Final Hydrologic and Water Quality Evaluation of the South County Water Recycling Master Plan, Santa Clara County, California

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 Project Assignment 205034

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1. INTRODUCTION

1.1 Background

As part of an effort to meet long-term water supply needs and improve water supply reliability in South Santa Clara County, California, the Santa Clara Valley Water District (the District) and the South County Regional Wastewater Authority (SCRWA) seek to expand the use of recycled water. Plans for this expansion are described in the South County Recycled Water Master Plan (Master Plan) (Carollo, 2004), developed jointly by the District and SCRWA. Under the existing partnership agreements between the District, SCRWA, and the Cities of Gilroy and Morgan Hill, the District serves as the recycled water wholesaler, SCRWA as the supplier, and the Cities of Gilroy and Morgan Hill as retailers for tertiary treated recycled water. The tertiary treated recycled water supply will come from the South County Regional Wastewater Treatment Plant (WWTP), which is operated by the SCRWA.

Existing facilities at the WWTP can produce up to 3 million gallons per day (mgd) of tertiary-treated wastewater suitable for recycling applications. Customers in Gilroy currently use most of this water. Expansion to a capacity of 9 mgd was completed in 2006. Utilization of this additional capacity involves construction of distribution pipelines and establishment of a customer base. The Master Plan phases the proposed expansion into three capital improvement programs: immediate-, short-, and long-term. Immediate-term program projects are targeted for implementation within the next year, and have already passed through the CEQA review process. The short-term program includes projects to be implemented within a five-year period and the long-term program represents the ultimate system configuration. Identification and prioritization of project alternatives within the Master Plan are based on assessment of the market for recycled water, peak flow demands, cost effectiveness, hydraulic analysis, pipeline routes, and environmental constraints.

1.2 Purpose and Objectives

The general purpose of this Hydrology Report is to provide an evaluation of the hydrologic and water quality effects of the short-term program in support of the Environmental Impact Report/Environmental Assessment (EIR/EA) documentation. Long-term program hydrologic impacts will be addressed at a general (programmatic) level in the EIR/EA. Some specific objectives associated with this purpose include the following:

- Summarize existing and proposed site conditions,
- Assess the potential hydrologic and water quality benefits of the program as well as the potential impacts of long-term use of recycled water for irrigation and industrial processes,
- Evaluate potential benefits and impacts of long-term use of recycled water on the ground water,
- Provide recommendations that may help increase the benefits and reduce the impacts associated with the proposed project, and
- Recommend monitoring measures, as appropriate.

1.3 Work Conducted

In order to achieve the objectives listed above, a number of tasks were conducted. Background research was performed to review the Master Plan, identify site soils, review existing applications and previous studies, and characterize existing flood zones. A site visit was conducted on August 8, 2005 to tour the proposed short-term program facilities with staff from the District. The tour focused on pipeline alignment. The potential effects of the project with respect to surface- and ground-water hydrology and drainage patterns were assessed along with water quality impacts potentially associated with the land application of recycled water. These analyses are summarized in this technical report.

2. PROJECT DESCRIPTION

2.1 Existing Conditions

The existing recycled water system is described in detail in South County Recycled Water Master Plan (Carollo, 2004), which also provides a list of additional background documents. SCWRA treats wastewater from the Cities of Gilroy and Morgan Hill at the existing wastewater treatment plant (WWTP) located on Southside Drive southeast of Gilroy (Figure 1). As of 2004, the average dry weather flow to the WWTP was 6 mgd. The WWTP has the capacity to treat up to 7.5 mgd to secondary treatment standards. Currently, up to 3 mgd of secondary effluent can be diverted to a tertiary treatment process. The tertiary process, consisting of coagulation, sand filtration, chlorination, and dechlorination, produces water that meets California's Title 22 criteria for unrestricted-use recycled water (Carollo, 2004), which are included as Appendix A. SCRWA expanded the tertiary treatment capacity at this WWTP to 9 mgd in 2006, and plans further increases as the demand for recycled water continues to increase.

The District, SCRWA, and the Cities of Gilroy and Morgan Hill entered into agreements in 1999 to distribute recycled water. These agreements designate SCRWA as the producer, the District as the wholesaler, and the Cities of Gilroy and Morgan Hill as retailers of recycled water. Recycled water is currently delivered only in the Gilroy area under the existing system. The existing distribution pipeline system, shown in Figure 1, consists of 8 miles (42,240 feet) of 12- to 14-inch diameter pipes, one booster station, and one 1.5 million gallon storage tank. The pipeline provides five customers with tertiary treated recycled water. These customers include Christmas Hill Park Ranch Addition, Christmas Hill Park, Eagle Ridge Development and Golf Course, Obata Farms, and the Calpine-Gilroy Energy Center. Christmas Hill Park Ranch Addition, Christmas Hill Park, and the Eagle Ridge Development and Golf Course use recycled water for landscape irrigation. Obata Farms uses recycled water for agricultural irrigation, and Calpine-Gilroy Energy Center uses recycled water for its cooling tower. Recycled water usage has been consistent over the four year period of 2000 through 2003, peaking during the month of July at a flow rate of approximately 1.2 mgd. Additional details on existing recycled water users are available in the Master Plan (Carollo, 2004).

2.2 Proposed Conditions

Carollo Engineers, District Staff, and SCRWA collaborated to develop screening criteria and perform a market analysis to identify and prioritize potential recycled water customers.

Hydraulic modeling was conducted by Carollo Engineers to assess existing pipeline capacity and the additional capacity needed for the planned expansion of recycled water customers. The hydraulic modeling indicated that expansion of the main pipeline is necessary to serve additional recycled water customers in the short-term and long-term phases.

The Master Plan also includes an environmental constraint analysis to ensure that selection of the proposed improvements considers potential environmental impacts. Most of the proposed pipelines will be constructed along existing roadways to minimize potential impacts.

2.2.1 Immediate-term phase

The immediate-term capitol improvement program (CIP) was completed in 2006 and consists of a pump station, reservoir, and 5,000 feet of a 12-inch pipeline. Obata Farms is the only agricultural recycled water user, and has been evaluated in a previous EIR evaluation as an existing and immediate term user (Earth Metrics Incorporated, 1986). These program elements were analyzed in a separate Initial Study for the Tertiary Filtration Expansion Project (MWH, 2005) and are incorporated by reference in this analysis.

2.2.2 Short-term phase

In the short-term phase, the new pipe alignment consists of 16,000 feet (3 miles) of 16-inch diameter pipe and 24,000 feet (4.5 miles) of 30-inch diameter pipe. Pumping capacity will also be increased at the WWTP and Christmas Hill Park with a total capacity of 6 mgd, and a 3 million gallon storage tank at the WWTP. The southeast portion of the pipeline will be along Gilroy city streets or within a 25-foot wide corridor on one side or the other of the paved surface. It will pass north from the WWTP, west along Southside Drive, Luchessa Avenue, and Thomas Road, and northwest through an open-space parcel where the Glen Loma Ranch Residential Community is proposed. On the west side of Glen Loma Ranch, the new pipeline will continue north along Miller Avenue and meet the existing recycled water pipeline near Christmas Hill Park (Figure 1). The new alignment will then run adjacent to the existing pipe from Christmas Hill Park west along a gravel road to Club Drive, where it will turn south for about 0.4 miles and terminate. Approximately 11,575 ft of pipeline is proposed within the Glen Loma Ranch Development area. The hydrologic and water quality impacts associated with this portion of the short-term program were analyzed in the EIR for that project (Gessford, 2005) and are incorporated herein by reference. The Glen Loma Ranch Development is sponsored by the City of Gilroy.

Two short additional pipeline segments are also proposed in the short-term phase. One runs north along Monterey Road from the proposed new main pipeline to near the existing pipeline, and south from the proposed new main pipeline to Gilroy Sports Park. This pipeline was constructed as part of the Gilroy Sports Park, which was completed in 2006. The second additional segment runs north from the existing pipeline along Camino Arroyo Drive and northeast along Holloway Street to the Cintas Corporation for industrial uses. The proposed short-term pipeline alignments will cross Uvas Creek at the West Luchessa Avenue/Thomas Road crossing. There are three additional channel crossings at unnamed tributaries to Uvas Creek, two of which are along the section where the new pipeline follows the existing pipeline alignment.

Immediate and short-term recycled water customers are listed in Table 1, with locations shown in Figure 1. Immediate-term customers are already using recycled water and are described above in Section 2.1. The proposed short-term customers are divided into two groups: A1 and A2. Group A1 includes customers that can be connected to the existing distribution system as soon as possible with minimum capital cost. These customers include Gilroy High School, Ascension Solorsano Middle School, Gilroy Golf Course, Gilroy Sports Park, and the Glen Loma Ranch Development. Group A2, consisting of Cintas Laundry, Inland Packaging, and Calpine's Gilroy Energy Center, represents industrial customers that will have year-round demand.

2.2.3 Long-term phase

The long-term phase proposed in the Master Plan, to be completed sometime after 2011, involves construction of 14,000 feet (2.65 miles) of 16-inch diameter pipeline and a 2 mgd expansion in booster pump capacity. The preliminary pipeline alignment is shown in Figure 1 but may be revised when more information is known about potential customers. The long-term pipeline alignment is likely to include a one-mile southern extension from Gilroy Sports Park between Monterey Road and Santa Theresa Boulevard. Land use in this area presently consists of agricultural fields. However, the current Gilroy Parks and Recreation Master Plan proposes a future trail through this area connecting the Gilroy Sports Park to the Gavilan College area. Therefore, it is recommended that this segment of the recycled water pipeline should join the construction of the trail to minimize the environmental impact and increase the economic efficiency. This trail and pipe segment would cross Uvas Creek a short distance south of the boundary of Gilroy Sports Park. The long-term plan also includes two new pipelines on the west side of Gilroy. One pipe route extends west to Santa Teresa Boulevard, north along Santa

Teresa Boulevard, and then west along State Highway 152. This segment would cross Uvas Creek at the Santa Teresa Road Bridge. The other proposed long-term pipe route connects to the existing pipeline in Ousley Canyon and extends southwest up Club Drive.

Long-term customers are located primarily in the Hecker Pass and Gavilan College areas. The customers in these groups are listed as large irrigators. Hecker Pass Development and Goldsmith Seeds are located at the far western end of the pipe system and would be served by the long-term pipe installed along Hecker Pass Highway. Bonfonte Gardens (Gilroy Garden) will be served by the long term pipe to the southwest along Club Drive. Gavilan College, Sports Park, and Golf Course are located at the south end of the pipe system along Santa Teresa Boulevard.

3. HYDROLOGIC SETTING

The occurrence and movement of surface and ground water in Southern Santa Clara County is dictated by regional climate, geologic, and hydrologic characteristics as well as the management activities of the Santa Clara Valley Water District. The proposed pipeline, and associated facilities and customers are located within the Uvas/Llagas watershed, which drains south to the Pajaro River and Monterey Bay. Virtually the entire southern Santa Clara valley floor draining to the Pajaro River is underlain by the Llagas ground water sub-basin.

The District acts as the water wholesaler and manages water resources in South Santa Clara County. Runoff from primarily rural areas in the foothills is collected in reservoirs for storage and sometimes blended with imported water before being conveyed to ground water recharge facilities. Uvas and Chesbro reservoirs are two large reservoirs located in the Uvas/Llagas watershed. Uvas reservoir is upstream of the proposed irrigation sites on the other side of Hecker Pass, to the northwest. Chesbro reservoir is on Llagas Creek upstream of Paradise Valley to the west of Morgan Hill.

3.1 Physiographic Description

The project site follows a linear corridor along Uvas Creek. A number of application sites are also located in the City of Gilroy in Southern Santa Clara County, approximately 32 miles south of San Jose and 300 miles north of Los Angeles. All project components are located in the portion of the Santa Clara Valley draining southward to the Pajaro River and Monterey Bay (Figure 2). The valley is bordered by the Santa Cruz Mountains to the west and the Diablo Range to the east. Elevations along the short-term pipeline alignment range from 155 feet at the WWTP to 220 feet on the west end. The application sites are at similar elevations (Table 1). The long-term pipeline alignment reaches elevations of up to 275 feet on its west end. Agriculture, although it is being gradually replaced by residential and industrial uses over the past years, is still a dominant land use in the region.

3.2 Climate Characteristics

Santa Clara County has a Mediterranean climate, with almost all precipitation falling between the months of November and April. Annual average rainfall amounts vary significantly due to topography. Higher elevations in the Santa Cruz Mountains can receive 40 to 60 inches per year, while the valley floor receives on average 21 inches in the vicinity of the City of Gilroy

(Carollo, 2004). Periods of abundant winter precipitation and prolonged periods of drought are both frequent in the historical record. During wet years, precipitation can attain about 240% of the annual mean, with the driest years being about 45% of the annual average.

Temperatures in the vicinity of the project site rise sharply in late spring and remain elevated through early fall. Evaporation rates and evapotranspiration (ET) rates also rise in response to the warmer weather and can be considerably higher than precipitation on an annual basis – averaging about 45 inches ET per year – with root zone soil moisture storage typically depleted by early to mid May.

3.3 Geology

Southern Santa Clara County is an extension of the larger Santa Clara Valley—an alluvial fill basin flanked by the Santa Cruz Mountains on the west and the Diablo Range on the northeast. The Santa Clara Valley, in the vicinity of Morgan Hill and Gilroy, is flanked by two active faults. The Calaveras fault is located along the eastern side of the valley, and the Sargent fault is located in the Santa Cruz Mountains above the western side of the valley (Brabb and Dibblee, 1974). These are predominantly strike-slip faults with right lateral displacements (east blocks move relatively south) (Helseth, 1968). The Santa Clara Valley is east of the San Andreas Fault and therefore, bedrock is primarily Franciscan greenstones, greywackes and argillites—a complexly folded and low-grade metamorphosed ancient sea floor. Consolidated sediments, with some volcanic-rock intermixed, lie above the Franciscan bedrock in places on each side of the main valley floor.

The southern Santa Clara Valley, referred to here as the Llagas/Uvas Basin, is filled with alluvium composed of an accumulation of Quaternary clay, sand and gravel. Lower and flat-lying portions of the valley, generally between Gilroy and Hollister, are underlain by thick deposits of heavy clays formed by at least two Pleistocene lakes, San Benito and San Juan (c.f., Jenkins, 1973). These clays thicken from the edges of the paleo-lakes to depths of several hundred feet. They form a classic aquitard, which acts as a confining layer separating a shallow unconfined aquifer and a deeper confined aquifer, from which most water is produced. Prior to the 1920s, the lower zone was fully artesian where confined below the clays (Clark, 1924). Presence or absence of these lake clays establish whether water will percolate directly to the deep aquifer. Although the aquitard feathers out toward its edges, it is a dominant hydrogeologic feature in this valley. Recent micro-stratigraphic work in the northern portion of the Llagas Basin by Mactec, Inc. has shown that the lacustrine deposits may not be as laterally extensive as previously thought (Taraszki and others, 2007). Alluvial channels may have incised through the clays to create local connections between the aquifer units (T. Hemmeter, pers. Com, 2008). It is also likely that protodeltas of Llagas and Uvas Creeks may have prograded far into the Pleistocene lakes, perhaps at times when upper Coyote Creek was draining southward through the study area (c.f., Clark, 1924 and subsequent geologic reports). Although the Mactec work was conducted outside the immediate area of this study, it is possible that the same process could have caused similar discontinuities in clays throughout the basin.

The clays also affect the form and pattern of Uvas Creek, which transitions from a wide, braided sand-and-gravel channel to an incised, narrow channel with clay and silt banks. This transition occurs as it flows downstream through the reach between Santa Teresa Boulevard and Thomas Road. South of Thomas Road, the creek is flowing within the lake-bed clays and is decoupled from the deeper ground-water zones. Uvas Creek can recharge up to 15 to 20 cfs in the roughly 7.5 miles between Uvas Dam and Santa Teresa Boulevard. The recharge rate diminishes sharply downstream of Santa Teresa Boulevard, with little or no percolation occurring 1.9 miles further downstream below Thomas Road.

3.4 Soils

The soils in the Gilroy area are a mix of deep, well-drained soils formed from the Quaternary alluvium, fans and stream benches, and poorly-drained soils which have developed on the silts and clays deposited in the former Pleistocene lakes (Helseth, 1968) (Figure 3 and Table 2). The majority of the area beneath and to the south and southeast of Gilroy is underlain by the Clear Lake-Campbell and Clear Lake-Pacheco soil associations. These soil associations are nearly level, poorly drained clays to clay loams in low positions on alluvial plains and fans. Clear Lake, Campbell, and Pacheco are three of the primary soils in these areas, all of which are clays or clay loams that drain slowly and have low erosion hazard (Table 2). The sandier Yolo association soils have developed on the alluvium of Uvas Creek and Llagas Creek channels, which extends along the foothills to the west of Gilroy, and in the southern half of Gilroy in the valley bottom. The Yolo association consists of nearly level to sloping, well-drained loams and silty clay loams on alluvial plains and fans. These soils are a mix of loams and silty-clay overlying loamy substrata. They are the most productive soils in the Santa Clara Valley, and have a low erosion hazard (Table 2). The Arbuckle-Pleasanton association occupies the nearly level to moderately sloping older alluvial fans and terraces along the edges of the valley to the west and northwest of Gilroy. This association consists of well to somewhat excessively drained, medium textured, gravelly soils, developed on gravelly alluvium. This soil also has gravelly loam surface and developed clay subsoils overlying mixed gravelly substrata.

The ability of a soil to infiltrate water should be considered in selecting management options at application sites. The proposed short-term recycled water customers appear to be located on moderately well or moderately slowly drained soils (hydrologic soil groups [HSG] B and C) (Figure 3). Irrigation sites 69 and 2 are underlain by Campbell soil series, clay loams that have somewhat limited infiltration capabilities (HSG C). Irrigation site 1 is underlain by the Sunnyvale soil series, which is silty clay that also has limited infiltration (HSG C). Irrigation site 46 is located in the moderately well drained (HSG B) Pleasanton gravelly loams. Water user 44 is located on well drained (HSG B) Garretson gravelly loams. The furthest western site (Site 7) is located on moderately well-drained (HSG B) and potentially erosive San Andreas fine sandy loams.

The proposed pipelines cross a variety of soil types. Along roadways, it is possible the native soil type was replaced with fill during road construction. The new pipeline passes from the WWTP across flat regions of Sunnyvale, Campbell, and Yolo soil series. The new spur lines along Monterey Road and Camino Arroyo Drive pass through these soils as well. Each of these soils is clay or clay loam with minimal to no erosion hazard, primarily due to the flat slope. The pipeline extends west, passing over the Uvas Creek channel on the Thomas Road Bridge, into the future Glen Loma Ranch residential community where it crosses Pleasanton, Hillgate, Keefers, and Los Osos soils. The Pleasanton series is a gravelly clay loam, the Hillgate a silt loam, and the Keefers series a clay loam. All three can present a slight to moderate erosion hazard. Los Osos soils are clay loams with moderate to high hazard of erosion. At this point the pipeline rejoins the existing pipeline and extends west through Pleasanton, Yolo, and Garretson loams and gravelly loams, which present only a slight erosion hazard. Three separate long-term pipe routes are shown. The only pipe route to cross a region of moderate to high erosion hazard is the northwestern line as it travels west from Santa Teresa Boulevard. This pipeline follows the route of the existing one; both lines pass through the moderately to highly erosive Los Osos clay loams immediately west of the connection with the existing pipeline heading south.

Outcrops of serpentine occur near the valley floor in several locations. The unique properties of serpentine bedrock and the soils weathered from serpentine are well documented (Sharsmith, 1982; Kruckeberg, 1984). Although these soils often contain montmorillonite clays with the capacity to retain moisture, the soil chemistry and alkalinity of the soil moisture creates relatively stressful conditions for plant growth (Kruckeberg, 1984), which typically reduces vegetation density and diversity. Serpentine soils can also be a source of naturally-occurring asbestos. The proposed short- and long-term pipeline segments are not located within any areas of serpentine soils based on the soils mapping data presented by the USDA Soil Conservation Service (Helseth, 1968; Figure 3).

3.5 Existing Surface Water Drainage

An alluvial divide at Morgan Hill separates the drainage of the Santa Clara Valley into a north-flowing system that drains into the San Francisco Bay and a south-flowing system that drains to the Pajaro River and out to Monterey Bay (Clark, 1924; Lindsey, 1974). The proposed pipeline alignments, facilities, and recycled water customers all lie in the Llagas and Uvas Creek sub-watersheds within the south-flowing drainage system. Both Uvas and Llagas Creeks originate in the Santa Cruz Mountains and drain south into the Pajaro River. The upper watershed of each creek is predominantly brushland vegetated with manzanita, scrub oak, canyon live oak, and other associated species (Sharsmith, 1982). The project area is situated in the valley among grasslands, residential and commercial development, and cultivated farmland.

At the more local scale, the southeast portion of the proposed short-term phase pipeline alignment is located in the flat portions of Gilroy underlain by the clays deposited in the Pleistocene lakes. Drainage in this area from Southside Drive typically runs into grass-lined ditches along the shoulder of the road and into open areas such as fields or industrial areas. Curb and gutter systems exist along parts of East Luchessa Drive. West of Monterey Street, a wide bike lane is present with a curb and sidewalk on the north side of the street and open agricultural land south of the road. The road appears to be crowned such that stormwater from the westbound lane runs to the curb, and stormwater from the eastbound land runs south across a vegetated buffer and onto the agricultural land south of the road.

From approximately the intersection of Princevalle Avenue to the bridge over Uvas Creek, Thomas Road runs immediately on the north side of and adjacent to the northern levee of Uvas Creek, with the same curb and sidewalk to the north. West of the Uvas Creek Bridge, Thomas Road splits to the south and West Luchessa Road expands to four lanes with curbs on each side and a paved median. All street runoff in this section drains to the outer curbs and into storm drain inlets. The proposed Glen Loma development is to drain into Uvas Creek and its tributaries. Stormwater quantity, peak discharge and quality would be managed using a detention basin and other pre-treatment BMPs such as grassy swales (Gessford, 2005). Runoff from Christmas Hill Park and open spaces to the west along the south side of Uvas Creek generally travels overland across the relatively flat fields into Uvas Creek.

3.5.1 Uvas-Carnaderos Creek

A significant portion of the project area is located within the Uvas Creek watershed, and in some cases along the creek corridor. Uvas Creek drains an approximately 90 square mile watershed originating 3,791 feet above mean sea level at Loma Prieta on the east slopes of Santa Cruz Mountains and ending at an elevation of 120 feet above msl at its confluence with the Pajaro River, southeast of Gilroy. Uvas Creek provides migration access, spawning and rearing, in all but extreme drought years, for adult steelhead (*Oncorhynchus mykiss*) using the Pajaro River as a migration pathway (HRG, 1997). Additional beneficial uses listed for Uvas Creek include municipal, domestic, industrial, and agricultural water supply; ground-water recharge; recreation; warm and cold freshwater habitat; endangered species habitat; and fishing (Table 3).

Uvas Creek is dammed in the Santa Cruz Mountains forming Uvas Reservoir approximately 15 miles upstream of Gilroy. Uvas Creek runs year round above the reservoir, with flows downstream of the dam regulated by the District. Summertime dry season reservoir releases are adjusted to the percolation capacity of the upper reach so that lower reaches of Uvas become dry by mid to late summer. The District maintains two stream gages on Uvas Creek: 1) below the Uvas Reservoir with a record dating back to 1990, and 2) at the former USGS gage site in Gilroy[1] with a flow record beginning in 1959. The USGS gage site data for the pre-1991 period show peak winter storm discharges ranging from as high as 6520 cubic feet per second (cfs) during the 1986 flood to summer baseflows as low as 0 cfs. The watershed area at this point in the drainage is 71.2 square miles. The creek exhibits highly variable storm runoff, and sediment transport with major influxes of sand and gravel particularly following episodic events such as fires and landslide-generating storms (c.f, Hecht, 1983; Hecht and Woyshner, 1991; also, Kondolf, 2001).

Typical of streams draining Franciscan geology, Uvas Creek was originally a braided channel prior to human intervention, transitioning to an incised, single-thread channel downstream of Thomas Road. The difference in planform is so great that the Spanish land-grant settlers used a different name (Carnaderos Creek) for the downstream portion of the creek. The transition in

[1] USGS station number 11154200 Uvas Creek nr Gilroy

the form of the creek coincides with (and is caused by) a transition from the gravelly upland alluvium to the heavy lake clays which dominate the lower flat portions of the valley. At the finer scale, the Uvas Creek channel currently exhibits a variety of planforms through the project area. It is a single channel at the western end of the long-term customer area. Despite previous reconstruction efforts that attempted to stabilize a single channel planform (Kondolf et al., 2001), the channel planform becomes more braided in the reach from a quarter mile west of Santa Teresa Boulevard through to Christmas Hill Park. Downstream of Christmas Hill Park, the banks are stabilized with trees and the creek forms a single channel again, which it maintains through the agricultural lands to the south until its confluence with the Pajaro River. The short-term proposed pipeline distribution system will cross Uvas Creek one time in the City of Gilroy at the Thomas Road Bridge. The long-term pipeline will cross the Uvas Creek twice, once to the south in the agricultural area, and also west of Gilroy at the Santa Teresa Boulevard Bridge.

3.5.2 Llagas Creek

Llagas Creek drains a 104 square-mile watershed that lies north and adjacent to Uvas Creek watershed. It originates on the eastern slopes of Santa Cruz Mountains and drains northeastward from Loma Prieta at 3,791 feet above mean sea level. Near Morgan Hill, Llagas Creek flows through Paradise Valley and the main Santa Clara Valley before its confluence with the Pajaro River at 140 feet above msl southeast of Gilroy. The upper watershed is mostly underlain by Franciscan geology. The lower sections of Llagas Creek are braided, and characterized by high storm flows, low baseflows and abundant sand and gravel transport. Sand and gravel transport is particularly high following episodic events such as wildfires and large storms that disturb the soils of vegetative cover. These characteristics are similar to those of Uvas Creek and are typical of streams draining Franciscan geology. Llagas Creek drains to the Pajaro River east of Gilroy. Steelhead migrate into Llagas Creek from the Pajaro River, but the use of Llagas Creek by steelhead is less frequent and less extensive than Uvas Creek (HRG, 1997).

Llagas Creek is dammed in its upper reaches within the Santa Cruz Mountains forming Chesbro Reservoir. Flow releases from Chesbro Dam are regulated by the District. Normally, reservoir releases are adjusted to the percolation capacity of the lower reach. Steelhead passage through the lower reaches of Llagas is commonly blocked by dry streambeds by May or early

June. The USGS has maintained a gage on Llagas Creek near Gilroy[2] since December 2002 that shows typical summer baseflows of 0.3 cfs. The District[3] has documented floods on the Llagas in 1937, 1955, 1958, 1962, 1963, 1969, 1982, 1986, 1996, 1997, 1998, and 2002.

3.5.3 FEMA Flooding

Flooding is an important consideration in Santa Clara County and the District is responsible for flood management in the creeks and major drainage channels. Local drainage systems, such as storm drains, are the responsibility of cities and counties. The conveyance capacity of channels is maintained and enhanced through implementation of the District's Stream Maintenance Program which includes three major activities: 1) sediment removal, 2) vegetation management, and 3) bank protection. Although the National Weather Service is responsible for flood warnings, the District assists the process by maintaining and providing access to data generated by the Automated Local Evaluation in Real Time (ALERT) system. The ALERT system is a network of 44 rain gages, 38 streamflow gages, 11 reservoir gages and one weather station. Data are made available on the District's web site (http://alert.valleywater.org/). In addition to real time stage, streamflow and rainfall data, the District publishes flood hazard threshold information for several ALERT stations. The conveyance capacity of these systems is listed with current levels. The only ALERT system gage within the Uvas/Llagas Creek Basin is on Uvas Creek at West Luchessa Avenue (Station ID 2084). The District and the USACE have ongoing flood protection projects on Llagas and Uvas Creeks to protect homes and businesses against flooding.

Flooding of varying severity has been documented along Llagas and Uvas Creeks in Gilroy since the late 1800s (FEMA, 1998). Flood damage in the early years was limited because the primary land use was agriculture. Flood damage became more of a concern in the early and mid-1900s as developed properties and impervious surfaces spread. Major floods have struck recently in 1952, 1955, 1982, 1986, 1995 and 1998 (FEMA, 1998). Completion of the Uvas Dam in 1957 reduced, but did not eliminate, flooding in Gilroy. Levees, channel realignments, bridge and culvert replacements, vegetative restoration, and flood channels have been emplaced to contain flood flows along Uvas and Llagas Creeks, although these measures have been of varying effectiveness. Special flood hazard areas in Gilroy designated by FEMA include the corridor along Uvas Creek, some of the fields south of Thomas Road, Santa Teresa Boulevard,

[2] USGS station number 11153650 Llagas Creek nr Gilroy, with a drainage area of 84.2 square miles.
[3] THE DISTRICT website, Upper Llagas Creek at www.valleywater.org

and Monterey Road, and a large expanse of agricultural fields east and south of the WWTP (Figure 4).

The proposed pipelines may fall within the FEMA flood zones in a number of locations:

- The short-term pipeline will run along the fringe of the Uvas Creek flood zone from Christmas Hill Park to Club Drive,
- The long-term pipeline will continue to run northwest along the fringe of the south Uvas Creek flood zone to Santa Teresa Drive,
- The short- and long-term pipelines will cross the flood zone area in the agricultural fields between Santa Teresa Boulevard and Monterey Road, and
- The short term pipeline spur off of the existing pipeline to Cintas Corporation will pass through the flood zone along Camino Arroyo Drive.

In some of the above cases, actual overlap of the pipeline with FEMA flood zones will depend on the details of the final placement of the pipe.

3.6 Ground Water

Most of Santa Clara Valley is underlain by three major, interconnected ground water sub-basins: the Santa Clara, Coyote, and Llagas (Figure 5). Aquifers (water bearing strata) within these ground water sub-basins supply nearly half of the District's total water supply. The Llagas ground water sub-basin extends from the divide at Morgan Hill south to the southern county border under both urban and rural areas including Gilroy. The Llagas sub-basin is approximately 15 miles long, 3 miles wide along the northern boundary and 6 miles wide along the southern boundary at the Pajaro River, resulting in a total surface area of approximately 74 square miles. The Coyote sub-basin extends northward from the Morgan Hill divide, and hence is well beyond the boundaries of the study area.

In the southernmost Llagas ground water sub-basin, a clay layer derived from Pleistocene lake deposits extends north from the Pajaro River to the region beneath Gilroy. This clay layer restricts hydrologic connectivity to the surface and acts as an aquitard dividing the aquifer vertically into a deep (>300-ft deep) confined aquifer and an unconfined shallow (roughly 100-ft deep) aquifer that is perched atop the clay layer.[4] These aquifers will be referred to as the "confined aquifer" and the "shallow aquifer" in the remainder of this report. Beyond the extent

[4] As noted above, the transition to a separate confined and shallow aquifer system is now thought to be further south than in previous reports, with more open exchange northward from the northern edges of Gilroy.

of the valley clay layer, the river valley alluviums underlying the Uvas River and other drainages tributary to the Santa Clara Valley bottom constitute a third type of aquifer that is directly connected to the ground surface. This aquifer will be referred to as the "unconfined aquifer" for the remainder of the report.

The Pleistocene clay layer was deposited in the low lying regions of the basin containing the paleo lakes and does not necessarily extend to the bedrock outcrops in all locations on the eastern and western boundaries of the Llagas sub-basin. Alluvial and mass wasting deposits from the Santa Cruz and Gabilan Ranges bound the extents of the clay layer and are also interspersed within the clay layer in some locations (Jenkins, 1973). These deposits can create hydrologic connections between the unconfined aquifer (Figure 5) and the deeper confined aquifer. In the Uvas watershed, these hydrologic connections allow the unconfined aquifer north and west of Gilroy to serve as a recharge forebay to the deep confined aquifer (Iwamura, 1995). The recycled water irrigation customers are generally located in areas underlain by the unconfined aquifer.

Stratigraphic and ground-water level observations from several well logs along the Uvas Creek corridor made available by the District provide evidence of the hydrologic connectivity between the unconfined and confined aquifers. These well bores are located in the unconfined ground water zone and were advanced into the recent alluvial sediments. The lack of silt in the boring logs, and the lateral extent of connected clay deposits near the edges of the Llagas basin (Taraszki et al., 2007), suggest potential pathways between the unconfined aquifer and confined aquifers, making the unconfined zones the principal recharge zones for the Llagas subbasin. Sources of recharge to the unconfined aquifer include rainfall, sub-surface inflow, deep percolation of streams, irrigation return flow, and sub-surface flow from water-bearing formations laterally bounding the Basin (email from Henry Barrientos, Associate Engineer, Ground Water Management Group, June 2008).

Other sources of recharge to the Llagas sub-basin confined aquifer include percolation facilities and dam releases. The District operates off-stream percolation ponds located throughout the county and the SCRWA uses off-channel percolation facilities located near the WWTP to increase the recharge of the shallow ground water basin. The District also operates seasonal dams to induce in-stream recharge to the unconfined aquifer (Reymers and Hemmeter, 1998) by releasing water during summer months into creeks that would otherwise be dry under natural conditions. Because the upper reaches of the creek beds tend to be composed of coarser sediment than the lower reaches, most infiltration likely takes place closer to the headwaters of the watersheds. The infiltrated water does not recharge the unconfined aquifer, however, until it reaches the aquifers western limit, which lies approximately 0.1 mile west of Santa Teresa Boulevard (Figure 5).

3.7 Water Quality

3.7.1 Surface Water

The quality of surface water in southern Santa Clara County waters varies with respect to location, waterway, source, and season. Headwater streams are supplied primarily by surface runoff during the wet season. During the dry season, springs are an important water source in many locations and a significant influence to water quality. Reservoirs operated in the Llagas and Uvas watersheds capture winter runoff from local drainages and release water in the summer. The quality of water in streams downstream of reservoirs can vary with the District management decisions and reservoir operations.

Llagas Creek water quality data for some constituents show surface water concentrations exceeding water quality objectives set forth in the Water Quality Control Plan, Central Coast Basin Plan (RWQCB, 1994). The limited surface water quality data available for Llagas Creek show that total dissolved solids (TDS), sodium, and chloride, all exceed Basin plan objectives (Table 4), and that fecal coliform levels are relatively high. The District does not presently collect water quality data from Uvas Creek.

A number of beneficial uses have been designated for surface waters in Llagas and Uvas Creeks, and the Pajaro River. These include all types of water supply, ground-water recharge, recreation, wildlife habitat and migration, support of endangered species, and fishing (Table 3). Where beneficial uses in the Pajaro River and Llagas Creek cannot be achieved due to specific impairments, total maximum daily load (TMDL) allocations are being developed (Table 5, RWQCB, 2005a and 2005b). For each impaired water body, the CWA Section 303(d) list of impaired waters lists the pollutants or stressors for which TMDLs have not yet been developed. In Llagas Creek, the 303(d) list identifies chloride, fecal coliforms, dissolved oxygen, pH, sodium, and TDS as low-priority pollutants, and nitrate as a high-priority pollutant. The 303(d) list identifies boron and fecal coliforms as low-priority pollutants in the Pajaro River.

The TMDL for nitrate in the Pajaro River and Llagas Creek was submitted to the EPA in November 2005 and became effective in October 2006 upon approval. This TMDL sets maximum nitrate concentrations and load allocations at the level of 10 mg/L (as N). The TMDL for sediment in the Pajaro River and Llagas Creek (including Rider Creek and the San Benito River) became effective November 27, 2006, prior to EPA approval on May 3, 2007. This TMDL sets numeric targets for suspended sediment concentration for a range of durations. No TMDL allocations have been established for Uvas Creek as yet.

3.7.2 Ground Water

Ground-water quality and chemistry is influenced by source waters, infiltration, the geologic substrate of the aquifer, interactions between adjacent ground-water sources, and human activities. The natural background chemical signature of the ground water is a reflection of the source water and how it changes as it passes through the substrate. The District has been monitoring the quality of ground water since the 1940s. The current General Groundwater Quality Monitoring Program includes a network of about 60 wells, at least 16 of which are located in the Southern Santa Clara County (Llagas) sub-basin (Reymers and Hemmeter, 2001). These wells are sampled regularly for general minerals, trace metals, and physical characteristics. Special studies, such as the MTBE study, may expand the sampling network beyond those 60 wells.

The ground-water quality characteristics in the shallow, confined, and unconfined aquifers in southern Santa Clara County around Gilroy differ. As is typical of Central Coast valleys, the shallow, perched aquifer beneath and to the southeast of Gilroy is vulnerable to contamination and is relatively more impaired, with higher measured levels of TDS, chloride, sulfate, boron and sodium than the confined and unconfined aquifers (Table 4). The water quality of the confined aquifer, which is used for municipal drinking water supply, is generally good and is currently considered suitable for most beneficial uses (Reymers and Hemmeter, 2001), including domestic wells, agriculture, and industrial process, and service water supply. The unconfined zone, which generally recharges the confined zone, is of similar quality. At 341.9, 33.7, 38.4, and 5.7 mg/L, average concentrations of TDS, chloride, sulfate, and nitrate (as N) in Gilroy municipal well samples fall below EPA maximum contaminant levels without treatment or filtration.

Application of fertilizers and septic tank leach fields can introduce nitrate to ground water (c.f., LLNL, 2005). According to 1997 to 2000 data, nitrate levels for an unspecified location in the Llagas sub-basin ranged from 9.8 to 10.4 mg/L (as N) (Reymers and Hemmeter, 2001), and often exceeded the drinking water standard of 10 mg/L (as N). Flow-weighted average data from the deep municipal aquifer water supply for Morgan Hill and Gilroy from March 2004, however, show a lower nitrate concentration of 5.7 mg/L-N (RWQCB, 2004) (Table 4). Nitrate levels are consistently higher in the shallow Llagas sub-basin in wells screened above 250 ft (LLNL, 2005). Because nitrate is generally not removed by soil particles below the root zone, reducing further loading of nitrate is the primary means of protecting ground water and has been identified as an objective of the District's Nitrate Management Program (see Reymers and Hemmeter, 2001), which has been in place since about 1997. It is unclear whether increasing trends in nitrate concentrations in the Llagas sub-basin are the result of a store of nitrate present in the shallow vadose or soil zone that is unaffected by the Nitrate Management Program, or whether nitrate loadings are continuing to increase (LLNL, 2005).

Typical urban and residential pollutants such as metals and oils can impact ground water as well. However, infiltration processes can be effective at removing these pollutants such that ground water meets drinking water standards. Spills and poor management of industrial chemicals and wastes (such as perchlorate) can also pose a potential threat to ground-water quality (Reymers and Hemmeter, 2001; Taraszki and others, 2007).

4. REGULATORY SETTING

The California State Water Resources Control Board (State Board) administers water rights, water pollution control, and water quality functions for the state as part of the California Environmental Protection Agency. The State Board provides policy guidelines and budgetary authority to the nine Regional Water Quality Control Boards (Regional Boards or RWQCB), which work to develop and enforce water quality objectives and implementation plans that will best protect the beneficial uses of the State's waters, recognizing local differences in climate, topography, geology and hydrology. The State and Regional Boards share authority for implementing the Section 319 nonpoint source program of the federal Clean Water Act, and the State's primary water-pollution control legislation, the Porter-Cologne Act. The Central Coast (Region 3) office of the Regional Board regulates water quality in streams and aquifers of the central California coast region through the following mechanisms:

- the creation and triennial update of the Water Quality Control Plan also referred to as the Basin Plan (RWQCB, 1994)
- administration of the National Pollutant Discharge Elimination System (NPDES) permit program for municipal storm water systems and construction site stormwater runoff;
- Section 401 water-quality certification where development results in discharge to or fill of jurisdictional wetlands or waters of the US under Section 404 of the Clean Water Act;
- policy preparation and revision; and
- coordination with other public agencies, the State Board and the public.

4.1 Central Coast Region Water Quality Control Plan ('Basin Plan')

The Regional Board is required by law to develop, adopt and implement a Basin Plan for the Central Coast region. This document describes the legal, technical, and programmatic bases of water quality regulation in the Central Coast region. The plan includes the following:

- the beneficial uses that the Regional Board has designated for local aquifers, streams, marshes, rivers, and bays (see Table 3 for designated beneficial uses in waters near the project),
- the water-quality objectives and criteria that must be met to protect the beneficial uses,

- the strategies and time schedules required for achieving the water quality objectives,
- a summary of State and Regional Board plans and policies to protect water quality, and
- a description of statewide and regional surveillance and monitoring programs.

The Regional Board implements the Basin Plan by issuing and enforcing waste discharge requirements to individuals, communities, or businesses whose waste discharges can affect water quality. The state typically issues requirements for discharges to land, while the National Pollutant Discharge Elimination System governs discharges to surface waters.

In addition to the numeric water quality objectives, the Basin Plan states "All waters shall be maintained free of toxic substances in concentrations which are toxic to, or which produce detrimental physiological responses in human, plant, animal, or aquatic life. Compliance with this objective will be determined by use of indicator organisms, analyses of species diversity, population density, growth anomalies, toxicity bioassays of appropriate duration, or other appropriate methods as specified by the Regional Board." The recent California Toxics Rule updates the Basin Plan regarding these substances.

On May 18, 2000, the EPA published the California Toxics Rule (CTR) in the Federal Register, adding Section 131.38 to Title 40 of the CFR. On May 22, 2000, the Office of Administrative Law approved, with modifications, the Policy for Implementation of Toxics Standards for Inland Surface Waters, Enclosed Bays, and Estuaries of California (Phase 1 of the Inland Surface Waters Plan and Enclosed Bays and Estuaries Plan). The Policy establishes implementation procedures for three categories of priority pollutant criteria or water quality objectives. These are (1) criteria promulgated by the EPA in the National Toxics Rule that apply in California, (2) criteria proposed by the EPA in the California Toxics Rule; and (3) water quality objectives contained in RWQCB water quality control plans (basins plans).

4.2 National Pollutant Discharge Elimination System (NPDES)

Section 402 of the Clean Water Act and Section 13370 of the California Porter Cologne Water Quality Control Act establish the NPDES permit system to regulate point source waste discharges to surface waters of the United States. The NPDES permits are issued by the State through the Regional Boards, who then review monitoring reports, verify compliance and take enforcement action if necessary. The program requires that NPDES permits prescribe conditions of discharge that will help protect beneficial uses of receiving water.

The 1987 amendments to the Clean Water Act [Section 402(p)] provided for U.S. EPA regulation of several new categories of nonpoint pollution sources within the existing National Pollutant Discharge Elimination System (NPDES) program. In Phase 1, NPDES permits were issued for urban runoff discharges from municipalities of over 100,000 people, from plants in industries recognized by the EPA as being likely sources of storm water pollutants, and from construction activities that disturb more than 5 acres. Phase 2 implementation, effective March 10, 2003, extended NPDES urban runoff discharge permitting to cities of 50,000 to 100,000 people, and to construction sites that disturb between 1 and 5 acres.

4.3 NPDES General Permit for Discharges of Storm Water Associated with Construction Activity

The NPDES program also requires projects that disturb more than 1 acre of land to obtain coverage under the general permit governing construction activities. Administration of these permits has not been delegated to cities, counties, or Regional Boards but remains with the State Board. Prior to construction the project applicant must submit a Notice of Intent to the State Board and apply for coverage under the NPDES Construction General Permit. Enforcement of permit conditions, however, is the responsibility of Regional Board staff, with assistance from local, municipal or county staff. The State Board requires the project applicant to prepare a Storm Water Pollution Prevention Plan (SWPPP) and submit it for review prior to commencing construction. Once grading begins, the SWPPP must be kept on site and updated as needed while construction progresses. The SWPPP details the site-specific best management practices that will be applied to control erosion and sedimentation and maintain water quality during the construction phase. The SWPPP also contains a summary of the structural and non-structural best management practices (BMPs) to be implemented during the post-construction period, pursuant to the nonpoint-source practices and procedures encouraged by the Santa Clara Valley Water District best management practices (SCVWD, 2003).

4.4 Total Maximum Daily Load Program

The State of California is required by Section 303(d) of the federal Clean Water Act to provide to the EPA a list of water bodies considered by the State to be impaired (i.e., not meeting water quality standards and not supporting their beneficial uses). The list also identifies the pollutant or stressor causing impairment, and establishes a schedule for developing a control plan to address the impairment, typically a Total Maximum Daily Load (TMDL). Recommendations are made to the SWRCB by each of the nine RWQCBs using available information and data.

The resulting list of impaired waters is employed by the EPA to prepare the biennial federal Clean Water Act Section 305(b) Report on Water Quality.

The total maximum daily load (TMDL) represents the amount of a material or pollutant that a waterbody can assimilate on a regular basis while protecting the designated beneficial uses of the waterbody. TMDLs are developed by analyzing data and information provided by existing and commissioned studies and by parties interested in the waterbody. They ultimately result in a clear definition of water quality problems, a numeric value for the TMDL and indicators of water quality, an assessment of proportional responsibility for controlling the pollutant, and an implementation plan for achieving the TMDL. The TMDL and associated implementation plan are developed by the Regional Board, and then approved by the State Water Resources Control Board and the US EPA. Approved TMDLs and their associated implementation plans are generally adopted into the Basin Plan. Local 303(d) listed impairments and TMDL initiatives are described above in Section 3.6.1.

4.5 Water Reclamation Requirements

4.5.1 General WWTP requirements

The Department of Health Services, the State Water Resources Control Board (SWRCB), and the Regional Board all regulate recycled water use in California. General waste discharge requirements for SCRWA are described in order number R3-2004-0099 by the Regional Board (RWQCB, 2004), included as Appendix B. The document contains a summary of nearly all aspects of the wastewater program in the region including:

- the SCRWA treatment facility,
- treatment performance and standards/criteria,
- surface and ground water quality parameters in the Llagas Creek and Pajaro River Basins,
- site characteristics,
- the Basin Plan,
- the monitoring and reporting program,
- considerations pertaining to waste discharge,
- the TMDL program in the Pajaro River and Llagas Creek, and
- the NPDES permit for the Facility.

Following the summary, Order R3-2004-0099 presents the prohibitions related to the program, and also summarizes secondary, tertiary and receiving water discharge specifications and limits. The order lists five prohibitions regarding the effects of wastewater discharged to designated land disposal sites on receiving waters in the Llagas ground water subbasin. The prohibitions specify that the discharges shall not cause:

1. ground water to contain taste- or odor-producing substances that adversely affect beneficial uses,
2. the median concentration of coliform organisms to exceed 2.2 /100mL over a seven day period,
3. ground-water nitrate concentrations to exceed 10mg/L (as N), or a statistically significant increase in nitrate concentrations, whichever is more stringent (the level of significance was not specified),
4. radionuclide concentrations to reach levels hazardous to human, plant, animal, or aquatic life, or
5. a statistically significant increase in mineral or organic constituent concentrations.

The information presented in the order primarily focuses on land disposal of secondary treated wastewater and direct discharge of tertiary-treated wastewater into the Pajaro River.

4.5.2 Recycled water use requirements

The California Code of Regulations contains the Department of Health Services (DHS) recycled water regulations governing wastewater treatment processes, effluent quality, and allowable recycled water uses. A compilation of these regulations is entitled the "Purple Book" (DHS, 2001). Additionally, recycling of tertiary treated water for irrigation is covered in the Master Water Reclamation Requirements Order 98-052 (RWQCB, 1998), which summarizes the water recycling requirements for the SCRWA and users in Santa Clara County. Order 98-052 enumerates the general findings by the Regional Board related to the SCRWA water recycling program, and lists the prohibitions and limitations associated with recycled water use. Some of the most notable requirements within the order include:

- SCRWA tertiary treated water meets the water reclamation criteria of the State Department of Health Services,
- cross-connections to potable water systems are not permitted and backflow prevention devices are required,

- warning signs shall exist (in English and Spanish) at pipeline works, reservoirs, and sites irrigated with recycled water,
- using recycled water for irrigation during periods of rainfall or when soils are saturated is prohibited,
- discharge to surface waters or overspray to areas outside the designated used area is prohibited,
- storage and application must be at least 100 feet from any domestic well,
- monthly average flows shall be a maximum of 15 mgd,
- recycled irrigation water quality shall not exceed Maximum Contaminant Levels (MCLs) reported in order 98-052,
- daily average turbidity must be less than or equal to 2 NTU, turbidity shall not exceed 10 NTU at any time, and turbidity must not exceed 5 NTU for more than 5 percent of the time,
- users must have permits on site and submit on-site observation reports and data to SCRWA, and
- SCRWA must conduct periodic inspections and file self monitoring reports with the Regional Board.

If tertiary-treated water will be used for irrigation of exposed edible food crops, parks, schools, residential areas, unrestricted access golf courses, commercial laundries, and at cooling towers or any systems that create a mist, it must first be disinfected. Disinfection involves the removal of living organisms in the water through methods such as ozone, chlorine, or ultra violet light. The WWTP uses chlorination for disinfection of tertiary water (Carollo, 2004) for reclamation.

4.5.3 Recycled wastewater reporting requirements (RWQCB Order No. 98-052)

The California Water Code and the RWQCB require the producer (SCRWA) to maintain a self monitoring and reporting program. This program is summarized in the RWQCB Master Water Reclamation Requirements Monitoring and Reporting Program 98-052 (RWQCB, 1998), which is included as Appendix C. Order 98-052 establishes a monitoring program based on Title 22 requirements. The District generally seeks DHS comment and review of monitoring results prior to distributing reclaimed wastewater for use (Matt Keeling, personal communication, 2005).

The primary stated purpose of the self monitoring program is to document compliance and facilitate self-policing by the producer. An annual report is due each January 30th and is to include the following:

- letter of transmittal summarizing the violations and corrective actions planned or taken,
- tabulations of monitoring results,
- lists of existing and newly authorized users,
- tabulations of inspections and observations of reuse sites along with violations found and corrective actions taken, and
- necessary updates to the SCRWA Water Recycling Work Plan.

Standard observations to be noted include evidence of runoff, odor, or ponding at recycled water irrigation sites; warning signs; and leaks or breaks in the irrigation system. The program is applicable when recycled water irrigation is in use. A complete inspection of irrigation lines is also required at least once a year during the dormant season. The schedule in program 98-052 calls for monitoring of the following parameters at the WWTP, specific reuse areas, and impoundments:

- flow rate (continuously),
- total coliform (daily),
- turbidity (continuously),
- DO (3 times per week),
- dissolved sulfides (3 times per week),
- pH (3 times per week),
- chlorine residual (frequency not stated), and
- other applicable standard observations on an annual basis.

Following a violation, the producer must immediately notify the RWQCB by phone and submit a written report within two weeks. Existing regulations and requirements currently do not set guidelines or monitoring requirements for pharmaceutical and personal care products (PPCPs). See Section 5.4 below for a discussion of PPCPs.

5. HYDROLOGIC AND WATER QUALITY CONSIDERATIONS AND RECOMMENDATIONS

The project offers a multitude of benefits as well as some potential impacts to the surface and ground water resources. As with any construction activity, there will be impacts associated with the initial installation of the new pipelines and associated facilities, and possibly during some long-term maintenance and repair procedures. Following implementation, the project will help sustain ground water levels by reducing the amount of ground water withdrawn for irrigation and other uses. Some considerations exist regarding the effect the project may have on the quality of surface and ground waters. These considerations and accompanying recommendations for reducing or eliminating impacts are discussed below.

5.1 Construction Activities

As with any construction the grading and installation of the pipeline may impact surface water drainage, erosion, and water quality. Devegetated slopes and disturbed soils will be susceptible to erosion, which may introduce sediments into storm drains and creeks. Construction access and staging areas will also disturb vegetation and soils, which will add to the erosion as well as the runoff volume from the site. In addition to hydrologic concerns, the operation and staging of heavy equipment may also introduce oils, solvents, fuels, heavy metals, and detergents into surface water drainage.

A Stormwater Pollution Prevention Plan (SWPPP) outlining appropriate construction practices will be prepared in compliance with RWQCB requirements and kept on site during construction. The SWPPP will outline revegetation techniques, erosion control measures, spill prevention practices, and emergency spill cleanup procedures. It will also identify the required cleanup and emergency response materials to have on site. The majority of these concerns can be addressed by limiting construction activities to dry months. Some typical erosion control measures include: installing silt fences or straw matting around site borders and over stormwater grates to contain sediment and silt in site runoff, grading slopes to a maximum of a 3:1 slope, covering excavated earthen materials to prevent mobilization from wind or rain, and using sediment settling tanks to clarify site runoff.

Comprehensive listings of Erosion and Sediment Control BMPs may be found in the California Stormwater Quality Associations Stormwater Best Management Practice Handbook for construction (CSQA, 2003) and the District Best Management Practices Comprehensive List (District, 2003).

Construction of the pipeline from Gilroy Sports Park and Gavilan College will require crossing Uvas Creek. This may necessitate some special consideration depending on the type of crossing used and the construction measures taken. The most benign crossing design would be to attach the pipe to the bridge that is installed for the proposed trail; bridge design should recognize and address the additional risks posed by potential rupture of pipeline with discharge directly into the creek. Otherwise, some type of trenchless technology would be recommended, such as horizontal directional drilling (HDD), although these methods would be complicated slightly by the depth of the incised channel (30-feet) below the adjacent field elevations and the overall width of the channel (75 to 100 feet). If a trench across the creek is required for pipe installation, additional environmental permits would be needed.

The proposed pipelines and structures are not located in any areas shown to have serpentine soils, so construction concerns associated with the asbestos and heavy metals in these soils should not be an issue. The possibility of encountering serpentine soils should not be completely discounted, however, and field verification is recommended, especially at the south end of the Club Drive spur and the west end of Glen Loma Ranch where serpentine soils are mapped (Lindsey, 1974). General erosion control BMPs will be used during pipeline construction and will reduce the potential for serpentine soils to contaminate waterways.

5.2 Surface Water

Although it is beyond the scope of this document to lay out a specific location for the pipeline along its proposed route, a few general considerations may influence the final design. Additionally, potential impacts to surface water associated with application of recycled water are evaluated. Potential impacts to ground water are discussed below in Section 5.3.

5.2.1 Hydrology and Drainage

Generally drainage does not appear to be a critical factor. Most of the pipe route occurs along roads with curbs and gutters, or within or adjacent to open space. Few, if any, large stormwater ditches were observed along the route. Some considerations are listed below.

- If the pipe is properly installed per specifications of the construction project's civil engineer to an appropriate depth (generally at least three feet), the soil replaced with the appropriate compacted fill, and the grading restored to pre-construction conditions, long-term effects of the pipeline on surface-water drainage should be insignificant.

- When possible, previously or currently disturbed areas or areas directly beneath the road/bike lane/curb should be selected in favor of agricultural or wildlife-habitat areas. This will have to be evaluated relative to the installation costs in many cases.
- A geotechnical evaluation should be performed prior to installing the pipe along the base of the Uvas Creek levee.
- West of the Uvas Creek Bridge along West Luchessa Road, more space for the pipeline appears to exist along the north side of the road. This should be taken into consideration in the final decision regarding where the install the pipe.

The completed pipe alignment and the use of recycled wastewater for irrigation are unlikely to substantially alter surface water drainage patterns. The pipeline should be installed in a manner that does not disturb existing drainage swales, ditches or creek channels. If possible, existing drainage swales along the road should be avoided during pipeline installation, or replaced in kind following construction with proper revegetation, cross-sectional area and slope. Similarly, at locations where the pipe alignment crosses drainage swales or creek channels, the channel should be avoided if possible. Otherwise, if the pipeline must pass underneath the channel or swale, it should be buried to the depth specified by the construction-project civil engineer, and in all cases at least 3 feet beneath the lowest point in the channel or swale cross section in a trench that minimizes the amount of channel disturbance. Following installation, the channel should be restored to its original condition, with appropriate revegetation and erosion protection measures emplaced. In many cases, negotiation of a Streambed Alteration Agreement from the California Department of Fish and Game may be required.

5.2.2 Water Quality

Although disinfected tertiary treated recycled water produced at the SCRWA WWTP meets all Title 22 water quality requirements (RWQCB, 1998), some constituents found in recycled water may potentially have a negative impact on sensitive plants and soil, or on the water quality of receiving surface waters. For example, boron levels in the range of 0.5 to 2.0 mg/L gradually increase in toxicity to certain sensitive plants such as lemon and blackberry (Table 6; Basin Plan, 1994). Sodium and chloride levels above 69 and 106 mg/L, respectively, start to stress plants, particularly woody species such as almond, apricot, citrus, and plum, and specific ion toxicity from root absorption begins at chloride levels from 142 to 355 mg/L. Elevated sodium levels can also impair soil permeability.

5.2.3 Basin Plan Criteria

Water-quality data indicate that the tertiary-treated recycled water contains some constituents at higher levels than in the Basin Plan objectives for surface waters. These constituents include TDS, chloride, sulfate, boron, and sodium (RWQCB, 1994) (Table 4). Chloride, boron, and sodium concentrations in tertiary-treated water also exceed measured concentrations in Llagas Creek, which is listed as having low priority impairments for TDS, sodium, and chloride (Table 5). In contrast, nitrate concentrations in the recycled water are lower than levels in Llagas Creek and the 10 mg/L (as N) allocation specified in the nitrate TMDL implementation plan

The Basin Plan provides Guidelines for Interpretation of water quality for irrigation (Table 6). Levels of boron in the tertiary-treated water (0.67 mg/L) (Table 4) fall at the very lower end of the "increasing problems" range (0.5 – 2.0 mg/L) for certain boron-sensitive plants listed in Basin Plan Guidelines. Lemon and blackberry may be affected at this boron level. Others crops can generally tolerate this level of boron. The boron concentrations recorded in 2005 averaged 0.5 ppm.

At 113 and 155 mg/L, sodium and chloride concentrations in tertiary treated water also exceed the Basin Plan water quality guidelines for the "increasing problems" category (69 and 106 mg/L, respectively) (Table 4). Some woody species including almond, apricot, citrus, and plum are sensitive to this level of chloride; however, others can tolerate it without negative impact. The, majority of other crops and common grass species used in landscaping are expected to tolerate this level of chloride, as shown by the fact that local farmers have been irrigating crops with this recycled water for several years without discernible effects.

5.2.4 Master Plan Criteria

The South County Recycled Water Master Plan requires that recycled water users attend a training course conducted by SCRWA. The course covers potential public health hazards and the application methods required by DHS criteria for different land uses. Direct contact between irrigation water and surface waters should be minimal if irrigation guidelines are observed. Overwatering and overspraying of wastewater onto paved surfaces, irrigating unnecessarily during wet weather or over saturated soils should be avoided and are prohibited under Master Water Reclamation Order 98-052 (RWQCB, 1998). To further safeguard against runoff of recycled water into surface waters, the permeability of the soil underlying the irrigation site should be considered in setting irrigation rates, with reduced rates applied to sites with less permeable soils. Ultimately, an adaptive management approach must be employed to maintain irrigation intensities/durations below the level that causes runoff. SCRWA has been conducting annual site inspections to encourage proper irrigation practices and prevent excess runoff and ponding.

Even if runoff of recycled water is prevented, dissolved constituents will remain on exposed soil and plant surfaces when irrigation water evaporates and these materials may flush into creeks during rain events. For water that does not evaporate, the cleansing action of filtration through soil and plant matter, and uptake by plants will function to help clean the irrigation water and reduce or eliminate impacts to surface waters. The amount of plant uptake will depend on the species, its growth cycle, and other factors. Potential effects of winter flushing of salts attached to soil surfaces are expected to be insignificant because (a) the recycled water replaces water that would ordinarily be applied to the soil (generally from local ground water) with roughly similar salinities, and (b) beneficial uses of the streams downstream from proposed new application sites will not be impaired.

5.2.5 Mitigation and Monitoring

The wastewater monitoring program in Order 98-052 specifies a limited monitoring regime that is intended to protect potential receiving waters and is focused on surface waters. It includes standard observations (such as evidence of runoff, odors, evidence of ponding and leaks, etc.) at application sites as well as sampling for water quality at the WWTP. However, the sampling program does not include boron, chloride, sodium, dissolved solids or salinity. Given the concerns with ground-water salinity and the tertiary-treated water having concentration values for boron, sodium, and chloride at the low end of the RWQCB's "increasing problems" range in the RWQCB irrigation water guidelines (Table 6), a more extensive sampling program could be considered for recycled water and several receiving waters downgradient of irrigation sites. Some of the key constituents would include TDS, nitrate, ammonia, sodium, chloride, boron, sulfate, pH, and occasional testing for general mineral and irrigation suitability parameters. Basin Plan pollutants, priority toxic pollutants, dioxins, regulated radionuclides, organic and inorganic chemicals could also be included at a lower frequency. Monitoring could be conducted on a weekly or monthly basis in both the tertiary effluent and the selected surface water locations. General mineral and irrigation suitability parameters might appropriately be tested annually. This level of information would make it possible to establish a baseline and track what is being applied to the landscape. Chloride, boron, and sodium concentrations (salinity or specific conductance) could also be monitored in Uvas Creek, since most of the irrigation users are in that watershed. Additional monitoring of ground water is discussed below in Sections 5.3.2.2 and 5.8.

The condition of tree crops and woody ornamental species could be monitored as well because certain species can be more sensitive to salinity and boron levels (California RWQCB, 2005). Information should be provided to customers on the salinity and boron tolerance of sensitive landscape plants so that they can make site specific decisions about recycled water application. If boron concentrations in the recycled water exceed the tolerance for a significant proportion of common plants, measures should be taken to remove additional boron during the treatment process.

5.3 Ground Water

5.3.1 Hydrology

The recycled water program is unlikely to significantly alter the ground-water hydrology of the basin, although a few considerations exist. The permeability and water holding properties of the pipe alignment may differ from the surrounding soils and could either inhibit transverse drainage across the pipeline or enhance drainage along the pipeline route. Either situation should be avoided by suitably designing excavations with native soils and providing adequate compaction. If an unforeseen concern arises about excessive subsurface drainage along the pipeline alignment, low-permeability baffles can be placed periodically along the pipeline to further reduce this possibility.

The primary benefit to using recycled wastewater for irrigation and industrial purposes is that it will reduce the amount of water drawn from the aquifer for these purposes. Given equivalent landscaping and irrigation practices, the use of recycled wastewater in place of pumped ground water is unlikely to affect ground water recharge, as irrigation will be occurring either way. It will, however, help to maintain or increase ground water levels by reducing the volume of water withdrawn from the underlying aquifer or from municipal supply wells.

Increased ground water levels are beneficial in that they generally represent an increase in water supply, as well as a decrease in pumping costs required to extract the water. They also reduce the risk of intrusion of salty waters and ground subsidence, which have been associated with overpumping of ground water elsewhere in Santa Clara County. In the case of the Gilroy area, the salty waters are naturally occurring, originating either (a) as connate waters in the marine sedimentary rocks surrounding the basin, or (b) waters percolating through former alkali lake beds, such as at Soap Lake, further concentrated by evaporation. In both instances, these salty natural waters are kept from entering the regional aquifer system in harmful quantities by the high ground-water levels in the regional aquifer. Irrigating with tertiary-treated waters helps maintain the high ground-water levels, thereby reducing the inflow of salts from the bedrock or alkali-lake deposits, which would otherwise likely occur at an unquantified but significant rate. Irrigating with recycled water will also help to preserve volume in the infiltration ponds at the WWTP and help reduce the volume of wastewater that must be released directly to the Pajaro River.

5.3.2 Quality

The quality of the recycled water is generally very good and meets drinking water standards set by the Environmental Protection Agency for all the constituents evaluated, with the exception of total dissolved solids. It also meets the objectives developed by the DHS and the Regional Board as listed in Order 98-052, which governs recycled water irrigation activities. It does not, however, meet the median ground water objectives listed in the RWQCB Basin Plan. A few noteworthy considerations exist that may generate questions from those reviewing the program.

Use of recycled water may add salts and other dissolved constituents to the ground-water systems and the wells that draw from those systems. Most of the short-term recycled water irrigation sites are located over the unconfined aquifer which plays a role in recharging the deeper confined aquifer (Figure 5). The recycled water is of similar or slightly better quality than the shallow aquifer. However, the unconfined and deep aquifers are of higher quality than the recycled water (Table 4). Although the municipal supply wells for the City of Gilroy are screened below 250 feet within the confined aquifer, and are relatively invulnerable to surface water contaminants (such as those introduced through irrigation), the unconfined and shallow aquifers could gradually accumulate salts or other constituents of concern (Applied Science and Engineering, Inc. 1999). The shallow aquifer is generally not used for domestic drinking water supply, and plays a very limited role in the long-term recharge to the deeper aquifer (SCVWD, 2001). The limited nature of this role is evidenced by tritium-helium isotope signatures in wells screened below 200 ft, which suggest residence times greater than 50 years, indicating that modern land use activities have not influenced the chemistry of these deep wells (LLNL, 2005). A portion of the unconfined aquifer beneath the Uvas Creek Valley does recharge the confined aquifer, however, and the potential effects of this are discussed below in Section 5.4.

5.3.2.1 Total Dissolved Solids (TDS)

Infiltration of TDS to the unconfined (shallow) aquifer can occur as a result of irrigation, and the impact of this should be considered over the long-term vision of the program. Irrigation using pumped ground water does not add new TDS to the system, but can concentrate them in the system because most of the extracted irrigation water evapotranspires and the TDS are left behind in the soil to eventually return to the aquifer. The use of recycled water for irrigation generally reduces the volume of water extracted from the aquifer, but this benefit is generally offset by the new salts added to the system in the recycled water. The leaching of TDS and other constituents to the aquifers will depend on the connectivity of the aquifer to surface waters, dilution with rainwater, amount of excess irrigation water that flows past the root zone, and the exchange and filtering action that plants, soils and substratum provide. Conversely, use of tertiary-treated water can reduce entry of salty naturally-occurring waters by maintaining static water levels in the aquifer(s) sufficiently high to inhibit salt delivery from these sources. Both the rate of salt addition from tertiary-treated water and the avoided influx of salts from the concentrated natural sources are difficult to quantify. However, we have attempted to provide some guidance through the development of a non-comprehensive steady state TDS recharge budget which estimates a worst-case scenario (see Section 5.4).

5.3.2.2 Chemical Constituents

Average SCRWA WWTP effluent values reported in annual reports for 2001-2002 indicate that the tertiary effluent exceeded the median ground water objectives set by the Basin Plan for TDS, chloride, sulfate, boron, and sodium (Table 4). The tertiary effluent also exceeded the median concentrations in the deep confined aquifer for TDS, chloride, sulfate, and sodium (Table 4) (based on 2004 Gilroy municipal well sampling data reported in RWQCB WDR Order R3-2004-0099). Order R3-2004-0099 lists concentrations for TDS, chloride, sulfate and sodium in the tertiary-treated water and the confined and shallow aquifers. These data are summarized in Table 4. Concentrations of most of the listed constituents were significantly lower in the confined aquifer than in the unconfined or shallow aquifers. Constituent concentrations in the tertiary effluent only exceeded those in the shallow aquifer slightly for chloride, boron, and sodium. TDS and sulfate concentrations were lower in tertiary effluent compared to the shallow aquifer.

Order 98-052 (RWQCB, 1998), and the ground-water monitoring program in place by the District should provide adequate information to identify adverse impacts to the ground-water quality, both in deep and shallow aquifers. If concentrations of TDS or salinity in the deep aquifer become a higher priority objective, additional monitoring may be necessary. A more comprehensive approach to ground-water monitoring is recommended below in Section 5.8.

5.4 Ground-Water Quality Impact Analyses

In order to gain perspective on the potential for impacts to ground water quality due to irrigation with tertiary-treated recycled water, a conceptual model was developed and well data records were analyzed.

5.4.1 Conceptual Model

We have constructed a simple conceptual model to assess the range of potential affects of the expansion of the SCRWA Phase 2 recycled water program on loadings of TDS to the unconfined zone of the Llagas Basin. The model is non–comprehensive in the sense that it does not track ground water or TDS movement in the unconfined aquifer. It essentially estimates the amount of TDS in the recharge to the confined aquifer on a yearly basis. The estimate is based on the quality and quantity of the various sources of recharge through what we have defined as the Uvas streambed recharge corridor (USRC). The USRC is defined as a 1-mile wide and 3-mile long reach of Uvas Creek overlying the Uvas Creek segment of the Llagas unconfined aquifer (Figure 5). The corridor, assumed to be a half mile wide on each side of Uvas creek, was created to include all SCRWA Phase 2 sites that will use recycled water for irrigation and could potentially recharge the unconfined aquifer. This simplified model only addresses the basic recharge components of the ground water system and only in the limited area defined here as the USRC[5]. Basic recharge components considered in the model include stream seepage, irrigation return flows, and precipitation. By defining the quality and quantity of these different sources of recharge to the unconfined aquifer, we have estimated the long-term percent increase of total salts that can be expected for each of the two irrigation water sources.

[5] The unconfined aquifer underlying Uvas Creek is only one of a number of drainages in the Llagas watershed that can act as forebays to the Llagas ground water basin.

5.4.1.1 Model Background and Assumptions

In order to assess the effects of salt loading on the Llagas ground water basin, the recharge mechanisms for the aquifer system must be understood. The unconfined aquifer in the Llagas Ground Water Basin is the forebay for recharge to the shallow and confined aquifers to the east. One of the regions contributing lateral recharge to the confined aquifer is the unconfined aquifer underlying the Uvas Creek Corridor. Water-level contour maps provided by the District show the ground water gradient sloping eastward from the unconfined aquifer (Fostersmith and others, 2005). This corridor is the primary recharge conduit to the confined aquifer in the western region of the Llagas Basin because the District percolates an average of 10,000 acre-feet of managed recharge through this reach of stream per year.

Seasonal oscillations in the water level of an unconfined aquifer monitoring well are on the order of three feet (Fostersmith and others, 2005). In an unconfined aquifer, these oscillations represent changes in aquifer storage volume. Multi-year declines in water levels represent longer term declining storage. Based on ground-water level data provided by the District, there have been no multi-year, large-scale declines or increases in ground water since 1995 in the unconfined aquifer (Fostersmith and others, 2005).[6] This suggests that water fluxes into and out of the aquifer are balanced under existing management practices and that the system is in an equilibrium or steady state condition. This balance of fluxes is in large part maintained by replenishing water withdrawals with managed recharge of Uvas Reservoir water through the USRC. Because the unconfined aquifer appears to be in an equilibrium condition, it is assumed that water is moving through the system, and that water quality in the unconfined aquifer represents the water quality of the annual recharge.

Assumptions for the model include the following:

- The USRC was defined because some proposed customers for the SCRWA expansion will not be applying recycled water directly to the ground or are located in areas not connected to the unconfined aquifer. For example, one of the proposed sites is on bedrock which does not infiltrate through to the unconfined aquifer. The model will therefore focus on a two square mile area (1 mile wide by 2 miles long) that recharges the unconfined aquifer.
- The recharge to the unconfined aquifer from the infiltration of managed releases from Uvas Reservoir was estimated as 10,000 acre-feet per year (Reymers and Hemmeter, 2001).

[6] Significant water-level declines were reported throughout southern Santa Clara Valley during the 1987-1991 drought, a period during which significant volumes of salts likely entered the aquifers from natural sources described above. Drought conditions are not considered in our equilibrium model.

- It is assumed that 30 percent of the irrigation water infiltrates past the root zone to recharge the ground water.
- The infiltrated irrigation water recharges the unconfined aquifer, a portion of which becomes deep percolation and recharges the regional confined aquifer (Fostersmith and others, 2005).
- Based on plates provided by the District, a vadose zone exists under all of the proposed sites (Appendix D).
- All dissolved salts pass through the vadose zone.
- The project area receives an average of 21 inches of precipitation per year and a runoff coefficient of 0.7 was used for land within the stream corridor. This amounts to 2,240 acre-feet of water over the 3 square mile USRC, with 672 acre-feet infiltrating into the ground.
- TDS concentration of the infiltrated reservoir water through the Uvas streambed was assumed to be 182 mg/L[7].
- The TDS concentrations used were 38 mg/L for precipitation water (Hem, 1989), 500 mg/L for well water[8], and 640 mg/L for recycled water[9].
- Land use in the Uvas Stream corridor is mainly low density rural or facilities with large permeable areas.
- Use of recycled water will replace water pumped from wells.
- As evident by well hydrographs published by the District, the unconfined aquifer is at a steady state, possibly due to the managed infiltration of Uvas reservoir water into the Uvas Creek Corridor, which has been occurring since 1995.
- Irrigation water volumes were estimated based on data reported in Appendix B of the Recycled Water Master Plan (Carollo, 2004). Data for immediate, short- and long-term users was included.

A number of assumptions made in this conceptual model are conservative:

- We did not consider recharge occurring over the entire area of the unconfined aquifer, which would increase the amount of recharge from precipitation and reduce the percent increase of salt concentrations in ground water through use of recycled water.
- Leaching, the vertical movement of water and solutes through the soil, was also treated conservatively. Leaching is typically estimated using a leaching factor, which is a function of the properties of the soil and the solutes. To promote leaching of salts and other constituents through the root zone, irrigators can apply water in excess of that needed to support plant growth (Young, 2007).

[7] Uvas Reservoir water quality data from December 1995 to June 1997 provided by the District.
[8] TDS concentrations for well water were based on well sampling data provided by the District.
[9] TDS values for the recycled water were obtained from Carollo, 2004.

Precipitation may also provide sufficient water to cause leaching of soils. For the sake of simplicity and to be conservative, we have assumed that all salts leach through the root zone and vadose zone to the ground water. This assumption is conservative because salts and other solutes are precipitated as water is consumed by plants in the root zone, and not all the solutes are necessarily transported through the soil to the ground water.

- A seasonal average runoff coefficient of 0.7 (30% of precipitation infiltrates) is also conservative because that would typically be the runoff from a significant storm event, and much of the precipitation for the year may fall during small events that infiltrate more completely. Infiltration of precipitation water is beneficial because it is typically very low in salts, TDS and other pollutants, and thus helps to dilute contaminants in the ground water.

5.4.1.2 Model Results

The infiltrated water volumes and associated water quality values were used to estimate the total salt loadings and average water quality of the recharge water to the unconfined zone for Pre-SCRWA, Phase I, and Phase II conditions[10]. The values used in the calculations and the results of the analyses are summarized in Table 7 for each condition. Only Immediate, Short-term, and Long-term customers are included in the analyses. Derivations of the values for water volumes, water quality and infiltration are discussed in the assumptions section above. The irrigation areas include current and proposed recycled water users and it was assumed that all areas actively irrigate under each condition (Pre-SCRWA, Phase I, Phase II). Total yearly irrigation prior to Phase I of the recycled water irritation program sums to 1,722 acre-feet. This irrigation was assumed to be entirely supplied by pumped ground water. Within the USRC under the Phase I condition (existing condition), the irrigation demand currently supplied by wells totals to approximately 1,144 acre-feet, and the demand supplied by recycled water totals to approximately 608 acre-feet per year. The Phase II plan proposes to apply a volume of 1,812 acre-feet recycled water and essentially no irrigation with pumped ground water by the customers included in these phases of the program.

The estimated TDS concentration in recharge through the USRC under Pre-SCRWA conditions is 250 mg/L. The estimated TDS concentration is 260 mg/L under during Phase I (the current phase) of the SCRWA program, which constitutes a 4.0 percent increase. Following implementation of the proposed Phase II recycled water plan, the estimated TDS concentration of estimated recharge water would be 270 mg/L, which constitutes a 3.8 percent increase above the Phase I condition and an 8.0 percent increase over the Pre-SCRWA levels. At these

[10] The Pre-SCRWA condition predates the use of recycled water for irrigation. The Phase I condition is the current condition and includes a limited number of customers that began irrigating with recycled water in July, 2000. The Phase II includes the immediate and short-term customers currently proposed.

concentrations, the recharge waters are lower than drinking water standards and the average salt concentrations in the unconfined aquifer.

5.4.2 Well Data Analyses

Well monitoring data provided by the District were used to assess whether implementation of Phase I of the recycled water program has affected the quality of the unconfined aquifer. Using the conceptual model, a 4.0 percent increase was estimated for the TDS concentration of the recharge water following implementation of Phase I. Two wells were chosen to evaluate the effects of this 4.0 percent increase on the unconfined aquifer. Monitoring wells P01 and D01 were selected because of the length of their chemical records, their locations (Figure 5), and similarities in their land uses. Both wells have records that predate the Phase 1 SCRWA deliveries. Monitoring well P01 is located down gradient from Phase 1 SCRWA sites that began irrigating with recycled water in 2000. Monitoring well D01 is located north and cross gradient from sites currently using SCRWA water (Appendix D). Data from MW P01 were analyzed to identify quantifiable changes in salt concentration down gradient of the sites irrigating with recycled water. Data from cross-gradient MW D01 was used as control to track if there were any large changes in regional ground water chemistry that was not attributable to recycled water.

Figure 6 shows the specific conductance (electrical conductivity normalized to 25° C) record for monitoring well P01 (down-gradient from application site). The dashed line represents the point at which SCRWA recycled water deliveries began (July, 2000). There is no noticeable increase in specific conductance levels detected in this well following the use of recycled water in July, 2000. Figure 7 shows the specific conductance record for monitoring well D01 (cross gradient from application site). The specific conductance record for this well seems to increase from about 500 microsiemens per centimeter (µS/cm) to about 600 µS/cm between 2003 and 2006 and then decrease from about 600 µS/cm to about 550 µS/cm between 2006 and 2007. Variations in specific conductance of this of this magnitude can be seen in the data prior to recycled water delivery. The high frequency data after recycled water deliveries began may suggest that variations in specific conductance of this magnitude are common in the unconfined aquifer but are not evident in the isolated sample points of the earlier data. Because this well is not down-gradient of any properties receiving SCRWA water, changes in specific conductance should not be associated with recycled water deliveries.

In addition to TDS, other constituents such as chloride, sulfate, calcium, magnesium, and carbonate were evaluated using a Piper diagram of the well and recycled water data. Piper diagrams graphically show the ionic composition, properties, and relationships of water samples in a manner that is useful for sample comparison. The Piper diagram in Figure 8 compares the composition of samples from wells P01 and D01 (from both before and after the application of Phase 1 recycled water in July, 2000), as well as the SCRWA facility water. The clustering of points shows that the well sample compositions are very similar, and do not shift toward the SCRWA sample following the Phase 1 application of recycled water.

If water quality degradation in the unconfined aquifer had occurred due to mixing with recycled water, the sample from monitoring well P01 post recycled water irrigation would shift toward the SCRWA sample. Such a shift is not evident and thus the graphic shows no change in the ionic balance of the unconfined aquifer as a result of recycled water recharge. Provided the recharge mechanisms for the unconfined and confined aquifers in the Llagas basin have not significantly changed, the estimated 3.8 percent increase in salt concentrations associated with Phase II is not expected to affect the unconfined aquifer.

5.4.3 Mitigation Measures for TDS

Although the analysis has shown that the concentration of TDS in the recharge water to the unconfined aquifer is significantly less than Basin Plan objectives, less than existing TDS concentrations in the unconfined aquifer, and only 3.8 percent higher than the existing recharge water concentration, a number of mitigation measures may be employed to further reduce potential impacts. Some of the measures that can be used include the following:

1. If feasible, more reservoir water can be percolated through the USRC, recognizing that increased use of reservoir water for percolation activities is based on supply and other factors.
2. Irrigation guidelines and trainings can be implemented to encourage best management practices such as not overwatering, avoiding surface runoff, watering at the appropriate time of day, etc. Avoidance of overwatering is particularly important because it will help prevent leaching of the salts into the aquifer.
3. Measures to reduce TDS levels in wastewater can be implemented or expanded upon. A significant amount of sodium and possibly potassium ions enter the wastewater stream due to water softeners used by water customers, which generally substitute

sodium for calcium and magnesium. The use of these softeners could be limited or alternative means of water softening could be encouraged.

4. The water quality in downstream wells can be monitored to quantify the natural variation of the target constituents of concern and to identify changes that may be due to recycled water application. If such changes are observed, the wells could be monitored more closely, and recycled water irrigation practices temporarily stopped or modified to address the problem.

5.5 Abandoned Wells

Inactive or improperly destroyed wells have been identified by the District as potential contaminant pathways. An abandoned well, either through the annular space or a compromised casing, can provide a conduit for water to reach deeper zones within an aquifer system. In this case, abandoned wells may short circuit travel paths through the vadose zone and decrease the removal of nitrate, TDS, PPCPs, etc. As a mitigation measure, the District should conduct a due diligence investigation to locate any abandoned wells on the premises of the proposed Phase II sites. If a process of how to locate abandoned wells were included in the application process to receive recycled water, many of the abandoned wells existing in the Phase II expansion could be located. Assessment for abandon wells should be required for customers to obtain a permit from SCWRA to receive recycled water. The process should be as follows:

1. A data request should be filed with the Department of Water Resources for all the well logs (Well Completion Forms) currently in their database for the region of interest.
2. Well logs should be located on a map through State Well Identification Township and Range methodology or parcel number supplied on well completion form.
3. The District database should be cross referenced with well completion forms for existing wells. A site inspection may be necessary to compare well casing radii and construction type.
4. Well completion forms for which District staff cannot locate an active well or a destruction record for should be considered abandoned.
5. If abandoned wells are determined to exist on a parcel, they should be located and properly destroyed. Title 22 Section 60310 specifies that no irrigation with disinfected tertiary recycled water shall take place within 50 feet of any domestic water supply well.

5.6 Pharmaceuticals and Personal Care Products

5.6.1 Background

The presence of pharmaceutical and personal care products (PPCPs) in water and the environment is becoming a source of agency and public concern in some settings, and this concern can negatively affect public perception of recycled water programs. PPCPs have been detected in the environment for over 20 years, with advances in analytical chemistry methods allowing detection of progressively smaller concentrations in more recent years (Daughton, 2001). Some well-known compounds most commonly detected in streams in a USGS study include coprostanol (estrogen), N-N-diethyltoluamide (DEET), caffeine, triclosan, cholesterol, and acetaminophen (Kolpin and others, 2002). Other PPCPs commonly detected in wastewater include analgesics (salicylic acid, ibuprofen), antibiotics (amoxicillin, erythromycin), tranquillizers, estrogens, synthetic fragrances, soaps and surfactants, and insect repellents (Williams and others, 2005). Additionally, some PPCPs have been detected in the tissue of aquatic animals (Snyder and others, 2003).

The potential effects of many substances on humans and aquatic ecosystems is poorly understood, particularly in situations involving very low concentrations over long exposure periods (Daughton, 2001). Certain types of PPCPs can mimic the natural hormones in the endocrine systems of animals and are referred to as endocrine disrupting compounds (EDCs). Examples of EDCs include: nonylphenol, ethinylestradiol (active ingredient in oral contraceptives), and dioxins. Evidence does exist of adverse effects due to EDCs in wildlife populations, typically in aquatic organisms immediately downstream of direct discharges into natural aquatic systems; however, no conclusive data linking population level impacts to fish has yet been published (Snyder, 2003).

Concentrations of PPCPs in wastewater, surface water and ground water are typically very low, which limits the potential for human exposure. Some PPCPs also occur naturally in plants and are consumed by humans in food, possibly at much higher levels than in water (Snyder, 2003). Exposure from the actual use of personal hygiene products and from environmental sources is probably significant as well. Some potential exposure pathways for contaminants in recycled wastewater to humans include recreational exposure through swimming, direct exposure to irrigation spray, surficial exposure through contact with grass, consumption of contaminated drinking water, and consumption of crops or animal flesh in which PPCPs have bioaccumulated. Aquatic organisms could be exposed to PPCPs through similar pathways.

5.6.2 Existing Studies

Research on wastewater samples collected at several wastewater treatment plants in California indicate that secondary effluent contains estrogenic hormone concentrations comparable to those that cause feminization in fish; whereas tertiary filtration removes approximately 70 percent of the hormones (Huang and Sedlak, 2001).

Studies are being conducted to assess whether there is a correlation between PPCP concentrations in ground water and treated wastewater and whether the source can be attributed to the treated wastewater. In a study of ground water quality in Helena, Montana, the two most frequently detected PPCPs in ground water used for drinking water were sulfamethoxazole and atrazine. Concentrations of these constituents correlated strongly with chloride and TDS, which are two typical inorganic indicators of ground-water degradation from domestic wastewater (Miller and Meek, 2006). A study analyzing 19 types of PPCPs in the shallow riparian aquifer of the Rio Grande shows that of the nine PPCPs found in the ground water, two compounds (bis phenol A and triphenyl phosphate) were detected downstream from the Albuquerque wastewater treatment plant but not upstream (Martinet, 2005). A study at the University of Hawaii was conducted to measure the fate and transport of pharmaceuticals in recycled water during percolation through soil into ground water. Results indicated that pharmaceuticals found in the recycled water were not detected in the ground water samples (Babcock and others, 2002).

In 2002, the District conducted a comprehensive water quality sampling program to characterize background water quality. The program entailed three rounds of sampling between November 2001 and July 2002 at several stations including: Anderson Reservoir; five ground water stations, two of which are near Christmas Hill park (Wren deep and shallow); and four tertiary-treated wastewater effluents including SCRWA. In addition to general water quality parameters such as general minerals and microbiological constituents, samples were analyzed for a suite of common PPCPs and EDCs including ibuprofen, gemfibrozil, 17-estradiol, estrone, medroxyprogesterone, and testosterone. PPCPs were not detected in the SCRWA effluent or the Wren wells, and EDCs were generally not detected or were reported to be below the quantification limit; however, estrone was detected in one SCRWA sample at 10.8 ng/L and 17-estradiol was detected in one sample from the shallow Wren well at 0.9 ng/L

(Debroux and Gittens, 2003). However, the sampling program was not designed to assess the fate and transport of PPCPs and it is not clear if the source of the 17-estradiol detected in the Wren well was SCRWA effluent applied as irrigation water at Christmas Hill park.

Additional PPCP and EDC sampling was conducted in December 2002 and May 2005 at six ground water stations in the vicinity of SCRWA recycled water application areas and at two stations located downgradient but far from application sites. Three sampling points were located in wells approximately 45 feet deep near Christmas Hill Park[11] where recycled water has been applied since about 2000. Three stations, at depths ranging from 40 to over 100 feet, were located near the SCRWA percolation ponds. PPCPs (ibuprofen, carbamazepine, gemfibrozil, ketoprofen, and naproxen) were not detected in any of the samples in December 2002[12] or May 2005. EDC analyses included testosterone, androstenenedione, 17-estradiol, estrone, medroxyprogesterone, estriol (in May 2005 only), and progesterone (in May 2005 only). EDCs were not detected in any of the May 2005 samples. In December 2002, the following EDCs were measured: 1.0 ng/L testosterone, 1.9 ng/L androstenenedione, and 0.8 ng/L medroxyprogesterone in the deep well near the percolation ponds; 0.6 17-estradiol in the 41-foot well near the percolation ponds; 0.4 ng/L 17□-estradiol in one of the Christmas Hill park wells; and 0.4 ng/L 17-estradiol in one of the downgradient wells screened at a depth of 70 to 80 feet. These data have not been published by the District, nor has a full evaluation of the findings been conducted. Therefore, no definitive conclusions about the influence of recycled wastewater percolation ponds or irrigation sites on ground water can be made at this time.

5.6.3 Regulations

Concentrations of PPCPs and EDCs in wastewater are typically not monitored. Federal regulations covering pharmaceuticals in drinking or natural waters also do not yet exist (Snyder, 2003). The Basin Plan's narrative water quality objective for toxicity and the CTR currently appear to be the most applicable water quality criteria for these compounds. In brief, the objective states that all waters should be free of substances that produce detrimental effects in living organisms, and compliance should be checked using appropriate biological or ecological methods. The Food and Drug Administration (FDA) also calls for ecological testing and evaluation of pharmaceuticals when water or soil concentrations exceed 1 μg/L or 100

[11] It is uncertain (but unlikely) if these stations are the same as the Wren shallow and deep wells that were sampled as part of the Debroux and Gittens (2003) work.
[12] In December 2002, PPCPs were not sampled from the two downgradient stations or from one of the stations near the percolations ponds.

μg/kg, respectively (FDA, 1998). In July 2003, the DHS issued draft regulations for indirect potable water reuse in California. These regulations called for the planned ground water recharge reuse projects to monitor recycled water for EDCs and pharmaceuticals specified by the Department. A new recycled water policy currently under review by the SWRCB recommends that landscape irrigation projects include annual effluent monitoring of PPCPs and EDCs.

5.6.4 Mitigation Measures for PPCPs

The recycled water irrigation practices set forth in RWQCB Order 98-052 and described previously herein for surface and ground water quality protection also mitigate concerns related to PPCPs and EDCs. Direct runoff should be avoided by using an appropriate irrigation rate and avoiding overspray or watering under saturated conditions. Ponding and evaporation of recycled water should be minimized as well to minimize buildup of PPCPs, EDCs, and other pollutants at the ground surface. In addition to these practices, buffers should be provided around seasonal wetlands and freshwater marshes, particularly if endangered or sensitive species are present.

As stated in Carollo, 2004, the District should also consider developing or at least plan for eventual monitoring of some of the most common PPCPs, and follow the evolution of the in-progress draft legislation regarding monitoring of PPCPs. Ground-water monitoring conducted by the District in December 2002 and May 2005 at recycled water irrigation sites in shallow and deep aquifers found little evidence of impacts. Suggested monitoring practices are summarized below in Section 5.8.

Although it is unlikely to be necessary, removal of certain constituents is possible. In conventional wastewater treatment plants, PPCPs and EDCs can be removed or reduced in concentration by microbial degradation, adsorption to particulates that are removed during wastewater treatment and by biotransformation (Crook, 2005). The removal method is important, however, because removal of PPCPs and EDCs from wastewater through oxidation with chlorine and ozone can result in formation of disinfection byproducts that also have detrimental health effects, which makes the use of activated carbon or reverse osmosis more promising alternatives (Snyder, 2003). SCRWA is currently proposing to install oxidation disinfection with ultraviolet lights which will be more effective in removing PPCPs and EDCs without resulting in disinfection byproducts. One study found that PPCPs such as acetaminophen, caffeine, and the antibiotic sulfamethoxazole were present in untreated wastewater, but they were not detected in secondary effluent or ground water underlying irrigation sites (Babcock and Huang, 2002). This study did not however report a specific treatment method.

The District should conduct an annual or semi-annual review of regulatory status of PPCPs and EDCs to evaluate which compounds are likely to be made subject to regulation, and what the regulations will require. In determining what constituents to monitor in the future, constituents on the most current EPA Contaminant Candidate List can be considered based on presence in recycled water, fate and transport, and known or potential impacts to beneficial uses or public health.

5.7 N-nitrosodimethylamine (NDMA)

5.7.1 Background

N-Nitrosodimethylamine (NDMA) is a semi-volatile organic chemical that causes cancer in humans and other animals when ingested orally (OEHHA, 2006). It can be found in rocket fuel, some PPCPs, tobacco smoke, cured meat products, beer, and other common products, usually in very low concentrations. NDMA is formed by the reaction of amines with nitrites during both industrial and natural processes. This reaction can occur during the treatment of drinking water and wastewater when chlorine or chloramine is used for disinfection. NDMA is therefore considered a disinfection byproduct.

5.7.2 Regulations

Presently, NDMA in drinking water is regulated in California by a "notification level" (previously known as Action Level) of 10 ng/L (parts per trillion) in drinking water. Local governments are to be contacted when concentrations are found to be above this level. Due to its carcinogenic characteristics and because NDMA is increasingly detected in drinking water, California has set a Public Health Goal (PHG) of 3 ng/L. The PHG will eventually support development of a maximum contaminant level (MCL) for NDMA in drinking water (OEHHA, 2006).

5.7.3 Studies

NDMA is found in most wastewater effluent at variable concentrations depending on specific treatment processes, the setting of the wastewater treatment plant (WWTP), and the relative contribution of industrial facilities. For example, composite samples of wastewater effluent collected between August 2002 and April 2004 at seven WWTPs in California had NDMA concentrations ranging from 7 to 790 ng/L with a median concentration of 73 ng/L (Sedlak and others, 2003). NDMA concentrations from three samples collected over a 10 month period in 2001 and 2002 at the SCRWA averaged 3.5 ng/L with a standard deviation of 2.3 ng/L. These concentrations were lower than those measured at other WWTPs in the County which ranged from 29 to 490 ng/L. The low levels at SCRWA may be explained by relatively effective removal of nitrogen, which is a precursor of NDMA (Debroux and Gittens, 2003).

5.7.4 Mitigation Measures for NDMA

With respect to NDMA concerns, recycled water application for irrigation is very likely a preferable alternative to direct discharge to creeks, rivers and bays in most cases because it provides opportunities for soil adsorption, biodegradation, assimilation and other removal processes. NDMA is soluble in water with a low affinity for particles and therefore can readily transport to ground water and other downstream receiving waters at wastewater discharge facilities. However, studies show that NDMA can be removed by ultraviolet (UV) direct photolysis (both natural sunlight and artificially generated), particularly in low pH environments (Stefan and Bolton, 2002)[13]. Additionally, the USGS documented significant biodegradation of NDMA in soils under both oxic and anoxic conditions at a test facility, suggesting that, under appropriate conditions, natural attenuation may be feasible (Bradley and others, 2005). The District is currently conducting a study to assess the fate and transport of NDMA and other constituents in local conditions (S. Zhu, personal communication, 2008).

Methods to prevent NDMA formation during wastewater chlorination should also be considered. Mitch and Sedlak (2004) found that particle-associated precursors can be removed by filtration; whereas biological treatment and/or reverse osmosis can be applied to remove dissolved precursors (Mitch and Sedlak, 2004). Monitoring of SCRWA effluent for NDMA to determine the reduction of NDMA resulting from UV treatment should be conducted. This

[13] It should be noted that the UV dosage required for significant NDMA removal is approximately 25 times higher than that required for typically wastewater disinfection (www.sfwater.org).

monitoring should be considered with results of the fate and transport study to evaluate the need for ground water monitoring and/or consideration of additional treatment methods.

5.8 Ground Water Monitoring and Adaptive Management

Tracking ground-water quality in the USRC can be an important component of an adaptive management program for protecting ground water quality in the Llagas Basin. The District should develop a ground-water monitoring program that can be reviewed on an annual basis and modified as new information and regulatory guidance becomes available. The monitoring program should include a sampling and analysis plan that clearly identifies sample stations, sampling frequency, collection methods, field and laboratory constituents, analytical methods, and mitigation measures to be implemented in accordance with monitoring results.

5.8.1 Monitoring

A monitoring network of seven to fifteen wells should be established to track the quality of the ground water that passes through the vadose zone and eventually mixes with Uvas Stream recharge. The wells used in the monitoring network should be selected or installed to cover the geographic extent of the USRC and sampled at a range of depths to capture the flow within both the vadose and phreatic zones.

In order to best meet the needs of the monitoring program, the following considerations should be applied when selecting wells for the monitoring network.

1. To the extent possible, the network of wells should be spaced throughout the USRC to provide representative samples of the areas where recycled water is used for irrigation, and also in control areas where it is not used.
2. Wells with historic data should be selected first and used to establish a baseline from data preceding the SCRAW Phase II start up. This will help provide a historical perspective on the ground water quality at these locations.
3. The screening configuration and integrity of the wells should be known. Wells with unknown screen intervals and or possible cracked casings should be avoided.
4. If wells are privately owned or located on private property, site access and permission to operate wells is should be granted by the landowner.

5. Wells screened over a range of depths are preferred because they should allow variations in water quality with depth to be identified.

The sampling frequency for water level and quality should be adequate to identify changes occurring on a semi-annual or shorter time frame. At a minimum, samples should be collected in late spring and early fall. In order to identify short-term affects, a mid summer round of sampling could also be considered for the first few seasons of expanded recycled water use. Sampling during the winter wet season should be considered as well to assess the leaching of contaminants precipitated from the recycled water during the previous season.

Water quality constituents to be measured in ground water include:

- Total dissolved solids
- Salinity/specific conductance
- Cations: Sodium, calcium, potassium, magnesium
- Anions: Chloride, sulfate, carbonate
- Other constituents: PPCP, EDC, and NDMA sampling may be initiated depending on changing regulatory guidance and findings from fate and transport studies currently underway.

As shown in the monitoring well plate provided by the District (Appendix D), the District currently monitors approximately seven wells in and around the USRC that can be used as the basis for the monitoring network. Additional wells can then be added over time to increase the spatial extent and density of the network. A cluster of monitoring wells should be constructed at the eastern side of the USRC to track the water quality of recharge water leaving the USRC and entering the shallow and deep zones of the Llagas Basin.

Monitoring results could be analyzed using techniques similar to those used in this study. Water quality changes for a given well could be evaluated using Piper, Ternary, and Stiff diagrams. These diagrams provide a graphical way to compare the composition of well data with previous samples and the recycled water data. Time series plots can also be used, particularly for wells with historic data, to identify changes in water levels or water quality parameters over time.

- Data collected from this monitoring network can be used to measure trends in water quality relative to recycled water application practices and other land uses. Interpretation of the results by qualified professionals will be necessary to identify or verify the source for contaminants observed in the samples. The information provided will then help the District to meet ground-water quantity and quality objectives through adaptive management of the water use in the USRC.

5.8.2 Mitigation Measures

If at any time it is determined that the use of tertiary treated recycled water is or could potentially negatively impact the beneficial uses of groundwater, mitigation measures should be implemented to protect ground-water resources. The primary mitigation measures available in this situation include:

- Implementation of additional treatment at SCRWA to reduce the concentration of the constituents of concern,
- Modification of irrigation practices such as reducing the spatial extent or the water volume applied,
- Blending with another source of water that has lower concentration of the constituents of concern,
- Infiltrating more reservoir water through the USRC, if possible given the available supply and other factors, and
- Discontinuing the use of recycled water.

The mitigation measures listed above are general in nature and can be used in combination with the monitoring program as the basis for an adaptive management approach to the program. Measures specific to TDS, PPCPs, and NDMA are described in more detail in the corresponding sections within the report.

6. LIMITATIONS

This report was prepared in general accordance with the accepted standard of practice existing in Northern California for projects of similar scale at the time the investigations were performed, and consistent with the level of effort identified by SCVWD in this scope. No other warranties, expressed or implied, are made.

As is customary, we note that readers should recognize that interpretation and evaluation of factors affecting the hydrologic context of any site is a difficult and inexact art. Judgments leading to conclusions and recommendations are generally made with an incomplete knowledge of the conditions present. The client is also actively reinterpreting the sedimentology of the area. If the client wishes to further reduce the uncertainty beyond the level associated with this study, the new interpretations and an expanded scope of work should be encompassed.

We have used standard environmental information -- such as rainfall, topographic mapping, and soil mapping -- in our analyses and approaches without verification or modification, in conformance with local custom. New information or changes in regulatory guidance could modify results, perhaps fundamentally. As updated information becomes available, the interpretations and recommendations contained in this report may warrant change. To aid in revisions, we ask that readers or reviewers advise us of new plans, conditions, or data of which they are aware.

Concepts, findings, interpretations and recommendations contained in this report are intended for the exclusive use of Recon Environmental, Inc. for environmental impact analysis in the study area under the conditions presently prevailing except where noted otherwise. Their use beyond the boundaries of the site could lead to environmental or structural damage, and/or to noncompliance with water-quality policies, regulations or permits.

Finally, we ask once again that readers who have additional pertinent information, who observed changed conditions, or who may note material errors should contact us with their findings at the earliest possible date, so that timely changes may be made.

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TABLES

Table 1. **Immediate- and short-term recycled water customers, southern Santa Clara County, California**

Customer	Group[a]	Master Plan Site No.	Location	Type	Irrigable Area *(acres)*	Seasonal Demand *(afy)*	Maximum Monthly Demand *(mgd)*	Soil Type(s)	HSG[b]	Approx. Elevation *(ft)*
Immediate										
Local Obata Farmlands	NA	E-4	near WWTP	Agr	225	1566.0	1.77 [c]	Cc	C	161
Short-Term										
Gilroy High School	A1	**23**	10th & Princevale	Irr	16	61.0	0.13	YaA	B	200
Ascencion Solorsano Middle School	A1	**44**	Grenache & Club	Irr	3	11.0	0.02	YaA	B	220
Gilroy Golf Course	A1	**7**	Hecker Pass Hwy	Irr	40	144.0	0.33	SaE2, SaG2	C	330
Gilroy Sports Park	A1	**8**	Monterey & W. Luchessa	Irr	60	226.0	0.49	YaA	B	192
Glen Loma Ranch Development	A1	**46**	Santa Teresa Blvd	Irr	30	114.0	0.25	PpC, HfC, KeC2	B,D,C	248
Cintas Laundry	A2	1	934 Holloway	Ind	----	45[d]	0.05	Su	C	174
Inland Packaging	A2	2	6400 Jamieson	Ind	----	26[d]	0.03	Ca	C	174
Calpine Gilroy Powerplant	A2	69	Pacheco Pass	Ind	----	307[d]	0.27	Ca	C	170

a. Group A1 customers can be connected to the existing distribution system with minimum capital cost. Group A2 customers are industrial users with year-round demand.

b. Hydrologic Soil Group (HSG) is standard USDA classification of soil water runoff potential, with group A having the lowest and group D having the highest runoff potential.

c. Calculated for an irrigable area of 225 acres at a max net irrigation requirement for Gilroy in July of 9.1 inches (See Table 2.2 in Carollo, 2004).

d. Water demand values of for industrial users represent year-round demand, while those for irrigation users represent the demand during the irrigation season.

Table 2. **Properties of surficial soils at and near the Santa Clara Valley Recycled Water Program Project Sites in Gilroy, California[1,2].**

Map symbol	Soil series	Description	Depth to bedrock	Depth from surface	Depth to seasonal high water table	Hydrologic soil group	Erosion hazard	Atterberg limits[3]		Permeability	Available water holding capacity[4]		Reaction	Salinity	Position
								Liquid	Plastic						
			(ft)	*(in)*	*(ft)*					*(in/hr)*	*(in./in. of soil)*	*(in/profile)*	*(pH)*	*(Mmhos/cm @ 25° C.)*	
ArA	Arbuckle	Gravelly loam	3-5	0-40	None	B	None	15-20	5-10	0.63-2.0	0.12-0.14	5.2	5.6-6.5	<1	Nearly level fans
		Gravelly loam or very gravely sandy loam	3-5	40-60	None		Moderate	15-25	5-10	2.00-6.30	0.05-0.07	1.2	6.1-6.5	<1	Moderately sloping fans
Ca, Cd	Campbell	Silty clay loam	>5	0-68	None	C	None	25-35	10-20	0.2-0.63	0.19-0.21	13.6	7.4-8.4	<1	Level alluvial plain
Cc	Campbell	Silty clay loam	>5	0-36	3-5		None	25-35	10-20	0.20-0.63	0.19-0.21	7.2	7.4-8.4	<1	Level alluvial plain
		Clay	>5	36-60			None	50-60	30-35	0.06-0.20	0.14-0.16	3.6	8.0-8.4	<1	Level alluvial plain
Ce	Campbell	Silty clay loam	>5	0-36	2.5-3.5		None	25-35	10-20	0.06-0.20	0.19-0.21	7.2	7.4-8.4	<1	Level alluvial plain
		Mucky clay	>5	36-60			None	70-90	15-30	0.20-0.63	0.23-0.25	5.8	8.0-8.4	<1	Level alluvial plain
Cg, Ch, Ck	Clear Lake	Clay	>5	0-60	>5	D	None	50-60	30-35	0.06-0.2	0.14-0.16	9.0	6.6-8.4	0-15	Low alluvial plain
CoB	Cortina	Very Gravelly Loam, fine sandy loam, or sandy loam	>5	0-60	None	A	Deposition	Non-Plastic	Non-Plastic	6.3-20	0.04-0.07	3.3	6.1-6.5	<1	Nearly level gently sloping stream benches
GaA	Garretson	Loam, sand gravel	>5	0-40	None	B	None	20-30	0-10	0.63-2.0	0.16-0.18	6.8	6.6-7.3	<1	Nealy level fans
GbB	Garretson	Gravelly loam	>5	0-60	None		Slight	Non-Plastic	Non-Plastic	>20	0.03-0.05	2.4	6.6-8.41	<1	Nearly level to gently sloping fans and benches
HfC, HfD2, HfE2, HfF2	Hillgate	Silt loam	>5	0-10	None	D	Moderate	20-25	0-10	0.63-2.0	0.19-0.31	2.5	5.6-6.0	<1	Moderate to steeply sloping terraces
HfC, HfD2, HfE2, HfF3	Hillgate	Clay and clay loam	>5	10-40	None		Moderate	35-45	15-25	<0.06	0.04-0.06	1.5	5.6-6.0	<1	Moderate to steeply sloping terraces
HfC, HfD2, HfE2, HfF4	Hillgate	Gravelly clay loam	>5	40-60	None		Moderate	25-30	10-15	0.2-0.63	0.15-0.17	3.2	5.6-6.0	<1	Moderate to steeply sloping terraces
KeA, KeC2	Keefers	Clay loam	>5	0-23	None	C	None to moderate	30-35	10-15	0.2-0.63	0.18-0.20	4.4	6.1-6.5	<1	Levely to moderately sloping fans
KeA, KeC3	Keefers	Very gravelly clay loam	>5	23-88	None		None to moderate	30-40	10-15	0.06-0.20	0.12-0.14	8.5	6.6-7.3	<1	Levely to moderately sloping fans
KeA, KeC4	Keefers	gravelly clay	>5	38-60	None		None to moderate	30-35	10-15	0.06-0.20	0.04-0.06	1.1	7.4-7.8	<1	Levely to moderately sloping fans

Continued next page

Table 2. Continued

Map symbol	Soil series	Description	Depth to bedrock	Depth from surface	Depth to seasonal high water table	Hydrologic soil group	Erosion hazard	Atterberg limits[3] Liquid	Plastic	Permeability	Available water holding capacity[4]		Reaction	Salinity	Position
			(ft)	*(in)*	*(ft)*					*(in/hr)*	*(in./in. of soil)*	*(in/profile)*	*(pH)*	*(Mmhos/cm @ 25° C.)*	
LoE, LoF, LoG	Los Osos	Clay loam	2-3.5	0-10	None	C	Moderate to high	30-40	10-20	0.20-0.63	0.19-0.21	2.0	6.1-6.5	1	Moderate to steep uplands
LoE, LoF, LoG	Los Osos	Clay	2-3.5	10-36	None		Moderate to high	50-60	30-40	0.06-0.20	0.14-0.16	3.9	6.1-6.5	1	Moderate to steep uplands
LoE, LoF, LoG	Los Osos	Sandstone	-----	36	None	-----	-----	-----	-----	-----	-----	-----	-----	1	Moderate to steep uplands
Pa, Pb, Pd	Pacheco	Clay loam, loam and very fine sandy loam	>5	0-60	3-6+	B/C	None	30-40	10-15	0.63-2.00	0.16-0.19	10.5	7.9-8.4	0-8	Low-level alluvial plains
PoA, PoC, PpA, PpC, PpD2	Pleasanton	Loam, gravelly clay loam, gravelly sandy clay loam	>5	0-60	None	B	Slight to moderate	20-40	10-20	0.2-0.63	0.13-0.18	33.0	6.1-7.3	<1	Nearly level to fans to moderately sloped terraces
Rg	Riverwash	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----		In-channel material
SaE2, SaG2	San Andreas	Fine sandy loam	2-2.5	0-23	None	C	High to very high	15-20	0-5	2.00-6.30	0.13-0.15	3.2	5.6-6.0	<1	Moderate to steep uplands
SaE2, SaG3	San Andreas	Soft sandstone	-----	23	None	-----	-----	-----	-----	-----	-----	-----	-----	<1	Moderate to steep uplands
SdA, SdB2, SfA, SfC	San Ysidro	Loam	>5	0-20	None	D	None to moderate	15-25	5-10	0.63-2.00	0.16-0.18	3.4	5.6-6.5	<1	Level fans to sloped terraces
SdA, SdB2, SfA, SfC	San Ysidro	Clay	>5	20-36	None		None to moderate	25-35	10-20	<0.06	0.04-0.06	0.8	6.1-7.3	<1	Level fans to sloped terraces
SdA, SdB2, SfA, SfC	San Ysidro	Clay loam or sandy clay loam	>5	36-60	None		None to moderate	20-30	5-10	0.20-0.63	0.14-0.16	3.6	7.9-8.4	<1	Level fans to sloped terraces
Su, Sv	Sunnyvale	Silty clay	>5	0-60	2.5-5+	C	None	35-45	15-25	0.06-0.20	0.15-0.17	9.6	7.9-8.4		Low-level alluvial plains
YaA, YaB	Yolo	Loam or silt loam	>5	0-60	None	B	None-slight	35-45	5-10	0.63-2.0	0.14-0.16	9.0	6.1-7.3	<1	Nearly level fans and alluvial plains
YeA, YeC,	Yolo	Clay loam or silty clay loam	>5	0-67	None		None-slight	28-35	12-20	0.2-0.63	0.18-0.2	12.7	6.1-8.4	<1	Nearly level fans and alluvial plains
ZaA, ZaC, ZbA, ZbC, ZeC3	Zamora	Clay loam	>5	0-58	None	B	Slight to moderate	30-40	15-20	0.2-0.63	0.18-0.2	11.0	6.6-7.3	<1	Level to gently sloping fans

Notes:
1) Information taken from USDA soil survey for the area (USDA SCS, 1974).
2) This soil survey generally does not distinguish areas smaller than about 20 to 40 acres, so that wetlands, alluvium, or swale fills smaller than 10 to 20 will not be mapped.
3) Atterberg limits represent the water contents, in percent of the weight of soil, corrosponding to the transition between liquid/plastic, and plastic/solid behavior.
4) Available water holding capacity is the held water available for use by most plants, usually defined as the difference between the amount of soil water at field capacity (one day of drainage after a rain or recharge event) and the amount at the wilting point.

Table 3. **Beneficial uses listed in the Basin Plan for Llagas and Uvas Creeks, and the Pajaro River in the Gilroy area, Santa Clara County, California**

	Llagas Creek	Uvas/Carnadera Creek	Pajaro River
	Below Chesbro Res		
Municipal and Domestic Supply (MUN)	X	X	X
Agricultural Supply (AGR)	X	X	X
Industrial Process Supply (PROC)			
Industrial Service Supply (IND)	X	X	X
Ground Water Recharge (GWR)	X	X	X
Water Contact Recreation (REC-1)	X	X	X
Non-Contact Water Recreation (REC-2)	X	X	X
Wildlife Habitat (WILD)	X	X	X
Cold Fresh Water Habitat (COLD)	X	X	X
Warm Fresh Water Habitat (WARM)	X	X	X
Migration of Aquatic Organisms (MIGR)	X	X	X
Spawning, Reproduction, and/or Early Development (SPWN)	X	X	X
Preservation of Biological Habitats of Special Significance (BIOL)			
Rare, Threatened, or Endangered Species (RARE)	X	X	
Estuarine Habitat (EST)			
Freshwater Replenishment (FRSH)			X
Navigation (NAV)			
Hydropower Generation (POW)			
Commercial and Sport Fishing (COMM)	X	X	X
Aquaculture (AQUA)			
Inland Saline Water Habitat (SAL)			
Shellfish Harvesting (SHELL)			

Source: RWQCB Basin Plan, 1994

Table 4. Regional water quality objectives and conditions, Santa Clara Valley Recycled Water Program, Santa Clara Valley Water District and South County Regional Wastewater Authority.

			Basin Plan Objectives			City of Gilroy Ground Water			Surface Water Data	
Constituent	Tertiary Effluent Data[a] *(mg/l)*	Drinking Water MCL[g] *(mg/l)*	Tertiary Effluent (to Pajaro) *(mg/l)*	Median GW[d] *(mg/l)*	Surface Water[d] *(mg/l)*	Confined (Deep) Aquifer[b] *(mg/l)*	Shallow Aquifer[c] *(mg/l)*	Unconfined Aquifer[i] *(mg/l)*	Llagas Creek[e] *(mg/l)*	Uvas Creek[h] *(mg/l)*
TDS	634	500	1000	300	200	341.9	795	301	684	182
Chloride	155	250	250	20	10	33.7	147	23	**87**	**5.7**
Sulfate	63	250	250	50	20	38.4	120	39.3	-----	26.1
Boron	0.67	-----	1	0.2	0.2	-----	0.34	0.11	-----	-----
Sodium	113	-----	200	20	20	22	85	25	67	11.1
Nitrate as N	3.7	10	10	5	-----	5.7	-----	5.2	12	0.8
Ammonia as N	0.07	-----	0.05	-----	-----	-----	-----	-----	0.11	<0.05
Fecal Coliform	<2-4 [f]	-----	-----	-----	6.5-8.5	-----	-----	-----	**315**	-----
pH	7.6	6.5-8.5	-----	-----	-----	7.4	-----	7.3	-----	8.1

a. Average SCRWA effluent values for 2001-2002. Source: Annual SCRWA Reports summarized in (Carollo, 2004)
b. Based on Gilroy municipal well sampling data for March 2004. RWQCB WDR Order R3-2004-0099
c. Based on average quarterly groundwater data for 21 monitoring wells during 1999. RWQCB WDR Order R3-2004-0099
d. Objectives listed in RWQCB Basin Plan, 1994
e. Based on monthly average concentrations for 2000 through 2003. Source: RWQCB WDR Order R3-2004-0099
f. Value represents Total Coliform value in (mpn/100ml). Source: RWQCB WDR Order R3-2004-0099
g. Values obtained from the EPA list of drinking water maximum contaminant levels (http://www.epa.gov/safewater/mcl.html#sec)
h. Values obtained from Uvas Reservoir water quality data provided by the District for the time period between 1/1995 through 6/1997.
i. Water quality data provided by the District for wells within unconfined zone; querry initiated July 2008; data period 1982 to 2008.

Table 5. Water quality impairments and TMDLs for Llagas and Pajaro Creeks, Central Coast Regional Board, California

Pollutant/Stressor	Priority [1]	Potential Sources	Location	Estimated channel length affected *(mi)*
Llagas Creek				
Chloride	Low	NP, Pt.	Downstream of confluence with Miller Slough (Near Southside Drive)	1
Fecal Coliforms	In progress	Graz., NP, Nat.	Btw confluence with Church Creek and Pajaro R.	9.5
Low DO	Low	Muni., Irr., Ag., Hab. Mod.	Listing made by USEPA, no location specified	16
pH	Low	Unknown	Not specified	16
Sodium	Low	Unknown NP source	Downstream of confluence with Miller Slough (Near Southside Drive)	1
Total Dissolved Solids	Low	NP, Pt.	Btw confluence with Church Creek and Pajaro R.	9.5
Pajaro River				
Boron	Not specified	Unknown	Not specified	32
Fecal Coliforms	In progress	Graz., NP, Pt.	Approx 4.5 mi upstream of confluence with Llagas Creek	4.5
EPA Approved TMDLs (all apply to the Pajaro and Llagas Creek)				
Nitrate	Approved 10/13/06	Ag., Irr., Urb., WW Disp., Chann., Rip. Veg. Rem., NP, Muni., Graz., Hab. Mod.	32 miles of Pajaro R., Llagas btw confluence with Church Creek and Pajaro River (9.5 miles)	41.5
Sediment	Approved 5/3/07	Ag., Irr., Res. Ext., Sur. Min., Hydromod., Chann., Hab. Mod., Rip. Veg. Rem., Bank Mod., Chann. Eros.	32 miles of Pajaro R., Llagas btw confluence with Church Creek and Pajaro River (9.5 miles)	41.5

Source: 2006 CWA Section 303(d) List of Water Quality Limited Segment, Central Coast Region RWQCB (http://www.waterboards.ca.gov/tmdl/docs/303dlists2006/final/r3_final303dlist.pdf)

Abbreviations and added detail on potential sources:

NP	Unspecified non-point source
Nat.	Natural sources
Pt.	Unspecified point source
Graz	Pature and riparian grazing
Muni.	Municipal
Irr.	Irrrigation
Ag.	Agricultural one or more of (runoff, irrigation return flows, subsurface drainage, irrigation tailwater)
Hab. Mod.	Habitat modification
Urb.	Urban runoff and storm sewers
WW Disp.	Land disposal of wastewater
Rip. Veg. Rem.	Removal of riparian vegetation
Res. Ext.	Resource extraction
Sur. Min.	Surface mining
Hydromod.	Hydromodification
Chann. Eros.	Channel erosion

Notes:

1. Priorities not included in the 2006 303(d) list. Priorities listed here are from the 2002 303(d) list.

Table 6. **Irrigation water quality guidelines from the RWQCB Basin Plan for the Central Coast Region (RWQCB, 1994).**

Problem and Related Constituent	*Units*	Water Quality Guidelines		
		No Problem	**Increasing Problems**	**Severe Problems**
Salinity				
EC or irrigation water	*mmho/cm*	<0.75	0.75 - 3.0	>3.0
Permeability				
EC of irrigation water	*mmho/cm*	>0.5	<0.5	<0.2
SAR, adjusted[a]	-----	<6.0	6.0 - 9.0	>9.0
Specific ion toxicity from root absorption[b]				
Sodium (evaluate by adjusted SAR)		<3	3.0 - 9.0	>9.0
Chloride	*mg/L*	<142	142 - 355	>355
Boron	*mg/L*	<0.5	0.5 - 2.0	2.0 - 10.0
Specific ion toxicity from foliar absorption				
Sodium	*mg/L*	<69	>69	-----
Chloride	*mg/L*	<106	>106	-----
Miscellanious				
NH_4-N	*mg/L*	<5	5 - 30	>30
NO_3-N	*mg/L*	<5	5 - 30	>30
HCO_3 (only with overhead sprinklers)	*mg/L*	<90	90 - 520	>520
pH	-----	Normal Range	6.5 - 8.4	-----

a. Sodium Adsorption Ratio (SAR) is calculated from a modified equation developed by the U.S. Salinity Laboratory. Refer to the Basin Plan for details on and assistance with SAR caclulation.

b Most tree crops and woody ornamentals are sensitive to sodium and chloride (use values shown). Most annual crops are less sensitive and may have higher tolerances.

Table 7. Estimated average water quality of recharge in the Uvas Stream Corridor for the three scenarios, Santa Clara County, California.

Source of Recharge	Volumes		Volumes Infiltrated (runoff excluded[a])		Water Quality		Total Salt	Average Water Quality of Recharge	% Increase
	(acre-ft/yr)	*(gal x 10^{-6})*	*(acre-ft/yr)*	*(gal x 10^{-6})*	*(mg/L)*	*(lbs/gal)*	*(lbs/yr)*		
Pre-SCRWA Deliveries									
Uvas stream bed infiltration [b]	10,000	3,259	10,000	3,259	182	0.0015	4,950,000		
Recharge from precipitation [c]	2,240	730	672	219	38	0.0003	230,000		
Irrigation return from wells [d]	1,722	561	517	168	500	0.0042	2,340,000		
Irrigation return from recycled [e]	0	0	0	0	634	0.0053	0	**250**	
Total	13,962	4,550	11,189	3,646			7,520,000		
Phase I of SCRWA Deliveries									
Uvas stream bed infiltration [b]	10,000	3,259	10,000	3,259	182	0.0015	4,950,000		
Recharge from precipitation [c]	2,240	730	672	219	38	0.0003	230,000		
Irrigation return from wells [d]	1,144	373	343	112	500	0.0042	1,560,000		
Irrigation return from recycled [e]	**608**	198	182	59	634	0.0053	1,050,000	**260**	**4.0**
Total	13,992	4,559	11,198	3,649			7,790,000		
Phase II SCRWA Deliveries									
Uvas stream bed infiltration [b]	10,000	3,259	10,000	3,259	182	0.0015	4,950,000		
Recharge from precipitation [c]	2,240	730	672	219	38	0.0003	230,000		
Irrigation return from wells [d]	0	0	0	0	500	0.0042	0		
Irrigation return from recycled [e]	1,812	590	544	177	634	0.0053	3,120,000	**270**	**3.8**
Total	14,052	4,579	11,216	3,655			8,300,000		
									8.0

Notes:

a. A runoff coefficient of 0.7 was used for rainfall and it was assumed that 30% of irrigaiton water infiltrated past the root zone.

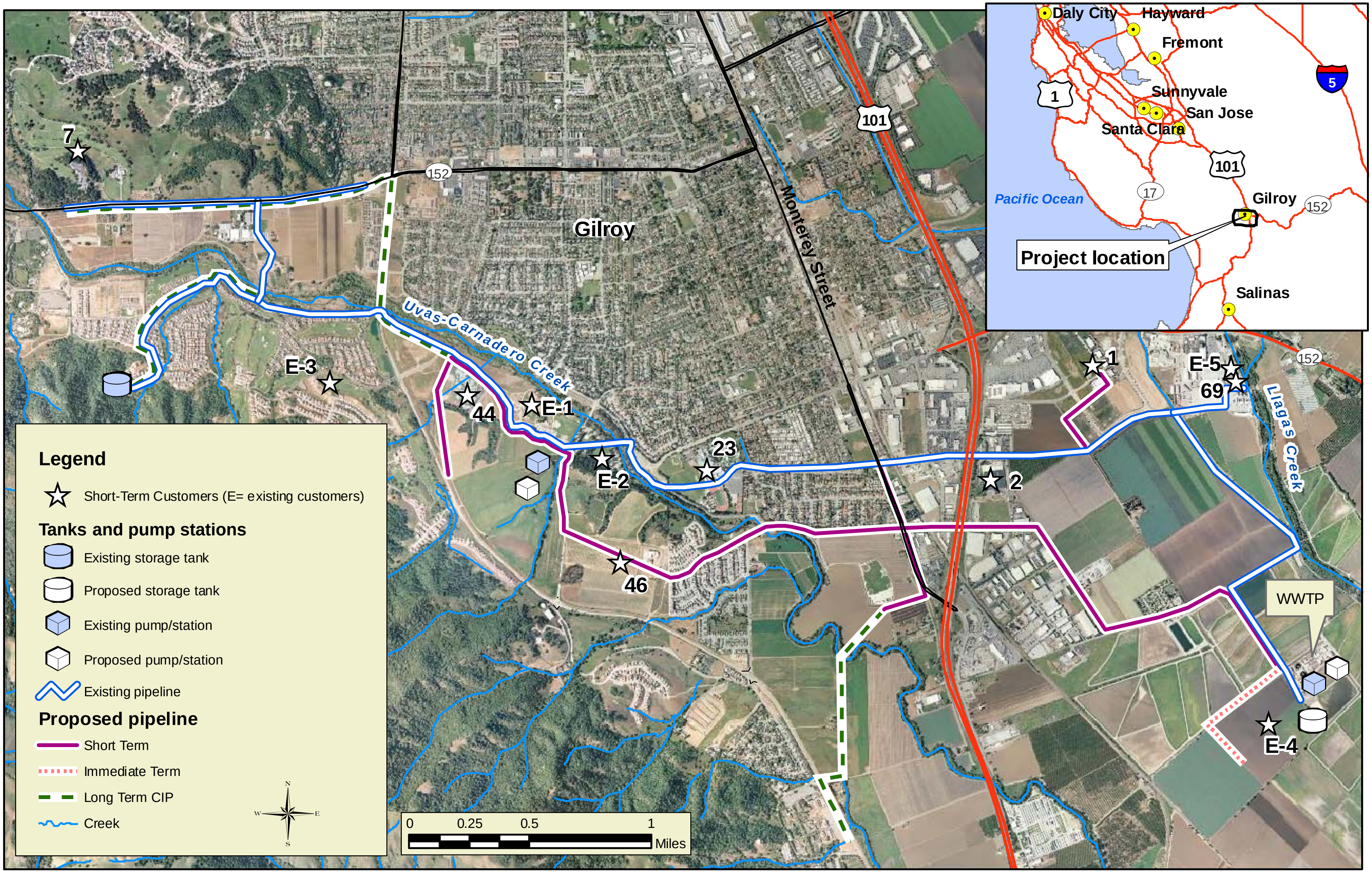
b. TDS values were estimated from Uvas Reservoir data provided by the District. Volumes estimated from Reymers and Hemmeter, 2001.

c. TDS values were estimated from Hem, 1989. Volumes were estimated from average annual raninfall of 21 inches (reference?)

d. TDS values from SCVWD database query 7/2008.

e. TDS values were estimated from Carollo, 2004.

FIGURES

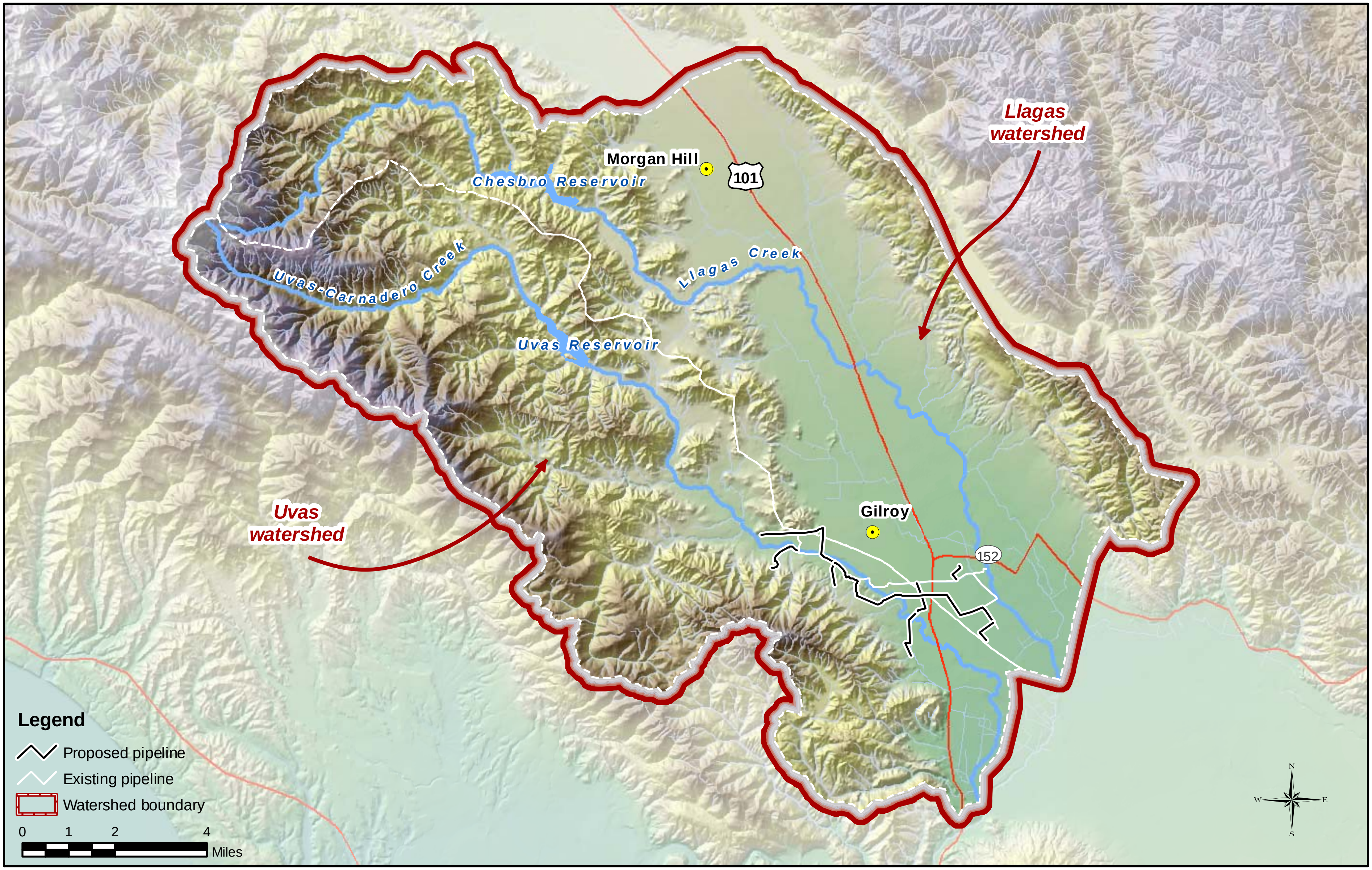


Source: Aerial photo from GlobeExplorer, captured 12/01/2003.

Balance Hydrologics, Inc.

Figure 1. Location map with existing and proposed recycled water program project conditions, in and near City of Gilroy, Santa Clara County, California

W:\Projects\205034 SCVWD\205034_location_map.mxd

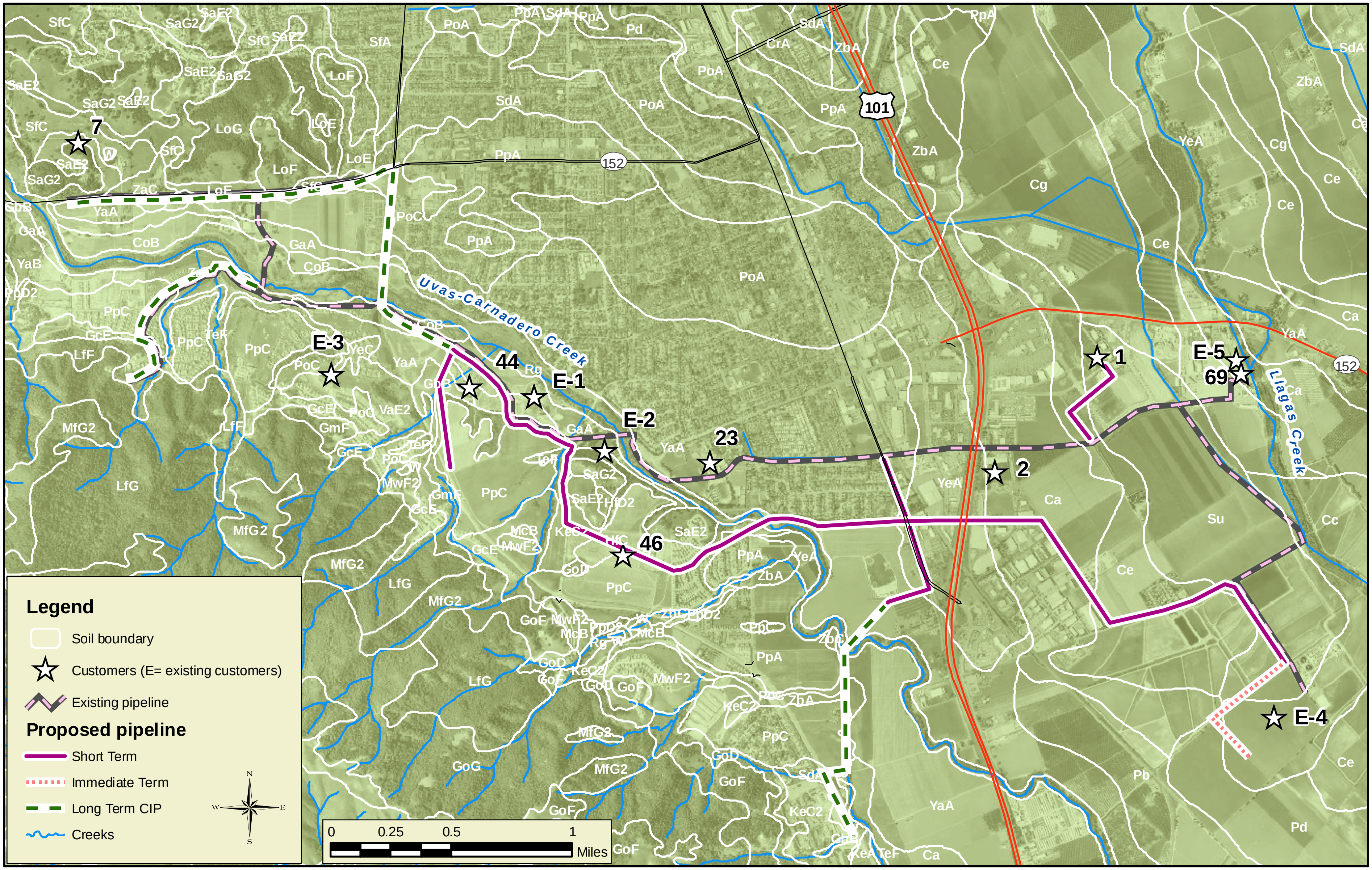


Balance Hydrologics, Inc.

Figure 2. Uvas-Carnadero and Llagas watershed map, Santa Clara County, California

Note: Watershed boundary approximate through the City of Gilroy.

W:\Projects\205034 SCVWD\205034_watershed_map.mxd

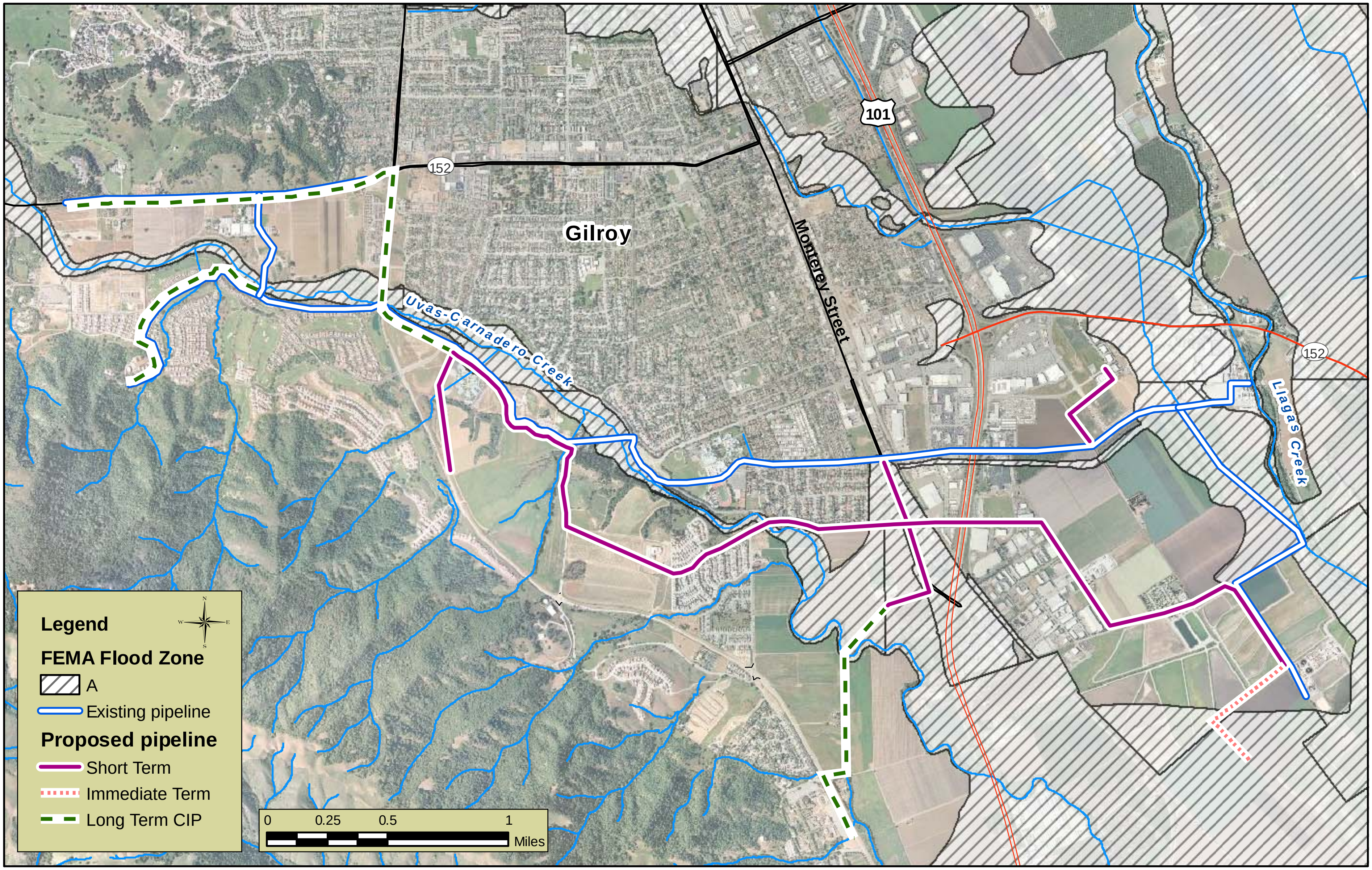


Source: Aerial photo from GlobeExplorer, captured 12/01/2003.
U.S. Department of Agriculture, Natural Resources, 2005, Soil Survey Geographic (SSURGO) database for Eastern Santa Clara Area, California.

Balance Hydrologics, Inc.

Figure 3. Soils map, near City of Gilroy, Santa Clara County, California
See Table 2 for soil descriptions.

W:\Projects\205034 SCVWD\205034_soils_map_new.mxd

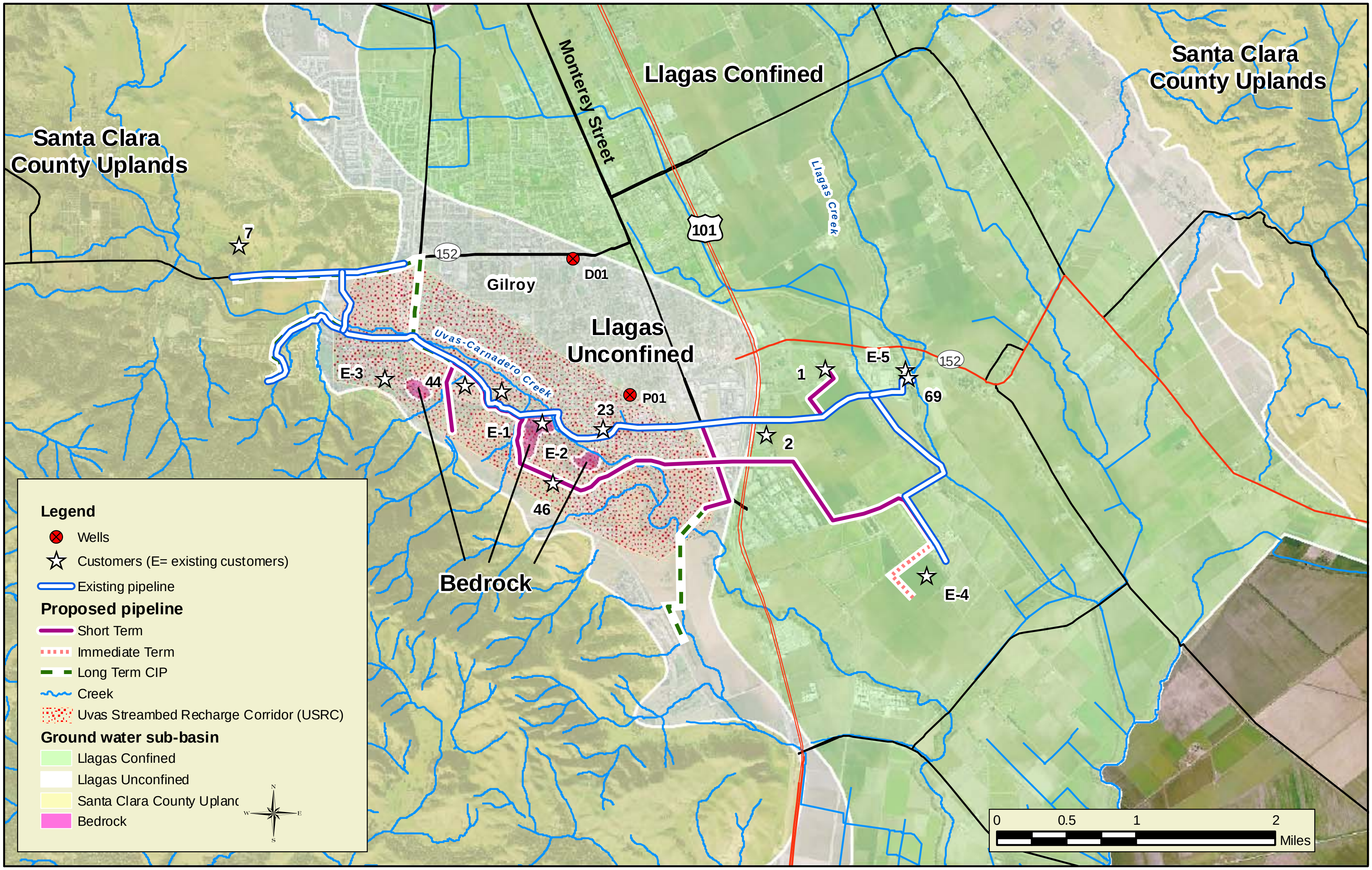


Source: Aerial photo from GlobeExplorer, captured 12/01/2003. FEMA Q3 data, 1996.

Balance Hydrologics, Inc.

Figure 4. FEMA flood zones, near City of Gilroy, Santa Clara County, California

W:\Projects\205034 SCVWD\205034_FEMA_map.mxd



Source: Aerial photo from GlobeExplorer, captured 12/01/2003. Ground water data courtesy of SCVWD.

Balance Hydrologics, Inc.

Figure 5. Ground-water zones, near City of Gilroy, Santa Clara County, California

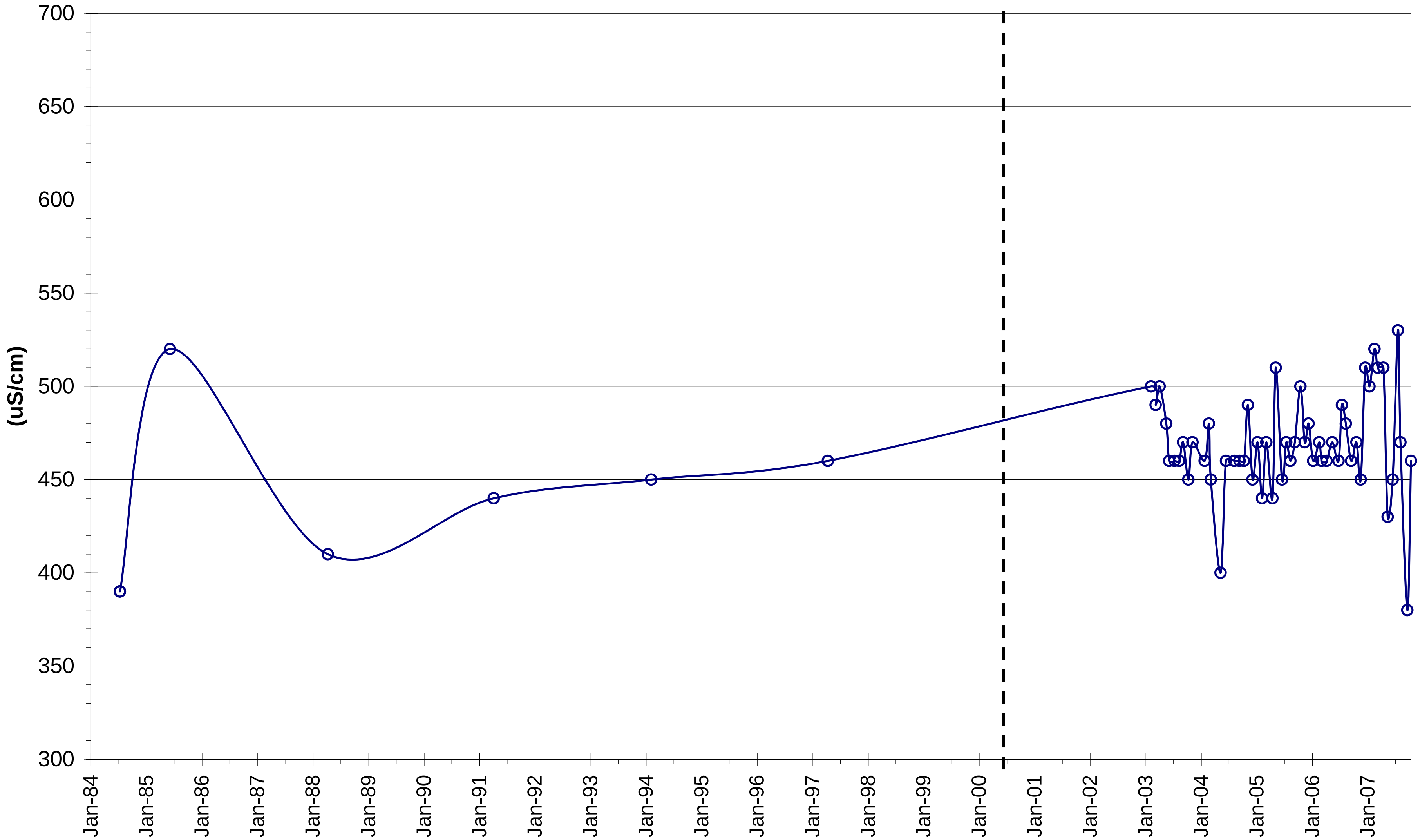


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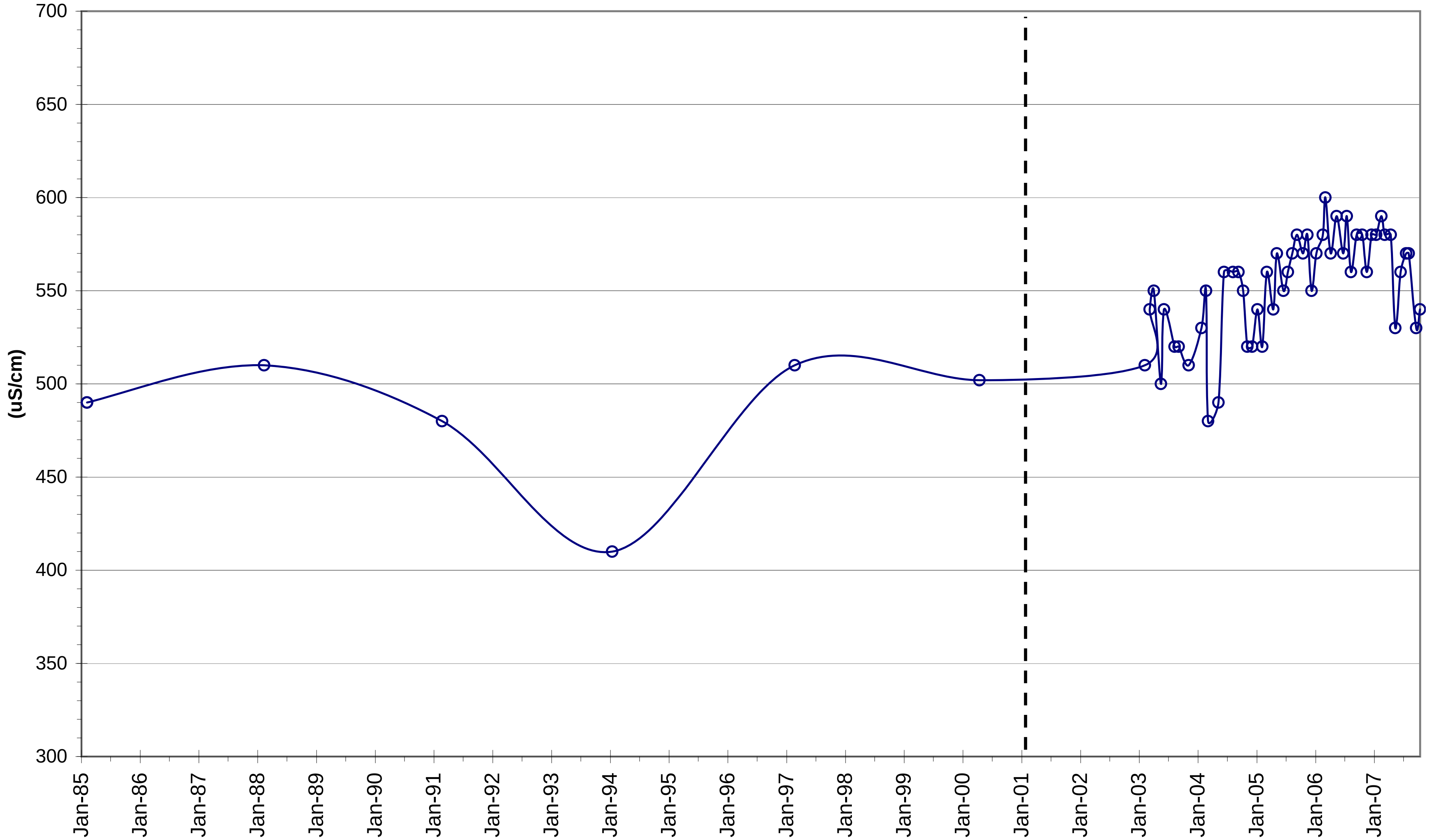
Figure 6. **Specific conductance for Monitoring Well P01 (downstream of the application site), Santa Clara County, California.**

Note: Dashed line represents first recycled water deliveries from SCRAW facility.
Source : SCVWD database query for monitoring wells in unconfined region Llagas Basin 6/2008



Balance Hydrologics, Inc.

Figure 7. **Specific conductance for Monitoring Well DO1 (upstream of the applicaton site), Santa Clara County, California.**

Note: Dashed line represents first recycled water deliveries from SCRAW facility.
Source: SCVWD database query for monitoring wells in unconfined region Llagas Basin 6/2008

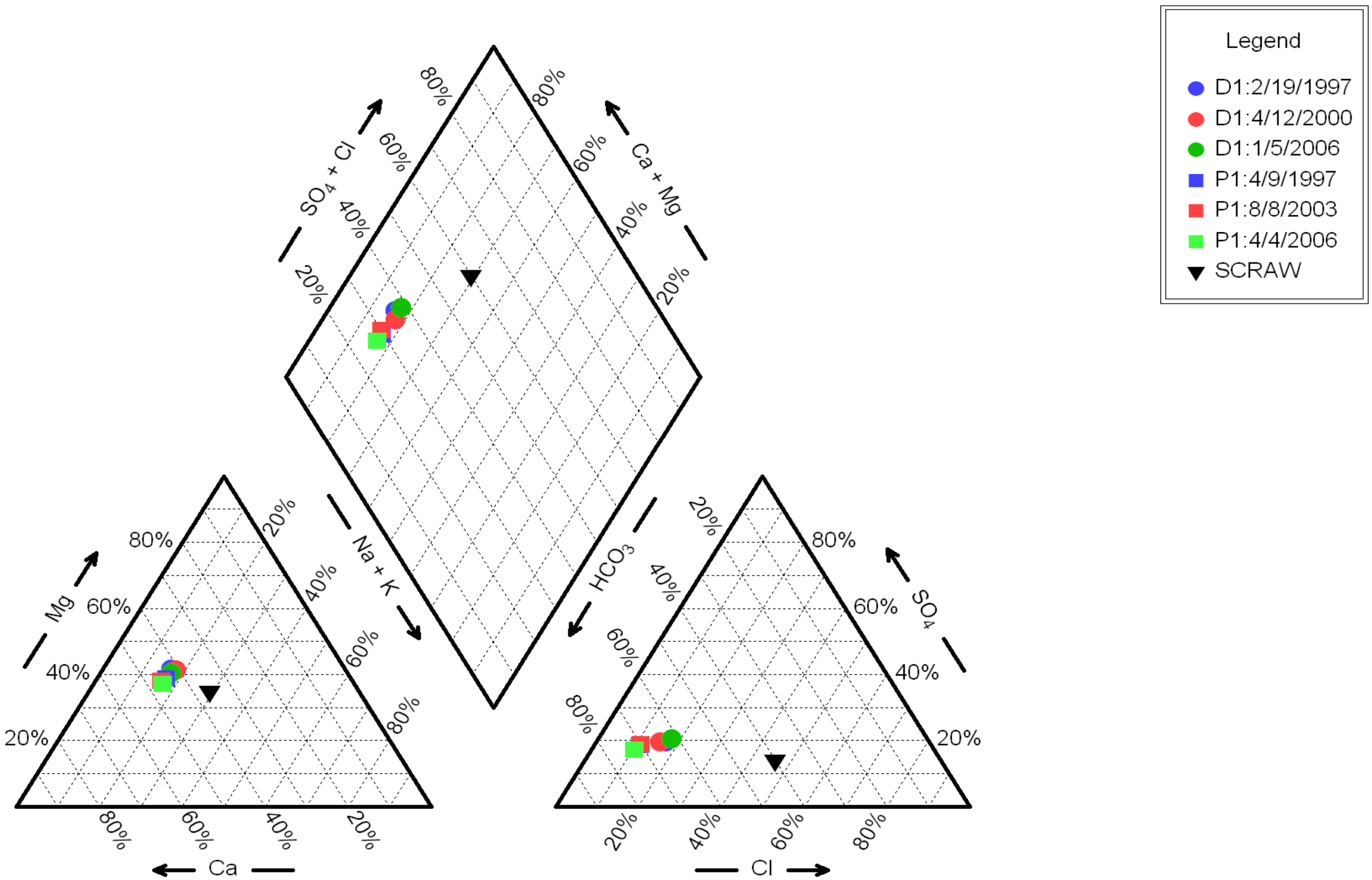


Figure 8. **Piper diagram of water sample data from Monitoring Wells D01 and P01, and SCRAW Facility Effluent, Santa Clara County, California.**

Source: SCVWD database query for monitoring wells in the unconfined region of Llagas Basin

APPENDICES

APPENDIX A

Title 22 Water Quality Objectives for Municipal Supply

Table 3-5 Water Quality Objectives for Municipal Supply

Parameter	Objective (in MG/L)
Physical:	
Color (units)[a]	15.0
Odor (number)[a]	3.0
Turbidity (NTU)[a]	5.0
pH[b]	6.5-8.0
TDS[c]	500.0
EC (mmhos/cm)[c]	900
Corrosivity	non-corrosive
Inorganic Parameters:	
Aluminum[d]	1.0[d]/0.2[a]
Antimony[d]	0.006
Arsenic[d]	0.05
Asbestos[d]	7 MFL[e]
Barium[d]	1.0
Beryllium[d]	0.004
Chloride[c]	250.0
Cadmium[d]	0.005
Chromium[d]	0.05
Copper[a]	1.0
Cyanide[d]	0.15
Fluoride[f]	0.6-1.7[g]
Iron[a]	0.3
Lead[b]	0.05
Manganese[a]	0.05
Mercury[d]	0.002
Nickel[d]	0.1
Nitrate (as NO_3)[d]	45.0
Nitrate + Nitrite (as N)[d]	10.0
Nitrite (as N)[d]	1.0
Selenium[d]	0.05
Silver[b]	0.1
Sulfate[c]	250.0
Thallium[d]	0.002
Zinc[a]	5.0
Organic Parameters:	
MBAS (Foaming agents)[a]	
Oil and grease[b]	none
Phenols[b]	0.001
Trihalomethanes[b]	0.1
Chlorinated Hydrocarbons:	
Endrin[h]	0.002
Lindane[h]	0.0002
Methoxychlor[h]	0.03
Toxaphene[h]	0.003
2,3,7,8-TCDD (Dioxin)[h]	
2,4-D[h]	0.07
2,4,4-TP Silvex[h]	0.05

Parameter	Objective (in MG/L)
Synthetic Organic Chemicals:	
Alachor[h]	0.002
Atrazine[h]	0.001
Bentazon[h]	0.018
Benzo(a)pyrene[h]	0.0002
Dalapon[h]	0.2
Dinoseb[h]	0.007
Diquat[h]	0.02
Endothall[h]	0.1
Ethylene dibromide[h]	0.00005
Glyphosate[h]	0.7
Heptachlor[h]	0.00001
Heptachlor epoxide[h]	0.00001
Hexachlorecyclopentadiene[h]	0.001
Molinate[h]	0.02
Oxarnyl[h]	0.05
Pentachlorophenol[h]	0.001
Picloram[h]	0.5
Polychlorinated Biphenyls[h]	0.0005
Simazine[h]	0.004
Thiobencarb[h]	0.07/0.001
Volatile Organic Chemicals:	
Benzene[h]	0.001
Carbon Tetrachloride[h]	0.005
1,2-Dibromo-3-chloropropane[h]	0.0002
1,2-Dichlorobenzene[h]	0.6
1,4-Dichlorobenzene[h]	0.005
1,1-Dichloroethane[h]	0.005
1,2-Dichloroethane[h]	0.0005
cis-1,2-Dichloroethlyene[h]	0.006
trans-1,2-Dichloroethylene[h] 0.5	0.01
1,1-Dichloroethylene[h]	0.006
Dichloromethane[h]	0.005
1,2-Dichloropropane[h]	0.005
1,3-Dichloropropene[h]	0.0005
Ethylbenzene[h]	0.7
Methyl-tert-butyl ether[h]	0.13/0.005
Monochlorobenzene[h]	0.07
Styrene[h]	0.1
1,1,2,2-Tetrachloroethane[h]	0.001
Tetrachloroethylene[h]	0.005
1,2,4-Trichlorobenzene[h]	0.005
1,1,1-Trichloroethane	0.200
1,1,2-Trichloroethane[h]	0.005
Trichloroethylene[h]	0.005
Trichlorofluoromethane	0.15

Parameter	Objective (in MG/L)
Volatile Organic Chemicals (cont'd):	
1,1,2-Trichloro-1,2,2-trifluoromethane[h]	1.2
Toluene[h]	0.15
Vinyl Chloride[h]	0.0005
Xylenes (single or sum of isomers)[h]	1.750
Radioactivity:	
Combined Radium-226 and Radium-228[i]	5
Gross Alpha Particle Activity[i]	15i
Tritium[i]	20,000
Strontium-90[i]	8
Gross Beta Particle Activity[i]	50
Uranium[i]	20

NOTES:

a. Secondary Maximum Contaminant Levels as specified in Table 64449-A of Section 64449, Title 22 of the California Code of Regulations, as June 3, 2005.

b. Table III-2, 1986 Basin Plan

c. Secondary Maximum Contaminant Levels as specified in Table 64449-B of Section 64449, Title 22 of the California Code of Regulations, as of June 3, 2005. (Levels indicated are "recommended" levels. Table 64449-B contains a complete list of upper and short-term ranges.)

d. Maximum Contaminant Levels as specified in Table 64431-A (Inorganic Chemicals) of Section 64431, Title 22 of the California Code of Regulations, as of June 3, 2005.

e. MFL = million fibers per liter; MCL for fibers exceeding 10 um in length.

f. Flouride objectives depend on temperature.

g. A complete list of optimum and limiting concentrations is specified in Table 64433.2-A of Section 64433.2, Title 22 of the California Code of

Regulations, as of June 3, 2005.

h. Maximum Contaminant Levels as specified in Table 64444-A (Organic Chemicals) of Section 64444, Title 22 of the California Code of Regulations, as of June 3, 2005.
i. Maximum Contaminant Levels as specified in Table 4 (Radioactivity) of Section 64443, Title 22 of the California Code of Regulations, as of June 3, 2005.
j. Included Radium-226 but excludes Radon and Uranium.

MG/L Milligrams per liter
pCi/L pico Curries per liter