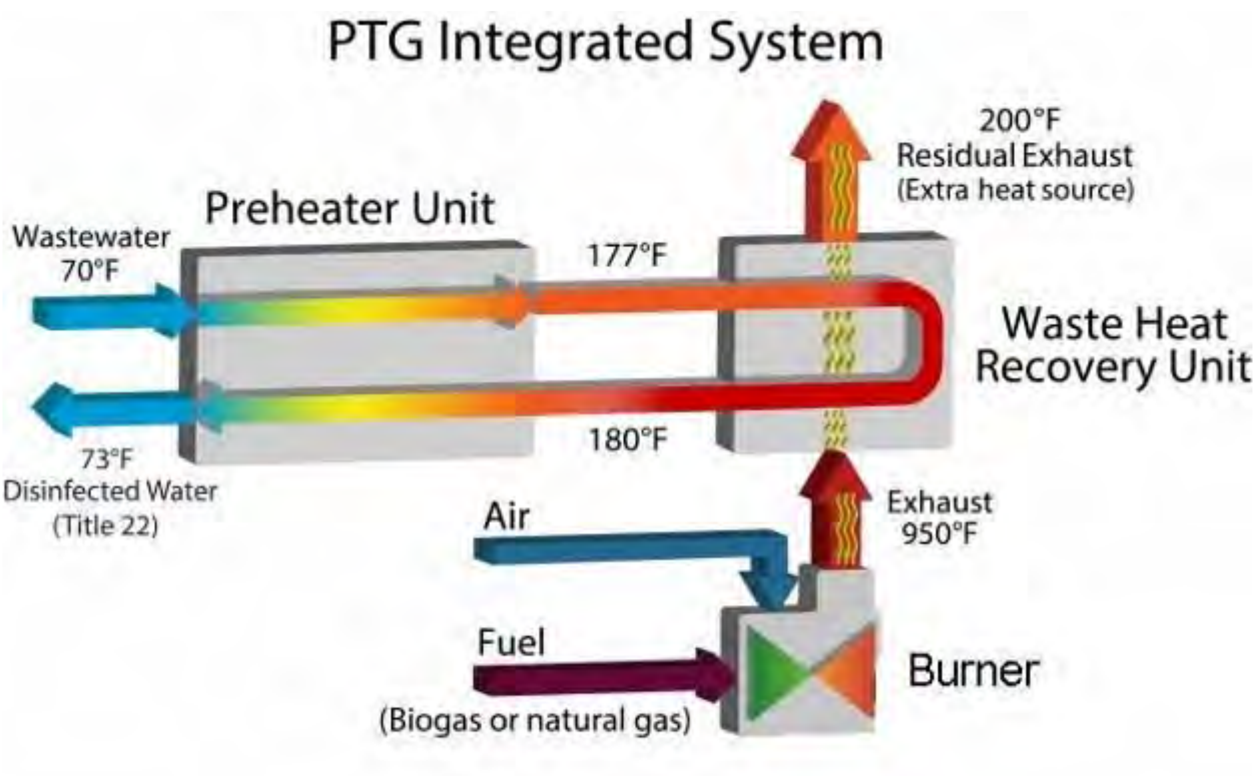


Figure 1: Process Overview. Note: temperatures shown are approximate and will vary depending upon specific application requirements

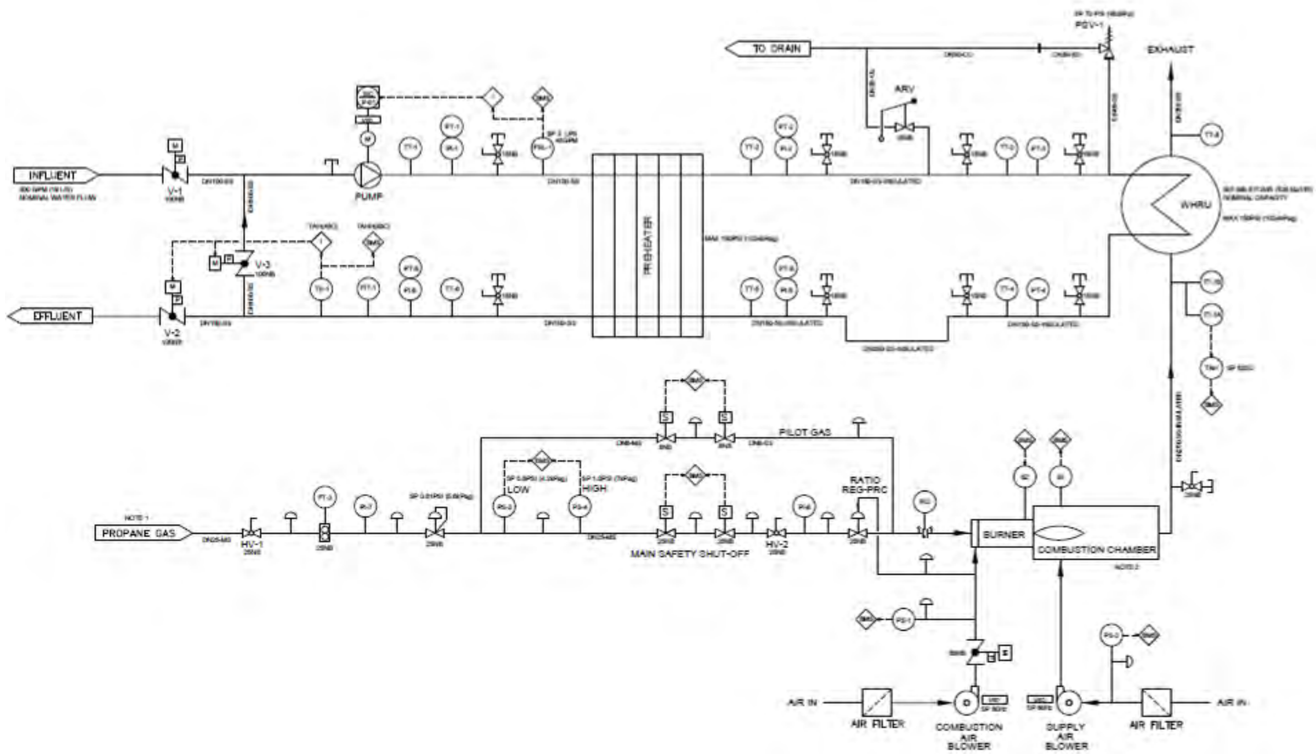


Figure 2: Process & Instrumentation Diagram

Major Components

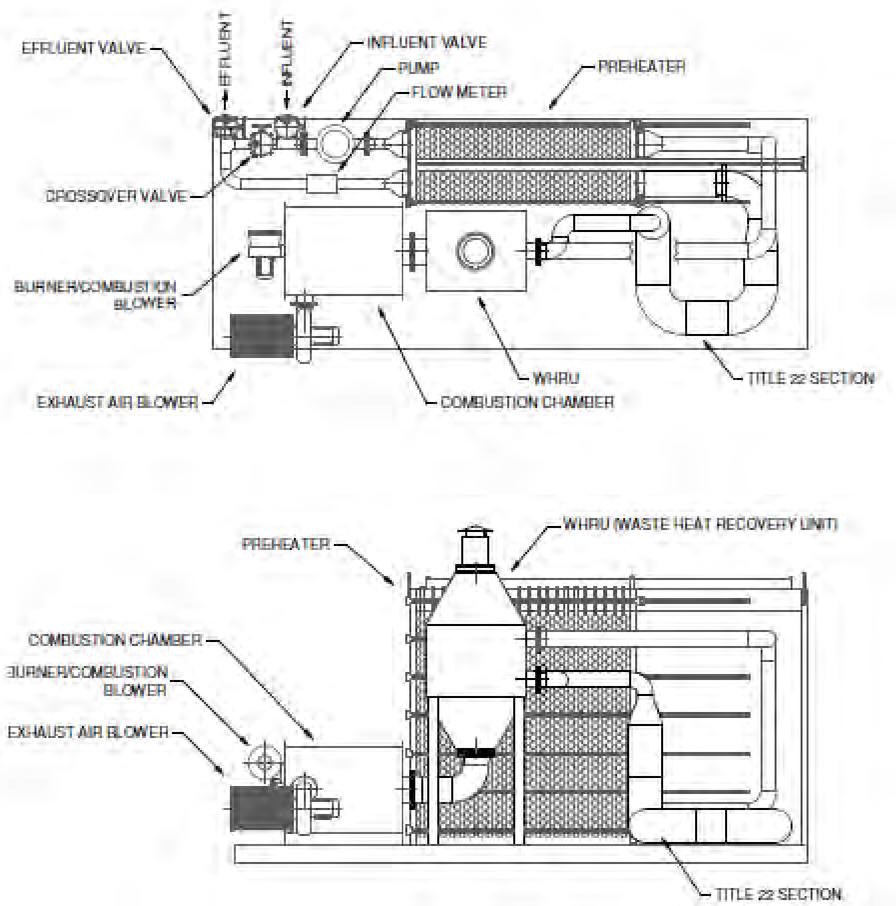


Figure 3: Major Components

Title 22 Section
Insulated plumbing section between WHRU and Preheater designed to maintain water above pasteurization temperature with >20 seconds residence time.

Burner
Natural gas fired, capable of supplying 1.0 million BTU/Hr. Will vary output as needed to meet the total range of demands without venting excess heat. Burner consists of Exhaust Air Blower, Burner Combustion Blower and Combustion Chamber.

Gas Train for 1MM BTU Ratiomatic Burner
- DMVDLE 701/622 Dual safety shut of valve w/CPI, Karl Dungs Inc.
- FRI 707/6 Regulator, 1", Karl Dungs Inc.
- GAO-A2-4-5 Low Gas Pressure Switch 2-20" W.C., Karl Dungs Inc.
- GAO-A2-4-6 High Gas Pressure Switch 12-60" W.C, Karl Dungs Inc.
- (2) 1" NPT Ball Valves, Karl Dungs Inc.
- Pressure Gauge 0-30 PSI
- Pressure Gauge 0-30" W.C.

Preheater
GEA stainless steel gasketed plate and frame construction. Designed for a 3 degree approach temperature at 400 gpm for influent water between 45 and 80 F.

Waste Heat Recovery Unit (WHRU)
IHT shell and tube heat exchanger capable of raising 400 gpm water flow 3 degrees F or the difference between the preheater effluent and 180 F.

Feed Pump
PACO 40127-VL equipped with variable speed drives to operate in parallel operation to move water thru the pasteurization system with sufficient head and flow.

Pressure Relief Valve
The pressure relief valve is a safety device designed to protect the pressurized system during an over-pressure event. An overpressure event refers to any condition which would cause pressure in the system to increase beyond the specified design pressure or maximum allowable working pressure (MAWP). The valve on the system is rated for 70 psi.

Combination Air Release and Vacuum Relief Valve
The purpose of the combination air valve is to release trapped air and to protect the system from vacuum. The valve is installed on a high point of the system.

Combination Air Valves prevent accumulation of air at high points within a system by exhausting large volumes of air as the system is filled and releasing accumulated pockets of air while the system is operational and under pressure. They also prevent potentially destructive vacuums from forming by admitting large quantities of air into the system. This can occur during power outage, water column separation or sudden rupture of the pipeline. Additionally, these valves allow the system to be easily drained because air will re-enter as needed.

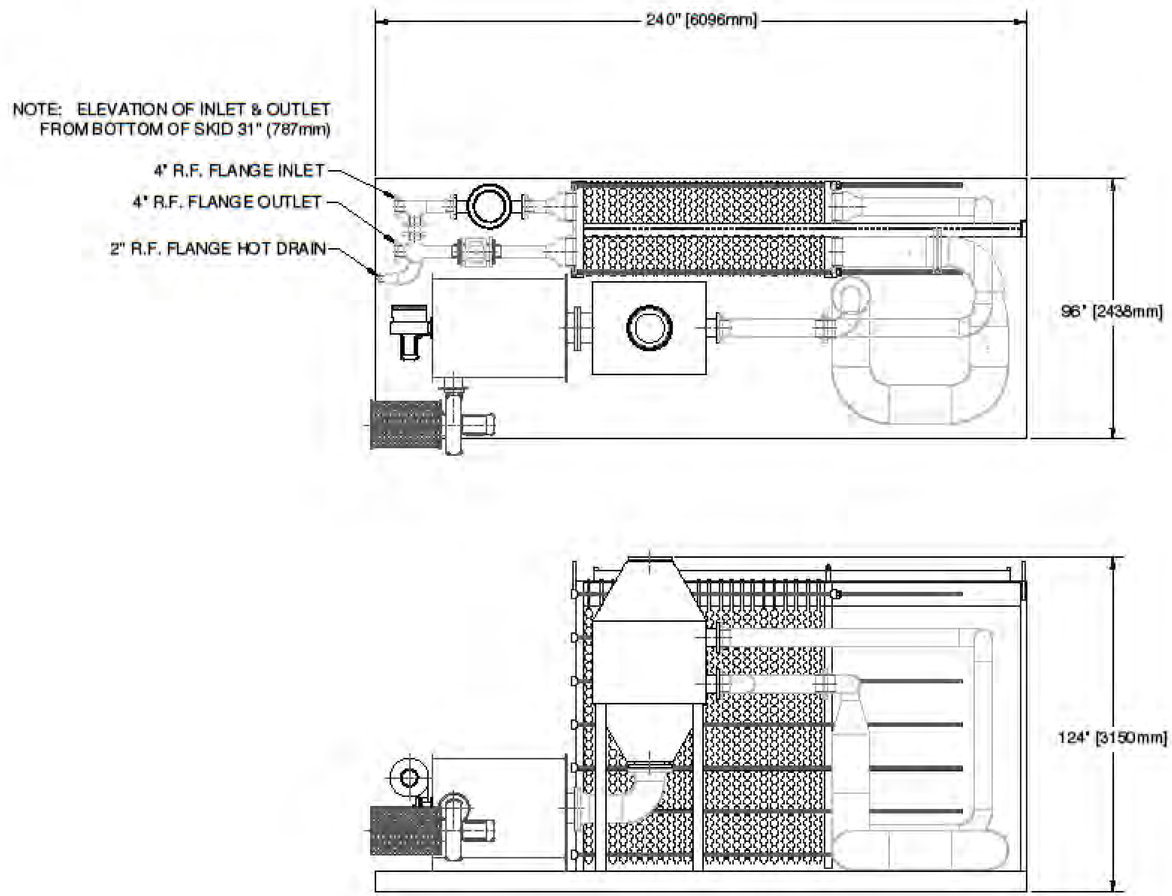
Flow Meter
Omega Magnetic Flowmeter System consists of a sensor and transmitter, and measures volumetric flow rate by detecting the velocity of a conductive liquid that passes through a magnetic field.

Control Panel
Steel enclosure containing the programmable logic controller (PLC), power supplies, I/O modules, breakers, variable frequency drive (VFD) for the system motors, fuses, and relays required to control the system.

Actuated Butterfly Valves
Resilient seated, lug style. Both OPEN/CLOSE and MODULATED actuators are used. The seat in a resilient seated butterfly valve has molded O-rings on its flange face. As a result, no gaskets are required as these O-rings serve the function of a gasket. The flange face and molded O-rings of the seat extend beyond the body face-to-face to ensure sealing at the flange faces.

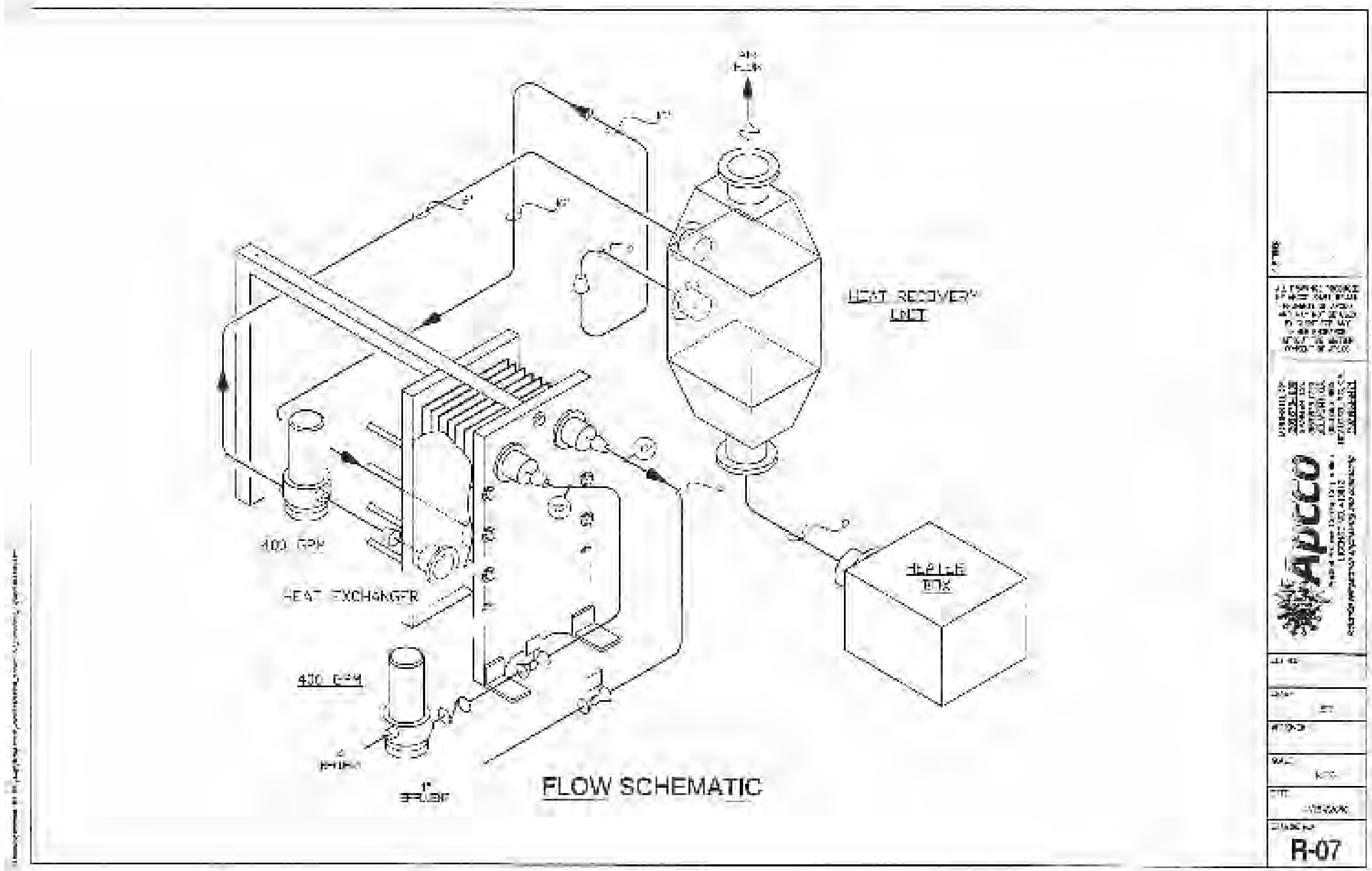
SYSTEM SPECIFICATIONS

X-500 SYSTEM SPECIFICATIONS	
Electrical	
Electrical Requirement	400-480 VAC , 3-Phase, 4 wire
Maximum Current Draw	50 Amps
Electrical Enclosure	NEMA 4
Fuel	
Type	Pipeline natural gas
Minimum Gas Pressure	2.5 PSIG
Maximum Gas Pressure	7 PSIG
Minimum Burner Heat Rate	30,000 BTU/hr
Maximum Burner Heat Rate	1, 137,000 BTU/hr
Maximum Burner Temperature	1150°F
Water	
Influent Connection	4” 150# flange
Effluent Connection	4” 150# flange
Hot Water Drain Connection	4” 150# flange
Minimum Influent Pressure	3 PSIG
Maximum Influent Pressure	60 PSIG
Maximum Effluent Backpressure	5 PSIG
Process Pressure Relief Valve	70 PSIG
Nominal Water Flow	300 GPM
Minimum Water Flow	150 GPM
Maximum Water Flow	400 GPM
Title 22 Holdup Volume	117 GAL
Heat Exchanger Design	ASME VIII, Division 1
Skid	
Skid Dimensions	L 244” x W 98” x H 144”
Skid Weight, Dry	31,000 LBS

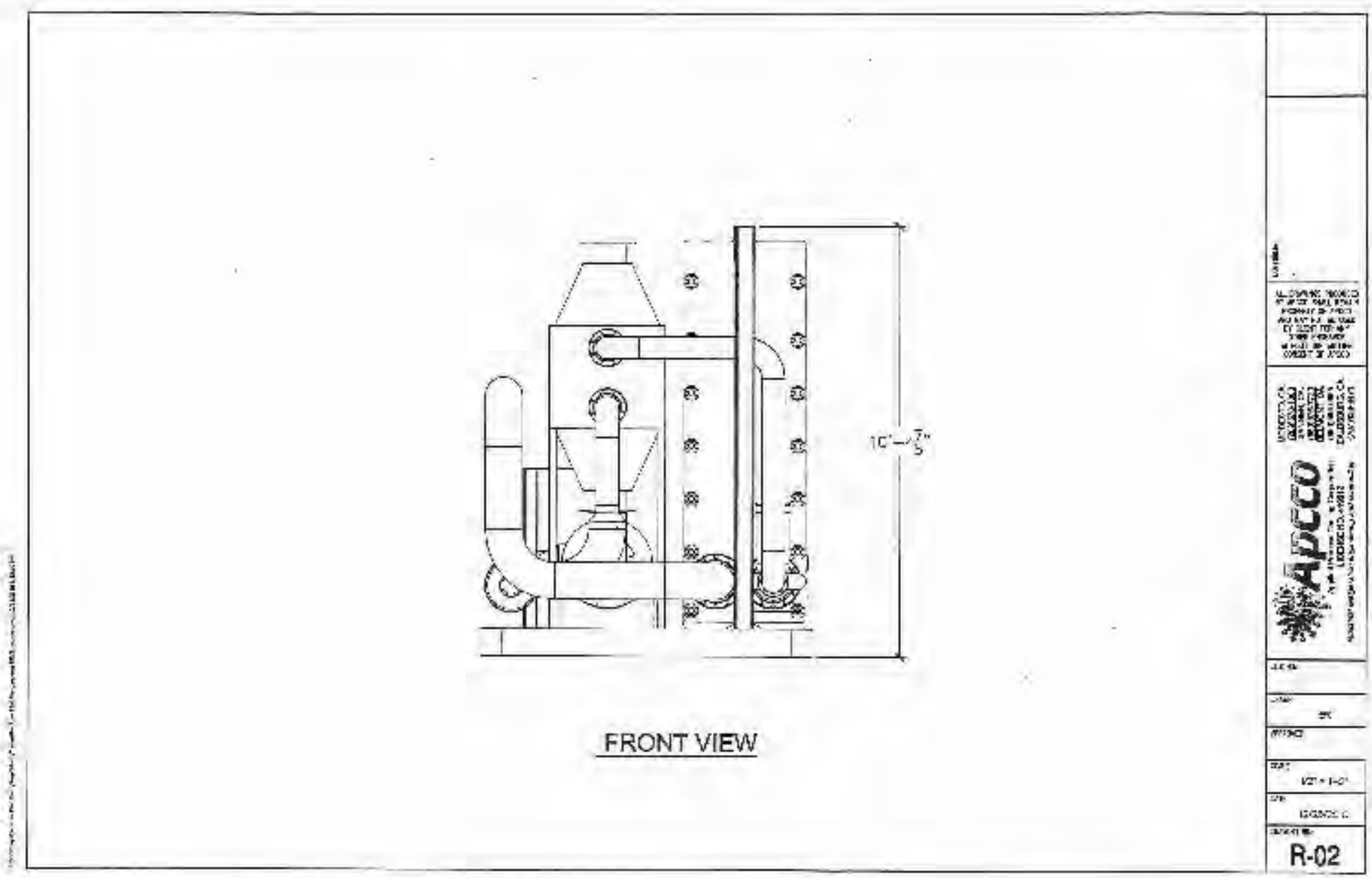


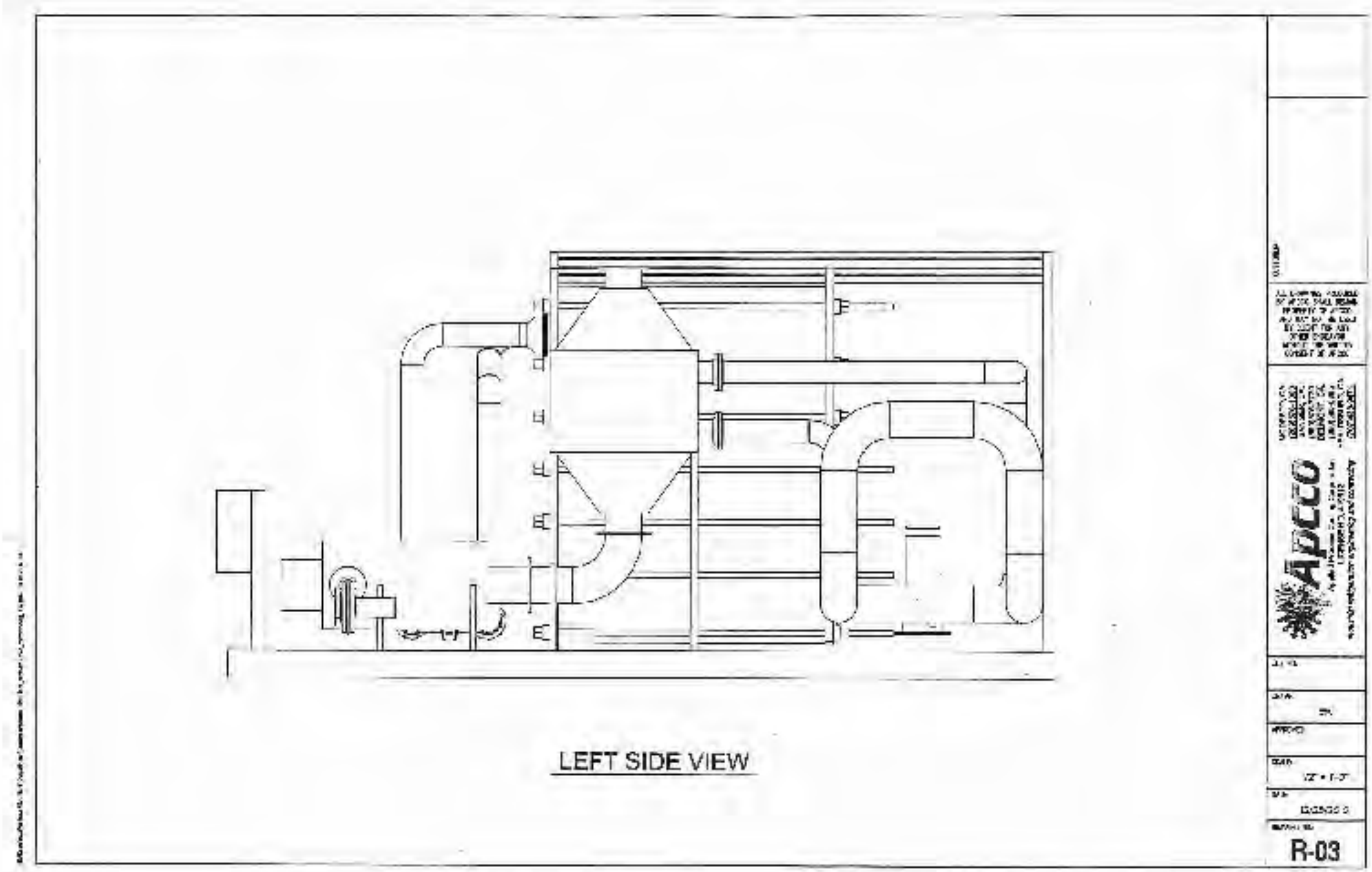
SYSTEM DRY WEIGHT 31,000 LBS (14,000 KG)

DBELL	PASTEURIZATION TECHNOLOGY GROUP
DBELL	
VLAD	X500 GENERAL ARRANGEMENT
VLAD	
12/18/14	B
1/1	DOC-000018 C

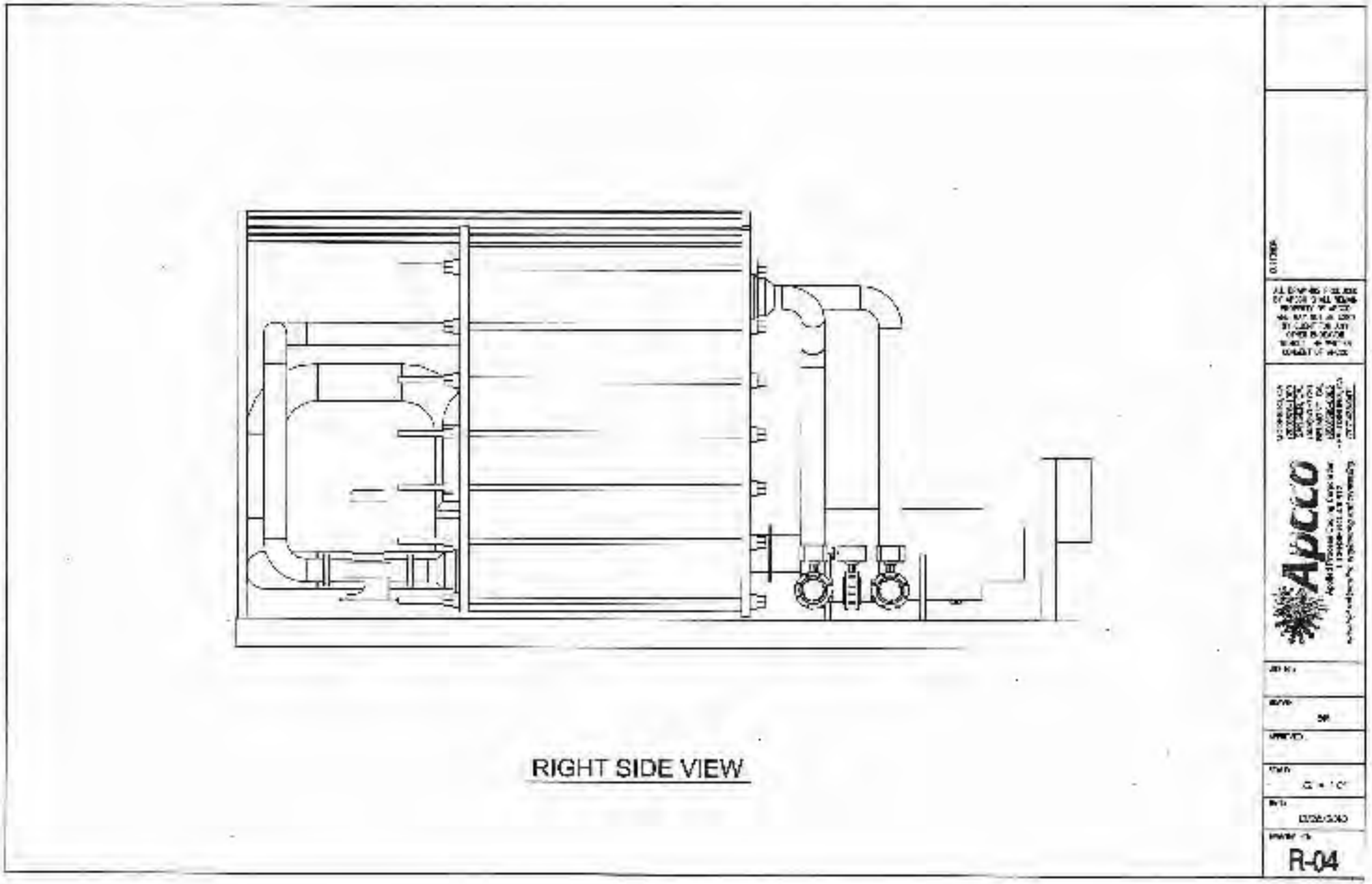


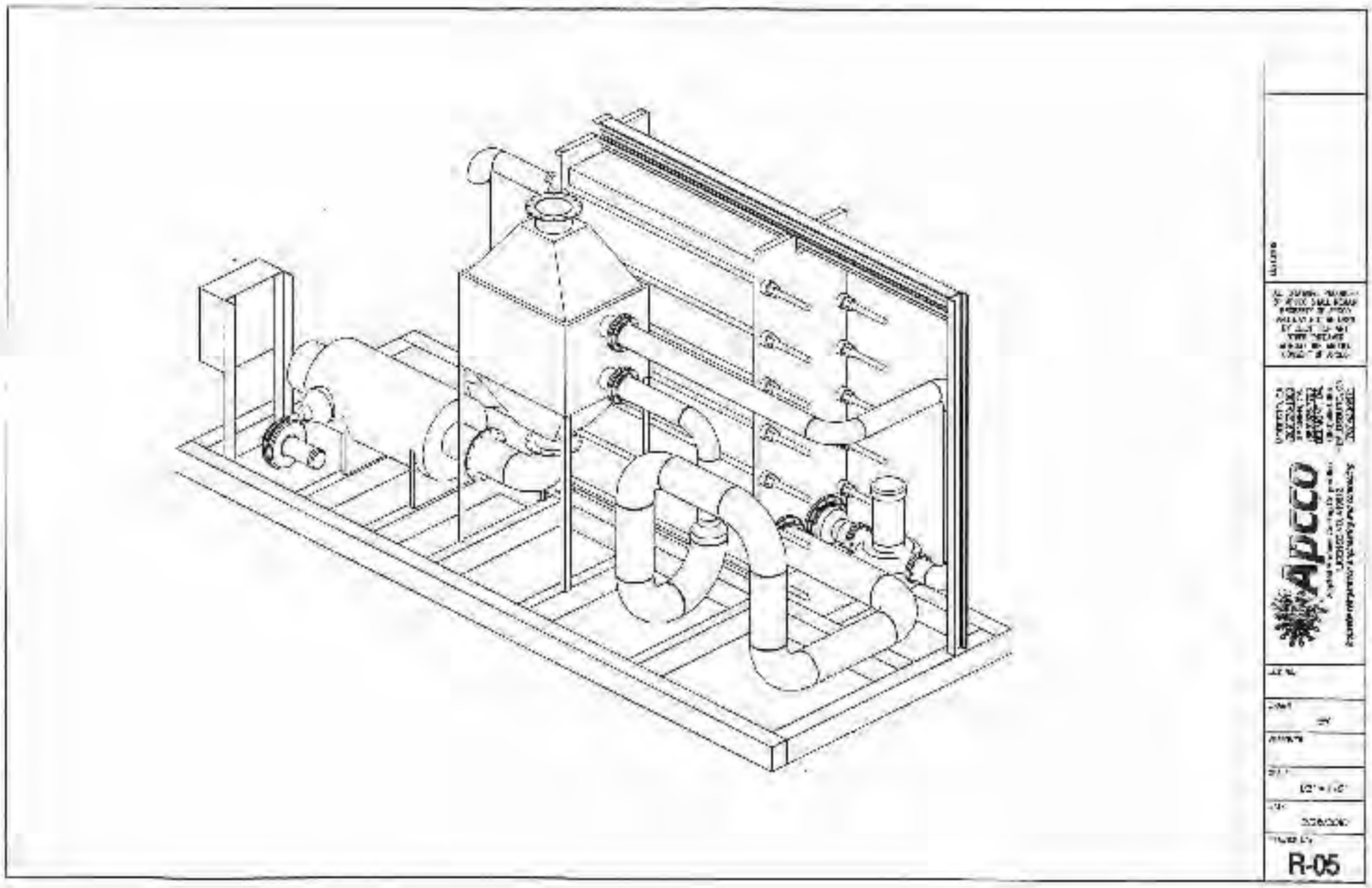
AIR FLOW
HEAT RECOVERY UNIT
HEATER BOX
400 GPM
HEAT EXCHANGER
400 GPM
1" EFFLUENT
FLOW SCHEMATIC
Apcco
R-07

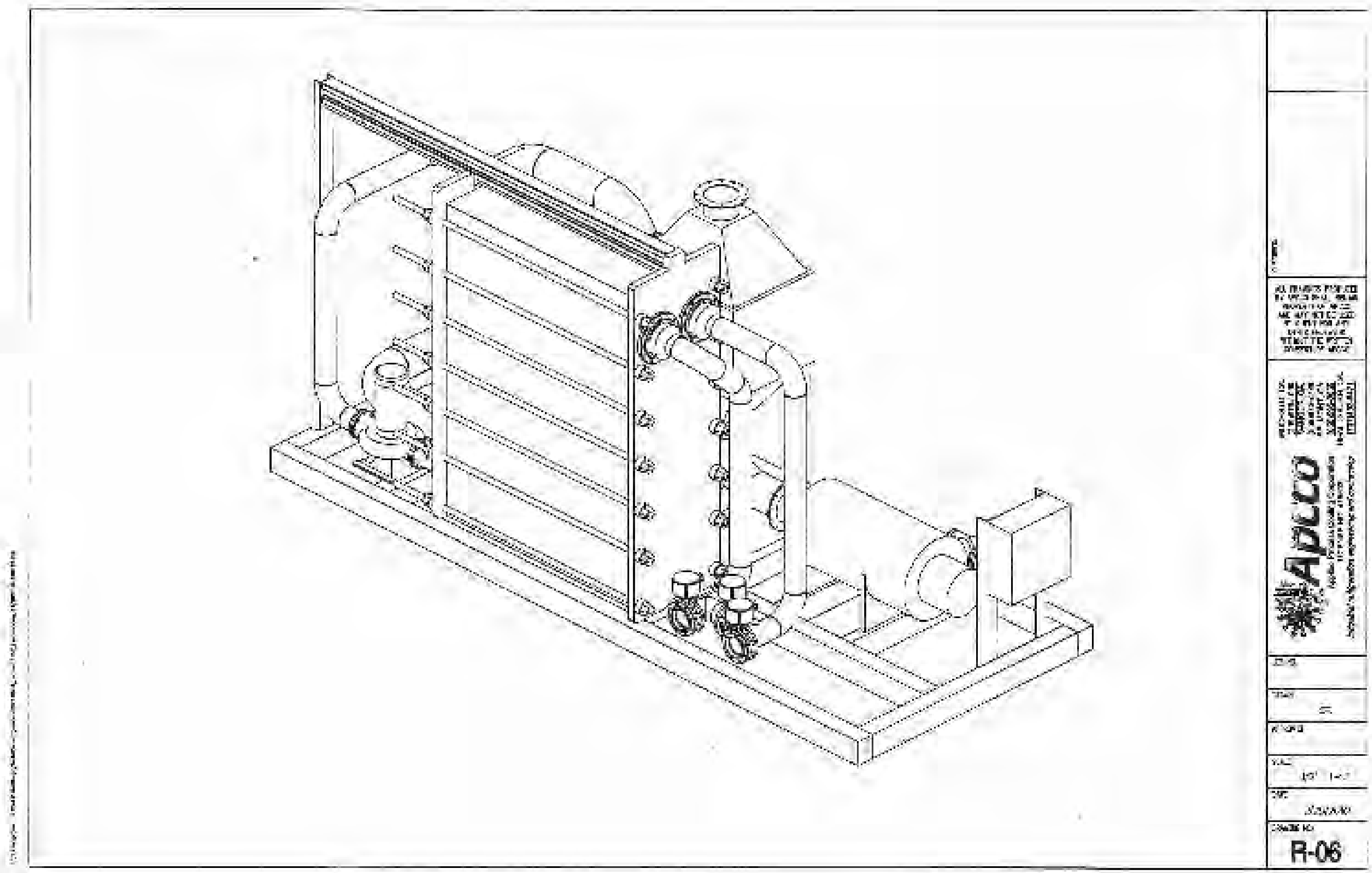

10'-7/8"
FRONT VIEW
APCCO
R-02



LEFT SIDE VIEW
APCCO
1/2" = 1'-0"
R-03


RIGHT SIDE VIEW
Apcco
R-04


R-05


Apcco
R-06

Appendix B: Non-Potable Demand Data

This appendix includes supporting information for the assessment of non-potable demands for the recycled water market assessment.

B.1 Recycled Water Demand Projection

As described in Section 6.2, 2013-meter data from the City was used to estimate the potential recycled water demand. 2013 demand is higher than the most recent 2015 demand. However, it is comparable to the projected 2035 non-domestic residential demand for the City identified in the 2015 UWMP (SCWD 2016). Table B-1 shows the projected demand by type of use. The total non-domestic residential demand in 2035 is 0.00274 mgd (3.07 AFY) and is close to the total 2013 non-domestic residential meter data 0.00272 mgd (3.05 AFY).

Table B-1: City of Santa Cruz Water Demand Projections (2015 - 2035)

Category	Use Type	Additional Description	Actual Demand (mgd)	Projected Demand (mgd)			
			2015	2020	2025	2030	2035
Domestic Residential	Single Family	Individually meter dwellings	2.29	3.50	3.35	3.26	3.21
	Multi-Family	2 or more dwelling units	1.47	2.12	1.96	1.89	1.86
		Total Domestic Residential	3.76	5.61	5.31	5.15	5.06
Non_Domestic Residential	Commercial		1.33	1.57	1.48	1.44	1.42
	Industrial		0.12	0.15	0.16	0.16	0.17
	Other	UC Santa Cruz	0.44	0.54	0.64	0.74	0.84
	Institutional/Governmental	Municipal (city) accounts	0.10	0.13	0.12	0.11	0.11
	Landscape	Dedicated Irrigation Accounts	0.13	0.31	0.33	0.37	0.39
	Landscape	Golf Irrigation	0.24	0.16	0.14	0.13	0.13
		Total Non-Domestic Residential	2.35	2.85	2.87	2.95	3.07
	Losses		0.61	0.65	0.66	0.68	0.69
TOTAL			6.72	9.12	8.84	8.78	8.82

Source: Table 4-1 and Table 4-3 City of Santa Cruz 2015 Urban Water Management Plan (SCWD 2016)

B.2 Meter Data Account Types

Meter data is classified into the account types shown in Table B-2. A summary of metered demand for each account type is provided in Table B-3.

Table B-2: City of Santa Cruz Meter Data Account Types

Category	Account Type	Description of Use
Irrigation	ir-glf	Golf Course
	ir-bus	Business
	ir-NC	North Coast
	ir-res	Residential
Commercial	indust	Industrial
	b-gen	General
	b-hotl	Hotel
	b- rest	Restaurant
City Owned	indept	City owned accounts
University of California Santa Cruz	ucsc	City meter was not used. UCSC sub-meter data was used instead.

Table B-3: Summary of Metered Non-Domestic Demand by Account Type

Category	Acct Type	All Non-Domestic Meters			Large Meters Only	
		Annual Average (mgd)	Annual Average (AFY)	Total # of Meters (#)	Annual Average for meters with >10 AFY demand (AFY)	Total # of Meters with > 10 AFY Demand (#)
Irrigation	ir-glf	0.30	333	6	331	5
	ir-bus	0.20	224	262	44	2
	ir-res	0.11	124	200	0	0
	ir-nc	0.07	78	38	31	1
Subtotal Irrigation		**0.68**	**759**	**506**	**406**	**8**
Commercial	indust	0.15	170	38	121	2
	b-gen	1.21	1360	1703	336	21
	b-hotl	0.22	247	87	28	2
	b-rest	0.11	119	106	0	0
Subtotal Commercial		**1.69**	**1897**	**1934**	**484**	**25**
City Owned	indept	0.17	189	217	56	4
UCSC	ucsc	0.14	155	47	80	5
TOTAL All Meters		**2.68**	**3000**	**2704**	**1027**	**42**

B.3 Major Demands by Account Types

The potential recycled water users with demands more than 10 AFY are shown in the following tables. These tables do not show smaller users with demands less than 10 AFY.

Table B-4: Major Potential Recycled Water Users with Irrigation Accounts

Category	Acct Type	Account Holder	Account Number	Potential RW Demand (mgd)	Potential RW Demand (AFY)
Irrigation	ir-glf	DeLaveaga Golf Course	100-08030	0.12	138
	ir-glf	Pasatiempo Golf Course	100-08630	0.06	68
	ir-glf	Pasatiempo Golf Course	100-08645	0.05	58
	ir-glf	Pasatiempo Golf Course	100-08640	0.04	39
	ir-nc	Laguna Creek – North Coast Agriculture	199-02300	0.03	31
	ir-glf	Pasatiempo	100-08655	0.02	28
	ir-bus	Santa Cruz Memorial Cemetery	100-08600	0.02	24
	ir-bus	Santa Cruz High School	100-09975	0.02	19
			Subtotal Irrigation Demand	**0.36**	**406**

Note: Pasatiempo Golf Course is within the City's service area and has an annual irrigation demand of about 0.2 mgd. Pasatiempo Golf Course has signed an agreement with City of Scotts Valley to receive their secondary effluent directly from the Scotts Valley outfall, which it will treat with filters on-site to produce tertiary water to irrigate the golf course. Hence, Pasatiempo is not considered to be a potential recycled water customer for the City, although the use of recycled water from Scotts Valley will provide a regional benefit of a potable water offset.

Table B-5: Major Potential Recycled Water Users with Commercial Accounts

Category	Acct Type	Account Holder	Account Number	Potential RW Demand (mgd)	Potential RW Demand (AFY)
Commercial	b-gen	Harbor High School	100-04930	0.03	36
	b-gen	Good Shepherd School	067-02170	0.02	25
	b-gen	DeLaveaga Elementary	100-07875	0.02	22
	b-gen	City School (former Nat. Bridges)	100-02250	0.02	20
	b-gen	Green Acres Elementary	100-04950	0.01	15
	b-gen	Gardens Elementary	090-05500	0.01	14
	b-gen	SC Seaside Co	100-03810	0.01	13
	b-gen	Westlake School	100-00600	0.01	11
	b-gen	Chaminade Resort and Spa	100-07855	0.01	10
			Subtotal Commercial Demand	**0.15**	**167**

Table B-6: Major Potential Recycled Water Users with City Owned Accounts

Category	Acct Type	Account Holder	Account Number	Potential RW Demand (mgd)	Potential RW Demand (AFY)
City Owned	indept	San Lorenzo Park	100-04225	0.0138	15.5
	indept	DeLaveaga	061-00960	0.0092	10.3
	indept	Sylvania Bulk Water Station	100-09105	0.0050	5.6
	indept	Delaware Bulk Water Station	100-02005	0.0029	3.2
	indept	Portola Bulk Water Station	100-06490	0.0008	0.9
	indept	Research Park Bulk Water Station	100-10076	0.0001	0.1
			Subtotal City Owned Demand	**0.03**	**35.6**

Note: The bulk water stations do not have individual demands greater than 10 AFY, but are shown on this table because of the ease of conversion to recycled water at these facilities.

Table B-7: Major Potential Recycled Water Users with UCSC Submeters

Area	Meter Number	Potential RW Demand (mgd)	Potential RW Demand (AFY)
East Field House Athletic Field	I00701	0.024	26.572
EFH Sand Field	I00703	0.014	15.415
Emergency Response Center	I09601	0.001	0.795
Cowell College Academic Building	I13001	0.00001	0.013
Cowell Upper Dorms	I13401	0.00001	0.016
Cowell Lower Dorms	I13402	0.00002	0.026
Stevenson Grounds North	I13701	0.00004	0.046
Stevenson Lower Quad	I13702	0.001	1.078
Stevenson Garden	I14001	0.00028	0.314
Arboretum - World Conifer Area	I18102	0.003	2.833
Grad Commons & Bookstore	I30201	0.00006	0.064
Arboretum (IR-01)	I43301	0.012	13.325
Arboretum (IR-05)	I43302	0.003	3.766
Arboretum Horticulture 1	I43303	0.005	5.218
Arboretum Nueva Selanda	I43304	0.002	2.586
Farm Project	I47901	0.012	13.948
Cowell Infill Apts	I70701	0.00029	0.324
Farm Food WHAT!	I75102	0.00015	0.173
Ranchview Terrace 02	I75202	0.00002	0.021
Ranchview Terrace Upper Quad	I75203	0.001	1.657
Stevenson Infill Apartments	I90601	0.001	1.016
Faculty Housing Cardiff Terrace 01	I94001	0.00042	0.473
Faculty Housing Cardiff Terrace 02	I94002	0.004	4.819
Faculty Housing Hagar Meadows	I95001	0.00001	0.007
Faculty Housing Hagar Court	I95002	0.00000	0.000

Area	Meter Number	Potential RW Demand (mgd)	Potential RW Demand (AFY)
Merrill Garden Project	I16901	0.004	5.036
Kresge College Central Area	I38401	0.009	9.84
College 8 Field	I75601	0.003	3.345
West Field House	I43501	0.003	3.238
Porter A&B Dorm NE Corner B	I71302	0.003	3.072
Oakes East	I74802	0.002	2.522
College 8 West of Dorm A	I75003	0.002	1.873
Porter East of A	I30601	0.002	2.033
Family Housing Playing Field	I35101	0.002	2.455
McHenry Library Addition	I14501	0.002	1.753
E2 Irrigation	I94201	0.0001	0.161
Wellness Center	I72601	0.001	1.365
E&MS Irrigation	I77501	0.0004	0.456
BioMed Main	I94701	0.001	0.592
Porter A&B Dormitories		0.006	6.4
Bio-Medical Sciences Building		0.001	0.7
Wellness Center		n/a	n/a
Cooling tower #4 make-up water	W06701	0.000	0.462
North Cooling Tower CT-1	W14603	0.010	10.958
South Cooling Tower CT-5	W14605	0.001	1.649
North Cooling Tower CT-2	W14606	0.000	0.092
North Cooling TowerCT-3	W14607	0.002	2.584
Subtotal UCSC Demands		**0.139**	**155**

Note: Individual submeter demands that are less than 10 AFY greater are also shown in this table. Demands for some potential customers sites were not available (n/a) but sub-meter information was listed as placeholders.

B.4 Peaking Factors

Peak month factors were estimated based on the 2013-meter data and 2013 UCSC sub-meter data for each account type. It was assumed that peak day demand is the same as peak month demand. Table B-8: Peaking Factors by Account Type shows the peaking factor by account type.

Table B-8: Peaking Factors by Account Type

Category	Account Type	Peak Day Demand Factor = Peak Month Demand Factors	Notes
Irrigation	ir-glf	1.96	Based on City of Santa Cruz 2013-meter data
	ir-bus	3.33	
	ir-NC	0.00	
	ir-res	4.78	
Commercial	indust	0.00	
	b-gen	2.24	
	b-hotl	1.56	
	b- rest	0.00	
City Owned	indept	3.01	
University of California Santa Cruz	UCSC Submeter	1.81	Based on UCSC 2013 submeter data

For irrigation demands, an 8-hour irrigation window from 10 p.m. to 6 a.m. on a daily basis is assumed to obtain the peak hour demand.

B.5 Demand Tables Associated with Alternatives

Table B-9: Alternative 1B – Potential Customers for Non-Potable Reuse

Pipeline Segment	Acct Type	Account Holder	Account Number	Potential RW Demand (mgd)	Potential RW Demand (AFY)	Pipeline Length (LF)
Alt 1B_Ph1_Main	N/A	N/A	N/A	N/A	N/A	9,571
	indept	San Lorenzo Park	100-04225	0.014	15.500	N/A
	indept	La Barranca Park	021-01725	0.001	0.896	N/A
	indept	Neary Lagoon Park	025-01880	0.000	0.004	N/A
	ir-bus	Santa Cruz High School	100-09975	0.017	19.400	N/A
	ir-bus	Prindle-Wilson	048-00650	0.000	0.482	N/A
	ir-bus	Asset Management Group	032-00315	0.000	0.425	N/A
	ir-bus	N/A	032-00665	0.000	0.005	N/A
	ir-res	San Lorenzo Pk Apts	100-04214	0.001	1.566	N/A
	ir-res	N/A	032-01362	0.000	0.388	N/A
Alt 1B_Ph1_A	N/A	N/A	N/A	N/A	N/A	6,532
	b-gen	Santa Cruz City School	100-02250	0.018	19.915	N/A
Alt1B_Ph2_A	N/A	N/A	N/A	N/A	N/A	3,023
	ir-bus	N/A	100-08600	0.022	24.481	N/A
	ir-bus	N/A	037-01000	0.001	0.877	N/A
	ir-bus	N/A	039-00370	0.000	0.014	N/A
	ir-res	N/A	037-01751	0.000	0.009	N/A
Alt1B_Ph2_B	N/A	N/A	N/A	N/A	N/A	4,413
	ir-bus	N/A	038-00517	0.001	1.412	N/A
	ir-res	N/A	061-03835	0.000	0.301	N/A
	ir-res	N/A	039-01695	0.000	0.080	N/A
	ir-res	N/A	061-00040	0.000	0.053	N/A
Alt1B_Ph2_C	N/A	N/A	N/A	N/A	N/A	4,723

Pipeline Segment	Acct Type	Account Holder	Account Number	Potential RW Demand (mgd)	Potential RW Demand (AFY)	Pipeline Length (LF)
	indept	DeLaveaga Park	061-00960	0.009	10.333	N/A
Alt1B_Ph2_D	N/A	N/A	N/A	N/A	N/A	6,088
	ir-glf	DeLaveaga Golf Course	100-08030	0.124	138.361	N/A
	ir-res	N/A	041-01080	0.000	0.459	N/A
Alt1B_Ph2_Main	N/A	N/A	N/A	N/A	N/A	1,688
Alt1B_Ph3_A	N/A	N/A	N/A	N/A	N/A	3,685
	ir-res	Santa Cruz Housing Authority	047-02481	0.001	1.292	N/A
	b-gen	Santa Cruz City School	100-07875	0.020	22.112	N/A
Alt1B_Ph3_B	N/A	N/A	N/A	N/A	N/A	1,213
	ir-bus	N/A	070-01782	0.000	0.124	N/A
	ir-bus	N/A	070-01777	0.000	0.007	N/A
	b-gen	Live Oak School District	100-04950	0.014	15.349	N/A
Alt1B_Ph3_C	N/A	N/A	N/A	N/A	N/A	2,568
	ir-bus	N/A	100-07800	0.005	5.606	N/A
	ir-bus	N/A	100-07816	0.002	2.610	N/A
	ir-bus	N/A	069-01141	0.002	2.468	N/A
	ir-bus	N/A	069-01143	0.002	2.045	N/A
	ir-bus	N/A	069-01310	0.001	0.879	N/A
	ir-bus	N/A	069-00468	0.000	0.266	N/A
	b-gen	Chaminade Resort & Spa	100-07855	0.009	10.085	N/A
Alt1B_Ph3_D	N/A	N/A	N/A	N/A	N/A	6,311
	ir-res	N/A	069-02152	0.000	0.464	N/A
	ir-res	N/A	069-01915	0.000	0.335	N/A

Pipeline Segment	Acct Type	Account Holder	Account Number	Potential RW Demand (mgd)	Potential RW Demand (AFY)	Pipeline Length (LF)
	ir-res	N/A	069-01916	0.000	0.253	N/A
	b-gen	Soquel Union School District	090-05500	0.013	14.256	N/A
Alt1B_Ph3_E	N/A	N/A	N/A	N/A	N/A	1,571
	b-gen	Good Shepherd School	067-02170	0.022	24.787	N/A
Alt1B_Ph3_Main	N/A	N/A	N/A	N/A	N/A	15,401
	ir-bus	N/A	049-00660	0.002	2.541	N/A
	ir-bus	N/A	049-00955	0.001	1.364	N/A
	ir-bus	N/A	049-00640	0.001	0.905	N/A
	ir-bus	N/A	069-00205	0.001	0.732	N/A
	ir-res	N/A	040-00410	0.000	0.500	N/A
	ir-bus	N/A	057-01155	0.000	0.356	N/A
	ir-bus	N/A	046-02079	0.000	0.285	N/A
	ir-bus	N/A	057-01620	0.000	0.129	N/A
	ir-bus	N/A	040-00384	0.000	0.007	N/A
	ir-bus	N/A	046-02073	0.000	0.007	N/A
	ir-bus	N/A	067-00423	0.000	0.005	N/A
	b-gen	Harbor High School	100-04930	0.032	35.863	N/A
Alt1B_Ph4	N/A	N/A	N/A	N/A	N/A	24,589
	Irrigation	East Field House Athletic Field	I00701	0.024	26.572	N/A
	Irrigation	EFH Sand Field	I00703	0.014	15.415	N/A
	Irrigation	Emergency Response Center	I09601	0.001	0.795	N/A
	Irrigation	Cowell College Academic Building	I13001	0.000	0.013	N/A
	Irrigation	Cowell Upper Dorms	I13401	0.000	0.016	N/A
	Irrigation	Cowell Lower Dorms	I13402	0.000	0.026	N/A

Pipeline Segment	Acct Type	Account Holder	Account Number	Potential RW Demand (mgd)	Potential RW Demand (AFY)	Pipeline Length (LF)
	Irrigation	Stevenson Grounds North	I13701	0.000	0.046	N/A
	Irrigation	Stevenson Lower Quad	I13702	0.001	1.078	N/A
	Irrigation	Stevenson Garden	I14001	0.000	0.314	N/A
	Irrigation	Arboretum - World Conifer Area	I18102	0.003	2.833	N/A
	Irrigation	Grad Commons & Bookstore	I30201	0.000	0.064	N/A
	Irrigation	Arboretum (IR-01)	I43301	0.012	13.325	N/A
	Irrigation	Arboretum (IR-05)	I43302	0.003	3.766	N/A
	Irrigation	Arboretum Horticulture 1	I43303	0.005	5.218	N/A
	Irrigation	Arboretum Nueva Selanda	I43304	0.002	2.586	N/A
	Irrigation	Farm Project	I47901	0.012	13.948	N/A
	Irrigation	Cowell Infill Apts	I70701	0.000	0.324	N/A
	Irrigation	Farm Food WHAT!	I75102	0.000	0.173	N/A
	Irrigation	Ranchview Terrace 02	I75202	0.000	0.021	N/A
	Irrigation	Ranchview Terrace Upper Quad	I75203	0.001	1.657	N/A
	Irrigation	Stevenson Infill Apartments	I90601	0.001	1.016	N/A
	Irrigation	Faculty Housing Cardiff Terrace 01	I94001	0.000	0.473	N/A
	Irrigation	Faculty Housing Cardiff Terrace 02	I94002	0.004	4.819	N/A
	Irrigation	Faculty Housing Hagar Meadows	I95001	0.000	0.007	N/A
	Irrigation	Faculty Housing Hagar Court	I95002	0.000	0.000	N/A
	Irrigation	Merrill Garden Project	I16901	0.004	5.036	N/A
	Irrigation	Kresge College Central Area	I38401	0.009	9.840	N/A
	Irrigation	College 8 Field	I75601	0.003	3.345	N/A

Pipeline Segment	Acct Type	Account Holder	Account Number	Potential RW Demand (mgd)	Potential RW Demand (AFY)	Pipeline Length (LF)
	Irrigation	West Field House	I43501	0.003	3.238	N/A
	Irrigation	Porter A&B Dorm NE Corner B	I71302	0.003	3.072	N/A
	Irrigation	Oakes East	I74802	0.002	2.522	N/A
	Irrigation	College 8 West of Dorm A	I75003	0.002	1.873	N/A
	Irrigation	Porter East of A	I30601	0.002	2.033	N/A
	Irrigation	Family Housing Playing Field	I35101	0.002	2.455	N/A
	Irrigation	McHenry Library Addition	I14501	0.002	1.753	N/A
	Irrigation	E2 Irrigation	I94201	0.000	0.161	N/A
	Irrigation	Wellness Center	I72601	0.001	1.365	N/A
	Irrigation	E&MS Irrigation	I77501	0.000	0.456	N/A
	Irrigation	BioMed Main	I94701	0.001	0.592	N/A
	Dual Plumbed	Porter A&B Dormitories		0.006	6.400	N/A
	Dual Plumbed	Bio-Medical Sciences Building		0.001	0.700	N/A
	Dual Plumbed	Wellness Center		0.000	0.000	N/A
	Cooling	Cooling tower #4 make-up water	W06701	0.000	0.462	N/A
	Cooling	North Cooling Tower CT-1	W14603	0.010	10.958	N/A
	Cooling	South Cooling Tower CT-5	W14605	0.001	1.649	N/A
	Cooling	North Cooling Tower CT-2	W14606	0.000	0.092	N/A
	Cooling	North Cooling TowerCT-3	W14607	0.002	2.584	N/A
Alt1B_Ph4_Main	N/A	N/A	N/A	N/A	N/A	9,002
	ir-res	N/A	003-05975	0.001	0.742	N/A
	ir-res	N/A	003-07480	0.000	0.457	N/A

Pipeline Segment	Acct Type	Account Holder	Account Number	Potential RW Demand (mgd)	Potential RW Demand (AFY)	Pipeline Length (LF)
	b-gen	Bayview School	100-02875	0.009	9.883	N/A
	b-gen	Santa Cruz City Schools	100-00600	0.010	11.180	N/A

Table B-10: Alternative 2 – Potential Customers for Non-Potable Reuse on UCSC

Pipeline Segment	Acct Type	Account Holder	Account Number	Potential RW Demand (mgd)	Potential RW Demand (AFY)	Pipeline Length (LF)
UCSC Pipelines	N/A	N/A	N/A	N/A	N/A	24,589
	Irrigation	East Field House Athletic Field	I00701	0.024	26.572	N/A
	Irrigation	EFH Sand Field	I00703	0.014	15.415	N/A
	Irrigation	Emergency Response Center	I09601	0.001	0.795	N/A
	Irrigation	Cowell College Academic Building	I13001	0.00001	0.013	N/A
	Irrigation	Cowell Upper Dorms	I13401	0.00001	0.016	N/A
	Irrigation	Cowell Lower Dorms	I13402	0.00002	0.026	N/A
	Irrigation	Stevenson Grounds North	I13701	0.00004	0.046	N/A
	Irrigation	Stevenson Lower Quad	I13702	0.001	1.078	N/A
	Irrigation	Stevenson Garden	I14001	0.00028	0.314	N/A
	Irrigation	Arboretum - World Conifer Area	I18102	0.003	2.833	N/A
	Irrigation	Grad Commons & Bookstore	I30201	0.00006	0.064	N/A
	Irrigation	Arboretum (IR-01)	I43301	0.012	13.325	N/A
	Irrigation	Arboretum (IR-05)	I43302	0.003	3.766	N/A

Pipeline Segment	Acct Type	Account Holder	Account Number	Potential RW Demand (mgd)	Potential RW Demand (AFY)	Pipeline Length (LF)
	Irrigation	Arboretum Horticulture 1	I43303	0.005	5.218	N/A
	Irrigation	Arboretum Nueva Selanda	I43304	0.002	2.586	N/A
	Irrigation	Farm Project	I47901	0.012	13.948	N/A
	Irrigation	Cowell Infill Apts	I70701	0.00029	0.324	N/A
	Irrigation	Farm Food WHAT!	I75102	0.00015	0.173	N/A
	Irrigation	Ranchview Terrace 02	I75202	0.00002	0.021	N/A
	Irrigation	Ranchview Terrace Upper Quad	I75203	0.001	1.657	N/A
	Irrigation	Stevenson Infill Apartments	I90601	0.001	1.016	N/A
	Irrigation	Faculty Housing Cardiff Terrace 01	I94001	0.00042	0.473	N/A
	Irrigation	Faculty Housing Cardiff Terrace 02	I94002	0.004	4.819	N/A
	Irrigation	Faculty Housing Hagar Meadows	I95001	0.00001	0.007	N/A
	Irrigation	Faculty Housing Hagar Court	I95002	0.00000	0	N/A
	Irrigation	Merrill Garden Project	I16901	0.004	5.036	N/A
	Irrigation	Kresge College Central Area	I38401	0.009	9.84	N/A
	Irrigation	College 8 Field	I75601	0.003	3.345	N/A
	Irrigation	West Field House	I43501	0.003	3.238	N/A
	Irrigation	Porter A&B Dorm NE Corner B	I71302	0.003	3.072	N/A
	Irrigation	Oakes East	I74802	0.002	2.522	N/A
	Irrigation	College 8 West of Dorm A	I75003	0.002	1.873	N/A
	Irrigation	Porter East of A	I30601	0.002	2.033	N/A

Pipeline Segment	Acct Type	Account Holder	Account Number	Potential RW Demand (mgd)	Potential RW Demand (AFY)	Pipeline Length (LF)
	Irrigation	Family Housing Playing Field	I35101	0.002	2.455	N/A
	Irrigation	McHenry Library Addition	I14501	0.002	1.753	N/A
	Irrigation	E2 Irrigation	I94201	0.0001	0.161	N/A
	Irrigation	Wellness Center	I72601	0.001	1.365	N/A
	Irrigation	E&MS Irrigation	I77501	0.0004	0.456	N/A
	Irrigation	BioMed Main	I94701	0.001	0.592	N/A
	Dual Plumbed	Porter A&B Dormitories		0.006	6.4	N/A
	Dual Plumbed	Bio-Medical Sciences Building		0.001	0.7	N/A
	Dual Plumbed	Wellness Center		0	0	N/A
	Cooling	Cooling tower #4 make-up water	W06701	0.000	0.462	N/A
	Cooling	North Cooling Tower CT-1	W14603	0.010	10.958	N/A
	Cooling	South Cooling Tower CT-5	W14605	0.001	1.649	N/A
	Cooling	North Cooling Tower CT-2	W14606	0.000	0.092	N/A
	Cooling	North Cooling TowerCT-3	W14607	0.002	2.584	N/A
	Cooling	Cooling tower #4 make-up water	W06701	0.000	0.462	N/A

Table B-11: Alternative 3B – Potential Customers for Non-Potable Reuse

Pipeline Segment	Acct Type	Account Holder	Account Number	Potential RW Demand (mgd)	Potential RW Demand (AFY)	Pipeline Length (LF)
Alt3B _Main	N/A	N/A	N/A	N/A	N/A	38,574
	ir-bus	N/A	100-9975	0.0173	19.380165	N/A
	ir-res	N/A	57-1515	0.003281	3.67539	N/A
	ir-bus	N/A	82-3180	0.00133	1.489899	N/A
	ir-bus	N/A	58-214	0.000807	0.9045	N/A
	ir-bus	N/A	71-5480	0.000471	0.528007	N/A
	ir-res	N/A	74-1250	0.000385	0.431589	N/A
	ir-bus	N/A	32-315	0.000379	0.424702	N/A
	ir-res	N/A	32-1362	0.000346	0.387971	N/A
	ir-bus	N/A	57-1155	0.000318	0.355831	N/A
	ir-res	N/A	81-3751	0.000172	0.192837	N/A
	ir-res	N/A	52-545	0.000148	0.165289	N/A
	ir-bus	N/A	76-2170	0.000072	0.080349	N/A
	ir-bus	N/A	071-0092	0.000049	0.055096	N/A
	ir-bus	N/A	75-2623	0.000049	0.055096	N/A
	ir-bus	N/A	81-7490	0.000047	0.052801	N/A
	ir-bus	N/A	74-1360	0.000041	0.045914	N/A
	ir-bus	N/A	68-3160	0.000033	0.036731	N/A
	ir-bus	N/A	74-20	0.000016	0.018365	N/A
	ir-bus	N/A	53-3	0.000014	0.01607	N/A
	ir-bus	N/A	32-665	0.000004	0.004591	N/A
	ir-bus	N/A	82-1360	0.000002	0.002296	N/A
	b-gen	Live Oak School District	100-7000	0.006091	6.822773	N/A
	indept	N/A	21-1725	0.000004	0.004358	N/A
	indept	N/A	25-1880	0.000004	0.004115	N/A
Alt3B -A	N/A	N/A	N/A	N/A	N/A	3,222
	b-gen	SC Seaside Co	100-3810	0.01138	12.747934	N/A
Alt3B –B	N/A	N/A	N/A	N/A	N/A	1,529

Pipeline Segment	Acct Type	Account Holder	Account Number	Potential RW Demand (mgd)	Potential RW Demand (AFY)	Pipeline Length (LF)
	ir-res	N/A	100-04214	0.001398	1.565657	N/A
	ir-bus	N/A	48-650	0.00043	0.482094	N/A
	indept	San Lorenzo Park	100-4225	0.013833	15.495868	N/A
Alt3B –C	N/A	N/A	N/A	N/A	N/A	1,697
	ir-bus	N/A	46-2079	0.000254	0.284665	N/A
	ir-bus	N/A	46-2073	0.000006	0.006887	N/A
Alt3B –D	N/A	N/A	N/A	N/A	N/A	2,047
	ir-bus	N/A	70-1782	0.000111	0.123967	N/A
	ir-bus	N/A	70-1777	0.000006	0.006887	N/A
	b-gen	Live Oak School District	100-4950	0.013702	15.348944	N/A
	b-gen	Harbor High School	100-4930	0.032014	35.863177	N/A

Note: The meters shown under Alternative 3B would also be served by Alternative 3D.

Table B-12: Alternative 3C – Potential Customers for Non-Potable Reuse

Pipeline Segment	Acct Type	Account Holder	Account Number	Potential RW Demand (mgd)	Potential RW Demand (AFY)	Pipeline Length (LF)
Alt3C_Main	N/A	N/A	N/A	N/A	N/A	23,392
	ir-bus	N/A	081-00600	0.004267	4.779614	N/A
	ir-bus	N/A	082-03180	0.00133	1.489899	N/A
	ir-bus	N/A	065-02155	0.000553	0.619835	N/A
	ir-res	N/A	081-03751	0.000172	0.192837	N/A
	ir-bus	N/A	065-02150	0.000158	0.176768	N/A
	ir-bus	N/A	065-02510	0.000105	0.11708	N/A
	ir-bus	N/A	065-02158	0.000092	0.103306	N/A
	ir-bus	N/A	082-01360	0.000002	0.002296	N/A

Table B-13: Alternative 3E – Potential Customers for Non-Potable Reuse

Pipeline Segment	Acct Type	Account Holder	Account Number	Potential RW Demand (mgd)	Potential RW Demand (AFY)	Pipeline Length (LF)
Alt3E_Main	N/A	N/A	N/A	N/A	N/A	38,574
	ir-bus	N/A	100-9975	0.0173	19.380165	N/A
	ir-res	N/A	57-1515	0.003281	3.67539	N/A
	ir-bus	N/A	82-3180	0.00133	1.489899	N/A
	ir-bus	N/A	58-214	0.000807	0.9045	N/A
	ir-bus	N/A	71-5480	0.000471	0.528007	N/A
	ir-res	N/A	74-1250	0.000385	0.431589	N/A
	ir-bus	N/A	32-315	0.000379	0.424702	N/A
	ir-res	N/A	32-1362	0.000346	0.387971	N/A
	ir-bus	N/A	57-1155	0.000318	0.355831	N/A
	ir-res	N/A	81-3751	0.000172	0.192837	N/A
	ir-res	N/A	52-545	0.000148	0.165289	N/A
	ir-bus	N/A	76-2170	0.000072	0.080349	N/A
	ir-bus	N/A	071-0092	0.000049	0.055096	N/A
	ir-bus	N/A	75-2623	0.000049	0.055096	N/A
	ir-bus	N/A	81-7490	0.000047	0.052801	N/A
	ir-bus	N/A	74-1360	0.000041	0.045914	N/A
	ir-bus	N/A	68-3160	0.000033	0.036731	N/A
	ir-bus	N/A	74-20	0.000016	0.018365	N/A
	ir-bus	N/A	53-3	0.000014	0.01607	N/A
	ir-bus	N/A	32-665	0.000004	0.004591	N/A
	ir-bus	N/A	82-1360	0.000002	0.002296	N/A
	b-gen	Live Oak School District	100-7000	0.006091	6.822773	N/A
	indept	N/A	21-1725	0.000004	0.004358	N/A
	indept	N/A	25-1880	0.000004	0.004115	N/A
Alt3E -A	N/A	N/A	N/A	N/A	N/A	3,222

Pipeline Segment	Acct Type	Account Holder	Account Number	Potential RW Demand (mgd)	Potential RW Demand (AFY)	Pipeline Length (LF)
	b-gen	SC Seaside Co	100-3810	0.01138	12.747934	N/A
Alt3E –B	N/A	N/A	N/A	N/A	N/A	1,529
	ir-res	N/A	100-04214	0.001398	1.565657	N/A
	ir-bus	N/A	48-650	0.00043	0.482094	N/A
	indept	San Lorenzo Park	100-4225	0.013833	15.495868	N/A
Alt3E –C	N/A	N/A	N/A	N/A	N/A	1,697
	ir-bus	N/A	46-2079	0.000254	0.284665	N/A
	ir-bus	N/A	46-2073	0.000006	0.006887	N/A
Alt3E–D	N/A	N/A	N/A	N/A	N/A	2,047
	ir-bus	N/A	70-1782	0.000111	0.123967	N/A
	ir-bus	N/A	70-1777	0.000006	0.006887	N/A
	b-gen	Live Oak School District	100-4950	0.013702	15.348944	N/A
	b-gen	Harbor High School	100-4930	0.032014	35.863177	N/A
Pipelines to Injection Wells	N/A	N/A	N/A	N/A	N/A	10,500
	ir-bus	N/A	081-00600	0.004267	4.779614	N/A
	ir-bus	N/A	065-02155	0.000553	0.619835	N/A
	ir-bus	N/A	065-02150	0.000158	0.176768	N/A
	ir-bus	N/A	065-02510	0.000105	0.11708	N/A
	ir-bus	N/A	065-02158	0.000092	0.103306	N/A

Table B-14: Alternative 4A – Potential Customers for Non-Potable Reuse

Pipeline Segment	Acct Type	Account Holder	Account Number	Potential RW Demand (mgd)	Potential RW Demand (AFY)	Pipeline Length (LF)
Alt4A _Main	N/A	N/A	N/A	N/A	N/A	26,337
	ir-bus	N/A	100-09975	0.0173	19.380165	N/A
	ir-res	N/A	057-01515	0.003281	3.67539	N/A
	ir-bus	N/A	058-00214	0.000807	0.9045	N/A
	ir-bus	N/A	071-05480	0.000471	0.528007	N/A
	ir-res	N/A	074-01250	0.000385	0.431589	N/A
	ir-bus	N/A	032-00315	0.000379	0.424702	N/A
	ir-res	N/A	032-01362	0.000346	0.387971	N/A
	ir-bus	N/A	057-01155	0.000318	0.355831	N/A
	ir-res	N/A	052-00545	0.000148	0.165289	N/A
	ir-bus	N/A	076-02170	0.000072	0.080349	N/A
	ir-bus	N/A	071-00092	0.000049	0.055096	N/A
	ir-bus	N/A	075-02623	0.000049	0.055096	N/A
	ir-bus	N/A	081-07490	0.000047	0.052801	N/A
	ir-bus	N/A	074-01360	0.000041	0.045914	N/A
	ir-bus	N/A	068-03160	0.000033	0.036731	N/A
	ir-bus	N/A	074-00020	0.000016	0.018365	N/A
	ir-bus	N/A	053-00003	0.000014	0.01607	N/A
	ir-bus	N/A	032-00665	0.000004	0.004591	N/A
	indept	La Barranca Park	021-01725	0.001	0.896	N/A
	indept	Neary Lagoon Park	025-01880	0.000004	0.004115	N/A
	b-gen	Live Oak School	100-07000	0.006091	6.822773	
Alt4A -A	N/A	N/A	N/A	N/A	N/A	3,222
	b-gen	SC Seaside Co	100-3810	0.01138	12.747934	N/A
Alt4B –B	N/A	N/A	N/A	N/A	N/A	1,529
	ir-res	N/A	100-04214	0.001398	1.565657	N/A
	ir-bus	N/A	48-650	0.00043	0.482094	N/A
	indept	San Lorenzo Park	100-4225	0.013833	15.495868	N/A

Pipeline Segment	Acct Type	Account Holder	Account Number	Potential RW Demand (mgd)	Potential RW Demand (AFY)	Pipeline Length (LF)
Alt4A –C	N/A	N/A	N/A	N/A	N/A	1,697
	ir-bus	N/A	46-2079	0.000254	0.284665	N/A
	ir-bus	N/A	46-2073	0.000006	0.006887	N/A
Alt4A –D	N/A	N/A	N/A	N/A	N/A	2,047
	ir-bus	N/A	70-1782	0.000111	0.123967	N/A
	ir-bus	N/A	70-1777	0.000006	0.006887	N/A
	b-gen	Live Oak School District	100-4950	0.013702	15.348944	N/A
	b-gen	Harbor High School	100-4930	0.032014	35.863177	N/A
Pipelines to Injection Wells	N/A	N/A	N/A	N/A	N/A	10,974
	ir-bus	N/A	081-00600	0.004267	4.779614	N/A
	ir-bus	N/A	065-02155	0.000553	0.619835	N/A
	ir-bus	N/A	065-00235	0.000178	0.199725	N/A
	ir-bus	N/A	065-02150	0.000158	0.176768	N/A
	ir-bus	N/A	065-02158	0.000092	0.103306	N/A

Table B-15: Alternative 4B – Potential Customers for Non-Potable Reuse

Pipeline Segment	Acct Type	Account Holder	Account Number	Potential RW Demand (mgd)	Potential RW Demand (AFY)	Pipeline Length (LF)
Alt4B_Main	N/A	N/A	N/A	N/A	N/A	14097
	ir-bus	N/A	065-00235	0.000178	0.199725	N/A
	ir-bus	N/A	085-03180	0.000039	0.043618	N/A

For Alternative projects 3C, 3D, 4A and 4B, the evaluation and assumptions associated with the amount of water to be used for groundwater replenishment is discussed in Appendix C.

For Alternatives 5, 6, 7 and 8, non-potable reuse would not be provided because all available summer effluent would be used for surface water augmentation, streamflow augmentation, direct potable reuse, or groundwater replenishment, respectively.

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Appendix C: Groundwater Replenishment Reuse – Supporting Information

This appendix includes supporting information for the evaluation of groundwater replenishment reuse projects and includes the following:

C.1 TM #2a Beltz Wellfield Area Injection Well Capacity and Siting Study

C.2 TM #2b Santa Margarita Injection Well Capacity and Siting Study

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19 September 2017

Technical Memorandum #2a – Beltz Wellfield Area Injection Well Capacity and Siting Study

To: Heidi Luckenbach
From: Eddy Teasdale (Kennedy/Jenks)
Review: Alex Peterson and Dawn Taffler (Kennedy/Jenks)
Subject: **Beltz Wellfield Area Injection Well Capacity and Siting Study**
[Santa Cruz Recycled Water Facilities Planning Study]
K/J 1668007*00

1. Overview

The City of Santa Cruz is developing a Santa Cruz Regional Recycled Water Facilities Planning Study (RWFPS) to explore opportunities to develop a local or regional recycled water program as part of their water supply portfolio. The RWFPS includes alternatives for non-potable uses, to meet irrigation and commercial/industrial demands, and potable uses to recharge local groundwater aquifers, augment surface waters or supplement the drinking water system.

This Technical Memorandum (TM) focuses on the results of a screening level groundwater flow model that was developed to assess the feasibility of using recycled water for groundwater replenishment through injection wells in the Purisima Formation, in the vicinity of the City of Santa Cruz's Beltz Wellfield area. This TM is supporting the development and evaluation of the RWFPS alternatives by evaluating groundwater injection travel times. The RWFPS will utilize information from this TM for the development of GRRP alternatives. It is not the intention of this TM to investigate all locational opportunities rather it focuses on the city's service area and utilization of existing infrastructure when possible. Further siting and modeling evaluation is recommended should a GRR project be pursued in this area.

2. Background

This section summarizes subsurface geologic and hydrogeological conditions and existing production well characteristics in the Purisima Formation, with a focus on opportunities for groundwater recharge in the Beltz Wellfield area.

2.1 Purisima Formation

The Purisima Formation encompasses the western portion of the Santa Cruz Mid-County Basin (**Figure 1**). The primary water-bearing units within the Santa Cruz Mid-County Basin are the Purisima Formation and the Aromas Red Sands (Aromas) aquifer. The hydrogeology of the Purisima Formation has been documented in detailed reports prepared by the United States Geological Survey (USGS), the California Department of Water Resources (CA DWR), and various consulting firms (Pueblo Water Resources (2015), Hopkins Groundwater Consultants (2006) and HydroMetrics (2014)). The Purisima Aquifer consists of several distinct zones within the geologic Purisima Formation. The Purisima Formation is consolidated and semi-consolidated marine sandstone with siltstone and claystone interbeds. The hydrostratigraphy of the Purisima Formation has been subdivided by previous investigators into nine hydrostratigraphic units (including both aquifers and aquitards). From youngest to oldest, a brief summary of the hydrostratigraphic units making up the Purisima Formation are shown in **Figure 2** and described as follows:

1. Aquifer F. Aquifer F represents the upper portion of the Purisima Formation, and in some areas is greater than 800 feet thick. Hydraulic conductivity ranges from 2 to 6 feet/day.
2. Aquifer DEF. Moderately coarse grained unit with intermittent fine grained intervals. Aquifer thickness is up to 330 feet. Hydraulic conductivity similar to Aquifer F.
3. Aquitard D. Fine grained with one or two major coarse-grained intervals. Hydraulic conductivity ranges from 0.0005 and 1 feet/day.
4. Aquifer BC. Moderately coarse-grained unit and hydraulic conductivity ranges from 1 to 3 feet/day.
5. Aquitard B. Fine-grained and hydraulic conductivity ranges from 0.005 to 1 feet/day
6. Aquifer A. Coarse grained and thickest grained unit (250 feet thick). Hydraulic conductivity ranges from 7 to 65 feet/day.
7. Aquifer AA. Interbedded moderately coarse to fine grained unites underlying Aquifer A. Hydraulic conductivity ranges from 1 to 10 feet/day.
8. Aquitard Tm. The Tm aquitard is fine-grained and hydraulic conductivity ranges from 0.005 to 1 foot/day.
9. Aquifer Tu – Forms the base of the Purisima Formation and consists of Sandstone. The hydraulic conductivity ranges from 1 to 20 feet/day.

2.2 Beltz Wellfield

The Beltz Wellfield is located on the eastern side of the City of Santa Cruz water service area. The City of Santa Cruz owns and operates Beltz Wells #8, #9, #10 and #12 as part of their water supply portfolio. Wells #8, #9 and #10 are screened in Aquifer A; Well #12 is screened across Aquifers AA and Tu. In addition to the Beltz Wells, nearby domestic wells (DW) and Soquel Creek Water District

(SqCWD) wells also extract groundwater from the Purisima Formation. **Figure 3** details the approximate locations for all pumping wells utilized in this screening level analysis

3. Injection Well Capacity Requirements

Groundwater Replenishment Reuse Regulations (GRRR) were promulgated by the California Division of Drinking Water (DDW) on June 18, 2014, which govern surface spreading and direct injection GRRPs. The GRRR define treatment requirements for pathogen control, requiring 12-log enteric virus removal, 10-log Giardia removal and 10-log Cryptosporidium removal (12/10/10 microorganism removal). Removal credit can be obtained through treatment processes and through the amount of time the recycled water is maintained underground (also referred to as retention time). For a GRRP utilizing direct injection, the GRRR mandates a minimum of 2 months retention time between the point of injection and extraction; however no existing GRRP facilities currently operate with a retention time under 6 months.

The GRRP concept being evaluated as part of the RWFPS is direct injection of advanced treated recycled water (purified water) into the groundwater basin via injection wells. Once in the subsurface, the purified water will comingle with local groundwater and be stored in the local aquifer. Groundwater would then be extracted via existing production wells to meet drinking water needs. For this evaluation, it was assumed that a minimum travel time of 6-months must be achieved between the point of injection and the point of extraction.

This section describes the high-level approach developed to identify injection well sites and estimate recharge capacity in the Beltz Wellfield area. Additional consideration of any GRRP concept would require a detailed analysis of groundwater travel times in a follow-on feasibility study.

3.1 Approach

Initially, the fixed radius method, based on the Drinking Water Source Assessment and Protection (DWSAP) Program was proposed to delineate an appropriate Radius of Influence (ROI) for the four existing production wells (Beltz #8, #9, #10 and #12) that would meet or exceed the GRRR retention time requirements. Given the potential for well interference from both extraction from existing municipal production and domestic wells, a simplified screening level MODFLOW model of the Beltz Wellfield area (herein referred to as the **Beltz Screening Model**) was developed instead of relying on the fixed-radius method. This approach was used to identify proposed injection wells based on site specific hydraulic conductivity information and regional gradient variations. Preliminary data from the Beltz Screening Model was also evaluated and compared against the fixed radius method (for Well #12) to assess reproducibility (see Section 3.3 for more information). This screening level groundwater model is not intended to be a replacement for the existing calibrated transient regional Santa Cruz Mid-County Groundwater Model (referred to herein as Mid-County Model), which is currently being updated. Once the Mid-County Model has been updated, the proposed scenarios provided in this TM should be incorporated into the model for further analysis if the City decides to evaluate them further.

3.2 Beltz Screening Model

The Beltz Screening Model was developed using the Brigham Young University Environmental Modeling Research Laboratory (EMRL) *Groundwater Modeling System* (GMS), Version 10.1. GMS is a comprehensive graphical user interface (GUI) for performing groundwater simulations. GMS provides a graphical preprocessor/postprocessor interface to several groundwater modeling codes: MODFLOW and MODPATH. GMS was used to develop a screening level conceptual hydrogeological model and then converted into groundwater flow model. A brief summary of the modeling codes and geological software tools used during this modeling effort are presented below.

- **MODFLOW Groundwater Flow Model.** The computer code selected to model groundwater flow beneath the site was MODFLOW. MODFLOW is a 3-D, cell-centered, finite difference, saturated flow model developed by the United States Geological Survey (USGS) (McDonald and Harbaugh, 1988). GMS provides an interface to the updated version, MODFLOW 2000 (Hill et al., 2000). Based on the information available, the uncertainties in site-specific information, the hydrogeologic complexity of the site, and the modeling objectives, MODFLOW was considered an appropriate groundwater flow code.

- **MODPATH Particle-Tracking Model**. Particle-tracking simulations provide a convenient means of visualizing groundwater flow paths. This is particularly useful for evaluating capture zones around a pumping well or understanding travel paths from injection. MODPATH was selected as the particle-tracking program for this effort. MODPATH is a 3-D particle-tracking program that enables reverse and forward tracking from sinks (wells) and sources, respectively. MODPATH also was developed by the USGS (Pollock, 1994). GMS has updated the interface for MODPATH to a seamless module that couples with MODFLOW 2000. MODFLOW flow modeling results (direction and rates of groundwater movement) are among the inputs for MODPATH runs.

3.2.1 Beltz Screening Model Grid

The model grid (**Figure 4**) extends approximately 5 miles in an east to west direction, and approximately 4 miles in a north to south direction, a total area of 20 square miles approximately centering on the project well sites. The model is this large to ensure that any irregularities along the model edges, caused by a lack of data, do not affect model calculations in the area of interest—the proposed well site and a one- to two-mile area surrounding it. The model grid is aligned in a north-south direction, which corresponds with the approximate regional groundwater flow direction. The model grid has been refined within the well site area to more accurately simulate hydrologic stresses in the area of primary interest. The variable model grid cell sizes range from 10 by 10 foot cells to 500 by 500 foot cells. The smaller grid spacing was used around the Beltz Well Sites to minimize numerical errors in the flow simulation. In addition, the variable grid size allows for finer resolution in areas of steep hydraulic gradients such as near pumping wells. The wider-spaced cells, located far away from the project area and near the model edges where less computation resolution is required, require less computer resources during simulations.

In plan view, the domain is spatially discretized into 132 columns in length and 115 rows in width. Vertically, the model extends to a maximum depth of approximately -500 feet msl. The screening level model is a single layered model. This model layer incorporates municipal production wells, domestic wells and monitoring zones beneath the site.

3.2.2 Beltz Screening Model Inputs

Fixed head boundaries were specified along the model's north and south boundary. The starting heads for the model were interpolated from regional groundwater elevation maps (**Figure 5**). Horizontal hydraulic conductivity and vertical anisotropy values were applied to each grid cell within the model domain. Hydraulic conductivity values were derived from data collected from specific wells. Horizontal conductivity was assigned a conductivity value of 40 feet/day for the South Beltz Well field (Well #8, #9 and #10) area and 10 feet/day for Well #12 area.

3.3 Qualitative verification

To qualitatively verify the Beltz Screening Model results, the ROI estimate from the DWSAP Program for Beltz #12 was compared to the model particle tracking results. The comparison is presented in **Figure 6**. The purpose of this verification was to provide a general understanding of the screening level analysis. The modeled results seemed similar, and more conservative, as compared to the fixed ROI method and were therefore considered adequate for this screening level analysis to simulate future operating injection and extraction well scenarios.

3.4 Injection Well Flow Rates and Storage Capacity Estimation

To estimate the injection storage capacity, groundwater surface elevation data from the production wells was subtracted from 2014 groundwater surface elevation data to derive a depth to water value in feet below ground surface (bgs). To reduce the risk of wellhead flooding, depth to water during injection was restricted to be maintained at approximately 10 feet below ground surface. Table 1 summarizes the available injection storage data.

Table 1: Beltz Wells - Water Level and Available Storage Data

Well Name	Ground Surface Elevation (aMSL)	Groundwater Elevation (aMSL)	Depth to Water (Feet BGS)	Available Storage (Feet)
Beltz #8	47	8.1	38.9	28.9
Beltz #9	43	5	38	28
Beltz #10	58	5.4	52.6	42.6
Beltz #12	120	35.4	84.6	74.6

To estimate the injection rate (gpm) potential for each well location, specific capacity (gallons per minute per foot of drawdown) data from each of the four wells was utilized from previous studies, and then the theoretical specific injectivity rate (gallons per minute of theoretical rise in feet) was assumed to vary from 50% to 70% of the individual specific capacity rate. Utilizing spring 2014 depth to water data from Table 1, a theoretical injection rate was calculated by multiplying available storage information by the applicable specific injectivity rate. Table 2 below summarizes the theoretical injection rate information.

Table 2: Screening Level Injection Capacity for Proposed Wells Located Near Existing Beltz Wells

Well Name	Pumping Rate (gpm)	Specific Capacity (gpm/foot)	Specific Injectivity (50% to 70%)	Theoretical Injection Rate (gpm/MGD)
Beltz #8	200	9.8	4.0 - 6.9	142 – 198/0.2 - 0.3
Beltz #9	225	10.4	5.2 - 7.3	146 – 204/ 0.21 – 0.3
Beltz #10	150	2.7	1.4 - 1.9	58 – 81/0.08 – 0.12
Beltz #12	700	8.5	4.3 - 6	317 – 444/0.45 – 0.64

3.5 Travel Time Estimation Simulation

As detailed above, MODPATH was utilized to calculate the ROI by utilizing particle tracking. In the particle tracking simulation, imaginary particles selected for tracking behave like a water molecule and are affected only by advection resulting from hydraulic influences (i.e. pumping and/or injection) and aquifer properties (i.e. groundwater gradient, hydraulic conductivity). A number of imaginary particles were placed at the production wells (#8, #9, #10 and #12), nearby domestic wells and proposed injection well locations. Details for production/domestic and injection wells particle tracking are presented in the following sections.

3.5.1 Travel Time Estimation for Production Wells

Individual particles were placed at each production well, and select domestic wells in the area. The particles were simulated to migrate backwards (up gradient) for approximately 5 years (approximately 60 months). Particle pathlines are displayed by blue curves that trace the locations of the water particle at the end of the simulation period. The pathlines show the predicted paths that the particle would follow over a 5-year period. Each arrowhead along a particle track represents the particle location after 5 years of simulated travel. The approximate hydraulic influence area or ROI for each production well and domestic well location over a 5-year simulation period is outlined in red (see **Figure 7 and Figure 8**).

3.5.2 Travel Time Estimation for Injection Wells

To assess the potential impacts injected purified water would have on downgradient users (i.e. production wells and domestic wells), a similar particle tracking effort was conducted for the injection wells.

Available sites for injection wells utilized prior siting study information (Hopkins, 2006) and discussions with City of Santa Cruz staff. The purpose of the siting evaluation was to identify available land within the City that could potentially accommodate well construction and operation within the City's water service area. Initially four potential injection well sites (Injection Wells A, B, C and D) were identified in the North Beltz Wellfield near Beltz #12 and ten injection wells were sites (Injection Wells A through J) were identified in the South Beltz Wellfield near wells #8, #9 and #10 based on the 2006 preliminary hydogeologic study (Hopkins, 2006). After further discussions with City staff, based on general aesthetic and environmental concerns being near sensitive areas, and preliminary model results, 5 final injection sites were identified:

- Two preferred injection well locations were selected for the North Beltz Wellfield (INJ-B and INJ-C)
- Three injection wells were selected for the South Beltz Wellfield (INJ-D, INJ-F and INJ-J)

Potential injection well locations are shown on **Figure 9 and Figure 10**.

For injection well travel estimation, particle tracks were placed at the applicable injection well, and then the applicable particles were allowed to move forward for 6-months. Particle pathlines are blue curves that trace the locations of the water particle at the end of the simulation period. The pathlines show the predicted paths that the particle would follow over a simulated 6-month period. Each arrowhead along a particle track represents the particle location after 6 months of simulated travel. The approximate 6-month hydraulic influence from the injection wells is outlined in red (see **Figure 9 and Figure 10**).

4. Beltz Screening Model Results

The Beltz Screening Model was used to simulate injection of 0.5 mgd of purified recycled water at potential injection sites and estimate the ROI for the injected water (at 6-months travel time) and nearby production wells (at 5 years travel time). Five injection sites were identified (two in the North Beltz wellfield and three in the South Beltz wellfield) based on prior well siting studies and discussions with City Staff. All injection well location sites except INJ-J, were outside of the impact the 1,000-foot ROI nearby production and applicable domestic wells, which represents approximately 5 year travel time. This provides a conservative approach to meeting a minimum of 6-month residence time between injection and extraction. **Figure 11 and Figure 12** detail the 6-month residence time for the applicable injection wells and the 1,000 radius of influence area (5-year travel time) for the nearby production well(s).

5. Summary of Results

The Beltz Screening Model, a 3-D steady state groundwater flow model developed for this analysis, serves as an adequate screening tool to assess the impact injecting purified water into the groundwater could have on downgradient users. Based on the modeling effort, the following conclusions and recommendations were derived:

- **North Beltz Wellfield (Beltz #12).** Assuming injection rates of 0.5 MGD per well is feasible, two injection wells could be located in areas close to INJ-B and INJ-C and operate at the North Beltz Wellfield and meet the GRRR direct injection criteria. The criteria mandate a minimum of 2-months retention time between the point of injection and extraction. In most cases, the Beltz Screening Model results indicate this mandate is met. However, for this analysis a conservative estimate of 6-months travel time to the edge of the ROI for the nearby downgradient production/domestic wells, and another 4 to 5 years until that drop of water would be extracted by the downgradient well is used for siting.

- **South Beltz Wellfield (Beltz #8, #9 and #10).** Assuming injection rates of 0.5 MGD per well is feasible, two injection wells could be located in areas close to INJ-D and INJ-F and operate at the South Beltz Wellfield with an estimated 6-months travel time to the edge of the ROI for the nearby downgradient production/domestic well, and another 4 to 5 years until that drop of water would be extracted by the downgradient well. For a third injection well location, INJ-J, the model simulated an estimated 6-months travel time from the point of injection to extraction at the nearby Beltz #10 well. Though this was still simulated to meet the desired 6-months travel time criteria for this study and the GRRR 2-month travel time criteria, it was removed from further consideration for this evaluation to be conservative as the 6-month residence travel time was just met.

Thus, the estimated GRR capacity for the Beltz Wellfield area is assumed to be 2.0 mgd (four wells, at 0.5 mgd injection capacity each). Though potential injection well sites are identified in this TM, further modeling using the Santa Cruz Mid County Groundwater Model and another siting evaluation is recommended should a GRR Project be pursued in this area.

6. Model Uncertainty and Limitations

This screening level groundwater model can be a powerful tool, if used appropriately, to assist in making management decisions for this site. Use of this model is subject to some limitations; like any computer model, it has inherent uncertainty. This does not, however, preclude its use to help make screening level management decisions. Any groundwater flow model is a simplification of the natural environment and, therefore, has recognized limitations. Hence, some uncertainty exists in the ability of any numeric model to completely predict groundwater flow. Considerable effort was expended to minimize model uncertainty by using real-world values as realistic model input whenever available. Uncertainty of the model output results from uncertainties in the conceptual model, input parameters, and the ability of the numerical model to effectively simulate field conditions.

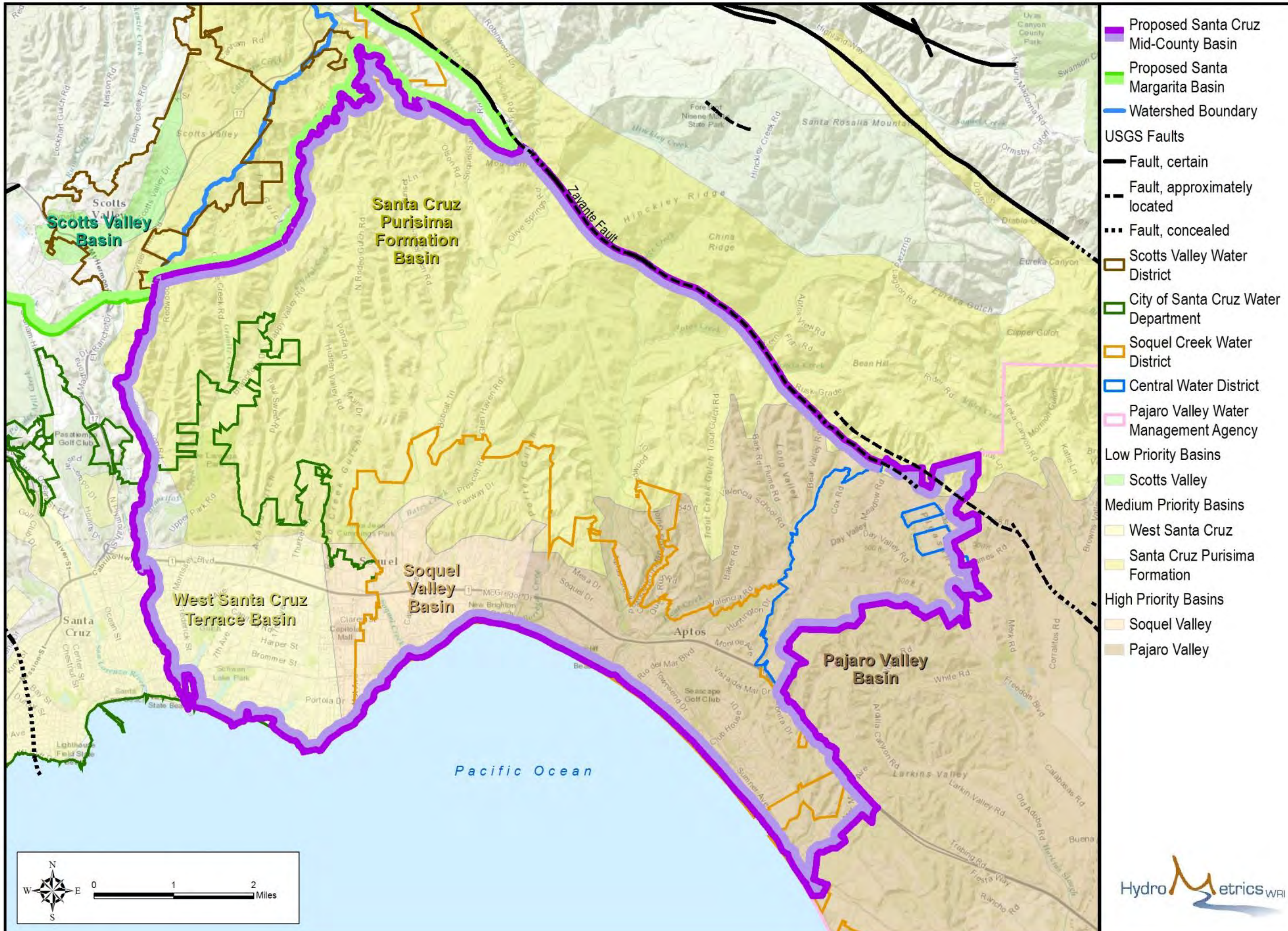
References

Hopkins Groundwater, 2006. Preliminary Hydrogeological Study, City of Santa Cruz Beltz Well Nos. 11 and 12 Well Siting Study, Santa Cruz, California, December

Hydrometrics, 2014. Soquel-Aptos Area Groundwater Management Annual Review and Report Water Year 2014, May

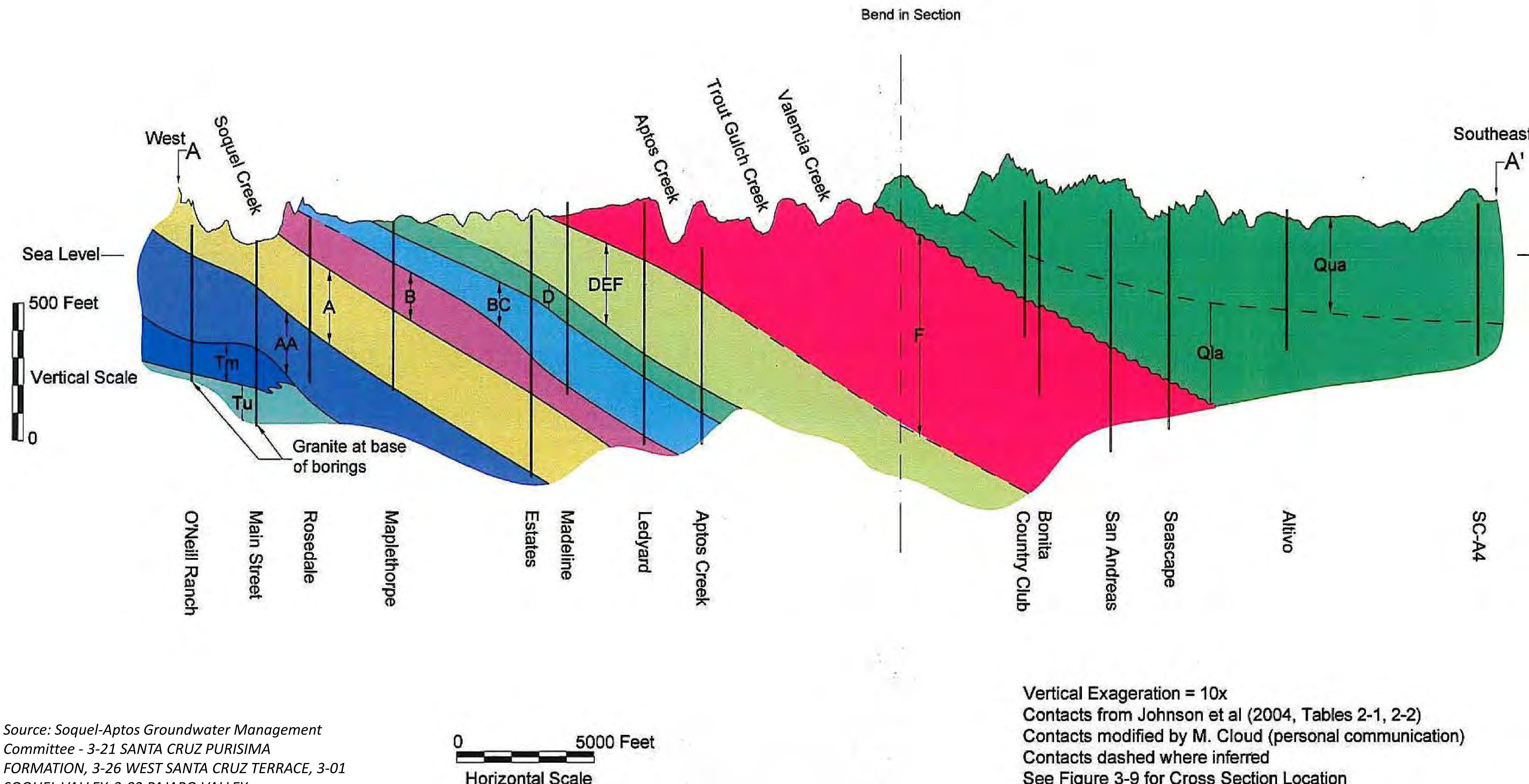
Pueblo Water Resources, 2015. City of Santa Cruz WSAC; Reconnaissance-Level Evaluation of ASR and IPR Technical Memorandum, May 15.

List of Figures



Source: Soquel-Aptos Groundwater Management Committee - 3-21 SANTA CRUZ PURISIMA FORMATION, 3-26 WEST SANTA CRUZ TERRACE, 3-01 SOQUEL VALLEY, 3-02 PAJARO VALLEY
http://sgma.water.ca.gov/basinmod/basinrequest/preview/27

Figure 1. Santa Cruz Mid-County Basin Boundary Modification



Source: Soquel-Aptos Groundwater Management Committee - 3-21 SANTA CRUZ PURISIMA FORMATION, 3-26 WEST SANTA CRUZ TERRACE, 3-01 SOQUEL VALLEY, 3-02 PAJARO VALLEY
http://sgma.water.ca.gov/basinmod/basinrequest/preview/27

Figure 2. Generalized Hydrostratigraphic Cross-Section of Proposed Santa Cruz Mid-County Basin

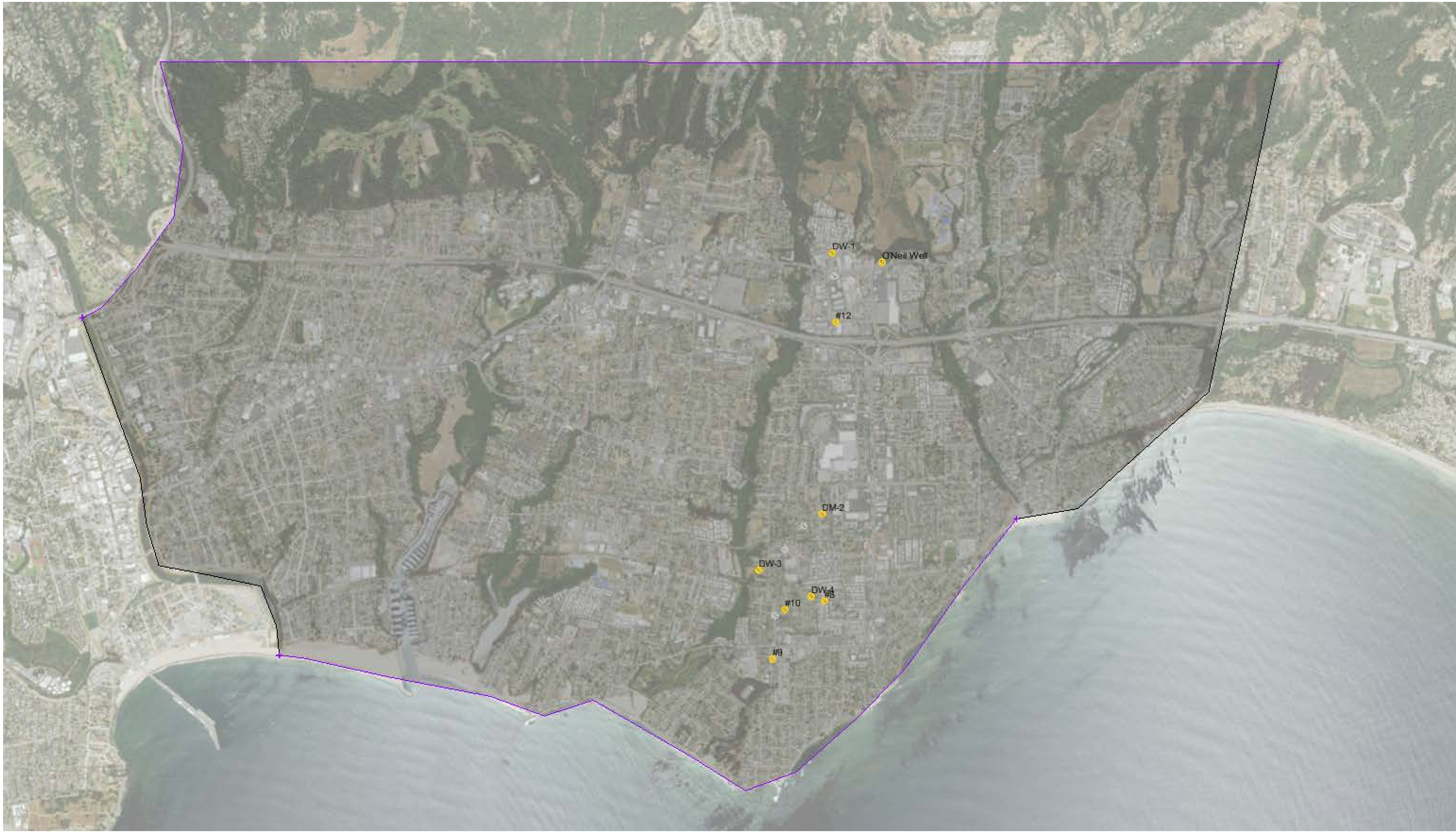


Figure 3. Location of Wells Utilized in the Analysis

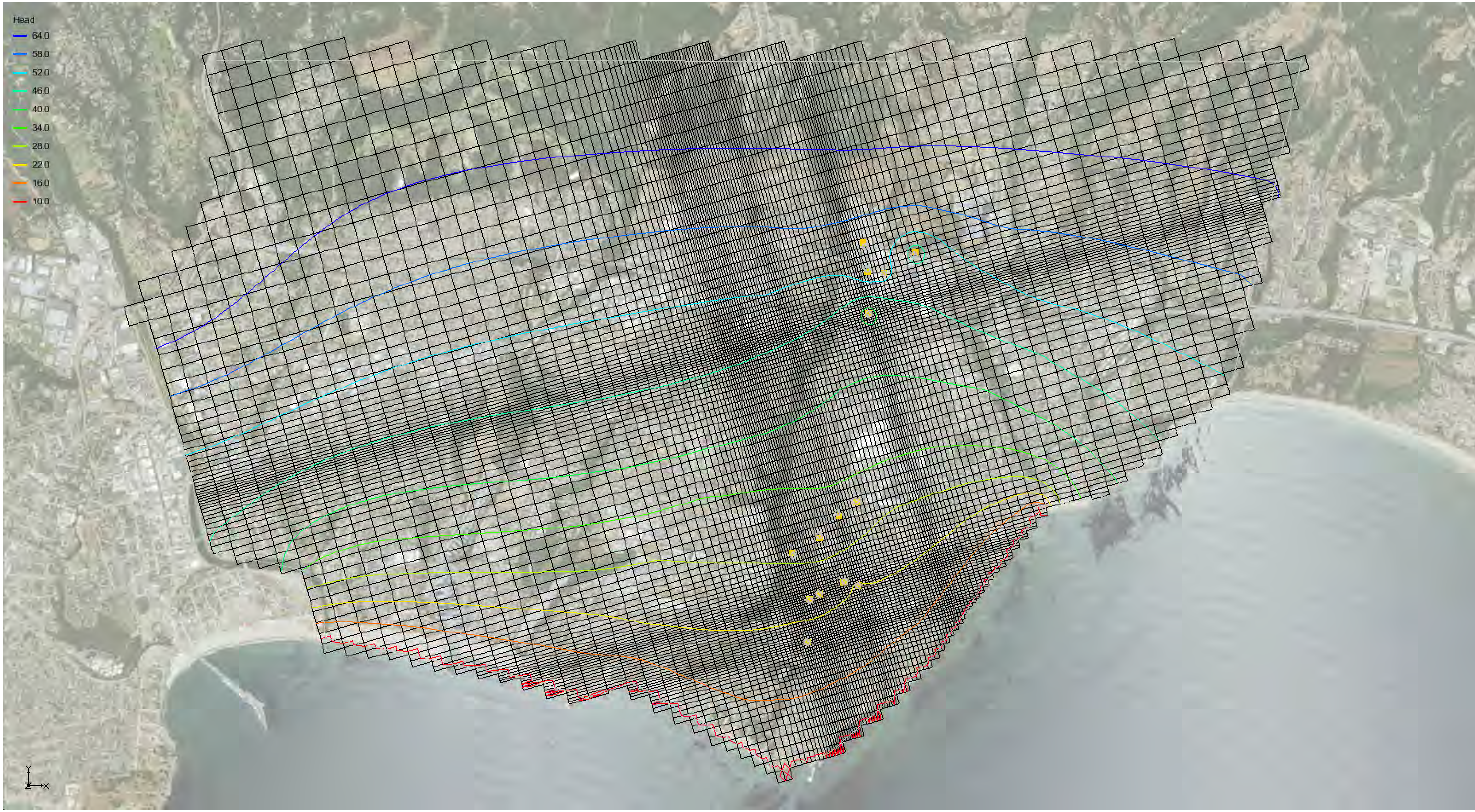
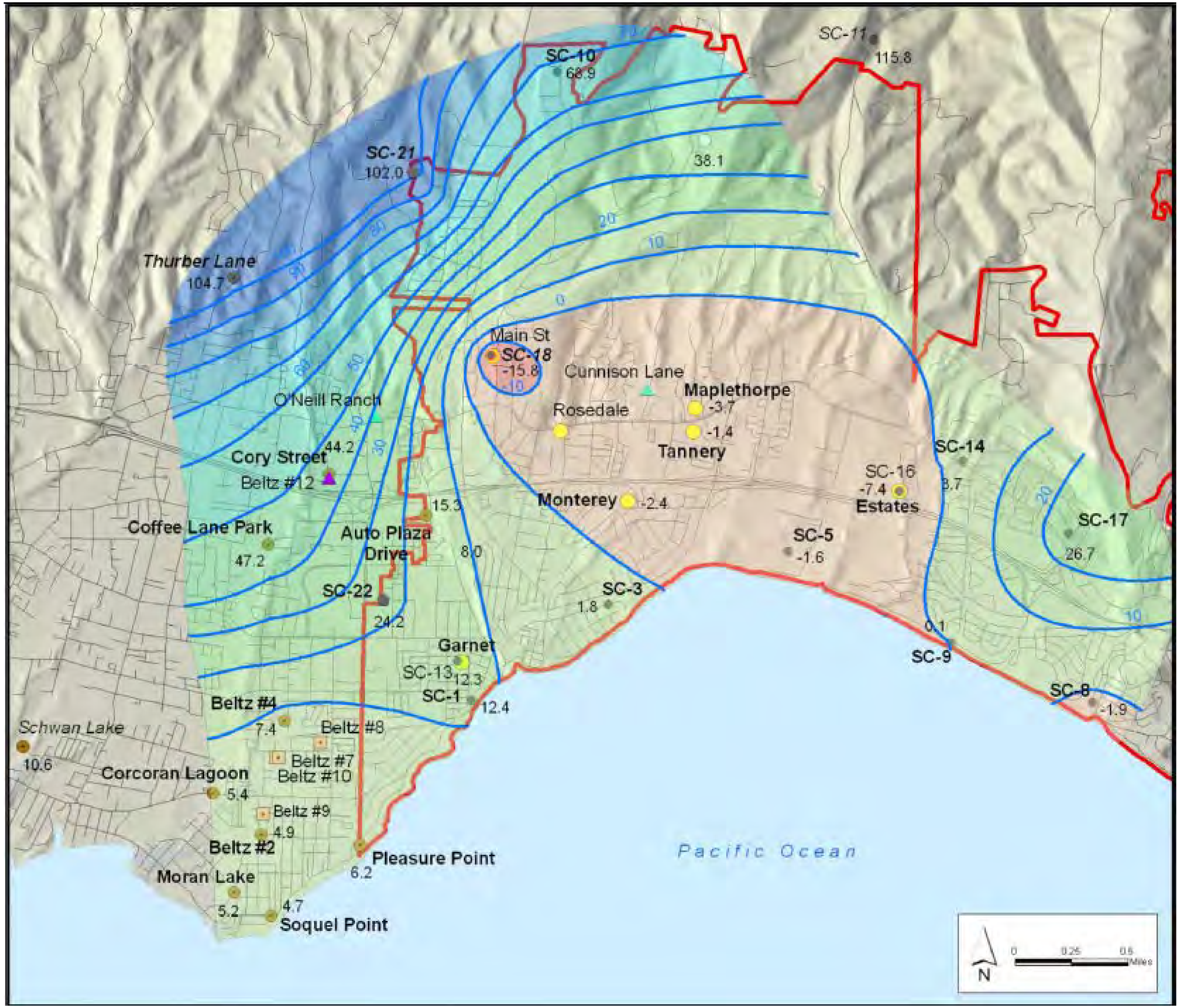


Figure 4. Study Area Screening Level Model Grid



Source: Modified from HMWRI

Figure 5. Regional Groundwater Elevation Map

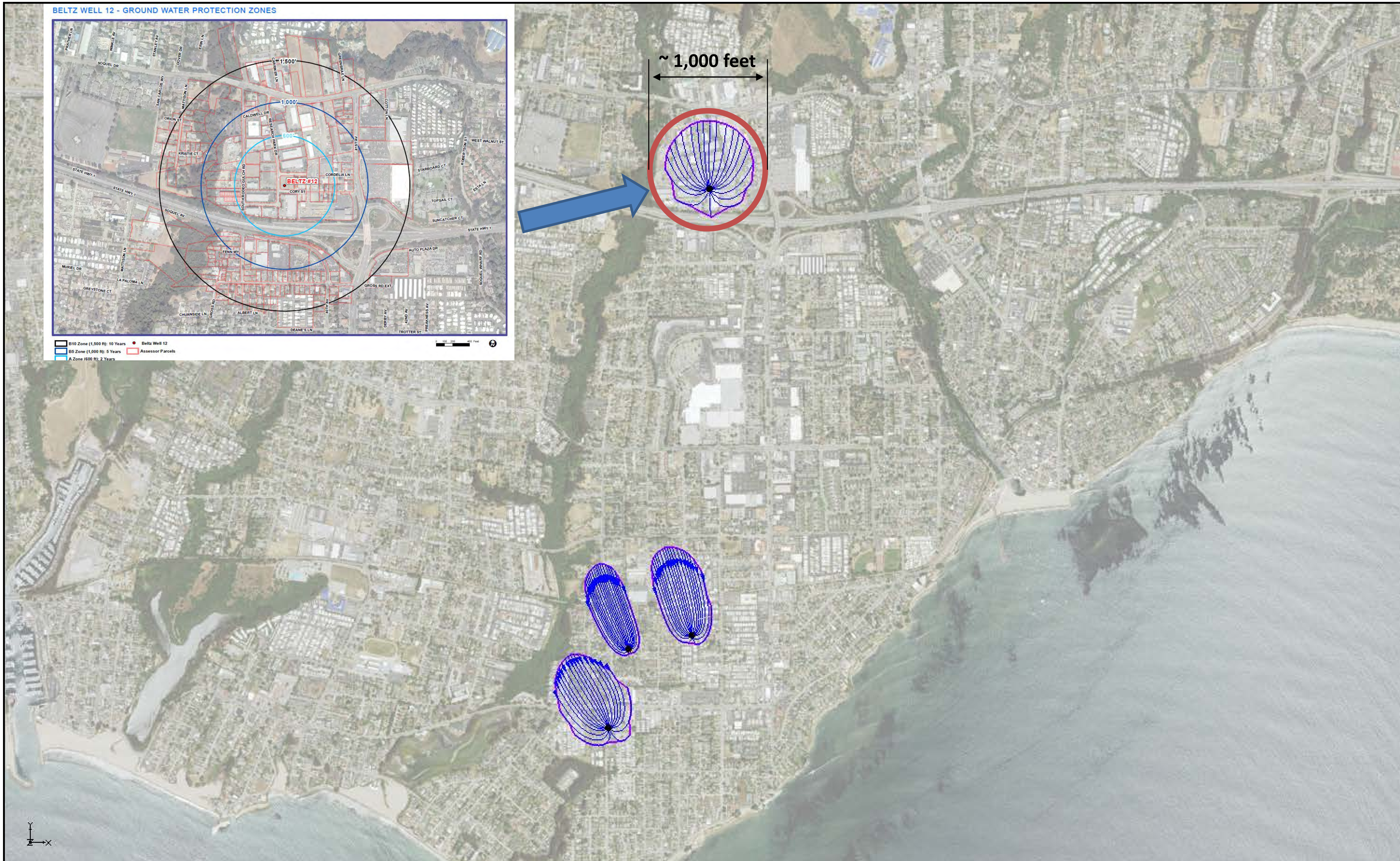


Figure 6. Analytical Radius of Influence Estimation Versus Numerical Particle Capture Zone Analysis

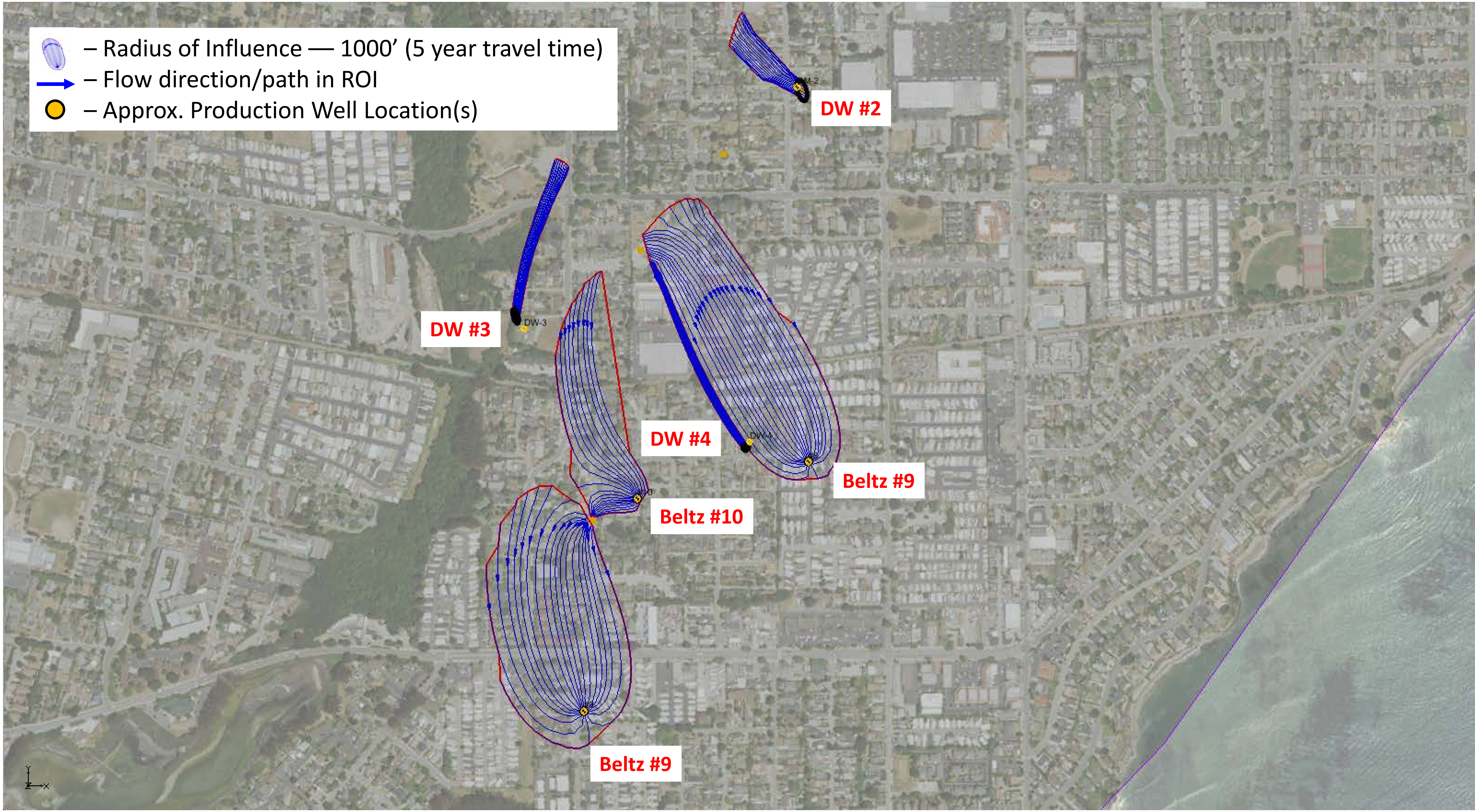


Figure 7. Radius of Influence Analysis for Pumping Wells in located in the South Beltz Wellfield Area

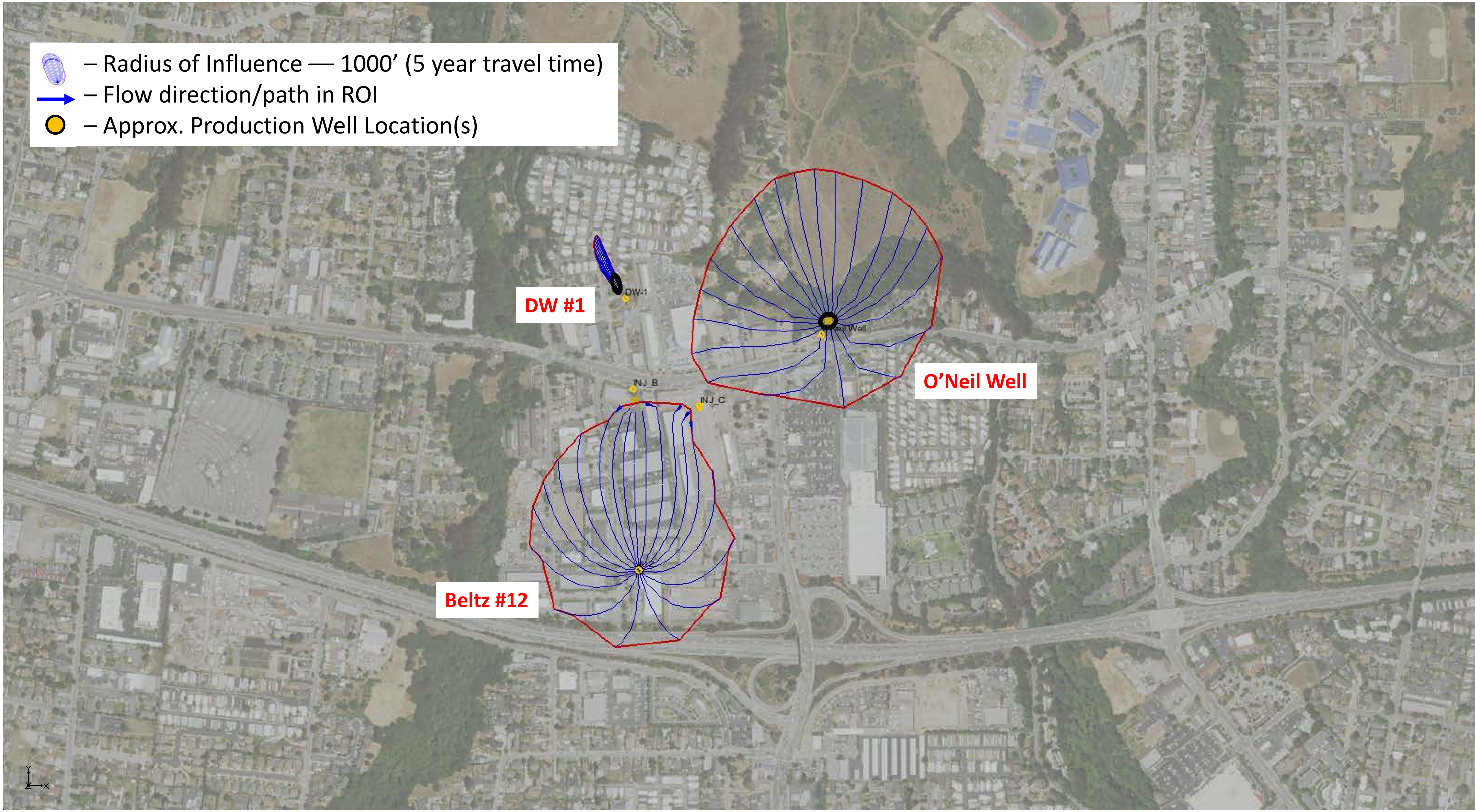


Figure 8. Radius of Influence Analysis for Pumping Wells in located in the North Beltz Wellfield Area

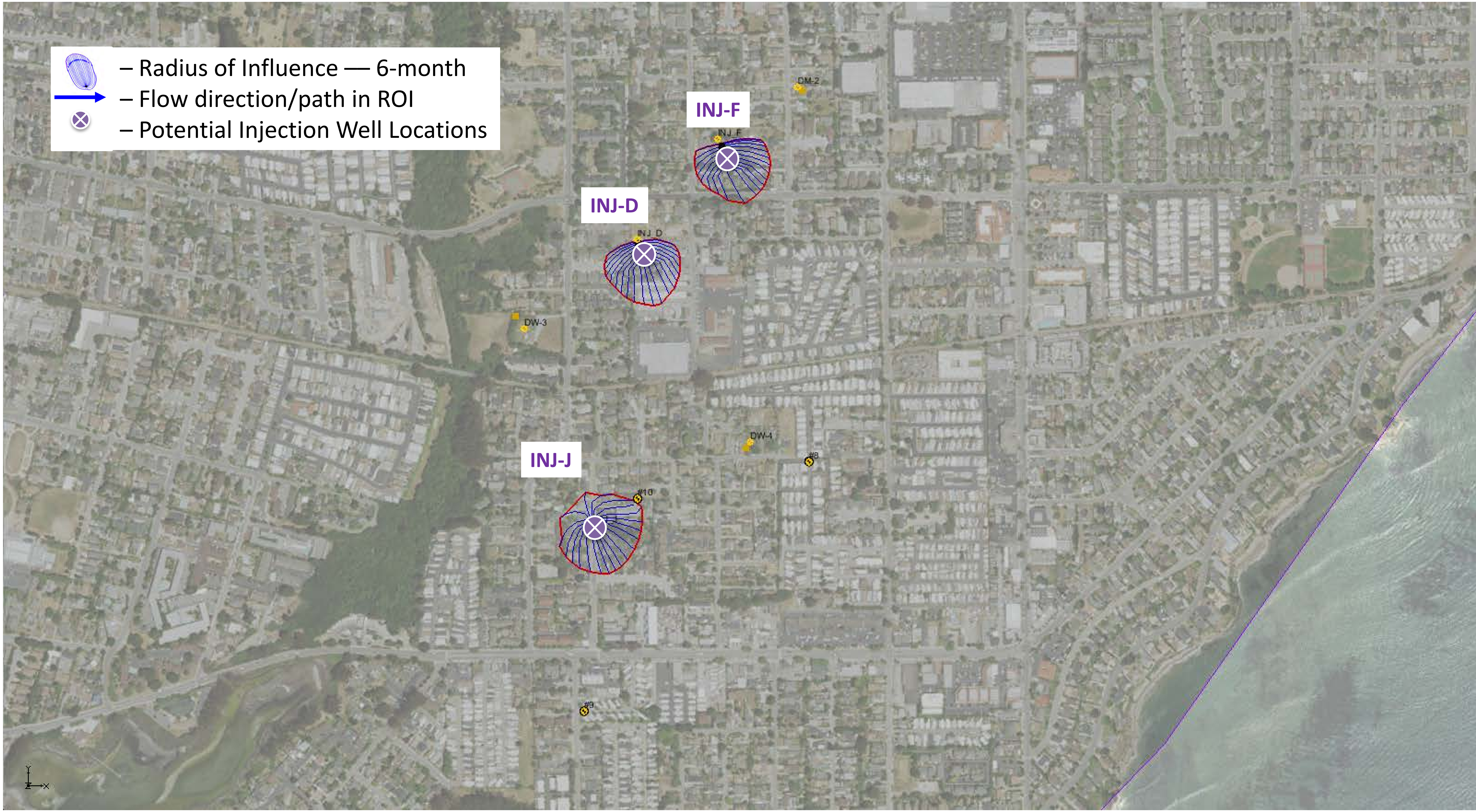


Figure 9. Radius of Influence Analysis for Injection Wells in located in the South Beltz Wellfield Area

Figure 10. Radius of Influence Analysis for Injection Wells in located in the North Beltz Wellfield Area

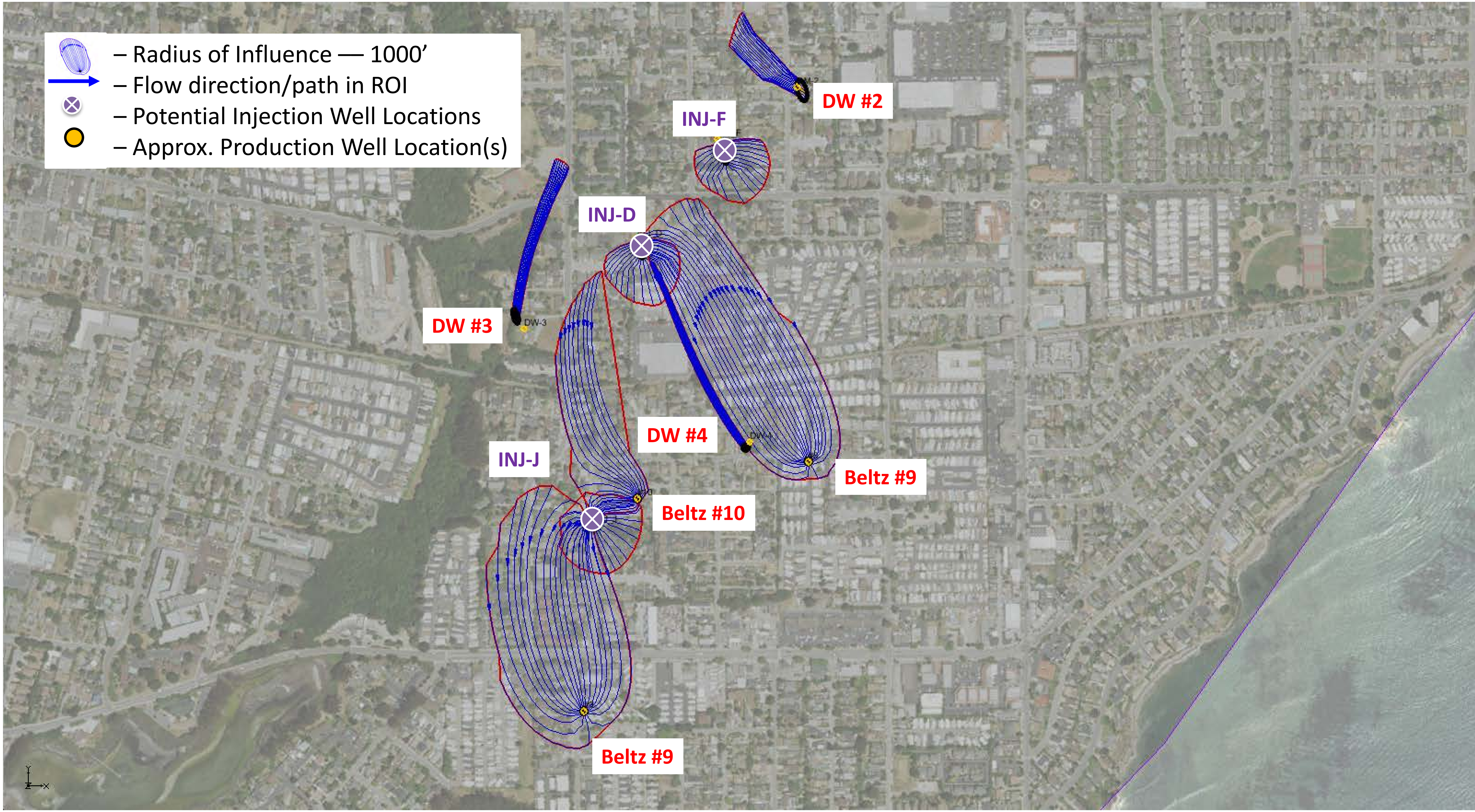


Figure 11. Radius of Influence Analysis for Injection and Production Wells in located in the South Beltz Wellfield Area

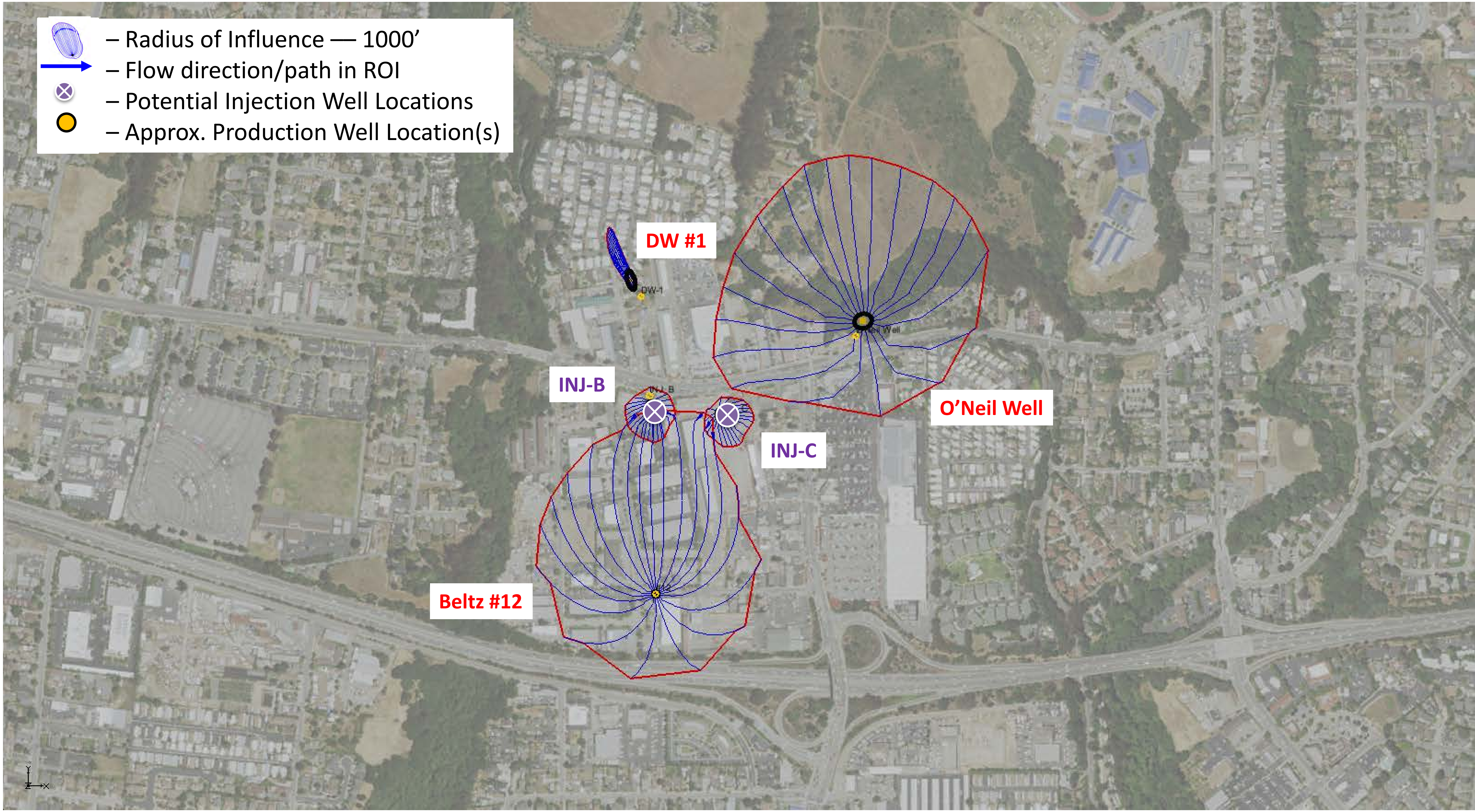


Figure 12. Radius of Influence Analysis for Injection and Production Wells in located in the North Beltz Wellfield Area

Kennedy/Jenks Consultants

26 September 2017

FINAL Technical Memorandum #2b (TM #2b)

To: Heidi Luckenbach and David Kehn
From: Eddy Teasdale, PG, CHG (Kennedy/Jenks)
Review: Melanie Tan, PE and Dawn Taffler, PE (Kennedy/Jenks)
Subject: **Santa Margarita Groundwater Basin - Injection Well Capacity and Siting Study**
[Recycled Water Facilities Planning Study]
K/J 1668007*00

1. Overview

The City of Santa Cruz is developing a Santa Cruz Regional Recycled Water Facilities Planning Study (RWFPS) to explore opportunities to develop a local or regional recycled water program as part of their water supply portfolio. The RWFPS includes alternatives for non-potable uses, to meet irrigation and commercial/industrial demands, and potable uses to recharge local groundwater aquifers, augment surface waters or supplement the drinking water system.

The Scotts Valley Water District (SVWD) recently developed a Recycled Water Facilities Planning Report (FPR) to explore opportunities for groundwater replenishment in the Santa Margarita Groundwater Basin, herein referred to as the Scotts Valley FPR (Kennedy/Jenks 2016). As part of this RWFPS, SVWD has worked in cooperation with the City to explore a Regional Groundwater Replenishment Reuse Project (Regional GRRP) to inject advanced purified recycled water into the Lompico Aquifer of the Santa Margarita Groundwater Basin (SMGB) near Scotts Valley (**Figure 1**). A Regional GRRP offers an opportunity to restore groundwater levels within the SMGB and maximize beneficial reuse in the region.

This Technical Memorandum (TM) focuses on the groundwater modeling results utilizing the 2015 SMGB hydrogeological groundwater flow model (Kennedy/Jenks 2015a) to evaluate the short-term and long-term effects and benefits of groundwater injection into the Lompico Aquifer in the southern portion of the SMGB (near Hanson Quarry) and at a proposed new injection well drilled at the Scotts Valley – El Pueblo site. The RWFPS utilized information from this groundwater TM to analyze two Regional GRRP alternatives to compare with other reuse alternatives being considered by the City.

2. Background

This section summarizes subsurface geologic and hydrogeological conditions and existing production well characteristics in the area, with a focus on opportunities for groundwater recharge (**Figure 2**). The SMGB covers approximately 30 square miles and includes the Santa Margarita, the Lompico and the Butano Aquifer units. The SVWD currently obtains all their potable water supply from the aquifers of the SMGB (Kennedy/Jenks, 2015b). The hydrogeological complexity of the SMGB is illustrated in a conceptual cross-section in **Figure 3**. A description of these aquifers is provided in the following sections.

2.1 Santa Margarita Sandstone Aquifer

The Santa Margarita Sandstone is the shallowest aquifer in the SVWD service area and currently is a source of only a small percentage of SVWD and SLVWD production. Groundwater levels steadily declined in the 1970s and 1980s due to increased pumping but have stabilized since the late 1990s. The Santa Margarita Sandstone Aquifer has high potential for groundwater recharge from precipitation due to the high permeability of the sandy soils and the shallow depth of the aquifer. Rainwater that percolated into the shallow Santa Margarita Aquifer is naturally discharged into Bean Creek and Carbonero Creek, and less of the percolated water reaches the lower Lompico aquifer.

2.2 Lompico Sandstone Aquifer

SVWD draws approximately 65% of its groundwater from the Lompico Sandstone Aquifer, which lies below the Santa Margarita Aquifer. Since the 1980s, groundwater levels have declined significantly in the Lompico Aquifer. Recent data indicates that the Lompico wells are able to sustain current pumping rates, which are below the estimated sustainable yield, and the Lompico Aquifer levels have stabilized. However, groundwater levels are not recovering in response to the reduced groundwater pumping rates. This indicates that recharge of the Lompico by percolation of rainwater or other surface recharge is a very slow process, and that areas of the Lompico would be a good candidate for injection or in-lieu recharge.

2.3 Butano Formation Aquifer

The deepest and least understood aquifer from which SVWD pumps is the Butano Formation Aquifer. Pumping began in 1994, and SVWD currently draws approximately 21% of its groundwater from the Butano.

3. Injection Well Capacity Requirements

Groundwater Replenishment Reuse Regulations (GRRR) were promulgated by the California Division of Drinking Water (DDW) on June 18, 2014, which govern surface spreading and direct injection GRRP (Project)s. The GRRR define treatment requirements for pathogen control, requiring 12-log enteric virus removal, 10-log Giardia removal and 10-log Cryptosporidium removal (12/10/10 microorganism removal). Removal credit can be obtained through treatment processes and through the amount of time the recycled water is maintained underground (also referred to as retention time). For a GRRP utilizing direct injection, the GRRR mandates a minimum of 2 months retention time between the point of injection and extraction; however, no existing GRRP facilities currently operate with a retention time under 6 months.

The GRRP concept being evaluated as part of the RWFPS is direct injection of advanced treated recycled water (purified water) into the groundwater basin via injection wells. Once in the subsurface, the purified water will comingle with local groundwater and be stored in the local aquifer. Groundwater would then be extracted via existing or new production wells to meet drinking water needs. For this evaluation, it was assumed that a minimum travel time of 6-months must be achieved between the point of injection and the point of extraction.

This section describes the high-level approach developed to identify injection well sites and estimate recharge capacity in the SMGB area. Additional consideration of any GRRP concept would require a detailed analysis of groundwater travel times in a follow-on feasibility study.

3.1 Approach

Given the potential for well interference from both extraction from existing municipal production and domestic wells, the 2015 SMGB hydrogeological groundwater flow model (2015 SMGB Model) was utilized (Kennedy/Jenks 2015a). The 2015 SMGB Model was used to identify proposed injection wells based on site specific hydraulic conductivity information and regional gradient variations. This 2015 SMGB Model is not intended to be a replacement for the 2017 transient regional SMGB model (2017 SMGB Model), which is currently being revised and updated by HydroMetrics. Once the 2017 SMGB Model has been updated, the proposed scenarios presented in this TM utilizing the 2015 SMGB Model should be incorporated into that model for further simulations and analysis.

3.2 SMGB Model Approach

The 2015 SMGB Model was developed using the Groundwater Vistas 6 (GWV). GWV is a comprehensive graphical user interface (GUI) for performing groundwater simulations. GWV provides a graphical preprocessor/postprocessor interface to several groundwater modeling codes: MODFLOW and MODPATH. A summary of the modeling codes and geological software tools used during this modeling effort are presented below.

- **MODFLOW Groundwater Flow Model.** The computer code selected to model groundwater flow beneath the site was MODFLOW. MODFLOW is a 3-D, cell-centered, finite difference, saturated flow model developed by the United States Geological Survey (USGS) (McDonald and Harbaugh, 1988). GWV provides an interface to the updated version, MODFLOW NWT. Based on the information available, the uncertainties in site-specific information, the hydrogeologic complexity of the site, and the modeling objectives, MODFLOW was considered an appropriate groundwater flow code.

- **MODPATH Particle-Tracking Model.** Particle-tracking simulations provide a convenient means of visualizing groundwater flow paths. This is particularly useful for evaluating capture zones around a pumping well or understanding travel paths from injection. MODPATH was selected as the particle-tracking program for this effort. MODPATH is a 3-D particle-tracking program that enables reverse and forward tracking from sinks (wells) and sources, respectively. MODPATH also was developed by the USGS (Pollock, 1994). GWV has updated the interface for MODPATH to a seamless module that couples with MODFLOW 2000. MODFLOW flow modeling results (direction and rates of groundwater movement) are among the inputs for MODPATH runs.

3.2.1 SMGB Model Grid

The SMGB covers over 30 square miles in the Santa Cruz Mountains. The SMGB forms a roughly triangular area that extends from Scotts Valley in the east, to Boulder Creek in the northwest, to Felton in the southwest. The area that is included in the SMGB Model is shown on **Figure 4**.

MODFLOW requires the application of a rectangular grid that encompasses the entire area, or domain, that will be modeled. The model grid forms the mathematical framework for the model. Each grid cell must be populated with aquifer properties. Physical features such as streams and wells are mapped onto the model grid. Using this information, the MODFLOW model calculates a groundwater elevation at each model grid cell for each stress period. The density of model grid cells is what defines the resolution of the model in resolving drawdown and other hydrologic effects.

The SMGB Model consists of 346 rows, 434 columns, and 7 layers. The rows and columns have a uniform spacing of 110 feet. The total number of model cells is just over one million cells (1,051,148 cells), of which 352,269 are active cells where MODFLOW calculates a groundwater levels. Areas not in the SMGB are represented as no-flow cells where MODFLOW does not perform calculations. The high percentage of no-flow cells in the model grid is due to both the triangular shape of the SMGB and because the distribution of active cells varies from layer to layer because not all the formations have the same areal extent in the subsurface. The bottom of the lowest model layer is a no-flow boundary condition, representing the crystalline bedrock, which is assumed to be relatively impermeable.

3.2.2 SMGB Model Layer Definition

The model layers are a representation of the geologic characteristics of the SMGB including the definition of the different aquifers. The definition of the model layers in the SMGB Model is defined using seven layers that represent the following geologic units:

- Santa Margarita Sandstone (Santa Margarita) – Model Layer 1
- Monterey Formation (Monterey) – Model Layer 2 and 3
- Lompico Sandstone (Lompico) – Model Layer 4
- Butano Formation (Butano) – Model Layer 5, 6 and 7
- Locatelli Formation – incorporated into Model Layer 5 and 6.

The Santa Margarita Aquifer is represented by a single model layer (Model Layer 1). The base of the lower Monterey is defined as the top of the Lompico Aquifer. The top of the Monterey is defined as either the topographic surface in the outcrop areas or the base of the Santa Margarita Aquifer where the top occurs in the subsurface. The lower Monterey is defined as a uniform 300 feet thickness across the SMGB. In areas where the total thickness of the Monterey is less than 300 feet, the available Monterey is assigned to the lower Monterey and the upper Monterey is absent. The available thickness on the Monterey Aquifer above the top of the lower Monterey is assigned to the upper Monterey so that it has a variable thickness across the SMGB.

The Lompico Aquifer is simulated using a single layer (Model Layer 4). The Lompico is defined as a uniform thickness over the majority of the SMGB, but is allowed to thin to 300 feet from the center of the Scotts Valley Syncline northwestward towards Boulder Creek. The top of the Lompico is defined as either adding the thickness from the base of the unit, the base of the Santa Margarita Aquifer, or the topographic surface, whichever is lower. The Lompico Aquifer is where direct injection and additional extraction is proposed to occur.

The Butano Aquifer is simulated using three layers (Model Layers 5, 6 and 7). The lower Butano is defined as a uniform 900 feet thickness across the SMGB. In areas where the total thickness of the Butano is less than 900 feet, the available Butano is assigned to the lower Butano. The upper Butano is defined as 500-foot thickness below the base of the Lompico that represents the upper and middle members of the Butano. Model Layer 6 represents the remaining section of the lower Butano between Model Layers 5 and 7.

The Locatelli Aquifer is simulated using two layers (Model Layers 5 and 6). Although the Locatelli is stratigraphically below the Butano, these units are not considered to be in contact within the SMGB; therefore, for operational efficiency in running the MODFLOW model, the Locatelli is included with the Butano on Model Layer 5 and 6. The Locatelli is only present in a small area in the southwestern SMGB. The Locatelli in Model Layer 5 represents the upper siltstone layer and Model Layer 6 represents the basal sandstone member.

3.3 TRAVEL TIME ESTIMATION SIMULATION

MODPATH was utilized to calculate the horizontal radius of influence (ROI) by utilizing particle tracking to estimate travel time. In the particle tracking simulation, imaginary particles selected for tracking behave like a water molecule and are affected only by advection resulting from hydraulic influences (i.e. pumping and/or injection) and aquifer properties (i.e. groundwater gradient, hydraulic conductivity). A number of particles were placed at existing production wells, nearby domestic wells and proposed injection well locations. Details for production/domestic and injection wells particle tracking are presented in the following sections.

3.4 EXISTING AND PROPOSED INJECTION WELLFIELD

This modeling evaluation assumed that nine potential injection well locations (**Figure 5**), conceptually identified as part of a regional well siting analysis (Pueblo, 2017), could be utilized for a Regional GRRP. These locations, SV 1 through SV 9, are preliminary and were selected based on factors such as current ownership, neighboring land use and access. Future siting, field investigations and additional modeling would be required to identify preferred injection locations.

The three existing wells near the proposed El Pueblo advanced water purification facility (AWPF) site (proposed Injection Well 3, and existing production wells SVWD 11A and 11B), also shown in **Figure 5**, are assumed to be repurposed to be GRRP injection wells, per the findings of the Scotts Valley FPR.

All existing and proposed injection wells are simulated to be screened within the Lompico Aquifer. Four alternative scenarios were evaluated as part of this modeling analysis. The details of the alternative scenario assumptions, inputs, and model results are summarized below.

3.5 MODELING SCENARIOS

The following scenarios were modeled as part of this TM:

- **Scenario 1**: 3.3 MGD total injection of purified water utilizing 9 new injection wells and three existing wells.
- **Scenario 2**: 4.9 MGD total injection of purified water utilizing 9 new injection wells and three existing wells.
- **Scenario 3**: 4.9 MGD total injection of purified water utilizing 9 new injection wells, three existing injection wells and 5 new extraction wells.
- **Scenario 4**: Simulated the potential for groundwater mounding and evaluated the vertical impacts from mounding for Scenarios 1, 2 and 3.

The following sections describe the injection well flow rates, storage capacity estimation and travel time estimation for each scenario.

3.5.1 Scenario 1 – 3.3 MGD Injection

Scenario 1 - Injection Well Flow Rates and Storage Capacity Estimation

To estimate the injection storage capacity for the proposed wells (SV 1 through SV 9), groundwater surface elevation data from the production wells was subtracted from groundwater surface elevation data to derive a depth to water value in feet below ground surface (bgs). To reduce the risk of wellhead flooding, depth to water during injection was restricted to be maintained at approximately 10 feet below ground surface. Proposed injection rates for scenario 1 are summarized in Table 1.

Table 1: Injection Capacity for Existing and Proposed Wells – Scenario 1

Well Name	Well Description	Est. Injection Rate (GPM)	Est Injection Rate (MGD)
SV 1	Proposed	150	0.22
SV 2	Proposed	205	0.30
SV 3	Proposed	200	0.29
SV 4	Proposed	430	0.62
SV 5	Proposed	250	0.36
SV 6	Proposed	190	0.27
SV 7	Proposed	205	0.30
SV 8	Proposed	50	0.07
SV 9	Proposed	207	0.30
INJ Well 3	Existing	120	0.2
11A	Existing	120	0.2
11B	Existing	120	0.2
Total	Existing	360	0.6
Total	Proposed	1,887	2.72
Total	Existing & Proposed	2,247	3.32

Scenario 1 - Travel Time Estimation for Production and Injection Wells

Individual particles were placed at current production wells, and select domestic wells in the area. The particles were simulated to migrate backwards (up gradient) for approximately 6 months. The approximate hydraulic influence area or ROI for each production well and domestic well location over a 6-month simulation period is outlined in red (**Figure 6**). To assess the potential impacts injected purified water would have on downgradient users (i.e. production wells and domestic wells), a similar particle tracking effort was conducted for the injection wells.

For injection well travel estimation, particle tracks were placed at the applicable injection well, and then the applicable particles were allowed to move forward for 6-months. The approximate 6-month hydraulic influence from the injection wells is outlined in blue (see **Figure 6**).

3.5.2 Scenario 2 – 4.9 MGD Injection

Scenario 2 - Injection Well Flow Rates and Storage Capacity Estimation

To estimate the injection storage capacity for the proposed wells (SV 1 through SV 9), groundwater surface elevation data from the production wells was subtracted from groundwater surface elevation data to derive a depth to water value in feet below ground surface (bgs). To reduce the risk of wellhead flooding, depth to water during injection was restricted to be maintained at approximately 10 feet below ground surface. Proposed injection rates for scenario 2 are summarized in Table 2.

Table 2: Injection Capacity for Existing and Proposed Wells – Scenario 2

Well Name	Well Description	Est. Injection Rate (GPM)	Est Injection Rate (MGD)
SV 1	Proposed	328	0.47
SV 2	Proposed	422	0.61
SV 3	Proposed	235	0.34
SV 4	Proposed	250	0.36
SV 5	Proposed	390	0.56
SV 6	Proposed	390	0.57
SV 7	Proposed	300	0.43
SV 8	Proposed	438	0.63
SV 9	Proposed	218	0.32
INJ Well 3	Existing	120	0.2
11A	Existing	120	0.2
11B	Existing	120	0.2
Total	Existing	360	0.6
Total	Proposed	2,971	4.28
Total	Existing & Proposed	3,331	4.88

Scenario 2 - Travel Time Estimation for Production and Injection Wells

Individual particles were placed at current production wells, and select domestic wells in the area. The particles were simulated to migrate backwards (up gradient) for approximately 6 months. The approximate hydraulic influence area or ROI for each production well and domestic well location over a 6-month simulation period is outlined in red (**Figure 7**). To assess the potential impacts injected purified water would have on downgradient users (i.e. production wells and domestic wells), a similar particle tracking effort was conducted for the injection wells.

For injection well travel estimation, particle tracks were placed at the applicable injection well, and then the applicable particles were allowed to move forward for 6-months. The approximate 6-month hydraulic influence from the injection wells is outlined in blue (see **Figure 7**).

3.5.3 Scenario 3 – Additional Production Wells

Scenario 3 - Injection Well Flow Rates and Storage Capacity Estimation

To estimate the potential recovery of injection storage capacity for the proposed wells (SV 1 through SV 9) and existing injection wells, and minimize mounding, scenario 3 included the addition of 5 new production/extraction wells. The total production/extraction rates of the new extraction wells are equal to the new proposed injection rates. Extraction and injection rates for scenario 3 are summarized in Table 3.

Scenario 3 - Travel Time Estimation for Production and Injection Wells

Individual particles were placed at current and the proposed new productions wells, and select domestic wells in the area. The particles were simulated to migrate backwards (up gradient) for approximately 6 months. The approximate hydraulic influence area or ROI for each existing production well and domestic well location over a 6-month simulation period is outlined in red and ROI for proposed new extraction wells is outlined in yellow (**Figure 8**). To assess the potential impacts injected purified water would have on downgradient users (i.e. production wells and domestic wells), a similar particle tracking effort was conducted for the injection wells.

For injection well travel estimation, particle tracks were placed at the applicable injection well, and then the applicable particles were allowed to move down gradient for 6-months. The approximate 6-month hydraulic influence from the injection wells is outlined in blue (see **Figure 8**).

Table 3: Injection Capacity for Existing and Proposed Wells – Scenario 3

Well Name	Well Description	Est. Injection Rate (GPM)	Est. Injection Rate (MGD)	Est. Extraction Rate (GPM)	Est. Extraction Rate (MGD)
SV 1	Proposed	328	0.47	--	--
SV 2	Proposed	422	0.61	--	--
SV 3	Proposed	235	0.34	--	--
SV 4	Proposed	250	0.36	--	--
SV 5	Proposed	390	0.56	--	--
SV 6	Proposed	390	0.57	--	--
SV 7	Proposed	300	0.43	--	--
SV 8	Proposed	438	0.63	--	--
SV 9	Proposed	218	0.32	--	--
INJ Well 3	Existing	120	0.2	--	--
11A	Existing	120	0.2	--	--
11B	Existing	120	0.2	--	--
PW 1	New Extraction	--	--	594	0.86
PW 2	New Extraction	--	--	594	0.86
PW 3	New Extraction	--	--	594	0.86
PW 4	New Extraction	--	--	594	0.86
PW 5	New Extraction	--	--	594	086
Total	Existing	360	0.6		
Total	Proposed	2,970	4.28	2,970	4.28
Total	Existing & Proposed	3,331	4.88		

3.5.4 Scenario 4 – Minimize Potential for Groundwater Mounding

Scenario 4 - Vertical Impacts from Groundwater Replenishment

Scenarios 1 through 3 evaluated the lateral radius of influence within the Lompico Aquifer, and did not specifically evaluate the potential for groundwater mounding (resulting in groundwater daylighting) that might occur at the surface. To evaluate the potential for mounding (defined as vertical mounding); an observation pseudo-point was placed directly above the Lompico Aquifer in the Santa Margarita Aquifer. The model then computed the groundwater levels from this pseudo-point. Five injection and pumping model scenarios (Scenario 4-1 through 4-5) were simulated over a 30-year period and groundwater levels from the pseudo-point were calculated. A summary of the scenarios are presented in Table 4.

Table 4: Injection Capacity for Existing and Proposed Wells – Scenario 4

Scenario 4	Description	Color Code Reference on Figure 9
Scenario 4-1	3.3 MGD Injection Only	Green Triangle
Scenario 4-2	3.3 MGD Injection and Pumping	Light Blue Cross
Scenario 4-3	4.9 MGD Injection Only	Purple Cross
Scenario 4-4	4.9 MGD Injection and Pumping	Blue Square
Scenario 4-5	4.9 MGD Injection and Pumping. Pumping occurs every 2 years	Pink Line

Scenario 4 – Vertical Impacts for Production and Injection Well Operations

Results from scenario 4 are summarized graphically on **Figure 9**. Ground surface elevation minimum, maximum and average in the general area of the injection wells are outlined as blue, green and orange dashed lines. Pumping and injection scenarios 4-1 through 4-5 are also detailed on **Figure 9**.

4. Summary of SMGB Model Results

The SMGB Model was used to simulate injection of purified water at potential injection sites and estimate the horizontal ROI for the injected water (at 6-months travel time) and nearby production wells. **Figure 6 through Figure 8** detail the 6-month residence time for the applicable injection and/or extraction wells. Potential groundwater mounding that might occur at land surface was also simulated (**Figure 9**). Table 5 summarizes the results of the four scenarios presented in Section 3.

Table 5: Summary of SMGB Model Results

	Scenario 1	Scenario 2	Scenario 3	Scenario 4
Assumed Injection (MGD)	3.3	4.9	4.9	3.3 and 4.9
Assumed Injection (AFY)	3,600	5,500	5,500	3,600 and 5,500
# Injection Wells	12	12	12	12
# New Production Wells	0	0	5	5
Possible Daylighting	Yes	Yes	No	Yes and No

Based on the modeling effort, the following conclusions and recommendations were derived:

- The geology under the Hanson Quarry area and the nearby surrounding areas including Scotts Valley would be favorable for groundwater injection into the Lompico Aquifer.
- Based on the assumptions herein, the proposed and existing injection wells could be capable of recharging 3.3 to 4.9 million gallons per day (MGD) or 3,600 to 5,500 Acre Feet per year (AFY) of purified recycled water, respectively, into the Lompico Aquifer of the SMGB.
- All injection well location sites are outside of the approximately 6-month travel time for a particle/drop of water to reach existing and proposed production/extraction wells. This provides a conservative approach to meeting the state mandated minimum of 2-month residence time between injection and extraction for full advanced treated water.
- Depending on surface elevation values, daylighting could occur at lower elevation areas, defined as less than 375 feet above mean seal level (aMSL); however, daylighting would likely not occur in well locations where land surfaces are above approximately 550 feet aMSL.
- The GRR regulatory requirements for greater than 2 months underground retention time between the point of injection and extraction could be easily met at all sites evaluated. Estimated travel time for a drop of water to migrate from proposed injection wells to downgradient production wells varies from 3 to 7 years.
- As shown in **Figure 9,** Groundwater mounding at the surface could become an issue for a GRRP without managed extraction occurring during injection operations.

Though potential injection well sites are identified in this TM, further groundwater modeling, siting evaluation, and pilot-testing is recommended should a GRRP be pursued in this area.

Additional benefits of active groundwater replenishment in the SMGB could include:

- Groundwater level rise would reduce groundwater pumping energy requirements for groundwater users.
- Potential for increased surface water flows in local creeks provides increased water for surface withdrawal.
- The benefits of active groundwater replenishment are regional and apply to the members of the Santa Margarita Groundwater Agency, the general community, regional stakeholders and environmental regulatory agencies.

5. Model Uncertainty and Limitations

The 2015 SMGB hydrogeological groundwater flow model can be a powerful tool, if used appropriately, to assist in making management decisions for this site. Use of this model is subject to some limitations; like any computer model, it has inherent uncertainty. This does not, however, preclude its use to help make screening level management decisions. Any groundwater flow model is a simplification of the natural environment and, therefore, has recognized limitations. Hence, some uncertainty exists in the ability of any numeric model to completely predict groundwater flow. Considerable effort was expended to minimize model uncertainty by using real-world values as realistic model input whenever available. Uncertainty of the model output results from uncertainties in the conceptual model, input parameters, and the ability of the numerical model to effectively simulate field conditions.

References

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Pueblo Consultants, 2017. Personal Communication, April 2017.

List of Figures

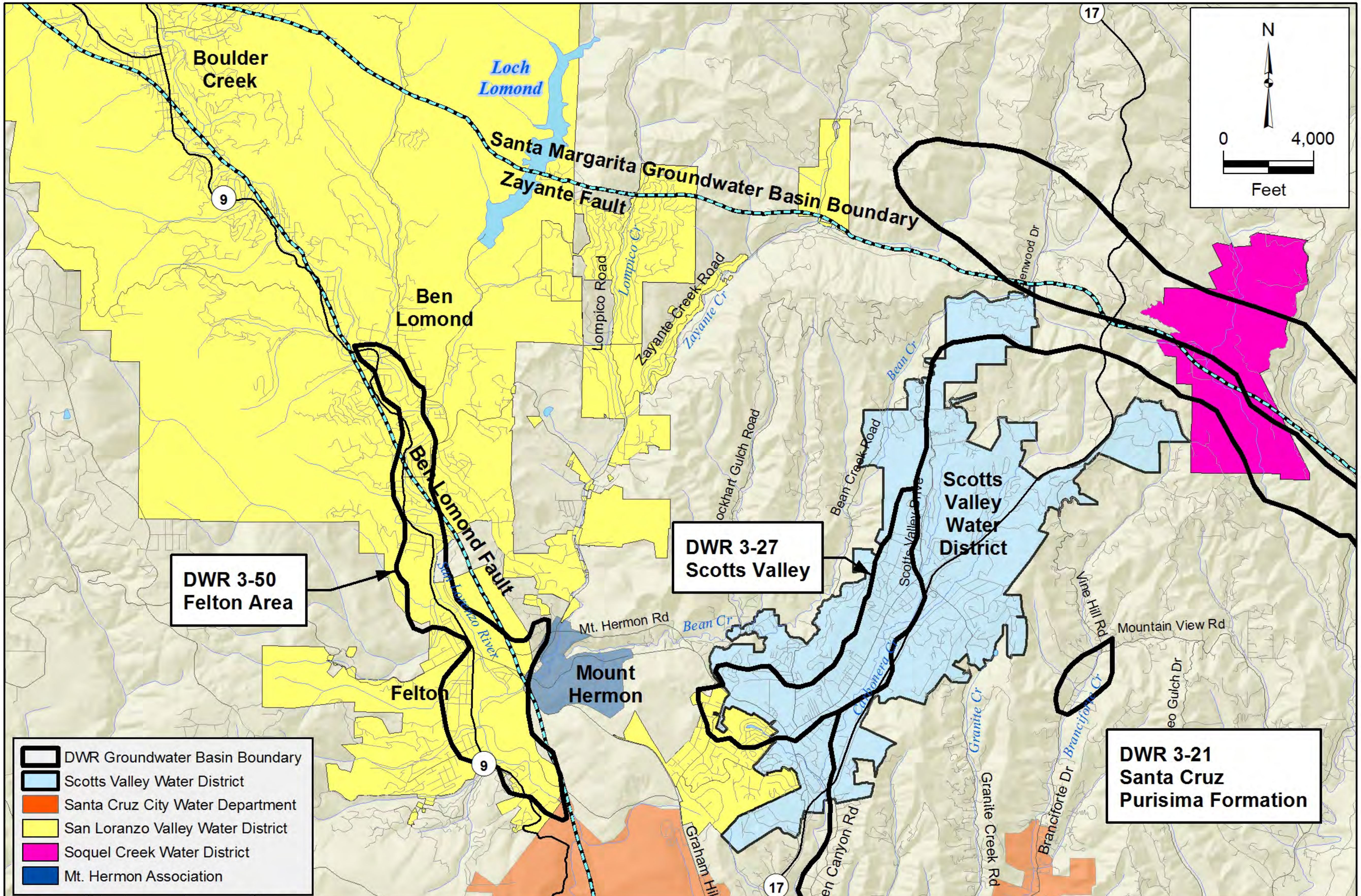

Figure 1. Santa Margarita Groundwater Basin

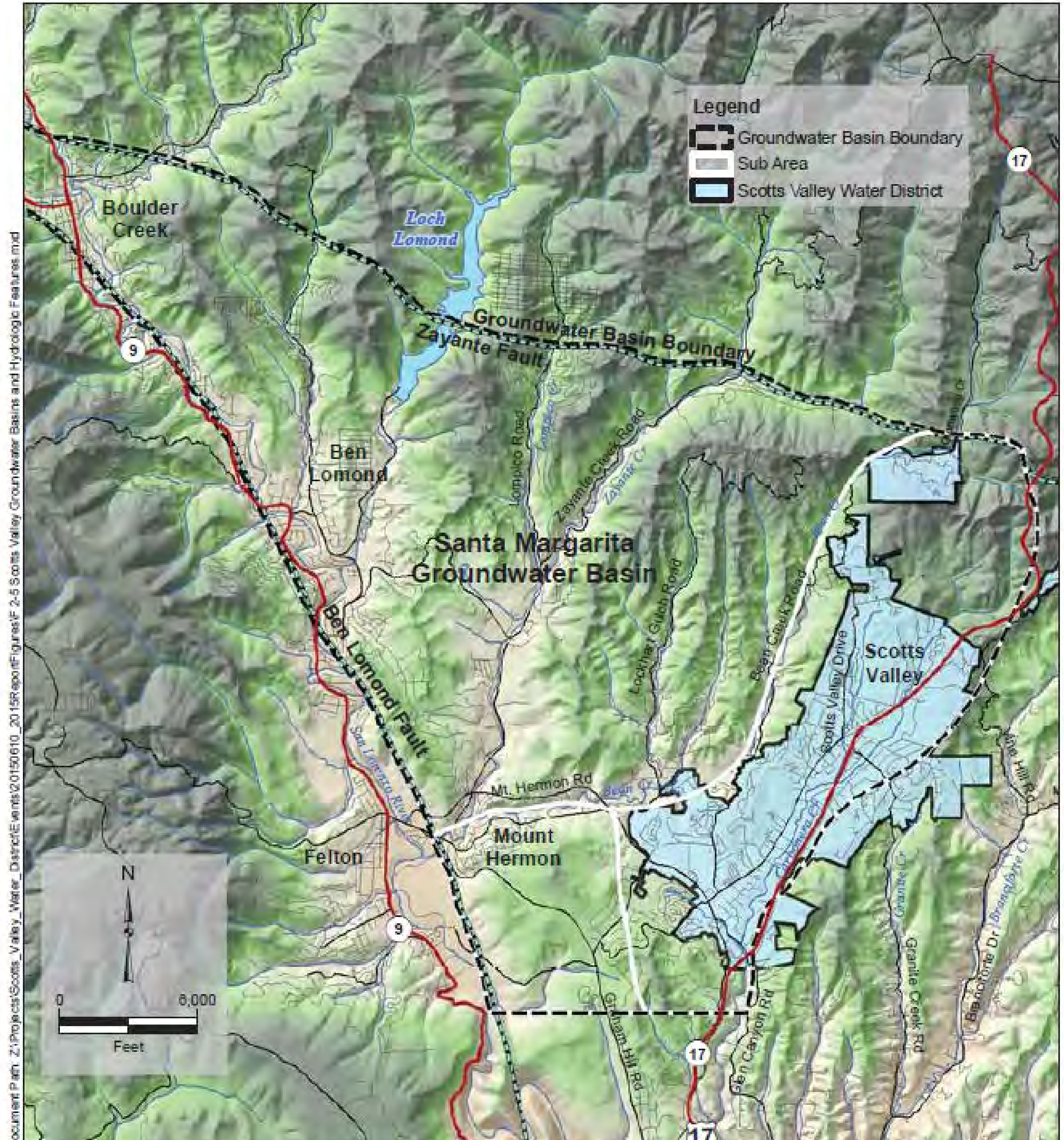

Figure 2. Scotts Valley Groundwater Basin Hydrologic Features
(Surface Water Features and Area Faults)

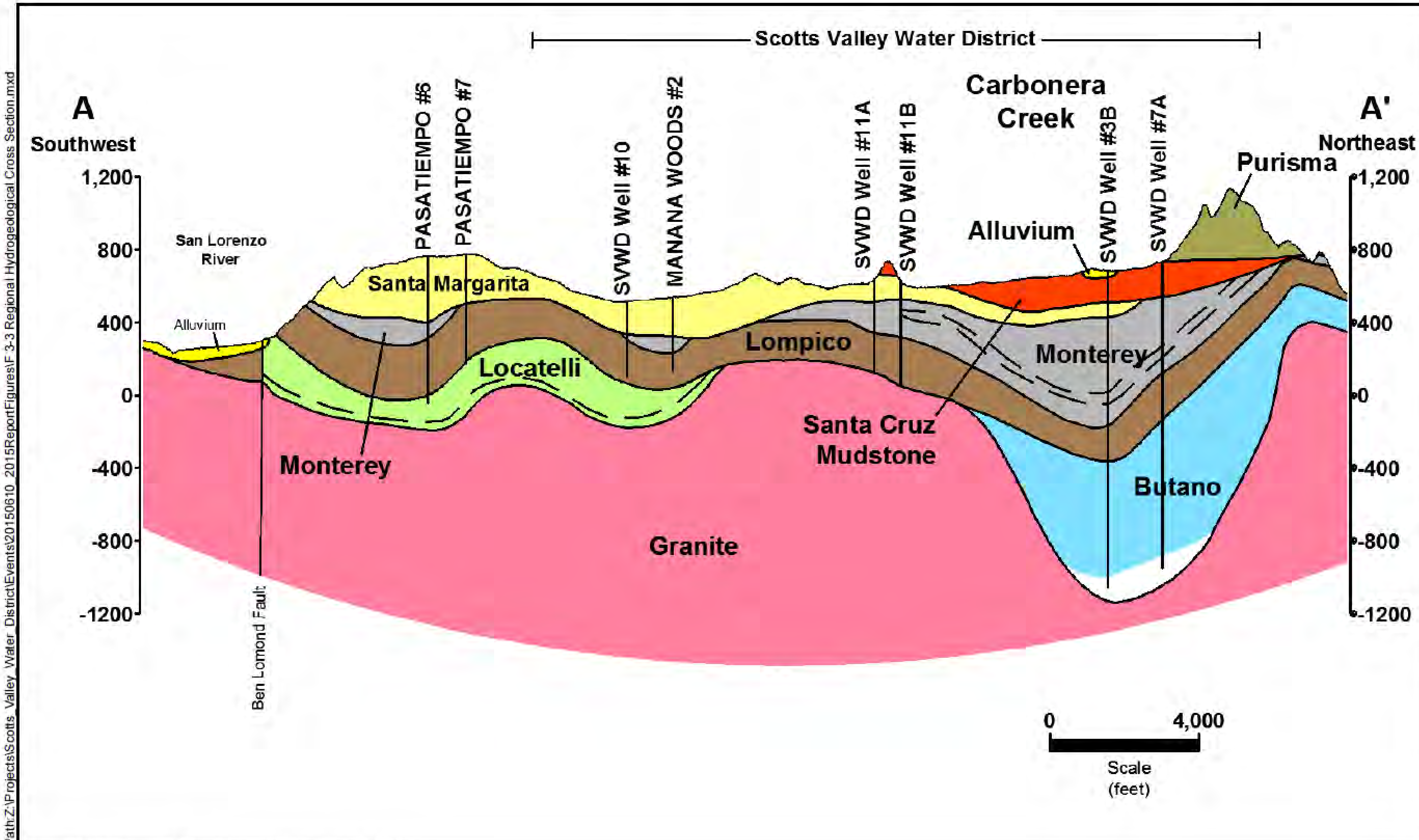

Figure 3. Generalized Hydrostratigraphic Cross-Section

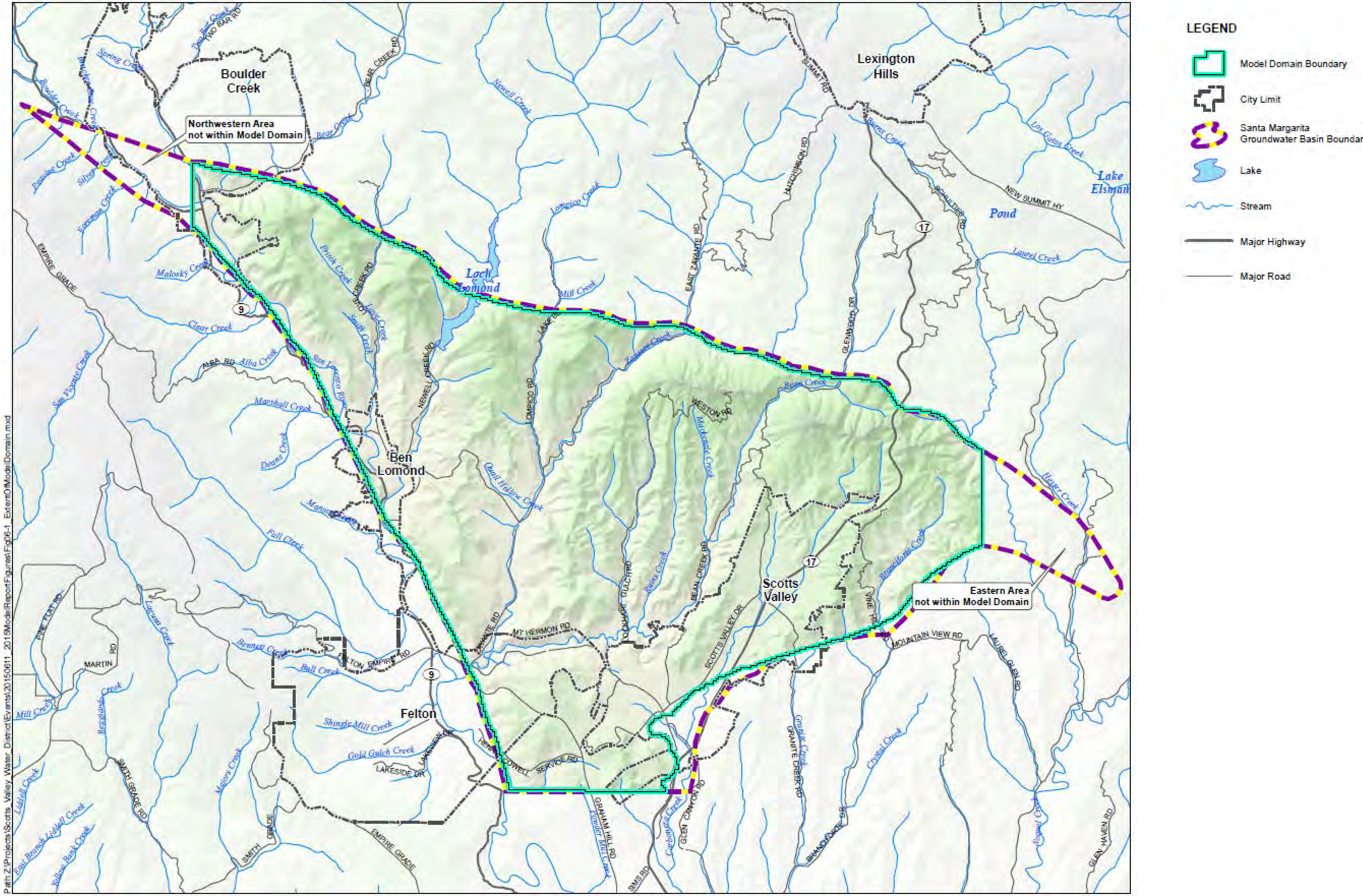

Figure 4. Study Area and 2015 SMGB Groundwater Model Domain

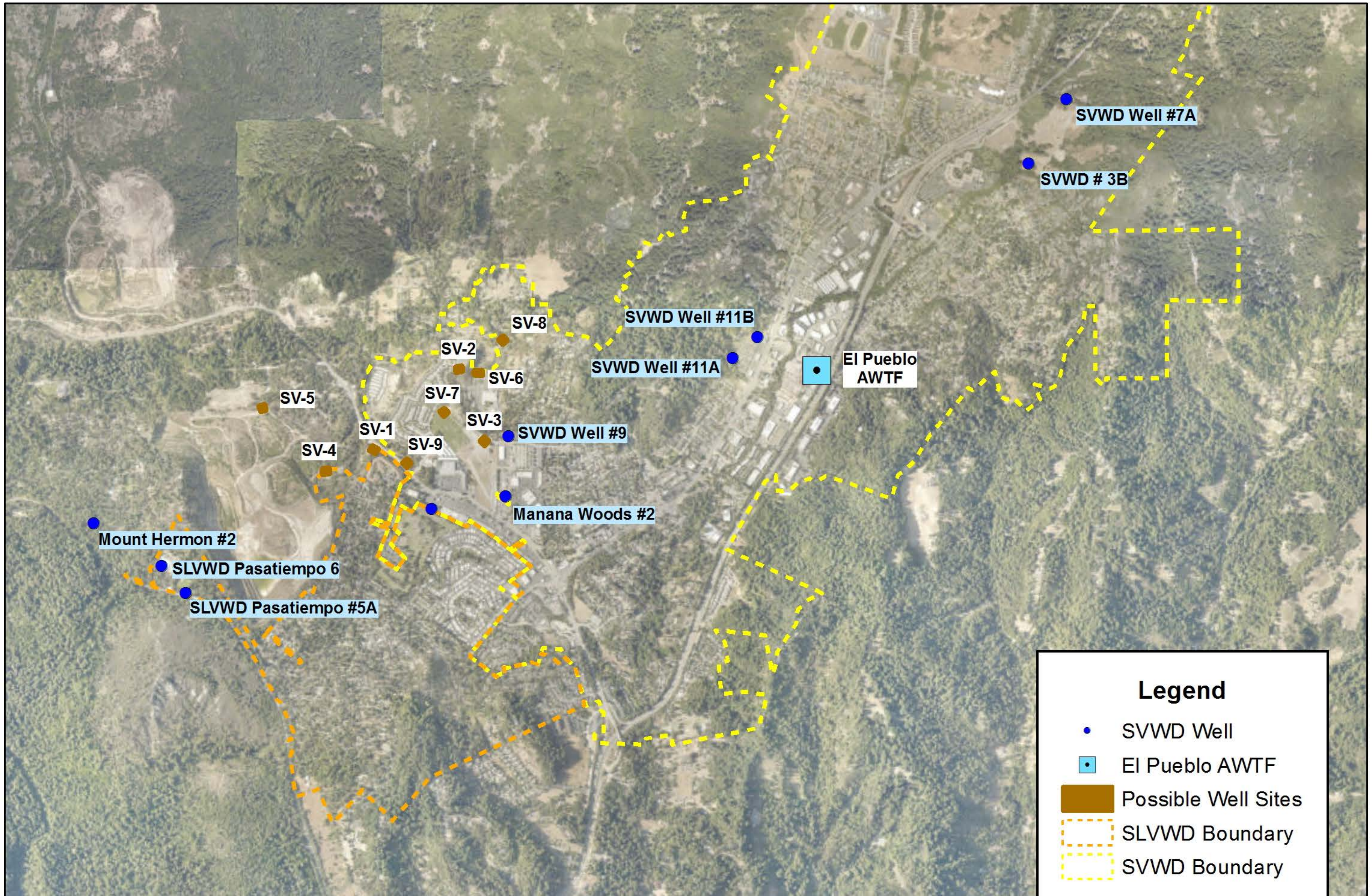

Figure 5. Existing and Proposed Injection and Production Wells

Estimated time a particle/drop of water would take 6 months to travel to Existing Production Well

Estimated time a particle/drop of water would take 6 months to travel from Injection Well

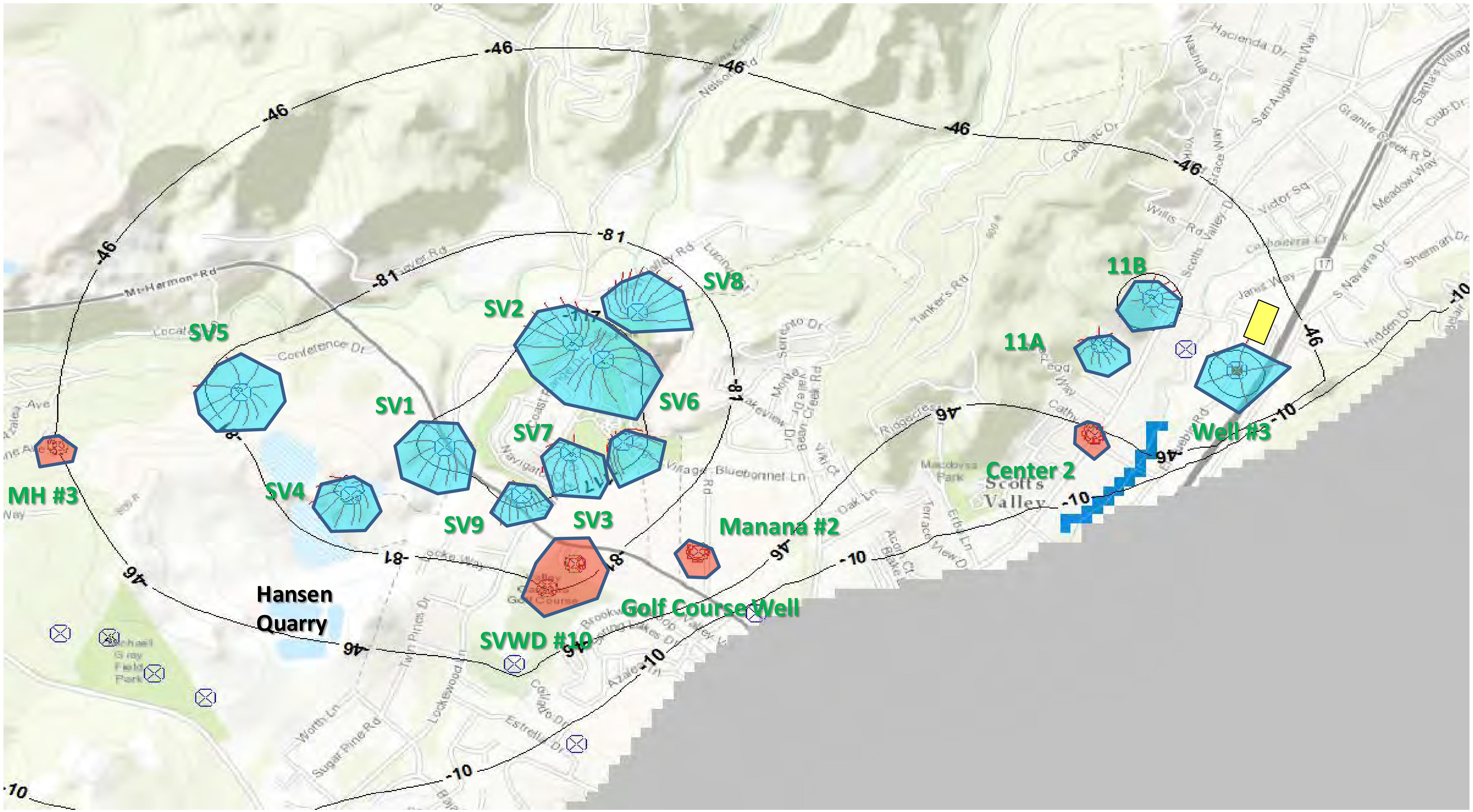

Figure 6. Scenario 1- Radius of Influence Analysis for Pumping and Injection Wells located in the South SMGB Wellfield Area

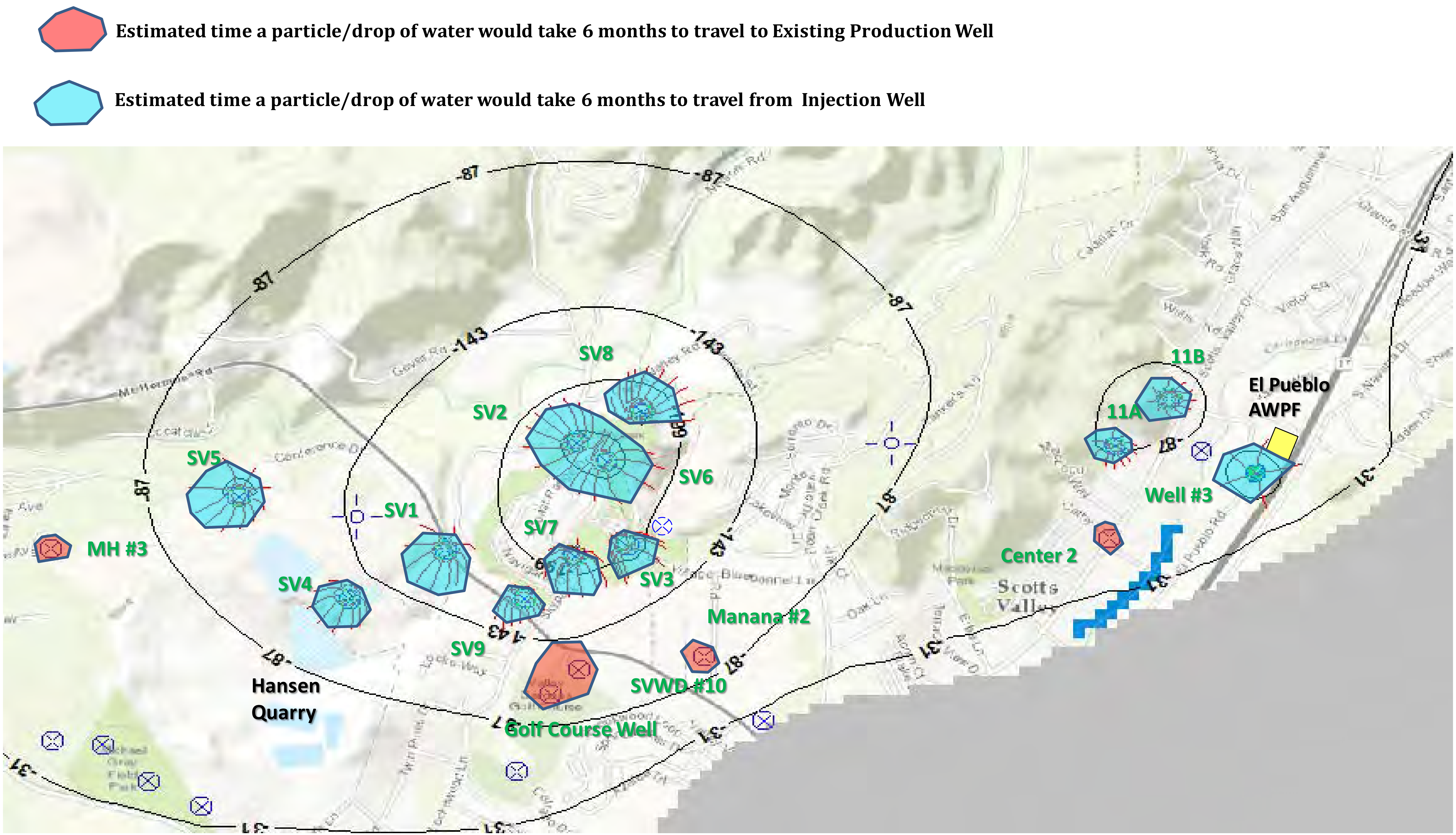

Figure 7. Scenario 2- Radius of Influence Analysis for Pumping and Injection Wells located in the South SMGB Wellfield Area

Estimated time a particle/drop of water would take 6 months to travel to Existing Production Well

Estimated time a particle/drop of water would take 6 months to travel from Injection Well

Estimated time a particle/drop of water would take 6 months to travel to Proposed Production Well

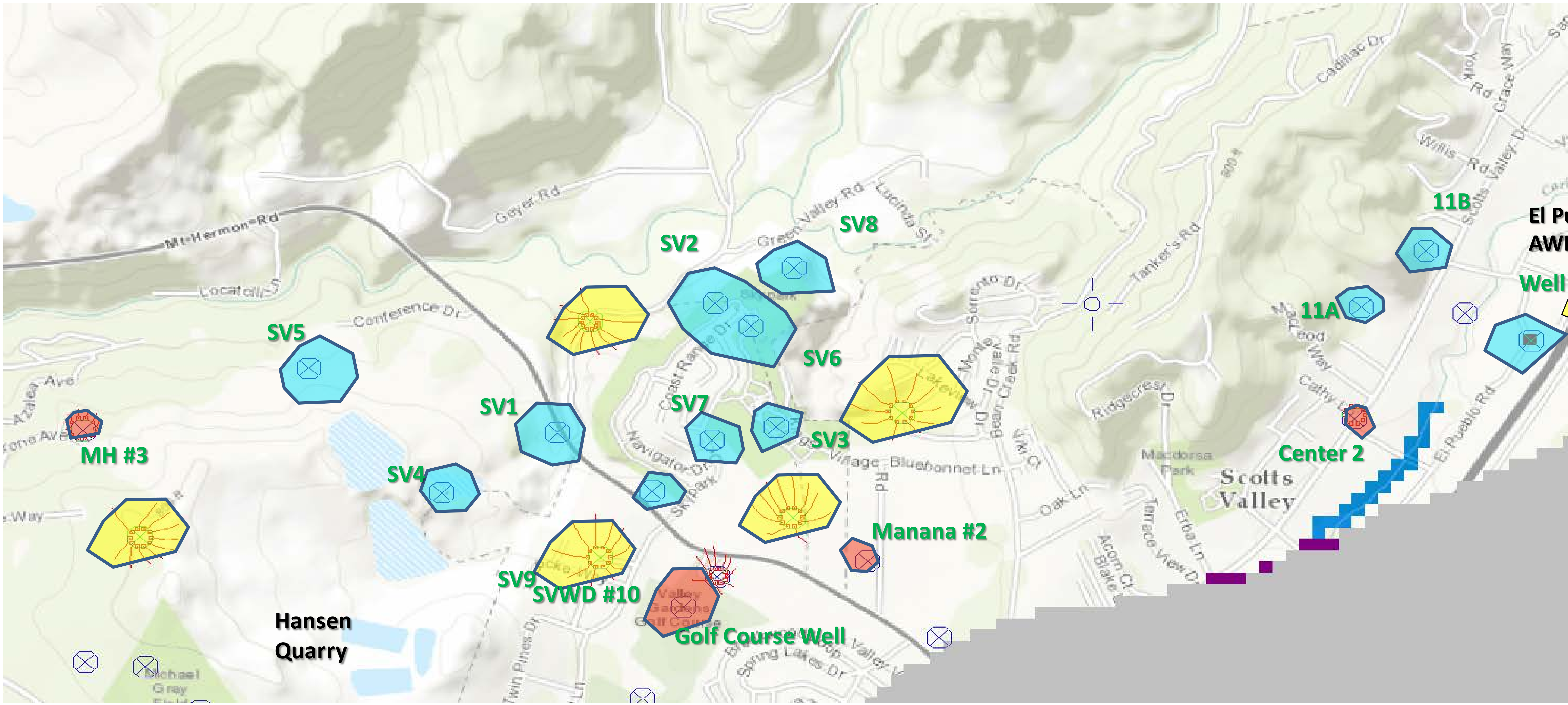

Figure 8. Scenario 3- Radius of Influence Analysis for Pumping and Injection Wells located in the South SMGB Wellfield Area

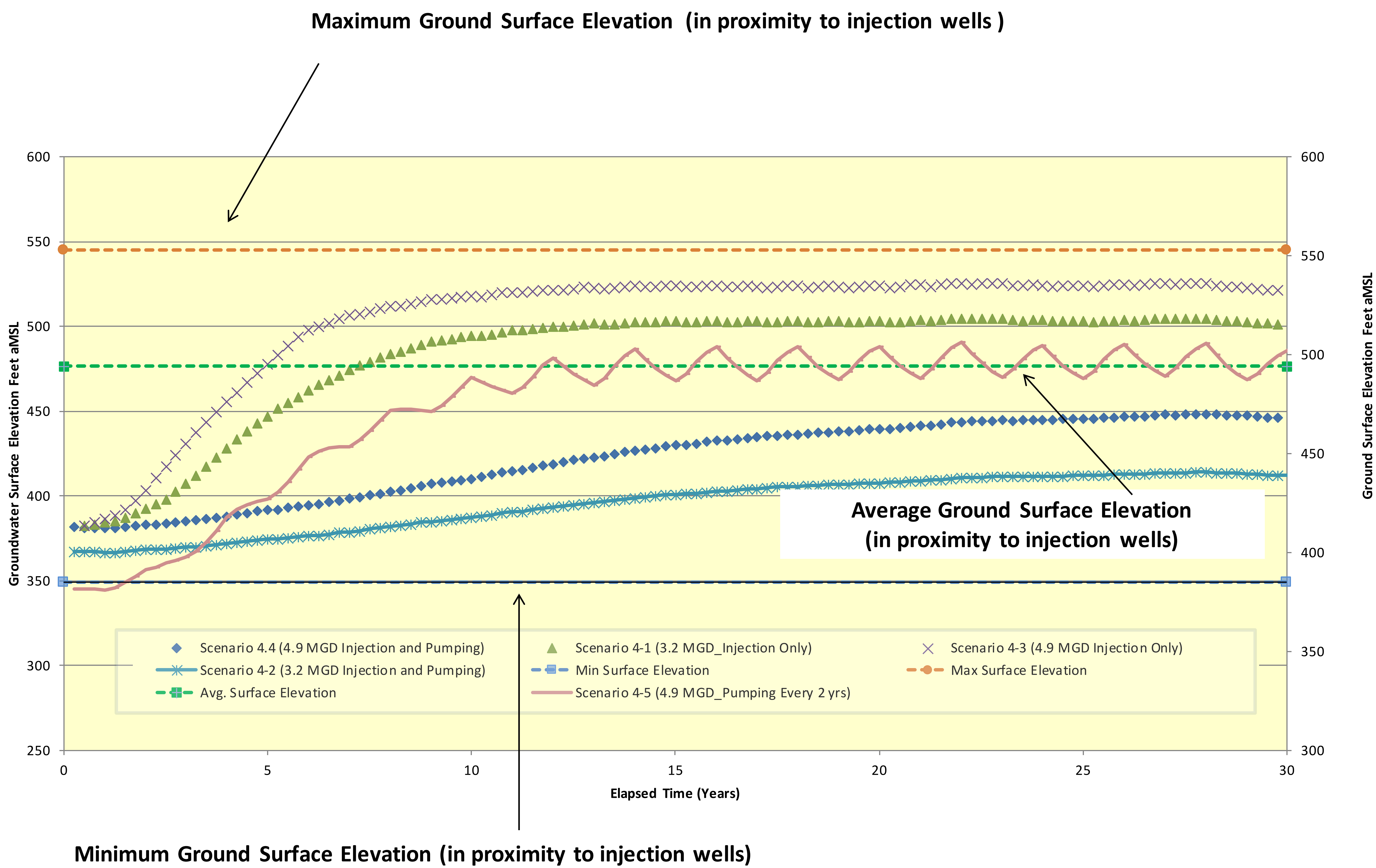

Figure 9. Scenario 4 – Groundwater Mounding Analyses for Injection and Production Wells in located in the South SMGB Wellfield Area

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Appendix D: Surface Water Augmentation

This appendix includes supporting information for the evaluation of the surface water augmentation project and includes the following:

D.1 TM #3 Surface Water Augmentation

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Technical Memorandum #3 – Surface Water Augmentation

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Review: Dawn Taffler, P.E., Melanie Tan, Janel Grebel, Ph.D
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Subject: Surface Water Augmentation at Loch Lomond Reservoir
City of Santa Cruz Water Department
Regional Recycled Water Facilities Planning

Date: 8 September 2017

Purpose of Memorandum. The City of Santa Cruz Water Department is evaluating a range of potential regional water supply opportunities as part of the Santa Cruz Regional Recycled Water Facilities Planning Study (RWFPS). Surface water augmentation (SWA) at Loch Lomond Reservoir is one of the water supply opportunities being evaluated within the RWFPS. Under the SWA concept, highly purified recycled water would be used as a source of supply to augment supplies within Loch Lomond Reservoir. As input to the RWFPS, this Technical Memorandum:

- presents an assessment of draft SWA regulatory requirements,
- identifies critical regulatory feasibility issues, and
- summarizes the suitability of Loch Lomond Reservoir for complying with anticipated SWA requirements.

SURFACE WATER AUGMENTATION CONCEPT

Overview. Figure 1 summarizes the SWA concept in which secondary effluent from the Santa Cruz Wastewater Treatment Facility (WWTF) would be treated at an Advanced Water Purification Facility (AWPF) and conveyed via a new pipeline to Loch Lomond Reservoir for storage.[1] The AWPF would provide a level of filtration, reverse osmosis treatment, advanced oxidation, and disinfection that meets existing State Water Resources Control Board, Division of Drinking Water (DDW) requirements for full advanced treatment[2] and SWA pathogen removal requirements being proposed for SWA[3]. Purified water would then be conveyed via a new pipeline to Loch Lomond Reservoir for storage. After storage, Loch Lomond Reservoir waters would be transported downstream to the City of Santa Cruz Graham Hill Water Treatment Plant (GHWTP) via the Newell Creek pipeline. As shown in Figure 2 (below), principal elements of the SWA concept includes treatment, reservoir storage (environmental buffer), and potable water treatment.

[1] AWPF treatment requirements for the SWA concept at Loch Lomond Reservoir are summarized in Technical Memorandum No. 1a, Evaluation of Treatment Requirements for Recycled Water in California (Trussell Technologies, Inc.).

[2] As defined by DDW in Section 60320.201, Title 22, Division 4, Chapter 3 of the *California Code of Regulations.*

[3] DDW regulations governing the implementation and operation of SWA projects are currently in draft form.. The public comment period for these draft regulations is open until Fall of 2017. Changes to the draft regulations in response to public comment may occur prior to adoption of the final regulations.

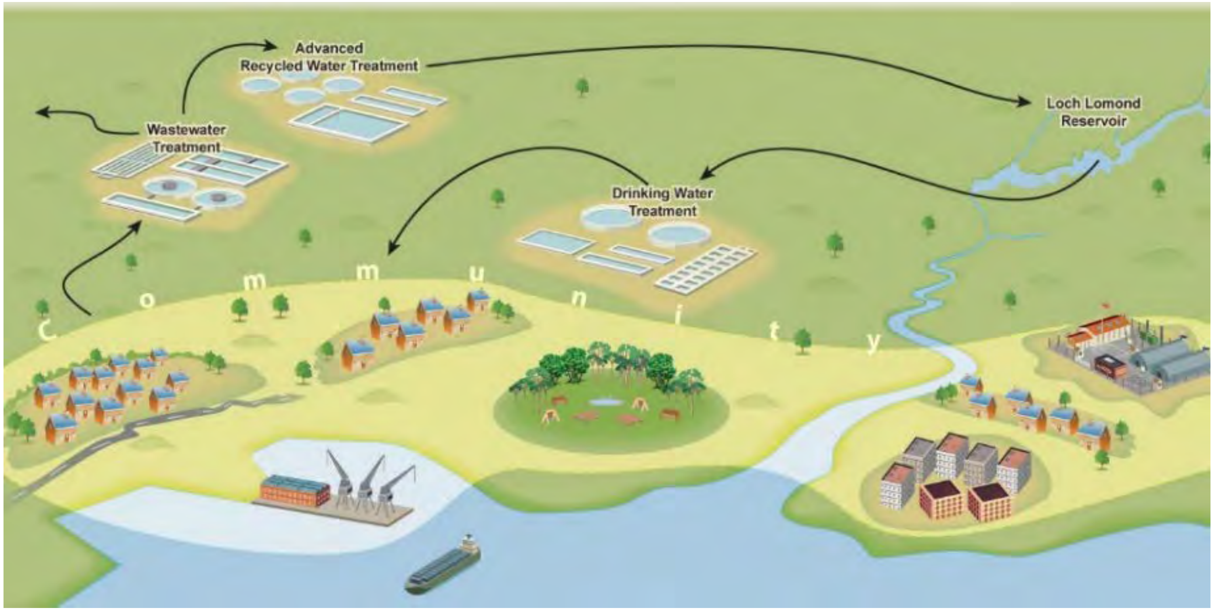

Figure 1 – Surface Water Augmentation Project Concept

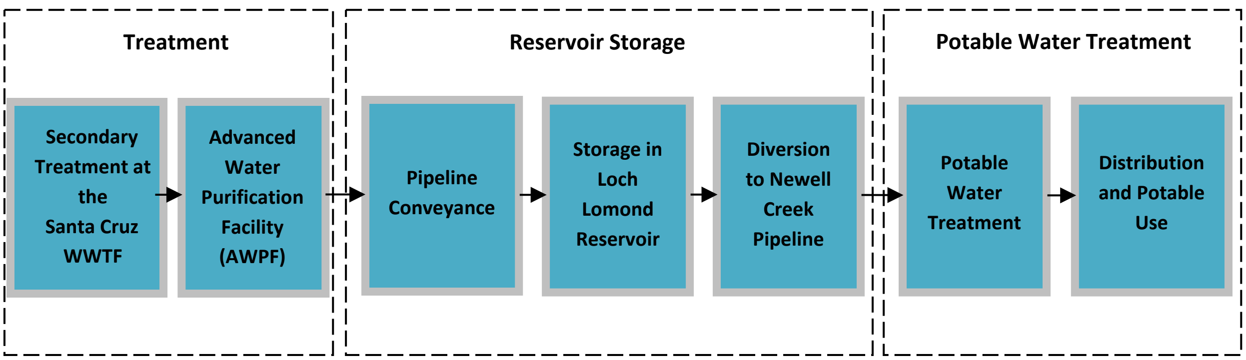

Figure 2 – Principal Surface Water Augmentation (SWA) Elements

Project Capacity. SWA is one of a number of alternative reuse concepts being evaluated as part of the RWFPS.[4] The SWA concept being evaluated within the RWFPS involves directing a purified water flow of 3.2 million gallons per day (mgd) to Loch Lomond Reservoir. This 3.2 mgd purified water capacity was developed on the basis of the average summer wastewater flows that would be available (6.1 mgd), less (1) existing Santa Cruz WWTF in-plant demands (0.25 mgd), (2) flows to Soquel Creek Water District (SqCWD) to support their Groundwater Replenishment Reuse Project (GRRP) (1.7 mgd) and (2) anticipated flow losses through the AWPF processes (0.95), including backwash and brine flows.[5]

LOCH LOMOND RESERVOIR

Reservoir Overview. Loch Lomond Reservoir is located in the Santa Cruz Mountains upstream from the community of Ben Lomond. The reservoir is owned by the City of Santa Cruz, and is used as a source of potable water supply. The reservoir is also used for non-contact recreation (e.g. fishing, boating, hiking).

4 Alternative reuse concepts being evaluated as part of the RWFPS include expanded non-potable reuse, groundwater recharge, streamflow augmentation, indirect potable reuse via groundwater recharge, indirect potable reuse via surface water augmentation, and direct potable reuse. Alternative 5 of the RWFPS assesses the SWA concept.

5 See the RWFPS project report for analyses that develop the recommended SWA project flow and analyses of available wastewater flows at the SCWWTP (RWFPS Alternative 5).

The north-south trending reservoir is formed by an approximately 190-foot-tall dam on Newell Creek, which is the principal tributary to the reservoir. Table 1 (page 3) summarizes general reservoir characteristics.

Newell Creek extends approximately three miles upstream from the reservoir. Newell Creek flows into the San Lorenzo River approximately two miles downstream from the reservoir dam. The spillway elevation is approximately 577 feet above mean sea level, while the upstream watershed reaches an elevation of approximately 2,300 feet. Because the topography along the reservoir sides is relatively steep, the reservoir surface area does not significantly change as storage levels increase or decrease.

Loch Lomond Reservoir is normally filled during winter and spring months and drawn down during summer and fall months. Demonstrating this, Figure 3 (page 3) presents average and minimum monthly storage volumes within Loch Lomond Reservoir during 2000-2016. Figure 4 (page 4) presents the history of Loch Lomond storage volumes during the past 16 years. As shown in Figure 4, reservoir storage volumes typically vary from 7,000 acre-feet (AF) to 8,900 AF, but during the 2014-2015 drought dropped to approximately 5,000 AF.

While runoff from within the Newell Creek watershed is the primary source of inflow to Loch Lomond Reservoir, the City maintains facilities that can divert flows from the San Lorenzo River to the reservoir. The City's Felton Diversion consists of an inflatable dam, intake structure and pump station. During prescribed conditions, the dam is inflated and water pumped to Loch Lomond Reservoir to augment reservoir storage during dry years when natural Newell Creek flow is low.

Water Entitlements. Table 2 (page 4) summarizes City of Santa Cruz water rights to flow from Loch Lomond and the San Lorenzo River at the Felton Diversion. The City is entitled to annually withdraw up to 3,200 AF per year (2.86 mgd) from Loch Lomond Reservoir.[6] In accordance with the provisions of its water rights, the City is required to release a minimum flow of 1.0 cubic feet per second[7] (cfs) from Loch Lomond Reservoir to support downstream fishery resources.[8]

Table 1
Loch Lomond Reservoir Characteristics

Reservoir Parameter	Value
Maximum storage volume[9]	8,991 acre-feet[10]
Watershed area	8 square miles
Maximum depth[9]	150 feet
Maximum water surface area[9]	175 acres
Length[9]	2.5 miles
Maximum width[9]	1,500 feet

6 State Water Resources Control Board Division of Water Rights License No. 9847.

7 A 1.0 cfs release corresponds to approximately 0.65 mgd or 724 acre-feet per year.

8 The 1.0 cfs fish flow release is per a 1958 agreement with State of California Department of Fish and Game, which has been incorporated into SWRCB Division of Water Rights License No. 9847.

9 Maximum storage volume and reservoir dimensions when the reservoir water level is at the spillway elevation.

10 Reported as 2,930 MG based on U.S. Geological Survey. *Storage Capacity and Sedimentation of Loch Lomond Reservoir, Santa Cruz California*. 1998. March 2009 modeled data by the SCWD estimate current storage capacity to be 2,820 MG (8,645 acre-feet). For the purpose of this TM, the USGS documented volume is used.

Figure 3
Loch Lomond Monthly Reservoir Volume (AF)
2000-2016

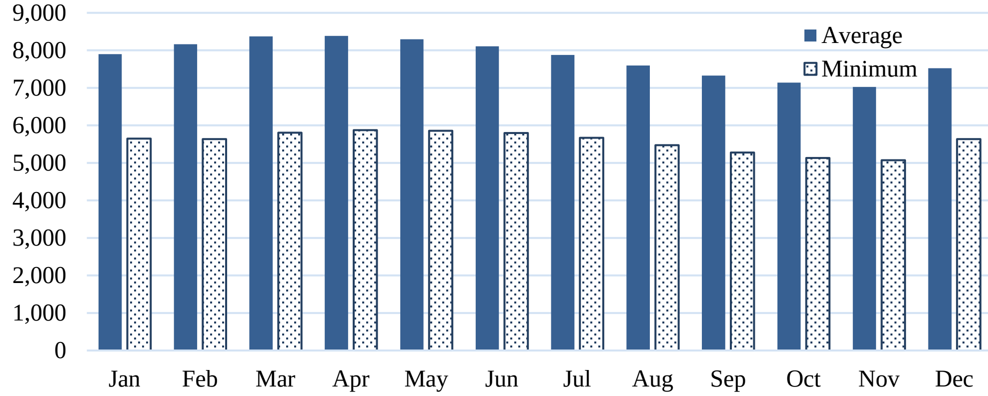

Figure 4
Loch Lomond Reservoir Volume (AF)
2000-2016

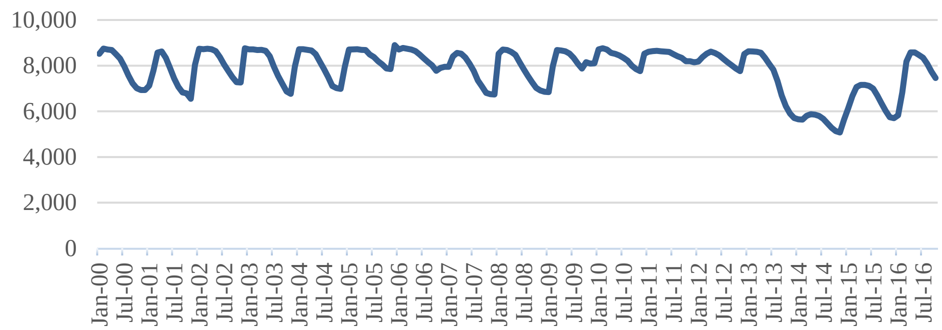

Table 2
City of Santa Cruz Water Rights
Loch Lomond Reservoir and Felton Diversion

Source	Maximum Annual Diversion[11]	
	million gallons per year	acre-feet per year
Felton Diversion (San Lorenzo River) to Loch Lomond[12]	977	3,000
Loch Lomond Reservoir Storage[13] (runoff from reservoir watershed – diversion to storage)	1,825	5,600
Loch Lomond Withdrawals[14,15]	1,042	3,200

[11] From page 6-10 of the *City of Santa Cruz 2015 Urban Water Management Plan* (City of Santa Cruz, 2015).

[12] SWRCB Permit Nos. 16123 and 16601 authorize the diversion of up to 3000 AF per year from the San Lorenzo River to Loch Lomond Reservoir.

[13] SWRCB License No. 9847 provides the right to capture up to 5600 AF per year of runoff from the Newell Creek watershed and divert the runoff to storage in Loch Lomond Reservoir.

[14] The City is required to release 1.0 cfs from Loch Lomond Reservoir to maintain downstream fish habitat, but the City may recover part of this release at the downstream San Lorenzo intake.

[15] The San Lorenzo Valley Water District has rights to 12.5 percent of the reservoir yield but would require new infrastructure to access the supply.

Water Quality and Treatability. Table 3 (page 5) summarizes recent water quality at Loch Lomond Reservoir. As shown in Table 3, concentrations of nitrate (as nitrogen) within Loch Lomond Reservoir are typically low (on the order of 0.2 mg/l). The 2015 sanitary survey of the Loch Lomond watershed, however, notes the historic occurrence of periodic algae blooms (primarily blue-green algae or cyanobacteria) at the reservoir.[16] To prevent algae-related taste and odor treatability problems, the City uses a non-copper based algaecide that produces oxygen and hydrogen peroxide by-products to control algae. The City also maintains the authority to use copper-based algaecides at the reservoir if the need arises.[17] To improve the treatability of Loch Lomond Reservoir waters, the City also utilizes a hypolimnetic aeration system to maintain dissolved oxygen levels in the deeper zones of the reservoir.[18]

Table 3
Summary of Loch Lomond Reservoir Water Quality, 2005-2011[19]

Parameter	Total Dissolved Solids (TDS)	Chloride	Sulfate	Nitrate (as N)	Hardness (as $CaCO_3$)
Average Concentration (mg/l)	256	13	70	0.23	155
Median Concentration (mg/l)	251	13	70	0.20	154
Minimum Concentration (mg/l)	246	10	67	0.07	122
Maximum Concentration (mg/l)	270	14	74	0.41	186
Number of Samples	6	14	13	23	120

SWA REQUIREMENTS

Overview. While no SWA projects currently exist within California, Senate Bill 918 required DDW to develop and adopt uniform water recycling criteria for SWA by December 31, 2016.[20] Draft SWA regulations were released on July 21, 2017 (SBDDW-16-02)[21]. The period for public comment on these draft SWA regulations is open until September 2017 and further modifications may be made prior to adoption. It is anticipated that the SWA regulations will be adopted by the end of 2017.

The draft SWA regulations establish requirements for:

- recycled water source control,
- treatment and pathogen removal,
- demonstration testing,

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16 From pages 3-11, 3-29, and 4-6 of the *San Lorenzo Valley and North Coast Watersheds Sanitary Survey*. Prepared for the City of Santa Cruz Water Department by Kennedy/Jenks Consultants. January 2013.

17 The Santa Cruz Water Department is enrolled for coverage under SWRCB Water Quality Order No. 2013-0002-DWQ (General Permit No. CAG990005) for the use of chelated copper and sodium carbonate peroxhydrate at Loch Lomond Reservoir.

18 From page 2-18 of *Watershed Sanitary Survey for the San Lorenzo Valley and North Coast Watersheds.* Prepared for the Santa Cruz Water Department by Balance Hydrologics, Inc. and Kennedy/Jenks Consultants. 2007.

19 From Tables 5-4, 5-5 and 5-15 of *San Lorenzo Valley and North Coast Watersheds Sanitary Survey*. Prepared for the Santa Cruz Water Department by Kennedy/Jenks Consultants. January 2013.

20 Senate Bill 918 was approved by the Governor of California and filed with the Secretary of State on September 30, 2010.

21 http://waterboards.ca.gov/drinking_water/certlic/drinkingwater/Surface_Water_Augmentation_Regulations.shtml

- operations and maintenance,
- effluent and process monitoring and reporting,
- reliability and redundancy,
- identification and responses to failure events,
- reservoir dilution, retention, tracer studies and monitoring, and
- public comment and notification.

The DDW SWA requirements would be implemented within two key permits:

- the City's DDW drinking water supply permit, and
- a National Pollutant Discharge Elimination System (NPDES) permit issued by the California Regional Water Quality Control Board, Central Coast Region (RWQCB) on behalf of the U.S. Environmental Protection Agency (EPA).

The City's current DDW drinking water supply permit implements applicable state and federal drinking water requirements and establishes the conditions under which the City acquires, stores, treats, monitors, and distributes public water supply. Modification of the City's drinking water supply permit would be required as part of implementing a SWA project at Loch Lomond Reservoir.

The RWQCB regulates discharges of recycled water to surface waters on behalf of the EPA through the issuance of NPDES permits. NPDES permits implement applicable state and federal water quality standards, policies, provisions, and prohibitions. The NPDES permit would also incorporate applicable DDW recycled water and SWA requirements.

DDW Treatment and Dilution Requirements. Table 4 summarizes SWA pathogen removal requirements proposed within the initial version of the draft SWA regulations.[22] As shown in Table 4, pathogen removal requirements are established for virus, *Giardia* cysts, and *Cryptosporidium* oocysts. Pathogen removal is to be achieved through advanced water treatment at the AWPF (prior to discharge to the reservoir).

Table 4
Projected SWA Pathogen Removal Requirements[22]

Required Treatment	Required Logarithmic Reduction[23]					
	If the reservoir provides a minimum 100:1 dilution of a 24-hour discharge of purified water[24]			If the reservoir provides a minimum 10:1 dilution of a 24-hour discharge of purified water[25]		
	Virus	*Giardia*	*Cryptosporidium*	Virus	*Giardia*	*Cryptosporidium*
Total Removal required at the AWPF	8	7	8	9	8	9

Note: removal credits at the drinking water treatment plant do not count towards the SWA pathogen removal requirements.

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22 Based on draft SWA regulations released by DDW for public comment l on July 21, 2017.

23 Required logarithmic reduction for the listed pathogen. A 2-log removal corresponds to 99 percent removal (10^2 removal), and 3-log reduction corresponds to a 99.9 percent removal (10^3 removal), etc.

24 For both options, treatment must be provided by at least two separate treatment processes, with each of the two processes achieving at least a 1-log reduction, and no more than a 6-log credit is allowed for any single process.

25 For this option, treatment must be provided by at least three separate treatment processes, with each of the three processes achieving at least a 1-log reduction, and no more than a 6-log credit is allowed for any single process.

The level of required pathogen removal will depend on the ability of the reservoir to provide dilution and prevent short-circuiting of off-spec discharge flows. Standard pathogen removal requirements are based on the reservoir being able to provide a 100:1 dilution of a 24-hour discharge of purified water. Pathogen removal requirements are increased by a factor of 10 (1-log) if the reservoir provides only a 10:1 dilution of a 24-hour discharge of purified water.[26]

The initial draft SWA regulations do not provide for any pathogen log removal credits for time spent or dilution achieved in the reservoir; however, as discussion below, projects that cannot provide minimum theoretical reservoir retention times greater than 120 days must provide additional pathogen removal credit through treatment.

DDW Reservoir Retention Requirements. The current draft SWA regulations would establish minimum reservoir retention requirements, defined as the total volume (V) in the reservoir at the end of a month divided by the total flow (Q) out of the reservoir during that month. Draft regulations released by DDW to the State Expert Panel in July 2017 specified that the theoretical retention time (V/Q) must be no less than 180 days; however, an alternative minimum theoretical retention time less than 180 days but no less than 60 days may be considered for approval.[27]Although alternative minimum reservoir retention times as low as 60 days may be considered, SWA projects with minimum retention times less than 120 days must provide an additional 1-log treatment above the requirements listed in Table 4.

NPDES Permit. As noted, the RWQCB would regulate the discharge of purified water to Loch Lomond Reservoir through issuance of a NPDES permit. The NPDES permit would incorporate applicable DDW SWA regulations and would implement state and federal water quality standards and plans, including:

- the *Water Quality Control Plan for the Central Coast Basin*[28] (Basin Plan), which designates beneficial uses and water quality objectives to protect the beneficial uses for ground and surface waters of the Central Coast Region, and
- the National Toxics Rule (NTR)[29] and California Toxics Rule (CTR),[30] which establishes state-wide water quality standards for discharges to surface waters.

Basin Plan Requirements. The Regional Water Quality Control Board, Central Coast Region (RWQCB) establishes designated beneficial uses and water quality objectives for ground and surface waters within the Central Coast Region. Key Basin Plan elements that may affect SWA at Loch Lomond Reservoir include:

- a narrative biostimulation objective,
- a prohibition against discharges to freshwater impoundments, and
- the incorporation of drinking water standards as raw water standards

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[26] The 100:1 dilution requirement provides that purified water discharged within the prior 24-hour period cannot comprise more than 1 percent of the water withdrawn from the reservoir, as demonstrated through modeling and a tracer study. The 10:1 dilution requirement provides that purified water discharged within the prior 24-hour period cannot comprise more than 10 percent of the withdrawn reservoir water.

[27] Based on draft SWA regulations released by DDW for public comment l on July 21, 2017.

[28] The current version of the *Water Quality Control Plan for the Central Coast Region* (Basin Plan) is dated March 17, 2016. Basin Plan water quality standards for surface waters have been approved by EPA as federal water quality standards protected under the Clean Water Act.

[29] National Toxics Rule, as set forth in Title 40, Section 131.36 of the Code of Federal Regulations (40 CFR 131.36).

[30] California Toxics Rule, as set forth in 40 CFR 131.38.

Biostimulation. The Basin Plan establishes the following biostimulation objective that is applicable to Loch Lomond Reservoir:

> *Waters shall not contain biostimulatory substances in concentrations that promote aquatic growths to the extent that such growths cause nuisance or adversely affect beneficial uses.*

Nitrogen and phosphorus are the primary nutrients that may affect biostimulation in surface waters. While the Basin Plan does not establish numerical concentration standards for nitrogen and phosphorus, the SWRCB has initiated an effort to enhance the regulation of nutrients in the state's surface waters, which may include establishing objectives, implementation guidance to improve water quality, evaluating biological response parameters, and identifying endpoints that describe conditions necessary to protect beneficial uses.[31]

EPA has provided guidance on nutrient concentrations that may potentially cause adverse biostimulatory effects in lakes and reservoirs. EPA's current approach is based on the assumption that 25th percentile values are representative of minimally impacted conditions. Table 5 summarizes EPA-published 25th percentile nitrogen and phosphorus values for the ecoregion (Coast Range Mountains) that contains Loch Lomond Reservoir. While it is highly unlikely that the RWQCB would impose numerical effluent limits for nitrogen and phosphorus at the concentration levels shown in Table 5, the Ecoregion II values are suggestive that biostimulation within the ecoregion is limited by phosphorus, as the 25th percentile nitrogen to phosphorus (N:P) ratio for the EPA biostimulation criteria is approximately 27:1.[32]

Table 5
EPA Biostimulation Criteria Recommendations[33]
Ecoregion II, Subregion 1 - Coast Range Mountains

Nutrient Parameter	25th Percentile Concentration (µg/l)[34]
Total phosphorus	7.1
Total nitrogen	190
Chlorophyll "a"	2.3

Prohibition Against Discharge to Freshwater Impoundments. Provision IV.B of Chapter 5 of the Basin Plan establishes the following prohibition against the discharge of treated wastewater to surface reservoirs and surface waters.[35]

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[31] Proposed Workplan for the Development of a Nutrient Control Program. SWRCB, January 2015. Available on the SWRCB website at: http://www.swrcb.ca.gov/water_issues/programs/nutrient_objectives/development/docs/nne_workplan.pdf.

[32] A N:P ratio of less than 10:1 is typically indicative of nitrogen-limited conditions, whereas a N:P ratio in excess of 10:1 is typically indicative of phosphorus-limited conditions under which biostimulation can be controlled by limiting phosphorus.

[33] From Table 3a, reference 25th percentile conditions for level III ecoregion 1 lakes (coast range mountains), in *Ambient Water Quality Criteria Recommendations, Lakes and Reservoirs in Nutrient Ecoregion II*. U.S. Environmental Protection Agency (EPA 822-B-00-007). December, 2000.

[34] EPA uses the 25th percentile value from the Ecoregion II lakes and reservoir data set as being indicative of minimally impacted biostimulation conditions.

[35] Pursuant to Provision IV.F of Chapter 5 of the Basin Plan, the RWQCB. can, subsequent to a public hearing, grant exception to any Basin Plan provision if the RWQCB determines (1) the exception will not compromise protection of waters for beneficial uses and (2) the public interest will be served.

Waste discharges to the following inland waters are prohibited:

1. *All surface freshwater impoundments and their immediate tributaries.*
2. *All surface waters within the San Lorenzo River, Aptos-Soquel, and San Antonio Creek Subbasins and all water contact recreation areas except where benefits can be realized from direct discharge of reclaimed water.*

The intent of the prohibition is to prevent the disposal of treated wastewater in potable supply reservoirs, but the Basin Plan currently does not make a distinction between purified recycled water used as a source of SWA and treated wastewater discharged for purposes of disposal. Given that DDW is moving forward with statewide SWA regulations for the discharge of highly purified recycled water into potable reservoirs, it is probable that the RWQCB will interpret this prohibition as pertaining to waste disposal (not SWA). Clarification, exception, or modification of this Basin Plan prohibition, however, will be required to support a reservoir augmentation project at Loch Lomond Reservoir.

Drinking Water Standards. DDW establishes primary drinking water standards to protect public health and secondary drinking water standards to address the aesthetics and consumer acceptability of water supplies. DDW applies the drinking water standards to the final treated potable supply provided to water customers. Attachment A summarizes DDW primary and secondary drinking water standards.

Section II.A.2 of the Basin Plan applies these primary and secondary drinking water standards to untreated inland surface waters with a municipal supply beneficial use designation. As a result, while DDW applies the standards to the final potable supply, the Basin Plan requires the RWQCB to implement the drinking water standards in untreated surface supplies used as a source for municipal supply.

EPA Toxics Rules. The National Toxics Rule (NTR)[36] and California Toxics Rule (CTR)[37] establish water quality standards applicable to California inland surface waters. The CTR (which incorporates the national standards previously promulgated as part of the NTR) establishes standards both for the protection of human health and for the protection of aquatic life.[38]

Attachment B presents CTR standards for toxic organic constituents that would be applicable to a SWA project at Loch Lomond Reservoir. CTR standards shown in Attachment B would be incorporated as effluent concentration standards within the SWA NPDES permit.[39] As shown in Attachment B, CTR standards for the protection of aquatic life tend to be more stringent than corresponding drinking water standards.

SUITABILITY OF SWA AT LOCH LOMOND RESERVOIR

Reservoir Dilution. As noted, DDW pathogen log-removal requirements will likely be dependent on the degree of dilution that is provided to a 24-hour discharge of off-spec water. The amount of dilution provided at Loch Lomond Reservoir will be dependent on:

- discharge location and depth,
- type and design of the discharge facility,

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36 As set forth in Title 40, Section 131.36 of the Code of Federal Regulations (40 CFR 131.36).

37 As set forth in 40 CFR 131.38. CTR implementation procedures are set forth in the *Policy for Implementation of Toxic Standards for Inland Surface Waters, Enclosed Bays, and Estuaries of California,* which was updated and adopted by the SWRCB in February, 2005.

38 Note: The CTR does not change any of the national toxics criteria established in 1992 by the NTR, but for convenience the CTR incorporates the NTR standards into the CTR table of standards.

39 CTR standards may be established as performance goals if the RWQCB determines that no reasonable potential exists for the pollutant to be present in the purified water discharge.

- weather (primarily wind) conditions, and
- reservoir hydrodynamics.

Detailed design studies and reservoir modeling studies will be required to assess initial dilution at Loch Lomond Reservoir. It is highly probable that facilities can be located and designed to ensure that no more than 10 percent of the water withdrawn from Loch Lomond Reservoir will be comprised of purified water that has been discharged within the prior 24 hours. As shown in Table 6 (below), at a 3.2 mgd purified water discharge rate, the percent of reservoir water that has been discharged in any prior 24-hour period would be extremely small. While Loch Lomond Reservoir would never achieve a complete mix (i.e. 100 percent dispersion of purified water throughout the entire reservoir volume) within any 24-hour period, it should prove possible to locate and design purified water discharge facilities so as to achieve a 10:1 dilution within a few hundred feet of the discharge point. As a result, it should be possible to achieve compliance with the DDW criteria that no more than 10 percent of the withdrawn reservoir water may be comprised of purified water that has been discharged in the prior 24 hours.

Table 6
Loch Lomond Dilution Under Complete Mix Conditions
3.2 mgd SWA Discharge

Percent Capacity	Loch Lomond Volume (AF)	Percent of reservoir volume that has been discharged within the prior 24 hours[40]	Dilution provided for a 24-hour pulse discharge of purified water under complete mix conditions[41]
100%	8,991	0.1 %	920 : 1
90%	8,092	0.1 %	820 : 1
80%	7,193	0.1 %	730 : 1
70%	6,294	0.2 %	640 : 1
60%	5,395	0.2 %	550 : 1
50%	4,496	0.2 %	460 : 1

Less certain is whether the discharge facilities can be located and designed to ensure that no more than 1 percent of the withdrawn water is comprised of purified water that has been discharged within the prior 24 hours. Since the proposed 3.2 mgd purified water discharge is small relative to the typical reservoir storage volumes, it may prove possible to design an engineered diffuser that achieves 100:1 dilution of a 24-hour discharge under all weather and reservoir conditions. Additional study would be required, however, to confirm this supposition. For the present, however, it appears prudent to assume that pathogen log-removal requirements will be based on providing a 10:1 dilution of a 24-hour purified water discharge.

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[40] Computed as the ratio of purified water discharged during the prior 24 hours (3.2 million gallons, or 9.8 acre-feet) divided by the listed Loch Lomond Reservoir volume. As shown above, even at 50 percent capacity (approximately 4500 acre-feet), purified water discharged during the prior 24-hour period would comprise only 0.2 percent of the total reservoir volume.

[41] Computed as the Loch Lomond Reservoir volume divided by 9.8 acre feet (the quantity of purified water delivered during the prior 24-hour period). Purified water discharged during any 24-hour period would only mix with a portion of the reservoir volume, so actual dilution of a 24-hour pulse discharge would be significantly less than the above dilutions computed under assumed complete mix conditions. The actual dilution would depend on the type and location of the discharge facilities, weather conditions, withdrawal flows, and reservoir hydrodynamics. Reservoir modeling and/or tracer studies will be required to assess the degree of actual dilution.

Reservoir Retention. As noted, DDW presented an initial draft version of proposed SWA regulations to the State Expert Panel that included a requirement that SWA projects provide a 180 days (6 month) detention time, as computed on the basis of the reservoir volume (V) at the end of the month divided by the reservoir outflows (Q) during the month. DDW guidance states that calculation of total outflow must include, but is not limited to, all outflows and withdrawals from the reservoir. This analysis assumes that reservoir outflow "Q" is computed as the sum of all reservoir withdrawals, reservoir spills, and fish flow releases.

While RWFPS Alternative 5 involves conveying 3.2 mgd of purified AWPF product water to Loch Lomond Reservoir, reservoir withdrawals during any given month would be a function of City of Santa Cruz water demands, the availability of other water sources, fish flow release needs, water rights limitations, and other considerations. For the purpose of conservatively estimating the range of withdrawals from the reservoir, it is assumed that the GHWTP has a peak production capacity of 16 mgd, with a year-round average production of 10 mgd.[42]

As shown in Figure 4 (page 4), Loch Lomond Reservoir storage volumes typically range from 6,500 to 8,500 AF, and have been above 5,000 AF at all times (including the recent drought) since 2000. With the addition of 3.2 mgd of purified supply, it is anticipated that the volume of water in storage at any given time would be an increase above historic conditions.

Table 7 (page 12) presents projected hydraulic detention time for reservoir operating conditions that range from a reservoir storage volume of 5,000 AF (minimum historic value) to over 8,500 AF, and monthly reservoir withdrawals of up to 10.65 mgd (1,013 acre-feet). Such a 10.65 mgd withdrawal would represent the sum of the average production at the GHWTP (10 mgd) plus a 0.65 mgd (1.0 cfs) fish flow release. Unshaded cells correspond to detection times greater than 6 months (180 days), while grey shaded cells indicate detention times between 4 months (120 days) and 6 months (180 days).

As shown in Table 7, monthly detention times (V/Q) of greater than 4 months are provided under all conditions. Further, 6 months or more are provided under all conditions in which reservoir volumes are maintained at 5,800 AF or more, even under conditions where total reservoir withdrawals average 10.65 mgd over a 31-day period.[43] RWFPS Alternative 5 would thus not be required to achieve pathogen removal credits beyond those summarized in Table 4.

Since it is probable that the 3.2 mgd (3,600 AF per year) purified water discharge into Loch Lomond Reservoir will allow the reservoir to be consistently operated at or above a storage level of 6,500 AF, compliance with the proposed 6-month DDW hydraulic detention time requirement should be achieved even under maximum potential reservoir withdrawal conditions. RWFPS Alternative 5 would thus be regulated as a SWA (e.g. indirect potable reuse) project and not a DPR (direct potable reuse) project under the proposed DDW SWA regulations.

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[42] See page 7-4 of the *City of Santa Cruz Water Department 2015 Urban Water Management Plan*. City of Santa Cruz Water Department. August, 2016.

[43] As shown in Table 7, it is projected that Loch Lomond Reservoir would comply with the reservoir retention and dilution requirements established in the draft SWA regulations throughout the range of anticipated reservoir operating conditions. In the event the City of Santa Cruz were to propose reservoir withdrawals that are outside this expected range (e.g. significantly higher withdrawals under low reservoir volume conditions), the draft SWA regulations (Section 60320.330) provide for the ability of agencies to seek approval of alternatives to the nominal SWA retention time and dilution requirements, provided that the agencies can demonstrate that the proposed alternatives demonstrate an equivalent or better level of performance with respect to the efficacy and reliability of removal of public health contaminants and ensures the same level of protection to public health.

Table 7
Computed Monthly Hydraulic Detention Time
For the Anticipated Range of Withdrawal Flows and Reservoir Volumes

Total Monthly Reservoir Withdrawals (Q) (water supply plus fish releases)			Computed Hydraulic Detention Time, V/Q (months)[44]								
			Reservoir volume (V) at the end of the month (% capacity and acre-feet)								
			95%	**90%**	**85%**	**80%**	**75%**	**70%**	**65%**	**60%**	**55%**
mgd	MG/month	AF/month	8,541	8,092	7,642	7,193	6,743	6,294	5,844	5,395	4,945
3.2	99	304	28.1	26.6	25.1	23.6	22.2	20.7	19.2	17.7	16.2
3.6	112	342	24.9	23.6	22.3	21.0	19.7	18.4	17.1	15.8	14.4
4.0	124	381	22.4	21.3	20.1	18.9	17.7	16.5	15.4	14.2	13.0
4.4	136	419	20.4	19.3	18.3	17.2	16.1	15.0	14.0	12.9	11.8
4.8	149	457	18.7	17.7	16.7	15.8	14.8	13.8	12.8	11.8	10.8
5.2	161	495	17.3	16.4	15.4	14.5	13.6	12.7	11.8	10.9	10.0
5.6	174	533	16.0	15.2	14.3	13.5	12.7	11.8	11.0	10.1	9.3
6.0	186	571	15.0	14.2	13.4	12.6	11.8	11.0	10.2	9.5	8.7
6.4	198	609	14.0	13.3	12.6	11.8	11.1	10.3	9.6	8.9	8.1
6.8	211	647	13.2	12.5	11.8	11.1	10.4	9.7	9.0	8.3	7.6
7.2	223	685	12.5	11.8	11.2	10.5	9.8	9.2	8.5	7.9	7.2
7.6	236	723	11.8	11.2	10.6	9.9	9.3	8.7	8.1	7.5	6.8
8.0	248	761	11.2	10.6	10.0	9.5	8.9	8.3	7.7	7.1	6.5
8.4	260	799	10.7	10.1	9.6	9.0	8.4	7.9	7.3	6.8	6.2
8.8	273	837	10.2	9.7	9.1	8.6	8.1	7.5	7.0	6.4	**5.9**
9.2	285	875	9.8	9.2	8.7	8.2	7.7	7.2	6.7	6.2	**5.6**
9.6	298	913	9.4	8.9	8.4	7.9	7.4	6.9	6.4	**5.9**	**5.4**
10.0	310	951	9.0	8.5	8.0	7.6	7.1	6.6	6.1	**5.7**	**5.2**
10.4	322	989	8.6	8.2	7.7	7.3	6.8	6.4	**5.9**	**5.7**	**5.2**
10.65[45]	330	1013	8.4	8.0	7.5	7.1	6.7	6.2	**5.8**	**5.3**	**4.9**

44 Computed as the reservoir volume (V) at the end of the month divided by the total monthly reservoir withdrawals (Q). Hydraulic detention times are computed for reservoir volumes in excess of 5000 AF (the minimum historic Loch Lomond Reservoir volume during 2000-2016. Reservoir volumes with implementation of SWA are projected to be higher than historic reservoir volumes. Hydraulic detention times are also computed for monthly reservoir withdrawal flows that range from 3.2 mgd to 10.65 mgd.

45 Represents the sum of the nominal sustainable treatment capacity of the GHWTP (10 mgd) plus 0.65 mgd fish flow (1.0 cfs) release. Reservoir withdrawals would typically be significantly less than this maximum flow.

Biostimulation. Controlling concentrations of nitrogen and phosphorus in the AWPF discharge will be required to comply with the Basin Plan objective for biostimulatory substances. A significant degree of phosphorus removal occurs through conventional filtration/coagulation treatment. Additionally, reverse osmosis treatment typically achieves nearly 100 percent removal of phosphate. As a result of this treatment, concentrations of total phosphorus in the AWPF product water are projected to be near zero.

Nitrogen removal, on the other hand, will present a considerably more significant treatment challenge. Pilot APWF operations conducted by the City of San Diego indicate that recycled water treated through AWPF processes that includes (1) biological optimization of nitrogen removal in secondary treatment and (2) reverse osmosis treatment could achieve consistent compliance with an overall total nitrogen concentration limit of approximately 1 – 2 mg/l.[46,47] The AWPF product water will thus contain concentrations of nitrogen that are in excess of typical Loch Lomond Reservoir nitrogen concentrations.[48]

The AWPF product water, however, is also likely to contain near zero concentrations of total phosphorus. As a result, N:P ratios in the AWPF product water are projected to be in excess of 100:1. Because a 3.2 mgd AWPF discharge would comprise a significant fraction of the Loch Lomond Reservoir water, it is likely that a year-round AWPF discharge will sustain high N:P ratios within the reservoir in which biostimulation is controlled by the limited availability of phosphorus. Such a limited nutrient biostimulation control strategy is being proposed as part of the proposed City of San Diego SWA project at Miramar Reservoir.[49]

While maintaining phosphorus-limited conditions in Loch Lomond Reservoir appears to represent a sound strategy for preventing biostimulation, insufficient data are currently available to assess how a SWA project may affect biostimulation within the reservoir and in the downstream San Lorenzo River, which is nitrogen limited due to the naturally occurring loads of phosphorus in the river. Additional nitrogen and phosphorus data (including data on nutrient loads within the Newell Creek watershed and in the San Lorenzo River diversions) and modeling, as well as coordination with regulators, would be required to assess overall conformance with the Basin Plan objective for biostimulatory substances. Since algae blooms are currently an issue at Loch Lomond; a SWA project would need to show that it would not further exacerbate this issue.

Another approach may be to provide full or partial denitrification through modification to the secondary treatment process at the Santa Cruz WWTF. Additional study would be needed to explore a preferred process for denitrification and available space at the Santa Cruz WWTF.

Compliance with Drinking Water Standards. Reverse osmosis treatment is efficient in removing metals and toxic organic compounds. As a result, it is highly probable that AWPF product water will:

- comply with applicable (see Attachment A) state and federal drinking water standards, and

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46 From *City of San Diego Advanced Water Purification Facility Project Report* (January 2013).

47 Additional site-specific treatability studies would be required to evaluate potential nitrogen reduction in the City of Santa Cruz's Wastewater Treatment Plant and the Scotts Valley Water Reclamation Facility. Achieving a consistent effluent AWPF concentration of 1 – 2 mg/l total nitrogen could require modification of the existing secondary treatment processes to achieve enhanced biological removal of nitrogen. Additionally, AWPF facilities would have to be designed to specifically target removal of nitrogen and nitrate.

48 As shown in Table 3 (page 3), Loch Lomond Reservoir nitrate concentrations are typically on the order of 0.23 mg/l (as N). Typical reservoir total nitrogen concentrations are not known, but are likely to be less than the projected 1 – 2 mg/l total nitrogen concentrations in the AWPF product water.

49 From *Proposed Approach, Compliance with Basin Plan Nutrient Objectives, Pure Water San Diego Discharge to Miramar Reservoir*. City of San Diego Water Utilities Department. 2016.

- be equal to or superior in quality (lower concentrations of dissolved minerals and lower concentrations of toxic organic compounds) to existing Loch Lomond Reservoir waters.

Pilot testing and monitoring of Loch Lomond Reservoir water and AWPF product water, however, will be required to confirm these suppositions.

Additional data will be required to address whether AWPF water quality would be chemically compatible with existing reservoir sources or what AWPF product water conditioning may be required prior to discharge to render the water compatible with Loch Lomond Reservoir water or water from other local sources. Additional study will also be required to evaluate whether and how SWA at Loch Lomond Reservoir might affect the treatability of reservoir water at the GHWTP.

Toxics Rule Compliance. CTR standards[50] for the protection of aquatic habitat can be significantly more stringent than drinking water standards. Because reverse osmosis treatment is highly efficient in removing metals, it is highly probable that the AWPF product water will comply with applicable CTR standards for the protection of aquatic habitat. AWPF product water that undergoes 100 percent reverse osmosis treatment is also likely to comply with CTR standards for the protection of human health (consumption of organisms plus water).

Table 8 (below) summarizes two potential exceptions (NDMA and NDPA) that will require additional analysis. NDMA (N-nitrosodimethylamine) is of particular concern. If trace quantities of NDMA are present in the AWPF influent, AWPF processes (including reverse osmosis or ultraviolet treatment) may not be capable of achieving sufficient reduction in NDMA concentrations to achieve compliance with the CTR standard.[51]

As shown in Attachment A, DDW has established notification levels for NDMA and NDPA, but the DDW notification levels are not as stringent as the CTR standards. Conventional wastewater analyses typically do not achieve detection limits necessary to assess conformance with the CTR standards, so special monitoring and analysis for NDMA and NDPA in the source supply of recycled water will be required to assess conformance with the CTR standards and DDW notification levels.

Table 8
Potential CTR Constituents of Concern for SWA

Nutrient Parameter	CTR Monthly Average Concentration Standard (μg/l)[52]
N-nitrosodimethylamine (NDMA)	0.00069
N-nitrosodi-n-propylamine (NDPA)	0.005

Note: See Attachment B for a complete list of CTR standards.

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50 CTR standards, as referenced herein, incorporate national NTR standards.

51 Site-specific treatability studies would be required to assess potential NDMA compliance and required treatment removal. It should be noted, however, that the CTR standards apply to receiving waters, and that the CTR provides that the permitting authority (e.g., RWQCB) can establish that the CTR standards are to be imposed on receiving waters outside a designated mixing zone. Blending (dilution) in receiving waters may thus represent a potential mechanism for demonstrating CTR compliance.

52 Monthly average concentration standard for the protection of human health for the consumption of water plus organisms. CTR standards are established within 40 CFR 131.38.

CONCLUSIONS

Alternative 5 of the RWFPS involves the discharge of up to 3.2 mgd of purified AWPF product water to Loch Lomond Reservoir. This initial feasibility assessment presented within this Technical Memorandum does not identify any regulatory "fatal flaws" for the implementation of a 3.2 mgd SWA project at Loch Lomond Reservoir. The Loch Lomond SWA project should comply with the 6-month (180 d) hydraulic detention time requirement being proposed by DDW under the entire range of probable reservoir operational scenarios.

The current draft DDW regulations require that purified water discharged to the reservoir in the prior 24-hour period comprise no more than 10 percent of the withdrawn reservoir water. While additional feasibility studies will be required to identify the reservoir discharge site and required discharge facilities, compliance with this hydraulic retention requirement should not represent a problem at Loch Lomond Reservoir due to the relatively low reservoir outflows compared to the reservoir volume. As part of the RWFPS, initial SWA plans should be developed assuming that AWPF treatment must provide 9-log removal of virus, 8-log removal of *Giardia* cysts, and 9-log removal of *Cryptosporidium* oocysts.

Additional study (including reservoir monitoring, reservoir modeling, and tracer studies) would be required to evaluate whether it proves possible to reduce these AWPF pathogen removal requirements by 1-log through providing a discharge location and engineered diffuser that ensures that no more than 1 percent of withdrawn reservoir water is comprised of purified water that has been introduced into the reservoir in the prior 24-hour period.

Operational practices and releases from the reservoir during the winter months would also need to be modeled in greater detail to estimate the demand for purified recycled water during periods when the reservoir is filled by naturally occurring precipitation and runoff. It may be found that it is not advantageous to operate the AWPF at full capacity in the peak winter months when the reservoir is naturally full; however there may also be an opportunity to optimize reservoir releases based on the reliable availability of purified water to replenish storage volumes.

Existing Loch Lomond Reservoir operations can be impacted by periodic biostimulation (algae blooms) and the AWPF flows will contain nitrogen concentrations in excess of existing Loch Lomond Reservoir concentrations. It should prove feasible, however, to comply with the Basin Plan biostimulation objective through implementation of a phosphorus-limited approach in which algae production is minimized by reducing phosphorus loads to the reservoir[53] or through additional denitrification at the Santa Cruz WWTF. Facility requirements for denitrification have not been developed as part of this TM.

Existing data are unavailable to characterize probable AWPF concentrations of NDMA, and virtually any detectable concentration of NDMA in the wastewater supply would result in noncompliance of the AWPF product water with CTR standards. Additional study will be required to determine if the CTR standard for NDMA represents a potential compliance issue.

Coordination with RWQCB staff will be required to address the existing Basin Plan prohibition against "waste discharges" to surface reservoirs. It is possible that RWQCB staff may interpret SWA as not

[53] Phosphorus concentrations in the purified AWPF product water are projected to be near zero, and total phosphorus loads to Loch Lomond Reservoir under SWA are likely to be reduced compared to current conditions.

falling under this prohibition, but it is also possible that the RWQCB may need to modify this Basin Plan prohibition to accommodate SWA projects.

As a final item, additional study and analysis will be required to assess treatment reliability, redundancy, monitoring, and required fail-safe response plans. This overall fail-safe analysis would include the need to identify and assess proposed facilities and action plans to be implemented in the unlikely event that water not meeting DDW specifications (off-spec water) is somehow discharged to the conveyance system or to the reservoir. Also included would be the need to assess options for diverting or disposing of off-spec water that has been inadvertently discharged to the conveyance system.

LIST OF ABBREVIATIONS

AF	acre-feet
AWPF	Advanced Water Purification Facility
Basin Plan	Comprehensive Water Quality Control Plan for the Central Coast Region
CCC	criteria continuous concentration
CFR	Code of Federal Regulations
cfs	cubic feet per second
CMC	criteria maximum concentration
CTR	California Toxics Rule
DDW	State Water Resources Control Board, Division of Drinking Water
EPA	U.S. Environmental Protection Agency
GHWTP	Graham Hill Water Treatment Plant
MG	million gallons
mg/l	milligrams per liter
mgd	million gallons per day
N	nitrogen
N:P	nitrogen to phosphorus ratio
NDMA	N-nitrosodimethylamine
NDPA	N-nitrosodiphenylamine
NPDES	National Pollutant Discharge Elimination System
NTR	National Toxics Rule
NWRI	National Water Research Institute
Q	Reservoir outflow
RWFPS	Regional Recycled Water Facilities Planning Study
RWQCB	Regional Water Quality Control Board, Central Coast Region
SWRCB	State Water Resources Control Board
SWA	surface water augmentation (indirect potable reuse)
TDS	total dissolved solids
µg/l	micrograms per liter
µS/cm	microSiemens per centimeter
V	reservoir volume
V/Q	mean hydraulic detention time (volume divided by outflow)
WWTF	Wastewater Treatment Facility

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Attachment A

State and Federal Drinking Water Standards

Table 6449-A Secondary Maximum Contaminant Levels Consumer Acceptance Contaminant Levels		
Constituent	**Units**	**Maximum Contaminant Level**
Aluminum	mg/l	0.2
Color	units	15
Copper	mg/l	1.0
Foaming Agents (MBAS – methylene blue active substances)	mg/l	0.5
Iron	mg/l	0.3
Manganese	mg/l	0.05
Methyl-tert-butyl-ether (MTBE)	mg/l	0.005
Odor	Units	3
Silver	mg/l	0.1
Thiobencarb	mg/l	0.001
Turbidity	units	5
Zinc	mg/l	5.0

Table 6449-B Secondary Maximum Contaminant Levels Consumer Acceptance Contaminant Level Ranges				
nstituent	**Units**	**Maximum Contaminant Level**		
		Recommended	**Upper Limit**	**Short Term**
Total dissolved solids (TDS)	mg/l	500	1,000	1,500
Conductivity	µS/cm	900	1,600	2,200
Chloride	mg/l	250	500	600
Sulfate	mg/l	250	500	600

Attachment B

California Toxics Rule (CTR) Standards

Table B-1
California Toxics Rule
Standards for the Protection of Aquatic Habitat - Toxic Inorganic Constituents

Toxic Inorganic Parameter	Concentration (µg/l) Standard for Protection of Aquatic Habitat [(1)]	
	Instantaneous Maximum [(2)]	4-Day Average [(3)]
Antimony	NS	NS
Arsenic	340	150
Cadmium	4.3[5]	2.2[5]
Chromium (hexavalent)	16	11
Copper	13[5]	9[5]
Lead	65[5]	2.5[5]
Mercury	1.4	0.77
Nickel	470[5]	52[5]
Selenium	NA	5
Silver	6.9	NA
Thallium	NA	NA
Zinc	118[5]	118[5]
Cyanide	22	5.2

NS indicates that no standard has been established for the listed constituent.

(1) Actual discharge concentration standards will be established in the NPDES permit established by the RWQCB. The above table reflects the probable discharge standards based on existing CTR standards (40 CFR 131.38). The above probable standards do not take into account potential mixing zone dilution credits that may be available.

(2) Based on CTR instantaneous maximum CMC (criteria maximum concentration) for the protection of aquatic habitat.

(3) Based on CTR 4-day average CCC (criteria continuous concentration) for the protection of aquatic habitat.

(4) CTR freshwater standards for cadmium, copper, lead, nickel and zinc standards are hardness dependent. The City of Santa Cruz Water Department reports that Loch Lomond Reservoir hardness concentrations averaged approximately 155 mg/l (as $CaCO_3$) during 2005-2011. To be reflective of anticipated reservoir augmentation conditions (where AWPF flows are expected to have a low overall hardness), the above-listed CTR concentration values are calculated on the basis of a receiving water hardness of 100 mg/l (as $CaCO_3$). Corresponding limits for cadmium, copper, lead, nickel, and zinc would be higher (less stringent) if receiving water hardness concentrations in the reservoir remain at 150 mg/l or higher.

Table B-2
California Toxics Rule
Standards for the Protection of Aquatic Habitat - Toxic Organic Constituents

Toxic Inorganic Parameter	Concentration (µg/l) Standard for Protection of Aquatic Habitat [1]	
	Instantaneous Maximum [2]	4-Day Average [3]
ACID EXTRACTABLE COMPOUNDS		
Pentachlorophenol	340	150
CHLORINATED PESTICIDES		
Aldrin	3.0	NS
gamma BHC (Lindane)	0.95	NS
Chlordane	2.4	0.0043
4,4'-DDT	1.1	0.001
4,4'-DDD	NS	NS
4,4'-DDE	NS	NS
Dieldrin	0.24	0.056
alpha Endosulfan	0.22	0.056
beta Endosulfan	0.22	0.056
Endosulfan Sulfate	NS	NS
Endrin	0.086	0.036
Endrin Aldehyde	NS	NS
Heptachlor	0.52	0.0038
Heptachlor Epoxide	0.52	0.0038
PCBs	NS	0.014
Toxaphene	0.73	0.0002

NS indicates that no standard has been established for the listed constituent.

(1) Actual discharge concentration standards will be established in the NPDES permit established by the RWQCB. The above table reflects the probable discharge standards based on existing CTR standards (40 CFR 131.38). The above probable standards do not take into account potential mixing zone dilution credits that may be available.

(2) Based on CTR instantaneous maximum CMC (criteria maximum concentration) for the protection of aquatic habitat.

(3) Based on CTR 4-day average CCC (criteria continuous concentration) for the protection of aquatic habitat.

Table B-3
California Toxics Rule Reservoir Augmentation Discharge Standards

Constituent	Concentration (µg/l) Standard for the Protection of Human Health for the Consumption of Water Plus Organisms (1) (Monthly Average)	Constituent	Concentration (µg/l) Standard for the Protection of Human Health for the Consumption of Water Plus Organisms (1) (Monthly Average)
TOXIC INORGANIC CONSTITUENTS		**ACID EXTRACTABLE COMPOUNDS**	
Antimony	14	2-chlorophenol	120
Arsenic	0.018	2,4-dichlorophenol	93
Copper	1300	2,4-dimethylphenol	540
Lead	50	2-methyl 4,6-dinitrophenol	13.4
Mercury	0.05	2,4-dinitrophenol	70
Nickel	610	Pentachlorophenol	0.28
Selenium	170	Phenol	21,000
Thallium	1.7	2,4,6-trichlorophenol	2.1
Zinc	9100	**BASE NEUTRAL COMPOUNDS**	
VOLATILE ORGANIC COMPOUNDS		Acenaphthene	1200
Acrolein	320	Anthracene	9600
Acrylonitrile	0.059	Benzidene	0.00012
Benzene	1.2	Benzo (a) anthracene	0.0044
Bromoform	4.3	Benzo (a) pyrene	0.0044
Carbon tetrachloride	0.25	Benzo (b) fluoranthene	0.0044
Chlorobenzene	680	Benzo (k) fluoranthene	0.0044
Chlorodibromomethane	0.41	Bis (2-chloroethoxy) ether	0.031
Dichlorobromomethane	0.56	Bis (2-chloroisopropyl) ether	1400
1,2-dichloroethane	0.38	Bis (2-ethylhexyl) phthalate	1.8
1,1-dichloroethylene	0.057	Butyl benzyl phthalate	3000
1,2-dichloropropane	0.52	2-chloronaphthalene	1700
1,3-dichloropropene	10	Chrysene	0.0044
Ethylbenzene	3100	Dibenzo (a,h) anthracene	0.0044
Methyl bromide	48	1,2,-dichlorobenzene	2700
Methylene chloride	4.7	1,3,-dichlorobenzene	400
1,1,2,2-tetrachloroethane	0.17	1,4,-dichlorobenzene	400
Tetrachloroethylene	0.8	3,3,-dichlorobenzidene	0.04
Toluene	6,800	Diethyl phthalate	23,000
1,2 trans-dichloroethylene	700	Dimethyl phthalate	313,000
1,1,2-trichloroethane	0.60	Di-n-octyl phthalate	2700
Trichloroethylene	2.7	2,4-dinitrotoluene	0.11
Vinyl chloride	2.0	1,2-diphenylhydrazine	0.04
CHLORINATED PESTICIDES		Fluoranthene	300
Aldrin	0.00013	Fluorene	1300
alpha BHC	0.0039	Hexachlorobenzene	0.00075
beta BHC	0.014	Hexachlorobutadiene	0.44
gamma BHC (Lindane)	0.019	Hexachlorocyclopentadiene	240
Chlordane	0.00057	Hexachloroethane	1.9
4,4'-DDT	0.00059	Ideno 1,2,3-cd Pyrene	0.0044
4,4'-DDD	0.00059	Isophorone	8.4
4,4'-DDE	0.00083	Nitrobenzene	17
Dieldrin	0.00014	N-nitrosodimethylamine	0.00069
alpha Endosulfan	110	N-nitrosodi-n-propylamine	0.005
beta Endosulfan	110	N-nitrosodiphenylamine	5.0
Endosulfan Sulfate	110	Pyrene	960
Endrin	0.76	1,2,4-trichlorobenzene	260
Endrin Aldehyde	0.76	**DIOXANS AND DIFURANS**	
Heptachlor	0.00021	2,3,7,8-TCDD	1.3E-008
Heptachlor Epoxide	0.00010		
PCBs	0.00017		
Toxaphene	0.00073		

(1) Actual discharge concentration standards will be established in the NPDES permit established by the RWQCB. The above table reflects the probable discharge standards based on existing CTR standards (40 CFR 131.38) for the protection of human health. The above probable standards do not take into account potential mixing zone dilution credits that may be available.

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Appendix E: Streamflow Augmentation

This appendix includes supporting information for the evaluation of the streamflow augmentation project and includes the following:

E.1 TM #4 Streamflow Augmentation

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6 September 2017

Technical Memorandum #4 - Streamflow Augmentation

To: Heidi Luckenbach
From: Dave Smith (Merritt Smith)
Review: Melanie Tan and Dawn Taffler (Kennedy/Jenks)
Subject: **Considerations for Recycled Water Augmentation in the San Lorenzo River**
[Santa Cruz Recycled Water Facilities Planning Study]
K/J 1668007*00

The City of Santa Cruz is developing a Santa Cruz Regional Recycled Water Facilities Planning Study (RWFPS) to explore opportunities to develop a local or regional recycled water program as part of their water supply portfolio. The RWFPS includes alternatives for non-potable uses, to meet irrigation and commercial/industrial demands, and potable uses to recharge local groundwater aquifers, augment surface waters or supplement the drinking water system.

This Technical Memorandum #4 (TM #4) explores the use of recycled water for augmenting streamflow in the San Lorenzo River (SLR or River). The streamflow augmentation concept would include advanced treatment of secondary effluent from the Santa Cruz Wastewater Treatment Facility (WWTF) prior to discharge into the San Lorenzo River below the City's San Lorenzo River Diversion, for the purposes of maximizing the City's diversion of river water (per existing water rights) and using the purified recycled water for the purposes of meeting in-stream flow requirements.

1. San Lorenzo River Background

The SLR drains a large watershed in Santa Cruz County, originating in the Santa Cruz Mountains and discharging to the Pacific Ocean at Monterey Bay. The River provides the majority of the water supply for the City of Santa Cruz. The River historically supported the largest salmon and steelhead fishery south of San Francisco Bay; however, Coho salmon and steelhead are now listed as endangered and threatened, respectively. Attachment A provides background and context for the San Lorenzo River and the San Lorenzo Estuary (Lagoon) including a summary of historic and future monitoring efforts in the watershed.

A streamflow augmentation project would be pursued to benefit water supply as a primary objective. Addressing some issues facing the San Lorenzo River and Lagoon could be a secondary benefit of streamflow augmentation project. The three primary issues facing the San Lorenzo River and Lagoon include nutrient loading, increasing temperatures and decreasing levels of dissolved oxygen. This section discusses the potential for streamflow augmentation with recycled water to contribute to or resolve some of these issues.

1.1 Nutrient Loading Considerations

Per the September 15, 2000 Central Coast Water Board Resolution No. 00-003, "The goal of a Total Maximum Daily Load (TMDL) is to attain state water quality standards. A TMDL is a quantitative assessment of water quality problems and contributing pollutant sources. It specifies the maximum amount of pollutant that can be discharged (or the amount of a pollutant that needs to be reduced) to meet water quality standards. The TMDL allocates pollutant loads among sources in the watershed and provides an implementation plan needed to protect or restore water quality".

1.1.1 San Lorenzo River Adopted TMDL

Currently, SLR TMDLs have been approved for chlorpyrifos, nitrates, pathogens and sediments. This TM focuses on the nitrate TMDL since streamflow augmentation in SLR with recycled water would be a nitrate source. Streamflow augmentation is not expected to adversely affect implementation of the TMDL with respect to chlorpyrifos, pathogens or sediments, although further analysis would be needed to confirm this preliminary conclusion.

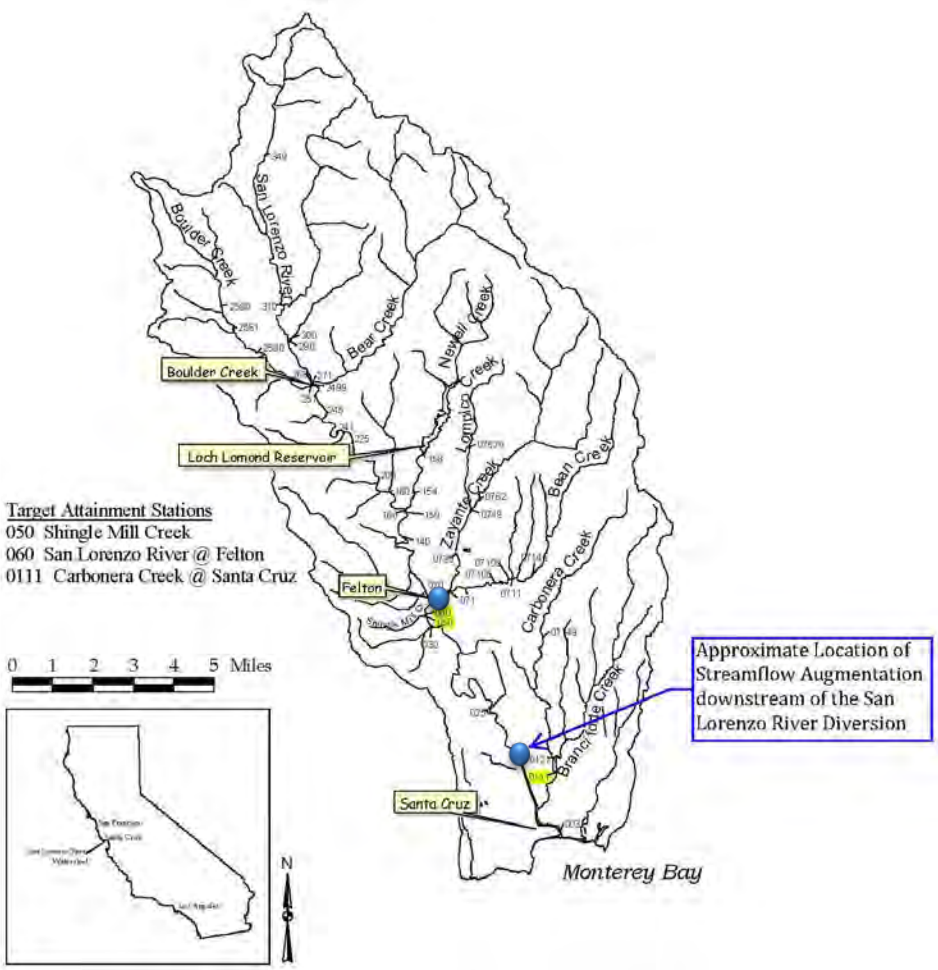
The SLR adopted nitrate TMDL is 1.5 mg/L nitrate (as nitrate) by 2020. The TMDL and the nitrate mass targets at the 3 target attainment locations identified are summarized in Table 1 and shown in Figure 1. The target attainment station for the SLR at Felton (station 060) was identified in the TMDL because nitrate reduction measures at this location would protect the City of Santa Cruz drinking water supply, located downstream of Felton (located near station 022), since the septic systems and livestock/stable discharges below Felton are minimal[1]. Recycled water discharge for streamflow augmentation would most likely take place below the City water diversion, thus the target attainment station of interest would be the SLR at Felton (station 060). Based on the information in Table 1 from Resolution R3-2000-003, the current total calculated nitrate load is 5,326 pounds at Felton (calculated as 3,728/ (1-0.3)).

[1] Resolution 00-003, Attachment B "San Lorenzo River Watershed Nitrate Total Maximum Daily Load for Santa Cruz, CA". Prepared by Central Coast Regional Water Quality Control Board September 15, 2000

Table 1: San Lorenzo River Nitrate TMDL (Resolution R3-2000-003)

Target Attainment Stations	Nitrate Concentration Target (mg/L Nitrate as Nitrate)	Nitrate Mass Target (pounds of nitrate per month)	Percent Reduction	Target Attainment Year
San Lorenzo River at Felton	1.5	3,728	30	2020
Carbonera Creek at the confluence of Branciforte Creek		299		
Shingle Mill Creek at the confluence of the San Lorenzo River		68		

Figure 1: San Lorenzo River Watershed



Source: San Lorenzo River Watershed Nitrate TMDL for Santa Cruz (CCRWQCB, 2000) – Attachment B Figure 1.

1.1.2 Preliminary Assessment of Nitrate Loads

Recycled Water Contribution to Nitrate Loads

To discharge recycled water nitrate into the SLR, the City would need to identify and control sources of nitrate at least equivalent to the quantity of nitrate it would discharge such that the 2020 TMDL goals shown in Table 1 at downstream locations could still be achieved. Simplistically, the RWQCB could be expected to require that the nitrate load from flow augmentation would need to be less than the allowable load of 3,728 pounds at Felton so that sufficient watershed load is available for the City to control to offset its nitrate discharge. The concentration goal of 1.5 mg/L nitrate would also need to be attained.

The flow augmentation nitrate load would depend on the amount of recycled water discharged and the recycled water treatment level. The nitrate concentration expected in recycled water at different treatment levels is shown in Table 2. Table 3 shows the amount of nitrate that would be added to SLR as result of streamflow augmentation expressed as a mass and as a percentage of the target load. Table 3 shows that advanced treatment would be needed such that the nitrate load from streamflow augmentation is less than the allowable watershed load of 3,728 pounds nitrate at Felton.

Table 2: Nitrate Concentrations at Different Treatment Levels

Treatment Level	Average Expected Concentrations		Comments
	mg/L Nitrate as N	mg/L Nitrate as Nitrate	
Secondary Effluent	17.8	79	Based on 2011 Santa Cruz WWTF Report
Tertiary Effluent	10	44	Nitrates can potentially be removed by adding biologically active filters
Full Advanced Treatment	Range from 1 to 3.6	4 to 16 is possible	Nitrate removal depends on technologies implemented in all phases of treatment

Table 3: Estimated Nitrate Load at Different Treatment Levels

	Units	Secondary Effluent	Tertiary Effluent	Full Advanced Treatment	
Recycled Water Discharged	mgd	3.0	3.0	3.0	
	Nitrate concentration (as mg nitrate/L)	79	44	16	4
Nitrate Mass	lbs nitrate / month (as nitrate)	61,100	34,500	12,400	3,500
	Percent of Total Load at Felton[1]	1100%	650%	230%	70%
	Percent of Target load at Felton[2]	1600%	930%	330%	90%

[1] based on the calculated total of 5,326 pounds nitrate at Felton
[2] based on the calculated total of 3,728 pounds nitrate, from Table 1.

None of the treatment levels shown in Tables 2 and 3 would meet the TMDL concentration goal of 1.5 mg nitrate per liter. Even though full advanced treatment may allow the recycled water discharge to meet the nitrate mass loading at Felton, there would be little room left to accommodate existing loads in the River, which are estimated to be approximately 3,600 lbs nitrate/month.

Additional treatment to denitrify the secondary effluent or purified water would likely be needed to reduce the nitrate load associated with a streamflow augmentation project. A variety of established technologies and new innovative technologies could be implemented to reduce nutrients prior to reuse, with a wide range of costs. Additional studies would be needed to identify a preferred alternative that would meet the potable reuse requirements, which would need to be further explored with the CCRWQCB as well as with the SC WWTF to provide a nexus with their long-term nutrient management objectives.

According to a recent Nutrient Regulatory Update, presented at BACWA's Annual meeting[2] the range of cost for nutrient reduction to meet the anticipated, stringent, nutrient discharge requirements to the San Francisco Bay could be on the order of $6 to $9 per gallon per day. This could add $20 to $30 million for a 3.2 mgd AWPF, assuming the influent flow is treated. It may also be possible to treat the post-RO water at a lower flow, and potentially lower cost depending on the selected technology. At this time, it is uncertain how much identifying treatment would be required and how much available space would be needed for nutrient removal facilities at the treatment site.

[2] https://bacwa.org/wp-content/uploads/2017/01/Nutrients-Regulatory-Update-by-HDR.pdf

Additional study could be done if project otherwise looks very promising in terms of water supply benefit, cost, instream benefits. For the purpose of this TM, and for the streamflow augmentation alternative developed in the RWFPS, facility requirements for denitrification have not been included.

Source Control for Nitrogen

Key sources of nitrogen were identified in RWQCB's 1995 Nitrate Reduction Plan and the 2000 TMDL documents as follows:

Urban/Nonpoint		
Septic Systems in Sandy Areas		38%
Septic Systems in Non-Sandy Areas		19%
Sewer Discharge from Boulder Creek Country Club		10%
Scott's Valley Nitrate Plume		9%
	Subtotal	76%
Agriculture		
Livestock & Stables		6%
Landscaping/Fertilizer Use		2%
	Subtotal	8%
Point Sources		
None		0%
Natural		
Natural Sources in Non-Sandy Areas		4%
Natural Sources in Sandy Areas		12%
	Sub-total	16%
	Total	100%

Understanding the progress toward controlling these sources and achieving the TMDL goals would be beneficial to assess the potential to mitigate for streamflow augmentation with recycled water. Additional effort would be necessary to confirm the status of TMDL load reduction goal attainment and source control opportunities and feasibility of meeting nitrate mass targets.

1.2 Temperature and Oxygen Considerations

Increasing temperature and declining dissolved oxygen (DO) concentrations have impacted water quality in the San Lorenzo Lagoon, particularly when the Lagoon is isolated from the daily tidal water level variations due to sandbar formations. Significant blooms of dinoflagellates have been observed during period of Lagoon closure. The Comparative Lagoon Ecological Assessment Project (CLEAP) findings indicate that eutrophication is a primary cause of water quality impairments in lagoons, which is often exacerbated by higher water temperatures and increasing organic matter loading, which increases biological oxygen demand and subsequently reduces dissolved oxygen concentrations (see Attachment A for more information).

The Water Quality Control Plan for the Central Coast Region (Basin Plan) (CCRWQCB 2016) identifies temperature and DO objectives for warm fresh water and cold fresh water habitat, which applies to local surface waters in the City's service area. The Basin Plan also notes that the "Water Quality Control Plan for Ocean Waters of California" (Ocean Plan) and the "Water Quality Control Plan for Control of Temperature in the Coastal and Interstate Waters and Enclosed Bays and Estuaries of California" (Thermal Plan), shall apply in their entirety to Monterey Bay. Table 4 summarizes temperature and DO objectives that would likely apply for streamflow augmentation with recycled water.

Table 4: Temperature and DO Objectives

Beneficial Use	Temperature	Dissolved Oxygen
Cold Freshwater Habitat	At no time or place shall the temperature be increased by more than 5 degF above natural receiving water temperature.	The dissolved oxygen concentration shall not be reduced below 7.0 mg/l at any time.
Warm Freshwater Habitat	At no time or place shall the temperature be increased by more than 5 degF above natural receiving water temperature.	The dissolved oxygen concentration shall not be reduced below 7.0 mg/l at any time.
Monterey Bay (Thermal Plan)	Natural receiving water temperature of intrastate waters shall not be altered unless it can be demonstrated to the satisfaction of the Regional Board that such alternation in temperature does not adversely affect beneficial uses.	The mean annual dissolved oxygen concentration shall not be less than 7.0 mg/l, nor shall the minimum dissolved oxygen concentration be reduced below 5.0 mg/l at any time.

Source: Text for objectives are extracted from Basin Plan verbatim[3] (a future 303D listing may further modify these objectives for the SLR)

Comparison of San Lorenzo River and WWTF Temperatures

River temperature data provided by the City for 2010, 2011, 2012 and 2014 is plotted alongside average monthly WWTF temperature data in Figure 2. During periods of overlapping data, the difference in the average monthly WWTF and SLR average monthly temperature ranges from 1.2 to 1.5 deg F. The difference between the maximum monthly WWTF and the minimum River temperatures ranges from 6.5 to 17 deg F. The difference between maximum monthly WWTF and minimum river temperatures would be relevant when the river temperature is lower than the effluent; which would occur in winter or early spring. It is likely that streamflow augmentation would be limited to the summer and early fall, when river temperatures are higher.

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[3] Basin Plan link: http://www.waterboards.ca.gov/centralcoast/publications_forms/publications/basin_plan/current_version/2016_basin_plan_r3_complete.pdf

The advanced treatment processes being considered to purify the secondary effluent prior to augmentation would further increase the temperature of the effluent. The anticipated amount of temperature increase would vary based on the difference between the purified water and river temperature during periods of augmentation. Another influencing factor could be the rate of discharge relative to streamflow and the discharge method used, which would affect the amount of dilution and rate of mixing. and is not estimated as part of this TM.

Figure 2: San Lorenzo River and WWTF Temperatures

Note: Seasonal data provided by the City. Higher observed temperatures in 2014 may be due to low streamflow and high temperatures during the prolonged drought.

Temperature and DO Compliance Strategies

Temperature management may be achieved by various types of treatment strategies, such as: cooling towers, chillers, two-pass heat exchange, and heat transfer to the earth. Oxygenation strategies may also be achieved by various types of treatment strategies, such as: cooling towers, compressed air addition, liquid oxygen addition, and hydraulic aeration at point of discharge.

Cooling towers represent the only mechanical treatment having the capability for simultaneously reducing temperature and increasing DO concentrations. Cooling towers could be operated by circulating recycled water through a counter-flowing stream of cool ambient air, where cooling would be achieved through passive evaporation only. Cooling towers are packed with fill material that spreads flowing water into thin sheets to create a high degree of surface area contact between water and air so that as much evaporative cooling can take place in the shortest length of time technically and economically possible. Heat leaves the system in the form of water vapor. Cooling towers are very efficient oxygenators. Water passing through a cooling tower becomes nearly 100 percent saturated with DO at that temperature.

Cooling for environmental compliance, for example to meet Basin Plan temperature limits, is quite different than industrial cooling. For environmental cooling, the temperature of water entering a cooling tower is already cool (perhaps 65 to 70 °F), and the "target" temperature is often close to the lowest temperature that can be achieved through evaporative cooling alone. Also, environmental cooling would be "once-through", that is, water would pass once through a cooling tower. Low-temperature operation for environmental compliance requires that cooling towers be operated at low surface loading rates, often in the range of 2.5 to 2.7 gallons per minute per square-foot (gpm/sf). As a result, a very large surface area is required for a given flow, which translates to a greater number of cooling tower cells. Cooling towers used for environmental compliance might be four times larger than cooling towers used in a typical industrial application for the same flow rate.

In California and the Pacific Northwest, cooling towers are the preferred technology for cooling and oxygenation of discharges for environmental compliance. Such towers are used by the City of Roseville, CA, the City of San Luis Obispo, CA, and the City of Quincy, WA. A cooling tower facility for temperature conditioning would consist of the following major components: cooling tower, cooling tower sump, recycled water pump station, control building, offsite power supply, and an operational buffer. Other important facility components might include meter vaults, plant water systems, buried electrical conduits, access roads, security fencing and intrusion-detection systems. Facility requirements for cooling to meet temperature and dissolved oxygen requirements have not been developed as part of this TM.

Use of evaporative cooling alone may not be able to meet the proposed Basin Plan temperature objectives under all augmentation flow rates, ambient receiving water conditions and climatic conditions. Additional study would be needed to determine the extent to which evaporative cooling could meet project needs and the associated costs.

1.3 Other Considerations

A successful streamflow augmentation project would also need to address surface water quality issues in addition to the TMDL. One such issue could be the effect of recycled water on olfactory sensation by migrating salmonid fish The City's WWTF two distinct water sources (surface water and groundwater) and their distinct signatures are important to salmonids and would be blended in the wastewater treatment plant. A deeper understanding of how much of the blended signature is lost or masked by other constituents that are added through use in the community and treatment at the WTP would be a very difficult issue to resolve. National Marine Fisheries Service (NMFS), Fish and Wildlife Service and other stakeholders would need to be convinced that streamflow augmentation and changes in the signature of the water would not adversely affect salmonid migration of other fisheries. If recycled water would be shown to not adversely affect fisheries, additional diversion upstream of the point of augmentation may be possible which may contribute to greater water supply benefits for the City.

Additional discussions with the RWQCB and NMFS would be necessary to understand possible criteria for regulatory agency evaluation of a project. The RWQCB and NMFS have already been discussing streamflow augmentation with other rivers and creeks in California, e.g. San Luis Obispo Creek and for the North Valley Regional Recycled Water Program. These efforts may provide some guidance for investigating a streamflow augmentation project in Santa Cruz, however it is likely that demonstrating success would be site specific and require extensive and stepwise lab and field evaluations of potential benefits and impacts.

2. Water Supply Considerations

The City has been evaluating various water supply opportunities through the use of the Confluence Model developed by Gary Fiske and Associates. Based on the wastewater supply evaluation for the RWFPS, 3.2 mgd of recycled water would be available for streamflow augmentation based on an advanced treatment facility sized to meet the summer annual average secondary effluent available. Attachment A includes a memo (Gary Fiske, 10/21/16) describing findings from water supply modeling for a 5 cubic feet per second (cfs) (3.2 mgd) streamflow augmentation project below the San Lorenzo River Diversion during the summer, which is assumed to be a 181-day dry period. The memo assumes that the addition of recycled water can serve to increase the City's diversion of river water (per existing water rights) by using the recycled water for the purpose of meeting in-stream flow requirements.

The Confluence Model shows that 5 cfs of streamflow augmentation during the summer, could reduce a worst year peak season shortage of 1.2 billion gallons per year (bgy) by ~700 million gallons per year (mgy). This would allow for increased diversions and decrease the number of years the City would experience a water supply shortage by half while also leaving Loch Lomond Reservoir slightly fuller at the beginning of the peak season.

3. Streamflow Augmentation Concept

Streamflow augmentation may have the potential to improve habitat and increase potable supplies; however, the practice of supplementing streamflow for the purpose of beneficial use of recycled water to increase water supply is not well understood nor documented. Even though the discharge of wastewater to a surface stream is common, and regulated through waste discharge requirements or NDPES permits, an agency seeking to pursue streamflow augmentation with recycled water will face many obstacles related to water quality, ecological risks, financial risks and public acceptance (Plumlee et. al 2012).

There are currently no regulatory requirements and/or criteria for the beneficial use of recycled water for streamflow augmentation in California. For the purpose of this RWFPS, streamflow augmentation is categorized with the other types of potable reuse because it would provide additional water supply and reliability by increasing streamflow downstream to compensate for increased diversions upstream to meet potable demands.

The streamflow augmentation concept for the City would involve adding advanced treated recycled water to the San Lorenzo River downstream of San Lorenzo River Diversion during the summer months. The City would then be able to increase diversions at the San Lorenzo River Diversion site to send to the Graham Hill Water Treatment Plant (GHWTP) to meet potable demands.

Streamflow Augmentation Project Elements and Assumptions include the following:

- 3.2 mgd of advanced recycled water treatment capacity, which includes microfiltration (MF), reverse osmosis (RO), ultraviolet light (UV) with advanced oxidation process (AOP), and disinfection to meet comparable requirements for a surface water augmentation project (See TM #1 Treatment Evaluation)
- The advanced recycled water treatment facility would be located at the Santa Cruz Wastewater Treatment Facility
- Source water from Santa Cruz Wastewater Treatment Facility effluent.
- Brine would be blended with existing Wastewater Treatment Facility ocean outfall.
- New, dedicated recycled water ("purple pipe") distribution system including a conveyance pipeline and pump station to deliver the advanced treated water to the point of discharge.
- A discharge facility consisting of an in-river diffuser with diffusers to provide efficient mixing of the discharge flow with ambient river flow.
- Discharge would occur during the summer months, over the assumed 181 day dry period, which would provide for an average annual streamflow augmentation of 1.6 mgd (1,780 AFY).

The preferred location of a discharge facility would require additional evaluation to confirm that (1) augmented flows would not contribute to flows diverted at the San Lorenzo River Diversion, (2) geomorphologic and hydraulic conditions are adequate to support a discharge facility and (3) hydraulic modeling demonstrates adequate mixing of the recycled water with ambient water such that impacts on water quality and aquatic life are acceptable and meet habitat enhancement objectives . The need and preferred process for denitrification and cooling would also need to be confirmed via a future study.

Section 8 of the RWFPS presents the associated conveyance facilities and costs associated with a streamflow augmentation project as described in the bullets above.

4. Conclusion

A streamflow augmentation project with advanced treated recycled water may have several advantages including making beneficial use of treated wastewater by augmenting natural stream flows and increasing the City's ability to divert more water from the San Lorenzo River to increase water supply. Limitations include lack of regulatory criteria to support streamflow augmentation with recycled water, uncertainty related to the ability to meet the existing or future TMDL requirements for nitrates and to meet Basin Plan requirements for temperature and dissolved oxygen. Additional fishery requirements and sensitivities of the Lagoon present further obstacles to permitting this type of project. Overall, there are many important considerations that must be better understood before streamflow augmentation with advanced treated wastewater can be considered as a water supply alternative. The advantages, disadvantages and uncertainties will be considered along-side of costs when evaluating streamflow augmentation with other recycled water alternatives in the RWFPS.

References

California Regional Water Quality Control Board Central Coast Region (CCRWQCB), 2000. Resolution R3-2000-003 and Project Report, September 15, 2000. http://www.swrcb.ca.gov/rwqcb3/water_issues/programs/tmdl/docs/san_lorenzo/nitrate/index.shtml

CCRWQCB, 2016. Water Quality Control Plan for the Central Coast Basin – March 2016 Edition. California Environmental Protection Agency. http://www.waterboards.ca.gov/centralcoast/publications_forms/publications/basin_plan/index.shtml

Halaburka et al, Economic and Ecological Costs and Benefits of Streamflow Augmentation Using Recycled Water in a California Coastal Stream, 2013

Plumlee et al, 2012. Recycled water for stream flow augmentation: Benefits, challenges, and the presence of wastewater-derived organic compounds. Science of the Total Environment (438 (2012) 541-548. Prepared by Megan H. Plumlee, Christopher J. Gurr, and Martin Reinhard. Accepted 14 August 2012.

Attachment A – Supporting Information

This attachment includes the following:

A.1 Memo from City

The memo "Streamflow Augmentation with Advanced Treated Wastewater" was developed by the City of Santa Cruz to summarize water supply, water quality and biological considerations for augmenting the San Lorenzo River with advanced treated recycled water.

A.2 Memos from Gary Fiske

The following two memos, developed by Gary Fiske and Associates for the City, describe the use of the Confluence Model to evaluate the water supply benefits of a streamflow augmentation project:

- Confluence Results with Flow Augmentation, Gary Fiske and Associates, Inc. September 18, 2016.
- Streamflow Augmentation: Further Modeling Results. Gary Fiske and Associates, Inc. October 21, 2016.

To: Kennedy/Jenks Consultants
From: City of Santa Cruz/Heidi Luckenbach and Catherine Borrowman
Date: November 14, 2016
Subject: Streamflow Augmentation with Advanced Treated Wastewater

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Background: The City of Santa Cruz (City) Recycled Water Facilities Planning Study (RWFPS) is considering potential alternative end-uses of advanced treated recycled water (ATW). The City's existing Wastewater Treatment Facility (WWTF) currently treats to secondary treatment standards except for a small side- stream, which receives more treatment for the purposes of on-site process water. The concept of Streamflow Augmentation would provide advanced treatment of 5 cfs of secondary effluent in the summer months, which would be discharged into the San Lorenzo River below the City's San Lorenzo River Diversion for the purposes of maximizing the City's diversion of river water (per existing water rights) and using the ATW for the purposes of meeting in-stream flow requirements.

Water Supply Advantages: Water supply modeling by Gary Fiske and Associates using their Confluence model has shown that, assuming the addition of 9 or 5 cubic feet per second (cfs) of highly treated wastewater into the San Lorenzo River below the San Lorenzo River Diversion, a benefit in terms of reduction in peak season shortages can be realized. (Refer to attached Fiske memos dated 9/18/16 and 10/21/16. Note that prior to understanding the production from the WWTF 9 cfs was assumed; the data however indicate a more reliable summer average of ATW of 5 cfs.) As shown in the October memo the peak season shortage, while not eliminated, is reduced fairly significantly with the addition over the peak season of 5 cfs of ATW: a worst year peak season shortage of 1.2 billion gallons per year (bgy) is reduced to ~700 million gallons per year (mgy). And, the number of years the City experiences any shortage is also reduced by about half. In addition to reducing peak season shortages, this alternative has the effect of leaving the Loch Lomond Reservoir slightly fuller at the beginning of the peak season.
While this opportunity may appear advantageous from the perspectives of making beneficial use of treated wastewater, augmenting natural stream flows, and increasing the City's ability to divert more water from the San Lorenzo River, this solution on its own does not solve the City's water supply problems and there are other important considerations that must be better understood before streamflow augmentation with highly treated wastewater can be considered as a water supply alternative.

San Lorenzo River, Background and Context: As described in numerous documents, the San Lorenzo River (SLR) watershed has a total drainage area of approximately 138 square miles. Residential development in the watershed is extensive. 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. Numerous municipal surface water diversions and groundwater wells, as well as other riparian and appropriative diversions, are scattered throughout the watershed. The upper watershed of the San Lorenzo River is a dense rural residential land use serviced by septic systems. The San Lorenzo River remains under strict Army Corp of Engineers (ACOE) flood control.
The San Lorenzo Estuary (Lagoon) is located in the center of the City of Santa Cruz, discharging to the Monterey Bay at Main Beach and the Santa Cruz Beach Boardwalk. The lower lagoon and associated tributaries are densely urban and populated. The City's surface diversion at Tait is located ~2 miles upstream of the Lagoon.

Monitoring of the San Lorenzo River, Historic and Future: Decades of information is available on the physical and water quality changes and impacts to the San Lorenzo River, watershed and Lagoon. The County of Santa Cruz prepared a Watershed Management Plan for the San Lorenzo River which was adopted in 1979. That Plan addressed various water quality issues affecting the San Lorenzo River, including septic systems, urban runoff, erosion, and other nonpoint pollution sources. The San Lorenzo River Enhancement Plan (1989) was developed for the City of Santa Cruz to enhance and restore riparian habitat in the river within the constraints of providing flood protection. The 1989 plan provided recommendations for maintaining better habitat values for the Lagoon and provided restoration recommendations including: "Consider alternative additional sources of water for streamflow entering the Lower River and Lagoon, such as reclaimed wastewater, if water quality standards are acceptable."
A number of changes post-1989 altered the landscape and management needs of the SLR and Lagoon including improvements to flood capacity and irregular vegetation management.

The 2002 Lower San Lorenzo River & Lagoon Management Plan was developed as an update to the 1989 plan and sought to identify recommendations to restore the biological and physical processes of a healthy and diverse ecosystem. As outlined in the following statement, the Management Plan provides for "the enhancement and management of the lower San Lorenzo River as a functioning riparian corridor to increase abundance and diversity of all native species, with added focus on anadromous fish and other special status species." Besides documenting existing conditions and performing new hydraulic analyses, the Management Plan makes specific management and restoration recommendations for a 15-year implementation period beginning in 2002.

The Comparative Lagoon Ecological Assessment Project (CLEAP) was initiated in 2003 to develop a more detailed understanding of key processes influencing chemical and biological health of the Lagoon. As shown in Figure 1, three years of data collection and analysis resulted in a final summary report. 2NDNature remains on contract to the City of Santa Cruz to perform annual data collection and analysis, and the preparation of an annual summary report. The most recent annual report was submitted June 2016. Based on monitoring, Lagoon enhancement opportunities may be developed to improve the ecosystem while working within the constraints of flood control, water supply, and nonpoint-source pollutants. Several projects and programs have and will continue to be implemented to improve the ecosystem:
The City Water Department has installed woody debris structures in the Lagoon per the Department of Fish and Wildlife permit for the sandbar breaching.

The City Parks Department has done some minimal weed removal with the Coastal Watershed Council. However, to date the focus has been mostly on monitoring. More recently, the "San Lorenzo River 2025 Partnership" has been created and is focused on improving overall watershed conditions to benefit the Lagoon and the rest of the river system. However, to date the focus has been on monitoring and data collection.

Figure 1 Summary of CLEAP Process

Source: 2006 CLEAP final report (2NDNature, 2006)

Issues facing the SLR and Lagoon The years of study of the San Lorenzo River and Lagoon have revealed that temperature, oxygen and nutrient loading are issues that need to be addressed in general and certainly before a Streamflow Augmentation project with ATW can be introduced to the system.

Following are brief descriptions of impacts to the river system that have created these challenges.
The oldest land use map of the Lagoon (1853) indicates the Lagoon in its present location, but with a greater channel cross-sectional area and associated access to its floodplain and marsh. Since 1853, the surface area of the Lagoon has been further constricted by the South Pacific railroad trestle 700 ft from the Monterey Bay, in addition to various road crossings, extensive floodplain development and an ACOE flood control project. The historic Lagoon surface area has been reduced by over 80%, dramatically simplifying the morphologic complexity of the Lower Lagoon. The necessity of flood control has eliminated the adjacent low-lying marsh habitat that would typically be inundated during winter runoff and summer lagoon conditions. The Lagoon area oceanward of the last roadway bridge (Riverside Drive) is extremely exposed, devoid of any vegetation and its substrate is homogenous beach sand. Annual vegetation management in the active channel is conducted each fall between Highway 1 and the Laurel Street Bridge to maintain flood capacity while preserving some channel complexity and sediment retention.

The Lagoon from Riverside Drive is the physical interface between the salt and freshwater environment. The Lower San Lorenzo River is a highly exposed, confined channel with dramatic daily water level variations when tidal connection to the coastal ocean is present. Following sandbar formation, the storage capacity of the Lower Lagoon limits the duration of sustained lagoon formation until the early fall when inflow volumes reach an annual minimum. As the season progresses and the sandbar becomes more stable as much as 15-20% of the lagoon can be characterized as brackish warm water overlying beach sand. High solar exposure, elevated nutrient inputs and anomalously deep lagoon locations are all assumed to contribute to the poor water quality.

As an example, in 2004, the Lagoon closed from the formation of a sand bar two times. The initial closure in mid-July was sustained for 6 days prior to a breach. Immediately following closure bottom water temperatures increased and dissolved oxygen (DO), pH and ORP all significantly declined. The continuous water quality records indicate daily DO fluctuations around 4mg/L despite bottom water temperatures above 20C. Previously, the normal range for DO was from 4 to 20 mg/L. During this closure, bottom water and surface water salinity never dropped below 8ppt. Following the second closure the sandbar remained until a permitted manual breach was conducted on September 21, 2004. The breach was conducted to facilitate completion of the bank restoration construction efforts at Riverside Bridge.

Significant blooms of dinoflagellates were observed during this closure, indicating episodic conditions that select for an undiversified food source at the base of the food chain. The zooplankton community in early September 2004 also exhibited an impaired community, dominated by a large number of a very small copepod cells.

CLEAP findings provide ample evidence to suggest that eutrophication is a primary cause of water quality impairments in the lagoons investigated. Nutrient loading and lagoon morphology directly influence the susceptibility of a lagoon (or location within a lagoon) to eutrophication. Eutrophic conditions are created by excess availability of dissolved inorganic nitrogen, the limiting nutrient in CLEAP lagoons. Eutrophication is exacerbated by increased light availability and water temperatures, resulting in the accumulation of organic detritus at the sediment water interface during summer reduced circulation conditions. The organic detritus is constantly respired by bacteria, consuming oxygen in the process. The greater the organic matter loading, the greater the biological oxygen demand. Continuous time series of dissolved oxygen in the CLEAP lagoons provide evidence of this biogeochemical cycling.

Summary: From a water supply perspective, as modeled by Gary Fiske, there are advantages to the discharge of advanced treated wastewater into the San Lorenzo River below the City's San Lorenzo River Diversion. Water supply shortages, in terms of both magnitude and frequency, decrease by ~50%. The San Lorenzo River and in particular the Lagoon face issues related to dissolved oxygen, temperature and nutrient loading. The elevated temperature and nutrient concentration of wastewater would contribute to these problems unless managed appropriately. Enhancements should focus on making the Lagoon less susceptible to eutrophication. While the introduction of ATW that was cooled and denitrified may help the Lagoon be less susceptible to eutrophication, the cost associated with treating water to this specification would likely be prohibitive. Assessments of San Lorenzo River and Lagoon conditions must continue to consider watershed land use and identify key pollutants of concern that may be impairing ecological function. If the concept of streamflow augmentation using ATW were advanced, its impact to the existing San Lorenzo River system must be evaluated carefully so as to not further exacerbate the existing issues.

Attachments:

Confluence Results with Flow Augmentation, Gary Fiske and Associates, Inc. September 18, 2016.

Streamflow Augmentation: Further Modeling Results. Gary Fiske and Associates, Inc. October 21, 2016.

References:

2NDNature. 2006. Comparative Lagoon Ecological Assessment Project (CLEAP). http://www.2ndnaturellc.com/wp-content/uploads/2011/12/CLEAP-Final_reduced.pdf

Santa Cruz County Planning Department. 1979. The San Lorenzo River Watershed Management Plan.

Swanson Hydrology & Geomorphology, Native Vegetation Network, Hagar Environmental Science. 2002. Lower San Lorenzo River & Lagoon Management Plan.

Swanson, M., Phillip Williams and Associates, and John Stanley and Associates. 1989. San Lorenzo River Enhancement Plan. Prepared for the City of Santa Cruz.

GARY FISKE AND ASSOCIATES, INC.
Water Resources Planning and Management

Date: September 18, 2016
From: Gary Fiske
To: Heidi Luckenbach
Re: Confluence Results with Flow Augmentation

In May 2015, we did some preliminary Confluence modeling of the water supply reliability impacts of augmenting San Lorenzo River flows below the City's Tait Street Diversion with recycled water. It was assumed that the only demands being served were Santa Cruz demands, that is, we did not attempt to serve Soquel Creek or Scotts Valley demands with this augmented supply. Other key modeling assumptions included climate change (which had the effect of modifying hydrology), DFG-5 flow rules, and the revised interim demand forecast.[1] Generally speaking, the assumptions that were used do not appear to differ enough from current assumptions to significantly affect the overall results.

The modeling assumed that <u>on all days, 9 cfs would be added to the river below Tait Street, and that available flows at Tait Street would be increased by this amount</u>. (This assumption ensures that flow rates downstream of Tait would never be adversely affected if this alternative were implemented. However, it was not confirmed whether or not 9 cfs would actually be available.) Flow rates would need to be confirmed, including diurnal flow rates as this may have an impact on the operation at Tait. It appears that the only other change in infrastructure that might be needed to achieve the results shown below is a very small addition to the assumed 11.52 cfs Tait Street diversion capacity, which stays within the 12.2 cfs water right.

The impacts are illustrated in Figures 1 and 2. Figure 1 shows the peak-season shortage duration curve without flow augmentation. Figure 2 shows the comparable curve with flow augmentation. The added flow availability at Tait Street is sufficient to essentially eliminate all peak-season shortages in all hydrologic years while maintaining the DFG-5 flow requirements downstream of the Tait Street Diversion.

If this alternative were pursued, we would need to further evaluate the potential water supply impacts, based on updated modeling assumptions regarding such things as demands, flows, available recycled water, Soquel Creek use of recycled water for their IPR project, etc. Moreover, water supply is only one issue that must be considered in evaluating this option. Treatment requirements, available flows, river water quality, etc., will be considered by others.

[1] The demand forecast was finalized in August 2015 and added approximately 150 mgy to the demand.

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Figure 1. Peak-Season Shortage Duration Curve Without Flow Augmentation

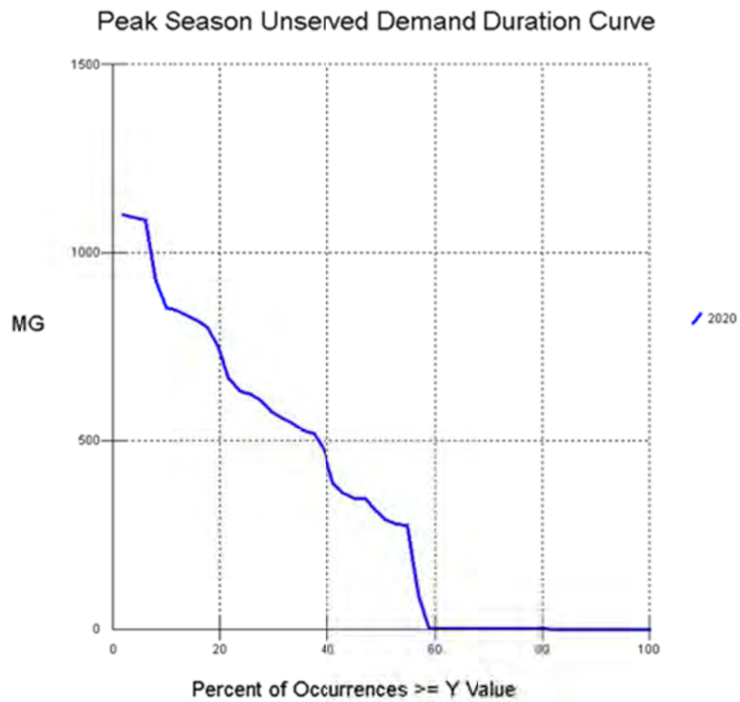
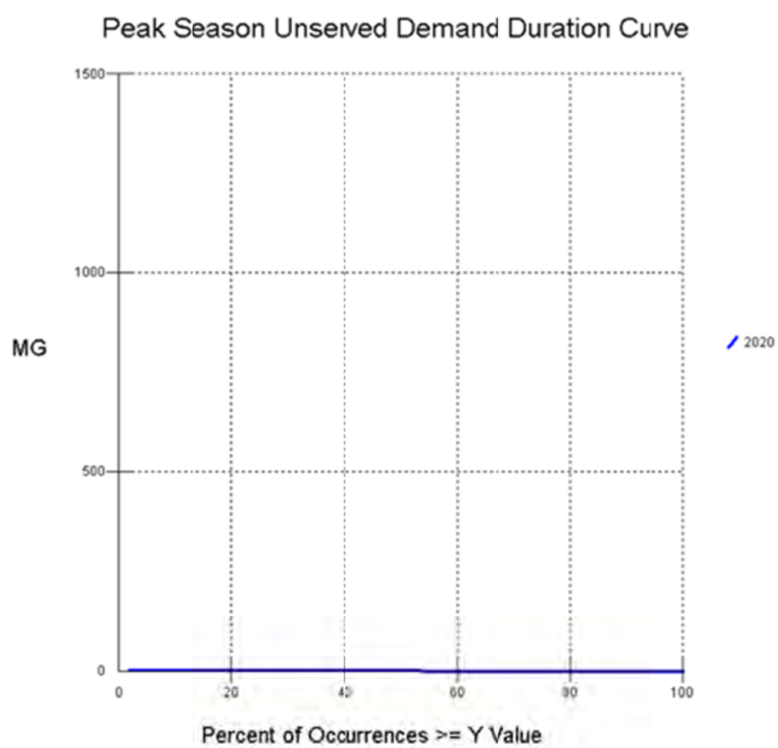


Figure 2. Peak-Season Shortage Duration Curve With Flow Augmentation



GARY FISKE AND ASSOCIATES, INC.
Water Resources Planning and Management

Date: October 21, 2016
From: Gary Fiske
To: Heidi Luckenbach
Re: Streamflow Augmentation: Further Modeling Results

In my September 18 memo, I summarized the results of some May 2015 Confluence modeling of treated-wastewater flow augmentation below Tait Street. These results assumed that on all days, 9 cfs of treated wastewater would be added to the river below Tait Street, and that available flows at Tait Street would be increased by this amount. The results assumed climate change and DFG-5 flow rules. They were also based on the then-current modeling assumptions, including the WSAC revised interim demand forecast. The substantial added available supply associated with the flow augmentation was sufficient to eliminate peak-season shortages under all hydrologic conditions.

This memo reports the results of re-analysis of the earlier assumed 9 cfs flow augmentation, and compares those results to outcomes assuming 5 cfs. <u>All of the results reported below are based on current modeling assumptions.</u> The most significant modeling assumption change from the May 2015 analysis is use of the final WSAC demand forecast which was completed in August 2015 and added approximately 150 mg of annual demand to the interim forecast.

Figure 1 compares the peak season shortage duration curves for the three cases (no flow augmentation, 5 cfs augmentation, and 9 cfs augmentation). While there is substantial benefit of 5 cfs flow augmentation, significant dry-year peak-season shortages remain.[1]

The reliability benefits result primarily from increased production at Tait Street. Figure 2 compares the mean monthly and mean annual Tait Street production for the three cases.

Aside from the direct impact of the flow augmentation on Tait production, there is a secondary impact on Loch Lomond. This is shown in Figure 3, which compares duration curves of the end-of-April lake content under the three alternatives. As flow augmentation levels – and Tait Street production – increase, there is noticeably more water in storage at the start of the dry season. This also contributes to the reliability improvements shown in Figure 1, particularly under the driest conditions.

[1] Total peak-season demand is about 2 billion gallons.

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Figure 1. Peak-Season Shortage Duration Curve Comparison

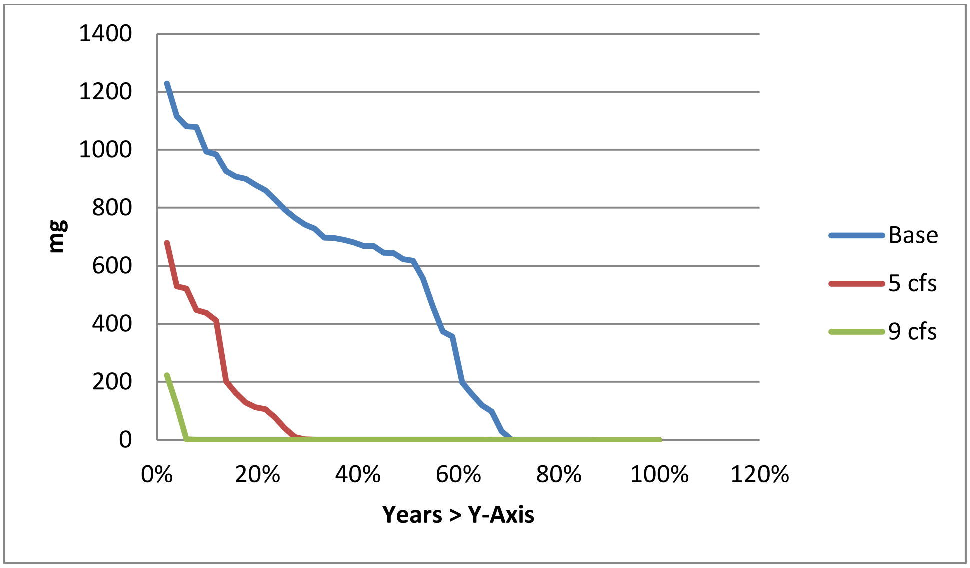


Figure 2. Mean Monthly Tait Street Production Comparison

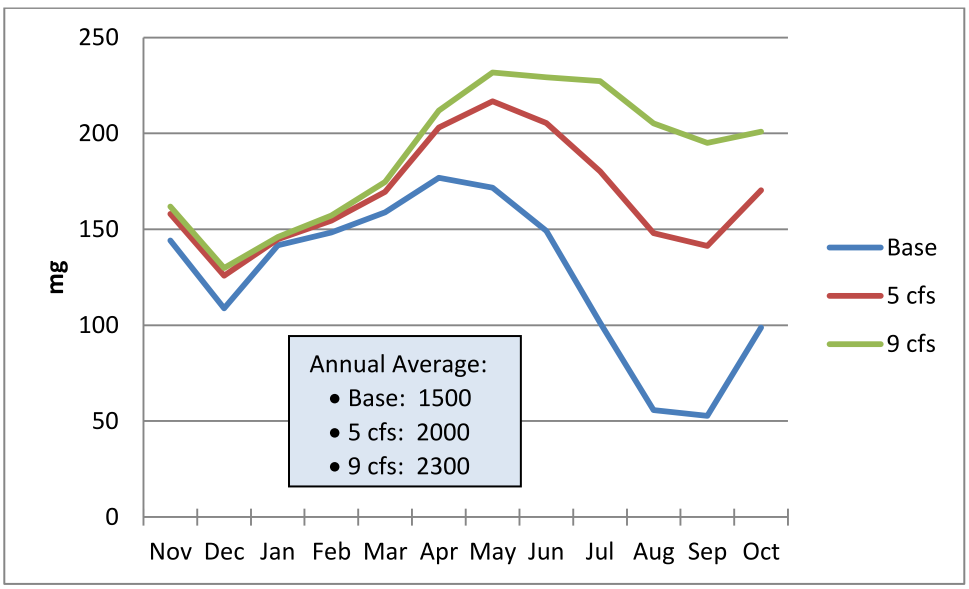
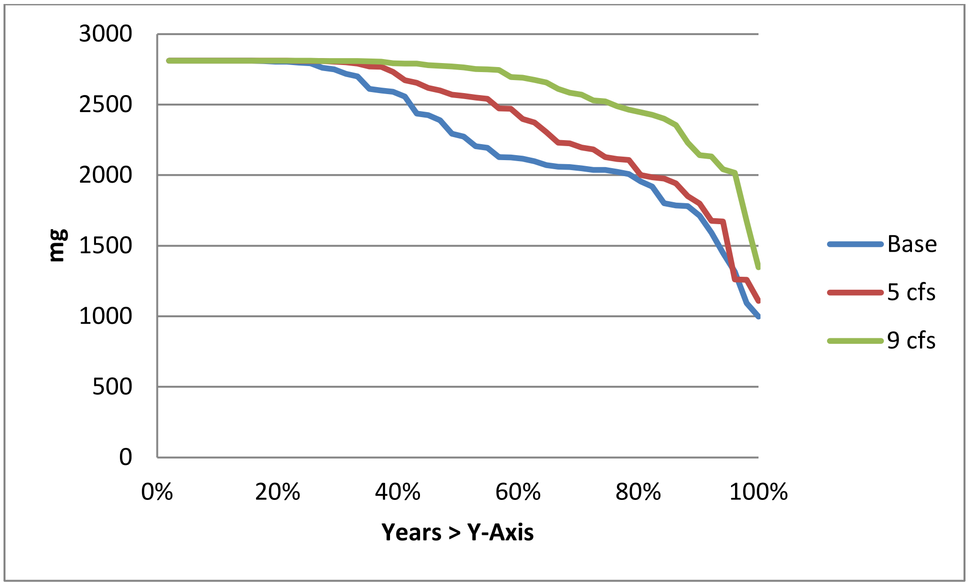


Figure 3. Duration Curves of End-of-April Loch Lomond Volumes in Storage



Appendix F: Engineers Opinion of Probable Costs

This appendix includes a summary of the cost approach and detailed cost sheets for each alternative.

F.1 Capital Cost Assumptions

The following assumptions are applied to estimate facility costs:

- **Distribution Pipelines:** Pipeline costs are based on a unit cost for each pipe size (i.e. dollar per inch-diameter linear foot) using conventional dry trenching techniques based on recently bid projects and professional experience. Costs include material and labor for total pipe segment. Special crossings, such as major intersections and jack-and-bore for river crossings are included at a higher unit cost.
- **Pump Stations:** Pumping costs were estimated based on brake horsepower requirements, assuming different redundancy factors for different alternatives, pumps and motor control centers located outside and variable speed pumps. Land acquisition costs for pump stations are not included in the cost estimate.
- **Operational Storage:** The unit cost for storage tanks (concrete and steel) is based on cost curves from RS Means, recently constructed projects in California and from professional experience.
- **Treatment Facility Costs:** Cost estimates for tertiary, MBR, MF, RO, UV/AOP, BAC, Ozone, and chlorination facilities are detailed in TM #1b.
- **Site Retrofit Costs:** Unit costs for retrofits were developed using a cost equation based on demand at each site
- **Wells:** Estimated costs for injection and production wells are based on unit costs for each well diameter and dept. Estimated costs for monitoring wells are based on costs per well. Estimates are based on recently bid projects and professional experience. Estimated costs production wells. Injection well building costs are based on unit building costs and a 20 ft by 20 ft footprint. Land acquisition costs have also been included based on unit land costs and a footprint of 100 ft by 100 ft per well.
- **Discharge Facility:** Based on a unit cost for a multi-port diffuser.

The following allowances, contingencies and non-contract cost percentages are applied to the **Subtotal Facility Costs:**

- **Additional Facility Capital Costs:** The following percentages are applied to subtotal of treatment, pump station, storage, discharge facility and well costs: site development costs at 5%, yard piping at 5% and Electrical, Instrumentation and Controls (I&C), and Remote (low-tech) Control at 20%.
- **Taxes:** 8.75% is applied to materials (estimated at 40% of the total facility cost).

The following allowances, contingencies and non-contract cost percentages are applied to the **Facility Direct Costs**:

- **Allowance for Unlisted Items:** A markup of 5% for mobilization, bonds and permits and 15% for Contractor Overhead and Profit are applied to the facility direct costs.
- **Estimate Contingency:** A markup of 30% of the facility direct costs was added to pay contractors for overruns on quantities, changed site conditions, change orders, etc. Contingencies are considered as funds to be used after construction starts and not for design changes or changes in project planning.

The resulting **Subtotal with Contractor Markups and Contingency** is increased by 2% per year to reflect escalation to midpoint of construction based on project implementation timeline assumptions. **The Project Capital Cost** includes all facility costs, allowances, markups, contingencies and the escalation to the midpoint of construction. Costs are provided in 2017 dollars using the Engineering News-Record Construction Cost Index (ENRCCI) for San Francisco.

F.2 O&M Cost Assumptions

Operations and maintenance (O&M) costs only include the City's portion of the costs and are estimated to include the following items:

- **Energy Cost:** The cost for power varies diurnally and seasonally, thus energy costs are estimated to be $0.20/kWh for continuous treatment and pumping and $0.15/kWh for off-peak pumping for irrigation only based on Santa Cruz WWTF average PG&E energy charges.
- **Labor Costs:**
  - Treatment-related labor is based on full time salary of $175,000 per year. The total number of FTEs estimated for each alternative is summarized in TM#1b, shown in App A.3. The number of FTEs used for the cost estimates only include the City's portion of the costs and are shown in the App F.3 cost tables.
  - Labor for other work such as work related to pipelines, pump stations, wells and customer service is based on a full-time salary of $125,000 per year. It is assumed that a minimum of 1 FTE will be required for each alternative. For alternatives that involve more pipelines or customer service (e.g. Alt 3B, 3E, 4, 5, 6, 7 and 8), 2 or 3 FTEs are assumed.
- **Treatment Facility Costs:** This includes energy, labor, chemicals, materials and replacement costs are based on level of treatment provided and average operating flow over the year as dictated by each Alternative.
- **Non-treatment Maintenance Costs**: Included based on 1% of direct facility costs, excluding treatment costs.
- **Contingency**: A contingency of 10% of the subtotal of O&M costs is also included.

F.3 Alternative Projects - Engineers Opinion of Probable Costs

This appendix includes detailed cost sheets for the following alternatives and projects:

Alternative 1: Centralized Non-Potable Reuse

- Alt 1a Santa Cruz PWD Title 22 Upgrade Project
- Alt 1b Maximize tertiary treatment at the Santa Cruz WWTF

Alternative 2: Decentralized Non-Potable Reuse - UC Santa Cruz

Alternative 3: SqCWD Led Groundwater Replenishment Reuse Project (GRRP)

- Alt 3a - Send secondary effluent from SCWWTF to SqCWD for injection in SqCWD basin
- Alt 3b - Send tertiary effluent from SCWWTF to SqCWD
- Alt 3c - Send additional secondary effluent from SCWWTF to SqCWD AWTF and deliver advanced treated water from SqCWD AWTF
- Alt 3d - Send advanced treated RW from SCWWTF to SqCWD
- Alt 3e - Send advanced treated RW from SCWWTF to SqCWD

Alternative 4: Santa Cruz Led GRRP

- Alt 4a – Santa Cruz Centralized GRRP
- Alt 4b - Santa Cruz Decentralized GRRP

Alternative 5: Surface Water Augmentation – Loch Lomond Reservoir

Alternative 6: Streamflow Augmentation - Direct Discharge to San Lorenzo River

Alternative 7: Direct Potable Reuse - Raw Water Blending at Graham Hill WTP

Alternative 8: Regional GRRP

- Alt 8a: 4-Way Regional GRR Project
- Alt 8b: 3-Way Regional GRR Project

Engineers Opinion of Probable Cost KENNEDY/JENKS CONSULTANTS

Alt 1A Santa Cruz PWD Title 22 Upgrades

Study:	Santa Cruz Recycled Water Facilities Planning Study	**Prepared By:**	MT, DTT	**Average Annual RW Delivered**	0.25	mgd
Project:	Alt 1A Santa Cruz PWD Title 22 Upgrades	**Date Prepared:**	Jun-2017	**(Tertiary)**	282	Average Annual Reuse (AFY)
RW Supply:	3°	**K/J Proj. No.**	1668007.00	**RW to Santa Cruz Only:**	0.25	mgd
Estimate:	Conceptual Level Cost-Analysis	**ENR**			282	Average Annual Reuse (AFY)

Item No.	Description	Qty	Units	Total Costs $/Unit	Capital Cost	Notes/Source
Facility Capital Costs						
1.0	**Treatment**				**403,200**	
1.1	PWD Title 22 Upgrade	0.25	MGD	1,600,000	403,200	Assume existing filters can be used. Only includes cost of chlorine disinfection.
2.0	**Pipelines**				**95,040**	
2.1	Tertiary Effluent Pipeline From SC WWTF to La Barranca Park	1,200	LF	72	86,400	6 in-diameter based on irrigation meter at La Barranca Park
	Pipeline Constructability (Along Roads)			10%	8,640	
	Pump Stations				**50,000**	1 duty, 0 stand by pumps. Rating per pump:
3.0	Small Pump Station	1	LS	50,000	50,000	10 total flow (gpm) 70 ft (TDH)
	Storage				**0**	
4.0	None	0	not incl.		0	
5.0	**Site Retrofit Costs**				**10,000**	
5.1	La Barranca Park	1	# of sites	10,000	10,000	Unit cost estimated using a retrofit cost curve based on demand at each site
	Subtotal Facility Costs				**$558,240**	
Additional Facility Capital Costs						
6.0	Site Development Costs	@	5%		22,660	% of Subtotal treatment, pump station, storage, discharge facility and well costs
						(Includes grading, erosion control, cut/fill, etc.)
7.0	Yard Piping	@	5%		22,660	% of Subtotal treatment, pump station, storage, discharge facility and well costs
8.0	Electrical, I&C, and Remote (low-tech) Control	@	5%		22,660	% of Subtotal treatment, pump station, storage, discharge facility and well costs
	Subtotal Additional Facility Costs				**$67,980**	
	Facility Direct Costs				**$626,220**	
	Taxes	@	8.75%		19,538	apply taxes to 40% of the Subtotal Facility Costs
	Mobilization/Bonds/Permits	@	5%		31,311	% of Facility Direct Costs
	Contractor Overhead & Profit	@	15%		93,933	% of Facility Direct Costs
	Estimate Contingency	@	30%		187,866	% of Facility Direct Costs
Subtotal with Contractor Markups and Contingency					**$958,868**	
	Escalation to Midpoint of Construction	@	8%		76,709	assume 2% percent over 4
						construction start = 2019 end = 2021
	Project Capital Cost Total				**$1,035,578**	
	Annualized Capital Cost ($mil/year)				**$0.1**	

Item No.	Description	Qty	Units	Total Annual Costs $/Unit	Total	
Annual Operations and Maintenance Costs						
1.0	**Energy Costs**					
1.1	Energy - Treatment	28,000	KWh	0.20	5,600	Treatment Operation = 24 hours per day
						8760 hours operated per year
						309 KWH/MG
1.2	Energy - Pumping to Irrigation	22,000	KWh	0.15	3,300	Pump Operation = 8 hours per day
						2920 hours operated per year
						Pump Station Hp = 10 Total Motor HP required for duty pumps
	Energy - Other	1,000	KWh	0.20	200	5% of sum of pumping energy requirements
2.0	**Labor Costs**					
2.1	Other Labor (pipeline, PS, customer service)	1.0	staff	175,000	175,000	full time staff at $175,000 average salary + benefits per year
3.0	**Maintenance**					
	Other	@	1.0%		1,550	% of facility cost (excluding treatment)
	Treatment Equipment (Maintenance/Replacement/Repair)	282	AF	7	1,892	For treatment only
4.0	**Chemicals**	282	AF	46	12,863	
5.0	**Contingency**	@	10.0%		20,041	% of above O&M costs
	Annual O&M Costs ($/year)				**$220,446**	
	Annual Unit O&M Costs ($/AF)				**$781**	

Engineers Opinion of Probable Cost

KENNEDY/JENKS CONSULTANTS

Alt 1B Maximize tertiary treatment and reuse in the City

Study:	Santa Cruz Recycled Water Facilities Planning Study	**Prepared By:**	MT, DTT	**Average Annual RW Delivered**	0.75	mgd
Project:	Alt 1B Maximize tertiary treatment and reuse in the City	**Date Prepared:**	Jun-2017	**(Tertiary)**	840	Average Annual Reuse (AFY)
RW Supply:	3°	**K/J Proj. No.**	1668007.00	**RW to Santa Cruz Only:**	0.75	mgd
Estimate:	Conceptual Level Cost-Analysis	**ENR**			840	Average Annual Reuse (AFY)

Item No.	Description	Qty	Units	Total Costs $/Unit	Total Costs Capital Cost	Notes/Source
Facility Capital Costs						
1.0	**Treatment**				**3,579,181**	NPR Demand
1.1	Phase 1 RW distribution - tertiary trmt expansion	0.25	MGD	1,600,000	400,000	Assume existing filters can be used. Only includes cost of chlorine disinfection. 0.30 MGD
	Includes SCWWTF Phase 2 Tertiary Expansion	0.10	MGD	3,400,000	345,063	
1.2	Phase 2 RW distribution - new tertiary system	0.29	MGD	3,400,000	1,001,073	Tertiary treatment assumed to be granular media filtration followed by chlorine dosing. 0.16 MGD
1.3	Phase 3 RW distribution - new tertiary system	0.24	MGD	3,400,000	826,555	0.13 MGD
1.4	Phase 4 RW distribution - new tertiary system	0.30	MGD	3,400,000	1,006,490	0.16 MGD
2.0	**Pipelines**				**8,786,438**	
2.1	Phase 1 - Tertiary Effluent Pipeline from SC WWTF to San Lorenzo Park					
	Alt1B_Ph1_A	6,500	LF	72	468,000	6 in-diameter
	Alt1B_Ph1_Main	8,650	LF	72	622,800	6 in-diameter
	Pipeline Constructability (Along Roads)			10%	109,080	
	Microtunneling (Trenchless)	950	$/LF	700	665,000	6 in-diameter
2.2	Phase 2 - Tertiary Effluent Pipeline from San Lorenzo Park to Santa Cruz Memorial Cemetery, DeLaveaga Park and Golf Course					
	Alt1B_Ph2_A	3,000	LF	72	216,000	6 in-diameter
	Alt1B_Ph2_B	4,400	LF	72	316,800	6 in-diameter
	Alt1B_Ph2_C	4,700	LF	72	338,400	6 in-diameter
	Alt1B_Ph2_D	6,100	LF	72	439,200	6 in-diameter
	Alt1B_Ph2_Main	1,550	LF	72	111,600	6 in-diameter
	Pipeline Constructability (Along Roads)			10%	142,200	
	Microtunneling (Trenchless)	150	$/LF	700	105,000	6 in-diameter
2.3	Phase 3 - Tertiary Effluent Pipeline to Good Shepherd School					
	Alt1B_Ph3_A	3,700	LF	72	266,400	6 in-diameter
	Alt1B_Ph3_B	1,200	LF	72	86,400	6 in-diameter
	Alt1B_Ph3_C	2,600	LF	72	187,200	6 in-diameter
	Alt1B_Ph3_D	6,300	LF	72	453,600	6 in-diameter
	Alt1B_Ph3_E	1,600	LF	72	115,200	6 in-diameter
	Alt1B_Ph3_Main	15,100	LF	72	1,087,200	6 in-diameter
	Pipeline Constructability (Along Roads)			10%	219,600	
	Microtunneling (Trenchless)	150	LF	700	105,000	6 in-diameter
	Major Intersections	150	LF	238	35,638	6 in-diameter
	Jack and Bore Pit Construction	1	EA	35,000	35,000	based on jacking and receiving pit costs
2.4	Phase 4 - Tertiary Effluent Pipeline from SC WWTF to Westlake School and UCSC					
	Alt1B_Ph4_Main	9,000	LF	72	648,000	6 in-diameter
	Pipeline Constructability (Along Roads)			10%	64,800	
2.2	Phase 4 - Pipelines within UCSC					
	Segment A (Green) - Boundary of SCWD to base of campus	2,200	LF	72	158,400	6 in-diameter
	Segment B (Red)- Base of campus to Atheletic Fields	7,700	LF	72	554,400	6 in-diameter
	Segment C (Yellow)- Base of campus to West Campus	10,700	LF	72	770,400	6 in-diameter
	Segment D (Orange) - West Campus to North Campus	4,000	LF	72	288,000	6 in-diameter
	Pipeline Constructability (Along Roads)			10%	177,120	
3.0	**Pump Stations**				**2,440,000**	3 pumps at each pump station. 2 duty, 1 standby. Rating per pump:
3.1	Phase 1	1	LS	480,000	480,000	950 total flow (gpm) 260 ft (TDH)
						2 pumps at each pump station. 1 duty, 1 standby. Rating per pump:
3.2	Phase 2	1	LS	420,000	420,000	610 total flow (gpm) 240 ft (TDH)
3.3	Phase 3	1	LS	480,000	480,000	640 total flow (gpm) 290 ft (TDH)
3.4	Phase 4	1	LS	390,000	390,000	240 total flow (gpm) 550 ft (TDH)
3.5	Phase 4 UCSC Pump Station	1	LS	670,000	670,000	540 total flow (gpm) 500 ft (TDH)
						Pump station locations not identified as part of this study
4.0	**Storage**				**1,165,000**	
4.1	Phase 1	0.40	MG	1,100,000	440,000	Steel Ground Tank
4.2	Phase 2		No incl.		0	No storage needed
4.3	Phase 3	0.50	MG	1,000,000	500,000	
4.4	Phase 4 UCSC Storage Tank	0.15	MG	1,500,000	225,000	Prestressed concrete tank
5.0	**Site Retrofit Costs**				**1,959,600**	
5.1	Phase 1	10	# of sites	19,800	198,000	Unit cost estimated using a retrofit cost curve based on demand at each site
5.2	Phase 2	11	# of sites	19,700	216,700	Unit cost estimated using a retrofit cost curve based on demand at each site
5.3	Phase 3	29	# of sites	18,100	524,900	Unit cost estimated using a retrofit cost curve based on demand at each site
5.4	Phase 4	51	# of sites	20,000	1,020,000	Unit cost estimated using a retrofit cost curve based on demand at each site
	Subtotal Facility Costs				**$17,930,219**	
Additional Facility Capital Costs						
6.0	Site Development Costs	@	5%		359,209	% of Subtotal treatment, pump station, storage, discharge facility and well costs
						(Includes grading, erosion control, cut/fill, etc.)
7.0	Yard Piping	@	5%		359,209	% of Subtotal treatment, pump station, storage, discharge facility and well costs
8.0	Electrical, I&C, and Remote (low-tech) Control	@	20%		1,436,836	% of Subtotal treatment, pump station, storage, discharge facility and well costs
	Subtotal Additional Facility Costs				**$2,155,254**	
	Facility Direct Costs				**$20,085,473**	
	Taxes	@	8.75%		627,558	apply taxes to 40% of the Subtotal Facility Costs
	Mobilization/Bonds/Permits	@	5%		1,004,274	% of Facility Direct Costs
	Contractor Overhead & Profit	@	15%		3,012,821	% of Facility Direct Costs
	Estimate Contingency	@	30%		6,025,642	% of Facility Direct Costs
Subtotal with Contractor Markups and Contingency					**$30,755,768**	
	Escalation to Midpoint of Construction	@	12%		3,690,692	assume 2% percent over 6
						construction start = 2020 end = 2024
	Project Capital Cost Total				**$34,446,460**	
	Annualized Capital Cost ($mil/year)				**$2**	

Engineers Opinion of Probable Cost **KENNEDY/JENKS CONSULTANTS**

Alt 1B Maximize tertiary treatment and reuse in the City

Study:	Santa Cruz Recycled Water Facilities Planning Study	**Prepared By:**	MT, DTT	**Average Annual RW Delivered**	0.75	mgd
Project:	Alt 1B Maximize tertiary treatment and reuse in the City	**Date Prepared:**	Jun-2017	**(Tertiary)**	840	Average Annual Reuse (AFY)
RW Supply:	3°	**K/J Proj. No.**	1668007.00	**RW to Santa Cruz Only:**	0.75	mgd
Estimate:	Conceptual Level Cost-Analysis	**ENR**			840	Average Annual Reuse (AFY)

Annual Operations and Maintenance Costs								
Item No.	**Description**	**Qty**	**Units**	**Total Annual Costs $/Unit**	**Total**			
1.0	**Energy Costs**					Pump Operation =	8	hours per day
	(included by Phase in items 1.1 - 1.4 below)						2920	hours operated per year
						Treatment Ops =	24	hours per day
							8760	hours operated per year
							269	KWH/MG
1.1	**Phase 1**							
	Energy - Pumping to Irrigation	260,000	KWh	0.15	39,000	Pump Station Hp =	120	Total Motor HP required for duty pumps
	Energy - Other	13,000	KWh	0.20	2,600	5%		of sum of pumping energy requirements
	Energy - Treatment	16,000	KWh	0.20	3,200			
1.2	**Phase 2**							
	Energy - Pumping to Irrigation	220,000	KWh	0.15	33,000	Pump Station Hp =	100	Total Motor HP required for duty pumps
	Energy - Other	11,000	KWh	0.20	2,200	5%		of sum of pumping energy requirements
	Energy - Treatment	8,300	KWh	0.20	1,660			
1.3	**Phase 3**							
	Energy - Pumping to Irrigation	260,000	KWh	0.15	39,000	Pump Station Hp =	120	Total Motor HP required for duty pumps
	Energy - Other	13,000	KWh	0.20	2,600	5%		of sum of pumping energy requirements
	Energy - Treatment	6,800	KWh	0.20	1,360			
1.4	**Phase 4**							
	Energy - Pumping to Irrigation	200,000	KWh	0.15	30,000	Pump Station Hp =	90	Total Motor HP required for duty pumps
	Energy - Other	0	KWh	0.20	0			of sum of pumping energy requirements
	Energy - Treatment	8,300	KWh	0.20	1,660			
	Phase 4 UCSC							
	Energy - Pumping to Irrigation	414,000	KWh	0.15	62,100	Pump Station Hp =	190	Total Motor HP required for duty pumps
	Energy - Other	0	KWh	0.20	0			of sum of pumping energy requirements
	Energy - Treatment	-	KWh	0.20	0			
2.0	**Labor Costs**							
2.1	Treatment Labor							
	Phase 1	1.00	staff	175,000	175,000	full time staff at	$175,000	average salary + benefits per year
	Phase 2	0.25	staff	175,000	43,750	full time staff at	$175,000	average salary + benefits per year
	Phase 3	0.25	staff	175,000	43,750	full time staff at	$175,000	average salary + benefits per year
	Phase 4	0.25	staff	175,000	43,750	full time staff at	$175,000	average salary + benefits per year
2.1	Other Labor (pipeline, PS, customer service)							
	Phase 1	0.5	staff	125,000	62,500	full time staff at	$125,000	average salary + benefits per year
	Phase 2	0.5	staff	125,000	62,500	full time staff at	$125,000	average salary + benefits per year
	Phase 3	0.5	staff	125,000	62,500	full time staff at	$125,000	average salary + benefits per year
	Phase 4	0.5	staff	125,000	62,500	full time staff at	$125,000	average salary + benefits per year
3.0	**Maintenance**							
	Other	@	1.0%		143,510	% of facility cost (excluding treatment)		
	Treatment Equipment (Maintenance/Replacement/Repair)	840	AF	6	4,897	For treatment only		
4.0	**Chemicals**	840	AF	46	38,285			
5.0	**Contingency**	@	10.0%		96,132	% of above O&M costs		
	Annual O&M Costs ($/year)				**$1,057,455**			
	Annual Unit O&M Costs ($/AF)				**$1,259**			

APPENDIX F.3

Engineers Opinion of Probable Cost KENNEDY/JENKS CONSULTANTS

Alt 2 UC Santa Cruz satellite treatment and reuse on campus

Study:	Santa Cruz Recycled Water Facilities Planning Study	**Prepared By:**	MT, DTT	**Average Annual RW Delivered**	0.14	mgd
Project:	Alt 2 UC Santa Cruz satellite treatment and reuse on campus	**Date Prepared:**	Jun-2017	**(Tertiary)**	155	Average Annual Reuse (AFY)
RW Supply:	3°	**K/J Proj. No.**	1668007.00	**RW to Santa Cruz Only:**	0.14	mgd
Estimate:	Conceptual Level Cost-Analysis	**ENR**			155	Average Annual Reuse (AFY)

Item No.	Description	Qty	Units	Total Costs $/Unit	Capital Cost	Notes/Source
Facility Capital Costs						
1.0	**Treatment**				**9,723,118**	
1.1	MBR Treatment	0.26	MGD	31,000,000	8,067,743	Unit Costs provided by Trussell Technologies
1.2	UV	0.26	MGD	1,500,000	390,375	Unit Costs provided by Trussell Technologies
1.3	Influent Equalization Tank	0.05	MG	2,300,000	115,000	Prestressed concrete tank 8 hour storage
1.4	Concrete Slab	1.00	LS	100,000	100,000	
1.6	Building	4,200	SF	250	1,050,000	250 $/SF
2.0	**Pipelines**				**1,948,320**	
2.1	Segment A (Green) - Boundary of SCWD to base of campus	2,200	LF	72	158,400	6 in-diameter
	Segment B (Red)- Base of campus to Atheletic Fields	7,700	LF	72	554,400	6 in-diameter
	Segment C (Yellow)- Base of campus to West Campus	10,700	LF	72	770,400	6 in-diameter
	Segment D (Orange) - West Campus to North Campus	4,000	LF	72	288,000	6 in-diameter
	Pipeline Constructability (Along Roads)			10%	177,120	
3.0	**Pump Stations**				**670,000**	1 duty, 1 stand by pumps. Rating per pump:
3.1	Small Pump Station	1	LS	670,000.00	670,000	540 total flow (gpm) 500 ft (TDH)
4.0	**Storage**				**225,000**	
4.1	Steel Ground Tank	0.15	MG	1,500,000	225,000	1 day effective diurnal product water storage
5.0	**Site Retrofit Costs**				**940,000**	
5.1	Customer Sites	47	# of sites	20,000	940,000	Unit cost estimated using a retrofit cost curve based on demand at each site
	Subtotal Facility Costs				**$13,506,438**	
Additional Facility Capital Costs						
6.0	Site Development Costs	@	5%		530,906	
						% of Subtotal treatment, pump station, storage, discharge facility and well costs
7.0	Yard Piping	@	5%		530,906	(Includes grading, erosion control, cut/fill, etc.)
8.0	Electrical, I&C, and Remote (low-tech) Control	@	20%		2,123,624	% of Subtotal treatment, pump station, storage, discharge facility and well costs
						% of Subtotal treatment, pump station, storage, discharge facility and well costs
	Subtotal Additional Facility Costs				**$3,185,435**	
	Facility Direct Costs				**$16,691,873**	
	Taxes	@	8.75%		472,725	
	Mobilization/Bonds/Permits	@	5%		834,594	apply taxes to 40% of the Subtotal Facility Costs
	Contractor Overhead & Profit	@	15%		2,503,781	% of Facility Direct Costs
	Estimate Contingency	@	30%		5,007,562	% of Facility Direct Costs
Subtotal with Contractor Markups and Contingency					**$25,510,535**	% of Facility Direct Costs
	Escalation to Midpoint of Construction	@	10%		2,551,053	assume 2% percent over 5
						construction start = 2020 end = 2022
	Project Capital Cost Total				**$28,061,588**	
	Annualized Capital Cost ($mil/year)				**$1.6**	

Annual Operations and Maintenance Costs

Item No.	Description	Qty	Units	Total Annual Costs $/Unit	Total	
1.0	**Energy Costs**					
1.1	Energy - Treatment	80,000	KWh	0.20	16,000	Treatment Operation = 24 hours per day
						8760 hours operated per year
						1592 KWH/MG
	Energy - Pumping to Irrigation	414,000	KWh	0.15	62,100	Pump Operation = 8 hours per day
1.2	Energy - Other	21,000	KWh	0.20	4,200	2920 hours operated per year
						Pump Station Hp = 190 Total Motor HP required for duty pumps
						5% of sum of pumping energy requirements
2.0	**Labor Costs**					
2.1	Other Labor (pipeline, PS, customer service)	1.0	staff	125,000	125,000	full time staff at $125,000 average salary + benefits per year
3.0	**Maintenance**					
	Other	@	1.0%		37,833	% of facility cost (excluding treatment)
	Treatment Equipment (Maintenance/Replacement/Repair)	155.0	AF	87	13,495	For treatment only
4.0	**Chemicals**	155.0	AF	27	4,262	
4.0	**Contingency**	@	10.0%		26,289	% of above O&M costs
	Annual O&M Costs ($/year)				**$289,179**	
	Annual Unit O&M Costs ($/AF)				**$1,865**	

Engineers Opinion of Probable Cost

KENNEDY/JENKS CONSULTANTS

Alt 3A Send secondary effluent from SCWWTF to SqCWD for injection in SqCWD basin (no reuse in City)

Study:	Santa Cruz Recycled Water Facilities Planning Study	**Prepared By:**	MT, DTT	**Average Annual RW Delivered**	1.70	mgd
Project:	Alt 3A Send secondary effluent from SCWWTF to SqCWD for injection in SqCWD basin (r	**Date Prepared:**	Jun-2017	**(Secondary)**	1903	Average Annual Reuse (AFY)
RW Supply:	2° + filter	**K/J Proj. No.**	1668007.00	**RW to Santa Cruz Only:**	0.00	mgd
Estimate:	Conceptual Level Cost-Analysis	**ENR**			0	Average Annual Reuse (AFY)

Item No.	Description	Qty	Units	Total Costs $/Unit	Capital Cost	Notes/Source
Facility Capital Costs						
1.0	**Treatment**				**0**	*Represents City's portion of Treatment (items below are associated with SqCWD)*
1.1	Microfiltration	1.5	MGD	2,600,000	3,976,471	Unit cost based on product flow
1.2	Reverse Osmosis	1.3	MGD	3,800,000	4,940,000	Unit cost based on product flow
1.3	Free Chlorine	1.3	MGD	200,000	260,000	
1.4	UV/AOP	1.3	MGD	700,000	910,000	
1.5	Post Treatment and Chemical Handling	1.3	MGD	900,000	1,170,000	Square foot estimated based on treatment plant design capacity.
1.6	Building	1.3	MGD	1,250,000	1,625,000	5,000 SF/mgd
						250 $/SF
2.0	**Pipelines**				**0**	*Represents City's portion of Pipelines (items below are assoicated with SqCWD)*
2.1	Secondary Effluent Pipeline from SC WWTF to SqCWD	37,800	LF	210.00	7,938,000	14 in-diameter
	Pipeline Constructability (Along Roads)			10%	793,800	
	Microtunneling (Trenchless)	800	LF	700	560,000	14 in-diameter
	Bore and Jack Pit Construction	0	EA	35,000	0	
2.2	Brine Pipeline from SqCWD to SC WWTF	38,600	LF	72.00	2,779,200	6 in-diameter
						Assume no additional costs for pipeline constructability and microtunneling since secondary and brine pipelines will be within the same trench
3.0	**Pump Stations**				**0**	*Represents City's portion of Pump Stations (items below are assoicated with SqCWD)*
						3 pumps at each pump station. 2 duty, 1 standby. Rating per pump:
3.1	Effluent Pump Station from SC WWTP to SqCWD	1	LS	850,000	850,000	1,180 total flow (gpm) 460 ft (TDH)
3.2	Brine Pump Station from SqCWD to SC WWTF	1	LS	450,000	450,000	280 total flow (gpm) 810 ft (TDH)
						Conveyance system optimization will need to be performed if alternative is selected
4.0	**Storage**				**0**	
			not incl.		0	
5.0	**Site Retrofit Costs**				**0**	
5.1	Customer Sites	0	# of sites	11,000	0	Unit cost estimated using a retrofit cost curve based on demand at each site
	Subtotal Facility Costs				**$0**	
Additional Facility Capital Costs						
6.0	Site Development Costs	@	5%		0	% of Subtotal treatment, pump station, storage, discharge facility and well costs
						(Includes grading, erosion control, cut/fill, etc.)
7.0	Yard Piping	@	5%		0	% of Subtotal treatment, pump station, storage, discharge facility and well costs
8.0	Electrical, I&C, and Remote (low-tech) Control	@	20%		0	% of Subtotal treatment, pump station, storage, discharge facility and well costs
	Subtotal Additional Facility Costs				**$0**	
	Facility Direct Costs				**$0**	
	Taxes	@	8.75%		0	apply taxes to 40% of the Subtotal Facility Costs
	Mobilization/Bonds/Permits	@	5%		0	% of Facility Direct Costs
	Contractor Overhead & Profit	@	15%		0	% of Facility Direct Costs
	Estimate Contingency	@	30%		0	% of Facility Direct Costs
Subtotal with Contractor Markups and Contingency					**$0**	
	Escalation to Midpoint of Construction	@	6%		0	assume 2% percent over 3
						construction start = 2018 end = 2020
	Project Capital Cost Total				**$0**	*Represents City's Share of Facilities (none)*
	Annualized Capital Cost ($mil/year)				**$0**	

Item No.	Description	Qty	Units	Total Annual Costs $/Unit	Total	
Annual Operations and Maintenance Costs						
1.0	**Energy Costs**				**0**	*Represents City's portion of Energy Costs (items below are assoicated with SqCWD)*
1.1	Energy - Treatment	190,000	KWh	0.20	38,000	Treatment Ops = 24 hours per day
						(all to SqCWD) 8760 hours operated per year
						309 KWH/MG
1.2	Energy - Pumping	1,700,000	KWh	0.20	340,000	Pump Operation = 24 hours per day
						8760 hours operated per year
						Pump Station Hp = 260 Total Motor HP required for duty pumps
1.3	Energy - Other	90,000	KWh	0.20	18,000	5% of sum of pumping energy requirements
2.0	**Labor Costs**				**0**	*Represents City's portion of Labor Costs (items below are assoicated with SqCWD)*
2.1	Other Labor (pipeline, PS, customer service)	1.0	staff	125,000	125,000	full time staff at $125,000 average salary + benefits per year
3.0	**Maintenance**					
	Other	@	1.0%		133,710	% of facility cost (excluding treatment)
	Treatment Equipment (Maintenance/Replacement/Repair)	1,903	AF	210	399,686	For treatment only
4.0	**Chemicals**	1,903	AF	100	190,327	
4.0	**Contingency**	@	10.0%		124,472	% of above O&M costs
	Annual O&M Costs ($/year)				**$0**	*Represents City's share of O&M costs (none)*
	Annual Unit O&M Costs ($/AF)				**$0**	

Engineers Opinion of Probable Cost KENNEDY/JENKS CONSULTANTS

Alt 3B Send tertiary effluent from SCWWTF to SqCWD (serve NPR users along the way)

Study:	Santa Cruz Recycled Water Facilities Planning Study	**Prepared By:**	MT, DTT	**Average Annual RW Delivered**	2.19	mgd
Project:	Alt 3B Send tertiary effluent from SCWWTF to SqCWD (serve NPR users along the way)	**Date Prepared:**	Jun-2017	**(Tertiary)**	2454	Average Annual Reuse (AFY)
RW Supply:	3°	**K/J Proj. No.**	1668007.00	**RW to Santa Cruz Only:**	0.49	mgd
Estimate:	Conceptual Level Cost-Analysis	**ENR**			550	Average Annual Reuse (AFY)

Item No.	Description	Qty	Units	Total Costs $/Unit	Capital Cost	Notes/Source
Facility Capital Costs						
1.0	**Treatment**				**6,240,000**	
1.1	New Tertiary Treatment (GMF and Chlorine)	2.40	MGD	2,600,000	6,240,000	capacity includes peak flows to meet summer NPR demand
						MF would cost about 50% more than GMF
1.2	AWTF at SqCWD Headquarters		not incl.			*Cost for PureWaterSoquel AWTF not included*
2.0	**Pipelines**				**3,238,113**	*Represents City's portion of Pipelines (sum of items below)*
2.1	Tertiary Effluent Pipeline from SC WWTF to SqCWD, serving NPR along the way					
	Alt3B_A	2,400	LF	72.00	172,800	6 in-diameter
	Alt3B_B	1,500	LF	72.00	108,000	6 in-diameter
	Alt3B_C	1,700	LF	72.00	122,400	6 in-diameter
	Alt3B_D	2,000	LF	72.00	144,000	6 in-diameter
	Alt3B_Main	37,800	LF	240	9,072,000	16 in-diameter
	Pipeline Constructability (Along Roads)			10%	961,920	
	Microtunneling (Trenchless)	800	$/LF	700	560,000	16 in-diameter
	Major Intersections	400	$/in-dia/LF	40	15,839	6 in-diameter
	Microtunneling (Trenchless)	400	$/LF	700	280,000	6 in-diameter
	Bore and Jack Pit Construction	0	EA	35,000	0	based on jacking and receiving pit costs
2.2	Brine pipeline from SqCWD to SC WWTF	38,600	LF	112	4,323,200	8 in-diameter
2.3	Remove SqCWD's portion of Tertiary Effluent pipe costs	1.70	MGD	(4,810,650)	(8,198,846)	
2.4	Remove SqCWD's portion of brine pipe costs	1	LS	(4,323,200)	(4,323,200)	
3.0	**Pump Stations**				**137,678**	*Represents City's portion of Pump Stations (sum of items below)*
						3 pumps at each pump station. 2 duty, 1 standby. Rating per pump:
3.1	Effluent Pump Station from SC WWTF to SqCWD	1	LS	620,000	620,000	880 total flow (gpm) 400 ft (TDH)
3.2	Brine Pump Station from SqCWD to SC WWTF	1	LS	360,000	360,000	280 total flow (gpm) 550 ft (TDH)
3.3	Remove SqCWD's portion of tertiary PS costs	1.70	MGD	(283,001)	(482,322)	
3.4	Remove SqCWD's portion of brine PS costs	1	LS	(360,000)	(360,000)	
						Conveyance system optimization will need to be performed if alternative is selected
4.0	**Storage**				**0**	
4.1			not incl.		0	
5.0	**Site Retrofit Costs**				**482,800**	
5.1	Customer sites	34	# of sites	14,200	482,800	Unit cost estimated using a retrofit cost curve based on demand at each site
	Subtotal Facility Costs				**$10,098,591**	
Additional Facility Capital Costs						
6.0	Site Development Costs	@	5%		318,884	% of Subtotal treatment, pump station, storage, discharge facility and well costs
						(Includes grading, erosion control, cut/fill, etc.)
7.0	Yard Piping	@	5%		318,884	% of Subtotal treatment, pump station, storage, discharge facility and well costs
8.0	Electrical, I&C, and Remote (low-tech) Control	@	20%		1,275,536	% of Subtotal treatment, pump station, storage, discharge facility and well costs
	Subtotal Additional Facility Costs				**$1,913,303**	
	Facility Direct Costs				**$12,011,895**	
	Taxes	@	8.75%		353,451	apply taxes to 40% of the Subtotal Facility Costs
	Mobilization/Bonds/Permits	@	5%		600,595	% of Facility Direct Costs
	Contractor Overhead & Profit	@	15%		1,801,784	% of Facility Direct Costs
	Estimate Contingency	@	30%		3,603,568	% of Facility Direct Costs
Subtotal with Contractor Markups and Contingency					**$18,371,293**	
	Escalation to Midpoint of Construction	@	11%		2,020,842	assume 2% percent over 6
						construction start = 2020 end = 2023
	Project Capital Cost Total				**$20,392,135**	
	Annualized Capital Cost ($mil/year)				**$1.1**	

Item No.	Description	Qty	Units	Total Annual Costs $/Unit	Total	
Annual Operations and Maintenance Costs						
1.0	**Energy Costs**					
1.1	Energy - Treatment	47,000	KWh	0.20	9,400	Treatment Ops = 24 hours per day
	(Only includes City's proportional share)					(City Flow Only) 8760 hours operated per year
						264 KWH/MG
1.2	Energy - Pumping	480,000	KWh	0.20	96,000	Pump Operation = 24 hours per day
	(Only includes City's proportional share)					8760 hours operated per year
	Energy - Other	24,000	KWh	0.20	4,800	Pump Station Hp = 330 Total Motor HP required for duty pumps
						5% of sum of pumping energy requirements
2.0	**Labor Costs**					
2.1	Other Labor (treatment, pipeline, PS, customer service)	1.0	staff	125,000	125,000	full time staff at $125,000 average salary + benefits per year
3.0	**Maintenance**					
	Other	@	1.0%		38,586	% of facility cost (excluding treatment)
	Treatment Equipment (Maintenance/Replacement/Repair)	550	AF	10	5,504	For treatment only
4.0	**Chemicals**	550	AF	50	27,522	
4.0	**Contingency**	@	10.0%		30,681	% of above O&M costs
	Annual O&M Costs ($/year)				**$337,493**	
	Annual Unit O&M Costs ($/AF)				**$613**	

APPENDIX F.3

Engineers Opinion of Probable Cost KENNEDY/JENKS CONSULTANTS

Alt 3C Send additional secondary effluent from SCWWTF to SqCWD AWTF and deliver advanced treated water from SqCWD AWTF to recharge Beltz Wel

Study:	Santa Cruz Recycled Water Facilities Planning Study	**Prepared By:**	MT, DTT	**Average Annual RW Delivered (Advanced Treated)**	3.31	mgd
Project:	Alt 3C Send additional secondary effluent from SCWWTF to SqCWD AWTF and deliver	**Date Prepared:**	Jun-2017		3704	Average Annual Reuse (AFY)
RW Supply:	AWT	**K/J Proj. No.**	1668007.00	**RW to Santa Cruz Only:**	2.01	mgd
Estimate:	Conceptual Level Cost-Analysis	**ENR**			2,248	Average Annual Reuse (AFY)

Item No.	Description	Qty	Units	Total Costs $/Unit	Capital Cost	Notes/Source
Facility Capital Costs						
1.0	**Treatment**				**16,920,201**	*Represents City's portion of Treatment (sum of items below)*
1.1	Microfiltration	3.9	MGD	2,000,000	7,853,779	Unit cost based on product flow; 90% MF Recovery Rate
1.2	Reverse Osmosis	3.3	MGD	3,000,000	10,013,569	Unit cost based on product flow; 85% RO Recovery Rate
1.3	Free Chlorine	3.3	MGD	200,000	667,571	
1.4	UV/AOP	3.3	MGD	600,000	2,002,714	
1.5	Post Treatment and Chemical Handling	3.3	MGD	900,000	3,004,071	Square foot estimated based on treatment plant design capacity.
1.6	Building	3.3	MGD	1,250,000	4,172,320	5,000 SF/mgd
						250 $/SF
1.7	Remove SqCWD portion of treatment	1.30	MGD	(8,302,941)	(10,793,824)	
2.0	**Pipelines**				**9,712,445**	*Represents City's portion of Pipelines (sum of items below)*
2.1	Secondary Effluent Pipeline from SC WWTF to SqCWD	37,800	LF	300	11,340,000	20 in-diameter
	Pipeline Constructability (Along Roads)	0		10%	1,134,000	
	Microtunneling (Trenchless)	800	LF	700	560,000	20 in-diameter
2.2	Advanced Treated Water Pipelines					
	from SqCWD AWTF to SC GWRR	13,000	LF	150	1,950,000	10 in-diameter
	from Main pipeline to Injection Well F	3,000	LF	112	336,000	8 in-diameter
	from Main pipeline to Injection Well D	600	LF	112	67,200	8 in-diameter
	from Injection Well D to Injection Well J	2,700	LF	112	302,400	8 in-diameter
	from Main pipeline to Injection Well B and C	3,800	LF	112	425,600	8 in-diameter
	Pipeline Constructability (Along Roads)			10%	308,120	
2.3	Brine pipeline from SqCWD to SC WWTF					
	from SqCWD AWTF to SC WWTP	38,600	LF	112	4,323,200	8 in-diameter
2.4	Remove SqCWD's portion of Secondary Effluent pipe costs	1.70	MGD	(3,941,637)	(6,698,207)	
2.5	Remove SqCWD's portion of brine pipe costs	0.40	MGD	(10,857,413)	(4,335,869)	
3.0	**Pump Stations**				**1,692,022**	*Represents City's portion of Pump Stations (sum of items below)*
						2 pumps at each pump station. 1 duty, 1 standby. Rating per pump:
3.1	Effluent Pump Station from SC WWTF to SqCWD	1	LS	2,620,000	2,620,000	2,720 total flow (gpm); 580 ft (TDH)
3.2	Advanced Treated Water Pump Station at SqCWD	1	LS	420,000	420,000	1,420 total flow (gpm); 100 ft (TDH)
3.3	Brine Pump Station from SqCWD to SC WWTF	1	LS	530,000	530,000	710 total flow (gpm); 290 ft (TDH)
3.4	Remove SqCWD's portion of secondary PS costs	1.7	MGD	(792,319)	(1,346,425)	
3.6	Remove SqCWD's portion of brine PS costs	0.40	MGD	(1,331,058)	(531,553)	
						Conveyance system optimization will need to be performed if alternative is selected
4.0	**Storage**				**0**	
4.1			not incl.		0	
5.0	**Site Retrofit Costs**				**113,600**	*Represents City's NPR customers*
5.1	Customer Sites	8	# of sites	14,200	113,600	
6.0	**Wells Costs**				**3,955,000**	*Represents City wells in Beltz Wellfied Area*
6.1	Injection Well B and Well C (near Beltz #12)	2	Wells	520,000	1,040,000	16 in-diameter
						650 feet deep
	Injection Well B and C Building	2	Nos	100,000	200,000	Assume 20 feet x 20 feet per injection well building and $250/SF of building cost
6.2	Injection Well D and Well F (near Beltz #10)	2	Wells	252,000	504,000	14 in-diameter
						360 feet deep
	Injection Well D and F Building	2	Nos	100,000	200,000	Assume 20 feet x 20 feet per injection well building and $250/SF of building cost
6.3	Injection Well J as back-up well (Near Beltz #8 and #9)	1	Wells	161,000	161,000	14 in-diameter
						230 feet deep
	Injection Well J Building	1	Nos	100,000	100,000	Assume 20 feet x 20 feet per injection well building and $250/SF of building cost
						Assume Injection Well J and back-up well share same building
6.4	Production Wells		not incl.			Assumes City's existing and planned production wells would be sufficient
6.5	Monitoring Wells	5	Wells	100,000	500,000	Assumes one monitoring well per injection well, excluding back-up well
6.6	Land Acquisition	50,000	SF	25	1,250,000	Assume 100 feet x 100 feet per well
	Subtotal Facility Costs				**$32,393,268**	
Additional Facility Capital Costs						
6.0	Site Development Costs	@	5%		1,128,361	% of Subtotal treatment, pump station, storage, discharge facility and well costs
						(Includes grading, erosion control, cut/fill, etc.)
7.0	Yard Piping	@	5%		1,128,361	% of Subtotal treatment, pump station, storage, discharge facility and well costs
8.0	Electrical, I&C, and Remote (low-tech) Control	@	20%		4,513,445	% of Subtotal treatment, pump station, storage, discharge facility and well costs
	Subtotal Additional Facility Costs				**$6,770,167**	
	Facility Direct Costs				**$39,163,434**	
	Taxes	@	8.75%		1,133,764	apply taxes to 40% of the Subtotal Facility Costs
	Mobilization/Bonds/Permits	@	5%		1,958,172	% of Facility Direct Costs
	Contractor Overhead & Profit	@	15%		5,874,515	% of Facility Direct Costs
	Estimate Contingency	@	30%		11,749,030	% of Facility Direct Costs
Subtotal with Contractor Markups and Contingency					**$59,878,916**	
	Escalation to Midpoint of Construction	@	15%		8,981,837	assume 2% percent over 8
						construction start = 2022; end = 2025
	Project Capital Cost Total				**$68,860,753**	For Santa Cruz facilities, not including baseline costs attributed to SqCWD
	Annualized Capital Cost ($mil/year)				**$3.7**	

Engineers Opinion of Probable Cost KENNEDY/JENKS CONSULTANTS

Alt 3C Send additional secondary effluent from SCWWTF to SqCWD AWTF and deliver advanced treated water from SqCWD AWTF to recharge Beltz Wel

Study:	Santa Cruz Recycled Water Facilities Planning Study	**Prepared By:**	MT, DTT	**Average Annual RW Delivered (Advanced**	3.31 mgd
Project:	Alt 3C Send additional secondary effluent from SCWWTF to SqCWD AWTF and deliver	**Date Prepared:**	Jun-2017	**Treated)**	3704 Average Annual Reuse (AFY)
RW Supply:	AWT	**K/J Proj. No.**	1668007.00	**RW to Santa Cruz Only:**	2.01 mgd
Estimate:	Conceptual Level Cost-Analysis	**ENR**			2,248 Average Annual Reuse (AFY)

Annual Operations and Maintenance Costs

Item No.	Description	Qty	Units	Total Annual Costs $/Unit	Total	Notes		
1.0	**Energy Costs**							
1.1	Energy - Treatment	2,130,000	KWh	0.20	426,000	Treatment Ops	24	hours per day
	(Only includes City's proportional share)						8760	hours operated per year
							2908	KWH/MG
1.2	Secondary Effluent Pumping:							
	Energy - Pumping	4,000,000	KWh	0.20	800,000	Pump Operation =	24	hours per day
	(Only includes City's proportional share)						8760	hours operated per year
						Pump Station Hp =	1000	Total Motor HP required for duty pumps
1.3	Advanced Treated Water Pumping from SqCWD back to City GRR:					Pump Operation =	24	hours per day
	Energy - Pumping (conveyance)	650,000	KWh	0.20	130,000		8760	hours operated per year
	(Only includes City's proportional share)					Pump Station Hp =	100	Total Motor HP required for duty pumps
1.4	Energy - Pumping (Injection Wells)	1,400,000	KWh	0.20	280,000	Well Pumps Hp =	220	Total Motor HP required for 5 wells
	(Only includes City injection wells)							
1.5	Energy - Other	100,000	KWh	0.20	20,000	5%		of sum of pumping energy requirements
2.0	**Labor Costs**					Only includes City's proportional share (SqCWD would support staff for treatment)		
2.1	Labor - AWTF	4.0	staff	175,000	700,000	full time staff at	$175,000	average salary + benefits per year
2.2	Other Labor (pipeline, PS, etc.)	2.0	staff	125,000	250,000	full time staff at	$125,000	average salary + benefits per year
3.0	**Maintenance**							
	Other	@	1.0%		154,731	% of facility cost (excluding treatment)		
	Treatment Equipment (Maintenance/Replacement/Repair)	2,248	AF	180	404,560	For treatment only		
4.0	**Chemicals**	2,248	AF	100	224,756			
4.0	**Well Costs:** water quality and water level monitoring	5	Well	20,000	100,000			
5.0	**Contingency**	@	10.0%		349,005	% of above O&M costs		
	Annual O&M Costs ($/year)				**$3,839,052**			
	Annual Unit O&M Costs ($/AF)				**$1,708**			

Engineers Opinion of Probable Cost

KENNEDY/JENKS CONSULTANTS

Alt 3D Send advanced treated RW from an AWTF at/near SCWWTF to SqCWD (serve NPR users along the way)

Study:	Santa Cruz Recycled Water Facilities Planning Study	**Prepared By:**	MT, DTT	**Average Annual RW Delivered**	1.38	mgd
Project:	Alt 3D Send advanced treated RW from an AWTF at/near SCWWTF to SqCWD (se	**Date Prepared:**	Jun-2017	**(Advanced Treated)**	1544	Average Annual Reuse (AFY)
RW Supply:	AWT	**K/J Proj. No.**	1668007.00	**RW to Santa Cruz Only:**	0.08	mgd
Estimate:	Conceptual Level Cost-Analysis	**ENR**			88	Average Annual Reuse (AFY)

Item No.	Description	Qty	Units	Total Costs $/Unit	Total Costs Capital Cost	Notes/Source
Facility Capital Costs						
1.0	**Treatment**				**1,362,274**	*Represents City's portion of Treatment (sum of items below)*
1.1	Microfiltration	1.7	MGD	2,600,000	4,397,000	Unit cost based on product flow 90% MF Recovery Rate
1.2	Reverse Osmosis	1.4	MGD	3,800,000	5,462,427	Unit cost based on product flow 85% RO Recovery Rate
1.3	Free Chlorine	1.4	MGD	200,000	287,496	
1.4	UV/AOP	1.4	MGD	700,000	1,006,237	
1.5	Post Treatment and Chemical Handling	1.4	MGD	900,000	1,293,733	Square foot estimated based on treatment plant design capacity.
1.6	Building	1.4	MGD	1,250,000	1,796,851	5,000 SF/mgd
						250 $/SF
1.7	Remove SqCWD portion of treatment	1.3	MGD	(9,908,824)	(12,881,471)	
2.0	**Pipelines**				**1,690,313**	*Represents City's portion of Pipelines (sum of items below)*
2.1	Advanced Treated Water Pipeline from AWTF at or near SC WWTF to SqCWD, serving NPR along the way					
	Alt3D_A	3,200	LF	72	230,400	6 in-diameter
	Alt3D_B	1,500	LF	72	108,000	6 in-diameter
	Alt3D_C	1,700	LF	72	122,400	6 in-diameter
	Alt3D_D	2,000	LF	72	144,000	6 in-diameter
	Alt3D_Main	37,800	LF	210	7,938,000	14 in-diameter
	Pipeline Constructability (Along Roads)			10%	854,280	
	Microtunneling (Trenchless)	800	LF	700	560,000	14 in-diameter
2.2	Remove SqCWD's portion of Advanced Treated pipe costs	1.30	MGD	(6,334,856)	(8,266,767)	
3.0	**Pump Stations**				**115,200**	*Represents City's portion of Pump Stations (sum of items below)*
						2 pumps at each pump station. 1 duty, 1 standby. Rating per pump:
3.1	From WWTP to SqCWD, serving NPR along the way	1	LS	2,160,000	2,160,000	7,790 total flow (gpm) 490 ft (TDH)
3.2	Remove SqCWD's portion of PS costs	1.30	MGD	(1,566,938)	(2,044,800)	
						Conveyance system optimization will need to be performed if alternative is selected
4.0	**Storage**				**0**	
4.1			not incl.		0	
5.0	**Site Retrofit Costs**				**469,200**	
5.1	Customer Sites	34	# of sites	13,800	469,200	Unit cost estimated using a retrofit cost curve based on demand at each site
	Subtotal Facility Costs				**$3,636,987**	
Additional Facility Capital Costs						
6.0	Site Development Costs	@	5%		73,874	% of Subtotal treatment, pump station, storage, discharge facility and well costs
						(Includes grading, erosion control, cut/fill, etc.)
7.0	Yard Piping	@	5%		73,874	% of Subtotal treatment, pump station, storage, discharge facility and well costs
8.0	Electrical, I&C, and Remote (low-tech) Control	@	20%		295,495	% of Subtotal treatment, pump station, storage, discharge facility and well costs
	Subtotal Additional Facility Costs				**$443,242**	
	Facility Direct Costs				**$4,080,229**	
	Taxes	@	8.75%		127,295	apply taxes to 40% of the Subtotal Facility Costs
	Mobilization/Bonds/Permits	@	5%		204,011	% of Facility Direct Costs
	Contractor Overhead & Profit	@	15%		612,034	% of Facility Direct Costs
	Estimate Contingency	@	30%		1,224,069	% of Facility Direct Costs
Subtotal with Contractor Markups and Contingency					**$6,247,638**	
	Escalation to Midpoint of Construction	@	11%		687,240	assume 2% percent over 6
						construction start = 2020 end = 2023
	Project Capital Cost Total				**$6,934,878**	
	Annualized Capital Cost ($mil/year)				**$0.4**	

Item No.	Description	Qty	Units	Total Annual Costs $/Unit	Total Annual Costs Total	
Annual Operations and Maintenance Costs						
1.0	**Energy Costs**					Pump Operation = 8 hours per day
						2920 hours operated per year
1.1	Energy - Treatment	101,000	KWh	0.20	20,200	Treatment Operation = 24 hours per day
	(Excludes SqCWD portion of treatment)					8760 hours operated per year
						3520 KWH/MG
1.2	Energy - Pumping	99,000	KWh	0.20	19,800	Pump Operation = 24 hours per day
	(Excludes SqCWD portion of pumping)					8760 hours operated per year
	Energy - Other	5,000	KWh	0.20	1,000	Pump Station Hp = 800 Total Motor HP required for duty pumps
						5% of sum of pumping energy requirements
2.0	**Labor Costs**					
2.1	Labor - AWPF	1.0	staff	175,000	175,000	full time staff at $175,000 average salary + benefits per year
2.2	Other Labor (pipeline, PS, etc.)	1.0	staff	125,000	125,000	full time staff at $125,000 average salary + benefits per year
3.0	**Maintenance**					
	Other	@	1.0%		22,747	% of facility cost (excluding treatment)
	Treatment Equipment (Maintenance/Replacement/Repair)	88	AF	210	18,460	For treatment only
4.0	**Chemicals**	88	AF	100	8,790	
4.0	**Contingency**	@	10.0%		39,100	% of above O&M costs
	Annual O&M Costs ($/year)				**$430,097**	
	Annual Unit O&M Costs ($/AF)				**$4,893**	

APPENDIX F.3

Engineers Opinion of Probable Cost KENNEDY/JENKS CONSULTANTS

Alt 3E Send advanced treated RW from an AWTF at/near SCWWTF to SqCWD (GRR in Beltz Wellfield + NPR along the way)

Study:	Santa Cruz Recycled Water Facilities Planning Study	**Prepared By:**	MT, DTT	**Average Annual RW Delivered**	3.41 mgd
Project:	Alt 3E Send advanced treated RW from an AWTF at/near SCWWTF to SqCWD (GRR in Beltz Well	**Date Prepared:**	Jun-2017	**(Advanced Treated)**	3824 Average Annual Reuse (AFY)
RW Supply:	AWT	**K/J Proj. No.**	1668007.00	**RW to Santa Cruz Only:**	2.11 mgd
Estimate:	Conceptual Level Cost-Analysis	**ENR**			2,368 Average Annual Reuse (AFY)

Item No.	Description	Qty	Units	Total Costs $/Unit	Total Costs Capital Cost	Notes/Source
Facility Capital Costs						
1.0	**Treatment**				**18,308,705**	*Represents City's portion of Treatment (sum of items below)*
1.1	Microfiltration	4.1	MGD	2,000,000	8,247,263	Unit cost based on product flow 90% MF Recovery Rate
1.2	Reverse Osmosis	3.5	MGD	3,000,000	10,515,260	Unit cost based on product flow 85% RO Recovery Rate
1.3	Free Chlorine	3.5	MGD	200,000	701,017	
1.4	UV/AOP	3.5	MGD	600,000	2,103,052	
1.5	Post Treatment and Chemical Handling	3.5	MGD	900,000	3,154,578	
1.6	Building	3.5	MGD	1,250,000	4,381,358	Square foot estimated based on treatment plant design capacity.
						5,000 SF/mgd
1.7	Remove SqCWD portion of treatment	1.30	MGD	(8,302,941)	(10,793,824)	250 $/SF
2.0	**Pipelines**				**8,084,622**	*Represents City's portion of Pipelines (sum of items below)*
2.1	Advanced Treated Water Pipeline from AWTF at or near SC WWTF to Beltz area	24,800	LF	240	5,952,000	16 in-diameter
	Advanced Treated Water Pipeline from Beltz Area to SqCWD	13,000	LF	180	2,340,000	12 in-diameter
	Pipeline Constructability (Along Roads)	0		10%	595,200	
	Microtunneling (Trenchless)	800	LF	700	560,000	16 in-diameter
2.2	Advanced Treated Water Pipelines					
	from Main pipeline to Injection Well F	3,000	LF	112	336,000	8 in-diameter
	from Main pipeline to Injection Well D	600	LF	112	67,200	8 in-diameter
	from Injection Well D to Injection Well J	2,700	LF	112	302,400	8 in-diameter
	from Main pipeline to Injection Well B and C	3,800	LF	112	425,600	8 in-diameter
	Alt3E_A	2,400	LF	72	172,800	6 in-diameter
	Alt3E_B	1,500	LF	72	108,000	6 in-diameter
	Alt3E_C	1,700	LF	72	122,400	6 in-diameter
	Pipeline Constructability (Along Roads)			10%	153,440	
	Microtunneling (Trenchless)	800	LF	700	560,000	16 in-diameter
2.3	Remove SqCWD's portion of Advanced Treated pipe costs	1.30	MGD	(2,766,677)	(3,610,418)	
3.0	**Pump Stations**				**1,151,872**	*Represents City's portion of Pump Stations (sum of items below)*
						2 pumps at each pump station. 1 duty, 1 standby. Rating per pump:
3.1	Advanced Treated Water Pump Station from SC WWTF to SqCWD	1	LS	1,860,000	1,860,000	2400 total flow (gpm) 450 ft (TDH)
3.2	Remove SqCWD's portion of PS costs	1.30	MGD	(544,714)	(708,128)	
						Conveyance system optimization will need to be performed if alternative is selected
4.0	**Storage**				**0**	N/A
4.1			not incl.		0	
5.0	**Site Retrofit Costs**				**538,200**	N/A
5.1	Customer Sites	39	# of sites	13,800	538,200	
6.0	**Wells Costs**				**3,955,000**	
6.1	Injection Well B and Well C (near Beltz #12)	2	Wells	520,000	1,040,000	16 in-diameter
						650 feet deep
	Injection Well B and C Building	2	Nos	100,000	200,000	Assume 20 feet x 20 feet per injection well building and $250/SF of building cost
6.2	Injection Well D and Well F (near Beltz #10)	2	Wells	252,000	504,000	14 in-diameter
						360 feet deep
	Injection Well D and F Building	2	Nos	100,000	200,000	Assume 20 feet x 20 feet per injection well building and $250/SF of building cost
6.3	Injection Well J as back-up well (Near Beltz #8 and #9)	1	Wells	161,000	161,000	14 in-diameter
						230 feet deep
	Injection Well J Building	1	Nos	100,000	100,000	Assume 20 feet x 20 feet per injection well building and $250/SF of building cost
						Assume Injection Well J and back-up well share same building
6.4	Production Wells			not incl.		Assumes City's existing and planned production wells would be sufficient
6.5	Monitoring Wells	5	Wells	100,000	500,000	Assumes one monitoring well per injection well, excluding back-up well
6.6	Land Acquisition	50,000	SF	25	1,250,000	Assume 100 feet x 100 feet per well
	Subtotal Facility Costs				**$32,038,399**	
Additional Facility Capital Costs						
6.0	Site Development Costs	@	5%		1,170,779	% of Subtotal treatment, pump station, storage, discharge facility and well costs
						(Includes grading, erosion control, cut/fill, etc.)
7.0	Yard Piping	@	5%		1,170,779	% of Subtotal treatment, pump station, storage, discharge facility and well costs
8.0	Electrical, I&C, and Remote (low-tech) Control	@	20%		4,683,115	% of Subtotal treatment, pump station, storage, discharge facility and well costs
	Subtotal Additional Facility Costs				**$7,024,673**	
	Facility Direct Costs				**$39,063,072**	
	Taxes	@	8.75%		1,121,344	apply taxes to 40% of the Subtotal Facility Costs
	Mobilization/Bonds/Permits	@	5%		1,953,154	% of Facility Direct Costs
	Contractor Overhead & Profit	@	15%		5,859,461	% of Facility Direct Costs
	Estimate Contingency	@	30%		11,718,922	% of Facility Direct Costs
Subtotal with Contractor Markups and Contingency					**$59,715,952**	
	Escalation to Midpoint of Construction	@	15%		8,957,393	assume 2% percent over 8
						construction start = 2022 end = 2025
	Project Capital Cost Total				**$68,673,344**	For Santa Cruz facilities, not including baseline costs attributed to SqCWD
	Annualized Capital Cost ($mil/year)				**$3.7**	

APPENDIX F.3

Engineers Opinion of Probable Cost KENNEDY/JENKS CONSULTANTS

Alt 3E Send advanced treated RW from an AWTF at/near SCWWTF to SqCWD (GRR in Beltz Wellfield + NPR along the way)

Study:	Santa Cruz Recycled Water Facilities Planning Study	**Prepared By:**	MT, DTT	**Average Annual RW Delivered**	3.41	mgd
Project:	Alt 3E Send advanced treated RW from an AWTF at/near SCWWTF to SqCWD (GRR in Beltz Well	**Date Prepared:**	Jun-2017	**(Advanced Treated)**	3824	Average Annual Reuse (AFY)
RW Supply:	AWT	**K/J Proj. No.**	1668007.00	**RW to Santa Cruz Only:**	2.11	mgd
Estimate:	Conceptual Level Cost-Analysis	**ENR**			2,368	Average Annual Reuse (AFY)

Annual Operations and Maintenance Costs

Item No.	Description	Qty	Units	Total Annual Costs $/Unit	Total Annual Costs Total	
1.0	**Energy Costs**					
						Treatment Ops 24 hours per day
1.1	Energy - Treatment	2,200,000	KWh	0.20	440,000	8760 hours operated per year
	(Excludes SqCWD portion of treatment)					2908 KWH/MG
						Pump Ops 24 hours per day
1.2	Energy - Pumping (conveyance)	1,100,000	KWh	0.20	220,000	8760 hours operated per year
	(Excludes SqCWD portion of pumping)					Pump Station Hp = 260 Total Motor HP required for duty pumps
1.3	Energy - Pumping (Injection Wells)	1,400,000	KWh	0.20	280,000	Well Pumps Hp = 220 Total Motor HP required for 5 wells
	(Only includes City injection wells)					
1.4	Energy - Other	125,000	KWh	0.20	25,000	5% of sum of pumping energy requirements
2.0	**Labor Costs**					
2.1	Labor - AWPF	4.0	staff	175,000	700,000	full time staff at $175,000 average salary + benefits per year
2.2	Other Labor (pipeline, PS, etc.)	2.0	staff	125,000	250,000	full time staff at $125,000 average salary + benefits per year
3.0	**Maintenance:** Other					
	Other	@	0.5%		68,648	% of facility cost (excluding treatment)
	Treatment Equipment (Maintenance/Replacement/Repair)	2,368	AF	180	426,311	For treatment only
4.0	**Chemicals**	2,368	AF	100	236,839	
4.0	**Well Costs:** water quality and water level monitoring	5	Well	20,000	100,000	
5.0	**Contingency**	@	10.0%		274,680	% of above O&M costs
	Annual O&M Costs ($/year)				**$3,021,479**	
	Annual Unit O&M Costs ($/AF)				**$1,276**	

Engineers Opinion of Probable Cost **KENNEDY/JENKS CONSULTANTS**

Alt 4A Santa Cruz GRR in Beltz Wellfield area with AWTF at/near SCWWTF (Serve NPR users along the way)

Study:	Santa Cruz Recycled Water Facilities Planning Study	**Prepared By:**	MT, DTT	**Average Annual RW Delivered**	2.13	mgd
Project:	Alt 4A Santa Cruz GRR in Beltz Wellfield area with AWTF at/near SCWWTF (Serve NPR users along the w	**Date Prepared:**	Jun-2017	**(Advanced Treated)**	2389	Average Annual Reuse (AFY)
RW Supply:	AWT	**K/J Proj. No.**	1668007.00	**RW to Santa Cruz Only:**	2.13	mgd
Estimate:	Conceptual Level Cost-Analysis	**ENR**			2,389	Average Annual Reuse (AFY)

Item No.	Description	Qty	Units	Total Costs $/Unit	Capital Cost	Notes/Source
Facility Capital Costs						
1.0	**Treatment**				**19,698,970**	
1.1	Microfiltration	2.6	MGD	2,200,000	5,704,210	Unit cost based on product flow 90% MF Recovery Rate
1.2	Reverse Osmosis	2.2	MGD	3,400,000	7,493,257	Unit cost based on product flow 85% RO Recovery Rate
1.3	Free Chlorine	2.2	MGD	200,000	440,780	
1.4	UV/AOP	2.2	MGD	600,000	1,322,340	
1.5	Post Treatment and Chemical Handling	2.2	MGD	900,000	1,983,509	Square foot estimated based on treatment plant design capacity.
1.6	Building	2.2	MGD	1,250,000	2,754,874	5,000 SF/mgd
						250 $/SF
2.0	**Pipelines**				**7,738,160**	
2.1	Advanced Treated Water Pipeline from AWTF at or near SC WWTF to Beltz area	26,000	LF	180	4,680,000	12 in-diameter
	from Main pipeline to Injection Well F	1,100	LF	72	79,200	6 in-diameter
	from Main pipeline to Injection Well D	600	LF	72	43,200	6 in-diameter
	from Injection Well D to Injection Well J	2,700	LF	150	405,000	10 in-diameter
	from Main pipeline to Injection Well B and C	6,100	LF	150	915,000	10 in-diameter
	Alt4A_A	2,400	LF	72	172,800	6 in-diameter
	Alt4A_B	1,500	LF	72	108,000	6 in-diameter
	Alt4A_C	1,700	LF	72	122,400	6 in-diameter
	Pipeline Constructability (Along Roads)			0	652,560	
	Microtunneling (Trenchless)	800	LF	700	560,000	10 in-diameter
3.0	**Pump Stations**				**850,000**	Represents City's portion of Pump Stations (items below are assoicated with SqCWD)
						2 pumps. 1 duty, 1 standby. Rating per pump:
3.1	Advanced Treated Water Pump Station from SC WWTF to SqCWD	1	LS	850,000	850,000	1,460 total flow (gpm) 310 ft (TDH)
4.0	**Storage**				**0**	
4.1			not incl.		0	
5.0	**Site Retrofit Costs**				**483,000**	
5.1	Customer Sites	35	# of sites	13,800	483,000	Unit cost estimated using a retrofit cost curve based on demand at each site
6.0	**Injection Wells Costs**				**3,955,000**	
6.1	Injection Well B and Well C (near Beltz #12)	2	Wells	520,000	1,040,000	16 in-diameter
						650 feet deep
	Injection Well B and C Building	2	Nos	100,000	200,000	Assume 20 feet x 20 feet per injection well building and $250/SF of building cost
6.2	Injection Well D and Well F (near Beltz #10)	2	Wells	252,000	504,000	14 in-diameter
						360 feet deep
	Injection Well D and F Building	2	Nos	100,000	200,000	Assume 20 feet x 20 feet per injection well building and $250/SF of building cost
6.3	Injection Well J as back-up well (Near Beltz #8 and #9)	1	Wells	161,000	161,000	14 in-diameter
						230 feet deep
	Injection Well J Building	1	Nos	100,000	100,000	Assume 20 feet x 20 feet per injection well building and $250/SF of building cost
						Assume Injection Well J and back-up well share same building
6.4	Production Wells		not incl.			Assumes City's existing and planned production wells would be sufficient
6.5	Monitoring Wells	5	Wells	100,000	500,000	Assumes one monitoring well per injection well, excluding back-up well
6.6	Land Acquisition	50,000	SF	25	1,250,000	Assume 100 feet x 100 feet per well
	Subtotal Facility Costs				**$32,725,130**	
Additional Facility Capital Costs						
6.0	Site Development Costs	@	5%		1,225,198	% of Subtotal treatment, pump station, storage, discharge facility and well costs
						(Includes grading, erosion control, cut/fill, etc.)
7.0	Yard Piping	@	5%		1,225,198	% of Subtotal treatment, pump station, storage, discharge facility and well costs
8.0	Electrical, I&C, and Remote (low-tech) Control	@	20%		4,900,794	% of Subtotal treatment, pump station, storage, discharge facility and well costs
	Subtotal Additional Facility Costs				**$7,351,191**	
	Facility Direct Costs				**$40,076,320**	
	Taxes	@	8.75%		1,145,380	apply taxes to 40% of the Subtotal Facility Costs
	Mobilization/Bonds/Permits	@	5%		2,003,816	% of Facility Direct Costs
	Contractor Overhead & Profit	@	15%		6,011,448	% of Facility Direct Costs
	Estimate Contingency	@	30%		12,022,896	% of Facility Direct Costs
Subtotal with Contractor Markups and Contingency					**$61,259,860**	
	Escalation to Midpoint of Construction	@	15%		9,188,979	assume 2% percent over 8
						construction start = 2022 end = 2025
	Project Capital Cost Total				**$70,448,839**	
	Annualized Capital Cost ($mil/year)				**$3.8**	

Engineers Opinion of Probable Cost KENNEDY/JENKS CONSULTANTS

Alt 4A Santa Cruz GRR in Beltz Wellfield area with AWTF at/near SCWWTF (Serve NPR users along the way)

Study:	Santa Cruz Recycled Water Facilities Planning Study	**Prepared By:**	MT, DTT	**Average Annual RW Delivered**	2.13	mgd
Project:	Alt 4A Santa Cruz GRR in Beltz Wellfield area with AWTF at/near SCWWTF (Serve NPR users along the w	**Date Prepared:**	Jun-2017	**(Advanced Treated)**	2389	Average Annual Reuse (AFY)
RW Supply:	AWT	**K/J Proj. No.**	1668007.00	**RW to Santa Cruz Only:**	2.13	mgd
Estimate:	Conceptual Level Cost-Analysis	**ENR**			2,389	Average Annual Reuse (AFY)

Annual Operations and Maintenance Costs

Item No.	Description	Qty	Units	Total Annual Costs $/Unit	Total			
1.0	**Energy Costs**							
1.1	Energy - Treatment	2,400,000	KWh	0.20	480,000	Treatment Operation =	24	hours per day
							8760	hours operated per year
							3138	KWH/MG
						Pump Operation =	24	hours per day
1.2	Energy - Pumping (conveyance)	1,700,000	KWh	0.20	340,000		8760	hours operated per year
						Pump Station Hp =	260	Total Motor HP required for duty pumps
1.3	Energy - Pumping (Injection Wells)	1,400,000	KWh	0.20	280,000	Well Pumps Hp =	220	Total Motor HP required for 5 wells
	(Only includes City injection wells)							
1.4	Energy - Other	160,000	KWh	0.20	32,000	5%		of sum of pumping energy requirements
2.0	**Labor Costs**							
2.1	Labor - AWPF	4.0	staff	175,000	700,000	full time staff at	$175,000	average salary + benefits per year
2.2	Other Labor (pipeline, PS, etc.)	2.0	staff	125,000	250,000	full time staff at	$125,000	average salary + benefits per year
3.0	**Maintenance**							
	Other	@	1.0%		130,262	% of facility cost (excluding treatment)		
	Treatment Equipment (Maintenance/Replacement/Repair)	2,389	AF	190	453,889	For treatment only		
4.0	**Chemicals**	2,389	AF	100	238,889			
4.0	**Contingency**	@	10.0%		290,504	% of above O&M costs		
	Annual O&M Costs ($/year)				**$3,195,543**			
	Annual Unit O&M Costs ($/AF)				**$1,338**			

Engineers Opinion of Probable Cost

KENNEDY/JENKS CONSULTANTS

Alt 4B Santa Cruz GRR in Beltz Wellfield area with MBR + AWTF at DA Porath PS (Serve NPR users along the way)

Study:	Santa Cruz Recycled Water Facilities Planning Study	**Prepared By:**	MT, DTT	**Average Annual RW Delivered**	2.00	mgd
Project:	Alt 4B Santa Cruz GRR in Beltz Wellfield area with MBR + AWTF at DA Porath PS (S	**Date Prepared:**	Jun-2017	**(Advanced Treated)**	2240	Average Annual Reuse (AFY)
RW Supply:	AWT	**K/J Proj. No.**	1668007.00	**RW to Santa Cruz Only:**	2.00	mgd
Estimate:	Conceptual Level Cost-Analysis	**ENR**			2,240	Average Annual Reuse (AFY)

Item No.	Description	Qty	Units	Total Costs $/Unit	Total Costs Capital Cost	Notes/Source
Facility Capital Costs						
1.0	**Treatment**				**36,863,601**	
1.1	MBR Treatment	2.4	MGD	10,600,000	24,956,358	Based on recent Anaegia quote for MBR adjusted for economies of scale
1.2	Reverse Osmosis	2.0	MGD	3,000,000	6,003,652	Unit cost based on product flow 85% RO Recovery Rate
1.3	Free Chlorine	2.0	MGD	600,000	1,200,730	
1.4	UV/AOP	2.0	MGD	200,000	400,243	
1.5	Post Treatment and Chemical Handling	2.0	MGD	900,000	1,801,096	
1.6	Building	2.0	MGD	1,250,000	2,501,522	Square foot estimated based on treatment plant design capacity.
						5,000 SF/mgd
						250 $/SF
2.0	**Pipelines**				**2,143,120**	
2.1	Advanced Treated Water Pipeline from MBR and AWTF @ DA Porath:					
	DA Porath to Injection Well J	3,100	LF	112.00	347,200	8 in-diameter
	Injection Well J to D	2,500	LF	72.00	180,000	6 in-diameter
	Injection Well D to F	1,000	LF	72.00	72,000	6 in-diameter
	Injection Well F to Injection Wells B and C	7,500	LF	112.00	840,000	8 in-diameter
	Pipeline Constructability (Along Roads)			10%	143,920	
	Microtunneling (Trenchless)	800	LF	700.00	560,000	8 in-diameter
3.0	**Pump Stations**				**700,000**	2 pumps. 1 duty, 1 standby. Rating per pump:
3.1	From DA Porath to Injection Wells	1	LS	700,000	700,000	1,390 total flow (gpm) 180 ft (TDH)
4.0	**Storage**				**0**	
4.1			not incl.		0	
5.0	**Site Retrofit Costs**				**27,600**	
5.1	Customer Sites	2	# of sites	13,800	27,600	Unit cost estimated using a retrofit cost curve based on demand at each site
6.0	**Injection Wells Costs**				**3,955,000**	
6.1	Injection Well B and Well C (near Beltz #12)	2	Wells	520,000	1,040,000	16 in-diameter
						650 feet deep
	Injection Well B and C Building	2	Nos	100,000	200,000	Assume 20 feet x 20 feet per injection well building and $250/SF of building cost
6.2	Injection Well D and Well F (near Beltz #10)	2	Wells	252,000	504,000	14 in-diameter
						360 feet deep
	Injection Well D and F Building	2	Nos	100,000	200,000	Assume 20 feet x 20 feet per injection well building and $250/SF of building cost
6.3	Injection Well J as back-up well (Near Beltz #8 and #9)	1	Wells	161,000	161,000	14 in-diameter
						230 feet deep
	Injection Well J Building	1	Nos	100,000	100,000	Assume 20 feet x 20 feet per injection well building and $250/SF of building cost
						Assume Injection Well J and back-up well share same building
6.4	Production Wells		not incl.			Assumes City's existing and planned production wells would be sufficient
6.5	Monitoring Wells	5	Wells	100,000	500,000	Assumes one monitoring well per injection well, excluding back-up well
6.6	Land Acquisition	50,000	SF	25	1,250,000	Assume 100 feet x 100 feet per well
	Subtotal Facility Costs				**$43,689,321**	
Additional Facility Capital Costs						
6.0	Site Development Costs	@	5%		2,075,930	% of Subtotal treatment, pump station, storage, discharge facility and well costs
						(Includes grading, erosion control, cut/fill, etc.)
7.0	Yard Piping	@	5%		2,075,930	% of Subtotal treatment, pump station, storage, discharge facility and well costs
8.0	Electrical, I&C, and Remote (low-tech) Control	@	20%		8,303,720	% of Subtotal treatment, pump station, storage, discharge facility and well costs
	Subtotal Additional Facility Costs				**$12,455,580**	
			Facility Direct Costs		**$56,144,901**	
	Taxes	@	8.75%		1,529,126	apply taxes to 40% of the Subtotal Facility Costs
	Mobilization/Bonds/Permits	@	5%		2,807,245	% of Facility Direct Costs
	Contractor Overhead & Profit	@	15%		8,421,735	% of Facility Direct Costs
	Estimate Contingency	@	30%		16,843,470	% of Facility Direct Costs
Subtotal with Contractor Markups and Contingency					**$85,746,478**	
	Escalation to Midpoint of Construction	@	15%		12,861,972	assume 2% percent over 8
						construction start = 2022 end = 2025
			Project Capital Cost Total		**$98,608,450**	
			Annualized Capital Cost ($mil/year)		**$5.6**	

Engineers Opinion of Probable Cost KENNEDY/JENKS CONSULTANTS

Alt 4B Santa Cruz GRR in Beltz Wellfield area with MBR + AWTF at DA Porath PS (Serve NPR users along the way)

Study:	Santa Cruz Recycled Water Facilities Planning Study	**Prepared By:**	MT, DTT	**Average Annual RW Delivered**	2.00	mgd
Project:	Alt 4B Santa Cruz GRR in Beltz Wellfield area with MBR + AWTF at DA Porath PS (S	**Date Prepared:**	Jun-2017	**(Advanced Treated)**	2240	Average Annual Reuse (AFY)
RW Supply:	AWT	**K/J Proj. No.**	1668007.00	**RW to Santa Cruz Only:**	2.00	mgd
Estimate:	Conceptual Level Cost-Analysis	**ENR**			2,240	Average Annual Reuse (AFY)

Annual Operations and Maintenance Costs

Item No.	Description	Qty	Units	Total Annual Costs $/Unit	Total			
1.0	**Energy Costs**							
1.1	Energy - Treatment	3,600,000	KWh	0.20	720,000	Treatment Operation =	24	hours per day
							8760	hours operated per year
							4898	KWH/MG
						Pump Operation =	24	hours per day
1.2	Energy - Pumping (conveyance)	1,300,000	KWh	0.20	260,000		8760	hours operated per year
						Pump Station Hp =	200	Total Motor HP required for duty pumps
	Energy - Pumping (Injection Wells)	1,400,000	KWh	0.20	280,000	Well Pumps Hp =	220	Total Motor HP required for 5 wells
	(Only includes City injection wells)							
	Energy - Other	135,000	KWh	0.20	27,000	5%		of sum of pumping energy requirements
2.0	**Labor Costs**							
2.1	Labor - AWPF	5.0	staff	175,000	875,000	full time staff at	$175,000	average salary + benefits per year
2.2	Other Labor (pipeline, PS, etc.)	2.0	staff	125,000	250,000	full time staff at	$125,000	average salary + benefits per year
3.0	**Maintenance**							
	Other	@	1.0%		68,257	% of facility cost (excluding treatment)		
	Treatment Equipment (Maintenance/Replacement/Repair)	2,240	AF	200	448,049	For treatment only		
4.0	**Chemicals**	2,240	AF	100	224,024			
4.0	**Contingency**	@	10.0%		315,233	% of above O&M costs		
	Annual O&M Costs ($/year)				**$3,467,563**			
	Annual Unit O&M Costs ($/AF)				**$1,548**			

Engineers Opinion of Probable Cost

KENNEDY/JENKS CONSULTANTS

Alt 5 Advanced treatment of Santa Cruz effluent for augmentation of Loch Lomond Reservoir (no NPR along the way)

Study:	Santa Cruz Recycled Water Facilities Planning Study	**Prepared By:**	MT, DTT	**Average Annual RW Delivered (Advanced**	3.20	mgd
Project:	Alt 5 Advanced treatment of Santa Cruz effluent for augmentation of Loch Lomond F	**Date Prepared:**	Jun-2017	**Treated)**	1777	Average Annual Reuse (AFY)
RW Supply:	AWT	**K/J Proj. No.**	1668007.00	**RW to Santa Cruz Only:**	3.20	mgd
Estimate:	Conceptual Level Cost-Analysis	**ENR**			1,777	Average Annual Reuse (AFY)

Item No.	Description	Qty	Units	Total Costs $/Unit	Capital Cost	Notes/Source
Facility Capital Costs						
1.0	**Treatment**				**26,876,870**	Unit Costs provided by Trussell Technologies (Nov 2016)
1.1	Microfiltration	3.8	MGD	2,000,000	7,524,000	Unit cost based on product flow 90% MF Recovery Rate
1.2	Reverse Osmosis	3.2	MGD	3,100,000	9,912,870	Unit cost based on product flow 85% RO Recovery Rate
1.3	Free Chlorine	3.2	MGD	600,000	1,920,000	
1.4	UV/AOP	3.2	MGD	200,000	640,000	
1.5	Post Treatment and Chemical Handling	3.2	MGD	900,000	2,880,000	Square foot estimated based on treatment plant design capacity.
1.6	Building	3.2	MGD	1,250,000	4,000,000	5,000 SF/mgd
						250 $/SF
2.0	**Pipelines**				**17,668,478**	
2.1	AWTF at or near SC WWTF to Loch Lomond Resevoir	68,000	LF	210	14,280,000	14 in-diameter
	Pipeline Constructability (Along Roads)			10%	1,428,000	
	Microtunneling (Trenchless)	900	LF	700	630,000	14 in-diameter
	Major Intersections	2,400	LF	554	1,330,478	14 in-diameter
3.0	**Pump Stations**				**1,810,000**	2 pumps. 1 duty, 1 standby. Rating per pump:
3.1	From SC WWTF to Loch Lomond	1	LS	1,810,000	1,810,000	2,220 total flow (gpm) 410 ft (TDH)
4.0	**Discharge Facility**				**1,000,000**	
4.1	Multi-Port Diffuser in the Reservoir	1	LS	1,000,000	1,000,000	Assume 5 port diffuser with duckbill valves for increased mixing
	Subtotal Facility Costs				**$47,355,348**	
Additional Facility Capital Costs						
5.0	Site Development Costs	@	5%		1,434,344	% of Subtotal treatment, pump station, storage, discharge facility and well costs
						(Includes grading, erosion control, cut/fill, etc.)
6.0	Yard Piping	@	5%		1,434,344	% of Subtotal treatment, pump station, storage, discharge facility and well costs
7.0	Electrical, I&C, and Remote Control	@	20%		5,937,374	% of Subtotal treatment, pump station, storage, discharge facility and well costs
	Subtotal Additional Facility Costs				**$8,806,061**	
	Facility Direct Costs				**$56,161,409**	
	Taxes	@	8.75%		1,657,437	apply taxes to 40% of the Subtotal Facility Costs
	Mobilization/Bonds/Permits	@	5%		2,808,070	% of Facility Direct Costs
	Contractor Overhead & Profit	@	15%		8,424,211	% of Facility Direct Costs
	Estimate Contingency	@	30%		16,848,423	% of Facility Direct Costs
Subtotal with Contractor Markups and Contingency					**$85,899,551**	
	Escalation to Midpoint of Construction	@	24%		20,615,892	assume 2% percent over 12
						construction start = 2026 end = 2030
	Project Capital Cost Total				**$106,515,443**	
	Annualized Capital Cost ($mil/year)				**$5.8**	

Annual Operations and Maintenance Costs

Item No.	Description	Qty	Units	Total Annual Costs $/Unit	Total	
1.0	**Energy Costs**					
1.1	Energy - Treatment	1,800,000	KWh	0.20	360,000	Process Operation = 24 hours per day
						4344 hours operated per year
						3061 KW/MG
1.2	Energy - Pumping to Loch Lomond	4,200,000	KWh	0.20	840,000	Pump Operation = 24 hours per day
						8760 hours operated per year
						Pump Station Hp = 650 Total Motor HP required for duty pumps
1.3	Energy - Other	210,000	KWh	0.20	42,000	5% of sum of pumping energy requirements
2.0	**Labor Costs**					
2.1	Labor - AWPF	6.0	staff	175,000	1,050,000	full time staff at $175,000 average salary + benefits per year
2.2	Other Labor (pipeline, PS, etc.)	3.0	staff	125,000	375,000	full time staff at $125,000 average salary + benefits per year
3.0	**Maintenance**					
	Other	@	1.0%		204,785	% of facility cost (excluding treatment)
	Treatment Equipment (Maintenance/Replacement/Repair)	1,777	AF	190	337,682	For treatment only
4.0	**Chemicals**	1,777	AF	100	177,727	
5.0	**Contingency**	@	10.0%		338,719	% of above O&M costs
	Annual O&M Costs ($/year)				**$3,725,913**	
	Annual Unit O&M Costs ($/AF)				**$2,096**	

Engineers Opinion of Probable Cost KENNEDY/JENKS CONSULTANTS

Alt 6 Advanced treatment of Santa Cruz effluent for discharge to the San Lorenzo River d/s of Tait Street Diversion (no NPR users along the way)

Study:	Santa Cruz Recycled Water Facilities Planning Study	**Prepared By:**	MT, DTT	**Average Annual RW Delivered**	3.20	mgd
Project:	Alt 6 Advanced treatment of Santa Cruz effluent for discharge to the San Lorenzo River d/s	**Date Prepared:**	Jun-2017	**(Advanced Treated)**	1777	Average Annual Reuse (AFY)
RW Supply:	AWT	**K/J Proj. No.**	1668007.00	**RW to Santa Cruz Only:**	3.20	mgd
Estimate:	Conceptual Level Cost-Analysis	**ENR**			1,777	Average Annual Reuse (AFY)

Item No.	Description	Qty	Units	Total Costs $/Unit	Total Costs Capital Cost	Notes/Source
Facility Capital Costs						
1.0	**Treatment**				**26,876,870**	
1.1	Microfiltration	3.76	MGD	2,000,000	7,524,000	
1.2	Reverse Osmosis	3.20	MGD	3,100,000	9,912,870	
1.3	Free Chlorine	3.20	MGD	600,000	1,920,000	
1.4	UV/AOP	3.20	MGD	200,000	640,000	
1.5	Post Treatment and Chemical Handling	3.20	MGD	900,000	2,880,000	Square foot estimated based on treatment plant design capacity.
1.6	Building	3.20	MGD	1,250,000	4,000,000	5,000 SF/mgd
						250 $/SF
2.0	**Pipelines**				**3,284,810**	
2.1	AWTF at or near SC WWTF to Tait Street Diversion	13,500	LF	210	2,835,000	14 in-diameter
	Pipeline Constructability (Along Roads)			10%	283,500	
	Major Intersections	300	LF	554	166,310	14 in-diameter
3.0	**Pump Stations**				**360,000**	2 pumps. 1 duty, 1 standby. Rating per pump:
3.1	From SC WWTF to Discharge Facility	1	LS	360,000	360,000	2,220 total flow (gpm) 50 ft (TDH)
4.0	**Discharge Facility**				**1,000,000**	
4.1	Multi-Port Diffuser in the River	1	LS	1,000,000	1,000,000	Assume 5 port diffuser with duckbill valves for increased mixing
	Subtotal Facility Costs				**$31,521,680**	
Additional Facility Capital Costs						
5.0	Site Development Costs	@	5%		1,361,844	% of Subtotal treatment, pump station, storage, discharge facility and well costs
						(Includes grading, erosion control, cut/fill, etc.)
6.0	Yard Piping	@	5%		1,361,844	% of Subtotal treatment, pump station, storage, discharge facility and well costs
7.0	Electrical, I&C, and Remote (low-tech) Control	@	20%		5,647,374	% of Subtotal treatment, pump station, storage, discharge facility and well costs
	Subtotal Additional Facility Costs				**$8,371,061**	
	Facility Direct Costs				**$39,892,741**	
	Taxes	@	8.75%		1,103,259	apply taxes to 40% of the Subtotal Facility Costs
	Mobilization/Bonds/Permits	@	5%		1,994,637	% of Facility Direct Costs
	Contractor Overhead & Profit	@	15%		5,983,911	% of Facility Direct Costs
	Estimate Contingency	@	30%		11,967,822	% of Facility Direct Costs
Subtotal with Contractor Markups and Contingency					**$60,942,370**	
	Escalation to Midpoint of Construction	@	23%		14,016,745	assume 2% percent over 12
						construction start = 2026 end = 2029
	Project Capital Cost Total				**$74,959,115**	
	Annualized Capital Cost ($mil/year)				**$4.2**	

Item No.	Description	Qty	Units	Total Annual Costs $/Unit	Total Annual Costs Total	
Annual Operations and Maintenance Costs						
1.0	**Energy Costs**					
1.1	Energy - Treatment	1,800,000	KWh	0.20	360,000	Process Operation = 24 hours per day
						4344 hours operated per year
						3061 KW/MG
1.2	Energy - Pumping to Loch Lomond	500,000	KWh	0.20	100,000	Pump Operation = 24 hours per day
						8760 hours operated per year
						Pump Station Hp = 80 Total Motor HP required for duty pumps
1.3	Energy - Other	25,000	KWh	0.20	5,000	5% of sum of pumping energy requirements
2.0	**Labor Costs**					
2.1	Labor - AWPF	6.0	staff	175,000	1,050,000	full time staff at $175,000 average salary + benefits per year
2.2	Other Labor (pipeline, PS, etc.)	3.0	staff	125,000	375,000	full time staff at $125,000 average salary + benefits per year
3.0	**Maintenance**					
	Other	@	1.0%		46,448	% of facility cost (excluding treatment)
	Treatment Equipment (Maintenance/Replacement/Repair)	1,777	AF	190	337,682	For treatment only
4.0	**Chemicals**	1,777	AF	100	177,727	
5.0	**Contingency**	@	10.0%		245,186	% of above O&M costs
	Annual O&M Costs ($/year)				**$2,697,042**	
	Annual Unit O&M Costs ($/AF)				**$1,518**	

Engineers Opinion of Probable Cost KENNEDY/JENKS CONSULTANTS

Alt 7 Raw Water Blending at Graham Hill WTP (via Coast PS or other point of blending)

Study:	Santa Cruz Recycled Water Facilities Planning Study	**Prepared By:**	MT, DTT	**Average Annual RW Delivered (Advanced**	3.20	mgd
Project:	Alt 7 Raw Water Blending at Graham Hill WTP (via Coast PS or other point of blendir	**Date Prepared:**	Jun-2017	**Treated)**	3584	Average Annual Reuse (AFY)
RW Supply:	AWT	**K/J Proj. No.**	1668007.00	**RW to Santa Cruz Only:**	3.20	mgd
Estimate:	Conceptual Level Cost-Analysis	**ENR**			3,584	Average Annual Reuse (AFY)

Item No.	Description	Qty	Units	Total Costs $/Unit	Capital Cost	Notes/Source
Facility Capital Costs						
1.0	**Treatment**				**35,695,870**	
1.1	Ozone Disinfection	4.18	MGD	1,100,000	4,598,000	
1.2	Biologically Active Carbon Filter	4.18	MGD	1,900,000	7,942,000	
1.3	Microfiltration	3.76	MGD	1,500,000	5,643,000	
1.4	Reverse Osmosis	3.20	MGD	3,100,000	9,912,870	
1.5	Free Chlorine	3.20	MGD	400,000	1,280,000	
1.6	UV/AOP	3.20	MGD	200,000	640,000	
1.7	Post Treatment and Chemical Handling	3.20	MGD	400,000	1,280,000	Square foot estimated based on treatment plant design capacity.
1.8	Building	3.20	MGD	1,375,000	4,400,000	5,500 SF/mgd
						250 $/SF
2.0	**Pipelines**				**3,238,610**	
2.1	AWTF at or near SC WWTF to Coast Pump Station	13,300	LF	210	2,793,000	14 in-diameter
	Pipeline Constructability (Along Roads)			10%	279,300	
	Major Intersections	300	LF	554	166,310	14 in-diameter
3.0	**Pump Stations**				**480,000**	2 pumps. 1 duty, 1 standby. Rating per pump:
3.1	From SC WWTF to SqCWD	1	LS	480,000	480,000	2,220 total flow (gpm) 80 ft (TDH)
4.0	**Storage**				**3,200,000**	
4.1	Engineered Storage Buffer	3	LS	1,000,000	3,000,000	Assume 24-hr storage, in 1 MG tanks
4.1	Connection to Coast Pump Station	1	LS	200,000	200,000	Preliminary Estimate for point of connection
	Subtotal Facility Costs				**$42,614,480**	
Additional Facility Capital Costs						
5.0	Site Development Costs	@	5%		1,968,794	% of Subtotal treatment, pump station, storage, discharge facility and well costs
						(Includes grading, erosion control, cut/fill, etc.)
6.0	Yard Piping	@	5%		1,968,794	% of Subtotal treatment, pump station, storage, discharge facility and well costs
7.0	Electrical, I&C, and Remote (low-tech) Control	@	20%		7,875,174	% of Subtotal treatment, pump station, storage, discharge facility and well costs
	Subtotal Additional Facility Costs				**$11,812,761**	
	Facility Direct Costs				**$54,427,241**	
	Taxes	@	8.75%		1,491,507	apply taxes to 40% of the Subtotal Facility Costs
	Mobilization/Bonds/Permits	@	5%		2,721,362	% of Facility Direct Costs
	Contractor Overhead & Profit	@	15%		8,164,086	% of Facility Direct Costs
	Estimate Contingency	@	30%		16,328,172	% of Facility Direct Costs
Subtotal with Contractor Markups and Contingency					**$83,132,368**	
	Escalation to Midpoint of Construction	@	33%		27,433,681	assume 2% percent over 17
						construction start = 2031 end = 2034
	Project Capital Cost Total				**$110,566,049**	
	Annualized Capital Cost ($mil/year)				**$6.2**	

Annual Operations and Maintenance Costs						
Item No.	**Description**	**Qty**	**Units**	**Total Annual Costs $/Unit**	**Total**	
1.0	**Energy Costs**					
1.1	Energy - Treatment	5,700,000	KWh	0.20	1,140,000	Process Operation = 24 hours per day
						8760 hours operated per year
						4863 KW/MG
1.2	Energy - Pumping to Loch Lomond	800,000	KWh	0.20	160,000	Pump Operation = 24 hours per day
						8760 hours operated per year
						Pump Station Hp = 120 Total Motor HP required for duty pumps
1.3	Energy - Other	40,000	KWh	0.20	8,000	5% of sum of pumping energy requirements
2.0	**Labor Costs**					
2.1	Labor - AWPF	8.0	staff	175,000	1,400,000	full time staff at $175,000 average salary + benefits per year
2.2	Other Labor (pipeline, PS, etc.)	2.0	staff	125,000	250,000	full time staff at $125,000 average salary + benefits per year
3.0	**Maintenance**					
	Other	@	1.0%		69,186	% of facility cost (excluding treatment)
	Treatment Equipment (Maintenance/Replacement/Repair)	3,584	AF	180	645,120	For treatment only
4.0	**Chemicals**	3,584	AF	120	430,080	
5.0	**Contingency**	@	10.0%		410,239	% of above O&M costs
	Annual O&M Costs ($/year)				**$4,512,625**	
	Annual Unit O&M Costs ($/AF)				**$1,259**	

Engineers Opinion of Probable Cost

KENNEDY/JENKS CONSULTANTS

Alt 8a Regional GRRP in the Santa Margarita GW Basin to serve the City, Scotts Valley, Soquel Creek and San Lorenzo Valley

Study:	Santa Cruz Recycled Water Facilities Planning Study	**Prepared By:**	MT, DTT		5.00	mgd
Project:	Alt 8a Regional GRRP in the Santa Margarita GW Basin to serve the City, Scotts Valley, So	**Date Prepared:**	Jun-2017	**Average Annual RW Delivered**	5600	Average Annual Reuse (AFY)
RW Supply:	AWT	**K/J Proj. No.**	1668007.00	**RW to Santa Cruz Only:**	3.20	mgd
Estimate:	Conceptual Level Cost-Analysis	**ENR**	11,696		3,584	Average Annual Reuse (AFY)

Item No.	Description	Qty	Units	Total Costs $/Unit	Total Costs Capital Cost	Notes/Source
Facility Capital Costs						
1.0	**Treatment**				**25,232,941**	*Represents City's portion of Treatment (sum of items below)*
1.1	Microfiltration	6.5	MGD	1,900,000	12,294,118	Unit cost based on product flow; 90% MF Recovery Rate
1.2	Reverse Osmosis	5.5	MGD	2,800,000	15,400,000	Unit cost based on product flow; 85% RO Recovery Rate
1.3	Free Chlorine	5.5	MGD	500,000	2,750,000	
1.4	UV/AOP	5.5	MGD	200,000	1,100,000	
1.5	Post Treatment and Chemical Handling	5.5	MGD	900,000	4,950,000	Square foot estimated based on treatment plant design capacity.
1.6	Building	5.5	MGD	1,250,000	6,875,000	5,000 SF/mgd
						250 $/SF
1.7	Remove SqCWD's portion of treatment	1.30	MGD	(7,885,294)	(10,250,882)	Proportional share based on treatment capacity for SqCWD
						PureWater Soquel Cost Estimate = $6.86 to $8.76 million
1.8	Remove SVWD's portion of treatment	1.00	MGD	(7,885,294)	(7,885,294)	Proportional share based on treatment capacity for SVWD
						SVWD RWFPS AWPF Cost Estimate = $6.98 to $7.63 million
2.0	**Pipelines**				**19,851,866**	*Represents City's portion of Pipelines (sum of items below)*
						Items not included: SVWD pipelines to El Pueblo injection site or use of existing purple pipe
2.1	Secondary Effluent Pipeline from SC WWTF to El Pueblo AWTF	46,000	LF	270	12,420,000	18 in-diameter; sqcwd, sc split
	Pipeline Constructability (Along Roads)			10%	1,242,000	
	Microtunneling (Trenchless)	900	LF	700	630,000	18 in-diameter
	Major Intersections	2,400	LF	713	1,710,615	18 in-diameter
2.2	Advanced Treated Water Pipeline from El Pueblo AWTF to Regional GW Injection Wells	10,100	LF	240	2,424,000	16 in-diameter; sqcwd, sc split
	Pipeline Constructability (Along Roads)			10%	242,400	
	Microtunneling (Trenchless)	0	LF	700	0	16 in-diameter
2.3	Extracted GW Pipeline from Regional GW Injection Wells to Existing Newell Creek Pipeline	25,500	LF	240	6,120,000	16 in-diameter; sqcwd, sc split
	Pipeline Constructability (Along Roads)			10%	612,000	
	Microtunneling (Trenchless)	0	LF	700	0	16 in-diameter
	Major Intersections	200	LF	634	126,712	16 in-diameter
2.4	Brine pipeline from El Pueblo AWTF to SVWD outfall pipeline, at Pasatiempo Golfcourse	23,700	LF	112	2,654,400	8 in-diameter; sqcwd, sc, svwd split
	Pipeline Constructability (Along Roads)			10%	265,440	
	Microtunneling (Trenchless)	0	LF	700	0	8 in-diameter
	Major Intersections	0	LF	317	0	8 in-diameter
2.5	Drinking Water pipeline to SqCWD (Segment 1 & 2)	1	LS	12,900,000	12,900,000	Based on Alt 1, Segment 1 and 2 identified in Desalination Plant Hydraulic Modeling and Analysis, AKEL, 2013
2.6	Remove SqCWD's share of Secondary, Advanced Treated and Extracted GW pipe costs	1.30	MGD	(5,672,828)	(7,374,677)	Proportional share based on pipeline capacity for SqCWD
2.7	Remove SqCWD's share of Drinking Water Pipe costs				(12,900,000)	Proportional share based on pipeline capacity for SqCWD (100%)
2.8	Remove SqCWD's share of Brine pipe costs	0.40	MGD	(1,728,184)	(690,144)	Proportional share based on brine capacity reserved for SqCWD
2.9	Remove SVWD's share of Brine pipe costs	0.31	MGD	(1,728,184)	(530,880)	Proportional share based on brine capacity reserved for SVWD
3.0	**Pump Stations**				**6,101,333**	*Represents City's portion of Pump Stations (sum of items below)*
						2 pumps. 1 duty, 1 standby. Rating per pump:
3.1	Secondary effluent pump station from SC WWTF to El Pueblo AWTF	1	LS	5,430,000	5,430,000	4,070 total flow (gpm); 890 ft (TDH)
3.2	Extracted groundwater pump station from Regional Injection Wells to Newell Creek Pipeline	1	LS	2,160,000	2,160,000	3,130 total flow (gpm); 380 ft (TDH)
3.3	Brine pump station from El Pueblo AWTF to SVWD outfall pipeline, at Pasatiempo Golfcourse	1	LS	1,210,000	1,210,000	670 total flow (gpm); 940 ft (TDH)
3.4	Remove SqCWD's share of Pump Station Costs					
	Secondary + Extracted GW	1.30	MGD	(1,686,667)	(2,192,667)	proportional share based on = 1.3 mgd production capacity for SqCWD
	Brine Pipeline	0.40	MGD	(716,170)	(286,000)	proportional share based on = 0.4 mgd brine production for SqCWD
3.5	Remove SVWD's share of Pump Station Costs					
	Brine Pump Station	0.31	MGD	(716,170)	(220,000)	proportional share based on = 0.3 mgd brine production for SqCWD
4.0	**Storage**				**0**	
4.1			not incl.		0	
5.0	**Site Retrofit Costs**				**0**	
5.1	Customer Sites		not incl.		0	
6.0	**Wells Costs**				**9,792,000**	Represents City's portion of Pump Stations (sum of items below)
						Items not included: SVWD wells identified in SVWD RWFPS
6.1	Regional Injection Wells (New and 2 Back-up)	11	Wells	520,000	5,720,000	16 in-diameter
						650 feet deep
6.2	Injection Well Building	11	Nos	100,000	1,100,000	Assume 20 feet x 20 feet per injection well building and $250/SF of building cost
6.3	NEW Production Wells for City	5	Wells	520,000	2,600,000	16 in-diameter
						650 feet deep
6.4	Production Well Building	5	Nos	100,000	500,000	Assume 20 feet x 20 feet per injection well building and $250/SF of building cost
6.5	Monitoring Wells	11	Wells	100,000	1,100,000	
6.6	Land Acquisition	110,000	SF	25	2,750,000	Assume 100 feet x 100 feet per well
6.7	Remove SqCWD's share of Injection Well Costs	1.30	MGD	(3,060,000)	(3,978,000)	proportional share based on = 1.3 mgd production capacity for SqCWD
6.8	Remove SVWD's share of Injection Well Costs				0	
	Subtotal Facility Costs				**$60,978,141**	

Engineers Opinion of Probable Cost KENNEDY/JENKS CONSULTANTS

Alt 8a Regional GRRP in the Santa Margarita GW Basin to serve the City, Scotts Valley, Soquel Creek and San Lorenzo Valley

Study:	Santa Cruz Recycled Water Facilities Planning Study	**Prepared By:**	MT, DTT		5.00	mgd
Project:	Alt 8a Regional GRRP in the Santa Margarita GW Basin to serve the City, Scotts Valley, Soc	**Date Prepared:**	Jun-2017	**Average Annual RW Delivered**	5600	Average Annual Reuse (AFY)
RW Supply:	AWT	**K/J Proj. No.**	1668007.00	**RW to Santa Cruz Only:**	3.20	mgd
Estimate:	Conceptual Level Cost-Analysis	**ENR**	11,696		3,584	Average Annual Reuse (AFY)

Additional Facility Capital Costs					
6.0	Site Development Costs	@	5%	2,056,314	% of Subtotal treatment, pump station, storage, discharge facility and well costs
					(Includes grading, erosion control, cut/fill, etc.)
7.0	Yard Piping	@	5%	2,056,314	% of Subtotal treatment, pump station, storage, discharge facility and well costs
8.0	Electrical, I&C, and Remote (low-tech) Control	@	20%	8,225,255	% of Subtotal treatment, pump station, storage, discharge facility and well costs
	Subtotal Additional Facility Costs			**$12,337,882**	
	Facility Direct Costs			**$73,316,023**	
	Taxes	@	8.75%	2,134,235	apply taxes to 40% of the Subtotal Facility Costs
	Mobilization/Bonds/Permits	@	5%	3,665,801	% of Facility Direct Costs
	Contractor Overhead & Profit	@	15%	10,997,403	% of Facility Direct Costs
	Estimate Contingency	@	30%	21,994,807	% of Facility Direct Costs
Subtotal with Contractor Markups and Contingency				**$112,108,270**	
	Escalation to Midpoint of Construction	@	11%	12,331,910	assume 2% percent over 6
					construction start = 2020 end = 2023
	Project Capital Cost Total			**$124,440,179**	
	Annualized Capital Cost ($mil/year)			**$7**	

Annual Operations and Maintenance Costs						
Item No.	**Description**	**Qty**	**Units**	**Total Annual Costs**		
				$/Unit	**Total**	
1.0	**Energy Costs**					
1.1	Energy - Treatment	3,200,000	KWh	0.20	640,000	Treatment Ops = 24 hours per day
	(Only includes City's proportional share)					8760 hours operated per year
						2755 KWH/MG
						Pump Operation = 24 hours per day
1.2	Energy - Pumping (conveyance)	3,300,000	KWh	0.20	660,000	8760 hours operated per year
	(Only includes City's proportional share)					Pump Station Hp = 800 Total Motor HP required for duty pumps
1.3	Energy - Pumping (Injection Wells)	4,600,000	KWh	0.20	920,000	Well Pumps Hp = 710 Total Motor HP required for 5 wells
	(Only includes City injection wells)					
1.3	Energy - Pumping (Production Wells)	4,400,000	KWh	0.20	880,000	Well Pumps Hp = 680 Total Motor HP required for 5 wells
	(Only includes City production wells)					
1.4	Energy - Other	615,000	KWh	0.20	123,000	5% of sum of pumping energy requirements
2.0	**Labor Costs**					
2.1	Labor - AWPF	7.0	staff	175,000	1,225,000	full time staff at $175,000 average salary + benefits per year
2.2	Other Labor (pipeline, PS, etc.)	2.0	staff	125,000	250,000	full time staff at $125,000 average salary + benefits per year
3.0	**Maintenance**					
	Other	@	1.0%		357,452	% of facility cost (excluding treatment)
	Treatment Equipment (Maintenance/Replacement/Repair)	3,584	AF	170	609,280	For treatment only
4.0	**Contingency**	@	10.0%		566,473	% of above O&M costs
	Annual O&M Costs ($/year)				**$6,231,205**	
	Annual Unit O&M Costs ($/AF)				**$1,739**	

Engineers Opinion of Probable Cost

KENNEDY/JENKS CONSULTANTS

Alt 8b Regional GRRP in the Santa Margarita GW Basin to serve the City, Scotts Valley and San Lorenzo Valley

Study:	Santa Cruz Recycled Water Facilities Planning Study	**Prepared By:**	MT, DTT		3.70	mgd
Project:	Alt 8b Regional GRRP in the Santa Margarita GW Basin to serve the City, Scotts Valley	**Date Prepared:**	Jun-2017	**Average Annual RW Delivered**	4144	Average Annual Reuse (AFY)
RW Supply:	AWT	**K/J Proj. No.**	1668007.00	**RW to Santa Cruz Only:**	3.20	mgd
Estimate:	Conceptual Level Cost-Analysis	**ENR**			3,584	Average Annual Reuse (AFY)

Item No.	Description	Qty	Units	Total Costs $/Unit	Total Costs Capital Cost	Notes/Source
Facility Capital Costs						
1.0	**Treatment**				**25,552,941**	*Represents City's portion of Treatment (sum of items below)*
1.1	Microfiltration	4.9	MGD	1,900,000	9,388,235	Unit cost based on product flow 90% MF Recovery Rate
1.2	Reverse Osmosis	4.2	MGD	2,900,000	12,180,000	Unit cost based on product flow 85% RO Recovery Rate
1.3	Free Chlorine	4.2	MGD	500,000	2,100,000	
1.4	UV/AOP	4.2	MGD	200,000	840,000	
1.5	Post Treatment and Chemical Handling	4.2	MGD	900,000	3,780,000	Square foot estimated based on treatment plant design capacity.
1.6	Building	4.2	MGD	1,250,000	5,250,000	5,000 SF/mgd
						250 $/SF
1.7	Remove SqCWD's portion of treatment	0.00	MGD	(7,985,294)	0	proportional share based on = 0.0 mgd treatment capacity for SqCWD
						SqCWD GWRWFPS AWPF Cost = $6.86 to $8.76 million
1.8	Remove SVWD's portion of treatment	1.00	MGD	(7,985,294)	(7,985,294)	proportional share based on = 1.0 mgd treatment capacity for SVWD
						SVWD RWFPS AWPF Cost = $6.98 to $7.63 million
2.0	**Pipelines**				**24,059,145**	*Represents City's portion of Pipelines (sum of items below)*
						Items not included: SVWD wells and pipelines to El Pueblo injection site identified in SVWD RWFPS
2.1	Secondary Effluent Pipeline from SC WWTF to El Pueblo AWPF	46,000	LF	240	11,040,000	16 in-diameter sqcwd, sc split
	Pipeline Constructability (Along Roads)			10%	1,104,000	
	Microtunneling (Trenchless)	900	LF	700	630,000	16 in-diameter
	Major Intersections	2,400	LF	634	1,520,546	16 in-diameter
2.2	Advanced Treated Water Pipeline from El Pueblo AWTF to Regional GW Injection Wells	10,100	LF	210	2,121,000	14 in-diameter sqcwd, sc split
	Pipeline Constructability (Along Roads)			10%	212,100	
	Microtunneling (Trenchless)	0	LF	700	0	14 in-diameter
2.3	Extracted GW Pipeline from Regional GW Injection Wells to Existing Newell Creek Pipeline	25,500	LF	210	5,355,000	14 in-diameter sqcwd, sc split
	Pipeline Constructability (Along Roads)			10%	535,500	
	Microtunneling (Trenchless)	0	LF	700	0	14 in-diameter
	Major Intersections	200	LF	554	110,873	14 in-diameter
2.4	Brine pipeline from El Pueblo AWTF to SVWD outfall pipeline, at Pasatiempo Golfcourse	23,700	LF	72	1,706,400	6 in-diameter sqcwd, sc, svwd split
	Pipeline Constructability (Along Roads)			10%	170,640	
	Microtunneling (Trenchless)	0	LF	700	0	6 in-diameter
	Major Intersections	0	LF	238	0	6 in-diameter
2.5	Remove SqCWD's share of Secondary, Advanced Treated and	0.00	MGD	(7,071,569)	0	proportional share based on = 0.0 mgd production capacity for SqCWD
2.6	Remove SqCWD's share of Drinking Water Pipe costs				0	Assume no additional drinking water pipeline needed
2.7	Remove SqCWD's share of Brine pipe costs	0.00	MGD	(1,454,849)	0	
2.8	Remove SVWD's share of Brine pipe costs	0.31	MGD	(1,454,849)	(446,914)	proportional share based on = 0.3 mgd brine production for SqCWD
3.0	**Pump Stations**				**8,511,905**	*Represents City's portion of Pump Stations (sum of items below)*
						2 pumps. 1 duty, 1 standby. Rating per pump:
3.1	Secondary effluent pump station from SC WWTF to El Pueblo AWTF	1	LS	5,430,000	5,430,000	2,910 total flow (gpm) 940 ft (TDH)
3.2	Extracted groundwater pump station from Regional Injection Wells to Newell Creek Pipeline	1	LS	2,160,000	2,160,000	2,220 total flow (gpm) 420 ft (TDH)
3.3	Brine pump station from El Pueblo AWTF to SVWD outfall pipeline, at Pasatiempo Golfcourse	1	LS	1,210,000	1,210,000	510 total flow (gpm) 440 ft (TDH)
3.4	Remove SqCWD's share of Pump Station Costs					
	Secondary + Extracted GW		MGD			proportional share based on = 0.0 mgd production capacity for SqCWD
	Brine Pipeline		MGD			
3.5	Remove SVWD's share of Pump Station Costs	0.31	MGD	(937,842)	(288,095)	proportional share based on = 1.0 mgd treatment capacity for SVWD
	Brine Pipeline					
4.0	**Storage**				**0**	
4.1			not incl.		0	
5.0	**Site Retrofit Costs**				**0**	
5.1	Customer Sites		not incl.		0	
6.0	**Wells Costs**				**11,210,000**	Represents City's portion of Pump Stations (sum of items below)
6.1	Regional Injection Wells (New and 2 Back-up)	9	Wells	520,000	4,680,000	16 in-diameter
						650 feet deep
6.2	Injection Well Building	9	Nos	100,000	900,000	Assume 20 feet x 20 feet per injection well building and $250/SF of building cost
6.3	NEW Production Wells for City	4	Wells	520,000	2,080,000	16 in-diameter
						650 feet deep
6.4	Production Well Building	4	Nos	100,000	400,000	Assume 20 feet x 20 feet per injection well building and $250/SF of building cost
6.5	Monitoring Wells	9	Wells	100,000	900,000	
6.6	Land Acquisition	90,000	SF	25	2,250,000	Assume 100 feet x 100 feet per well
6.7	Remove SqCWD's share of Injection Well Costs	0.00	MGD	(3,503,125)	0	proportional share based on = 0.0 mgd production capacity for SqCWD
6.8	Remove SVWD's share of Injection Well Costs				0	
	Subtotal Facility Costs				**$69,333,991**	
Additional Facility Capital Costs						
6.0	Site Development Costs	@	5%		2,263,742	% of Subtotal treatment, pump station, storage, discharge facility and well costs
						(Includes grading, erosion control, cut/fill, etc.)
7.0	Yard Piping	@	5%		2,263,742	% of Subtotal treatment, pump station, storage, discharge facility and well costs
8.0	Electrical, I&C, and Remote (low-tech) Control	@	20%		9,054,969	% of Subtotal treatment, pump station, storage, discharge facility and well costs
	Subtotal Additional Facility Costs				**$13,582,454**	
			Facility Direct Costs		**$82,916,445**	

Engineers Opinion of Probable Cost

KENNEDY/JENKS CONSULTANTS

Alt 8b Regional GRRP in the Santa Margarita GW Basin to serve the City, Scotts Valley and San Lorenzo Valley

Study:	Santa Cruz Recycled Water Facilities Planning Study	**Prepared By:**	MT, DTT		3.70	mgd
Project:	Alt 8b Regional GRRP in the Santa Margarita GW Basin to serve the City, Scotts Valley	**Date Prepared:**	Jun-2017	**Average Annual RW Delivered**	4144	Average Annual Reuse (AFY)
RW Supply:	AWT	**K/J Proj. No.**	1668007.00	**RW to Santa Cruz Only:**	3.20	mgd
Estimate:	Conceptual Level Cost-Analysis	**ENR**			3,584	Average Annual Reuse (AFY)

	Taxes	@	8.75%	2,426,690	apply taxes to 40% of the Subtotal Facility Costs
	Mobilization/Bonds/Permits	@	5%	4,145,822	% of Facility Direct Costs
	Contractor Overhead & Profit	@	15%	12,437,467	% of Facility Direct Costs
	Estimate Contingency	@	30%	24,874,933	% of Facility Direct Costs
Subtotal with Contractor Markups and Contingency				**$126,801,357**	
	Escalation to Midpoint of Construction	@	11%	13,948,149	assume 2% percent over 6
					construction start = 2020 end = 2023
	Project Capital Cost Total			**$140,749,506**	
	Annualized Capital Cost ($mil/year)			**$7.4**	

Annual Operations and Maintenance Costs								
Item No.	**Description**	**Qty**	**Units**	**Total Annual Costs $/Unit**	**Total**			
1.0	**Energy Costs**					Pump Operation =	8	hours per day
							2920	hours operated per year
1.1	Energy - Treatment	3,300,000	KWh	0.20	660,000	Treatment Operation =	24	hours per day
	(Only includes City's proportional share)						8760	hours operated per year
							2832	KWH/MG
	Remove SqCWD's share Treatment O&M Costs					proportional share based on =		0.0 mgd treatment capacity for SqCWD
	Remove SVWD's share Treatment O&M Costs					proportional share based on =		0.5 mgd treatment capacity for SVWD
						Pump Operation =	24	hours per day
1.2	Energy - Pumping (conveyance)	470,000	KWh	0.20	94,000		8760	hours operated per year
	(Only includes City's proportional share)					Pump Station Hp =	250	Total Motor HP required for duty pumps
1.3	Energy - Pumping (Injection Wells)	4,600,000	KWh	0.20	920,000	Well Pumps Hp =	710	Total Motor HP required for 5 wells
	(Only includes City injection wells)							
1.3	Energy - Pumping (Production Wells)	4,400,000	KWh	0.20	880,000	Well Pumps Hp =	680	Total Motor HP required for 5 wells
	(Only includes City injection wells)							
1.4	Energy - Other	470,000	KWh	0.20	94,000	5%		of sum of pumping energy requirements
	Energy - Other	24,000	KWh	0.20	4,800	5%		of sum of pumping energy requirements
2.0	**Labor Costs**							
2.1	Labor - AWPF	7.0	staff	175,000	1,225,000	full time staff at	$175,000	average salary + benefits per year
2.2	Other Labor (pipeline, PS, etc.)	2.0	staff	125,000	250,000	full time staff at	$125,000	average salary + benefits per year
3.0	**Maintenance**							
	Other	@	1.0%		437,811	% of facility cost (excluding treatment)		
	Treatment Equipment (Maintenance/Replacement/Repair)	3,584	AF	172	616,627	For treatment only		
4.0	**Contingency**	@	10.0%		518,224	% of above O&M costs		
	Annual O&M Costs ($/year)				**$5,700,461**			
	Annual Unit O&M Costs ($/AF)				**$1,591**			

F.4 Regional Cost Sharing Approaches

This section presents possible cost sharing approaches that could be explored between regional partners for Alternatives 3B, 3C, 3D, 3E, 8A and 8B. Three cost-sharing approaches were analyzed:

(1) Proportional Cost Sharing based on Facility Capacity

- This approach assumes that regional partners would split the cost of new facilities based on the recycled water produced for or conveyed to each service area.
- The cost of new facilities that would be used by the City, SqCWD and/or SVWD was pro-rated based on the volume of water required by each stakeholder.
- For example, for Alternative 3B, the cost of the tertiary effluent pipeline was split between SqCWD and SCWD based on the proportional amount of tertiary effluent conveyed to SqCWD (1.7 mgd tertiary RW/ 2.19 mgd pipeline capacity = 78%) and the City (0.49 mgd tertiary RW / 2.19 mgd pipeline capacity = 22%), respectively.
- The cost of new facilities that would only be used by SqCWD (e.g. for Alternative 3B this would include the brine pipeline and brine pump station) was assigned 100% to SqCWD.
- This is the basis for the cost tables presented in the Appendix F3, which show the total capital costs and annualized unit costs attributed to the City only.

(2) Cost of Upsizing

- This approach assumes that SqCWD would pay for the baseline cost of Alternative 3A and SVWD would pay for the baseline cost for their recommended project as estimated in the SVWD's 2017 Groundwater Replenishment Facilities Planning Report.
- The City would pay for the incremental cost to increase the size of facilities needed for a regional project.

(3) Cost of Whole Project– Shows Costs to all Stakeholders

- This approach assumes that the total capital cost is distributed over the total project demand and that there would be no cost sharing ratio applied between stakeholders.
- The annualized unit cost for water would be paid equally by all project partners.

Table F.1 shows a summary of the demands, estimated construction costs and annualized unit construction cost for all three approaches, the City, SqCWD and SVWD as appropriate for each project. Should one of the regional project move forward, it is recommended that a framework for regional cooperation is developed to establish key principles for the planning, permitting, design, construction, and on-going operations and maintenance of recycled water facilities and services. The framework should be based on an understanding that the successful implementation of regional recycled water facilities and services will require the cooperative and coordinated efforts between all project partners. The cost-sharing options presented herein are only initial concepts, which should be further vetted as part of the framework process.

Table F-9: Summary of Potential Cost-Sharing Options

Cost Sharing Approach	Alt 3A	Alt 3B	Alt 3C	Alt 3D	Alt 3E	Alt 8a	Alt 8b
Reuse by Regional Partner (AFY)							
Santa Cruz	0	550	2,248	88	2,368	3,584	3,584
SqCWD	1,903	1,903	1,456	1,456	1,456	1,456	-
SVWD	-	-	-	-	-	560	560
Total Project Reuse	**1,903**	**2,454**	**3,704**	**1,544**	**3,824**	**5,600**	**4,144**
(1) Proportional Cost Sharing based on Facility Capacity							
Estimated Construction Cost ($ mil)							
Santa Cruz	$0	$20	$69	$7	$69	$124	$141
SqCWD	$49	$52	$48	$47	$33	$74	-
SVWD	-	-	-	-	-	$17	$17
Total Project Cost	**$49**	**$72**	**$117**	**$54**	**$101**	**$216**	**$160**
Annualized Buildout Unit Construction Cost ($/AFY)							
Santa Cruz	n/a	$2,000	$1,600	$4,100	$1,600	$1,800	$2,100
SqCWD	$1,390	$1,430	$1,720	$1,620	$1,170	$2,550	$0
SVWD	-	-	-	-	-	$1,550	$250
(2) Cost of Upsizing							
Estimated Construction Cost ($ mil)							
Santa Cruz	-	$22	$68	$4	$52	$144	$138
SqCWD	$49	$49	$49	$49	$49	$49	-
SVWD	-	-	-	-	-	$22	$22
Total Project Cost	**$49**	**$72**	**$117**	**$54**	**$101**	**$216**	**$160**
Annualized Buildout Unit Construction Cost ($/AFY)							
Santa Cruz	n/a	$2,150	$1,570	$2,530	$1,090	$2,280	$1,950
SqCWD	$1,390	$1,390	$1,810	$1,810	$1,810	$1,810	-
SVWD	-	-	-	-	-	$2,280	$2,280
(3) Cost of Whole Project for All Regional Partners							
Total Project Cost ($mil)	$49	$72	$117	$54	$101	$216	$160
Total Project Reuse (AFY)	1,903	2,454	3,704	1,544	3,824	5,600	4,144
Annualized Buildout Unit Construction Cost ($/AFY)							
Costs to all Project Partners ($/AFY)	$1,400	$1,600	$1,700	$1,900	$1,400	$2,000	$2,000

F.5 Recommended Projects - Engineers Opinion of Probable Costs

This section includes detailed cost sheets for the recommended projects:

- **SCPWD Title 22 Upgrade Project**
- **BayCycle Project**

Engineers Opinion of Probable Cost
Recommended Project: Phase 1 PWD Title 22 Project

KENNEDY/JENKS CONSULTANTS

Study:	Santa Cruz Recycled Water Facilities Planning Study	**Prepared By:**	MT, DTT	**Average Annual RW Delivered**	0.13 mgd
Project:	Recommended Project: Phase 1 PWD Title 22 Project	**Date Prepared:**	Jun-2017		148 Average Annual Reuse (AFY)
RW Supply:	3°	**K/J Proj. No.**	1668007.00	**RW Use Off-WWTP:**	0.01 mgd
Estimate:	Conceptual Level Cost-Analysis	**ENR**		(Parks + Bulk Water Station)	7.2 Average Annual Reuse (AFY)

Item No.	Description	Qty	Units	Total Costs $/Unit	Total Capital Cost	Notes/Source
Facility Capital Costs						
1.0	**Treatment**				**278,850**	Existing tertiary filters will be used to produce recycled water - no additional filtration capacity required
1.1	Pasteurization Unit	1	LS	48,000	48,000	0.5 mgd capacity purchased from Ventura Demo Project - sufficient for Phase 1
1.2	Concete Pad	33	CY	500	16,500	Assume 30' x 10' x 3' = 35 CY 500 $/CY
1.3	Connect Pasteurization Unit to Existing System	@	30%		19,350	Placeholder for other modifications for setup
1.4	Chemical Dosing System	1	LS	95,000	95,000	From Title 22 Upgrade Nov 2015 Cost Estimate (Trussell)
1.5	Filter Rehaibilitation	1	LS	100,000	100,000	Update pumps, valves or media replacement as-needed
2.0	**Pipelines**				**228,492**	
2.1	Pipeline from Pasteurization Unit to Existing 2Water Tank	1,000	LF	72	72,000	6 in-diameter Assume same alignment as existing 4"-dia 2W pipe
2.2	Pipeline from Pasteurization Unit to Parks and Bulk Water Station	1,885	LF	72	135,720	6 in-diameter Assume trench along Alt 3 alignment
2.3	Pipeline Constructability (Along Roads)			10%	20,772	
3.0	**Pump Stations**				**50,000**	1 duty, 0 standby
3.1	Pump Station at SC WWTF	1	LS	50,000	50,000	Small pump station to pump to La Barranca Park and Bulk Water Station (with pressure)
4.0	**Storage**				**25,000**	
4.1	Conversion of 25,000 gal CCT	1	LS	25,000	25,000	Conversion of 25,000 gal CCT
						Assume no cost to use 75,000 gal existing 2W storage and
5.0	**Site Retrofit Costs**				**60,000**	
5.1	La Barranca and Neary Parks	2	# of sites	20,000	10,000	Unit cost estimated using a retrofit cost curve based on demand at each site
5.1	New Bulk Water Station	1	LS	50,000	50,000	Based on recent experience for truck fill station
	Subtotal Facility Costs				**$642,342**	
Additional Facility Capital Costs						Input from PWD to increase percentages for Phase 1 only
						(to account for upgrades of existing faciliteis not called out in items above)
6.0	Site Development Costs	@	15%		53,078	% of Subtotal treatment, pump station, storage, discharge facility and well costs
						(Includes grading, erosion control, cut/fill, etc.)
7.0	Yard Piping	@	10%		35,385	% of Subtotal treatment, pump station, storage, discharge facility and well costs
8.0	Electrical, I&C, and Remote (low-tech) Control	@	10%		35,385	% of Subtotal treatment, pump station, storage, discharge facility and well costs
	Subtotal Additional Facility Costs				**$123,848**	
	Facility Direct Costs				**$766,190**	
	Taxes	@	8.75%		22,482	apply taxes to 40% of the Capital Costs for facilities
	Mobilization/Bonds/Permits	@	5%		38,309	% of Facility Direct Costs
	Contractor Overhead & Profit	@	15%		114,928	% of Facility Direct Costs
	Estimate Contingency	@	30%		229,857	% of Facility Direct Costs
Subtotal with Contractor Markups and Contingency					**$1,171,766**	
	Escalation to Midpoint of Construction	@	7%		82,024	assume 2% percent over 4
						construction start = 2019 end = 2020
	Project Capital Cost Total				**$1,253,790**	
	Annualized Capital Cost ($/year)				**$67,000**	based on facility life and 4% interest
	Annualized Unit Capital Cost ($/AFY)				**$450**	

Item No.	Description	Qty	Units	Total Annual Costs $/Unit	Total	
Annual Operations and Maintenance Costs						
1.0	**Energy Costs**					
1.1	Energy - Treatment (Filtration - electrical)	15,000	KWh	0.20	3,000	Treatment Operation = 24 hours per day
						8760 hours operated per year
						309 KWH/MG (Filtration)
	Energy - Treatment (Pasteurization - natural gas)	365	day	16	5,840	Cost of natural gas for the pasteurization unit to deliver 0.25 mgd is $31/day based on $5.00 per MBTU.
1.2	Energy - Pumping to Irrigation	22,000	KWh	0.15	3,300	Pump Operation = 8 hours per day
						2920 hours operated per year
						Pump Station Hp = 10 Total Motor HP required for duty pumps
	Energy - Other	1,000	KWh	0.20	200	5% of sum of pumping energy requirements
2.0	**Labor Costs**					
2.1	Labor (treatment, pipeline, PS, customer service)	1.0	staff	175,000	175,000	full time staff at $175,000 average salary + benefits per year
						(Includes staff at WWTF + staff for Bulk Water Station + Parks)
3.0	**Maintenance**					
	Other	@	5.0%		18,175	% of facility cost (excluding treatment)
	Treatment - Filtration Equip. (Maintenance/Replacement/Repair)	1	LS	10,000	10,000	Estimate provided by PWD
	Treatment - Pasteurization Equip. (Maintenance/Replacement/Repair)	1	LS	10,000	10,000	Estimate provided by PWD
4.0	**Chemicals**					
	Treatment - Chlorination	148	AF	46	6,758	
	Treatment - Pasteurization		not incl.			None assumed at this time
5.0	**Contingency**	@	10.0%		23,227	% of above O&M costs
	Annual O&M Costs ($/year)				**$255,500**	
	Annual Unit O&M Costs ($/AF)				**$1,700**	

Engineers Opinion of Probable Cost KENNEDY/JENKS CONSULTANTS

Recommended Project: Phase 2 BayCycle Project (to Serve UCSC)

Study:	Santa Cruz Recycled Water Facilities Planning Study	**Prepared By:**	MT, DTT	**Average Annual RW Delivered**	0.16 mgd
Project:	Recommended Project: Phase 2 BayCycle Project (to Serve UCSC)	**Date Prepared:**	Jun-2017		176 Average Annual Reuse (AFY)
RW Supply:	3°	**K/J Proj. No.**	1668007.00	**RW to Santa Cruz Only:**	0.019 mgd
Estimate:	Conceptual Level Cost-Analysis	**ENR**			21 Average Annual Reuse (AFY)

Item No.	Description	Qty	Units	Total Costs $/Unit	Total Capital Cost	Notes/Source
Facility Capital Costs						
1.0	**Treatment**				**100,000**	Existing tertiary filters and pasteurization assumed to have capacity required
1.1	Pasteurization Unit		not incl		0	0.5 mgd capacity purchased from Ventura Demo Project - sufficient for Phase 1 and 2
1.3	Filter Optimization	1	LS	100,000	100,000	Assume lump sump for minor upgrades to optimize filter performance to meet Phase 1 and 2 demand
1.4	Chemical Dosing System		not incl		0	Assum Phase 1 upgrade is sufficient to mee increased flow with phase 2
1.5	Filter Rehaibilitation	1	LS	100,000	100,000	Update pumps, valves or media replacement as-needed to meet increased demand
2.0	**Pipelines**				**2,661,120**	
2.1	Tertiary Effluent Pipeline from Bulk Water Station to Westlake School and UCSC					
	Alt1B_Ph4_Main	9,000	LF	72	648,000	6 in-diameter
	Pipeline Constructability (Along Roads)			10%	64,800	
2.2	Pipelines within UCSC Campus					
	Segment A (Green) - Boundary of SCWD to base of campus	2,200	LF	72	158,400	6 in-diameter
	Segment B (Red)- Base of campus to Atheletic Fields	7,700	LF	72	554,400	6 in-diameter
	Segment C (Yellow)- Base of campus to West Campus	10,700	LF	72	770,400	6 in-diameter
	Segment D (Orange) - West Campus to North Campus	4,000	LF	72	288,000	6 in-diameter
	Pipeline Constructability (Along Roads)			10%	177,120	
3.0	**Pump Stations**				**1,060,000**	1 duty, 1 stand by pumps. Rating per pump:
3.1	Pump Station from WWTF to Campus Boundary	1	LS	390,000	390,000	assume open cans available from Phase 1
3.2	Pump Station on Campus	1	LS	670,000	670,000	540 total flow (gpm) 500 ft (TDH)
						Pump station locations not identified as part of this study
4.0	**Storage**				**200,000**	
4.1	UCSC on Campus Storage Tank	0.10	MG	2,000,000	200,000	Prestressed concrete tank
						Storage tank locations not identified as part of this study
5.0	**Site Retrofit Costs**				**960,000**	
5.1	City User Sites	6	# of sites	20,000	120,000	Unit cost estimated using a retrofit cost curve based on demand at each site
5.2	UCSC User Sites	42	# of sites	20,000	840,000	Unit cost estimated using a retrofit cost curve based on demand at each site
	Subtotal Facility Costs				**$4,981,120**	
Additional Facility Capital Costs						
6.0	Site Development Costs	@	10%		136,000	% of Subtotal treatment, pump station, storage, discharge facility and well costs
						(Includes grading, erosion control, cut/fill, etc.)
7.0	Yard Piping	@	5%		68,000	% of Subtotal treatment, pump station, storage, discharge facility and well costs
8.0	Electrical, I&C, and Remote (low-tech) Control	@	20%		272,000	% of Subtotal treatment, pump station, storage, discharge facility and well costs
	Subtotal Additional Facility Costs				**$476,000**	
	Facility Direct Costs				**$5,457,120**	
	Taxes	@	8.75%		174,339	apply taxes to 40% of the Capital Costs for facilities
	Mobilization/Bonds/Permits	@	5%		272,856	% of Facility Direct Costs
	Contractor Overhead & Profit	@	15%		818,568	% of Facility Direct Costs
	Estimate Contingency	@	30%		1,637,136	% of Facility Direct Costs
Subtotal with Contractor Markups and Contingency					**$8,360,019**	
	Escalation to Midpoint of Construction	@	12%		1,003,202	assume 2% percent over 6
						construction start = 2020 end = 2024
	Project Capital Cost Total				**$9,363,222**	
	Annualized Capital Cost ($/year)				**$470,000**	based on facility life and 4% interest
	Annualized Unit Capital Cost ($/AFY)				**$2,700**	

Item No.	Description	Qty	Units	Total Annual Costs $/Unit	Total	
Annual Operations and Maintenance Costs						
1.0	**Energy Costs**					Pump Operation = 8 hours per day
1.1	Energy - Treatment (Filtration - electrical)	17,800	KWh	0.20	3,560	2920 hours operated per year
						Pasteurization assume 3x filtration $ 24 hours per day
						to be confirmed by City 8760 hours operated per year
						309 KWH/MG
	Energy - Treatment (Pasteurization - natural gas)	365	day	20	7,300	Cost of natural gas for the pasteurization unit to deliver 0.25 mgd is $31/day based on $5.00 per MBTU.
1.2	Energy - Pumping to UCSC Boundary	200,000	KWh	0.20	40,000	Pump Station Hp = 90 Total Motor HP required for duty pumps
	Energy - Pumping UCSC on Campus	414,000	KWh	0.20	82,800	Pump Station Hp = 190 Total Motor HP required for duty pumps
	Energy - Other	31,000	KWh	0.20	6,200	5% of sum of pumping energy requirements
2.0	**Labor Costs**					
2.1	Labor (pipeline, PS, customer service)	1.0	staff	125,000	125,000	full time staff at $125,000 average salary + benefits per year
						assume treatment labor does not increase, additional staff for Phase 2 conveyance/customers only
3.0	**Maintenance**					
	Other	@	1.0%		48,811	% of facility cost (excluding treatment)
	Treatment - Filtration Equip. (Maintenance/Replacement/Repair)	1	LS	10,000	10,000	Estimate provided by PWD
	Treatment - Pasteurization Equip. (Maintenance/Replacement/Repair)	1	LS	10,000	10,000	Estimate provided by PWD
4.0	**Chemicals**					
	Treatment - Chlorination	176	AF	46	8,029	
	Treatment - Pasteurization		not incl.			None assumed at this time
5.0	**Contingency**	@	10.0%		34,170	% of above O&M costs
	Annual O&M Costs ($/year)				**$375,870**	
	Annual Unit O&M Costs ($/AFY)				**$2,130**	

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Appendix G: Scoring and Ranking Evaluation

This appendix includes supporting information for the scoring and ranking of alternatives. It includes a discussion of the screening criteria and scoring guidelines, the environmental evaluation and triple bottom line evaluation to support the alternatives analysis. A discussion of the scoring results and sensitivity analysis are included herein and summarized in Section 8.

G.1 Scoring Criteria Guidelines

As introduced in Section 8.3, four categories were used to compare alternatives against one another: (1) Engineering & Operational Considerations (2) Economic, (3) Environmental and (4) Social. For each category, quantitative results and qualitative screening criteria were used to evaluate and score each recycled water alternative to identify a preferred project or list of prioritized projects.

The quantitative metrics used in the alternatives screening evaluation include:

- **Recycled Water Delivered:** Annual Volume (AFY), Average Annual Flow (mgd), Peak Season Deliveries (AF Summer), and/or Peak Flow (mgd).
- **Costs:** Construction Costs ($), Operational and Maintenance (O&M) Costs ($/year), Annualized Life Cycle Costs ($/AFY). A more detailed discussion of the cost estimating approach is provided in Section 8.2.
- **Energy Related:** Energy (kilowatt-hour per (kWh/yr) of recycled water delivered, greenhouse gas (GHG) emissions (tons of carbon dioxide equivalent (CO_2e) per year), Social Cost of Carbon ($/metric ton (MT)).
- **Other:** Construction Footprint (SF), number and Size of Facilities

Table G-1 provides the scoring guidelines used for assessing each alternative based on the screening criteria.

The following supporting documents are included in this appendix, following Table G-1) to support the scoring or projects:

G.2 Environmental Evaluation

This memorandum, by GHD, presents an assessment of relative CEQA considerations for comparing alternative projects.

G.3 Social Cost of Carbon Evaluation

This memorandum, by Corona Environmental Consulting, presents a summary of the approach for valuing the climate change impacts of carbon emissions for the environmental enhancement screening criteria. The memorandum describes the factors used to estimate the social cost of carbon for each alternative project to provide a quantitative assessment of the relative contribution to climate change (based on GHG emissions).

Table G-1: Alternatives Screening Criteria

Categories	Alternatives Screening Criteria	Considerations for Assessing Project based on Criteria	Fully Meets Criteria (Score = 5)	Mostly Meets to Somewhat Meets Criteria (Score = 4 to 2)	Unable to Meet Criteria (Score = 1)
ENGINEERING & OPERATIONAL CONSIDERATIONS	**Improve Water Supply**	- Ability to fill City supply gap (1.2 BGY or 3,700 AFY), supplement peak season supply with a new source or offset and/or contribute to regional supply	Can fully fill supply gap (over multiple year types and in peak season)	Partially fills supply gap (seasonally or diurnally)	Does not provide any water towards supply gap
		- Ability to implement Project, with supplies available in a timely manner	<5 years for implementation	5-15 years for implementation	>15 years for implementation
	Maximize Beneficial Reuse	- Maximizes reuse of wastewater effluent now	Maximum beneficial use of existing wastewater compared to other recycled water projects	Beneficial use of existing wastewater is limited by the proposed recycled water demand	Minimal beneficial use of existing wastewater compared to other recycled water projects
		- Does not limit future options at the WWTF to fully utilize wastewater effluent	No or limited facilities anticipated at the WWTF, leaving sufficient space and/or opportunity for future expansions to fully utilize wastewater	Proposed facilities could be located at or near the WWTF with the potential constrain space and/or opportunity for future expansions to fully utilize wastewater	Not used since exact location of additional treatment is not defined as part of this study
	Ease of Implementation	- Regulatory viability and ability to obtain a recycled water and other permits - Current (DDW and RWQCB) regulatory pathway/approved use	Existing regulations allow type of reuse with straightforward permitting requirements	Case-by-Case approach possible	Existing regulations have not been developed or highly complex permitting process
		- Potential construction challenges (# of facilities, terrain, and potential location in disturbed/undisturbed area, etc.)	Few new facilities on already disturbed areas with minimal construction complexities	Some new facilities located in relatively disturbed areas with a range of construction complexities	Facilities located in undisturbed areas with higher degree of construction complexity
		- Flexibility for phasing and opportunities to expand/transition to a higher yield and/or treatment level.	Flexible to expand/transition to higher yield/treatment level	Some limited ability to expand/transition to higher yield/treatment level	Significant constraints to expand/transition to higher yield/treatment level
	Operational Complexity	- Source of wastewater and/or type of treatment required for beneficial reuse minimizes impacts to wastewater collection and/or WWTF operations	Use of secondary effluent with tertiary treatment would have minimal impact to WWTF operations	Mining local raw wastewater and/or AWT with brine discharge directly to the outfall may have some impacts on operations	AWT with brine discharge back to the headworks of the WWTF would have significant impacts to operations
		- Type of reuse and facilities minimize impacts to water department operations and responsibilities	Significant additional considerations and potential impacts related to	Some additional considerations and potential impacts related to	Few additional considerations and potential impacts related to

Categories	Alternatives Screening Criteria	Considerations for Assessing Project based on Criteria	Fully Meets Criteria (Score = 5)	Mostly Meets to Somewhat Meets Criteria (Score = 4 to 2)	Unable to Meet Criteria (Score = 1)
			modifications to operations and new responsibilities.	modifications to operations and new responsibilities.	modifications to operations and new responsibilities.
ECONOMIC	**Cost Effectiveness**	- Economically feasible or cost-effective project (relative life cycle unit costs)	Anticipated LOW relative unit cost (based on recycled water deliveries)	Range of relative unit cost (based on recycled water deliveries)	Anticipated VERY HIGH relative unit cost (based on recycled water deliveries)
	Financial Implementability	- Financially implementable project (capital investment does not limit ability to implement other water projects and program)	Relative to other projects: LOWEST capital cost, MINIMAL impact on rates and/or FEW tradeoffs	Relative to other projects: LOW to HIGH capital cost, SOME impact on rates and/or SOME tradeoffs	Relative to other projects: VERY HIGH capital cost, HIGHEST impact on rates and/or MANY tradeoff
ENVIRONMENTAL	**CEQA Considerations**	- Potential environmental impacts and mitigation requirements	Potential for Mitigated Negative Declaration (MND) with few impacts and minimal mitigation	Range of potential impacts and mitigation requirements	Complex CEQA requirements with potential for significant impacts and substantial mitigation required
	Environmental Enhancement	- Potential to enhance local and regional ecosystems and environments including rivers, groundwater basins	Potential to contribute significant benefit to enhancing the environment	Potential to contribute some benefit to enhancing environment	Potential to contribute minimal benefit to enhancing the environment.
		- Social cost of carbon compared to other projects and supplies; Relative contribution to climate change (based on GHG emissions)	Low relative social cost of carbon and/or minimal contribution to climate change	Some social cost of carbon and/or contribution to climate change	High relative social cost of carbon and high cost to climate change
SOCIAL	**Agency Coordination, Partnerships and Agreements**	- Alternative reliance on cooperation and coordination of other agencies	Requires partnerships with multiple entities	Requires some partnerships	Does not require partnerships
	Public Perception *(removed from consideration)*	- Perceived public acceptance and comfort with level of public health and safety associated with reuse	Though originally included in the criteria development, this consideration has been removed from the scoring of alternative projects. The City recognizes its importance and will include it in the next analysis of water supply alternatives when more information can be drawn from the community in terms of their preferences and acceptance of the different types of beneficial reuse.		
	Local Disruption	- Level of impact on local residents for new construction based on the number of facilities and ongoing maintenance based on the type of facilities.	Relative amount of local disruption during construction and the relative long-term impact on residents due to ongoing maintenance.	Some facilities require land acquisition with some long-term impact on residents due to ongoing maintenance.	Requires land acquisition for most new facilities with significant long-term impacts on residents due to ongoing maintenance

Memorandum

August 30, 2017

To:	Dawn Taffler, Kennedy/Jenks Consultants	Ref. No.:	11121658
From:	Pat Collins, GHD		

Subject: **Approach to Ranking Alternatives relative to CEQA Considerations and Environmental Enhancement**

The purpose of this memorandum is to summarize the approach taken to rank alternatives relative to two evaluation criteria: CEQA Considerations and Environmental Enhancement.

1. CEQA Considerations

The ranking of alternatives relative to CEQA considerations has been done qualitatively. This criterion is intended to evaluate the extent and seriousness of environmental impacts and the work required to evaluate them in a thorough, high quality CEQA document.

It is very early in the design process, so that details regarding the construction and operation of the various alternatives are not available. Therefore, quantitative estimates of environmental impacts and CEQA costs or schedule needs are not feasible.

Because CEQA requires that you evaluate the "whole of the project", the ranking for each alternative assumes that each project would be pursued separately. Even though some projects may be combined, we assume for now that each alternative would have a separate CEQA document.

It is expected that the City of Santa Cruz would serve as Lead Agency for the CEQA documentation of all alternatives, except for Alternative 3 where either the City of Santa Cruz or the Soquel Creek Water District (SqCWD) would be able to serve as the Lead Agency. The CEQA documentation for a regional project under Alternative 3 could potentially tier from the SqCWD project EIR using an EIR Addendum, if the regional project were simply an expansion of the SqCWD project, and it had no new significant impacts and no impacts of substantially greater severity than those identified in the SqCWD project EIR. The NEPA Lead Agency, if any, will be determined based on whether a federal agency provides funding for a project.

While specific funding for each alternative has not been decided upon, the most likely options include the Bureau of Reclamation (USBR) for large projects with a total capital cost of $50 million or more, the State Water Resources Control Board, the State Revolving Fund (SRF) Loan Program that is administered by the State Board on behalf of the U.S. EPA, and the City of Santa Cruz in coordination with its potential local-agency partners. Federal funding through the USBR would require preparation of a NEPA document. SRF funding would require a CEQA Plus document. And local funding would require a CEQA document.

In general, the ranking is based on the extent of environmental impacts to be evaluated in the CEQA/NEPA documents, combined with the amount and complexity of mitigation that is expected to be required. A secondary consideration is the cost and duration of the CEQA/NEPA process. The following specific issues were considered:

- The City may decide to apply for federal funding through the USBR or similar sources for larger alternatives with a total capital cost of $50 million or more. SqCWD is expected to apply for USBR funding for Alternative 3 projects. NEPA documentation for these larger projects tends to take longer, cost more, and require more coordination with federal agencies.
- Precise siting of pipelines and facilities will be done in a future design phase and has not yet occurred. However, longer pipelines and larger facilities run the risk of additional biological and cultural resources impacts, as well as construction-phase impacts to trees, noise, and air quality.
- Groundwater recharge, irrespective of the groundwater basin to be affected, has the potential for a number of groundwater impacts. Evaluation of these impacts and preparation of adequate mitigation plans would require extensive modeling, analysis of potential groundwater issues such as well interference or dewatering of creeks, and coordination with neighboring property owners and local agencies.
- Streamflow augmentation would require extensive evaluation of water quality impacts and hydrologic modeling of flows in order to protect habitat for anadromous fish.
- So long as adopted guidelines for drinking water standards have not been promulgated for direct potable reuse and surface water augmentation, a significant additional burden would fall on the CEQA/NEPA document.

2. Environmental Enhancements

The ranking of alternatives relative to Environmental Enhancements has been done qualitatively. This criterion is intended to evaluate broad opportunities for enhancement and/or restoration of environmental resources.

The ranking assumes that each alternative would only be implemented if its environmental impacts and risks could be fully mitigated through the CEQA/NEPA and resource agency permitting processes.

In general, the ranking is based on the extent of environmental benefits that are expected to occur, together with the likelihood of their occurrence. The following specific issues were considered:

- Streamflow augmentation could benefit stream flows and lake levels, increasing habitat and recreational values.
- Groundwater replenishment would be beneficial in that it would help to maintain groundwater levels and improve groundwater quality.
- Reduction of ocean discharge through reuse would provide some benefit to the ocean environment. However, discharge of brine from an RO facility would counterbalance any benefit from a reduction in discharge volumes.

Memo

To: Dawn Taffler, Kennedy/Jenks

Cc: Heidi Luckenbach, City of Santa Cruz Water Department

From: Jim Henderson, Bob Raucher, Corona Environmental Consulting

Date: September 29, 2017

Re: Use of the "Social Cost of Carbon" in Valuing Emission Reductions

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In the following memorandum, we present a summary of a common approach for valuing the climate change impacts of carbon emissions, and discuss how to apply it to emissions associated with recycled water project options. The valuation approach is known as the "social cost of carbon" (SCC), and estimates monetized damages, now and into the future, associated with an incremental increase in carbon emissions emitted now. These damages "include but are not limited to the impact on agricultural productivity, human health, property damages from increased flood risk, and the value of ecosystem services due to climate change" (IWG, 2010).

An intergovernmental working group (IWG) of U.S. governmental agencies developed these estimates based on runs from several models that estimate the global impacts from climate change. The agencies involved in developing the estimate included the Council of Economic Advisers, Council on Environmental Quality, Department of Agriculture, Department of Commerce, Department of Energy, Department of Transportation, Environmental Protection Agency, National Economic Council, Office of Management and Budget, Office of Science and Technology Policy, and the Department of the Treasury. These agencies developed this estimate of damages over a series of memoranda starting in 2010, the most recent of which is an August 2016 revision to a memorandum initially developed in May 2013.

This memorandum outlines methods and data available for valuing avoided (or increased) carbon dioxide equivalent (CO2e) greenhouse gas emissions as a result of different project approaches compared to the baseline. This memo is organized as follows: Section 1 presents a brief overview the approach used for estimating the social cost of carbon, and the social cost of carbon values, and Section 2 briefly discusses the application of those values.

1. Social Cost of Carbon Estimates

Three integrated assessment models (IAMs) were used by the IWG to develop SCC estimates – the DICE, PAGE, and FUND models. IAMs are mathematical models that include both physical and social science models that consider demographic, political, and economic variables that affect greenhouse gas emission scenarios in addition to the physical climate system. These models have been published and peer reviewed in the literature, and updated to include recent advances. (Hanemann, 2015).

The interagency method developed four SCC estimates. Three values are based on the average SCC from the IAMs at discount rates of 2.5, 3, and 5 percent. The fourth value represents the 95th percentile SCC estimate across all three models at a 3 percent discount rate, and is included to represent higher-than-expected impacts from temperature change further out in the tails of the SCC distribution. The 3 percent discount rate is the central value, which is the average SCC across models and model runs at the 3 percent discount rate (IWG, 2010).

Table 1 shows the four SCC estimates at different discount rates, in five-year increments from 2010 to 2050. The SCC calculated for 2015 for the 3% discount rate is $42 per metric ton (MT) of carbon dioxide (CO2). The SCC values were calculated in 2007 dollars and have been updated to 2016 dollars using the Consumer Price Index (CPI). The 2015 SCC values in 2016 dollars range from $13 per MT using the 5% discount rate to $65 per MT using the 2.5% discount rate and $121 per MT using the 95th percentile estimate from the 3% discount rate.

Table 1: SCC Estimates, Updated to 2016 Dollars ($/MT CO_2)

Year	5% Average	3% Average	2.5% Average	3% 95th Percentile
2010	12	36	58	100
2015	13	42	65	122
2020	14	49	72	142
2025	16	53	79	160
2030	19	58	85	176
2035	21	64	90	195
2040	24	69	97	212
2045	27	74	103	228
2050	30	80	110	245

Source: Table 2, IWG 2016a. Updated from 2007 to 2016 dollars using the CPI.

The IWG's estimate of the SCC increases over time because there is a greater accumulation of CO2 in the atmosphere over time, and higher future levels of population, global output, and emissions. This leads to a higher total willingness to pay to avoid climate change damages. This rate of increase should be considered a "real" escalation rate, which shows increases in values above the general rate of inflation. The real rate of increase is slightly different for each discount rate – we have calculated the annual rate of increase from 2015 to 2050 for 3% discount rate, and it comes out to 1.9%.

The IWG recommends using the mean of the 3% discount rate ($42 per MT for 2015 in this case) as the central tendency value for the social cost of carbon. The recommended mean estimate reflects the worldwide net benefits of reducing CO2 emissions.[1] Estimates of the portion of the net benefits occurring in the United States range from 7% to 23% of the worldwide social cost of carbon.

[1] The Trump administration has since stated that it will apply a 7% discount rate and account only for benefits that accrue in the U.S. This approach is at odds with the original intent of the IWG, which was to recognize that the problem of carbon emissions is a global externality that accumulates in the atmosphere over time, and therefore

2. Emissions Associated with Recycled Water Production and Delivery

The Santa Cruz region gets electricity from Pacific Gas and Electric (PG&E) company. Average emission rates for PG&E over the last five years (2011-2015) is reported to be 421 pounds of CO2 per MWh of electricity used, or 0.191 metric tons (MT) of CO2 per MWh (based on PG&E 2015). PG&E states that its emissions of nitrous oxide and methane associated with power production should be considered "de minimus" in GHG inventory calculations, and so are not reported.[2]

Recycled water energy use includes treatment and distribution costs. Energy use associated with an advanced water purification facility (AWPF) depends on the flow rate, the characteristics of the incoming effluent, and the specific treatment processes used. A representative AWPF energy use is around 1.1 MWh per AF (Raucher and Tchobanoglous, 2014).[3] Typical distribution cost might be approximately 0.1 MWh per AF (based on SCVWD, 2011). Kennedy Jenks may develop more option-specific energy use requirements for the various recycled water alternatives considered in the analysis; however, for illustration purposes, we apply the general values noted above. The resulting carbon emissions using the PG&E emissions factor is 0.229 MT of CO2 emission per AF (1.2 MWh/AF * 0.191 MT /MWh).

As an example, an AWPF project option that delivered 3,700 AF per year (the full water supply gap), would have estimated emissions of 847 MT of CO2 emissions per year. At $42 per MT, the value of damages from those emissions would be roughly $35,575 per year for the year 2015 (in 2016 dollars). Applying the range of values from the IWG for the year 2015 of $13 to $122 per MT, would result in a range of $11,100 to $103,330 per year. Yearly values will increase in future years as emissions accumulate in the atmosphere. Actual change in carbon emissions with each project option depends on the baseline selected.

CO2 emissions associated with manufacture of pipe used for distribution of recycled water is another potential factor in distinguishing project options. As an example, production of 1 km of steel pipe including steel production and pipe welding, transport, equipment fuel usage, coating and welding, and overhead, is approximately 1.26 MT per km of pipe. A project option involving 10 miles of pipe (16 kilometers) would result in approximately 20 MT of CO2 emissions, or $840 if manufactured in 2015, with a range of $260 to $2,440 (in 2016 dollars). Emissions from plastic pipe (e.g. PVC or HDPE) are expected to be less than emissions from manufacture of steel pipe. The carbon footprint of pipe manufacture is expected to be a

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affects future generations in addition to the current generation. Lower discount rates better reflect situations where investments today can affect people's welfare over long time horizons.

[2] California statewide average emission factors for CH4 and N2O are available, but not specifically for PG&E electricity generation. California averages could be used to obtain rough estimates of CH4 and N2O emissions from the electricity used in Santa Cruz. In addition, the 2016 update to the IWG memorandum for the first time included damage estimates for CH4 and N2O, and so specific damage estimates for CH4 and N2O emissions could be estimated. There are theoretical reasons why having separate damage estimates for CH4 and N2O are better than incorporating them as carbon dioxide equivalents using their global warming potential, and valuing them using CO2 damage estimates. For instance, CO2 emissions contribute to ocean acidification, while CH4 and other GHGs do not. Similarly, damages from CH4 emissions are not offset by any positive effect of CO2 fertilization on agriculture (IWG, 2016b). However, valuation of CH4 and N2O emissions separately from CO2 emissions is usually reserved for actions that substantially affect emissions of CH4 and N2O, and is not recommended in this case.

[3] A range of 1.05 to 1.14 MWh per AF is reported in Raucher and Tchobanoglous based on actual operating data from Orange County Water District (OCWD).

one-time societal expense that will be small compared to ongoing emissions from recycled water treatment and distribution.

As mentioned above, this information can be used to monetize the potential impacts from CO2 emissions associated with energy use from recycled water production and delivery. This allows the Water Department to understand the potential savings (in terms of the estimated value of damages caused by carbon emissions) associated with different recycled water options compared to the baseline.

There are other potential uses of the social cost of carbon value associated with the recycled water program. For instance, the value of damages from CO2 emissions could be used as a potential amount for the City to invest in mitigation projects to offset the damage. This investment would not only potentially generate revenue for the City from sale of renewable energy, but would also allow the city to understand that it is offsetting the monetized damage from CO2 emissions associated with recycled water production and delivery. A review by the Water Research Foundation of water utility renewable energy projects did not reveal that the social cost of carbon had been used to assess the potential amount that utilities should invest in renewable energy projects (Lisk et al. 2012). However, the social cost of carbon can be used to frame the potential value of carbon credits. Purchasing carbon credits is a way for utilities to invest in carbon mitigation projects without building the project themselves.

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G.4 Scoring and Ranking Results

As described in Section 8.3, a three-step process was used for weighting and ranking the alternatives:

1. **Scoring** each alternative on a scale of one to five against each screening criteria

2. **Weighting** factors and themes were developed to reflect the relative importance of each criteria from various perspectives, as presented in Table 8-14.

3. **Ranking** alternative projects such that the highest score receives a rank of one and the lowest score receives a rank of 14. A sensitivity analysis was performed to see how weighting criteria impacts ranking.

The scoring and results for the alternative projects are summarized in Section 8.3. Supporting tables are provided herein.

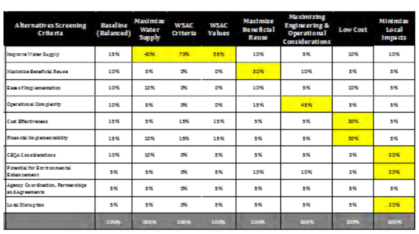
- Table G-2 lists quantitative results used to inform the qualitative metrics (described in Table G-1).

- Table G-3 shows the raw scores for each criterion by project.

- Table G-4 shows the total weighted score and ranking for each project.

As illustrated below, the weighting factors were multiplied by the raw scores for each criterion to get a total weighted score and ranking for each project. Conditional shading shows GREEN as top scoring/top ranking and RED as bottom scoring/bottom ranking of all projects.

Weighting Factors (Table 8-13) **Raw Scores (Table G-3)** **Ranking (Table G-4)**



Alternatives Screening Criteria	Baseline (Balanced)	Maximize Water Supply	WSAC Criteria	WSAC Values	Maximize Beneficial Reuse	Maximizing Engineering & Operational Considerations	Low Cost	Minimize Local Impacts
Improve Water Supply	15%	40%	70%	55%	10%	5%	10%	10%
Maximize Beneficial Reuse	10%	5%	0%	0%	30%	10%	5%	5%
Ease of Implementation	10%	10%	0%	0%	10%	5%	10%	5%
Operational Complexity	10%	5%	0%	0%	15%	45%	5%	5%
Cost Effectiveness	15%	5%	15%	15%	5%	5%	30%	5%
Financial Implementability	15%	10%	15%	15%	5%	5%	30%	5%
CEQA Considerations	10%	10%	0%	5%	5%	5%	5%	20%
Potential for Environmental Enhancement	5%	5%	0%	5%	10%	10%	2%	20%
Agency Coordination, Partnerships and Agreements	5%	5%	0%	5%	5%	5%	5%	5%
Local Disruption	5%	5%	0%	5%	5%	5%	5%	20%
	100%	100%	100%	105%	100%	100%	105%	100%

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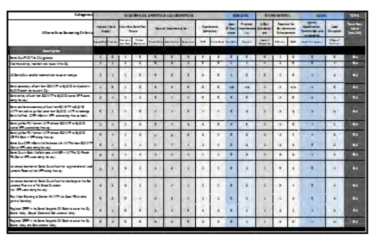

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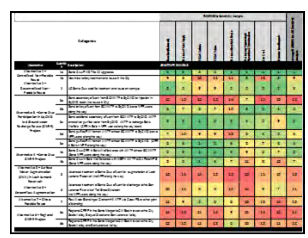

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Table G-2: Summary of Quantitative Results

				Recycled Water Delivered						Estimated Costs			Energy / Others								
Alternative		Sub Alt	Description	Regional Ave Annual Reuse (AFY)	Regional Average Annual Flow (MGD)	RW Use in Santa Cruz (AFY)	RW Use in Santa Cruz (MGD)	Peak Season Deliveries (AF in Summer - June)	Peak Hourly Flow (MGD)	Estimated Construction Cost ($mil)	Annual O&M Cost ($mil/yr)	Total Annual Cost ($/AF)	Unit Energy of RW Delivered (KWH/AF)	Est O&M GHG Emissions (MTCO2/yr)	Total Pipeline Length (ft)	Total Pipeline Length (miles)	Pipeline GHG Emissions (MTCO2)	# of Non-Pipeline Facility Sites (#)	Est Non-Pipeline Footprint (SF)	Social Cost of Carbon ($)
Non Potable Reuse	Alternative 1 – Centralized Non-Potable Reuse	Alt 1A	Santa Cruz PWD Title 22 Upgrades	282	0.25	282	0.25	44	1.4	$1	$0.2	$1,000	181	10	1,200	0.2	0.46	2	3,710	429
		Alt 1B	Maximize tertiary treatment and reuse in the City	840	0.75	840	0.75	131	4.2	$34	$1.1	$3,400	1,703	273	99,000	18.8	38	6	7,078	13,072
	Alternative 2 – Decentralized Non-Potable Reuse	Alt 2	UC Santa Cruz satellite treatment and reuse on campus	155	0.14	155	0.14	45	0.5	$28	$0.3	$12,000	3,323	98	24,600	4.7	9	3	6,576	4,529
SqCWD Led GRRP	Alternative 3 – Santa Cruz Participation in SqCWD led GRRP	Alt 3A	Send secondary effluent from SCWWTF to SqCWD for injection in SqCWD basin (no reuse in City)	1,903	1.70	0.00	0.00	297	3.2	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
		Alt 3B	Send tertiary effluent from SCWWTF to SqCWD (serve NPR users along the way)	2,454	2.19	550	0.49	419	4.5	$20	$0.3	$2,600	1,002	105	45,400	8.6	17	6	10,267	5,156
		Alt 3C	Send additional secondary effluent from SCWWTF to SqCWD AWTF and deliver advanced treated water from SqCWD AWTF to recharge Beltz Wellfield (GRR in Beltz + NPR users along the way back)	3,704	3.31	2,248	2.01	577	6.2	$69	$3.8	$3,300	3,683	1,581	60,900	11.5	23	16	5,559	67,391
		Alt 3D	Send advanced treated RW from an AWTF at/near SCWWTF to SqCWD (serve NPR users along the way)	1,544	1.38	88	0.08	295	9.5	$7	$0.4	$9,000	2,330	39	46,200	8.8	18	3	21,966	1,643
		Alt 3E	Send advanced treated RW from an AWTF at/near SCWWTF to SqCWD (GRR in Beltz Wellfield + NPR along the way)	3,824	3.41	2,368	2.11	596	6.4	$69	$3	$2,900	2,038	922	53,500	10.1	21	13	45,082	39,576
City Led GRRP	Alternative 4 – Santa Cruz GRRP	Alt 4A	Santa Cruz GRR in Beltz Wellfield area with AWTF at/near SCWWTF (Serve NPR users along the way)	2,389	2.13	2,389	2.13	372	4.0	$70	$3	$2,900	2,369	1,081	42,100	8.0	16	12	32,855	46,081
		Alt 4B	Santa Cruz GRR in Beltz Wellfield area with MBR + AWTF at DA Porath PS (Serve NPR users along the way)	2,240	2.00	2,240	2.00	349	3.7	$99	$3	$4,000	2,873	1,229	14,100	2.7	5	12	52,459	51,855
SWA	Alternative 5 – Surface Water Augmentation (SWA) in Loch Lomond Reservoir	Alt 5	Advanced treatment of Santa Cruz effluent for augmentation of Loch Lomond Reservoir (no NPR along the way)	1,777	3.20	1,777	3.20	559	6.0	$107	$4	$5,500	4,508	1,530	68,000	12.9	26	3	42,533	65,363
Stream Aug	Alternative 6 – Streamflow Augmentation	Alt 6	Advanced treatment of Santa Cruz effluent for discharge to the San Lorenzo River d/s of Tait Street Diversion (no NPR users along the way)	1,777	3.20	1,777	3.20	559	6.0	$75	$3	$4,100	2,321	788	13,500	2.6	5	3	42,533	33,314
DPR	Alternative 7 – Direct Potable Reuse	Alt 7	Raw Water Blending at Graham Hill WTP (via Coast PS or other point of blending)	3,584	3.20	3,584	3.20	559	6.0	$111	$5	$3,000	1,825	1,249	3	5.1	10	6	166,765	52,678
Regional GRR	Alternative 8 – Regional GRRP	Alt 8a	Regional GRRP in the Santa Margarita GW Basin to serve the City, Scotts Valley, Soquel Creek and San Lorenzo Valley	5,600	5.00	3,584	3.20	559	6.0	$124	$6	$3,500	4,496	3,078	105,300	19.9	40	31	69,729	130,973
		Alt 8b	Regional GRRP in the Santa Margarita GW Basin to serve the City, Scotts Valley and San Lorenzo Valley	4,144	3.70	3,584	3.20	559	6.0	$141	$6	$3,700	3,701	2,533	105,300	19.9	40	26	57,143	108,102

Table G-3: Alternative Project Scoring

Categories			ENGINEERING & OPERATIONAL CONSIDERATIONS									ECONOMIC		ENVIRONMENTAL			SOCIAL		TOTAL
Alternatives Screening Criteria			Improve Water Supply		Maximize Beneficial Reuse		Ease of Implementation			Operational Complexity		Cost Effectiveness	Financial Implementability	CEQA Considerations	Potential for Environmental Enhancement		Agency Coordination, Partnerships and Agreements	Local Disruption	Total Raw Score (max 100)
			Supply Gap	Timeline	Maximize Use Now	Future Expansion	Permitability	Construction	Expansion	PWD	Water Dept.	Unit Costs	Capital	Impact/ Mitigation	Enhance	GHG	Level/ Willingness	#/Type of Facilities	
Alternative	**Sub-Alt #**	**Description**																	
Alternative 1 – Centralized Non-Potable Reuse	1a	Santa Cruz PWD Title 22 Upgrades	1	5	1	5	5	5	5	5	5	5	5	5	2	5	5	5	69.0
	1b	Maximize tertiary treatment and reuse in the City	2	4	2	3	5	3	3	5	5	2	4	4	2	5	5	4	58.0
Alternative 2 – Decentralized Non-Potable Reuse	2	UC Santa Cruz satellite treatment and reuse on campus	1	4	1	5	5	5	3	3	5	2	5	5	2	5	2	3	56.0
Alternative 3 – Santa Cruz Participation in SqCWD led Groundwater Recharge Reuse (GRR) Project	3a	Send secondary effluent from SCWWTF to SqCWD for injection in SqCWD basin (no reuse in City)	Not analyzed because it provides no water to the City and would have no value in the ranking exercise																
	3b	Send tertiary effluent from SCWWTF to SqCWD (serve NPR users along the way)	2	4	2	2	5	4	3	5	5	4	5	2	2	5	3	4	57.0
	3c	Send additional secondary effluent from SCWWTF to SqCWD AWTF and deliver advanced treated water from SqCWD AWTF to recharge Beltz Wellfield (GRR in Beltz + NPR users along the way back)	4	4	4	5	4	4	4	4	4	3	3	2	3	3	3	3	57.0
	3d	Send advanced treated RW from an AWTF at/near SCWWTF to SqCWD (serve NPR users along the way)	1	4	1	3	5	4	3	3	5	3	5	2	2	5	4	4	54.0
	3e	Send advanced treated RW from an AWTF at/near SCWWTF to SqCWD (GRR in Beltz Wellfield + NPR along the way)	4	4	4	3	4	3	4	3	4	4	3	2	3	4	4	3	56.0
Alternative 4 – Santa Cruz GRRP	4a	Santa Cruz GRR in Beltz Wellfield area with AWTF at/near SCWWTF (Serve NPR users along the way)	4	4	4	4	4	4	4	2	4	4	3	2	3	4	5	3	58.0
	4b	Santa Cruz GRR in Beltz Wellfield area with MBR + AWTF at DA Porath PS (Serve NPR users along the way)	4	3	4	4	3	3	4	1	4	4	3	1	3	3	4	2	50.0
Alternative 5 – Surface Water Augmentation (SWA) in Loch Lomond Reservoir	5	Advanced treatment of Santa Cruz effluent for augmentation of Loch Lomond Reservoir (no NPR along the way)	4	2	3	4	2	3	4	2	1	3	2	1	5	3	5	3	47.0
Alternative 6 – Streamflow Augmentation	6	Advanced treatment of Santa Cruz effluent for discharge to the San Lorenzo River d/s of Tait Street Diversion (no NPR users along the way)	3	2	3	4	1	4	4	2	1	4	2	1	5	4	5	4	49.0
Alternative 7 – Direct Potable Reuse	7	Raw Water Blending at Graham Hill WTP (via Coast PS or other point of blending)	5	1	5	4	2	3	4	2	2	5	2	1	1	3	5	3	48.0
Alternative 8 – Regional GRRP	8a	Regional GRRP in the Santa Margarita GW Basin to serve the City, Scotts Valley, Soquel Creek and San Lorenzo Valley	4	1	5	5	3	2	5	4	3	4	2	1	3	1	4	3	50.0
	8b	Regional GRRP in the Santa Margarita GW Basin to serve the City, Scotts Valley and San Lorenzo Valley	4	1	5	5	3	2	5	4	3	4	2	1	3	2	4	3	51.0

Table G-4: Alternative Project Ranking and Sensitivity Analysis

Summary of Alternative Project Ranking and Sensitivity Analysis

Alternative	Sub-Alt #	Description	SENSITIVITY SCORING: Baseline (Balanced)	Maximize Water Supply	WSAC Criteria	WSAC Values	Maximize Beneficial Reuse	Maximizing Engineering & Operational Considerations	Low Cost	Minimize Local Impacts	SENSITIVITY RANKING: Baseline (Balanced)	Maximize Water Supply	WSAC Criteria	WSAC Values	Maximize Beneficial Reuse	Maximizing Engineering & Operational Considerations	Low Cost	Minimize Local Impacts
Alternative 1 – Centralized Non-Potable Reuse	**1a**	Santa Cruz PWD Title 22 Upgrades	89	81	72	77	81	91	93	88	1	1	4	1	1	1	1	1
	1b	Maximize tertiary treatment and reuse in the City	70	69	60	64	69	83	65	74	4	5	8	7	7	2	10	2
Alternative 2 – Decentralized Non-Potable Reuse	**2**	UC Santa Cruz satellite treatment and reuse on campus	70	66	56	58	68	73	69	71	5	7	11	11	8	5	6	3
Alternative 3 – Santa Cruz Participation in SqCWD led Groundwater Recharge Reuse (GRR) Project	**3a**	Send secondary effluent from SCWWTF to SqCWD for injection in SqCWD basin (no reuse in City)	*Not Analyzed*								*Not Analyzed*							
	3b	Send tertiary effluent from SCWWTF to SqCWD (serve NPR users along the way)	73	68	69	70	66	81	81	67	2	6	6	5	9	3	2	4
	3c	Send additional secondary effluent from SCWWTF to SqCWD AWTF and deliver advanced treated water from SqCWD AWTF to recharge Beltz Wellfield (GRR in Beltz + NPR users along the way back)	68	71	74	71	75	73	66	62	7	4	3	4	2	4	9	9
	3d	Send advanced treated RW from an AWTF at/near SCWWTF to SqCWD (serve NPR users along the way)	67	63	59	62	62	72	74	65	8	8	9	9	12	6	3	5
	3e	Send advanced treated RW from an AWTF at/near SCWWTF to SqCWD (GRR in Beltz Wellfield + NPR along the way)	69	71	77	75	70	69	71	64	6	3	1	3	6	7	5	7
Alternative 4 – Santa Cruz GRRP	**4a**	Santa Cruz GRR in Beltz Wellfield area with AWTF at/near SCWWTF (Serve NPR users along the way)	71	73	77	76	73	67	72	65	3	2	1	2	3	8	4	5
	4b	Santa Cruz GRR in Beltz Wellfield area with MBR + AWTF at DA Porath PS (Serve NPR users along the way)	62	62	70	68	65	57	67	52	9	9	5	6	10	11	7	12
Alternative 5 – Surface Water Augmentation (SWA) in Loch Lomond Reservoir	**5**	Advanced treatment of Santa Cruz effluent for augmentation of Loch Lomond Reservoir (no NPR along the way)	54	56	57	59	60	49	53	56	14	11	10	10	14	14	14	10
Alternative 6 – Streamflow Augmentation	**6**	Advanced treatment of Santa Cruz effluent for discharge to the San Lorenzo River d/s of Tait Street Diversion (no NPR users along the way)	57	55	53	58	62	51	59	62	13	13	12	11	13	13	13	8
Alternative 7 – Direct Potable Reuse	**7**	Raw Water Blending at Graham Hill WTP (via Coast PS or other point of blending)	61	58	63	64	65	53	66	52	10	10	7	8	11	12	8	13
Alternative 8 – Regional GRRP	**8a**	Regional GRRP in the Santa Margarita GW Basin to serve the City, Scotts Valley, Soquel Creek and San Lorenzo Valley	60	54	53	54	70	65	61	51	12	14	12	14	5	10	12	14
	8b	Regional GRRP in the Santa Margarita GW Basin to serve the City, Scotts Valley and San Lorenzo Valley	61	55	53	54	71	66	61	53	11	12	12	13	4	9	11	11

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Appendix H: Other Supporting Material

This appendix includes other supporting material used and referenced in the RWFPS

H.1 MOU between City and SqCWD for Pure Water Soquel, Groundwater Replenishment and Seawater Intrusion Prevention Project

H.2 Letters of Interest

- September 7, 2017 letter from Santa Cruz Public Works Department
- September 7, 2017 letter from Parks and Recreation
- September 20, 2017 letter from University of California, Santa Cruz

H.3 Water Rates and Fees

- City of Santa Cruz (2016 to 2020) – Inside City Rates, Outside City Rates and Drought Cost Recovery Fee
- SqCWD (2017 and 2018) – Monthly Service Charges, Emergency Rates and Additional Charges
- SVWD (2017 to 2020) – Bi-Monthly Rates for Potable Water, Monthly Rates for Recycled Water and Fee Schedule for New Connections

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MEMORANDUM OF UNDERSTANDING BETWEEN SOQUEL CREEK WATER DISTRICT AND CITY OF SANTA CRUZ MEMORIALIZING PRELIMINARY TERMS RELATED TO "PURE WATER SOQUEL," AN ADVANCED PURIFIED GROUNDWATER REPLENISHMENT PROJECT

This Memorandum of Understanding ("MOU") is made and entered into on this 21st day of July, 2017 (the "Effective Date") by and between the Soquel Creek Water District ("District"), a special district organized and existing under the County Water District Law (Cal. Water Code §30000, et seq.) and the City of Santa Cruz ("City"), a charter law city organized and existing under Article XI of the Constitution of the State of California and the City Charter (collectively the "Parties"), and provides as follows:

RECITALS

WHEREAS, City owns and operates a regional wastewater treatment facility ("WWTF") that provides wastewater treatment and disposal services to the City of Santa Cruz, Santa Cruz County Sanitation District (including Live Oak, Capitola and Aptos areas) and disposal services to the City of Scotts Valley; and

WHEREAS, wastewater generated by development in the service area of the District is conveyed through facilities owned and operated by the Santa Cruz County Sanitation District to the City of Santa Cruz WWTF for treatment and disposal, making the City's wastewater facility a regional asset for the treatment of wastewater; and

WHEREAS, the City of Santa Cruz WWTF pumps approximately on average eight (8) million gallons per day of treated water into the Monterey Bay National Marine Sanctuary and reduction and recycling of this treated water would be considered a benefit; and

WHEREAS, the Santa Cruz Mid-County Groundwater Basin (the "Basin") is currently the sole source of potable water supply for the water service area of the District; and

WHEREAS, the Basin has been designated by the State of California as being in a state of critical overdraft and threatened by seawater intrusion that will, if not promptly and effectively addressed, cause irreparable damage to the Basin making it unsuitable for continued use as a source of potable water; and

WHEREAS, the District has prepared and is implementing a Community Water Plan that includes a range of possible approaches that would, if implemented, provide the means of reducing or eliminating the threat of seawater intrusion and contributing to the restoration of the Basin to sustainable levels, as required by the state's 2014 Sustainable Groundwater Management Act; and

WHEREAS, a key conclusion from the Community Water Plan is that, in addition to ongoing water conservation and proactive groundwater management, a supplemental source of supply is required to eliminate the threat of seawater intrusion and begin the longer term process of restoring the Basin to sustainable levels; and

WHEREAS, in accordance with the California Environmental Quality Act ("CEQA"), the Community Water Plan identified options the District intends to evaluate, including at least the following range of potential water supply alternatives: 1) No Action; 2) Water Transfers and Exchanges using treated, available surface water from City of Santa Cruz's sources; 3) Desalination based on the proposed Deep Water Desal project that would be located in Moss Landing; and 4) Advanced Purified Recycled Water Facility (APWF) for groundwater replenishment; and

WHEREAS, in November of 2016, the District issued a Notice of Preparation/Initial Study ("NOP/IS") in accordance with CEQA and began preparing an Environmental Impact Report ("EIR") for "Pure Water Soquel," an advanced purified groundwater replenishment project (the "Project") to utilize advanced treated wastewater to supplement natural recharge of the Basin with purified water, and thereby to increase the sustainability of the District's groundwater supply, reduce overdraft conditions in the Basin, protect against seawater intrusion, and promote beneficial reuse by reducing discharge of treated wastewater into the Monterey Bay National Marine Sanctuary; and

WHEREAS, as described in the NOP/IS, the District is considering three options and two potential locations for treatment system components of the Project, including: **Option 1:** upgrading a portion of the WWTF to provide on-site tertiary treatment, coupled with developing an advanced water purification facility ("AWPF") on District property located at the Capitola Avenue-Soquel Drive intersection (the "West Annex Site") for advanced purification of the tertiary effluent; **Option 2:** developing an AWPF at the West Annex Site for advanced purification of WWTF secondary effluent; and **Option 3:** development of a membrane bioreactor ("MBR") plus AWPF at the West Annex Site for the treatment of raw wastewater from the Santa Cruz County Sanitation District; and

WHEREAS, at its regular meetings of January 17 and March 3, 2017, the District's Board of Directors directed staff to evaluate other potential site locations for the AWPF, including the potential construction of such a facility on the City's WWTF site; and

WHEREAS, at its regular meeting of January 17, 2017, the District's Board of Directors expressed concerns about siting challenges associated with Option 3, such as the cost of such a facility, and potential environmental impacts that could be avoided if other options were pursued;

WHEREAS, to eliminate Option 3 as described above from further analysis due to potential siting challenges, the District requires certain assurances from the City that wastewater effluent from the City's WWTF will be available for its project, should it choose to pursue an advanced water purification facility option, and that such assurances would include both clarity about the available volumes of secondary, tertiary, or advanced purified recycled water that it could count on receiving from the City of Santa Cruz's WWTF, and a commitment from the City that such volumes of secondary or tertiary treated recycled water would be available over at least the reasonable life of any advanced water purification facility the District might choose to pursue following completing of its CEQA process; and

WHEREAS, the City acknowledges the legitimacy of the District's need for clarity and certainty regarding the timeframe of source availability as well as the volumes of effluent that it could count on under the various advanced purified recycled water options it is evaluating in its CEQA process; and

WHEREAS, due to the lack of other wastewater treatment facilities in the region, which makes the City's facility the sole source of treated wastewater effluent that would be suitable for the District's use in an advanced water purification project, the City believes it is appropriate and necessary that the City should provide reasonable assurances to the District regarding the availability of a source of supply for any advanced water purification recycled project it may choose to pursue; and

WHEREAS, nothing about any assurances made by the City to provide clarity and certainty regarding the timeframe of source water availability as well as the volumes of treated effluent that would be available to the District, should it pursue one of the above-referenced options following completion of its environmental review process, in any way affects the City's commitment to implementing its Water Supply Advisory Committee's recommendations, including recommendations regarding the preference for using winter river flows to develop a supplemental source of supply for Santa Cruz that would increase water supply reliability and reduce vulnerability to drought in the City's water service area.

NOW THEREFORE, the Parties agree as follows:

1. Definitions: In addition to the terms defined above, capitalized terms used in this MOU have the meanings specified in this section:
    a. "AWPF" shall mean an advanced water purification facility capable of treating secondary or tertiary treated effluent to advanced purified water standards suitable for groundwater replenishment via direct injection/recharge.
    b. "Capitola" shall mean the City of Capitola.
    c. "County" shall mean the County of Santa Cruz.

d. "MGD" shall mean million gallons per day.
e. "Purified Water" shall mean water that has undergone advanced water purification treatment for beneficial reuse (groundwater recharge).
f. "RO Concentrate" shall mean concentrate produced from the advanced water purification (reverse osmosis) process.
g. "SCCSD" shall mean the Santa Cruz County Sanitation District.
h. "Secondary Effluent" shall mean existing wastewater effluent from the WWTF that has been treated to remove settable solids and also includes a biological process to remove dissolved and suspended organic compounds.
i. "Tertiary Effluent" shall mean secondary effluent that undergoes additional treatment for removal of organic and inorganic material to produce a higher quality of effluent typically used for water recycling.

2. Subject to full CEQA compliance, and subject to the Districts potential decision to pursue any of the Pure Water Soquel project options, the City would deliver treated effluent to the District of a quantity sufficient to produce a not to exceed amount of 1,500 acre-feet per year (approximately1.3 million MGD) of advanced treated recycled water for a Pure Water Soquel Project. The Parties also agree to working together to develop and enter into a final agreement on terms and conditions (the "Project Agreement") including, but not limited to, those issues set forth in Paragraph 3 below.

3. The term of this MOU shall commence on the Effective Date and shall continue in effect until the earlier to occur of: (1) final approval of the Project Agreement by City and District; or (2) December 31, 2022 unless further extended by mutual agreement of the parties (the "Term"). Except for costs reimbursed by District in accordance with Paragraph 4, below, both City and District shall hold each other free and harmless for their respective costs incurred in connection with this MOU in the event the Parties are unable to successfully conclude negotiations toward a mutually acceptable Project Agreement prior to the conclusion of the Term.

4. Pending any final approval of the Project Agreement by City and the District, the Parties agree that District shall reimburse City for agreed upon costs incurred by City in connection with the environmental review, planning, design, permitting and construction of the Project, within thirty (30) days of the City providing District with appropriate documentation of such costs incurred.

5. The Project Agreement shall provide for all of the following, based upon information produced from the Final EIR for the Project:
    a. Determination of the design, location and configuration of secondary or tertiary effluent treatment facilities to be constructed at the WWTP site to serve the Project.

b. Determination of the design, location and configuration of facilities within the City, unincorporated County and City of Capitola to deliver treated effluent from the WWTF to the AWPF and the return of RO concentrate from the AWPF to the WWTF for possible treatment and disposal at the City's ocean outfall.
c. Ownership and operation of various components of the Project facilities.
d. Selection of process for the construction phase, including development of plans, specification and contract documents and methodologies for construction of Project facilities, including consideration of proceeding with design-build or design-bid-build processes.
e. Preparation and implementation of an Operations Plan that shall serve as the basis for identifying responsible parties for operating costs and operation requirements.
f. Coordination as necessary with the SCCSD in accordance with the requirements of state law, including Water Code Section 13550-13551.
g. Term and termination of the Project Agreement and any extension option periods. At present, it is contemplated that the Project Agreement shall be for a period of thirty-five (35) years from its effective date, with automatic five (5) year extension periods thereafter unless either party gives notice of termination at least twenty-four (24) months in advance of the term or extension period then in effect.
h. Provisions for ownership and/or disposition of Project Facilities upon termination.
i. Provisions for relocation of Project Facilities in connection with future public works projects, including parties responsible for the costs of relocation.
j. Additional terms
    1. Liability/indemnification provisions
    2. Force majeure
    3. Dispute resolution
    4. Attorneys' fees and costs
    5. Remedies for non-performance
    6. Conditions precedent
    7. Assignment
    8. Notice
    9. Governing law/venue
    10. Amendments
    11. Availability of records/audits
    12. Cessation during declared emergency
    13. Relationship of parties
    14. Severability
    15. Waiver
    16. Counterparts

17. Representations, warranties and covenants

6. The purpose of this MOU is to memorialize preliminary terms between the Parties and provide a general framework for good faith negotiations. All obligations of the Parties under this MOU, including but not limited to the consideration of the Project Agreement and the commitment to deliver treated effluent set forth in Paragraph 2 above, are conditioned upon compliance with CEQA. In no event shall the City or the District be required to implement any provision of this MOU prior to the District's approval of the Project and certification of the EIR, if such actions occur.

IN WITNESS WHEREOF, the Parties, by their duly authorized agents, have executed this MOU on the dates set forth below.

SOQUEL CREEK WATER DISTRICT

By: ______________________ Dated: 7/12/17

Tom LaHue, President

APPROVED AS TO FORM:

____

Robert E. Bosso, District Counsel

CITY OF SANTA CRUZ

By: ______________________ Dated: 7-21-17

Martin Bernal, City Manager

APPROVED AS TO FORM:

____

Anthony P. Condotti, City Attorney

Appendix H.2

CITY OF SANTA CRUZ

PUBLIC WORKS DEPARTMENT
809 Center Street, Santa Cruz, CA 95060 • (831) 420-5216 • Fax (831) 420-5161

September 7, 2017

Ms. Heidi Luckenbach
City of Santa Cruz Water Department
212 Locust Street, Suite C
Santa Cruz, CA 95060

RE: INTEREST AND INTENTION IN PURSUING RECYCLED WATER PROJECTS

Ms. Luckenbach:

The Santa Cruz Public Works Department wishes to express its support for the Recommended Projects as described in the Water Department's Regional Recycled Water Feasibility Study.

Currently our wastewater facility recycles water for in-plant use only. Conversion to Title 22 compliant recycled water for off-site use would demonstrate the quality and safety of this water to the community. By converting the identified neighboring parks and City irrigation services from potable water to tertiary recycled water the City of Santa Cruz as a whole benefits by reducing peak season potable water demand.

Our wastewater facility is a quality of life service to the community. We believe that pursuing recycled water to offset non-potable and potable water demands is in line with our commitment to the community and we look forward to working with the Water Department to further develop these projects.

Sincerely,

Mark Dettle
Director
Public Works Department

CITY OF SANTA CRUZ

PARKS AND RECREATION DEPARTMENT
323 Church Street, Santa Cruz, CA 95060 • (831) 420-5270 • Fax (831) 420-5271

September 7, 2017

Ms. Heidi Luckenbach
City of Santa Cruz Water Department
212 Locust Street, Suite C
Santa Cruz, CA 95060

RE: INTEREST AND INTENTION IN PURSUING RECYCLED WATER PROJECTS

Ms. Luckenbach:

Thank you for the informative presentation that you provided Parks staff recently over potential plans for recycled water in Santa Cruz. The Santa Cruz Parks and Recreation Department wishes to express its extreme interest and support in the recommended projects as described in the Water Department's Regional Recycled Water Feasibility Study.

All City parks and the golf course are currently irrigated with potable water. By transitioning La Barranca Park and potentially other City parks from potable water to tertiary recycled water we can demonstrate the safety, quality and reliability of recycled water to the community.

The Parks and Recreation Department and the Water Department will both benefit from these projects. During times of drought, reducing potable water demand increases our resiliency and by irrigating with recycled water we are able to maintain healthy vegetation and green spaces for our community.

We are excited about this opportunity and look forward to participating as potential users of recycled water.

Sincerely,

Mauro Garcia
Parks and Recreation Director

UNIVERSITY OF CALIFORNIA, SANTA CRUZ

BERKELEY • DAVIS • IRVINE • LOS ANGELES • MERCED • RIVERSIDE • SAN DIEGO • SAN FRANCISCO SANTA BARBARA • SANTA CRUZ

BUSINESS AND ADMINISTRATIVE SERVICES SANTA CRUZ, CALIFORNIA 95064

September 20, 2017

Ms. Heidi Luckenbach
City of Santa Cruz Water Department
212 Locust Street, Suite C
Santa Cruz, CA 95060

RE: INTEREST AND INTENTION IN PURSUING RECYCLED WATER PROJECTS

Ms. Luckenbach:

University of California Santa Cruz (UCSC) wishes to express its support for the Recommended Projects as described in the Water Department's Regional Recycled Water Feasibility Study.

UCSC is committed to continued water conservation, efficient use of our limited water resources, and partnering with our water provider to explore technologies and techniques to reduce potable water demand as our campus grows. Identified as one of the key opportunities in our 2013 Water Action Plan, we plan to evaluate the use of non-potable water sources for irrigation of the Farm, toilets, and recreation fields. To seize this opportunity we plan to include non-potable water piping in infrastructure and roads whenever possible.

If non-potable water demands can be met with non-potable water instead of potable water this will reduce our per capita potable water use which is in line with our water conservation goals. In addition, our recreation fields and green spaces provide a place for our students to maintain a healthy lifestyle and calming environment. By irrigating with non-potable water we would be able to better maintain these spaces through droughts.

As the City pursues the initial non-potable water projects of irrigating La Barranca Park and creating a bulk water station, we will work together with the Water Department and the City to further evaluate a non-potable recycled water project to serve UCSC.

We are excited about this opportunity and look forward to participating as potential users of recycled water.

Sincerely,

Sarah C. Latham

Sarah C. Latham
Vice Chancellor
Business and Administrative Services

Inside City Rates

Inside City Fixed Rates - Ready to Serve

Meter Size	Ready to Serve ($/Meter) As of 10/1/16	As of 7/1/17	As of 7/1/18	As of 7/1/19	As of 7/1/20
5/8-in	$ 8.78	$ 9.53	$ 10.18	$ 10.71	$ 11.26
3/4-in	$ 9.01	$ 9.78	$ 10.45	$ 10.99	$ 11.56
1-in	$ 9.70	$ 10.53	$ 11.25	$ 11.83	$ 12.44
1 1/2-in	$ 10.61	$ 11.52	$ 12.31	$ 12.94	$ 13.61
2-in	$ 13.14	$ 14.26	$ 15.24	$ 16.02	$ 16.85
3-in	$ 31.74	$ 34.45	$ 36.82	$ 38.71	$ 40.71
4-in	$ 38.63	$ 41.93	$ 44.81	$ 47.11	$ 49.55
6-in	$ 54.70	$ 59.37	$ 63.45	$ 66.71	$ 70.16
8-in	$ 73.07	$ 79.31	$ 84.76	$ 89.11	$ 93.73
10-in	$ 93.74	$ 101.75	$ 108.73	$ 114.32	$ 120.24
Fire Service - All Sizes *	$1 /month	$1.09 /month	$1.15 /month	$1.21 /month	$1.26 /month

Inside City Volume (Commodity) Rates - Consumption

	As of 10/1/16	As of 7/1/17	As of 7/1/18	As of 7/1/19	As of 7/1/20
Single Family Residential and Multi-Family Residential (calculation is based upon the number of dwelling units multiplied by the tier width)					
Tier 1 (0-5 ccf**)	$ 5.75	$ 6.24	$ 6.66	$ 7.01	$ 7.37
Tier 2 (6-7 ccf)	$ 6.42	$ 6.97	$ 7.45	$ 7.83	$ 8.24
Tier 3 (8-9 ccf)	$ 7.41	$ 8.05	$ 8.60	$ 9.04	$ 9.51
Tier 4 (10 ccf & above)	$ 8.79	$ 9.54	$ 10.20	$ 10.72	$ 11.28
Commerical: Business, Industrial, Restaurant, Hotel, Golf, Municipal, Bulk, Fire Service Leaks					
Uniform	$ 6.57	$ 7.13	$ 7.62	$ 8.01	$ 8.43
UCSC					
Uniform	$ 6.70	$ 7.27	$ 7.77	$ 8.17	$ 8.60
Landscape / Irrigation (tiers based on percent of water budget)					
Tier 1 (≤100% of budget)	$ 6.86	$ 7.44	$ 7.95	$ 8.36	$ 8.80
Tier 2 (101% - 150%)	$ 9.15	$ 9.93	$ 10.62	$ 11.16	$ 11.74
Tier 3 (150% & above)	$ 10.27	$ 11.14	$ 11.91	$ 12.52	$ 13.17
Elevation Surcharge					
As Applicable	$ 0.42	$ 0.46	$ 0.49	$ 0.51	$ 0.54

Inside City Volume (Commodity) Rates - Infrastructure Reinvestment Fee

	As of 10/1/16	As of 7/1/17	As of 7/1/18	As of 7/1/19	As of 7/1/20
Single Family Residential and Multi-Family Residential (calculation is based upon the number of dwelling units multiplied by the tier width)					
Tier 1 (0-5 ccf**)	$ 1.55	$ 1.73	$ 1.82	$ 2.02	$ 2.23
Tier 2 (6-7 ccf)	$ 2.32	$ 2.59	$ 2.73	$ 3.03	$ 3.34
Tier 3 (8-9 ccf)	$ 2.86	$ 3.20	$ 3.37	$ 3.74	$ 4.13
Tier 4 (10 ccf & above)	$ 3.85	$ 4.30	$ 4.53	$ 5.02	$ 5.55
Commerical: Business, Industrial, Restaurant, Hotel, Golf, Municipal, Bulk					
Uniform	$ 2.27	$ 2.53	$ 2.66	$ 2.96	$ 3.27
UCSC					
Uniform	$ 2.40	$ 2.68	$ 2.82	$ 3.13	$ 3.46
Landscape / Irrigation (tiers based on percent of water budget)					
Tier 1 (≤100% of budget)	$ 2.82	$ 3.14	$ 3.31	$ 3.67	$ 4.06
Tier 2 (101% - 150%)	$ 4.22	$ 4.71	$ 4.96	$ 5.50	$ 6.08
Tier 3 (150% & above)	$ 4.27	$ 4.77	$ 5.02	$ 5.57	$ 6.16

Inside City Volume (Commodity) Rates - Rate Stabilization Fee

	As of 10/1/16	As of 7/1/17	As of 7/1/18	As of 7/1/19	As of 7/1/20
All accounts (Per ccf)	$ -	$ 1.00	$ 1.00	$ 1.00	$ 1.00

*This amount may be billed annually and will be added to any other applicable water use fixed and volume charges. **ccf equals 100 cubic foot of water.

Outside City Rates

Outside City Fixed Rates - Ready to Serve

Meter Size	Ready to Serve ($/Meter)				
	As of 10/1/16	As of 7/1/17	As of 7/1/18	As of 7/1/19	As of 7/1/20
5/8-in	$ 10.05	$ 10.91	$ 11.66	$ 12.26	$ 12.89
3/4-in	$ 10.32	$ 11.20	$ 11.97	$ 12.59	$ 13.24
1-in	$ 11.11	$ 12.06	$ 12.89	$ 13.55	$ 14.25
1 1/2-in	$ 12.16	$ 13.20	$ 14.10	$ 14.83	$ 15.60
2-in	$ 15.05	$ 16.34	$ 17.46	$ 18.35	$ 19.30
3-in	$ 36.36	$ 39.47	$ 42.17	$ 44.34	$ 46.64
4-in	$ 44.25	$ 48.03	$ 51.33	$ 53.96	$ 56.76
6-in	$ 62.66	$ 68.01	$ 72.68	$ 76.42	$ 80.37
8-in	$ 83.71	$ 90.86	$ 97.10	$ 102.09	$ 107.38
10-in	$ 107.38	$ 116.55	$ 124.55	$ 130.95	$ 137.74
Fire Service - All Sizes *	$1.15 /month	$1.23 /month	$1.30 /month	$1.35 /month	$1.40 /month

Outside City Volume (Commodity) Rates - Consumption

	As of 10/1/16	As of 7/1/17	As of 7/1/18	As of 7/1/19	As of 7/1/20
Single Family Residential and					
Multi-Family Residential (calculation is based upon the number of dwelling units multiplied by the tier width)					
Tier 1 (0-5 ccf**)	$ 6.59	$ 7.16	$ 7.65	$ 8.04	$ 8.46
Tier 2 (6-7 ccf)	$ 7.37	$ 8.00	$ 8.55	$ 8.99	$ 9.46
Tier 3 (8-9 ccf)	$ 8.54	$ 9.27	$ 9.90	$ 10.41	$ 10.95
Tier 4 (10 ccf & above)	$ 10.15	$ 11.02	$ 11.78	$ 12.38	$ 13.02
Commerical: Business, Industrial, Restaurant, Hotel, Golf, Municipal, Bulk, Fire Service Leaks					
Uniform	$ 7.53	$ 8.17	$ 8.73	$ 9.18	$ 9.66
North Coast AG					
Uniform	$ 3.58	$ 3.88	$ 4.15	$ 4.36	$ 4.59
Landscape / Irrigation (tiers based on percent of water budget)					
Tier 1 (≤100% of budget)	$ 7.85	$ 8.53	$ 9.11	$ 9.58	$ 10.08
Tier 2 (101% - 150%)	$ 10.48	$ 11.38	$ 12.16	$ 12.79	$ 13.45
Tier 3 (150% & above)	$ 11.76	$ 12.77	$ 13.64	$ 14.34	$ 15.09
Elevation Surcharge					
As Applicable	$ 0.48	$ 0.52	$ 0.56	$ 0.59	$ 0.62

Outside City Volume (Commodity) Rates - Infrastructure Reinvestment Fee

	As of 10/1/16	As of 7/1/17	As of 7/1/18	As of 7/1/19	As of 7/1/20
Single Family Residential and					
Multi-Family Residential (calculation is based upon the number of dwelling units multiplied by the tier width)					
Tier 1 (0-5 ccf**)	$ 1.78	$ 1.99	$ 2.10	$ 2.33	$ 2.57
Tier 2 (6-7 ccf)	$ 2.68	$ 2.99	$ 3.15	$ 3.49	$ 3.86
Tier 3 (8-9 ccf)	$ 3.30	$ 3.69	$ 3.88	$ 4.31	$ 4.76
Tier 4 (10 ccf & above)	$ 4.44	$ 4.96	$ 5.22	$ 5.80	$ 6.41
Commerical: Business, Industrial, Restaurant, Hotel, Golf, Municipal, Bulk					
Uniform	$ 2.59	$ 2.90	$ 3.05	$ 3.38	$ 3.74
North Coast AG					
Uniform	$ 3.05	$ 3.40	$ 3.58	$ 3.98	$ 4.39
Landscape / Irrigation (tiers based on percent of water budget)					
Tier 1 (≤100% of budget)	$ 3.23	$ 3.60	$ 3.79	$ 4.21	$ 4.65
Tier 2 (101% - 150%)	$ 4.83	$ 5.39	$ 5.68	$ 6.30	$ 6.97
Tier 3 (150% & above)	$ 4.89	$ 5.46	$ 5.75	$ 6.38	$ 7.05

Outside City Volume (Commodity) Rates - Rate Stabilization Fee

	As of 10/1/16	As of 7/1/17	As of 7/1/18	As of 7/1/19	As of 7/1/20
All accounts (Per ccf)	$ -	$ 1.00	$ 1.00	$ 1.00	$ 1.00

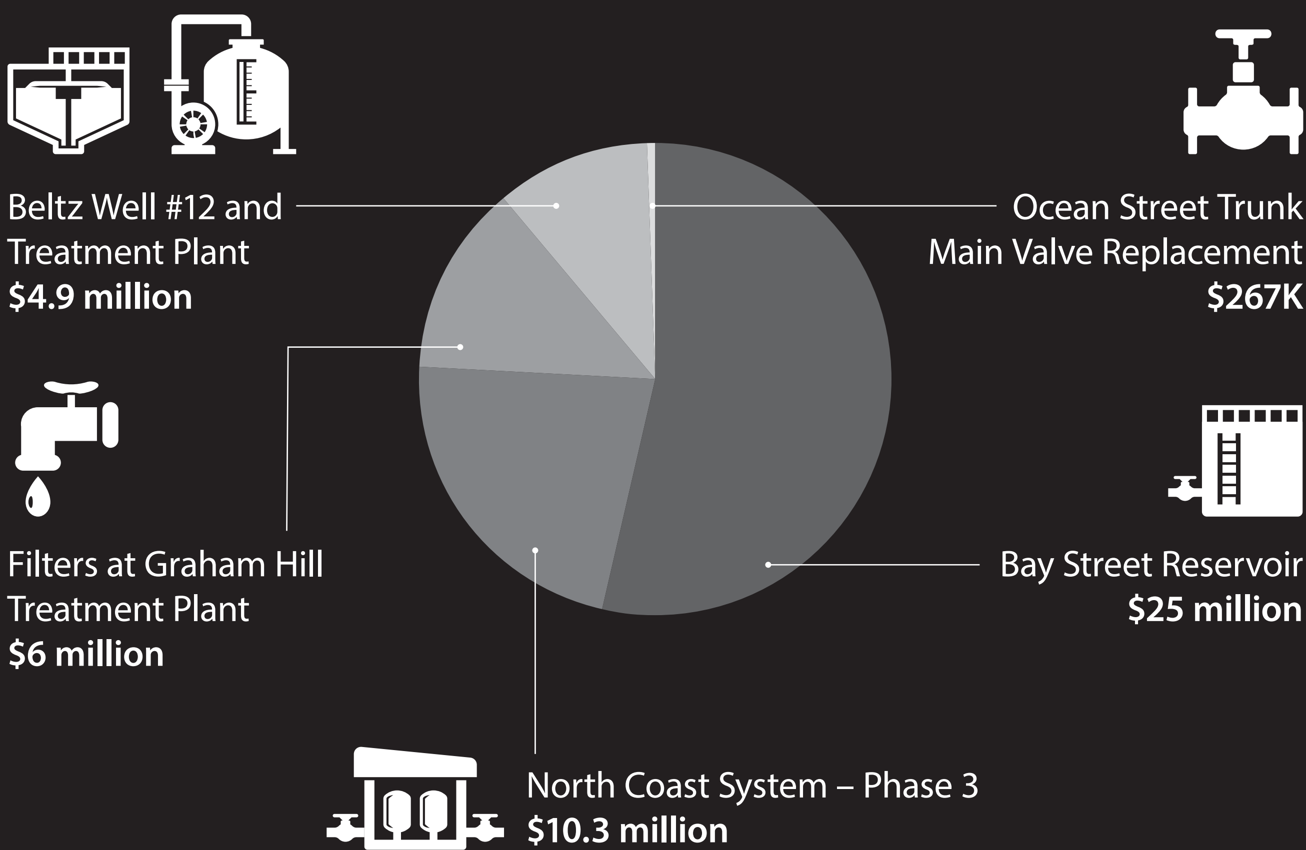
*This amount may be billed annually and will be added to any other applicable water use fixed and volume charges. **ccf equals 100 cubic foot of water.

Drought Cost Recovery Fee (DCRF)

	Stage 1 – 5% Shortage	Stage 2 – 15% Shortage	Stage 3 – 25% Shortage	Stage 4 – 35% Shortage	Stage 5 – 50% Shortage
Maximum Targeted Cost Recovery	$ 1,000,000	$ 2,500,000	$ 4,000,000	$ 5,500,000	$ 7,500,000
5/8-in	$ 2.45	$ 6.12	$ 9.79	$ 13.46	$ 18.35
3/4-in	$ 2.45	$ 6.12	$ 9.79	$ 13.46	$ 18.35
1-in	$ 6.13	$ 15.30	$ 24.48	$ 33.65	$ 45.88
1 1/2-in	$ 12.25	$ 30.60	$ 48.95	$ 67.30	$ 91.75
2-in	$ 19.60	$ 48.96	$ 78.32	$ 107.68	$ 146.80
3-in	$ 36.75	$ 91.80	$ 146.85	$ 201.90	$ 275.25
4-in	$ 61.25	$ 153.00	$ 244.75	$ 336.50	$ 458.75
6-in	$ 122.50	$ 306.00	$ 489.50	$ 673.00	$ 917.50
8-in	$ 281.75	$ 703.80	$ 1,125.85	$ 1,547.90	$ 2,110.25
10–in	$ 347.90	$ 869.04	$ 1,390.18	$ 1,911.32	$ 2,605.70

The Drought Cost Recovery Fee maximum amounts set forth above are a fixed fee and are hereby established and shall be applicable for the full fiscal year (twelve months) following the water shortage declaration made by City Council. The maximum targeted cost recovery amount is indicated below and is linked to the water shortage stage declared by the City Council.

How Your Money Has Been Spent



Single-family Residential Monthly Service Charge (1-2 residences)

Meter Size	2017 Rate (effective January 1, 2017)	2018 Rate (effective January 1, 2018)
5/8" Restricted	$14.71	$16.47
5/8"	$29.42	$32.95
3/4"	$29.42	$32.95
1"	$29.42	$32.95
1.5"	$29.42	$32.95

Multi-family Residential Monthly Service Charge (3 or more residences)

Meter Size	2017 Rate (effective January 1, 2017)	2018 Rate (effective January 1, 2018)
5/8" Restricted	$9.94	$11.14
5/8	$19.89	$22.27
3/4"	$29.83	$33.41
1"	$49.72	$55.68
1.5"	$89.49	$100.23
2"	$174.01	$194.89
3"	$328.13	$367.51
4"	$437.51	$490.01
6"	$1,193.20	$1,336.39
8"	$1,590.94	$1,781.85

Commercial Monthly Service Charge

Meter Size	2017 Rate (effective January 1, 2017)	2018 Rate (effective January 1, 2018)
5/8" Restricted	$16.94	$18.97
5/8"	$33.88	$37.94
3/4"	$50.81	$56.91

1"	$84.69	$94.85
1.5"	$152.44	$170.73
2"	$296.41	$331.98
3"	$558.94	$626.01
4"	$745.25	$834.68
6"	$2,032.51	$2,276.41
8"	$2,710.02	$3,035.22

Fire Service Monthly Service Charge

These monthly charges fund fire protection in the District. They help cover the cost of fire hydrant maintenance and pump upgrades, water mains, and a portion of the associated facility maintenance costs.

Meter Size	2017 Rate (effective January 1, 2017)	2018 Rate (effective January 1, 2018)
1.5"	$9.51	$10.65
2"	$16.91	$18.93
2.5"	$30.64	$34.32
3"	$36.98	$41.42
4"	$66.57	$74.55
6"	$147.92	$165.67
8"	$253.58	$284.01

Irrigation/Outdoor Use Monthly Service Charge

Meter Size	2017 Rate (effective January 1, 2017)	2018 Rate (effective January 1, 2018)
5/8" Restricted	$26.87	$30.10
5/8"	$53.75	$60.20
3/4"	$80.62	$90.30
1"	$134.37	$150.49
1.5"	$241.86	$270.89
2"	$470.29	$526.73
3"	$886.83	$993.25
4"	$1,182.44	$1,324.34
6"	$3,224.85	$3,611.83
8"	$4,299.80	$4,815.78

Water Quantity Charges

Water quantity charges are billed for units of water used during the 30-day billing cycle. One unit of water is equal to 748 gallons. Residential customers have a 4-tier rate structure. Tier 1 covers basic operational costs. Tiers 2, 3, and 4 cover the increased costs of providing water during a supply shortage such as conservation and developing additional water sources.

Emergency Rates

During water shortages, the District raises rates to maintain operating revenue during the period of decreased water usage. The District is currently under a Stage 3 Water Shortage Emergency, and Stage 3 Rates were enacted effective June 1, 2015 and are currently still in effect.

Single-family Residential Water Use Charge (Including Stage 3 Emergency rates. For 1-2 residences)

Tier	Units	Rate per unit of water used (effective January 1, 2017)	Rate per unit of water used (effective January 1, 2018)
Tier 1	1-3.99 Units	$6.16	$6.90
Tier 2	4-7.99 Units	$8.14	$9.11
Tier 3	8-13.99 Units	$18.76	$21.01
Tier 4	14+ Units	$39.30	$44.01

Multi-Family Residential Water Use Charge (Including Stage 3 Emergency Rates. For 3 or more residences)

Tiers	Units per Dwelling	Rate per unit of water used (effective January 1, 2017)	Rate per unit of water used (effective January 1, 2018)
Tier 1	1-2.99 Units	$6.16	$6.90
Tier 2	3-5.99 Units	$8.14	$9.11
Tier 3	6-10.99 Units	$18.76	$21.01
Tier 4	11+ Units	$39.30	$44.01

Commercial and Irrigation/Outdoor Water Use Charge (Including Stage 3 Emergency Rates)

Rate (effective January 1, 2017)	Rate (effective January 1, 2018)
$9.28	$10.40

Additional Charges

- Customer returned checks $25.00
- Delinquent charge (48-Hour Notice) $25.00
- Reestablishment of service $40.00 (Additional $60 if water is to be turned on after normal business hours)
- Automated Meter Read Opt-Out Fee $10.00 per read

SCOTTS VALLEY WATER DISTRICT

RATE SCHEDULE - POTABLE WATER

Bi-Monthly Rates

BASIC METER CHARGE	Effective 10/13/17	Effective 12/13/17	Effective 12/13/18	Effective 12/13/19	Effective 12/13/20
Meter Size					
5/8"	$59.93	$68.92	$75.82	$83.41	$91.76
5/8" Fire Service (Residential/Commercial)	$16.30	$18.75	$20.63	$22.70	$24.97
3/4" (Multi-Residential, incl Fire Service) *	$76.23	$87.67	$96.45	$106.11	$116.73
3/4"	$94.29	$108.44	$119.29	$131.22	$144.35
1"	$101.43	$116.65	$128.32	$141.16	$155.28
1 1/2"	$238.39	$274.15	$301.57	$331.73	$364.91
2"	$323.68	$372.24	$409.47	$450.42	$495.47
3"	$577.08	$663.65	$730.02	$803.03	$883.34
4"	$1,009.03	$1,160.39	$1,276.43	$1,404.08	$1,544.49
6"	$2,155.44	$2,478.76	$2,726.64	$2,999.31	$3,299.25

RESIDENTIAL TIERED RATES (Per 1,000 Gal)	Effective 12/13/16	Effective 12/13/17	Effective 12/13/18	Effective 12/13/19	Effective 12/13/20
Tiers for Residential Units with Individual Meters					
0 TO 6,000	$4.89	$5.63	$6.20	$6.83	$7.52
6,001 TO 12,000	$8.59	$9.82	$10.77	$11.82	$12.97
12,001 TO 16,000	$13.72	$15.72	$17.26	$18.95	$20.81
OVER 16,000	$16.56	$18.99	$20.86	$22.91	$25.17
Tiers for Multi-Residential Units with Master Meters **					
0 TO 6,000	$4.89	$5.63	$6.20	$6.83	$7.52
6,001 TO 6,400	$8.59	$9.82	$10.77	$11.82	$12.97
6,401 TO 16,000	$13.72	$15.72	$17.26	$18.95	$20.81
OVER 16,000	$16.56	$18.99	$20.86	$22.91	$25.17

UNIFORM RATES (Per 1,000 Gal)	Effective 12/13/16	Effective 12/13/17	Effective 12/13/18	Effective 12/13/19	Effective 12/13/20
Commercial, Industrial, Institutional (CII)	$11.45	$13.14	$14.44	$15.87	$17.44
Landscape Potable	$14.31	$16.43	$18.06	$19.85	$21.82
Other	$12.75	$14.64	$16.09	$17.68	$19.43
Qualifying Medical Needs Residential	$8.59	$9.82	$10.77	$11.82	$12.97

* Meter at Multi-Residential Units that is upsized only to provide fire service (equivalent to 5/8" plus fire detection meter)
** Tier allocation is per unit

Notes: 1) Board will evaluate and determine the need prior to implementing increases scheduled for 2017 - 2020
2) Rates will be implemented in the first full service/billing period following the effective date

Source: https://www.svwd.org/customer-info/rates-and-fees (downloaded on 6-6-2018)

SCOTTS VALLEY WATER DISTRICT

RATE SCHEDULE - RECYCLED WATER

Monthly Rates

BASIC METER CHARGE *	Effective 12/13/16	Effective 12/13/17	Effective 12/13/18	Effective 12/13/19	Effective 12/13/20
Meter Size					
5/8"	$6.00	$13.79	$22.75	$33.37	$45.88
3/4"	$9.43	$21.69	$35.79	$52.49	$72.18
1"	$10.15	$23.33	$38.50	$56.47	$77.64
1 1/2"	$23.84	$54.83	$90.48	$132.70	$182.46
2"	$32.37	$74.45	$122.85	$180.17	$247.74
3"	$57.71	$132.73	$219.01	$321.22	$441.67
4"	$100.91	$232.08	$382.93	$561.64	$772.25
6"	$215.55	$495.76	$818.00	$1,199.73	$1,649.63

UNIFORM RATES (Per 1,000 Gal)	Effective 12/13/16	Effective 12/13/17	Effective 12/13/18	Effective 12/13/19	Effective 12/13/20
Landscape Recycled	$11.77	$12.64	$13.19	$13.37	$13.64

* Gradual implementation of the new rate structure phasing-in basic meter charges and shifting costs from uniform commodity rates to basic meter charges over 5-year period.

Notes: 1) Board will evaluate and determine the need prior to implementing increases scheduled for 2017 - 2020
2) Rates will be implemented in the first full service/billing period following the effective date

Source: https://www.svwd.org/customer-info/rates-and-fees (downloaded on 6-6-2018)

SCOTTS VALLEY WATER DISTRICT

FEE SCHEDULE FOR NEW CONNECTIONS

Effective 12/13/17

Potable Service Connections			
Meter Size	**Capacity Fee**	**Meter Fee ***	**Total Fee**
5/8"	$20,971	$223	$21,194
COMBO SMALL SYSTEM **	$20,971	$446	$21,417
5/8" MULTI UNIT RESIDENTIAL ***	$12,583	$223	$12,806
DETAIL 4A (3/4") MULTI UNIT RESIDENTIAL ****	$12,583	$250	$12,833
COMBO MULTI UNIT RESIDENTIAL **/***	$12,583	$446	$13,029
3/4"	$31,457	$250	$31,707
1"	$52,428	$310	$52,738
1 1/2"	$104,854	$551-$1,090	varies
2"	$167,768	$750-$2,199	varies
3"	$366,990	$1,332-$2,699	varies
4"	$660,581	$1,891-$4.080	varies

Recycled Service Connections			
Meter Size	**Capacity Fee**	**Meter Fee ***	**Total Fee**
5/8"	$5,948	$223	$6,171
3/4"	$8,921	$250	$9,171
1"	$14,869	$310	$15,179
1 1/2"	$29,738	$551-$1,090	varies
2"	$47,581	$750-$2,199	varies
3"	$104,081	$1,332-$2,699	varies
4"	$187,346	$1,891-$4.080	varies

Fire Service Connections *****			
Meter Size/Hydrant	**Capacity Fee**	**Meter Fee ***	**Total Fee**
Private Fire Service (5/8" detection meter)	$0	$223	$223
Fire Hydrant - Publicly Owned	$0	-	$0
Fire Hydrant - Privately Owned	$0	-	$0

* Cost of the actual meter provided and installed by District

** Combo Small System combined 5/8" domestic meter with 5/8" fire detection meter

*** 5/8 Multi Unit Residential is a domestic meter (for indoor use) installed for individual units in a high-density development that uses recycled water for irrigation

**** Detail 4A (3/4") Multi Unit Residential is a domestic meter (for indoor use) installed for individual units in a high-density development that uses recycled water for irrigation

***** Regardless of the required pipe size, District installs 5/8" detection meter for all Private Fire Services

Note: Capacity Fees will be subject to annual adjustments based on Engineering News Record (ENR) Cost Index and Meter Fees will be subject to annual adjustments based on actual costs

Source: https://www.svwd.org/customer-info/rates-and-fees (downloaded on 6-6-2018)

Appendix I: Meeting Materials

Agendas and materials from the following meetings, workshops and webinars conducted with project partners during the study are included in this appendix.

Meeting/Workshop	Date	Focus
Kick-Off Meeting	03/30/16	Define study objectives, scope, roles and responsibilities.
Long-List Prelim Screening	06/28/16	Align on short-list of alternatives
Screening Criteria Webinar	08/29/16	Define alternative screening criteria
Alternative Webinar Part 1	10/18/16	Non-potable reuse alternative focus
Alternative Webinar Part 2	12/02/16	Potable reuse alternative focus (SWA/SFA/DPR)
Alternative Webinar Part 3	03/01/17	Beltz Wellfield IPR focus
Alternative Webinar Part 4	04/27/17	Regional IPR focus
Alternative Scoring and Ranking	06/01/17	Scoring and ranking outcomes
Recommended Facilities Plan	07/17/17	Align on recommended project

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Santa Cruz Regional
Recycled Water Facilities Planning Study (RWFPS)

Kick-Off Meeting
30 March 2016 from 9 am – 11 am

Location: 809 Center St., Santa Cruz, CA 95060
Planning Department Conference Room, Room 107

ATTENDEES:

Kennedy/Jenks - Dawn Taffler, Sachi Itagaki and Melanie Tan
City of Santa Cruz - Heidi Luckenbach, David Kehn, Catherine Borrowman, Anne Hogan, Rosemary Menard, Eileen Cross, Dan Seidel, Mark Dettle, Mike Sanders, Amy Poncato
Soquel Creek WD - Ron Duncan
Scotts Valley WD - Piret Harmon
Santa Cruz County - John Ricker, Kent Edler

AGENDA:

1. Introduction and Roles (All)
2. Background (City)
3. Overall project goals and expectations (All)
   a. Meet SWRCB Grant Requirements
   b. Assess beneficial reuse of wastewater from a resource recovery perspective
   c. Evaluate local and regional recycled water projects
   d. Identify near-term, mid-term and long-term projects
   e. Meet schedule for WSAC Outcome Element #3 - Advanced Treated Recycled Water
   f. Initiate strategy for continued outreach related to recycled water
   g. Others?
4. Scope of Work (Tables 1, 2, and 3) (K/J)
5. RWFPS Schedule (Figure 1) (K/J)
6. Data Request (K/J)
7. Open Discussion (All)

ACTION ITEMS:

** Regional Recycled Water Study Driving Tour to Follow **

Table 1: Scope of Work – Tasks and Major Deliverables

Task	Regional RWFPS Chapter	Major Deliverables
Task 1 - Project Management & QA/QC		Monthly Invoices, Status Reports, Schedule Updates, Project Work Plan
Task 2 - Background Information	Chapter 1 – Study Area Characteristics Chapter 2 – Water Supply Characteristics and Facilities	Data Request / Tracking Sheet Summary Tables/Figures
Task 3 - RW Market Analysis	Chapter 3 – Wastewater Characteristics and Facilities Chapter 5 – Recycled Water Market	Summary Tables/Figures Market Survey Map TM #1 Groundwater Replenishment TM #2 Surface Water Augmentation TM #3 Streamflow Augmentation TM #4 Direct Potable Reuse
Task 4 - Treatment Evaluation / Reg Requirements	Chapter 4 – Treatment Requirements for Discharge and Reuse	Summary Tables/Figures TM #5 Treatment Evaluation
Task 5 - Alternatives Analysis	Chapter 6 – Project Alternative Analysis	Summary Tables/Figures Screening Tables, Cost Tables
Task 6 – Stakeholder Involvement	Chapter 5 – Recycled Water Market	Materials as requested
Task 7 - Recommended Project	Chapter 7 – Recommended Facilities Project Plan	Summary Tables/Figures
Task 8 – Financial Analysis	Chapter 8 – Construction Financing Plan and Revenue Program	Summary Tables/Figures
Task 9 – Regional RWFPS Report		Admin Draft, SWRCB Draft, Final
Task 10 - Meetings and Workshops		Meeting Materials

Subconsultants

- Merritt Smith Consulting– Regulatory Strategy Support (Tasks 3, 5, 9 & 10)
- Data Instincts – Stakeholder Outreach (Tasks 6 & 10)
- Trussell Technologies – WWTF Facility/Supply Analysis, Treatment Technologies and QA/QC Support (Tasks 3, 4 & 10)
- Stratus Consulting/Abt Associates – Triple Bottom Line Analysis (Tasks 5 & 10)
- GHD Inc. – CEQA/Environmental Compliance Support (Task 5)
- Michael Welch, PhD. – Reservoir Augmentation (Task 3)

Table 2: Scope of Work – SubTasks and Budgets

Description	Total Budget
Task 1 – PM & QA/QC	
1.1 Project Management	$ 20,216
1.2 Status Calls/Web Meetings	$ 20,655
Task 2 – Background Info	
2.1 Data Collection	$ 16,493
2.2 Background Info	$ 6,508
Task 3 – Recycled Water Market Analysis	
3.1 WWTF Facility and Supply Analysis	$ 10,540
3.2 Non Potable Reuse Market Analysis	$ 15,249
3.3 Groundwater Recharge Reuse	$ 16,838
3.4 Reservoir Augmentation	$ 12,055
3.6 Streamflow Augmentation	$ 8,473
3.7 Direct Potable Reuse Potential	$ 22,253
Task 4 – Treatment Evaluation/Regulatory Requirements	
4.1 Water Quality and Regulatory Requirements	$ 8,660
4.2 Treatment Evaluation	$ 16,821
Task 5 – Alternatives Analysis	
5.1 Refine Long-List of Alternatives	$ 14,610
5.2 Preliminary Screening	$ 28,477
5.3 Evaluate Short List of Alternatives	$ 51,091
5.4 Alternative Capital, O&M and Life Cycle Costs	$ 16,493
Task 6 – Stakeholder Involvement	
6.1 Outreach Strategy and Advice	$ 15,325
6.2 Outreach Materials and Support	$ 14,825
Task 7 – Recommended Project	
7.1 Preliminary Facilities Design Criteria	$ 13,648
7.2 Implementation Plan	$ 7,630
Task 8 – Financial Analysis	
8.1 Anticipated Financing Plan	$ 6,161
8.2 Revenue Projection Program	$ 4,570
Task 9 – Regional RWFPS Report	
9.1 Admin Draft for City	$ 33,290
9.2 SWRCB Draft	$ 22,673
9.3 Final Report	$ 17,577
Task 10 - Meetings and Workshops	
10.1 Face to Face Meetings	$ 24,645
10.2 Workshops	$ 24,381
10.3 Presentations	$ 15,845
Total =	**$ 486,000**

Table 3: Preliminary List of Recycled Water Projects

Long-List of Projects	Recycled Water Use	Source Water	Treatment	Project Area(s)
1a	Industrial Use/ Landscape Irrigation	Santa Cruz WWTP	Tertiary	City, District and County
1b		Local Raw Wastewater	MBR Tertiary	UC Santa Cruz
2a	Irrigation	Santa Cruz WWTP	Tertiary	North Coast Agricultural Irrigation
2b		Santa Cruz WWTP -or- SVWD WWTP	Secondary or Tertiary	Pasatiempo + Other Landscape
2c		Santa Cruz WWTP	Tertiary	Landscape
3	Seawater Barrier	Santa Cruz WWTP	Advanced Treatment	Lower Groundwater Basins
4a	Groundwater Replenishment	Santa Cruz WWTP	Advanced Treatment	Upper/Lower Groundwater Basins
4b		Local Raw Wastewater	MBR + Advanced Treatment	
4c		Santa Cruz WWTP -and- SVWD WWTP	Advanced Treatment	Santa Margarita GW Basin
5	Reservoir Augmentation	Santa Cruz WWTP	Advanced Treatment	Loch Lomond Reservoir
6	Streamflow Augmentation	Santa Cruz WWTP	Tertiary or Advanced Treatment	San Lorenzo River
7	Direct Potable Reuse	Santa Cruz WWTP	Advanced Treatment	City, District and County

Discussion:

Figure 1: Schedule

Task and Key Deliverables			2016												2017							
	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug
SWRCB Grant Commitment Letter	✓																					
SWRCB Meeting					✴											⭘						
Notice to Proceed				✓																		
Task 1 – PM & QA/QC					)	)	)	)	)	)	)	)	)	)	)	)	)	)	)	)	)	)
Task 2 – Background Info																						
Task 3 – Recycled Water Market Analysis																						
Task 4 – Treatment Eval/Reg Requirements																						
Task 5 – Alternatives Analysis																						
Task 6 – Stakeholder Involvement																						
Task 7 – Recommended Project																						
Task 8 – Financial Analysis																						
Task 9 – Regional RWFPS Report																◆			◆		✓	
Task 10 - Meetings and Workshops					🗋			🗋			🗋		🗋			🗋			🗋			🗋
					Kickoff			*Long-List*			*Short-List*		*Recommended*			*Admin Draft*			*Draft*			*Final*
								Prelim Screening			*Ranking*		*Facilities Plan*									

✴	SWRCB Scoping Call	🗋	F2F Meeting/Workshop	◆	Draft Deliverable
⭘	SWRCB Meeting	)	Conf Call/Web	✓	Final Deliverable

Schedule for Water Supply Advisory Committee (WSAC) Outcome

Element 3: Advanced Treated Recycled Water or Desalination (from WSAC)

- **Advanced Treated RW or Desalinated Water =** Supply augmentation plan to use advanced-treated recycled water with desalination as a back-up if advanced-treated recycled water is not feasible. Enacted if Strategy 1 proves insufficient to meet the plan's goals of cost-effectiveness, timeliness or yield.
  - 2016 = Identify RW alternatives, increase understanding of recycled water (regulatory framework, feasibility, funding opportunities, public outreach and education) **** this is the RWFPS (Start in March 2016 – 18 months duration)***
  - 2017 = Complete high level feasibility studies, as-needed demonstration testing and conceptual level designs of alternatives; define CEQA processes and continue public outreach and education. Select preferred approach (i.e. DPR, IPR, desal) **** this is the outcome of the RWFPS (end mid-2017)***
  - 2020 = Preliminary design, CEQA (including preparation of draft EIR) and apply for approvals and permits (except building permit)
  - 2022 = Complete property acquisition, final design , complete CEQA and all permits
  - 2024 = Construction completed: plant start-up, water production begins (milestone)

Element 2: Aquifer Storage and Recovery (ASR)

- ASR will be studied in parallel to Element 3, using raw water sources
- ***Nexus with the RWFPS***
    - Using recycled water for ASR may be beneficial if (1) there is not enough supply, (2) if the facilities have to be too large to meet the supply gap during the winter when the water is available or (3) if the ability of the basin to be actively recharged in the winter is insufficient
    - An ASR pilot could also be useful for assessing RW IPR
    - There may be overlap with WQ and geochemical analyses to meet both needs

City of Santa Cruz Recycled Water Facilities Planning Study

Kick Off Meeting
March 30 2016

Agenda

- Introduction and Roles (All)
- Background (City, SqCWD, SVWD)
- Overall project goals and expectations (All)
- Scope of Work (Tables 1, 2, and 3) (K/J)
- RWFPS Schedule (Figure 1) (K/J)
- Data Request (K/J)
- Open Discussion (All)
- Driving Tour

Background – Prior RW Studies

- Fall 2013
  - Contemplated as Regional Project; City and Soquel Creek co-applicants to SWRCB grant
- Early 2014
  - Agencies still thinking of doing joint project as the details of Water Supply Planning for each agency unfolded
- WSAC April 2014 – October 2015
- Late 2014
  - Decided to apply to SWRCB separately
- Early 2015
  - Did similar hiring process, interviewed together, hired different consultants, Soquel Creek nearing completion of their study
- Early 2016 – Hired Kennedy/Jenks
  - Deferred until conclusion of WSAC process

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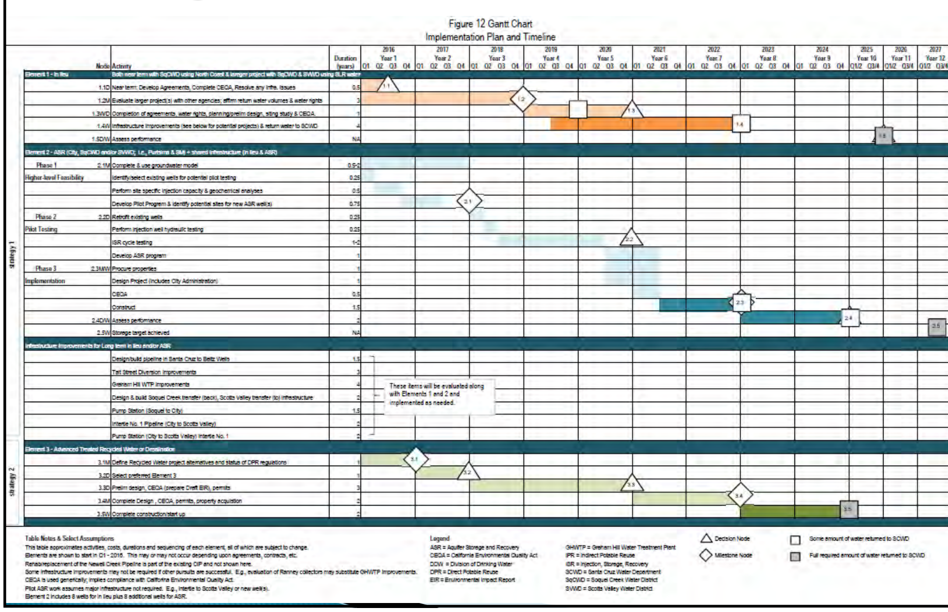
Background – WSAC Outcome



Background – Project Participants

- Joint project between Water &Public Works Departments
- Technical Working Group
- Regional Partners – Scotts Valley Water District & Soquel Creek Water District
- Other agency work (Scotts Valley/SqCWD)

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City of Santa Cruz Water System

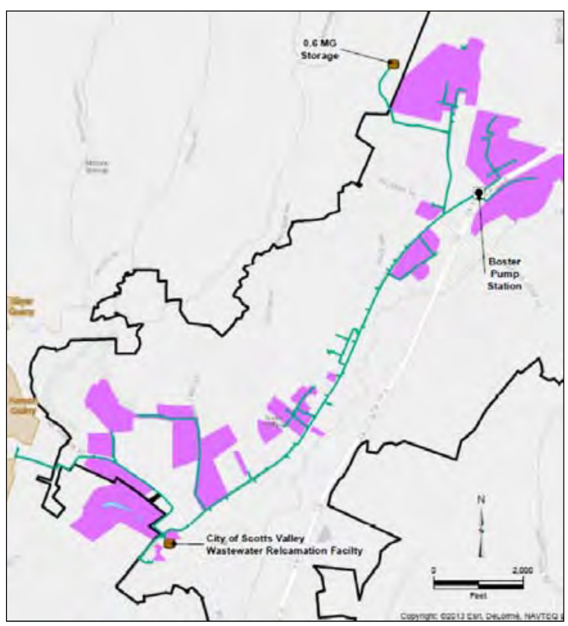
6

Scotts Valley Water District

Update on Recycled Water Activities

7

Existing RW System



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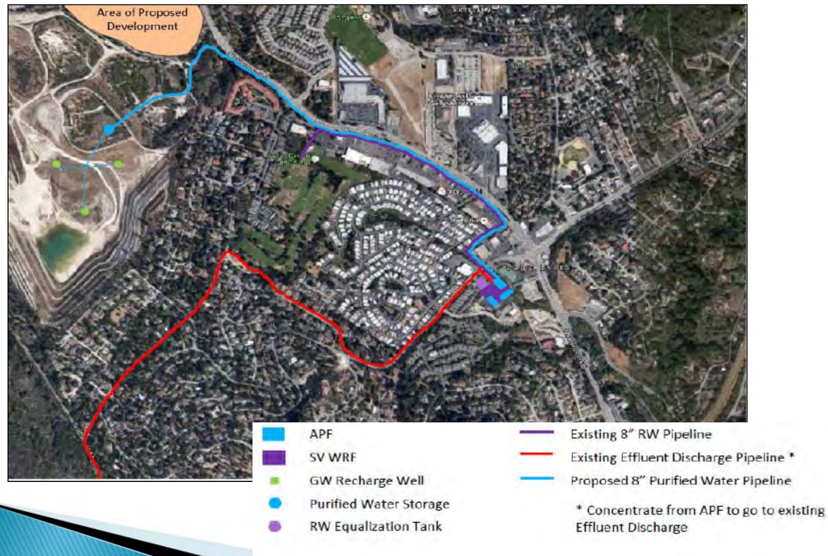
Groundwater Replenishment



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Soquel Creek Water District

Update on Recycled Water Activities

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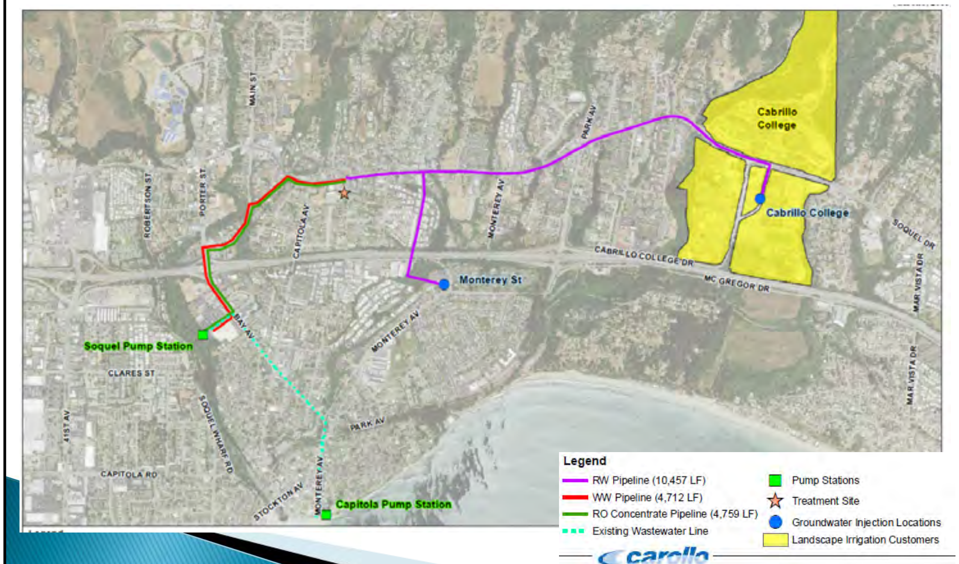
SqCWD – AWPR at SC WWTF

SqCWD – AWPR at SqCWD

SqCWD – MBR at SqCWD



City of Santa Cruz Recycled Water Facilities Planning Study

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Overall Project Goals & Expectations

1. Meet SWRCB Grant Requirements
2. Assess beneficial reuse of wastewater from a resource recovery perspective
3. Evaluate local and regional recycled water projects
4. Identify near-term, mid-term and long-term projects
5. Meet schedule for WSAC Outcome Element #3 – Advanced Treated Recycled Water
6. Initiate strategy for continued outreach related to recycled water
7. Others?

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Scope of Work

Task	Regional RWFPS Chapter
Task 1 – Project Management & QA/QC	
Task 2 – Background Information	Chapter 1 – Study Area Characteristics Chapter 2 – Water Supply Characteristics and Facilities
Task 3 – RW Market Analysis	Chapter 3 – Wastewater Characteristics and Facilities Chapter 5 – Recycled Water Market
Task 4 – Treatment Evaluation / Reg Requirements	Chapter 4 – Treatment Requirements for Discharge and Reuse
Task 5 – Alternatives Analysis	Chapter 6 – Project Alternative Analysis
Task 6 – Stakeholder Involvement	Chapter 5 – Recycled Water Market
Task 7 – Recommended Project	Chapter 7 – Recommended Facilities Project Plan
Task 8 – Financial Analysis	Chapter 8 – Construction Financing Plan and Revenue Program
Task 9 – Regional RWFPS Report	
Task 10 – Meetings and Workshops	

RWFPS must meet SWRCB Grant Requirements

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Major Deliverables & Budget

Task	Major Deliverables	Total Budget
Task 1 – Project Management & QA/QC	Monthly Invoices, Status Reports, Schedule Updates, Project Work Plan	$40,871
Task 2 – Background Information	Data Request / Tracking Sheet Summary Tables/Figures	$23,001
Task 3 – RW Market Analysis	Summary Tables/Figures Market Survey Map TM #1 Groundwater Replenishment TM #2 Surface Water Augmentation TM #3 Streamflow Augmentation TM #4 Direct Potable Reuse	$85,408
Task 4 – Treatment Evaluation / Reg Requirements	Summary Tables/Figures TM #5 Treatment Evaluation	$25,481
Task 5 – Alternatives Analysis	Summary Tables/Figures Screening Tables, Cost Tables	$110,672
Task 6 – Stakeholder Involvement	Materials as requested	$30,150
Task 7 – Recommended Project	Summary Tables/Figures	$21,277
Task 8 – Financial Analysis	Summary Tables/Figures	$10,730
Task 9 – Regional RWFPS Report	Admin Draft, SWRCB Draft, Final	$73,539
Task 10 – Meetings and Workshops	Meeting Materials	$64,870
	Total Budget	$486,000

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Subconsultant Roles

- **Merritt Smith Consulting**– Regulatory Strategy Support (Tasks 3, 5, 9 & 10)
- **Data Instincts** – Stakeholder Outreach (Tasks 6 & 10)
- **Trussell Technologies** – WWTF Facility/Supply Analysis, Treatment Technologies and QA/QC Support (Tasks 3, 4 & 10)
- **Stratus Consulting/Abt Associates** – Triple Bottom Line Analysis (Tasks 5 & 10)
- **GHD Inc.** – CEQA/Environmental Compliance Support (Task 5)
- **Michael Welch, PhD.** – Reservoir Augmentation (Task 3)

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Preliminary List of Projects

Long-List of Projects	Recycled Water Use	Source Water	Treatment	Project Area(s)
1a	Industrial Use/ Landscape Irrigation	Santa Cruz WWTP	Tertiary	City, District and County
1b		Local Raw Wastewater	MBR Tertiary	UC Santa Cruz
2a	Irrigation	Santa Cruz WWTP	Tertiary	North Coast Agricultural Irrigation
2b		Santa Cruz WWTP -or- SVWD WWTP	Secondary or Tertiary	Pasatiempo + Other Landscape
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6	Streamflow Augmentation	Santa Cruz WWTP	Tertiary or Advanced Treatment	San Lorenzo River
7	Direct Potable Reuse	Santa Cruz WWTP	Advanced Treatment	City, District and County

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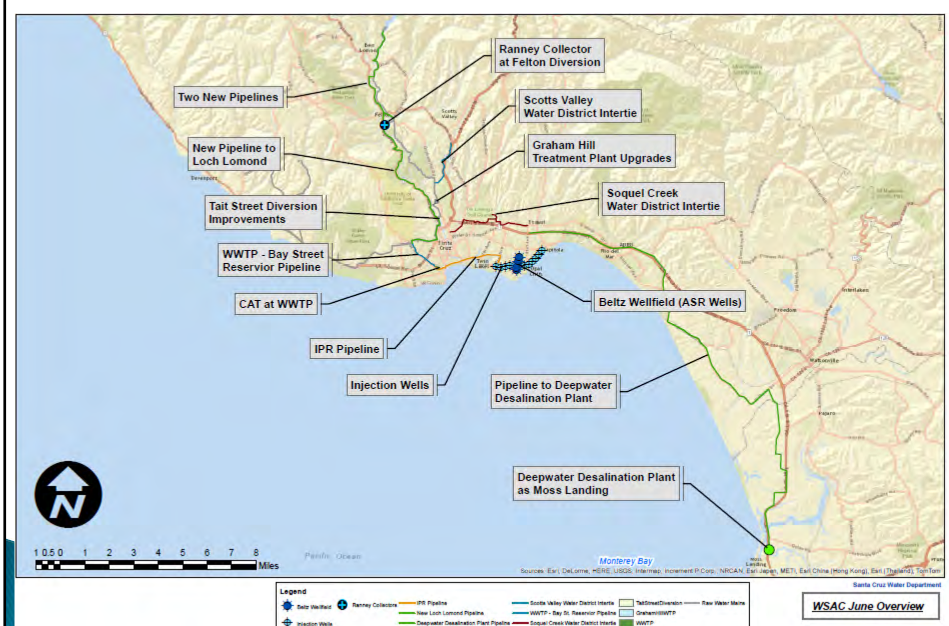
WSAC June Overview

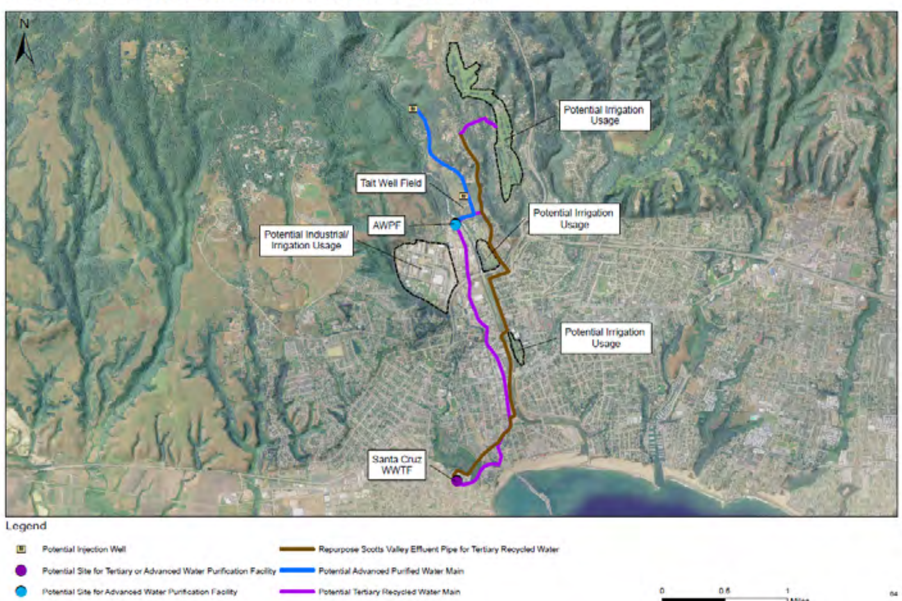


2014 Water Reuse Water Supply Convention Maps (City)

Tertiary Treated Recycled Water to North Coast

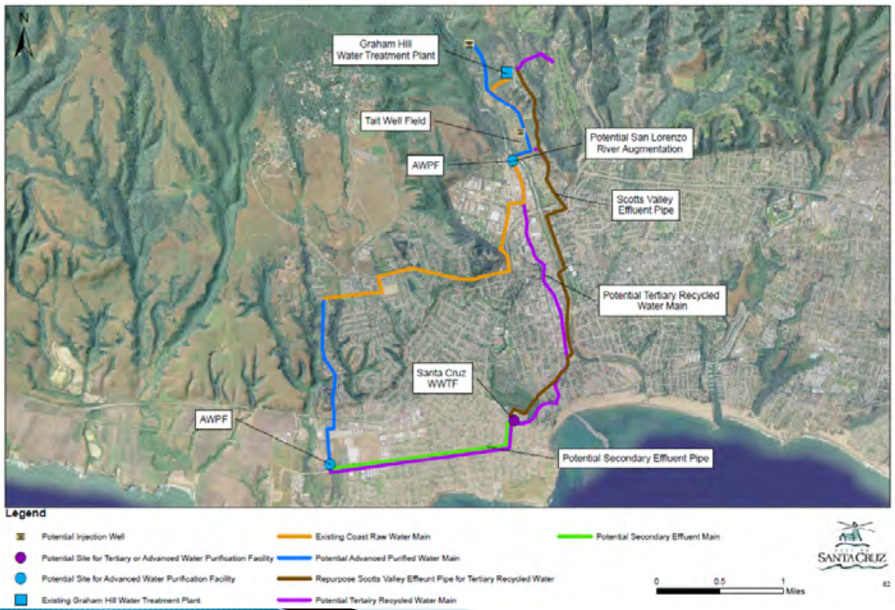
2014 Water Reuse Water Supply Convention Maps (City)

Joint Irrigation & Groundwater Replenishment for Tait Well Field



2014 Water Reuse Water Supply Convention Maps (City)

Potable Reuse and Groundwater Replenishment for Tait Well Field and River Augmentation



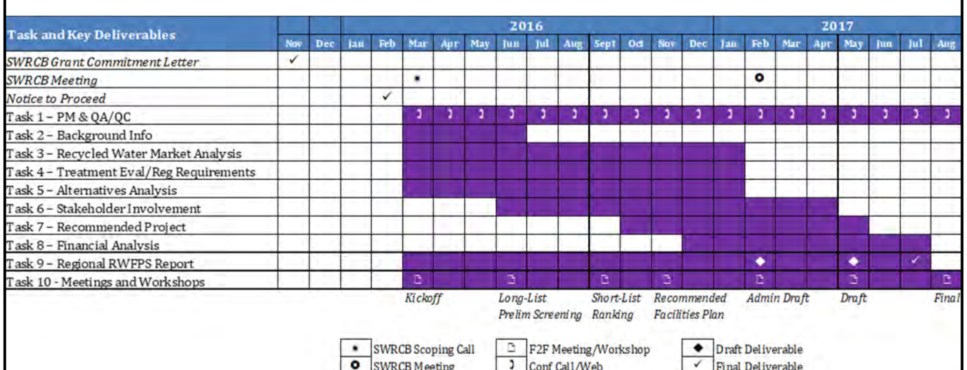
2014 Water Reuse Water Supply Convention Maps (City)

Santa Cruz Regional Groundwater Replenishment Project

2014 Water Reuse Water Supply Convention Maps (City)

Mid-County Regional Groundwater Replenishment Project

RWFPS Schedule



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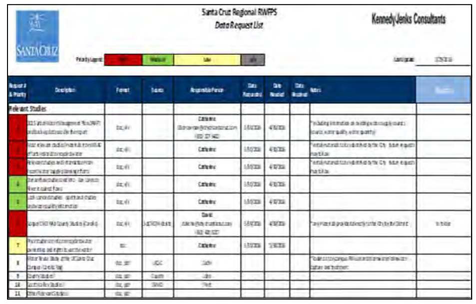
Data Request

- Relevant Studies
- Demand Data
- WWTP Information
- GIS/Drawings
- Financial Information
- Other Information



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Open Discussion

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Driving Tour

Estimated Arrival Time	Location	Points of Interest
11:00	City Hall	Kick-Off Meeting (9 am to 10:55 am)
11:10	Santa Cruz Wastewater Treatment Plant (WWTP)	Santa Cruz WWTP
11:20	Delaware Ave industrial area, west of WWTP	Potential AWTF Site
		Possible Recycled Water Pipeline alignment
		RW Alignment View
11:30	Drive north to past potential Industrial and Irrigation Use sites	Possible Irrigation User - UCSC
	Drive north along Upper Western Drive	Potential Raw Water tie-in - Bay Street Reservoir
	Time-Permitting: Potential Viewing Point at UCSC	Panoramic View of System
11:45	Coast Pump Station	Point out Potential AWTF Site
		Point out Tait Well approx location
12:05	Graham Hill WTP	Location of Graham Hill WTP + Lunch
12:55	Pasatiempo	Pasatiempo Proposed Recycled Water tank
13:05	Drive along Highway 1 towards Soquel	Possible Recycled Water Pipeline alignment
13:15	Beltz Well and nearby City Wells	Beltz 12 WTP
13:35	Capitola	Oneill Ranch (Proximity of two major wells)
13:45		SqCWD Headquarters
14:10		Capitola City Hall
14:20	Beltz Well Field	Beltz WTP
14:30		Various Beltz wells
14:40	Lode Street, Mid-County RAWPF	DA Porath District Pump Station
14:50	Possible drive along Front Street pipeline alignment	
14:55	Santa Cruz Water Department	

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Driving Tour

Santa Cruz Regional
Recycled Water Facilities Planning Study (RWFPS)

Alternatives Workshop
28 June 2016 from 9 am – 1 pm

Location: 110 California Street Santa Cruz 95060

Come through unlocked gate. Staff will be available to direct traffic.
Conference call and Web Meeting info to be provided

AGENDA

Overall Workshop Objective: Present approach to identify preliminary alternatives, obtain input from Study Partners and come to alignment on the alternatives to be studied in the Santa Cruz RWFPS.

PART I Goal: Identify alternatives for evaluation in the Santa Cruz RWFPS **9:00 am to 11:00 am**

1. Introduction and Roles
2. Review of Study Objectives
3. Project Component Matrix (Long List)
4. Set Basic Guidelines for Evaluating Project Components
5. Evaluate Project Components
6. Identify Alternatives for Further Evaluation
7. Open Discussion

-- BREAK & SNACKS --

PART II Goal: Discuss recycled water treatment concepts, siting preferences and relocation considerations for treatment options at the Santa Cruz WWTF. **11:30 am to 12:15 pm**

1. Tertiary Treatment Concepts (process, capacity, footprint)
2. Advanced Water Treatment Concepts (process, capacity, footprint)
3. Siting Preferences and Facility Relocation Considerations
4. Open Discussion

-- WWTF TOUR --

PART III Tour Goal: Visit identified locations for expanding tertiary treatment, siting advanced water treatment facilities and potential opportunities for relocating displaced facilities on-site. **12:15 pm to 1:00 pm**

City of Santa Cruz
Recycled Water Facilities Planning Study

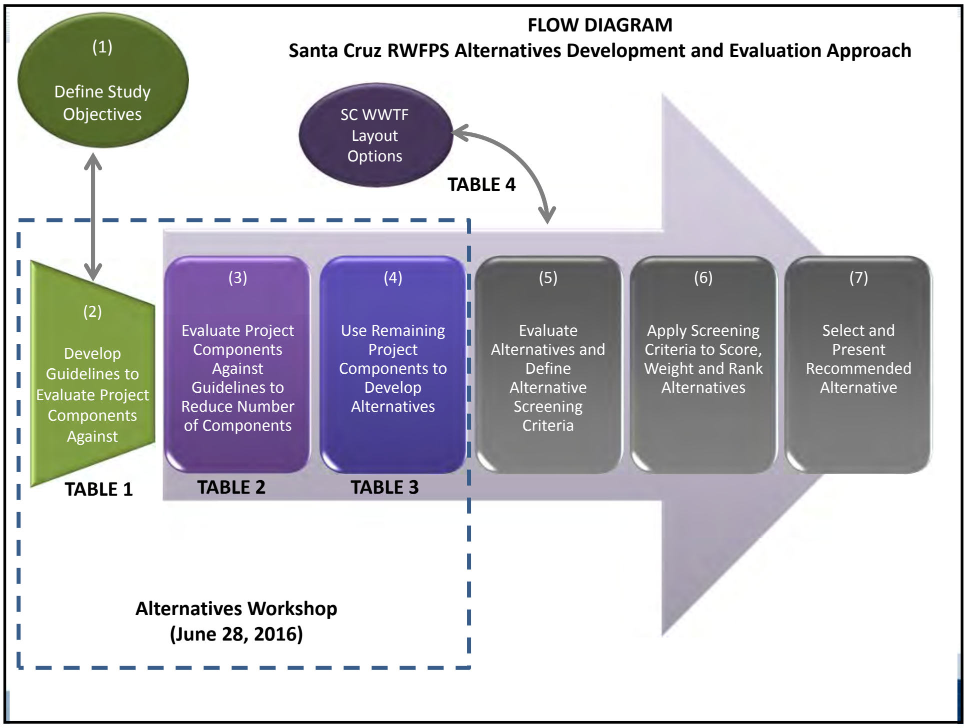
Alternatives Workshop

June 28 2016

** Includes amended notes to reflect discussion at workshop*

Agenda

- Introduction and Roles
- Review of Study Objectives
- Project Component Matrix (Long List)
- Set Basic Guidelines for Evaluating Project Components
- Evaluate Project Components
- Identify Alternatives for Further Evaluation
- Open Discussion



Review of Study Objectives

TABLE 1

#	Study Objectives	Abbreviated
1	Assess beneficial reuse of wastewater from a resource recovery perspective	Beneficial Reuse
2	Meet or reduce the water supply gap (1.2 BGY, 3.3 MGD or 3,700 AFY)	Water Supply Gap
3	Evaluate local and regional recycled water projects	Local and Regional Projects
4	Identify a phased approach to reuse in Santa Cruz	Phased Approach
5	Identify potential impacts to WWTF operations	SCWWTF Impacts
6	Initiate plan for continued recycled water outreach and education	Outreach Plan
7	Meet SWRCB grant requirements	SWRCB Grant
8	Meet schedule and intent of WSAC Outcome Element #3	WSAC Outcome

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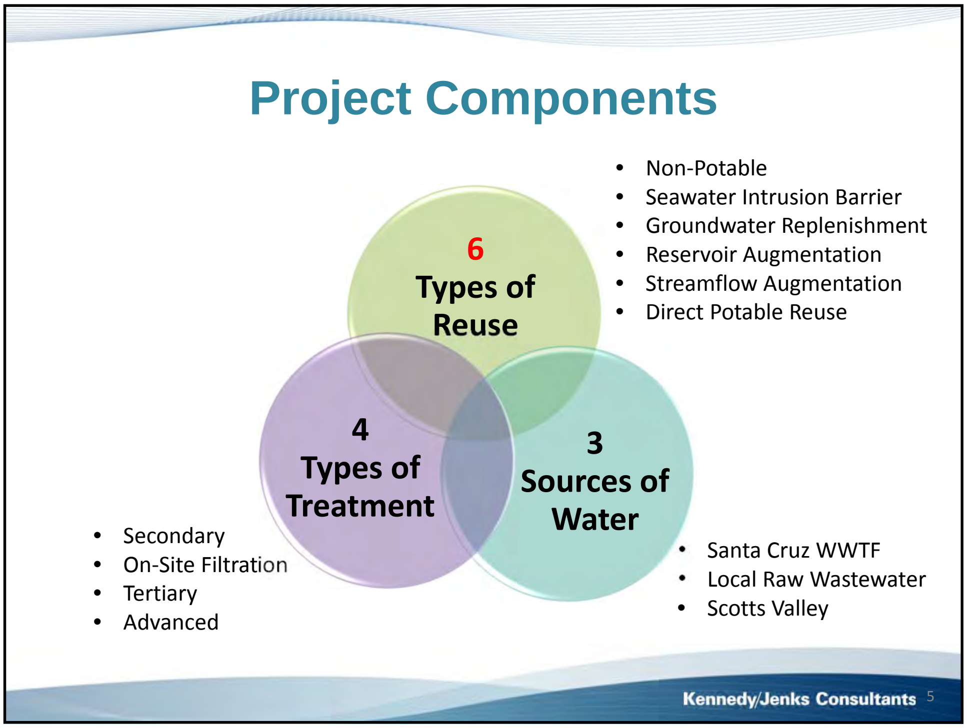

Basic Guidelines for Evaluating Project Components

TABLE 1

#	Basic Guidelines for Evaluation of Project Components	Abbreviated
A	Project uses Santa Cruz WWTF effluent or wastewater destined for Santa Cruz WWTF	Reuse of Santa Cruz WWTF Effluent
B	Project offsets or increases Santa Cruz potable supplies to meet or reduce the Santa Cruz water supply gap	Offset or Increase Potable Supplies
C	Non-Potable reuse that is at least tertiary level of treatment; Potable reuse and streamflow augmentation require advanced treatment; Preference is to avoid over-treatment for a given use	Right Treatment for Right Use
D	Tertiary treatment is located at SC WWTF; AWTF located at the SC WWTF or GHWTP.	Consolidate Treatment Facilities
E	Sewer mining would only be considered at sites with flows > 2 MGD; MBR would only be considered for demands >1 MGD	Sufficient Flows and Demands for MBR
F	WWTF impacts to water quantity, water quality, facilities and O&M activities should be minimized	Minimize Impacts to WW collection and treatment
G	ASR study will identify potential City GWRR location(s), characteristics and limitations	GWRR at Identified ASR Sites
H	Potable Reuse and streamflow augmentation project capacity will be bookended by available space for treatment facilities	AWTF Capacity Limited by Siting
I	Projects could involve outside agencies/users and/or have (at least) a preliminary agreement (letter of willingness to pursue) for anticipated use (farmers, UCSC, industry)	Preliminary Agreements Imminent
J	RW use is currently approved under existing regulatory conditions or implemented in the USA	Approved/Practiced Reuse

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Alignment of Objectives and Guidelines

TABLE 1

	Basic Guidelines for Evaluation of Project Components	Primary Alignment of Guidelines with Study Objectives							
		1	2	3	4	5	6	7	8
		Beneficial Reuse	Water Supply Gap	Local and Regional Projects	Phased Approach	SCWWTF Impacts	Outreach Strategy	SWRCB Grant	WSAC Outcome
A	Reuse of Santa Cruz WWTF Effluent	✓							
B	Offset or Increase Potable Supplies		✓						
C	Right Treatment for Right Use			✓					
D	Consolidate Treatment Facilities					✓			
E	Sufficient Flows and Demands for MBR					✓			
F	Minimize Impacts to WW collection and treatment					✓			
G	GWRR at Identified ASR Sites								✓
H	AWTF Capacity Limited by Siting				✓				
I	Preliminary Agreements Imminent							✓	
J	Approved/Practiced Reuse						✓		

Intent is to have at least one objective tied to each guideline, though others may apply

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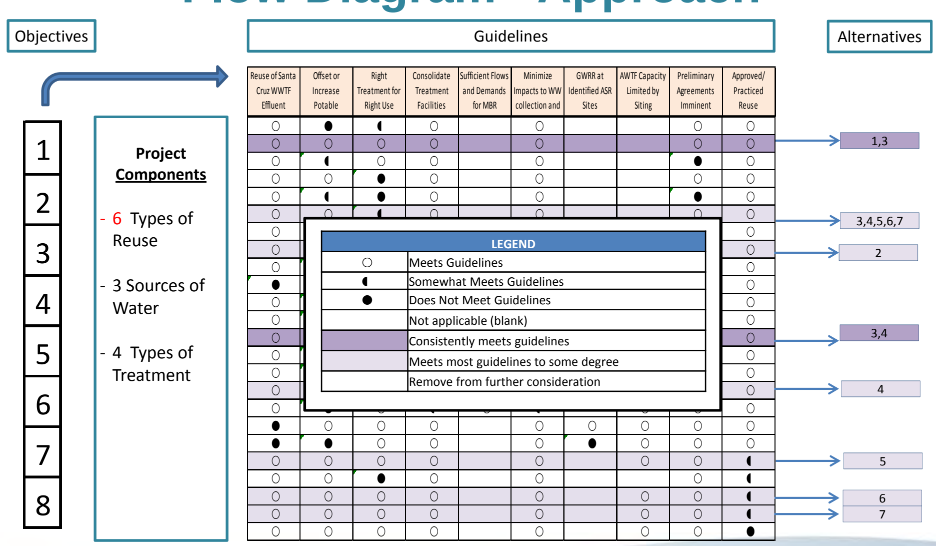
Flow Diagram - Approach



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Non-Potable Reuse Component Evaluation (1 – 10)

TABLE 2

Potential Project Components	Recycled Water Use	Source Water	Treatment	Description	Reuse of Santa Cruz WWTF Effluent	Offset or Increase Potable Supplies	Right Treatment for Right Use	Consolidate Treatment Facilities	Sufficient Flows and Demands for MBR	Minimize Impacts to WW collection and treatment	GWRR at Identified ASR Sites	AWTF Capacity Limited by Siting	Preliminary Agreements Imminent	Approved/ Practiced Reuse
1	Non-Potable Reuse	Santa Cruz WWTF	Secondary	Limited use in Santa Cruz (in-plant, restricted areas, truck filling)	○	●	◖	○		○			○	○
2			Tertiary	Unrestricted use in Santa Cruz (irrigation, commercial, industrial, truck filling) including UC Santa Cruz	○	○	○	○		○			○	○
3				North Coast Agricultural Irrigation	○	●	○	○		○			◖	○
4			Advanced Treatment	Unrestricted use in Santa Cruz (irrigation, commercial, industrial, truck filling) including UC Santa Cruz	○	○	●	○		○			○	○
5				North Coast Agricultural Irrigation	○	◖	●	○		○			◖	○
6				Customers along pipelines alignments to IPR/DPR or streamflow augmentation	○	○	◖	○		○			○	○
7		Local Raw Wastewater	MBR (Tertiary)	Anchor customers in Santa Cruz (Unrestricted use)	○	○	○	◖	●	◖			●	○
8				UC Santa Cruz	○	○	○	◖	◖	◖			○	○
9				North Coast Agricultural Irrigation	○	●	○	◖	●	●			●	○
10		Scotts Valley WWTF	Secondary (outfall)	Pasatiempo Golf Course	●	○	●	◖		○			○	○

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Non-Potable Reuse: Components Removed from Further Consideration

- **Secondary: Limited use in Santa Cruz**
  - Limited uses, minimal benefit to water supply
  - Public acceptance issues
- **Tertiary/AWT: North Coast Agricultural Irrigation**
  - Uncertainty about the quantity, quality and seasonality of water available for exchange
  - Permitting challenges for State Parks
  - Challenge to confirm willingness to use (ag opponents)
  - High cost with minimal incentive to support rates for revenue
- **AWT: Unrestricted use in Santa Cruz**
  - Beyond regulatory requirement for NPR
  - Significantly higher cost/energy
  - Keep as an option for customers along pipeline alignments that carry advanced treated water for potable reuse.

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Seawater Intrusion Barrier Component Evaluation (11 – 12)

TABLE 2

Potential Project Components	Recycled Water Use	Source Water	Treatment	Description	Reuse of Santa Cruz WWTF Effluent	Offset or Increase Potable Supplies	Right Treatment for Right Use	Consolidate Treatment Facilities	Sufficient Flows and Demands for MBR	Minimize Impacts to WW collection and treatment	GWRR at Identified ASR Sites	AWTF Capacity Limited by Siting	Preliminary Agreements Imminent	Approved/ Practiced Reuse
11	Seawater Intrusion Barrier	Santa Cruz WWTF	Advanced Treatment	Identified groundwater basin subject to seawater intrusion	○	●	○	○		○	◖	○	○	○
12		Local Raw Wastewater	MBR + Advanced Treatment	Identified groundwater basin subject to seawater intrusion	○	●	○	◖	●	○	◖		○	○

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Seawater Intrusion Barrier: Removed from Further Consideration

- Threat to City wells is currently low
- Provides limited water supply
- Very costly "insurance"
  (potential future loss of Beltz coastal wells)
- Potential opportunity for zero discharge study
- MBR has limited available supply

Seawater intrusion avoidance could be considered a baseline assumption for any groundwater replenishment alternative

Per City: Seawater intrusion is included in the ASR groundwater modeling scenarios. The intent is to use it more as a barrier, while managing wells for extraction.

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Groundwater Replenishment Reuse (GWRR) Component Evaluation (13 – 19)

TABLE 2

Potential Project Components	Recycled Water Use	Source Water	Treatment	Description	Reuse of Santa Cruz WWTF Effluent	Offset or Increase Potable Supplies	Right Treatment for Right Use	Consolidate Treatment Facilities	Sufficient Flows and Demands for MBR	Minimize Impacts to WW collection and treatment	GWRR at Identified ASR Sites	AWTF Capacity Limited by Siting	Preliminary Agreements Imminent	Approved/ Practiced Reuse
13	Groundwater Replenishment	Santa Cruz WWTF	Advanced Treatment	Suitable Santa Cruz GWRR site(s) to be defined in the ASR Study	○	○	○	○		○	○	○	○	○
14				SqCWD GWRR Sites in Aptos/Purisima Basins (per GWRR Feasibility Study)	○	●	○	○		◖		○	○	○
15				Santa Margarita GW Basin	○	●	○	○		○	●	○	○	○
16		Local Raw Wastewater	MBR + Advanced Treatment	Suitable Santa Cruz GWRR site(s) to be defined in the ASR Study	○	○	○	◖	◖	◖	○	○	○	○
17				SqCWD GWRR Sites in Aptos/Purisima Basins (per GWRR Feasibility Study)	○	●	○	◖	○	◖		○	○	○
18		Scotts Valley WWTF or Outfall	Advanced Treatment	Suitable site to be defined in the ASR Study	●	○	○	○		○	○	○	○	○
19				Santa Margarita GW Basin	●	●	○	○		○	●	○	○	○

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GWRR: Components Removed from Further Consideration

- **SqCWD GWRR Sites in Aptos/Purisima Basins: per GWRR Feasibility Study**
  - No direct augmentation of Santa Cruz potable supplies
  - Indirect access would require complex institutional arrangements and significant new infrastructure
  - Siting challenges for MBR/AWTF

  Potential to "T" off of conveyance system for NPR or IPR in Santa Cruz is covered under other alternatives

- **Santa Margarita GW Basin**
  - No direct augmentation of Santa Cruz potable supplies
  - Indirect access would require complex institutional arrangements and significant new infrastructure
  - High cost to treat and pump to this upper basin

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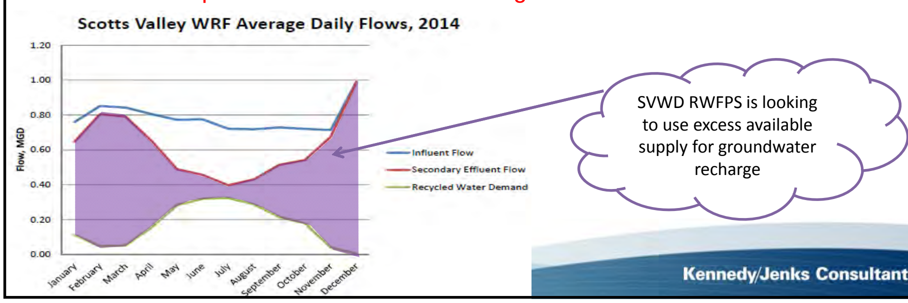
GWRR: Components Removed from Further Consideration

- **Use of Scotts Valley WWTF or Outfall**
  - Does not use Santa Cruz WW
  - Minimal flow is available in the outfall due to
    - ✓ existing SVWD recycled water program,
    - ✓ planned Pasatiempo use of RW from the outfall and
    - ✓ proposed GWRR currently being explored for SVWD
  - SVWD is already studying this project in a separate RWFPS
  - Use of outfall for conveyance of recycled water from SC WWTF is not viable due to operational concerns if discharge is needed



Reservoir Augmentation, Streamflow Augmentation and Direct Potable Reuse Component Evaluation (20 - 24)

TABLE 2

Potential Project Components	Recycled Water Use	Source Water	Treatment	Description	Reuse of Santa Cruz WWTF Effluent	Offset or Increase Potable Supplies	Right Treatment for Right Use	Consolidate Treatment Facilities	Sufficient Flows and Demands for MBR	Minimize Impacts to WW collection and treatment	GWRR at Identified ASR Sites	AWTF Capacity Limited by Siting	Preliminary Agreements Imminent	Approved/ Practiced Reuse
20	Reservoir Augmentation	Santa Cruz WWTF	Advanced Treatment	Loch Lomond Reservoir	○	○	○	○		○		○	○	◖
21	Streamflow Augmentation	Santa Cruz WWTF	Tertiary	San Lorenzo River (Direct/Indirect Discharge)	○	○	●	○		○			○	◖
22			Advanced Treatment	San Lorenzo River (Direct/Indirect Discharge)	○	○	○	○		○		○	○	◖
23	Direct Potable Reuse	Santa Cruz WWTF	Advanced Treatment	Raw Water Blending at Graham Hill WTP (via Coast PS)	○	○	○	○		○		○	○	◖
24				Pipe to Pipe (Downstream of Graham Hill WTP)	○	○	○	○		○		○	○	●

Streamflow: Components Removed from Further Consideration

- **Tertiary Treatment**
  - Environmental and habitat concerns related to water quality
  - Proximity to raw water diversion
  - Regulatory and permitting challenges
  - TMDL for Nitrogen would be a limiting factor

Assume higher level of treatment as the baseline for a streamflow augmentation project
** An advanced treatment option should consider need for denitrification to minimize nitrogen loading in the basin.*

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DPR: Components Removed from Further Consideration

- **Pipe-to-Pipe: d/s of Graham Hill WTP**
  - Lacks additional treatment, barrier and response time provided by blending prior to a drinking WTP
  - No project of this type is currently or has been permitted in the US
  - Significant public acceptance issues

Assume source water blending u/s of the WTP as the baseline for a DPR project

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Alternatives for Further Evaluation

- Alternative 1 – Centralized Non-Potable Reuse
- Alternative 2 – Decentralized Non-Potable Reuse
- Alternative 3 – Santa Cruz Participation in SqCWD-led GWRR Project
- Alternative 4 – Santa Cruz GWRR Project
- Alternative 5 – Surface Water Augmentation (SWA) in Loch Lomond Reservoir
- Alternative 6 – Streamflow Augmentation
- Alternative 7 – Direct Potable Reuse

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Alternatives 1 & 2: Non-Potable Reuse

TABLE 3

Alternative	Sub Alt	Description	Source Water	Treatment		Use
Alternative 1 – Centralized Non-Potable Reuse	1a	Santa Cruz PWD Phase 2 Project	Santa Cruz WWTF	Tertiary Treatment at SC WWTF	3°	In-plant uses, truck filling and demonstration site (park near WWTF)
	1b	Maximize tertiary treatment at the SC WWTF			3°	Unrestricted use in Santa Cruz including UC Santa Cruz (Sites TBD)
Alternative 2 – Decentralized Non-Potable Reuse	2	UC Santa Cruz	Local Raw Wastewater (UCSC)	MBR at UCSC	3°	On campus uses (irrigation, agricultural, cooling towers, dual-plumbed facilities)

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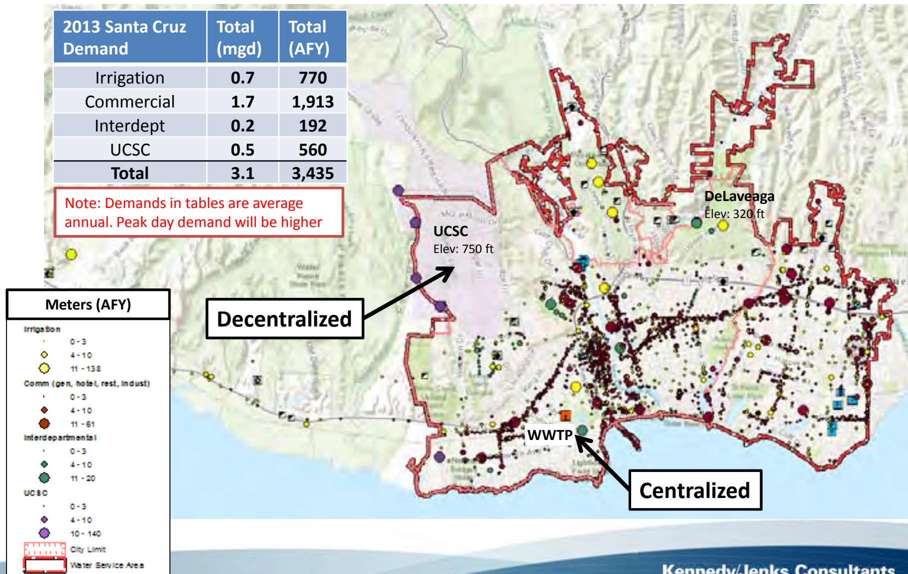
Alternatives 1 & 2: Non-Potable Reuse

2013 Santa Cruz Demand	Total (mgd)	Total (AFY)
Irrigation	0.7	770
Commercial	1.7	1,913
Interdept	0.2	192
UCSC	0.5	560
Total	**3.1**	**3,435**

Note: Demands in tables are average annual. Peak day demand will be higher



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Alternative 3: Santa Cruz Participation in a SqCWD-led GWRR

TABLE 3

Sub Alt	Description	Source Water	Treatment		Use
3a	Send secondary effluent from SCWWTF to SqCWD for injection in SqCWD basin (serve NPR users along the way)	Santa Cruz WWTF	On-Site Treatment at NPR Customer sites	2° + filter	NPR Customers along secondary pipelines alignment from SC WWTF to AWTF
3b	Send tertiary effluent from SCWWTF to SqCWD (serve NPR users along the way)		Tertiary Treatment at SC WWTF	3°	NPR Customers along tertiary pipeline alignment from SC WWTF to AWTF
3c (New)	Send additional secondary effluent from SCWWTF to SqCWD AWTF and deliver purified water from SqCWD WTF to recharge Santa Cruz GWRR		Advanced Treatment at SqCWD Headquarters	AWT	SqCWD AWTF water delivered to Santa Cruz GWRR injection sites
3d	Send advanced treated RW from SCWWTF to SqCWD, (serve NPR users along the way)		Advanced Treatment at SC WWTF	AWT	NPR Customers along pipeline alignment from SC WWTF to SqCWD injection sites
3e	Send advanced treated RW from SCWWTF to SqCWD, (GWRR and NPR along the way)			AWT	GWRR in Santa Cruz (Beltz Well Field) and NPR customers along pipeline alignments
removed	GWRR in Santa Cruz through an extension from MBR + AWTF at SqCWD	Local Raw Wastewater (SCCSD)	MBR + Advanced Treatment at SqCWD	AWT	GWRR in Santa Cruz (Beltz Well Field)

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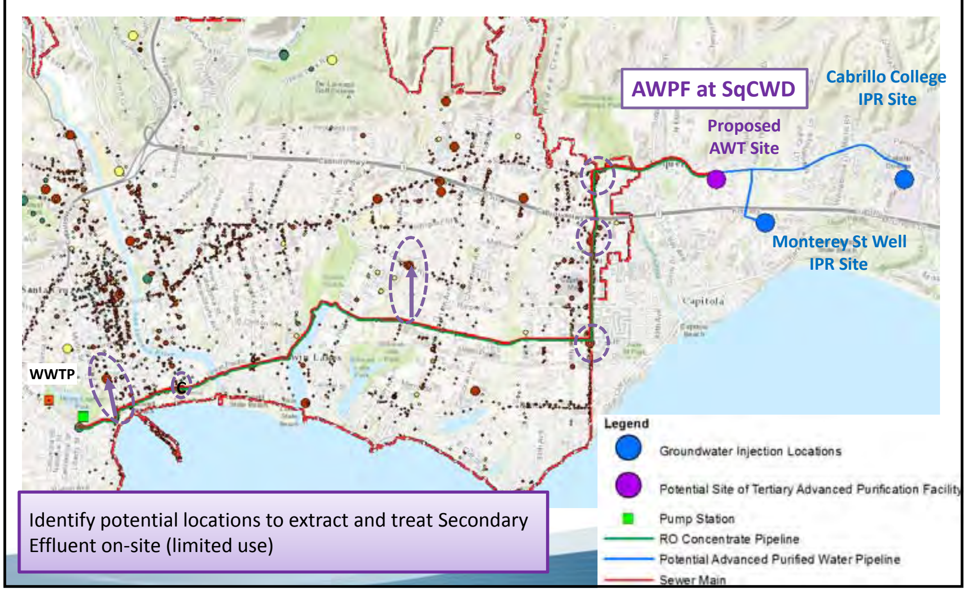
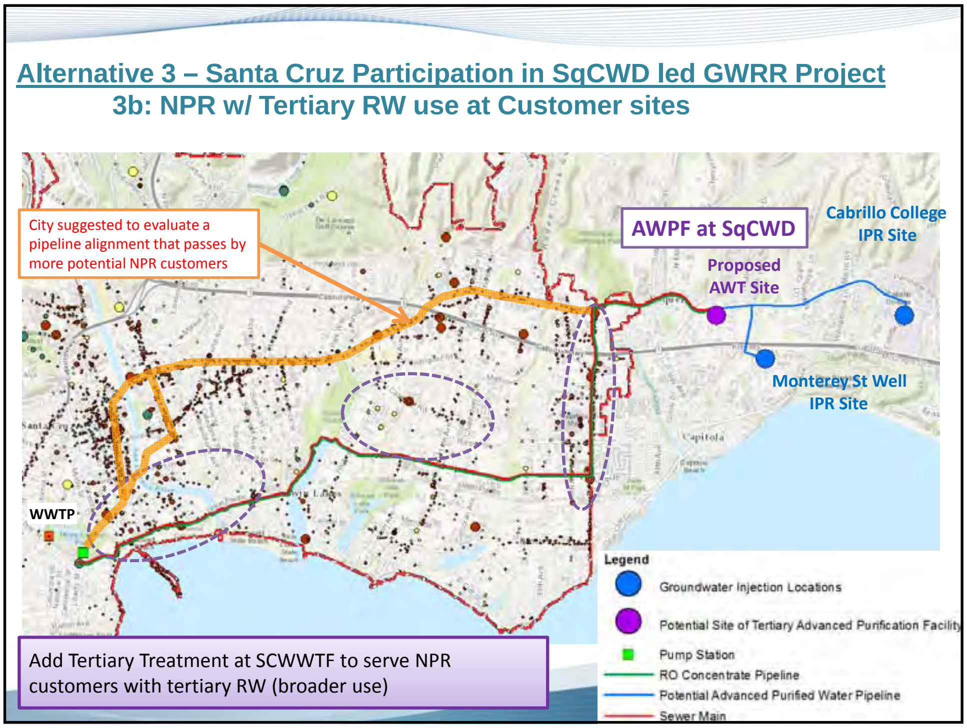
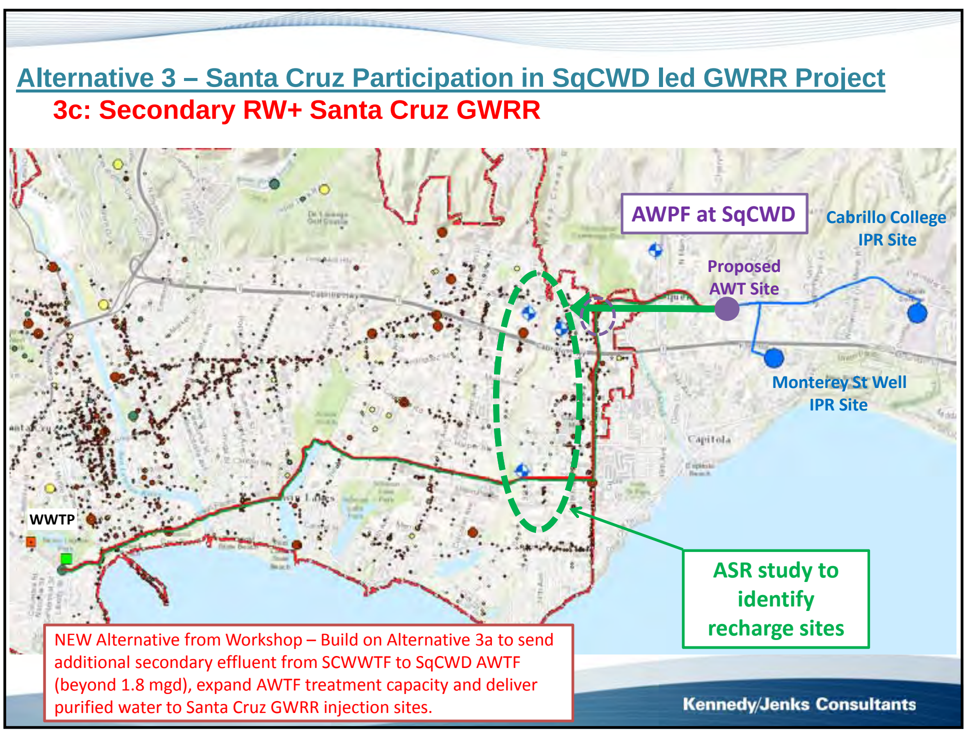
SqCWD GWRR Feasibility Study Recommended Alternative: AWPF at SqCWD

Alternative 3 – Santa Cruz Participation in SqCWD led GWRR Project

3a: NPR w/ On-Site Treatment of Secondary RW




Alternative 3 – Santa Cruz Participation in SqCWD led GWRR Project
3b: NPR w/ Tertiary RW use at Customer sites
City suggested to evaluate a pipeline alignment that passes by more potential NPR customers
AWPF at SqCWD
Cabrillo College IPR Site
Proposed AWT Site
Monterey St Well IPR Site
WWTP
Add Tertiary Treatment at SCWWTF to serve NPR customers with tertiary RW (broader use)
Legend
Groundwater Injection Locations
Potential Site of Tertiary Advanced Purification Facility
Pump Station
RO Concentrate Pipeline
Potential Advanced Purified Water Pipeline
Sewer Main


Alternative 3 – Santa Cruz Participation in SqCWD led GWRR Project
3c: Secondary RW+ Santa Cruz GWRR
AWPF at SqCWD
Cabrillo College IPR Site
Proposed AWT Site
Monterey St Well IPR Site
WWTP
ASR study to identify recharge sites
NEW Alternative from Workshop – Build on Alternative 3a to send additional secondary effluent from SCWWTF to SqCWD AWTF (beyond 1.8 mgd), expand AWTF treatment capacity and deliver purified water to Santa Cruz GWRR injection sites.
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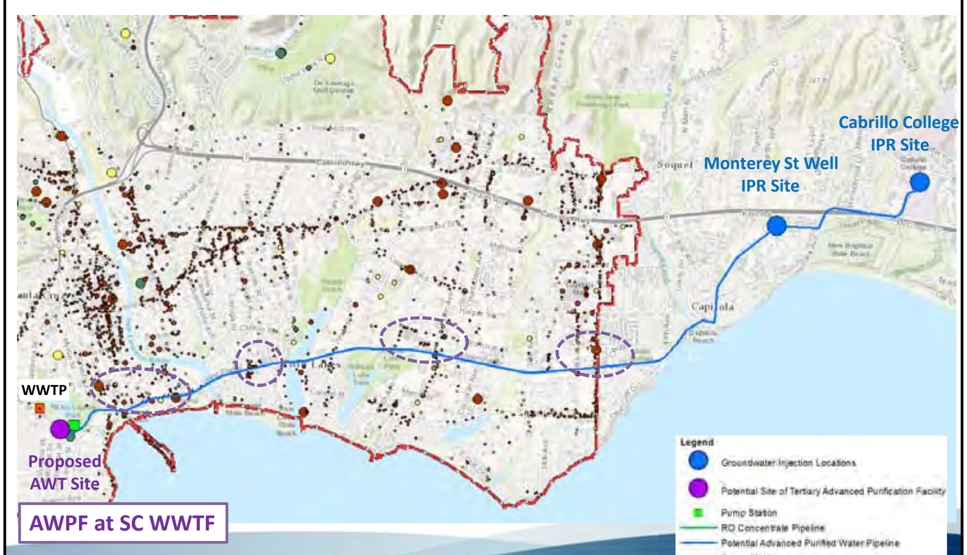
SqCWD GWRR Feasibility Study Recommended Alternative: AWPF at SC WWTP

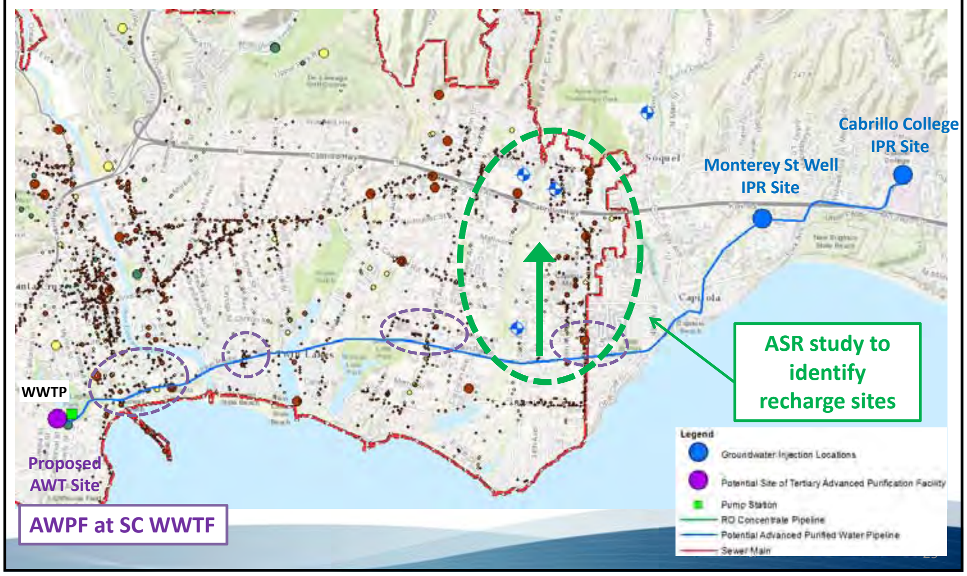
Alternative 3 – Santa Cruz Participation in SqCWD led GWRR Project

3d: Serve NPR users along the way

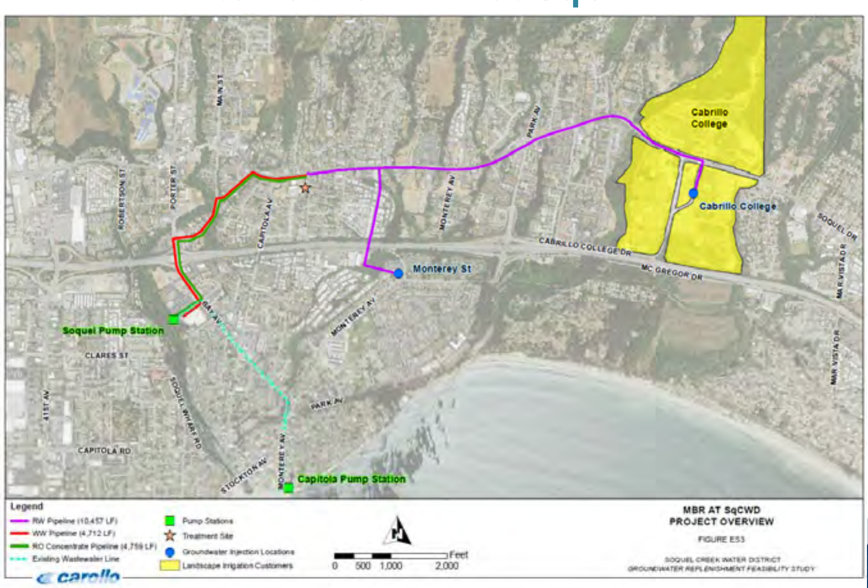


Alternative 3 – Santa Cruz Participation in SqCWD led GWRR Project

3e: GWRR near City wells and serve NPR users along the way

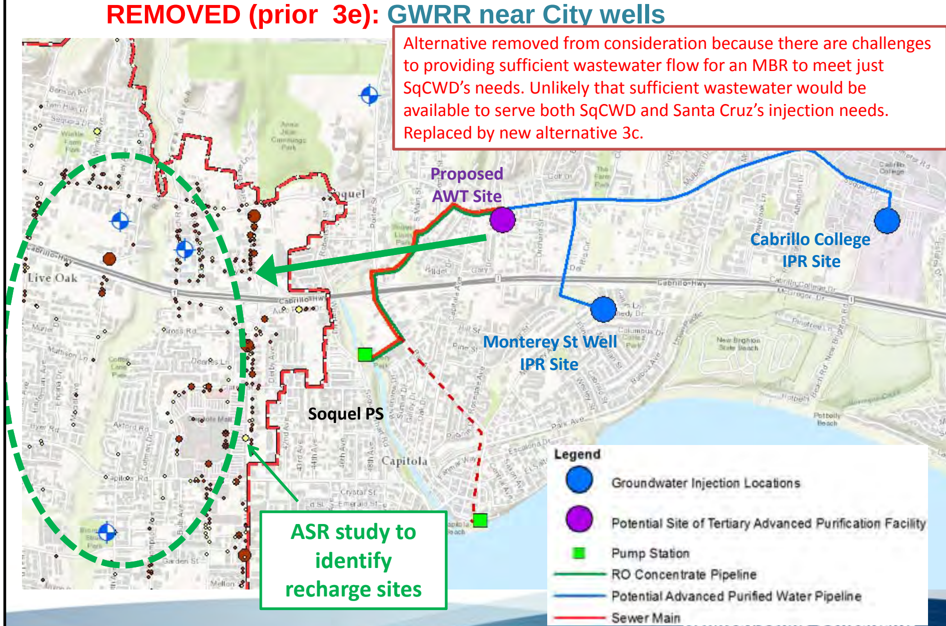


SqCWD GWRR Feasibility Study Recommended Alternative: MBR at SqCWD



Alternative 3 – Santa Cruz Participation in SqCWD led GWRR Project

REMOVED (prior 3e): GWRR near City wells



Alternative 4: Santa Cruz GWRR

TABLE 3

Sub Alt	Description	Source Water	Treatment		Use
4a	Santa Cruz GWRR with AWTF at SC WWTF (serve NPR users along the way)	Santa Cruz WWTF	Advanced Treatment at SC WWTF	AWT	Suitable Santa Cruz GWRR site(s) to be defined in the ASR Study. Once extracted, recharged water would be distributed through the existing potable water distribution system.
4b	Santa Cruz GWRR with AWTF of secondary effluent at off-site location (serve NPR users along the way)		Advanced Treatment off-site (location TBD)	AWT	
4c	Santa Cruz GWRR with MBR + AWTF at DA Porath PS (serve NPR users along the way)	Local Raw Wastewater (SCCSD)	MBR + Advanced Treatment	AWT	

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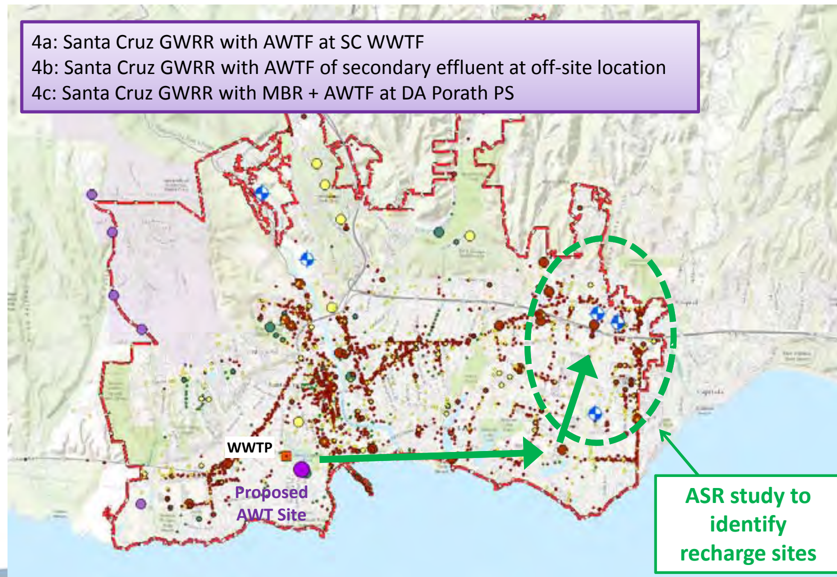
Alternative 4: Santa Cruz GWRR



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Alternative 5: Surface Water Augmentation

TABLE 3

Sub Alt	Description	Source Water	Treatment		Use
5	Advanced treatment of Santa Cruz effluent for bending in Loch Lomond Reservoir	Santa Cruz WWTF	Advanced Treatment at SC WWTF	AWT	Reservoir augmentation in Loch Lomond for blending and storage, to be conveyed to the GHWTP and enter the City's potable water distribution system.

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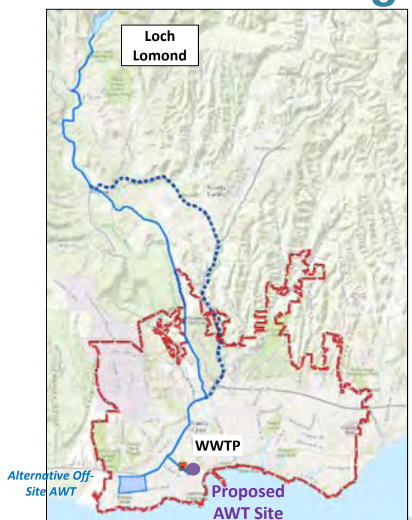
Alternative 5: Surface Water Augmentation



- RW delivered ~ 3 mgd
  - Based on treating only City of Santa Cruz flows
- Potentially limited by
  - Regulatory requirements (i.e. dilution and retention time)
  - Available AWTF space

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Alternative 6: Streamflow Augmentation

TABLE 3

Sub Alt	Description	Source Water	Treatment		Use
6a	AWTF of secondary effluent with direct discharge to the San Lorenzo River btw Felton and Tait (serve NPR users along the way)	Santa Cruz WWTF	Advanced Treatment at SC WWTF	AWT	Augment San Lorenzo River flows to maintain habitat, meet future fish release requirement, and allow for increased diversions to expand future drinking water supplies.
6b	AWTF of secondary effluent with indirect discharge to the San Lorenzo River d/s of Tait Street Diversion at Tait Well Field (serve NPR users along the way)			AWT	

Key Consideration: Meeting TMDL for Nitrogen in the river

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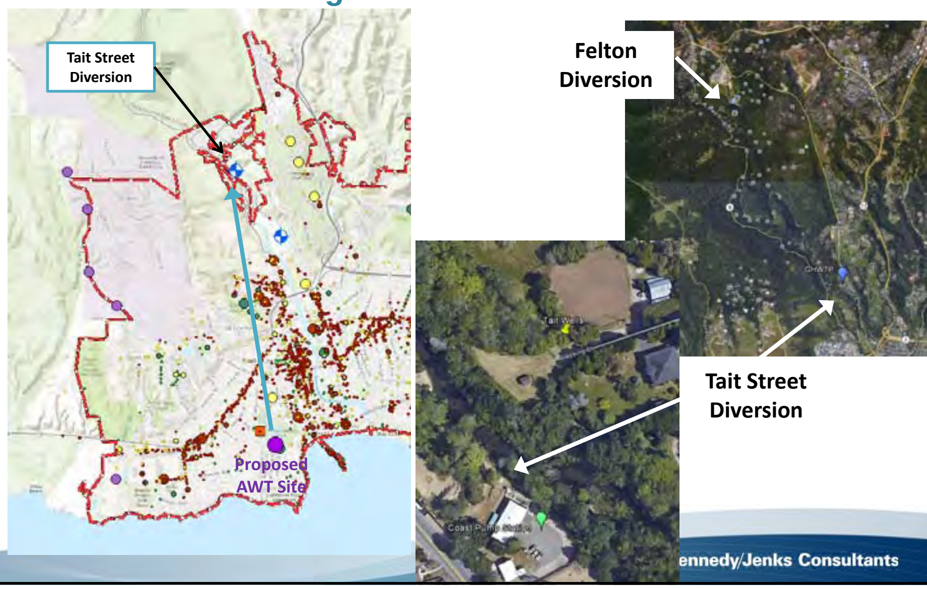
Alternative 6: Streamflow Augmentation
6a: Direct Discharge to San Lorenzo River
6b: Indirect Discharge to San Lorenzo River



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Alternative 7: Direct Potable Reuse

TABLE 3

Sub Alt	Description	Source Water	Treatment		Use
7	Raw Water Blending at Graham Hill WTP (via Coast PS)	Santa Cruz WWTF	Advanced Treatment at SC WWTF	AWT	The advanced treated water would be blended with raw water coming from North Coast sources, the San Lorenzo River, and Loch Lomond water at the Coast Pump Station, and further treated at the GHWTP prior to distribution as finished water, suitable for drinking.

Additional Consideration: GHWTP source water issues include high turbidity, high TOC, DBPs, solids issues, etc. Consider synergies between GHWTP investments and AWPF when evaluating siting and blending.

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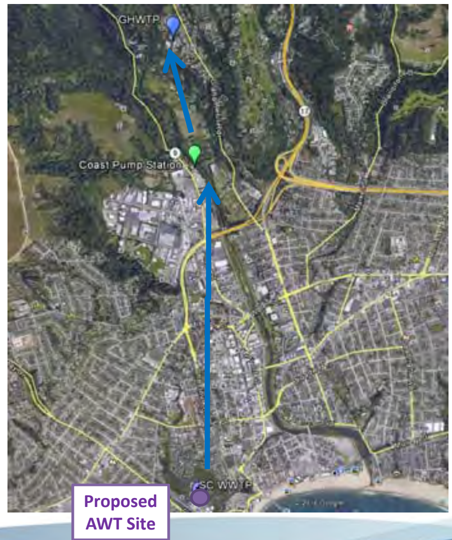
Alternative 7: DPR with Raw Water Blending at Graham Hill WTP



- **GHWTP** : Treat blended raw water + purified water to produce drinking water
- **Coast Pump Station:** Raw Water
- **SC WWTP + AWPF:** Purified Water

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OPEN DISCUSSION

* Workshop participants came to alignment on alternatives as developed, upon incorporation of comments from today's workshops.

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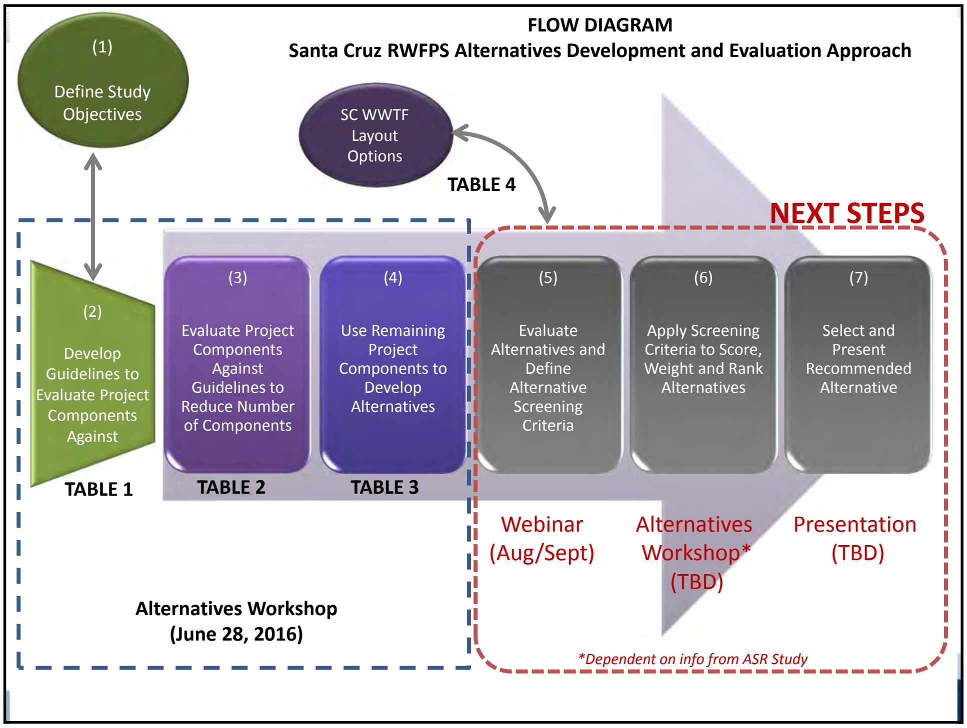

QUESTIONS

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City of Santa Cruz
Wastewater Treatment Facility

Future Facility Layout Estimates

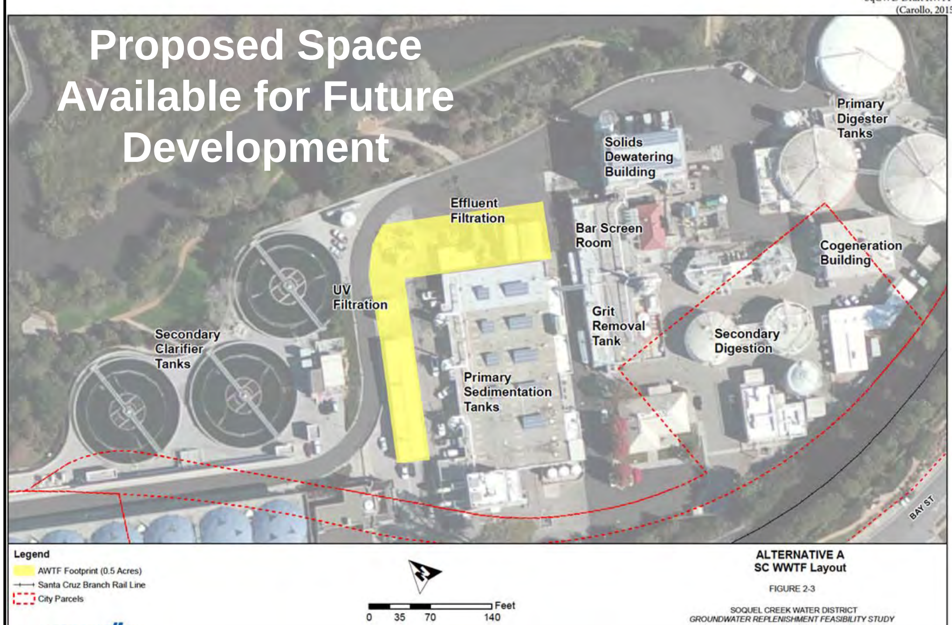
Trussell Technologies, Inc.

June 28, 2016

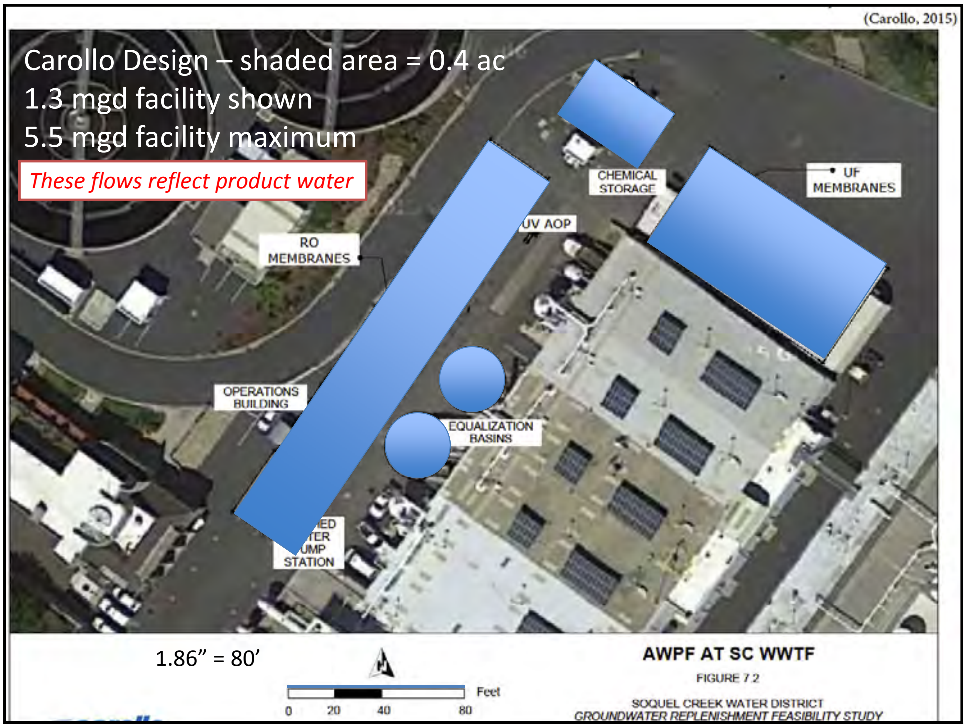
** Includes amended notes to reflect decisions at workshop*

Trussell

SqCWD Draft RWFPS
(Carollo, 2015)



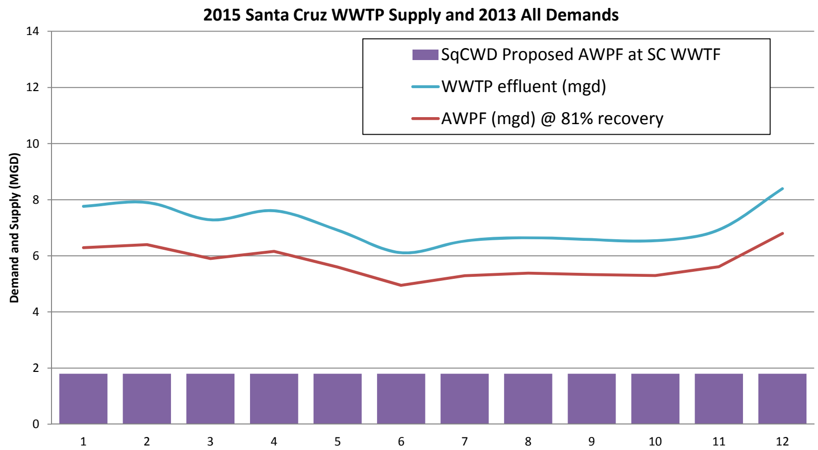
Trussell



Layout considerations

- **Goal**: identify space limitations at WWTF
- **Two water quality objectives:**
  - Compatibility with 175 gpm (0.25 mgd) tertiary
  - Tertiary (non-potable):
    - ✓ 1.5 mgd
  - AWPF (advanced treated water):
    - ✓ Scenario 1: 1.3 mgd (based on Soquel RWFPS)
    - ✓ Scenario 2: 5.0 mgd (based on June flow)
- **Siting Considerations:** Potential layout options and relocation of displaced facilities can be discussed at a high-level.

Initial Supply Evaluation



City PWD noted that these represent drought flows, normal weather flows can range from 8.5 to 9.0 mgd in June

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Processes Included in TT Estimate

AWPF

- MF (n+1)
  - 20 gfd flux
  - 90% recovery
- RO (n+1)
  - 12 gfd flux
  - 80% recovery
- UV/AOP (n+1)
  - H_2O_2
- Chemical Storage
- Not YET included
  - Operations building
  - Post treatment
  - Product water pump station
  - Relocation of facilities

Tertiary

- Granular media filtration
  - 5 gpm/sf
- Disinfection
  - Combined chlorine
    - ✓ 80% baffling efficiency CCB
    - ✓ > 90-min modal, 450 CT
  - UV (smaller footprint)
    - ✓ 55% UVT minimum influent possible
- Meets Title-22 requirements
- No product water storage

Trussell

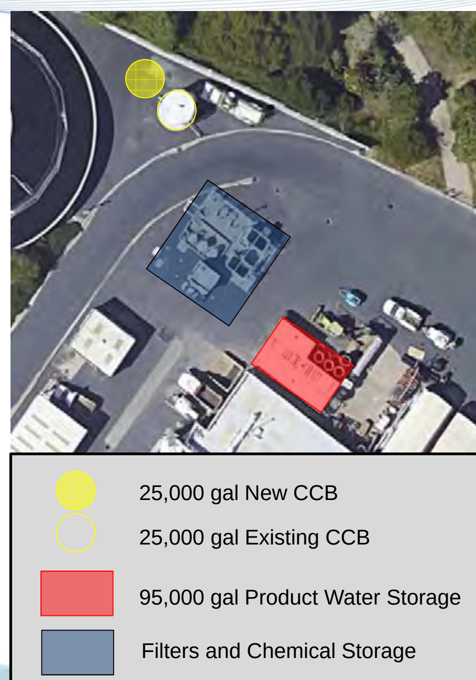
0.25 mgd Tertiary Layout (Phase 2 Project)

Trussell

0.25 mgd Tertiary Treatment Design

(Phase 2 Project)

- Footprint area estimate
  – 0.08 acre
- Uses existing conveyance infrastructure, filters and chemical storage



Increasing Capacity Beyond 0.25 mgd

Up to 0.25 mgd Capacity

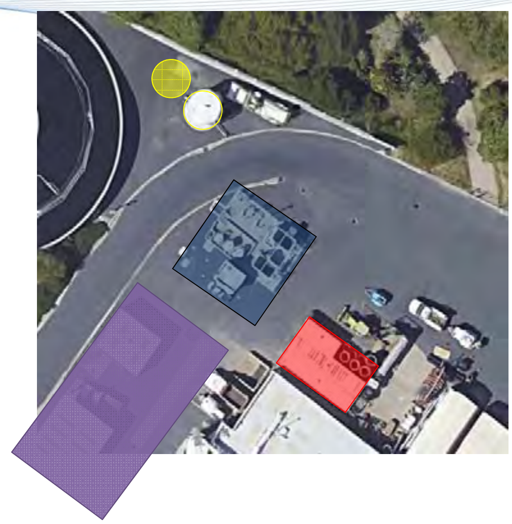
- Existing infrastructural limitations:
  - Conveyance piping
  - Conveyance pumps
  - Filter capacity

Beyond 0.25 mgd Capacity

- Upgrade conveyance piping and pumps
- Add additional filters
- Add additional disinfection capacity

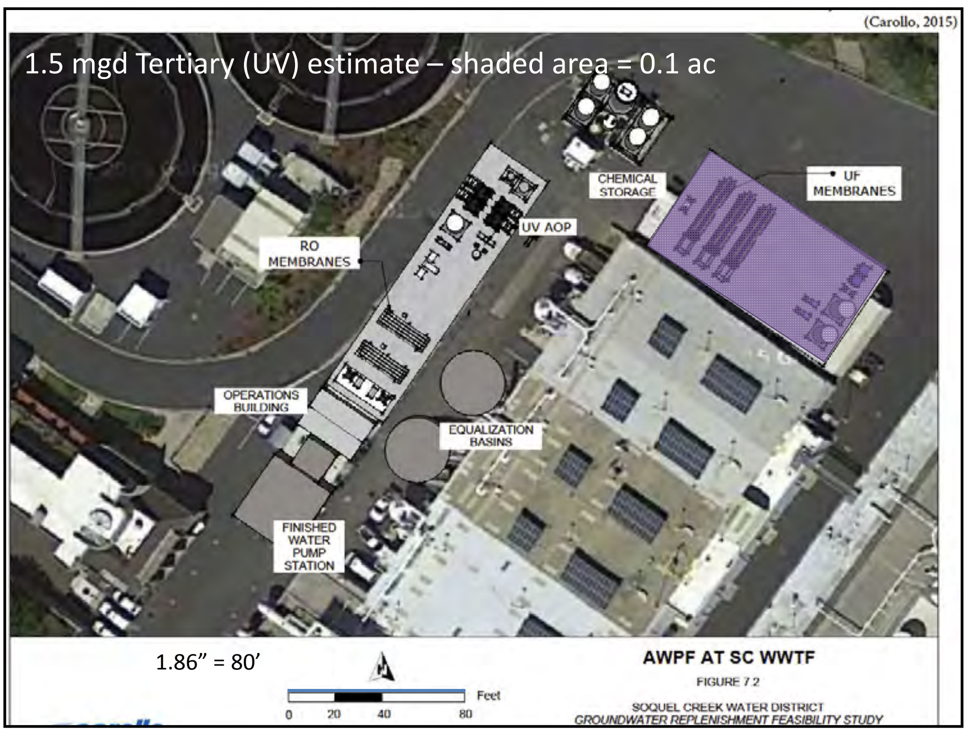
Flexibility of 0.25 mgd Tertiary Treatment Design

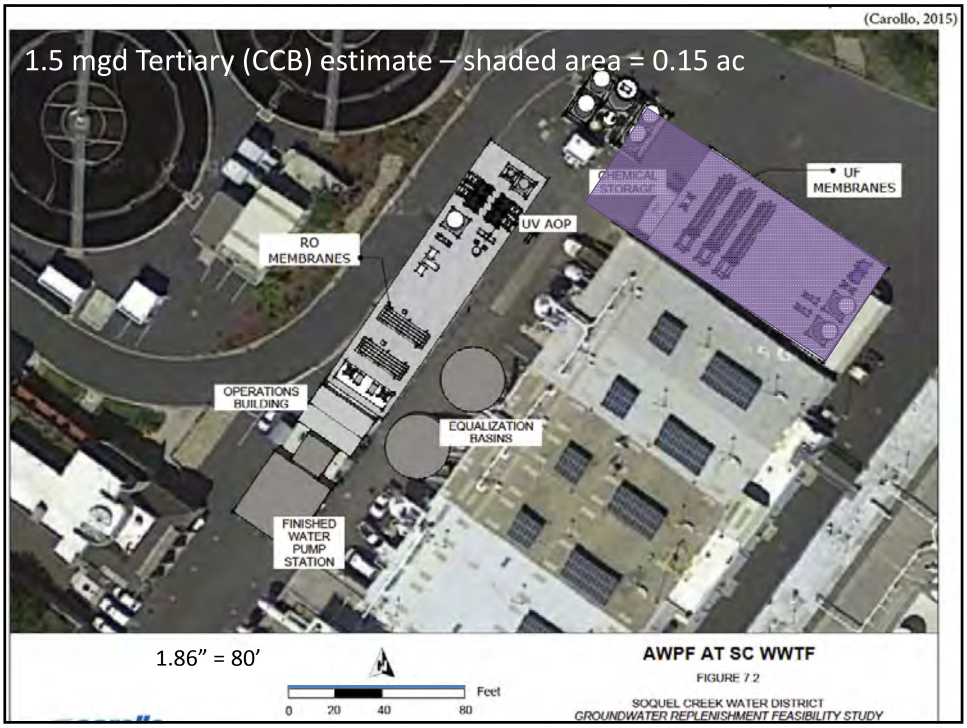
- Allows space for 1.5 mgd tertiary



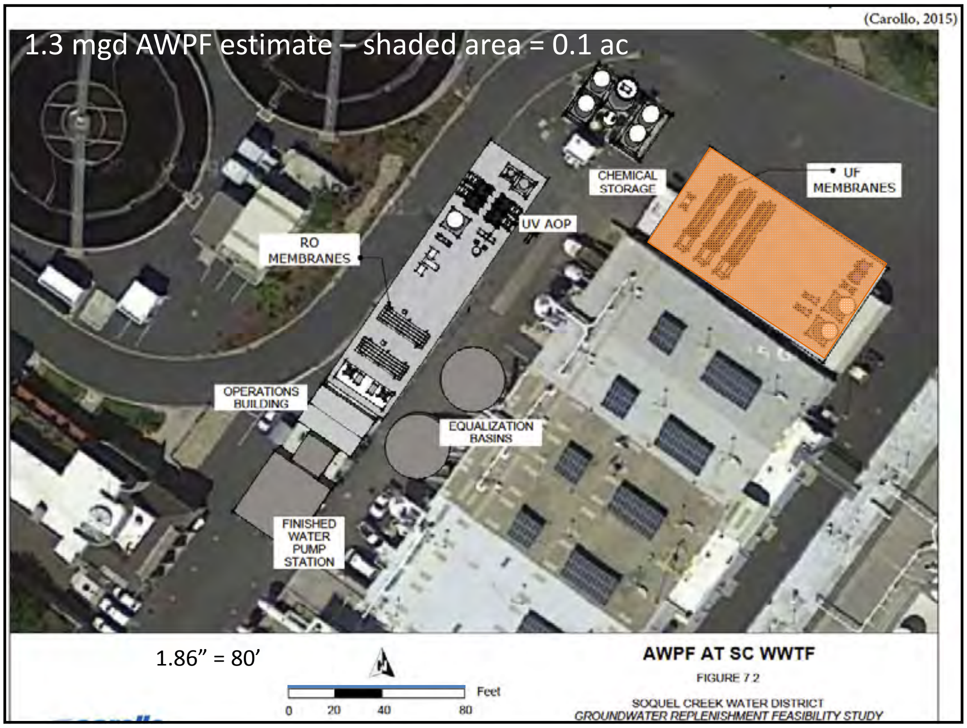
1.5 mgd Tertiary Layout

Trussell

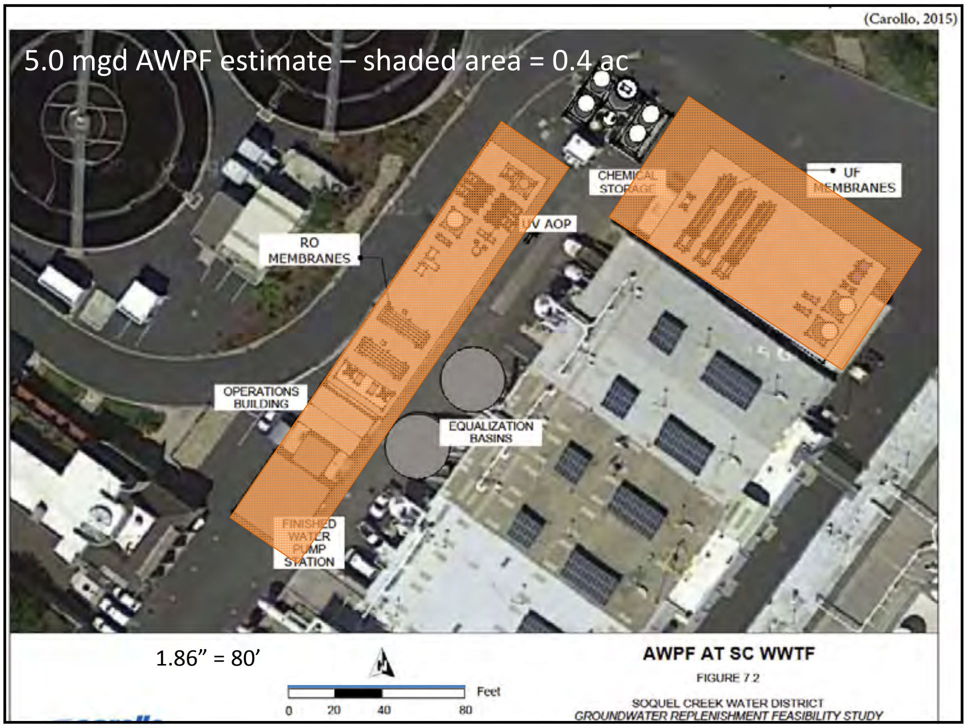




1.3 mgd AWPF Layout



5.0 mgd AWPF Layout



Preliminary Site Layout Options Summary

Treatment Design Options	Flow Rate (mgd)	Footprint Estimate (acre)
Phase 2 Tertiary	0.25	0.08
Tertiary Alternatives:		
Chlorine Contact Basin	1.5	0.15
UV Disinfection	1.5	0.10
AWPF Alternatives	1.3 5.0	0.10 0.40

Per discussions during the workshop, the bookends of site layouts for tertiary and AWTF are to be expanded to maximize treatment in the available space.
The table on the following page represents the revised layouts to be evaluated.

Revised Site Layout Options (to be evaluated)

Treatment Design Options	Min Flow Rate (mgd)	Min Footprint Estimate (acre)	Max Flow Rate (mgd)	Max Footprint Estimate (acre)
Phase 2 Title 22 Tertiary Project	0.25	0.08	same	same
Tertiary Alternatives:				
Media Filtration + Chlorine Disinfection	1.5	0.15	5.5	TBD
Media Filtration + UV Disinfection	1.5	0.10	5.5	TBD
MF Filtration + UV Disinfection	1.5	0.10	9.5	TBD
AWTF Alternatives:				
AWTF Alternative for IPR	1.3	0.10	5.5	0.40
AWTF Alternative for DPR	5.5	0.40	9.5	TBD

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Santa Cruz Regional
Recycled Water Facilities Planning Study (RWFPS)

Screening Webinar
29 Aug 2016 from 1 to 3 pm

Conf Call - (855) 813-2486 Code – 2484

Web Meeting - http://conf.kennedyjenks.com/conference/2484

AGENDA

Overall Webinar Objective: Present approach for screening alternatives. Discuss and seek input on screening categories, criteria, guidelines for scoring and weighting to compare alternative projects in the Santa Cruz RWFPS.

Action Item: Project Partners to fill out and submit weighting table following the workshop.

----

1. Introduction and Roles
2. Overview of Today's Workshop
3. Overall Alternatives Evaluation Approach (Figure 1)
4. Alternatives Screening Approach (Figures 2 & 3)
5. Screening Criteria and Guidance for Scoring (Table 5)
6. Weighting for Screening Criteria (Table 6)
7. Method to Score and Weight Alternative Projects (Table 7)
8. Ranking and Sensitivity Analysis (Table 8)
9. Open Discussion
10. Next Steps

City of Santa Cruz Recycled Water Facilities Planning Study

Screening Criteria Workshop

August 29, 2016

Kennedy/Jenks Consultants

Agenda

- Introduction and Roles
- Today's Workshop
- Overall Alternatives Evaluation Approach (Figure 1)
- Alternatives Screening Approach (Figures 2 & 3)
- Screening Criteria and Guidance for Scoring (Table 5)
- Weighting for Screening Criteria (Table 6)
- Method to Score and Weight Alternative Projects (Table 7)
- Ranking and Sensitivity Analysis (Table 8)
- Open Discussion
- Next Steps

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Today's Workshop

- **Objective:** Present approach for screening alternatives.
- **Goal:** Discuss and seek input on screening categories, criteria and guidelines for scoring and weighting alternative projects.
- **Action Items:** Project Partners to fill out and submit weighting table following the workshop.

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Overall Approach Flow Diagram

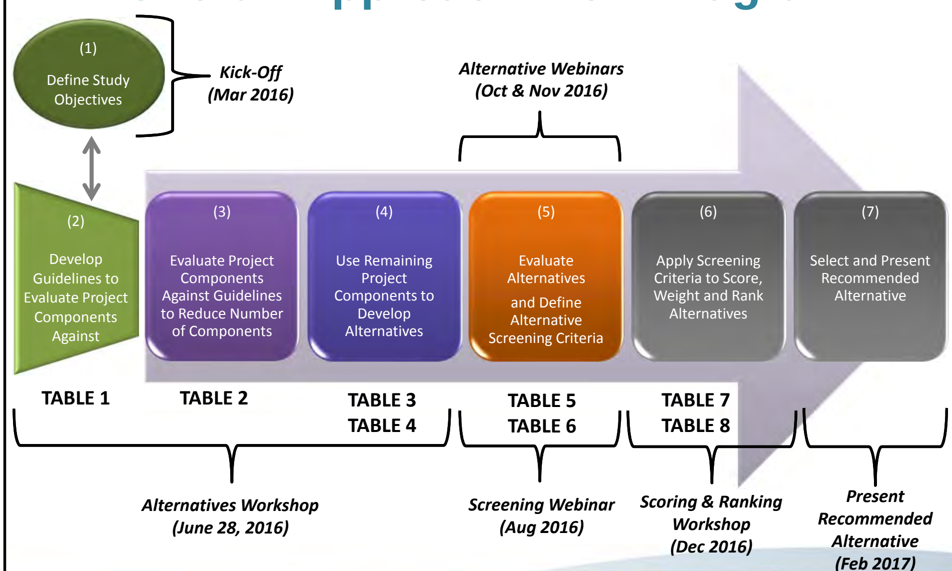

FIGURE 1

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Overall Approach - Meetings

- Mar-2016 Kickoff
- Jun-2016 Alternatives Workshop
- Aug-2016 Screening Webinar **(TODAY)**
- Oct-2016 Alternative Webinar – Part I
- Nov-2016 Alternative Webinar – Part II
- Dec-2016 Scoring and Ranking Workshop
- Feb-2017 Present Recommended Alternatives

FIGURE 1 (Table at Bottom)

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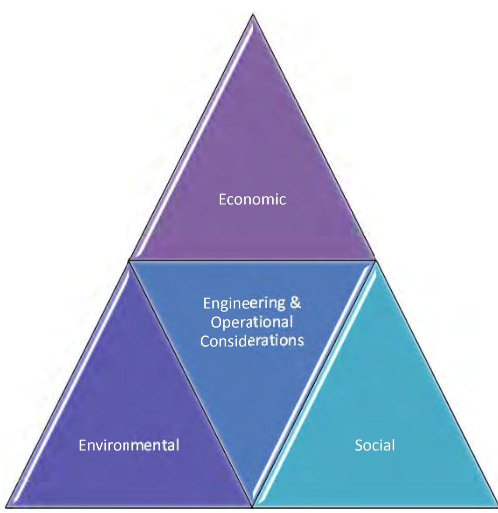
Alternatives Screening Categories



- Four categories to compare alternatives
- Triple Bottom Line (TBL) approach
- Integrates engineering and operational considerations

FIGURE 2

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Quantitative Results and Qualitative Screening Criteria

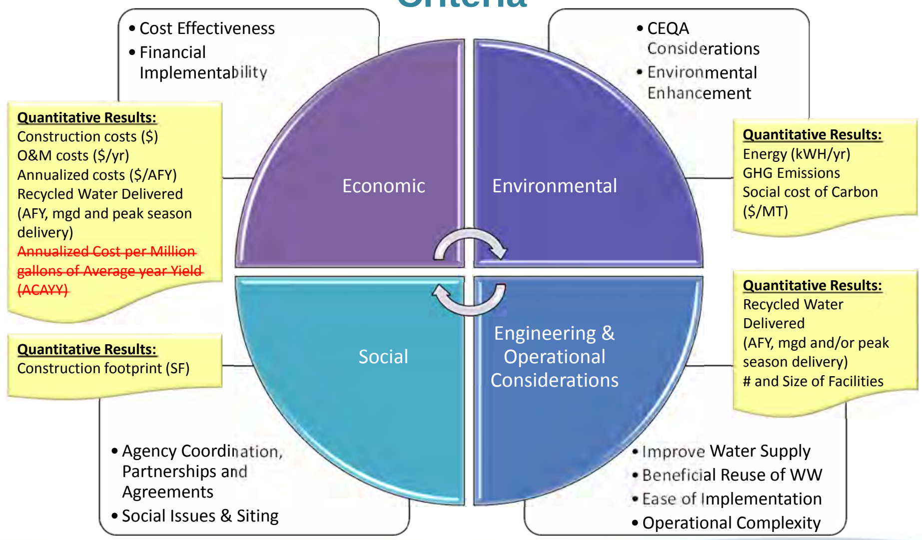

FIGURE 3

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QUANTITATIVE Results from Alternatives Evaluation

Recycled Water Delivered:	Costs:	Energy / Other:
Annual Volume (AFY)	Construction Costs ($)	Energy (kWH/AF) of RW Delivered
Average Annual Flow (mgd)	O&M Costs ($/yr)	GHG emissions (MT of CO_2e per year)
Peak Season Deliveries (AF Summer)	Life Cycle Costs ($/AFY)	Social Cost of Carbon ($/MT)
Peak Flow (mgd)	~~Annualized Cost per Million gallons of Average year Yield (ACAYY)~~	Construction Footprint (SF)
~~Average year Yield (MG)~~		# and Size of Facilities

QUANTITATIVE results will be provided for each alternative and used to inform qualitative scoring

AF = acre-feet
AFY = acre-feet per year
MG = million gallons
mgd = million gallons per day
kWH = kilowatt hour
MT = metric ton
CO_2e = carbon dioxide equivalent
SF = square feet

TABLE 5

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QUALITATIVE Criteria for Comparing Alternatives

Categories	Alternatives Screening Criteria	Considerations for Assessing Project based on Criteria
ENGINEERING & OPERATIONAL CONSIDERATIONS	Improve ~~Regional~~ Water Supply	Ability to fill City water supply gap, supplement supply in peak season, timeline for implementation
	Maximize Beneficial Reuse	Maximizes reuse of wastewater now and/or does not limit future options to fully utilize wastewater
	Ease of Implementation	Permitability, construction complexity, flexibility for phasing and potential for expansion
	Operational Complexity	Complexity of treatment requirements and short- and long-term impacts to WWTF O&M activities
ECONOMIC	Cost Effectiveness	Relative unit life cycle costs
	Financial Implementability	Relative capital investment and tradeoffs
ENVIRONMENTAL	CEQA Considerations	Potential impacts and mitigation requirements
	Environmental Enhancement	Opportunity to enhance ecosystem and social cost of carbon (GHG emissions)
SOCIAL	Agency Coordination, Partnerships and Agreements	Level of effort and willingness to work together
	Social Issues & Siting	Public acceptance and local disruption

QUANTITATIVE results and other considerations are used to guide scoring for each QUALITATIVE screening criteria

TABLE 5

Scoring for QUALITATIVE Criteria

Scoring Legend:	Score
Fully ~~Exceeds~~ Meets Criteria	5
Mostly ~~Exceeds~~ Meets Criteria	4
Generally Meets Criteria	3
Somewhat Meets Criteria	2
Unable to Meet Criteria	1

Scores are assigned based on the range of QUANTITATIVE results and relative findings from the QUALITATIVE assessment

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Engineering and Operational Considerations

- Water Supply Gap = 1.2 BGY, 3.3 mgd or 3,700 AFY
  - Quantitative Results = RW Delivered annually and during peak season (mgd or AF).
  - Qualitative Assessment = How often and to what level can project fill the City water supply gap. Considers potential excess supply to fill Regional water supply gap
- Construction Challenges
  - Quantitative Results = Number and size of facilities.
  - Qualitative Assessment = How much anticipated disturbance and likely construction complexity.

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Engineering and Operational Considerations

- Source of WW and Type of Treatment
  - Quantitative Results = Flow variation and source water quality.
  - Qualitative Assessment = Level of complexity for treatment processes and related operations.
- Siting new Treatment Facilities
  - Quantitative Results = Number and size of facilities and construction footprint.
  - Qualitative Assessment = Impact of relocation of existing facilities or disruption due to off-site operations.

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Economic

- Economic Feasibility / Cost Effectiveness
  - Quantitative Results = Capital, O&M and life cycle unit costs and ~~Annualized Cost per Million gallons of Average year Yield (ACAYY)*~~.
  - Qualitative Assessment = Comparison to baseline and avoided baseline costs.

** The WSAC defined ACAYY as a cost metric to evaluate the cost-effectiveness of different water supply projects using the Confluence Model to estimate yield. A similar approach will be used to the yield of each recycled water alternative to allow for comparison btw alternatives and with other water supply options (i.e. ASR Study). The RWFPS will provide the data to calculate the ACAYY for others to use in the comparison of priority RW projects with other WSAC projects; however, the ACAYY will not be used in the evaluation of RW alternatives in the RWFPS.*

- Financially implementable project
  - Quantitative Results = Capital costs.
  - Qualitative Assessment = Need to issue debt, potential impact on rates and required tradeoffs (i.e. the ability to implement other water supply projects.)

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Environmental

- CEQA Considerations
  - Quantitative Results = Need for MND vs. EIR.
  - Qualitative Assessment = Complexity of CEQA and permitting process; extent of mitigation required, especially if on-going effects on O&M.

Note: City will strive to offset energy requirement of any project(s) with green power. Other environmental impacts may include construction, noise, brine discharge, etc.

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Environmental

- Enhance Ecosystems
  - Quantitative Results = Not available.
  - Qualitative Assessment = Contributes significant, some or minimal benefit to enhancing the environment.
- Contribution to global warming
  - Quantitative Results = GHG emissions (Metric Tons of CO2e per year) based on energy (kWH/AF) of RW delivered and social cost of carbon ($/MT).
  - Qualitative Assessment = Relative social cost of carbon compared to other projects and sources.

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Social

- Level of Coordination and Partnership
  - Quantitative Results = Not available.
  - Qualitative Assessment = Level of City control and current interest from partners in agreements and cost sharing.
- Perceived Public Acceptance
  - Quantitative Results = Not available.
  - Qualitative Assessment = Supportive to opposed.
- Local Disruption
  - Quantitative Results = Construction footprint.
  - Qualitative Assessment = Challenges with land acquisition and opposition to on-going O&M activities.

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Weighting for Screening Criteria

Categories	Alternatives Screening Criteria	Example % Weighting	What's YOUR Weighting?
ENGINEERING & OPERATIONAL CONSIDERATIONS	Improve Regional Water Supply	20%	
	Ease of Implementation	15%	
	Operational Complexity	10%	
ECONOMIC	Cost Effectiveness	12%	
	Financial Implementability	12%	
ENVIRONMENTAL	CEQA Considerations	8%	
	Environmental Enhancement	8%	
SOCIAL	Agency Coordination, Partnerships and Agreements	10%	
	Social Issues & Siting	5%	
	TOTAL	100%	

Consultant Team
City Water Team
City PW Team
SqCWD Team*
SVWD Team*
Santa Cruz County Team*

Each team provides a unique point of view.
** Integration of non-financial partner weighting in ranking to be determined .*

TABLE 6

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Alternative Project Scoring and Weighting Evaluation

TABLE 7

PLACEHOLDER SCORES/WEIGHTING FOR EXAMPLE ONLY

Categories			ENGINEERING & OPERATIONAL CONSIDERATIONS										ECONOMIC			ENVIRONMENTAL				SOCIAL				TOTAL
Alternatives Screening Criteria			Improve Water Supply		Maximize Beneficial Reuse		Ease of Implementation			Operational Complexity		Subtotal	Cost Effectiveness	Financial Implementability	Subtotal	CEQA Considerations 4	Environmental Enhancement		Subtotal	Agency Coordination, Partnerships and Agreements	Social Issues & Siting		Subtotal	Total Weighted Score (max 100)
			Supply Gap	Timeline	Maximize Use Now	Future Expansion	Permitability	Construction	Expansion	Treatment	Siting		Unit Costs	Capital		Impact/ Mitigation	Enhance	GHG		Level/ Willingness	Public Acceptance	Local Disruption		
RECOMMENDED Weighting based on input from Project Partners			10.4		4.6		13.9			16.1		45.1	15.0	10.6	25.6	6.8	6.4		13.2	10.6	5.0		15.6	100
Alternative	Sub-Alt #	Description																						
Alternative 1 – Centralized Non-Potable Reuse	1a	Santa Cruz PWD Phase 2 Project	3	4	3	3	4	5	4	5	5	38.2	4	5	22.6	5	4	4	11.9	5	5	5	15.6	88.4
	1b	Maximize tertiary treatment at the SC WWTF	3	3	3	3	4	5	5	5	5	38.1	4	4	20.5	5	4	4	11.9	5	5	4	15.1	85.6
Alternative 2 – Decentralized Non-Potable Reuse	2	UC Santa Cruz	1	1	3	3	3	4	4	4	4	27.9	3	4	17.5	5	4	4	11.9	4	5	4	13.0	70.3
Alternative 3 – Santa Cruz Participation in SqCWD led Groundwater Recharge Reuse (GWRR) Project	3a	Send secondary effluent from SCWWTF to SqCWD for injection in SqCWD basin (serve NPR users along the way)	1	1	3	3	5	5	2	5	5	32.1	5	5	25.6	5	4	4	11.9	5	5	4	15.1	84.7
	3b	Send tertiary effluent from SCWWTF to SqCWD (serve NPR users along the way)	2	[illegible]	3	[illegible]	5	5	4	5	5	[illegible]	5	5	25.6	5	4	4	[illegible]	5	5	4	15.1	88.7
	3c	Send additional secondary effluent from SCWWTF to SqCWD AWTF and deliver purified water from SqCWD AWTF o recharge Santa Cruz GWRR	5	5	3	3	4	4	4	4	4	37.2	4	4	20.5	4	4	4	10.6	4	3	4	12.0	80.3
	3d	Send advanced treated RW from SCWWTF to SqCWD, (serve NPR users along the way)	2	2	3	3	3	4	4	[illegible]	5	[illegible]	[illegible]	5	[illegible]	5	4	4	11.9	5	5	4	15.1	85.9
	3e	Send advanced treated RW from SCWWTF to SqCWD, (GWRR and NPR along the way)	5	5	3	3	ceeds Meets	xceeds Meet	4	4	4	37.2	4	4	20.5	4	4	4	10.6	4	3	4	12.0	80.3
Alternative 4 – Santa Cruz GWRR Project	4a	Santa Cruz GWRR with AWTF at SC WWTF (DO NOT serve NPR users along the way)	5	5	3	3	3	4	3	3	3	32.1	4	3	18.4	4	4	4	10.6	4	3	3	11.5	72.6
	4b	Santa Cruz GWRR with AWTF of secondary effluent at off-site location (DO NOT serve NPR users along the way)	nd/or supp	5	3	3	3	3	3	3	2	29.6	4	3	18.4	3	4	4	9.2	4	3	3	11.5	68.7
	4c	Santa Cruz GWRR with MBR + AWTF at DA Porath PS (DO NOT serve NPR users along the way)	4	4	3	3	2	2	1	3	3	25.4	3	3	15.4	3	4	2	7.9	4	3	3	11.5	60.2
Alternative 5 – Surface Water Augmentation (SWA) in Loch Lomond Reservoir	5	Advanced treatment of Santa Cruz effluent for bending in Loch Lomond Reservoir (DO NOT serve NPR users along the way)	5	5	3	3	2	3	3	2	2	27.1	4	2	16.3	3	3	1	6.6	2	2	2	6.3	56.2
Alternative 6 – Streamflow Augmentation	6a	AWTF of secondary effluent with direct discharge to the San Lorenzo River btw Felton and Tait (DO NOT serve NPR users along the way)	2	2	3	3	1	3	3	2	2	19.9	2	2	10.3	1	3	2	4.6	2	3	3	7.3	41.9
	6b	AWTF of secondary effluent with indirect discharge to the San Lorenzo River d/s of Tait Street Diversion at Tait Well Field (DO NOT serve NPR users along the way)	2	2	3	3	1	3	3	2	2	19.9	2	2	10.3	1	3	2	4.6	2	3	3	7.3	41.9
Alternative 7 – Direct Potable Reuse	7	Raw Water Blending at Graham Hill WTP (via Coast PS)	5	5	3	3	3	4	4	2	2	29.8	4	2	16.3	3	2	2	6.6	4	2	3	11.0	63.7

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Alternative Project Ranking

TABLE 8

Alternative	Sub-Alt #	Description	SCORING: ENGINEERING & OPERATIONAL CONSIDERATIONS	SCORING: ECONOMIC	SCORING: ENVIRONMENTAL	SCORING: SOCIAL	SCORING: Total Score	RANKING (AVE WEIGHTED RANKING): ENGINEERING & OPERATIONAL CONSIDERATIONS	RANKING: ECONOMIC	RANKING: ENVIRONMENTAL	RANKING: SOCIAL	RANKING: Total Score
Alternative 1 – Centralized Non-Potable Reuse	1a	Santa Cruz PWD Phase 2 Project	35.7	22.6	13.9	17.2	89.5	1	1	1	1	1
	1b	Maximize tertiary treatment at the SC WWTF	35.2	20.5	13.9	16.6	86.2	1	2	1	2	3
Alternative 2 – Decentralized Non-Potable Reuse	2	UC Santa Cruz	23.9	17.5	13.9	14.4	69.8	1	6	1	6	10
Alternative 3 – Santa Cruz Participation in SqCWD led Groundwater Recharge Reuse (GWRR) Project	3a	Send secondary effluent from SCWWTF to SqCWD for injection in SqCWD basin (serve NPR users along the way)	27.6	25.6	13.9	16.6	83.8	1	2	1	2	5
	3b	Send tertiary effluent from SCWWTF to SqCWD (serve NPR users along the way)	32.3	25.6	13.9	16.6	88.5	1	2	1	2	2
	3c	Send additional secondary effluent from SCWWTF to SqCWD AWTF and deliver purified water from SqCWD AWTF o recharge Santa Cruz GWRR	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	3d	Send advanced treated RW from SCWWTF to SqCWD, (serve NPR users along the way)	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	3e	Send advanced treated RW from SCWWTF to SqCWD, (GWRR and NPR along the way)	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Alternative 4 – Santa Cruz GWRR Project	4a	Santa Cruz GWRR with AWTF at SC WWTF (serve NPR users along the way)	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	4b	Santa Cruz GWRR with AWTF of secondary effluent at off-site location (serve NPR users along the way)	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	4c	Santa Cruz GWRR with MBR + AWTF at DA Porath PS (serve NPR users along the way)	24.4	15.4	9.3	12.6	61.6	11	9	11	9	12
Alternative 5 – Surface Water Augmentation (SWA) in Loch Lomond Reservoir	5	Advanced treatment of Santa Cruz effluent for bending in Loch Lomond Reservoir	27.2	16.3	7.7	6.9	58.1	12	15	12	15	13
Alternative 6 – Streamflow Augmentation	6a	AWTF of secondary effluent with direct discharge to the San Lorenzo River btw Felton and Tait(serve NPR users along the way)	17.7	10.3	5.4	8.1	41.4	14	13	14	13	14
	6b	AWTF of secondary effluent with indirect discharge to the San Lorenzo River d/s of Tait Street Diversion at Tait Well Field (serve NPR users along the way)	17.7	10.3	5.4	8.1	41.4	14	13	14	13	14
Alternative 7 – Direct Potable Reuse	7	Raw Water Blending at Graham Hill WTP (via Coast PS)	29.9	16.3	7.7	11.9	65.9	12	12	12	12	11

PLACEHOLDER SCORES/RANKING FOR EXAMPLE ONLY

Ranking Legend: Categories	
Highest Ranked	
Lowest Ranked	

Sensitivity Analysis

TABLE 8

Alternative	Sub-Alt #	Description	RANKING (AVE WEIGHTED RANKING): ENGINEERING & OPERATIONAL CONSIDERATIONS	ECONOMIC	ENVIRONMENTAL	SOCIAL	Total Score	SENSITIVITY RANKING: Agency Weighted Objective Score	Maximize Water Supply	Most Financially Viable	Maximize Environmental Benefits	Average Ranking (sensitivity analysis scenarios)
Alternative 1 – Centralized Non-Potable Reuse	1a	Santa Cruz PWD Phase 2 Project	1	1	1	1	1	1	1	4	1	2
	1b	Maximize tertiary treatment at the SC WWTF	1	2	1	2	3	3	3	5	3	4
Alternative 2 – Decentralized Non-Potable Reuse	2	UC Santa Cruz	1	6	1	6	10	10	12	10	8	10
Alternative 3 – Santa Cruz Participation in SqCWD led Groundwater Recharge Reuse (GWRR) Project	3a	Send secondary effluent from SCWWTF to SqCWD for injection in SqCWD basin (serve NPR users along the way)	1	2	1	2	5	5	8	3	5	5
	3b	Send tertiary effluent from SCWWTF to SqCWD (serve NPR users along the way)	1	2	1	2	2	2	5	1	2	3
	3c	Send additional secondary effluent from SCWWTF to SqCWD AWTF and deliver purified water from SqCWD AWTF o recharge Santa Cruz GWRR	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	3d	Send advanced treated RW from SCWWTF to SqCWD, (serve NPR users along the way)	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	3e	Send advanced treated RW from SCWWTF to SqCWD, (GWRR and NPR along the way)	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Alternative 4 – Santa Cruz GWRR Project	4a	Santa Cruz GWRR with AWTF at SC WWTF (serve NPR users along the way)	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	4b	Santa Cruz GWRR with AWTF of secondary effluent at off-site location (serve NPR users along the way)	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	4c	Santa Cruz GWRR with MBR + AWTF at DA Porath PS (serve NPR users along the way)	11	9	11	9	12	12	13	13	11	12
Alternative 5 – Surface Water Augmentation (SWA) in Loch Lomond Reservoir	5	Advanced treatment of Santa Cruz effluent for bending in Loch Lomond Reservoir	12	15	12	15	13	13	11			
Alternative 6 – Streamflow Augmentation	6a	AWTF of secondary effluent with direct discharge to the San Lorenzo River btw Felton and Tait(serve NPR users along the way)	14	13	14	13	14	14	14			
	6b	AWTF of secondary effluent with indirect discharge to the San Lorenzo River d/s of Tait Street Diversion at Tait Well Field (serve NPR users along the way)	14	13	14	13	14	14	14			
Alternative 7 – Direct Potable Reuse	7	Raw Water Blending at Graham Hill WTP (via Coast PS)	12	12	12	12	11	11	10			

PLACEHOLDER SCORES/RANKING FOR EXAMPLE ONLY

Sensitivity Analysis Weighting Factors
Equal Weighted (average of participant weighting factors)
Maximizing Water Supply
Lower Cost
Maximize Environmental Benefits
Average Project Partner Weighting Factors

OPEN DISCUSSION

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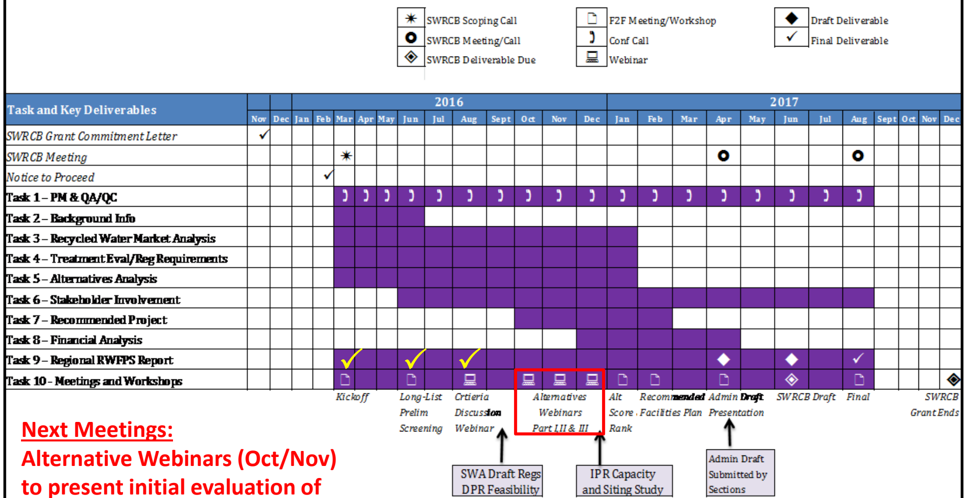
Next Steps - RWFPS Schedule



Next Meetings:
Alternative Webinars (Oct/Nov) to present initial evaluation of alternative projects

Part III

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Next Steps

- Alternative Webinar - Part I (Oct 2016)
  - **Objective:** Present evaluation for 1st set of Alternatives
    - ✓ Preliminary maps, facilities, costs, etc.
    - ✓ Alt 1&2 (NPR), Alt 3 (NPR only)
  - **Goal:** Obtain input and clarify assumptions
  - **Action Items:** Response to specific requests for information

Next Steps

- Alternative Webinar - Part II (Nov 2016)
  - Present evaluation for 2nd set of Alternatives
    - ✓ Preliminary maps, facilities, costs, etc.
    - ✓ Alt 5 (SWA), Alt 6 (SFA) and Alt 7 (DPR)
- Alternative Webinar - Part III (Dec 2016/Jan 2017)
  - Present evaluation for 3rd set of Alternatives
    - ✓ Preliminary maps, facilities, costs, etc.
    - ✓ Alt 3 & 4 (GWRR)

Next Steps

- Scoring & Ranking Workshop (Dec 2016)
  - **Objective:** Overview of Alternatives, Discuss Prelim Scoring and Ranking
  - **Goal:** Identify Recommended Alternative (or Phased Projects) for further development
  - **Action Items:** Input from each project partner on scoring and ranking tables.

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Homework

Categories	Alternatives Screening Criteria	Considerations for Assessing Project based on Criteria	TEAM: Individual:
ENGINEERING & OPERATIONAL CONSIDERATIONS	Improve Water Supply	- Ability to fill City supply gap (1.2 BGY or 3,700 AFY), supplement peak season supply with a new source or offset and/or contribute to regional supply	
		- Ability to implement Project, with supplies available in a timely manner	
	Maximize Beneficial Reuse	- Maximizes reuse of wastewater effluent now	
	Ease of Implementation	- Regulatory viability and ability to obtain a recycled water permit - Current (DDW and RWQCB) regulatory pathway/approved use	
		- Potential construction challenges (#/size of facilities, ROW, utilities, terrain, disturbed/undisturbed area, seismic/sea level rise vulnerability, etc.)	
		- Flexibility for phasing and opportunities to expand/transition to a higher yield and/or treatment level.	
	Operational Complexity	- Source of wastewater and/or type treatment required for beneficial reuse minimizes impacts to wastewater collection and/or WWTF operations	
		- Siting new treatment facilities minimize short-term impacts on SC WWTF operations (during construction) and long-term impacts (related to facility relocation, off-site location and/or interference with O&M activities).	
ECONOMIC	Cost Effectiveness	- Economically feasible or cost effective project (relative life cycle unit costs)	
	Financial Implementability	- Financially implementable project (capital investment does not limit ability to implement other water projects and program)	
ENVIRONMENTAL	CEQA Considerations	- Potential environmental impacts and mitigation requirements	
	Financial Implementability	- Enhance local and regional ecosystems and environments including rivers, groundwater basins	
		- Social cost of carbon compared to other projects and supplies; Relative contribution to global warming (based on GHG emissions)	
SOCIAL	Agency Coordination, Partnerships and Agreements	- Level of cooperation and coordination required between multiple outside agencies/users - Willingness and interest of anticipated users/partners for cost-sharing	
	Social Issues & Siting	- Perceived public acceptance and comfort with level of public health and safety associated with reuse	
		- Level of impact on local residents for new construction and ongoing maintenance - land acquisition requirements (property not currently owned by the City)	
			0%
			* Percentages must add up to 100%

Please fill out and submit your proposed weightings for each of the screening criteria by Friday, Sept 2nd

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QUESTIONS

Kennedy/Jenks:	Dawn Taffler	DawnTaffler@KennedyJenks.com
	Melanie Tan	MelanieTan@KennedyJenks.com
Abt Associates:	Bob Raucher	Bob_Raucher@abtassoc.com
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GHD:	Pat Collins	Pat.Collins@ghd.com

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THANK YOU

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Santa Cruz Regional
Recycled Water Facilities Planning Study (RWFPS)

Alternatives Webinar – Part 1
18 October 2016 from 9 am to 11 am

Conf Call - (855) 813-2486 Code – 2484

Web Meeting - http://conf.kennedyjenks.com/conference/2484

AGENDA

Overall Webinar Objective: Present preliminary evaluation for non-potable reuse (NPR) alternatives using preliminary maps, tables and figures to illustrate facility locations, capacities and costs.

Goal: Discuss and seek input on assumptions, facility locations and other project components.

Action Items: Respond to specific requests for information, update alternatives (as-needed) and memorialize discussion points to support scoring of alternative projects.

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1. Recycled Water Supply
2. NPR Market Assessment and Demand
3. NPR Treatment Requirements
4. NPR Alternatives
    a. Alternative 1: Centralized
    b. Alternative 2: Decentralized
    c. Alternative 3: Santa Cruz Participation in SqCWD-led GWRR Project (NPR uses only)
5. Quantitative Results
6. Cost Comparison
7. Qualitative Considerations
8. Next Steps

City of Santa Cruz
Recycled Water Facilities Planning Study

Alternatives Webinar Part I

October 18, 2016

** Includes amended notes to reflect discussion at workshop*

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Agenda

- Approach & Objective
- Recycled Water Supply
- NPR Market Assessment and Demand
- NPR Treatment Requirements
- NPR Alternatives
  - Quantitative Results
  - Cost Comparison
- Qualitative Considerations
- Open Discussion

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Overall Approach Flow Diagram

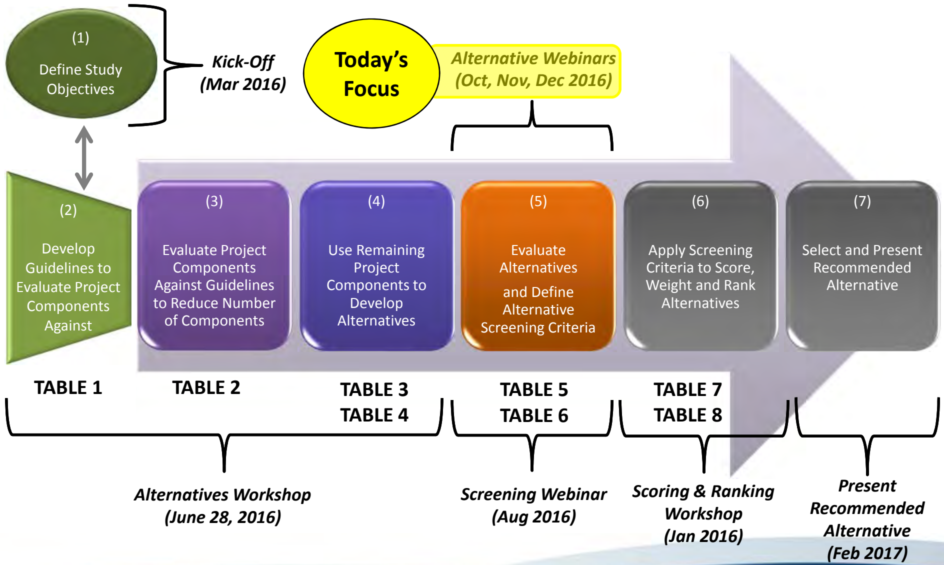

FIGURE 1 – Screening Webinar

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Alternatives Webinar Objective

- **Objective:** Present preliminary evaluation for non-potable reuse (NPR) alternatives using preliminary maps, tables and figures to illustrate facility locations, capacities and preliminary costs.
- **Goal:** Obtain input and clarify assumptions
- **Action Items:** Response to specific requests for information, update alternatives, and memorialize discussion points to support scoring of alternative projects.

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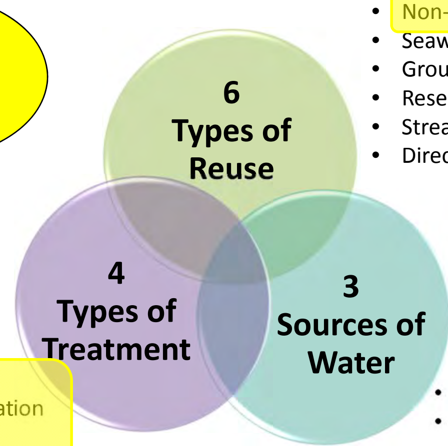
Project Components

Today's Focus



- Non-Potable
- Seawater Intrusion Barrier
- Groundwater Replenishment
- Reservoir Augmentation
- Streamflow Augmentation
- Direct Potable Reuse

- Secondary
- On-Site Filtration
- Tertiary
- Advanced

- Santa Cruz WWTF
- Local Raw Wastewater
- Scotts Valley

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Recycled Water Supply

	Effluent (MGD)	2015	2008 - 2016 Average
Dry Weather Flow (June)	Average	6.1	7.1
	Minimum	5.4	5.1
Wet Weather Flow (Dec)	Average	8.4	9.0
	Maximum	20.9	28.8

- 2015 econometric analysis of demand and forecast shows average annual wastewater flow increase by 0.18 MGD (about 1%)
  - 2015 flow data is used

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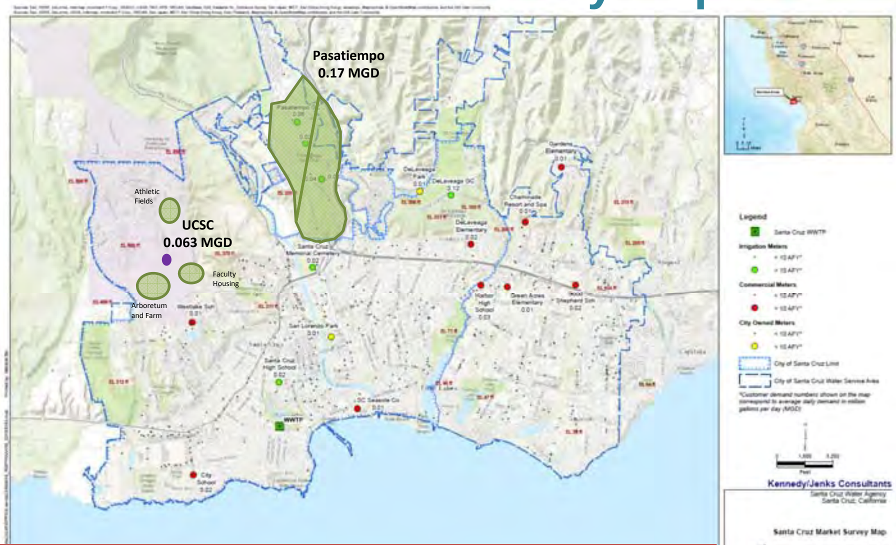
NPR Market Survey Map



** Add demands at SC WWTF, La Barranca Park, Truck Fill hydrant, SqCWD meters near Alt 3 alignments = add to map and demand tables and graphs*

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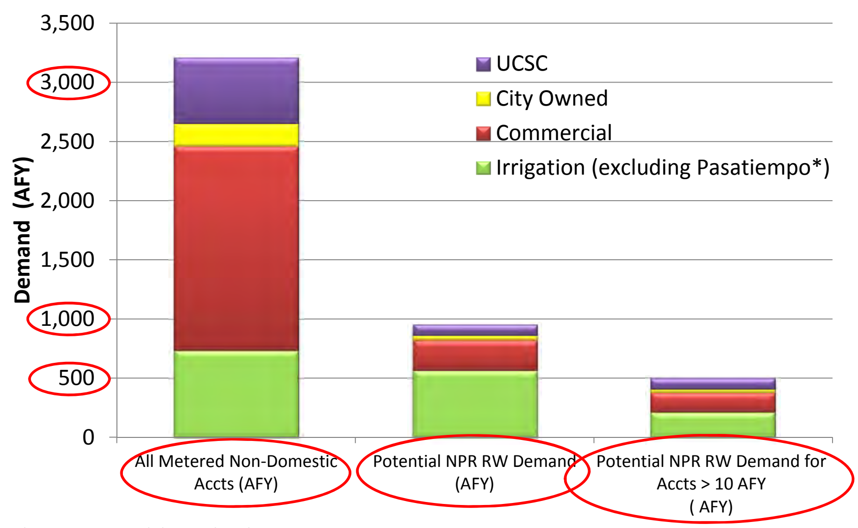
Estimated NPR RW Demand



Typical Santa Cruz total demand is about 7,500 AFY

- ✓ *Add SqCWD meters near Alt 3 alignments as a new stacked bar.*
- ✓ *Add Caltrans, SC WWTF and Truck fill (new category or integrate)*

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Estimated NPR RW Demand

Account Type	All Metered Non-Domestic Accts		Potential NPR RW Demand		Potential NPR RW Demand for Accts > 10 AFY	
	MGD	AFY	MGD	AFY	MGD	AFY
Irrigation (excluding Pasatiempo*)	0.66	736.25	0.50	563.54	0.19	213.10
Commercial	1.54	1727	0.23	257	0.15	166
City Owned	0.17	189	0.03	37	0.02	26
UCSC	0.50	559	0.08	93	0.08	93
Others	0.00	8	0.00	0	0.00	0
TOTAL	**2.87**	**3219**	**0.85**	**951**	**0.45**	**499**

~50% of annual potable water demand

Recycled water can only be served to be subset of non-domestic users

About half of the demand is from very small users

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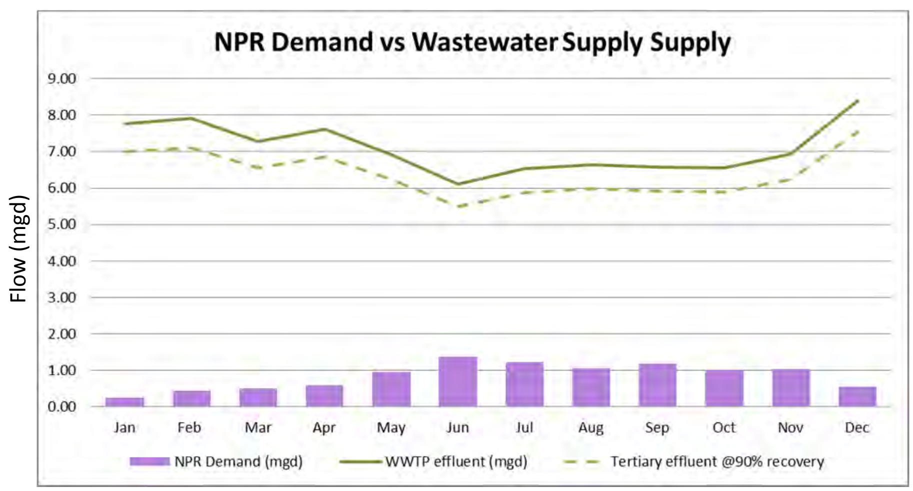
Supply and Demand



Sufficient effluent to meet NPR demands in Santa Cruz service area (0.85 mgd, 950AFY)

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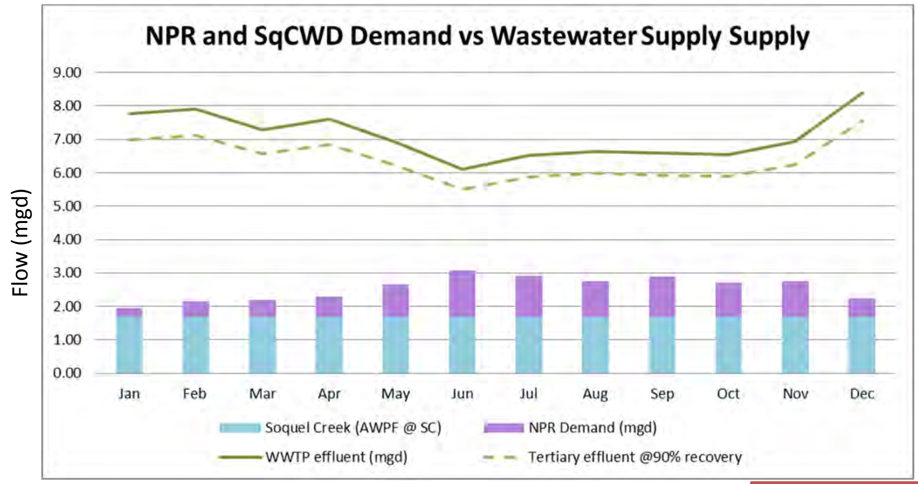
Supply and Demand



Sufficient effluent to meet NPR demands in Santa Cruz service area + SqCWD groundwater recharge demand (1.7 mgd, 1,900 AFY)

To be updated with added demands

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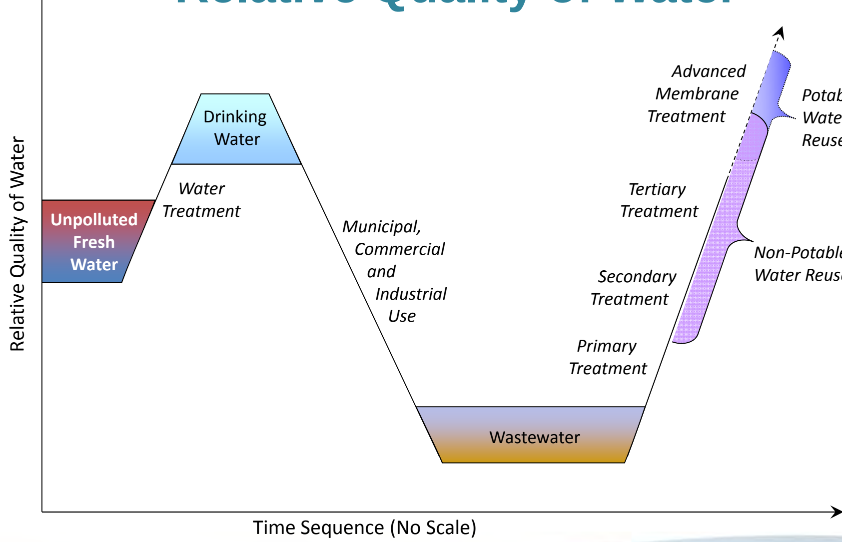
Relative Quality of Water



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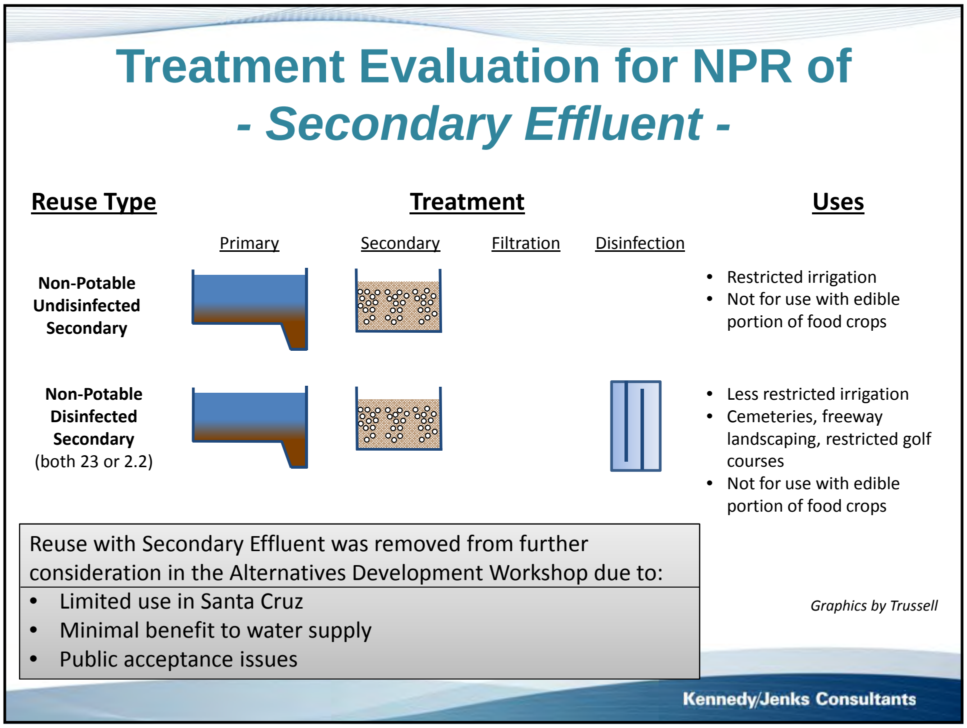
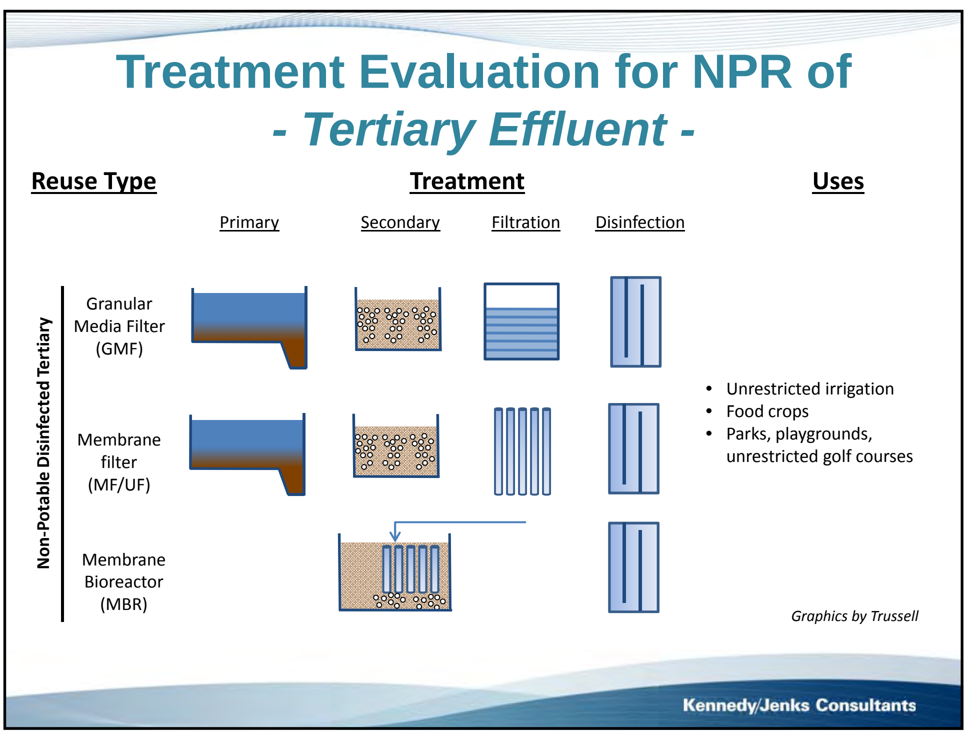

Treatment Evaluation for NPR of
- Secondary Effluent -
Reuse Type
Treatment
Uses
Primary
Secondary
Filtration
Disinfection
Non-Potable Undisinfected Secondary
• Restricted irrigation
• Not for use with edible portion of food crops
Non-Potable Disinfected Secondary (both 23 or 2.2)
• Less restricted irrigation
• Cemeteries, freeway landscaping, restricted golf courses
• Not for use with edible portion of food crops
Reuse with Secondary Effluent was removed from further consideration in the Alternatives Development Workshop due to:
• Limited use in Santa Cruz
• Minimal benefit to water supply
• Public acceptance issues
Graphics by Trussell
Kennedy/Jenks Consultants


Treatment Evaluation for NPR of
- Tertiary Effluent -
Reuse Type
Treatment
Uses
Primary
Secondary
Filtration
Disinfection
Non-Potable Disinfected Tertiary
Granular Media Filter (GMF)
Membrane filter (MF/UF)
Membrane Bioreactor (MBR)
• Unrestricted irrigation
• Food crops
• Parks, playgrounds, unrestricted golf courses
Graphics by Trussell
Kennedy/Jenks Consultants

Satellite Treatment of Secondary Effluent

(Photo: Waterworks Engineers)

Described by manufacturer as a “self-cleaning microfiber water-filters for treatments as fine as 2 micron that provides cartridge filter performance without cartridge filter replacement”, which indicates performance similar to a tertiary media filter.

Treatment Evaluation for NPR of
- Advance Treated Effluent -

Reuse Type | **Treatment*** | **Uses**

Potable Reuse
With Secondary Feedwater

Membrane Filtration | Reverse Osmosis | Ultraviolet Light/Advanced Oxidation

- Potable and non-potable applications

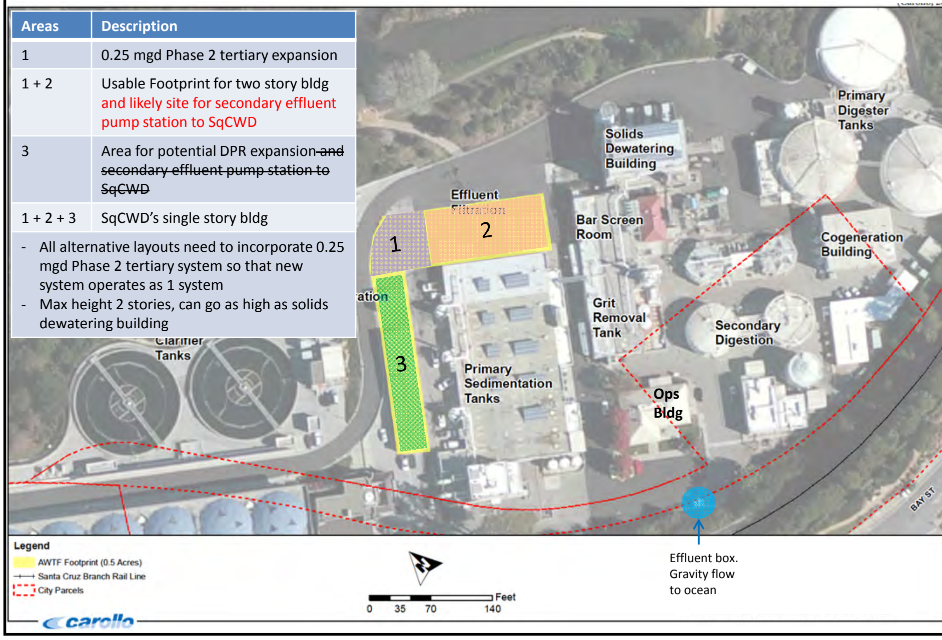
Unrestricted AWT for reuse, as discussed the Alternatives Development Workshop:
- Beyond regulatory requirement for NPR
- Significantly higher cost/energy
- Keep as an option for customers along pipeline alignments that carry advanced treated water for potable reuse

**Based on the proposed treatment train for the SqCWD GRRP Feasibility Study.*

Graphics by Trussell

Treatment Facility Siting at the Santa Cruz WWTF

Areas	Description
1	0.25 mgd Phase 2 tertiary expansion
1 + 2	Usable Footprint for two story bldg and likely site for secondary effluent pump station to SqCWD
3	Area for potential DPR expansion ~~and secondary effluent pump station to SqCWD~~
1 + 2 + 3	SqCWD's single story bldg
	- All alternative layouts need to incorporate 0.25 mgd Phase 2 tertiary system so that new system operates as 1 system - Max height 2 stories, can go as high as solids dewatering building



Alternatives for Further Evaluation

- Alternative 1 – Centralized Non-Potable Reuse
- Alternative 2 – Decentralized Non-Potable Reuse
- Alternative 3 – Santa Cruz Participation in SqCWD-led GWRR Project*

** NPR projects only*

- Alternative 4 – Santa Cruz GWRR Project
- Alternative 5 – Surface Water Augmentation (SWA) in Loch Lomond Reservoir
- Alternative 6 – Streamflow Augmentation
- Alternative 7 – Direct Potable Reuse

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Preliminary capital & annualized costs

- Capital Costs
  - Treatment
  - Pipelines
  - Pump Stations
  - Storage
  - Site Retrofit
- Annualized capital & O&M costs for alternative comparison
- Further inputs to confirm the following after webinar
  - Phasing of capital costs
  - Pipeline special crossing costs
  - Energy and labor costs
  - Interest and contingencies
  - Retrofit costs

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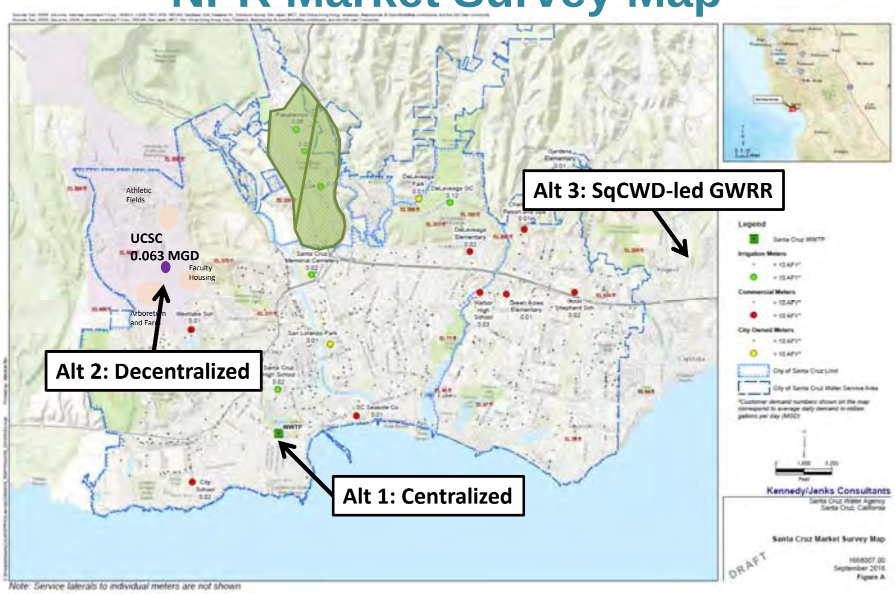
NPR Market Survey Map



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Alternatives 1: Centralized Non-Potable Reuse

Alternative	Sub Alt	Description	Source Water	Treatment		Use
Alternative 1 – Centralized Non-Potable Reuse	1A	Santa Cruz PWD Phase 2 Project	Santa Cruz WWTF	Tertiary Treatment at SC WWTF	3°	In-plant uses, truck filling and demonstration site (park near WWTF)
	1B	Maximize tertiary treatment at the SC WWTF			3°	Unrestricted use in Santa Cruz including UC Santa Cruz

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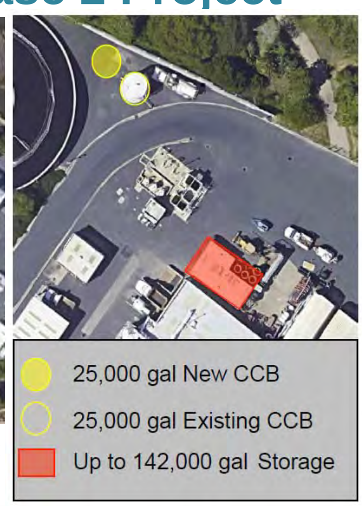
Alternative 1A: Santa Cruz PWD Phase 2 Project



0.25 MGD tertiary treatment capacity to meet in-plant needs and provide irrigation to La Barranca Park

✓ *Add pipeline to truck fill hydrant on California street*

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Alternative 1A: Santa Cruz PWD Phase 2 Project

- Project Size
  - 0.25 MGD tertiary treated recycled water
- Facilities
  - No new filters needed
  - Chlorine Contact Basin #2
  - Interconnecting Piping
  - Chemical dosing System
  - Control System
  - Other Miscellaneous Components – including pipeline to La Barranca Park
- RFP expected to be released late 2016

** Add demand and associated pipeline for hydrant at California street*

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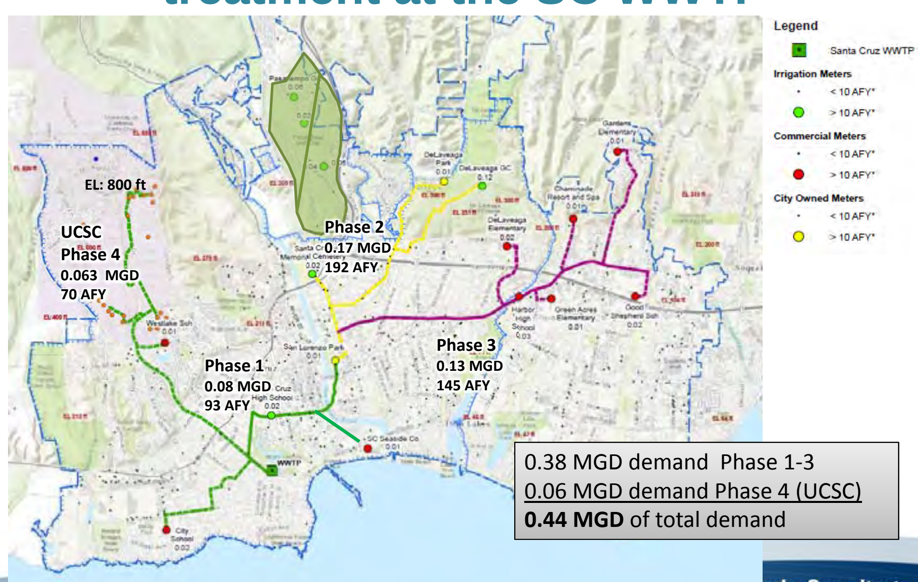
Alternative 1B: Maximize tertiary treatment at the SC WWTF



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Alternative 1B: Maximize tertiary treatment at the SC WWTF

	Phase 1 (To San Lorenzo Park)	Phase 2 (To DeLaveaga Park & Golf Course)	Phase 3 (To Good Shepherd School)	Phase 4 (To UCSC)	Total
NPR Demand	0.06 MGD/ 71 AFY	0.17 MGD/ 192 AFY	0.13 MGD/ 145 AFY	0.06 MGD/ 71 AFY	**0.44 MGD/ 493 AFY**
Treatment Capacity	0.11 MGD	0.24 MGD	0.18 MGD	0.09 MGD	**0.62 MGD**
Pipelines	29,000 LF – 6”	20,000 LF – 6”	31,000 LF – 6”	14,000 LF – 6”	**17.5 miles**
Pump Stations	80 gpm 50 HP	-	500 gpm 90 HP	100 gpm, 50 HP	
Storage	To be determined by hydraulic modeling				
# of Customer Sites	7	13	29	3 clusters	**52**

Treatment capacity based on summer flow factor = 1.35
Pipeline and pump station sizing based on peak hourly demand, with pumping over 9 hours a day

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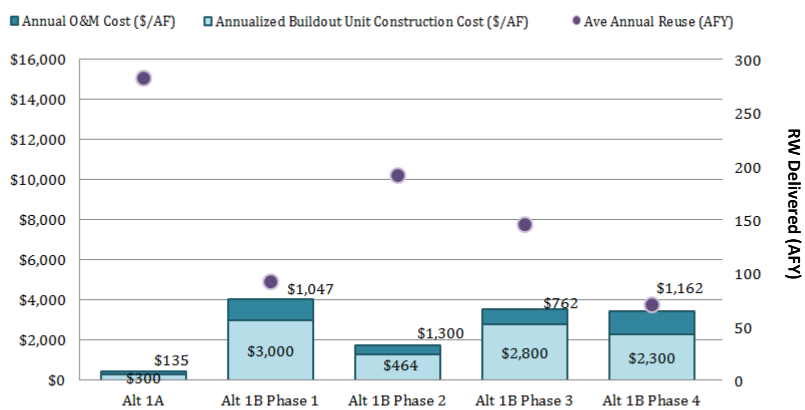
Alternative 1A and 1B



Capital Cost ($mil)	$1.6	$4.9	$4.3	$7.0	$2.8

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Alternatives 2: Decentralized Non-Potable Reuse

Alternative	Sub Alt	Description	Source Water	Treatment		Use
Alternative 2 – Decentralized Non-Potable Reuse	2	UC Santa Cruz	Local Raw Wastewater (UCSC)	MBR at UCSC	3°	On campus uses (irrigation, agricultural, cooling towers, dual-plumbed facilities)

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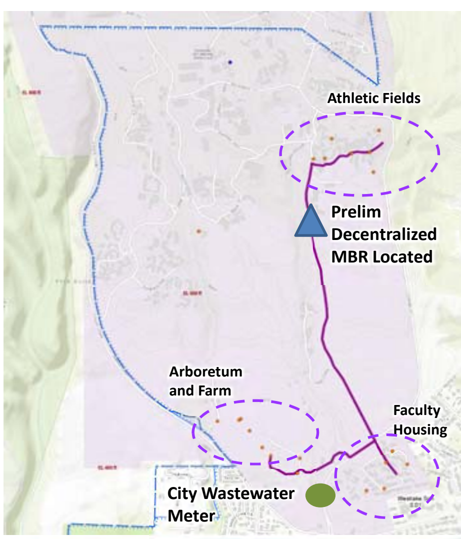
Alternatives 2: Decentralized Non-Potable Reuse at UCSC



- Project Size
  - 0.063 MGD tertiary treated recycled water
- Facilities
  - Decentralized MBR
  - Pipelines
  - Small Pump station
  - Pipelines
- Available sewer flows to be confirmed

✓ *Confirm that potential demand from UCSC dual plumbed building has been captured*

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Alternatives 2: Decentralized Non-Potable Reuse at UCSC

	Decentralized MBR
NPR Demand	0.06 MGD / 71 AFY
Treatment Capacity	0.09 MGD
Pipelines	~2 miles of 6" pipeline
Pump Stations	TBD – depends on location of MBR, which depends on available WW flows
Storage	To be determined by hydraulic modeling
# of Customer Sites	3 clusters

Treatment capacity based on summer flow factor = 1.35
Pipeline and pump station sizing based on peak hourly demand, with pumping over 9 hours a day

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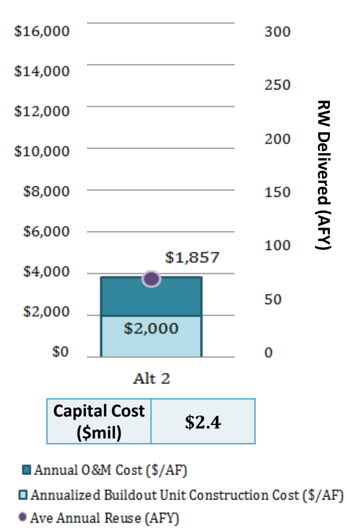
Alternatives 2: Decentralized Non-Potable Reuse at UCSC



Preliminary capital & annualized costs

- To confirm location of MBR on UCSC campus
  - Available sewer flow
  - Land availability
- O&M costs would depend on location of facilities

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Alternative 3: Santa Cruz Participation in a SqCWD-led GWRR

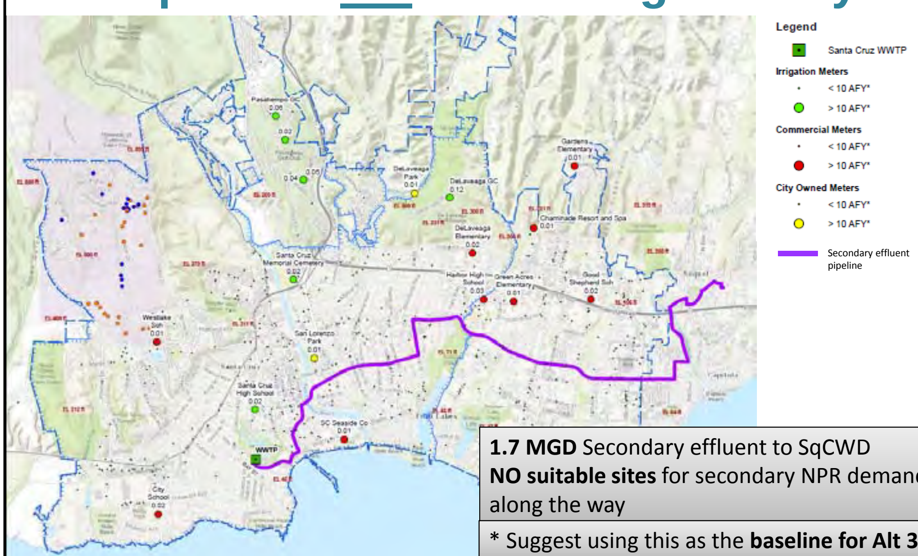
TABLE 3

Sub Alt	Description	Source Water	Treatment		Use
3a	Send secondary effluent from SCWWTF to SqCWD for injection in SqCWD basin (serve NPR users along the way)	Santa Cruz WWTF	On-Site Treatment at NPR Customer sites	2° + filter	NPR Customers along secondary pipelines alignment from SC WWTF to AWTF
3b	Send tertiary effluent from SCWWTF to SqCWD (serve NPR users along the way)		Tertiary Treatment at SC WWTF	3°	NPR Customers along tertiary pipeline alignment from SC WWTF to AWTF
3c	Send additional secondary effluent from SCWWTF to SqCWD AWTF and deliver purified water from SqCWD WTF to recharge Santa Cruz GWRR		Advanced Treatment at SqCWD Headquarters	AWT	SqCWD AWTF water delivered to Santa Cruz GWRR injection sites
3d	Send advanced treated RW from SCWWTF to SqCWD, (serve NPR users along the way)		Advanced Treatment at SC WWTF	AWT	NPR Customers along pipeline alignment from SC WWTF to SqCWD injection sites
3e	Send advanced treated RW from SCWWTF to SqCWD, (GWRR and NPR along the way)			AWT	GWRR in Santa Cruz (Beltz Well Field) and NPR customers along pipeline alignments

Today's focus is NPR in Santa Cruz - Only includes Alts 3a, 3b and 3d

Apply to all Alt 3:
- ✓ *To include Caltrans irrigation demand*
- ✓ *To include SqCWD NPR demand*
- ✓ *Update pump station sizing*
- ✓ *Identify one pipeline alignment for use in the RWFPS alternative comparison*

Alternative 3A: Secondary Effluent to SqCWD + NO NPR along the way



1.7 MGD Secondary effluent to SqCWD
NO suitable sites for secondary NPR demand along the way

* Suggest using this as the **baseline for Alt 3**

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Alternative 3A: Secondary Effluent to SqCWD NPR along the way

	Facilities
NPR Demand	0
SqCWD Demand	1.7 MGD Effluent
Treatment Capacity	No additional treatment required
Pipelines	7 miles – 14”
Pump Stations	2,800 gpm, 25 HP (or with booster station) *Update to reflect SqCWD constant flow*
Storage	To be determined by hydraulic modeling
Customer Sites	0

No NPR demand along the way.

All 1.7 mgd RW delivered is going to SqCWD

Treatment capacity based on summer flow factor = 1.35
Pipeline and pump station sizing based on peak hourly demand, with pumping over 9 hours a day

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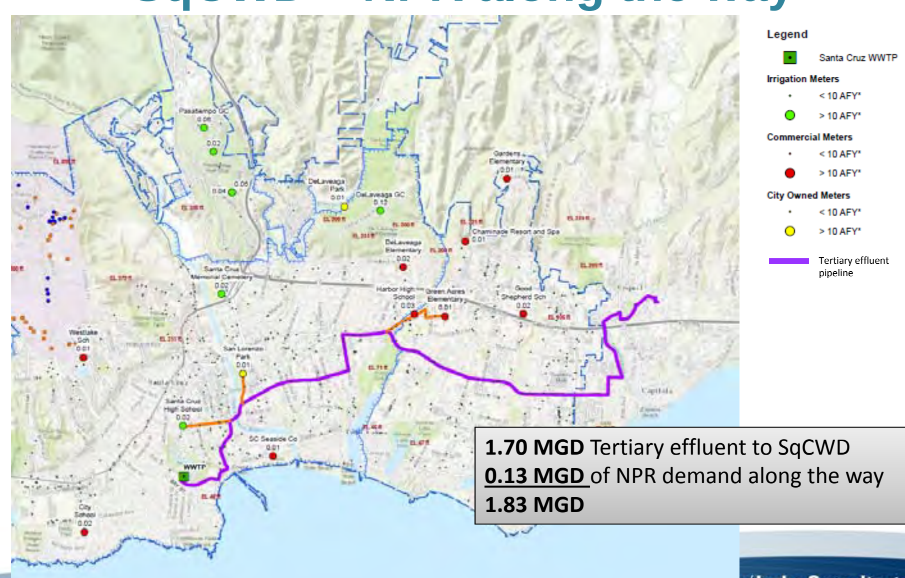
Alternative 3B.1: Tertiary Effluent to SqCWD + NPR along the way



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Alternative 3B: Tertiary Effluent to SqCWD + NPR along the way

	Facilities
NPR Demand	0.13 MGD
SqCWD Demand	1.7 MGD Effluent
Treatment Capacity	1.87 MGD
Pipelines	7,700 LF – 6” (distribution) 7 miles – 16” (transmission – 2” larger than baseline Alt 3A)
Pump Stations	3,000 gpm, 760 HP (or with booster station) *Update to reflect SqCWD constant flow and NPR peak flow*
Storage	To be determined by hydraulic modeling
# of Customer Sites	43

Treatment capacity based on summer flow factor = 1.35 for NPR demand + no summer flow factor for SqCWD effluent demand
Pipeline and pump station sizing based on peak hourly demand, with pumping over 9 hours a day

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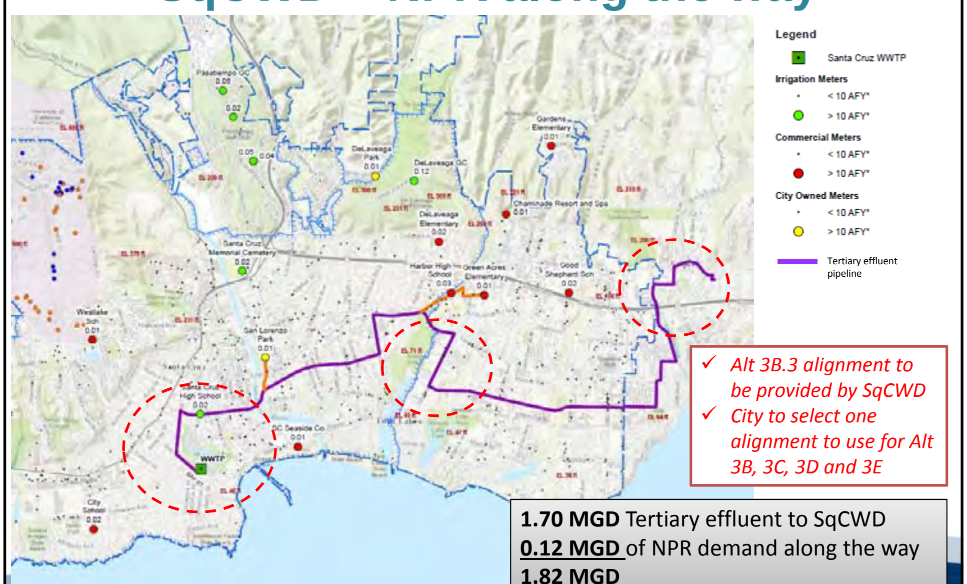
Alternative 3B.2: Tertiary Effluent to SqCWD + NPR along the way



- ✓ *Alt 3B.3 alignment to be provided by SqCWD*
- ✓ *City to select one alignment to use for Alt 3B, 3C, 3D and 3E*

1.70 MGD Tertiary effluent to SqCWD
<u>0.12 MGD</u> of NPR demand along the way
1.82 MGD

Alternative 3B.2: Tertiary Effluent to SqCWD + NPR along the way

	Facilities
NPR Demand	0.12 MGD
SqCWD Demand	1.7 MGD Effluent
Treatment Capacity	1.86 MGD
Pipelines	5,300 LF – 6” (distribution) 8.35 miles – 16” (transmission – 2” larger than baseline Alt 3A)
Pump Stations	3,000 gpm, 850 HP (or with booster station) *Update to reflect SqCWD constant flow and NPR peak flow*
Storage	To be determined by hydraulic modeling
Customer Sites	32

Treatment capacity based on summer flow factor = 1.35 for NPR demand + no summer flow factor for SqCWD effluent demand
Pipeline and pump station sizing based on peak hourly demand, with pumping over 9 hours a day

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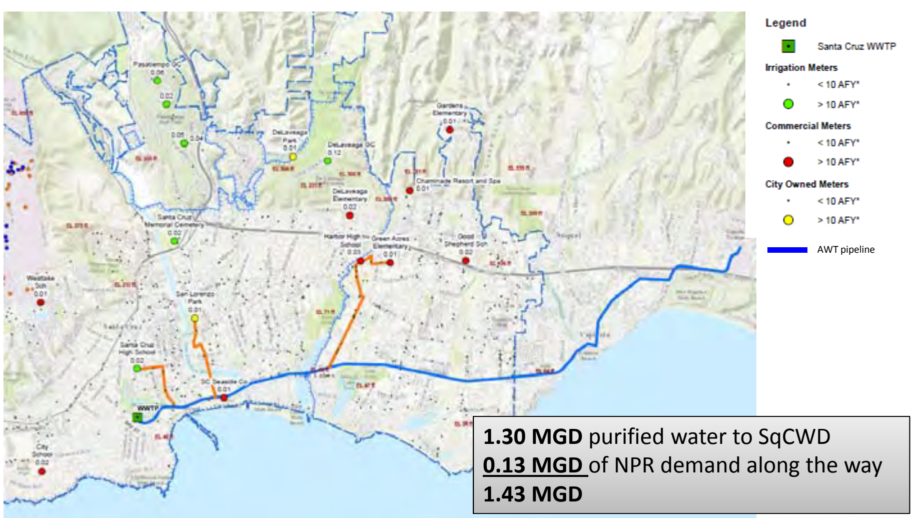
Alternative 3D: AWT @ SC WWTF send to SqCWD + NPR along the way



1.30 MGD purified water to SqCWD
0.13 MGD of NPR demand along the way
1.43 MGD

✓ *Confirm that potential commercial user demands consider high quality of AWT water, as compared to tertiary water offered for other alternatives*

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Alternative 3D: AWT @ SC WWTF sent to SqCWD + NPR along the way

	Facilities
NPR Demand	0.13 MGD
SqCWD Demand	1.3 MGD AWT Product Water
Treatment Capacity	0.18 MGD
Pipelines	4,200 LF – 6” (distribution) 7 miles – 14” (transmission)
Pump Stations	2,400 gpm, 215 HP (or with booster station) *Update to reflect SqCWD constant flow and NPR peak flow*
Storage	To be determined by hydraulic modeling
Customer Sites	34

Treatment capacity based on summer flow factor = 1.35 for NPR demand + no summer flow factor for SqCWD effluent demand
Pipeline and pump station sizing based on peak hourly demand, with pumping over 9 hours a day

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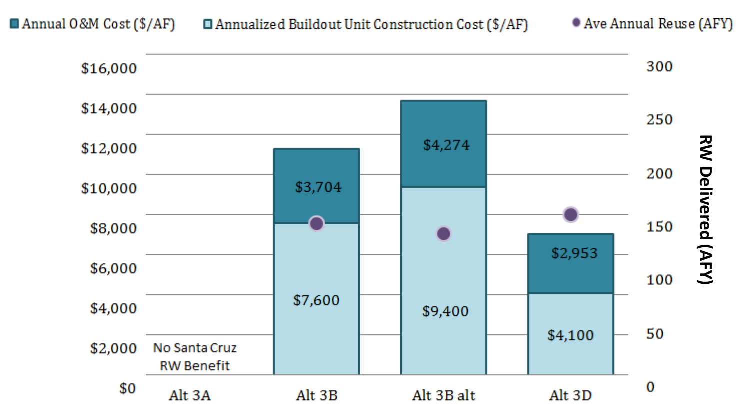
Alternative 3A, 3B.1, 3B.2 and 3D



Capital Cost ($mil)	n/a ~~$16.8~~	$18.7	$21.5	$10.7

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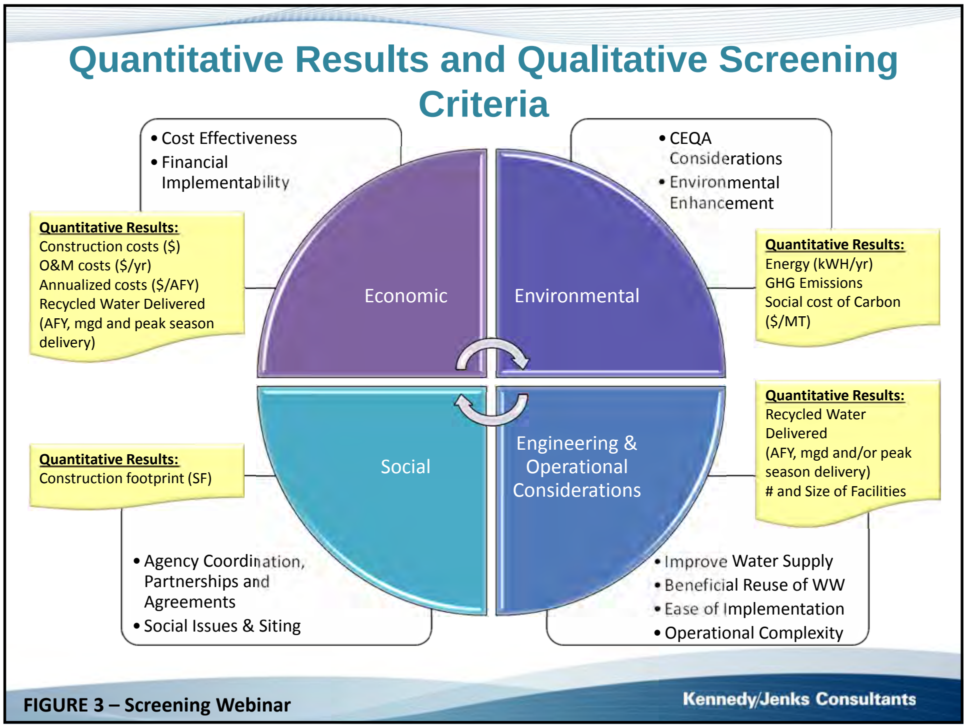
Quantitative Results and Qualitative Screening Criteria
• Cost Effectiveness
• Financial Implementability
• CEQA Considerations
• Environmental Enhancement
Quantitative Results:
Construction costs ($)
O&M costs ($/yr)
Annualized costs ($/AFY)
Recycled Water Delivered
(AFY, mgd and peak season delivery)
Economic
Environmental
Quantitative Results:
Energy (kWH/yr)
GHG Emissions
Social cost of Carbon ($/MT)
Quantitative Results:
Recycled Water Delivered
(AFY, mgd and/or peak season delivery)
and Size of Facilities
Quantitative Results:
Construction footprint (SF)
Social
Engineering & Operational Considerations
• Agency Coordination, Partnerships and Agreements
• Social Issues & Siting
• Improve Water Supply
• Beneficial Reuse of WW
• Ease of Implementation
• Operational Complexity
FIGURE 3 – Screening Webinar
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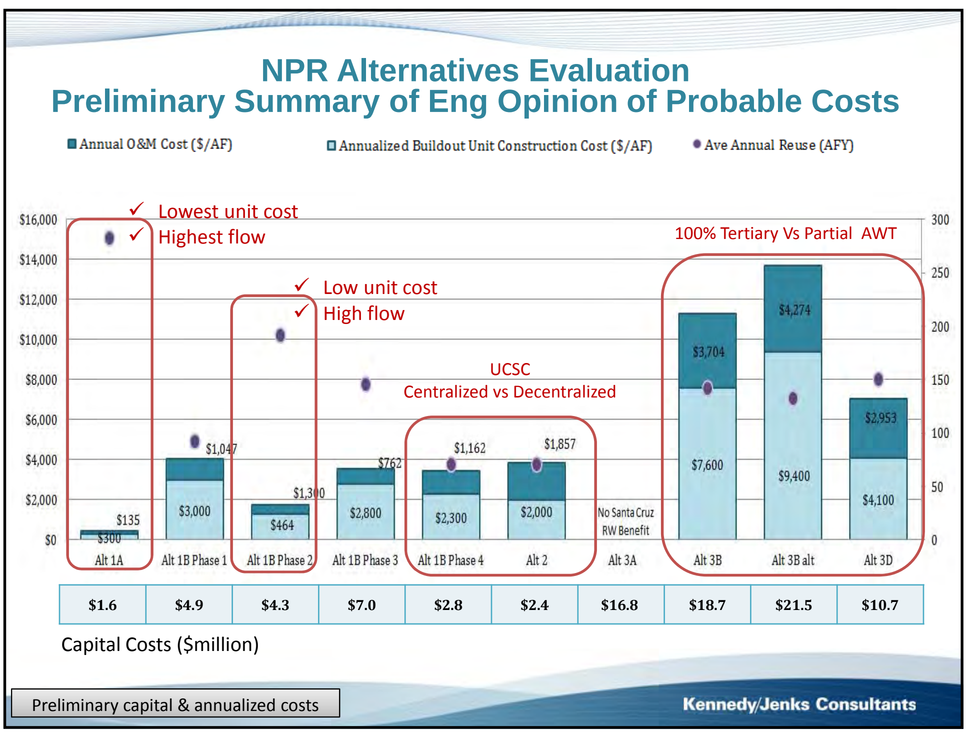
NPR Alternatives Evaluation
Preliminary Summary of Eng Opinion of Probable Costs
Annual O&M Cost ($/AF)
Annualized Buildout Unit Construction Cost ($/AF)
Ave Annual Reuse (AFY)
✓ Lowest unit cost
✓ Highest flow
✓ Low unit cost
✓ High flow
UCSC
Centralized vs Decentralized
100% Tertiary Vs Partial AWT
$16,000
$14,000
$12,000
$10,000
$8,000
$6,000
$4,000
$2,000
$0
300
250
200
150
100
50
0
$135
$300
$1,047
$3,000
$1,300
$464
$762
$2,800
$1,162
$2,300
$1,857
$2,000
No Santa Cruz RW Benefit
$3,704
$7,600
$4,274
$9,400
$2,953
$4,100
Alt 1A
Alt 1B Phase 1
Alt 1B Phase 2
Alt 1B Phase 3
Alt 1B Phase 4
Alt 2
Alt 3A
Alt 3B
Alt 3B alt
Alt 3D
$1.6
$4.9
$4.3
$7.0
$2.8
$2.4
$16.8
$18.7
$21.5
$10.7
Capital Costs ($million)
Preliminary capital & annualized costs
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NPR Alternatives Evaluation
Summary of QUANTITATIVE Results

				Recycled Water Delivered				Estimated Costs			Energy / Others				
Alternative	Sub Alt	Description	Treatment Level	Ave Annual Reuse (AFY)	Average Annual Flow (MGD)	Peak Season Deliveries (AF in Summer - June)	Peak Hourly Flow (MGD)	Estimated Construction Cost ($mil)	Annual O&M Cost ($mil/yr)	Total Annual Cost ($/AF)	Unit Energy of RW Delivered (KWH/AF)	GHG Emissions (MTCO2/yr)	Social Cost of Carbon ($)	Footprint (SF)	Number and Size of Facilities
Non Potable Reuse	Alt 1A	Centralized Non-Potable Reuse - Santa Cruz PWD Phase 2 Project	3°	282	0.25	32	1.04	$2	$0.0	$435	TBD	TBD	TBD	TBD	TBD
	Alt 1B	Centralized Non-Potable Reuse - Maximize tertiary treatment at the SC WWTF	3°	501	0.45	42	1.34				TBD	TBD	TBD	TBD	TBD
		Phase 1		93	0.08	11	0.34	$5	$0.1	$4,047	TBD	TBD	TBD	TBD	TBD
		Phase 2		192	0.17	22	0.71	$4	$0.1	$1,764	TBD	TBD	TBD	TBD	TBD
		Phase 3		146	0.13	17	0.54	$7	$0.1	$762	TBD	TBD	TBD	TBD	TBD
		Phase 4		71	0.06	8	0.26	$3	$0.1	$1,162	TBD	TBD	TBD	TBD	TBD
	Alt 2	Decentralized Non-Potable Reuse	3°	71	0.06	8	0.26	$2	$0.1	$3,857	TBD	TBD	TBD	TBD	TBD
SqCWD Led GWRR	Alt 3A	Secondary Effluent to SqCWD + NPR along the way	2° + filter	1,903	1.70	159	5.10	$0	$0.0	$0	TBD	TBD	TBD	TBD	TBD
	Alt 3B	Tertiary Effluent to SqCWD + NPR along the way	3°	141	0.13	175	5.62	$19	$0.5	$11,304	TBD	TBD	TBD	TBD	TBD
	Alt 3B alt	Tertiary Effluent to SqCWD + NPR along the way	3°	132	0.12	174	5.59	$22	$0.6	$13,674	TBD	TBD	TBD	TBD	TBD
	Alt 3C	Secondary Effluent to SqCWD + SC GWRR (AWT @ SqCWD)	AWT												
	Alt 3D	AWT @ SC WWTF sent to SqCWD + NPR along the way	AWT	150	0.13	17	0.55	$11	$0.6	$13,674	TBD	TBD	TBD	TBD	TBD
	Alt 3E	AWT @ SC WWTF sent to SqCWD + NPR along the way + SC GWRR	AWT												
SC GWRR	Alt 4A	Santa Cruz GWRR Project - Advanced treatment at SCWWTF	2°												
	Alt 4B	Santa Cruz GWRR Project - Advanced treatment at off-site	2°												
	Alt 4C	Santa Cruz GWRR Project - MBR + AWPF at DA Porath	AWT												
SWA	Alt 5	Surface Water Augmentation (SWA) in Loch Lomond Reservoir	AWT												
Stream Aug	Alt 6	Streamflow Augmentation	AWT												
DPR	Alt 7	Direct Potable Reuse	AWT												

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NPR Alternatives Evaluation
QUALITATIVE Considerations

Categories	Alternatives Screening Criteria	General Comments on NPR
ENGINEERING & OPERATIONAL CONSIDERATIONS	Improve Water Supply	Ability to fill City water supply gap, supplement supply in peak season, timeline for implementation
	Beneficial Reuse of Wastewater	Maximizes reuse of wastewater now and/or does not limit future options to fully utilize wastewater
	Ease of Implementation	Permitability, construction complexity, flexibility for phasing and potential for expansion
	Operational Complexity	Treatment requirements and impacts to WWTF, facility siting
ECONOMIC	Cost Effectiveness	Relative unit costs
	Financial Implementability	Relative capital costs and tradeoffs
ENVIRONMENTAL	CEQA Considerations	Potential impacts and mitigation requirements
	Environmental Enhancement	Opportunity to enhance ecosystem and social cost of carbon (GHG emissions)
SOCIAL	Agency Coordination, Partnerships and Agreements	Level of effort and willingness to work together
	Social Issues & Siting	Public acceptance and local disruption

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OPEN DISCUSSION

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Next Steps

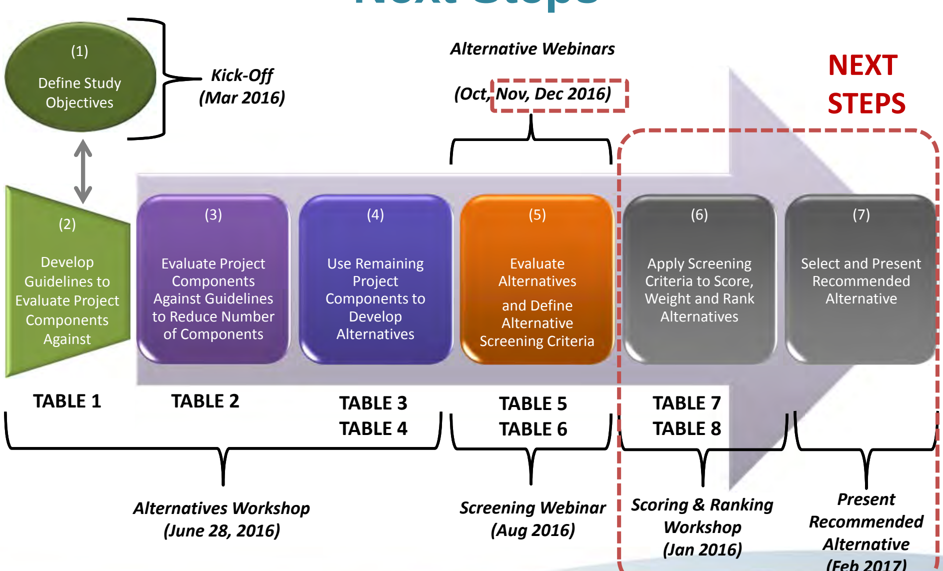

FIGURE 1 – Screening Webinar

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QUESTIONS

Kennedy/Jenks:	Dawn Taffler	DawnTaffler@KennedyJenks.com
	Melanie Tan	MelanieTan@KennedyJenks.com

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Santa Cruz Regional
Recycled Water Facilities Planning Study (RWFPS)

Alternatives Webinar – Part 2
02 December 2016 from 9 am to 11 am

Conf Call - (855) 813-2486 Code – 2484

Web Meeting - http://conf.kennedyjenks.com/conference/2484

AGENDA

Overall Webinar Objective: Present preliminary evaluation for surface water augmentation (SWA), streamflow augmentation and direct potable reuse (DPR) alternatives using preliminary maps, tables and figures to illustrate facility locations, capacities and costs.

Goal: Discuss and seek input on assumptions, facility locations and other project components.

Action Items: Respond to specific requests for information, update alternatives (as-needed) and memorialize discussion points to support scoring of alternative projects.

---

1. Approach & Objective
2. Recycled Water Supply
3. Market Assessment for Potable Reuse
4. Treatment Requirements
5. SWA Alternative
6. Streamflow Augmentation Alternative
7. Direct Potable Reuse Alternative
8. Cost Comparison
9. Next Steps

City of Santa Cruz Recycled Water Facilities Planning Study

Alternatives Webinar Part 2

December 02, 2016

** Includes amended notes to reflect discussion at workshop*

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Agenda

- Approach & Objective
- Recycled Water Supply
- Market Assessment for Potable Reuse
- Treatment Requirements
- Alternatives Analysis
  - Surface Water Augmentation
  - Streamflow Augmentation
  - Direct Potable Reuse
- Cost Comparison
- Open Discussion

(Alternatives Analysis items:) Facilities, Quantitative Results, Qualitative Considerations

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Overall Approach Flow Diagram

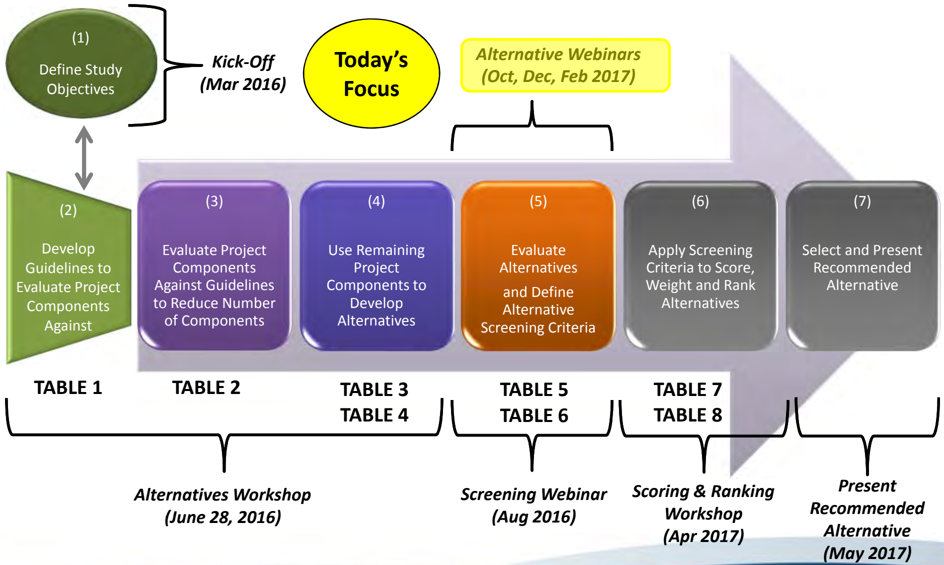

FIGURE 1 – Screening Webinar

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Alternatives Webinar Objective

- **Objective:** Present preliminary evaluation for potable reuse alternatives using preliminary maps, tables and figures to illustrate facility locations, capacities and preliminary costs.
- **Goal:** Obtain input and clarify assumptions
- **Action Items:** Response to specific requests for information, update alternatives, and memorialize discussion points to support scoring of alternative projects.

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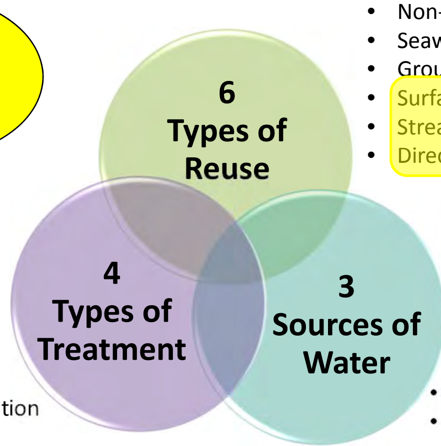
Project Components

Today's Focus



- Non-Potable
- Seawater Intrusion Barrier
- Groundwater Replenishment
- Surface Water Augmentation
- Streamflow Augmentation
- Direct Potable Reuse

- Secondary
- On-Site Filtration
- Tertiary
- Advanced Treatment (Purified)

- Santa Cruz WWTF
- Local Raw Wastewater
- Scotts Valley

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Total Available Effluent Supply

	Effluent (MGD)	2015	2008 - 2016 Average
Dry Weather Flow (June)	Average	6.1	7.1
	Minimum	5.4	5.1
Wet Weather Flow (Dec)	Average	8.4	9.0
	Maximum	20.9	28.8

- 2015 dry weather flow data is used to estimate the amount of effluent that would be consistently available for potable reuse

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Purified Water Supply for Potable Reuse Alternatives

Total WW Supply		SC WWTF In-Plant Demand		SqCWD GWRR Demand		Secondary Effluent Available		Purified Water Produced
Average Daily Dry Weather Flow[1] (mgd)		Year-Round Internal Use + La Barranca Park[2] (mgd)		Year-Round Secondary Effluent (mgd)		after meeting other Demands (mgd)		Based on assumed AWPF Recovery Rate[3]
6.1	−	0.25	−	1.7	=	4.16	→	3.2

Brine

[1] Based on June 2015 flow data
[2] Assumes no additional NPR demands in Santa Cruz will be served
[3] Assumes MF/UF recover rate of 90% and RO recovery rate of 85%

Discussion that there may be an interest in serving NPR demands along a purified water alignment even if these demands were small. Review of potential customers only identified ~ 0.02 mgd of demand along the purified water alignments. These customers could be added later but recommendation was not to complicate the potable reuse alternatives .

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Market Assessment for Potable Reuse

- Includes indirect and direct potable reuse opportunities
- Not associated with meters
- Focus is a more holistic approach to beneficially reuse the recycled water for potable uses, directly or indirectly, to fill the Santa Cruz region water supply gaps

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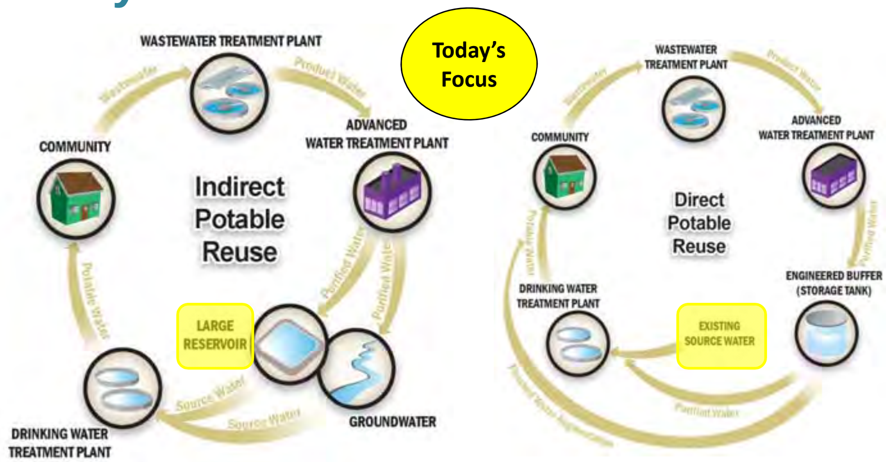
Recycled Water Market: Potable Reuse



GWRR = Groundwater Replenishment Reuse
SWA = Surface Water Augmentation

DPR = Direct Potable Reuse

* Streamflow Augmentation

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Recycled Water Market: Potable Reuse

Potable Reuse	Available Supply mgd (AFY)	Demand mgd (AFY)	Use Limited by
Groundwater Recharge *	3.2 mgd (3,600 AFY)	TBD*	• Summer wastewater generation • GRR Regulations • Groundwater Basin Capacity • Travel time from injection to extraction
Surface Water Augmentation	3.2 mgd (3,600 AFY)	3.2 mgd (3,600 AFY)	• Summer wastewater generation • SWA Regulations • Operation of Loch Lomond Reservoir
Streamflow Augmentation	3.2 mgd (3,600 AFY)	3.2 mgd (3,600 AFY)	• Summer wastewater generation • TMDL for Nitrate • Basin Plan requirements for Temperature and Dissolved Oxygen
Direct Potable Reuse	3.2 mgd (3,600 AFY)	3.2 mgd (3,600 AFY)	• Summer wastewater generation • GHWTP Treatment Capacity • Coast Pump Station Capacity • Pending DPR Regulations

** The demand for a GRRP will be evaluated based on the capacity of the groundwater aquifer to receive recycled water and meet GRR regulatory criteria.*

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Recycled Water Market: Potable Reuse

Potential Benefits

- Develop a local, drought-proof and sustainable water supply
- Use of available recycled water flows in the winter and off-peak irrigation months
- Recharge groundwater basin(s) (via groundwater recharge)
- Maintain lake levels (via surface water augmentation)
- Supplement in-stream flows to maintain habitat and fisheries
- Provide an integrated approach solving multiple issues related to regional water supplies, which could bring together a number of stakeholders in the Santa Cruz Region

Potential Challenges

- Higher costs associated with advanced treatment
- Higher costs associated with pumping and conveyance (for GRR and SWA projects)
- Additional regulatory requirements (i.e. permitting, monitoring, and reporting)
- Public acceptance
- Development of partnerships and agreements (between regional partners)
- Regulatory uncertainty related to SWA and DPR requirements

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Market Assessment: Surface Water Augmentation

- No SWA projects currently exist in California
  - 2 moving forward
- Draft Uniform SWA criteria anticipated by end of 2016 and finalized in early 2017.
- Two key permits
  - City DDW drinking water supply permit
  - NPDES permit by RWQCB on behalf of EPA

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Market Assessment: Surface Water Augmentation

- Minimum Retention Time of 4 to 6 months (TBD)
- Dilution and Mixing Options:
  - 100-to-1 dilution, or
  - 10-to-1 dilution with additional 1-log treatment
- Other Considerations
  - Source control
  - Reservoir O&M
  - Reliability, redundancy and response to failure
  - Reservoir dilution, retention, tracer studies and monitoring, and
  - public comment and notification

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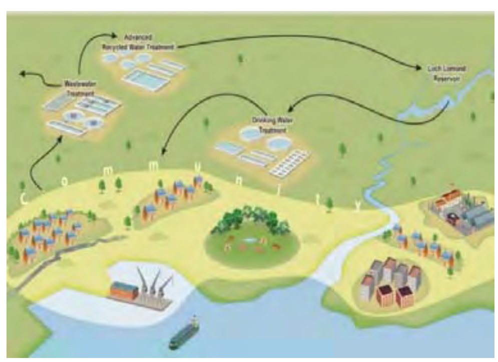
Market Assessment: Surface Water Augmentation

- RWFPS Concept
  - Augment Loch Lomond Reservoir
  - Surface water impoundment used for drinking water
  - GHWTP provides additional treatment prior to potable distribution



- Market Limited by:
  - Wastewater generation
  - SWA Regulations

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Market Assessment: Streamflow Augmentation

- Currently no regulatory requirements and/or criteria for the beneficial use of recycled water for streamflow augmentation
  - Wastewater discharge is regulated by WDRs and NPDES permits
- Considerations
  - Water quality objectives in receiving water
  - Ecological risks
  - Public acceptance

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Market Assessment: Streamflow Augmentation

- San Lorenzo River & Lagoon
  - 1.5 mg/L nitrate TMDL
  - Temp and Dissolved Oxygen (DO) Objectives
  - Eutrophication issues, morphology
- RWFPS Concept
  - Discharge purified water d/s of Tait Street Diversion
  - Maximize diversions within existing water rights
  - Reduce peak water supply shortage in dry years
- Market Limited by:
  - Wastewater generation
  - TMDL
  - Temperature and DO WQOs

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Market Assessment: Direct Potable Reuse

- Loss of Environmental Buffer
  - For treatment
  - For response time
- Treatment Robustness and Reliability
  - Assurance of meeting microbial pathogen and chemical risk
- Other Considerations
  - Source Control
  - Coordination btw WWTF and DWTF
  - Public Perception
- Research needs to fill knowledge gaps

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Market Assessment: Direct Potable Reuse

- RWFPS Concept
  - Provide highest level of advanced treatment
  - Blend with other raw water supplies entering the GHWTP
  - Utilize existing potable water distribution system.
- Market limited by
  - Wastewater generation
  - GHWTP Treatment Capacity
  - Coast Pump Station Capacity

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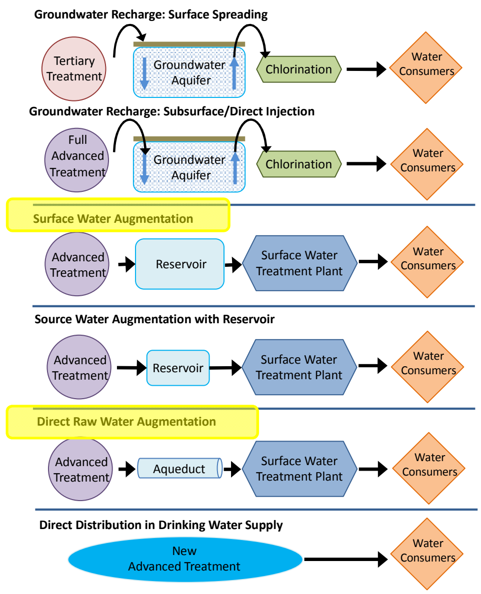
Types of Potable Reuse

Today's Focus



Graphics by Trussell

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Typical Log Inactivation Requirements

Groundwater Replenishment Reuse (GRR) or more for SWA or DPR

Groundwater Replenishment Reuse (GRR)		more for SWA or DPR	
Virus: 12-log removal	99.9999999999%	Virus: 13-log removal	99.99999999999%
Giardia: 10-log removal	99.99999999%	Giardia: 11-log removal	99.999999999%
Crypto: 10-log removal	99.99999999%	Crypto: 11-log removal	99.999999999%

Also referred to as:

- Log Removal Value (LRV) for Virus/Giardia/Crypto (V/G/C)
- For example - 12/10/10 or 13/11/11

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Treatment Criteria - SWA

- Pathogen credits to be achieved at both the AWTF and the Drinking Water Treatment Facility
- Log reduction of V/G/C* depends on:
  - Amount of dilution in the reservoir
  - Amount of residence time in reservoir

Dilution	Total log reduction	DWTF log reduction	AWTF log reduction (min)
100-to-1	12/10/10	4/3/2	8/7/8
10-to-1	13/11/11	4/3/2	9/8/9

*V/G/C = virus, *Giardia,* and *Cryptosporidium*

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Advanced Treatment Process - SWA

Reuse Type | **Potential Treatment Train*** | **Uses**

Potable Reuse With Nitrified Secondary Feedwater

Membrane Filtration | Reverse Osmosis | Ultraviolet Light/Advanced Oxidation | Free Chlorine

- Potable and non-potable applications

Log Removal	MF	RO	UV/AOP	Free Chl.	Total
Virus	0	1.5 – 2	6	6	13.5 – 14
Giardia	4	1.5 – 2	6	0-1	11.5 – 13
Cryptosporidium	4	1.5 – 2	6	0	11.5 – 12

**Assumes conservative reservoir operation with V/Q > 6 months and > 10:1 dilution*

Discussion about need for denitrification at the WWTF and whether to include a placeholder cost

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Treatment Criteria – Streamflow Augmentation

- Not defined in Title 22
- Likely site specific based on discharge requirements
- San Lorenzo River/Lagoon Considerations
  - Nutrients (nitrate TMDL)
  - Temperature
  - Dissolved Oxygen

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Market Assessment: Streamflow Augmentation

- Nitrate Mass Target in SLR at Felton = 3,728 lbs nitrate per month
- Nitrate Concentration Target = 1.5 mg/L

	Units	Secondary Effluent	Tertiary Effluent	Full Advanced Treatment	
Recycled Water Discharged	mgd	3.0	3.0	3.0	
	Nitrate concentration (as mg nitrate/L)	79	44	16	4
Nitrate Mass	lbs nitrate / month (as nitrate)	61,100	34,500	12,400	3,500
	Percent of Target load at Felton	1600%	930%	330%	90%

Comment that there is already an existing nitrate load of 3,600 lbs/month in the watershed so adding 3,500 from purified water would exceed the mass target.

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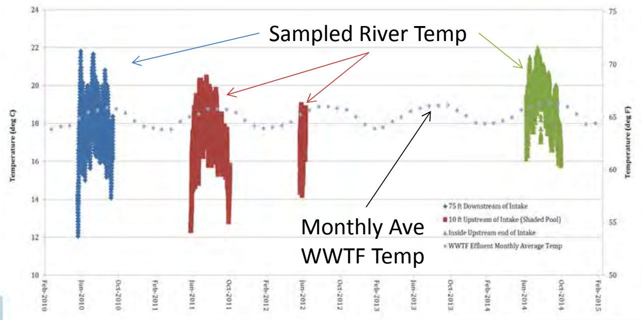
Market Assessment: Streamflow Augmentation

- Temperature Objective per Basin Plan
  - Discharge < 5 deg F diff from ambient or no change
- DO Objective per Basin Plan
  - Discharge > 7.0 mg/L or > 5 mg/L

Comment that a 303D list may come out next week that will further address temperature

Ave monthly WWTF Temp
- Ave monthly River Temp
1.2 to 1.5 deg F;

Max monthly WWTF Temp
- Min monthly River Temp
6.5 to 17 deg F.



Treatment Criteria – Streamflow Augmentation

- Assume same criteria as for SWA
  - 13/11/11 log reduction of V/G/C*
- Additional treatment may be required for
  - Temperature reduction
  - Denitrification

Discussion about need for denitrification at the WWTF and whether to include a placeholder cost. Similarly, need and cost for temperature reducing facility (i.e. cooling tower) and whether to include a placeholder cost.

*V/G/C = virus, *Giardia*, and *Cryptosporidium*

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Market Assessment: Direct Potable Reuse

- Per the Water Code, DPR comprises the
  - "planned introduction of recycled water either directly into a public water system…or into a raw water supply immediately upstream of a water treatment plant."
- No DPR projects currently exist in California
- Draft DPR Feasibility Report recognized phased implementation of three types of DPR projects
  1. Source water Augmentation
  2. Direct Raw water Augmentation
  3. Direct Distribution in Drinking Water Supply
- Primary challenge is to ensure public health is reliably protected

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Treatment Criteria - DPR

- No existing regulations or applications in California
- No specific LRV requirements for DPR
  - Bookend the range of likely value
  - Assume more stringent than SWA b/c no env buffer

DPR	Total log reduction	DWTF log reduction	AWTF log reduction (min)	
Source Water Blending	14/12/12 to 20/19/16	4/3/2	10/9/10 to 16/16/14	
Pipe-to-Pipe	13/11/11 to 20/19/16	0/0/0	13/11/11 to 20/19/16	Not included in RWFPS Alternatives

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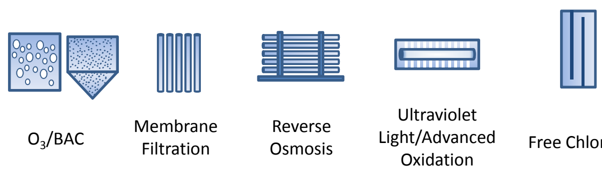
Advanced Treatment Process - DPR

Reuse Type | **Potential DPR Treatment*** | **Uses**

Potable Reuse With Nitrified, Filtered Feedwater



- Potable and non-potable applications

Log Removal	O_3/BAC	MF	RO	UV/AOP	Free Chl.	Total
Virus	6	0	1.5 – 2	6	6	19.5 – 20
Giardia	6	4	1.5 – 2	6	0-1	17.5 – 19
Cryptosporidium	1-2	4	1.5 – 2	6	0	12.5 – 14

**Based on treatment train studied in WRRF 14-12 and evaluated by State DPR Expert Panel*

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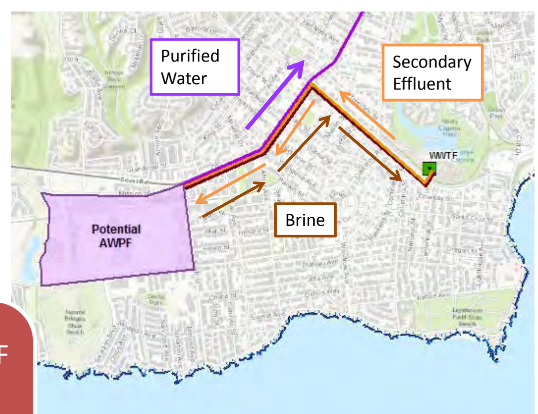
Treatment Facility Siting

- Santa Cruz WWTF
- Delaware Industrial Site
- Other locations



For Potable Reuse Alternatives: assume AWTF at the industrial site with caveat that the facility could be located at the SC WWTF or another site to be determined.

Discussion about benefits of keeping AWTF at the WWTF to address prior concerns by public. Challenge is space, competing projects and need to relocate facilities.
City to reconsider decision on whether Alts 5-7 should show AWTF at WWTF

Brine Discharge

- Potential Concerns
  - TDS
    - ✓ No TDS limit – exception because of TDS of marine waters exceed 3,000 mg/L
    - ✓ Brine likely around 6,000 – 7,000 mg/L, 25% of ocean TDS
  - Toxicity
    - ✓ Discharge mixing nozzle can be added

City's existing outfall has a diffuser at the end.

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Alternatives for Further Evaluation

- Alternative 1 – Centralized Non-Potable Reuse
- Alternative 2 – Decentralized Non-Potable Reuse
- Alternative 3 – Santa Cruz Participation in SqCWD-led GWRR Project
- Alternative 4 – Santa Cruz GWRR Project
- Alternative 5 – Surface Water Augmentation (SWA) in Loch Lomond Reservoir
- Alternative 6 – Streamflow Augmentation (SFA)
- Alternative 7 – Direct Potable Reuse (DPR)

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Preliminary capital & annualized costs

- Capital Costs
  - Treatment
  - Pipelines
  - Pump Stations
  - Storage
  - Site Retrofit
- Annualized capital & O&M costs for alternative comparison
- Further inputs to confirm the following after webinar
  - Phasing of capital costs
  - Pipeline special crossing costs
  - Energy and labor costs
  - Interest and contingencies

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Alternative 5: Surface Water Augmentation

TABLE 3

Sub Alt	Description	Source Water	Treatment		Use
5	Advanced treatment of Santa Cruz effluent for bending in Loch Lomond Reservoir	Santa Cruz WWTF	Advanced Treatment at SC WWTF *(or Offsite?)*	AWT	Reservoir augmentation in Loch Lomond for blending and storage, to be conveyed to the GHWTP and enter the City's potable water distribution system.

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Alternative 5: Surface Water Augmentation

- AWTF capacity 3.2 mgd
- Brine to existing ocean outfall
- Conveyance to Loch Lomond
- Point of discharge TBD
- Other uses – not included in costs
  - 0.25 MGD Phase 2
  - 1.70 MGD Secondary to SqCWD

3.2 MGD Purified water to Loch Lomond

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Suitability of SWA at Loch Lomond

Reservoir Dilution

- ✓ Purified water discharged during any 24-hour period must achieve a minimum 10:1 dilution into water that has been previously discharged into the reservoir
- ✓ Dilution must be verified by modeling and tracer studies
- ✓ The reservoir can theoretically be 100% comprised of purified water, as purified water that has been in the reservoir longer than a day can be used to meet the 10:1 dilution requirement
- ✓ The 3.2 mgd Loch Lomond purified discharge will be small compared to reservoir volume
- ✓ 10:1 dilution should be achievable even if the AWPF discharge point is near the withdrawal point
- ✓ It may be possible to achieve a 100:1 dilution of a 24-hour discharge with an appropriately engineered outfall/diffuser system

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Suitability of SWA at Loch Lomond

Computed Monthly Hydraulic Detention Time

Total Monthly Reservoir Withdrawals (Q) (water supply plus fish releases)			Computed Hydraulic Detention Time, V/Q (months)[1]								
			Reservoir volume (V) at the end of the month (% capacity and acre-feet)								
			95%	90%	85%	80%	75%	70%	65%	60%	55%
mgd	MG/month	AF/month	8,541	8,092	7,642	7,193	6,743	6,294	5,844	5,395	4,945
3.2	99	304	28.1	26.6	25.1	23.6	22.2	20.7	19.2	17.7	16.2
3.6	112	342	24.9	23.6	22.3	21.0	19.7	18.4	17.1	15.8	14.4
4.0	124	381	22.4	21.3	20.1	18.9	17.7	16.5	15.4	14.2	13.0
4.4	136	419	20.4	19.3	18.3	17.2	16.1	15.0	14.0	12.9	11.8
4.8	149	457	18.7	17.7	16.7	15.8	14.8	13.8	12.8	11.8	10.8
5.2	161	495	17.3	16.4	15.4	14.5	13.6	12.7	11.8	10.9	10.0
5.6	174	533	16.0	15.2	14.3	13.5	12.7	11.8	11.0	10.1	9.3
6.0	186	571	15.0	14.2	13.4	12.6	11.8	11.0	10.2	9.5	8.7
6.4	198	609	14.0	13.3	12.6	11.8	11.1	10.3	9.6	8.9	8.1
6.8	211	647	13.2	12.5	11.8	11.1	10.4	9.7	9.0	8.3	7.6
7.2	223	685	12.5	11.8	11.2	10.5	9.8	9.2	8.5	7.9	7.2
7.6	236	723	11.8	11.2	10.6	9.9	9.3	8.7	8.1	7.5	6.8
8.0	248	761	11.2	10.6	10.0	9.5	8.9	8.3	7.7	7.1	6.5
8.4	260	799	10.7	10.1	9.6	9.0	8.4	7.9	7.3	6.8	6.2
8.8	273	837	10.2	9.7	9.1	8.6	8.1	7.5	7.0	6.4	5.9
9.2	285	875	9.8	9.2	8.7	8.2	7.7	7.2	6.7	6.2	5.6
9.6	298	913	9.4	8.9	8.4	7.9	7.4	6.9	6.4	5.9	5.4
10.0	310	951	9.0	8.5	8.0	7.6	7.1	6.6	6.1	5.7	5.2
10.4	322	989	8.6	8.2	7.7	7.3	6.8	6.4	5.9	5.7	5.2
10.65[2]	330	1013	8.4	8.0	7.5	7.1	6.7	6.2	5.8	5.3	4.9

Key Take Aways:

- ✓ Monthly detention times (V/Q) > 6 months when reservoir volume > 6,000 AF
- ✓ The addition of 3,600 AF of purified water (3.2 mgd) would likely maintain storage above 6,500 AF
- ✓ SWA criteria may allow for as low as 4 months detention time

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Other SWA Considerations

- Biostimulation: controlling concentrations of nitrogen and phosphorus
  - ✓ Potential to comply with Basin Plan Objective through phosphorus-limited approach
  - ✓ Requires coordination with regulatory agencies
- Compliance with Drinking Water Standards
  - ✓ AWPF will comply with drinking water standards and exceed existing reservoir water quality
  - ✓ To be confirmed with pilot testing

Discussion about SLR as a nitrogen limited system due to the naturally occurring loads of phosphorus in the river. Emphasis that modeling and monitoring phosphorus will be critical to validate.

Other SWA Considerations

- Toxics Rule Compliance
  - ✓AWPF likley to comply with most CTR standards for aquatic habitat
  - ✓Compliance with NDMA and NDPA CTR standards may require special monitoring and analysis
  - ✓Additional data is needed
- Hydrodynamic reservoir modeling and tracer studies
  - ✓Required to confirm initial and 24-hour dilution

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Alternative 5: Surface Water Augmentation

	Loch Lomond Reservoir Augmentation
NPR Demand	No new customers added
AWPF Capacity	3.2 MGD
Pipelines	~13.0 miles of 14" pipeline (to Loch Lomond) ~1.3 miles of 16" pipeline (to AWT) ~1.3 miles of 8" pipeline (brine line)
Pump Stations	2,222 gpm (3.2 mgd) 412 TDH; 1,400 HP
Discharge Facility	3.2 MGD

✓Assumes that Phase 2 is implemented (does not include assoc. facilities and costs)
✓Assumes that secondary effluent is delivered for the SqCWD GWRR Project (does not include assoc. facilities and costs)
✓Treatment capacity = produced flow (based on available summer flows)
✓Pipeline and pump station sizing based on average daily flow

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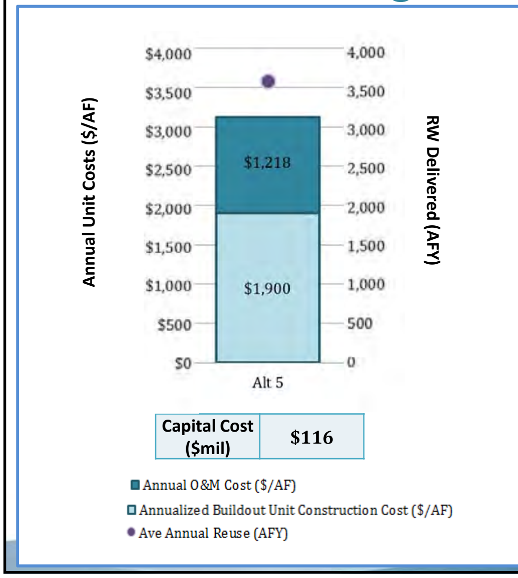
Alternative 5: Surface Water Augmentation



Qualitative Considerations

- Maximizes beneficial reuse of wastewater in summer
- Environmental benefits to maintaining lake levels
- Challenging but viable regulatory requirements
- Operational flexibility for reservoir operations
- Operational complexity for treatment
- Significant energy for treatment and conveyance
- Public acceptance uncertain

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Alternative 6: Streamflow Augmentation

Sub Alt	Description	Source Water	Treatment		Use
6	AWTF of secondary effluent with direct discharge to the San Lorenzo River ~~(serve NPR users along the way)~~	Santa Cruz WWTF	Advanced Treatment at SC WWTF *(or Offsite?)*	AWT	Augment San Lorenzo River flows to allow for increased diversions to expand future drinking water supplies, while maintaining habitat, and meeting fishery flow requirements.

- All purified water is delivered to the stream due to limitation of summer effluent.
- Removed sub-alternative for discharge near felton due to potential for classification as a direct potable reuse Project.

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Alternative 6: Streamflow Augmentation
Direct Discharge to San Lorenzo River

Felton Diversion

Tait Street Diversion

Coast Pump Station

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Streamflow Augmentation

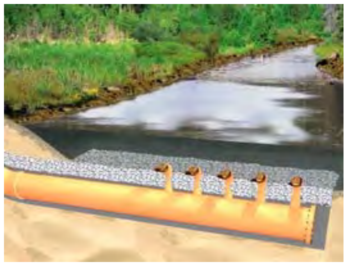
Tait Street Diversion:
- Concrete box with circular screened intake
- 6 - 7 mgd capacity
- Cleared in low season when top exposed
- Flows into a sump that blends raw water supplies from north coast, Lidel springs, major diversions, Laguna and SLR
- Pumped to GHWTP

Key Considerations:
- Meeting TMDL for Nitrogen in the river
- Temperature/DO of discharge flow
- Eutrophication in the Lagoon
- Proximity of point of discharge to Tait Street Diversion

The Confluence Model shows that:
- ✓ 5 cfs (3.2 mgd) of streamflow augmentation could
- ✓ reduce a worst year peak season shortage by 500 mg/year, or

K/J to work with City/Gary Fiske to confirm the assumed reasonable annual descharge volume for streamflow augmentation – 3.2 mgd max in summer but the annual average discharge would be less to recognize that the augmentation would only occur primarily in the summer (Confluence Model based on 181 days) and likely not in winter.

Streamflow Augmentation



Discharge Facility Concept:

- Multi-port diffuser
- Maximize rapid and complete dispersion
- Minimize disruption to receiving water
- Maintain separation from Tait Street diversion

Santa Rosa Diffuser

- *48 mgd capacity,*
- *48"-dia pipeline,*
- *40 ft-long diffuser,*
- *11, 24"-dia duckbill valves*
- *Above ground steel tee with manway access and air event*

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Alternative 6: Streamflow Augmentation

	Direct Discharge
NPR Demand	No new customers added
AWPF Capacity	3.2 MGD
Pipelines	~2.6 miles of 14" pipeline (to discharge) ~1.3 miles of 16" pipeline (to AWT) ~1.3 miles of 8" pipeline (brine line)
Pump Stations	2,222 gpm (3.2 mgd) 50 TDH; 170 HP
Discharge Facility	3.2 MGD

✓Assumes that Phase 2 is implemented (does not include assoc. facilities and costs)
✓Assumes that secondary effluent is delivered for the SqCWD GWRR Project (does not include assoc. facilities and costs)
✓Treatment capacity = produced flow (based on available summer flows)
✓Pipeline and pump station sizing based on average daily flow

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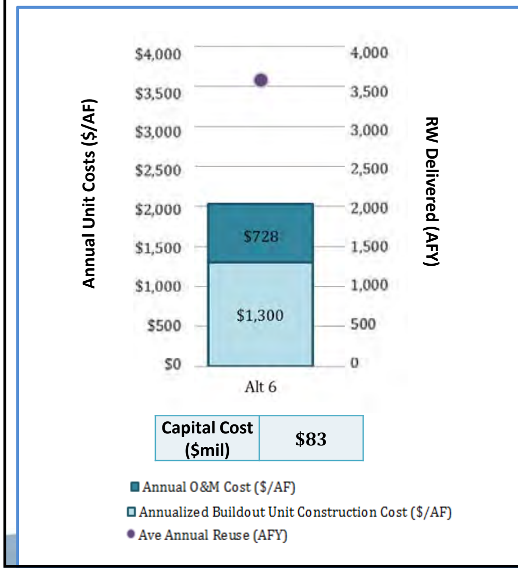
Alternative 6: Streamflow Augmentation



Qualitative Considerations?

- Potential to maximize beneficial reuse of wastewater in summer
- Benefits to providing fishery flows
- Regulatory viability is highly uncertain (TMDL/WQOs)
- Operational complexity for treatment
- High energy/GHG emissions for treatment
- Public acceptance uncertain

Based on Demand identified from Confluence Model, the RW delivered over the entire year will decrease and annual unit capital costs will increase

Alternative 7: Direct Potable Reuse

TABLE 3

Sub Alt	Description	Source Water	Treatment		Use
7	Raw Water Blending at Graham Hill WTP (via Coast PS)	Santa Cruz WWTF	Advanced Treatment at SC WWTF *(or Offsite?)*	AWT	The advanced treated water would be blended with raw water coming from North Coast sources, the San Lorenzo River, and Loch Lomond water at the Coast Pump Station, and further treated at the GHWTP prior to distribution as finished water, suitable for drinking.

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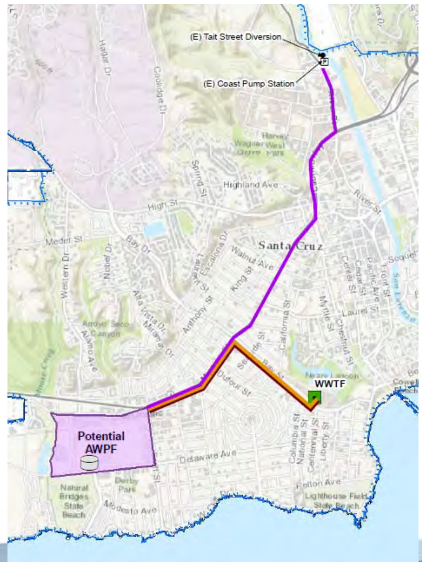
Alternative 7: DPR with Raw Water Blending at Graham Hill WTP



- **GHWTP** : Treat blended raw water + purified water to produce drinking water
- **Coast Pump Station:** Raw Water
- **SC WWTP + AWPF:** Purified Water

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Alternative 7: DPR with Raw Water Blending at Graham Hill WTP

	Direct Discharge
NPR Demand	No new customers added
AWPF Capacity	3.2 MGD
Pipelines	~2.6 miles of 14" pipeline (to Coast PS) ~1.3 miles of 16" pipeline (to AWT) ~1.3 miles of 8" pipeline (brine line)
Pump Stations	2,222 gpm (3.2 mgd) 85 TDH; 280 HP
Mixing (?) – check with Todd	3.2 MGD
Storage	Engineered Storage Buffer

✓Assumes that Phase 2 is implemented (does not include assoc. facilities and costs)
✓Assumes that secondary effluent is delivered for the SqCWD GWRR Project (does not include assoc. facilities and costs)
✓Treatment capacity = produced flow (based on available summer flows)
✓Pipeline and pump station sizing based on average daily flow

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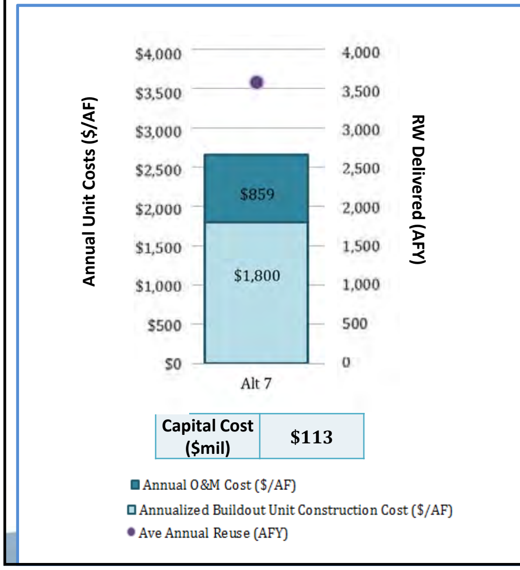
Alternative 7: DPR with Raw Water Blending at Graham Hill WTP



Qualitative Considerations?

- Potential to maximize beneficial reuse of wastewater in summer
- Existing regulations have not been developed
- Operational complexity for treatment
- Impact on GHWTP source water issues (i.e. high turbidity, high TOC, DBPs, solids, etc)
- High energy/GHG emissions for treatment
- Public acceptance uncertain

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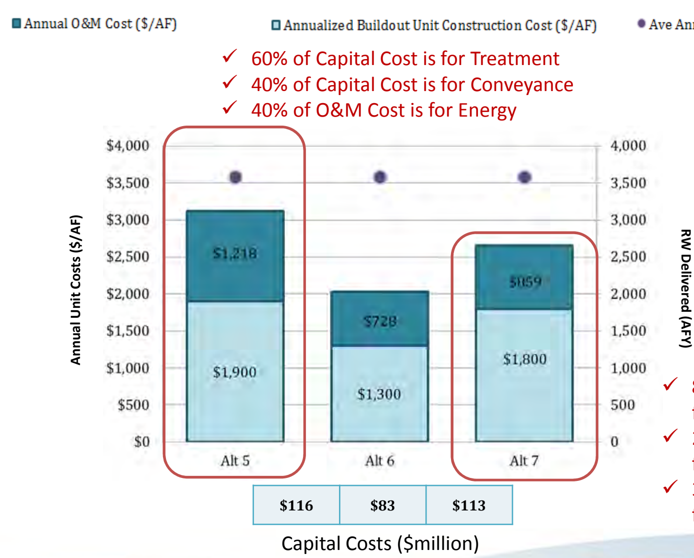
Alternatives 5, 6 and 7 Evaluation
Preliminary Summary of Eng Opinion of Probable Costs



- ✓ 80% of Capital Cost is for Treatment
- ✓ 20% of Capital Cost is for Conveyance
- ✓ 34% of O&M Cost is for Energy

Preliminary capital & annualized costs

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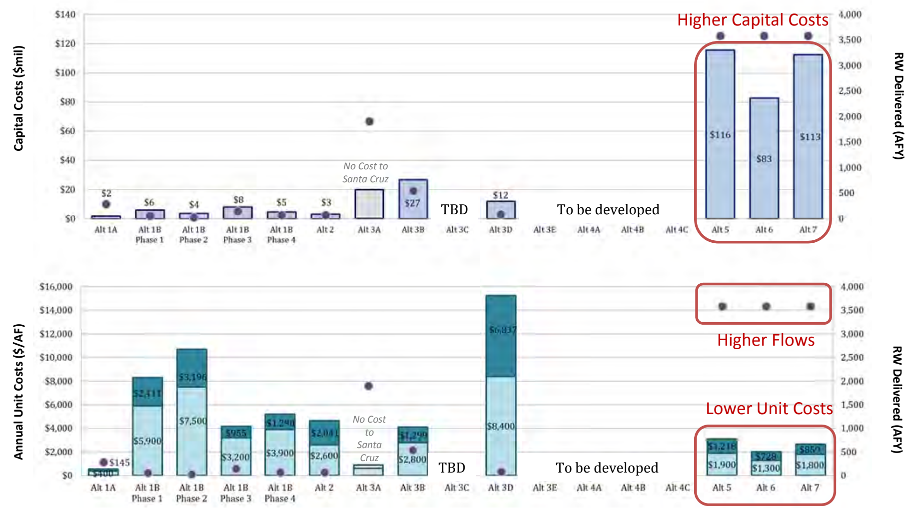
Comparison of Alternatives 1, 2, 3, 5, 6 and 7 Evaluation
Preliminary Summary of Eng Opinion of Probable Costs



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NPR Alternatives Evaluation
Summary of QUANTITATIVE Results

Alternative	Sub Alt	Description	Treatment Level	Recycled Water Delivered: Ave Annual Reuse (AFY)	Recycled Water Delivered: Average Annual Flow (MGD)	Recycled Water Delivered: Peak Season Deliveries (AF in Summer - June)	Recycled Water Delivered: Peak Hourly Flow (MGD)	Estimated Costs: Estimated Construction Cost ($mil)	Estimated Costs: Annual O&M Cost ($mil/yr)	Estimated Costs: Total Annual Cost ($/AF)	Energy / Others: Unit Energy of RW Delivered (KWH/AF)	Energy / Others: GHG Emissions (MTCO2/yr)	Energy / Others: Social Cost of Carbon ($)	Energy / Others: Footprint (SF)	Energy / Others: Number and Size of Facilities
Non Potable Reuse	Alt 1A	Centralized Non-Potable Reuse - Santa Cruz PWD Phase 2 Project	3°	282	0.25	32	1.04	$2	$0.0	$545	TBD	TBD	TBD	TBD	TBD
	Alt 1B	Centralized Non-Potable Reuse - Maximize tertiary treatment at the SC WWTF	3°	866	0.77	67	2.16				TBD	TBD	TBD	TBD	TBD
		Phase 1		340	0.30	32	1.04	$6	$0.1	$8,311	TBD	TBD	TBD	TBD	TBD
		Phase 2		27	0.02	4	0.14	$4	$0.1	$10,696	TBD	TBD	TBD	TBD	TBD
		Phase 3		146	0.13	23	0.74	$8	$0.1	$955	TBD	TBD	TBD	TBD	TBD
		Phase 4		71	0.06	11	0.36	$5	$0.1	$1,290	TBD	TBD	TBD	TBD	TBD
	Alt 2	Decentralized Non-Potable Reuse	3°	71	0.06	11	0.12	$3	$0.1	$4,641	TBD	TBD	TBD	TBD	TBD
SqCWD Led GWRR	Alt 3A	Secondary Effluent to SqCWD + NPR along the way	2° + filter	1,903	1.70	219	2.35	$20	$0.6	$891	TBD	TBD	TBD	TBD	TBD
	Alt 3B	Tertiary Effluent to SqCWD + NPR along the way	3°	545	0.49	293	3.14	$27	$0.7	$4,099	TBD	TBD	TBD	TBD	TBD
	Alt 3C	Secondary Effluent to SqCWD + SC GWRR (AWT @ SqCWD)	AWT	0	0.00	0	0.00	#N/A	#N/A	#N/A	TBD	TBD	TBD	TBD	TBD
	Alt 3D	AWT @ SC WWTF sent to SqCWD + NPR along the way	AWT	82	0.07	13	0.42	$12	$0.6	$15,237	TBD	TBD	TBD	TBD	TBD
	Alt 3E	AWT @ SC WWTF sent to SqCWD + NPR along the way + SC GWRR	AWT	0	0.00	$0.0	$0	#N/A	#N/A	#N/A	TBD	TBD	TBD	TBD	TBD
SC GWRR	Alt 4A	Santa Cruz GWRR Project - Advanced treatment at SCWWTF	2°	0	0.00	0.00	$0	#N/A	#N/A	#N/A	TBD	TBD	TBD	TBD	TBD
	Alt 4B	Santa Cruz GWRR Project - Advanced treatment at off-site	2°	0	0.00	0.00	$0	#N/A	#N/A	#N/A	TBD	TBD	TBD	TBD	TBD
	Alt 4C	Santa Cruz GWRR Project - MBR + AWPF at DA Porath	AWT	0	0.00	0.00	$0	#N/A	#N/A	#N/A	TBD	TBD	TBD	TBD	TBD
SWA	Alt 5	Surface Water Augmentation (SWA) in Loch Lomond Reservoir	AWT	3,584	3.20	412.16	$4	$116	$4	$3,118	TBD	TBD	TBD	TBD	TBD
Stream Aug	Alt 6	Streamflow Augmentation	AWT	3,584	3.20	412.16	$4	$83	$3	$2,028	TBD	TBD	TBD	TBD	TBD
DPR	Alt 7	Direct Potable Reuse	AWT	3,584	3.20	412.16	$4	$113	$3	$2,659	TBD	TBD	TBD	TBD	TBD

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OPEN DISCUSSION

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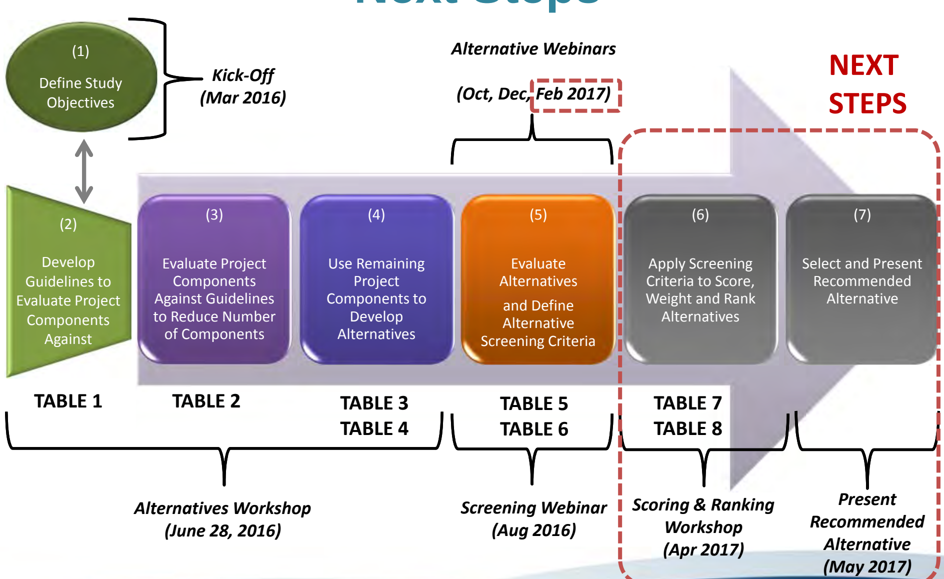
Next Steps



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QUESTIONS

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Santa Cruz Regional
Recycled Water Facilities Planning Study (RWFPS)

Alternatives Webinar – Part 3
01 March 2017 from 9 am to 10:30 am

Conf Call - (855) 813-2486 Code – 2484

Web Meeting - http://conf.kennedyjenks.com/conference/2484

AGENDA

Overall Webinar Objective: Present preliminary evaluation for groundwater replenishment reuse alternatives within the City's boundaries using preliminary maps, tables and figures to illustrate facility locations, capacities and costs.

Goal: Discuss and seek input on assumptions, facility locations and other project components.

Action Items: Respond to specific requests for information, update alternatives (as-needed) and memorialize discussion points to support scoring of alternative projects.

---

1. Approach & Objective
2. Recycled Water Supply
3. Market for Groundwater Replenishment Reuse (GRR)
4. GRR Treatment Requirements
5. Beltz Wellfield Injection Capacity and Siting Study
6. Alternatives Analysis
    a. Alternative 3 – Santa Cruz Participation in SqCWD-led GWRR Project
    b. Alternative 4 – Santa Cruz GRR Project
7. Cost Comparison
8. Open Discussion
9. Next Steps

City of Santa Cruz Recycled Water Facilities Planning Study

Alternatives Webinar Part 3

March 1, 2017

** Includes amended notes to reflect discussion at workshop*

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Agenda

- Approach & Objective
- Recycled Water Supply
- Market for Groundwater Replenishment Reuse (GRR)
- GRR Treatment Requirements
- Beltz Wellfield Injection Capacity and Siting Study
- Alternatives Analysis
  - Alternative 3 – Santa Cruz Participation in SqCWD-led GWRR Project
  - Alternative 4 – Santa Cruz GRR Project
- Cost Comparison
- Open Discussion

(Alternatives Analysis, Alternatives 3 and 4, and Cost Comparison:) Facilities, Quantitative Results, Qualitative Considerations

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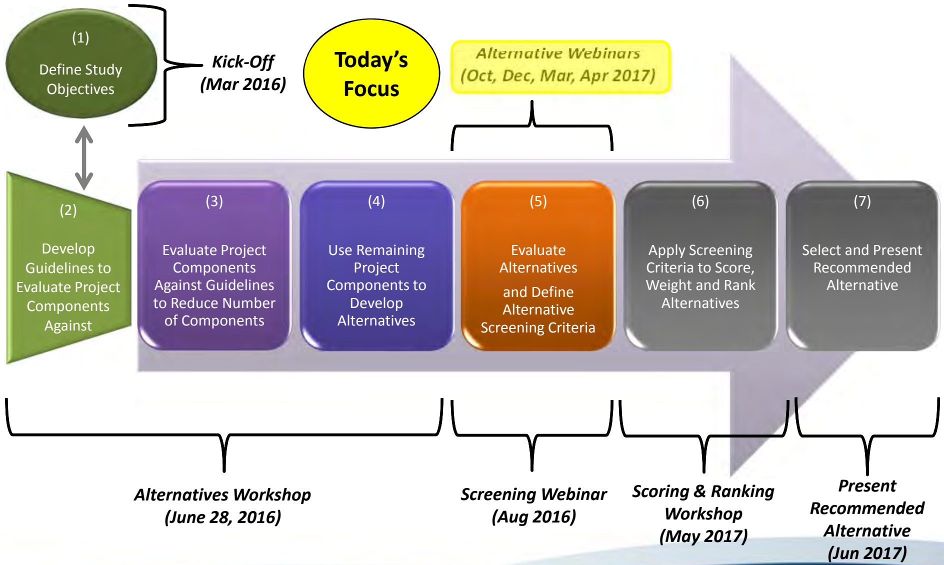
Overall Approach Flow Diagram



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Alternatives Webinar Objective

- **Objective:** Present preliminary evaluation for potable reuse alternatives using preliminary maps, tables and figures to illustrate facility locations, capacities and preliminary costs.
- **Goal:** Obtain input and clarify assumptions
- **Action Items:** Response to specific requests for information, update alternatives, and memorialize discussion points to support scoring of alternative projects.

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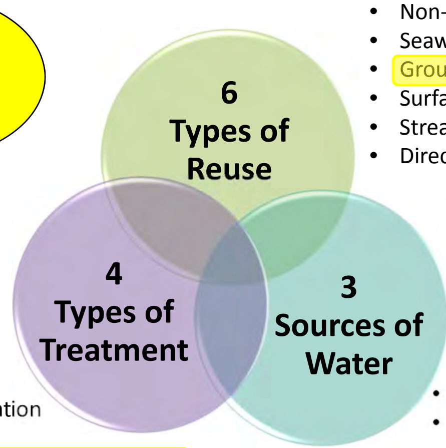
Project Components

Today's Focus



- Non-Potable
- Seawater Intrusion Barrier
- Groundwater Replenishment
- Surface Water Augmentation
- Streamflow Augmentation
- Direct Potable Reuse

- Secondary
- On-Site Filtration
- Tertiary
- Advanced Treatment (Purified)

- Santa Cruz WWTF
- Local Raw Wastewater
- Scotts Valley

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Santa Cruz WWTF Supply for GRRP Alternatives

Total SC WWTF Supply		SC WWTF In-Plant Demand		SqCWD GWRR Demand		Secondary Effluent Available	Purified Water Produced
Average Daily Dry Weather Flow[1] (mgd)		Year-Round Internal Use + La Barranca Park[2] (mgd)		Year-Round Secondary Effluent (mgd)		after meeting other Demands (mgd)	Based on assumed AWPF Recovery Rate[3]
6.1	−	0.25	−	1.7	=	4.16 →	3.2

Brine

[1] Based on June 2015 flow data
[2] Assumes no additional NPR demands in Santa Cruz will be served
[3] Assumes MF/UF recover rate of 90% and RO recovery rate of 85%

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Local Raw WW Supply for GRRP Alternatives

D.A. Porath Pump Station

- Operated by the Santa Cruz County Sanitation District
- Main raw wastewater PS along the sewer transmission main
- Average Flow = 3.6 mgd (2014)
- Diurnal and seasonal flow patterns would need to be further evaluated
- Assumed Recovery rates
  - MBR (90% recovery)
  - RO/UV-AOP (85% recovery)
- Assuming no bypass and ability to treat average annual flow
- Max production of purified water would be 2.75 mgd

Source: SqCWD GW Replenishment Feasibility Study, 2015

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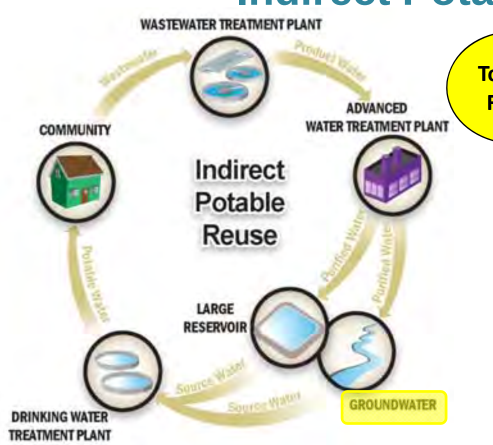
Recycled Water Market: Indirect Potable Reuse



GRR = Groundwater Replenishment Reuse

Today's Focus

- Exploring GRR in two basins
  - Santa Cruz Mid County Basin
  - Santa Margarita

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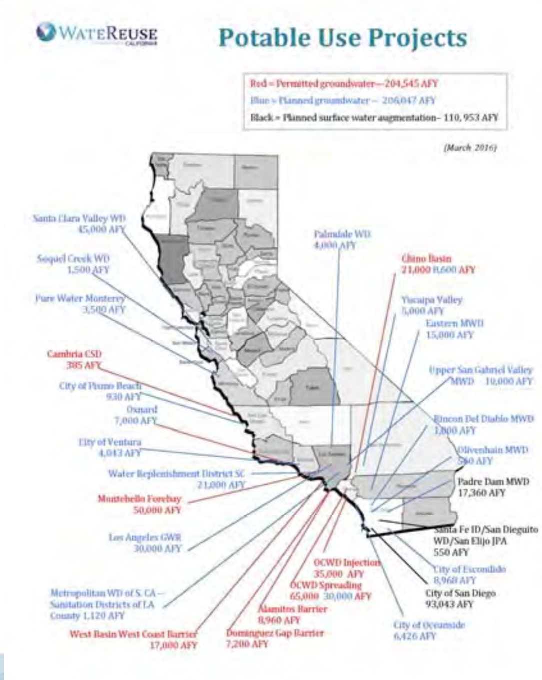
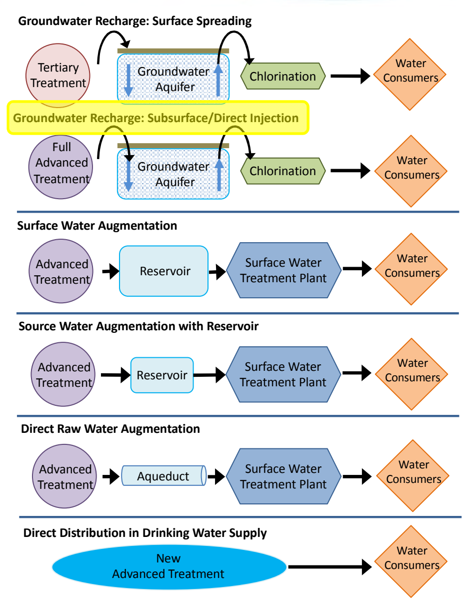
Market Assessment: GRRP

- Decades of GRRP in California
- 8 permitted projects
- Many more being planned



Types of Potable Reuse



Today's Focus

Graphics by Trussell

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GRR Treatment Requirements Direct Injection

- IPR regulations were finalized June 18, 2014
  - Reduction Credits = 12/10/10 microorganism removal,
  - Response Time = ≥ 2 months
  - Recycled Water Contribution ~ 100%
- Treatment
  - Credits from raw sewage to finished water
  - Min 2 separate treatment processes (max 6 LRV each)
  - Requires Full Advanced Treatment (RO + AOP)
  - 1-log virus reduction credit per month of subsurface retention

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GRR Treatment Requirements Direct Injection

- Other Requirements
  - Total N ≤ 10 mg-N/L; TOC ≤ 0.5/RWC
  - Nitrogen = GW Quality Objectives, Basin Plan
- Compliance with regulated compounds
  - NDMA ~ 10 ng/L California notification limit
  - Other Chemicals of Emerging Concern (CECs) with regulatory notification limits
  - Title 22 drinking water primary and secondary MCL's
  - Disinfection Byproducts – i.e. HAAs, THMs, chlorite
- Challenges: costs, brine disposal, siting
- Benefits: no diluent water required, less space

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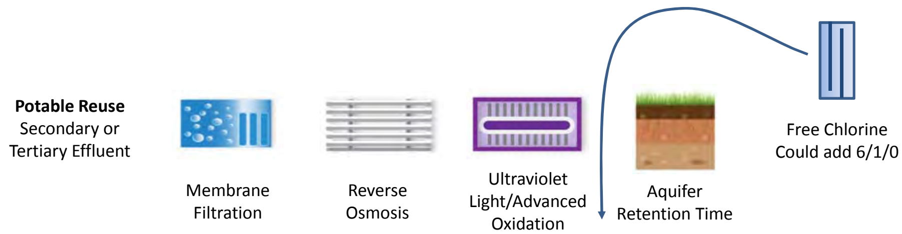
GRRP Treatment Train



Log Removal	MF	RO	UV/AOP	RT	Total
Virus	0	1.5 – 2	6	4 - 6	11.5 – 13.5
Giardia	4	1.5 – 2	6	0	11.5 – 12
Cryptosporidium	4	1.5 – 2	6	0	11.5 – 12

[1] Based on June 2015 flow data
[2] Assumes no additional NPR demands in Santa Cruz will be served
[3] Assumes MF/UF recover rate of 90% and RO recovery rate of 85%

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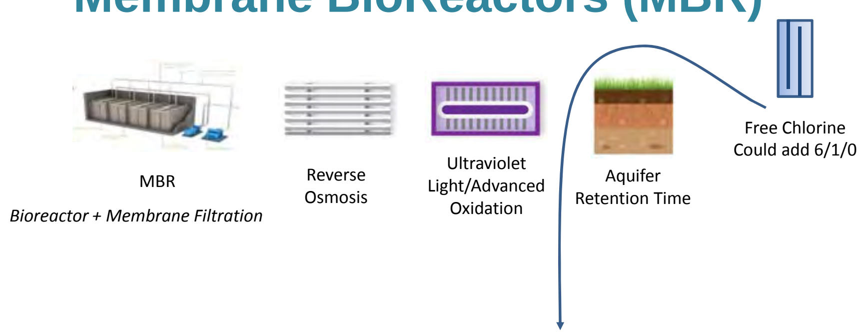
Membrane BioReactors (MBR)



Log Removal	MBR	RO	UV/AOP	RT	Total (without MBR credit)
Virus	TBD	1.5 – 2	6	4 - 6	11.5 – 13.5
Giardia	TBD	1.5 – 2	6	0	7.5 – 8
Cryptosporidium	TBD	1.5 – 2	6	0	7.5 – 8

Can we get similar pathogen credits for MBR if it replaces MF/UF in a potable reuse train? To Be Determined (TBD)

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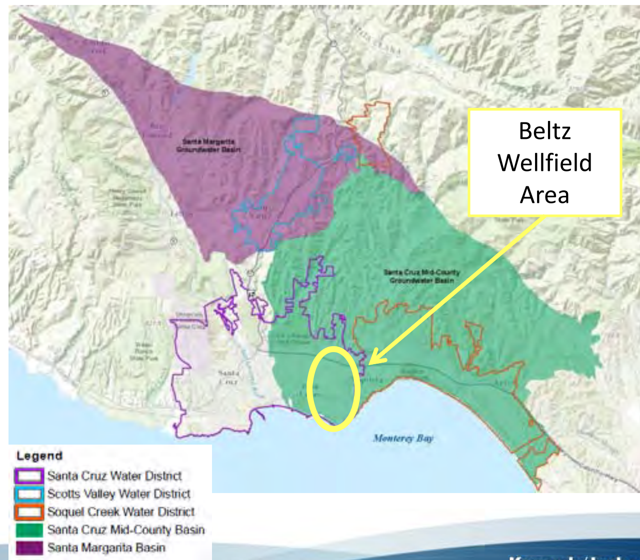
Groundwater Basins



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Beltz Wellfield
Injection Capacity and Siting Study

- Perform a conceptual-level analysis of injection well capacity and siting for a GRRP at the Beltz Wellfield
  - Utilizing production and specific capacity data from Beltz Wells #8, #9, #10 and #12
  - Identify potential sites using prior siting studies
  - Estimate injection rate and travel time to extraction
  - Meet minimum of 6-month travel time

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Beltz Wellfield
Injection Capacity and Siting Study

- Approach
  - Injection rate is assumed to be 50% to 70% of extraction rate from existing wells
  - Utilized Darcy's Law
  - Utilized Simple MODFLOW/MODPATH Model
  - Proposed Injection Well Locations Based on Previous Siting Studies and Communication with City Staff

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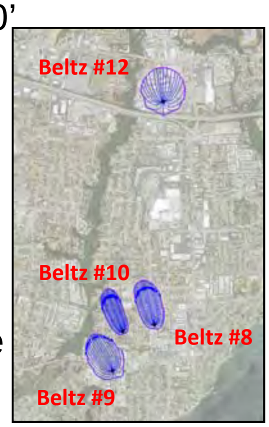
Beltz Wellfield
Existing Production Wells

ROI – Radius of Influence – 1000'

- Est. time a particle/drop of water 1,000' away would take 5 years to reach the production well)
- ROI is not symmetrical as approach accounts for regional groundwater gradient and groundwater pumping

Flow direction path = how a drop of water moves in the subsurface

Approx. **EXISTING** Production Well Location(s)



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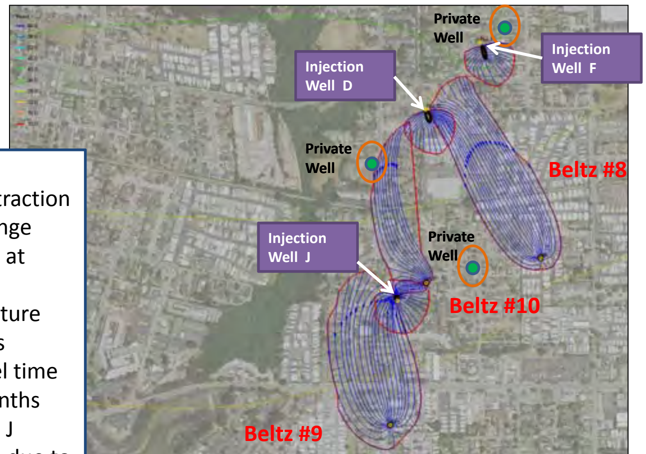
Injection Sites near Beltz Wells #8, #9 and #10



RESULTS:
- This shows how the extraction well capture zones change upon 0.5 mgd injection at each location
- The extraction well capture zone represents 5 years
- The injection well travel time shape represents 6 months
- Based on initial results, J would be less desirable due to travel time at or near 6 months

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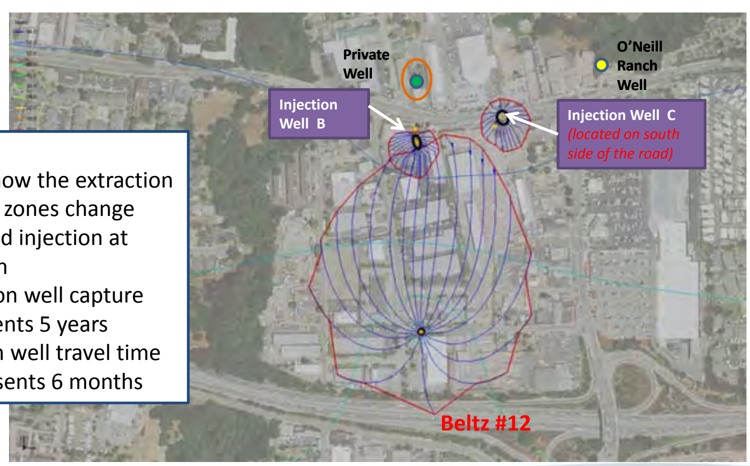
Injection Sites near Beltz Well #12



RESULTS:
- This shows how the extraction well capture zones change upon 0.5 mgd injection at each location
- The extraction well capture zone represents 5 years
- The injection well travel time shape represents 6 months

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Beltz Wellfield
Injection Capacity and Siting Study

- Recycled Injection Potential = 2 MGD
  - Beltz Well No's 8, 9 and 10 Sites
    - ✓Injection Rate = Approx. 0.5 MGD per well location
    - ✓Two Wells= 1.0 MGD
      - *Potential to do three wells if another viable site is identified.*
      - *Additional production wells may also need to be considered*
  - Beltz Well No. 12 Site
    - ✓Injection Rate = Approx. 0.5 MGD per well
    - ✓Two Wells = 1.0 MGD

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Recycled Water Market: Potable Reuse

Potable Reuse	Available Supply mgd (AFY)	Demand mgd (AFY)	Use Limited by
Groundwater Recharge – Beltz Wellfield	*SC WWTF Effluent* 3.2 mgd (3,600 AFY)	2.0 (2,200 AFY)	• Groundwater basin capacity • Injection well siting • Travel time from injection to extraction
Groundwater Recharge – Beltz Wellfield	*Local Raw WW* 2.75 mgd (3,080 AFY)	2.0 (2,200 AFY)	• Groundwater basin capacity • Injection well siting • Travel time from injection to extraction
Groundwater Recharge – Santa Margarita Basin	*SC WWTF Effluent* 3.2 mgd (3,600 AFY)	TBD*	• Regional wastewater generation • Groundwater basin capacity • Travel time from injection to extraction
Surface Water Augmentation	*SC WWTF Effluent* 3.2 mgd (3,600 AFY)	3.2 mgd (3,600 AFY)	• Summer wastewater generation • SWA Regulations • Operation of Loch Lomond Reservoir
Streamflow Augmentation	*SC WWTF Effluent* 3.2 mgd (3,600 AFY)	3.2 mgd (3,600 AFY)	• Summer wastewater generation • TMDL for Nitrate • Basin Plan requirements for Temperature and Dissolved Oxygen
Direct Potable Reuse	*SC WWTF Effluent* 3.2 mgd (3,600 AFY)	3.2 mgd (3,600 AFY)	• Summer wastewater generation • GHWTP Treatment Capacity • Coast Pump Station Capacity • Pending DPR Regulations

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Alternatives for Further Evaluation

- Alternative 1 – Centralized Non-Potable Reuse
- Alternative 2 – Decentralized Non-Potable Reuse
- Alternative 3 – Santa Cruz Participation in SqCWD-led GRR Project
- Alternative 4 – Santa Cruz GRR Project
- Alternative 5 – Surface Water Augmentation (SWA) in Loch Lomond Reservoir
- Alternative 6 – Streamflow Augmentation (SFA)
- Alternative 7 – Direct Potable Reuse (DPR)

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Preliminary capital & annualized costs

- Capital Costs
  - Treatment
  - Pipelines
  - Pump Stations
  - Injection & Monitoring Wells
  - Site Retrofit
- Annualized capital & O&M costs for alternative comparison
- Further inputs to confirm the following after webinar
  - Phasing of capital costs
  - Pipeline special crossing costs
  - Energy and labor costs
  - Interest and contingencies

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Alt 3 - Santa Cruz Participation in a SqCWD-led GRR

- **AWPF @ SqCWD Headquarters** **(3 Sub-alternatives)**
  - Alt 3a - Send secondary effluent from SCWWTF to SqCWD for injection in SqCWD basin
    - ✓ *Baseline – no use in Santa Cruz
  - Alt 3b - Send tertiary effluent from SCWWTF to SqCWD
    - ✓ Serve tertiary RW to NPR users along the way
  - Alt 3c - Send additional secondary effluent from SCWWTF to SqCWD AWTF and deliver purified water from SqCWD AWTF
    - ✓ Recharge advanced treated RW in Santa Cruz GW basin
    - ✓ Serve advanced treated RW to NPR users along the way to SC GW basin
- **AWPF @ Santa Cruz WWTF** **(2 Sub-alternatives)**
  - Alt 3d - Send advanced treated RW from SCWWTF to SqCWD
    - ✓ Serve advanced treated RW to NPR users along the way
  - Alt 3e - Send advanced treated RW from SCWWTF to SqCWD
    - ✓ Serve advanced treated RW to NPR users along the way
    - ✓ Recharge advanced treated RW in Santa Cruz GW Basin

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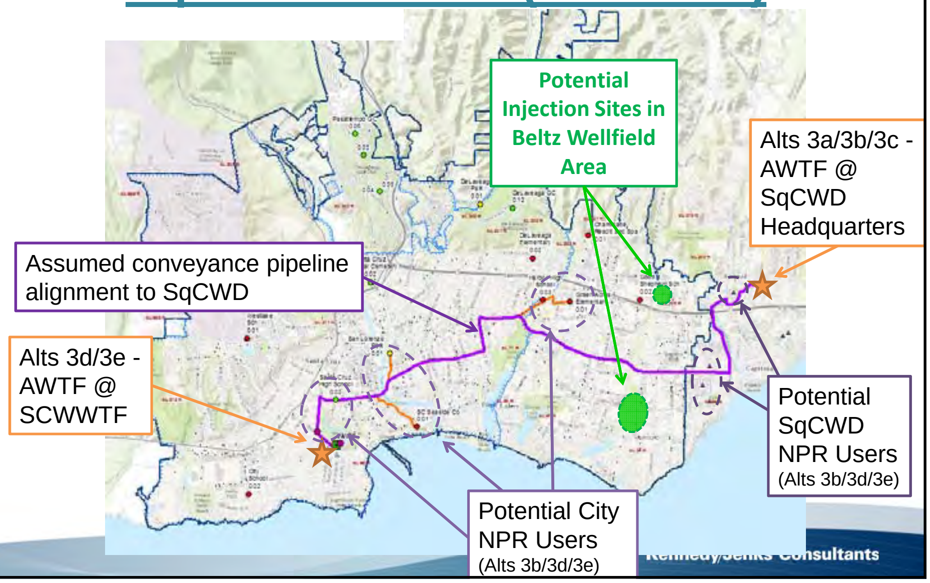
Alt 3 - Santa Cruz Participation in a SqCWD-led GRR

	Alt	Delivery to SqCWD	Use in Santa Cruz	Major Facilities in Santa Cruz
AWTF @ SqCWD Headquarters	3a	1.7 mgd secondary	None	Pump Station (PS) at SCWWTF, pipeline to SqCWD, brine line to SCWWTF
	3b	1.7 mgd tertiary	0.12 mgd NPR (~30 sites)	Tertiary Treatment and PS at SCWWTF, pipeline to SqCWD, brine line to SCWWTF, distribution pipelines to customer sites
	3c	4.3 mgd secondary	~2.0 mgd for GRR + 0.01 mgd NPR	PS at SCWWTF, pipeline to SqCWD, brine line to SCWWTF, pipeline from SqCWD to GW injection sites, GW injection wells
AWTF @ SCWWTF	3d	1.3 mgd purified	0.12 mgd NPR	AWTF and PS at SCWWTF, pipeline to SqCWD, distribution pipelines to customer sites
	3e	1.3 mgd purified *	0.15 mgd NPR + 2.0 mgd for GRR	AWTF and PS at SCWWTF, pipeline to SqCWD, distribution pipelines to customer sites and GW injection sites, GW injection wells

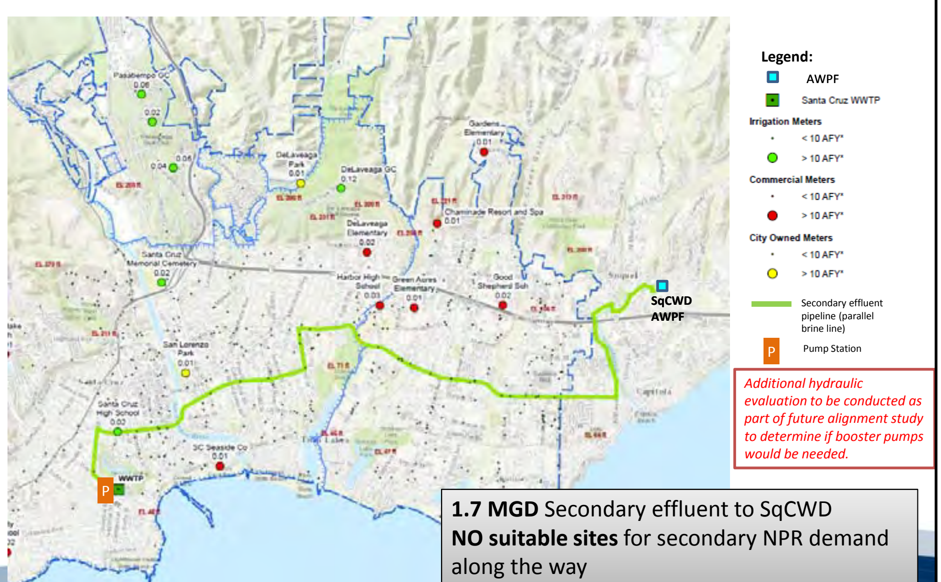
* Pipeline to injection wells in Santa Cruz is sized to convey 3.3 mgd.

Additional hydraulic evaluation to be conducted as part of future alignment study to determine if booster pumps would be needed along transmission main.

Alt 3 - Santa Cruz Participation in a SqCWD-led GRR (Overview)



Alternative 3a: Secondary Effluent to SqCWD + NO NPR along the way (BASELINE)



Alternative 3a: Secondary Effluent to SqCWD + NO NPR and NO GRR in the City along the way (BASELINE)

	Facilities
NPR Demand	0
SqCWD Demand	1.7 MGD Effluent (Constant Demand)
City GRR Demand	0
Treatment Capacity	No additional treatment required
Pipelines	8.4 miles – 14"
Pump Stations	WWTP PS – 2 nos: 670 gpm, 75 HP *(booster pump station if needed)*
Storage	None
Customer Sites	0

No NPR demand and No SC GRR along the way.

All 1.7 mgd secondary delivered is going to SqCWD

No peak factor was used to size pipeline and pump station since it is a constant demand.

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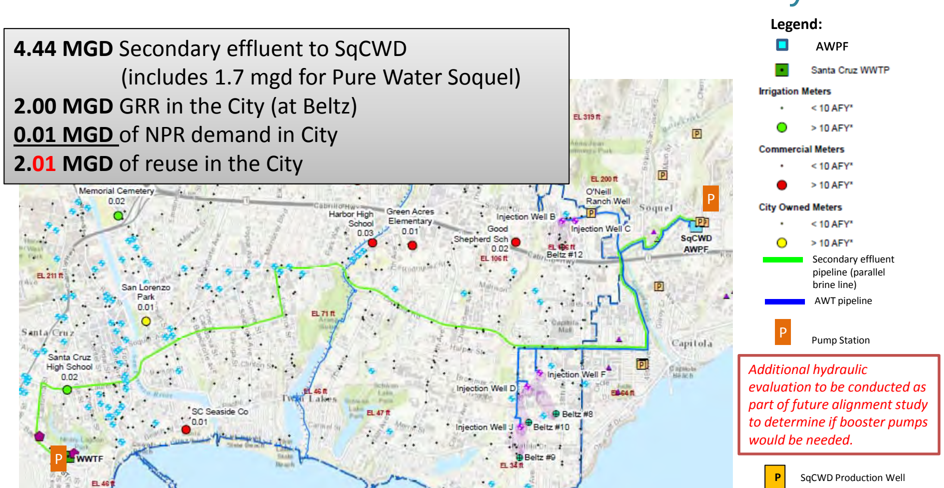
Alternative 3c: Secondary Effluent to SqCWD AWPF + Purified Water for NPR + GRR in the City

4.44 MGD Secondary effluent to SqCWD (includes 1.7 mgd for Pure Water Soquel)
2.00 MGD GRR in the City (at Beltz)
0.01 MGD of NPR demand in City
2.01 MGD of reuse in the City



Additional hydraulic evaluation to be conducted as part of future alignment study to determine if booster pumps would be needed.

*Current sizing does not include SqCWD NPR use in SqCWD

AWT pipeline would NOT be in the same trench as the secondary pipeline due to separation requirements. Shown in same alignment to reduce community disruption if installed at same time. Future alignment study to evaluation further.

Alternative 3c: Secondary Effluent to SqCWD AWPF + Purified Water for NPR + GRR in the City

	Facilities
NPR Demand	0.01 MGD
SqCWD Demand	1.7 MGD Effluent
City GRR Demand	2.0 MGD AWT Product Water
AWPF Treatment Capacity	3.3 MGD
Pipelines	8.4 miles – 20" (transmission – 6" larger than baseline Alt 3A) 4.35 miles – 10" and 8" (to injection wells)
Pump Stations	WWTP PS – 2,720 gpm, 140 HP *(booster pump station if needed)*
Wells	5 injection wells (+ 1 backup); 5 monitoring wells
Customer Sites	11

Treatment capacity at SqCWD based on constant flow of 3.3 mgd (1.3 mgd SqCWD GRR and 2 mgd SC GRR) and summer peak month flow factor of 1.87 applied to NPR demands (0.01 mgd).
For pipeline capacity, peak hour factor (assuming 8 hours of irrigation) only applied to NPR demand

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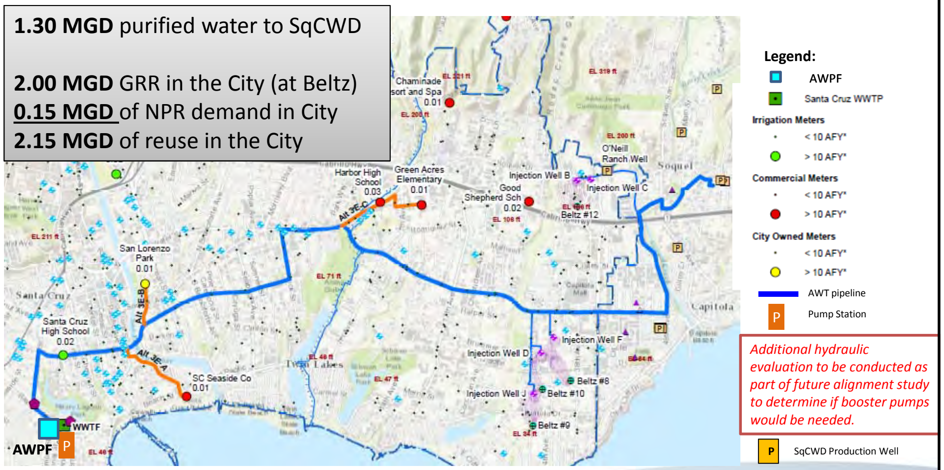
Alternative 3e: AWPF @ SC WWTF, use purified water for NPR + GRR in the City + SqCWD GRR

1.30 MGD purified water to SqCWD

2.00 MGD GRR in the City (at Beltz)
0.15 MGD of NPR demand in City
2.15 MGD of reuse in the City



Additional hydraulic evaluation to be conducted as part of future alignment study to determine if booster pumps would be needed.

*Current sizing does not include SqCWD NPR use

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Alternative 3e: AWPF @ SC WWTF, use purified water for NPR + GRR in the City + SqCWD GRR

	Facilities
NPR Demand	0.15 MGD
SqCWD Demand	1.3 MGD AWT Product Water
City GRR Demand	2.0 MGD AWT Product Water
Treatment Capacity	3.45 MGD
Pipelines	8.4 miles – 16” (transmission – 2” larger than baseline Alt 3A) 3.1 miles – 6” and 8 “(to injection wells)
Pump Stations	WWTP PS – 2,720 gpm, 140 HP *(booster pump station if needed)*
Wells	5 injection wells (+ 1 backup); 5 monitoring wells
Customer Sites	41

Treatment capacity at SqCWD based on constant flow of 3.3 mgd (1.3 mgd SqCWD GRR and 2 mgd SC GRR) and summer peak month flow factor of 1.87 applied to NPR demands (0.15 mgd).
For pipeline capacity, peak hour factor (assuming 8 hours of irrigation) only applied to NPR demand

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Alternative 3a, 3b, 3c, 3d and 3e

Facility Capital Costs					
1.0	**Treatment**				**1,729,866**
1.1	Microfiltration	1.7	MGD	2,250,000	3,805,096
1.2	Reverse Osmosis	1.4	MGD	3,308,000	4,755,187
1.3	UV/AOP	1.4	MGD	125,000	179,685
1.4	Free Chlorine	1.4	MGD	575,000	826,551
1.5	Post Treatment and Chemical Handling	1.4	MGD	923,000	1,326,795
1.6	Building	1.4	MGD	1,250,000	1,796,851
1.7	Remove SqCWD portion of treatment	1.30	MGD	8,431,000	(10,960,300)
2.0	**Pipelines**				**1,179,947**
2.1	Purified Water Pipeline from SCWWTP to SqCWD, serving NPR along the way				
	Alt3D_A	3,177	LF	72.00	228,769
	Alt3D_B	1,529	LF	72.00	110,099
	Alt3D_C	1,697	LF	72.00	122,182
	Alt3D_D	2,047	LF	72.00	147,359
	Alt3D_Main	44,106	LF	210.00	9,262,260
	Alt3D_A	3,222	LF	72	231,989
	Alt3D_B	1,529	LF	72	110,099
	Alt3D_C	1,697	LF	72	122,182
	Pipeline Constructability (Along Roads)			10%	1,033,494
	Microtunneling (Trenchless)	800	LF	700.00	560,000
2.2	Remove Baseline Pipeline Cost for Alt3A	1	LS	(10,748,486)	(10,748,486)
3.0	**Pump Stations**				**430,000**
3.1	From WWTP to SqCWD, serving NPR along the way		LS		1,740,000
3.2	Remove Baseline Pump Station Cost for Alt3A	1	LS	(1,310,000)	(1,310,000)

Alt 3A baseline costs removed from cost of Alts 3B, 3C, 3D and 3E

- ✓ Treatment
- ✓ Pipelines
- ✓ Pump Station

Alternative approach to distribute pipeline and PS costs by flow (rather than taking out baseline cost from 3A) will also be looked at.

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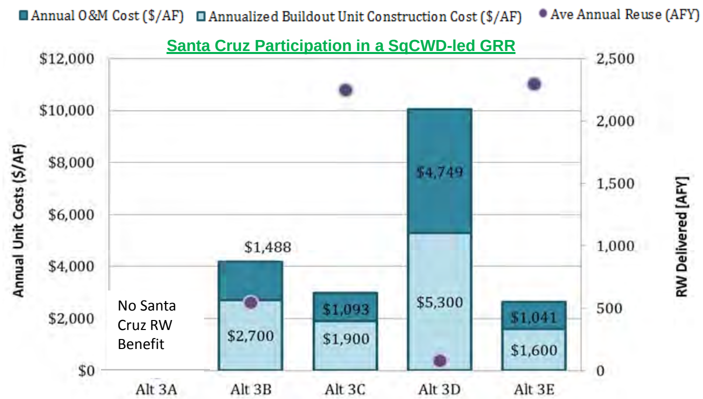
Alternative 3a, 3b, 3c, 3d and 3e



	AWPF @ SqCWD Headquarters			AWPF @ SC WWTF	
	No Reuse	NPR only	NPR + IPR	NPR only	NPR + IPR
Capital Cost ($mil)	Not incl* ~~$20~~	$25.9	$68.6	$7.6	$60.5

Other GRRP Considerations

- Maximizes beneficial reuse of wastewater in summer
- Maintains GW levels
- Operational complexity and energy for treatment
- Public acceptance uncertain
- Additional studies needed to confirm assumptions

*Alt 3A baseline costs removed from cost of Alts 3B, 3C, 3D and 3E

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Alt 4 - Santa Cruz GWRR

- **AWPF @ Santa Cruz WWTF**
  - Alt 4a - Send advanced treated RW from SCWWTF to SC GRR
    - ✓ Serve advanced treated RW to NPR users along the way to injection wells (more customers compared to Alt 4b)
    - ✓ Recharge advanced treated RW in Santa Cruz GW Basin
- **MBR + AWPF @ DA Porath**
  - Alt 4b - Send advanced treated RW from DA Porath (MBR + AWPF) to SC GRR
    - ✓ Serve advanced treated RW to NPR users along the way to injection wells
    - ✓ Recharge advanced treated RW in Santa Cruz GW Basin

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Alt 4 - Santa Cruz Led GRRP

	Alt	Delivery to SqCWD	Use in Santa Cruz	Major Facilities in Santa Cruz
AWTF @ SCWWTF	4a	1.7 mgd secondary	0.13 mgd NPR + 2.0 mgd for GRR	AWPF and PS at SCWWTF, distribution pipelines to customer sites and GW injection sites, GW injection wells
MBR + AWTF @ DA Porath	4b	1.7 mgd secondary	0.01 mgd NPR + 2.0 mgd for GRR	MBR and AWPF at DA Porath, PS at SCWWTF, DA Porath, pump station, short brine line, distribution pipelines to customer sites and GW injection sites, GW injection wells

*Facilities and cost of conveying secondary effluent to SqCWD not included as part of Alt 4

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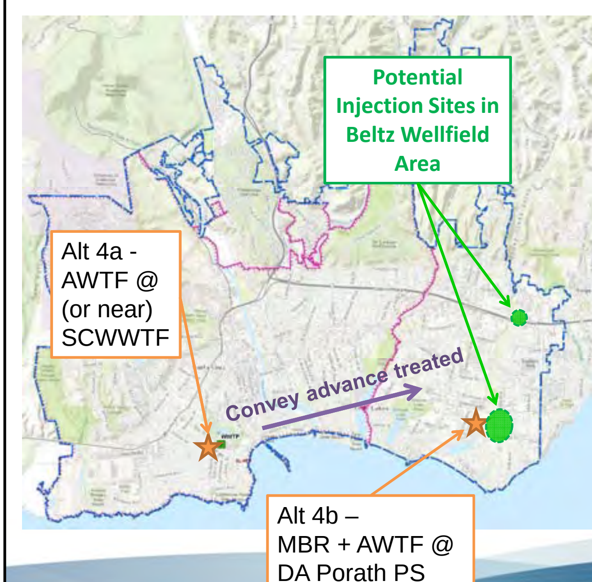
Alt 4 - Santa Cruz Led GRRP



Other Considerations

- Maximizes beneficial reuse of wastewater in summer
- Maintaining GW levels
- Siting issues for MBR
- Operational complexity and energy for treatment
- Public acceptance uncertain
- Additional studies needed to confirm assumptions

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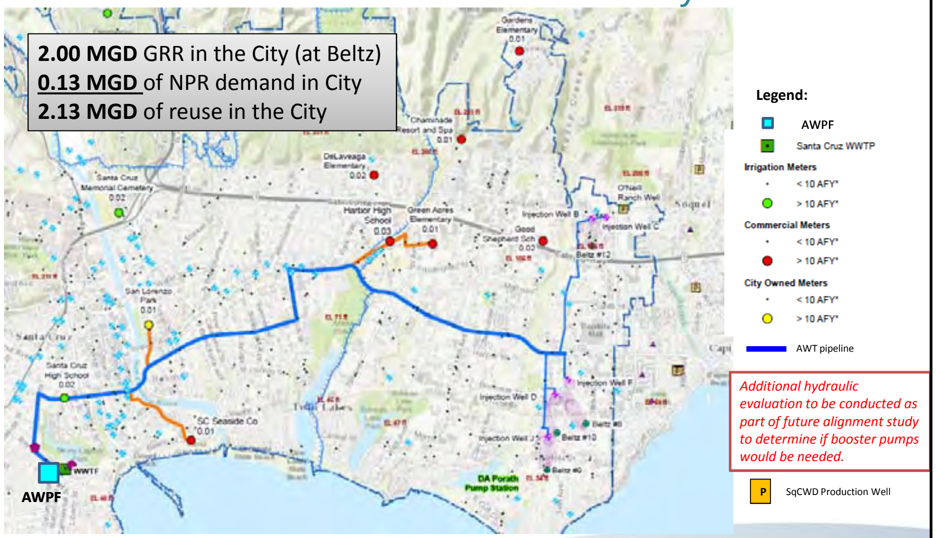
Alternative 4a: Send advanced treated RW from SCWWTF to GRR in the City



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Alternative 4a: Send advanced treated RW from SCWWTF to GRR in the City

	Facilities
NPR Demand	0.13 MGD
SqCWD Demand	Facilities and cost of conveying secondary effluent to SqCWD not included as part of Alt 4
City GRR Demand	2.0 MGD AWT Product Water
Treatment Capacity	2.25 MGD
Pipelines	5.1 miles – 12" (transmission) 3.6 miles – 6" and 10" (distribution to injection wells)
Pump Stations	WWTP PS – 2 nos: 670 gpm, 75 HP *(booster pump station if needed)*
Wells	5 injection wells (+ 1 backup); 5 monitoring wells
Customer Sites	37

Treatment capacity at SqCWD based on constant flow of 3.3 mgd (1.3 mgd SqCWD GRR and 2 mgd SC GRR) and summer peak month flow factor of 1.87 applied to NPR demands (0.15 mgd).
For pipeline capacity, peak hour factor (assuming 8 hours of irrigation) only applied to NPR demand

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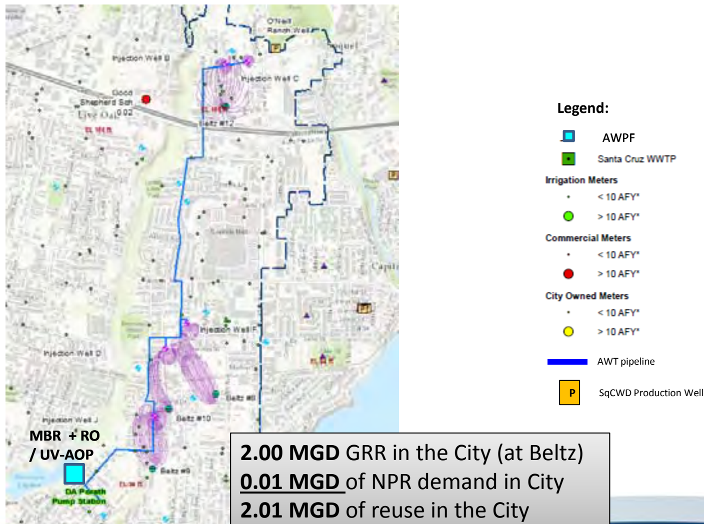
Alternative 4b: Send advanced treated RW from DA Porath (MBR + AWPF) to GRR in the City



2.00 MGD GRR in the City (at Beltz)
0.01 MGD of NPR demand in City
2.01 MGD of reuse in the City

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Alternative 4b: Send advanced treated RW from DA Porath (MBR + AWPF) to GRR in the City

	Facilities
NPR Demand	0.01 MGD
SqCWD Demand	Facilities and cost of conveying secondary effluent to SqCWD not included as part of Alt 4
City GRR Demand	2.0 MGD AWT Product Water
Treatment Capacity	2.02 MGD
Pipelines	2.7 miles – 6" and 8" (distribution to injection wells), short brine line for disposal back to sewer
Pump Stations	DA Porath Pump Station – 1,400 gpm, 190 HP
Wells	5 injection wells (+ 1 backup); 5 monitoring wells
Customer Sites	11

Treatment capacity at SqCWD based on constant flow of 3.3 mgd (1.3 mgd SqCWD GRR and 2 mgd SC GRR) and summer peak month flow factor of 1.87 applied to NPR demands (0.15 mgd).
For pipeline capacity, peak hour factor (assuming 8 hours of irrigation) only applied to NPR demand

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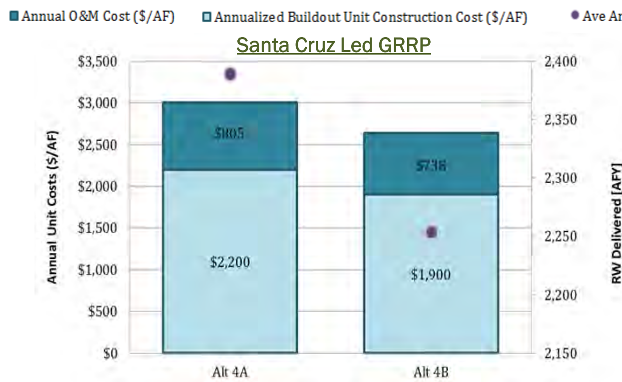
Alternative 4a and 4b



AWPF @ SC WWTF	MBR-AWPF
NPR + IPR	NPR + IPR

Capital Cost ($mil)	$85.1	$74.0

Other GRRP Considerations

- Maximizes beneficial reuse of wastewater in summer
- Maintains GW levels
- Operational complexity and energy for treatment
- Public acceptance uncertain
- Additional studies needed to confirm assumptions
- Siting issues for MBR at DA Porath PS (monarch ubutterfies, coastal commission zone, cultural and biological resources)

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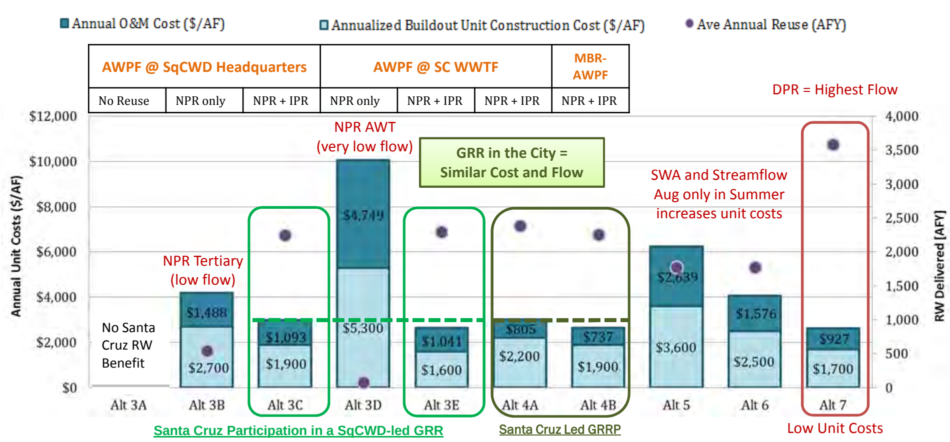
Alternatives 3 & 4 Evaluation
Preliminary Summary of Eng Opinion of Probable Costs



Capital Cost ($mil)	Not incl ~~$20~~	$25.9	$68.6	$7.6	$60.5	$85.1	$74.0	$111.2	$77.7	$107.6

Preliminary capital & annualized costs

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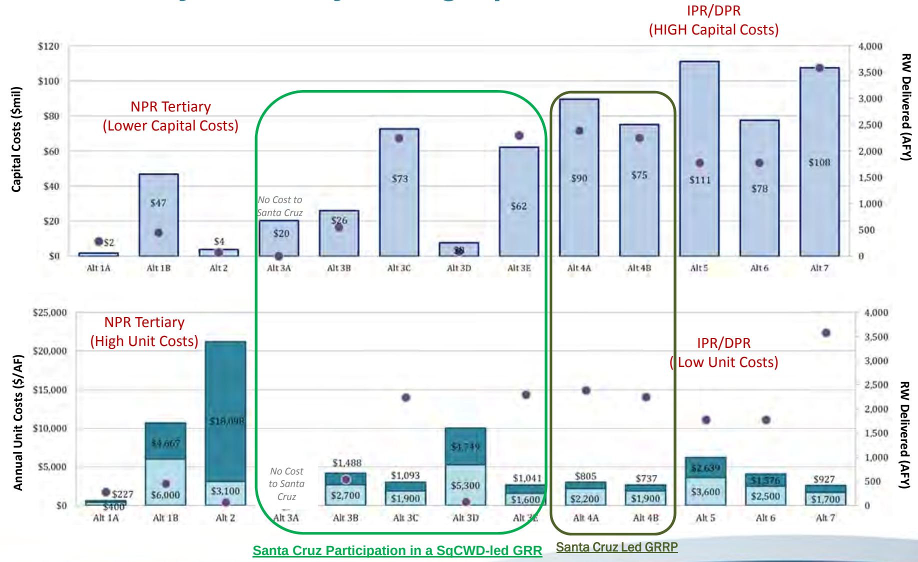
Comparison of Alternatives 1 to 7 Evaluation
Preliminary Summary of Eng Opinion of Probable Costs



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NPR Alternatives Evaluation
Summary of QUANTITATIVE Results

				Recycled Water Delivered						Estimated Costs			Energy / Others				
Alternative	Sub Alt	Description	Treatment Level	Regional Ave Annual Reuse (AFY)	Regional Average Annual Flow (MGD)	RW Use in Santa Cruz (AFY)	RW Use in Santa Cruz (MGD)	Peak Season Deliveries (AF in Summer - June)	Peak Hourly Flow (MGD)	Estimated Construction Cost ($mil)	Annual O&M Cost ($mil/yr)	Total Annual Cost ($/AF)	Unit Energy of RW Delivered (KWH/AF)	GHG Emissions (MTCO2/yr)	Social Cost of Carbon ($)	Footprint (SF)	Number and Size of Facilities
Non Potable Reuse	Alt 1A	Centralized Non-Potable Reuse - Santa Cruz PWD Phase 2 Project	3°	282	0.25	282	0.25	44	1.41	$2	$0.1	$627	TBD	TBD	TBD	TBD	TBD
	Alt 1B	Centralized Non-Potable Reuse - Maximize tertiary treatment at the SC WWTF	3°	807	0.72	807	0.72	126	4.04				TBD	TBD	TBD	TBD	TBD
		Phase 1		340	0.30	340	0.30	44	1.40	$20	$1.2	$40,124	TBD	TBD	TBD	TBD	TBD
		Phase 2		176	0.16	176	0.16	51	1.65	$6	$0.2	$2,819	TBD	TBD	TBD	TBD	TBD
		Phase 3		146	0.13	146	0.13	42	1.36	$15	$0.6	$4,210	TBD	TBD	TBD	TBD	TBD
		Phase 4		146	0.13	146	0.13	42	1.36	$6	$0.2	$2,268	TBD	TBD	TBD	TBD	TBD
	Alt 2	Decentralized Non-Potable Reuse	3°	71	0.06	71	0.06	20	0.21	$4	$1.3	$21,198	TBD	TBD	TBD	TBD	TBD
SqCWD Led GWRR	Alt 3A	Secondary Effluent to SqCWD + NPR along the way	2° + filter	1,903	1.70	0.00	0.00	297	3.18	$20	$0.8	#DIV/0!	TBD	TBD	TBD	TBD	TBD
	Alt 3B	Tertiary Effluent to SqCWD + NPR along the way	3°	2,448	2.19	545	0.49	417	4.47	$26	$0.8	$4,188	TBD	TBD	TBD	TBD	TBD
	Alt 3C	Secondary Effluent to SqCWD + SC GWRR (AWT @ SqCWD) + NPR along the way back	AWT	3,704	3.31	2,248	2.01	577	6.18	$73	$2.5	$2,993	TBD	TBD	TBD	TBD	TBD
	Alt 3D	AWT @ SC WWTF sent to SqCWD + NPR along the way	AWT	1,538	1.37	82	0.07	295	9.49	$8	$0.4	$10,049	TBD	TBD	TBD	TBD	TBD
	Alt 3E	AWT @ SC WWTF sent to SqCWD + NPR along the way + SC GWRR	AWT	3,755	3.35	2,299	2.05	585	$6	$62	$2	$2,641	TBD	TBD	TBD	TBD	TBD
SC GWRR	Alt 4A	Santa Cruz GWRR Project - Advanced treatment at SCWWTF + NPR along the way	AWT	2,389	2.13	2,389	2.13	372	$4	$90	$2	$3,005	TBD	TBD	TBD	TBD	TBD
	Alt 4B	Santa Cruz GWRR Project - MBR + AWPF at DA Porath + NPR along the way	AWT	2,254	2.01	2,254	2.01	351	$4	$75	$2	$2,637	TBD	TBD	TBD	TBD	TBD
SWA	Alt 5	Surface Water Augmentation (SWA) in Loch Lomond Reservoir	AWT	1,777	3.20	1,777	3.20	558.51	$6	$111	$5	$6,239	TBD	TBD	TBD	TBD	TBD
Stream Aug	Alt 6	Streamflow Augmentation	AWT	1,777	3.20	1,777	3.20	558.51	$6	$78	$3	$4,076	TBD	TBD	TBD	TBD	TBD
DPR	Alt 7	Direct Potable Reuse	AWT	3,584	3.20	3,584	3.20	558.51	$6	$108	$3	$2,627	TBD	TBD	TBD	TBD	TBD
Regional GRR	Alt 8a	With SqCWD	AWT	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD
	Alt 8b	Without SqCWD	AWT	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD

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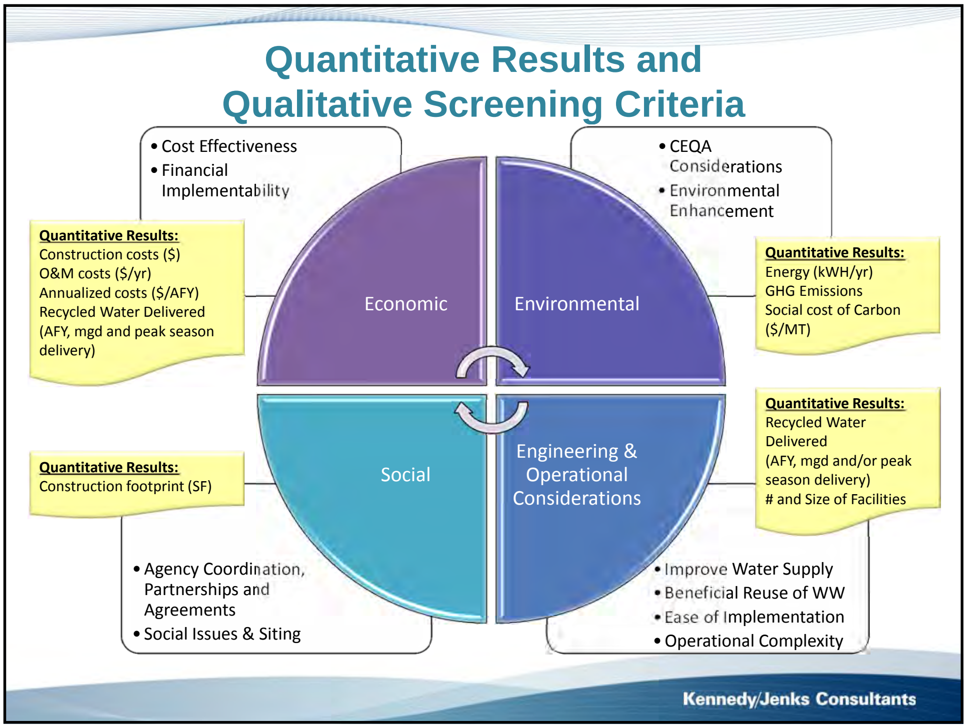
Quantitative Results and
Qualitative Screening Criteria
• Cost Effectiveness
• Financial Implementability
• CEQA Considerations
• Environmental Enhancement
Quantitative Results:
Construction costs ($)
O&M costs ($/yr)
Annualized costs ($/AFY)
Recycled Water Delivered
(AFY, mgd and peak season delivery)
Economic
Environmental
Quantitative Results:
Energy (kWH/yr)
GHG Emissions
Social cost of Carbon ($/MT)
Quantitative Results:
Recycled Water Delivered
(AFY, mgd and/or peak season delivery)
and Size of Facilities
Social
Engineering & Operational Considerations
Quantitative Results:
Construction footprint (SF)
• Agency Coordination, Partnerships and Agreements
• Social Issues & Siting
• Improve Water Supply
• Beneficial Reuse of WW
• Ease of Implementation
• Operational Complexity
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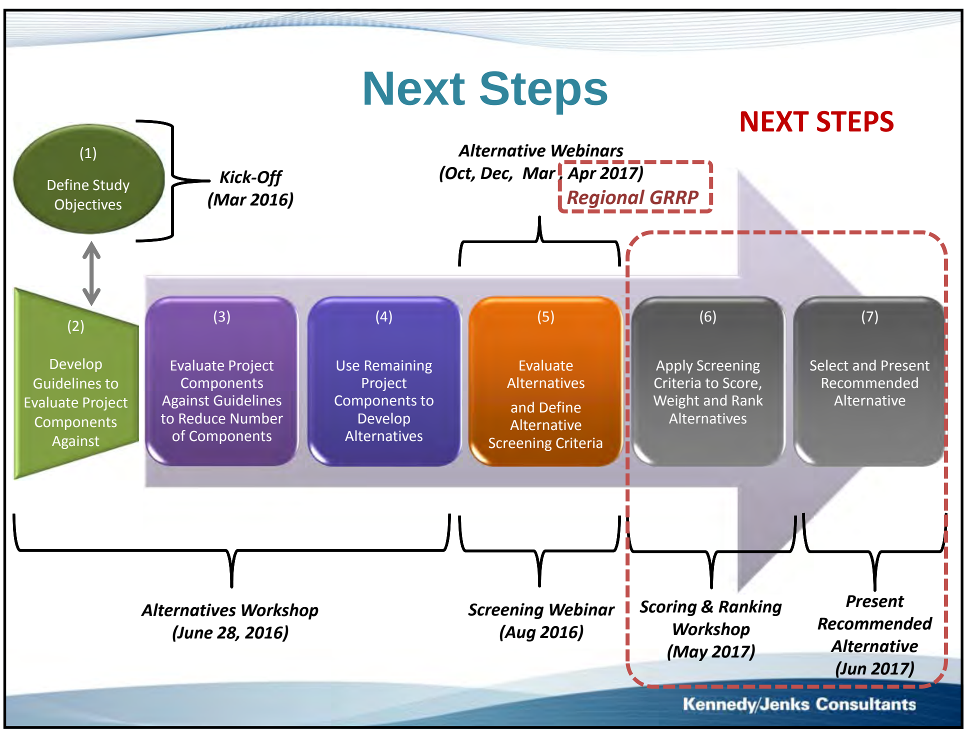
Next Steps
NEXT STEPS
(1) Define Study Objectives
Kick-Off (Mar 2016)
Alternative Webinars
(Oct, Dec, Mar, Apr 2017)
Regional GRRP
(2) Develop Guidelines to Evaluate Project Components Against
(3) Evaluate Project Components Against Guidelines to Reduce Number of Components
(4) Use Remaining Project Components to Develop Alternatives
(5) Evaluate Alternatives and Define Alternative Screening Criteria
(6) Apply Screening Criteria to Score, Weight and Rank Alternatives
(7) Select and Present Recommended Alternative
Alternatives Workshop (June 28, 2016)
Screening Webinar (Aug 2016)
Scoring & Ranking Workshop (May 2017)
Present Recommended Alternative (Jun 2017)
Kennedy/Jenks Consultants

QUESTIONS

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	Eddy Teasdale	EddyTeasdale@KennedyJenks.com

Kennedy/Jenks Consultants

Santa Cruz Regional
Recycled Water Facilities Planning Study (RWFPS)

Alternatives Webinar – Part 4
27 April 2017 from 9 am to 11:00 am

Conf Call - (855) 813-2486 Code – 2484

Web Meeting - http://conf.kennedyjenks.com/conference/2484

AGENDA

Overall Webinar Objective: Present preliminary evaluation for regional groundwater replenishment reuse alternatives in the Santa Margarita Groundwater Basin using preliminary maps, tables and figures to illustrate facility locations, capacities and costs.

Goal: Discuss and seek input on assumptions, preliminary model results, facility locations and other project components.

Action Items: Respond to specific requests for information, update alternatives (as-needed) and memorialize discussion points to support scoring of alternative projects.

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1. Approach & Objective
2. Regional Recycled Water Supply
3. Santa Margarita Groundwater Basin (SMGB) Initial Injection Capacity and Siting Study Results
4. GRR Treatment Requirements and Regional Considerations
5. Alternatives Analysis
    a. Alternative 8a – 4-Way Regional GRR Project (to serve the City, Scotts Valley, Soquel Creek and San Lorenzo Valley)
    b. Alternative 8b – 3-Way GWRR Project (to serve the City, Scotts Valley, and San Lorenzo Valley)
6. Preliminary Cost Comparison
7. Open Discussion
8. Scoring and Weighting Discussion
9. Next Steps

City of Santa Cruz Recycled Water Facilities Planning Study

Alternatives Webinar Part 4

April 27, 2017

Kennedy/Jenks Consultants 1

Agenda

- Approach & Objective
- Regional GRRP Concept
- Regional Recycled Water Supply
- GRR Treatment Requirements and Regional Considerations
- Santa Margarita Groundwater Basin (SMGB)
  - Initial Injection Capacity and Siting Study Results
- Alternative 8a/8b Analysis
- Preliminary Cost Comparison
- Open Discussion
- Scoring and Weighting Discussion

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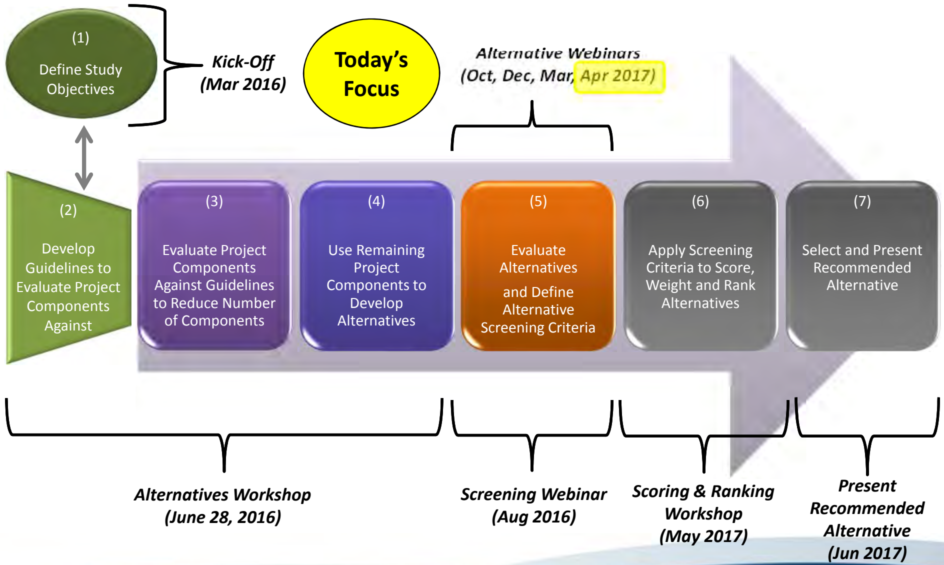
Overall Approach Flow Diagram



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Alternatives Webinar Objective

- **Objective:** Present preliminary evaluation for potable reuse alternatives using preliminary maps, tables and figures to illustrate facility locations, capacities and preliminary costs.
- **Goal:** Obtain input and clarify assumptions
- **Action Items:** Response to specific requests for information, update alternatives, and memorialize discussion points to support scoring of alternative projects.

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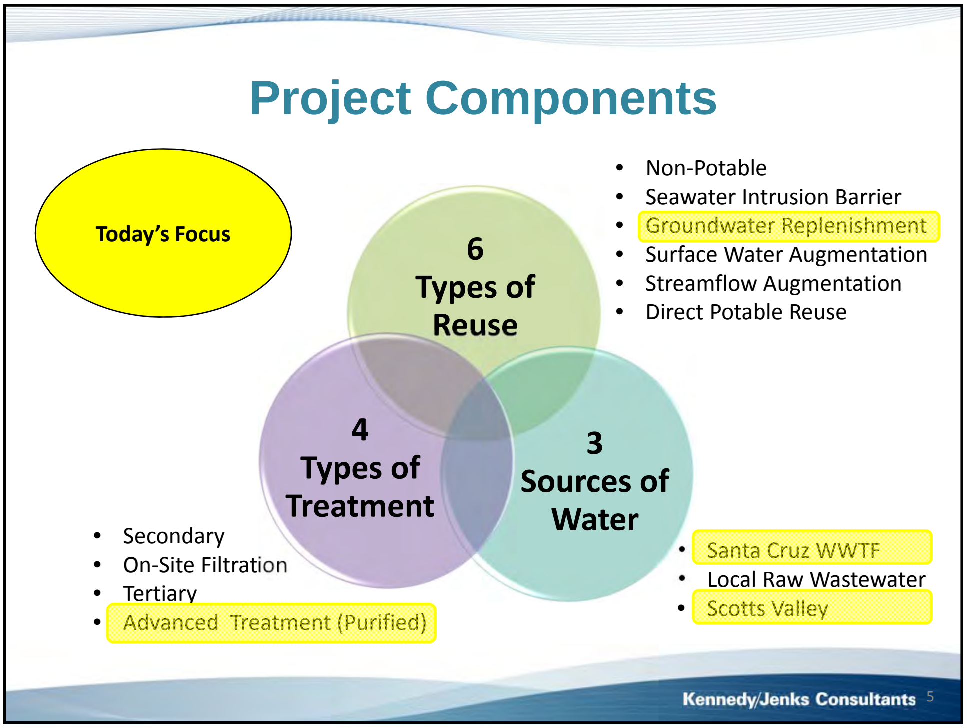
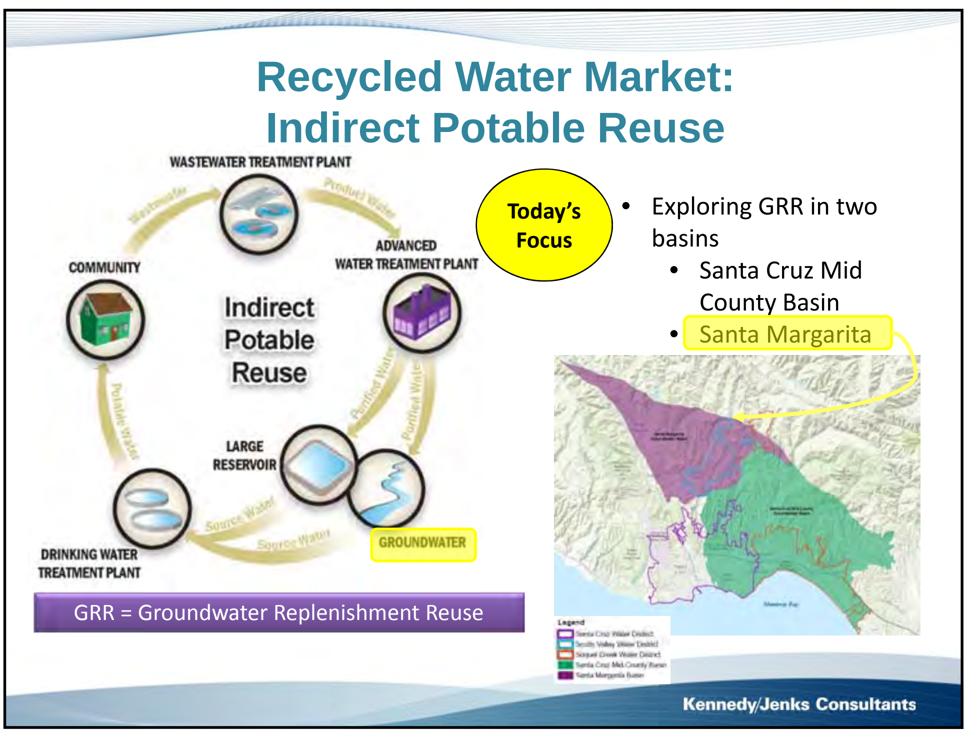

Project Components
Today's Focus
6 Types of Reuse
4 Types of Treatment
3 Sources of Water
Non-Potable
Seawater Intrusion Barrier
Groundwater Replenishment
Surface Water Augmentation
Streamflow Augmentation
Direct Potable Reuse
Secondary
On-Site Filtration
Tertiary
Advanced Treatment (Purified)
Santa Cruz WWTF
Local Raw Wastewater
Scotts Valley
Kennedy/Jenks Consultants
5


Recycled Water Market:
Indirect Potable Reuse
WASTEWATER TREATMENT PLANT
COMMUNITY
ADVANCED WATER TREATMENT PLANT
Indirect Potable Reuse
LARGE RESERVOIR
GROUNDWATER
DRINKING WATER TREATMENT PLANT
GRR = Groundwater Replenishment Reuse
Today's Focus
Exploring GRR in two basins
Santa Cruz Mid County Basin
Santa Margarita
Kennedy/Jenks Consultants

Regional GRR Concept

- **Description:** Regional AWTF to produce purified water for groundwater replenishment in the Santa Margarita Groundwater Basin. Utilize existing or new production wells to serve Santa Cruz, SVWD, SLVWD and SqCWD (or in parallel to an independent SqCWD GRRP)
- **Source:** Santa Cruz WWTF + Scotts Valley WRF
- **Project Size:** Groundwater recharge based on injection and extraction capacity
- **Uses:** Groundwater recharge only
- **Major Facilities:** AWTF, conveyance and distribution pipelines, pump stations, injection wells, production wells, brine line

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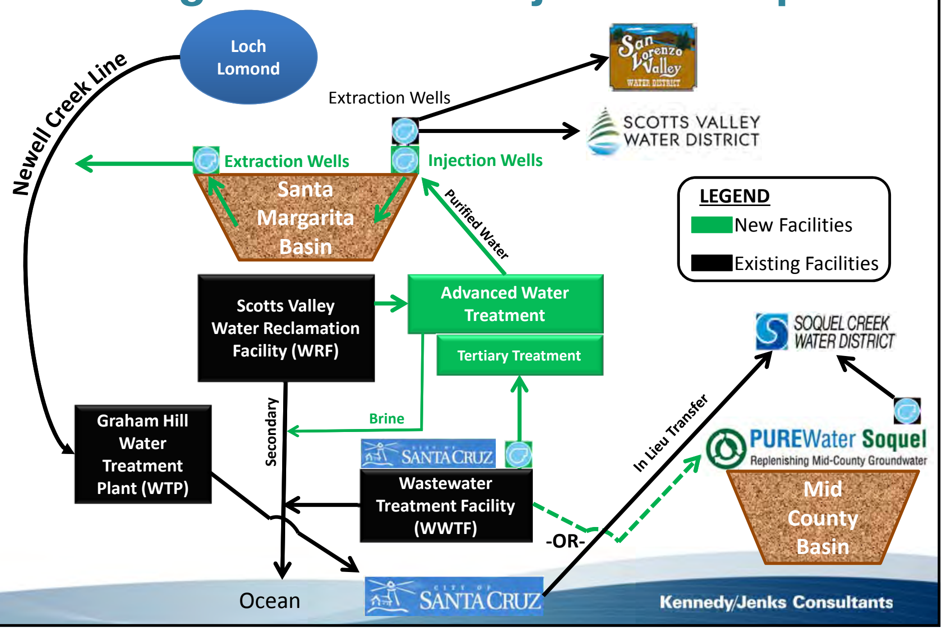
Regional GRR Project Concept



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City WWTF Supply for a Regional GRRP

(assuming independent SqCWD GRRP)

Total SC WWTF Supply		SC WWTF In-Plant Demand		SqCWD GRRP Demand		Secondary Effluent Available	Purified Water Produced
Average Daily Dry Weather Flow[1] (mgd)		Year-Round In-plant Use + La Barranca [2] (mgd)		Year-Round Secondary Effluent (mgd)		after meeting other Demands (mgd)	Based on assumed AWPF Recovery Rate[3]
6.1	−	0.25	−	1.7	=	4.2 →	3.2

Brine

[1] Based on June 2015 flow data
[2] Assumes no additional NPR demands in Santa Cruz will be served
[3] Assumes MF/UF recover rate of 90% and RO recovery rate of 85%

Same as assumed Available City WWTF for Alts 3 through 7 (IPR/DPR)

City WWTF Supply for a Regional GRRP

(assuming no SqCWD GRRP)

Total SC WWTF Supply		SC WWTF In-Plant Demand		SqCWD GRRP Demand		Secondary Effluent Available	Purified Water Produced
Average Daily Dry Weather Flow[1] (mgd)		Year-Round In-plant Use + La Barranca [2] (mgd)		Year-Round Secondary Effluent (mgd)		after meeting other Demands (mgd)	Based on assumed AWPF Recovery Rate[3]
6.1	−	0.25	−	0	=	5.9 →	4.5

Brine

[1] Based on June 2015 flow data
[2] Assumes no additional NPR demands in Santa Cruz will be served
[3] Assumes MF/UF recover rate of 90% and RO recovery rate of 85%

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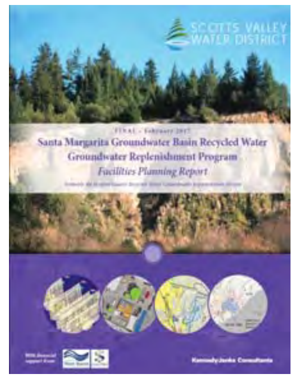
SVWD WWTF Supply for a Regional GRRP

- Per the SVWD Facilities Planning Report (K/J 2017)
  - AWPF Treatment design capacity = 1.0 mgd for peak month
  - Average annual flow of product (purified water) = 0.5 mgd
  - After meeting existing RW demand + Pasatiempo GC secondary effluent needs there is little available supply in the summer
  - Winter supply is greater, thus the AWPF is sized to meet winter flows



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Regional AWPF Capacity GRRP Alternatives

Treatment Design Capacity	Alt 8a Regional *(no SqCWD GRRP)*	Alt 8b Regional *(independent SqCWD GRRP)*	Assumptions
From Santa Cruz WWTF Secondary Flow	4.5	3.2	Based on available secondary effluent with assumed AWPF Recovery Rate[1]
From Scott Valley WRF Tertiary Flow	1.0	1.0	Based on peak month treatment capacity in winter months when NPR demand is low.
Treatment Production at Regional AWPF	**5.5**	**4.2**	This will be the aver annual volume recharged into the groundwater basin (assuming adequate available capacity in the SMGB).
Regional Alternatives:	Alt 8a	Alt 8b	

[1] Assumes MF/UF recover rate of 90% and RO recovery rate of 85%

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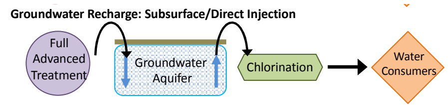
GRR Treatment Requirements Direct Injection

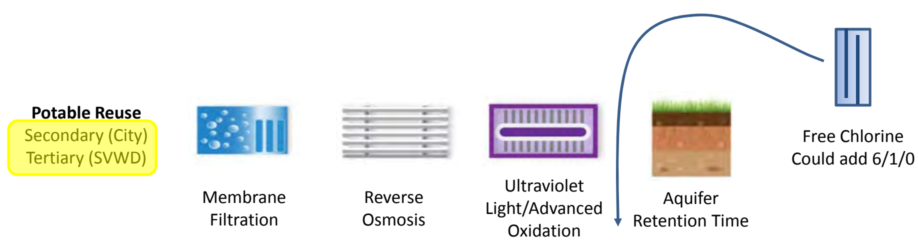
- IPR regulations were finalized June 18, 2014
  - Reduction Credits = 12/10/10 microorganism removal,
  - Response Retention Time = ≥ 2 months
  - Recycled Water Contribution ~ 100%
- Requires Full Advanced Treatment (RO + AOP)



- Other requirements (Total N, TOC, NDMA, CECs, and other GW water quality objectives from Basin Plan)

Summary of requirements for Alts 3 & 4; presented in Webinar Part 3

GRRP Treatment Train

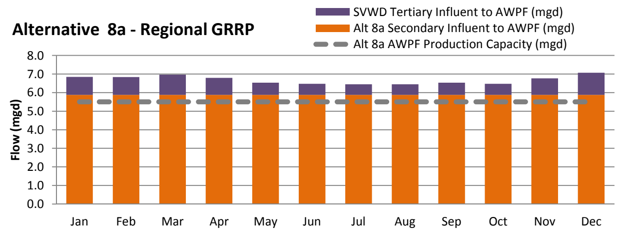


Log Removal	MF	RO	UV/AOP	RT	Total
Virus	0	1.5 – 2	6	4 - 6	11.5 – 13.5
Giardia	4	1.5 – 2	6	0	11.5 – 12
Cryptosporidium	4	1.5 – 2	6	0	11.5 – 12

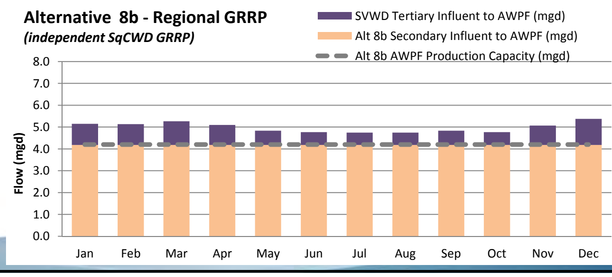
Summary of Treatment Train for Alts 3 & 4; presented in Webinar Part 3

Regional Treatment Considerations

- Influent to the AWPF is combination of secondary (City) and tertiary (SVWD)



Tertiary Effluent from SVWD is ~ 12% of the inflow to the AWPF



Tertiary Effluent from SVWD is ~ 16% of the inflow to the AWPF

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Regional Treatment Considerations

- Tertiary effluent comprising 12-16% of Inflow
  - No change to treatment processes
  - Potential for reduced fouling of membranes
    - ✓ lower energy requirements
    - ✓ reduced membrane replacement
- Increased AWPF production capacity
  - Benefit from economy of scale to bring capital cost down
    - ✓ Reduced duplication of facilities
    - ✓ Regional distribution of site development costs
    - ✓ Reduced building costs, also distributed regionally (i.e. admin, controls, etc)

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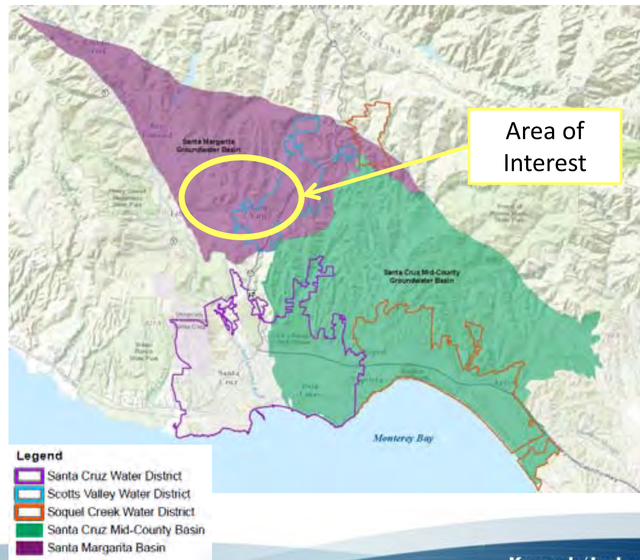
Groundwater Basins



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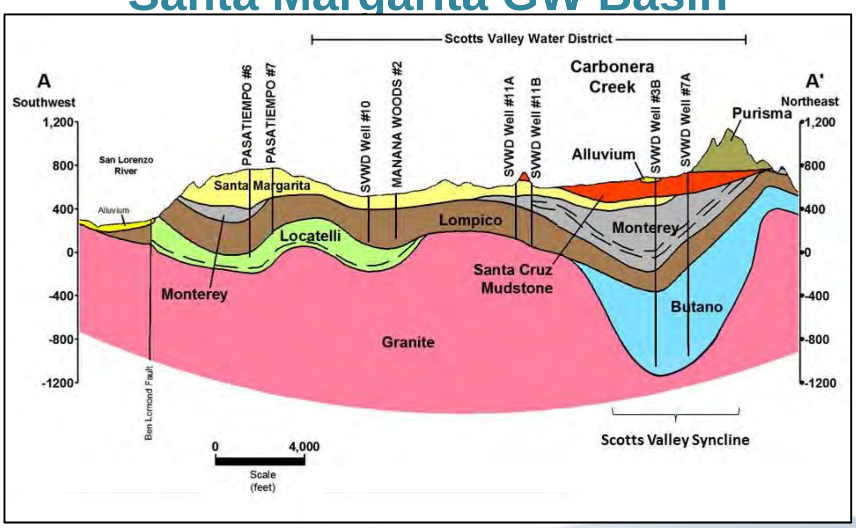
Recharge the Lompico Aquifer of the Santa Margarita GW Basin



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SMGB Injection Capacity and Siting Study Approach

- Perform a conceptual-level analysis of injection well capacity and siting for a GRRP in the SMGB
- Utilize existing MODFLOW Model of SMGB
- Methodology for estimate production and specific capacity
- Identify potential sites for injection and extraction
- Estimate injection rate and travel time to extraction
- Meet minimum of 6-month travel time from injection and extraction wells

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SMGB Well Siting Study

- Proposed Well Locations Based on Preliminary Siting Study from Pueblo

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SMGB Hydrogeology Assumptions

- Injection/Extraction Rates based on preliminary estimates from Pueblo (**Scenario 1**)

Potential NEW Well Sites	Est Injection Flow Rate (GPM)	Est Injection Flow Rate (MGD)
SV1	150	0.22
SV2	205	0.30
SV3	200	0.29
SV4	430	0.62
SV5	250	0.36
SV6	190	0.27
SV7	205	0.30
SV8	50	0.07
SV9	207	0.30
Total	**1,887**	**2.72**

Potential SVWD FPS Well Sites	Est Injection Flow Rate (GPM)	Est Injection Flow Rate (MGD)
INJ Well #3	120	0.2
11A	120	0.2
11B	120	0.2
Total	**360**	**0.6**

Based on SMGB Prior Model Runs for SVWD FPS for 1.0 mgd purified water production capacity

Insufficient to meet remaining purified water production of 4.5 mgd or 3.2 mgd

SMGB Hydrogeology Assumptions

- Injection/Extraction Rates based on injection rate on percentage of production – 25% (**Scenario 2**)

Potential NEW Well Sites	Est Injection Flow Rate (GPM)	Est Injection Flow Rate (MGD)
SV1	328	0.47
SV2	422	0.61
SV3	235	0.34
SV4	250	0.36
SV5	390	0.56
SV6	390	0.57
SV7	300	0.43
SV8	438	0.63
SV9	218	0.32
Total	**11,890**	**4.28**

Potential SVWD FPS Well Sites	Est Injection Flow Rate (GPM)	Est Injection Flow Rate (MGD)
INJ Well 3	120	0.2
11A	120	0.2
11B	120	0.2
Total	**360**	**0.6**

Based on SMGB Prior Model Runs for SVWD FPS for 1.0 mgd purified water production capacity

sufficient to meet remaining purified water production of 4.5 mgd or 3.2 mgd

SMGB Hydrogeology Assumptions

- Injection/Extraction Rates based on injection rate on percentage of production of 25% and added 5 new production wells (**Scenario 3**)

Potential NEW Well Sites	Est Injection Flow Rate (GPM)	Est Injection Flow Rate (MGD)
SV1	328	0.47
SV2	422	0.61
SV3	235	0.34
SV4	250	0.36
SV5	390	0.56
SV6	390	0.57
SV7	300	0.43
SV8	438	0.63
SV9	218	0.32
Total	**11,890**	**4.28**

Potential SVWD FPS Well Sites	Est Extraction Flow Rate (GPM)	Est Injection Flow Rate (MGD)
5 Wells	594	0.86
Total	**360**	**4.28**

New Extraction Rates = Proposed Injection Rates (SV-1 through SV-9)

sufficient to meet remaining purified water production of 4.5 mgd or 3.2 mgd

SMGB
Injection and Production Wells

ROI – Radius of Influence

- Est. time a particle/drop of water would take 6 months to travel from Injection Well

ROI – Radius of Influence

- Est. time a particle/drop of water would take 6 months to travel from Existing Production Well

ROI – Radius of Influence

- Est. time a particle/drop of water would take 6 months to travel from Proposed Production Well

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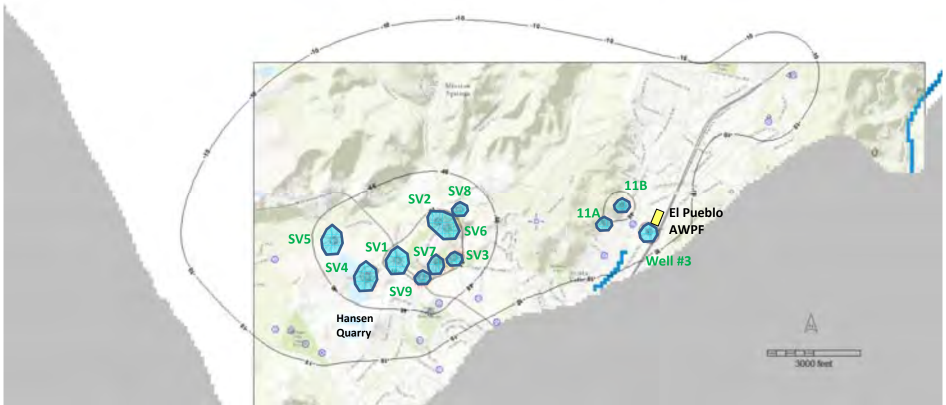
Preliminary "Scenario 1" Results for ALL Sites Considered



RESULTS:
- The injection well travel time shape represents 6 months

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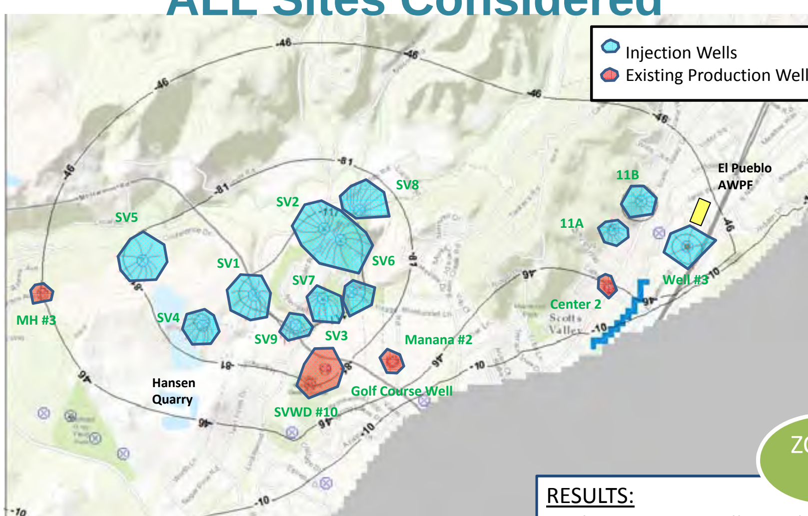
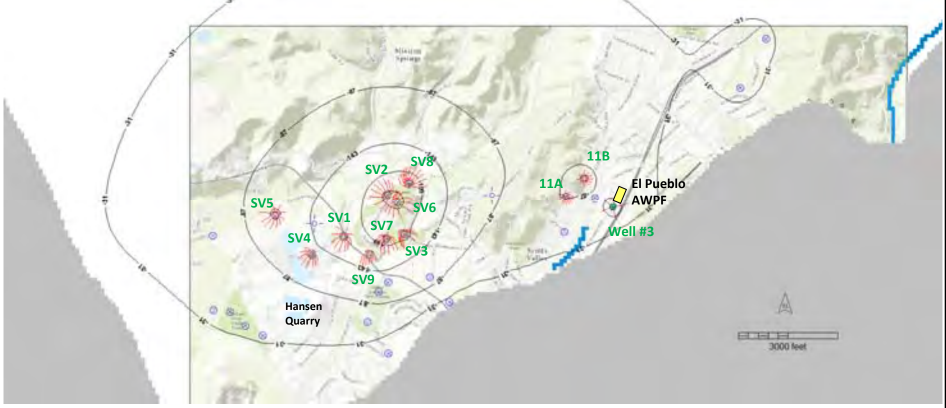
Preliminary "Scenario 1" Results for ALL Sites Considered



ZOOM IN

RESULTS:
- The injection well travel time shape represents 6 months

Preliminary "Scenario 2" Results for ALL Sites Considered



RESULTS:

- The injection well travel time shape represents 6 months

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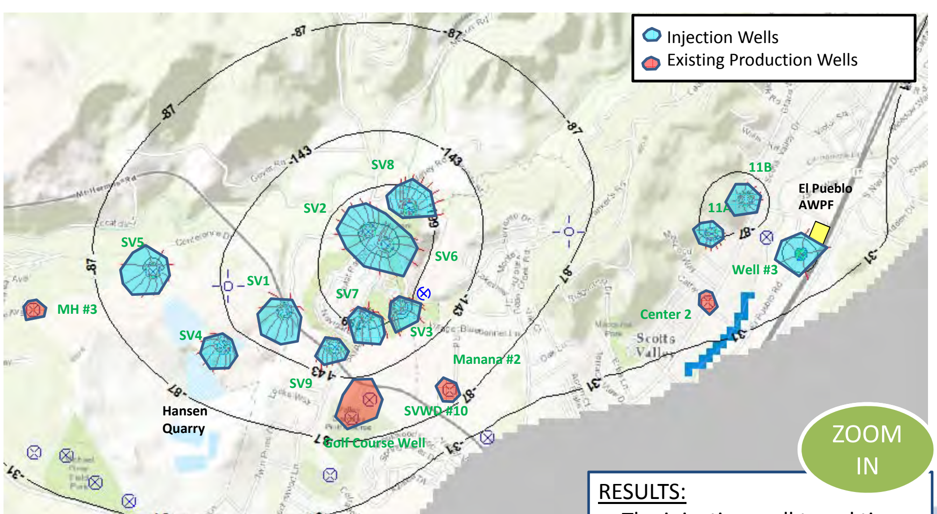
Preliminary "Scenario 2" Results for ALL Sites Considered

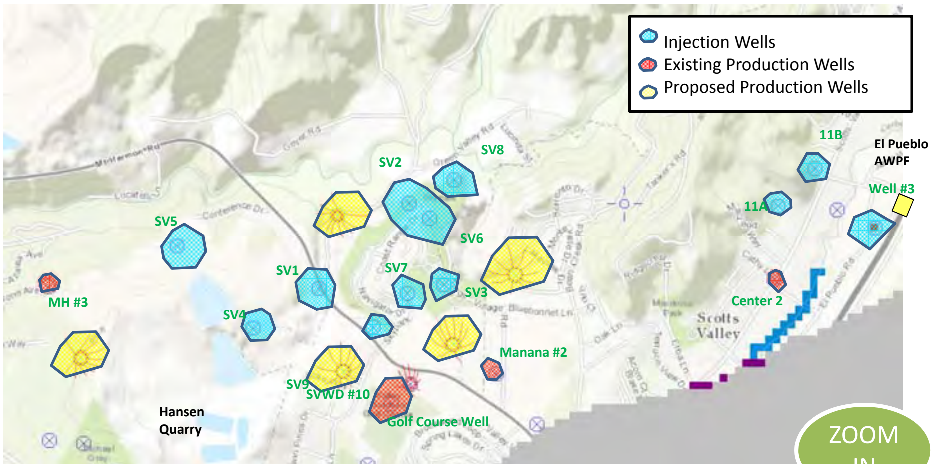


ZOOM IN

RESULTS:

- The injection well travel time shape represents 6 months

Preliminary "Scenario 3" Results for ALL Sites Considered



ZOOM IN

RESULTS:
- The injection well travel time shape represents 6 months

SMGB
Injection Capacity and Siting Study

- SVWD FPS – Repurpose Existing Wells for Injection
  - 11A/B + Inj Well #3 (Recommended Project)
  - 3 Wells = 0.6 mgd
- New Injection Wells to Serve City + SqCWD
  - SV1 – SV9 (Siting Study Identified by Pueblo)
  - Scenario 1 Injection Rate = Approx. 0.3 mgd per well location
    - ✓ 9 Wells = 2.72 mgd
    - ✓ 2 to 6 additional sites needed to utilize Alt 8a and 8b Purified Water Supply
  - Scenario 2 Injection Rate = Approx. 0.5 mgd per well location
    - ✓ 9 Wells = 4.28 mgd
  - Scenario 3 Injection Rate
    - ✓ 9 Injection Wells = 4.28 mgd (0.48 mgd/well)
    - ✓ 5 Extraction Wells = 4.28 mgd (0.86 mgd/well)

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SMGB
Production Capacity and Siting Study

- SVWD FPS
  - Utilize existing production wells to capture replenished purified water
- Existing Production Wells
  - Next model run simulate interaction btw injection and extraction
- New Production Wells to Serve City (+ SqCWD)
  - Extraction Rate = Approx. 0.86 mgd per well location
  - Alt 8a (4.5 mgd supply) = Need 5 NEW well sites
  - Alt 8b (3.2 mgd supply) = Need 4 NEW well sites

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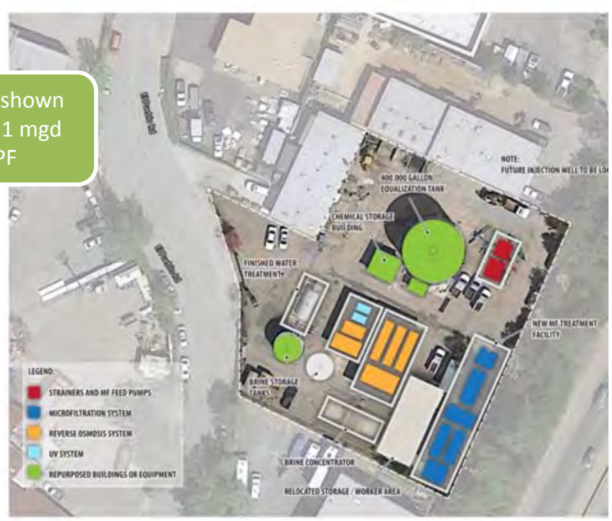
El Pueblo Treatment Site

Facilities shown are for a 1 mgd AWPF



SVWD Facilities Planning Report (K/J 2017)

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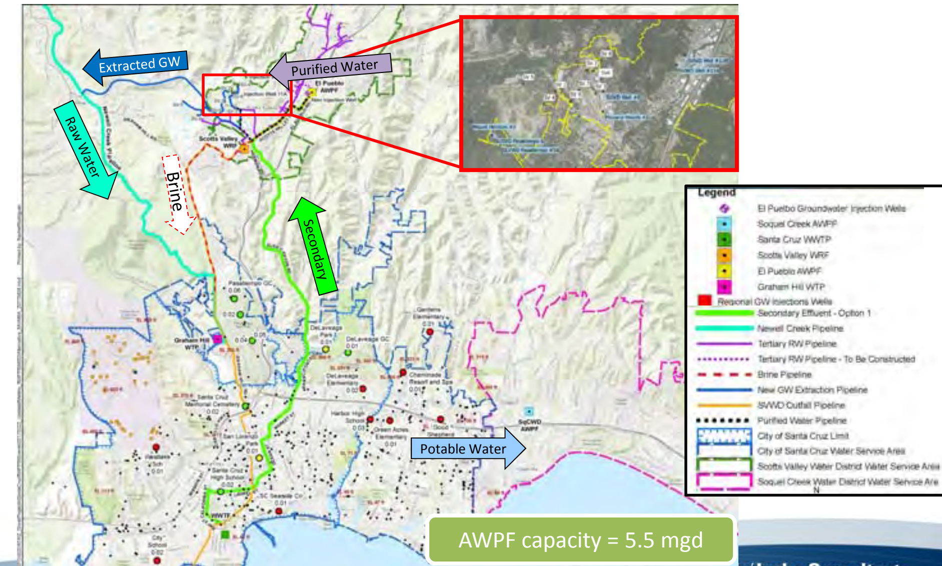
Alternative 8a: 4-Way Regional GRR Project

(to serve the City, Scotts Valley, Soquel Creek and San Lorenzo Valley)



AWPF capacity = 5.5 mgd

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Alternative 8a: 4-Way Regional GRR Project

(to serve the City, Scotts Valley, Soquel Creek and San Lorenzo Valley)

	Facilities
NPR Demand	0 MGD
City Demand	3.2 MGD AWT Product Water
SqCWD Demand	1.3 MGD AWT Product Water
SVWD Demand	1.0 MGD AWT Product Water Capacity (0.5 mgd ave annual)
Treatment Capacity	5.5 MGD
Pipelines	8.7 miles – 16” (secondary to El Pueblo) 6.7 miles – 16” (purified to injection and from extraction) 4.5 miles – 8” (brine to SVWD outfall at Pasatiempo)
Pump Stations	WWTP PS – 4,100 gpm, 2,300 HP GW PS from Production Wells to Newell Crk – 3,200 gpm, 800HP
New Wells	9 injection (+ 2 backup); 11 monitoring; 5 production
Customer Sites	0

For pipeline capacity, no peak hour factor applied.

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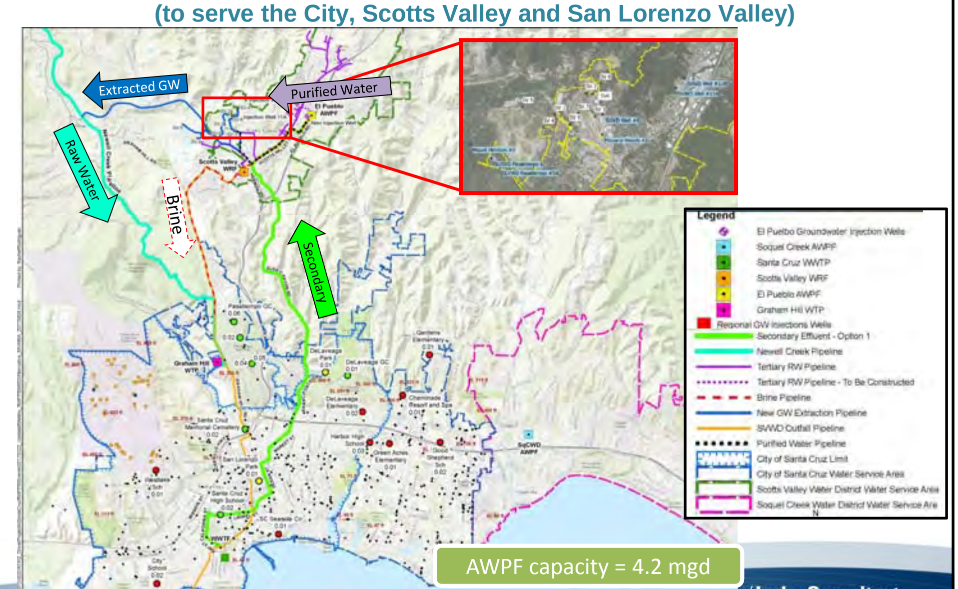
Alternative 8b: 3-Way Regional GRR Project

(to serve the City, Scotts Valley and San Lorenzo Valley)



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Alternative 8b: 3-Way Regional GRR Project

(to serve the City, Scotts Valley and San Lorenzo Valley)

	Facilities
NPR Demand	0 MGD
City Demand	3.2 MGD AWT Product Water
SqCWD Demand	0 MGD AWT Product Water
SVWD Demand	1.0 MGD AWT Product Water Capacity (0.5 mgd ave annual)
Treatment Capacity	4.2 MGD
Pipelines	8.7 miles – 18” (secondary to El Pueblo) 6.7 miles – 14” (purified to injection and from extraction) 4.5 miles – 6” (brine to SVWD outfall at Pasatiempo)
Pump Stations	WWTP PS – 2,900 gpm, 710 HP GW PS from Production Wells to Newell Crk – 2,300 gpm, 260HP No Brine PS at El Pueblo AWPF needed
New Wells	7 injection (+ 2 backup); 9 monitoring; 4 production
Customer Sites	0

For pipeline capacity, no peak hour factor applied.

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Alternative 8a and 8b

Item No.	Description	Qty	Units	Total Costs $/Unit	Total Capital Cost
Facility Capital Costs					
1.0	Treatment				20,974,852
1.1	Microfiltration	6.5	MGD	1,575,000	10,191,176
1.2	Reverse Osmosis	5.5	MGD	2,315,600	12,735,800
1.3	UV/AOP	5.5	MGD	87,500	481,250
1.4	Free Chlorine	5.5	MGD	402,500	2,213,750
1.5	Post Treatment and Chemical Handling	5.5	MGD	646,100	3,553,550
1.6	Building	5.5	MGD	1,250,000	6,875,000
1.7	Remove SqCWD's portion of treatment	1.30	MGD	(6,554,641)	(8,521,034)
1.8	Remove SVWD's portion of treatment	1.00	MGD	(6,554,641)	(6,554,641)

Proportional Cost Sharing

- ✓ Treatment
- ✓ Pipelines
- ✓ Pump Station
- ✓ Wells

Project Partner	FPR AWPF Alternative Costs ($mil)	Santa Cruz FPR AWPF Unit Cost ($mil)	Santa Cruz FPR AWPF Flow Based Cost ($mil)	Based on AWPF Capacity (mgd)
SqCWD	$6.9 - $8.8	$9.3	$8.5	1.3 mgd
SVWD	$6.9 - $7.6	$7.2	$6.6	1.0 mgd

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Alternative 8a and 8b

Item No.	Description	Qty	Units	Total Costs $/Unit	Total Capital Cost
2.0	Pipelines				18,058,441
2.1	Secondary Effluent Pipeline from SC WWTP to El Pueblo AWPF	45,792	LF	270	12,363,840
	Pipeline Constructability (Along Roads)			10%	1,236,384
	Microtunneling (Trenchless)	0	LF	700	0
	Major Intersections	0	LF	713	0
2.2	Purified Water Pipeline from El Pueblo AWPF to Regional GW Injection Wells	10,100	LF	240	2,424,000
	Pipeline Constructability (Along Roads)			10%	242,400
	Microtunneling (Trenchless)	0	LF	700	0
2.3	Extracted GW Pipeline from Regional GW Injection Wells to Existing Newell Creek Pipeline	25,533	LF	240	6,127,920
	Pipeline Constructability (Along Roads)			10%	612,792
	Microtunneling (Trenchless)	0	LF	700	0
	Major Intersections	0	LF	634	0
2.4	Brine pipeline from El Pueblo AWPF to SVWD outfall pipeline, at Pasatiempo Golfcourse	23,684	LF	112	2,652,608
	Pipeline Constructability (Along Roads)			10%	265,261
	Microtunneling (Trenchless)	0	LF	700	0
	Major Intersections	0	LF	317	0
2.5	Remove SqCWD's share of pipeline costs				
	Secondary + Purified + Extracted GW	1.30	MGD	(5,112,741)	(6,646,564)
	Drinking Water Pipeline				0
	Brine Pipeline	1.30	MGD	(530,521)	(689,678)
2.6	Remove SVWD's share of pipeline costs				
	Brine Pipeline	1.00	MGD	(530,521)	(530,521)

Proportional Cost Sharing

- ✓ Treatment
- ✓ Pipelines
- ✓ Pump Station
- ✓ Wells

Remove Flow Based Proportional Costs

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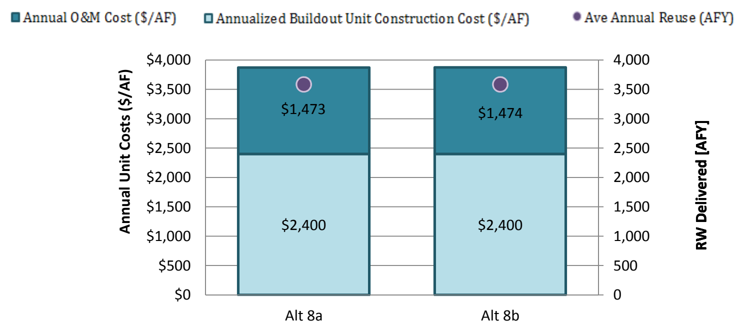
Alternative 8a and 8b



	4-way GRRP	3-way GRRP
SqCWD's Share ($mil)	$18.6	$0
SVWD's Share($mil)	$7.2	$7.2
Santa Cruz's Share ($mil)	**$150.6**	**$146.1**

SqCWD Proportional Cost Sharing includes: Treatment, Pipelines (2o, purified, GW and brine), Pump Stations, and Wells based on 1.3 mgd

SVWD Proportional Cost Sharing includes: Treatment and Brine based on 1.0 mgd

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Alt 8 – Regional GRR Project

Other Considerations

- Maximizes beneficial reuse of wastewater in the Region
- Operational complexity for treatment
- Significant energy for treatment and conveyance
- Level of cooperation and coordination required between multiple agencies
- Interagency infrastructure challenges (ownership, operations, construction, etc)
- Potential for cost-sharing and pursuing funding as a Region
- Water rights and transfer agreements
- Future studies needed

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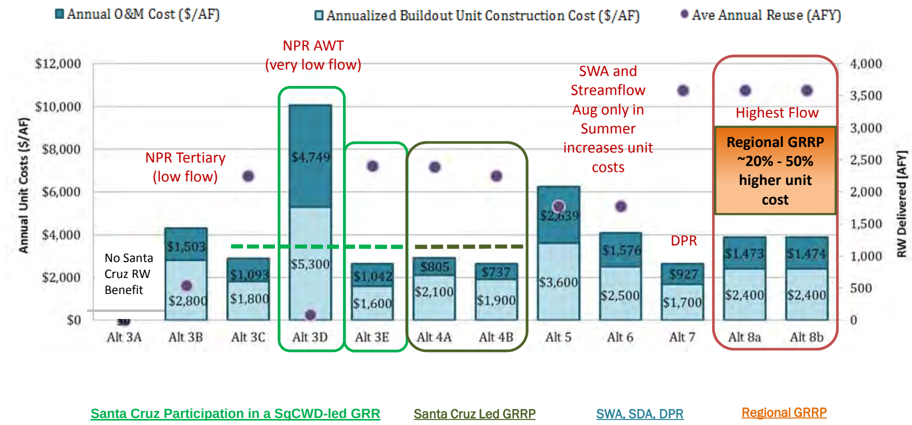
Alternative 8 Evaluation
Preliminary Summary of Eng Opinion of Probable Costs



Capital Cost ($mil)	Not incl ~~$20~~	$25.9	$68.6	$7.6	$60.5	$85.1	$74.0	$111.2	$77.7	$107.6	$150.2	$146.1

Preliminary capital & annualized costs

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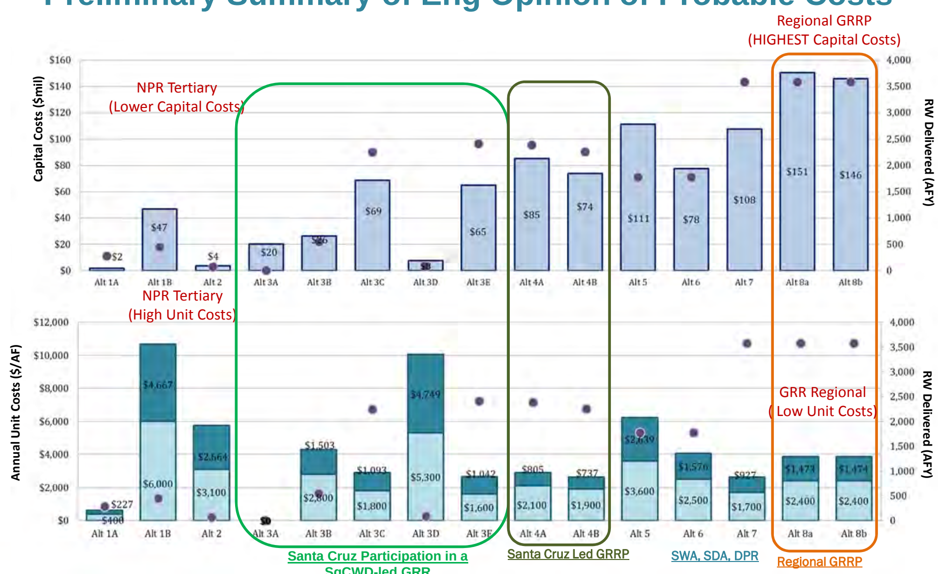
Comparison of Alternatives 1 to 8 Evaluation
Preliminary Summary of Eng Opinion of Probable Costs



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NPR Alternatives Evaluation
Summary of QUANTITATIVE Results

Alternative		Sub Alt	Description	Treatment Level	Recycled Water Delivered: Regional Ave Annual Reuse (AFY)	Regional Average Annual Flow (MGD)	RW Use in Santa Cruz (AFY)	RW Use in Santa Cruz (MGD)	Peak Season Deliveries (AF in Summer - June)	Peak Hourly Flow (MGD)	Estimated Costs: Estimated Construction Cost ($mil)	Annual O&M Cost ($mil/yr)	Total Annual Cost ($/AF)	Energy / Others: Unit Energy of RW Delivered (KWH/AF)	Est O&M GHG Emissions (MTCO2/yr)	Total Pipeline Length (ft)	Total Pipeline Length (miles)	Pipeline GHG Emissions (MTCO2)	# of Non-Pipeline Facility Sites (#)	Est Non-Pipeline Footprint (SF)
Non Potable Reuse	Alternative 1 – Centralized Non-Potable Reuse	Alt 1A	Santa Cruz PWD Phase 2 Project	3°	282	0.25	282	0.25	44	1.4	$2	$0.1	$627	733	39	2,429	0	0.93	2	2,100
		Alt 1B	Maximize tertiary treatment at the SC WWTF	3°	807	0.72	807	0.72	126	4.0	$47	$2.1	$49,421	12,104	1,867	89,466	17	34	4	4,600
			Phase 1		340	0.30	340	0.30	44	1.4	$20	$1.2	$40,124	8,219	534	16,103	3	6	1	1,533
			Phase 2		176	0.16	176	0.16	51	1.7	$6	$0.2	$2,819	76	3	19,934	4	8	0	1,533
			Phase 3		146	0.13	146	0.13	42	1.4	$15	$0.6	$4,210	3,746	104	30,749	6	12	1	1,533
			Phase 4		146	0.13	146	0.13	42	1.4	$6	$0.2	$2,268	63	2	22,680	4	9	1	1,533
	Alternative 2 – Decentralized Non-Potable Reuse	Alt 2	UC Santa Cruz	3°	71	0.06	71	0.06	20	0.2	$4	$0.2	$5,764	1,040	14	10,160	2	4	3	4,920
SqCWD Led GRRP	Alternative 3 – Santa Cruz Participation in SqCWD led GRRP	Alt 3A	Send secondary effluent from SCWWTF to SqCWD for injection in SqCWD basin (DO NOT serve NPR users along the way)	2° + filter	1,903	1.70	0.00	0.00	297	3.2	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
		Alt 3B	Send tertiary effluent from SCWWTF to SqCWD (serve NPR users along the way)	3°	2,448	2.19	545	0.49	417	4.5	$26	$0.8	$4,303	1,367	142	52,601	10	20	5	3,520
		Alt 3C	Send additional secondary effluent from SCWWTF to SqCWD AWTF (DO NOT serve NPR users along the way) and deliver purified water from SqCWD AWTF to recharge Santa Cruz GWRR (serve NPR users along the way back)	AWT	3,704	3.31	2,248	2.01	577	6.2	$69	$2.5	$2,893	1,991	855	66,921	13	26	17	17,100
		Alt 3D	Send advanced treated RW from SCWWTF to SqCWD, (serve NPR users along the way)	AWT	1,538	1.37	82	0.07	295	9.5	$8	$0.4	$10,049	2,507	39	59,004	11	23	3	440
		Alt 3E	Send advanced treated RW from SCWWTF to SqCWD, (GWRR and NPR along the way)	AWT	3,866	3.45	2,410	2.15	602	6.5	$65	$3	$2,642	2,073	954	60,477	11	23	16	16,000
City Led GRRP	Alternative 4 – Santa Cruz GRRP	Alt 4A	Santa Cruz GWRR with AWTF at SC WWTF (Serve NPR users along the way)	AWT	2,389	2.13	2,389	2.13	372	4.0	$85	$2	$2,905	1,370	625	45,421	9	17	14	14,680
		Alt 4B	Santa Cruz GWRR with MBR + AWTF at DA Porath PS (Serve NPR users along the way)	AWT	2,254	2.01	2,254	2.01	351	3.8	$74	$2	$2,637	1,260	543	14,096	3	5	13	13,510
SWA	Alternative 5 – Surface Water Augmentation (SWA) in Loch Lomond Reservoir	Alt 5	Advanced treatment of Santa Cruz effluent for bending in Loch Lomond Reservoir (DO NOT serve NPR users along the way)	AWT	1,777	3.20	1,777	3.20	559	6.0	$111	$5	$6,239	8,365	2,839	67,993	13	26	3	19,300
Stream Aug	Alternative 6 – Streamflow Augmentation	Alt 6	AWTF of secondary effluent with discharge to the San Lorenzo River d/s of Tait Street Diversion (DO NOT serve NPR users along the way)	AWT	1,777	3.20	1,777	3.20	559	6.0	$78	$3	$4,076	2,682	910	13,482	3	5	3	19,300
DPR	Alternative 7 – Direct Potable Reuse	Alt 7	Raw Water Blending at Graham Hill WTP (via Coast PS)	AWT	3,584	3.20	3,584	3.20	559	6.0	$108	$3	$2,627	2,121	1,452	3	6	12	6	136,800
Regional GRR	Alternative 8 – Regional GWRR Project	Alt 8a	Regional GRRP to serve the City, Scotts Valley, Soquel Creek and San Lorenzo Valley	AWT	5,600	5.00	3,584	3.20	559	6.0	108	5	3,873	2,799	1,916	105,109	20	40	31	25,900
		Alt 8b	Regional GRRP to serve the City, Scotts Valley and San Lorenzo Valley	AWT	4,144	3.70	3,584	3.20	559	6.0	146	5	3,874	3,584	2,453	105,109	20	40	26	24,500

The Quantitative Results will be used to inform the Qualitative Metrics for Screening, Scoring and Ranking Alternative Projects

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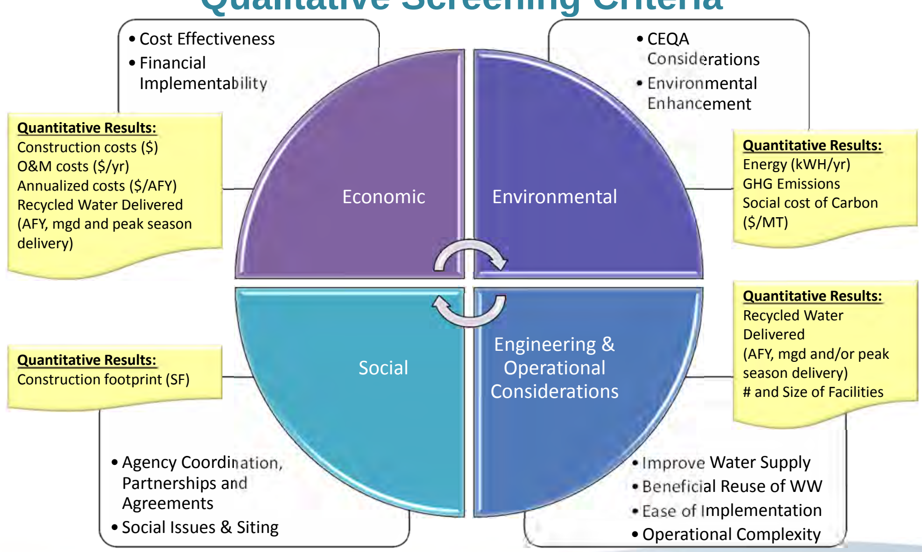
Quantitative Results and Qualitative Screening Criteria



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Scoring, Weighting & Ranking Approach

- Alternative projects will be **scored** from 1 to 5 for each criteria
  - ✓ Score = 5 Fully Meets Criteria
  - ✓ Score = 4 Mostly Meets Criteria
  - ✓ Score = 3 Partially Meets Criteria
  - ✓ Score = 2 Somewhat Meets Criteria
  - ✓ Score = 1 Unable to Meet Criteria
- Scores will be **weighted** to provide a preliminary ranking of alternative projects
  - ✓ Weighting for Screening Criteria provided by SCWD and SCPWD
  - ✓ SCWD and SCPWD to provide input on initial scoring
  - ✓ Initial scores to be sent out prior to the next workshop
- Sensitivity Analysis will be performed to explore how **ranking** changes with different weightings

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Categories	Screening Criteria	Considerations for Assessing Project based on Criteria
ENGINEERING & OPERATIONAL CONSIDERATIONS	Improve Water Supply	- Ability to fill City supply gap (1.2 BGY or 3,700 AFY), supplement peak season supply with a new source or offset and/or contribute to regional supply - Ability to implement Project, with supplies available in a timely manner
	Maximize Beneficial Reuse	- Maximizes reuse of wastewater effluent - Does not limit future options at the WWTF to fully utilize wastewater effluent
	Ease of Implementation	- Regulatory viability and ability to obtain a recycled water permit - Current (DDW and RWQCB) regulatory pathway/approved use - Potential construction challenges (#/size of facilities, ROW, utilities, terrain, disturbed/undisturbed area, seismic/sea level rise vulnerability, etc.) - Flexibility for phasing and opportunities to expand/transition to a higher yield and/or treatment level.
	Operational Complexity	- Source of wastewater and/or type of treatment required for beneficial reuse minimizes impacts to wastewater collections and/or WWTF operations - Siting new treatment facilities minimizes short-term impacts on SC WWTF operations (during construction) and long-term impacts (related to facility relocation, off-site location and/or interference with O&M activities)
ECONOMIC	Cost Effectiveness	- Economically feasible or cost effective project (relative life cycle unit costs)
	Financial Implementability	- Financially implementable project (capital investment does not limit ability to implement other water projects and program)
ENVIRONMENTAL	CEQA Considerations	- Potential environmental impacts and mitigation requirements
	Environmental Enhancement	- Enhance local and regional ecosystems and environments including rivers, groundwater basins - Social cost of carbon compared to other projects and supplies; Relative contribution to climate change (based on GHG emissions)
SOCIAL	Agency Coordination, Partnerships and Agreements	- Level of cooperation and coordination required between multiple outside agencies/users - Willingness and interest of anticipated users/partners for cost-sharing
	Social Issues & Siting	- Perceived public acceptance and comfort with level of public health and safety associated with reuse - Level of impact on local residents for new construction and ongoing maintenance - Land acquisition requirements (property not currently owned by the City)

Input on Approach for Scoring

- Solicit SqCWD experience with criteria being scrutinized
- Discuss public perception of scoring by project team
- How to address **Social Issues & Siting** category
  - Perceived public acceptance and comfort with level of public health and safety associated with reuse
  - Level of impact on local residents for new construction and ongoing maintenance
  - Land acquisition requirements (property not currently owned by the City)

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Sensitivity Analysis

- Use of sensitivity analysis to address variation in different perceptive by artificially increasing weighting for certain categories
- Discuss Weighting Scenarios such as …
  - ✓ Maximize Water Supply & Beneficial Reuse
  - ✓ Minimize Costs
  - ✓ Minimize Implementation Challenges & Minimize Operational Complexity
  - ✓ Maximize Environmental Benefits and Minimize Environmental Impacts
  - ✓ Strive for a Regional Solution

RANKING for Sensitivity Analysis

Project Partner Weighting	Maximize Water Supply & Beneficial Use	Minimize Implementation Challenges & Operational Complexity	Strive for a Regional Solution
SENSITIVITY RANKING			
1	2	3	6
2	1	4	1
8	5	7	2
6	7	2	3
5	8	1	4
3	3	5	5
4	4	6	7
7	5	8	8

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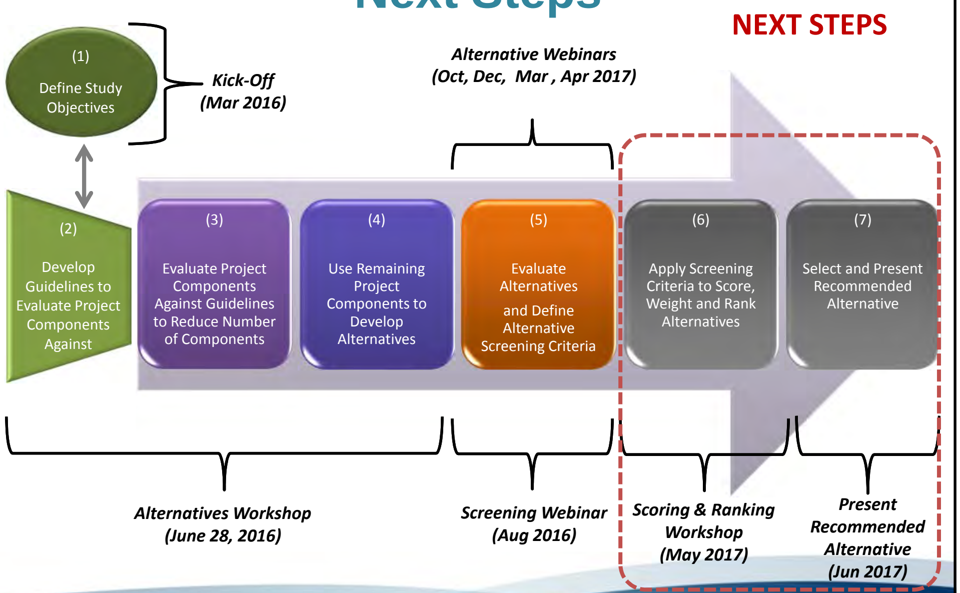
Next Steps



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QUESTIONS

Speakers:

Dawn Taffler DawnTaffler@KennedyJenks.com
Brian Pecson brianp@trusselltech.com
Eddy Teasdale EddyTeasdale@KennedyJenks.com
Melanie Tan MelanieTan@KennedyJenks.com

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Santa Cruz Regional
Recycled Water Facilities Planning Study (RWFPS)

Scoring and Ranking Workshop
1 June 2017 from 10 am – 12:30 pm

Location: 809 Center Street California Street Santa Cruz 95060
Public Work Conference Room (aka Temp in Finance Room 100)
Conf Call - (855) 813-2486 Code – 2484
Desktop Sharing - http://conf.kennedyjenks.com/conference/2484

AGENDA

Overall Workshop Objective: Review alternatives, discuss prelimiminary scoring and ranking, obtain consensus on recommended alternative (or Phased Projects) for further development.

PART I: Overview of Alternatives and Screening Approach **10:00 am to 10:45 am**

1. High Level Review of Alternatives (maps, facilities and costs) (K/J)
2. Review of Screening Criteria & Guidance (K/J)
3. Approach to Scoring, Weighting and Ranking (adjustments made to Criteria) (K/J)

PART II: Discuss Preliminary Results and Solicit Input **10:45 am to 12:30 pm**

4. Discuss Outcome of Sensitivity Analysis (K/J)
    a. Projects that consistently rose to the top and why
    b. Projects that fell to the bottom and why
    c. Criteria most influenced by weighting

5. Finalizing RWFPS (City/All)
    a. Putting sensitivity analysis into perspective when selecting project
    b. Discuss and select what projects will be evaluated in Financial Analysis Phase 1.
    c. Discuss how project alternative section will frame the next steps with regard to further financial analysis, potential to phase projects, potential for other (not selected) projects to be part of a water supply portfolio

6. Next Steps Beyond the RWFPS (City/All)
    a. Parallel projects pursued by different departments/regional entities
    b. Near-term vs Long-term pursuits
    c. Nexus with WSAC Work (Phase 2 work for Corona and Raftelis is creating water supply portfolio(s))

City of Santa Cruz
Recycled Water Facilities Planning Study

Scoring and Ranking Workshop
June 1, 2017

Meeting Location: 809 Center Street California Street
Santa Cruz 95060
Conf Call: *(855) 813-2486 Code – 2484*
Desktop Sharing: http://conf.kennedyjenks.com/conference/2484

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Agenda

- **Today's Workshop**
- **PART I: Overview of Alternatives and Screening Approach**
- **PART II: Discuss Preliminary Results and Solicit Input**

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Today's Workshop

- **Objective:** Present an overview of alternatives, discuss preliminary scoring and ranking and identify recommended alternative for further development.
- **Goal:** Obtain consensus on recommended alternative (or Phased Projects) for further development.

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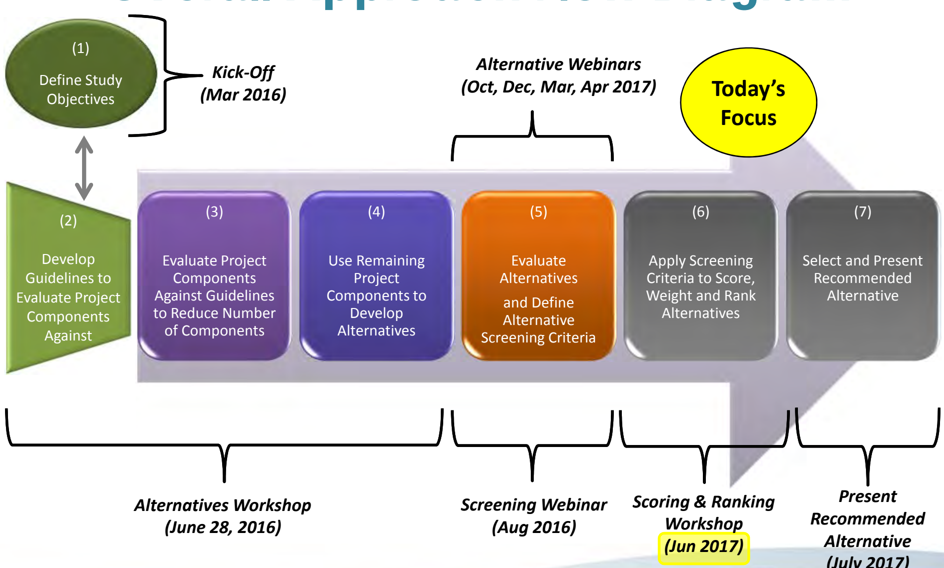
Overall Approach Flow Diagram



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PART I: Overview of Alternatives and Screening Approach

1. High Level Review of Alternatives
2. Review of Screening Criteria & Guidance
3. Approach to Scoring, Weighting and Ranking

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1. High Level Review of Alternatives

NPR
- Alternative 1 – Centralized Non-Potable Reuse
- Alternative 2 – Decentralized Non-Potable Reuse

IPR
- Alternative 3 – Santa Cruz Participation in SqCWD-led GRR Project
- Alternative 4 – Santa Cruz GRR Project
- Alternative 5 – Surface Water Augmentation (SWA) in Loch Lomond Reservoir
- Alternative 6 – Streamflow Augmentation

DPR
- Alternative 7 – Direct Potable Reuse

IPR
- Alternative 8 – Regional GRR Project

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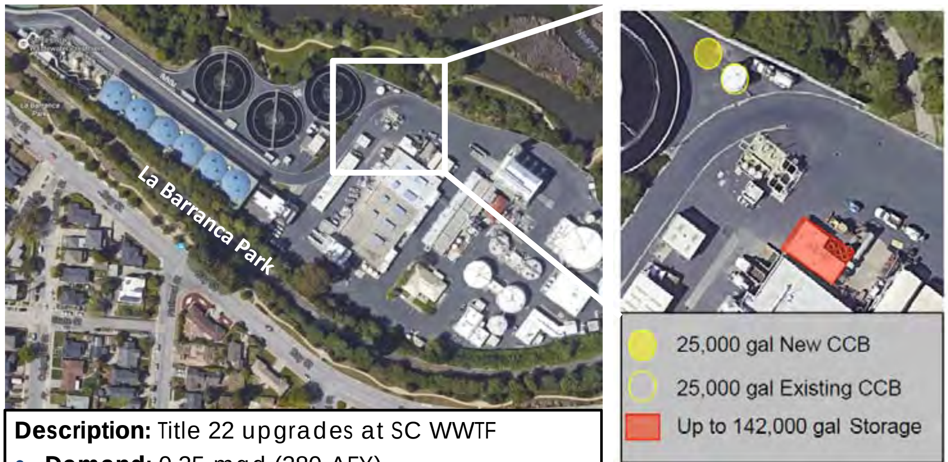
Alt 1 - Centralized Non-Potable Reuse

Alt 1a – PWD Title 22 Upgrade



Description: Title 22 upgrades at SC WWTF

- **Demand:** 0.25 mgd (280 AFY)
- **Use:** NPR In-plant, truck fill & La Barranca Park
- **Major Facilities:** at SC WWT

CCB = Chlorine Contact Basin

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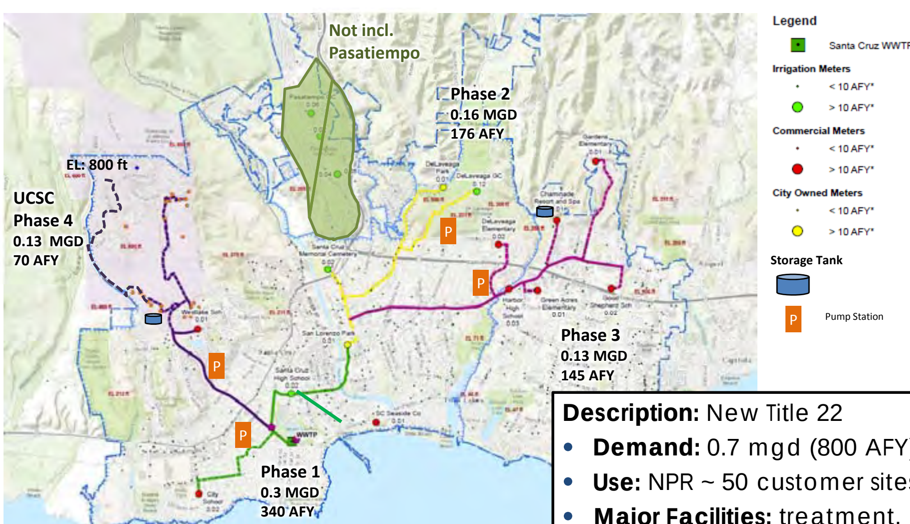
Alt 1 - Centralized Non-Potable Reuse

Alt 1b – Maximize Tertiary Treatment

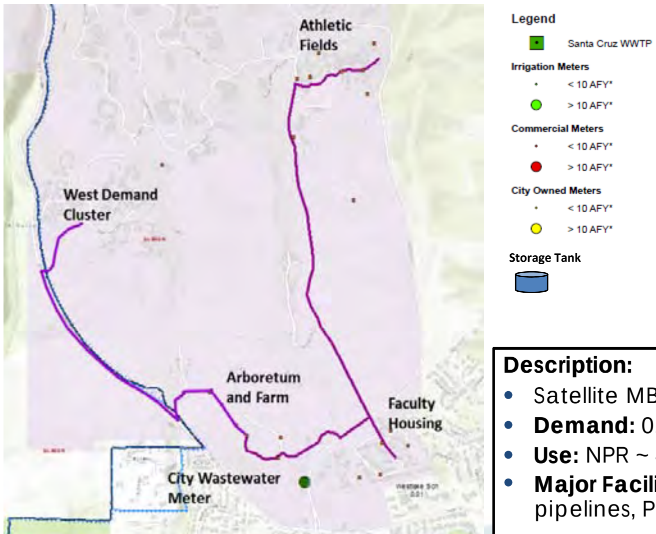


Description: New Title 22

- **Demand:** 0.7 mgd (800 AFY)
- **Use:** NPR ~ 50 customer sites
- **Major Facilities:** treatment, pipelines, PS, storage

Alt 2 - Decentralized Non-Potable Reuse

UC Santa Cruz



Description:
- Satellite MBR at UCSC
- **Demand:** 0.12 mgd (140 AFY)
- **Use:** NPR ~ 42 customer sites
- **Major Facilities:** treatment, pipelines, PS, storage

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Alt 3 - Santa Cruz Participation in a SqCWD-led GWRR

- **AWTF @ SqCWD Headquarters** **(3 Sub-alternatives)**
  - Alt 3a - Send secondary effluent from SCWWTF to SqCWD for injection in SqCWD basin
  - Alt 3b - Send tertiary effluent from SCWWTF to SqCWD
  - Alt 3c - Send additional secondary effluent from SCWWTF to SqCWD AWTF and deliver purified water from SqCWD AWTF
- **AWTF @ Santa Cruz WWTF** **(2 Sub-alternatives)**
  - Alt 3d - Send advanced treated RW from SCWWTF to SqCWD
  - Alt 3e - Send advanced treated RW from SCWWTF to SqCWD,

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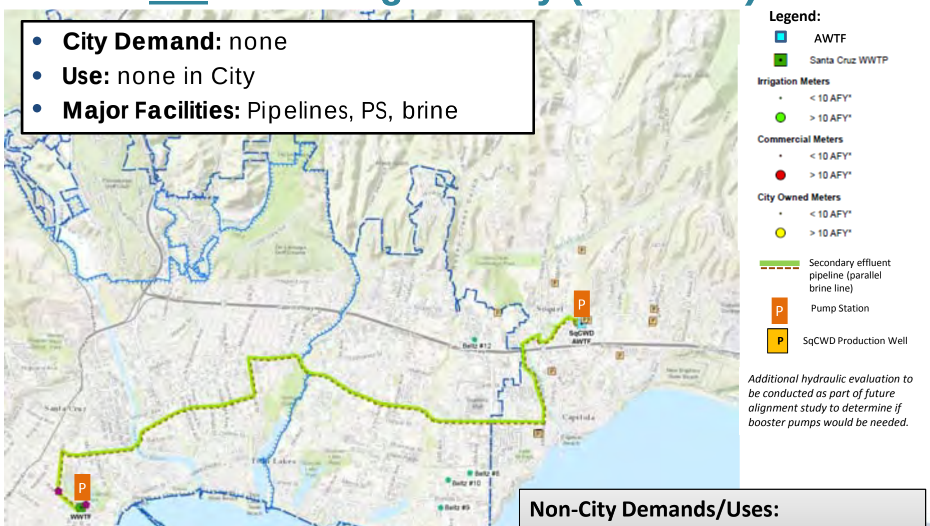
Alternative 3a: Secondary Effluent to SqCWD + NO NPR along the way (BASELINE)

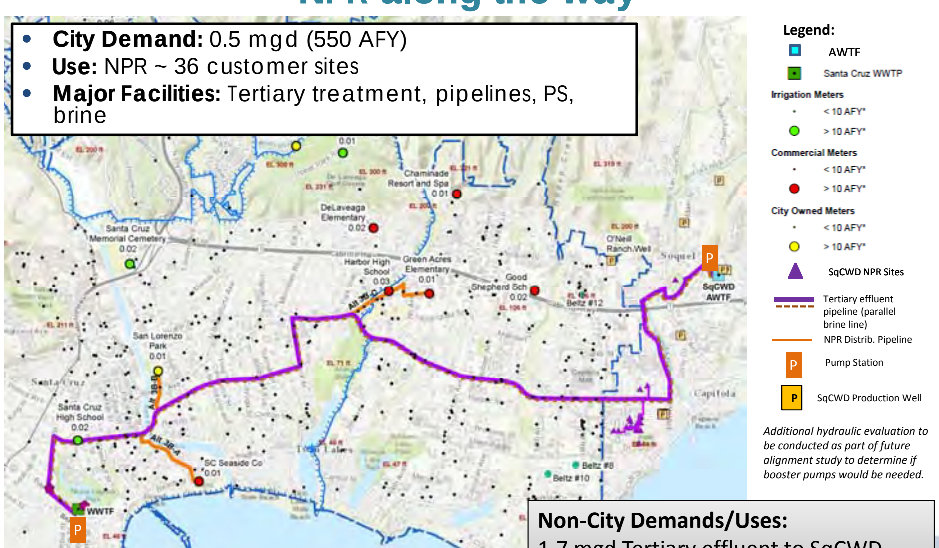
- **City Demand:** none
- **Use:** none in City
- **Major Facilities:** Pipelines, PS, brine



Non-City Demands/Uses:
1.7 mgd Secondary effluent to SqCWD (for a 1.3 MGD GRRP)

Alternative 3b: Tertiary Effluent to SqCWD + NPR along the way

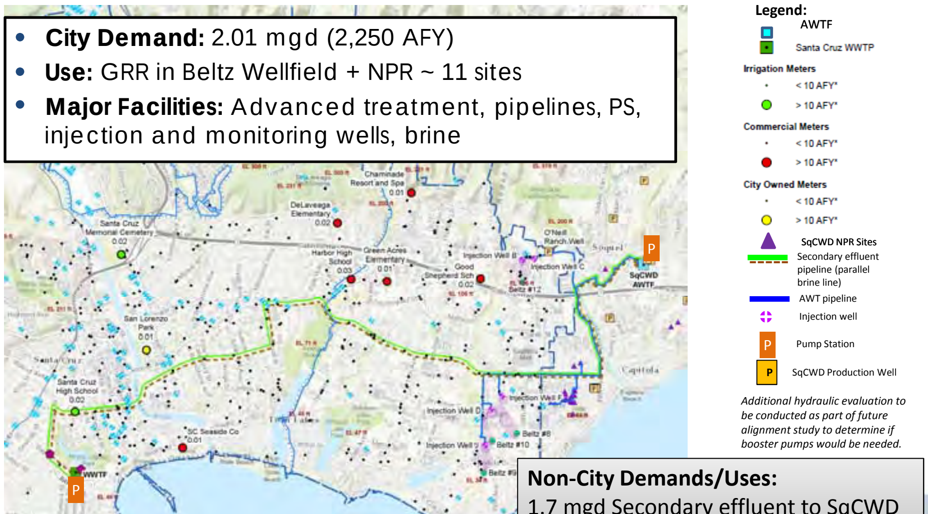
- **City Demand:** 0.5 mgd (550 AFY)
- **Use:** NPR ~ 36 customer sites
- **Major Facilities:** Tertiary treatment, pipelines, PS, brine



Non-City Demands/Uses:
1.7 mgd Tertiary effluent to SqCWD
0.005 mgd SqCWD NPR along the way

Alternative 3c: Secondary Effluent to SqCWD AWPF + Purified Water for NPR + GRR in the City

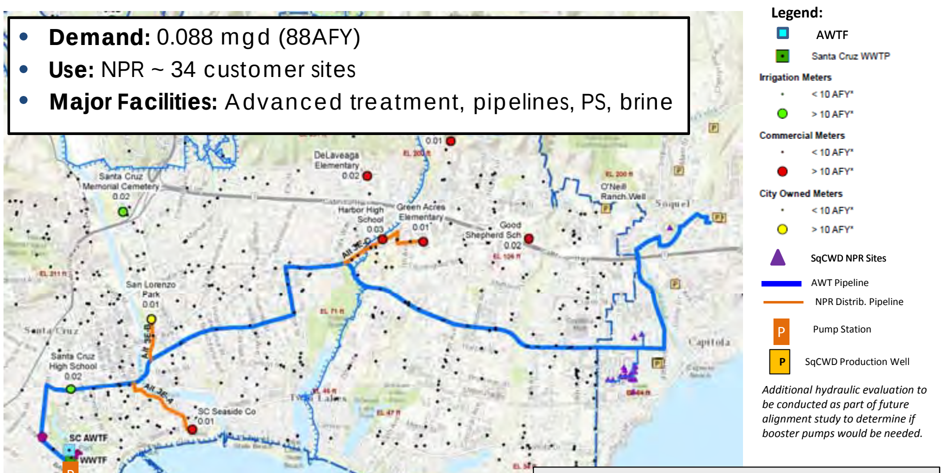
- **City Demand:** 2.01 mgd (2,250 AFY)
- **Use:** GRR in Beltz Wellfield + NPR ~ 11 sites
- **Major Facilities:** Advanced treatment, pipelines, PS, injection and monitoring wells, brine



Non-City Demands/Uses:
1.7 mgd Secondary effluent to SqCWD
0.005 mgd SqCWD NPR along the way

Alternative 3d: Advanced treated RW to SqCWD + NPR along the way

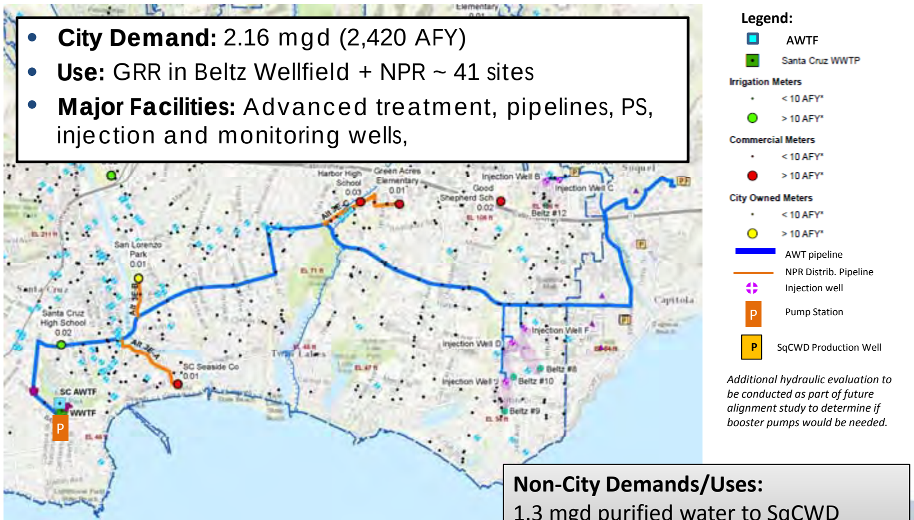
- **Demand:** 0.088 mgd (88AFY)
- **Use:** NPR ~ 34 customer sites
- **Major Facilities:** Advanced treatment, pipelines, PS, brine



Non-City Demands/Uses:
1.3 mgd purified water to SqCWD
0.005 mgd SqCWD NPR along the way

Alternative 3e: AWPF @ SC WWTF, use purified water for NPR + GRR in the City + SqCWD GRR

- **City Demand:** 2.16 mgd (2,420 AFY)
- **Use:** GRR in Beltz Wellfield + NPR ~ 41 sites
- **Major Facilities:** Advanced treatment, pipelines, PS, injection and monitoring wells,



Non-City Demands/Uses:
1.3 mgd purified water to SqCWD
0.005 mgd SqCWD NPR along the way

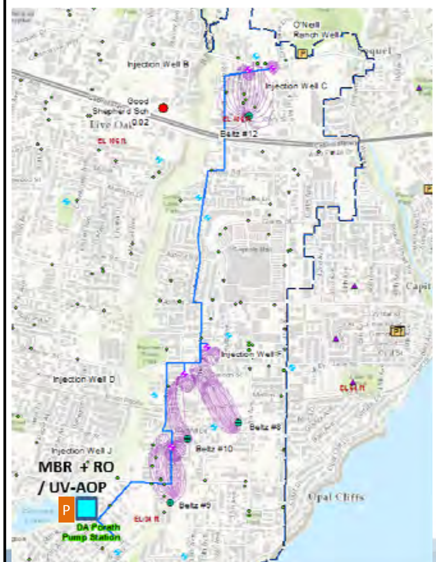
Alt 4 - Santa Cruz GRRP

Alt 4a – Santa Cruz Centralized GRRP

- **Description:** independent GRRP in Purisma (Beltz Wellfield area)
- **Project Size:** 2.13 mgd (2,400 AFY)
- **Uses:** GRR in Beltz Wellfield + NPR ~37 customers sites
- **Major Facilities:** AWTF, pipelines, PS, injection and monitoring wells, brine discharge

Alt 4 - Santa Cruz GRRP

Alt 4b - Santa Cruz Decentralized GRRP



Legend:
- AWTF
- Santa Cruz WWTP

Irrigation Meters
- < 10 AFY*
- > 10 AFY*

Commercial Meters
- < 10 AFY*
- > 10 AFY*

City Owned Meters
- < 10 AFY*
- > 10 AFY*

- AWT pipeline
- Injection well
- Pump Station
- SqCWD Production Well

Additional hydraulic evaluation to be conducted as part of future alignment study to determine if booster pumps would be needed.

- **Description:** independent GRRP in Purisma (Beltz Wellfield area)
- **Demand:** 2.01 mgd (2,250 AFY)
- **Uses:** GRR + NPR ~ 11 customers sites
- **Major Facilities:** MBR/AWTF, pipelines, PS, injection and monitoring wells, brine discharge

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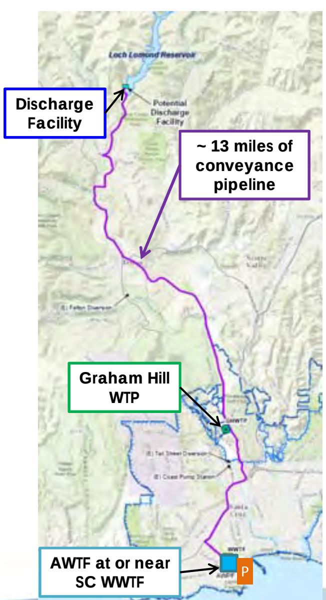
Alt 5 - Surface Water Augmentation (SWA)

Loch Lomond Reservoir



- **Description:** Augment Loch Lomond in summer months with purified water
- **AWTF:** 3.2 mgd production capacity
- **Annual Reuse:** 1.6 mgd (1,800 AFY)
- **Uses:** SWA
- **Major Facilities:** AWTF, pipelines, PS, discharge facility at reservoir, brine discharge

- AWT pipeline
- Pump Station
- AWTF
- Drinking Water Treatment Plant

Additional hydraulic evaluation to be conducted as part of future alignment study to determine if booster pumps would be needed.

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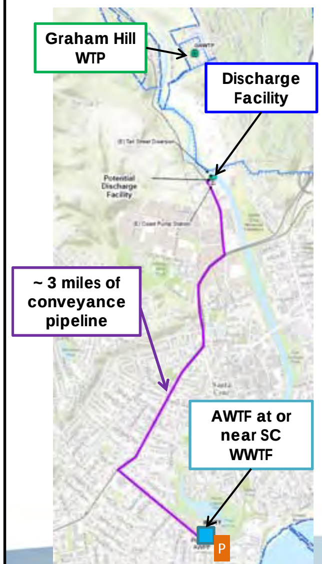
Alt 6 - Streamflow Augmentation

Direct Discharge to San Lorenzo River



- **Description:** Augment San Lorenzo River d/s of Tait Street Diversion in summer months with purified water
- **AWTF:** 3.2 mgd production capacity
- **Annual Reuse:** 1.6 mgd (1,800 AFY)
- **Uses:** Streamflow Augmentation
- **Major Facilities:** AWTF, pipelines, PS, discharge facility, brine discharge

AWT pipeline
P Pump Station
AWTF
Drinking Water Treatment Plant

Additional hydraulic evaluation to be conducted as part of future alignment study to determine if booster pumps would be needed.

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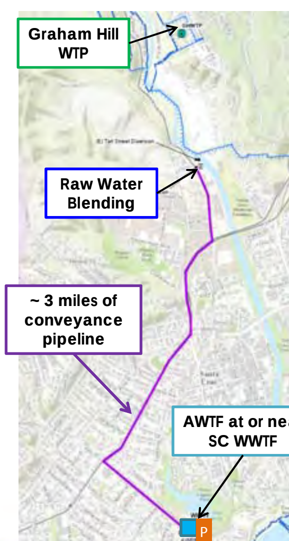
Alt 7 – Direct Potable Reuse

Raw Water Blending at Graham Hill WTP



- **Description:** Blend purified water with raw water coming from city's other flowing sources for further treatment at the GHWTP prior to distribution as finished water
- **AWTF:** 3.2 mgd production capacity
- **Annual Reuse:** 3.2mgd (3,600 AFY)
- **Uses:** Augment potable supplies
- **Major Facilities:** AWTF, pipelines, PS, brine discharge

AWT pipeline
P Pump Station
AWTF
Drinking Water Treatment Plant

Additional hydraulic evaluation to be conducted as part of future alignment study to determine if booster pumps would be needed.

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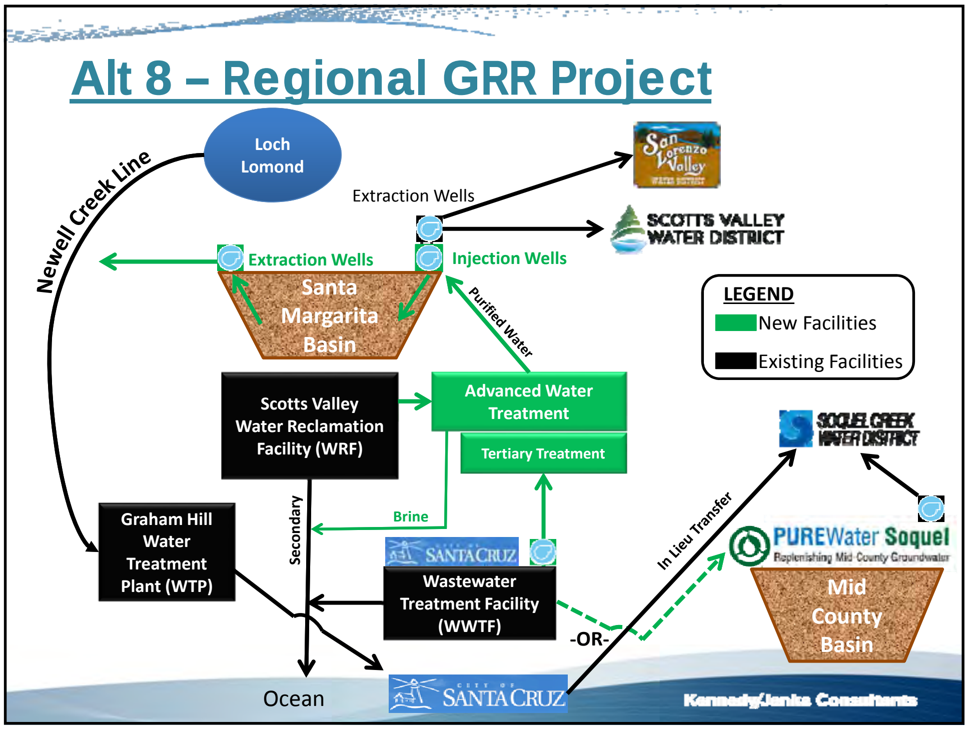
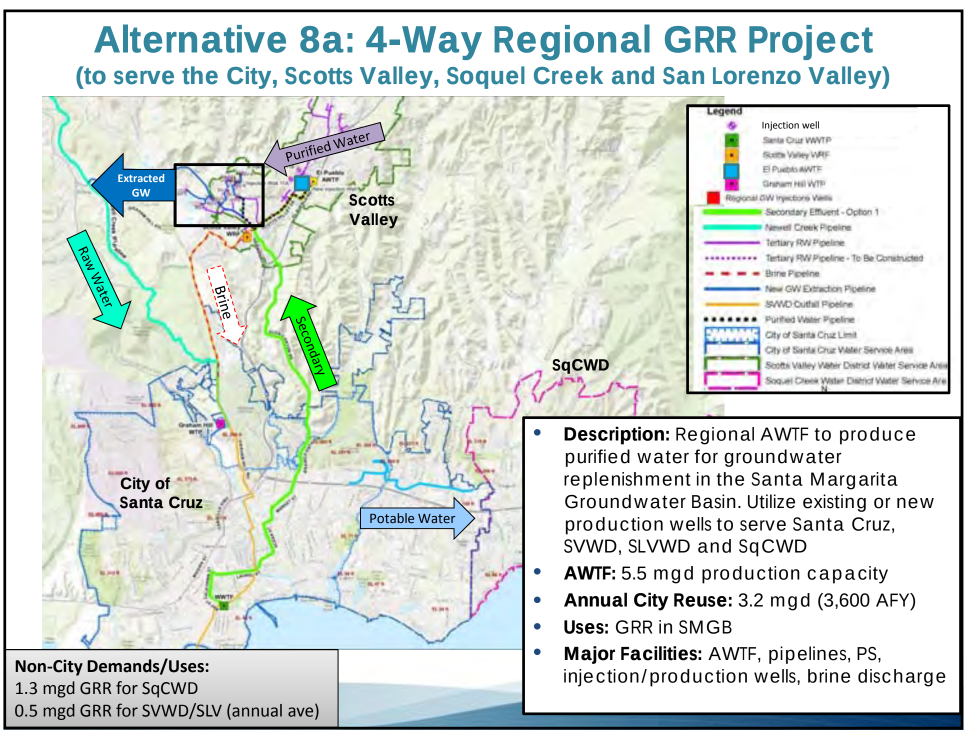
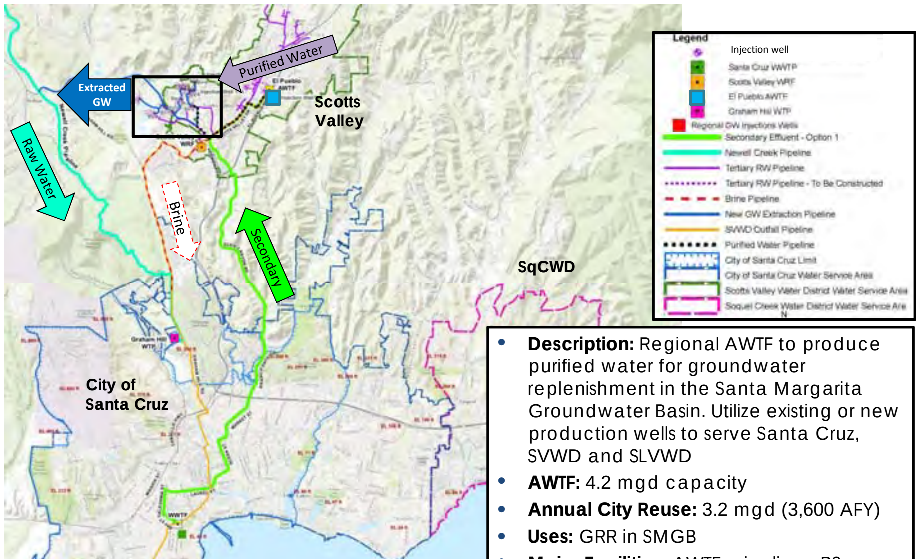

Alt 8 – Regional GRR Project
Loch Lomond
Newell Creek Line
Extraction Wells
SCOTTS VALLEY WATER DISTRICT
Extraction Wells
Injection Wells
Santa Margarita Basin
Purified Water
LEGEND
New Facilities
Existing Facilities
Scotts Valley Water Reclamation Facility (WRF)
Advanced Water Treatment
Tertiary Treatment
SOQUEL CREEK WATER DISTRICT
In Lieu Transfer
Brine
Secondary
Graham Hill Water Treatment Plant (WTP)
PUREWater Soquel
Replenishing Mid-County Groundwater
Wastewater Treatment Facility (WWTF)
Mid County Basin
-OR-
Ocean
SANTA CRUZ
Kennedy/Jenks Consultants


Alternative 8a: 4-Way Regional GRR Project
(to serve the City, Scotts Valley, Soquel Creek and San Lorenzo Valley)
Purified Water
Extracted GW
Scotts Valley
Raw Water
Brine
Secondary
SqCWD
City of Santa Cruz
Potable Water
Legend
Injection well
Non-City Demands/Uses:
1.3 mgd GRR for SqCWD
0.5 mgd GRR for SVWD/SLV (annual ave)
Description: Regional AWTF to produce purified water for groundwater replenishment in the Santa Margarita Groundwater Basin. Utilize existing or new production wells to serve Santa Cruz, SVWD, SLVWD and SqCWD
AWTF: 5.5 mgd production capacity
Annual City Reuse: 3.2 mgd (3,600 AFY)
Uses: GRR in SMGB
Major Facilities: AWTF, pipelines, PS, injection/production wells, brine discharge

Alternative 8b: 3-Way Regional GRR Project

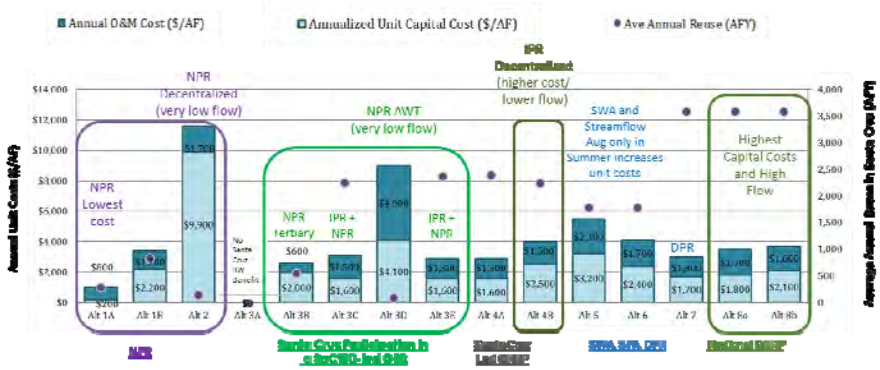
(to serve the City, Scotts Valley and San Lorenzo Valley)



- **Description:** Regional AWTF to produce purified water for groundwater replenishment in the Santa Margarita Groundwater Basin. Utilize existing or new production wells to serve Santa Cruz, SVWD and SLVWD
- **AWTF:** 4.2 mgd capacity
- **Annual City Reuse:** 3.2 mgd (3,600 AFY)
- **Uses:** GRR in SMGB
- **Major Facilities:** AWTF, pipelines, PS, injection/production wells, brine discharge

Non-City Demands/Uses:
0.5 mgd GRR for SVWD/SLV (annual ave)

Summary of Engineers Opinion of Probable Costs



Capital Cost ($mil)	$1	$36	$25	Not incl	$20	$69	$7	$70	$71	$100	$107	$75	$111	$124	$141

Notes: The stacked bars represent the life cycle unit cost for each project (left y-axis).
The purple dots represent the average annual reuse in SCWD's service area.
All costs represent City facilities or the City's proportional share of regional facilities based on flow.

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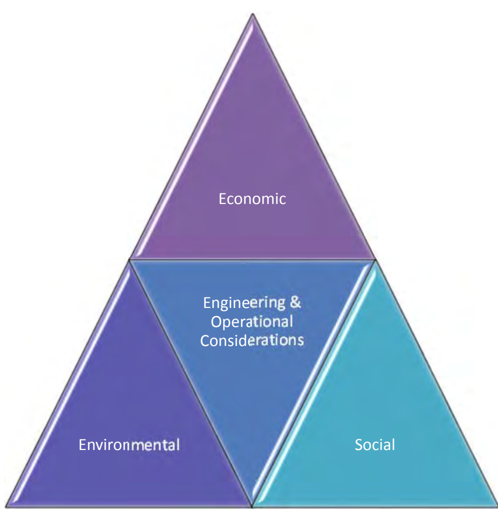
2. Review of Screening Criteria & Guidance

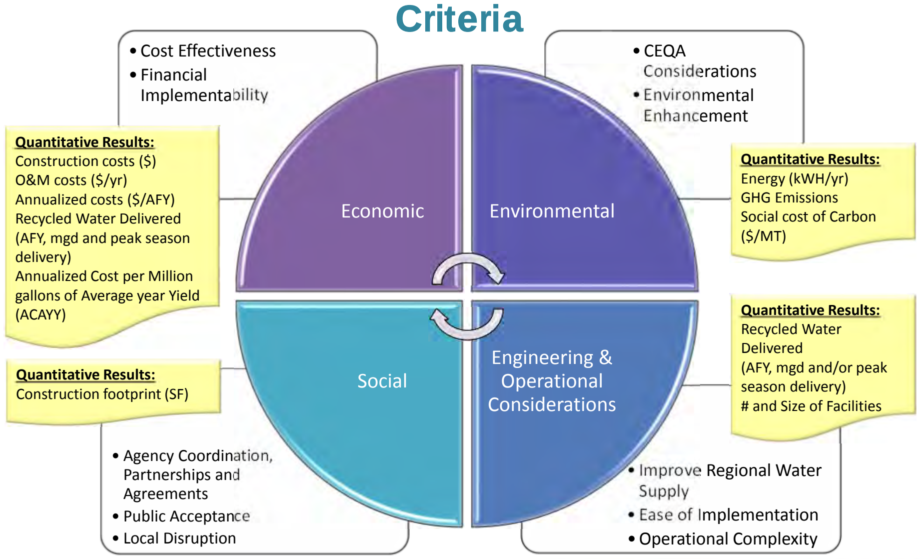
- Screening Categories
- Quantitative Results from Alternative Evaluation
- Guidance for Qualitative Screening Criteria

Screening Categories



- Four categories to compare alternatives
- Triple Bottom Line (TBL) approach
- Integrates engineering and operational considerations

Quantitative Results and Qualitative Screening Criteria



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QUANTITATIVE Results from Alternatives Evaluation

Recycled Water Delivered:	Costs:	Energy / Other:
Annual Volume (AFY)	Construction Costs ($)	Energy (kWH/AF) of RW Delivered
Average Annual Flow (mgd)	O&M Costs ($/yr)	GHG emissions (MT of CO_2e per year)
Peak Season Deliveries (AF Summer)	Life Cycle Costs ($/AFY)	Social Cost of Carbon ($/MT)
Peak Flow (mgd)	Annualized Cost per Million gallons of Average year Yield (ACAYY)	Construction Footprint (SF)
Average year Yield (MG)		# and Size of Facilities

QUANTITATIVE results were provided for each alternative (Alt Webinars Part 1-4) and used to inform qualitative scoring

AF = acre-feet
AFY = acre-feet per year
MG = million gallons
mgd = million gallons per day
kWH = kilowatt hour
MT = metric ton
CO_2e = carbon dioxide equivalent
SF = square feet

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Summary of QUANTITATIVE Results

The Quantitative Results are used to inform the Qualitative Metrics for Screening, Scoring and Ranking Alternative Projects

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QUALITATIVE Criteria for Comparing Alternatives

Categories	Alternatives Screening Criteria	Considerations for Assessing Project based on Criteria
ENGINEERING & OPERATIONAL CONSIDERATIONS	Improve Regional Water Supply	Ability to fill water supply gap, supplement supply in peak season, timeline for implementation
	Ease of Implementation	Permitability, construction complexity, flexibility for phasing and potential for expansion
	Operational Complexity	Treatment requirements and impacts to WWTF, ~~facility siting~~ and potential impacts to Water Department operations
ECONOMIC	Cost Effectiveness	Relative unit costs
	Financial Implementability	Relative capital costs and tradeoffs
ENVIRONMENTAL	CEQA Considerations	Potential impacts and mitigation requirements
	Potential for Environmental Enhancement	Potential to enhance ecosystem and social cost of carbon (GHG emissions)
SOCIAL	Agency Coordination, Partnerships and Agreements	Level of effort and willingness to work together
	Public acceptance	~~Perceived public acceptance~~
	Local disruption	During construction and ongoing maintenance

The City recognizes the importance of public acceptance and will include it in the next analysis of water supply alternatives when more information can be drawn from the community in terms of their preferences and acceptance of the different types of beneficial reuse.

3. Approach to Scoring, Weighting & Ranking

- Alternative projects will be **scored** from 1 to 5 for each criteria
  - ✓ Score = 5 Fully Meets Criteria
  - ✓ Score = 4 Mostly Meets Criteria
  - ✓ Score = 3 Partially Meets Criteria
  - ✓ Score = 2 Somewhat Meets Criteria
  - ✓ Score = 1 Unable to Meet Criteria
- Scores are **weighted** to provide ranking of alternative projects by themes
- Sensitivity Analysis explores how **ranking** changes with different weighting themes

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Weighting Screening Criteria

Categories	Alternatives Screening Criteria	Baseline (Balanced)	Maximize Water Supply	WSAC Criteria	WSAC Values	Maximize Beneficial Reuse	Maximizing Engineering & Operational Considerations	Low Cost	Minimize Local Impacts
ENGINEERING & OPERATIONAL CONSIDERATIONS	Improve Water Supply	15%	40%	70%	55%	10%	5%	10%	10%
	Maximize Beneficial Reuse	10%	5%	0%	0%	30%	10%	5%	5%
	Ease of Implementation	10%	10%	0%	0%	10%	5%	10%	5%
	Operational Complexity	10%	5%	0%	0%	15%	45%	5%	5%
ECONOMIC	Cost Effectiveness	15%	5%	15%	15%	5%	5%	30%	5%
	Financial Implementability	15%	10%	15%	15%	5%	5%	30%	5%
ENVIRON MENTAL	CEQA Considerations	10%	10%	0%	5%	5%	5%	3%	20%
	Potential for Environmental Enhancement	5%	5%	0%	5%	10%	10%	2%	20%
SOCIAL	Agency Coordination, Partnerships and Agreements	5%	5%	0%	5%	5%	5%	3%	5%
	Local Disruption	5%	5%	0%	0%	5%	5%	2%	20%
		100%	100%	100%	100%	100%	100%	100%	100%

"THEMES" Developed to support a sensitivity analysis to see how weighting criteria impacts ranking

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Alternative Project Raw Scores

Categories			ENGINEERING & OPERATIONAL CONSIDERATIONS									ECONOMIC		ENVIRONMENTAL			SOCIAL		TOTAL
Alternatives Screening Criteria			Improve Water Supply		Maximize Beneficial Reuse		Ease of Implementation			Operational Complexity		Cost Effectiveness	Financial Implementability	CEQA Considerations	Potential for Environmental Enhancement		Agency Coordination, Partnerships and Agreements	Local Disruption	Total Raw Score (max 100)
			Supply Gap	Timeline	Maximize Use Now	Future Expansion	Permitability	Construction	Expansion	PWD	Water Dept.	Unit Costs	Capital	Impact/ Mitigation	Enhance	GHG	Level/ Willingness	#/Type of Facilities	
Alternative	Sub-Alt #	Description																	
Alternative 1 – Centralized Non-Potable Reuse	1a	Santa Cruz PWD Title 22 Upgrades	1	5	1	5	5	5	5	5	5	5	5	5	2	5	5	5	69.0
	1b	Maximize tertiary treatment and reuse in the City	2	4	2	3	5	3	3	5	5	2	4	4	2	5	5	4	58.0
Alternative 2 – Decentralized Non-Potable Reuse	2	UC Santa Cruz satellite treatment and reuse on campus	1	4	1	5	5	5	3	3	5	2	5	5	2	5	2	3	56.0
Alternative 3 – Santa Cruz Participation in SqCWD led Groundwater Recharge Reuse (GRR) Project	3a	Send secondary effluent from SCWWTF to SqCWD for injection in SqCWD basin (no reuse in City)	Not analyzed because it provides no water to the City and would have no value in the ranking exercise																
	3b	Send tertiary effluent from SCWWTF to SqCWD (serve NPR users along the way)	2	4	2	2	5	4	3	5	5	4	5	2	2	5	3	4	57.0
	3c	Send additional secondary effluent from SCWWTF to SqCWD AWTF and deliver purified water from SqCWD AWTF to recharge Beltz Wellfield (GRR in Beltz + NPR users along the way back)	4	4	4	5	4	4	4	4	4	3	3	2	3	3	3	3	57.0
	3d	Send purified RW from an AWTF at/near SCWWTF to SqCWD (serve NPR users along the way)	1	4	1	3	5	4	3	3	5	3	5	2	2	5	4	4	54.0
	3e	Send purified RW from an AWTF at/near SCWWTF to SqCWD (GRR in Beltz + NPR along the way)	4	4	4	3	4	3	4	3	4	4	3	2	3	4	4	3	56.0
Alternative 4 – Santa Cruz GRRP	4a	Santa Cruz GRR in Beltz Wellfield area with AWTF at/near SCWWTF (Serve NPR users along the way)	4	4	4	4	4	4	4	2	4	4	3	2	3	4	5	3	58.0
	4b	Santa Cruz in Beltz Wellfield area with MBR + AWTF at DA Porath PS (Serve NPR users along the way)	4	3	4	4	3	3	4	1	4	4	3	1	3	3	4	2	50.0
Alternative 5 – Surface Water Augmentation (SWA) in Loch Lomond Reservoir	5	Advanced treatment of Santa Cruz effluent for augmentation of Loch Lomond Reservoir (no NPR along the way)	4	2	3	4	2	3	4	2	1	3	2	1	5	3	5	3	47.0
Alternative 6 – Streamflow Augmentation	6	Advanced treatment of Santa Cruz effluent for discharge to the San Lorenzo River d/s of Tait Street Diversion (no NPR users along the way)	3	2	3	4	1	4	4	2	1	4	2	1	5	4	5	4	49.0
Alternative 7 – Direct Potable Reuse	7	Raw Water Blending at Graham Hill WTP (via Coast PS or other point of blending)	5	1	5	4	2	3	4	2	2	5	2	1	1	3	5	3	48.0
Alternative 8 – Regional GRRP	8a	Regional GRRP in the Santa Margarita GW Basin to serve the City, Scotts Valley, Soquel Creek and San Lorenzo Valley	4	1	5	5	3	2	5	4	3	4	2	1	3	1	4	3	50.0
	8b	Regional GRRP in the Santa Margarita GW Basin to serve the City, Scotts Valley and San Lorenzo Valley	4	1	5	5	3	2	5	4	3	4	2	1	3	2	4	3	51.0

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Sensitivity Analysis

- Addresses variation in different perspectives by artificially increasing weighting for certain categories or criteria.
- Multiple percentages from Weighting Themes by Alternative Project Raw Scores
- Conditional shading shows GREEN as top scoring/top ranking and RED as bottom scoring/bottom ranking of all projects.

Categories	Alternatives Screening Criteria	Baseline (Balanced)	Maximize Water Supply	WSAC Criteria	WSAC Values	Maximize Beneficial Reuse	Maximizing Engineering & Operational Considerations	Low Cost	Minimize Local Impacts
ENGINEERING & OPERATIONAL CONSIDERATIONS	Improve Water Supply	15%	40%	70%	55%	10%	5%	10%	10%
	Maximize Beneficial Reuse	10%	5%	0%	0%	30%	10%	5%	5%
	Ease of Implementation	10%	10%	0%	0%	10%	5%	10%	5%
	Operational Complexity	10%	5%	0%	0%	15%	45%	5%	5%
ECONOMIC	Cost Effectiveness	15%	5%	15%	15%	5%	5%	30%	5%
	Financial Implementability	15%	10%	15%	15%	5%	5%	30%	5%
ENVIRONMENTAL	CEQA Considerations	10%	10%	0%	5%	5%	5%	3%	20%
	Potential for Environmental Enhancement	5%	5%	0%	5%	10%	10%	2%	20%
SOCIAL	Agency Coordination, Partnerships and Agreements	5%	5%	0%	5%	5%	5%	3%	5%
	Local Disruption	5%	5%	0%	0%	5%	5%	2%	20%
		100%	100%	100%	100%	100%	100%	100%	100%

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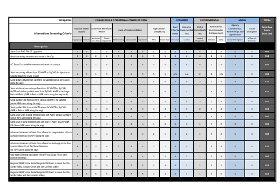

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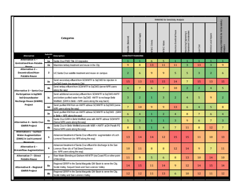

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BREAK

PART II: Overview of Alternatives and Screening Approach

4. Discuss Outcome of Sensitivity Analysis
5. Finalizing the RWFPS
6. Next Steps Beyond the RWFPS

4. Outcome of Sensitivity Analysis

a. Projects that consistently rose to the top
b. Projects that fell to the bottom
c. Criteria most influenced by weighting

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Outcome of Ranking and Sensitivity Analysis

Summary of Alternative Project Ranking and Sensitivity Analysis

Alternative	Sub-Alt #	Description	Baseline (Balanced)	Maximize Water Supply	WSAC Criteria	WSAC Values	Maximize Beneficial Reuse	Maximizing Engineering & Operational Considerations	Low Cost	Minimize Local Impacts
			SENSITIVITY RANKING							
Alternative 1 – Centralized Non-Potable Reuse	1a	Santa Cruz PWD Title 22 Upgrades	1	1	4	1	1	1	1	1
	1b	Maximize tertiary treatment and reuse in the City	4	5	8	7	7	2	10	2
Alternative 2 – Decentralized Non-Potable Reuse	2	UC Santa Cruz satellite treatment and reuse on campus	5	7	11	11	8	5	6	3
Alternative 3 – Santa Cruz Participation in SqCWD led Groundwater Recharge Reuse (GRR) Project	3a	Send secondary effluent from SCWWTF to SqCWD for injection in SqCWD basin (no reuse in City)	*Not Analyzed*							
	3b	Send tertiary effluent from SCWWTF to SqCWD (serve NPR users along the way)	2	6	6	5	9	3	2	4
	3c	Send additional secondary effluent from SCWWTF to SqCWD AWTF and deliver purified water from SqCWD AWTF to recharge Beltz Wellfield (GRR in Beltz + NPR users along the way back)	7	4	3	4	2	4	9	9
	3d	Send purified RW from an AWTF at/near SCWWTF to SqCWD (serve NPR users along the way)	8	8	9	9	12	6	3	5
	3e	Send purified RW from an AWTF at/near SCWWTF to SqCWD (GRR in Beltz + NPR along the way)	6	3	1	3	6	7	5	7
Alternative 4 – Santa Cruz GRRP	4a	Santa Cruz GRR in Beltz Wellfield area with AWTF at/near SCWWTF (Serve NPR users along the way)	3	2	1	2	3	8	4	5
	4b	Santa Cruz in Beltz Wellfield area with MBR + AWTF at DA Porath PS (Serve NPR users along the way)	9	9	5	6	10	11	7	12
Alternative 5 – Surface Water Augmentation (SWA) in Loch Lomond Reservoir	5	Advanced treatment of Santa Cruz effluent for augmentation of Loch Lomond Reservoir (no NPR along the way)	14	11	10	10	14	14	14	10
Alternative 6 – Streamflow Augmentation	6	Advanced treatment of Santa Cruz effluent for discharge to the San Lorenzo River d/s of Tait Street Diversion (no NPR users along the way)	13	13	12	11	13	13	13	8
Alternative 7 – Direct Potable Reuse	7	Raw Water Blending at Graham Hill WTP (via Coast PS or other point of blending)	10	10	7	8	11	12	8	13
Alternative 8 – Regional GRRP	8a	Regional GRRP in the Santa Margarita GW Basin to serve the City, Scotts Valley, Soquel Creek and San Lorenzo Valley	12	14	12	14	5	10	12	14
	8b	Regional GRRP in the Santa Margarita GW Basin to serve the City, Scotts Valley and San Lorenzo Valley	11	12	12	13	4	9	11	11

Projects That Consistently Rose to the Top

Summary of Alternative Project Ranking and Sensitivity Analysis

Alternative	Sub-Alt #	Description	TOP 4 RANKING PROJECTS: 1 (First)	2 (Second)	3 (Third)	4 (Fourth)
			Count # of Times RANKING Occurs			
Alternative 1 – Centralized Non-Potable Reuse	1a	Santa Cruz PWD Title 22 Upgrades	7			1
	1b	Maximize tertiary treatment and reuse in the City		2		1
Alternative 2 – Decentralized Non-Potable Reuse	2	UC Santa Cruz satellite treatment and reuse on campus			1	
Alternative 3 – Santa Cruz Participation in SqCWD led Groundwater Recharge Reuse (GRR) Project	3a	Send secondary effluent from SCWWTF to SqCWD for injection in SqCWD basin (no reuse in City)				
	3b	Send tertiary effluent from SCWWTF to SqCWD (serve NPR users along the way)		2	1	1
	3c	Send additional secondary effluent from SCWWTF to SqCWD AWTF and deliver purified water from SqCWD AWTF to recharge Beltz Wellfield (GRR in Beltz + NPR users along the way back)		1	1	3
	3d	Send purified RW from an AWTF at/near SCWWTF to SqCWD (serve NPR users along the way)			1	
	3e	Send purified RW from an AWTF at/near SCWWTF to SqCWD (GRR in Beltz + NPR along the way)	1		2	
Alternative 4 – Santa Cruz GRRP	4a	Santa Cruz GRR in Beltz Wellfield area with AWTF at/near SCWWTF (Serve NPR users along the way)	1	2	2	1
	4b	Santa Cruz in Beltz Wellfield area with MBR + AWTF at DA Porath PS (Serve NPR users along the way)				
Alternative 5 – Surface Water Augmentation (SWA) in Loch Lomond Reservoir	5	Advanced treatment of Santa Cruz effluent for augmentation of Loch Lomond Reservoir (no NPR along the way)				
Alternative 6 – Streamflow Augmentation	6	Advanced treatment of Santa Cruz effluent for discharge to the San Lorenzo River d/s of Tait Street Diversion (no NPR users along the way)				
Alternative 7 – Direct Potable Reuse	7	Raw Water Blending at Graham Hill WTP (via Coast PS or other point of blending)				
Alternative 8 – Regional GRRP	8a	Regional GRRP in the Santa Margarita GW Basin to serve the City, Scotts Valley, Soquel Creek and San Lorenzo Valley				
	8b	Regional GRRP in the Santa Margarita GW Basin to serve the City, Scotts Valley and San Lorenzo Valley				1

NPR:
- ✓ Santa Cruz PWD Title 22 Upgrades
- ✓ Maximize Tertiary Treatment

IPR:
- ✓ Alt 3b Send tertiary to SqCWD for NPR along the way
- ✓ Alt 3c SqCWD led GRR in Purisma with AWTF at Soquel
- ✓ Alt 3e SqCWD led GRR in Purisma with AWTF at SC WWTF
- ✓ Alt 4a City led GRR in Purisma

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Projects That Consistently Drop to the Bottom

Summary of Alternative Project Ranking and Sensitivity Analysis

Alternative	Sub-Alt #	Description	BOTTOM 2 RANKING PROJETS: 13 (Second to Last)	14 (Last)
Alternative 1 – Centralized Non-Potable Reuse	1a	Santa Cruz PWD Title 22 Upgrades		
	1b	Maximize tertiary treatment and reuse in the City		
Alternative 2 – Decentralized Non-Potable Reuse	2	UC Santa Cruz satellite treatment and reuse on campus		
Alternative 3 – Santa Cruz Participation in SqCWD led Groundwater Recharge Reuse (GRR) Project	3a	Send secondary effluent from SCWWTF to SqCWD for injection in SqCWD basin (no reuse in City)		
	3b	Send tertiary effluent from SCWWTF to SqCWD (serve NPR users along the way)		
	3c	Send additional secondary effluent from SCWWTF to SqCWD AWTF and deliver purified water from SqCWD AWTF to recharge Beltz Wellfield (GRR in Beltz + NPR users along the way back)		
	3d	Send purified RW from an AWTF at/near SCWWTF to SqCWD (serve NPR users along the way)		
	3e	Send purified RW from an AWTF at/near SCWWTF to SqCWD (GRR in Beltz + NPR along the way)		
Alternative 4 – Santa Cruz GRRP	4a	Santa Cruz GRR in Beltz Wellfield area with AWTF at/near SCWWTF (Serve NPR users along the way)		
	4b	Santa Cruz in Beltz Wellfield area with MBR + AWTF at DA Porath PS (Serve NPR users along the way)		
Alternative 5 – Surface Water Augmentation (SWA) in Loch Lomond Reservoir	5	Advanced treatment of Santa Cruz effluent for augmentation of Loch Lomond Reservoir (no NPR along the way)		4
Alternative 6 – Streamflow Augmentation	6	Advanced treatment of Santa Cruz effluent for discharge to the San Lorenzo River d/s of Tait Street Diversion (no NPR users along the way)	5	
Alternative 7 – Direct Potable Reuse	7	Raw Water Blending at Graham Hill WTP (via Coast PS or other point of blending)	1	
Alternative 8 – Regional GRRP	8a	Regional GRRP in the Santa Margarita GW Basin to serve the City, Scotts Valley, Soquel Creek and San Lorenzo Valley		3
	8b	Regional GRRP in the Santa Margarita GW Basin to serve the City, Scotts Valley and San Lorenzo Valley	1	

IPR:
- ✓ Alt 5: SWA
- ✓ Alt 6: Streamflow Augmentation
- ✓ Alt 7: DPR
- ✓ Alt 8a: 4-Way Regional GRRP

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Results Most Influenced by Weighting

Results	Directly Impacted Criteria	# of Criteria Influenced	% of Total Weighting *(Average of Themes)*
Annual Volume of Reuse in City	Water Supply, Beneficial Reuse, Cost Effectiveness, Env Enhancement	4	54%
Costs	Cost Effectiveness, Finical Implementability	2	24%
#/Size of New Facilities	Cost Effectiveness, Financial Implementability, Ease of Implementation, CEQA, Env Enhancement, Local Disruption	6	51%
Need for Advanced Treatment	Cost Effectiveness, Financial Implementability, Operational Complexity, Local Disruption	3	40%

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Ranking Most Affected by Weighting Theme

- **High Volume Reuse Projects** dominate WSAC Criteria and WSAC Values weighting themes (which only give 0-5% weight to other factors)
- **DPR and Regional GRRPs** score higher from a Maximizing Beneficial Reuse perspective
- Projects that **increase City responsibilities** for O&M rank low for Maximizing Eng/Ops Considerations
- **NPR Projects** rank higher for Low Cost and Minimize Local Impacts weighting themes

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5. Finalizing RWFPS

a. Putting sensitivity analysis into perspective when selecting project

b. Discuss and select what projects will be evaluated in Financial Analysis Phase 1.

c. Discuss how project alternative section will frame the next steps with regard to

- ✓ further financial analysis,
- ✓ potential to phase projects,
- ✓ potential for other (not selected) projects to be part of a water supply portfolio

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Selection of Project(s) for Financial Analysis Phase 1

Summary of Alternative Project Ranking and Sensitivity Analysis

RANKING for Sensitivity Analysis / SENSITIVITY RANKING

Alternative	Sub-Alt #	Description	Baseline (Balanced)	Maximize Water Supply	WSAC Criteria	WSAC Values	Maximize Beneficial Reuse	Maximizing Engineering & Operational Considerations	Low Cost	Minimize Local Impacts	Average RANKING for All Sensitivity Analysis
Alternative 1 – Centralized Non-Potable Reuse	1a	Santa Cruz PWD Title 22 Upgrades	1	1	6	5	1	1	1	1	1
	1b	Maximize tertiary treatment and reuse in the City	9	8	13	11	11	3	13	3	9
Alternative 2 – Decentralized Non-Potable Reuse	2	UC Santa Cruz satellite treatment and reuse on campus	2	6	9	9	5	5	3	2	6
Alternative 3 – Santa Cruz Participation in SqCWD led Groundwater Recharge Reuse (GRR) Project	3a	Send secondary effluent from SCWWTF to SqCWD for injection in SqCWD basin (no reuse in City)	15	13	15	15	14	7	15	13	15
	3b	Send tertiary effluent from SCWWTF to SqCWD (serve NPR users along the way)	4	7	6	7	10	2	2	4	5
	3c	Send additional secondary effluent from SCWWTF to SqCWD AWTF and deliver purified water from SqCWD AWTF to recharge Beltz Wellfield (GRR in Beltz + NPR users along the way back)	3	2	1	3	2	4	5	9	2
	3d	Send purified RW from an AWTF at/near SCWWTF to SqCWD (serve NPR users along the way)	7	10	9	9	13	6	4	5	8
	3e	Send purified RW from an AWTF at/near SCWWTF to SqCWD (GRR in Beltz + NPR along the way)	6	4	1	2	4	8	7	6	4
Alternative 4 – Santa Cruz GWRR Project	4a	Santa Cruz GRR in Beltz Wellfield area with AWTF at/near SCWWTF (Serve NPR users along the way)	5	3	1	1	3	9	6	7	3
	4b	Santa Cruz in Beltz Wellfield area with MBR + AWTF at DA Porath PS (Serve NPR users along the way)	8	5	1	4	7	11	8	12	7
Alternative 5 – Surface Water Augmentation (SWA) in Loch Lomond Reservoir	5	Advanced treatment of Santa Cruz effluent for augmentation of Loch Lomond Reservoir (no NPR along the way)	13	14	14	12	15	15	11	10	13
Alternative 6 – Streamflow Augmentation	6	Advanced treatment of Santa Cruz effluent for discharge to the San Lorenzo River d/s of Tait Street Diversion (no NPR users along the way)	10	11	8	8	12	14	9	7	11
Alternative 7 – Direct Potable Reuse	7	Raw Water Blending at Graham Hill WTP (via Coast PS or other point of blending)	11	9	5	6	8	13	10	14	10
Alternative 8 – Regional GWRR Project	8a	Regional GRRP in the Santa Margarita GW Basin to serve the City, Scotts Valley, Soquel Creek and San Lorenzo Valley	14	15	11	14	9	12	14	15	14
	8b	Regional GRRP in the Santa Margarita GW Basin to serve the City, Scotts Valley and San Lorenzo Valley	12	12	11	13	6	10	12	11	12

6. Next Steps Beyond the RWFPS

a. Parallel projects pursued by different departments/regional entities

b. Near-term vs Long-term pursuits

c. Nexus with WSAC Work (Phase 2 work for Corona and Raftelis is creating water supply portfolio(s))

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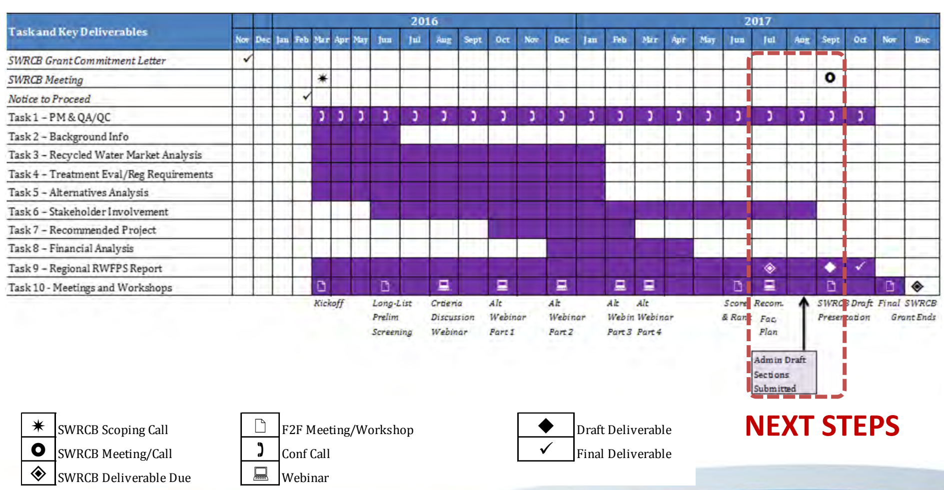
Schedule



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OPEN DISCUSSION

QUESTIONS

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Merritt Smith:	Dave Smith	davesmith@merritt-smith.com

Santa Cruz Regional
Recycled Water Facilities Planning Study (RWFPS)

WEBINAR
Recommended Project and Financing and Revenue Considerations
17 July 2017 from 10 am to 12:00 pm

Conf Call - (855) 813-2486 Code – 2484
Web Meeting - http://conf.kennedyjenks.com/conference/2484

AGENDA

Overall Webinar Objective: Present Recommended Projects with updated maps and costs. Present considerations for implementation, operations, financing and options for a future revenue program.

Goal: Obtain consensus on considerations and assumptions for Recommended Plan, Construction Financing Plan and Revenue Program to include in Sections 9 & 10 of the RWFPS

Caveat: Sections 9 & 10 are structured to meet the SWRCB Grant Requirements. Many of the elements related to the implementation plan, operation plan, financing and revenue program will require additional studies, agreements and design details to confirm. This webinar and the RWFPS will provide an overview of considerations and next steps to develop the City's recycled water program.

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1. **Today's Webinar**
2. **Recommended Project**
    a. Phase 1: SCPWD Title 22 Project ………………………………………………………… Ann/Dan (PWD)
    b. Phase 2: BayCycle Project
    c. Other Reuse Opportunities
3. **Implementation Plan Considerations**
4. **Operation Plan Considerations**
5. **Financing and Revenue Considerations** ……………………………………………………………… Andrea (RFC)
6. **Next Steps**

City of Santa Cruz
Recycled Water Facilities Planning Study

WEBINAR
Recommended Projects and
Financing and Revenue Considerations
July 17, 2017

Conf Call: *(855) 813-2486 Code – 2484*
Desktop Sharing: http://conf.kennedyjenks.com/conference/2484
Recording: http://conf.kennedyjenks.com/recording/6180669

** Includes amended notes to reflect discussion at webinar*

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Agenda

- **Recommended Project**
  - Phase 1: SCPWD Title 22 Project
  - Phase 2: BayCycle Project
  - Other Reuse Opportunities
- **Implementation Plan Considerations**
- **Operation Plan Considerations**
- **Financing and Revenue Considerations**

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Today’s Webinar

- **Objective:** Present Recommended Projects with updated maps and costs. Present considerations for implementation, operations, financing and options for a future revenue program.

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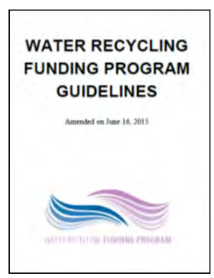
WATER RECYCLING FUNDING PROGRAM GUIDELINES

Amended on June 16, 2015

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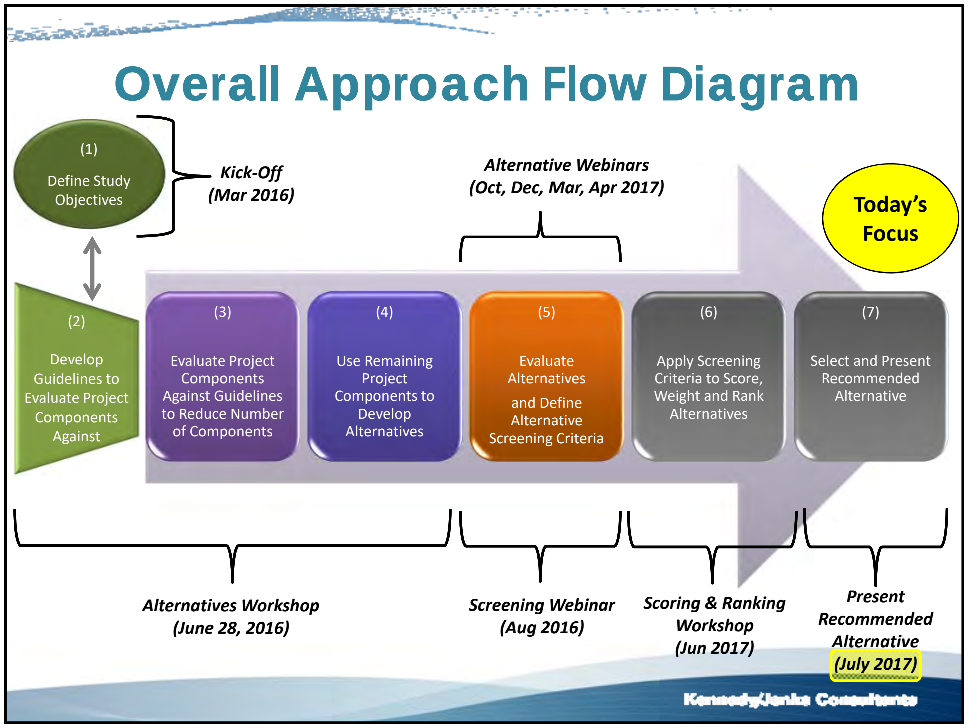

Recommended Projects

- **Phase 1: SCPWD Title 22 Project** – implement a near-term non-potable reuse project to meet in-plant demands, develop a bulk water station and serve the near-by La Barranca Park.

- **Phase 2: BayCycle Project** – expand the Phase 1 project to increase production and non-potable reuse to serve customers along Bay Street including UCSC and other City customers

Phase 1 and 2 are the focus of the Recommended Project and Construction Financing Plan for the RWFPS

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Other Reuse Opportunities

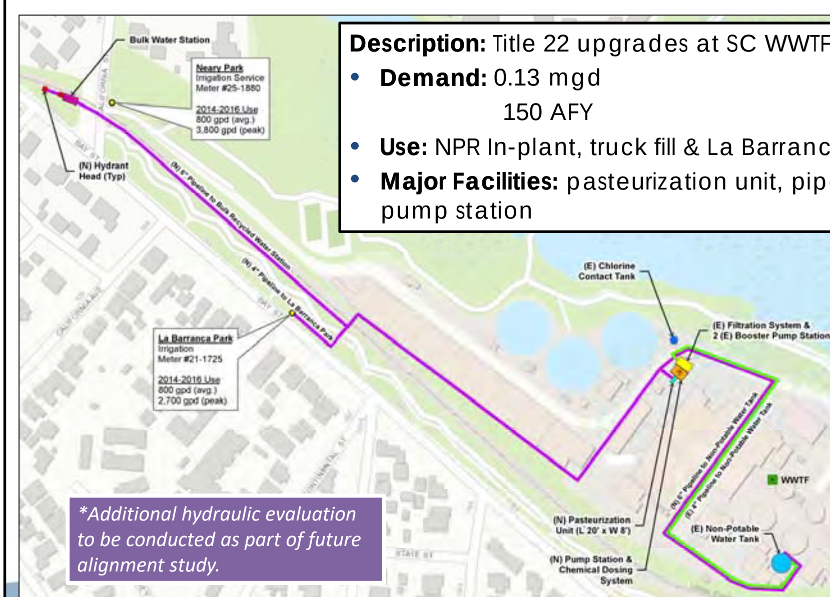
1. **Coordination with Pure Water Soquel** – continue to work closely with SqCWD to support the Pure Water Soquel project including, but not limited to, the delivery of source water and considerations for benefits of shared infrastructure.
2. **Explore GRR in Mid-County Basin** – to replenish the Mid-County Basin through a collaborative project with Pure Water Soquel or as an independent City led project
3. **Explore GRR in Santa Margarita Basin –** continue regional discussions related to the benefits and limitations for a Regional GRRP in the SMGB, which has the potential to make the region more resilient in the long term.

Represent longer term efforts that will require more time to work collaboratively with regional partners and/or future studies to confirm the viability of groundwater replenishment.

Phase 1: SCPWD Title 22 Project

Description: Title 22 upgrades at SC WWTF

- **Demand:** 0.13 mgd
  150 AFY
- **Use:** NPR In-plant, truck fill & La Barranca Park
- **Major Facilities:** pasteurization unit, pipelines, pump station



**Additional hydraulic evaluation to be conducted as part of future alignment study.*

Phase 1: SCPWD Title 22 Project

- Purpose of the project is to enhance the robustness of the reclaimed water system and provide Title 22 water for off-site use.
- Estimated Demands

Demands	Average (gpd)	Peak (gpd)
In-plant Use	126,000	193,000
Bulk Water Station Use*	4,800	11,000
La Barranca Park**	800	2,700
Neary Park**	800	3,800
TOTAL	**132,400**	**210,500**

* Total average demand from 3 bulk water stations in 2014
** Average irrigation demand between 2012-2014

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Phase 1: SCPWD Title 22 Project

- Key component upgrades
  - Upgrade treatment with Title 22 pasteurization unit
  - Convert existing chlorine contact tank to storage
  - New distribution system pump station and pipelines
  - New bulk water station
  - New dedicated pipeline to 2 water tank
  - Upgrade secondary effluent booster pumps

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Phase 1: SCPWD Title 22 Project

- **Funding**
  - $250,000 in FY 2018 WWTF CIP
  - Water /Public Works FY 2019 Funds TBD
- **Next Steps**
  - Title 22 Engineering Report
  - Environmental Documents
  - Design of Treatment System Upgrades
  - Design of Distribution System

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Phase 1: Summary of Costs

Facility Component	Est. Loaded Cost ($)
Treatment	730,000
Pipelines	380,000
Pump Stations	130,000
Storage	0
Site Retrofit Costs	20,000
Total Construction Cost ($)	**1,260,000**
Annual O&M Costs ($/year)	**$250,000**

Annual Life Cycle Unit Cost ($/AFY) = $2,200

* Based on reuse of 0.13 mgd (150 AFY) of Title 22 water

Facility Costs at the WWTF to be differentiated from those off-site (capital and O&M)

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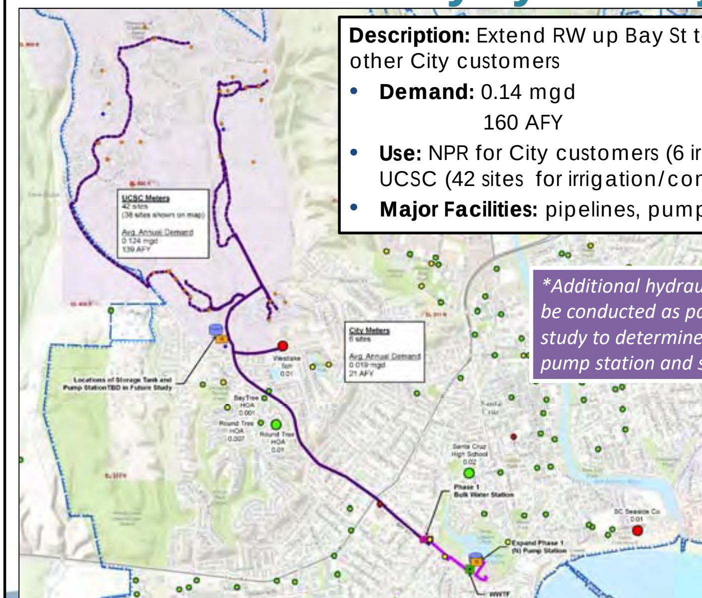
Phase 2: BayCycle Project



Description: Extend RW up Bay St to serve UCSC and other City customers

- **Demand:** 0.14 mgd
  160 AFY
- **Use:** NPR for City customers (6 irrigaiton sites) and at UCSC (42 sites for irrigation/commercial)
- **Major Facilities:** pipelines, pump station and storage

**Additional hydraulic evaluation and siting to be conducted as part of future alignment study to determine optimal location for pump station and storage on UCSC Campus.*

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Phase 2: Summary of Costs

Facility Component	Est. Loaded Cost ($)
Treatment	220,000
Pipelines	7,380,000
Pump Stations	690,000
Storage	380,000
Site Retrofit Costs	3,030,000
Total Construction Cost ($)	**11,700,000**
Annual O&M Costs ($/year)	**$320,000**

Annual Life Cycle Unit Cost = $5,400

Facility Costs on campus to be differentiated from those off-campus (capital and O&M)

* Based on annual demand of 0.14 mgd (160 AFY) for City and UCSC customers

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Implementation Plan Considerations

Considerations	Phase 1	Phase 2
Coordination	SCPWD and SCWD	City and UCSC
Ability and Timing of Users	SCWWTF = Ready to connect Bulk Water Station = New Park = Retrofit needed	City customers = retrofit UCSC = Agreement and retrofits
Water Recycling Requirements	Title 22 Report, Title 17 cross-connection, Supervisor training, monitoring and reporting, etc.	
Commitments from Potential Users	Memo or Letter of intent to use from SCPWD, SCWD and City Parks	Letter of interest from UCSC; develop agreement prior to initial design work or other financial commitments
Water Rights Impact	None required as Water Code Section 2010 assigns ownership of the treated wastewater to the owner of the wastewater treatment plant.	
Permits, Right-of-Way, Design and Construction	RWQCB/DDW permits for production and distribution, NOI for RW program, obtain ROW for pipelines and infrastructure, design, construction & environmental	

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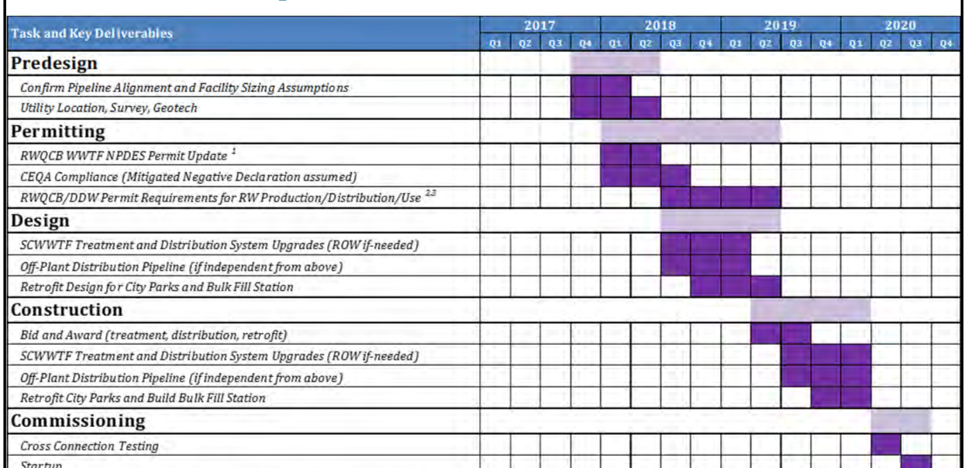
Anticipated Phase 1Schedule



[1] Changes at the WWTF will likely trigger an update to the NPDES permit even if discharge limits don't change.

[2] Per SWRCB Order WQ 2016-0068-DDW http://www.waterboards.ca.gov/board_decisions/adopted_orders/water_quality/2016/wqo2016_0068_ddw.pdf

[3] Includes Title 22 Engineering Report, Retrofit Report and Notice of Intent for Uses.

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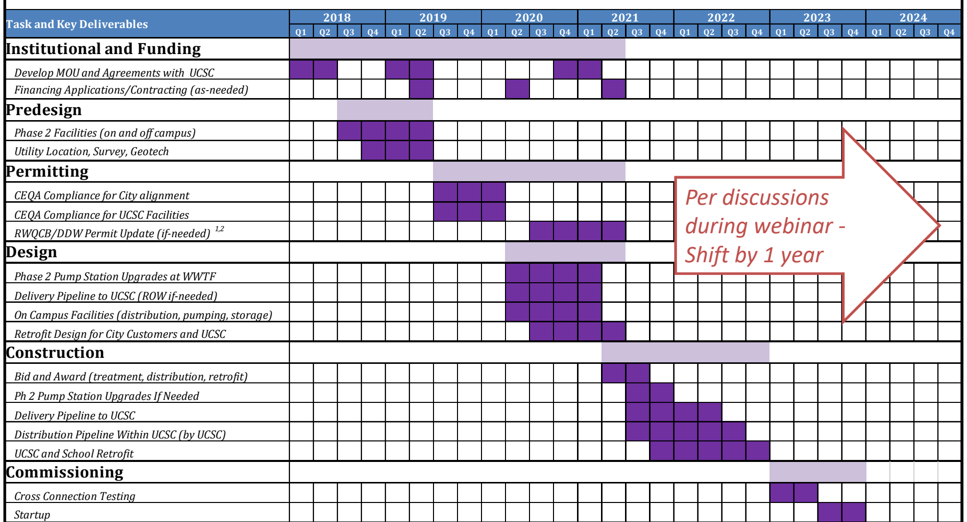
Potential Phase 2 Schedule



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[2] Includes Title 22 Engineering Report, Retrofit Report and Notice of Intent for Uses.

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Operation Plan Considerations

Considerations	Phase 1	Phase 2
Responsible Parties	Water Dept (SCWD), Public Works (SCPWD), City Parks Supervisor	City, UCSC, Customer Site Supervisors
Equipment Operations & Maintenance	SCPWD = Title 22 upgrades SCPWD = on-site distribution SCPWD/SCWD[1] = off-site distribution SCPWD/SCWD[1] = bulk water station SCWD = City Parks SCWD = residential fill station[2]	SCWD = distribution SCWD = City customers UCSC = campus customers
Monitoring	SCPWD = production SCWD = distribution/customers	SCPWD = production SCWD = distribution & customers UCSC = Campus customers
Irrigation Scheduling	SCWD = work with customers	SCWD = work with customers UCSC = Campus customers

[1] City department lead for facilities outside of the WWTF to be determined
[2] Residential fill station could be initiated as part of Phase 1 or 2

Water Department to be the "face" of RW for customers

Financing and Revenue Considerations

RAFTELIS FINANCIAL CONSULTANTS, INC.

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Construction Financing Options

- PAYGO (Pay-as-you-go)
  - Water, Recycled Water, or Wastewater
- Debt Financing
- Grants / Loans
- Capacity Fees
- Combination of two or more

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Potential Funding Mechanisms PAYGO vs Debt

PAYGO

Advantages	Disadvantage
• Save on interest charges • Eliminate cost of issuance • No bond covenants to satisfy • Projects only funded when cash is available • Additional admin. costs are avoided	• If capital costs spike - rates spike • Capital may need to be deferred due to liquidity • Existing customers are absorbing entire burden • Inequity between existing / future customers • Other needs not addressed due to CIP costs

Debt

Advantages	Disadvantage
• Favorable low interest rates • Critical capital projects may move forward • Achieve intergenerational equity • Mitigate rate spikes in specific years • Smooth out revenue adjustments	• Total project cost increases due to interest and COI • Bond coverage requires additional revenue collection • Incurring debt may not be an option - politically • Debt payments must be made while commodity revenue may fluctuate

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Potential Funding Mechanisms Grant / Loan Funding

- Grant Funding
  - There are quite a few grants available for recycled water projects
    - ✓ SWRCB Water Recycling Funding Program
      - Research, feasibility studies, planning, and construction
    - ✓ Integrated Regional Water Mgt. Implementation Grant
    - ✓ Proposition 1
      - Regional Water Reliability, Water Recycling, Groundwater Sustainability
    - ✓ NOAA Coastal Resiliency Grants Program
  - Competitive basis, additional requirements (regulatory & administrative), timing of funds, often require ability to fund project without grants (matching funds)

Phase 1: Candidate for SRF Loan
Phase 2: Candidate for Category III SWRCB Grant 25% = ~$3M

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Financing Plan Considerations

It's important to look at the entire picture

- Objectives
  - ✓ Meet Regulations, New Water Supply, Reliability/Sustainability
- Assessing Revenue Needs
  - ✓ Capital Costs (Grants / Debt / PAYGO)
  - ✓ Annual Operations and Maintenance Costs
  - ✓ Conversion Costs (user hookup)
  - ✓ Depreciation recovery for ongoing reinvestment
- Revenue Recovery
  - ✓ Cost of Service
  - ✓ Interfund Transfers (Cost Sharing between Enterprises)
  - ✓ Type of capital expense may dictate funding mechanism

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What is the Industry Standard / Practice?

- Historically, recycled water rates have been pegged as percent of potable water rates (75% - 95%)
  - Legacy approach; not necessarily defensible
  - Provides financial incentive to use recycled water; otherwise, no reason to switch
  - RFC recommends a cost of service approach providing similar result (i.e. 75% -95% of potable)
    - ✓ Cost sharing required
    - ✓ Compliant with Proposition 218 & Proposition 26

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Legal Case Study:

- **Griffith vs. Pajaro Valley Water Mgt. Agency (2013)**
  - Agency included revenue requirements related to recycled water in the potable water rates as a groundwater augmentation charge
  - Plaintiff argued rates violated the proportionality requirements and that recycled water was not available to ALL customers
  - Ruling: Groundwater augmentation does NOT exceed the proportionate cost of providing service because ALL groundwater users benefit from the agencies groundwater management activities
    - ✓ Charges may be used to fund debt service
    - ✓ Charges may be used to fund recycled water service

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Legal Case Study:

- **CTA vs. City of San Juan Capistrano**
  - Proposition 218 **does** allow public water agencies to pass on to their customers the capital costs of improvements to provide additional water, including building a recycling system
  - Recycled water is a **new source** of water
  - Government Code § 53750(m) – water is part of a holistic distribution system

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Why do we need recycled water?

- **Is it for additional water supply/reliability? If so:**
  - Expansion of purple pipe may be covered through connection fees and/or potable water rates
  - Tertiary cost may be covered in the higher tiers of potable water users since their demand requires additional supply
  - Remaining operating costs recovered by recycled rates
- **Is it due to wastewater discharge requirements that require tertiary level treatment? If so:**
  - Expansion of treatment plant may be covered in wastewater connection fees or recycled water
  - Tertiary cost may be covered as part of the wastewater rates

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Why do we need recycled water?

- **Is it combination of both?**
  - Tertiary costs may be allocated to wastewater and to the higher potable water tiers
  - Purple pipe can be covered in utility capacity fees and rates
  - O&M should still be recovered from recycled water

Costs	Potable Rates	Wastewater Rates	Recycled Rates	Water Capacity Fees	Recycled Capacity Fees
Tertiary	Commonly	Commonly	Not usually	Commonly	Not usually
Purple Pipe	Commonly	No	Commonly	Commonly	Commonly
Operating	Not usually	No	Yes	No	No

City to fill out this table with preliminary guidance for cost sharing.

What is going on in the Industry?

- El Toro Water District
  - Potable water rates have a RW component in the inefficient tiers (Tiers 3 & 4) that fund RW capital costs
  - Recycled water rates fund O&M and a portion of R&R / Debt Service
- Elsinore Valley MWD
  - Potable rates have rate components to fund RW
    - ✓ O&M is based on avoided purchased water costs
    - ✓ Capital costs are shared by future users (capacity fee), RW rates, and Potable rates for customers beyond their allocated water budget
- Fallbrook PUD
  - WW treatment plant costs (debt service) are allocated between wastewater and recycled water customers. Recycled users pay for the tertiary portion of costs.

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Industry…

- Camarillo CSD
  - Relatively new enterprise
  - Potable funded Infrastructure – treated as an interfund loan with repayment occurring in future years
  - O&M covered by recycled rates
- Temescal Valley Water District
  - Mature enterprise, ~50% of total water demand is from recycled water
  - 100% of recycled revenue needs is funded from Recycled water rates
  - New recycled customers pay a recycled capacity fee

There are lots of options and some level of flexibility, however, Projects and Policy should drive revenue recovery

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Using Data to Guide Policy Decisions

- **Phase I – PWD Title 22 Project**
  - Majority of Title 22 tertiary treated water will be used within the plant
  - Construction costs will be funded by the Wastewater Enterprise Fund (i.e. paid for by existing wastewater customers)
    - ✓ May consider applying for Grant/Low interest SRF Loan
  - Will ongoing costs be born by wastewater customers or should recycled/potable customers share in these costs?

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Using Data to Guide Policy Decisions

- **Phase 2 - BayCycle**
  - Substantial Construction Costs
    - ✓ ~$12M Construction Costs
    - ✓ Expected recycled demand ~ 160 AFY
  - It may be reasonable to fund these costs via the potable water enterprise (New Water Supply)
    - ✓ However, is it feasible given the considerable potable infrastructure reinvestment already underway?
  - Consider using SRF Loan (1.7% interest) and grant funding / reimbursement

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Other Key Considerations

- **Phase 2 - BayCycle**
  - Timing of the project and new user connections
  - Demand Projections
    - ✓ What happens if UCSC doesn't commit or uses more/less recycled water than projected?
    - ✓ May need to consider setting up a contract rate with an annual minimum charge based on a "Use or Lose" structure
  - Keep in mind the fiscal impact of converting potable users over to recycled
    - ✓ A significant portion of Potable revenue requirements are recovered over the variable charge.
    - ✓ Recycled user candidates are currently potable customers
    - ✓ This will result in lost revenue if no adjustments are made to the potable rates

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Partnerships through Contract Customers

- Major stakeholder
- Engagement starts early and customers have skin in the game
- Contract agreement outside of Prop. 218
  - Identify minimum revenue needs for project viability
  - Provides more flexibility for negotiations and agreement
  - Competitive rate may be determined for usage above minimum
  - Term for rates may be for multiple years

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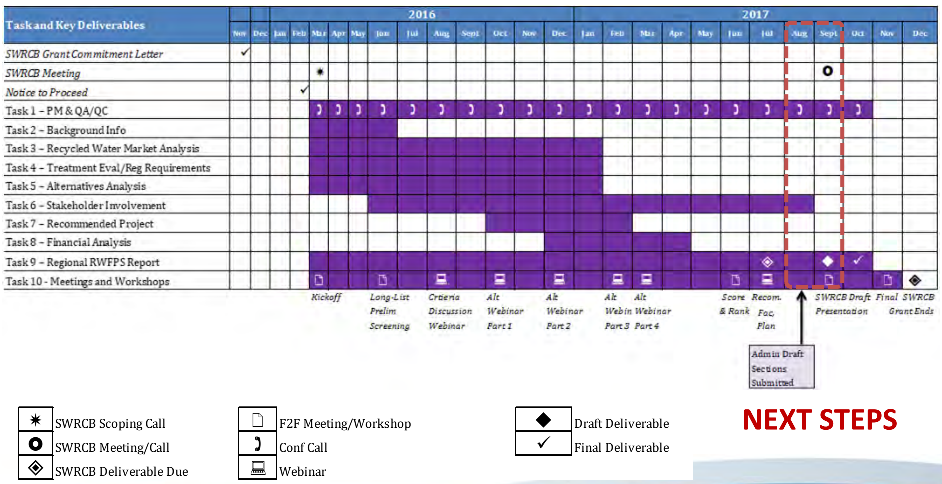
Long-term Projects

- Will need to be further evaluated once projects are known
- Good candidates for grant funding
  - Benefits a wider community / region
  - Supports groundwater sustainability and regional water reliability
- Pricing Policy
  - Purified recycled water likely seen as a new water source and may be priced as supplemental water supply

IPR / Groundwater Recharge

- Multiple agencies have separate charge for groundwater recharge
  - East Valley – all units of water
  - Met customers – standby charge
  - Tustin – Recharge fee by OCWD
  - Sierra Madre – New ground water recharge (current project)
  - San Diego – IPR – new project to assist with setting rates
    - ✓ Reservoir replenishment
    - ✓ Pure Water SD

Schedule



OPEN DISCUSSION

QUESTIONS

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