Appendix A - Existing and Future Groundwater Quality Technical Memorandum

Todd Engineers

Technical Memorandum

Sonoma Valley Salt and Nutrient Management Plan

Subject: **Existing and Future Groundwater Quality**

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Executive Summary

The Sonoma Valley Groundwater Subbasin is located in southern Sonoma County, California abutting San Pablo Bay. Due to an area of historical brackish groundwater located adjacent to San Pablo Bay, the Sonoma Valley Subbasin is divided into a Baylands Area (containing the historical brackish groundwater) and an Inland Area for assessment of groundwater quality. Sonoma Creek is the main surface water feature draining the valley. The Sonoma Valley relies on groundwater, imported surface water, and recycled water to meet domestic, agricultural and urban demands. Recycled water is used for agricultural irrigation in the southern part of the subbasin to offset groundwater pumping and mitigate the potential for saline water intrusion from the bay related to groundwater pumping depressions within the Inland Area. Increased use of recycled water is planned in the future.

The State Water Resources Control Board Recycled Water Policy encourages increased reliance on local water supplies such as recycled water and stormwater. Due to water quality concerns associated with recycled water, the Recycled Water Policy requires completion of a Salt and Nutrient Management Plan that assesses the water quality impacts of recycled water (and all other salt and nutrient sources) in terms of the use of the groundwater basin available assimilative capacity by recycled water projects. Total dissolved solids (TDS) and nitrate are the indicator salts and nutrients assessed for this study. Assimilative capacity is the difference between average TDS and nitrate concentrations in the subbasin and the respective basin plan objectives.

Generally, relatively low TDS and nitrate concentrations are observed throughout most of the Inland Area of the subbasin and water quality concentration trends over time are flat or stable. Average TDS and nitrate concentrations in the Inland Area are below basin plan objectives, and there is available assimilative capacity.

The use of the available assimilative capacity by recycled water projects in the subbasin for the future planning period through 2035 was estimated for this study. The Recycled Water Policy established an impacts evaluation criteria, such that a single recycled water project may use less than 10% of the available assimilative capacity (and multiple recycled water projects may use less than 20% of the available assimilative capacity) until such time as a Salt and Nutrient Management Plan is adopted. If these criteria are satisfied, the associated anti-degradation analysis would only need to document the projected future assimilative capacity use.

The analysis presented in this Technical Memorandum demonstrates that the recycled water irrigation projects planned for the Sonoma Valley Subbasin through 2035 use less than 10% of the available TDS and nitrate assimilative capacity.

1 Introduction

This Technical Memorandum (TM) was prepared by Todd Engineers on behalf of the stakeholders of Sonoma Valley, including the Sonoma Valley County Sanitation District (SVCSD), for the Sonoma Valley Salt and Nutrient Management Plan (SNMP). The key components of this TM include:

- Description of hydrogeologic conceptual model
- Characterization of the existing average salt and nutrient (S/N) groundwater quality
- Calculation of the existing available assimilative capacity for S/Ns
- Description of the baseline period (1997 to 2006) basin water and S/N balances and loading calibration
- Estimation of the water and S/N balances for the future planning period (2014 to 2035)
- Prediction of future S/N groundwater quality
- Calculation of the use of the available assimilative capacity by recycled water projects

2 Hydrogeologic Conceptual Model

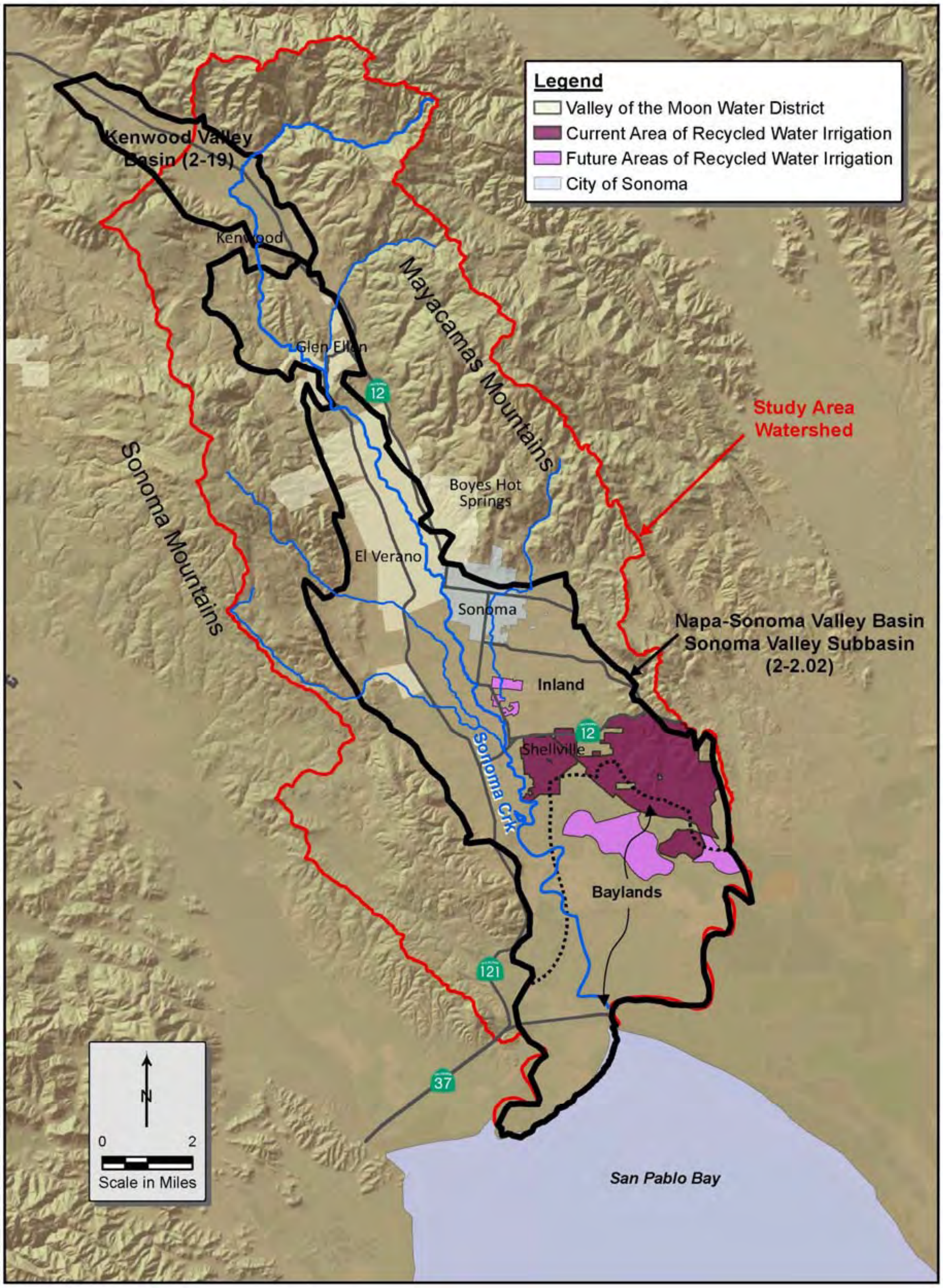
Much of the hydrogeologic conceptual model discussion below is based on data and analysis presented in the "Geohydrological Characterization, Water-Chemistry, and Ground-Water Flow Simulation Model of the Sonoma Valley Area, Sonoma County, California" prepared by the United States Geological Survey (USGS, 2006).

2.1 Study Area

Figure 2-1 shows the Sonoma Valley Subbasin (No. 2-2.02), or Study Area, as defined by the California Department of Water Resources (DWR), Bulletin 118-4 (DWR, 2003). The Sonoma Creek Watershed, which includes part of the Kenwood Valley Groundwater Basin located northwest of the Sonoma Valley Subbasin, is also shown on Figure 2-1 and encompasses an area of 166 square miles (106,680 acres). Due to an area of historical brackish groundwater located adjacent to and northwest of San Pablo Bay, the Sonoma Valley Subbasin is divided into a Baylands Area and an Inland Area as shown in Figure 2-1. The Baylands Area is defined for this study as the area beneath the tidal sloughs adjacent to San Pablo Bay generally containing groundwater with greater than 750 milligrams per liter (mg/L) total dissolved solids (TDS). The Sonoma Valley Subbasin, also referred to as Sonoma Valley, is located in southeastern Sonoma County. The Sonoma Valley is a northwest trending, elongated depression. Geologic units dipping toward the center of the valley are bounded on the southwest by the Sonoma Mountains and on the northeast by the Mayacamas Mountains (Figure 2-1). The uppermost part of the valley is relatively flat and stretches from Kenwood to near Glen Ellen. The middle part of the valley is narrower than the upper part and has a hilly topography. This portion is sometimes referred to as the Valley of the Moon and extends southward to near Boyes Hot Springs and includes the Glen Ellen area. The remainder of the valley slopes gently southward to San Pablo Bay, has flat topography, and extends to a maximum width of about 5 miles.

Sonoma Creek is the main surface water feature draining the valley. The creek originates in the Mayacamas Mountains in the northeastern area of the watershed. The creek flows into the Kenwood Valley Basin before flowing south into the Sonoma Valley Subbasin and ultimately discharging into San Pablo Bay. Other smaller tributary creeks flow into Sonoma Creek from the east and west.

Figure 2-1: Study Area



The watershed area comprises large tracks of native vegetation, as well as lands used for agriculture, primarily vineyards. Urban, residential, commercial, and industrial development constitutes a relatively small percentage of the watershed area and is primarily located in the valley areas. Sonoma is the largest city in the Study Area. Other cities and unincorporated areas in the valley include Kenwood, Glen Ellen, Boyes Hot Springs, El Verano, and Schellville (Figure 2-1).

2.2 Water Use

The Sonoma Valley relies on groundwater, imported surface water, and recycled water to meet domestic, agricultural and urban demands. Based on the USGS study (2006), more than half of the water demand in 2000 was met with groundwater (57%). The remaining demand was met with imported water (36%), recycled water (7%), and local surface water (<1%). The largest use of groundwater in the Sonoma Valley in 2000 was irrigation (72%), followed by rural domestic use (19%), and urban demand (9%). In 2000, total water use in the Sonoma Valley (including groundwater and imported surface water) was estimated at 14,018 acre-feet (AF), of which 48% was used for irrigation, 41% for urban use, and the remaining 11% for rural domestic use.

Groundwater serves approximately 25% of the Sonoma Valley population and is the primary source of drinking water supply for rural domestic and other unincorporated areas not being served by urban suppliers. Rural domestic demand is predominantly met by groundwater through privately owned and operated water wells. There are also mutual water companies in the Sonoma Valley that supply multiple households predominantly with groundwater although some companies also provide imported water. Agricultural water demands are largely met by groundwater supplies. It was estimated that as of 2000 the Sonoma Creek Watershed contained approximately 2,000 domestic, agricultural, and public supply wells (USGS, 2006).

Imported surface water represents the primary source of drinking water to meet urban demands, which serves approximately 75% of the Sonoma Valley population. These imported water supplies are sourced from the Russian River and are provided via aqueduct by the Sonoma County Water Agency (SCWA) to the Valley of the Moon Water District (VOMWD) and the City of Sonoma (City) who, in turn, provide water directly to their urban customers. The imported water is supplemented with local groundwater from the City and VOMWD public supply wells. The City and VOMWD boundaries are shown in Figure 2-1.

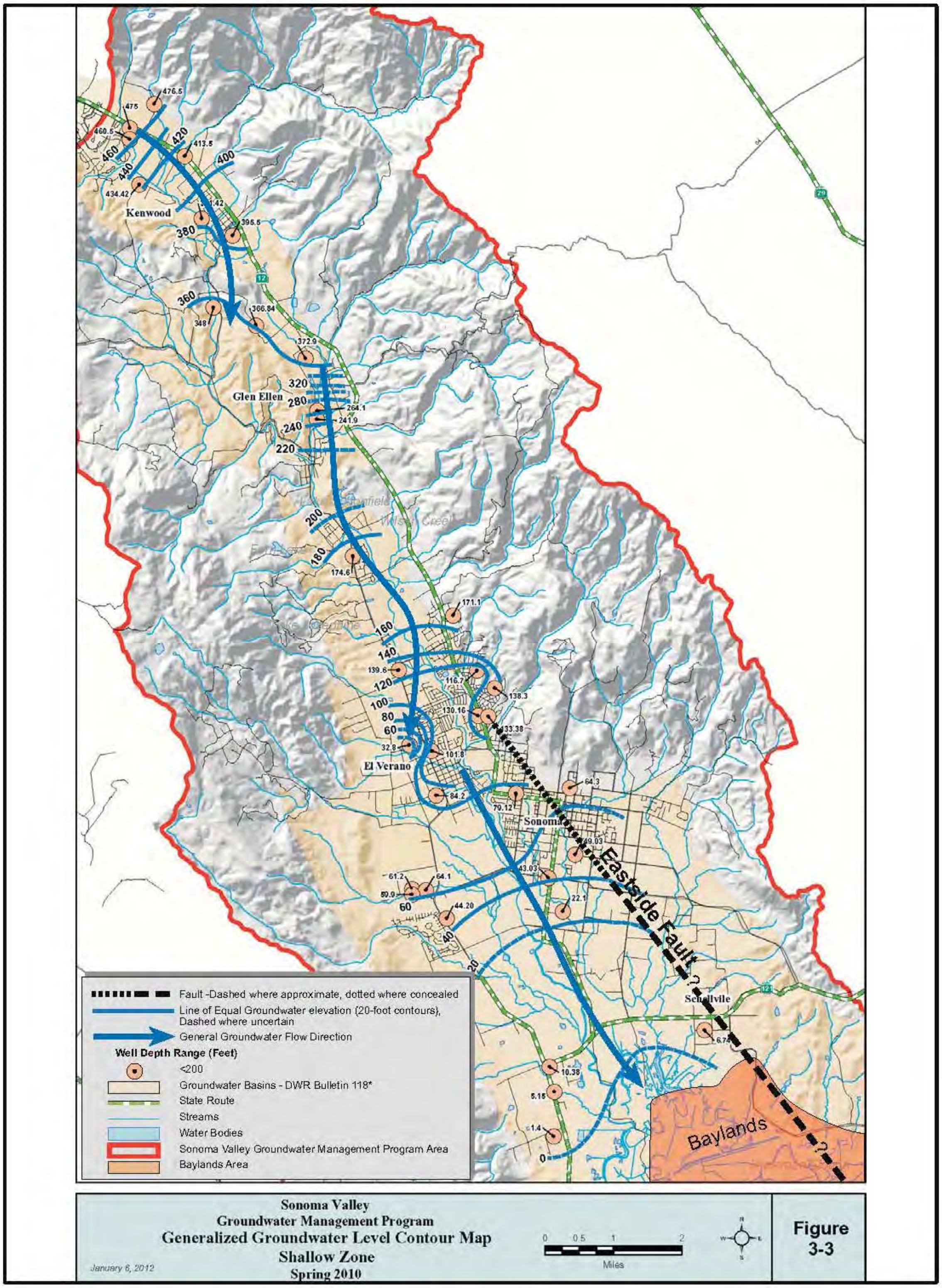
The SCWA manages and operates the wastewater treatment facility owned by the SVCSD. During dry weather months from May through October, the SVCSD provides 1,000 to 1,200 acre-feet per year (AFY) of recycled water for vineyards, dairies, and pasturelands in the southern part of Sonoma Valley. As of 2007, recycled water accounted for approximately 7% of the total estimated water use in Sonoma Valley (SCWA, December 2007). The current and future areas of recycled water use for irrigation are shown in Figure 2-1. Recycled water irrigation areas are located in southern Inland Area and northern Baylands Area.

2.3 Groundwater Levels and Flow

Groundwater levels in the Sonoma Valley are monitored and reported as part of the Sonoma Valley Groundwater Management Program (GMP) (SCWA, 2011). The majority of wells monitored in the program are voluntary private wells, with a smaller but significant number of publicly-owned water supply wells. As of 2010, there were a total of 141 wells in the water level monitoring program with monitoring conducted generally twice per year in the spring (April) and fall (October/November).

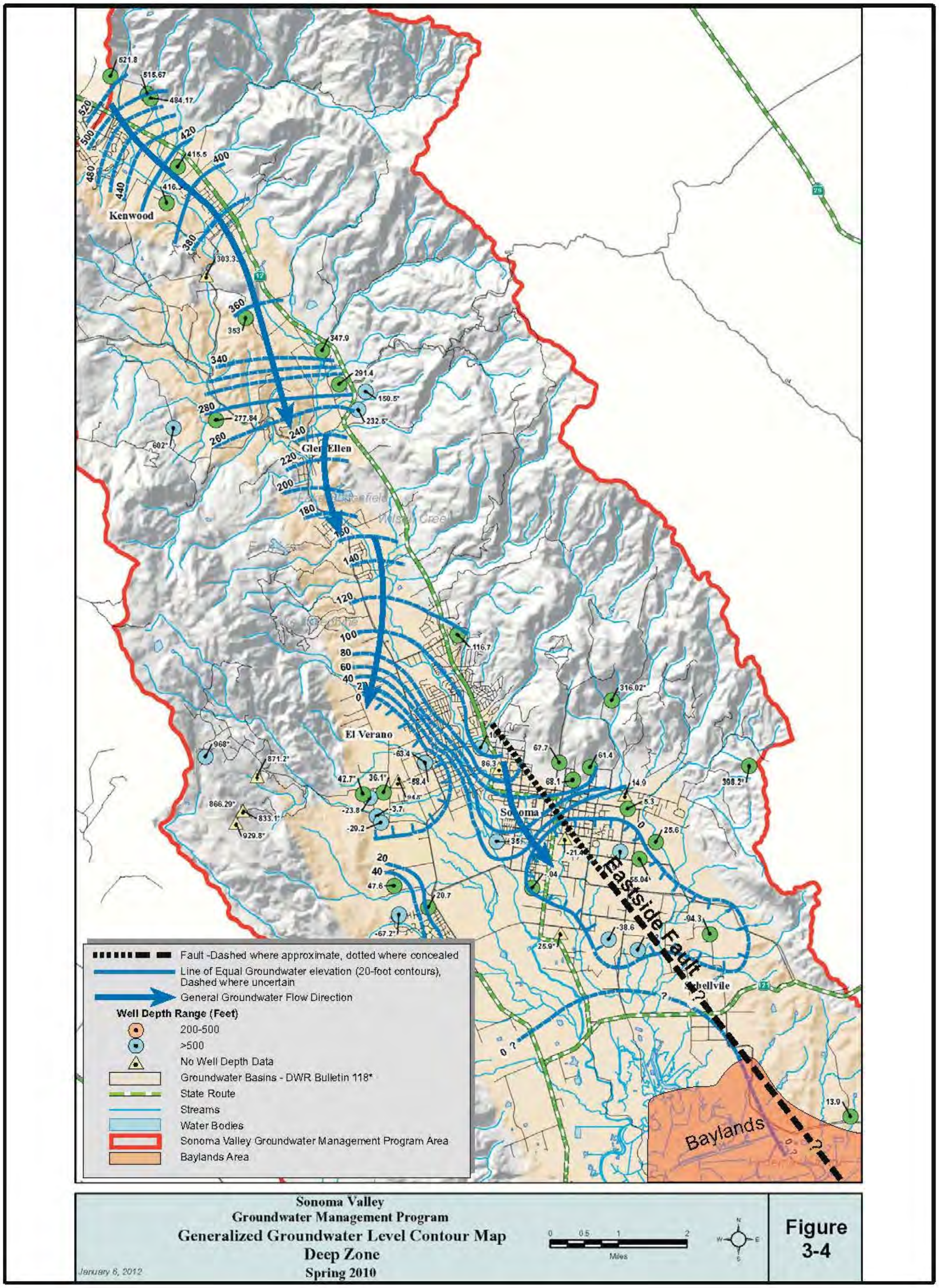
Groundwater elevation contour maps are prepared by the Agency for the shallow zone (less than 200-feet deep) and the deep zone (greater than 200-feet deep). Groundwater elevation contour maps for spring 2010 in the shallow and deep zones are shown in **Figures 2-2** and **2-3**, respectively. There is a

Figure 2-2: Generalized Groundwater Elevation Contour Map, Shallow Zone, Spring 2010



Modified from: SCWA, 2011

Figure 2-3: Generalized Groundwater Elevation Contour Map, Deep Zone, Spring 2010



Modified from: SCWA, 2011

groundwater divide within the Kenwood Valley Basin, with groundwater in the northern half of the Kenwood Basin flowing in a northwestward direction toward Santa Rosa and groundwater in the southern half of the Kenwood Basin flowing in a southeasterly direction toward the Sonoma Valley Subbasin in both the shallow and deep zones. In general, groundwater in the mountains surrounding the Sonoma Valley flows towards lower elevations and follows the dips of the geologic units toward the center of the valley.

Comparison of the shallow and deeper groundwater elevation contour maps indicates that groundwater elevations in the deep zone 1) are similar to groundwater elevations in the shallow zone in northern Sonoma Valley, and 2) are up to 100 feet lower than groundwater elevations in the shallow zone in southern Sonoma Valley, indicating a downward vertical gradient in southern Sonoma Valley.

Two groundwater pumping depressions are apparent in the deep zone groundwater elevation contour map (Figure 2-3) southeast of the City of Sonoma and in the El Verano area. Measured groundwater levels are as low as 94 feet below mean sea level (-94 feet msl) southeast of the City and 63 feet below sea level (-63 feet msl) in deep zone wells southwest of El Verano. There is only one groundwater elevation monitoring well between the pumping depression southeast of the City and the area of saline groundwater. Groundwater elevations in this area are uncertain as shown with the dashed and queried zero elevation contour line. As a result, the potential for the pumping depression to draw brackish groundwater further north into the subbasin is not well characterized. This potential brackish water intrusion is being addressed through replacement of pumped groundwater with recycled water for irrigation in and north of the Baylands Area. Continued monitoring and assessment of groundwater levels and groundwater quality will be conducted to assess inland movement of the brackish water. This monitoring and assessment will be included in the triennial SNMP report.

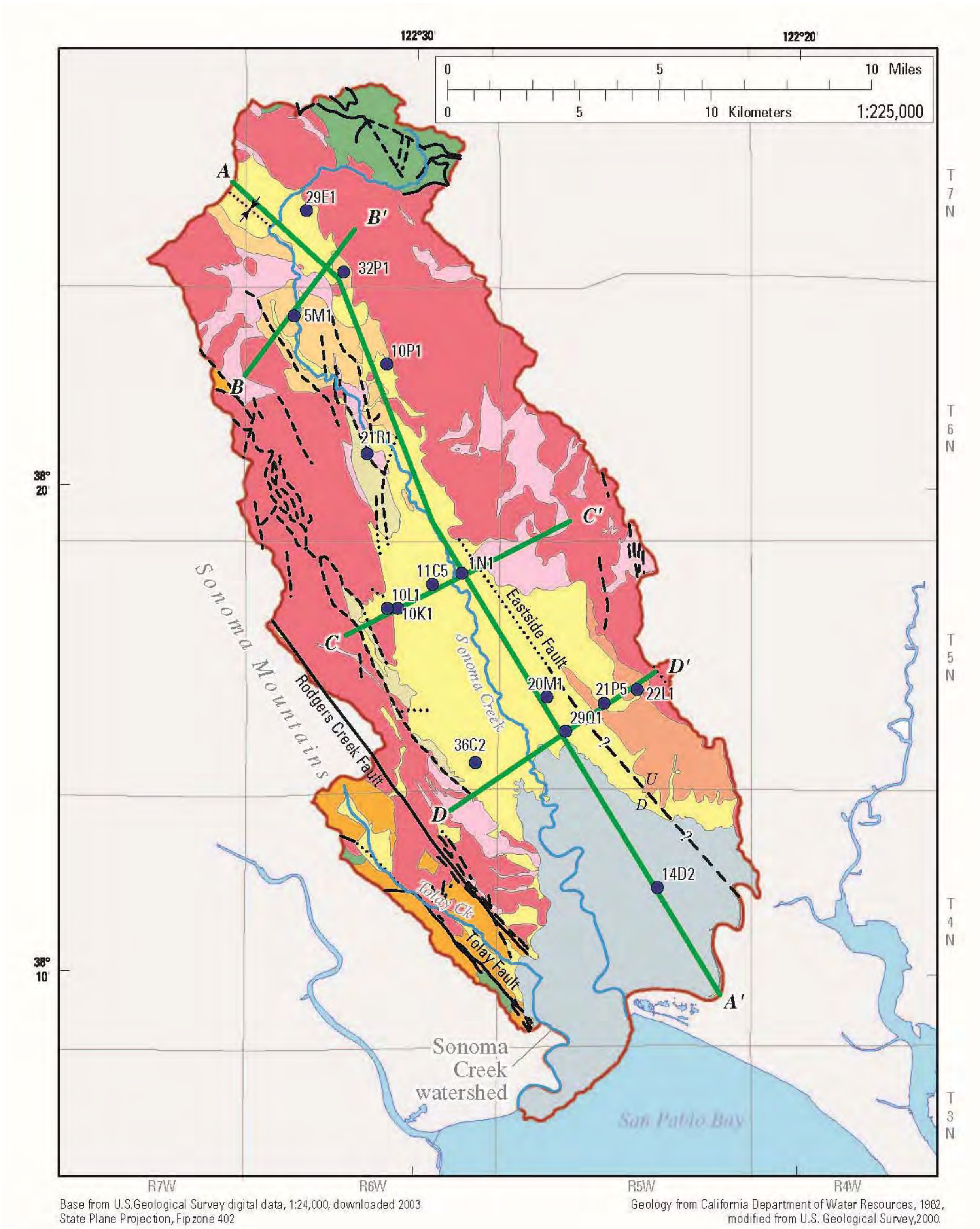
Faults can act barriers to groundwater flow. It has been proposed that the Eastside Fault shown on Figures 2-2 and 2-3 may restrict groundwater movement in the deep zone (USGS, 2006); however, no effects on groundwater levels are apparent in Figure 2-3.

2.3.1 Aquifer Parameters

The most important sources of groundwater in the Study Area are the Quaternary alluvial deposits, the Glen Ellen Formation, the Huichica Formation, and the Sonoma Volcanics. These geologic units are widely distributed and contain zones of high porosity and permeability. Where the units contain a large fraction of silt and clay sized materials, permeability is greatly reduced. The alluvial units, where sufficiently thick and saturated, are the highest yielding materials in the valley. Most wells, except those near the valley axis, that were drilled in the past few decades are screened in both the alluvial units and deeper formations and volcanics (USGS, 2006). Bay Mud deposits crop out over a large area between Schellville and San Pablo Bay and are underlain by the Huichica and Glen Ellen formations. The Bay Mud exhibits low permeability and contains brackish groundwater.

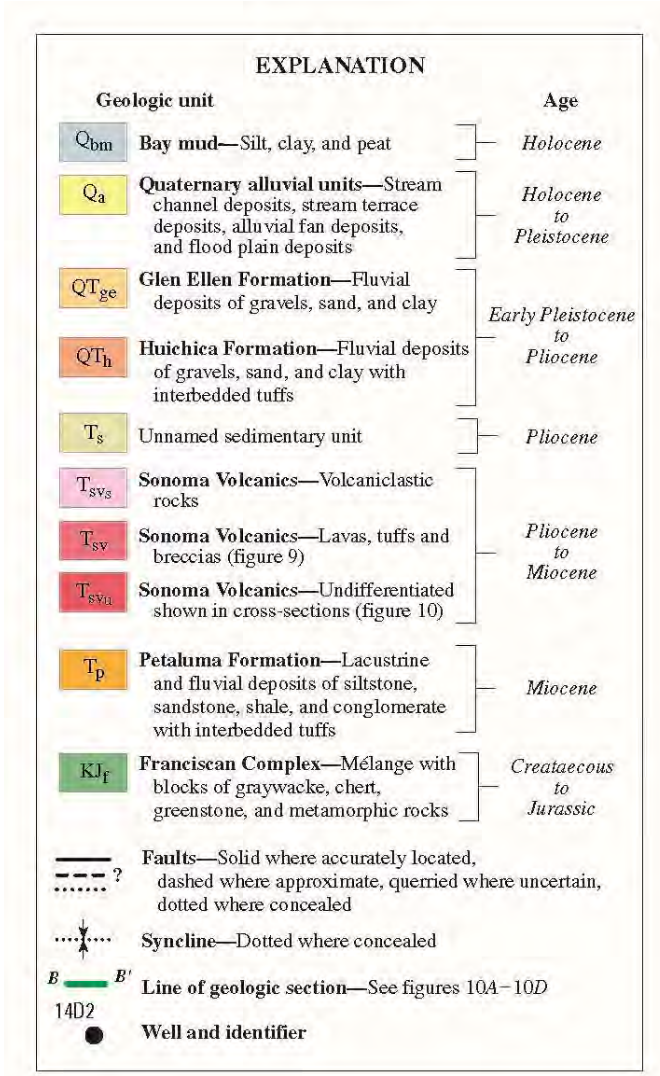
Figure 2-4 shows the surficial geology of the Sonoma Creek Watershed. **Figure 2-5** is a cross section along the axis of the valley, and **Figure 2-6** is a cross section perpendicular to the valley axis near the southern end of the subbasin (USGS, 2006). The cross sections show that alluvial deposits are at the surface in the northern two-thirds of the valley with Bay Muds at the surface in the southern portion of the valley near San Pablo Bay. In the northern two-thirds of the valley, alluvial deposits are underlain by the Glen Ellen Formation, which overlies the Huichica Formation, which overlies Sonoma Volcanics. In the southern portion of the valley, the Bay Muds are underlain by the Huichica Formation, which overlies the Sonoma Volcanics.

Figure 2-4a: Geology of Sonoma Creek Watershed



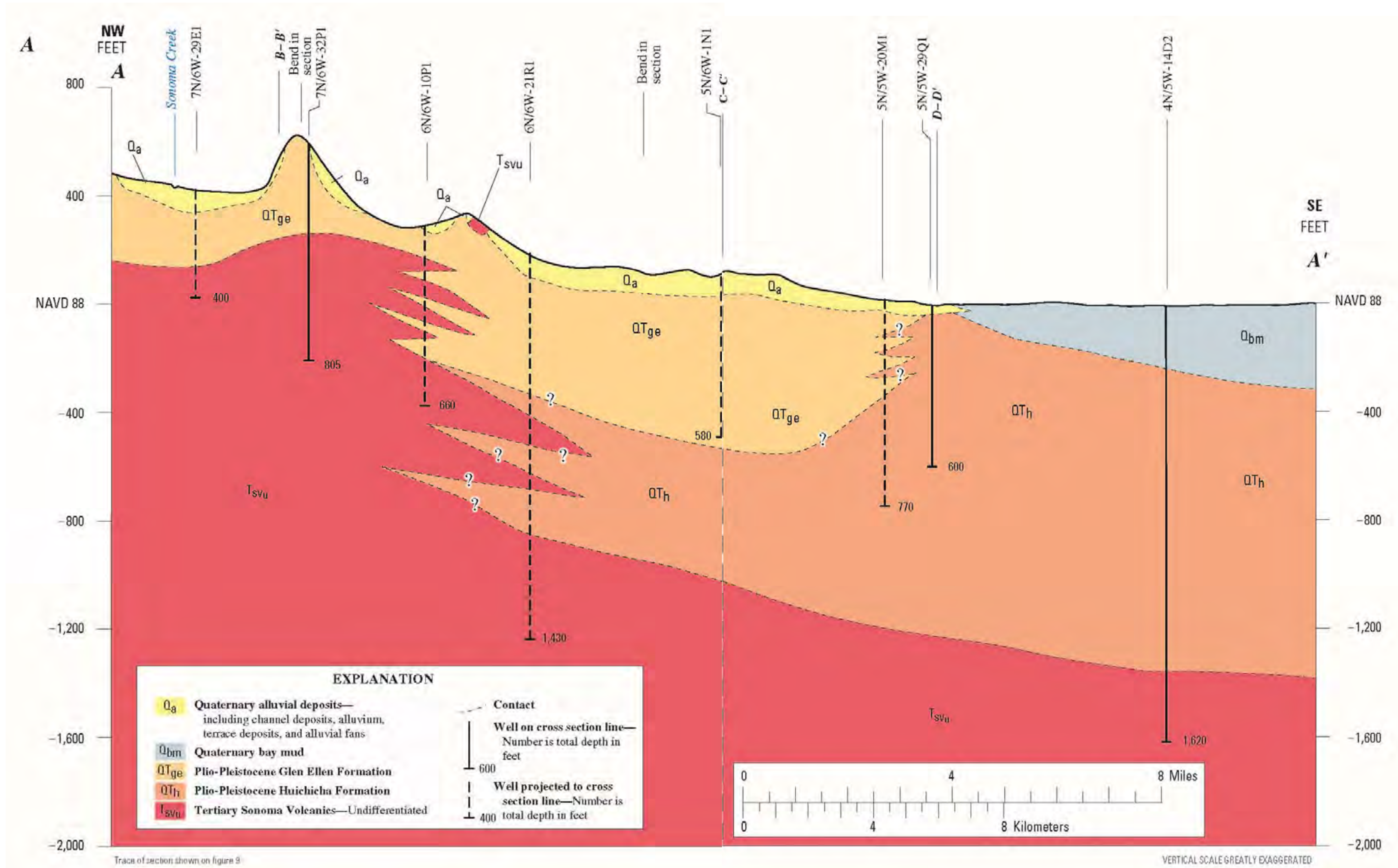
From: USGS, 2006

Figure 2-4b: Explanation for Geology of Sonoma Creek Watershed



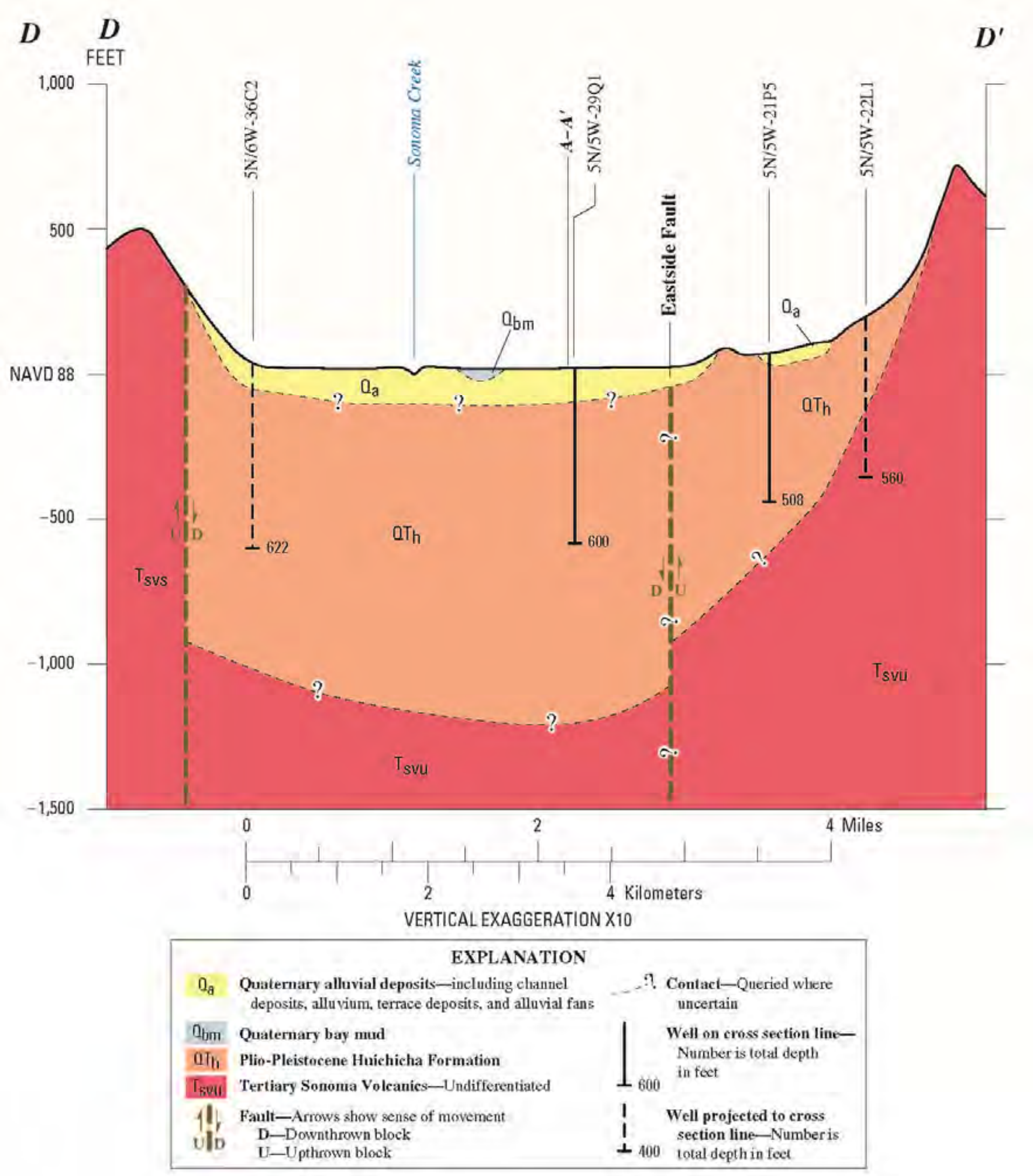
From: USGS, 2006

Figure 2-5: Cross Section A-A'



From: USGS, 2006

Figure 2-6: Cross Section D-D'



From: USGS, 2006

Groundwater in the Sonoma Valley Subbasin occurs under both confined and unconfined conditions. Generally unconfined conditions prevail at depths less than 200 feet below ground surface (ft-bgs). Groundwater is more commonly confined in deeper aquifers found in the Sonoma Volcanics and Huichica and Glen Ellen formations. An unconfined aquifer is saturated with water, and the surface of the water is at atmosphere pressure. The groundwater in a confined aquifer is under pressure. When a well penetrates a relatively impermeable layer (aquitard) that confines the aquifer, the water will rise above the confining layer in the well to the potentiometric (pressure) surface of the confined aquifer. In terms of fate and transport, unconfined aquifers are more vulnerable to releases at the land surface, while for deeper confined aquifers, the confining units provide some protection by limiting downward migration of contaminants. However, improperly constructed and abandoned wells can provide conduits for downward migration of contaminants into confined layers along improperly sealed well casings.

In most parts of the valley and watershed, groundwater is obtained from wells that are less than 700 feet deep.

2.3.2 Surface Water – Groundwater Interaction

Sonoma Valley is drained by Sonoma Creek, which discharges to San Pablo Bay. Seepage testing conducted by the USGS in 2003 showed Sonoma Creek to be a gaining (groundwater discharging to the creek) creek through most of the valley with the exception of a short reach in the northern part of the watershed where the creek enters the Kenwood Valley Basin from the Mayacamas Mountains crossing the alluvial fan between the mountain front and Highway 12 (USGS, 2006).

Based on an average annual rainfall of 29.8 inches per year from 1953 through 2000 measured at the City, the USGS estimated that the Sonoma Creek watershed receives on average 269,000 AFY of precipitation. The mean annual runoff of surface water outflowing from the valley into San Pablo Bay is estimated to be approximately 101,000 AF (USGS, 2006).

3 Existing Groundwater Quality

3.1 Indicator Parameters of Salts and Nutrients

Total dissolved solids (TDS) and nitrate are the indicator salts and nutrients selected for the Sonoma Valley SNMP. Total salinity is commonly expressed in terms of TDS in mg/L. TDS (and electrical conductivity data that can be converted to TDS) are available for source waters (both inflows and outflows) in the valley. While TDS can be an indicator of anthropogenic impacts such as infiltration of runoff, soil leaching, and land use, there is also a natural background TDS concentration in groundwater. The background TDS concentration in groundwater can vary considerably based on purity and crystal size of the formation minerals, rock texture and porosity, the regional structure, origin of sediments, the age of the groundwater, and many other factors (Hem, 1989).

Nitrate is a widespread contaminant in California groundwater. High levels of nitrate in groundwater are associated with agricultural activities, septic systems, confined animal facilities, landscape fertilization, and wastewater treatment facility discharges. Nitrate is the primary form of nitrogen detected in groundwater. Nitrate data are available for source waters (both inflows and outflows) in the valley. Natural nitrate levels in groundwater are generally very low, with concentrations typically less than 10 mg/L for nitrate as nitrate (nitrate-NO_3) or 2 to 3 mg/L for nitrate as nitrogen (nitrate-N). Nitrate is commonly reported as either nitrate nitrate-NO_3 or nitrate-N; and one can be converted to the other. Nitrate-N is the form of nitrate selected for assessment for this SNMP.

3.2 Water Quality Objectives

Water quality objectives provide a reference for assessing groundwater quality in the Sonoma Valley Groundwater Subbasin. The California Department of Public Health (DPH) has adopted a Secondary

Maximum Contaminant Level (SMCL) for TDS. SMCLs address aesthetic issues related to taste, odor, or appearance of the water and are not related to health effects, although elevated TDS concentrations in water can damage crops, affect plant growth, and damage municipal and industrial equipment. The recommended SMCL for TDS is 500 milligrams per liter (mg/L) with an upper limit of 1,000 mg/L. It has a short-term limit of 1,500 mg/L. The San Francisco Bay Regional Water Quality Control Board (Regional Water Board) has established a basin plan objective (BPO) of 500 mg/L for TDS for municipal and domestic supply in their Basin Plan (December 2010). They have also established a limit for livestock watering at 10,000 mg/L. The Regional Water Board has also established a BPO for EC at 900 micromhos per centimeter (mmhos/cm).

The primary Maximum Contaminant Level (MCL) for nitrate-NO_3 is 45 mg/L based on a health concern due to methemoglobinemia, or "blue baby syndrome," which affects infants, ruminant animals (such as cows and sheep) and infant monogastrics (such as baby pigs and chickens). Elevated levels may also be unhealthy for pregnant women (SWRCB, August 2010). The MCL for nitrate plus nitrite as nitrogen (as N) is 10 mg/L. The Regional Water Board has established the BPOs at the MCLs for these constituents. **Table 3-1** lists numeric BPOs for groundwater with municipal and domestic water supply and agricultural water supply beneficial uses in the San Francisco Bay Region.

Table 3-1: Basin Plan Objectives

Constituent	Units	Municipal Concentration	Agricultural Concentration
TDS	mg/L	500	10,000
EC	mmhos/cm	900	
Nitrate (as NO_3)	mg/L	45	
Nitrate + Nitrite (as N)	mg/L	10	

mg/L - milligrams per liter   EC – electrical conductivity
mmhos/cm – micromhos per centimeter

3.3 TDS and Nitrate Fate and Transport

Salt and nutrient (S/N) fate and transport describes the way salts and nutrients move through an environment or media. In groundwater, it is determined by groundwater flow directions and rate, the characteristics of individual salts and nutrients, and the characteristics of the aquifer media. The S/N loading and unloading from the groundwater subbasin inflows and outflows are discussed below in Sections 4 and 5. Aquifer characteristics, groundwater flow directions and gradients, and surface water/groundwater interaction were discussed above in Section 2.

Water has the ability to naturally dissolve salts and nutrients along its journey in the hydrologic cycle. The types and quantity of salts and nutrients present determine whether the water is of suitable quality for its intended uses. Salts and nutrients present in natural water result from many different sources including atmospheric gases and aerosols, weathering and erosion of soil and rocks, and from dissolution of existing minerals below the ground surface. Additional changes in concentrations can result due to ion exchange, precipitation of minerals previously dissolved, and reactions resulting in conversion of some solutes from one form to another such as the conversion of nitrate to gaseous nitrogen. In addition to naturally occurring salts and nutrients, anthropogenic activities can add salts and nutrients.

TDS and nitrate are contained in the source water that recharges the Sonoma Valley. Addition of new water supply sources, either through intentional or unintentional recharge, can change the groundwater quality either for the worse by introducing contamination or for the better by diluting some existing contaminants in the aquifer. Another important influence on S/Ns in groundwater is unintentional recharge, which can occur, for example, when irrigation water exceeds evaporation and plant needs and infiltrates into the aquifer (i.e., irrigation return flow). Irrigation return flows can carry fertilizers high in nitrogen and soil amendments high in salts from the yard or field into the aquifer. Similarly, recycled water used for irrigation also introduces salts and nutrients.

TDS is considered conservative in that it does not readily attenuate in the environment. In contrast, processes that affect the fate and transport of nitrogen compounds are complex, with transformation, attenuation, uptake, and leaching in various environments. Nitrate is the primary form of nitrogen detected in groundwater. It is soluble in water and can easily pass through soil to the groundwater table.

3.4 Monitoring Programs

Groundwater quality in the Study Area has historically been monitored under different monitoring programs including:

- California Department of Water Resources (DWR) Monitoring
- California DPH Required Monitoring
- Sonoma Valley Groundwater Management Program Monitoring
- USGS Special Studies

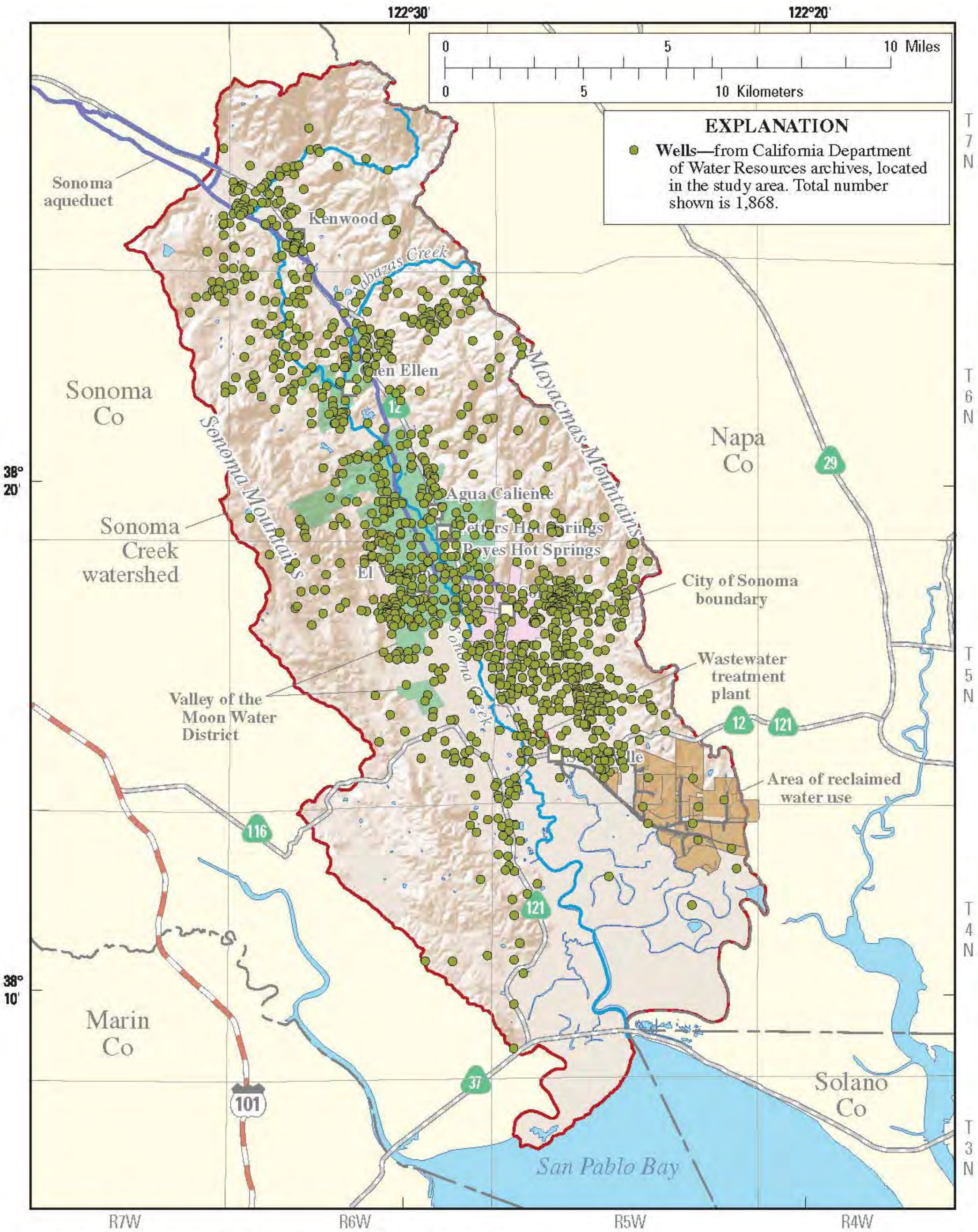
These monitoring programs are described in more detail in the SNMP Monitoring Program TM. All available groundwater quality data have been compiled by the Agency. All available TDS, EC, and nitrate data were used to evaluate S/N groundwater quality in the Sonoma Valley Subbasin for this SNMP.

3.5 Analysis Methodologies

3.5.1 Lateral and Vertical Discretization

Initially, the available groundwater quality data and well completion information were assessed to determine if the subbasin groundwater quality characterization could be divided into subareas and layers to assess differences in groundwater quality laterally and vertically. Unfortunately, well completion information for many of the monitored wells is unavailable, and the available data are considered insufficient to differentiate groundwater quality in the shallow and deep zones. The Baylands Area shown in Figure 2-1 is defined as the area with median TDS concentrations greater than 750 mg/L. This general area was recognized by Kunkel and Upson (1960) and the USGS (2006) as an area of historical saline groundwater. Due to the elevated salt in this area, groundwater pumping is limited, and the area is unlikely to be developed for groundwater supply in the future. Accordingly, this area is considered separately from the remainder of the subbasin referred to as the Inland Area. **Figure 3-1** shows that there were a limited number of wells in the Baylands Area based on DWR well logs acquired for the USGS study (2006). Many of the wells in the Baylands Area have been destroyed and agricultural land use in the area is limited to non-irrigated crops such as hay. Available monitoring data do not indicate clear differences between groundwater quality in the northern and southern portion of the Inland Area. Therefore average groundwater quality in the subbasin is characterized for the Inland Area, the Baylands Area, and the combined Inland and Baylands areas as one aquifer. This approach was presented and approved by the Regional Water Board at the January 2013 project meeting (RMC, January 2013).

Figure 3-1: Wells in Study Area



Base from U.S. Geological Survey digital data, 1:250,000, 2003. State Plane Projection, Fipzone 402
Shaded relief base from 1:250,000 scale Digital Elevation Model: sun illumination from northwest at 30 degrees above horizon

From: USGS, 2006

3.5.2 Groundwater Quality Averaging Period

In accordance with the State Water Resources Control Board (SWRCB) Recycled Water Policy, the available assimilative capacity shall be calculated by comparing the BPOs with the average ambient S/N concentrations in the subbasin over the most recent five years of available data (2007 to 2012) or a time period approved by the Regional Water Board. **Table 3-2** and **Figure 3-2** show the number of wells sampled over the history of sampling in the subbasin. As shown in the figure and table, a significant number of wells were sampled in the 2000 to 2006 time period, predominantly as part of the work conducted by the USGS (2006). In order to provide a more robust dataset, data collected during the 12 year period from 2000 to 2012 are used to assess the average groundwater quality in the subbasin. This approach was presented and approved by the Regional Water Board at the January 2013 project meeting (RMC, January 2013).

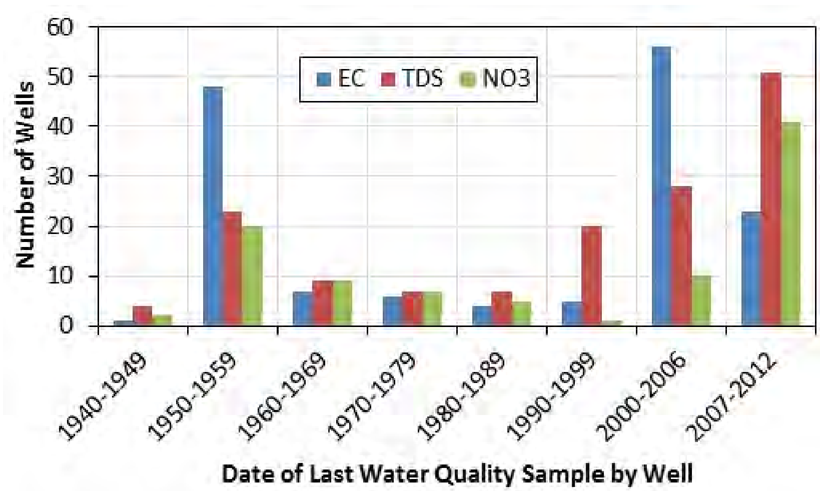
Evaluation of concentration trends finds overall relatively stable or flat trends for TDS and nitrate in most wells in the subbasin, which also supports use of a longer averaging period.

Table 3-2: Summary of Available Water Quality Data

Period	EC	TDS	Nitrate
1940-1949	1	4	2
1950-1959	48	23	20
1960-1969	7	9	9
1970-1979	6	7	7
1980-1989	4	7	5
1990-1999	5	20	1
2000-2006	56	28	10
2007-2012	23	51	41

EC – electrical conductivity
TDS – total dissolved solids

Figure 3-2: Summary of Available Water Quality Data



3.5.3 Calculation of Existing Ambient Groundwater Quality and Assimilative Capacity

The median groundwater concentration for samples collected from individual wells over the 12-year averaging period for TDS and nitrate are plotted on maps with different size and color circles representing median concentrations (dots maps). Well median concentrations were selected over arithmetic average concentrations to represent the ambient groundwater quality in each well. The median statistic is recommended over averages, because the median: 1) does not assume a normal distribution of data, 2) minimizes the effect of potential and/or actual data outliers without removing them from consideration, and 3) can be reliably calculated for datasets with a mix of censored (non-detect) and non-censored values, which is often important for nitrate datasets.

The TDS and nitrate dots maps are then used to develop concentration contour maps for TDS and nitrate. The concentration contour maps were developed by first manually contouring the 2000-2012 median concentrations to address concentration variability in data-dense areas and to control the interpretation in data-poor areas. In some areas, older (pre-2000) water quality data were used to guide contouring (i.e. Baylands Area). Following manual contouring, the contours were used to generate interpolated surfaces representing the concentation of TDS and nitrate using the GIS Spatial Analyst "Topo to Raster" tool. Average TDS and nitrate concentrations in each area were directly extracted from the interpolated surfaces using the GIS Spatial Analyst "Zonal Statistics" tool.

To calculate a volume-weighted average concentration for the combined Inland and Baylands Areas, the average concentration in each area is weighted by the representative volume of water in storage in each area. A uniform saturated aquifer thickness of 400 feet is assumed. Groundwater in storage is calculated by multiplying the constant saturated thickness (400 feet) by a constant effective porosity of 0.1.

The average TDS and nitrate concentrations for each area (Inland and Baylands) and for the entire subbasin are compared to the BPOs to determine the current available assimilative capacity. Assimilative capacity is simply the difference between the average subbasin concentration and the BPO.

3.5.4 Time-Concentration Plots and Trends

Time-concentration plots are prepared and evaluated to assess whether TDS and nitrate groundwater concentrations across the subbasin have been historically increasing, decreasing, or showing no significant change. The trend analysis facilitates the comparison of observed concentration trends in individual wells with simulated average groundwater concentration trends from the mixing model over the baseline period, from water year (WY) 1996-97 (WY 1997) through WY 2005-06 (WY 2006), for calibration purposes. A water year is from October 1 to September 30 of the following year and is commonly used for hydrogeologic analysis in North America.

3.5.5 Simulation of Baseline and Future Groundwater Quality

Groundwater quality concentrations for TDS and nitrate are simulated for the baseline period and future planning period using a mixing model. Concentration estimates are based on water and S/N inflows and outflows (balances) mixed with the volume of water in the aquifer and the average ambient groundwater quality. The baseline period is from WY 1997 to 2006. This baseline period was selected based on the period for which water balances were available from the USGS (2006) groundwater flow model and updated groundwater model (Bauer, 2008). The future planning period is from WY 2014 to WY 2035 based on the planning horizon in supporting planning documents.

The baseline period water balances estimate all groundwater inflows and outflows for the baseline period and the associated change in storage based on estimates provided in the groundwater model and updated model. Not all components of inflow important to the SNMP are specifically quantified by the model. For example, quantified model inflows include areal recharge from precipitation, stream recharge, and mountain front recharge. Mountain front recharge includes both subsurface inflow and stream recharge at the base of the mountains. Other recharge sources such as irrigation return flows and septic system recharge are important sources of S/Ns, but are not specifically quantified in the model water balances. Accordingly these flows are quantified as part of the SNMP analysis as components of other model-defined inflows, while honoring the total modeled water balance flows. For the future planning period, the average of the baseline period water balance is used for each year of the future planning period and any changes in inflows suggested in the area planning documents are superimposed on top of the baseline averages. Future changes simulated include increased use of recycled water for irrigation and managed stormwater capture.

TDS and nitrate concentrations are associated with each water balance inflow and outflow component. The TDS and nitrate concentrations of the various inflow components were estimated as described in Section 4. In order to simulate the effect of current and future S/N loading on groundwater quality in the Sonoma Valley Subbasin, the spreadsheet mixing model mixes the volume and quality of each inflow and outflow with the existing volume of groundwater and mass of TDS and nitrate in storage and tracks the annual change in groundwater storage and S/N mass for the baseline and future planning period. The existing volume of water in the groundwater basin is calculated based on the subbasin or subarea (Inland and Baylands) surface areas, a uniform saturated thickness of 400 feet and a porosity of 0.1. The mixing model produces an average TDS and nitrate concentration for each year of the baseline and future planning period.

The baseline period mixing model simulation is conducted in order to calibrate the loading factors. The simulated baseline period annual concentrations and trends are compared with the predominant observed groundwater quality concentrations and trends. If the observed and simulated concentrations and trends are not in reasonable agreement, loading factors can be adjusted to achieve a more reasonable match. All loading factor assumptions generated from the baseline calibration process are applied to the future loading analysis. Similar to the water balance assumption, for the future planning period, the average of the baseline period S/N balance is used for each year of the future planning period, and any changes in S/N loading are superimposed on top of the baseline averages. As mentioned above, future changes simulated include increased use of recycled water for irrigation and managed stormwater capture.

3.5.6 Use of Assimilative Capacity by Recycled Water Projects

In accordance with the SWRCB Recycled Water Policy, a recycled water irrigation project that meets the criteria for a streamlined irrigation permit and is within a basin where a SNMP is being prepared, may be approved by the local RWQCB by demonstrating through a S/N mass balance or similar analysis that the project uses less than 10% of the available assimilative capacity (or multiple projects use less than 20% of available assimilative capacity). Accordingly, the recycled water irrigation projects in place and planned for the Sonoma Valley Subbasin are assessed in terms of their use of available assimilative capacity.

3.6 TDS in Groundwater

Figure 3-3 shows the median TDS concentrations in wells sampled between 2000 and 2012. EC data were also used for the analysis. For wells with only EC data, EC was converted to TDS. The conversion factor was estimated from the EC/TDS relationship in wells that had both TDS and EC data. The upper chart on **Figure 3-4** shows the strong relationship between TDS and EC. The bottom chart on Figure 3-4 shows ratio between the two measurements used to convert EC to TDS.

Figure 3-3: Median Well Concentrations (2000 to 2012) Total Dissolved Solids

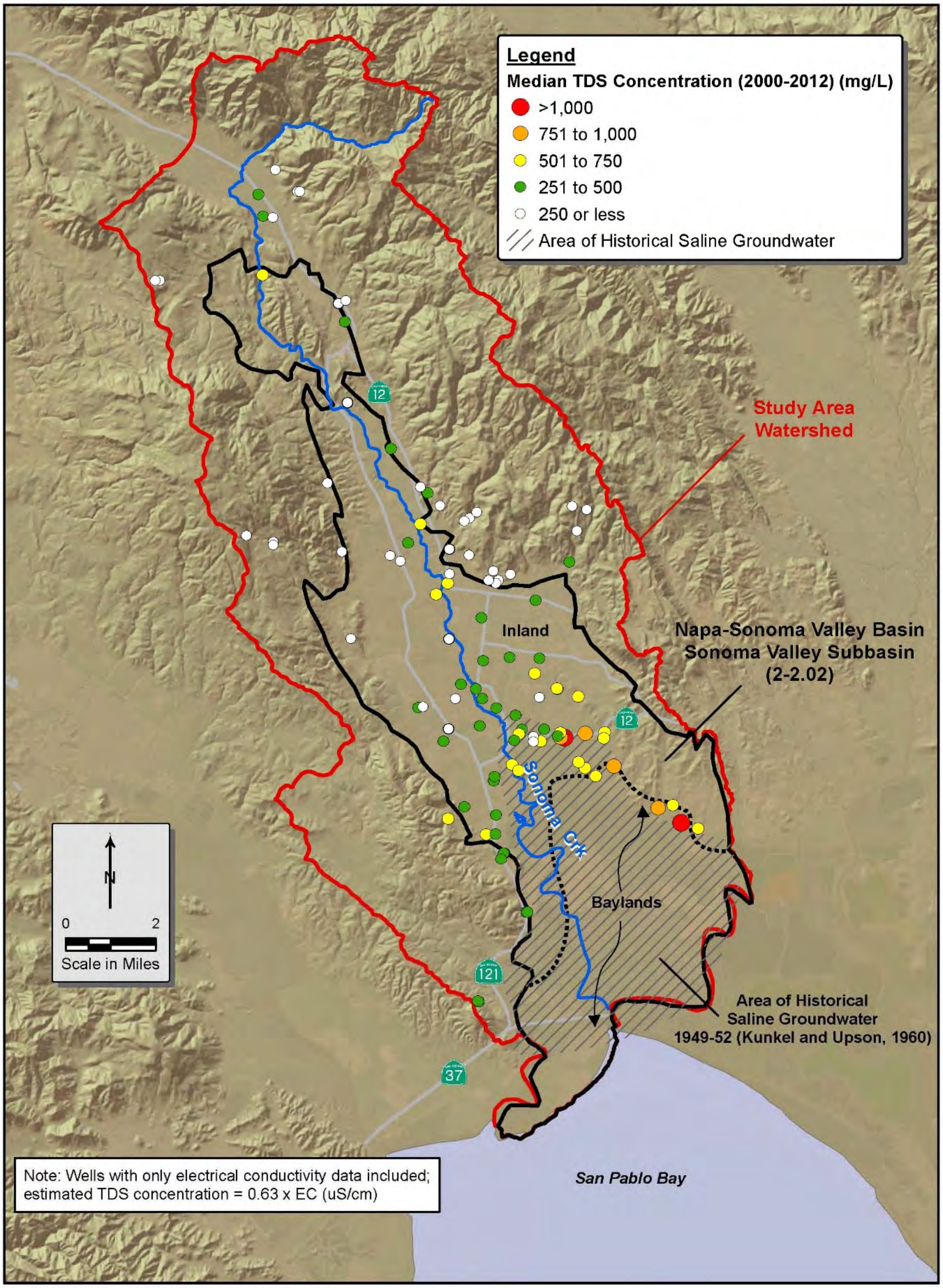
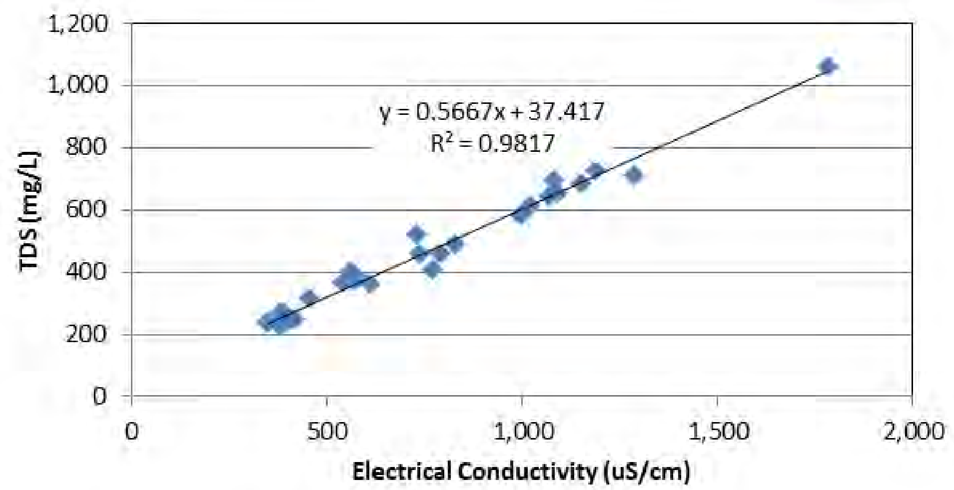
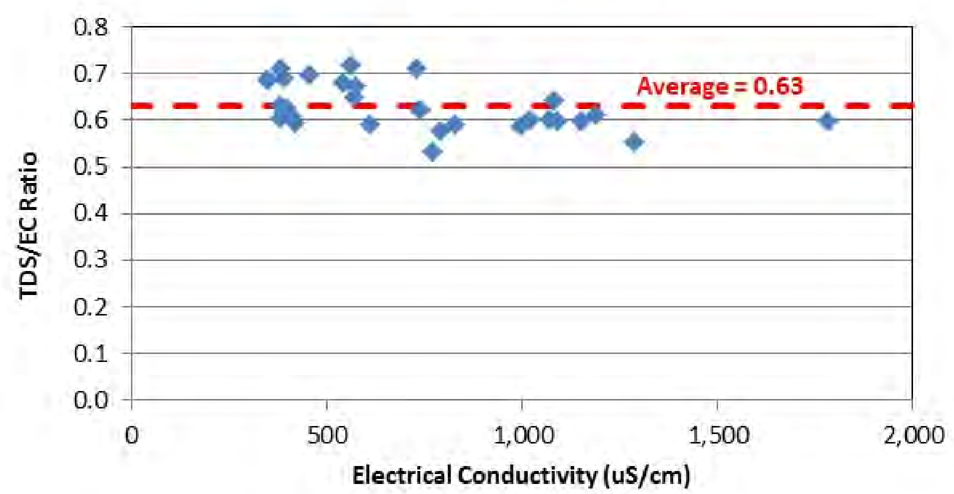


Figure 3-4: Total Dissolved Solids/Electrical Conductivity Relationship





TDS – total dissolved solids
EC – electrical conductivity
mg/L – milligrams per liter
µS/cm – microsiemens per centimeter

Generally, relatively low TDS concentrations (less than 500 mg/L) are observed throughout most of the subbasin. The BPO for TDS is 500 mg/L. A few wells with elevated concentrations (above 750 mg/L) are seen in the southeastern portion of the subbasin. The southeastern portion of the subbasin is an area of historical brackish groundwater. Kunkel and Upson (1960) mapped the zero groundwater elevation contour and stated that generally, salty water was found south of this contour line in the shallow zone. The area south of the historical zero groundwater elevation contour is shown in the hatched area in Figure 3-3.

A TDS concentration contour map was generated based on the Figure 3-3 well median data plus some available older data in the area near San Pablo Bay. **Figure 3-5** is a TDS concentration contour map. Again, relatively low (less than 500 mg/L) TDS concentrations are seen in most of the subbasin. As discussed above, the Baylands Area is defined as the area beneath the tidal sloughs adjacent to San Pablo Bay generally containing groundwater with TDS concentrations above 750 mg/L. This area along with the historical brackish groundwater area are illustrated on Figure 3-5. The area of very high TDS near San Pablo Bay with TDS greater than 1,500 mg/L is based on older well sampling conducted between 1954 and 1973 by DWR. Use of these older data is conservative in that their use results in higher average concentrations in the Baylands Area and there are no more recent data available for this area.

The average TDS concentration in the Inland Area, Baylands Area, and combined Sonoma Valley Subbasin area are shown in **Table 3-3** and **Figure 3-6**. The average Inland Area TDS concentration is 372 mg/L, well below the BPO of 500 mg/L, resulting in available assimilative capacity of 128 mg/L. As expected the average TDS concentration in the Baylands Area is high, with an average concentration of 1,220 mg/L, resulting in no available capacity. The average TDS concentration for the combined subbasin including both the Inland and Baylands Areas is 635 mg/L, also resulting in no available assimilative capacity.

The analysis indicates the importance of preventing additional saline intrusion into the Inland Area. The USGS (2006) evaluated the change in EC in the southeastern area over time. **Figure 3-7** shows the Kunkel and Upson area of historical brackish groundwater based on the zero groundwater elevation contour and EC contours mapped by the USGS based on September 2003 water quality data. The more recent USGS mapping shows both the 1,000 μS/cm and 500 μS/cm EC contours. USGS stated that the generalized contour lines suggest that the area affected by brackish groundwater in the southern part of the Sonoma Valley shifted between 1949–52 and 2003. The northern edge of the brackish area may have advanced as much as 1 mi north of Highway 12/121. This apparent movement of brackish groundwater may have been in response to groundwater pumping and the resulting depression of hydraulic heads southeast of the City (Figure 2-3). In contrast, the northwestern part of the 1949–52 area of brackish groundwater, near the intersections of Highways 12 and 121 and Sonoma Creek, may have diminished between 1949-52 and 2003.

Figure 3-5: Total Dissolved Solids Concentration Contours (2000 to 2012)

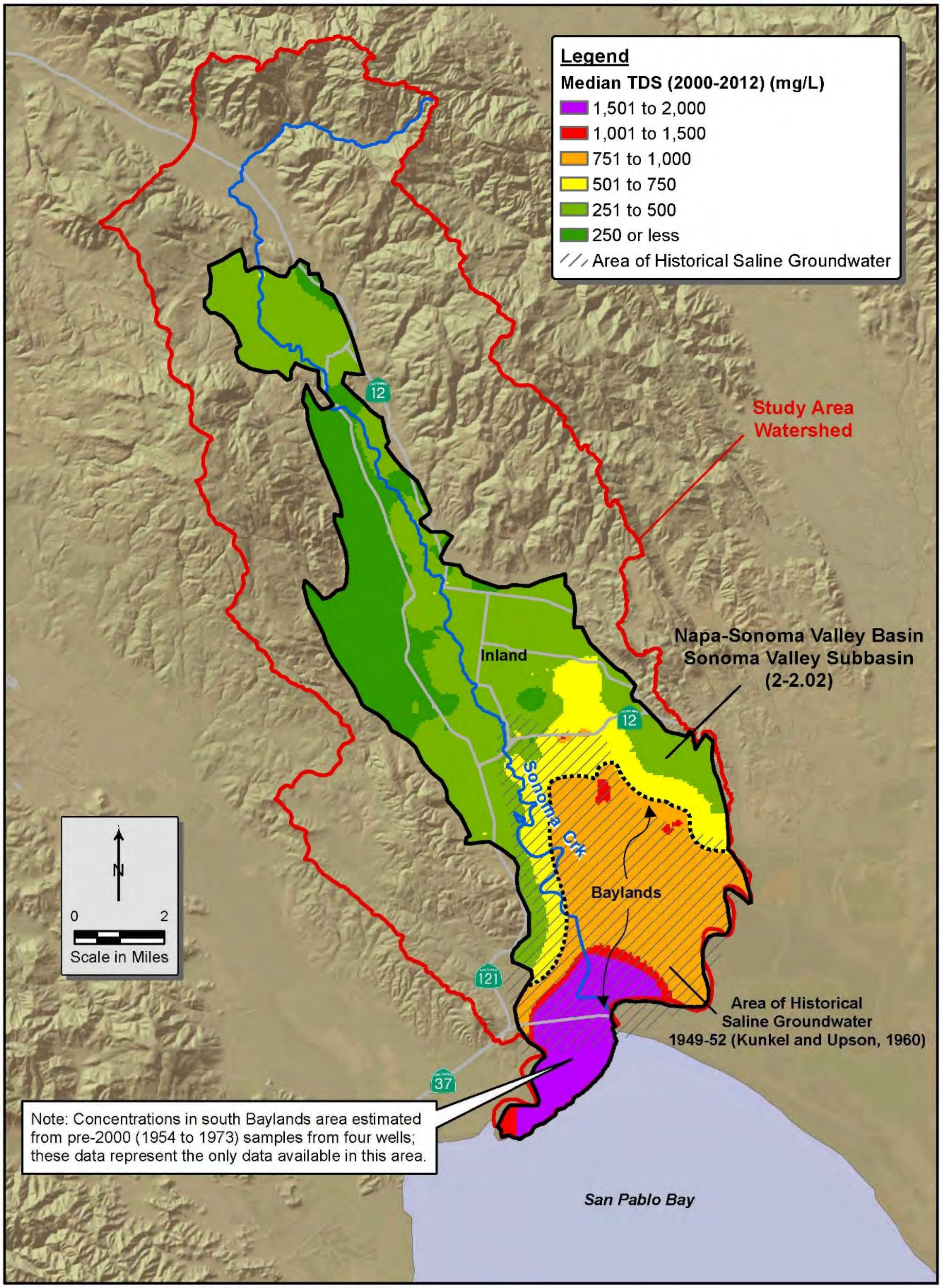


Table 3-3: Average TDS Concentrations and Available Assimilative Capacity

Concentrations in mg/L	Sonoma Valley Subbasin	Inland Area	Baylands Area
Average	635	372	1,220
BPO	500	500	500
Available Assimilative Capacity	**-135**	**128**	**-720**

TDS – total dissolved solids
mg/L – milligrams per liter

Figure 3-6: Average TDS Concentrations and Available Assimilative Capacity

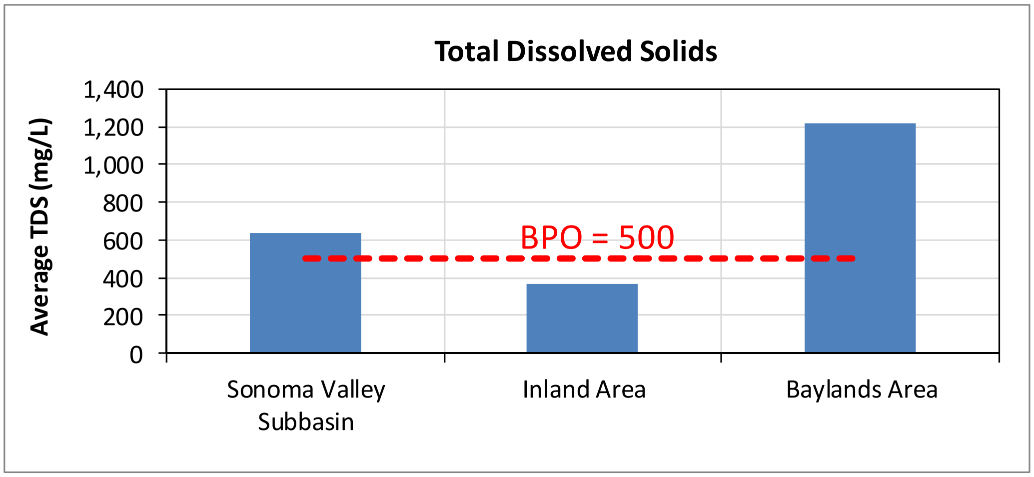
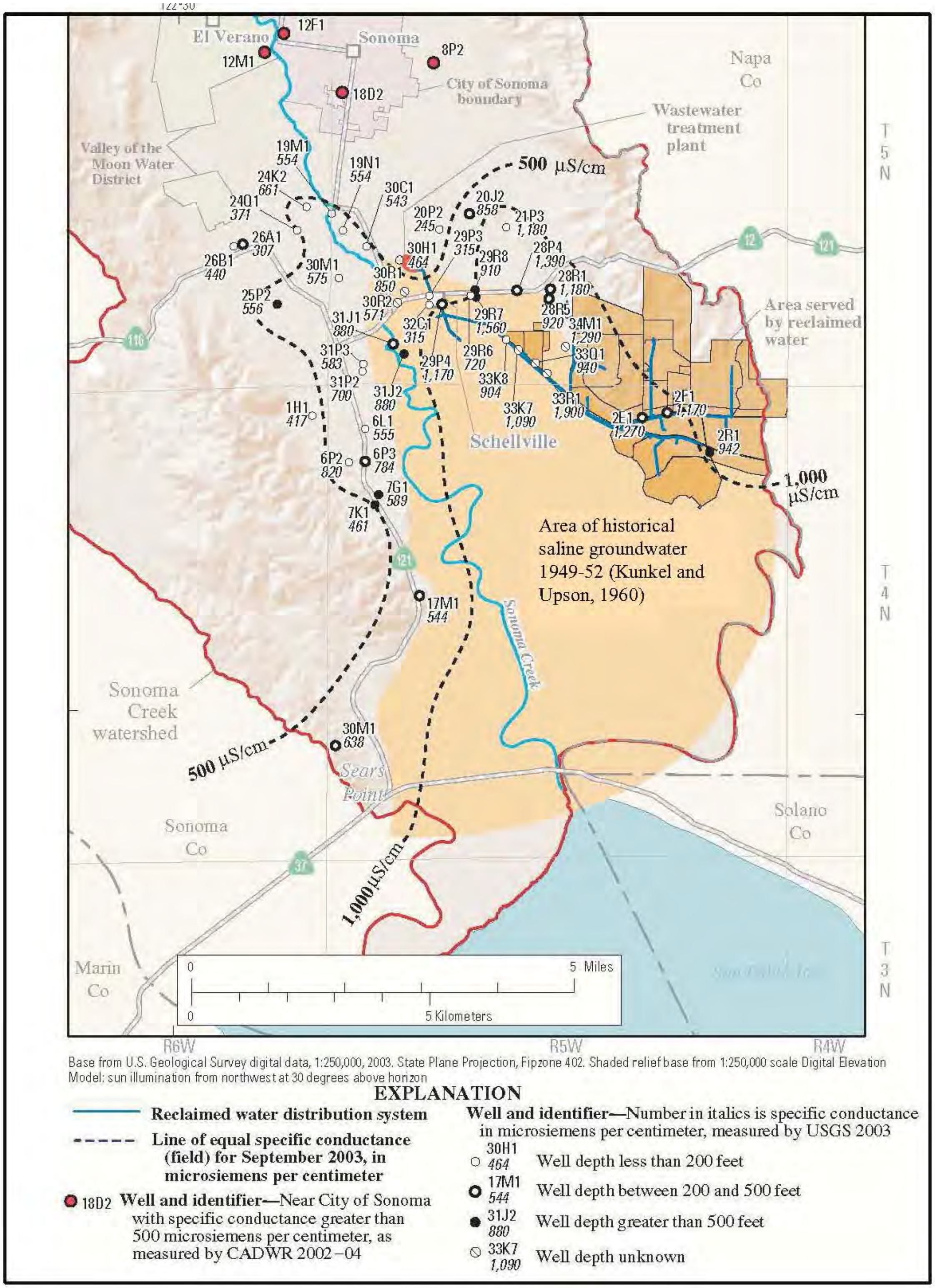


Figure 3-7: Comparison of Saline Area 1949-52 and EC Data 2003



From: USGS, 2006

The USGS report (2006) further concludes that conductivity measurements from September 2003 indicate that significant spatial variability in water quality exists with depth in the vicinity of the saline groundwater area. The vertical variability in conductivity may be illustrated by comparing the values from samples of two adjacent wells of different depths. For example, the conductivities of water from wells 5N/5W-29R6 (less than 200 feet deep) and -29R7 (greater than 500 feet deep), were 720 and 1,560 μS/cm, respectively (Figure 3-7). The variation of conductivity with depth may be indicative of different sources of salinity in the southern part of the Sonoma Valley. The primary source of salinity to shallow wells may be modern saltwater that has intruded the Bay Mud deposits along the tidal sloughs that extend northward from San Pablo Bay. High evaporation rates in the marshlands also could increase salinity in the shallow groundwater in or near the marshes. The source of salinity to intermediate and deep wells may be connate water incorporated into the sediments during deposition or modern saltwater in areas where abandoned or improperly constructed wells may act as conduits for the downward movement of surface water or shallow groundwater.

The Baylands brackish groundwater area is a S/N concern in the Sonoma Valley. One of the objectives of developing and increasing the use of recycled water for irrigation is to reduce groundwater pumping in the southern Sonoma Valley, prevent additional saline intrusion, and potentially reduce the existing inland extent of brackish groundwater. Irrigation with recycled water began in 1992 and is projected to increase in the future. To date, the data are insufficient to determine if the replacement of groundwater with recycled water has reduced the areal extent of brackish groundwater. However, continued monitoring of this area is a key component of the ongoing GMP and SNMP.

Figures 3-8 and **3-9** show time-concentration plots for TDS and EC, respectively along with the applicable BPO. The well dot and charts are shaded to indicate the wells depths with red wells and charts indicating wells less than 200 feet deep, yellow wells and charts indicating wells between 200 and 500 feet deep, and green wells and charts indicating wells greater than 500 feet deep. Wells and charts shaded gray indicated wells with unknown completion depths. Both figures show relatively flat TDS and EC trends in the subbasin indicating generally stable conditions. However, Wells 5N/5W-28R1 and 5N/5W-28N1 located in the southern portion of the subbasin near the Baylands Area show modest increasing concentration trends, which could be attributed increasing saline intrusion as well as other sources. One well is an intermediate zone well (200 to 500 feet deep) and the other is a shallow zone well (less than 200 feet deep). The shallow well (5N/5W-28N1) is owned by a dairy, and this well also shows increasing nitrate concentrations as discussed in the next section. Therefore, it is possible that the increasing TDS/EC concentrations could be associated with local surface sources rather than saline intrusion. The other intermediate well with increasing TDS/EC does not have a similar increasing nitrate trend.

Figure 3-8: Time-Concentration Plots Total Dissolved Solids

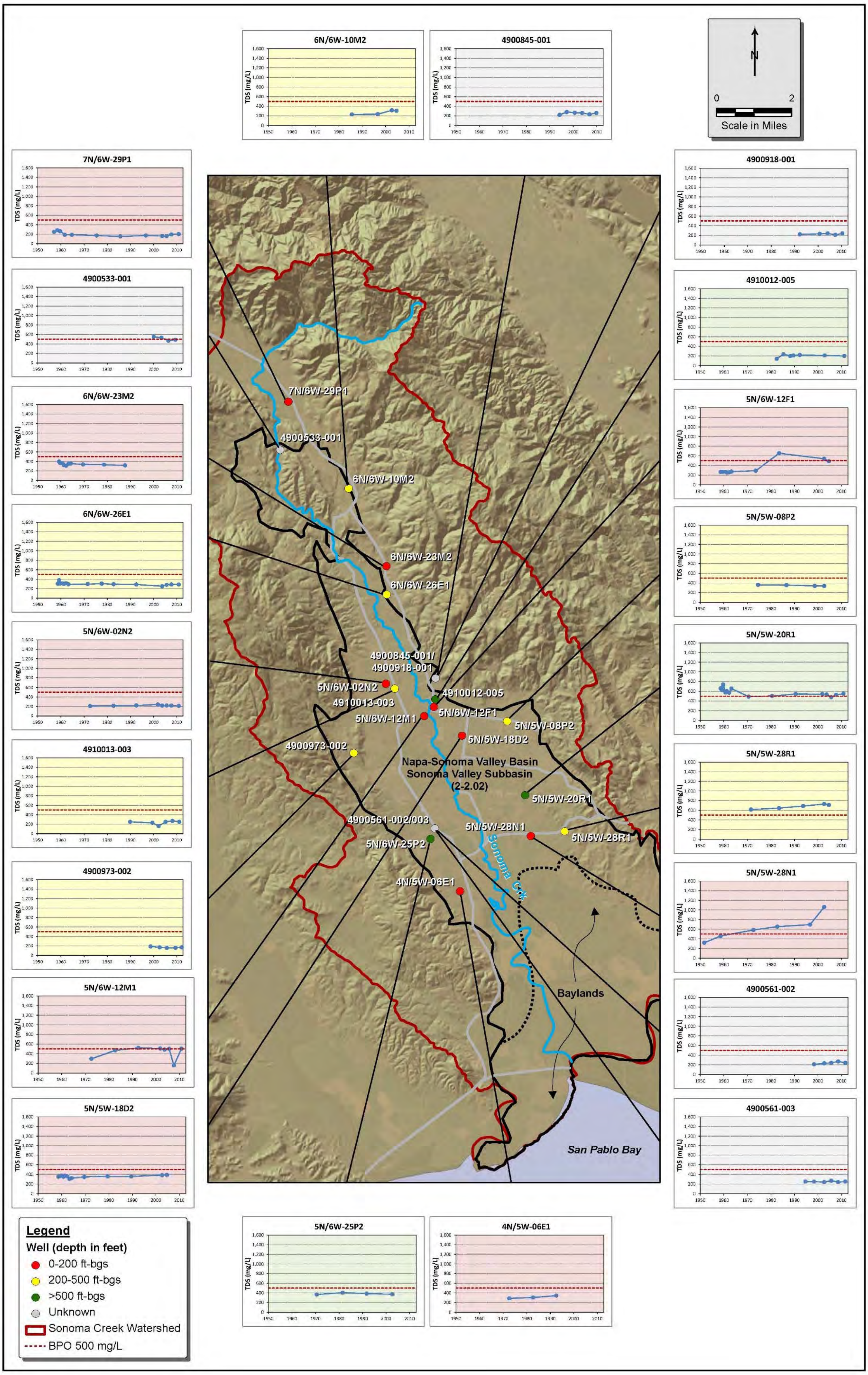
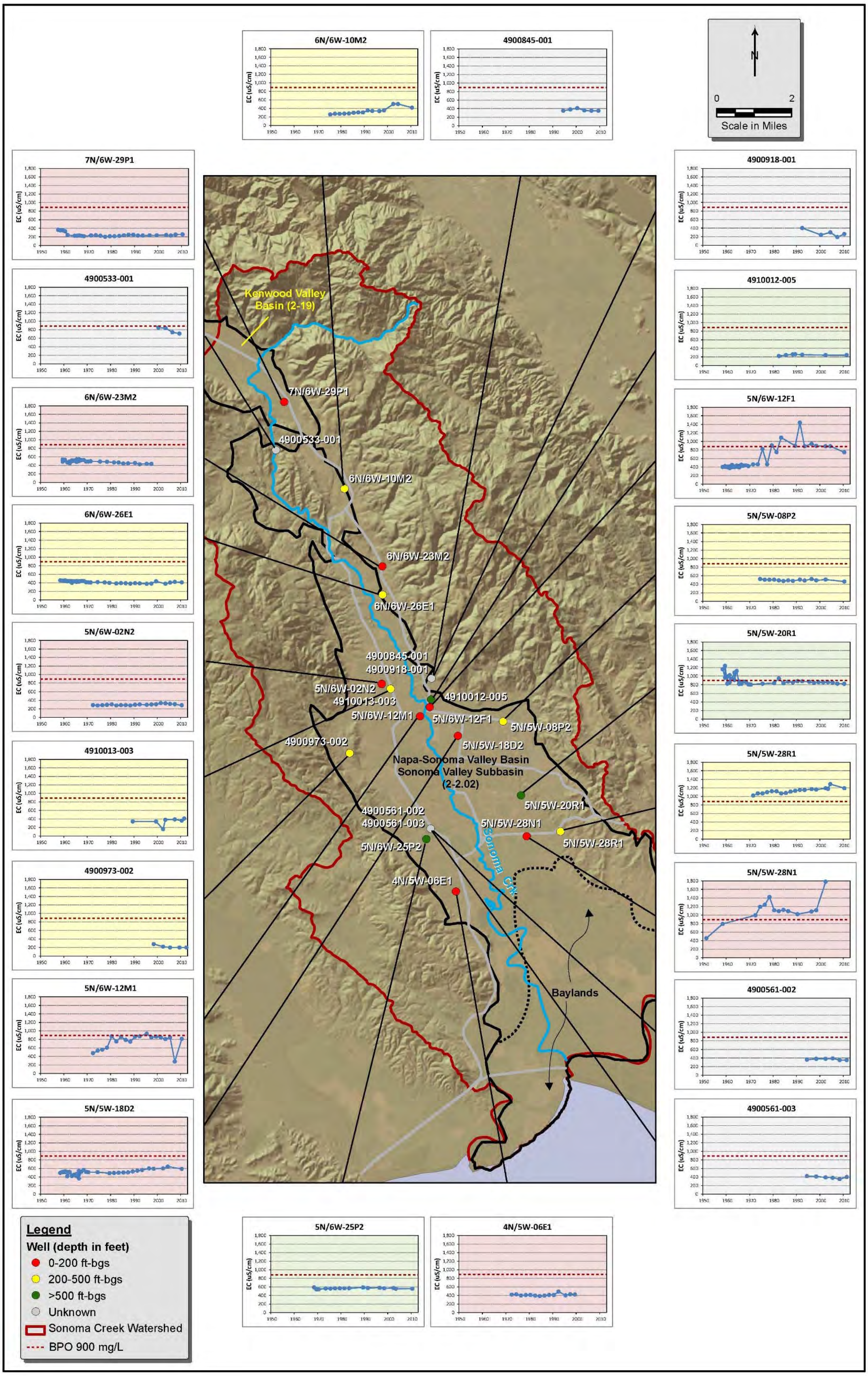


Figure 3-9: Time-Concentration Plots Electrical Conductivity



3.7 Nitrate in Groundwater

Figure 3-10 shows the median nitrate-N concentrations in wells sampled between 2000 and 2012. Generally low nitrate concentrations are observed throughout most of the subbasin. The nitrate-N BPO is 10 mg/L. While median nitrate-N concentrations are below the BPO in all wells, median nitrate concentrations in a few wells are between 5 and 10 mg/L.

A nitrate concentration contour map (**Figure 3-11**) was generated based on the median well data shown on Figure 3-10 plus available older (pre-2000) data in the southern Baylands Area. Again, relatively low (less than 1.0 mg/L) nitrate-N concentrations are seen in most of the subbasin. The area of nitrate between 2.6 and 5.0 mg/L near the San Pablo Bay is based on older well sampling conducted by the DWR between 1954 and 1973.

The average nitrate concentration in the Inland Area, Baylands Area, and combined Sonoma Valley Subbasin area are shown in **Table 3-4** and **Figure 3-12**. The average Inland Area nitrate concentration is 0.06 mg/L, well below the BPO of 10 mg/L, resulting in available assimilative capacity of 9.94 mg/L. The average nitrate concentration in the Baylands Area is 0.07 mg/L, resulting in 9.93 mg/L of available assimilative capacity. The average nitrate concentration for the combined subbasin including both the Inland and Baylands areas is 0.06 mg/L, resulting in 9.94 mg/L of assimilative capacity.

Table 3-4: Average Nitrate-N Concentrations and Available Assimilative Capacity

Concentrations in mg/L	Sonoma Valley Subbasin	Inland Area	Baylands Area
Average	0.06	0.06	0.07
BPO	10.00	10.00	10.00
Available Assimilative Capacity	**9.94**	**9.94**	**9.93**

TDS – total dissolved solids
mg/L – milligrams per liter

Figure 3-13 show time-concentration plots for nitrate-N along with the applicable BPO. As discussed above, the wells and charts are shaded to indicate relative well depth. Generally flat concentrations are observed in most wells in the subbasin, typically well below the BPO of 10 mg/L.

Figure 3-10: Median Well Concentrations (2000 to 2012) Nitrate as N

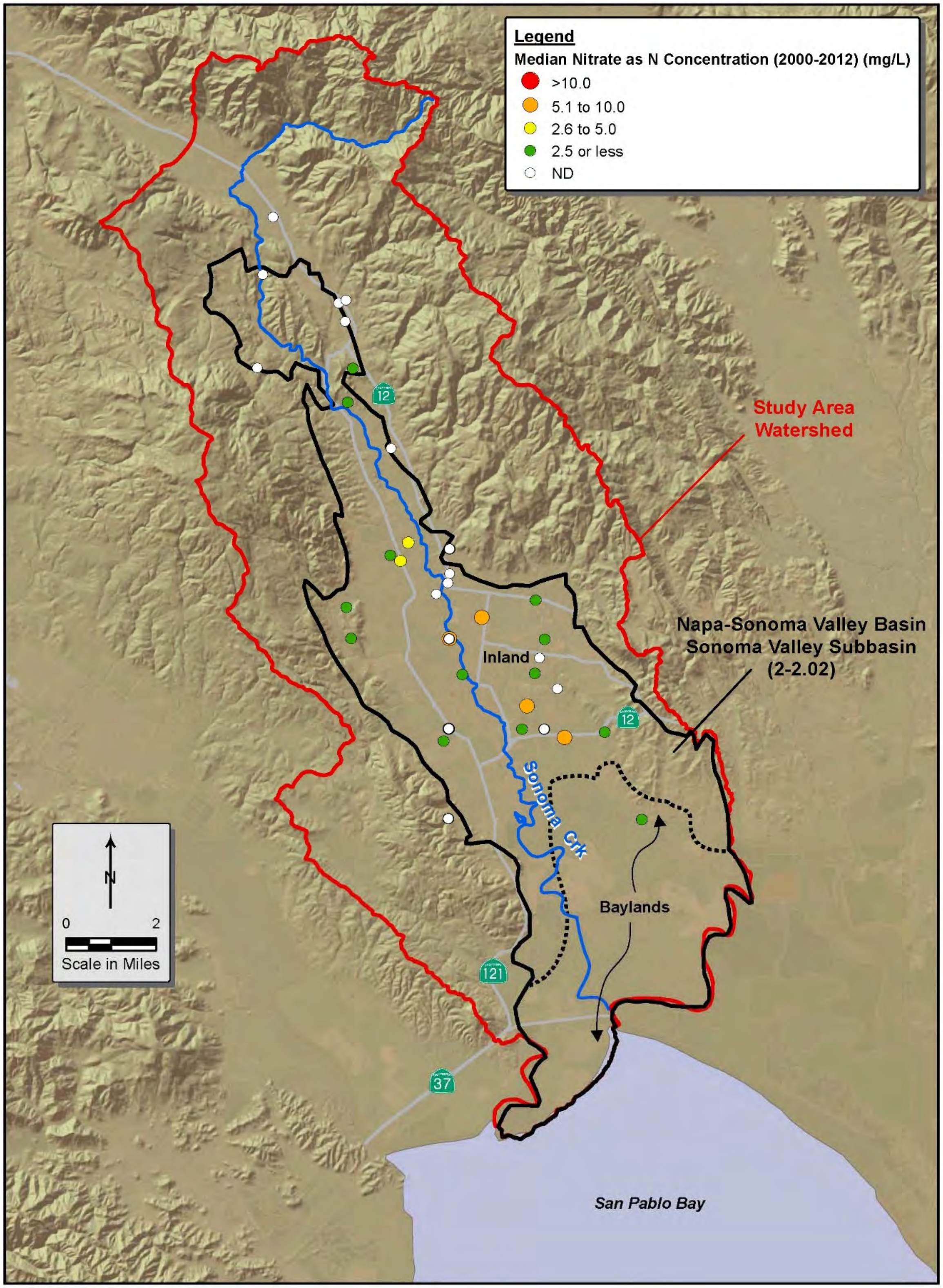


Figure 3-11: Nitrate as N Concentration Contours (2000 to 2012)

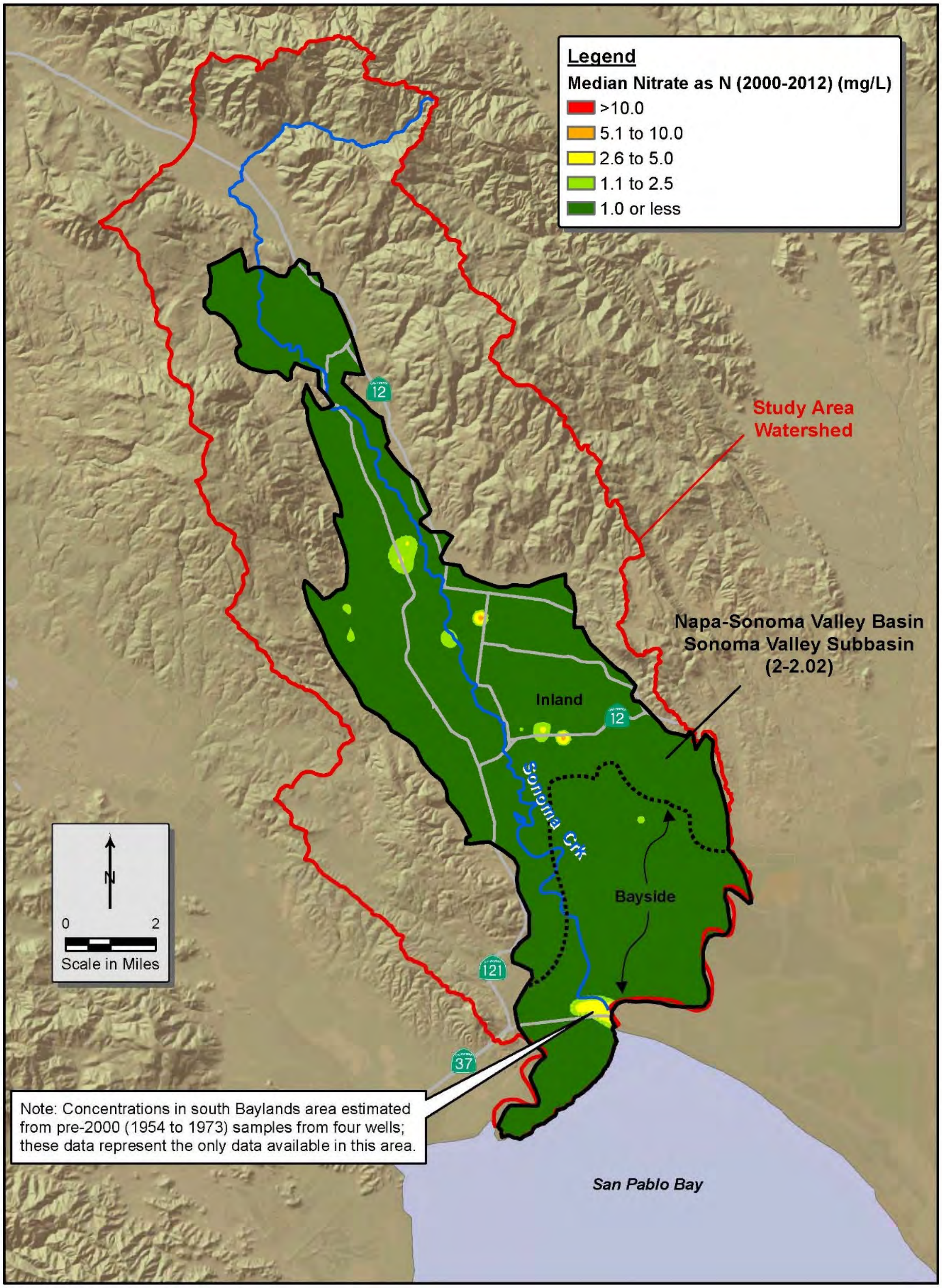


Figure 3-12: Average Nitrate Concentrations and Available Assimilative Capacity

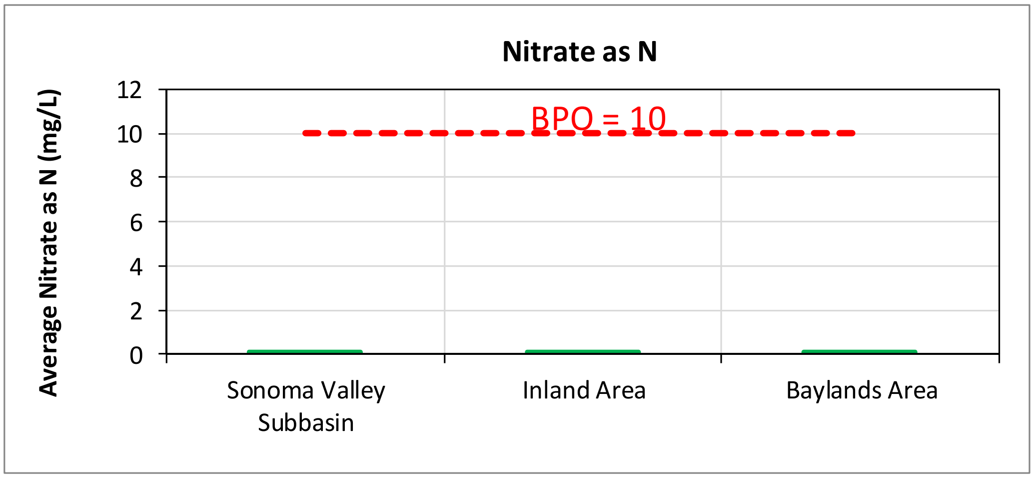
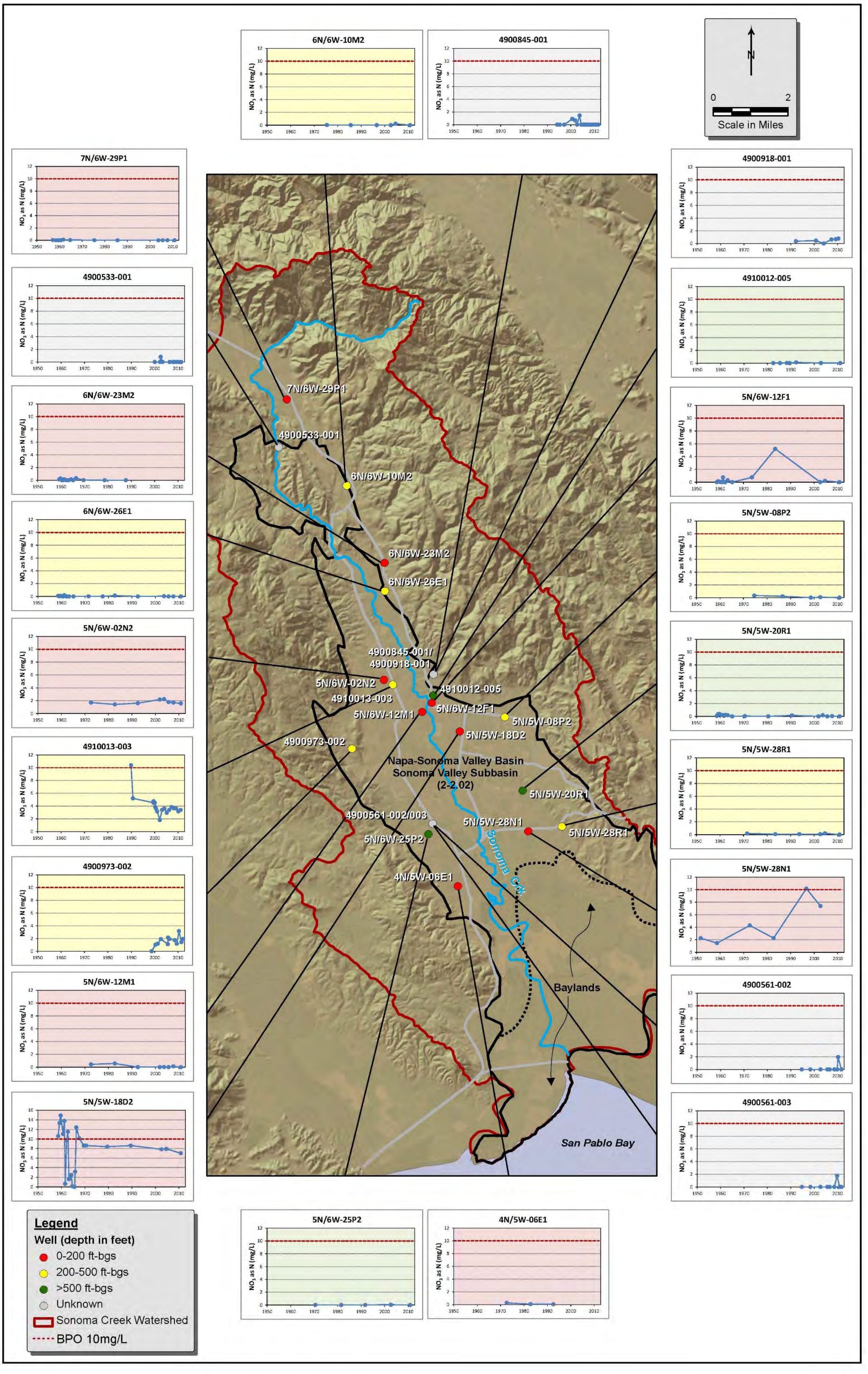


Figure 3-13: Time-Concentration Plots Nitrate as N



4 Baseline Period Analysis

The baseline period water balance tracks groundwater inflows and outflows and storage changes from WY 1996-97 through WY 2005-06. This period represents a recent time period characterized by average climatic conditions. The primary source of information used to develop the water balance is the Sonoma Valley groundwater flow model. The flow model was originally developed by the USGS (2006) and later updated by Bauer (2008). Annual water balances in the flow model were developed from WY 1974-75 through WY 2005-06 (historical flow model period). Groundwater recharge from natural precipitation in the flow model for the baseline period represented 94% of the natural recharge over the historical flow model period.

Major inflows accounted for in the baseline water balance include:

- deep percolation of precipitation and mountain front recharge,
- natural stream recharge,
- agricultural irrigation water return flow,
- domestic/municipal irrigation water (including recycled water) return flow,
- septic system return flow, and
- subsurface groundwater inflow (from Baylands Area)

Major outflows accounted for in the water balance include:

- groundwater pumping,
- groundwater discharge to streams, and
- subsurface groundwater outflow (to Baylands Area)

Areal anthropogenic recharge sources (return flows from agricultural and municipal irrigation and septic systems) are not independently considered in the flow model but instead subsumed within the model areal recharge rates. Model areal recharge rates were apportioned into natural sources (precipitation) and anthropogenic sources (return flows) based on the results of the S/N loading evaluation conducted for the SNMP (RMC, 2013).

4.1 Baseline Water Balance

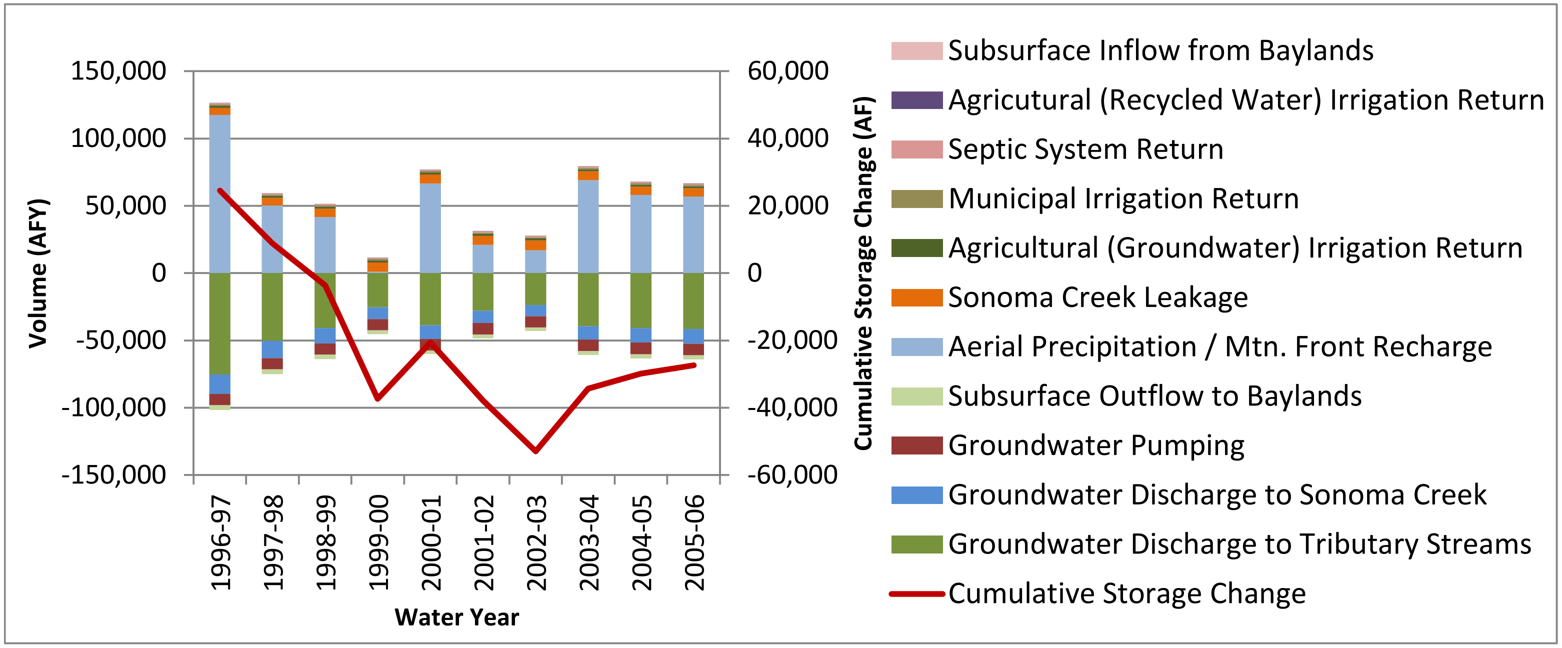
Table 4-1 summarizes the baseline water balance for the Inland Area of the subbasin. **Figure 4-1** graphically illustrates the water balance. Inflows are stacked on top of one another above the zero line in the figure, while outflows are stacked below the zero line. The cumulative change in groundwater storage over the baseline period is depicted by the red line in the figure.

Table 4-1: Baseline Water Balance for Inland Area of Sonoma Valley Subbasin (WYs 1997-2006)

	1996-97	1997-98	1998-99	1999-2000	2000-01	2001-02	2002-03	2003-04	2004-05	2005-06	Average
	All values in acre-feet per year (AFY) unless otherwise noted										
INFLOWS											
Aerial Precipitation / Mtn. Front Recharge	117,453	50,265	41,773	1,081	66,655	20,883	17,009	69,074	58,101	56,852	49,915
Sonoma Creek Leakage	5,350	5,596	6,017	6,891	6,662	6,737	7,266	6,675	6,256	6,180	6,363
Agricultural (Groundwater) Irrigation Return	1,415	1,415	1,415	1,415	1,415	1,415	1,415	1,415	1,415	1,415	1,415
Agricultural (Recycled Water) Irrigation Return	91	91	91	91	91	91	91	91	91	91	91
Municipal Irrigation Return	1,074	1,074	1,074	1,074	1,074	1,074	1,074	1,074	1,074	1,074	1,074
Septic System Return	899	899	899	899	899	899	899	899	899	899	899
Subsurface Inflow from Baylands	54	56	54	49	48	49	47	48	51	52	51
TOTAL INFLOWS	**126,335**	**59,396**	**51,322**	**11,500**	**76,844**	**31,147**	**27,801**	**79,276**	**67,887**	**66,563**	**59,807**
OUTFLOWS											
Groundwater Pumping	-8,204	-8,281	-8,411	-8,466	-8,484	-8,476	-8,472	-8,654	-8,832	-8,576	-8,486
Groundwater Discharge to Tributary Streams	-75,270	-50,379	-40,834	-25,375	-38,768	-27,899	-23,797	-39,308	-40,798	-41,599	-40,403
Groundwater Discharge to Sonoma Creek	-14,599	-12,864	-11,375	-8,737	-10,071	-9,186	-8,154	-9,955	-10,668	-10,821	-10,643
Subsurface Outflow to Baylands	-3,667	-3,562	-3,218	-2,656	-2,802	-2,738	-2,481	-2,811	-3,070	-3,111	-3,011
TOTAL OUTFLOWS	**-101,739**	**-75,086**	**-63,838**	**-45,234**	**-60,125**	**-48,298**	**-42,905**	**-60,727**	**-63,368**	**-64,108**	**-62,543**
ANNUAL STORAGE CHANGE (AF)	24,596	-15,690	-12,515	-33,734	16,719	-17,151	-15,104	18,549	4,520	2,456	-2,736
CUMULATIVE STORAGE CHANGE (AF)	24,596	8,906	-3,609	-37,343	-20,625	-37,776	-52,880	-34,331	-29,812	-27,356	

AF – acre-feet
Mtn. – mountain
WY – water year

Figure 4-1: Baseline Water Balance for Inland Area of Sonoma Valley Subbasin (WYs 1997-2006)



4.1.1 Inflows

As shown in Table 4-1 and Figure 4-1, total annual subbasin inflows over the baseline period ranged from 11,500 AF in WY 2000 up to 126,335 AF in WY 1997, averaging 59,807 AFY. The large variability in annual inflows is dependent primarily on the volume of natural recharge derived from areal precipitation and mountain front recharge, which averaged 49,915 AFY (or 83% of total inflows). It is noted that mountain front recharge is simulated using the recharge package in the flow model and, while concentrated along the basin margins, is not separated from areal precipitation recharge. Sonoma Creek leakage is the second largest source of recharge (6,363 AFY on average; or 11% of total inflows). Return flows from agricultural irrigation (1,415 AFY), municipal irrigation (1,074 AFY), and septic systems (899 AFY) collectively contribute about 6% of total inflows. Agricultural recycled water return flows (91 AFY) and subsurface inflow from the Baylands Area (51 AFY) represent minor inflows.

4.1.2 Outflows

As shown in Table 4-1 and Figure 4-1, total annual subbasin outflows over the baseline period averaged -62,543 AFY. The largest subbasin outflow is represented by groundwater discharge to streams. The model differentiates between groundwater discharge to tributary streams of Sonoma Creek (-40,403 AFY on average; 65% of total outflows) and groundwater discharge to Sonoma Creek (-10,643 AFY on average; 17% of total outflows). The next largest outflow is groundwater pumping (-8,486 AFY on average, 14% of total outflows) followed by subsurface outflow to the southern Baylands Area (-3,011 AFY; 5% of total outflows). While net subsurface flow is from the Inland area to the Baylands Area, a small portion of groundwater flows from the Baylands area to the Inland area (51 AFY).

4.1.3 Change in Storage

Over the baseline period, a total of -27,356 AF was lost from groundwater storage, equivalent to -2,736 AFY on average.

4.2 Water Quality of Inflows and Outflows

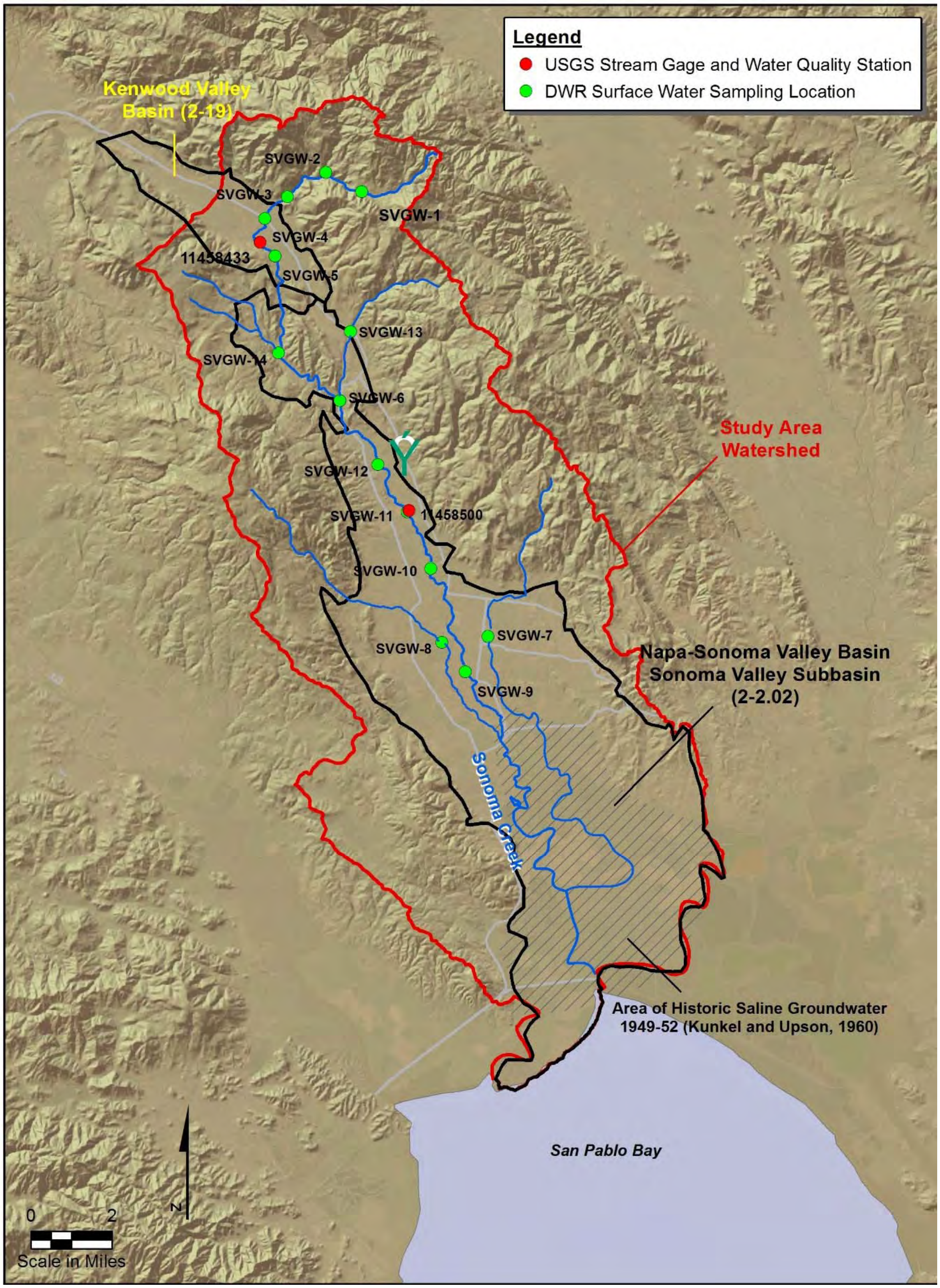
Initial and adjusted TDS and nitrate concentration estimates for subbasin inflows and outflows in the water balance are described below followed by a discussion of the baseline mixing model calibration and results.

4.2.1 Sonoma Creek Leakage

TDS and nitrate data from available surface water quality monitoring stations in the watershed were assessed to characterize the water quality of stream leakage from Sonoma Creek, the second largest subbasin inflow.

Figure 4-2 shows the locations of DWR and USGS surface water quality monitoring stations along Sonoma Creek and its tributaries. As shown in the figure, there are two USGS and fourteen DWR surface water monitoring stations with water quality data.

Figure 4-2: Surface Water Monitoring Locations



<u>USGS stations</u>

USGS Sonoma Creek station 11458433 – Since October 2008, daily EC has been measured for this station located in the northern portion of the subbasin. From October 2008 through March 2013, daily TDS concentrations (estimated from EC data using the regression equation on Figure 3-3) ranged from 95 to 238 mg/L, averaging 191 mg/L. No nitrate data are available.

USGS Sonoma Creek station 11458500 – While continuous EC data are not available for this station located in the central portion of the subbasin, discrete water quality data are available for two sampling events in 2002 and 2003:

- TDS concentrations were 248 and 210 mg/l in November 2002 and June 2003, respectively.
- Nitrate concentrations were non-detect (<0.06 mg/L) and 0.25 mg/L in November 2002 and June 2003, respectively.

<u>DWR stations</u>

Water quality sampling was conducted in May and November 2010 at fourteen DWR surface water monitoring stations shown on Figure 4-2. **Table 4-2** summarizes the TDS and nitrate results.

TDS concentrations for the fourteen DWR stations range from 140 to 301 mg/L. On average, TDS concentrations for the May 2010 samples (191 mg/L) were slightly lower than for the November 2010 samples (229 mg/L). This difference is expected given that the flow rate in Sonoma Creek (measured at USGS station 11458500) was much higher on May 4 and 5 (above 30 cubic feet per second [cfs]) (i.e. comprised predominantly of storm runoff versus groundwater discharge), compared to approximately 8 cfs on average from November 1 through 16. Average TDS concentrations of Sonoma Creek samples were only slightly higher (216 mg/L) compared to those collected from the other four tributary creeks (190 mg/L). The overall average TDS concentration for the fourteen DWR stations was 209 mg/L. **For the SNMP, a constant TDS concentration of 210 mg/L was applied to Sonoma Creek leakage for the baseline period of WY 1996-97 to WY 2005-06.**

Nitrate concentrations for the fourteen DWR stations range from 0.01 to 1.2 mg/L. There is no significant difference in nitrate concentrations between the May and November samples. Average nitrate concentrations of samples collected from Sonoma Creek were lower (0.19 mg/L) compared to those collected from the other four tributary creeks (0.40 mg/L). The average nitrate concentration for the fourteen DWR stations was 0.24 mg/L. **For the SNMP, a constant nitrate-N concentration of 0.19 mg/L was applied to Sonoma Creek leakage for the baseline period of WY 1996-97 to WY 2005-06.**

4.2.2 Deep Percolation of Areal Precipitation and Mountain Front Recharge

Recharge from deep percolation of areal precipitation and mountain front recharge represents 65% of total subbasin inflows and is the primary controlling S/N load factor. Generally, precipitation contains minimal salts and nutrients. However, due to its low solute content, precipitation also dissolves (or leaches) salts and nutrients along its subsurface flow path from near-surface soils through the vadose zone sediments and saturated zone sediments. The degree of leaching is dependent on numerous site-specific factors and is difficult to predict reliably.

Table 4-2: 2010 DWR Surface Water Quality Monitoring Results

Station ID	Stream	Sampling Date	TDS (mg/L)	Nitrate-N (mg/L)
SVGW-1	Sonoma Creek	05/04/10	198	0.07
		11/01/10	214	0.16
SVGW-2	Sonoma Creek	05/04/10	213	0.05
		11/15/10	301	
SVGW-3	Sonoma Creek	05/04/10	225	0.02
		11/01/10	231	0.14
		11/15/10		0.20
SVGW-4	Sonoma Creek	05/04/10	218	0.02
		11/01/10	230	0.32
		11/16/10		0.01
SVGW-5	Sonoma Creek	05/04/10	204	0.36
		11/16/10	234	0.09
SVGW-6	Sonoma Creek	05/04/10	186	0.32
		11/01/10	196	0.20
SVGW-7	Nathanson Creek	05/05/10	202	1.20
		11/02/10	235	0.97
SVGW-8	Carriger Creek	05/05/10	171	0.07
SVGW-9	Sonoma Creek	05/05/10	204	0.27
		11/01/10	231	0.27
SVGW-10	Sonoma Creek	05/05/10	194	0.25
		11/02/10	222	0.23
SVGW-11	Sonoma Creek	05/05/10	187	0.27
		11/01/10	221	0.20
SVGW-12	Sonoma Creek	05/05/10	189	0.32
		11/01/10	214	0.23
SVGW-13	Calabazas Creek	05/05/10	140	0.27
		11/01/10	213	0.23
SVGW-14	Yulupa Creek	05/05/10	140	0.05
		11/01/10	230	0.02
Average	**May 2010 Samples**		**191**	**0.25**
	November 2010 Samples		**229**	**0.25**
	Sonoma Creek Samples Only		**216**	**0.19**
	All Samples		**209**	**0.24**

TDS – total dissolved solids
Nitrate-N – nitrate as nitrogen
mg/L – milligrams per liter
Conf. – confluence
Hwy - Highway

TDS concentrations for deep percolation of areal precipitation and mountain front recharge were estimated from available groundwater quality of wells located in the watershed outside of the subbasin. **Figure 4-3** shows the median TDS concentrations (from 2000 to 2012) of 43 wells in the watershed outside of the subbasin. Median TDS concentrations for these wells ranged from 160 to 580 mg/L with an average of 245 mg/L. Based on these data, **an initial constant concentration of 245 mg/L TDS was applied to deep percolation of areal precipitation and mountain front recharge for the loading estimate**. Based on the mixing model calibration, **a final adjusted TDS concentration of 250 mg/L for deep percolation of areal precipitation and mountain front recharge was applied**. The basis for this TDS adjustment is discussed in Section 4.3.

The process by which airborne pollutants are deposited on the ground surface is known as dry deposition. Nitrogen is one of the pollutants commonly associated with dry deposition. Additionally, nitrogen leaching from dry deposition can occur. Nitrate concentrations for deep percolation of areal precipitation and mountain front recharge could not be estimated in the same manner as TDS, because there are no nitrate data for wells in the watershed outside of the subbasin. The USEPA manages the Clean Air Status and Trends Network (CASTNET), a national air quality monitoring network that provides data to assess trends in atmospheric deposition, among other purposes. The closest CASTNET monitoring station to the Sonoma Valley is in Hopland, California (CASTNET ID CA45) approximately 60 miles to the northwest of the valley. Annual data for the Hopland station show that precipitation nitrate concentrations ranged from 0.01 to 0.04 mg/L over the baseline period, with an average of 0.02 mg/L. Available nitrate deposition maps indicate that precipitation nitrate concentrations increase slightly to the south of the station toward Sonoma Valley. For the loading estimate, **a constant nitrate concentration of 0.06 mg/L, equivalent to the ambient average nitrate concentration in the subbasin, was applied to deep percolation of areal precipitation and mountain front recharge**.

4.2.3 Return Flows – Agricultural (Groundwater and Recycled Water), Municipal, and Septic System

Source water used for irrigation includes imported water, groundwater, and recycled water. In order to determine the quality of irrigation return flows that percolate to groundwater, the S/N concentrations for each source water used for irrigation was characterized. In addition to the S/N concentrations of the source water, S/Ns are added through use and concentrated by evapotranspiration, added through fertilizer use, and removed by plant uptake and attenuation processes in the root zone. Nutrient plant uptake is the process by which plants absorb nutrients from applied water and surrounding soil.

For the loading estimate, TDS and nitrogen mass loads for agricultural (groundwater and recycled water source water) and municipal (groundwater and imported water source water) irrigation and septic system return flows were estimated. Documentation of the loading estimates for these return flows are provided in the *Salt and Nutrient Source Identification and Loading* TM (RMC, 2013) included in Appendix C. Salt and nutrient loading for the return flows were extracted from the RMC loading model based on the land use category, irrigation source water, and presence of septic systems. Loading from agricultural return flows include grasslands, irrigated and non-irrigated agricultural lands, farmsteads, concentrated animal feed operations (CAFOs) and dairies. Municipal return flows include paved areas, urban, commercial, and industrial sources. For the mixing model, the TDS and nitrogen mass load for each return flow component was mixed with its respective annual return flow volume to obtain a concentration. For the loading estimate, it was conservatively assumed that all nitrogen mass is converted to nitrate. Based on initial simulation results for the baseline period, nitrate loading from return flows was reduced by 15% to account for attenuation processes beneath the soil root zone and septic system, in order to provide a better match between simulated average concentrations and observed regional trends.

Figure 4-3: Median TDS Concentration (2000 to 2012) Watershed Area Wells Outside Subbasin

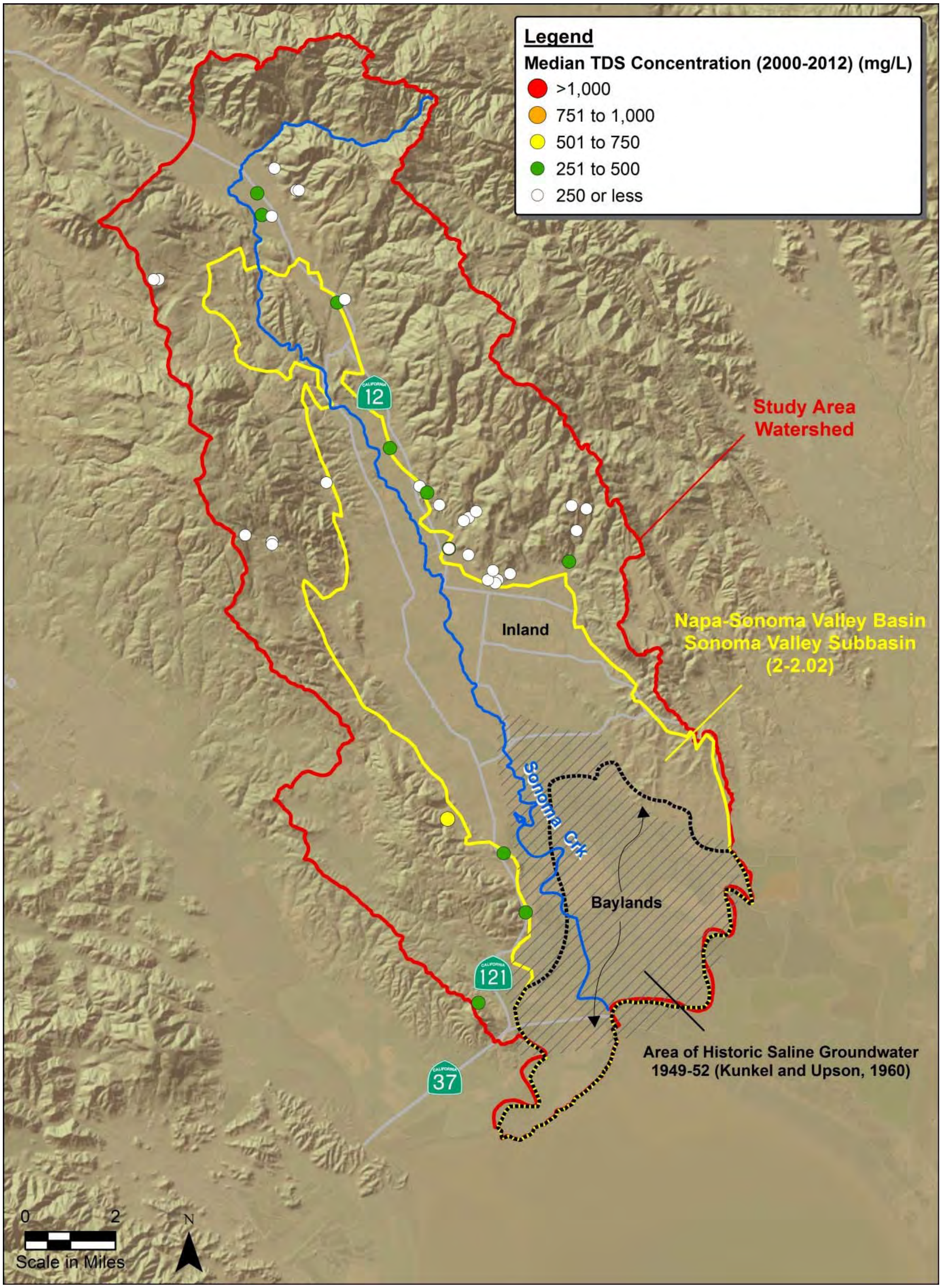


Table 4-3 shows the initial calculated and adjusted (during calibration) TDS and nitrate mass and concentrations for each return flow component. The adjusted concentrations are applied as a constant concentration over the baseline period.

Table 4-3: Return Flow TDS and Nitrate-N Mass and Concentrations for Baseline Period Analysis

Return Flows	Volumetric Rate	Iniitial and Adjusted TDS Concentration[1]	Inititial Nitrate-N Concentration[1]	Adjusted Nitrate-N Concentration[1]
	AFY	mg/L	mg/L	mg/L
Agricultural (Groundwater) Return	1,415	**4,347**	**28.0**	**23.8**
Agricultural (Recycled Water) Return	91	**4,344**	**28.0**	**23.8**
Municipal Return	1,074	**1,182**	**23.9**	**20.3**
Septic System	621	**572**	**30.0**	**25.5**
Total	3,201			
Weighted-average		**2,552**	**27.0**	**23.0**

[1]Initial TDS and nitrate concentrations calculated from mass loading estimates in *Salt and Nutrient Source Identification and Loading TM* (RMC, 2013). Initial TDS concentrations for return flows were not adjusted during calibration. Adjusted nitrate concentrations reflect 15% reduction to account for additional attenuation below the root zone/septic system in the mixing model.
TDS – total dissolved solids
Nitrate-N – nitrate as nitrogen
mg/L – milligrams per liter

As shown in Table 4-3, the initial and final adjusted TDS concentration of agricultural return flow (groundwater and recycled water source water) at about 4,300 mg/L is the highest of the return flow components. Differences between agricultural return flow concentrations/mass for groundwater and recycled water are attributable to differences in source water quality. The TDS concentration of municipal return flow (1,182 mg/L) is lower than for agricultural return flows. Septic system return flows have the lowest TDS concentration (572 mg/L) compared to the agricultural and municipal return flows. Overall, the volume weighted-average TDS concentration of the agricultural, municipal, and septic system return flows is 2,552 mg/L.

Initial nitrate concentrations in the table represent the concentration of return flows at the base of the soil root zone or at the septic system. Based on the mixing model calibration, **the nitrate concentration for each individual return flow component was adjusted downward by 15% in the mixing model to account for additional nitrate attenuation by soil bacteria below the root zone/septic system**. The basis for this adjustment is described in more detail in Section 4.3.

For nitrate, initial and adjusted agricultural return flow (groundwater and recycled water source water) have the same concentrations (28.0 mg/L and 23.8 mg/L, respectively). Similar to TDS, the initial and adjusted nitrate concentration of municipal return flow (23.9 mg/L and 20.3, respectively) are lower than for agricultural returns. Septic system return flows have a higher initial and adjusted nitrate concentrations (30.0 mg/L and 25.5 mg/L, respectively) compared to the agricultural and municipal return flows. Overall, the volume weighted-average initial and adjusted nitrate concentrations of the agricultural, municipal, and septic system return flows are 27.0 mg/L and 23.0 mg/L, respectively.

4.2.4 Subsurface Inflows from Baylands Area

While groundwater levels and the flow model-based water balance indicate that subsurface groundwater flows generally from the Inlands area to the Baylands Area, there is a small component of subsurface inflow from the Baylands Area. This is likely caused by groundwater pumping, which has created a pumping depression in the southern portion of the subbasin.

The concentrations applied to subsurface inflows from the Baylands Area were assumed to be the current average concentration in the Baylands Area (1,220 mg/L for TDS and 0.07 mg/L for nitrate-N).

4.3 Mixing Model Calibration and Salt and Nutrient Balance

In order to simulate the effect of current S/N loading on groundwater quality in the Inland Area of the subbasin, a spreadsheet mixing model was developed. As discussed in Section 3.5.5, the simulated baseline period concentrations and trends are compared to the predominant pattern of observed concentrations and trends. Loading factors may be adjusted (calibrated) to achieve a better match between simulated and observed concentrations and trends.

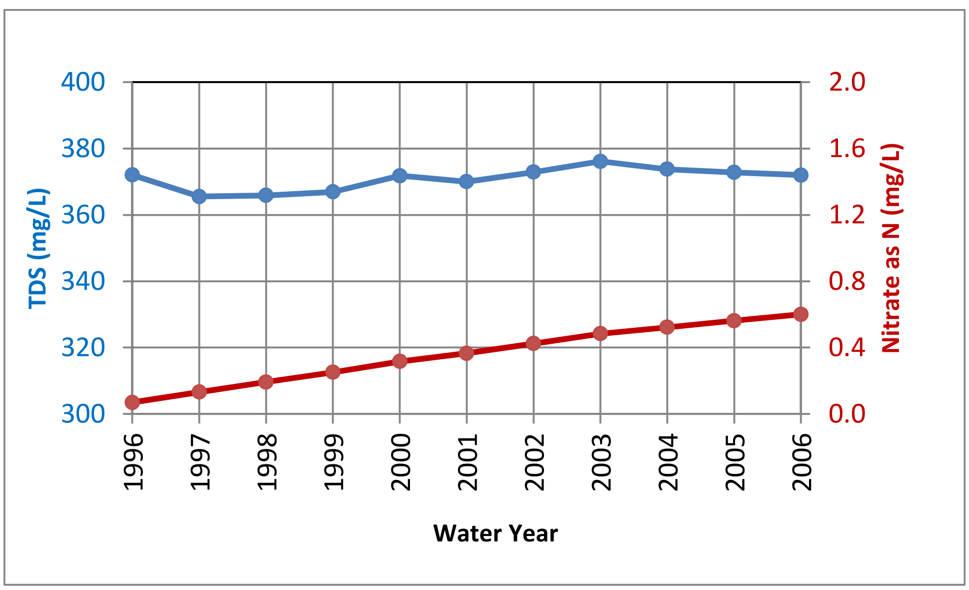
Based on initial baseline simulations, the estimated concentration for one TDS loading factor was adjusted. For the final calibration, the TDS concentration for deep percolation of areal precipitation and mountain front recharge was adjusted upwards from 245 mg/L to 250 mg/L. This adjustment resulted in a more reasonable match between simulated and observed TDS trends.

With respect to nitrate, preliminary mixing model results indicated that initial nitrate loading to groundwater was likely overestimated, resulting in the average concentration of nitrate in the Inland Area to increase measurably over the baseline period. For the final calibration, nitrate loading from return flows was reduced by 15% in the mixing model to account for additional attenuation by soil bacteria below the root zone and septic system, which was not considered in the *Salt and Nutrient Source Identification and Loading TM* (RMC, 2013).

No other inflow loading estimates were adjusted for the baseline period calibration.

Figure 4-4 shows the final simulated average subbasin TDS and nitrate concentrations over the 10-year baseline period (WY 1996 represents the hypothetical initial water quality condition equivalent to the current ambient condition).

Figure 4-4: Final Simulated Baseline Average Groundwater Concentrations for Inland Area of Sonoma Valley Subbasin (WYs 1997-2006)



As shown in the figure, simulated average subbasin TDS concentrations vary slightly from year to year, but exhibit no change over the 10-year baseline period. This flat trend compares well to observed flat trends in wells across the subbasin over the baseline period, as indicated in TDS and EC time-concentration plots shown in Figures 3-8 and 3-9, respectively.

In contrast to the TDS trend, simulated average nitrate-N concentrations increase by about 0.5 mg/L over the baseline period, despite nitrate loading from return flows being reduced by 15% to account for additional attenuation below the root zone/septic system. Observed nitrate concentrations in monitoring wells across the subbasin (see Figure 3-13) are not increasing regionally, but instead show overall flat or stable concentrations over time. The discrepancy between simulated and observed trends may be caused by an overestimate of the nitrate load due to one or more of the following:

1. assumption that 100% of nitrogen is converted to nitrate;
2. potential underestimation of ambient average groundwater nitrate concentrations due to limited spatial distribution of wells with recent nitrate data;
3. Application of all nitrate loading associated with recycled water use within the Inlands area in the mixing model, despite portions of existing (and proposed future) recycled water use areas being located south of the Inlands area in the Baylands area (see Figure 2-1),
4. Underestimation of nitrate attenuation below the root zone/septic system in the mixing model

For the reasons mentioned above, simulated nitrate concentrations generated from the calibrated mixing model are likely conservative and overestimated for both baseline and future nitrogen loading. While application of higher nitrate attenuation rate was considered, given the limited distribution of monitoring wells with long-term nitrate trend data in the subbasin, a 15% attenuation rate was maintained.

Table 4-4 and **Figure 4-5** show the baseline period TDS mass balance for the Inland Area of the Sonoma Valley Subbasin. The mass balance is based on the annual volumetric flows and final calibrated TDS concentrations applied to each S/N loading factor. As shown in table and figure, the largest TDS load is from deep percolation of areal precipitation and mountain front recharge, which represents 57% of the overall TDS loading to the subbasin. Agricultural (groundwater source water) return is the second largest TDS load (28% of total loading), followed by Sonoma Creek leakage (6%) and municipal return (6%). Septic system return, agricultural (recycled water) return, and subsurface inflow from the Baylands Area each represent less than 2% of the total TDS loading in the subbasin.

The annual change in TDS mass varies annually from about -9,000 tons to +5,600 tons. Over the baseline period, TDS mass decreased by about 15,300 tons. It is noted that the direction (positive or negative) of the change in mass does not necessarily correlate to a change in average TDS concentration in the same direction (increase or decrease). This is best explained by an example: in WY 2000-01, TDS mass in the subbasin increased by 5,400 tons. However, the average subbasin TDS concentration decreased by 1.8 mg/L that year, because groundwater storage gains outweighed the positive change in TDS mass that year due to the large influx of low-TDS areal precipitation and mountain front recharge. This example demonstrates the importance of evaluating the mass balance within the context of the water balance.

Table 4-5 and **Figure 4-6** show the nitrate mass balance for the baseline period for the Inland area of the Sonoma Valley Subbasin. As shown in table and figure, the largest nitrate load is agricultural (groundwater source water) return, which represents approximately 43% of the overall nitrate loading to the subbasin. Municipal return is the second largest TDS load (28% of total loading), followed by septic system return (20%), deep percolation of areal precipitation and mountain front recharge (4%) and agricultural (recycled water source water) return (3%). Sonoma Creek leakage and subsurface inflow from the Baylands Area represent minor nitrate loading factors in the subbasin. The change in nitrate mass varies annually from about +60 tons to +101 tons. Over the baseline period, nitrate mass increased by about 807 tons.

Table 4-4: Baseline TDS Balance for Inland Area of Sonoma Valley Subbasin (WYs 1997-2006)

	1996-97	1997-98	1998-99	1999-2000	2000-01	2001-02	2002-03	2003-04	2004-05	2005-06	Average
					All values in tons						
INFLOWS											
Aerial Precipitation / Mtn. Front Recharge	39,988	17,113	14,222	368	22,694	7,110	5,791	23,517	19,781	19,356	16,994
Sonoma Creek Leakage	1,527	1,598	1,718	1,968	1,902	1,924	2,075	1,906	1,786	1,765	1,817
Agricultural (Groundwater) Irrigation Return	8,363	8,363	8,363	8,363	8,363	8,363	8,363	8,363	8,363	8,363	8,363
Agricultural (Recycled Water) Irrigation Return	538	538	538	538	538	538	538	538	538	538	538
Municipal Irrigation Return	1,726	1,726	1,726	1,726	1,726	1,726	1,726	1,726	1,726	1,726	1,726
Septic System Return	483	483	483	483	483	483	483	483	483	483	483
Subsurface Inlow from Baylands	89	93	89	82	79	81	77	79	85	86	84
TOTAL INFLOWS	**52,714**	**29,913**	**27,138**	**13,526**	**35,783**	**20,223**	**19,051**	**36,611**	**32,761**	**32,315**	**30,003**
OUTFLOWS											
Groundwater Pumping	-4,149	-4,116	-4,184	-4,223	-4,289	-4,264	-4,296	-4,425	-4,488	-4,347	-4,278
Groundwater Discharge to Tributary Streams	-38,072	-25,039	-20,313	-12,658	-19,597	-14,036	-12,066	-20,100	-20,733	-21,085	-20,370
Groundwater Discharge to Sonoma Creek	-7,384	-6,393	-5,658	-4,359	-5,091	-4,621	-4,134	-5,091	-5,421	-5,485	-5,364
Subsurface Outflow to Baylands	-1,855	-1,770	-1,601	-1,325	-1,416	-1,377	-1,258	-1,437	-1,560	-1,577	-1,518
TOTAL OUTFLOWS	**-51,460**	**-37,319**	**-31,755**	**-22,565**	**-30,393**	**-24,298**	**-21,754**	**-31,053**	**-32,203**	**-32,493**	**-31,529**
Annual TDS Mass Change	1,254	-7,406	-4,618	-9,040	5,390	-4,076	-2,702	5,558	558	-178	-1,526
Cumulative TDS Mass Change	1,254	-6,152	-10,769	-19,809	-14,419	-18,495	-21,197	-15,639	-15,081	-15,259	

Mtn. – mountain
TDS – total dissolved solids
WY – water year

Figure 4-5: Baseline TDS Balance for Inland Area of Sonoma Valley Subbasin (WYs 1997-2006)

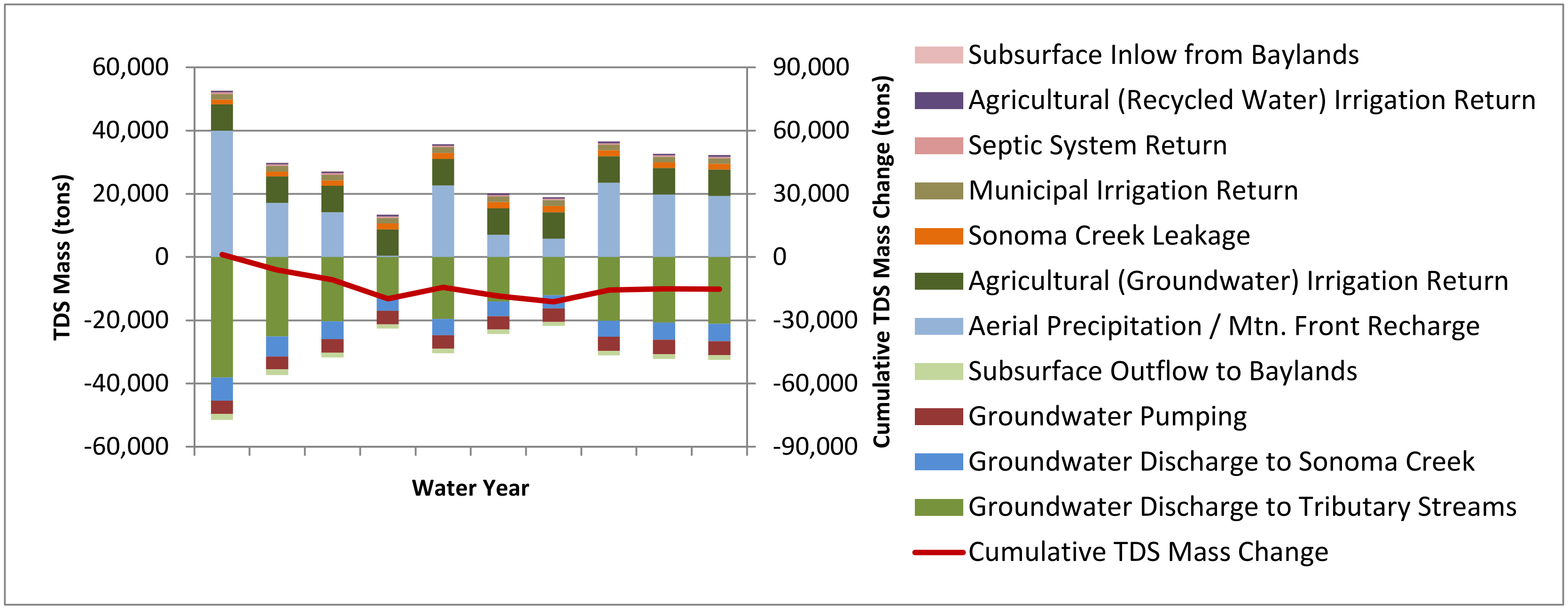
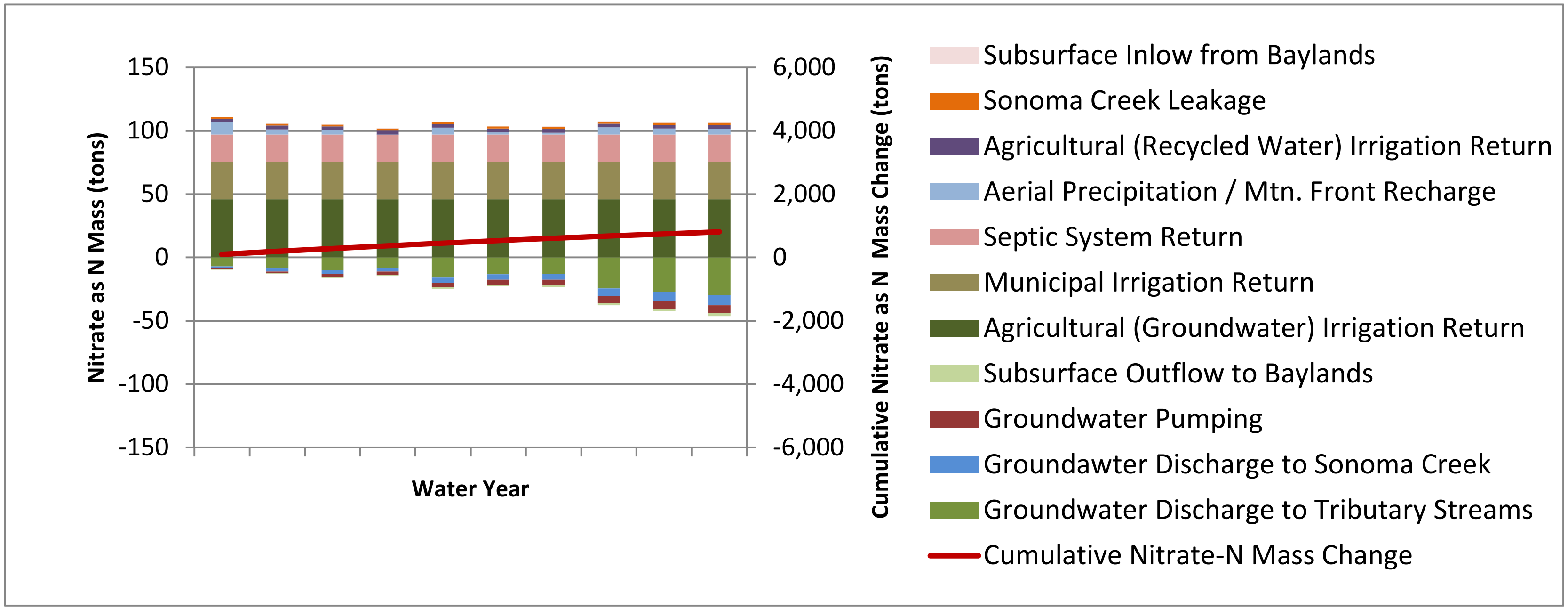


Table 4-5: Baseline Nitrate-N Balance for Inland Area of Sonoma Valley Subbasin (WYs 1997-2006)

	1996-97	1997-98	1998-99	1999-2000	2000-01	2001-02	2002-03	2003-04	2004-05	2005-06	Average
					All values in tons						
INFLOWS											
Aerial Precipitation / Mtn. Front Recharge	9.6	4.1	3.4	0.1	5.4	1.7	1.4	5.6	4.7	4.6	4.1
Sonoma Creek Leakage	1.4	1.4	1.6	1.8	1.7	1.7	1.9	1.7	1.6	1.6	1.6
Agricultural (Groundwater) Irrigation Return	45.8	45.8	45.8	45.8	45.8	45.8	45.8	45.8	45.8	45.8	45.8
Agricultural (Recycled Water) Irrigation Return	2.9	2.9	2.9	2.9	2.9	2.9	2.9	2.9	2.9	2.9	2.9
Municipal Irrigation Return	29.7	29.7	29.7	29.7	29.7	29.7	29.7	29.7	29.7	29.7	29.7
Septic System Return	21.5	21.5	21.5	21.5	21.5	21.5	21.5	21.5	21.5	21.5	21.5
Subsurface Inflow to Baylands	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
TOTAL INFLOWS	**110.9**	**105.5**	**104.9**	**101.9**	**107.1**	**103.4**	**103.2**	**107.3**	**106.3**	**106.2**	**105.7**
OUTFLOWS											
Groundwater Pumping	-0.8	-1.4	-2.1	-2.8	-3.5	-4.0	-4.6	-5.4	-5.9	-6.2	-3.7
Groundwater Discharge to Tributary Streams	-7.2	-8.8	-10.2	-8.3	-15.8	-13.1	-13.0	-24.4	-27.3	-29.9	-15.8
Groundwater Discharge to Sonoma Creek	-1.4	-2.2	-2.9	-2.8	-4.1	-4.3	-4.4	-6.2	-7.1	-7.8	-4.3
Subsurface Outflow to Baylands	-0.3	-0.6	-0.8	-0.9	-1.1	-1.3	-1.4	-1.7	-2.1	-2.2	-1.2
TOTAL OUTFLOWS	**-9.7**	**-13.1**	**-16.0**	**-14.7**	**-24.5**	**-22.7**	**-23.4**	**-37.7**	**-42.4**	**-46.2**	**-25.0**
Annual Nitrate-N Mass Change	101.3	92.5	88.9	87.1	82.6	80.7	79.9	69.7	63.9	60.1	80.7
Cumulative Nitrate-N Mass Change	101.3	193.7	282.7	369.8	452.4	533.1	612.9	682.6	746.6	806.6	

Mtn. – mountain
Nitrate-N – nitrate as nitrogen
WY – water year

Figure 4-6: Baseline Nitrate-N Balance for Inland Area of Sonoma Valley Subbasin (WYs 1997-2006)



5 Future Planning Period Water Quality

The *Salt and Nutrient Source Identification and Loading* TM (RMC, 2013) identified future projections for imported water use, and increased recycled water use through the future planning period. These projections define the future projects simulated in this TM. Future project changes are superimposed over average water balance conditions during the 10-year baseline period to simulate future groundwater quality. The spreadsheet mixing model developed for the baseline analysis was modified to evaluate the effects of planned future S/N loading on overall groundwater quality in the Sonoma Valley Subbasin for the future planning period (WY 2013-14 through WY 2034-35).

The mixing model methodology is described in Sections 3.5.5. Baseline conditions for the Inland Area of Sonoma Valley Subbasin between WY 1996-97 through WY 2005-06 were simulated with the mixing model. Comparison of simulated and actual observed water quality concentrations and trends during the baseline period were used to adjust key loading factors. The calibrated loading factors are then applied to the future loading assumptions. The mixing model is used to predict future water quality, water quality trends, and the percentage of the existing available assimilative capacity used by recycled water projects in the subbasin during the future planning period. The mixing model is designed to incorporate the existing volume of groundwater and mass of TDS and nitrate in storage and track the annual change in groundwater storage and S/N mass for the subbasin as a whole.

A No-Project scenario was simulated to evaluate the impacts of future recycled water projects. For the No-Project scenario, average water balance conditions (WY 1996-97 through WY 2013-14) over the baseline conditions were reproduced for each year of the future planning period.

Future projected changes included the following:

- Increased use of recycled water for agricultural irrigation (replacing groundwater). Two future scenarios were simulated:
  - Planned recycled water use by 2035 (Scenario 1)
  - Planned recycled water use by 2035 plus an additional 5,000 AFY of recycled water (Scenario 2)

While recycled water use is projected to ramp up gradually over time, the maximum 2035 recycled water use conditions were applied beginning in WY 2013-14 and applied over the entire future planning period (from WY 2013-14 through WY 2034-35). Additionally, while portions of existing and proposed future recycled water use areas are located south of the Inlands Area in the Baylands Area (see Figure 2-1), all S/N loading associated with recycled water use was applied in the Inlands Area. Thus, the simulated groundwater quality impacts from recycled water projects are considered highly conservative. Also, while future conditions within the Baylands Area were not explicitly simulated, it is expected that replacing groundwater with recycled water for irrigation will lower TDS levels in groundwater because recycled water has lower TDS concentrations than the average groundwater in the Baylands Area.

Although future stormwater capture and recharge is planned for the area (approximately 50 AFY), to maintain a conservative projection, this recharge source water was not applied to the model.

5.1 Scenarios

Three future scenarios were simulated:

- Future Scenario 0 (No-Project): Assumes average baseline water balance conditions and no additional enhanced stormwater capture and recharge is applied.

- Future Scenario 1: Assumes 2035 planned recycled water use of about 4,100 AFY (applied consistently from WY 2013-14 through WY 2034-35)
- Future Scenario 2: Assumes 2035 planned recycled water use plus an additional 5,000 AFY of recycled water (applied consistently from WY 2013-14 through WY 2034-35).

5.2 Water Balances

The water balance for Scenario 0 (No-Project) is shown in **Table 5-1** and **Figure 5-1**. The water balance for Future Scenario 1 is shown in **Table 5-2** and **Figure 5-2**. The water balance for Future Scenario 2 is shown in **Table 5-3** and **Figure 5-3**. The table and figure shows that for all three future scenarios a total of 66,299 AF is lost from groundwater storage over the 22-year future planning horizon, corresponding to an average annual loss of 3,014 AFY. Agricultural (recycled water) irrigation return flows increase from No-Project (91 AFY) to Scenario 1 (508 AFY) to Scenario 2 (1,132 AFY), while agricultural (groundwater) irrigation return flows decrease from No-Project (1,415 AFY) to Scenario 1 (998 AFY) to Scenario 2 (374 AFY).

5.3 Water Quality

The average TDS and nitrate concentrations for the baseline period were applied to all future scenarios for the following inflows:

- deep percolation of areal precipitation and mountain front recharge
- leakage from Sonoma Creek
- subsurface inflow from Baylands area

Concentrations for future return flow components are described below.

5.3.1 Return Flows – Agricultural and Municipal Irrigation and Septic System

The same methodology used to estimate TDS and nitrogen loading from return flows over the baseline period was used to estimate future return flow loading. Documentation of future loading estimates for return flows is provided in the *Salt and Nutrient Source Identification and Loading* TM (RMC, 2013). For the mixing model, mass loads for each return flow component were mixed with respective annual return flow volumes to obtain a concentration. Similar to the baseline period analysis, 100% of the nitrogen mass is assumed to convert to nitrate. To account for attenuation below the root zone, the same 15% reduction in nitrate loading from return flows applied in the baseline calibration was also applied in future simulations.

Table 5-1: Future Scenario 0 (No-Project) Water Balance for Inland Area of Sonoma Valley Subbasin (WYs 2014-2035)

	2013-14	2014-15	2015-16	2016-17	2017-18	2018-19	2019-20	2020-21	2021-22	2022-23	2023-24	2024-25	2025-26	2026-27	2027-28	2028-29	2029-30	2030-31	2031-32	2032-33	2033-34	2034-35
	All values in acre-feet per year (AFY) unless otherwise noted																					
INFLOWS																						
Aerial Precipitation / Mtn. Front Recharge	49,915	49,915	49,915	49,915	49,915	49,915	49,915	49,915	49,915	49,915	49,915	49,915	49,915	49,915	49,915	49,915	49,915	49,915	49,915	49,915	49,915	49,915
Sonoma Creek Leakage	6,363	6,363	6,363	6,363	6,363	6,363	6,363	6,363	6,363	6,363	6,363	6,363	6,363	6,363	6,363	6,363	6,363	6,363	6,363	6,363	6,363	6,363
Agricultural (Groundwater) Irrigation Return	1,415	1,415	1,415	1,415	1,415	1,415	1,415	1,415	1,415	1,415	1,415	1,415	1,415	1,415	1,415	1,415	1,415	1,415	1,415	1,415	1,415	1,415
Agricultural (Recycled Water) Irrigation Return	91	91	91	91	91	91	91	91	91	91	91	91	91	91	91	91	91	91	91	91	91	91
Municipal Irrigation Return	1,074	1,074	1,074	1,074	1,074	1,074	1,074	1,074	1,074	1,074	1,074	1,074	1,074	1,074	1,074	1,074	1,074	1,074	1,074	1,074	1,074	1,074
Septic System Return	621	621	621	621	621	621	621	621	621	621	621	621	621	621	621	621	621	621	621	621	621	621
Subsurface Inflow from Baylands	51	51	51	51	51	51	51	51	51	51	51	51	51	51	51	51	51	51	51	51	51	51
TOTAL INFLOWS	**59,529**	**59,529**	**59,529**	**59,529**	**59,529**	**59,529**	**59,529**	**59,529**	**59,529**	**59,529**	**59,529**	**59,529**	**59,529**	**59,529**	**59,529**	**59,529**	**59,529**	**59,529**	**59,529**	**59,529**	**59,529**	**59,529**
OUTFLOWS																						
Groundwater Pumping	-8,486	-8,486	-8,486	-8,486	-8,486	-8,486	-8,486	-8,486	-8,486	-8,486	-8,486	-8,486	-8,486	-8,486	-8,486	-8,486	-8,486	-8,486	-8,486	-8,486	-8,486	-8,486
Groundwater Discharge to Tributary Streams	-40,403	-40,403	-40,403	-40,403	-40,403	-40,403	-40,403	-40,403	-40,403	-40,403	-40,403	-40,403	-40,403	-40,403	-40,403	-40,403	-40,403	-40,403	-40,403	-40,403	-40,403	-40,403
Groundwater Discharge to Sonoma Creek	-10,643	-10,643	-10,643	-10,643	-10,643	-10,643	-10,643	-10,643	-10,643	-10,643	-10,643	-10,643	-10,643	-10,643	-10,643	-10,643	-10,643	-10,643	-10,643	-10,643	-10,643	-10,643
Subsurface Outflow to Baylands	-3,011	-3,011	-3,011	-3,011	-3,011	-3,011	-3,011	-3,011	-3,011	-3,011	-3,011	-3,011	-3,011	-3,011	-3,011	-3,011	-3,011	-3,011	-3,011	-3,011	-3,011	-3,011
TOTAL OUTFLOWS	**-62,543**	**-62,543**	**-62,543**	**-62,543**	**-62,543**	**-62,543**	**-62,543**	**-62,543**	**-62,543**	**-62,543**	**-62,543**	**-62,543**	**-62,543**	**-62,543**	**-62,543**	**-62,543**	**-62,543**	**-62,543**	**-62,543**	**-62,543**	**-62,543**	**-62,543**
ANNUAL STORAGE CHANGE (AF)	-3,014	-3,014	-3,014	-3,014	-3,014	-3,014	-3,014	-3,014	-3,014	-3,014	-3,014	-3,014	-3,014	-3,014	-3,014	-3,014	-3,014	-3,014	-3,014	-3,014	-3,014	-3,014
CUMULATIVE STORAGE CHANGE (AF)	-3,014	-6,027	-9,041	-12,054	-15,068	-18,081	-21,095	-24,109	-27,122	-30,136	-33,149	-36,163	-39,176	-42,190	-45,204	-48,217	-51,231	-54,244	-57,258	-60,271	-63,285	-66,299

Mtn. – mountain
AF – acre-feet
WY – water year

Figure 5-1: Future Scenario 0 (No-Project) Water Balance for Inland Area of Sonoma Valley (WYs 2014-2035)

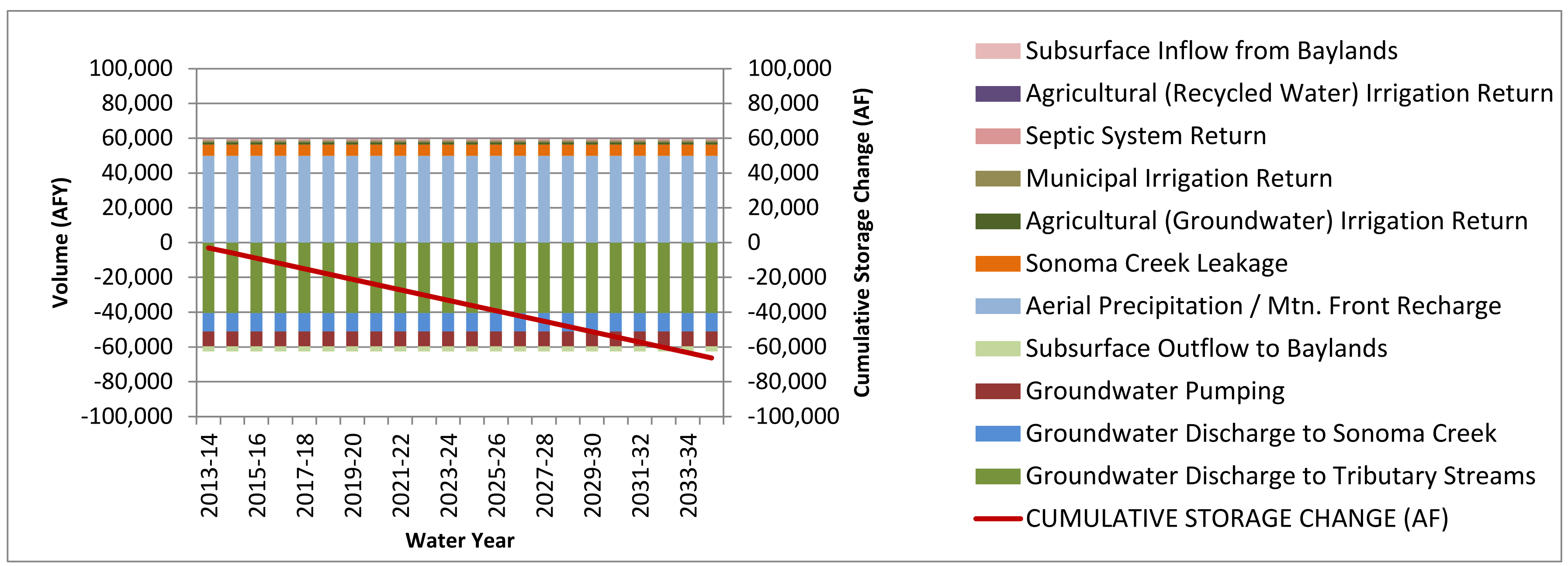


Table 5-2: Future Scenario 1 (2035 recycled water conditions) Water Balance for Inland Area of Sonoma Valley Subbasin (WYs 2014-2035)

	2013-14	2014-15	2015-16	2016-17	2017-18	2018-19	2019-20	2020-21	2021-22	2022-23	2023-24	2024-25	2025-26	2026-27	2027-28	2028-29	2029-30	2030-31	2031-32	2032-33	2033-34	2034-35
	All values in acre-feet per year (AFY) unless otherwise noted																					
INFLOWS																						
Aerial Precipitation / Mtn. Front Recharge	49,915	49,915	49,915	49,915	49,915	49,915	49,915	49,915	49,915	49,915	49,915	49,915	49,915	49,915	49,915	49,915	49,915	49,915	49,915	49,915	49,915	49,915
Sonoma Creek Leakage	6,363	6,363	6,363	6,363	6,363	6,363	6,363	6,363	6,363	6,363	6,363	6,363	6,363	6,363	6,363	6,363	6,363	6,363	6,363	6,363	6,363	6,363
Agricultural (Groundwater) Irrigation Return	998	998	998	998	998	998	998	998	998	998	998	998	998	998	998	998	998	998	998	998	998	998
Agricultural (Recycled Water) Irrigation Return	508	508	508	508	508	508	508	508	508	508	508	508	508	508	508	508	508	508	508	508	508	508
Municipal Irrigation Return	1,074	1,074	1,074	1,074	1,074	1,074	1,074	1,074	1,074	1,074	1,074	1,074	1,074	1,074	1,074	1,074	1,074	1,074	1,074	1,074	1,074	1,074
Septic System Return	621	621	621	621	621	621	621	621	621	621	621	621	621	621	621	621	621	621	621	621	621	621
Subsurface Inflow from Baylands	51	51	51	51	51	51	51	51	51	51	51	51	51	51	51	51	51	51	51	51	51	51
TOTAL INFLOWS	**59,529**	**59,529**	**59,529**	**59,529**	**59,529**	**59,529**	**59,529**	**59,529**	**59,529**	**59,529**	**59,529**	**59,529**	**59,529**	**59,529**	**59,529**	**59,529**	**59,529**	**59,529**	**59,529**	**59,529**	**59,529**	**59,529**
OUTFLOWS																						
Groundwater Pumping	-8,486	-8,486	-8,486	-8,486	-8,486	-8,486	-8,486	-8,486	-8,486	-8,486	-8,486	-8,486	-8,486	-8,486	-8,486	-8,486	-8,486	-8,486	-8,486	-8,486	-8,486	-8,486
Groundwater Discharge to Tributary Streams	-40,403	-40,403	-40,403	-40,403	-40,403	-40,403	-40,403	-40,403	-40,403	-40,403	-40,403	-40,403	-40,403	-40,403	-40,403	-40,403	-40,403	-40,403	-40,403	-40,403	-40,403	-40,403
Groundwater Discharge to Sonoma Creek	-10,643	-10,643	-10,643	-10,643	-10,643	-10,643	-10,643	-10,643	-10,643	-10,643	-10,643	-10,643	-10,643	-10,643	-10,643	-10,643	-10,643	-10,643	-10,643	-10,643	-10,643	-10,643
Subsurface Outflow to Baylands	-3,011	-3,011	-3,011	-3,011	-3,011	-3,011	-3,011	-3,011	-3,011	-3,011	-3,011	-3,011	-3,011	-3,011	-3,011	-3,011	-3,011	-3,011	-3,011	-3,011	-3,011	-3,011
TOTAL OUTFLOWS	**-62,543**	**-62,543**	**-62,543**	**-62,543**	**-62,543**	**-62,543**	**-62,543**	**-62,543**	**-62,543**	**-62,543**	**-62,543**	**-62,543**	**-62,543**	**-62,543**	**-62,543**	**-62,543**	**-62,543**	**-62,543**	**-62,543**	**-62,543**	**-62,543**	**-62,543**
ANNUAL STORAGE CHANGE (AF)	-3,014	-3,014	-3,014	-3,014	-3,014	-3,014	-3,014	-3,014	-3,014	-3,014	-3,014	-3,014	-3,014	-3,014	-3,014	-3,014	-3,014	-3,014	-3,014	-3,014	-3,014	-3,014
CUMULATIVE STORAGE CHANGE (AF)	-3,014	-6,027	-9,041	-12,054	-15,068	-18,081	-21,095	-24,109	-27,122	-30,136	-33,149	-36,163	-39,176	-42,190	-45,204	-48,217	-51,231	-54,244	-57,258	-60,271	-63,285	-66,299

Mtn. – mountain
AF – acre-feet
WY – water year

Figure 5-2: Future Scenario 1 (2035 recycled water conditions) Water Balance for Inland Area of Sonoma Valley Subbasin (WYs 2014-2035)

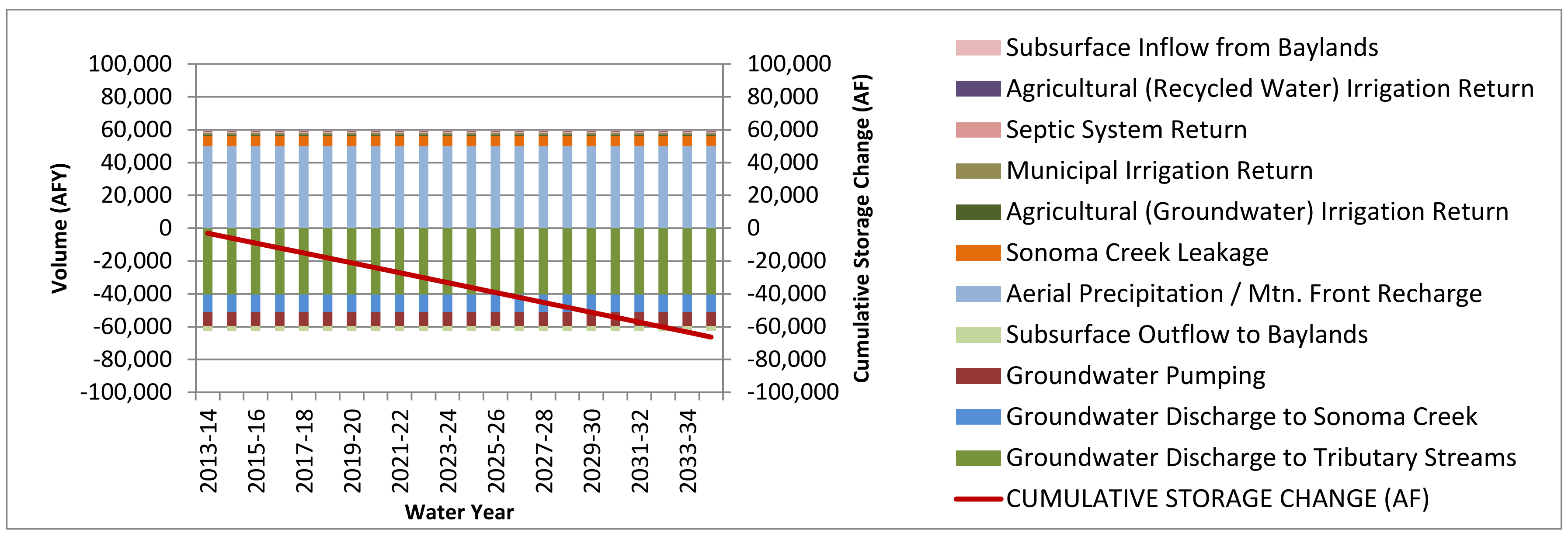
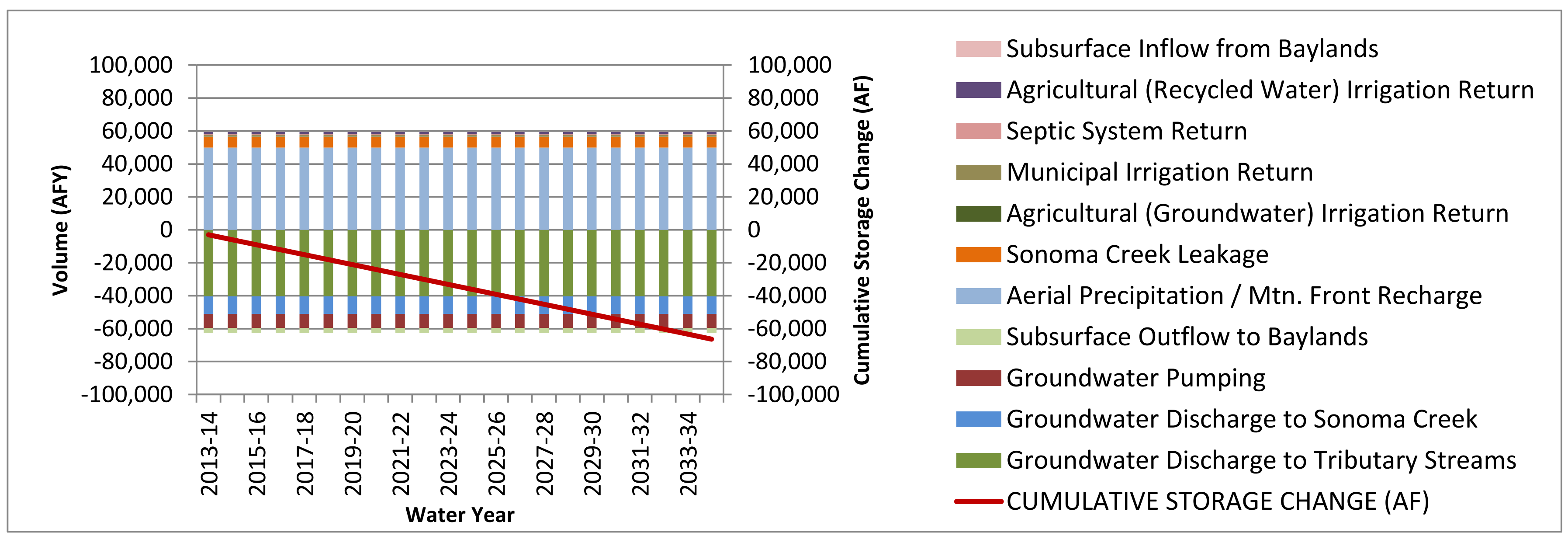


Table 5-3: Future Scenario 2 (2035 recycled water conditions plus 5,000 AFY recycled water) Water Balance for Inland Area of Sonoma Valley Subbasin (WYs 2014-2035)

	2013-14	2014-15	2015-16	2016-17	2017-18	2018-19	2019-20	2020-21	2021-22	2022-23	2023-24	2024-25	2025-26	2026-27	2027-28	2028-29	2029-30	2030-31	2031-32	2032-33	2033-34	2034-35
All values in acre-feet per year (AFY) unless otherwise noted																						
INFLOWS																						
Aerial Precipitation / Mtn. Front Recharge	49,915	49,915	49,915	49,915	49,915	49,915	49,915	49,915	49,915	49,915	49,915	49,915	49,915	49,915	49,915	49,915	49,915	49,915	49,915	49,915	49,915	49,915
Sonoma Creek Leakage	6,363	6,363	6,363	6,363	6,363	6,363	6,363	6,363	6,363	6,363	6,363	6,363	6,363	6,363	6,363	6,363	6,363	6,363	6,363	6,363	6,363	6,363
Agricultural (Groundwater) Irrigation Return	374	374	374	374	374	374	374	374	374	374	374	374	374	374	374	374	374	374	374	374	374	374
Agricultural (Recycled Water) Irrigation Return	1,132	1,132	1,132	1,132	1,132	1,132	1,132	1,132	1,132	1,132	1,132	1,132	1,132	1,132	1,132	1,132	1,132	1,132	1,132	1,132	1,132	1,132
Municipal Irrigation Return	1,074	1,074	1,074	1,074	1,074	1,074	1,074	1,074	1,074	1,074	1,074	1,074	1,074	1,074	1,074	1,074	1,074	1,074	1,074	1,074	1,074	1,074
Septic System Return	621	621	621	621	621	621	621	621	621	621	621	621	621	621	621	621	621	621	621	621	621	621
Subsurface Inflow from Baylands	51	51	51	51	51	51	51	51	51	51	51	51	51	51	51	51	51	51	51	51	51	51
TOTAL INFLOWS	**59,529**	**59,529**	**59,529**	**59,529**	**59,529**	**59,529**	**59,529**	**59,529**	**59,529**	**59,529**	**59,529**	**59,529**	**59,529**	**59,529**	**59,529**	**59,529**	**59,529**	**59,529**	**59,529**	**59,529**	**59,529**	**59,529**
OUTFLOWS																						
Groundwater Pumping	-8,486	-8,486	-8,486	-8,486	-8,486	-8,486	-8,486	-8,486	-8,486	-8,486	-8,486	-8,486	-8,486	-8,486	-8,486	-8,486	-8,486	-8,486	-8,486	-8,486	-8,486	-8,486
Groundwater Discharge to Tributary Streams	-40,403	-40,403	-40,403	-40,403	-40,403	-40,403	-40,403	-40,403	-40,403	-40,403	-40,403	-40,403	-40,403	-40,403	-40,403	-40,403	-40,403	-40,403	-40,403	-40,403	-40,403	-40,403
Groundwater Discharge to Sonoma Creek	-10,643	-10,643	-10,643	-10,643	-10,643	-10,643	-10,643	-10,643	-10,643	-10,643	-10,643	-10,643	-10,643	-10,643	-10,643	-10,643	-10,643	-10,643	-10,643	-10,643	-10,643	-10,643
Subsurface Outflow to Baylands	-3,011	-3,011	-3,011	-3,011	-3,011	-3,011	-3,011	-3,011	-3,011	-3,011	-3,011	-3,011	-3,011	-3,011	-3,011	-3,011	-3,011	-3,011	-3,011	-3,011	-3,011	-3,011
TOTAL OUTFLOWS	**-62,543**	**-62,543**	**-62,543**	**-62,543**	**-62,543**	**-62,543**	**-62,543**	**-62,543**	**-62,543**	**-62,543**	**-62,543**	**-62,543**	**-62,543**	**-62,543**	**-62,543**	**-62,543**	**-62,543**	**-62,543**	**-62,543**	**-62,543**	**-62,543**	**-62,543**
ANNUAL STORAGE CHANGE (AF)	-3,014	-3,014	-3,014	-3,014	-3,014	-3,014	-3,014	-3,014	-3,014	-3,014	-3,014	-3,014	-3,014	-3,014	-3,014	-3,014	-3,014	-3,014	-3,014	-3,014	-3,014	-3,014
CUMULATIVE STORAGE CHANGE (AF)	-3,014	-6,027	-9,041	-12,054	-15,068	-18,081	-21,095	-24,109	-27,122	-30,136	-33,149	-36,163	-39,176	-42,190	-45,204	-48,217	-51,231	-54,244	-57,258	-60,271	-63,285	-66,299

Mtn. – mountain
AF – acre-feet
WY – water year

Figure 5-3: Future Scenario 2 (2035 recycled water conditions plus 5,000 AFY recycled water) Water Balance for Inland Area of Sonoma Valley Subbasin (WYs 2014-2035)



Tables 5-4 through **5-6** show the calculated TDS and nitrate mass and concentrations of each return flow for Scenario 0 (No-Project), Scenario 1, and Scenario 2, respectively. The adjusted values are applied as a constant concentration over the entire future planning period.

For both TDS and nitrate, the total cumulative mass and weighted-average concentration of return flows increases slightly from Scenario 0 (No-Project) to Scenario 1 to Scenario 2.

Table 5-4: Future Scenario 0 (No-Project)
Return Flow TDS and Nitrate-N Concentrations

Return Flows	Volumetric Rate	Iniitial and Adjusted TDS Concentration[1]	Initital Nitrate-N Concentration[1]	Adjusted Nitrate-N Concentration[1]
	AFY	mg/L	mg/L	mg/L
Agricultural (Groundwater) Irrigation Return	1,415	**4,347**	**28.0**	**23.8**
Agircultural (Recycled Water) Irrigation	91	**4,344**	**28.0**	**23.8**
Municipal Irrigation	1,074	**1,182**	**23.9**	**20.3**
Septic System	621	**572**	**30.0**	**25.5**
Total	3,201			
Weighted-average		**2,552**	**27.0**	**23.0**

[1]Initial TDS and nitrate concentrations calculated from mass loading estimates in *Salt and Nutrient Source Identification and Loading TM* (RMC, 2013). Initial TDS concentrations for return flows were not adjusted for future simulations. Adjusted nitrate concentrations reflect 15% reduction to account for additional attenuation below the root zone/septic system in the mixing model.
TDS – total dissolved solids
Nitrate-N – nitrate as nitrogen
mg/L – milligrams per liter

Table 5-5: Future Scenario 1 (2035 recycled water conditions)
Return Flow TDS and Nitrate-N Concentrations

Return Flows	Volumetric Rate	Iniitial and Adjusted TDS Concentration[1]	Initital Nitrate-N Concentration[1]	Adjusted Nitrate-N Concentration[1]
	AFY	mg/L	mg/L	mg/L
Agricultural (Groundwater) Irrigation Return	998	**4,481**	**29.3**	**24.9**
Agircultural (Recycled Water) Irrigation	508	**4,479**	**29.3**	**24.9**
Municipal Irrigation	1,074	**1,182**	**23.9**	**20.3**
Septic System	621	**572**	**30.0**	**25.5**
Total	3,201			
Weighted-average		**2,615**	**27.6**	**23.5**

[1]Initial TDS and nitrate concentrations calculated from mass loading estimates in *Salt and Nutrient Source Identification and Loading TM* (RMC, 2013). Initial TDS concentrations for return flows were not adjusted for future simulations. Adjusted nitrate concentrations reflect 15% reduction to account for additional attenuation below the root zone/septic system in the mixing model.
TDS – total dissolved solids
Nitrate-N – nitrate as nitrogen
mg/L – milligrams per liter

Table 5-6: Future Scenario 2 (2035 recycled water conditions plus 5,000 AFY recycled water) Return Flow TDS and Nitrate-N Concentrations

Return Flows	Volumetric Rate	Iniitial and Adjusted TDS Concentration[1]	Inititial Nitrate-N Concentration[1]	Adjusted Nitrate-N Concentration[1]
	AFY	mg/L	mg/L	mg/L
Agricultural (Groundwater) Irrigation Return	374	**4,706**	**31.6**	**26.8**
Agircultural (Recycled Water) Irrigation	1,132	**4,706**	**31.6**	**26.8**
Municipal Irrigation	1,074	**1,182**	**23.9**	**20.3**
Septic System	621	**572**	**30.0**	**25.5**
Total	3,201			
Weighted-average		**2,722**	**28.7**	**24.4**

[1]Initial TDS and nitrate concentrations calculated from mass loading estimates in *Salt and Nutrient Source Identification and Loading TM* (RMC, 2013). Initial TDS concentrations for return flows were not adjusted for future simulations. Adjusted nitrate concentrations reflect 15% reduction to account for additional attenuation below the root zone/septic system in the mixing model.
TDS – total dissolved solids
Nitrate-N – nitrate as nitrogen
mg/L – milligrams per liter

5.4 Future Salt and Nutrient Mass Balances

5.4.1 TDS Mass Balances

Table 5-7 through **5-9** show the TDS mass balances for the three future scenarios. The mass balances are also depicted in **Figures 5-4** through **5-6**. The tables and figures show that the cumulative change in TDS mass from WY 2013-14 through WY 2034-35 is negative for all three scenarios. For Scenario 0 (No-Project), the cumulative change in TDS mass is -34,941 tons. The negative cumulative change in TDS mass is slightly smaller for Scenario 1 (-31,315 tons) and even smaller for Scenario 2 (-25,213 tons).

For Scenario 0 (No-Project), TDS mass loading factors presented from largest to smallest are as follows:

1) areal precipitation and mountain front recharge
2) agricultural (groundwater source water) irrigation return
3) Sonoma Creek leakage
4) municipal irrigation return
5) agricultural (recycled water source water) return
6) septic system return
7) subsurface inflow from the Baylands Area

For Scenario 1, TDS mass loading from agricultural (recycled water source water) irrigation return flow increases and represents the third largest TDS loading factor. Agricultural (groundwater source water) irrigation return flow decreases but remains the second largest TDS mass loading factor. All other factors have the same TDS mass loading as in the No-Project scenario.

For Scenario 2, TDS mass loading from agricultural (recycled water source water) irrigation return increases and replaces agricultural (groundwater source water) irrigation return as the second largest TDS loading factor. Agricultural (groundwater source water) irrigation return decreases and represents the third largest TDS mass loading factor. All other factors have the same TDS mass loading as in the No-Project scenario.

Table 5-7: Future Scenario 0 (No-Project) TDS Mass Balance for Inland Area of Sonoma Valley Subbasin (WYs 2014-2035)

All values in tons

	2013-14	2014-15	2015-16	2016-17	2017-18	2018-19	2019-20	2020-21	2021-22	2022-23	2023-24
INFLOWS											
Aerial Precipitation / Mtn. Front Recharge	16,994	16,994	16,994	16,994	16,994	16,994	16,994	16,994	16,994	16,994	16,994
Sonoma Creek Leakage	1,817	1,817	1,817	1,817	1,817	1,817	1,817	1,817	1,817	1,817	1,817
Agricultural (Groundwater) Irrigation Return	8,363	8,363	8,363	8,363	8,363	8,363	8,363	8,363	8,363	8,363	8,363
Agricultural (Recycled Water) Irrigation Return	538	538	538	538	538	538	538	538	538	538	538
Municipal Irrigation Return	1,182	1,182	1,182	1,182	1,182	1,182	1,182	1,182	1,182	1,182	1,182
Septic System Return	483	483	483	483	483	483	483	483	483	483	483
Subsurface Inflow from Baylands	84	84	84	84	84	84	84	84	84	84	84
TOTAL INFLOWS	**30,003**	**30,003**	**30,003**	**30,003**	**30,003**	**30,003**	**30,003**	**30,003**	**30,003**	**30,003**	**30,003**
OUTFLOWS											
Groundwater Pumping	-4,292	-4,290	-4,288	-4,286	-4,284	-4,282	-4,281	-4,279	-4,278	-4,276	-4,275
Groundwater Discharge to Tributary Streams	-20,436	-20,426	-20,416	-20,407	-20,398	-20,390	-20,382	-20,374	-20,367	-20,360	-20,354
Groundwater Discharge to Sonoma Creek	-5,383	-5,381	-5,378	-5,376	-5,373	-5,371	-5,369	-5,367	-5,365	-5,363	-5,362
Subsurface Outflow to Baylands	-1,523	-1,522	-1,522	-1,521	-1,520	-1,520	-1,519	-1,519	-1,518	-1,518	-1,517
TOTAL OUTFLOWS	**-31,634**	**-31,629**	**-31,624**	**-31,619**	**-31,614**	**-31,610**	**-31,605**	**-31,601**	**-31,597**	**-31,594**	**-31,590**
Annual TDS Mass Change	-1,631	-1,625	-1,620	-1,615	-1,611	-1,606	-1,602	-1,598	-1,594	-1,590	-1,587
Cumulative TDS Mass Change	-1,631	-3,256	-4,876	-6,492	-8,102	-9,708	-11,310	-12,908	-14,502	-16,092	-17,678

	2024-25	2025-26	2026-27	2027-28	2028-29	2029-30	2030-31	2031-32	2032-33	2033-34	2034-35
INFLOWS											
Aerial Precipitation / Mtn. Front Recharge	16,994	16,994	16,994	16,994	16,994	16,994	16,994	16,994	16,994	16,994	16,994
Sonoma Creek Leakage	1,817	1,817	1,817	1,817	1,817	1,817	1,817	1,817	1,817	1,817	1,817
Agricultural (Groundwater) Irrigation Return	8,363	8,363	8,363	8,363	8,363	8,363	8,363	8,363	8,363	8,363	8,363
Agricultural (Recycled Water) Irrigation Return	538	538	538	538	538	538	538	538	538	538	538
Municipal Irrigation Return	1,182	1,182	1,182	1,182	1,182	1,182	1,182	1,182	1,182	1,182	1,182
Septic System Return	483	483	483	483	483	483	483	483	483	483	483
Subsurface Inflow from Baylands	84	84	84	84	84	84	84	84	84	84	84
TOTAL INFLOWS	**30,003**	**30,003**	**30,003**	**30,003**	**30,003**	**30,003**	**30,003**	**30,003**	**30,003**	**30,003**	**30,003**
OUTFLOWS											
Groundwater Pumping	-4,274	-4,272	-4,271	-4,270	-4,269	-4,268	-4,267	-4,266	-4,265	-4,264	-4,263
Groundwater Discharge to Tributary Streams	-20,348	-20,342	-20,336	-20,331	-20,326	-20,321	-20,316	-20,312	-20,308	-20,304	-20,300
Groundwater Discharge to Sonoma Creek	-5,360	-5,358	-5,357	-5,356	-5,354	-5,353	-5,352	-5,351	-5,349	-5,348	-5,347
Subsurface Outflow to Baylands	-1,517	-1,516	-1,516	-1,515	-1,515	-1,515	-1,514	-1,514	-1,514	-1,513	-1,513
TOTAL OUTFLOWS	**-31,587**	**-31,583**	**-31,580**	**-31,578**	**-31,575**	**-31,572**	**-31,570**	**-31,567**	**-31,565**	**-31,563**	**-31,561**
Annual TDS Mass Change	-1,583	-1,580	-1,577	-1,574	-1,571	-1,569	-1,566	-1,564	-1,562	-1,559	-1,557
Cumulative TDS Mass Change	-19,262	-20,842	-22,419	-23,993	-25,564	-27,133	-28,699	-30,263	-31,824	-33,383	-34,941

Mtn. – mountain
TDS – total dissolved solids
WY – water year

Figure 5-4: Future Scenario 0 (No-Project) TDS Mass Balance for Inland Area of Sonoma Valley (WYs 2014-2035)

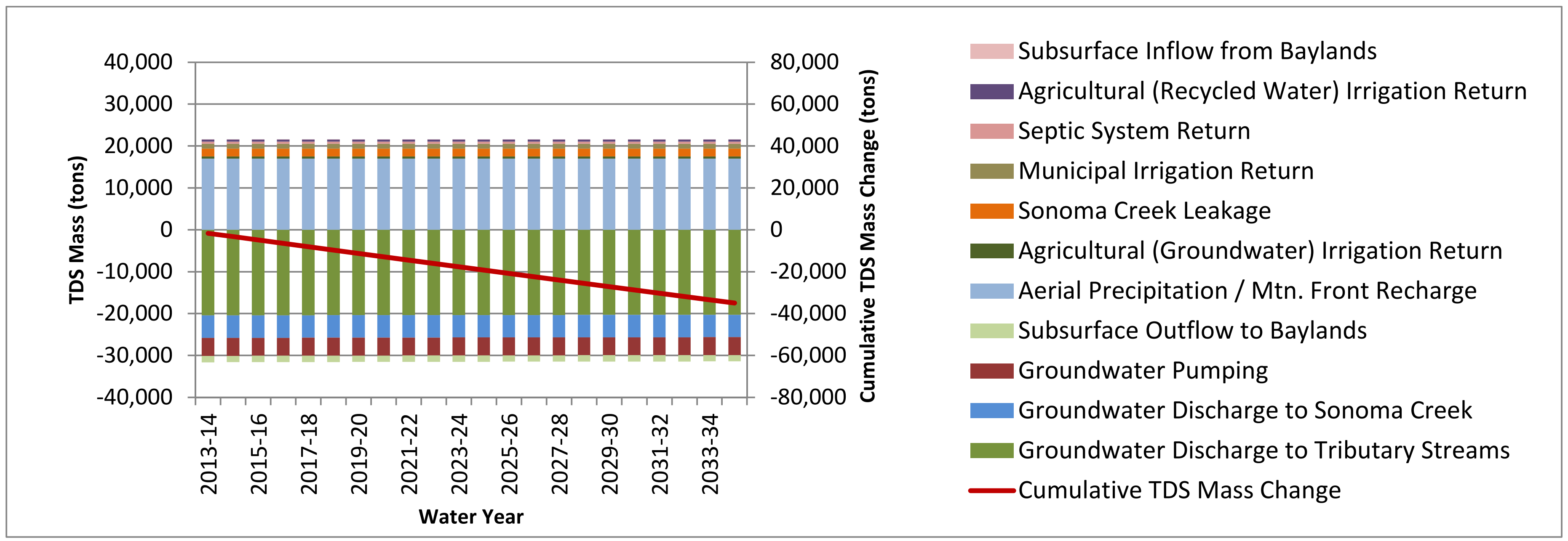


Table 5-8: Future Scenario 1 (2035 recycled water conditions) TDS Mass Balance for Inland Area of Sonoma Valley (WYs 2014-2035)

All values in tons

	2013-14	2014-15	2015-16	2016-17	2017-18	2018-19	2019-20	2020-21	2021-22	2022-23	2023-24
INFLOWS											
Aerial Precipitation / Mtn. Front Recharge	16,994	16,994	16,994	16,994	16,994	16,994	16,994	16,994	16,994	16,994	16,994
Sonoma Creek Leakage	1,817	1,817	1,817	1,817	1,817	1,817	1,817	1,817	1,817	1,817	1,817
Agricultural (Groundwater) Irrigation Return	6,081	6,081	6,081	6,081	6,081	6,081	6,081	6,081	6,081	6,081	6,081
Agricultural (Recycled Water) Irrigation Return	3,094	3,094	3,094	3,094	3,094	3,094	3,094	3,094	3,094	3,094	3,094
Municipal Irrigation Return	1,726	1,726	1,726	1,726	1,726	1,726	1,726	1,726	1,726	1,726	1,726
Septic System Return	483	483	483	483	483	483	483	483	483	483	483
Subsurface Inflow from Baylands	84	84	84	84	84	84	84	84	84	84	84
TOTAL INFLOWS	**30,278**	**30,278**	**30,278**	**30,278**	**30,278**	**30,278**	**30,278**	**30,278**	**30,278**	**30,278**	**30,278**
OUTFLOWS											
Groundwater Pumping	-4,292	-4,293	-4,294	-4,295	-4,296	-4,297	-4,298	-4,299	-4,300	-4,301	-4,302
Groundwater Discharge to Tributary Streams	-20,436	-20,441	-20,447	-20,452	-20,456	-20,461	-20,465	-20,469	-20,473	-20,477	-20,481
Groundwater Discharge to Sonoma Creek	-5,383	-5,385	-5,386	-5,387	-5,389	-5,390	-5,391	-5,392	-5,393	-5,394	-5,395
Subsurface Outflow to Baylands	-1,523	-1,524	-1,524	-1,524	-1,525	-1,525	-1,525	-1,526	-1,526	-1,526	-1,527
TOTAL OUTFLOWS	**-31,634**	**-31,643**	**-31,651**	**-31,659**	**-31,666**	**-31,673**	**-31,680**	**-31,686**	**-31,692**	**-31,698**	**-31,704**
Annual TDS Mass Change	-1,356	-1,365	-1,373	-1,381	-1,388	-1,395	-1,402	-1,408	-1,415	-1,420	-1,426
Cumulative TDS Mass Change	-1,356	-2,721	-4,094	-5,475	-6,863	-8,258	-9,660	-11,069	-12,483	-13,904	-15,330

	2024-25	2025-26	2026-27	2027-28	2028-29	2029-30	2030-31	2031-32	2032-33	2033-34	2034-35
INFLOWS											
Aerial Precipitation / Mtn. Front Recharge	16,994	16,994	16,994	16,994	16,994	16,994	16,994	16,994	16,994	16,994	16,994
Sonoma Creek Leakage	1,817	1,817	1,817	1,817	1,817	1,817	1,817	1,817	1,817	1,817	1,817
Agricultural (Groundwater) Irrigation Return	6,081	6,081	6,081	6,081	6,081	6,081	6,081	6,081	6,081	6,081	6,081
Agricultural (Recycled Water) Irrigation Return	3,094	3,094	3,094	3,094	3,094	3,094	3,094	3,094	3,094	3,094	3,094
Municipal Irrigation Return	1,726	1,726	1,726	1,726	1,726	1,726	1,726	1,726	1,726	1,726	1,726
Septic System Return	483	483	483	483	483	483	483	483	483	483	483
Subsurface Inflow from Baylands	84	84	84	84	84	84	84	84	84	84	84
TOTAL INFLOWS	**30,278**	**30,278**	**30,278**	**30,278**	**30,278**	**30,278**	**30,278**	**30,278**	**30,278**	**30,278**	**30,278**
OUTFLOWS											
Groundwater Pumping	-4,302	-4,303	-4,304	-4,304	-4,305	-4,305	-4,306	-4,306	-4,307	-4,307	-4,317
Groundwater Discharge to Tributary Streams	-20,484	-20,487	-20,491	-20,494	-20,496	-20,499	-20,502	-20,504	-20,506	-20,509	-20,555
Groundwater Discharge to Sonoma Creek	-5,396	-5,397	-5,398	-5,398	-5,399	-5,400	-5,401	-5,401	-5,402	-5,402	-5,415
Subsurface Outflow to Baylands	-1,527	-1,527	-1,527	-1,528	-1,528	-1,528	-1,528	-1,528	-1,528	-1,529	-1,532
TOTAL OUTFLOWS	**-31,709**	**-31,714**	**-31,719**	**-31,724**	**-31,728**	**-31,732**	**-31,736**	**-31,740**	**-31,743**	**-31,747**	**-31,818**
Annual TDS Mass Change	-1,431	-1,436	-1,441	-1,446	-1,450	-1,454	-1,458	-1,462	-1,466	-1,469	-1,472
Cumulative TDS Mass Change	-16,761	-18,197	-19,638	-21,084	-22,534	-23,988	-25,446	-26,908	-28,374	-29,843	-31,315

Mtn. – mountain
TDS – total dissolved solids
WY – water year

Figure 5-5: Future Scenario 1 (2035 recycled water conditions) TDS Mass Balance for Inland Area of Sonoma Valley (WYs 2014-2035)

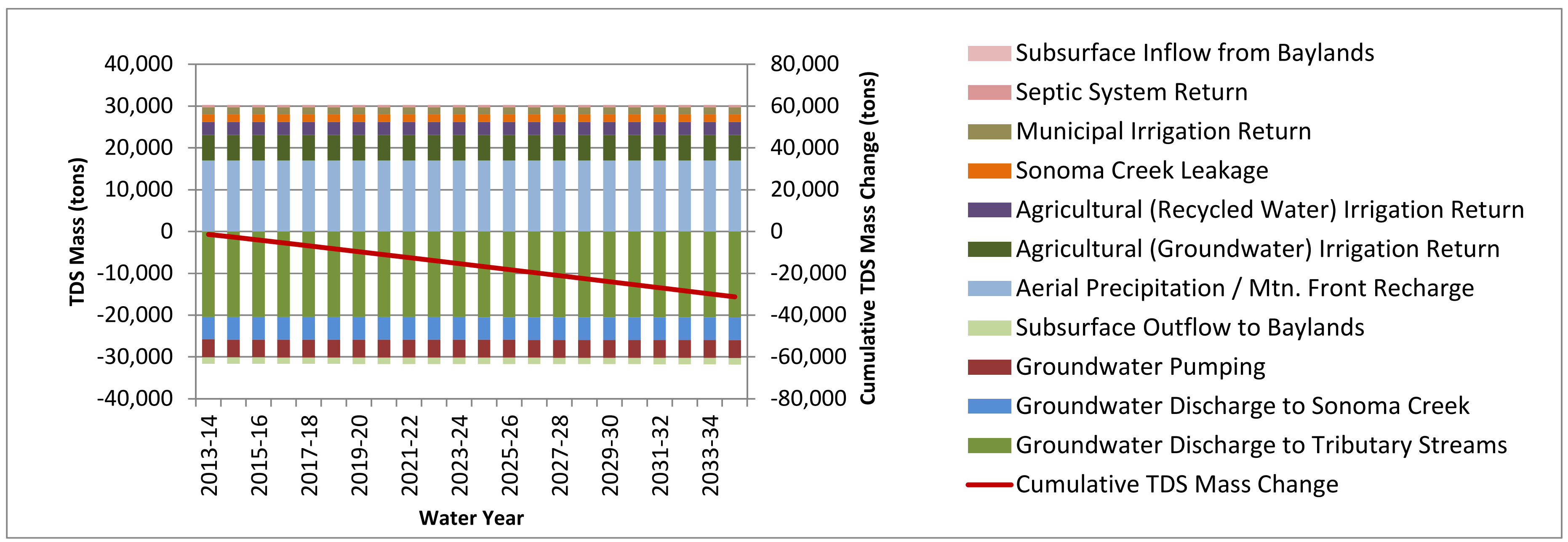
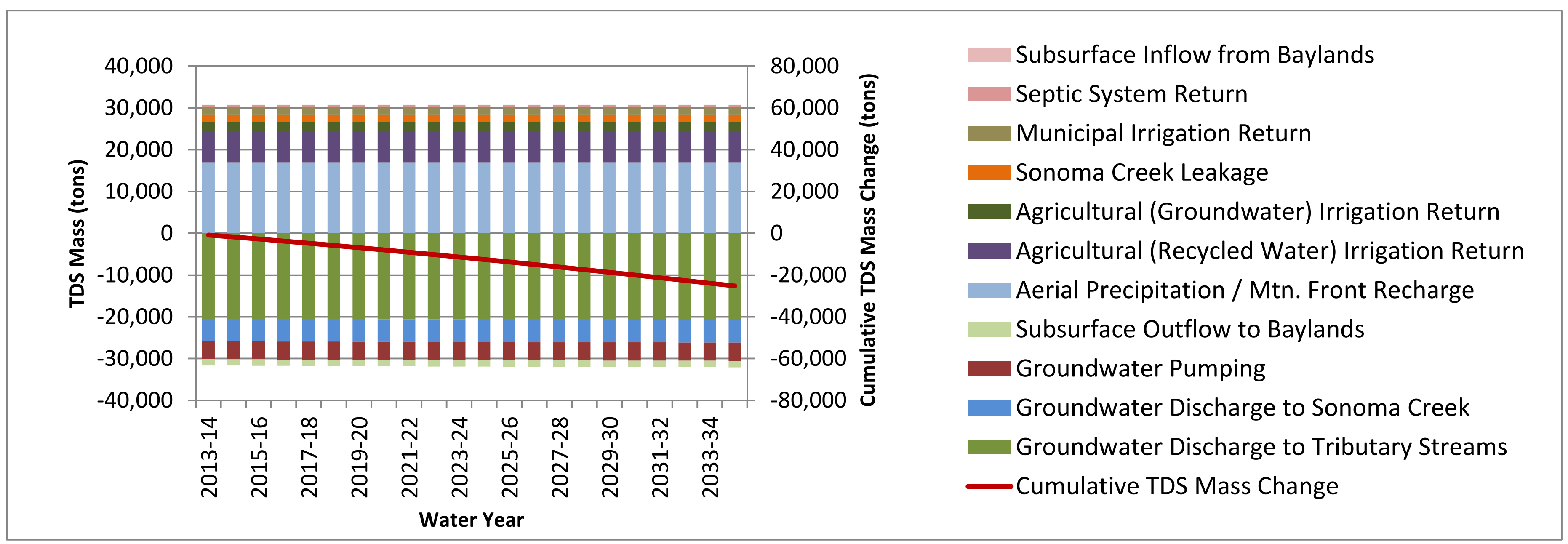


Table 5-9: Future Scenario 2 (2035 recycled water conditions plus 5,000 AFY recycled water) TDS Mass Balance for Inland Area of Sonoma Valley (WYs 2014-2035)

	2013-14	2014-15	2015-16	2016-17	2017-18	2018-19	2019-20	2020-21	2021-22	2022-23	2023-24	2024-25	2025-26	2026-27	2027-28	2028-29	2029-30	2030-31	2031-32	2032-33	2033-34	2034-35
											All values in tons											
INFLOWS																						
Aerial Precipitation / Mtn. Front Recharge	16,994	16,994	16,994	16,994	16,994	16,994	16,994	16,994	16,994	16,994	16,994	16,994	16,994	16,994	16,994	16,994	16,994	16,994	16,994	16,994	16,994	16,994
Sonoma Creek Leakage	1,817	1,817	1,817	1,817	1,817	1,817	1,817	1,817	1,817	1,817	1,817	1,817	1,817	1,817	1,817	1,817	1,817	1,817	1,817	1,817	1,817	1,817
Agricultural (Groundwater) Irrigation Return	2,393	2,393	2,393	2,393	2,393	2,393	2,393	2,393	2,393	2,393	2,393	2,393	2,393	2,393	2,393	2,393	2,393	2,393	2,393	2,393	2,393	2,393
Agricultural (Recycled Water) Irrigation Return	7,244	7,244	7,244	7,244	7,244	7,244	7,244	7,244	7,244	7,244	7,244	7,244	7,244	7,244	7,244	7,244	7,244	7,244	7,244	7,244	7,244	7,244
Municipal Irrigation Return	1,726	1,726	1,726	1,726	1,726	1,726	1,726	1,726	1,726	1,726	1,726	1,726	1,726	1,726	1,726	1,726	1,726	1,726	1,726	1,726	1,726	1,726
Septic System Return	483	483	483	483	483	483	483	483	483	483	483	483	483	483	483	483	483	483	483	483	483	483
Subsurface Inflow from Baylands	84	84	84	84	84	84	84	84	84	84	84	84	84	84	84	84	84	84	84	84	84	84
TOTAL INFLOWS	**30,740**	**30,740**	**30,740**	**30,740**	**30,740**	**30,740**	**30,740**	**30,740**	**30,740**	**30,740**	**30,740**	**30,740**	**30,740**	**30,740**	**30,740**	**30,740**	**30,740**	**30,740**	**30,740**	**30,740**	**30,740**	**30,740**
OUTFLOWS																						
Groundwater Pumping	-4,292	-4,296	-4,301	-4,305	-4,308	-4,312	-4,315	-4,319	-4,322	-4,325	-4,328	-4,330	-4,333	-4,335	-4,338	-4,340	-4,342	-4,344	-4,346	-4,348	-4,349	-4,351
Groundwater Discharge to Tributary Streams	-20,436	-20,456	-20,476	-20,495	-20,513	-20,530	-20,547	-20,562	-20,577	-20,591	-20,605	-20,617	-20,630	-20,641	-20,652	-20,663	-20,673	-20,683	-20,692	-20,700	-20,709	-20,717
Groundwater Discharge to Sonoma Creek	-5,383	-5,389	-5,394	-5,399	-5,404	-5,408	-5,412	-5,416	-5,420	-5,424	-5,428	-5,431	-5,434	-5,437	-5,440	-5,443	-5,446	-5,448	-5,451	-5,453	-5,455	-5,457
Subsurface Outflow to Baylands	-1,523	-1,525	-1,526	-1,528	-1,529	-1,530	-1,531	-1,533	-1,534	-1,535	-1,536	-1,537	-1,538	-1,539	-1,539	-1,540	-1,541	-1,542	-1,542	-1,543	-1,544	-1,544
TOTAL OUTFLOWS	**-31,634**	**-31,666**	**-31,697**	**-31,726**	**-31,754**	**-31,780**	**-31,806**	**-31,830**	**-31,853**	**-31,875**	**-31,896**	**-31,915**	**-31,934**	**-31,952**	**-31,970**	**-31,986**	**-32,002**	**-32,016**	**-32,031**	**-32,044**	**-32,057**	**-32,069**
Annual TDS Mass Change	-894	-926	-957	-986	-1,014	-1,040	-1,066	-1,090	-1,113	-1,135	-1,156	-1,175	-1,194	-1,212	-1,230	-1,246	-1,262	-1,276	-1,291	-1,304	-1,317	-1,329
Cumulative TDS Mass Change	-894	-1,821	-2,778	-3,764	-4,778	-5,818	-6,884	-7,973	-9,086	-10,221	-11,376	-12,552	-13,746	-14,959	-16,188	-17,434	-18,696	-19,973	-21,263	-22,567	-23,884	-25,213

Mtn. – mountain
TDS – total dissolved solids
WY – water year

Figure 5-6: Future Scenario 2 (2035 recycled water conditions plus 5,000 AFY recycled water) TDS Mass Balance for Inland Area of Sonoma Valley (WYs 2014-2035)



5.4.2 Nitrate-N Mass Balances

Table 5-10 through **5-12** show the nitrate-N mass balances for the three future scenarios. The mass balances are also depicted in **Figures 5-7** through **5-9**. The tables and figures show that the cumulative change in nitrate-N mass from WY 2013-14 through WY 2034-35 is positive for all three scenarios. For Scenario 0 (No-Project), the cumulative change in nitrate-N mass is +1,410 tons. The cumulative change in nitrate-N mass is slightly higher for Scenario 1 (+1,440 tons) and even higher for Scenario 2 (+1,491 tons).

For Scenario 0 (No-Project), nitrate mass loading factors presented from largest to smallest are as follows:

1) agricultural (groundwater) return
2) municipal return
3) septic system return
4) areal precipitation and mountain front recharge
5) agricultural (recycled water) return
6) Sonoma Creek leakage
7) subsurface inflow from Baylands

For Scenario 1, nitrate mass loading from agricultural (recycled water) return increases and represents the fourth largest nitrate loading factor. Agricultural (groundwater) return decreases but remains the largest nitrate mass loading factor. All other factors have the same nitrate mass loading as in the No-Project scenario.

For Scenario 2, nitrate mass loading from agricultural (recycled water) return increases and replaces agricultural (groundwater) return as the largest nitrate loading factor. Agricultural (groundwater) return decreases and represents the fourth largest nitrate mass loading factor, behind municipal and septic system return. All other factors have the same nitrate mass loading as in the No-Project scenario.

5.5 Assimilative Capacity and Use by Recycled Water Projects

5.5.1 Future TDS Groundwater Concentrations

Figure 5-10 shows the simulated future TDS concentrations from the calibrated mixing model for the three future scenarios from WY 2013-14 through 2034-35 for the Inland area of the Sonoma Valley Subbasin. Also shown on the chart is the 10% assimilative capacity threshold. Values depicted in the chart are tabulated in **Table 5-13**. The cumulative concentration change is translated into assimilative capacity use at the bottom of the table. The table also shows the difference between each of future Scenarios 1 and 2 and the Scenario 0 (No-Project). This difference represents the water quality and assimilative capacity impact of just the future project(s) with the background impacts of the No Project conditions removed.

As depicted in Figure 5-10 and shown in Table 5-13, the following conclusions can be made:

- Average TDS concentrations in the subbasin are projected to decrease from WY 2013 through WY 2035 by 0.9 mg/L for Scenario 0 (No-Project).
- Average TDS concentrations in the subbasin are projected to increase from WY 2013 through WY 2035 by 1.4 mg/L for Scenario 1 and by 3.5 mg/L for Scenario 2.

Table 5-10: Future Scenario 0 (No-Project) Nitrate-N Mass Balance for Inland Area of Sonoma Valley Subbasin (WYs 2014-2035)

All values in tons

	2013-14	2014-15	2015-16	2016-17	2017-18	2018-19	2019-20	2020-21	2021-22	2022-23	2023-24	2024-25	2025-26	2026-27	2027-28	2028-29	2029-30	2030-31	2031-32	2032-33	2033-34	2034-35
INFLOWS																						
Aerial Precipitation / Mtn. Front Recharge	4.1	4.1	4.1	4.1	4.1	4.1	4.1	4.1	4.1	4.1	4.1	4.1	4.1	4.1	4.1	4.1	4.1	4.1	4.1	4.1	4.1	4.1
Sonoma Creek Leakage	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.6
Agricultural (Groundwater) Irrigation Return	45.8	45.8	45.8	45.8	45.8	45.8	45.8	45.8	45.8	45.8	45.8	45.8	45.8	45.8	45.8	45.8	45.8	45.8	45.8	45.8	45.8	45.8
Agricultural (Recycled Water) Irrigation Return	2.9	2.9	2.9	2.9	2.9	2.9	2.9	2.9	2.9	2.9	2.9	2.9	2.9	2.9	2.9	2.9	2.9	2.9	2.9	2.9	2.9	2.9
Municipal Irrigation Return	29.7	29.7	29.7	29.7	29.7	29.7	29.7	29.7	29.7	29.7	29.7	29.7	29.7	29.7	29.7	29.7	29.7	29.7	29.7	29.7	29.7	29.7
Septic System Return	21.5	21.5	21.5	21.5	21.5	21.5	21.5	21.5	21.5	21.5	21.5	21.5	21.5	21.5	21.5	21.5	21.5	21.5	21.5	21.5	21.5	21.5
Subsurface Inflow from Baylands	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
TOTAL INFLOWS	**105.7**	**105.7**	**105.7**	**105.7**	**105.7**	**105.7**	**105.7**	**105.7**	**105.7**	**105.7**	**105.7**	**105.7**	**105.7**	**105.7**	**105.7**	**105.7**	**105.7**	**105.7**	**105.7**	**105.7**	**105.7**	**105.7**
OUTFLOWS																						
Groundwater Pumping	-0.8	-1.5	-2.2	-2.8	-3.4	-4.0	-4.5	-5.0	-5.5	-6.0	-6.4	-6.9	-7.3	-7.7	-8.0	-8.4	-8.7	-9.0	-9.3	-9.6	-9.9	-10.2
Groundwater Discharge to Tributary Streams	-3.8	-7.1	-10.3	-13.3	-16.1	-18.8	-21.4	-23.9	-26.3	-28.5	-30.6	-32.7	-34.6	-36.5	-38.2	-39.9	-41.5	-43.0	-44.5	-45.9	-47.2	-48.4
Groundwater Discharge to Sonoma Creek	-1.0	-1.9	-2.7	-3.5	-4.2	-5.0	-5.6	-6.3	-6.9	-7.5	-8.1	-8.6	-9.1	-9.6	-10.1	-10.5	-10.9	-11.3	-11.7	-12.1	-12.4	-12.8
Subsurface Outflow to Baylands	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
TOTAL OUTFLOWS	**-6.0**	**-11.0**	**-15.9**	**-20.5**	**-24.9**	**-29.2**	**-33.2**	**-37.0**	**-40.6**	**-44.1**	**-47.4**	**-50.6**	**-53.6**	**-56.5**	**-59.2**	**-61.8**	**-64.3**	**-66.6**	**-68.9**	**-71.0**	**-73.1**	**-75.0**
Annual Nitrate-N Mass Change	99.7	94.7	89.8	85.2	80.8	76.5	72.5	68.7	65.1	61.6	58.3	55.1	52.1	49.2	46.5	43.9	41.4	39.1	36.8	34.7	32.6	30.7
Cumulative Nitrate-N Mass Change	99.7	194.4	284.2	369.4	450.1	526.7	599.2	667.9	732.9	794.5	852.8	907.9	960.0	1,009.2	1,055.7	1,099.6	1,141.0	1,180.1	1,216.9	1,251.6	1,284.2	1,314.9

Mtn. – mountain
Nitrate-N – nitrate as nitrogen
WY – water year

Figure 5-7: Future Scenario 0 (No-Project) Nitrate-N Mass Balance for Inland Area of Sonoma Valley Subbasin (WYs 2014-2035)

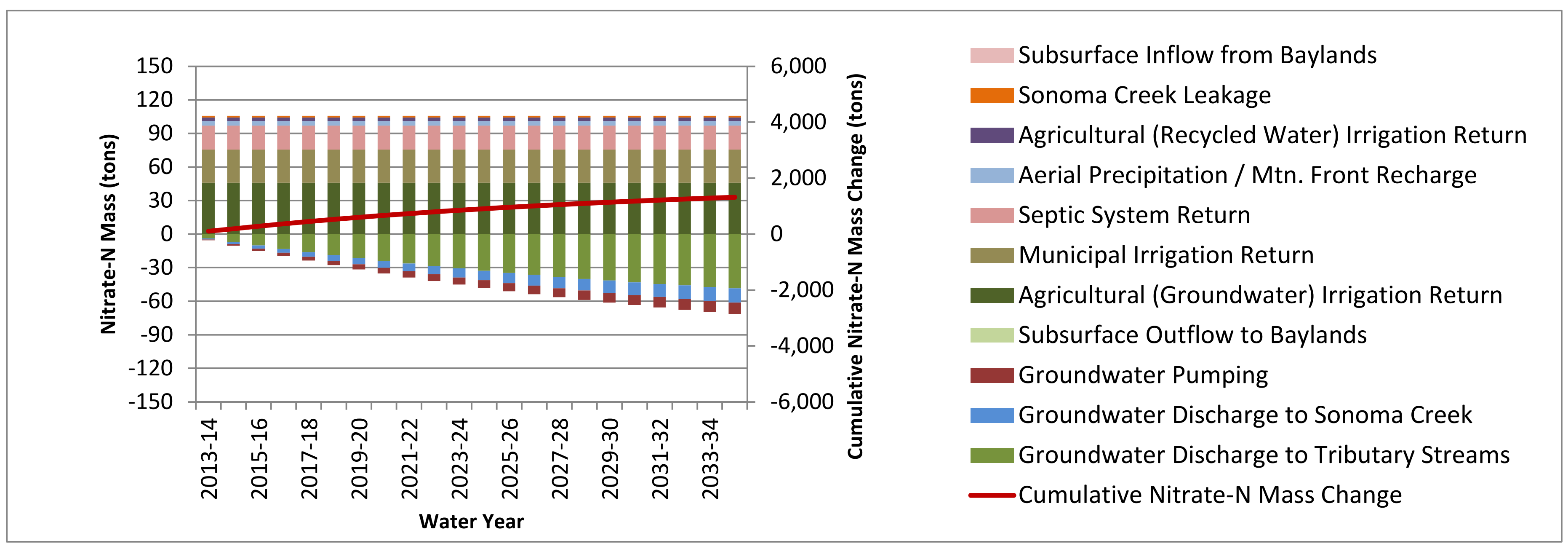


Table 5-11: Future Scenario 1 (2035 recycled water conditions) Nitrate-N Mass Balance for Inland Area of Sonoma Valley Subbasin (WYs 2014-2035)

	2013-14	2014-15	2015-16	2016-17	2017-18	2018-19	2019-20	2020-21	2021-22	2022-23	2023-24	2024-25	2025-26	2026-27	2027-28	2028-29	2029-30	2030-31	2031-32	2032-33	2033-34	2034-35
	All values in tons																					
INFLOWS																						
Aerial Precipitation / Mtn. Front Recharge	4.1	4.1	4.1	4.1	4.1	4.1	4.1	4.1	4.1	4.1	4.1	4.1	4.1	4.1	4.1	4.1	4.1	4.1	4.1	4.1	4.1	4.1
Sonoma Creek Leakage	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.6
Agricultural (Groundwater) Irrigation Return	33.8	33.8	33.8	33.8	33.8	33.8	33.8	33.8	33.8	33.8	33.8	33.8	33.8	33.8	33.8	33.8	33.8	33.8	33.8	33.8	33.8	33.8
Agricultural (Recycled Water) Irrigation Return	17.2	17.2	17.2	17.2	17.2	17.2	17.2	17.2	17.2	17.2	17.2	17.2	17.2	17.2	17.2	17.2	17.2	17.2	17.2	17.2	17.2	17.2
Municipal Irrigation Return	29.7	29.7	29.7	29.7	29.7	29.7	29.7	29.7	29.7	29.7	29.7	29.7	29.7	29.7	29.7	29.7	29.7	29.7	29.7	29.7	29.7	29.7
Septic System Return	21.5	21.5	21.5	21.5	21.5	21.5	21.5	21.5	21.5	21.5	21.5	21.5	21.5	21.5	21.5	21.5	21.5	21.5	21.5	21.5	21.5	21.5
Subsurface Inflow from Baylands	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
TOTAL INFLOWS	**108.0**	**108.0**	**108.0**	**108.0**	**108.0**	**108.0**	**108.0**	**108.0**	**108.0**	**108.0**	**108.0**	**108.0**	**108.0**	**108.0**	**108.0**	**108.0**	**108.0**	**108.0**	**108.0**	**108.0**	**108.0**	**108.0**
OUTFLOWS																						
Groundwater Pumping	-0.8	-1.5	-2.2	-2.8	-3.4	-4.0	-4.6	-5.1	-5.6	-6.1	-6.6	-7.0	-7.4	-7.8	-8.2	-8.6	-8.9	-9.2	-9.5	-9.8	-10.1	-10.4
Groundwater Discharge to Tributary Streams	-3.8	-7.2	-10.4	-13.5	-16.4	-19.2	-21.8	-24.4	-26.8	-29.1	-31.3	-33.3	-35.3	-37.2	-39.0	-40.8	-42.4	-43.9	-45.4	-46.8	-48.2	-49.5
Groundwater Discharge to Sonoma Creek	-1.0	-1.9	-2.7	-3.6	-4.3	-5.1	-5.8	-6.4	-7.1	-7.7	-8.2	-8.8	-9.3	-9.8	-10.3	-10.7	-11.2	-11.6	-12.0	-12.3	-12.7	-13.0
Subsurface Outflow to Baylands	-0.3	-0.5	-0.8	-1.0	-1.2	-1.4	-1.6	-1.8	-2.0	-2.2	-2.3	-2.5	-2.6	-2.8	-2.9	-3.0	-3.2	-3.3	-3.4	-3.5	-3.6	-3.7
TOTAL OUTFLOWS	**-6.0**	**-11.2**	**-16.1**	**-20.9**	**-25.4**	**-29.7**	**-33.8**	**-37.7**	**-41.4**	**-45.0**	**-48.4**	**-51.6**	**-54.7**	**-57.6**	**-60.4**	**-63.1**	**-65.6**	**-68.0**	**-70.3**	**-72.5**	**-74.6**	**-76.6**
Annual Nitrate-N Mass Change	102.0	96.8	91.9	87.1	82.6	78.3	74.2	70.3	66.5	63.0	59.6	56.4	53.3	50.4	47.6	44.9	42.4	40.0	37.7	35.5	33.4	31.4
Cumulative Nitrate-N Mass Change	102.0	198.9	290.7	377.9	460.5	538.8	613.0	683.2	749.8	812.8	872.4	928.7	982.0	1,032.4	1,080.0	1,124.9	1,167.2	1,207.2	1,244.9	1,280.4	1,313.8	1,345.2

Mtn. – mountain
Nitrate-N – nitrate as nitrogen
WY – water year

Figure 5-8: Future Scenario 1 (2035 recycled water conditions) Nitrate-N Mass Balance for Inland Area of Sonoma Valley Subbasin (WYs 2014-2035)

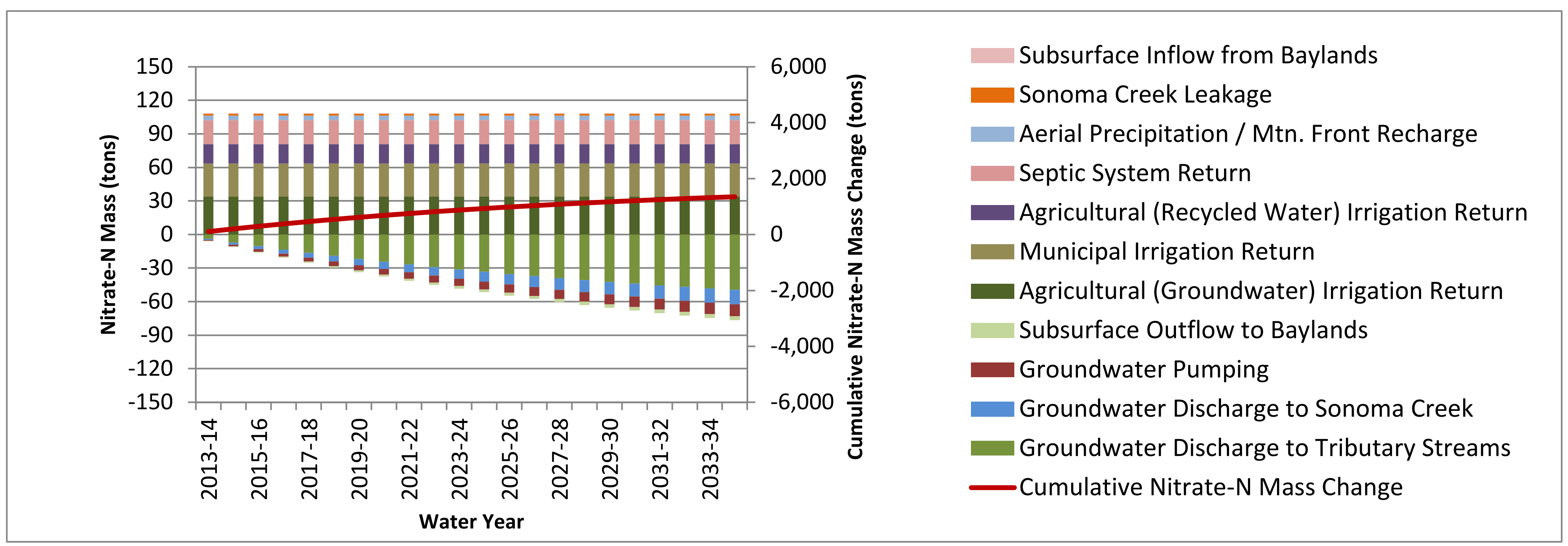


Table 5-12: Future Scenario 2 (2035 recycled water conditions plus 5,000 AFY recycled water) Nitrate-N Mass Balance for Inland Area of Sonoma Valley Subbasin (WYs 2014-2035)

	2013-14	2014-15	2015-16	2016-17	2017-18	2018-19	2019-20	2020-21	2021-22	2022-23	2023-24	2024-25	2025-26	2026-27	2027-28	2028-29	2029-30	2030-31	2031-32	2032-33	2033-34	2034-35
											All values in tons											
INFLOWS																						
Aerial Precipitation / Mtn. Front Recharge	4.1	4.1	4.1	4.1	4.1	4.1	4.1	4.1	4.1	4.1	4.1	4.1	4.1	4.1	4.1	4.1	4.1	4.1	4.1	4.1	4.1	4.1
Sonoma Creek Leakage	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.6
Agricultural (Groundwater) Irrigation Return	13.6	13.6	13.6	13.6	13.6	13.6	13.6	13.6	13.6	13.6	13.6	13.6	13.6	13.6	13.6	13.6	13.6	13.6	13.6	13.6	13.6	13.6
Agricultural (Recycled Water) Irrigation Return	41.3	41.3	41.3	41.3	41.3	41.3	41.3	41.3	41.3	41.3	41.3	41.3	41.3	41.3	41.3	41.3	41.3	41.3	41.3	41.3	41.3	41.3
Municipal Irrigation Return	29.7	29.7	29.7	29.7	29.7	29.7	29.7	29.7	29.7	29.7	29.7	29.7	29.7	29.7	29.7	29.7	29.7	29.7	29.7	29.7	29.7	29.7
Septic System Return	21.5	21.5	21.5	21.5	21.5	21.5	21.5	21.5	21.5	21.5	21.5	21.5	21.5	21.5	21.5	21.5	21.5	21.5	21.5	21.5	21.5	21.5
Subsurface Inflow from Baylands	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
TOTAL INFLOWS	**111.8**	**111.8**	**111.8**	**111.8**	**111.8**	**111.8**	**111.8**	**111.8**	**111.8**	**111.8**	**111.8**	**111.8**	**111.8**	**111.8**	**111.8**	**111.8**	**111.8**	**111.8**	**111.8**	**111.8**	**111.8**	**111.8**
OUTFLOWS																						
Groundwater Pumping	-0.8	-1.5	-2.2	-2.9	-3.5	-4.1	-4.7	-5.3	-5.8	-6.3	-6.8	-7.2	-7.7	-8.1	-8.5	-8.9	-9.2	-9.5	-9.9	-10.2	-10.5	-10.7
Groundwater Discharge to Tributary Streams	-3.8	-7.3	-10.7	-13.8	-16.9	-19.8	-22.5	-25.1	-27.6	-30.0	-32.3	-34.5	-36.5	-38.5	-40.4	-42.1	-43.8	-45.5	-47.0	-48.5	-49.9	-51.2
Groundwater Discharge to Sonoma Creek	-1.0	-1.9	-2.8	-3.6	-4.4	-5.2	-5.9	-6.6	-7.3	-7.9	-8.5	-9.1	-9.6	-10.1	-10.6	-11.1	-11.5	-12.0	-12.4	-12.8	-13.1	-13.5
Subsurface Outflow to Baylands	-0.3	-0.5	-0.8	-1.0	-1.3	-1.5	-1.7	-1.9	-2.1	-2.2	-2.4	-2.6	-2.7	-2.9	-3.0	-3.1	-3.3	-3.4	-3.5	-3.6	-3.7	-3.8
TOTAL OUTFLOWS	**-6.0**	**-11.4**	**-16.5**	**-21.4**	**-26.1**	**-30.6**	**-34.8**	**-38.9**	**-42.8**	**-46.5**	**-50.0**	**-53.3**	**-56.5**	**-59.6**	**-62.5**	**-65.2**	**-67.9**	**-70.4**	**-72.7**	**-75.0**	**-77.2**	**-79.2**
Annual Nitrate-N Mass Change	105.9	100.5	95.3	90.4	85.7	81.3	77.0	72.9	69.1	65.4	61.9	58.5	55.3	52.3	49.4	46.6	44.0	41.5	39.1	36.8	34.7	32.6
Cumulative Nitrate-N Mass Change	105.9	206.4	301.7	392.1	477.9	559.2	636.2	709.1	778.2	843.5	905.4	963.9	1,019.2	1,071.5	1,120.8	1,167.5	1,211.4	1,252.9	1,292.0	1,328.9	1,363.5	1,396.1

Mtn. – mountain
Nitrate-N – nitrate as nitrogen
WY – water year

Figure 5-9: Future Scenario 2 (2035 recycled water conditions plus 5,000 AFY recycled water) Nitrate-N Mass Balance for Inland Area of Sonoma Valley Subbasin (WYs 2014-2035)

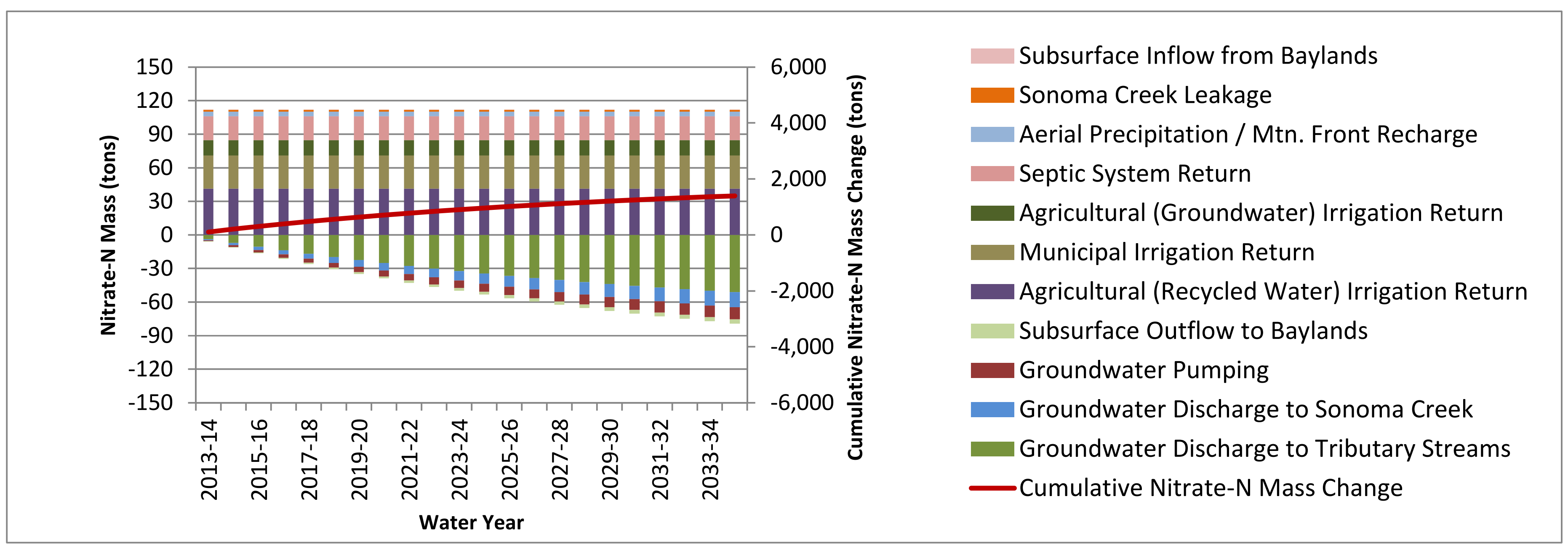


Figure 5-10: Simulated Future Groundwater TDS Concentrations

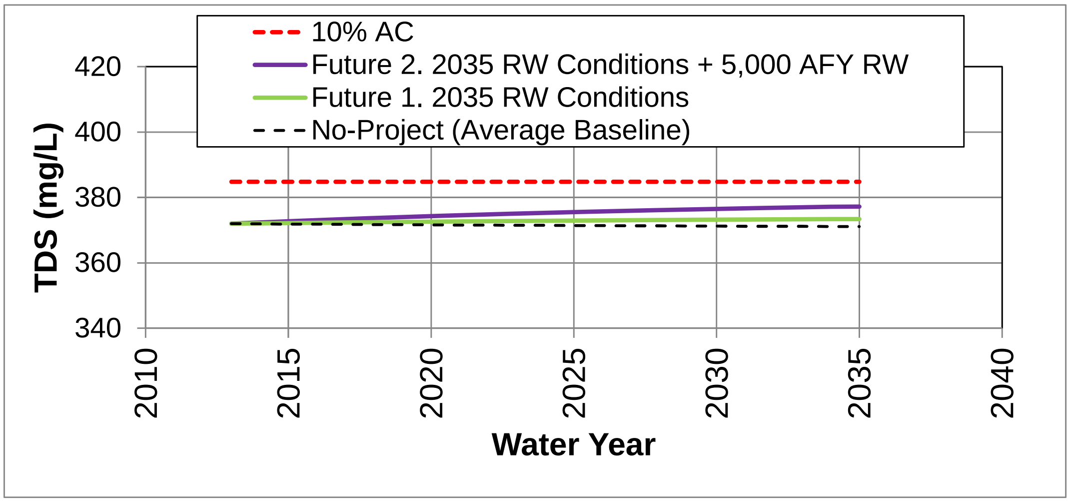


Table 5-13: Simulated Future Groundwater TDS Concentrations and Assimilative Capacity Use

Water Year	TDS (mg/L)		
	Future Scenario 0 (No-Project)	Future Scenario 1 (2035 Recycled Water Conditions)	Future Scenario 2. (2035 RW Conditions + 5,000 AFY RW)
2013	372.0	372.0	372.0
2014	371.9	372.1	372.4
2015	371.9	372.2	372.7
2016	371.8	372.3	373.1
2017	371.8	372.4	373.4
2018	371.7	372.5	373.7
2019	371.7	372.5	374.0
2020	371.6	372.6	374.3
2021	371.6	372.7	374.6
2022	371.5	372.8	374.8
2023	371.5	372.8	375.1
2024	371.4	372.9	375.3
2025	371.4	372.9	375.5
2026	371.4	373.0	375.7
2027	371.3	373.1	375.9
2028	371.3	373.1	376.1
2029	371.3	373.2	376.3
2030	371.2	373.2	376.5
2031	371.2	373.2	376.7
2032	371.2	373.3	376.8
2033	371.2	373.3	377.0
2034	371.1	373.4	377.1
2035	371.1	373.4	377.2
Basin Plan Objective	500.0		
Average Ambient TDS Concentration (mg/L)	372.0		
Assimilative Capacity (mg/L)	128.0		
10% AC concentration change (mg/L)	12.8		
10% AC concentration (mg/L)	384.8		
WY 2035 concentration (mg/L)	371.1	373.4	377.2
WY 2013 to WY 2035 change (mg/L)	(0.9)	1.4	5.2
WY 2013 to WY 2035 (% AC Used)	0%	1.1%	4.1%
Difference compared to No-Project (mg/L)		2.3	6.1
Difference compared to No-Project (% AC)		1.8%	4.8%

TDS – total dissolved solids
mg/L – milligrams per liter
AFY – acre-feet per year
RW – recycled water
WY – water year
AC – assimilative capacity

- For all three scenarios, recycled water projects use less than 10% of the available assimilative capacity, and projected TDS concentrations remain well below the BPO of 500 mg/L.

When considering the differences between Scenarios 1 and 2 and the No-Project Scenario (i.e., loading associated with the No Project components is removed), Scenarios 1 uses 1.8% (2.3 mg/L) of the available assimilative capacity, while Scenario 2 use 4.8% (6.1 mg/L) of the assimilative capacity.

5.5.2 Nitrate-N Groundwater Concentrations

Figure 5-11 shows the simulated results of the calibrated mixing model for nitrate for the three future scenarios from WY 2013-14 through 2034-35 for the Inland area of the Sonoma Valley Subbasin. The chart shows the simulated concentration trends for each scenario and the 10% assimilative capacity threshold. **Table 5-14** shows the mixing model simulated nitrate concentration change over the future planning period for each scenario in mg/L. The cumulative concentration change is translated into assimilative capacity use at the bottom of the table. The table also shows the difference between each of future Scenarios 1 and 2 and the Scenario 0 (No-Project). This difference represents the water quality and assimilative capacity impact of just the future project(s) with the background impacts of the No Project conditions removed.

As depicted in Figure 5-11 and shown in Table 5-14, the following conclusions can be made:

- Average nitrate concentrations in the subbasin are projected to increase similarly for all three scenarios from WY 2013 to WY 2035 (between 0.83 and 0.88 mg/L).
- For all three scenarios, recycled water projects use less than 10% of the available assimilative capacity, and projected nitrate concentrations remain well below the BPO of 10 mg/L.

When considering the difference between Scenarios 1 and 2 and the No-Project Scenario (i.e., loading associated with the No Project components is removed), Scenarios 1 uses 0.2% (0.02 mg/L) of the available assimilative capacity (9.93 mg/L), while Scenario 2 uses 0.5% (0.05 mg/L) of the available assimilative capacity. It is noted that projected increases in nitrate concentrations in the Inland area of the subbasin are considered conservative given the assumptions incorporated in the calibration of the mixing model for nitrate (see discussion in Section 4.3). Additionally, despite portions of existing and proposed future recycled water use areas being located south of the Inlands area in the Baylands area (see Figure 2-1), all TDS and nitrate loading associated with recycled water use was applied within the Inlands area in the mixing model and S/N balance. Average groundwater nitrate concentrations are predicted to increase asymptotically toward the volume-weighted average nitrate concentration of basin inflows for each scenario (1.31 mg/L for Scenario 0, 1.33 mg/L for Scenario 1, and 1.38 mg/L for Scenario 2).

Figure 5-11: Simulated Future Groundwater Nitrate-N Concentrations

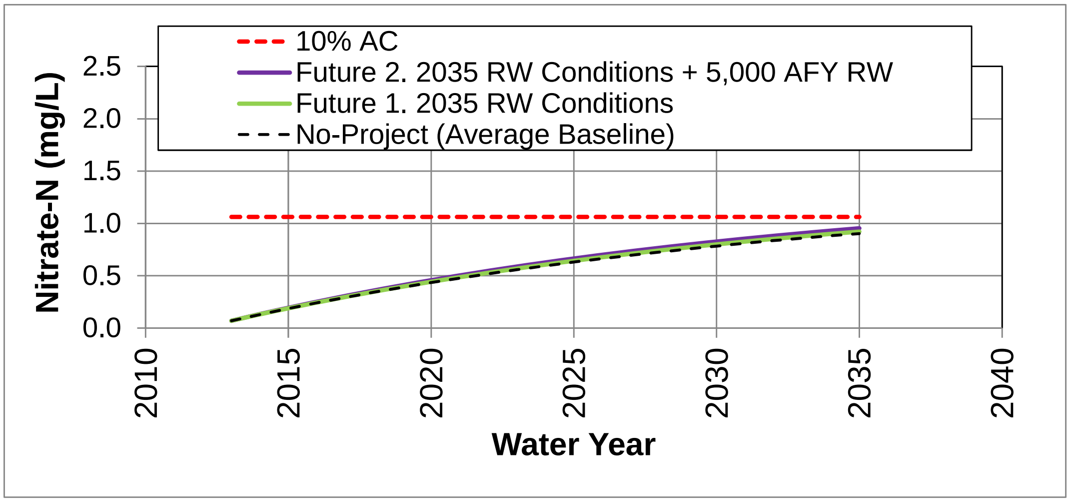


Table 5-14: Simulated Future Groundwater Nitrate-N Concentrations and Assimilative Capacity Use

Water Year	Nitrate-N (mg/L)		
	Future Scenario 0 (No-Project)	Future Scenario 1 (2035 Recycled Water Conditions)	Future Scenario 2 (2035 RW Conditions + 5,000 AFY RW)
2013	0.07	0.07	0.07
2014	0.13	0.13	0.13
2015	0.19	0.19	0.19
2016	0.24	0.25	0.25
2017	0.29	0.30	0.31
2018	0.34	0.35	0.36
2019	0.39	0.40	0.41
2020	0.44	0.44	0.46
2021	0.48	0.49	0.50
2022	0.52	0.53	0.55
2023	0.56	0.57	0.59
2024	0.60	0.61	0.63
2025	0.63	0.64	0.66
2026	0.66	0.68	0.70
2027	0.70	0.71	0.73
2028	0.73	0.74	0.77
2029	0.76	0.77	0.80
2030	0.78	0.80	0.83
2031	0.81	0.83	0.86
2032	0.84	0.85	0.88
2033	0.86	0.88	0.91
2034	0.88	0.90	0.93
2035	0.90	0.92	0.95
Basin Plan Objective	10.00		
Average Ambient TDS Concentration (mg/L)	0.07		
Assimilative Capacity (mg/L)	9.93		
10% AC concentration change (mg/L)	0.99		
10% AC concentration (mg/L)	1.06		
WY 2035 concentration (mg/L)	0.90	0.92	0.95
WY 2013 to WY 2035 change (mg/L)	0.83	0.85	0.88
WY 2013 to WY 2035 (% AC Used)	8.4%	8.6%	8.9%
Difference compared to No-Project (mg/L)		0.02	0.05
Difference compared to No-Project (% AC)		0.2%	0.5%

Nitrate-N – nitrate as nitrogen
mg/L – milligrams per liter
AFY – acre-feet per year
RW – recycled water
WY – water year
AC – assimilative capacity

6 References

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Appendix B - Meeting Summaries for Regional Water Quality Control Board Meetings

Meeting Minutes

Sonoma Valley - Salt & Nutrient Management Plan

Subject:	**Meeting with SF Bay Region RWQCB**
Prepared For:	Sonoma County Water Agency
Prepared By:	Christy Kennedy
Date/Time:	January 10, 2013: 2-3pm
Location:	SFRWQCB Office, Oakland
Project Number:	0047-008.00

Attendees:
Ralph Lambert, Alec Naugle, Barbara Baginska (RWQCB); Marcus Trotta, Kevin Booker (SCWA); Dave Richardson, Christy Kennedy (RMC); Tim Parker (Parker Groundwater); Sally McCraven (Todd Engineers)

1. Purpose of Meeting

The purpose of the meeting was to communicate process and progress of the Sonoma Valley Salt and Nutrient Management Plan (SNMP), and to confirm the approach to the analysis.

2. Discussion Summary

The Sonoma County Water Agency (Water Agency) and RMC provided an overview of the Sonoma Valley groundwater basin, the Groundwater Management Plan and the Salt and Nutrient Plan process and progress to date. The Water Agency manages and operates the Sonoma Valley County Sanitation District (CSD), which is the primary purveyor of recycled water within the basin, and is leading development of the SNMP for Sonoma Valley. Handouts were provided and attached that highlight the key discussion items below.

2.1 Groundwater Management in Sonoma Valley

1. The Water Agency described the current groundwater basin setting and water management in Sonoma Valley. Currently, there is not a robust system of dedicated groundwater monitoring wells, and the Water Agency does not operate supply wells in the basin.

2. There are around 1,800 rural/domestic wells and 60% of the water use in the basin is groundwater, 40% is imported Russian River water for urban supplies.

3. The basin has an AB303 Groundwater Management Plan (GMP) and groundwater management group, which is a voluntary and non-regulatory program.

4. The Water Agency is the lead agency for the AB303 GMP, but does not have regulatory powers related to groundwater within the basin.

2.2 SNMP Approach

1. The approach to developing the SNMP collaboratively in Sonoma Valley is to hold a series of stakeholder workshops at key milestones within the technical analysis process. The workshops are held in conjunction with the Technical Advisory Committee and the Basin Advisory Panel for the Groundwater Management Plan. The next workshop being held on January 17, 2013 was discussed and the Regional Water Quality Control Board (RWQCB) was invited to attend.

2.3 Baseline Groundwater Quality

1. Data sources include the Department of Water Resources (DWR), California Department of Public Health (CDPH), United States Geological Survey (USGS), State Water Resources Control Board's (SWRCB) Groundwater Ambient Monitoring and Assessment (GAMA) program, and the Water Agency. While the SWRCB Recycled Water Policy recommends using the most recent five years of data to establish average groundwater quality for the basin, significant data from older studies will be used to provide a more robust data set. Specifically, the SNMP proposes using the 2003-2006 data from the USGS Study to supplement the data set in order to calculate basin averages. RWQCB staff agreed that it is reasonable to use the 2000-2012 period for establishing current basin averages.

2. Historic total dissolved solids (TDS) and nitrate concentration trends in shallow and deep aquifer zones are fairly flat across the period of record.

3. The areal distribution of water quality data and depth-discrete data were analyzed with the intent of developing local area and depth-discrete salt and nutrient averages and assimilative capacity estimates; however, it was determined that the data are too limited to support such an analysis. Accordingly, the proposed approach for establishing average TDS and nitrate and available assimilative capacity, is to average across the basin and all depth intervals to estimate one average TDS and nitrate concentration for the entire basin.

   a. RWQCB staff (BB) asked that shallow and deep zones be taken into account in the monitoring plan and potential implementation measures. While a depth discrete analysis of the assimilative capacity is preferred, the consultant team stated that it was not possible for this basin with the available data.

   b. Areas exceeding Basin Plan Objectives (BPOs) for TDS or nitrate would be considered when developing implementation measures, however, the source of elevated concentration may not be able to be determined based on available data.

4. Overall the basin has good water quality with very low nitrate levels and mostly flat trends for TDS. The southwestern portion of the basin (called "Baylands" area) is an area with historical saline groundwater due to the proximity of and possible intrusion from San Pablo Bay. The area is a marshy tidally-influenced wetland adjacent to the Bay. There are no active public water supply wells in the area and available water quality data is limited to data collected from seven wells prior to 1973 and three former public water supply wells prior to 1988 located at the former Skaggs Island Naval Communication Center which was decommissioned in 1993 (note: details on dates and number of wells added to minutes for reader clarification after the meeting with RWQCB). All historical water quality samples collected from these wells (between 1954 and 1988) exhibit TDS concentrations exceeding the BPO for TDS of 500 milligrams per liter (mg/l), ranging from 520 to 2,740 mg/l. The Sonoma Valley SNMP approach is to develop an assimilative capacity estimate for the inland portion of the valley excluding this historically intruded area. RWQCB staff agreed that it made sense to break out the two areas (Inland and Baylands). There is available assimilative capacity for both TDS and nitrate in the Sonoma Valley basin when the historically saline groundwater from the Baylands area is excluded from the average calculations.

2.4 Loading Model

1. A GIS model is being used for the loading analysis, which looks at loading of TDS and nitrate to the groundwater basin. Key model assumptions and preliminary loading estimates for land cover categories with similar salt and nutrient characteristics were shared with the group.

2.5 Water Recycling and Stormwater Recharge Goals

1. For goal setting, the approach is to use the recycling water use goals from Urban Water Management Plans developed by the City of Sonoma and Valley of the Moon Water District, and for stormwater recharge, numeric goals will not be set for the SNMP. The SNMP will reference stormwater recharge efforts within the Valley and indicate that updates to the SNMP will be made when stormwater recharge projects are further developed. The RWQCB staff agreed with our proposed approach for goal setting.

2.6 SNMP Template for the Bay Area Region

1. The Sonoma Valley SNMP is being funded through a Prop. 84 Planning Grant, and as part of that grant the team will develop SNMP template. The template will be available to other agencies within the region to use as a guide when preparing their own SNMP. Specific direction was not provided for template development but RWQCB staff noted these templates could be useful, and that they had done outreach to Napa and the Westside basin along the San Francisco Peninsula.

2.7 Basin Plan Amendment

1. RWQCB staff (BB) requested that the SNMP Executive Summary (or other similar section) include text that could be readily used for the Basin Plan Amendment (BPA) description of the SNMP, should a BPA be required for the basin (note: there is still ongoing discussion of this requirement internally within RWQCB). The summary should include goals, why the plan was developed, where the region/basin is located, major components of the SNMP and should be a short summary of what was done as part of the SNMP process and how.

2. The group discussed the California Environmental Quality Act (CEQA) needs for the SNMP. While some basins with extensive implementation measures (example: Zone 7) will require a CEQA analysis to amend the Basin Plan, it is unclear at this time if CEQA is necessary for the Sonoma Valley plan where implementation measures beyond what is currently being done in the basin. The Sonoma Valley team is not intending to complete a CEQA analysis on the SNMP at this time. RWQCB staff will be discussing this item with their management and will follow-up with the Sonoma Valley team.

Meeting Minutes

Sonoma Valley - Salt & Nutrient Management Plan

Subject:	**Coordination Meeting with SF Bay RWQCB**
Prepared For:	Sonoma Valley County Sanitation District
Prepared By:	Christy Kennedy
Date/Time:	May 14, 2013: 1:30-3:30pm
Location:	SFBRWQCB Office, Oakland
Project Number:	0047-008.00

Attendees:
Alec Naugle, Barbara Baginska, Ben Livsey (RWQCB); Marcus Trotta, Kevin Booker, Jay Jasperse (SCWA); Dave Richardson, Christy Kennedy (RMC); Edwin Lin (Todd Engineers)

1. Purpose of Meeting

The purpose of the meeting was to communicate progress of the Sonoma Valley Salt and Nutrient Management Plan (SNMP), convey the technical analysis findings, obtain input on approach to management measures and monitoring plan, and understand what is needed for plan finalization and approval by the Regional Water Quality Control (RWQCB).

2. Discussion Summary

The Sonoma Valley team (SCWA/SVCSD, RMC and Todd Engineers) provided an overview of the Sonoma Valley SNMP process and progress to date. Handouts (amended in the attached version to include the dairy loading table) were provided and attached that highlight the key discussion items below.

2.1 Introduction

Around the table introduction were made and Christy Kennedy, RMC, gave an overview of the SNMP progress to-date. The SNMP is being conducted in a collaborative manner utilizing the stakeholder infrastructure developed through the Sonoma Valley Groundwater Management Plan (GMP) process. This consists of a Technical Advisory Committee (TAC) which meets monthly and Basin Advisory Panel (BAP) that meets quarterly. Stakeholders include a wide cross-section of municipal agencies, non-profit organizations, environmental groups, private well owners, dairy owners, and various vineyard and agricultural groups that represent those with interest in groundwater management and salt and nutrient impacts within the basin.

2.2 Existing Water Quality and Assimilative Capacity

1. Edwin Lin, Todd Engineers, gave an overview of the existing water quality within the basin, utilizing a baseline period dataset from 2000-2012. The basin is divided into the Inland and Baylands areas at a dividing line of 750 mg/L TDS. The average concentration of total dissolved solids (TDS) and nitrate-N in the Inland area is 372 mg/L and 0.07 mg/L, respectively. Both constituents are well below the Basin Plan Objectives (BPOs) of 500 mg/L for TDS, and 10 mg/L for nitrate-N. Trends for TDS and nitrate are generally flat across the full data set representing up to about 50 years of data.

2. RWQCB staff (BB) asked if hotspots were present around dense septic areas. Edwin responded that no hotspots are visible within the existing dataset however the data is fairly limited and well completion reports are not available for all of the wells to denote their depth (shallow or deep).

3. Edwin gave an overview of the water balance and answered calibration questions, then described the mixing model. The mixing model was developed as one-layer or box for the Inland Area, and mixes over a reasonable depth of the basin (limited to a saturated depth of 400 feet for operating volume).

4. Christy described the loading model and gave an overview of loading parameters. It was noted that the TDS and nitrate-N values for septic system return are currently being refined (increased) but were not expected to change the findings.

2.3 Future Water Quality and Assimilative Capacity

1. Edwin gave an overview of the future water quality assessment. Three scenarios were run, 1- No project, 2 – Future recycled water estimates of 4,069 AFY, and 3 – Future recycled water estimates plus an additional 5,000 acre-feet per year (AFY) of recycled water. Scenarios showed that recycled water projects will use <10% of the available assimilative capacity and average concentrations stay below BPOs for both TDS and nitrate.

2. Marcus Trotta, Sonoma County Water Agency, noted that recycled water programs are in place to help alleviate a pumping depression in the deeper aquifer zones by offsetting groundwater pumping through deliveries of recycled water for irrigation. Increasing the use of recycled water can reduce the potential for saline water intrusion into the groundwater basin.

2.4 Implementation Measures

1. The results of the technical analysis show good water quality with relatively flat trends through 2035, therefore, no implementation measures beyond continuing existing programs are recommended. RWQCB staff acknowledged that the approach to not recommend new implementation measures might be appropriate. Further consideration of this issue will be given once the draft SNMP is submitted for final review by RWQCB staff.

2. The voluntary Groundwater Management Program will be identified as a process that the SNMP will support, but programs and activities covered by the Groundwater Management Program will not be considered "implementation measures" for the SNMP. Other management measures that should continue but do not constitute "implementation measures" are recycled water permit requirement BMPs, agricultural BMPs, onsite wastewater treatment system (septic) BMPs and municipal wastewater treatment plant source control programs.

3. The Water Agency is also evaluating the feasibility of aquifer storage and recovery (ASR) utilizing wintertime Russian River drinking water. The recycled water, stormwater recharge and ASR programs and studies are being conducted as voluntary programs to help manage water supply reliability within the basin and are not considered implementation measures within this SNMP.

4. The future expansion of the recycled water application in Sonoma Valley is already covered under existing CEQA/NEPA documents, and any GMP programs resulting in infrastructure projects like groundwater banking or stormwater recharge would be covered under a separate environment compliance process.

2.5 Groundwater Monitoring Program

1. The recommended groundwater monitoring program consists of existing wells monitored by CDPH, DWR and SVGMP.

2. The Groundwater Monitoring Plan will be submitted as a stand-alone document that is an appendix of the SNMP so that if modification of the monitoring plan is required it can be done without a complete SNMP update.

3. SCWA recently obtained outside funding through an AB303 grant to install additional monitoring wells within the basin. There is a data gap area around the Baylands-Inland area transition and future funding will be pursued to expand the monitoring network.

4. The monitoring program reporting should be uploaded in the RWQCB's Geotracker online data system. This will be completed on a three-year interval.

2.6 Basin Plan Amendment and CEQA Process

1. The Sonoma Valley team asked for direction for RWQCB approval of the final SNMP.

2. The Final SNMP will likely go the SCWA Board of Directors as an informational item only and not be submitted for formal approval or adoption. After this action has been completed, the Final SNMP (including an Executive Summary for the RWQCB's use in their BPA process) will be submitted to the RWQCB.

3. RWQCB staff is obtaining direction from the State Water Resources Control Board (SWRCB) on the Basin Plan Amendment process. The SWRCB is considering whether the scientific peer review of the SNMP and/or BPA would be needed.. It is not known at this time if the Sonoma Valley SNMP which has no new implementation measures recommended, would need to go through this peer review process. The peer review process could add four+ months to the schedule.

4. If a peer review is required for the Sonoma Valley SNMP, RWQCB staff will request help from the Sonoma Valley team in providing responses to peer review comments. If necessary, the SNMP may require revisions from peer review findings.

5. It has not been determined at this time if CEQA for the Sonoma Valley SNMP is required. RWQCB staff may need to develop a "Substitute CEQA Document" but it is not clear if that is necessary if the Sonoma Valley SNMP is approved as a "non-regulatory" Basin Plan Amendment. RWQCB staff concurred that moving forward as a "non-regulatory" document for inclusion in the Basin Plan Amendment is an option, and is reasonable since no new implementation measures are recommended and no discretionary items are incorporated in the SNMP that require CEQA documentation. More information about the CEQA process will be forth coming in the June, CEQA specific meeting to be hosted by the RWQCB for the region (see bullet # 2 under Next Steps). The Sonoma Valley team requested that the Sonoma Valley basin be considered as a special case that may not require the same Basin Plan Amendment and CEQA actions that other basins with poorer water quality, increasing quality trends, and implementation measures may be subject to.

6. If a CEQA process is determined to be needed for the Sonoma Valley SNMP the RWQCB staff have requested assistance in the following areas:

    a. Developing CEQA alternatives - likely alternatives will be the "no-project" alternative, and Scenario 1 describing future recycling project implementation

    b. Scoping meeting coordination, noticing, and presentation of findings

2.7 Next Steps

1. The Sonoma Valley SNMP is being funded through a Prop. 84 Planning Grant, and as part of that grant the team will develop SNMP template. The template will be available to other agencies within the region to use as a guide when preparing their own SNMP. The template is being drafted and will be discussed and reviewed by the Bay Area agencies at the June 3rd Integrated Regional Water Management Plan (IRWMP) Coordinating Committee Meeting. After comments are incorporated into the template, it will be submitted to the RWQCB for review.

2. RWQCB staff (BB) noted they are planning to convene an all-agency meeting to go through the CEQA process requirements for SNMPs, and asked input on the benefits of this proposed meeting. The Sonoma Valley team agreed this meeting would be useful. This meeting will likely be scheduled in mid June. RWQCB will send out a list of questions in advance of the meeting and allow each agency up to 15 minutes to provide an overview of their basin and response to the submitted questions.

3. RWQCB staff (BL) is planning on attending the July 17, 2013 Sonoma Valley stakeholder workshop presenting the Draft SNMP.

Appendix C - Guidance Document for SNMPs for the San Francisco Bay Region

Guidance Document for Salt and Nutrient Management Plans

San Francisco Bay Region

Prepared by: Sonoma Valley County Sanitation District

August 2013

Table of Contents

Step 1 Initial Basin Characterization 3
- Task 1.1 Identify the Basin and Delineate the Study Area 3
- Task 1.2 Identify Stakeholders 4
- Task 1.3 Identify Beneficial Uses and Water Quality Objectives 4
- Task 1.4 Identify, Collect, and Review Existing Groundwater Studies and Data 4
- Task 1.5 Perform Initial Groundwater Quality Characterization 5

Step 2 Recycled Water and Recharge Water 6
- Task 2.1 Identify Recycled Water and Recharge Water/Use Quantities 6
- Task 2.2 Identify Recycled Water and Recharge Water Goals 6

Step 3 Comprehensive Review of Salt and Nutrient Sources 6
- Task 3.1 Evaluate Sources within the Basin 6
- Task 3.2 Quantify Basin Assimilative Capacity 7
- Task 3.3 Develop Source Load Assessment Tools 7
- Task 3.4 Gather Fate and Transport Information 7

Step 4 Salt/Nutrient Loading and Implementation Measures 8
- Task 4.1 Determine Planning Horizon 8
- Task 4.2 Estimate Future Salt/Nutrient Source Loads 8
- Task 4.3 Determine Future Water Quality 8
- Task 4.4 Identify Appropriate Implementation Measures and Management Strategies 9
- Task 4.5 Assess Load Reduction & Water Quality Improvement Associated with Additional Measures 9

Step 5 Antidegradation Analysis 9

Step 6 Basin/Sub-basin Wide Monitoring Plan 10

Step 7 Plan Documents and Regional Water Board Coordination 10

This Guidance Document was developed as a result of the Sonoma Valley Salt and Nutrient Management Plan (SNMP) preparation effort. Sonoma Valley County Sanitation District, along with the Zone 7 Water Agency and Santa Clara Valley Water District are developing SNMPs in three priority groundwater basins (as identified by the Regional Water Board) for the San Francisco Bay Region. The Sonoma Valley SNMP received funding through the Proposition 84 Planning Grant for SNMP preparation and development of a guidance document to assist other Bay Area agencies wanting to undergo a similar process in developing their SNMPs.

The California state-wide Recycled Water Policy, adopted by the State Water Resources Control Board in 2009, indicates that Salt and Nutrient Management Plans (SNMPs) are to be developed for groundwater basins in California, to address the potential for increased salt and nutrient loading from increased recycled water use and other sources. It is anticipated that SNMPs will contain the following components to be responsive to both the Recycled Water Policy requirements and the Basin Planning Amendment process undertaken by the Regional Water Board:

- General groundwater basin information and characteristics
- Beneficial use designation
- Goals for water recycling and stormwater recharge/use (as applicable);
- Salt and nutrient source identification;
- Water quality objectives (both narrative and numeric)
- Salt and nutrient source loading and assimilative capacity estimates;
- Implementation measures and management strategies;
- Antidegradation analysis, as needed;
- Development of a basin-wide monitoring plan; and
- A provision for monitoring Constituents of Emerging Concern (CECs) in recycled water used for groundwater recharge reuse.
- A statement regarding Plan limitations

The purpose of this document is to describe the common steps that may be undertaken by Bay Area groups in preparing an SNMP. The San Francisco Bay Regional Water Quality Control Board (Regional Water Board) is expected to consider the size, complexity, level of activity, and site-specific factors within a basin in reviewing the level of detail and the specific tasks required for each SNMP. It may be appropriate to meet with Regional Water Board staff early in the process of developing an SNMP, to ensure common expectations before resources are expended.

Step 1 Initial Basin Characterization

Task 1.1 Identify the Basin and Delineate the Study Area

- Delineate the study area for salt and nutrient management planning.

- Identify the areal extent of the groundwater basin, including if known, the watershed area tributary to the aquifer, known source loads or impacts within the watershed, the location of existing or proposed recycled water use areas, and/or jurisdictional boundaries.
    - In developing SNMPs, it is recognized that the SNMP may wish to address study areas using a sub-basin approach.
    - SNMPs interested in focusing on groundwater supply development may define the study area to encompass anticipated project sites other than recycled water, or source control needs such as control of pollutants from a dairy operation.

Task 1.2 Identify Stakeholders

- Develop a preliminary list of stakeholders (including potential interest, contact person, and contact information). Key stakeholders include local agencies involved in groundwater management, owners and operators of recharge facilities, water purveyors, water districts, wastewater agencies, known salt and nutrient contributing dischargers, and the general public.
- Perform outreach and obtain stakeholder feedback for planning process (now or near future).

Task 1.3 Establish Communication with the Regional Water Board

- Identify a point of contact at the Regional Water Board with whom to coordinate the preparation of your SNMP.

Task 1.4 Identify Beneficial Uses and Water Quality Objectives

- Identify designated beneficial uses of the groundwater basin (see 2011 Basin Plan, Table 2-2).
- Identify water quality objectives for groundwater basin (see 2011 Basin Plan, starting on page 2-8).

Task 1.5 Identify, Collect, and Review Existing Groundwater Studies and Data

- Collect and review readily available and applicable regional groundwater and salt/nutrient management studies and data. Studies with data on groundwater quality, use, supply development, and salt and nutrient loading may be useful. The types of studies and data that may be useful include the following:
    - Planning documents, including Urban Water Management Plans (UWMPs) and Groundwater Management Plans
    - Groundwater supply, storage, or conjunctive use studies;
    - Groundwater aquifer hydrogeologic investigations;
    - Groundwater quality studies or groundwater protection studies;
    - Groundwater models
    - Recycled water compliance, assimilative capacity, and Basin Plan studies;

    - Pollutant modeling and transport studies;
    - Watershed studies; and
    - Source assessment evaluations.
- Collect and review readily available and applicable well data and information, as follows:
    - Existing and planned municipal supply wells or projects within the basin.
    - Private groundwater wells or private well areas within the basin.
- Contact organizations engaged in ongoing groundwater monitoring to determine if the collected data can be made available for use in the SNMP.

Task 1.6 Perform Initial Groundwater Quality Characterization

- Review prior reference studies and data (collected as part of Task 1.5) and assess the reliability and specificity of the groundwater quality data, depth-to-water data, and estimates for hydrogeologic parameters, as applicable.

Potential Off-Ramp #1

Evaluate the potential feasibility of water uses for beneficial use consistent with land use within the region. If groundwater is not considered suitable for use as a municipal or domestic water supply by meeting an exception listed in State Board Resolution No. 88-63 - *The Sources of Drinking Water Policy*, then at a minimum, Best Management Practices can be documented along with the basin characterization and comprise the SNMP in lieu of the standard required elements listed in the Recycled Water Policy. Depending on stakeholder input, other elements, such as a simplified groundwater monitoring plan could also be included. If groundwater is used as a public water supply in the basin, proceed to next bullet.

- Identify the parameters of interest for the plan which should include salts and nutrients but could include other parameters of interest that adversely affect groundwater quality. These parameters should be based on collected groundwater quality information and stakeholder input.
- Identify whether readily available data and information is sufficient to complete a baseline analysis to determine if the groundwater basin is currently meeting water quality objectives. If not, develop a plan for collecting data, collect the data, and then return to next step.
- If data are sufficient, review data to determine whether (1) water quality objectives are being exceeded, and (2) any trends that show an increase in salt or nutrient management concentrations.
- Select and justify preliminary planning horizon to look into the future (such as 20 years – similar to a UWMP planning horizon), depending on expected changes in the future such

as growth, land use changes, water supply changes and increases in recycled water application.

- Evaluate historical trends and anticipated projects that would contribute salt or nutrients to the groundwater, and estimate whether an exceedance of water quality objectives is anticipated within the planning horizon (document the evaluation and results).

Potential Off-Ramp #2

If there is a sound basis that water quality objectives will not be exceeded, this basin is a No Threat basin. Document the basin characterization, evaluation and results, including Best Management Practices. This documentation will comprise the SNMP unless stakeholders determine collaboratively that other elements suggested by the Recycled Water Policy (i.e. a groundwater monitoring plan) should be included. If it is estimated that water quality objectives would be exceeded, or if there is uncertainty regarding whether water quality objectives would be exceeded, proceed to next section (Step 2).

Step 2 Recycled Water and Recharge Water

Task 2.1 Identify Recycled Water and Recharge Water/Use Quantities

- Collect available data and information about current and predicted recycled water and recharge water (including stormwater or imported water)/use. Urban Water Management Plans (UWMPs) can be used as an initial data source. Recycled water producers will also have information about recycled water and potential plans for future expanded use.

Task 2.2 Identify Recycled Water and Recharge Water Goals

- Identify the goals of the recycled water studies, and stormwater and other recharge water studies related to the basin. Goals should be consistent with the goals within the Recycled Water Policy to increase recycled water use and stormwater recharge. Gather data about the future quantitative goals for these projects.

Step 3 Comprehensive Review of Salt and Nutrient Sources

Task 3.1 Evaluate Sources within the Basin

- Identify general land uses within the basin.
- Identify known sources of salt/nutrient loads within the basin, to supplement work from Task 1.4. Sources may include:
    - Applied Water (groundwater)

- Applied Water (surface water)
- Recycled Water Application
- Artificial Recharge of Stormwater Runoff
- Artificial Recharge with Imported Water Supplies
- Atmospheric Deposition
- Biosolids Application
- Commercial, Industrial, and Institutional Facilities
- Creek Recharge
- Agriculture, including applied fertilizer and soil amendments
- Dairy Operations
- Mines
- Natural Geologic Sources
- Natural Soil Conditions
- Point Source Wastewater Discharges
- Rainfall
- Seawater Intrusion
- Septic Tank Discharges
- Storage Ponds
- Streamflow Infiltration
- Subsurface Inflow (including upstream inflow and seawater intrusion)
- Urban Runoff

- Identify the locations where source loads are impacting the basin.

Task 3.2 Quantify Basin Assimilative Capacity

- Using water quality data gathered under Task 1, establish the baseline water quality. Calculation of constituent concentrations can be performed with a spatial averaging approach.
- Compare these values to the Basin Plan water quality objectives, taking dilution into account if appropriate, to determine the assimilative capacity of the basin. The assimilative capacity is the difference between the water quality objectives and the existing water quality, taking into account dilution if appropriate. If the basin has either an existing or potential beneficial use of municipal and domestic supply (see 2011 Basin Plan, Table 2-2), compliance with the water quality objectives for municipal supply should be assessed (see Basin Plan, Table 3-5).

Task 3.3 Develop Source Load Assessment Tools

- Develop tools for assessing salt and nutrient loading, as well as fate and transport, of salts and nutrients. Examples of tools include geographical information system (GIS) relational models, groundwater flow/transport models (complex basins) or spreadsheet-based mass balance computations.

Task 3.4 Gather Fate and Transport Information

- Gather information about the fate and transport of salts and nutrients in the basin. Reviewing California's Groundwater Bulletin 118 can be a starting point for this process.
- Additional tasks that may be useful are as follows:

- On the basis of available hydrogeological, water quality, or geologic studies, determine fault lines, bedrock constrictions, or vertical stratification that may affect transport and groundwater quality.
- Identify known hydrogeologic parameters for the basin (e.g. hydraulic conductivity, storage coefficient, etc.) and the bases on which these parameters were estimated.
- Assess the geographic completeness of existing groundwater quality data, depth-to-water data, and hydrogeologic parameters and determine if any data gaps exist that prevent geographic, seasonal, or depth-dependent characterization of groundwater quality, occurrence or transport.
- Assess the geographic distribution of water quality concentrations for the salt/nutrient parameters of interest, and assess the depth-dependent distribution of water quality.

Step 4 Salt/Nutrient Loading and Implementation Measures

Task 4.1 Determine Planning Horizon

- Determine an appropriate planning horizon (the number of years to look into the future), and justify the selection. A longer timeframe may be useful, such as the one established in the region's UWMPs (e.g., 25 years), especially if the region expects limited growth. If the region expects significant land use changes or projects with expected impacts to salt and nutrient loadings (such as recharge projects with stormwater or recycled water), a shorter time frame (e.g., 10 years) is recommended.

Task 4.2 Estimate Future Salt/Nutrient Source Loads

- Prepare estimates for future recharge flow to the basin from surface and subsurface sources, discharge/withdrawal (flow) from the basin, and salt and nutrient loading from the sources identified in Task 3.1. Land use data may provide valuable information for estimating source loads.
- Building on the baseline calculations performed in Task 3.2, use the tool developed in Task 3.3 to compute predicted concentration estimates that are representative of the basin for the identified constituents of interest.

Task 4.3 Determine Future Water Quality

- Develop a mixing model on an annual time step for the selected planning horizon to mix the load concentrations developed within the basin. A spreadsheet model is typically adequate for the mixing analysis. Available data from other basin models (e.g. existing USGS or other models) such as hydrogeology characteristics (depth of mixing), water balance and water quality concentration information may be extracted and used within the mixing model. Comment on limitations and sensitivities within the mixing model (i.e. mixing depth, timing of future land use or land management changes, etc).
- Determine the degree to which the basin will be exceeding applicable water quality objectives for the identified salt and nutrient parameters within the planning horizon.

- Determine the impact of recycled water on the assimilative capacity of the basin.
- Assess the general level of effort for managing salts and nutrients in the basin. Consider the basin's characteristics and uses in this assessment.

Task 4.4 Identify Appropriate Implementation Measures and Management Strategies

- Identify the basin's existing implementation measures and strategies to manage salt and nutrient loading in the basin. If future water quality trends are flat, BPOs are not being exceeded or projected to be exceeded, and recycled water project utilize less than 10% assimilative capacity (or 20% for multiple projects); existing management measures may be sufficient for managing salts and nutrients within the basin.
- If salt and/or nutrient concentrations are increasing, additional implementation measures may be necessary. In a collaborative manner with Plan participants, develop (as applicable) a list of additional, appropriate implementation measures and management strategies (additional measures) to manage salt and nutrient loading in the basin on a sustainable basis. Examples of best management practices (BMPs) include:
    - Irrigation at agronomic rates
    - Configuration of irrigation and drainage facilities in land application fields to reasonably minimize runoff of applied animal waste
    - Fertilizer use workshops
    - Industrial discharge controls (local pretreatment limits, high strength surcharge for nutrients and/or salts)
    - Irrigation workshops
    - Land use policy modification
    - Recharge program adoption or modification (stormwater, recycled water, imported water)
    - Recycled water application limitations or quality guidelines
    - Septic system BMPs
    - Source load diversion/control

Task 4.5 Assess Load Reduction & Water Quality Improvement Associated with Additional Measures

- If additional measures are being considered, it may be of interest to evaluate the ability of the additional measures to achieve load reduction or groundwater quality improvement. Use the tool developed in Task 3.3 to assess the ranges of potential load reduction and water quality improvement effects associated with additional measures, if appropriate.
- Evaluate and compare the additional implementation measures and select the preferred measure(s) for implementation. It may be appropriate to consult among stakeholders to inform the process of making decisions about implementation measures.

Step 5 Antidegradation Analysis

- Conduct an antidegradation analysis to demonstrate that implementation measures, including identified projects, included within the SNMP will collectively comply with the requirements of Resolution No. 68-16.

Step 6 Basin/Sub-basin Wide Monitoring Plan

- Identify existing monitoring wells and select appropriately located wells to determine water quality throughout the most critical areas of the basin. Focus on water quality near water supply wells, but also consider wells near large water recycling projects and groundwater recharge projects. Consider a range of well depths to monitor shallow or deep zones, as appropriate.
- Propose additional (new) monitoring wells if appropriate.
- Determine appropriate salt and nutrient parameters and monitoring frequencies that are reasonable and cost-effective that may help determine whether the Basin Plan water quality objectives for salts and nutrients are being, or are threatening to be, exceeded. Monitoring data should be evaluated to understand the effectiveness of the BMPs developed as part of Task 4.4. Refer to the amended Recycled Water Policy (April 2013) for guidance on CEC monitoring requirements.
- Identify stakeholders responsible for maintaining, assessing, and storing the monitoring data.

Step 7 Plan Documents and Regional Water Board Coordination

- Compile analyses in a Plan document.
- Coordinate with the Regional Water Board on next steps regarding Plan submittal and support of their Basin Plan Amendment and California Environmental Quality Act compliance process.

Appendix D - Salt and Nutrient Source Identification and Loading Technical Memorandum

Technical Memorandum

Sonoma Valley Salt and Nutrient Management Plan

Subject: **Salt and Nutrient Source Identification and Loading**

Prepared For: Marcus Trotta, SVCSD

Prepared by: Chris van Lienden, RMC

Reviewed by: Christy Kennedy, RMC, John Dickey, PlanTierra

Date: 28 June 2013

Reference: 0047-008

1 Introduction

An analysis of salt and nutrient loading occurring due to surface activities is presented to identify sources of salt and nutrients, evaluate their linkage with the groundwater system, and estimate the mass of salts and nutrients loaded to the Sonoma Valley groundwater subbasin associated with those sources.

Salt and nutrient loading from surface activities to the Sonoma Valley groundwater basin are due to various sources, including:

- Irrigation water (potable water, surface water, groundwater, and recycled water)
- Agricultural inputs (fertilizer, soil amendments, and applied water)
- Residential inputs (septic systems, fertilizer, soil amendments, and applied water)
- Animal waste (dairy manure land application)

Most of these sources, or "inputs", are associated with rural and agricultural areas. Urban area salt and nutrient loads (e.g. due to indoor water use) are assumed to be primarily routed to the municipal wastewater system for recycling or discharge rather than to groundwater, except for landscape irrigation. Other surface inputs of salts and nutrients, such as atmospheric loading, are not considered a significant net contributing source of salts and nutrients and are not captured in the loading analysis. In addition to surface salinity inputs, potential subsurface inputs of high salinity waters from San Pablo Bay, thermal water upwelling and connate groundwater exists within the basin. These potential subsurface inputs are discussed in this Technical Memorandum (TM) and are further described along with other subsurface inputs in the Existing and Future Groundwater Quality TM.

The purpose of this TM is to document the inputs of salts and nutrients in the Sonoma Valley, along with the methodology used to estimate the effect of those inputs on water quality in the groundwater basin.

2 Methodology

To support the Sonoma Valley Salt and Nutrient Management Plan (SNMP) and to better understand the significance of various loading factors, a GIS-based loading model was developed. The loading model is a simple, spatially based mass balance tool that represents total dissolved solids (TDS) and nitrogen loading on an annual-average basis. Calibration of the model was limited to focusing on comparing recent historical trends to changes in concentrations estimated through incorporating the loading model results into the mixing model. In addition to the limited calibration activities, extensive stakeholder coordination was performed to refine the parameters in the loading model, including land use, applied water, TDS and N application (in applied water, as fertilizers and amendments, and in land applied manure), irrigation water source quality, and sewer service areas (to determine septic loads). Given these activities, the model is considered suitable for this analysis of basin conditions.

Primary inputs to the model are land use, irrigation water source and quality, recycled water storage pond locations and percolation, septic system areas and loading, and soil characteristics. These datasets are described in the following sections. The general process used to arrive at the salt and nutrient loads was:

- Identify the analysis units to be used in the model. In the case of Sonoma Valley, parcels from the Sonoma County Assessor's Office are the analysis units.
- Categorize land use categories into discrete groups. These land use groups represent land uses that have similar water demand as well as salt and nutrient loading and uptake characteristics.
- Apply the land use group characteristics to the analysis units.
- Apply the irrigation water source to the analysis units. Each water source is assigned concentrations of TDS and nitrogen.
- Apply the septic system assumption to the analysis units.
- Apply the soil texture characteristics to the analysis units.
- Estimate the water demand for the parcel based on the irrigated area of the parcel and the land use group.
- Estimate the TDS load applied to each parcel based on the land use practices, irrigation water source and quantity, septic load, and infrastructure load. The loading model makes the conservative assumption that no salt is removed from the system once it enters the system. Other transport mechanisms (such as runoff draining to creeks exiting the basin) likely reduce the total quantity of salt in the basin.
- Estimate the nitrogen load applied to each parcel based on the land use practices, irrigation water source and quantity, septic load, and infrastructure (e.g. wastewater ponds) load. The loading model assumes that a portion of the applied nitrogen is taken up by plants and (in some cases) removed from the system (through harvest of plant material). Additional nitrogen is converted to gaseous forms and lost to the atmosphere. Remaining nitrogen is assumed to convert to nitrate and to be subject to leaching. Soil texture is used to estimate and account for mobility of leaching water and the efficiency of nitrate transport through the root zone.

3 Data Inputs

Data inputs to the model include the spatial distribution of land uses (with associated loading factors), irrigation water sources (with associated water quality), septic inputs, wastewater infrastructure loads, and soil textures. These inputs are discussed below.

3.1 Land Use

Land use data are obtained from the 2012 Sonoma County Assessor's Office parcel dataset. This dataset contains several hundred discrete land use categories. These categories are consolidated into the following land use groups for the Sonoma Valley basin area:

- Flowers and nursery
- Pasture
- Vines
- Other row crops
- Dairies
- Other confined animal feeding operations
- Non-irrigated vines
- Non-irrigated field crops
- Non-irrigated orchard
- Shrub/Scrub
- Grassland/ Herbaceous
- Barren land
- Farmsteads
- Urban commercial and industrial
- Urban commercial and industrial, low impervious surface (e.g. maintenance yards, schools)
- Urban landscape
- Urban residential
- Paved areas (roads and parking lots)

Local stakeholders and Plan partners confirmed that the land use is substantially unchanged since the 2012 dataset, within the accuracy requirements of this type of analysis. The spatial distribution of land uses is shown in Figure 3-1. Upon review of the land use dataset, stakeholders provided updates to the dairies and grassland/herbaceous categories in the October 10, 2012 SNMP Workshop with the Sonoma Valley Groundwater Management Program's (SVGMP's) Technical Advisory Committee (TAC). Because there are so many distinct categories, a discrete color for each type could not be assigned. Therefore, land use categories with similar characteristics (i.e. urban categories, non- irrigated agriculture categories, irrigated agriculture categories) are shown combined into a color category.

Each land use group is assigned characteristics including:

- Applied water
- Percent irrigated
- Applied nitrogen
- Used nitrogen
- Leachable nitrogen
- Applied TDS

Leachable nitrogen is assumed to be the applied nitrogen less 10 percent of the applied nitrogen for gaseous loss, less nitrogen removal in harvested plant material. Table 3-1 consists of a matrix of values for the land use categories and characteristics. These values were also presented to the stakeholder group and refined based on their input. Refinements included adjustments to vineyards, farmsteads/rural residential, and non-irrigated field crops. For vineyards, coordination with stakeholders included modification to applied TDS and irrigation volume to reflect practices in the area. For farmsteads/rural residential, modifications were made to applied TDS, applied N, and irrigation volume based on improved understanding of land uses on these diverse parcels. Finally, non-irrigated field crops were given the non-irrigated designation based on stakeholder input on the farming practices of what are generally small-grain hay crops in the southern portion of the basin.

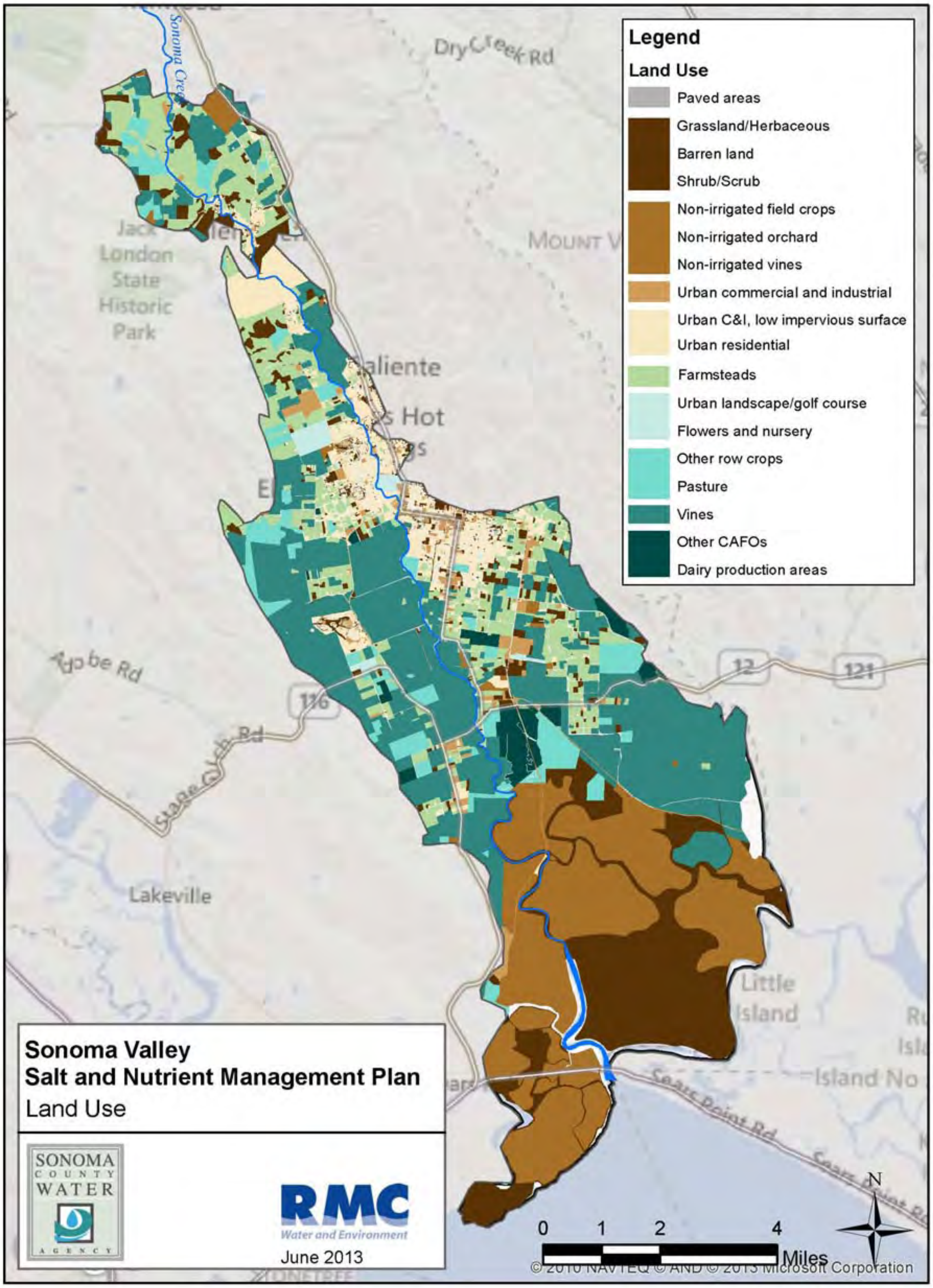


Figure 3-1: Land Use

Table 3-1: Land Use Related Loading Factors

Land Use Group	Total Area (acres)	Percent Cultivated[1]	Applied Water[2] (in/yr)	Applied Nitrogen[3] (lbs/acre-year)	Nitrogen Uptake[4] (lbs/acre-year)	Leachable Nitrogen[5] (lbs/acre-year)	Applied TDS[6] (lbs/acre-year)
Paved Areas	28	0%	0	0	0	0	0
Grasslands/Barren/ Herbaceous	7,212	0%	0	0	0	0	0
Non-irrigated vines	284	80%	0	18	16	0	84
Non-irrigated Orchard	41	80%	0	75	60	8	292
Non-irrigated field crops (hay)	8,489	80%	0	34	22	8	170
Urban Commercial and Industrial	1,018	5%	48.5	92	60	23	657
Urban C&I, Low Impervious Surface	807	30%	48.5	92	60	23	438
Farmsteads/Rural-Residential[7]	5,608	10%	28.7	60	42	13	303
Urban Residential	2,238	15%	51.1	92	60	23	438
Urban Landscape/Golf Course	327	75%	48.5	92	60	23	584
Pasture	2,266	40%	51.1	110	90	14	584
Vines[8]	13,075	100%	6.3	29	23	3	168
Other CAFOs	102	10%	0.0	84	-	75	730
Dairy[9]	769	N/A	N/A	N/A	N/A	N/A	N/A

Notes:

1 Percent of land area assumed to be cultivated within each class is estimated is based review of aerial photography and agricultural scientist professional judgment of a reasonable, broad average for each class.

2 Applied water values and other climatic data are taken from Department of Water Resources (DWR) land and water use data (http://www.water.ca.gov/landwateruse/anlwuest.cfm). On this website, four years of data are available. Climatic data averages, based on these four years of data, was compared to the 21-year average of available CIMIS climatic data for the Sonoma Valley area. As the two data sets correspond well, the average DWR applied water values were used, with some adjustment using crop coefficients for the Sonoma Valley area to fit the study land use classes.

3 Applied nitrogen estimates are based on literature review for individual land cover classes and professional judgment. Applied nitrogen was then calculated for total acreage and checked against fertilizer sales records for Sonoma County (available from the California Department of Food and Agriculture). Application rates were then scaled to match sales records, and adjusted if appropriate based on discussions with growers in the region.

4 Uptake of nitrogen was estimated from available literature by multiplying reported yield figures by reported nitrogen concentrations for harvested plant parts. Balances between uptake and application were checked to ensure that nitrogen use efficiencies were in the reported ranges, adjusted for professional knowledge of irrigation and fertilization practice in each land cover class.

5 Maximum nitrogen leaching calculations for each land cover unit were calculated based on the balance between application, gaseous loss (volatilization and denitrification), and uptake. The maximum was then reduced based on soil conditions mapped for the area.

6 Applied TDS estimates are based on literature review for individual land cover classes and professional judgment. Applied TDS was then calculated for total acreage and checked against amendment sales records for Sonoma County (available from the California Department of Food and Agriculture). Application rates were then scaled to match sales records. Amendment application rates were adjusted if appropriate based on discussions with growers in the region.Farmstead irrigated areas are assumed to be a mix of turf grasses and vineyards.

7 Assumes that irrigated vines have a larger percent cultivation due to increased production efficiency from irrigation and a conservative value of 100% cultivation was used. An additional assumption for vines is that vines irrigated with recycled water utilize the same fertilizer and amendment application rates as those irrigated with groundwater (conservative estimate).

8 See discussion on dairy parcels below.

Due to the importance of dairies, some additional consideration is applied to dairy parcels. To better reflect land use practices, the applied, used, and leachable nitrogen characteristics and the applied TDS characteristic are further subdivided into production areas, ponds, and land application areas. Leachable nitrogen is calculated the same way as for the other land use groups except that gaseous loss is assumed to be 20 percent, as opposed to the 10 percent assumed loss for other land use groups, mainly due to the regular timing and highly organic nature of applied nitrigen. Table 3-2 summarizes the assumed dairy characteristics.

Table 3-2: Assumed Characteristic Dairy Values for the Loading Model

Dairy Subdivision Designation	Percent of Total Parcel Area Used Per Designation	Applied Nitrogen **(lbs/acre-year)**	Used Nitrogen **(lbs/acre-year)**	Leachable Nitrogen **(lbs/acre-year)**	Applied TDS **(lbs/acre-year)**
Production Area	6%	20	0	8	82
Ponds	1%	141	0	113	933
Land Application Area	93%	367	352	30	1,280

3.2 Irrigation Water Source

The irrigation water source data input is the result of a compilation of several different data sets. Potable water service areas were used as the initial layer. Those areas not served by a potable municipal water source are then assumed to obtain irrigation water from local groundwater wells. The spatial extent of these water sources is determined by city water service limits, recycled water studies, local knowledge, and stakeholder input. Stakeholder input was specifically utilized to refine irrigation and frost protection volumes for vineyards; water supply sources for the Temelec area; irrigation volumes on pasture, grazing land, field crops, and farmsteads; and the percentage of irrigated land at the Sonoma Developmental Center. Parcels in a recycled water service area are assumed to use recycled water for irrigation. Based on recycled water use rates and estimated demands, it has been assumed that vineyards were receiving recycled water blended with groundwater (~60% recycled water) to irrigate. Based on imagery of the area receiving recycled water, it has also been assumed that pastures receiving recycled water only irrigate 10% of their total area.

For irrigation water source from Valley of the Moon Water District and the City of Sonoma, TDS and nitrogen concentrations were obtained from annual water quality reports. The values assumed for groundwater are based on a basin-wide average calculated from groundwater samples collected from various public supply wells between the years 2000 to 2012 (the baseline period for the SNMP). More information on the existing groundwater quality can be found in the Existing and Future Water Quality TM. The values assumed for recycled water were estimated from effluent sampling conducted in 2012.

Table 3-3 summarizes the water quality inputs used for each irrigation water source. The spatial distribution of water sources is shown in Figure 3-2.

Table 3-3: Water Quality Parameters for Loading Model Water Sources

Source	TDS (mg/L)	Nitrate (as N) (mg/L)
Valley of the Moon Water District	162	0.2
City of Sonoma	172	0.4
Groundwater	372	0.1
Recycled Water	440	5.2

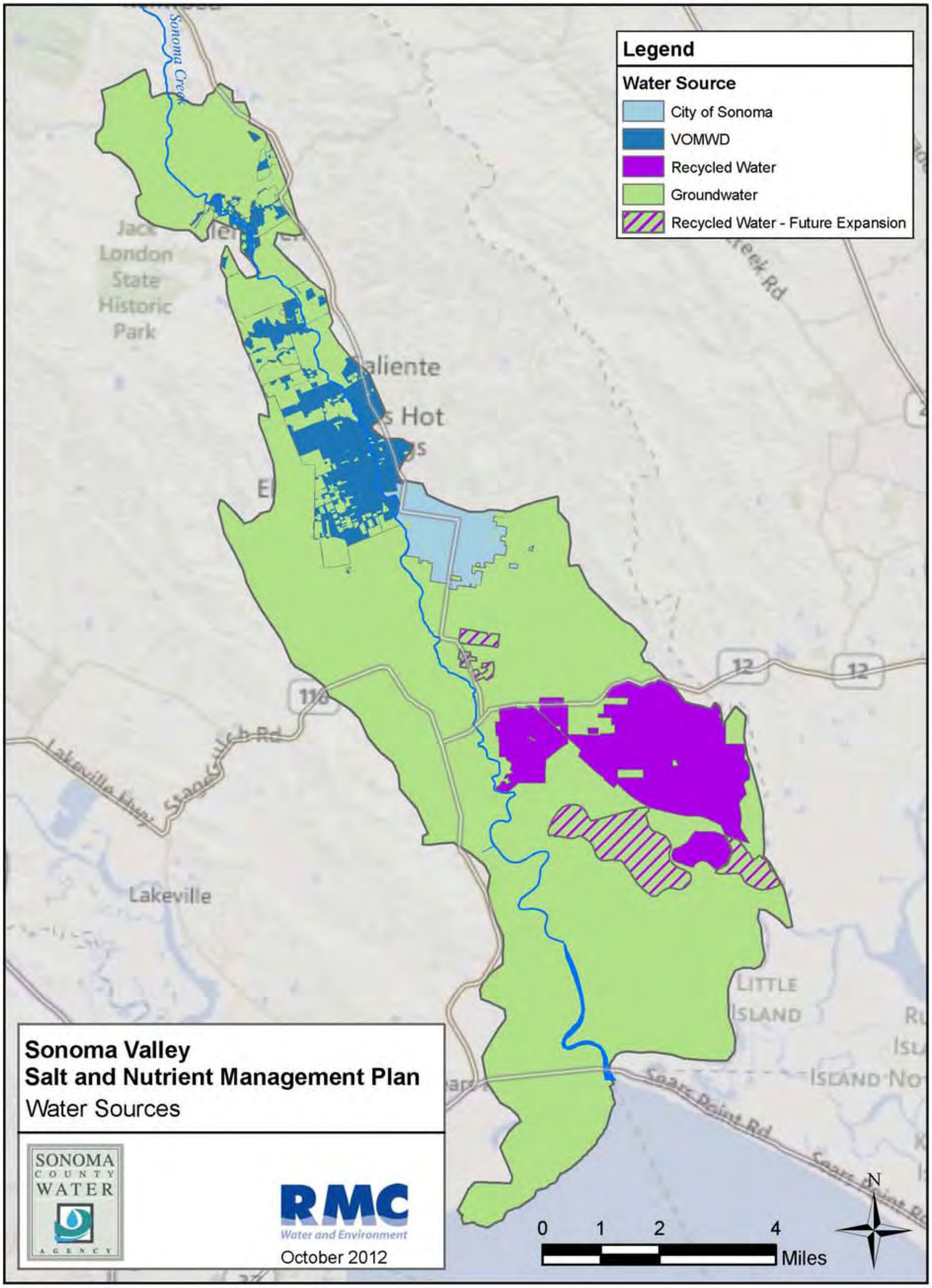


Figure 3-2: Water Sources

3.3 Septic Systems

A dataset documenting which parcels have septic systems was not available. It has been assumed that parcels outside of the Sonoma Valley County Sanitation District Service Area use a septic system. Of those parcels, septic systems are assumed where a residence is identified in the land use dataset. Each parcel with a septic system is assumed to produce 263 gallons per day (gpd), based on 75 gpd/person with 3.5 people per system. The 75 gpd/person estimate is based domestic use quantity estimates per California Code of Regulations, Title 23, Section 697. An estimate of 3.5 persons per household is a conservative estimate which assumes that household size for homes with septic is larger than that that of homes within the City (per the census bureau, persons per household for 2007-2011 is 2.54 in Sonoma County, with the City at only 2.07 people per household, therefore the outlying areas must be greater than 2.54 persons per household). The septic waste is assumed to have TDS concentrations of 572 mg/L, based on typical groundwater concentrations plus an assumed household contribution of 200 mg/L (Metcalf & Eddy, 2003). N concentrations were assumed to be 30 mg/L, based on typical wastewater concentrations for medium strength wastewater (Metcalf & Eddy, 2003) of 40 mg/L minus an assumed volatization rate of 25 percent within the septic system. The areas within the basin that could potentially have septic systems are shown in Figure 3-3.

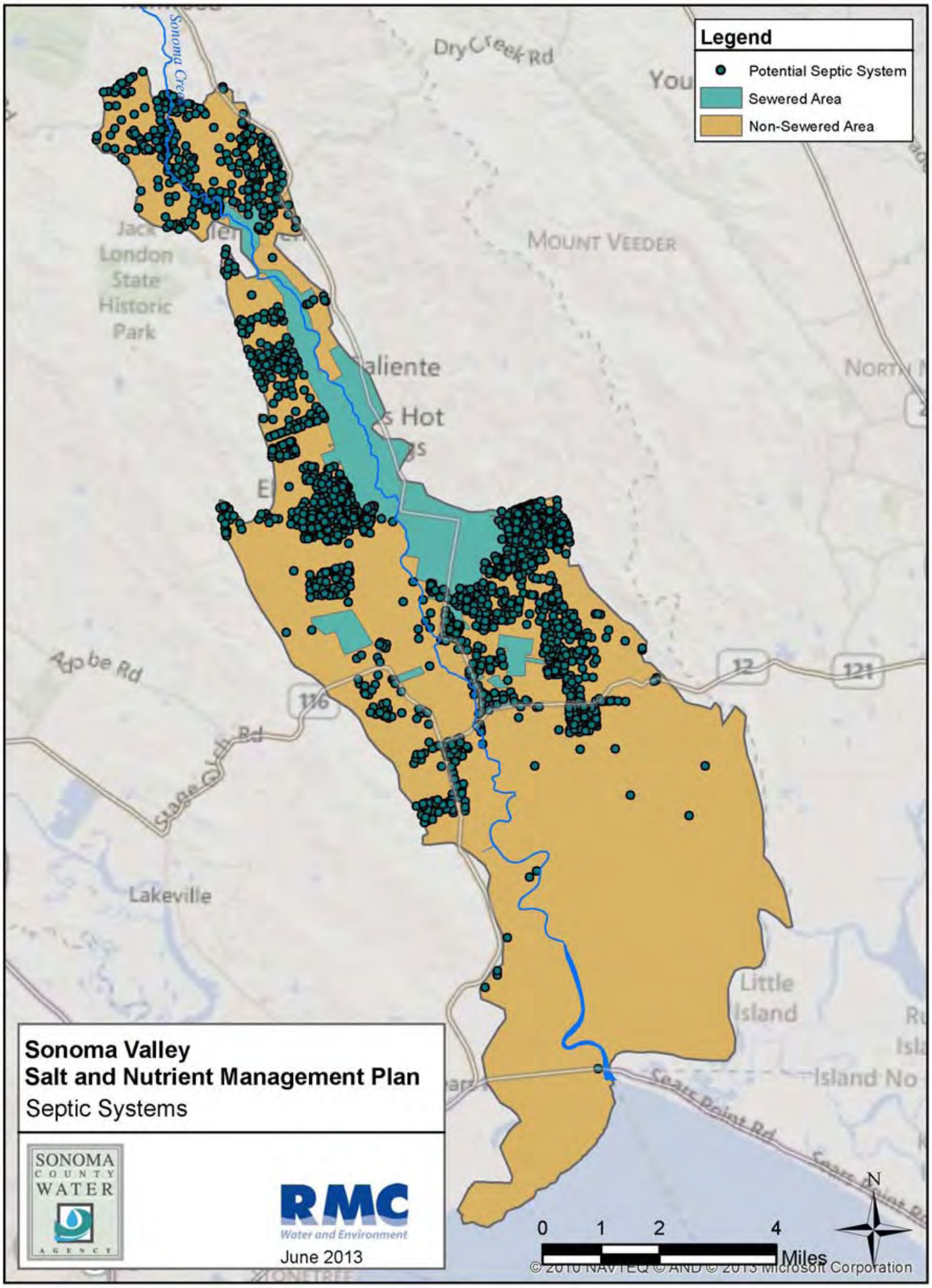


Figure 3-3: Septic Systems

3.4 Wastewater/Recycled Water Infrastructure

Sonoma Valley County Sanitation District operates five recycled water ponds within the groundwater basin; these are indicated in Attachment 1. Two of the ponds use clay liners, while the other three ponds use plastic liners. Due to the liners, it is assumed that no significant loading occurs at pond locations. It is also assumed that leakage from wastewater (sanitary sewer) and recycled water pipelines is not likely to be a significant source of salt and nutrient loading.

An effort was also undertaken to quantify potential salt and nutrient loading from winery wastewater ponds. These ponds are often lined with plastic or clay and contain rinsewater with salt and TDS concentrations similar to the source water (likely groundwater) because no additional salts and nutrients are added in the winemaking process. This effort showed that salt and nutrient loading from these ponds were likely negligible, with biological oxygen demand (BOD) the primary concern. These loads were not included in the model, beyond the loads already included through irrigation of the vineyards.

3.5 Soil Textures

Soil textures (NRCS, 2013) were obtained from the the Soil Survey of Sonoma County (SCS, 1972). Soil textures were assigned a hydraulic conductivity (NRCS, 1993). Hydraulic conductivity was used to develop an adjustment factor through linearly scaling the estimated conductivities from 0.1 (lowest) to 1.00 (highest). The adjustment factor is used to represent the proportion of nitrate that will migrate to the aquifer, relative to the other textural classes. Where conductivity is slower, it is reasoned (and observed) that nitrogen resides longer in the soil, increasing the proportion that is either taken up or lost through conversion to gaseous species.

Similar logic is not applied to TDS as salts are mostly not subject to conversion to gaseous forms, and rapidly saturate soil capacity to adsorb and retain them. Table 3-4 summarizes soil textures within the basin boundaries and how those textures are represented in the loading model. The spatial distribution of textures is shown in Figure 3-4.

Table 3-4: Loading Parameters for Surface Textures

Surface SoilTexture	Textural Class of Soil Matrix	Saturated Hydraulic Conductivity **(in/hr)**	Adjustment Factor[1]
Unweathered bedrock	-	0	0
Clay	Clay	0.03	0.1
Clay loam	Clay loam	0.18	0.13
Cobbly clay loam	Clay loam	0.18	0.13
Gravelly clay loam	Clay loam	0.18	0.13
Silty clay loam	Silty clay loam	0.23	0.14
Variable	Variable	0.48	0.19
Gravelly silt loam	Silty loam	0.48	0.19
Silt loam	Silty loam	0.48	0.19
Gravelly loam	Loam	0.73	0.24
Loam	Loam	0.73	0.24
Very gravelly loam	Loam	0.73	0.24
Fine sandy loam	Sandy loam	1.98	0.49
Gravelly sandy loam	Sandy loam	1.98	0.49
Sandy loam	Sandy loam	1.98	0.49
Very gravelly sandy loam	Sandy loam	1.98	0.49
Gravelly sand	Sand	4.49	1
Very gravelly sand	Sand	4.49	1

Notes:

1 Adjustment factors are based on hydraulic conductivity. The factor linearly scales estimated conductivity from 0.1 (lowest) to 1.00 (highest). The adjustment factor is used to represent how likely the nitrogen is to migrate to the aquifer, relative to the other textural classes.

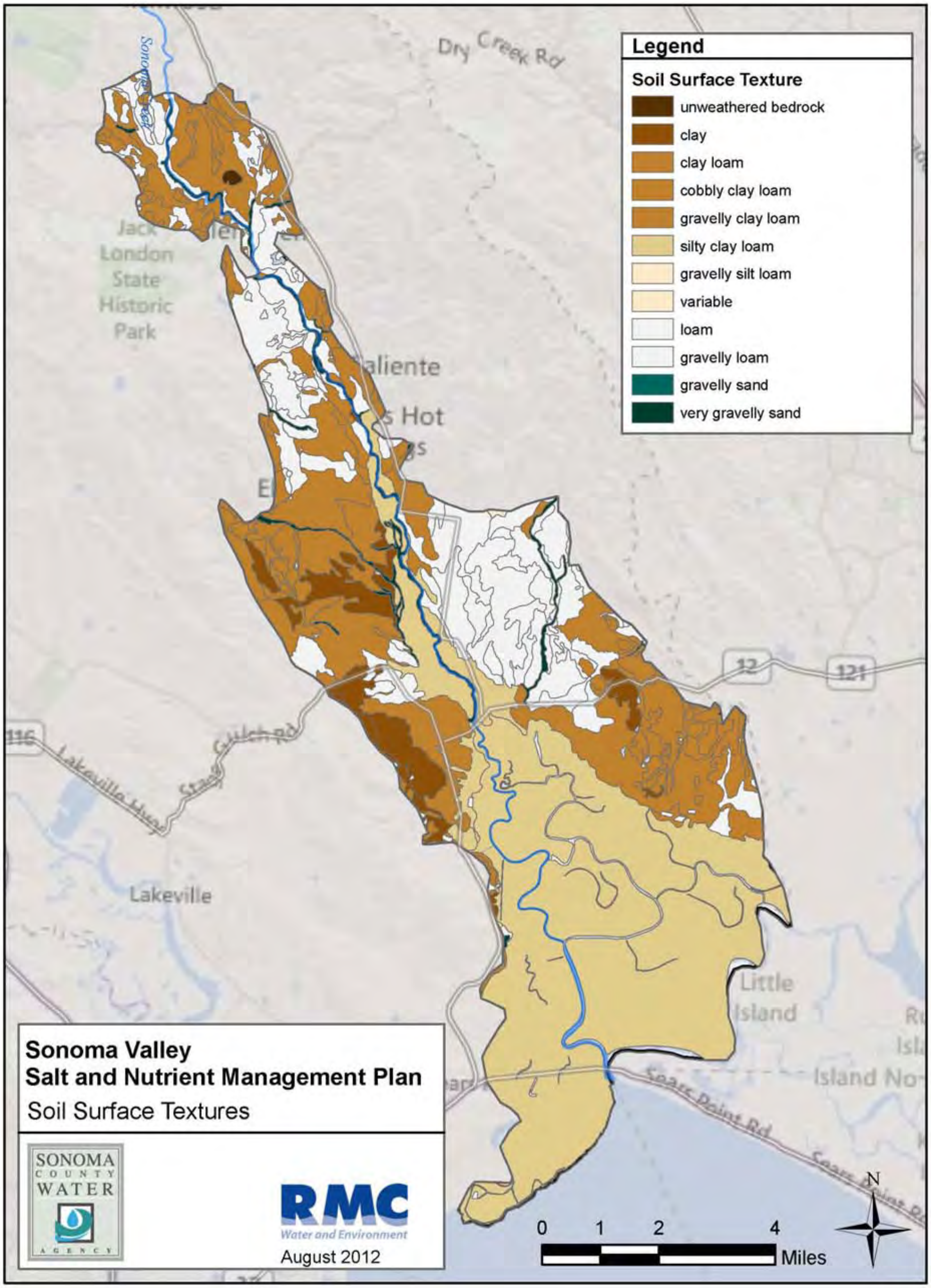


Figure 3-4: Soil Surface Textures

4 Loading Model Results

Based on the loading parameters and methodology described above, the loading model is used to develop TDS and nitrogen loading rates across the basin. Table 4-1 summarizes the overall contribution of each land use group to total TDS and nitrogen loading. The spatial distribution of TDS and nitrogen loading rates are shown in Figure 4-1 and Figure 4-2, respectively. The loading analysis estimates somewhat higher loading of TDS in the rural and agricultural areas of the basin, while nitrate loading is higher in the urban areas largely due to the low nitrogen application rates on vineyards. These results areutilized in the Existing and Future Water Quality TM.

Table 4-1: TDS and Nitrate Loading Results

Land Use Group	Total Area **(acres)**	Percent of Total Area	Percentage of Total TDS Loading	Percentage of Nitrogen Loading
Paved Areas	28	0%	0%	0%
Grasslands/Barren/ Herbaceous	7,212	17%	0%	0%
Non-irrigated vines	284	1%	0%	0%
Non-irrigated Orchard	41	0%	0%	0%
Non-irrigated field crops (hay)	8,489	20%	5%	6%
Urban Commercial and Industrial	1,018	2%	1%	8%
Urban C&I, Low Impervious Surface	807	2%	5%	7%
Farmsteads/Rural-Residential	5,608	13%	11%	37%
Urban Residential	2,238	5%	6%	22%
Urban Landscape/Golf Course	327	1%	5%	1%
Pasture	2,266	5%	17%	10%
Vines	13,075	31%	42%	3%
Other CAFOs	102	0%	0%	0%
Dairy	769	2%	7%	5%

The relative proportion of the land uses by area, nitrogen loading, and TDS loading are shown in Figure 4-3, Figure 4-4, and Figure 4-5, respectively.

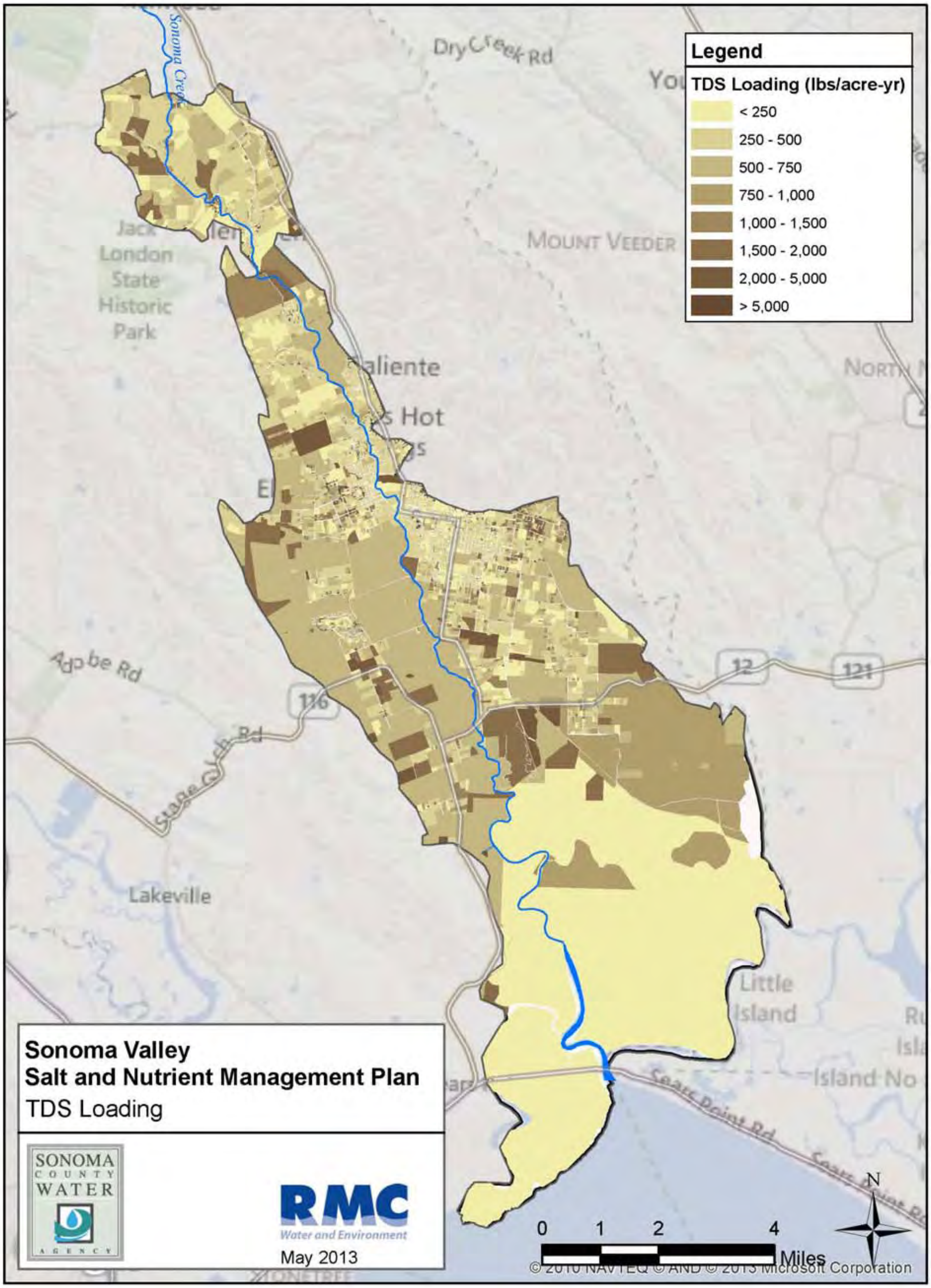


Figure 4-1: Estimated TDS Loading

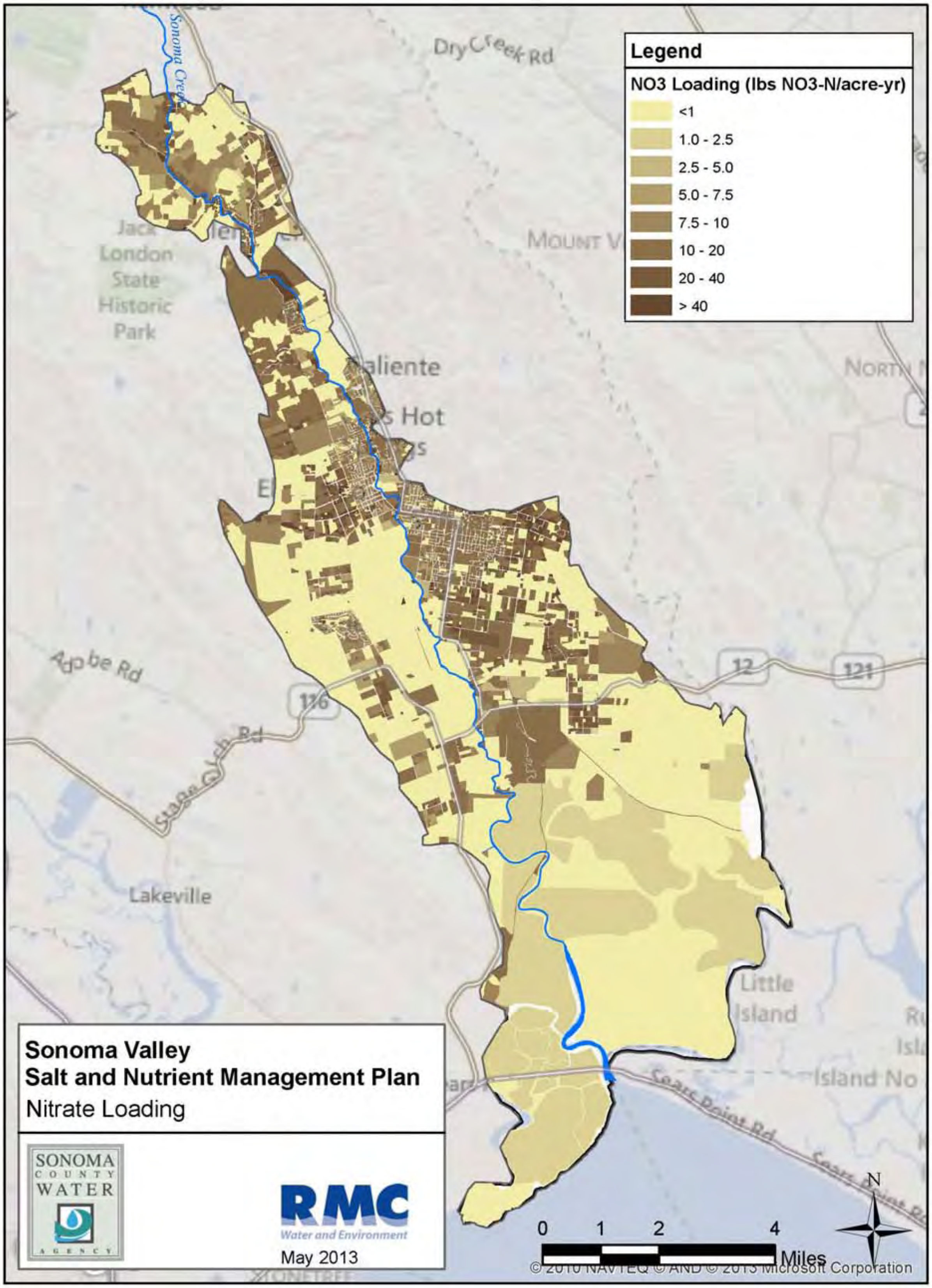
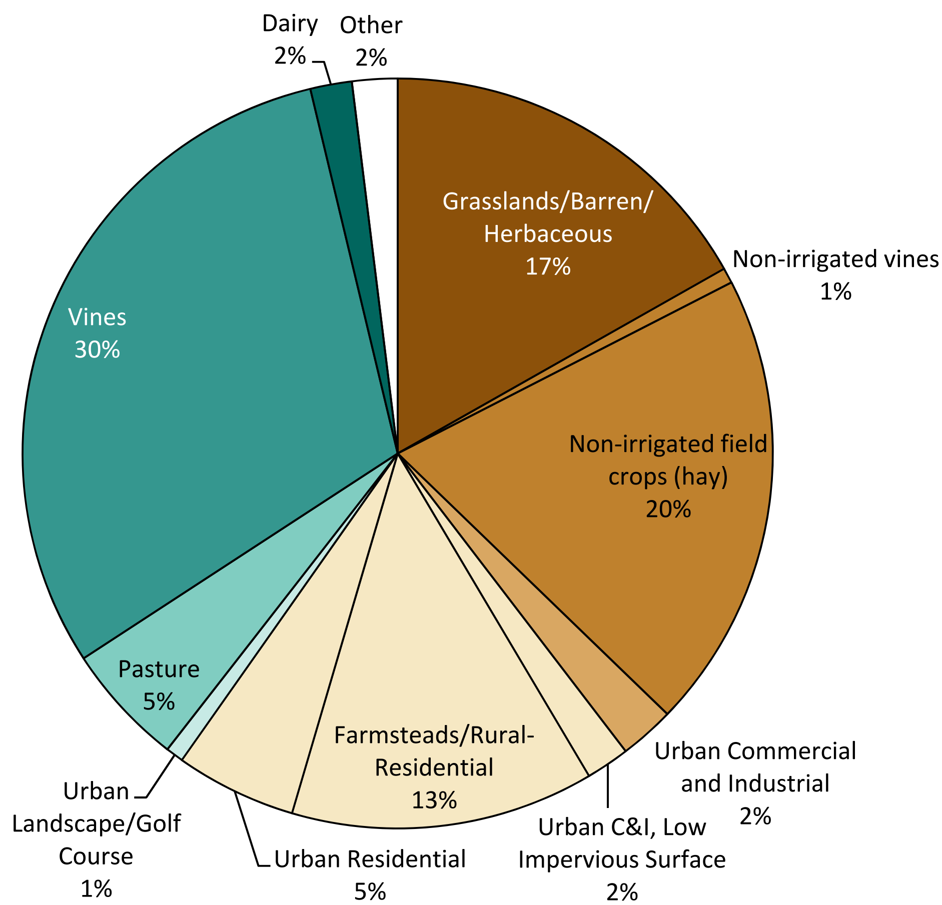
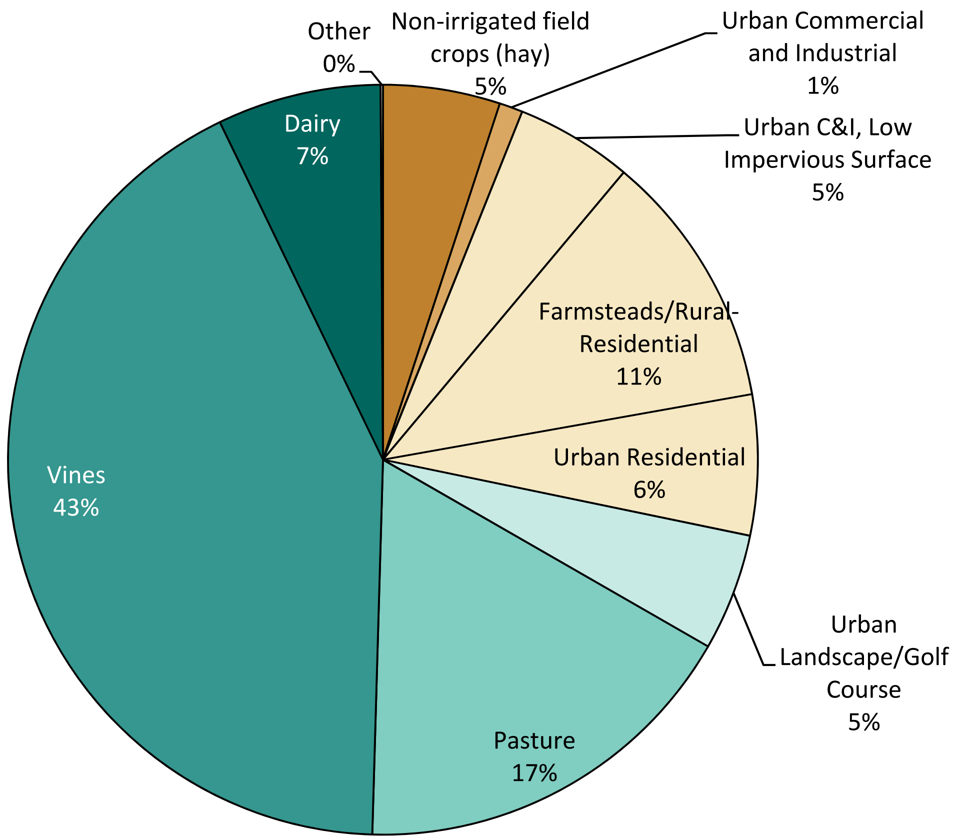


Figure 4-2: Estimated Nitrate Loading



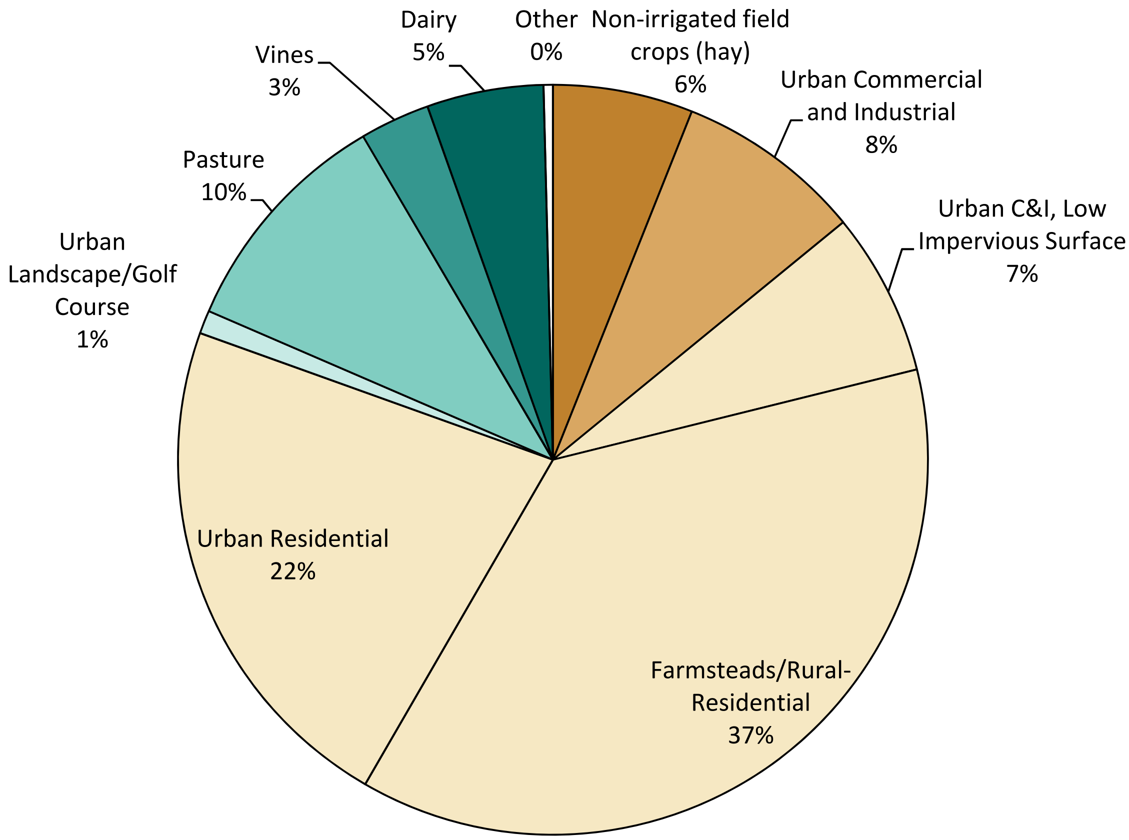
Other: Categories contributing less than 1% of land area: paved areas, non-irrigated orchards, other CAFOs

Figure 4-3 Percentage of Land Use in Study Area



Other: Categories contributing less than 1% of TDS loading: paved areas, grasslands/barren/shrubs, non-irrigated vines, non-irrigated orchards, other CAFOs

Figure 4-4 Percentage of TDS Loading in Study Area, by Land Use



Other: Categories contributing less than 1% of nitrogen loading: paved areas, grasslands/barren/shrubs, non-irrigated vines, non-irrigated orchards, other CAFOs

Figure 4-5 Percentage of Nitrogen Loading in Study Area, by Land Use

5 Brackish Groundwater

Kunkel and Upson (1960) originally identified an area of historical brackish groundwater (conductivity greater than 1,000 uS/cm) located primarily beneath the marshlands south of Highway 12/121. In 2006, The U.S. Geological Survey (USGS) developed new estimates of the extent of brackish water using conductivity measurements from 44 wells (USGS, 2006). The report found that intrusion had advanced as much as one mile north of Highway 121 in one area, and indicated the advancement may be attributed to increased groundwater pumping southeast of the City of Sonoma. In other areas (e.g., west of Highway 12), salinity levels diminished. Other potential subsurface inputs of salinity to the groundwater basin include upwelling of high-TDS thermal groundwater along fault zones and inflow connate groundwater.

The occurrence and trends related to brackish groundwater in southern Sonoma Valley are further discussed in the Existing and Future Groundwater Quality TM (Todd, 2013).

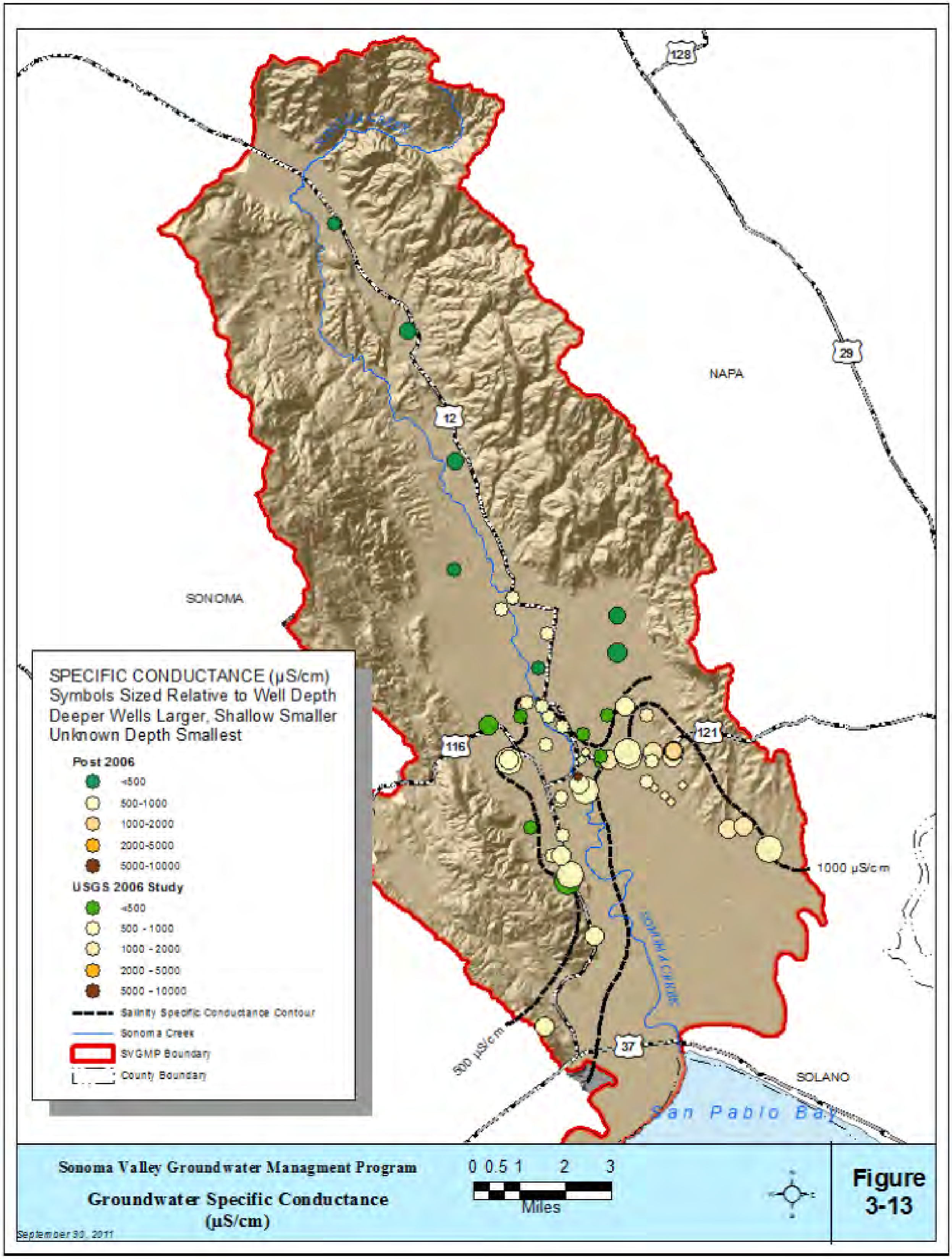


Figure 5-1: Groundwater Specific Conductance (SCWA, 2010)

6 References

California Code of Regulations, Title 23, Section 697

Census Data, 2007-2011; Sonoma County and City of Sonoma

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USGS, 2006, "Geohydrological Characterization, Water-Chemistry, and Ground-Water Flow Simulation Model of the Sonoma Valley Area, Sonoma County, California"

Valley of the Moon Water District, 2011, "Annual Water Quality Report"

Attachment 1 – Current and Future Recycled Water Users

SVCSD Recycled Water Users and Parcels

Sonoma County, California

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Appendix E - SNMP Groundwater Monitoring Plan

Technical Memorandum

Todd Engineers

Sonoma Valley Salt and Nutrient Management Plan

Subject: **Salt and Nutrient Management Plan Groundwater Quality Monitoring Program**

Prepared For: Marcus Trotta, Sonoma Valley County Sanitation District

Prepared by: Sally McCraven, Todd Engineers

Reviewed by: Christy Kennedy, RMC Water and Environment

Date: August 26, 2013

1 Introduction

This technical memorandum (TM) describes a proposed Salt and Nutrient Management Plan (SNMP) Groundwater Quality Monitoring Plan for the Sonoma Valley. In February 2009, the State Water Resources Control Board (SWRCB) adopted Resolution No. 2009-0011, which established a statewide Recycled Water Policy. Draft amendments to the Recycled Water Policy were released in May 2012, September 2012, October 2012 (SWRCB hearing change sheets), and January 2013. The Recycled Water Policy Amendment was adopted by the SWRCB on January 22, 2013.

With respect to monitoring, the Recycled Water Policy states that the SNMP should include a monitoring program that consists of a network of monitoring locations ". . . adequate to provide a reasonable, cost-effective means of determining whether the concentrations of salts, nutrients, and other constituents of concern as identified in the salt and nutrient plans are consistent with applicable water quality objectives." Additionally, the SNMP ". . . must focus on basin water quality near water supply wells and areas proximate to large water recycling projects, particularly groundwater recharge projects. Also, monitoring locations shall, where appropriate, target groundwater and surface waters where groundwater has connectivity with the adjacent surface waters." The preferred approach is to ". . . collect samples from existing wells if feasible as long as the existing wells are located appropriately to determine water quality throughout the most critical areas of the basin. The monitoring plan shall identify those stakeholders responsible for conducting, sampling, and reporting the monitoring data. The data shall be reported to the Regional Water Board at least every three years." With regards to constituents of emerging concern (CECs), the Recycled Water Policy Attachment A states that "Monitoring of health-based CECs or performance indicator CECs is not required for recycled water used for landscape irrigation due to the low risk for ingestion of the water." While the policy does not discuss agricultural irrigation application uses, the conclusion of low risk for ingestion of the water applies to agricultural irrigation uses as well.

In 2006, the Sonoma County Water Agency (Water Agency) coordinated development of a voluntary, non-regulatory Sonoma Valley Groundwater Management Plan (GMP) in compliance with the 1992 Assembly Bill 3030 (AB3030) and the 2002 Senate Bill 1938 (SB1938) with the participation and collaboration of a broad range of local stakeholders who served as a Basin Advisory Panel. As part of the GMP, the Water Agency and stakeholders have identified implementation of a long-term water quality monitoring program as a funding-dependent component of the GMP (SCWA, 2007). The SNMP monitoring program incorporates the GMP monitoring program. Data gaps in the existing monitoring program are identified.

The purpose of this TM is to describe the SNMP Groundwater Quality Monitoring Program for Sonoma Valley including groundwater sampling locations, sampling frequency, constituents monitored, sampling protocols and associated quality assurance and quality control (QA/QC) procedures, data analysis and evaluation criteria, and reporting. The entities responsible for monitoring and reporting will also be described.

2 SNMP Groundwater Quality Monitoring Program

2.1 Monitored Parameters

Total dissolved solids (TDS) and nitrate are the indicator salts and nutrients (S/Ns) selected for the Sonoma Valley SNMP. Total salinity is commonly expressed in terms of TDS in milligrams per liter (mg/L). TDS (and electrical [EC] conductivity data that can be converted to TDS) are available for source waters (both inflows and outflows) in the valley. While TDS can be an indicator of anthropogenic impacts such as infiltration of runoff, soil leaching, and land use, there is also a natural background TDS concentration in groundwater. The background TDS concentration in groundwater can vary considerably based on purity and crystal size of the formation minerals, rock texture and porosity, the regional structure, origin of sediments, the age of the groundwater, and many other factors (Hem, 1989).

Nitrate is a widespread contaminant in California groundwater. High levels of nitrate in groundwater are associated with agricultural activities, septic systems, confined animal facilities, landscape fertilization, and wastewater treatment facility discharges. Nitrate is the primary form of nitrogen detected in groundwater. Nitrate data are available for source waters (both inflows and outflows) in the valley. Natural nitrate levels in groundwater are generally very low (typically less than 2 mg/L for nitrate as nitrogen (nitrate-N). Nitrate is commonly reported as either nitrate-NO_3 or nitrate-N; and one can be converted to the other. Nitrate-N is the form of nitrate selected for assessment for this SNMP.

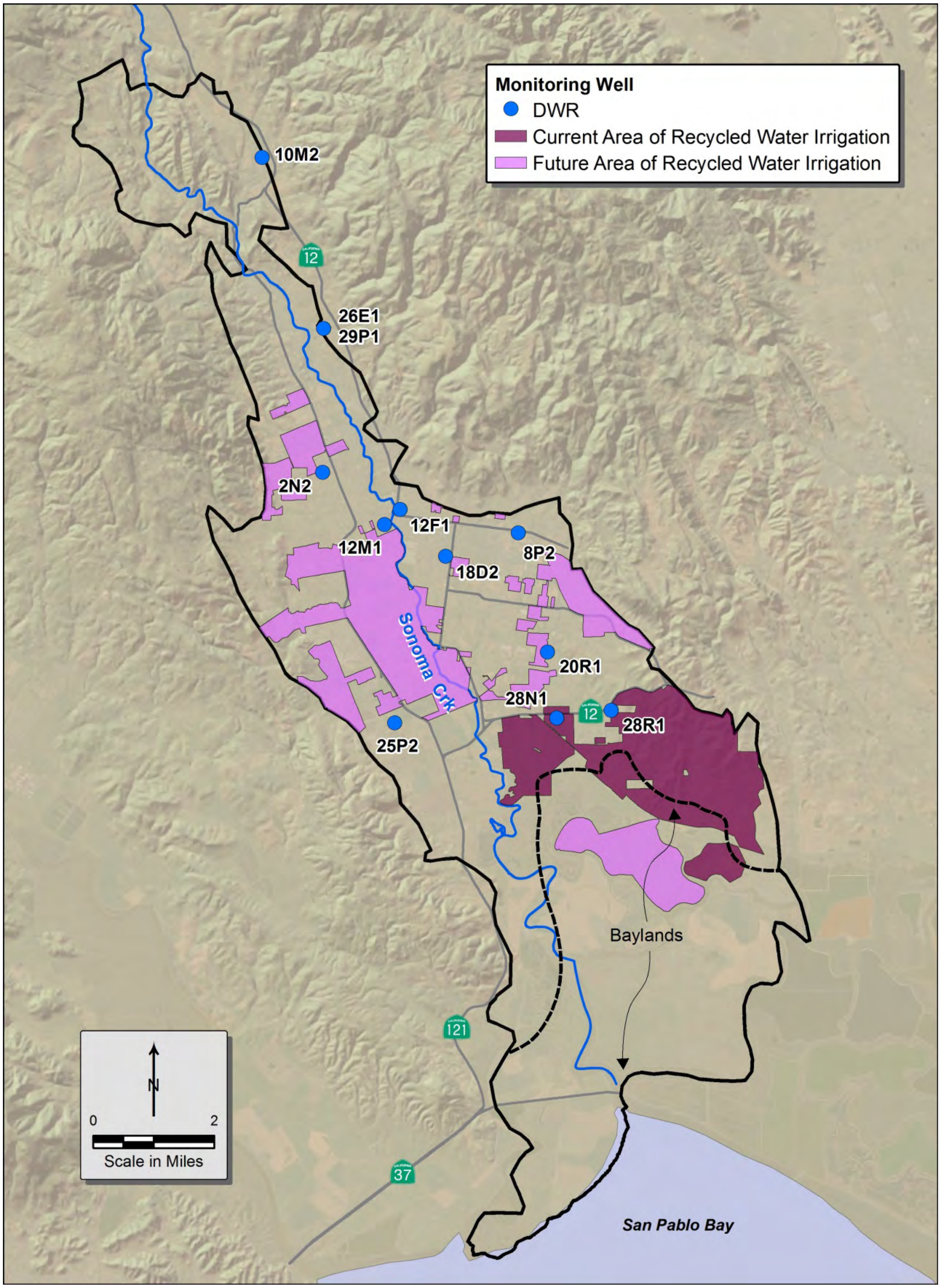
The SNMP monitoring program focused on TDS, nitrate, and EC as S/N indicator chemicals.

2.2 Basin Groundwater Quality and S/N Loading

As discussed in Chapter 5 of the SNMP, generally, relatively low TDS and nitrate concentrations are observed throughout most of the Inland Area of the subbasin and water quality concentration trends over time are flat or stable. The subbasin was divided into Inland and Baylands areas as shown in **Figure 2-1**. The Baylands Area is an area of historically elevated TDS concentrations due to proximity to San Pablo Bay. Due to the elevated salt in this area, groundwater pumping is limited, and the area is unlikely to be developed for groundwater supply in the future. Average TDS and nitrate as nitrogen (nitrate-N) groundwater quality were calculated for the Inland Area, Baylands Area, and combined Inland/Baylands area. The average TDS concentrations of the Inland, Baylands, and combined areas are 372, 1,220, and 635 mg/L respectively. The average nitrate-N concentrations of the Inland, Baylands, and combined areas are 0.06, 0.07, and 0.06 mg/L, respectively.

As discussed in Appendix A of the SNMP, TDS and nitrate loading to the subbasin is a function of the volume of water recharged and the concentration of that water. The largest TDS load to the subbasin is from deep percolation of aerial precipitation and mountain front recharge, which are the represent the largest volumes of recharge. These two sources represents 57% of the overall TDS loading to the subbasin. However, the TDS concentration of recharge from these source waters is low; 250 mg/L for both precipitation infiltration and mountain front recharge. So while these two sources add TDS load, they act to improve overall groundwater quality with respect to TDS because their TDS concentration is lower than the ambient average groundwater quality (372 mg/L in the Inland Area. Agricultural (groundwater source water) return flow is the second largest TDS load (28% of total loading).

Figure 2-1: DWR Monitoring Wells



The TDS concentration of agricultural return flow is high (4,347 mg/L). As such, agricultural return flows add mass and reduce TDS groundwater quality. Sonoma Creek leakage (6% of total loading at a concentration of 21 mg/L) and municipal return (6% of total loading at a concentration of 1,182 mg/L) contribute the next highest mass of TDS to the subbasin. Septic system return flows (572 mg/L), agricultural (recycled water) return flow (4,344 mg/L), and subsurface inflow from the Baylands Area (1,220 mg/L) combined represent less than 2% of the TDS loading to the subbasin.

The largest nitrate load is agricultural (groundwater source water) return flow (at a concentration of 24 mg/L), which represents approximately 43% of the total nitrate loading to the subbasin. Municipal return flow (20 mg/L) is the second largest nitrate load (28% of total loading), followed by septic system return flow (20% at a concentration of 26 mg/L), deep percolation of aerial precipitation and mountain front recharge (4% at a concentration of 0.06 mg/) and agricultural (recycled water source water) return flow (3% at 24 mg/L). Sonoma Creek leakage (0.2 mg/L) and subsurface inflow from the Baylands Area (0.07 mg/L) represent minor nitrate loading factors in the subbasin.

2.3 Monitoring Programs

Groundwater quality in the Sonoma Valley has been monitored since 1949. Most data represent one-time samples for short-term studies or individual well-specific assessments. The GMP monitoring program and the proposed SNMP monitoring program rely on three existing ongoing programs:

- California Department of Water Resources (DWR) Monitoring
- California Department of Public Health (DPH) Required Monitoring
- Sonoma County Water Agency (Water Agency) Monitoring

The SNMP monitoring program will also collect and consider data from any other special studies conducted in the subbasin, such as studies conducted through the GMP to evaluate salinity sources in southern Sonoma Valley and studies conducted under the California Groundwater Ambient Monitoring and Assessment (GAMA) Program. Each program is described in the following sections.

2.4 DWR Monitoring

Beginning in the 1950s, DWR initiated the longest sustained water quality monitoring effort in the Sonoma Valley. Since the late 1950s the DWR has sampled and analyzed groundwater for major ions (calcium, magnesium, potassium, sodium, chloride and sulfate), boron, nitrate, TDS, total alkalinity, specific conductance or electrical conductance, pH, and water temperature. DWR has monitored 12 private volunteer water supply wells in Sonoma Valley on a regular basis since 2004. Figure 2-1 shows the locations of the current DWR monitoring wells. **Table 2-1** lists the wells and provides approximate location; construction information (if available); and the period of data available for EC, TDS, and nitrate. Total well depths are available for all wells and screened interval information is available for seven of the 12 wells.

Table 2-1: Current Wells Monitored by DWR

Well No.	DPH Well No.	Latitude	Longitude	Depth Drilled (feet)	Depth Cased (feet)	Depth of Top Perf. (feet)	Depth of Bottom of Perf. (feet)	Land Surface Elevation (ft-msl)	Period of Data		
									EC	TDS	Nitrate
5N/5W-8P2		38.2896	-122.4387	250	245	170	240	100	1974–2002	1974–2002	1974–2010
5N/5W-18D2		38.2839	-122.4608	75	75	—	—	—	1958–2004	1958–2004	1958–2010
5N/5W-20R1		38.2611	-122.4297	504	449	—	—	32	1969–2010	1958 - 2010	1958 - 2010
5N/5W-28N1		38.2453	-122.4268	130	110	—	—	11	1951–2002	1951–2002	1951–2010
5N/5W-28R1		38.2472	-122.4103	280	280	80	270	70	1971–2004	1971–2004	1971–2010
5N/6W-2N2		38.3038	-122.4983	171	171	150	167	135	1972–2010	1972–2010	1972–2010
5N/6W-12F1		38.2950	-122.4747	113	113	—	—	80	1958–2004	1958–2004	1958–2010
5N/6W-12M1		38.2914	-122.4794	60	58	49	57	80	1972 - 2010	1972 - 2010	1972 - 2010
5N/6W-25P2		38.2440	-122.4760	640	640	175	640	37	1968–2003	1970 - 2002	1970 - 2010
6N/6W-10M2		38.3791	-122.5172	228	224	84	224	320	1975–2004	1985 - 2004	1975–2010
6N/6W-26E1		38.3382	-122.4982	304	241	—	—	180	1958 -2010	1958 - 2010	1958 - 2010
7N/6W-29P1		38.3381	-122.4981	112	112	—	63	70	1957 - 2010	1957 - 2010	1957 - 2007

EC - electrical conductivity
TDS - total dissolved solids
Perf. - perforation

One half of the wells are typically sampled in odd numbered years and the remaining half in even numbered years, so that wells are sampled once every two years. DWR has confirmed that funding is available to continue this regular monitoring program (Nordberg, 2013). Currently analyzed water quality parameters are listed in **Table 2-2**. Indicator S/Ns to be included in the SNMP monitoring program are highlighted in orange.

Water quality data collected by DWR are provided to the Agency and incorporated into the GMP water quality database. Selected water quality data are analyzed and periodically reported in the GMP annual report (SCWA, 2011). The GMP reports are available online at the Agency website.

Table 2-2: Constituents Monitored by DWR

List of Constituents Monitored by DWR	
• pH	• Total dissolved solids (TDS)
• Specific conductance or electrical conductivity (EC) (field & lab)	• Chloride
• Temperature	• Sulfate
• Hardness	• Boron
• Calcium	• Bromide
• Magnesium	• Barium
• Potassium	• Iron
• Sodium	• Manganese
• Alkalinity	• Arsenic
• Bicarbonate	• Stable Isotopes of Oxygen and Hydrogen
• Nitrate	

2.5 DPH Monitoring

The DPH regulates public drinking water systems. A public drinking water system means a system for the provision of water for human consumption through pipes or other constructed conveyances that has 15 or more service connections or regularly serves at least 25 individuals daily at least 60 days out of the year. Private domestic wells and irrigation wells are not regulated by the DPH. The DPH regulates all public water systems in the State to ensure the delivery of safe drinking water from these systems.

The DPH establishes the monitoring requirements for drinking water wells and all the data collected must be reported to DPH by the well owner. Production wells that supply drinking water are regulated under Title 22 of the California Code of Regulations. Title 22 also establishes the regulatory limits for volatile organic compounds, non-volatile synthetic organic compounds, inorganic chemicals, radionuclides, disinfection byproducts, and other general physical constituents.

Public groundwater purveyors are obligated to collect groundwater samples to determine compliance with maximum contaminant levels (MCLs) in accordance with monitoring schedules developed by DPH based on the size of the water system. Purveyors are required to submit data directly to DPH via electronic transfer. The constituents monitored and the frequency of monitoring varies based on the well, size of the water system, and history of water quality monitoring results. DPH provides drinking water quality monitoring notification documents to water systems that identify upcoming required contaminant testing. These are updated periodically and vary for each water system. Sonoma's (District 18) monitoring schedule for small water systems can be found at:
http://www.cdph.ca.gov/certlic/drinkingwater/Documents/Monitoringschedule/DistrictReports-Monitoring%20Page/SonomaDistrict18.pdf

There are currently 26 wells with recent data (2000 to 2012) for at least one of the S/Ns; EC, TDS, and nitrate. The well data reported to the DPH may change in the future as wells are put on standby or abandoned and as new wells are drilled and operated. Accordingly, the DPH data included in the SNMP may change over time. However, the general geographic distribution and sampling frequency is not anticipated to vary significantly. **Figure 2-2** shows the approximate locations of wells in the DPH monitoring network. **Table 2-3** provides information on the wells. The table lists 39 wells including several City of Sonoma and Valley of the Moon Water District wells that have not been sampled recently for EC, TDS, or nitrate. Well depth and screened interval information is available for 12 of the 39 wells.

Water quality data reported to the DPH is incorporated by the Agency into the GMP water quality database. Selected water quality data are analyzed and periodically reported in the GMP annual report (SCWA, 2011). The GMP reports are posted on the Agency website.

2.6 SCWA Monitoring

In 2011, the Agency and GMP stakeholders installed two nested monitoring wells with drilling and construction funded through a Local Groundwater Assistance (LGA) grant. **Figure 2-3** shows the locations of the wells. Well depth and screened interval information is available for all the wells (**Table 2-4)**. At SVMW-1, four target zones were selected and a nested groundwater monitoring well was constructed comprising four individual nested 3-inch diameter polyvinyl chloride (PVC) well casings within a single borehole. At SVMW-2, five target zones were selected and a nested groundwater monitoring well was constructed comprising four individual nested 3-inch diameter PVC well casings within a single borehole and a separate shallow-zone groundwater monitoring well was constructed within a separate borehole adjacent to the nested well. Parameters analyzed by the Agency are shown in **Table 2-5**. Indicator S/Ns to be monitored for the SNMP monitoring program are highlighted in orange.

The wells have been sampled twice since their installation in November 2011 and September 2012. The Agency and GMP stakeholders intend to sample the wells a minimum of once per year. The water quality data will be analyzed and periodically reported in the GMP annual report and the report will be posted on the Agency website.

2.7 Special Studies

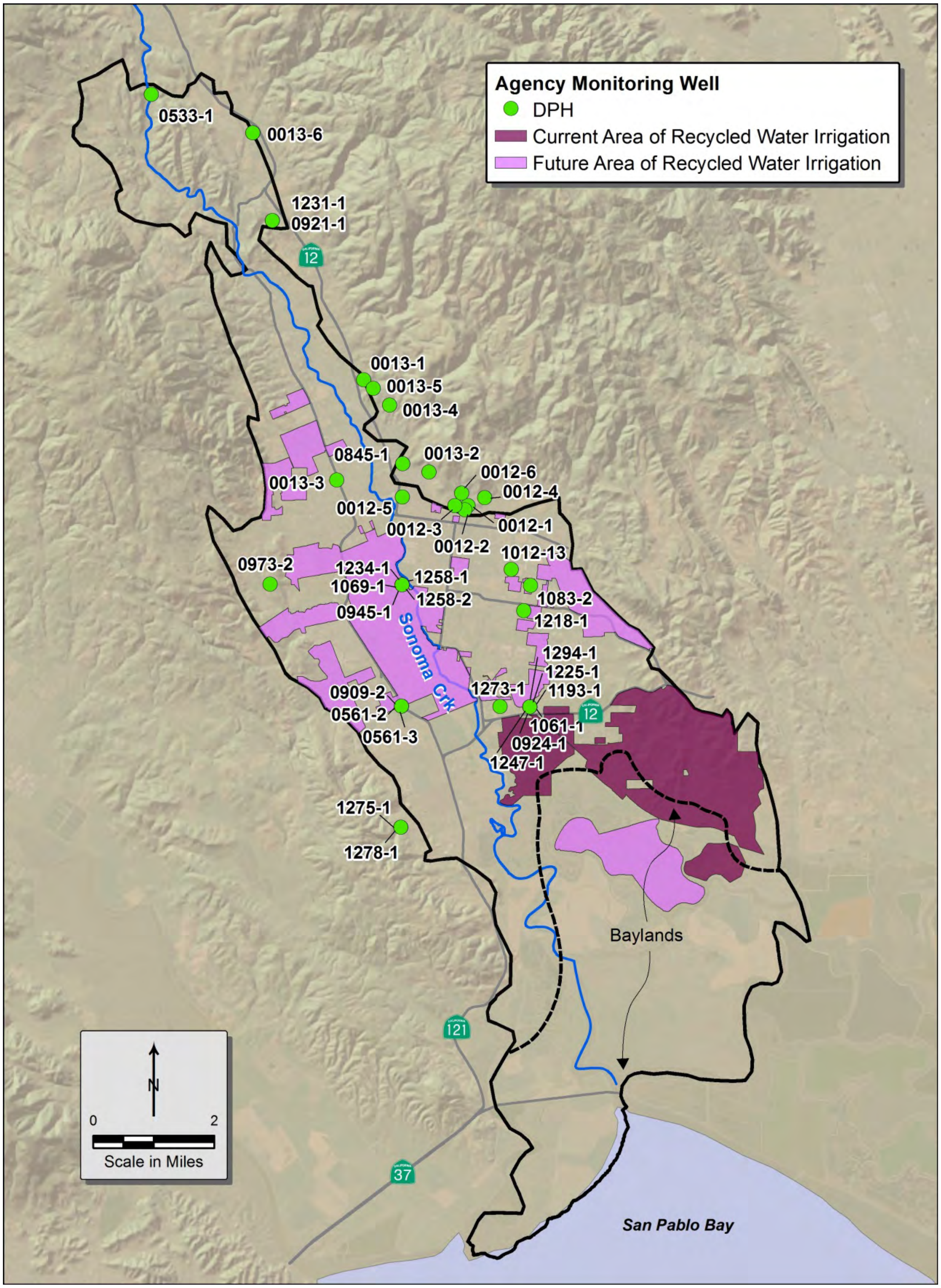
The United States Geological Survey (USGS) has also sampled and analyzed both surface and groundwater in Sonoma Valley for special studies. In 2002, 2003, and 2004, wells were sampled by USGS for the “Geohydrological Characterization, Water-Chemistry, and Ground-Water Flow Simulation Model of the Sonoma Valley Area, Sonoma County, California” (USGS, 2006). That report also incorporated sampling conducted under the (GAMA) Program for the North San Francisco Bay Hydrologic Region (USGS, 2004). Special studies associated with the GAMA program have also been conducted in Sonoma Valley, including “Interpretation of Isotopic Data in Sonoma Valley, California” (Moran, et al., 2010 and a Shallow Aquifer Assessment Program (USGS, in preparation).

Data from these special studies have been incorporated into the GMP water quality database. These and any future special studies that conduct S/N monitoring will be incorporated and reported through the SNMP monitoring program.

2.8 Monitoring Locations and Frequency

Figure 2-4 shows the monitoring locations that will be included in the SNMP monitoring program. The sampling points, frequency, and monitored parameters are described in **Table 2-6**. As mentioned previously, the DPH required monitoring frequency and constituents monitored are variable based on the well and DPH requirements. All available DPH S/N data will be incorporated in the SNMP monitoring program and described in monitoring reports.

Figure 2-2: DPH Monitoring Wells



Note: Well locations are approximate

Table 2-3: Wells Monitored for DPH

State Well No.	DPH Well No.	Latitude	Longitude	Depth Drilled (feet)	Depth Cased (feet)	Depth of Top Perf. (feet)	Depth of Bottom of Perf. (feet)	Land Surface Elevation (ft-msl)	Period of Data		
									EC	TDS	Nitrate
6N/6W-36M2	4910013-003	38.3020	-122.4940	214?	214?	140	214?	230	1989 - 2011	1989 - 2011	1989 - 2011
5N/6W-8B1	4900973-002	38.2770	-122.5140	380	380	90	380	968	1998 - 2012	1998 - 2012	1998 - 2012
5N/6W-12C1	4910012-005	38.2980	-122.4740	730	730	530	730	95	1982 - 2011	1982 - 2011	1982 - 2011
	4910012-001	38.2960	-122.4540	405	395	100	395	98		1988 - 2002	
5N/5W-7G1	4910012-002	38.2950	-122.4550	221	75	-	-	95		2008	
5N/5W-7F1	4910012-003	38.2960	-122.4580	263	165	-	-	95		2008	
5N/5W-7A2	4910012-004	38.2980	-122.4490	500	210	-	-	140		2008	
5N/5W-7C2	4910012-006	38.2990	-122.4560	250	266	140	236	120		2008	
5N/5W-17E1	4910012-013	38.2808	122.4409	861	666	473	646	69		2008	
6N/6W-35A1	4910013-001	38.3260	-122.4860	-	-	-	-	-		2008	
5N/6W-1J3	4910013-002	38.3040	-122.4660	460	440	140	440	125		2008	
5N/6W-2P2	4910013-004	38.3200	-122.4780	425	360	60	350	118		2008	
	4910013-005	38.3240	-122.4830	-	-	-	-	-		2008	
6N/6W-9A1	4910013-006	38.3850	-122.5200	265	258	41	258	320	1979 - 2001	1979 - 2001	1979 - 2001
	4910013-019	38.3850	-122.5200	-	-	-	-	-		2009	
	4900533-001	38.3940	-122.5510	-	-	-	-	-	2000 - 2009	2000 - 2009	2000 - 2011
	4900561-002	38.2480	-122.4740	-	-	-	-	-	1994 - 2011	1994 - 2011	1994 - 2011
	4900561-003	38.2480	-122.4740	-	-	-	-	-	1994 - 2011	1994 - 2011	1994 - 2011
	4900845-001	38.3060	-122.4740	-	-	-	-	-	1994 - 2009	1994 - 2009	1994 - 2009
	4900909-002	38.2480	-122.4740	-	-	-	-	-		2010 -2010	2000 - 2011
	4900918-001	38.3060	-122.4740	-	-	-	-	-	1992 - 2010	1992 - 2010	1992 - 2010
	4900921-001	38.3640	-122.5140	-	-	-	-	-			1997 - 2011
	4900924-001	38.2480	-122.4350	-	-	-	-	-			1997 - 2011
	4900945-001	38.2770	-122.4740	-	-	-	-	-			2001 - 2010
	4901061-001	38.2480	-122.4350	-	-	-	-	-	2010 - 2011	2010 -2010	2003 - 2011
	4901069-001	38.2770	-122.4740	-	-	-	-	-			1997 - 2012
	4901083-002	38.2770	-122.4350	-	-	-	-	-			2000 - 2011
	4901193-001	38.2480	-122.4350	-	-	-	-	-			2000 - 2010
	4901218-001	38.2710	-122.4370	-	-	-	-	-	2000 - 2000	2000 - 2000	2000 - 2012
	4901225-001	38.2480	-122.4350	-	-	-	-	-	1998 - 1998	1998 - 1998	1998 - 2010
	4901231-001	38.3640	-122.5140	-	-	-	-	-	1996 - 1996	1996 - 1996	1996 - 2012
	4901234-001	38.2770	-122.4740	-	-	-	-	-	1998 - 1998	1998 - 1998	1998 - 2011
	4901247-001	38.2480	-122.4350	-	-	-	-	-	2010 - 2011	2010 - 2010	1999 - 2011
	4901258-001	38.2770	-122.4740	-	-	-	-	-	2000 - 2000	2000 - 2000	2000 - 2011
	4901258-002	38.2770	-122.4740	-	-	-	-	-	2000 - 2000	2000 - 2000	2000 - 2011
	4901273-001	38.2480	-122.4440	-	-	-	-	-	2002 - 2002	2002 - 2002	2002 - 2011
	4901275-001	38.2190	-122.4740	-	-	-	-	-			2004 - 2011
	4901278-001	38.2190	-122.4740	-	-	-	-	-	2010 - 2010	2010 - 2010	2010 - 2012
	4901294-001	38.2480	-122.4350	-	-	-	-	-	2008 - 2011	2009 - 2011	2004 - 2012

EC - electrical conductivity
TDS - total dissolved solids
Perf. - perforation

Figure 2-3: Agency Monitoring Wells

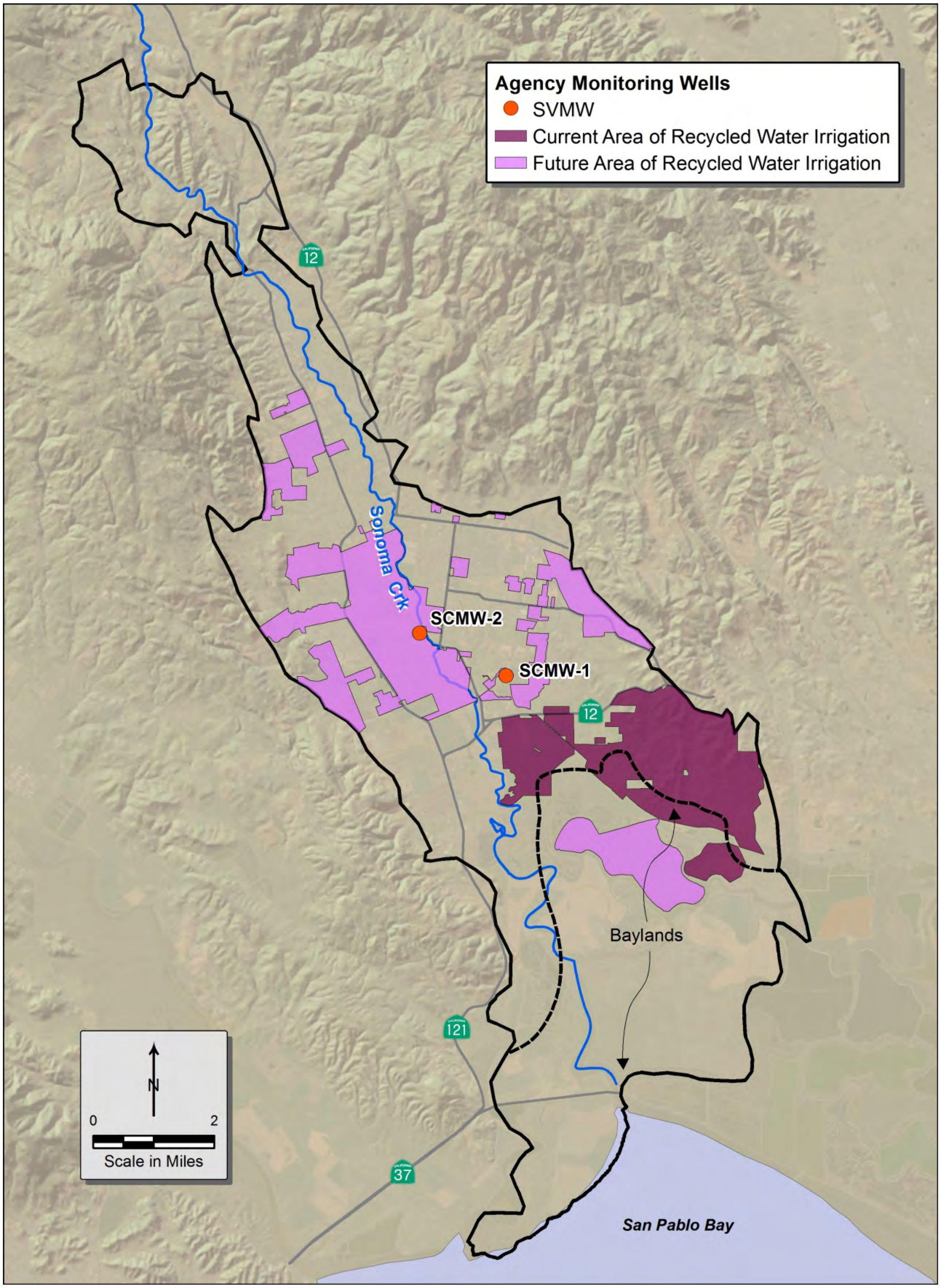


Table 2-4: Wells Monitored by the Agency

Well No.	DPH Well No.	Latitude	Longitude	Depth Drilled (feet)	Depth Cased (feet)	Depth of Top Perf. (feet)	Depth of Bottom of Perf. (feet)	Land Surface Elevation (ft-msl)	Period of Data			Owner	Well Name
									EC	TDS	Nitrate		
SVMW-1-95		38.2554	-122.4422	470	105	85	95	2.87 [1]	2011 - 2012	2011 - 2012	2011 - 2012	SCWA	MW-1
SVMW1-233		38.2554	-122.4422	470	243	223	233	22.83 [1]	2011 - 2012	2011 - 2012	2011 - 2012	SCWA	MW-1
SVMW1-365		38.2554	-122.4422	470	374	355	365	22.85 [1]	2011 - 2012	2011 - 2012	2011 - 2012	SCWA	MW-1
SVMW1-455		38.2554	-122.4422	470	465	440	455	22.83 [1]	2011 - 2012	2011 - 2012	2011 - 2012	SCWA	MW-1
SVMW2-52		38.2655	-122.4685	485		32	52	45.2 [1]	2011 - 2012	2011 - 2012	2011 - 2012	SCWA	MW-2
SVMW2-100		38.2655	-122.4685	485	110	80	100	45.43 [1]	2011 - 2012	2011 - 2012	2011 - 2012	SCWA	MW-2
SVMW2-220		38.2655	-122.4685	485	230	200	220	45.42 [1]	2011 - 2012	2011 - 2012	2011 - 2012	SCWA	MW-2
SVMW2-409		38.2655	-122.4685	485	419	374	384	45.42 [1]	2011 - 2012	2011 - 2012	2011 - 2012	SCWA	MW-2
SVMW2-480		38.2655	-122.4685	485	490	460	480	45.42 [1]	2011 - 2012	2011 - 2012	2011 - 2012	SCWA	MW-2

EC - electrical conductivity
TDS - total dissolved solids
Perf. - perforation
1 - Top of casing elevation

Table 2-5: Constituents Monitored by Agency

List of Constituents Monitored by Agency

- Temperature (field)
- pH (field and lab)
- Electrical conductivity (field and lab)
- Aluminum
- Antimony
- Arsenic
- Barium
- Beryllium
- Boron
- Bromide
- Cadmium
- Calcium
- Chloride
- Chromium
- Cobalt
- Copper
- Iron
- Lead
- Magnesium
- Manganese
- Mercury
- Molybdenum
- Nickel
- Potassium
- Selenium
- Silver
- Sodium
- Strontium
- Sulfate
- Titanium
- Vanadium
- Zinc Bicarbonate
- Carbonate
- Hardness
- Total Alkalinity
- Total Dissolved Solids
- Hydroxide
- Iodide
- Nitrate

Figure 2-4: SNMP Monitoring Program

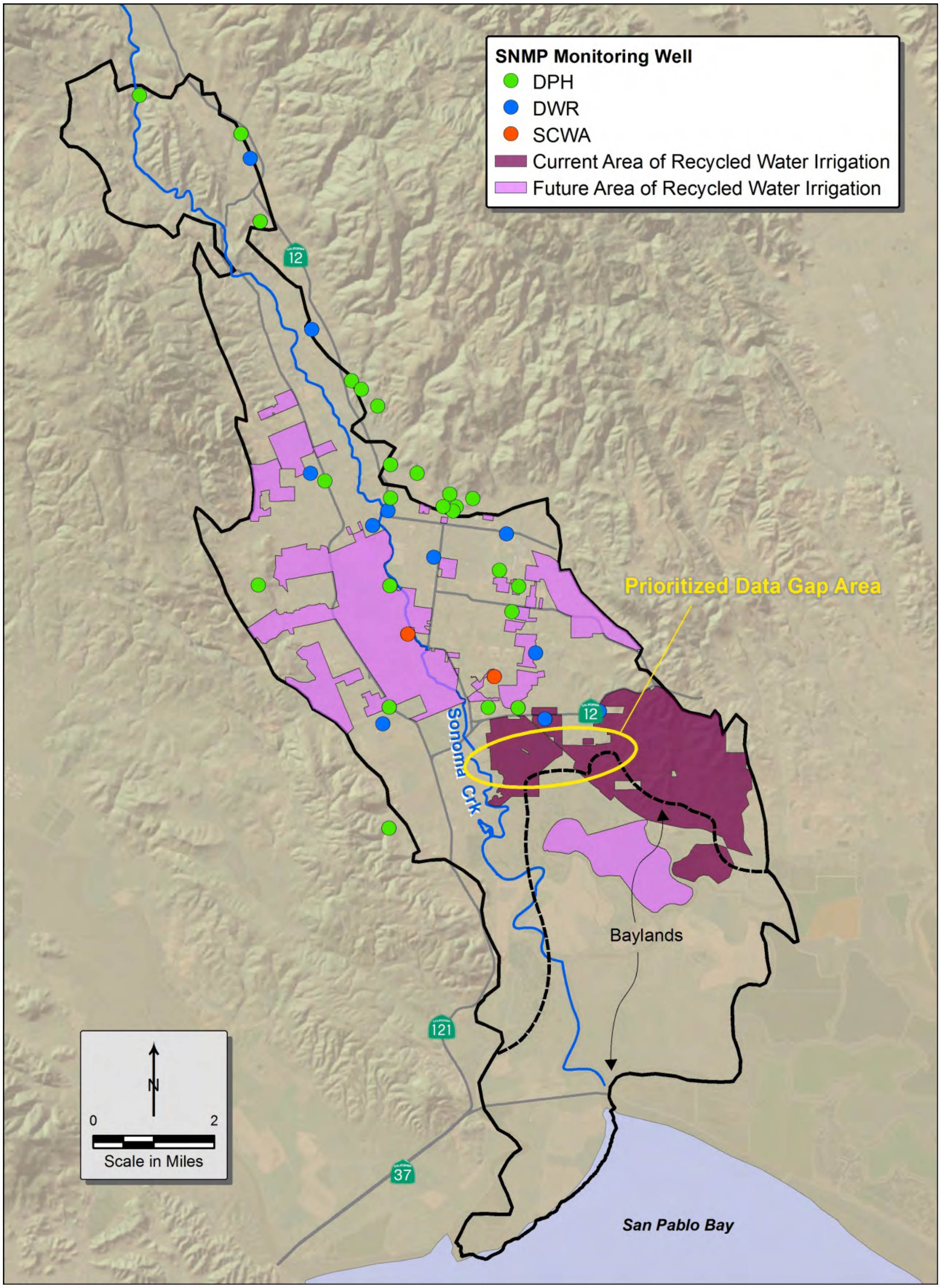


Table 2-6: SNMP Monitoring Program

Program	No. of Wells	Monitoring Frequency	Constituents
DWR	12	Every 2 years	EC, TDS, and nitrate
DPH	26 [1]	Typically every 3 years	EC, TDS, or nitrate
Agency	9	Once per year	EC, TDS, and nitrate

DWR – California Department of Water Resources
DPH – California Department of Public Health
Agency – Sonoma County Water Agency
EC – Electrical Conductivity
TDS – total dissolved solids
1 – Number of wells sampled may vary

2.9 Adequacy of Proposed Monitoring Program and Recommendations for Additional Data

In general, the proposed SNMP monitoring program described above is deemed adequate to monitor the spatial variability and transient change in S/N groundwater quality as required by the Recycled Water Policy. Specifically, the proposed monitoring program focuses on monitoring "basin water quality near water supply wells" and a number of wells are located within or proximate to areas of recycled water use. Additionally, shallow wells 5N/6W-12F1, 5N/6W-12M1 and SVMW2-52 are located in areas with connectivity with adjacent surface waters (i.e., Sonoma Creek). Nonetheless, three areas where additional data would benefit the SNMP monitoring program have been identified. These include:

- Characterization of well completions for wells in the monitoring program
- Additional monitoring well(s) immediately north of the Baylands Area
- Collection of TDS, EC, and nitrate from all DPH monitored wells

Well completion information for some wells is not available as shown in Tables 2-1, 2-3, and 2-4. More well completion information would allow better characterization of the vertical distribution of S/Ns in the subbasin. If a funding mechanism were available, the following is recommended for wells without well completion information:

- Contact the DPH and well owners to ask for available well completion information
- Review available DWR well logs for completion information on wells in the monitoring network

Figure 2-4 shows an area just north of the Baylands Area where additional monitoring would be desirable to monitor potential changes in the area of saline intrusion, if a funding mechanism was available. The additional monitoring point or points could include existing production wells, ideally with completion information, or new nested monitoring wells.

TDS, EC, and nitrate data are not available for all DPH monitored wells. It would be helpful if both TDS and nitrate were collected for all wells. The well owners could be asked to voluntarily provide both analyses to DPH, if not currently doing so.

2.10 Data Analysis and Reporting

Responsible Party

The monitoring data described above will be collected by the Water Agency. The data will be analyzed and reported to the RWQCB every three years by the SVCSD. The SNMP report will include the following:

- Discussion of TDS and EC water quality including
    - Water quality summary tables (TDS and specific conductance)
    - Water quality concentration maps (TDS and specific conductance)
    - Time-concentration plots (specific conductance) to assess trends
    - Comparison of detections with BPOs
- Status of recycled water use and stormwater capture projects and implementation measures

The SNMP monitoring program will be reviewed every three years as part of the triennial SNMP reporting.

Nitrate

As discussed in the *Salt and Nutrient Management Plan,* nitrate concentrations are typically low and well below the basin plan objective (BPO) and time-concentration plots indicate generally stable trends. Only one well (28N1) in the monitoring program shows an increasing nitrate trend. Accordingly, nitrate has not been a focus of analysis for the triennial GMP water quality report. For future SNMP reporting it is recommended that nitrate data be presented in summary tables, any concentrations approaching the BPO or increasing trends should be noted, and a time-concentration plot for 28N1 should be included to track future trends in this well. Water quality concentration maps are not recommended unless increasing nitrate concentrations are observed in the future.

Specific Conductance and TDS

It is recommended that the TDS and specific conductance maps and specific conductance time-concentration plots continue to be presented in the future SNMP report. TDS and specific conductance are equivalent and it is not necessary to present time concentrations plots for both. In addition, specific conductance is more frequently monitored. It is recommended that the BPO be plotted for reference on the time-concentration charts.

Evaluation Criteria

The criteria or performance measures to evaluate groundwater quality are the TDS/specific conductance and nitrate trends and concentrations. The BPOs are the primary evaluation criteria used to evaluate S/N groundwater quality. Accordingly, the monitoring report should discuss whether S/N concentration trends are generally consistent with the patterns described and predicted in SNMP. TDS, specific conductance, and nitrate groundwater quality should be compared with BPOs to determine if overall basins groundwater quality meets basin plan objectives and will continue to meet BPOs in the future.

Other

The monitoring reports should also discuss the status of recycled water and stormwater recharge projects and S/N implementation measures.

3 Sampling Protocols and QA/QC

Groundwater sampling is conducted by trained professionals from the Agency, DWR, USGS, and water providers (for DPH required monitoring). The DWR, USGS, DPH, and Agency sampling follows established industry standards. A formal sampling protocol and QA/QC program for the recently installed Agency nested monitoring wells has not yet been established. Accordingly, this TM describes the recommended sampling protocol and QA/QC program for the Agency nested well sampling. Sampling protocols and QA/QC procedures for each of these four programs are described below.

3.1 DWR Sampling Procedures

The DWR does not have formalized sampling procedures, but follows standard industry protocols (Nordberg, 2013). DWR typically samples a well from an outside water hose tap. Water is allowed to run through a flow-through cell until field parameters including pH, temperature, dissolved oxygen (DO), oxidation-reduction potential (ORP), and TDS stabilize. Then, the sample is collected in prepared bottles provided by the laboratory. Samples are placed in coolers with ice packs and transported to an in-house laboratory called Bryte Labs following standard chain-of-custody procedures.

Bryte Labs QA/QC procedures follow United States Environmental Protection Agency (USEPA) policy guidelines outlined in the *Interim Guidelines and Specifications for Preparing Quality Assurance Project Plans*, QAMS-005/80 and also meet the DPH, Environmental Laboratory Accreditation Program. QA/QC may include equipment, field, and trip blanks for field sampling; and duplicates, method and instrument blanks for laboratory checks. These blanks and duplicates monitor:

- contamination from the collection, transport, and storage of the samples
- contamination that originates in the lab or exists in the analytical procedure
- repeatability or precision of the analytical method.

The types of blanks and duplicates collected depend upon the constituents being analyzed. Trip blanks are typically only needed if volatile organic compounds are being analyzed.

3.2 DPH Sampling Procedures

The DPH (formally California Department of Health Services (DHS)) has established formal sampling procedures *Water Sampling Manual* (DHS, 2006). Water suppliers are to send samples to State-certified laboratories and follow the sampling and QA/QC requirements of those laboratories. Samples are to be taken before the check valve on the wellhead and collected after the well has been pumped sufficiently to ensure that the sample represents the groundwater source (DPH, 2013).

Laboratories are to meet various requirements available on DPH's website:
http://www.cdph.ca.gov/certlic/drinkingwater/Pages/Labinfo.aspx

QA/QC may include the analysis of duplicates and equipment, field, trip, method, and instrument blanks.

3.3 SCWA Sampling Procedures

The two nested monitoring wells will be sampled by the Water Agency. Purging and sampling of each of the nine intervals (four in SVMW-1 and five in SVMW-2) will follow standard monitoring well sampling guidelines such as those presented in the *National Field Manual for the Collection of Water-Quality Data* (USGS, 2010) http://water.usgs.gov/owq/FieldManual/chapter4/html/Ch4_contents.html.
These procedures are described in the following sections.

3.3.1 Purging and Sampling

Generally, the nested wells may be purged prior to sample collection. Purging is conducted until field instruments indicate that water quality parameters (pH, ORP, specific conductance, and temperature) have stabilized and turbidity measurements are below five Nephelometric Turbidity Unit (NTUs). Industry-accepted purge methods include purging a standard three casing volumes as well as no-purge and low-flow purge methods. Any of these methods, as well as new industry- and regulatory-accepted sampling technologies, may be used. The method used will demonstrate that the sample collected is representative of formation water and not stagnant water in the well casing or well filter pack.

All groundwater samples are collected in laboratory supplied pre-labeled containers and include prescribed preservatives.

3.3.2 Record Keeping and Sample Transport

All field measurements will be recorded in a field logbook or worksheets and the sample containers will be labeled correctly and recorded on the chain-of-custody form. The applicable chain-of-custody sections will be completed and forwarded with the samples to the laboratory. Upon receipt of the samples at the laboratory, laboratory personnel will complete the chain-of-custody. Samples will be shipped to the laboratory in sealed insulated shipping containers (ice chests) to maintain the samples at approximately 4°C.

3.3.3 QA/QC

Field QA/QC

QA/QC assessment of field sampling will include field blanks and duplicates as described below.

Field Blank - Field blanks identify sample contamination that is associated with the field environment and sample handling. These samples will be prepared in the field by filling the appropriate sample containers with the distilled water used for cleaning and decontamination of all field equipment. One field blank per sampling will be collected.

Duplicates - Duplicates document the precision of the sampling and analytical process. A duplicate is a second sample collected concurrently with the primary sample using the exact same method and analysis. Duplicates will not be identified as to their primary sample source to the laboratory. One duplicate per sampling will be collected.

Laboratory QA/QC

Samples will be sent to a State-certified laboratory that has in place a documented analytical QA/QC program that includes procedures to reduce variability and errors, identify and correct measurement problems, and provide a statistical measure of data quality. The laboratory will conduct all QA/QC procedures in accordance with its QA/QC program. All QA/QC data shall be reported in the laboratory analytical report, including: the method, equipment, and analytical detection limits, the recovery rates, an explanation for any recovery rate that is less than 80 percent, the results of equipment and method blanks, the results of spiked and surrogate samples, the frequency of quality control analysis, and the name of the person(s) performing the analyses. Sample results shall be reported unadjusted for blank results or spike recovery.

3.4 USGS Special Studies

USGS sampling is conducted in compliance with standard monitoring well sampling guidelines presented in the *National Field Manual for the Collection of Water-Quality Data* (USGS, 2010) http://water.usgs.gov/owq/FieldManual/.

4 References

California Department of Health Services (DHS) Drinking Water and Environmental Management Division, Sanitation and Radiation Laboratories Branch, Microbial Disease Laboratory Branch, January 06, 2006, "Water Sampling Manual"

California Department of Public Health (DPH) Sonoma and Mendocino Field Office, April 24, 2013, "Personal Communication"

California Department of Water Resources (CDWR), April 2012, "Bryte Chemical Laboratory Quality Assurance Manual, Quality Assurance Technical Document 8"

Nordberg, Mark, California Department of Water Resources (DWR), April 2013, "Verbal communications"

Sonoma County Water Agency (SCWA), December 2007, "Sonoma Valley Groundwater Management Plan"

Sonoma County Water Agency (SCWA), December 30, 2011, "Sonoma Valley Groundwater Management Plan 2010 annual Report"

Sonoma County Water Agency (SCWA), July 2012, "Well Completion Technical Memorandum for Nested Groundwater Monitoring Wells SVMW-1 & SVMW-2, Sonoma Valley"

State Water Resources Control Board (SWRCB), May 2009, "Draft Recycled Water Policy", amended September 2012, October 2012, and January 2013, approved January 2013

United States Environmental Protection Agency (USEPA), Revised January 19, 2012, "Low Stress (Low Flow) Purging and Sampling Procedure for the Collection of Groundwater Samples from Monitoring Wells"

United States Geological Survey, 2004, "Ground-Water Quality Data in the North San Francisco Bay Hydrologic Provinces, California, 2004: results from the California Ground-Water Ambient Monitoring and Assessment (GAMA) Program", Data Series 167

United States Geological Survey, 2006, "Geohydrologic Characterization, Water-Chemistry, and Ground-Water Flow Simulation Model of the Sonoma Valley Area, Sonoma County, California", Scientific Investigation Report 2006-5092

United States Geological Survey (USGS), (variously dated) Compiled 2012, "National Field Manual for the Collection of Water-Quality Data, Techniques of Water-Resources Investigations, Book 9 Chaps. A1-A9", http://pubs.water.usgs.gov/twri9A

Appendix F - Regional Water Quality Control Board Basin Planning Template

DRAFT

Attachment A to Resolution No. __________

[NO THREAT BASIN EXAMPLE]
Amendment to the Water Quality Control Plan – [*Region*] to Incorporate the Groundwater Quality Management Plan for the [*Basin(s)*]

Adopted by the California Regional Water Quality Control Board, [*Region*] on [*Date*].

This groundwater quality management plan satisfies the Recycled Water Policy requirement for salt/nutrient management plans. This groundwater quality management plan applies to groundwater basin(s) considered a low threat for impairment of groundwater quality.

Amendments:

Table of Contents

Chapter X. Groundwater Quality Management Plans <This would potentially be a new chapter to the Basin Plan>

X-X Groundwater Quality Management Plan for Low Threat to Groundwater Quality Basins
[List…]

List of Figures, Tables and Inserts

Chapter X. Groundwater Quality Management Plans

Tables
X-X [*Basin(s)*] Salt/Nutrient Management and Related Effects
X-X.1 [*Basin(s)*] Salt/Nutrient Management and Related Effects: Elements
X-X.2 [*Basin(s)*] Salt/Nutrient Management and Related Effects: Implementation Schedule

Chapter X. Groundwater Quality Management Plan
[*Basin(s)*] Groundwater Quality Management Plan

This [*Basin(s)*] Groundwater Management Plan was adopted by: The Regional Water Quality Control Board on [*Date*].
This [*Basin(s)*] Groundwater Management Plan was approved by: The State Water Resources Control Board on [*Date*].
This [*Basin(s)*] Groundwater Management Plan was approved by: The Office of Administrative Law on [*Date*].
This [*Basin(s)*] Groundwater Management Plan was approved by: U.S. Environmental Protection Agency on [*Date*].
This [*Basin(s)*] Groundwater Management Plan is effective on [*Date*].

The following tables include the elements of this Groundwater Quality Management Plan.

DRAFT

Attachment A to Resolution No. __________

Table X-X.1. [*Basin*] Groundwater Quality Management Plan and Related Effects: Elements

Element	Key Findings and Regulatory Provisions
Purpose Statement	***Is the groundwater basin impaired or threatened to be impaired by [nutrients, salts, and other constituents]?*** Overall, water quality in the Sonoma Valley Subbasin is very good and the subbasin is not impaired. Generally, TDS is less than Basin Plan Objectives (BPOs) of 500 milligrams per liter (mg/L) through most of the basin, with concentrations reaching above 500 mg/L in the southeastern portion of the basin that borders San Pablo Bay due to brackish water intrusion. These elevated concentrations are consistent with historical brackish groundwater reported in that area of the basin. This southeastern portion of the basin (delineated as "Baylands Area" in the Salt and Nutrient Management Plan [SNMP]) is impaired (brackish), and further brackish water intrusion is a concern in the basin. Nitrate levels are generally very low with a basin average of roughly 0.06 mg/L, well below the BPO of 10 mg/L, therefore the basin is not impaired or threatened to be impaired by nutrients. ***What are the effects of increased levels of [nutrients, salts, and other constituents] on the beneficial uses of groundwater and surface water? What detrimental effects are attributed to [nutrients, salts, and other constituents]? Concerns involving taste and odor, toxicity, human health, crop yields, etc.*** Increased TDS levels from brackish water intrusion affect the municipal and agricultural beneficial uses of the groundwater subbasin in the Baylands Area. Highly saline water becomes non-potable (due to taste), and from an agricultural perspective, there exists the potential for crop damage and stunted plant growth. While TDS levels within the subbasin are not high enough to warrant a health threat to humans, levels above 1,000 mg/L may have an objectionable taste and odor. Increased levels of nutrients could also affect the beneficial uses of the groundwater subbasin; however, basin-wide average nitrate levels are far below the BPO and nitrate contamination is not a concern. ***Are surface water and/or groundwater affected by [nutrients, salts, and other constituents]?*** Groundwater is affected by brackish water intrusion in the southeastern portion of the subbasin, which borders San Pablo Bay, but is not affected by salts and nutrients in the Inland Area due to the few sources and high amount of flushing from precipitation and mountain front recharge. Surface water is affected by excess sediment,

Element	Key Findings and Regulatory Provisions
	pathogens and nutrients and there are existing total maximum daily load (TMDL) programs in place for these constituents. ***Is groundwater quality affected by [nutrients, salts, and other constituents] in surface water; and vise versa?*** Because both groundwater and surface water quality (for TDS and nitrate) are good and below BPOs, water quality impacts from one on the other are minimal. A small percentage of inflow (11% or about 6,400 acre-feet per year [AFY]) into the groundwater subbasin is from surface waters, which have a low estimated average TDS concentration of 210 mg/L and average nitrate concentration of 0.19 mg/L. Average Inland Area (excluding the Baylands Area) groundwater quality is 372 mg/L for TDS and 0.07 mg/L for nitrate. Therefore, surface water leakage to groundwater adds TDS and nitrate load, but improves TDS groundwater quality (i.e., average TDS in surface water is lower than in groundwater) and degrades nitrate groundwater quality very slightly (i.e., average nitrate in surface water is higher than in groundwater). Groundwater discharge to surface water is about 51,000 AFY. Groundwater discharge to surface water adds TDS and nitrate load; degrades TDS surface water quality slightly (i.e., average TDS in groundwater is higher than in surface water) and improves nitrate surface water quality slightly (i.e., average nitrate in groundwater is lower than in surface water). ***What are the beneficial uses (i.e., MUN, AGR, IND, FRSH, AQUA, etc.) of groundwater in the [Basin(s)]?*** The Sonoma Valley Subbasin has both MUN and AGR as existing beneficial uses. IND and PROC are listed as potential beneficial uses. ***What regulatory provisions are there to protect beneficial uses related to impacts by [nutrients, salts, and other constituents]; such as, Resolution No. 68-16 (Antidegradation Policy), etc.?*** Resolution No. 68-16 protects the beneficial uses of water bodies related to impacts associated with increased nutrients, salts, and other constituents. The Sonoma Valley County Sanitation District provides recycled water to the area under a Recycled Water Permit (Order 92-067), which includes stringent guidelines to ensure proper application to minimize runoff. The SNMP finds that the use of recycled water can be increased while still protecting groundwater quality.
Narrative and Numeric Water Quality Objectives *(Interpretation of the narrative and numeric water*	***What are the bases for narrative and numeric Water Quality Objectives (WQOs) for the Groundwater Quality Management Plan?*** The Water Quality Objective (WQO) for TDS is based on the California Department of Public Health's

Element	Key Findings and Regulatory Provisions
quality objective, used to calculate the load allocations)	(CDPHs) adoption of a secondary maximum contaminant level (SMCL) for TDS. SMCLs address aesthetic concerns like odor, taste, and color and are not related to health concerns. The BPO for TDS is 500 mg/L, following the SMCL adopted by the CDPH. The objective for TDS allows an upper limit of 1,000 mg/L with a short-term limit of 1,500 mg/L. For nitrates, the BPO is set at the maximum contaminant level (MCL) of 10 mg/L. ***What are the narrative and numeric WQOs?*** Narrative: Bacteria, Organic and Inorganic Chemical Constituents, Radioactivity, and Taste and Odor Relevant numeric WQOs for Municipal and Agricultural Supply: TDS = 500 mg/L (municipal), 10,000 mg/L (agricultural) Nitrate-N = 10 mg/L (municipal), 22.22 mg/L (agricultural)
Source Analysis	***Point sources and non-point sources: <Explain and identify sources and loads from sources. Sources should be inventoried.>*** Most of the constituent sources are associated with point sources from agricultural and rural areas. These sources include irrigation water, agricultural inputs, residential inputs, and animal waste. 1. Irrigation water. This includes potable water, surface water, groundwater, and recycled water. 2. Agricultural inputs. This includes fertilizer, soil amendments, and applied water. 3. Residential, commercial and industrial inputs. This includes septic systems, fertilizer, soil amendments, and applied water. 4. Animal waste. This includes dairy manure land application. Urban loads are assumed to be routed to municipal wastewater systems for recycling or discharge rather than to the groundwater, with the exception of landscape irrigation. Non-point sources, like atmospheric deposition, are not considered to be a main source of the constituents of concern. Potential subsurface inputs of high salinity include San Pablo Bay, thermal water upwelling, and existing connate groundwater within the basin. ***Explain factors that contribute to the basin not being impaired or threatened to be impaired (e.g., high precipitation, few and low-volume sources, etc.).*** The findings from the technical analysis completed for the SNMP indicate that overall groundwater quality in the basin is stable with low salinity and nutrient values resulting from a combination

Element	Key Findings and Regulatory Provisions
	of factors including the high percentage of mountain front and precipitation recharge with very low TDS and nitrate concentrations, the low amount of loading from the few sources identified, and the low volume and high quality of recycled water used for irrigation.
Basin Water Quality	***Is groundwater quality being maintained? What is the mass balance of constituents within the basin?*** Current groundwater quality within the basin is being maintained. Both TDS and nitrate have relatively stable concentrations from the period of record, which are predicted into the future through 2035. ***What is the basin-wide average concentration for constituents?*** TDS: Inland Area = 372 mg/L; Baylands Area = 1,220 mg/L Nitrate-N: Inland Area = 0.06 mg/L; Baylands Area = 0.07 mg/L ***Provide maps showing basin characteristics: locations of wells, water quality, contour maps of TDS, nitrogen and other contaminants*.** Groundwater subbasin, drainages, recycled water use areas: Figure 2-1 Groundwater elevation map: Figure 2-2 Location of wells: Figures 5-3, 5-5, 9-1 Water quality: Figures 5-3 (TDS), 5-5 (Nitrate) Contour map of TDS: Figure 5-2 Contour map of nitrate: Figure 5-4 Land use: Figure 6-1
Potential for Impairment	***Acknowledge types of activities or land uses that have the potential to degrade groundwater (fertilizer use, manure spreading, recycled water application etc.).*** Land uses that have the most potential to degrade groundwater quality are vineyards, pasture land, urban residential areas, and farmsteads or rural-residential areas. Other land uses which contribute to the TDS and nitrate loading of the basin are dairy operations, urban landscape or golfing areas, non-irrigated field crops, and urban commercial and industrial areas. Each of these land uses was a designated loading factor for nitrogen and TDS, as well as applied water and percent irrigated.
Recycled Water Projects	***List recycled water projects/uses*.** As discussed in Chapter 4 of the SNMP, planned future recycled water projects include expanding agricultural irrigation within the Valley; serving irrigation water to large, urban landscape areas (i.e. Sonoma Valley High School, The Plaza, Sonoma Mission Inn Golf Course, etc); and environmental enhancement through the Napa-Sonoma Salt Marsh Restoration Project. ***Provide general information, categories and/or specific***

Element	Key Findings and Regulatory Provisions
	discharges. The volume of recycled water currently used within the Sonoma Valley Subbasin is approximately 1,110 AFY; and is expected to increase to around 4,100 AFY by 2035. The majority of recycled water application is for irrigation and therefore, it is most typically applied in the summer and fall months. Recycled water application follows stringent guidelines within the Recycled Water Permit (Order 92-067). These guidelines include irrigating at agronomic rates and other best management practices (BMPs) which target minimizing irrigation runoff.
Limitations	***Describe limitations and uncertainties associated with the development of the Plan.*** Spatially, while historical information from the Baylands brackish area was available, no known wells currently exist in the Baylands Area and therefore no current groundwater quality information was available. Vertically within the aquifer, many wells lack well construction information rendering the depth of many wells unknown. Without sufficient depth-specific well screen information, water quality for shallow and deep zones could not be distinguished. Therefore, the simplicity of the mixing model is a limitation, because it simulates two big "buckets" (Inland and Baylands areas with movement between) and mixing is instantaneous. Additionally, verification of assumptions/estimates for individual anthropogenic loading sources during the calibration process was limited by the sensitivity of groundwater quality to and dominance of natural inflows (precipitation and stream recharge) in Sonoma Valley. Data collected as part of the SNMP Groundwater Monitoring Program will help to determine if relatively flat trends predicted by the SNMP are verified in the future. Information used to derive future conditions was obtained from planning documents such as Urban Water Management Plans; however, this information is projected on a 20-year planning horizon and can change. For instance recycled water expansion is planned to serve additional agricultural irrigation customers and the urban area of the City of Sonoma; however, exact sites and demands may shift as projects are implemented in the future. To address this, the SNMP Groundwater Monitoring Plan will assess changes in recycled water use on a triennial basis.
Monitoring Plan	***Monitoring Plan:*** ***What are the types of monitoring is required (i.e., ambient, site specific, groundwater, surface water, discharges, recycled water, effectiveness of the Implementation Plan, etc.)? What is the goal or need of the monitoring program(s)?*** The Plan requires groundwater monitoring, with the ultimate goal of determining if the salt and nutrient concentrations remain below BPOs and future trends are consistent with those outlined in the SNMP. ***Who is responsible for implementing the monitoring***

Element	Key Findings and Regulatory Provisions
	program(s)? Because the SNMP monitoring program relies on three existing programs, those responsible for implementing the existing programs will also be responsible for implementing the SNMP monitoring program. Those entities are the California Department of Water Resources (DWR), the California Department of Public Health (CDPH), and the Sonoma Valley Groundwater Management Program (SVGMP). ***What shall be analyzed and the frequency?*** Electrical conductivity (EC), total dissolved solids (TDS), and nitrate are analyzed. Because the monitoring plan relies on the current monitoring conducted by DWR, CDPH, and SVGMP, the frequency will follow those monitoring schedules. Namely, DWR wells will be monitored every 2 years, CDPH wells will be monitored between one and three years, and SVGMP wells will be monitored annually. ***Where are the monitoring locations?*** The 47 monitoring locations are spread throughout Sonoma Valley, with the majority clustered in the northern portion of the subbasin. ***What are the reporting requirements?*** Monitoring results will be reported through the Geotracker database system to the Regional Water Board every three years and will include an SNMP Groundwater Monitoring Report. ***Review period and reopener: The basin monitoring plan will be reviewed on a _3_ year basis. Implementation Schedule, Table X-X.2***
Implementation Plan	***Describe any actions resulting from the plan.*** There are no new implementation measures resulting from the SNMP, the SNMP only endorses current groundwater supply and quality management measures underway within the subbasin and these are not considered actions resulting from the Plan. ***Special Studies (What special studies are needed and why? The schedule for the special studies [Implementation Schedule, Table X-X.2]?*** No special studies are recommended to be undertaken as part of this SNMP. ***Include goals and objectives for recycled water and stormwater recharge/use.*** The overall goal for both recycled water and stormwater recharge/use is to increase water supplies and supply reliability within the groundwater subbasin, and decrease the amount of pumping and strain on groundwater supplies. For the SNMP, recycled water goals and objectives are based on information provided in 2010 UWMPs and 2012 recycled water usage data. Recycled water goals were set based on 2010 UWMP recycled water use projections. No quantitative goals were set for stormwater recharge/use in this SNMP because planning efforts and specific projects for

Element	Key Findings and Regulatory Provisions
	stormwater recharge in the basin are now underway which would establish these objectives.

Environmental Considerations

Because the Salt and Nutrient Management Plan does not recommend or require any new implementation measures, it does not fit the definition of a “project” under CEQA, and thus does not require the completion of a CEQA document. According to Section 21065 of CEQA:

“Project” means an activity which may cause either a direct physical change in the environment, or a reasonably foreseeable indirect physical change in the environment

As described in further detail in the table on the following pages, the SNMP does not include implementation of any new actions that would have potential to affect any environmental resources.

Resource Categories	Potential Impacts	Significance
Aesthetics	None. The SNMP does not recommend new implementation measures; therefore, no aesthetic impacts are anticipated as part of Plan approval.	No impact
Agriculture and Forest Resources	None. The SNMP does not recommend new implementation measures; therefore, no agriculture and forest resources impacts are anticipated as part of Plan approval.	No impact
Air Quality	None. The SNMP does not recommend new implementation measures; therefore, no air quality impacts are anticipated as part of Plan approval.	No impact
Biological Resources	None. The SNMP does not recommend new implementation measures; therefore, no biological resource impacts are anticipated as part of Plan approval.	No impact
Cultural Resources	None. The SNMP does not recommend new implementation measures; therefore, no cultural resource impacts are anticipated as part of Plan approval.	No impact
Geology and Soils	None. The SNMP does not recommend new implementation measures; therefore, no geology and soil impacts are anticipated as part of Plan approval.	No impact
Greenhouse Gas Emissions	None. The SNMP does not recommend new implementation measures; therefore, no greenhouse gas emissions are anticipated as part of Plan approval.	No impact
Hazards and Hazardous Materials	None. The SNMP does not recommend new implementation measures; therefore, no hazard and hazardous material impacts are anticipated as part of Plan approval.	No impact
Hydrology and Water Quality	No negative impacts. The SNMP does not recommend new implementation measures; therefore, no negative hydrology and water quality impacts are anticipated as part of Plan approval. Plan approval does result in beneficial water quality outcomes by formalizing a groundwater monitoring program and through a number of projects in which the Plan promotes.	No negative impact/ Beneficial impact
Land Use and Planning	None. The SNMP does not recommend new implementation measures; therefore, no negative land use and planning impacts are anticipated as part of Plan approval.	No impact
Mineral Resources	None. The SNMP does not recommend new implementation measures; therefore, no negative mineral resource impacts are anticipated as part of Plan approval.	No impact

Resource Categories	Potential Impacts	Significance
Noise	None. The SNMP does not recommend new implementation measures; therefore, no noise impacts are anticipated as part of Plan approval.	No impact
Population and Housing	None. The SNMP does not recommend new implementation measures; therefore, no population and housing impacts are anticipated as part of Plan approval.	No impact
Public Services	None. The SNMP does not recommend new implementation measures; therefore, no public service impacts are anticipated as part of Plan approval.	No impact
Recreation	None. The SNMP does not recommend new implementation measures; therefore, no recreation impacts are anticipated as part of Plan approval.	No impact
Transportation/Traffic	None. The SNMP does not recommend new implementation measures; therefore, no transportation/traffic impacts are anticipated as part of Plan approval.	No impact
Utilities and Service Systems	None. The SNMP does not recommend new implementation measures; therefore, no utilities and service system impacts are anticipated as part of Plan approval.	No impact
Mandatory Findings of Significance	While the SNMP does not recommend new implementation measures, the projects and activities it endorses provide a net benefit to the region.	Beneficial impact