Draft Recycled Water White Paper
Opportunities and Limitations for Recycled Water Use
Santa Cruz Water Department & Soquel Creek Water District

INTRODUCTION

To ensure reliable, high quality drinking water supplies, the City of Santa Cruz Water Department (SCWD), and the Soquel Creek Water District (SqCWD) have joined together to conserve, protect and create a diverse water supply portfolio. The two agencies have partnered, forming the **scwd²** Task Force to implement the **scwd²** Seawater Desalination Program.

The SCWD Integrated Water Plan (IWP, 2005) and the SqCWD Integrated Resources Plan (IRP, 2006) provide a flexible, phased approach for providing a reliable supply of water during a drought, preserving coastal aquifers from saltwater intrusion, and ensuring protection of public health and safety. Both agencies are looking at the following four components.

- **Conservation** – Permanently reduce customer demand for water and increase water use efficiency to obtain the greatest public benefit from available supplies.
- **Rationing** – Further reduce water use, by up to 15-percent, through temporary water restrictions during times of drought.
- **Supplemental Supply** – Construct a desalination plant to provide supplemental water during drought and to help protect our coastal aquifers.
- **Recycled Water** – Develop and use recycled water for non-potable irrigation and other uses where feasible.

SUMMARY

This white paper introduces **scwd²**, discusses recycled water and its benefits, and describes the opportunities and limitations with recycled water as an opportunity to offset potable water needs for these two agencies. Major findings of this recycled water white paper include:

- Both SCWD and SqCWD have implemented and/or are investigating recycled water programs as part of their integrated water portfolios.
- Current California (CA) regulations do not allow recycled water (i.e., highly-treated wastewater) to be discharged directly into a potable/drinking water distribution system (otherwise known as direct potable use) and therefore would not meet SCWD's drought water supply needs.

- Current California (CA) regulations do allow recycled water to be used for indirect potable reuse whereby highly-treated wastewater is injected into the ground via percolation ponds or pumping, and extracted later for use. However indirect potable reuse is not practical for SqCWD or SCWD because 1) it requires blending recycled water with surface or groundwater prior to injection and both surface and groundwater supplies are already limited; 2) injection wells are required to be located a prescribed distance away from any public or private drinking water well which is difficult due to the thousands of wells within Soquel-Aptos area groundwater basin; and, 3) local land limitations are not conducive to percolation/blending ponds.

- Recycled water for SCWD and SqCWD could potentially provide irrigation water for parks, sports fields, and/or golf courses during a drought, but would require a new dedicated distribution system that would be prohibitively expensive compared with the relatively small volumes of water delivered for appropriate use.

BACKGROUND

SCWD Water Supply Portfolio

The City of Santa Cruz (SCWD) relies primarily on surface water runoff that is captured in reservoirs or withdrawn through stream diversions. The SCWD also has a small well field that seasonally supplies about 5-percent of their water supply. The SCWD water supply facilities include:

- Surface water storage in Loch Lomond Reservoir,
- Surface diversions from two locations on the San Lorenzo River,
- Surface diversions from three coastal streams and a natural spring (i.e. North Coast sources), and
- Groundwater from the Live Oak Wells.

The SCWD system relies on surface runoff from local rainfall and groundwater infiltration. No water is purchased from State or Federal sources or otherwise imported to the region from outside the Santa Cruz area. The primary threat to the SCWD water supply is the lack of water during a drought. If the City were faced with drought conditions similar to the 1976-1977 drought, the SCWD does not have enough water to meet current demands and would require rationing of approximately 45-percent. Even with a plan of ongoing conservation efforts and 15-percent additional rationing/water-use restrictions during drought, additional water supplies are needed to meet potable water needs for public health and safety and economic stability during drought.

SqCWD Water Supply Portfolio

SqCWD obtains all of its water supply from two separate groundwater aquifers. Approximately two-thirds of SqCWD’s supply comes from the Purisima Formation and one-third from the Aromas Red Sands. Similar to SCWD, no water is purchased from State or Federal sources or imported to the region from outside the Santa Cruz area.

The primary threat to the SqCWD water supply is overdrafting of the aquifers and the subsequent potential for seawater intrusion. The Soquel-Aptos area groundwater basin provides water supply for more than just SqCWD. It is also pumped by several mutual water districts, SCWD and over a thousand private well owners. The basin is in overdraft and the cumulative impact of pumping in excess of sustainable yield will eventually lead to seawater intrusion and resulting contamination of the groundwater basin.

SqCWD has practiced groundwater management for over 25 years and continually monitors for changes in water quality and groundwater levels. In addition, to protect their potable water supply, SqCWD has an aggressive water conservation program and has joined SCWD to address common water supply issues. SqCWD needs to find a supplemental water supply that will permit them to reduce pumping from the over-drafted groundwater aquifers. This will permit the groundwater levels to rise and prevent seawater intrusion.

RECYCLED WATER – WHAT IS IT?

People generally associate “recycling” with recovering materials such as aluminum cans, newspapers, etc. in order to reuse the material and minimize waste. Recycled water involves a similar concept, where treated water (effluent) from a municipal wastewater treatment plant is further treated to a high level of quality so it is suitable for beneficial uses like irrigation, commercial or industrial use, or in some cases, indirect potable reuse. Recycled water can also include the onsite reuse of water at an industrial facility, such as water that is used for cooling processes.

The natural water cycle includes recycling/reusing through natural processes such as precipitation, infiltration, evaporation and evapotranspiration. Wetlands, for example, act as Mother Nature’s treatment systems; filtering runoff from storms to provide high quality water in the environment.

As urbanization has increased, water recycling/reusing also occurs as one city draws their drinking water supply from the same river into which an upstream city has discharged its treated wastewater. Water from most major rivers has been used, treated, and reused a number of times before the last downstream user withdraws their water supply.

Figure 1 illustrates the relative quality of water used for municipal water supplies.

More intentional recycled water projects are being developed with specific goals to beneficially reuse treated water from municipal wastewater treatment plants. These projects include water that is reused for both non-potable and indirect potable purposes, and are subject to specific regulatory requirements to ensure public health.

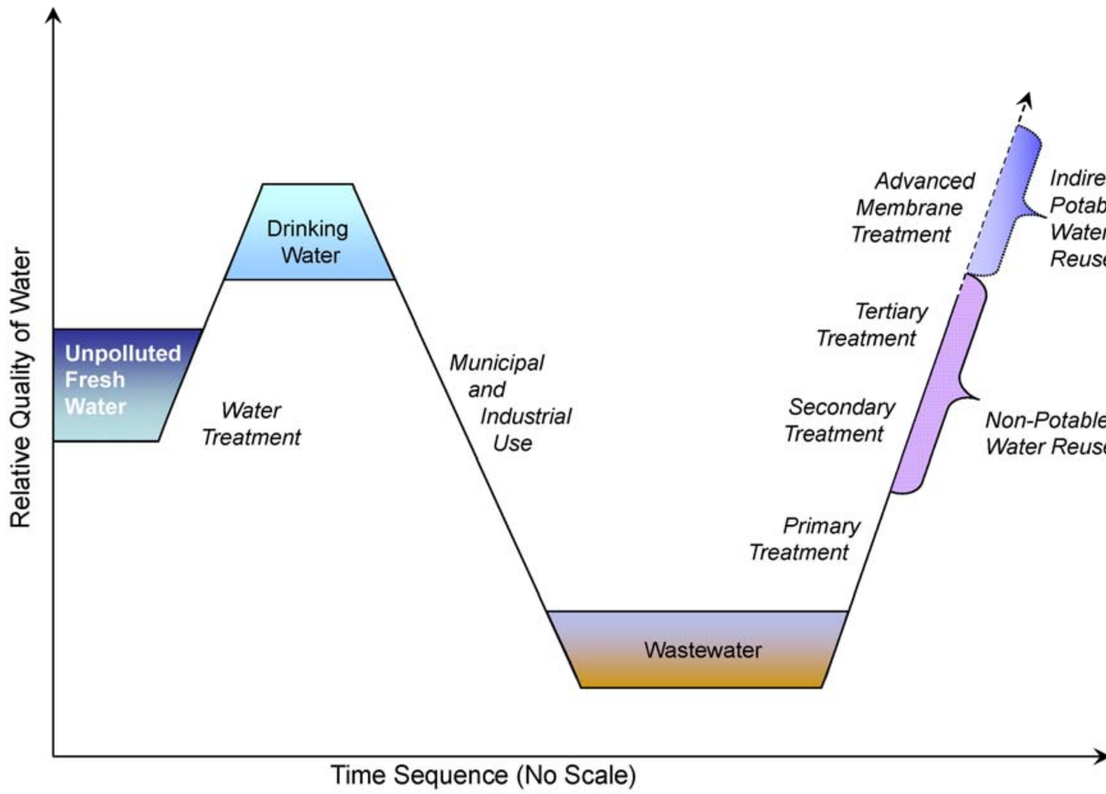

Figure 1: Relative Water Quality of Municipal Water Supplies
Source: Adapted from Water quality changes during municipal uses of water in a time sequence and the concept of water recycling (Asano, T., Water Science & Technology, Vol. 45, No. 8, p. 29, 2001.)

THE BENEFITS OF RECYCLED WATER

Recycled water is generally used as an alternative to potable water for irrigation and other non-potable uses such as commercial car-washing and industrial washwater. The benefits of implementing a municipal recycled water program include:

- Reducing potable water demands from irrigation and other non-potable uses;
- Drought protection for irrigation, and other non-potable uses; and
- Potential groundwater replenishment through recharge with blended recycled water (indirect potable reuse).

Currently, recycled water is not approved or permitted for discharge directly into a potable water distribution system (a.k.a. direct potable reuse).

Approved Uses of Recycled Water

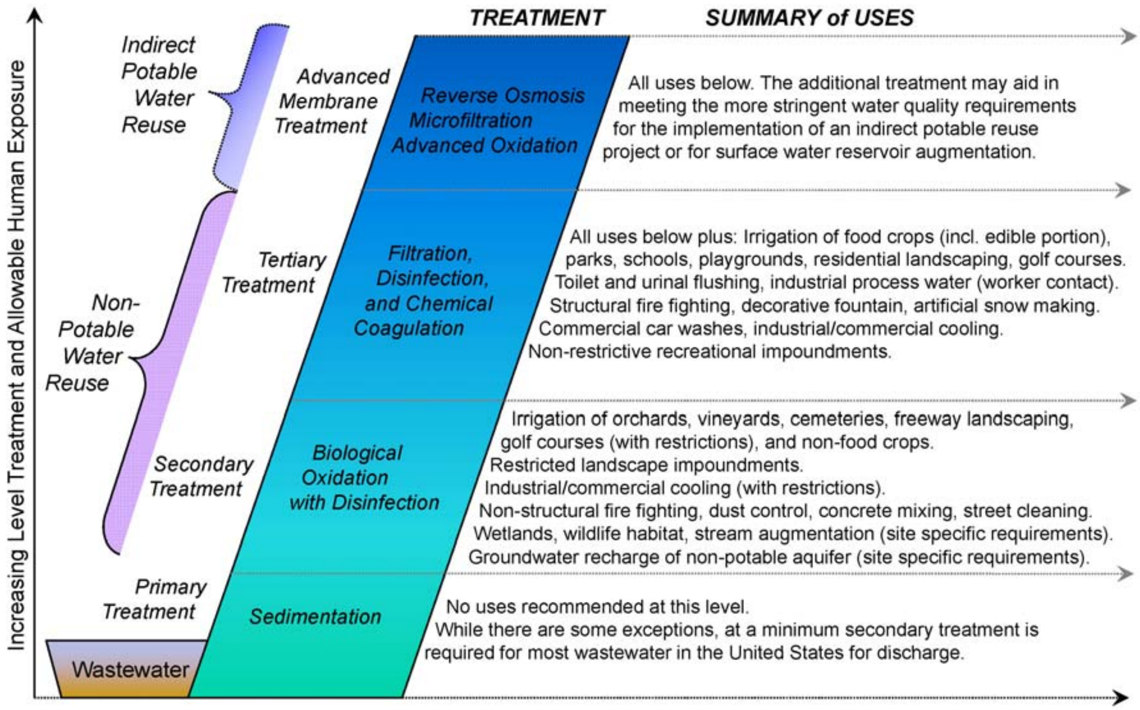

Figure 2 summarizes the generally recommended uses for recycled water based on the level of treatment (EPA, 2004). Because state regulations and groundwater management plans may have site-specific treatment requirements, the approved uses for recycled water must always be evaluated on a case by case basis.

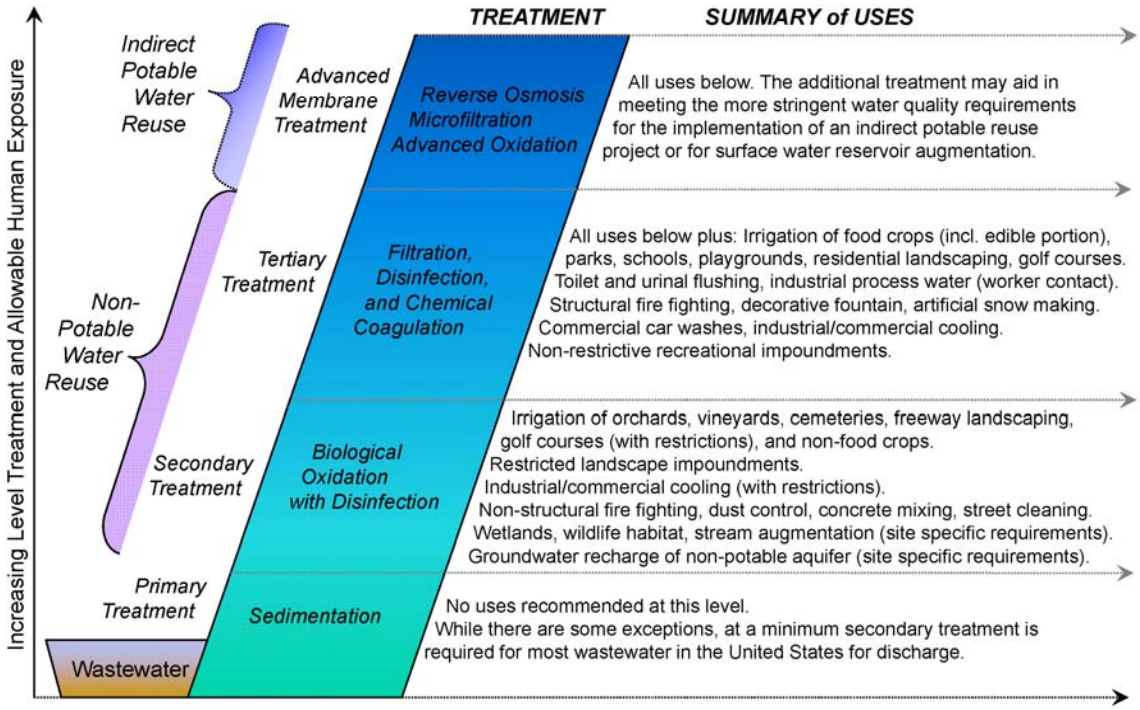

Figure 2: Suggested Uses for Recycled Water based on Level of Treatment

Understanding the relationship between water quality requirements for potential uses, health related water quality requirements, and other regulatory water quality requirements related to the use of recycled water is critical to identifying the suitability and benefits of recycled water use.

Recycled Water Regulations and Permitting

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. In the State of California, recycled water requirements are administered by the State Water Resource Control Board (SWRCB), individual Regional Water Quality Control Boards (RWQCBs), and the California Department of Public Health (CDPH).

The regulatory requirements for recycled water projects in California are contained in the following sources:

- California Code of Regulations (CCR), which includes Title 22 and Title 17
- California Health and Safety Code
- California Water Code.

Applicable excerpts from Title 22, Title 17, and the California Health and Safety Code are documented in "*The Purple Book,*" which provides a single source of guidelines and requirements for recycled water production, distribution and use in California. Appendix

A to this paper provides a more in-depth discussion of the current recycled water regulations in California.

OPPORTUNITIES & LIMITATIONS OF RECYCLED WATER USE

Recycled Water Options and Limitations for SCWD

The City of Santa Cruz owns and operates a regional wastewater treatment facility which provides secondary treatment to meet State and Federal waste discharge requirements. Treated wastewater is discharged to Monterey Bay through a deep water outfall. The plant is not currently permitted to produce recycled water for use offsite; however, recycled water is used at the plant to help meet its major process water needs such as chemical mixing, cooling water, equipment washing, and irrigation.

The SCWD investigated the potential for using recycled water as a supplemental water supply in two studies:

- The City of Santa Cruz Alternative Water Supply Study. Carollo Engineers, 2000.
- The City of Santa Cruz/Soquel Creek Water District Evaluation of Regional Water Supply Alternatives. Carollo Engineers, 2002.

There were several water reuse concepts evaluated in the two studies, including:

- Direct potable reuse;
- Urban landscape irrigation;
- Agricultural application for the North Coast;
- Using recycled water from Scotts Valley Water District; and,
- Using recycled water for groundwater recharge. (I.e., “indirect potable reuse” or “GRRP.” See section below.)

Direct Potable Reuse

As stated above, recycled water, regardless of level of treatment provided, is not currently approved or permitted for discharge directly into a potable water distribution system. (I.e., direct potable reuse.) This is not to say the regulations will not change in the future. Should regulations change and allow for direct potable reuse following treatment, a seawater desalination facility could be modified to treat effluent from a wastewater treatment facility.

Urban Landscape Irrigation

Recycled water may not be added to the pipelines of an existing drinking water distribution system, so a new pipeline distribution system (commonly referred to as “purple pipes”) must be constructed to deliver recycled water to customers. This can be very costly in an urban environment when neighborhoods have already been developed and the larger irrigation demands like parks and schools are spread out across a large geographic area.

In addition, the City of Santa Cruz made the decision to enforce water use restrictions, targeted mainly towards outdoor uses such as irrigation, as a strategy in the SCWD IWP (SCWD, 2005) for meeting demands during drought. As a result, water demand projections during a drought assume that very little potable water is used for irrigation. Therefore, while recycled water use for urban irrigation could help maintain public parks and sports field irrigation during a drought, it would not provide the potable needs for the SCWD during a drought when additional supplies are in need.

Agricultural Application for the North Coast

This concept involved construction of a 4-7 mgd tertiary wastewater treatment plant and associated facilities to deliver treated wastewater to North Coast farmers for irrigation purposes. The plant would be located either on the existing wastewater treatment plant site, or in the industrial area of Santa Cruz and would include construction of approximately 45,000 feet of 18-inch pipe and pump station. In return, the City would get access to the groundwater supplies currently being used by these farmers.

Several major, if not fatal, flaws occurred during the evaluation of this option including most critically the following:

1. After gathering and evaluating available data on groundwater supply on the North Coast, the City discovered that there was insufficient groundwater to provide a reliable source of supply in the second year of a prolonged drought.
2. The overlying land owner, California Department of Parks and Recreation, felt the exchange involved “uncharted legal and complex policy issues having serious long-term implications of statewide consequence… .” And further that “it is the Department’s assessment that the use of reclaimed wastewater at Wilder Ranch could result in potential adverse impacts to sensitive natural resources, place possible constraints on recreational usage and adversely impact organic agricultural leasing operations at Wilder Ranch State Park.”
3. This opinion was shared with the organic farmers: “We are in favor of recycling reclaimed water on golf courses, car washing, commercial landscaping and home landscaping but not on plants grown for food, and especially not on plants that are eaten uncooked.”

Given these three factors, this concept was removed from further consideration during the analyses done in the SCWD Integrated Water Plan.

Using Recycled Water from Scotts Valley Water District

Importing recycled water from a nearby producer is an alternative to producing recycled water at the City of Santa Cruz wastewater plant. The Scotts Valley Water District (SVWD) and the Pasatiempo Golf Course (Pasatiempo), which presently receives potable water from SCWD for irrigation, entered into a Memorandum of Agreement (MOA) expressing the intent to implement a “Pasatiempo Water Conservation Initiative” in cooperation with the City of Santa Cruz. This MOA initiated discussion regarding the supply of potable water from Santa Cruz, when excess wintertime surface water is available, in exchange for an equal volume of recycled water provided by SVWD to Pasatiempo to meet the golf course irrigation demands in the summer.

However, similar to the Urban Irrigation concept, this solution does not significantly offset potable water needs for SCWD during drought.

Recycled Water Options and Limitations for SqCWD

SqCWD does not currently treat or reclaim any wastewater. Wastewater collected in the SqCWD's service area is treated at the Santa Cruz wastewater treatment facility located approximately five miles from the SqCWD's western service area boundary.

Use of recycled water from the Santa Cruz wastewater plant by SqCWD is therefore limited by the relatively long distance from the treatment plant to the SqCWD boundary, the limited irrigation market within the SqCWD service area, and constraints on the ability to use recycled water for groundwater recharge (SqCWD, 2005). The cost/benefit ratio to produce recycled water at the Santa Cruz wastewater treatment plant and deliver it to irrigation users within SqCWD's service area in a new recycled water distribution pipeline is very high compared to other supplemental supply alternatives that could use the existing potable water distribution piping system to deliver water.

The SqCWD recently investigated the potential for using recycled water as a supplemental water supply in the study:

- Water Recycling Facilities Planning Study. Black and Veatch, 2009.

This study evaluated potential applications of a newer concept of using satellite reclamation plants (SRPs) to locally treat and reuse wastewater. The concept is to divert wastewater from the sewer system for localized treatment and subsequent use by large-scale irrigation users. SRPs would allow water agencies to provide recycled water without the expense of dedicated distribution systems since the source, treatment and use would be in close proximity to one another. However, a primary limitation in making SRPs a cost-effective option is finding large irrigation demands near equally large wastewater flows.

SqCWD evaluated a total of 25 potential recycled water users. This number was limited to two based on the amount of (waste) water supply and irrigation demand. Preliminary cost estimates provided to SqCWD for a 0.12 mgd (134afy) SRP at one of the sites, the Seascape Golf Course, were approximately $9 million in construction costs with the cost of water ranging from $20-25/1000gal. Besides being more expensive than other supplemental supply projects, this particular user is not actually a customer of SqCWD. Therefore, while this project may help the overall aquifer, this particular SRP would not reduce the water demand placed on the aquifer by SqCWD.

GROUNDWATER RECHARGE WITH RECYCLED WATER (GRRP)

Another option for re-use of recycled wastewater is groundwater recharge, or GRRP. A GRRP program injects advance treated recycled water into a groundwater basin for future extraction-treatment-potable water use. Locally, a GRRP would help replenish the over-drafted Soquel-Aptos area groundwater basins.

The treatment requirements for recycled water for indirect potable reuse include advanced filtration and oxidation processes such as reverse osmosis (RO) membrane separation and ozone oxidation. The regulatory requirements governing GRRPs are discussed in more detail in Appendix A to this white paper and include compliance with:

- Blending with dilution water
- Underground residence time
- Compliance with water quality limits
- Monitoring and reporting of results.

Figures 3 and 4, below, show how recycled water would be blended with dilution water (typically filtered surface water or groundwater) for recharge into a ground water basin through percolation ponds and injection wells, respectively.

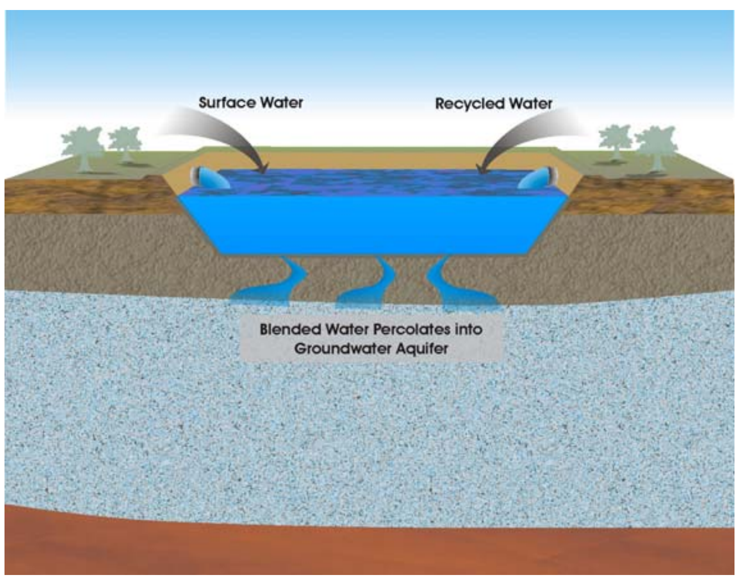

Figure 3: Dilution water and recycled water added to a percolation pond for groundwater recharge.

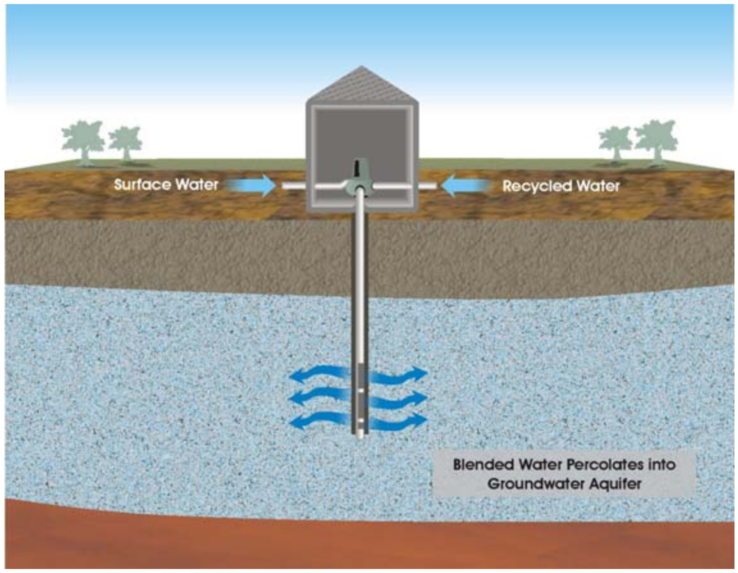

Figure 4: Dilution water and recycled water combined at an injection well for groundwater recharge.

Table 1 shows the blending percentages that are permitted for each recharge approach. In the case of a percolation pond only 20% of the percolating water is initially permitted to be recycled water. For an injection well only 50% of the percolating water is permitted to be recycled water.

Table 1: Summary of Initial Blending Requirements for Groundwater Recharge

Application	Initial Blending Requirements - Max. Recycled Water % [1]	Minimum Underground Residence Time
Surface spreading (recharge ponds)	20%	6 months
Surface spreading (recharge ponds) with reverse osmosis and advanced oxidation treatment	50%	6 months
Subsurface injection (injection wells)	50%	6 months

Source: California Code of Regulations (CCR) Title 22, Article 5.1, Groundwater Recharge Reuse Draft Regulation Table 60320.041 (dated August 5, 2008)

[1] These percentages can be increased over time based on the results of an extensive groundwater monitoring program to demonstrate that no degradation of groundwater quality is occurring, as discussed in Appendix A.

Figure 5 shows the minimum underground residence time requirement for the percolation pond or injection well with respect to a potable water source. The "groundwater travel time" separation requirement is the distance over which groundwater must travel in 6 months before it can be extracted for use.

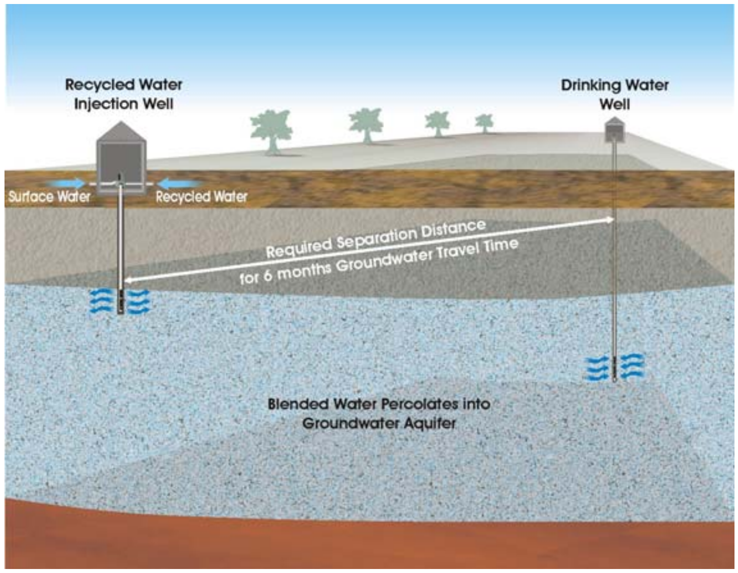

Figure 5: GRRP injection well for groundwater recharge must be separated from public and private potable wells by 6 months groundwater travel time.

GRRP for SCWD and SqCWD

Geologic, financial, regulatory, and operational constraints make it difficult for a GRRP to supply SCWD and SqCWD with sufficient water to meet their average annual and drought year demands. Constraints on a GRRP program include:

1. Numerous wells would be required to inject a sufficient quantity of recycled water to meet the average annual and drought year demands. Local geology is not conducive to the type of large, high-capacity injection wells.

2. Locating GRRP injection wells to meet the physical and travel time separation requirements would be very challenging. The injection wells would be required to be separated from all public and private wells by a minimum 6-month travel time[1] ("groundwater travel time separation distance"). There are over a thousand private potable water wells within the area referred to as the Soquel/Aptos groundwater basin, as well as the nineteen public wells for SqCWD and SCWD.

3. Blending water requirements with other surface or groundwater sources puts additional demands on these already-insufficient sources.

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[1] The 6-month minimum travel time requirement is only applicable after substantial testing has occurred. Initially, a 12 to 24-month separation between injection wells and production wells would be required, further limiting the available injection well locations.

4. Because of the urban nature of the SCWD and SqCWD groundwater basin areas, percolation ponds are not practical.

5. The recycled water must be piped long distances from the treatment plant to the injection sites further limiting potential injection locations to areas in or near the City of Santa Cruz.

A specific GRRP project that may benefit the over-drafted aquifer is an injection barrier that raises groundwater levels to prevent seawater intrusion. However, the constraints identified above prevent GRRP projects from being considered in this region.

CONCLUSION

The major conclusions of this recycled water white paper include:

- Both SCWD and SqCWD have implemented and/or are investigating small recycled water programs as part of their integrated water portfolios.

- Under current CA regulations, highly-treated recycled water is not permitted for discharge into the potable water distribution system (direct potable use) and therefore would not meet SCWD's drought water supply needs.

- Groundwater recharge with recycled water (indirect potable reuse) is not practical for SCWD or SqCWD because of the requirements that 1) recycled water be blended with up to 50% of another water source before recharge and 2) extraction by any public or private potable drinking water well must occur at a prescribed distance from the point of injection measured in terms of travel time.

- Recycled water for SCWD and SqCWD could potentially provide irrigation water for parks, sports fields, and/or golf courses, but could be prohibitively expensive both from the wastewater treatment facility and satellite reclamation plants (SRPs). From the Santa Cruz Wastewater Treatment Plant a lengthy new "purple pipe" distribution system would be required and relatively small volumes of water would be delivered. In addition, this would not satisfy SCWD's potable water supply needs during a drought. SRPs within SqCWD's service area have very limited feasible application due to the few sites with both large scale irrigation and sufficient wastewater flow and are also prohibitively expensive.

REFERENCES

Water Recycling Facilities Planning Study for Soquel Creek Water District. Black and Veatch, 2009.

California Health Laws Related to Recycled Water “The Purple Book.” June 2001.

City of Santa Cruz Alternative Water Supply Study. Carollo Engineers, 2000.

City of Santa Cruz/Soquel Creek Water District Evaluation of Regional Water Supply Alternatives. Carollo Engineers, 2002.

City of Santa Cruz Water Department 2005 Urban Water Management Plan. City of Santa Cruz Water Department, 2005.

City of Santa Cruz Water Department Integrated Water Plan. Gary Fiske and Associates, 2005.

“2004 Guidelines for Water Reuse.” Environmental Protection Agency, 2004.

Soquel Creek Water District Integrated Resources Plan. ESA, 2006.

Soquel Creek Water District Urban Water Management Plan Update. Soquel Creek Water District (SqCWD), 2005.

Appendix A: Recycled Water Regulations

A.1 Summary of Groundwater Recharge Reuse Project Regulations

The following discussion provides an overview of the regulatory requirements governing Groundwater Recharge Reuse Projects (GRRP). Implementation of groundwater recharge with recycled water requires compliance with:

- Residence time
- Blending with dilution water
- Compliance with water quality limits
- Extensive monitoring and reporting of results

The Groundwater Recharge Reuse Draft Regulations (Draft Regulations), contained in Article 5.1 of Title 22 of the California Code of Regulations (CCR), dated August 5, 2008 were used as a guide to identify the steps that may be required to evaluate the feasibility of using recycled water for groundwater recharge. These requirements may change once the Draft Regulations are finalized. A GRRP is defined as

> *"a project that uses recycled municipal wastewater, has been planned and is operated for the purpose of recharging a groundwater basin designated in the Water Quality Control Plan [defined in Water Code section 13050(j)] for use as a source of domestic water supply, and has been identified as a GRRP by a RWQCB [Regional Water Quality Control Board]."* (Title 22, Division 4, Chapter 3, Article 1)

The intent of the Draft Regulations is to protect the beneficial uses of the aquifer and demonstrate that the project will not degrade any groundwater aquifers. The feasibility of a GRRP will depend on the recycled water quality, availability and quality of diluent water, and geology, hydrogeology. Another critical component of any GRRP project is to maintain public, policy maker and government agency confidence.

CDPH and RWQCB approvals are required for all aspects of the GRRP. Communication with these agencies from project conception is highly encouraged as agency input is integral to the development of the GRRP engineering report and associated monitoring program.

A summary of the requirements for developing a GRRP is provided in the following sections.

A.1.1 Required Residence Time

For control of pathogenic microorganisms (Section 60320.010), the wastewater must be filtered and meet the definition of disinfected tertiary recycled water. In addition, the underground residence time must be ≥ 6 months prior to extraction for use as a drinking water supply for both surface spreading (i.e. recharge ponds) and subsurface injection (i.e. injection well) projects.

A.1.2 Blending Requirements

Diluent water is defined as water, other than treated wastewater, that actively or passively is used to dilute treated wastewater in a GGRP. Diluent water requirements (Section 60320.035) may be satisfied by using surface water, stormwater, or groundwater. The amount of diluent water required is a function of the water quality of the recycled water and diluent water.

The Recycled Water Contribution (RWC) is defined by the following equation in Section 60320.041:

$$RWC = \frac{\text{Recycled Water}}{\text{Recycled Water + Diluent Water}}$$

The initial RWC is based on CDPH's review of the engineering report, information from public hearings, but shall not exceed the following.

- o $RWC_{initial} \leq 0.2$ for surface spreading (i.e. 20% recycled water)
- o $RWC_{initial} \leq 0.5$ for surface spreading projects that provide reverse osmosis and subsequent advanced oxidation treatment (i.e. 50% recycled water)
- o $RWC_{initial} \leq 0.5$ for subsurface injection (i.e. 50% recycled water)

Increasing the allowable RWC is dependent on the Total Organic Carbon (TOC) in the recycled water (Section 60320.045) and would require approval by CDPH and the RWQCB modified in the permit. To increase the RWC, the previous year's TOC 20-week average must not have exceeded the following equation and the stipulations in Tables A-1 and A-2 must be met. Typically Reverse Osmosis (RO) would be required to increase the allowable RWC beyond the initial value.

$$TOC_{max} = \frac{0.5 \text{ mg/l}}{RWC_{proposed}}$$

Table A-1. GRRP RWC Operating Range Requirements – Surface Application Projects

For Operating Ranges A through E, where A = 0.00 ≤RWC < 0.20 B = 0.20 ≤RWC < 0.35 C = 0.35 ≤RWC < 0.50 D = 0.50 ≤RWC < 0.75 E = 0.75 ≤RWC ≤1.00	**RWC Operating Range**				
	A	B	C	D	E
1. Provide documentation that a groundwater monitoring well located between the GRRP and a drinking water well has received recharge water from the GRRP for at least six months such that the fraction of the GRRP's recycled municipal wastewater in the monitoring wells equals a value of at least 0.50 multiplied by $RWC_{proposed.}$		✔	✔	✔	✔
2. The groundwater impacted by a GRRP from a monitoring well and a drinking water well meets all drinking water standards and the requirements of section 60320.020 (Control of Nitrogen Compounds).		✔	✔	✔	✔
3. Provide a proposal to the Department prepared and signed by an engineer licensed in California with at least three years experience in wastewater treatment and public water supply. The proposal shall include:	✔	✔	✔	✔	✔
A. GRRP operations, monitoring, and compliance data;	✔	✔	✔	✔	✔
B. Evidence that a groundwater monitoring well located between the GRRP and a drinking water well has received recharge water from the GRRP for at least one year such that the fraction of the GRRP's recycled municipal wastewater in the monitoring well equals a value of at least 0.8 multiplied by $RWC_{maximum.}$		✔	✔	✔	✔
C. Validation of appropriate construction and siting of monitoring wells pursuant to section 60320.070.	✔	✔	✔	✔	✔
D. A scientific peer review by an independent advisory panel that includes, as a minimum, a toxicologist, a registered engineering geologist or hydrogeologist, an engineer licensed in California with at least three years experience in wastewater treatment and public water supply, a microbiologist, and a chemist.				✔	✔
E. Submittal of an updated engineering report and operations		✔	✔	✔	✔
4. At a minimum, for that portion of the recycled municipal wastewater stream needing additional treatment to meet the TOC limit in section 60320.045, provide reverse osmosis treatment as well as subsequent advanced oxidation treatment. The advanced oxidation treatment shall provide, at minimum, a level of treatment equivalent to a 1.2 log NDMA reduction and 0.5 log 1,4-dioxane reduction, whether NDMA or 1,4-Dioxane are present or not.	✔	✔	✔	✔	✔

Table A-2. GRRP RWC Operating Range Requirements – Subsurface Application Projects

For Operating Ranges A through C, where A = 0.00 ≤RWC < 0.50 B = 0.50 ≤RWC < 0.75 C = 0.75 ≤RWC < 1.00	**RWC Operating Range**		
	A	B	C
1. Provide documentation that a groundwater monitoring well located between the GRRP and a drinking water well has received recharge water from the GRRP for at least six months such that the fraction of the GRRP's recycled municipal wastewater in the monitoring wells equals a value of at least 0.50 multiplied by $RWC_{proposed.}$		✔	✔
2. The groundwater impacted by a GRRP from a monitoring well and a drinking water well meets all drinking water standards and the requirements of section 60320.020 (Control of Nitrogen Compounds).		✔	✔
3. Provide a proposal to the Department prepared and signed by an engineer licensed in California with at least three years experience in wastewater treatment and public water supply. The proposal shall include:	✔	✔	✔
A. GRRP operations, monitoring, and compliance data;	✔	✔	✔
B. Evidence that a groundwater monitoring well located between the GRRP and a drinking water well has received recharge water from the GRRP for at least one year such that the fraction of the GRRP's recycled municipal wastewater in the monitoring well equals a value of at least 0.8 multiplied by $RWC_{maximum.}$		✔	✔
C. Validation of appropriate construction and siting of monitoring wells pursuant to section 60320.070.	✔	✔	✔
D. A scientific peer review by an independent advisory panel that includes, as a minimum, a toxicologist, a registered engineering geologist or hydrogeologist, an engineer licensed in California with at least three years experience in wastewater treatment and public water supply, a microbiologist, and a chemist.		✔	✔
E. Submittal of an updated engineering report and operations		✔	✔
4. For the entire municipal wastewater stream, provide reverse osmosis treatment as well as subsequent advanced oxidation treatment. The advanced oxidation treatment shall provide, at minimum, a level of treatment equivalent to a 1.2 log NDMA reduction and 0.5 log 1,4-dioxane reduction .	✔	✔	✔

Source: California Code of Regulations (CCR) Title 22, Article 5.1, Groundwater Recharge Reuse Draft Regulation Table 60320.041 (dated August 5, 2008)

A.1.3 Water Quality Limits

The GRRP includes stringent water quality limits for recycled water intended for groundwater recharge. Certain treatment technologies such as nitrification and denitrification will aid in meeting monitoring requirements. Reverse osmosis is the preferred method of treatment to achieve the water quality standards and limits laid out in the GRRP and to support increasing the RWC. Advanced oxidation may also be required to reduce concentrations of NDMA and other constituents of concern.

Nitrification and denitrification in the treatment process is recommended to make meeting monitoring requirements for control of nitrogen compounds easier. Three methods, with varying monitoring programs, sampling frequencies and constituent limits, are permitted to demonstrate control of nitrogen compounds (Section 60320.020).

As described in Section 60320.030, regulated chemicals and physical characteristics of the recycled water should:

- meet most drinking water standards (primary and secondary)
- not exceed MCLs for inorganic chemicals,
- not exceed MCLs for disinfection byproducts,
- have lead concentration ≤ 0.015 mg/l,
- have copper concentration ≤ 1.3 mg/l, and
- meet secondary MCLs defined in Tables 64449-A and B in Chapter 15 of the Water Code (salinity can be a problem)

Additional constituent monitoring of unregulated contaminants such as pharmaceuticals, endocrine disrupting chemicals, and other indicators will be required based on a review of the GRRP engineering report (Section 60320.047). Monitoring of unregulated contaminants is for informational use, rather than for compliance, to assist in addressing public perception about the safety of the GRRP.

A.1.4 Monitoring and Reporting Requirements

The following sections of the Draft Regulations stipulate monitoring and reporting requirements prior to initiating the GRRP, during the first year of operations, and annual reporting requirements thereafter; Operation Optimization (Section 60320.065), Monitoring between the GRRP and Down Gradient Drinking Water Supply Wells (Section 60320.070), and Annual Five-Year Reporting (Section 60320.090). Approaches to meet the requirements will be described in the engineering report and will require approval by the CDPH and RWQCB. Requirements for monitoring well locations and sampling frequency are also detailed to provide assurance that the GRRP are meeting the required residence time, travel time, and water quality constituents specified by the CDPH.

To demonstrate successful implementation of strategies to meet these requirements, the site-specific Engineering Report (Article 7, Section 60323) will need to include the following:

- Description of the existing geologic and groundwater characteristics around the GRRP area, including identification of potable water wells in the area, prepared by a registered engineer and registered geologist
- Description of the proposed RWC and anticipated TOC.
- Evaluation of how the groundwater basin would respond to recycled water recharge based on groundwater modeling and monitoring. This would include but not be limited to:
    - Provide evidence that it is possible to track the movement of water from the GRRP facility to the downgradient extraction point(s)
    - Provide evidence the GRRP would not result in an exceedence of the MCLs at any downgradient extraction points(s).
    - Provide evidence the GRRP would meet groundwater quality requirements, underground residence time, assimilative capacity requirements', other requirements specified in the groundwater management plan.
- Description of the operation of the recharge facility and how it would be connected to the recycled water lateral.
- Discussion of plan to provide an alternative source of domestic water supply, or a department approved treatment mechanism to any user of a producing drinking water source that may be affected by the groundwater.
- Description of proposed means for compliance with groundwater recharge regulations and water recycling criteria.
    - Demonstrate recycled water has been treated to meet water quality treatment and groundwater standards for control of microorganisms, nitrogen compounds, dissolved oxygen, regulated chemicals, total organic carbon, and additional constituent as needed (i.e. non-regulated contaminants).
    - Develop comprehensive operations, sampling, and monitoring plan to meet the required reporting requirements for the aforementioned water quality constituents. Construction of monitoring wells between the GRRP and down gradient drinking water supply wells are required.
- Meet all RWC requirements specified by the CDPH and/or RWQCB, as described in Table 1 GRRP RWC Operating Range Requirements.
- Develop the following plans:
    - a contingency plan which will assure that no untreated or inadequately treated wastewater will be delivered to the use area.
    - an operations plan to ensure optimization during the first year of operation.

- a plan to meet public notification and hearing requirements.
- a plan to meet annual and five-year reporting requirements

The groundwater recharge facility plans would be developed and submitted to CDPH for review and approval. CDPH will hold a public meeting for the GRRP prior to submitting recommendations for the initial permit to the RWQCB. This process would also be required any time an increase in the RWC is proposed.

A.2 Evaluation of Seasonal Storage in Groundwater Aquifer

Recycled water could be used seasonally to recharge the groundwater aquifer. Typically, these projects are designed to increase the volume of groundwater in aquifer storage to build up long-term water supplies for the area. Recycled water is currently being used for groundwater recharge projects in California with the following agencies:

- Orange County Water District
- Inland Empire Utilities Agency
- West Basin Water District
- Sanitation Districts of Los Angeles County

In developing a groundwater recharge project, finding an available water source is a common limiting factor. Water rights may not exist to use available natural sources and importing water can be expensive. Recycled water provides a potential local water source. Recycled water is anticipated to be available seasonally during the winter and early spring when irrigation demand is at its lowest. Rather than allowing the water to be discharged to the ocean, the recycled water could be incorporated into a groundwater recharge project.

A.2.1 Recharge Methods

Surface spreading (i.e. recharge ponds) and subsurface injection (i.e. injection wells) are the two primary methods for groundwater recharge. Recharge ponds are large, shallow ponds enclosed by dikes or levees that are filled intermittently with water and the water is allowed to percolate into the ground. The pond bottom is situated above the water table, so the recharge flow percolates through the unsaturated soils to reach groundwater. Surface recharge facilities have lesser regulatory requirements than subsurface injection primarily because percolation of recycled water through the vadose zone is considered to provide a water quality benefit.

Groundwater recharge using subsurface injection consists of a series of wells drilled into a suitably transmissive zone in the underlying groundwater aquifer. Water is pumped under low pressures into these wells and allowed to infiltrate into the aquifer. Recycled water is discharged directly to the saturated zone bypassing the unsaturated zone. Therefore, the injection well option would produce the water quality benefits from flow through the aquifer, but not the benefits from flow through the unsaturated soils (Bouwer, 1997, 2002; Morris and Quinn, 1999; Asano, 1985).

A.2.2 Aquifer Characteristics

Local aquifers must be characterized to evaluate their feasibility for recharge with recycled water. Aquifers that occur at the surface can be used for surface spreading, while aquifers that overlain by other formations can be used for well injection. Aquifers that occur at great depths are less likely to be candidates for recharge. Other factors considered in evaluating recharge potential are hydraulic conductivity, porosity, existing groundwater levels, and groundwater flows.

A.2.3 Assessment

Water quality is a major issue when using recycled water; therefore, the addition of recycled water to a groundwater aquifer used for drinking water supplies is regulated by the CDPH. The regulations require a residence time and setback distance from a drinking water source for control of pathogenic microorganisms. Site specific evaluations would be necessary for areas under the influence of large pumping wells or other hydrologic conditions that produce higher hydraulic gradients.

The regulations also limit the initial recycled water contribution for a groundwater recharge reuse project to 20%. These percentages can be increased over time based on the results of an extensive groundwater monitoring program to demonstrate that no degradation of groundwater quality is occurring.