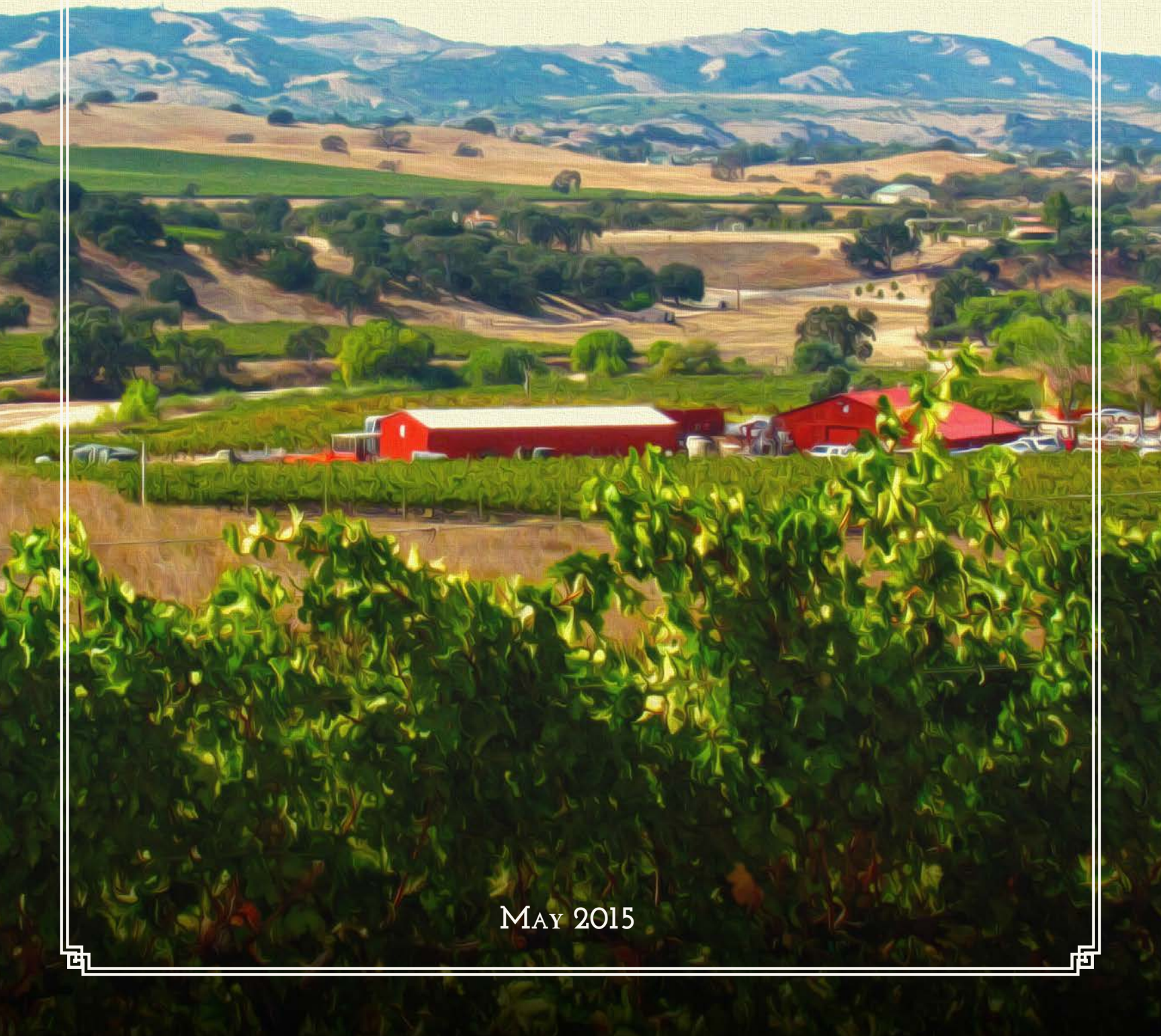
Salt/Nutrient Management Plan for the Paso Robles Groundwater Basin



May 2015

Salt/Nutrient Management Plan for the Paso Robles Groundwater Basin

Final Report

Prepared by:

May 2015

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List of Abbreviations

Act	Sustainable Groundwater Management Act
AF	Acre-feet
AFY	Acre-feet per year
AMWC	Atascadero Mutual Water Company
Basin	Paso Robles Groundwater Basin
Basin Plan	Water Quality Control Plan for the Central Coastal Basin
Basin Study	Paso Robles Groundwater Basin Study
bgs	Below ground surface
BMO	Basin management objectives
BMP	Best Management Practice
CCGC	Central Coast Groundwater Coalition
CCRs	California Code of Regulations
CCRWWCB	Central Coast Regional Water Quality Control Board
CEC	Constituents of emerging concern
CIMIS	California Irrigation Management Information System
CSA	County Service Area
CSD	Community Service District
DDW	Department of Drinking Water
DWR	Department of Water Resources
ETo	Evapotranspiration
GAMA	Groundwater Ambient Monitoring & Assessment Program
GIS	Geographical Information System
gpd	Gallons per day
gpm	Gallons per minute
GSAs	Groundwater Sustainability Agencies
GSPs	Groundwater Sustainability Plans
GWMP	Groundwater Management Plan
IRWM	Integrated Regional Water Management
LID	Low impact development
MCLs	Maximum contaminant levels
mg/L	Milligram per liter
mgd	Million gallons per day
N	Nitrogen
NPDES	National Pollutant Discharge Elimination System
NWP	Nacimiento Water Project
PRGMP	Paso Robles Groundwater Management Plan
RWMP	Recycled Water Master Plan
RWQCB	Regional Water Quality Control Board
S/Ns	Salt and nutrients
Selby Ponds	Selby Percolation Pond Site
SNMP	Salt and Nutrient Management Plan
SWP	State Water Project
SWRCB	State Water Resources Control Board
TDS	Total Dissolved Solids
TM	Technical Memoranda
USGS	United States Geological Survey
VOC	Volatile organic compounds
WQO	Water Quality Objective

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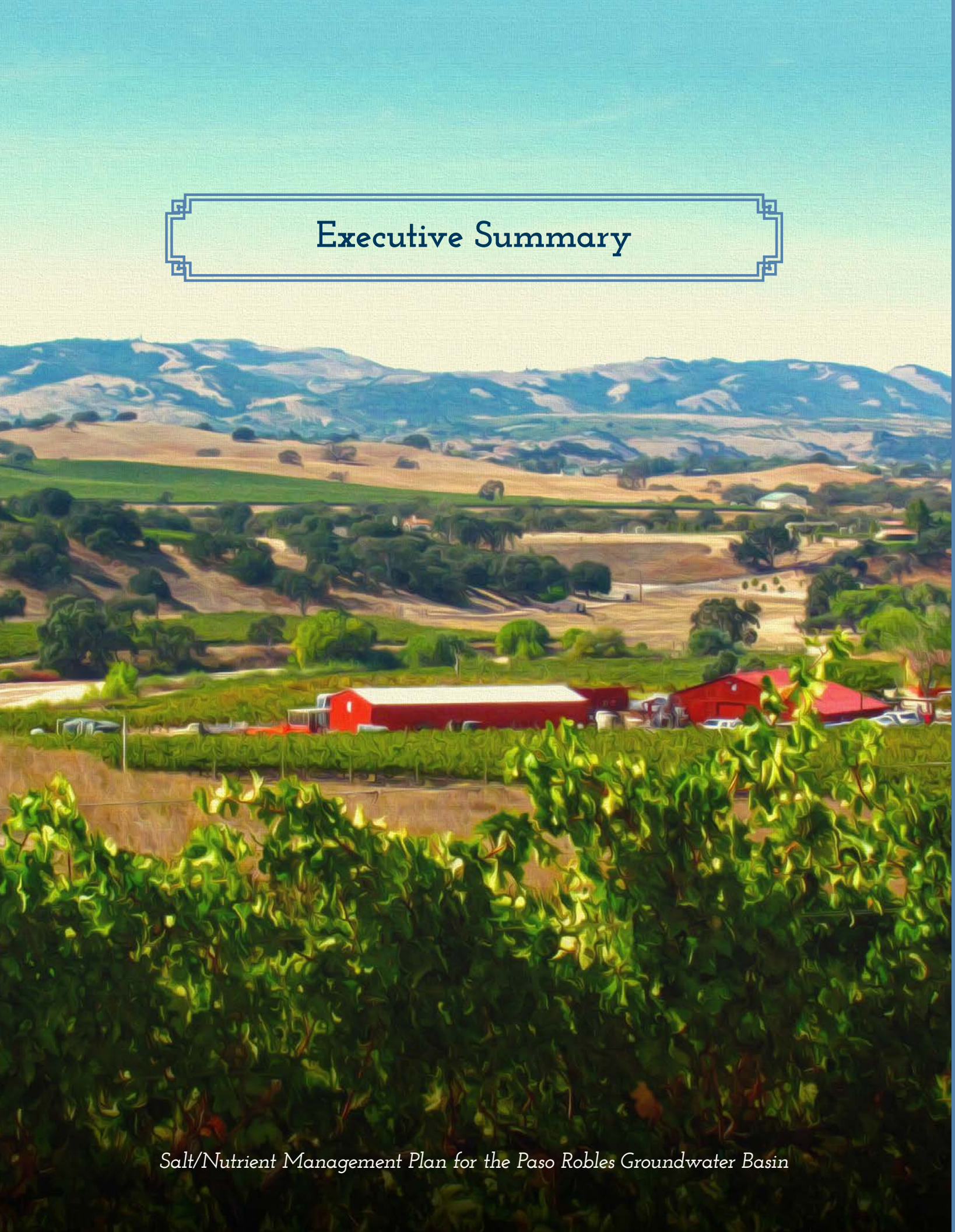
Executive Summary



Executive Summary

In February 2009, the State Water Resources Control Board (SWRCB) adopted Resolution No. 2009-011, which established a statewide Recycled Water Policy. Central to this Policy was the requirement that local water and wastewater entities, together with local salt- and nutrient-contributing stakeholders, develop a Salt and Nutrient Management Plan (SNMP) for each groundwater basin and subbasin in California. In response, the City of Paso Robles, along with the City of Atascadero, San Miguel, Templeton and Heritage Ranch Community Services Districts (CSDs), San Luis Obispo County and Camp Roberts (U.S. Army), retained a consultant team led by RMC Water and Environment (and including Todd Engineers and Fugro Consultants) to prepare a SNMP for the Paso Robles Groundwater Basin (Basin) in accordance with State's Recycled Water Policy.

The Paso Robles SNMP analyses and management program contained herein was initially presented to stakeholders as a series of technical memoranda (TMs) prepared between June 2013 and February 2015. These TMs were prepared according to the consultant's scope of work and associated tasks, and together comprise the contents of the SNMP. The content of these TMs have been converted into the chapters of this SNMP as follows:

- Chapter 1 Introduction
- Chapter 2 Outreach
- Chapter 3 Basin Characteristics
- Chapter 4 Loading Analysis
- Chapter 5 Assimilative Capacity and Anti-Degradation Analysis
- Chapter 6 SNMP Goals and Objectives
- Chapter 7 Implementation Measures
- Chapter 8 Groundwater Quality Monitoring
- Chapter 9 References

Stakeholder participation and outreach was key throughout preparation of this SNMP; this effort is described in the Outreach discussion in Chapter 2. The hydrogeologic conceptual model used for development of the SNMP, including an evaluation of existing groundwater quality, is described in the Basin Characteristics discussions included in Chapter 3. The loading and mixing analyses conducted to evaluate future groundwater quality and assimilative capacity is included in the Loading Analysis and Assimilative Capacity Analysis results presented in Chapters 4 and 5. This evaluation assumes two possible future scenarios - recycled water use and 'business as usual'. SNMP Goals and Objectives are presented in their own chapter (Chapter 6), as are the groundwater basin management strategies identified to aid in the management of salt and nutrient loading to the basin (Chapter 7). The Groundwater Quality Monitoring Chapter (developed from the SNMP Monitoring Program TM), describes the proposed Paso Robles groundwater quality monitoring program for management of salt and nutrients within the basin.

ES-1 Introduction

The SWRCB resolution establishing the statewide Recycled Water Policy encourages increased use of recycled water and local stormwater capture and reuse. As previously noted, it also requires local water and wastewater entities, together with local salt and nutrient-contributing stakeholders to develop an SNMP

for each groundwater basin or subbasin in California. The Paso Robles SNMP was developed through a collaborative process initiated in January 2013.

As outlined in the Recycled Water Policy, the required elements of an SNMP are the following:

- A basin/sub-basin wide monitoring plan that includes an appropriate network of monitoring locations.
- A provision for annual monitoring of constituents of emerging concern (CECs) consistent with recommendations by California Department of Public Health (now the Division of Drinking Water under the SWRCB) and SWRCB.
- Water recycling and stormwater recharge/use goals and objectives.
- Salt and nutrient source identification, basin/sub-basin assimilative capacity and loading estimates, together with fate and transport of salts and nutrients.
- Implementation measures to manage salt and nutrient loading in the basin on a sustainable basis.
- An anti-degradation analysis demonstrating that the projects included within the plan will, collectively, satisfy the requirements of the SWRCB's *Statement of Policy with Respect to Maintaining High Quality of Waters in California* (also referred to as Resolution No. 68-16).

The objective of the SNMP is to manage salts and nutrients from all sources "…on a basin-wide or watershed-wide basis in a manner that ensures attainment of water quality objectives and protection of beneficial uses." The Plan presents a baseline picture of groundwater quality, establishes a framework under which salt and nutrient issues can be managed, and streamlines the permitting process of new recycled water projects while meeting water quality objectives and protecting beneficial uses. The Paso Robles SNMP will eventually be utilized by the Central Coast Regional Water Quality Control Board (CCRWQCB) to aid in the management of basin groundwater quality.

ES-2 Outreach

Development of the Paso Robles SNMP was a stakeholder-driven process allowing for transparency and inclusiveness throughout the planning process. During preparation of the SNMP, a variety of outreach mechanisms were used to ensure stakeholder interactions, including stakeholder/public workshops, creation of a SNMP-specific website, informational handouts, and the opportunity to review and comment on the draft TMs that would ultimately contribute toward completion of the SNMP.

ES-2.1 Stakeholders

In order to effectively engage a variety of stakeholders and interested parties, the stakeholders were divided into two groups: primary and secondary. Primary stakeholders are those entities with direct water management authority and include the following:

- City of Paso Robles
- City of Atascadero
- San Luis Obispo County
- Templeton CSD
- San Miguel CSD
- Heritage Ranch CSD
- California Army National Guard: Camp Roberts
- Central Coast RWQCB

These entities also funded the SNMP development through a Proposition 84 Integrated Regional Water Management (IRWM) grant and have been heavily involved in management of the Paso Robles Groundwater Basin over the years.

Secondary stakeholders include local businesses, environmental groups, and other organizations that were interested in participating in the SNMP process. Many of the secondary stakeholders involved in the development of the Paso Robles SNMP included local agriculture and included, but were not limited to, the San Luis Obispo County Farm Bureau, the University of California Cooperative Extension, the Central Coast Vineyard Team, and the Paso Robles Wine County Alliance. A stakeholder list, including contact information for primary and secondary stakeholders, was developed and used throughout the planning process. Both stakeholder groups were vital in developing a thorough and comprehensive SNMP for the Paso Robles Groundwater Basin.

ES-2.2 Outreach Mechanisms

A variety of outreach mechanisms were used to reach out to stakeholders during development of the SNMP. These included the following:

- **Website:** A website specific to the Paso Robles SNMP planning process was prepared and regularly updated. The website, which can be accessed at http://pr.saltnutrient.com/ and includes general information about the purpose and need of the SNMP; downloadable copies the draft TMs prepared for the SNMP; contact information for questions or for stakeholders or others interested in getting involved in the planning process; the current stakeholder list, announcement of workshops, workshop materials and handouts; and links to other helpful websites.
- **Stakeholder Workshops:** Public workshops were conducted at key milestones of the SNMP planning process. A total of four publically-noticed workshops were conducted at the Paso Robles City Hall. Meetings covered topics including an introduction to the SNMP process; the groundwater basin conceptual model, source identification, future water quality, assimilative capacity, the anti-degradation analysis, SNMP goals and objectives and the SNMP monitoring program.

The stakeholder contact list was used to email workshop announcements and postings of draft TMs to the Paso Robles SNMP website. Workshop flyers were prepared and hung at public places to announce the workshop, its topic, and seek local participation.

ES-3 Basin Characterization

The objectives of the Basin Characterization were to:

1. Collect data necessary to quantify, characterize, and describe the setting, land use, climate, hydrology, geology, and hydrogeology of the Basin.
2. Organize the collected data into a Geographical Information System (GIS) database in a format that is accessible for future use by project stakeholders and that is compatible with the existing County GIS data management system.
3. Establish the baseline conditions (i.e., current spatial distributions) for each of the water quality constituents chosen to be addressed in the SNMP.
4. Estimate a water balance for the study areas of the Basin for use in the assimilative capacity and anti-degradation analyses to be conducted in later tasks of this project.

Chapter 3, Basin Characteristics, presents the findings of the afore-mentioned efforts.

ES-3.1 Setting

The Paso Robles Groundwater Basin is formally recognized by the California Department of Water Resources (DWR) as Basin No. 3-4.06 in Bulletin 118, *California's Groundwater*. It is approximately 505,000 acres in size with approximately 72% of its area located in San Luis Obispo County and the remaining portion in Monterey County. A significant source of data used in the basin characterization was from the *Paso Robles Groundwater Basin Study* (Basin Study), prepared by Fugro and Cleath in 2002. This study divided the Basin into eight study areas which were carried forward into this SNMP; these study areas are shown in Table ES-1 and Figure ES-1.

Land uses in the groundwater basin consist of grassland/barren areas, agricultural crops, farmsteads, urban land use, and paved areas. The primary source of water in the Basin for all land uses is groundwater, provided by the City of Paso Robles, Atascadero Mutual Water Company, Templeton CSD, San Miguel CSD, and the County. A secondary source of water is Lake Nacimiento surface water.

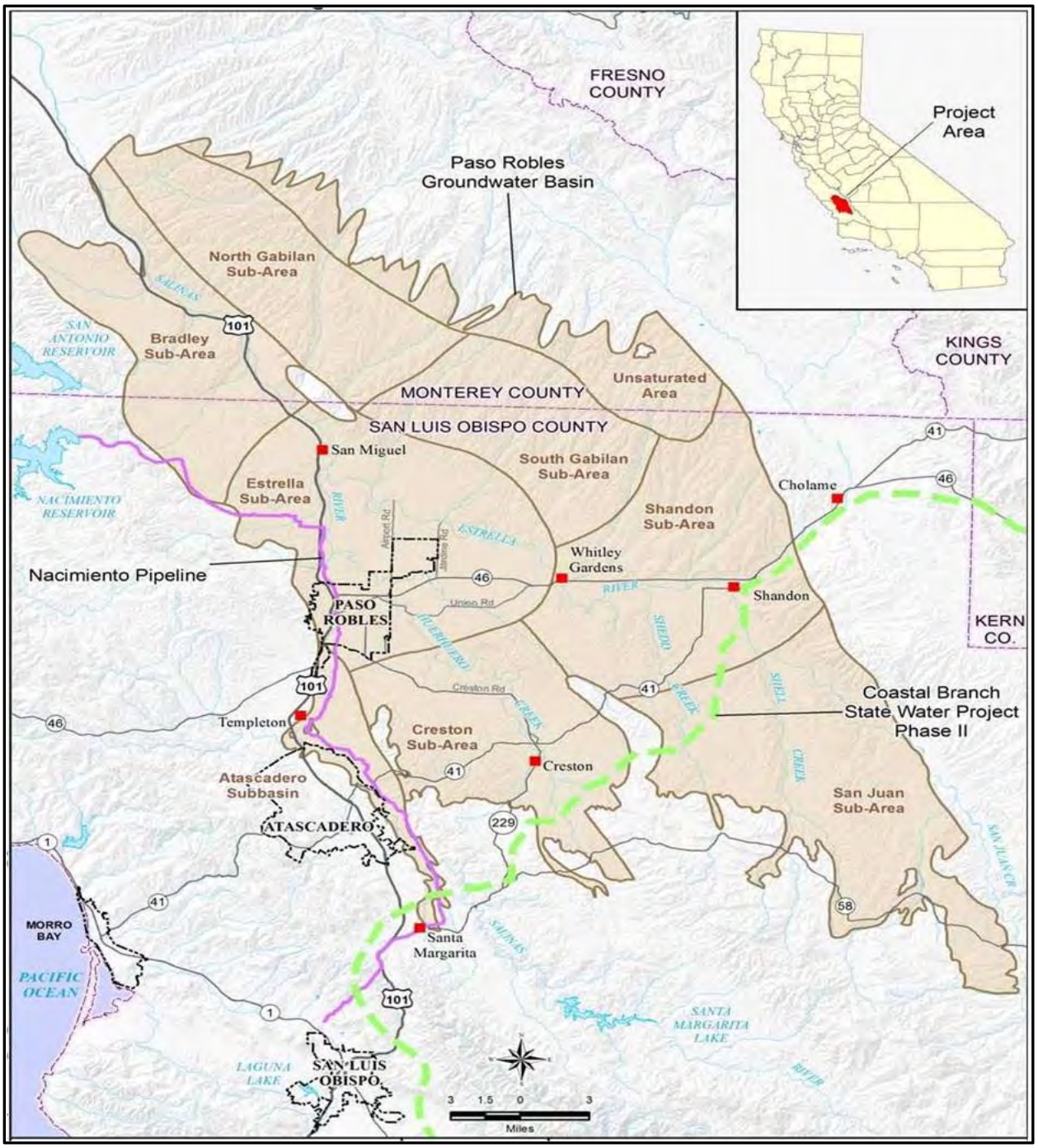
ES-3.2 Water Quality

The three water quality constituents that are addressed in the Paso Robles SNMP are Total Dissolved Solids (TDS), nitrate (as N), and chloride. These constituents are defined as 'indicator constituent' in this SNMP. The Basin Characterization task established the baseline conditions for these constituents using water quality data from the Fugro and Cleath (2002) and GeoTracker GAMA databases. Maps of baseline conditions were created and used to estimate average indicator constituent concentrations in each of the study areas. The water quality analysis consisted of the review of RWQCB water quality objectives and drinking water standards for the Basin, a description of the water quality databases used in the analysis, discussion of historical trends for the three indicator constituents, estimation of the baseline conditions of each indicator constituents, and a presentation of the ranges of measured constituent concentrations and estimated average constituent concentrations for each study area. The average concentrations for TDS, nitrate, and chloride are summarized in Table ES-1 and discussed at greater length in Chapter 3.

Table ES-1: Average Water Quality Constituent Concentrations for the Study Areas

Study Area	Average TDS Concentration (mg/L)	TDS Groundwater Objective Range (mg/L)	Average Nitrate Concentration (mg/L)	Nitrate Groundwater Objective Range (mg/L)	Average Chloride Concentration (mg/L)	Chloride Groundwater Objective Range (mg/L)
Atascadero	573	550-730	1.8	2.3-2.7	77.5	70-100
Creston	388	400	3.2	3.4	69.4	60
San Juan	425	--	2.8	--	64.2	--
Estrella	552	400-1050	2.5	2.3-4.5	94.2	60-270
Shandon	563	400-1390	4.6	2.3-3.4	80.0	60-430
North Gabilan	856	--	8.4	--	112.9	--
South Gabilan	451	--	6.3	--	37.2	--
Bradley	751	--	2.7	--	84.4	--

Figure ES-1: Hydrogeologic Definition of Paso Robles Groundwater Basin Subareas



ES-3.3 Water Balance

Average annual water balances for the unconfined and confined aquifers in the eight study areas were developed for use in the SNMP analyses. These water balances identified and quantified major groundwater recharge and discharge processes within the Paso Robles Groundwater Basin. Major groundwater recharge and discharge components are summarized in the following table and can be generally categorized as natural or anthropogenic.

Table ES-2: Groundwater Recharge and Discharge Components

Groundwater Recharge Components	Groundwater Discharge Components
Subsurface inflows	Subsurface outflows
Deep percolation and precipitation	Groundwater pumping
Streambed seepage from rivers and creeks	Groundwater discharge to rivers and creeks
Agricultural irrigation return flows	Phreatophyte extraction of shallow groundwater
Wastewater discharge	

The water balances for the study areas were estimated using the results of the Basin groundwater flow model (Fugro et. al, 2005), the Basin groundwater pumping study performed by Todd (2009), and the Basin water balance update and review study performed by Fugro in 2010. The model was developed in MODFLOW with a base period of 1981 to 1997. Average annual groundwater recharge in the unconfined and confined aquifers is summarized in Table ES-3.

Table ES-3: Average Annual Groundwater Recharge (acre-feet)

	Basin Subsurface Inflows	Deep Percolation	Stream Recharge	Ag Irrigation Return Flows	Municipal WW Discharge	Small Community WW Discharge	Small Commercial WW Discharge	Rural Residential WW Discharge
Total (Unconfined Aquifer)	4	5,708	26,643	6,361	5,134	103	575	2,689
Total (Confined Aquifer)	25,022	20,998	33,805	3,420	--	135	362	2,757

ES-4 Existing and Foreseeable Salt and Nutrient Sources

A primary element of the SNMP is the assimilative capacity analysis of the groundwater basin. In this analysis, the average ambient groundwater quality in the basin, subbasin or management area is compared with the Water Quality Objectives (WQOs) set forth in the Central Coast RWQCB's *Water Quality Control Plan for the Central Coastal Basin* (also known as the Basin Plan). The difference between these two values (assuming that the WQO is greater than the ambient groundwater quality concentration) represents the assimilative capacity of the groundwater basin, or the additional 'load' which the groundwater basin can accept without exceeding the water quality objectives. This analysis is then repeated using projected future conditions (land use, water usage and type, etc.) to determine if, under those future conditions, the groundwater quality will remain below the water quality objectives.

To prepare the assimilative capacity analysis, one must understand the current and projected future loading of salts and nutrients to the groundwater basin from parameters such as the land use types overlying the

groundwater basin and the activities that occur on that land (such as irrigation, soil amendment application, agricultural practices) that have the potential to allow for salts and/or nutrients to migrate down to the groundwater table. These loading factors are estimated and used in a GIS-based model to determine the portion of the applied material (fertilizer, water, etc.) that can leach to groundwater. These data are then utilized along with groundwater volumetric inflows and outflows in a spreadsheet-based mixing model to estimate future groundwater quality trends. (The initial volumes of groundwater and salt/nutrient mass present in the basin have been estimated to provide a reference point for predicting groundwater volume [and water levels] and chemical mass changes over time.)

Salt and nutrient loading from surface activities to the Paso Robles Groundwater Basin is presently due to numerous sources, including:

- Irrigation water (e.g., potable water, groundwater, and future recycled water);
- Agricultural inputs (e.g., fertilizer and amendments);
- Septic system recharge;
- Infrastructure (e.g., percolation from treated wastewater ponds, leaking pipes); and
- Rainfall infiltration, mountain front recharge, and natural stream losses.

Chapter 5 documents the sources of salts and nutrients and presents the methodology and assumptions used to estimate the impact of those sources on the groundwater basin. For the purposes of this analysis, the Paso Robles SNMP study area is defined as the Paso Robles Groundwater Basin, including the Atascadero Sub-Basin and those areas within Monterey County.

ES-4.1 Identification of Salt and Nutrient Indicator Constituents

The major dissolved ions potentially included in recycled water that reflect its salinity and nutrient content are many and varied, and include sulfate, chloride, nitrate, iron, boron and manganese. Simulation of each constituent is beyond the scope of this study; therefore indicators of salt and nutrient loading to the Paso Robles Groundwater Basin were selected for further study.

To select indicator constituents, criteria/questions were applied (e.g. Is the constituent regularly monitored and detected in source waters? Is the constituent representative of other salts and nutrients?) to identify those best for the planned analyses. Each selected indicator constituent evaluated was not required to meet all criteria, but as a group, at least one should meet each criterion. Both chloride and TDS, as salts, meet all the criteria, while sodium, sulfate and boron did not. However, TDS, as a compilation of general minerals, provides a good relative indicator of concentrations trends in the groundwater basin for these other constituents. Nitrate, as a nutrient, meets most of the criteria and has the most water quality data available in the groundwater basin. The selection of chloride, TDS and nitrate as indicator constituents also correlated well with the average percentage of the different general minerals found in each subarea of the groundwater basin and the availability of groundwater quality data.

ES-4.2 Loading Analysis Tools

To support the SNMP and to better understand the significance of various loading factors, a GIS-based loading model was developed to simulate salt and nutrient loadings from surface activities to the groundwater basin. The loading model is a simple, spatially-based mass balance tool that represents TDS, chloride and nitrogen loading on an annual-average basis. It is not a calibrated model, as insufficient data are available to support such an effort, and therefore the model results are more uncertain than results from a fully-calibrated model. Despite the uncalibrated nature of the model, the results were considered suitable for this analysis of basin conditions, with the recognition that a more rigorous model, potentially based on the ongoing groundwater numerical modeling update effort, may be developed in a future update to the Plan.

Primary inputs to the loading model are land use, irrigation water source, recycled water use locations, septic system areas, and surface geology characteristics. The general process used to arrive at the salt and nutrient loads includes identifying the analysis unit to be used in the model and categorizing land uses 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. The land use group characteristics are then applied, along with irrigation water sources, septic system and infrastructure assumptions and soil texture characteristics, to estimate the water demand by parcel and TDS, chloride and nitrate loads. The loading model assumes that no salt is removed from the system once it enters the system (as salt is considered to be 'conservative'); however, it does assume that a portion of the applied nitrogen is used by plants and removed from the system. The results of the loading model were then imported into the spreadsheet-based mixing model along with output from the water balance components of the Paso Robles Groundwater Basin numerical groundwater model to simulate water quality changes resulting from projected future basin uses.

ES-4.3 Identification and Quantification of Salt and Nutrient Sources

Salt and nutrient loads result predominantly from urban, irrigation water and agricultural inputs associated with land use. Most of the salt and nutrient sources in the Paso Robles Groundwater Basin are associated with municipal wastewater system discharges to groundwater and the use of regenerative water softeners in the basin. Rural and agricultural land uses (i.e. septic systems and fertilizer use) have also contributed to groundwater basin loadings. Figure ES-2 presents land use by percent as depicted in the loading model, while Figure ES-3 presents the percent of TDS load attributable to each land use and loading type.

At present, there is no recycled water use in the groundwater basin; therefore, this is not a current contribution to salts and/or nutrients in the groundwater basin. However, future recycled water use, along with the introduction of surface water from Lake Nacimiento to the groundwater basin (both directly and indirectly), will change groundwater and potable water qualities in the future in the vicinity of the Cities of Paso Robles and Atascadero and the community of Templeton.

Figure ES-2: Land Use Overlying Paso Robles Groundwater Basin by Percent

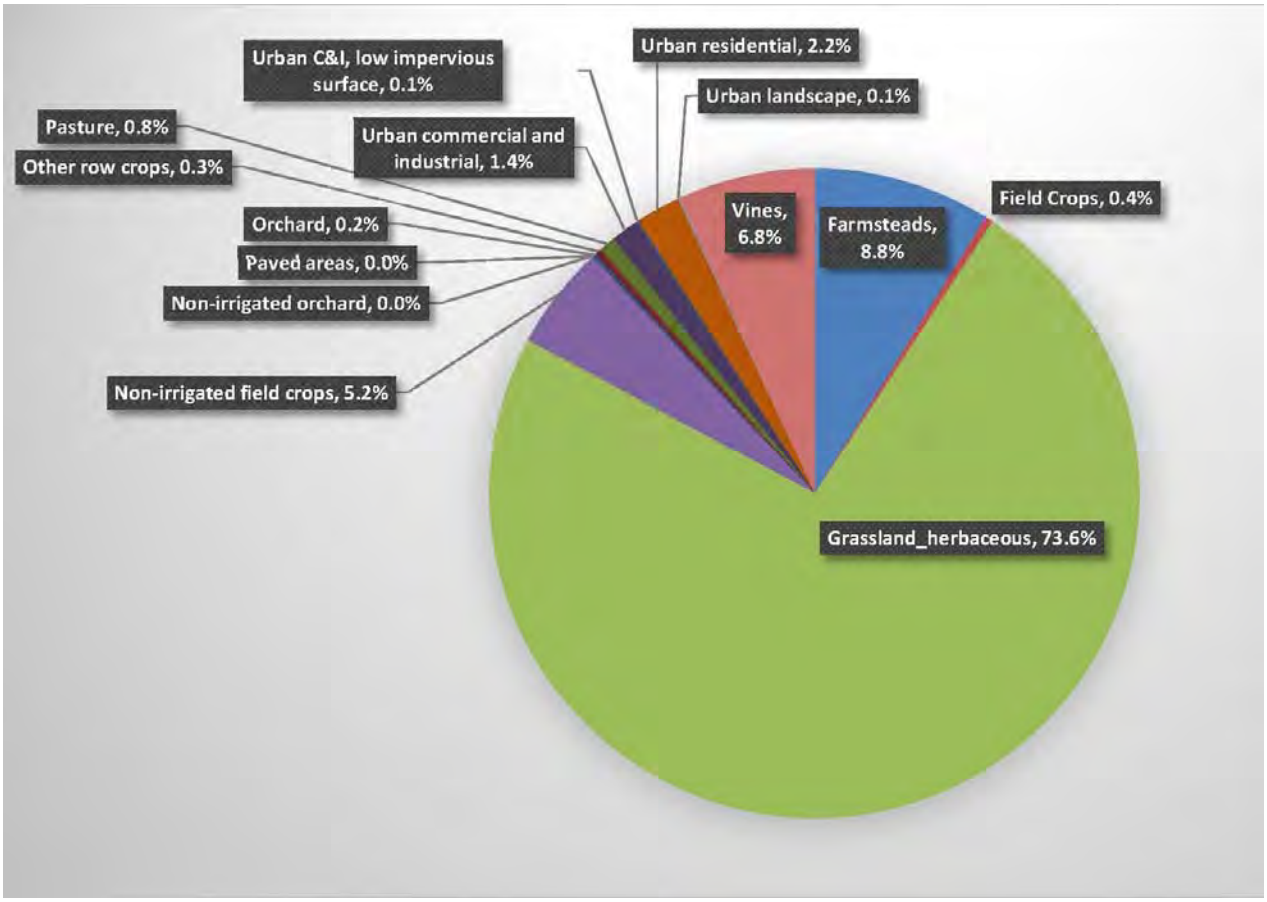
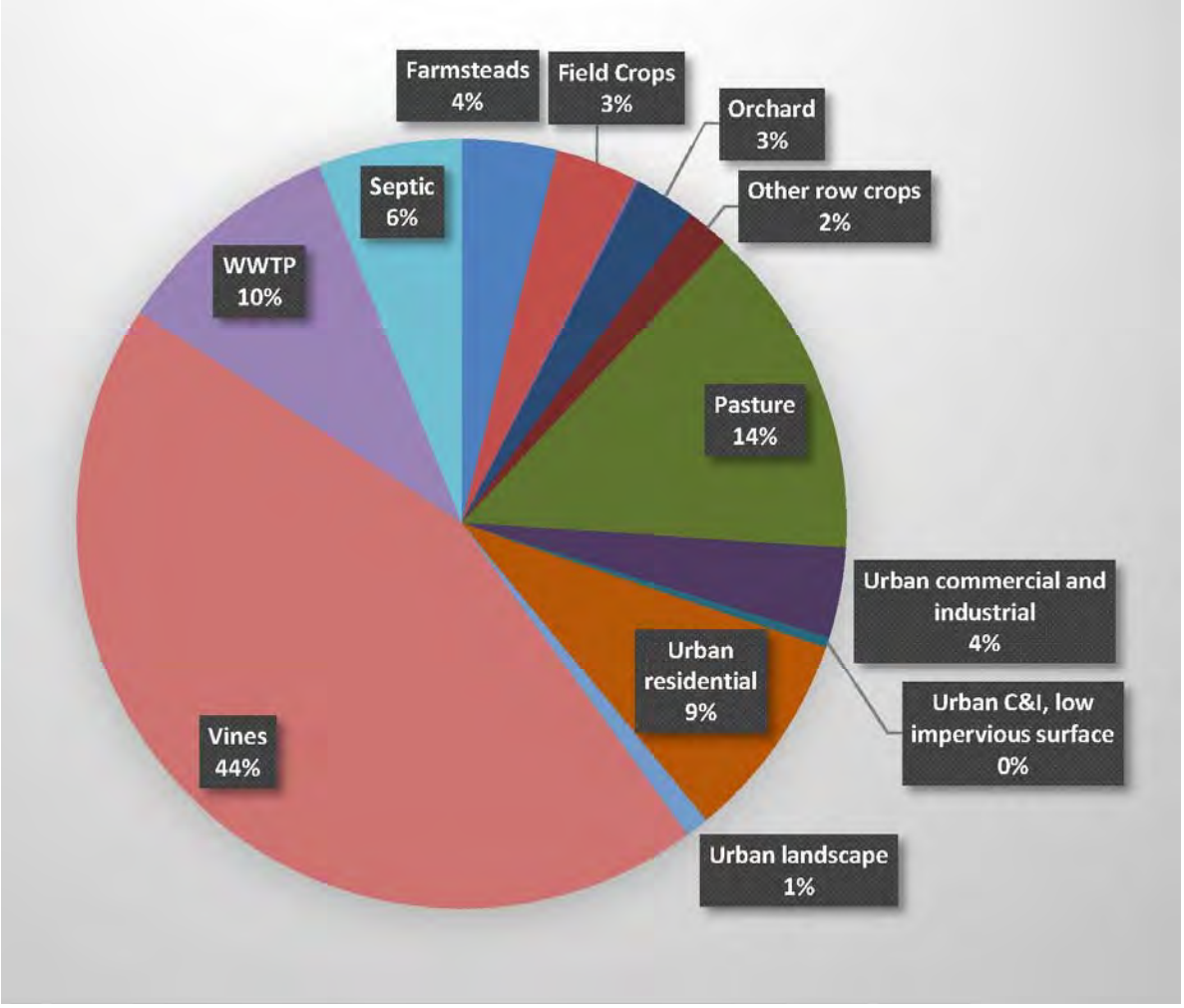


Figure ES-3: Percent TDS Loading to Paso Robles Groundwater Basin by Land Use or Source



ES-5 Assimilative Capacity and Anti-Degradation Analysis

As previously described, the concentration differences between ambient groundwater quality and the WQOs (assuming that the WQO concentration is greater than the ambient groundwater quality) represents the assimilative capacity of the groundwater basin, or the additional 'load' which the groundwater basin can accept without exceeding the WQOs. To evaluate anticipated future conditions with recycled water use, an assimilative capacity and anti-degradation analysis was conducted using project future conditions to determine if, under projected future conditions, the groundwater quality will remain below the WQOs.

ES-5.1 Assimilative Capacity

The eight subareas presented in Figure ES-3.1 were used in the assimilative capacity analysis and the anti-degradation assessment. Baseline water quality was determined based on average concentrations over time as identified in the Basin Characterization. TDS, nitrate, and chloride concentrations were found to be stable in most areas of the basin; however, there have been increasing TDS and chloride trends in the shallow Paso Robles Formation in the Atascadero Subbasin and Estrella Study Area, increasing chloride concentrations in the Creston Study Area, and increasing TDS and chloride concentrations in the Bradley Study Area.

In order to determine if assimilative capacity exists, baseline groundwater quality concentrations must be compared to the WQOs. For the Paso Robles Groundwater Subbasin, however, this comparison is impeded by the differing study area definitions as defined herein and as used by the Basin Plan. Therefore, in evaluating the assimilative capacity of the study areas, baseline groundwater quality was compared to the lowest WQO for that area. Where no WQOs were available, primary and secondary maximum contaminant levels (MCLs) were used instead. These MCLs are as follows:

- For TDS – 1,000 mg/L [secondary MCL]
- For nitrate (as N) – 10 mg/L [primary MCL]
- For chloride – 250 mg/L [secondary MCL]

The assimilative capacity of each study area in the Basin using WQOs and MCLs are shown in Table ES-4.

Table ES-4: Assimilative Capacity by Study Area

Study Area	Using Water Quality Objectives			Using MCLs		
	TDS (mg/L)	Nitrate (mg/L as N)	Chloride (mg/L)	TDS (mg/L)	Nitrate (mg/L as N)	Chloride (mg/L)
Atascadero	0	0.5	0	427	8.2	172.5
Creston	12	0.2	0	612	6.8	180.6
San Juan	--	--	--	575	7.2	185.8
Estrella	0	0	0	448	7.5	155.8
Shandon	0	0	0	437	5.4	170.0
North Gabilan	--	--	--	144	1.6	137.2
South Gabilan	--	--	--	549	3.7	212.8
Bradley	--	--	--	249	7.3	165.6
Overall	0	0	0	427	8.2	172.5

Source: Central Coast RWQCB Basin Plan (2011)

a. All concentrations are in mg/L.

b. The WQO for 'Central Basin', as defined in the Basin Plan, was used for the overall groundwater basin.

ES-5.2 Anti-degradation Assessment

SWRCB Resolution No. 68-16 is the State of California's antidegradation policy which, in summary, establishes the requirement that discharges to waters of the State be regulated to achieve the "…highest water quality constituent to the maximum benefit to the people of the State". This resolution essentially establishes a two-step process for compliance. First, if a discharge will degrade high quality water, the discharge may be allowed if any change in water quality (1) will be consistent with the maximum benefit to the people of the State, (2) will not unreasonably affect present and anticipated beneficial uses of such water (as defined in the Basin Plan), and (3) will not result in water quality less than that prescribed in State policies. This point is demonstrated in an antidegradation analysis. The second step requires the use of best practicable treatment or control of the discharge necessary to avoid a pollution or nuisance and to maintain the highest water quality consistent with the maximum benefit to the people of the State. Resolution No. 68-16 was incorporated into the SWRCB's Recycled Water Policy in Section 9, Anti-Degradation, which sets forth the parameters under which recycled water may be used. Specifically, the Recycled Water Policy states that in cases where more than 10% of a basin's assimilative capacity will be used by a project (or more than 20% of a basin's assimilative capacity will be used by multiple projects), an antidegradation analysis consistent with Resolution No. 68-16 must be performed to provide sufficient information to the RWQCB to make a determination that the proposed projects will provide the maximum benefit to the people of the State.

Analysis of existing basin-wide groundwater quality conditions indicates that the existing groundwater quality is generally better than the WQOs set forth in the Basin Plan. However, such a comparison is hampered by disparity in study area definitions as generally used to describe the groundwater basin relative to those used in the Basin Plan. If drinking water standards (MCLs) are used for this analysis, there is assimilative capacity remaining in the groundwater basin for chlorides and nitrates. If the recommended secondary MCL for TDS is used (500 mg/L), then assimilative capacity exists only in three study areas in the groundwater basin, whereas assimilative capacity is available throughout the groundwater basin if the upper secondary MCL is used for TDS (1,000 mg/L).

In such situations, Resolution 68-16 states that "…such existing high quality water will be maintained until it has been demonstrated to the State that any change will be consistent with maximum benefit to the people of the State, will not unreasonably affect present and anticipated beneficial use of such water and will not result in water quality less than that prescribed in the policies." The results of the groundwater quality trend and loading analyses, based on a series of conservative assumptions and over a 25-year planning horizon, indicate that basin-wide average TDS concentrations will increase over time, but will not exceed the WQOs in those areas where the WQOs are presently met. Nitrate and chloride concentrations are anticipated to be relative stable basin-wide. Given the following assumptions, the qualitative anti-degradation analysis concludes that increases in the indicator constituents (TDS, chloride and nitrate) in the groundwater basin with anticipated future uses are consistent with the maximum benefit to the people of the State of California:

- Current groundwater elevation trends (the basin moving towards overdraft conditions);
- The economic importance of the existing water supplies that contribute to salt and nutrient loading in the basin;
- Current state mandates to increase recycled water use; and
- The projected continued ability of groundwater to meet present and anticipated beneficial uses.

ES-6 Implementation Measures, Goals & Objectives

The completed SNMP technical analysis findings indicate that overall basin groundwater quality will be stable through the projected study period (25 years). Therefore, no new implementation measures or Best Management Practices (BMPs) are recommended as part of the SNMP process. However, the SNMP results also indicate that the existing groundwater quality BMPs or measures already in place should continue. In addition, the BMPs or measures already planned for recycled water use should be implemented to allow for recycled water use as irrigation and the long-term protection and sustainability of groundwater quality. Chapter 6 and Chapter 7 document the identified groundwater basin management goals and objectives and the implementation measures that will aid in managing salt and nutrient loading in the basin.

ES-6.1 Basin Management Goals and Objectives

Groundwater basin management goals and objectives were developed and vetted during a series of stakeholder workshops held in 2013 and 2014. Identified preferred basin management objectives (BMOs) and goals that the SNMP will aim to achieve were established for future groundwater use, water recycling and stormwater management. These BMOs consider anticipated future development in the Basin in accordance with relevant master plans and other available planning documents. Specific basin management goals and objectives developed for the SNMP through stakeholder meetings include:

- **BMO-1**: Protect surface water resources
- **BMO-2**: Minimize impacts on local water supply
- **BMO-3**: Minimize impacts on groundwater quality

These qualitative BMOs address issues related to groundwater levels, groundwater quality, and the interaction of groundwater with surface water. It is anticipated that the BMOs will be supported by management actions such as those outlined below, and that the specific objectives for this SNMP will be updated to coordinate with these other efforts as they move towards completion.

- Groundwater monitoring
- Integration of recycled water resources
- Well ordinances including construction, abandonment, and destruction policies
- Identification and mitigation of soil and groundwater contamination
- Public education and conservation programs

Groundwater Management, Recycled Water, and Stormwater Recharge goals were also developed as shown in Table ES-5.

ES-6.2 Groundwater Basin Management Strategies

The SNMP technical analyses indicate that overall groundwater quality in the basin is generally stable with general water quality below the Regional Water Board's WQOs. Analysis of future water quality (over the 25 year planning horizon) indicates improving water quality as Lake Nacimiento water becomes available to the basin and groundwater quality trends stabilize.

With these trends in mind, several categories of possible groundwater basin implementation/management strategies were considered during Public Workshop 3, as described in the following table.

Table ES-5: Groundwater, Recycled Water, and Stormwater Recharge Goals

Groundwater Management	Recycled Water	Stormwater Recharge
Maintain groundwater levels to ensure the long-term reliability of groundwater sources for the economic well-being of the area. Protect against adverse impacts to surface water flows. Preserve floodplain to promote groundwater recharge. Prevent water pollution, including limiting upwelling of geothermal waters into potable groundwater aquifers by maintaining groundwater levels. Protect against potential inelastic land surface subsidence.	The City of Paso Robles has its own set of recycled water goals as described in their updated Recycled Water Master Plan (AECOM, March 2014). Paso Robles is seeking to maximize the beneficial use of recycled water in their service area, and is planning to meet an average annual recycled water demand for irrigation 1,750 AFY. The City's short-term goal is to provide 650 AFY of tertiary-treated recycled water for landscape irrigation beginning in 2025. The City of Atascadero's goal is to replace potable water irrigation with recycled water in five of its parks, and anticipates using approximately 60 AFY of recycled water in the future. The City will evaluate recycled water goals during its wastewater master planning efforts. Templeton CSD is presently coordinating with San Luis Obispo County in preparation of a Regional Recycled Water Strategic Plan. While specific recycled water use goals by Templeton CSD are not presently available, they are planning to redirect wastewater currently being sent to the City of Paso Robles and instead treat the influent at its own treatment facilities and percolate the treated effluent into the basin for retrieval down gradient. Under this scenario, the District anticipates recycling up to 224 AFY. Like Templeton CSD, San Miguel CSD is currently percolating secondary effluents at its wastewater treatment facility; however, the District is considering using the recycled water for landscape irrigation of parks, streetscapes and open space areas in new developments. Heritage Ranch CSD, County Service Area (CSA) 7A and Camp Roberts currently have no plans for recycled water use.	Maximize onsite runoff capture and infiltration through low impact development (LID) techniques and implementation of the Central Coast RWQCB Post-Construction Runoff Control Requirements. Maximize instream infiltration. Use of dual-purpose stormwater runoff management facilities for both flood control and groundwater infiltration.

Table ES-6: Implementation / Management Strategies

Category	Implementation / Management Strategies
Stormwater / Runoff Management	• Minimize the compaction of highly permeable soils • Limit clearing and grading of native vegetation • Direct roof runoff to cisterns or rain barrels for reuse • Direct roof runoff onto vegetated areas away from building foundations • Direct runoff from sidewalks, patios, walkways, driveways and/or uncovered parking lots onto vegetated areas away from building foundations • Construct bike lanes, driveways, uncovered parking lots, sidewalks, walkways and patios with permeable surfaces

Groundwater Basin Management	• The Paso Robles Groundwater Management Plan (GWMP) set forth goals and objectives for basin management, identified a governmental structure and process for stakeholder involvement, outlined a groundwater monitoring and data collection program, and presented recommendations for ensuring groundwater sustainability.
	• Develop other strategies as part of amendments to the GWMP.
	• Implement additional measures in the basin including:
	  o Groundwater elevation and quality monitoring
	  o Flow modeling
	  o Maintenance of updated land cover maps

Salinas River Underflow Augmentation	• Augment the shallow groundwater basin aquifers and Salinas River underflow through percolation of treated effluent from urban wastewater treatment systems to aid in the management of shallow groundwater elevations.
Water Management BMPs	• Practice water conservation, minimize waste, and protect groundwater quality including water conservation programs, water budgeting, ordinances to minimize over-irrigation, landscape irrigation BMPs, controlling salinity from water softeners and industrial and/or commercial dischargers.
Wastewater Salinity / Nutrient Source Control	• Regulate industrial and commercial discharges • Source control permits • Inspect and monitor of discharges • Develop source control and pollution prevention requirements • Enforce afore-mentioned requirements
Source Water Salinity Control	• Use less-saline Lake Nacimiento water in the groundwater basin. • Implement ordinances regulating the use of self-regenerating water softeners and/or discharges of wastes with high salt concentrations. • Implement education programs to discourage the use of water softeners utilizing salts.
Public Education	• San Luis Obispo County and various municipalities maintain websites and provide outreach to the public on issues such as water conservation and groundwater protection. • Distribute landscape management materials discussing the use of fertilizer, appropriate irrigation techniques, etc. to the public through various outreach programs.
Institutional	• The County is establishing a governance structure to develop solutions for the groundwater basin. • San Luis Obispo County Flood Control and Water Conservation District acts as the designated monitoring entity for CASGEM-required monitoring. • Use ordinances and regulations to promote onsite stormwater recharge for groundwater augmentation and to minimize potential loading of salts and pollutants to the groundwater basin.

Category	Implementation / Management Strategies
Recycled Water	• Monitor Water quality at the treatment plant to ensure regulatory compliance with Title 22 and monitoring requirements for indicator emerging contaminants as part of the Recycled Water Policy. • Irrigate at agronomic rates. • Maintain the use of Site Supervisors. • Minimize runoff of recycled water from irrigation.
Other	• Monitor salt and nutrient concentrations in groundwater to determine if water quality improvement objectives are met in the future. • Reassess the need for additional implementation measures when the SNMP is updated in the future.

ES-7 Salt and Nutrient Groundwater Quality Monitoring Program

The SWRCB Recycled Water Policy states that SNMPs should include a monitoring program that consists of a network of groundwater 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 Groundwater Quality Monitoring Program "….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 SNMP Groundwater Quality Monitoring Plan identified those stakeholders responsible for conducting, sampling, and reporting the monitoring data. The resultant monitoring data are to be reported to the RWQCB at least every three years. Because there currently are no recycled water recharge projects and recycled water is not used for irrigation in the Paso Robles Groundwater Basin, monitoring for CECs in groundwater in the Paso Robles Basin is not presently required under the Recycled Water Policy or other state regulations.

ES-7.1 Existing Groundwater Quality and Level Monitoring Programs

ES-7.1.1 Groundwater Quality and Level Monitoring

As described in the Paso Robles GWMP (GEI *et al*., 2011), sources of water quality data include DWR, local municipalities, United States Geological Survey (USGS), and local growers. Groundwater is also monitored by other water purveyors. In addition, an extensive groundwater sampling program was conducted in 2001 by San Luis Obispo County to support the Paso Robles Groundwater Basin Study (Fugro and Cleath, 2002). Groundwater quality is also monitored at environmental release sites; however, these sites typically monitor shallow groundwater and do not typically monitor for the salts and nutrients addressed in the SNMP. Of these sources of groundwater quality data, monitoring conducted by water purveyors in accordance with the California Code of Regulations (CCRs), Title 22 Drinking Water Program is currently the only ongoing regular monitoring of shallow and deeper production zones.

The existing groundwater quality monitoring programs in the SNMP study area include the following:

- Title 22 Drinking Water Program enforced by the SWRCB, Division of Drinking Water

- SWRCB's Groundwater Ambient Monitoring & Assessment (GAMA) Program and USGS Groundwater Monitoring
- Agricultural Order issued by CCRWQCB in 2012

San Luis Obispo County Flood Control and Water Conservation District has monitored groundwater levels county-wide on a semi-annual basis for more than 50 years to support general planning and for engineering purposes. The current groundwater level monitoring network provides a reference for identifying wells that could potentially be added in the SNMP Groundwater Quality Monitoring Program in the future.

ES-7.1.2 Regional Groundwater Basin Management

Since 1998, local agencies and stakeholders have worked cooperatively to complete several projects to conduct technical investigations and improve groundwater management of the Paso Robles Basin (GEI *et al.*, 2011). The City of Paso Robles, in coordination with a Paso Robles Groundwater Basin Groundwater Advisory Committee, prepared and adopted a *Groundwater Management Plan* (GEI *et al.*, 2011) in accordance with Assembly Bill 3030 to facilitate basin management.

Recently, legislation was passed that encourages active groundwater management. The Sustainable Groundwater Management Act of 2014 is the first legislation in California to comprehensively regulate groundwater. Building on the recognition that groundwater management in California is best accomplished locally, it provides local water agencies with considerable new powers, most notably the power to regulate pumping. Nonetheless, the Act also imposes substantial responsibility to find solutions for overdraft and to achieve long-term sustainability of groundwater supply. If local agencies fail to achieve sustainability, it establishes the power of the State to manage a groundwater basin and regulate groundwater use.

The Sustainable Groundwater Management Act, defined in three linked legislative bills, is detailed and comprehensive. It provides a priority list of groundwater basins, defines Groundwater Sustainability Agencies (GSAs), outlines the contents of Groundwater Sustainability Plans (GSPs), establishes the roles of State agencies, and sets a timeline with deadlines. Although the Act generally applies to all groundwater basins in the State, it imposes groundwater management requirements only on groundwater basins that the DWR has designated as high- or medium-priority pursuant to the CASGEM Program. In its 2014 Final Basin Prioritization, DWR categorized the Paso Robles Groundwater Basin as a high priority basin.

ES-7.2 Summary of SNMP Groundwater Quality Monitoring Program

Currently no funding mechanism exists to support a regional groundwater quality monitoring and reporting program. Accordingly, the proposed SNMP Groundwater Quality Monitoring Program is based on the existing Title 22 Drinking Water Program.

ES-7.2.1 Monitoring Locations

The groundwater monitoring program documented in Chapter 7 identified wells that currently (over the last four years) report groundwater quality data to the SWRCB Division of Drinking Water under the program. A total of 127 wells have recent water quality data in the SWRCB Division of Drinking Water data base. Well locations in the program have been located to within ½ to one mile of the actual location based on x-y coordinates downloaded from the GAMA GeoTracker database. The SWRCB Division of Drinking Water database does not include detailed well location information for security reasons.

San Luis Obispo County has compiled all available DWR drilling logs and entered well construction information into confidential database (Fugro and Cleath, 2002) unless the well owner has agreed to release

the well log. The Title 22 wells are typically screened in the shallow alluvium along rivers and streams and/or in the Paso Robles Formation.

ES-7.2.2 Sampling Parameters, Frequency and Reporting

Constituents monitored and the frequency of monitoring varies based on the well location, size of the water system, and history of water quality results. Typically, TDS, chloride, and nitrate are monitored along with other constituents. For some wells, only nitrate sampling is reported in the SWRCB Division of Drinking Water database.

Data are uploaded by the responsible water purveyors to the SWRCB Division of Drinking Water quality portal and data are available on the Division of Drinking Water website and via the GAMA GeoTracker site. Responsible parties in the Basin have included water companies, water districts, municipalities/water departments, other government agencies, community services districts, water associations, schools, private companies and businesses, residential developments, camp grounds, golf courses, prisons, and hospitals.

ES-7.2.3 Monitoring Recommendations

The Salt and Nutrient Groundwater Quality Monitoring Program TM (incorporated into Chapter 8) concluded that a basin-wide water quality monitoring program, consistent with the Sustainable Groundwater Management Act, should be developed, which would be more comprehensive than the SNMP Groundwater Quality Monitoring Program.

Introduction/Background

Chapter 1 Introduction

The City of Paso Robles partnered with the City of Atascadero, San Luis Obispo County, Templeton Community Service District, San Miguel Community Service District, Heritage Ranch Community Service District, California Army National Guard: Camp Roberts, and Central Coast Regional Water Quality Control Board (CCRWQCB) to prepare a Salt and Nutrient Management Plan (SNMP) for the Paso Robles Groundwater Basin, underlying both San Luis Obispo and Monterey Counties. These agencies (except for the CCRWQCB) provide water and/or wastewater services in the Paso Robles Groundwater Basin or adjoining Atascadero Subbasin.

The Paso Robles Groundwater Basin has been studied extensively. Existing reports relating to the basin hydrogeology and groundwater quality were referenced to during preparation of this SNMP. These documents included a 1993 study by the California Polytechnic State University, San Luis Obispo (Cal Poly) documenting groundwater quality in the basin, identifying sources of salt loading, and presenting water quality objectives (WQOs) and possible best management practices (BMPs). The Paso Robles Groundwater Basin Study Phases I and II, completed in 2002 and 2005, respectively, provided a comprehensive understanding of the groundwater system and a numerical model simulating that system, and documented water quality conditions, including areas of concern along the Salinas River corridor. Subsequent efforts have provided basin updates, local investigations of wastewater disposal effects on groundwater, urban water management plans, and most recently, the Paso Robles Groundwater Basin Management Plan (GWMP). A major accomplishment in this drive to manage local water supplies has been securing high-quality Lake Nacimiento water for municipal supply. Deliveries of Nacimiento water began in 2010, and provided an important step toward improving delivered water quality, and subsequently, wastewater quality.

San Luis Obispo County, along with local water managers and basin stakeholders, have been actively managing local water resources for years—developing and implementing local monitoring programs, investigating local hydrogeology, determining the basin's water balance, and planning cooperatively with sustained outreach. Underlying this has been the recognition that managing salt and nutrient loading is implicit to successful basin management.

1.1 Regulatory Framework

In February 2009, the State Water Resources Control Board (SWRCB) adopted Resolution No. 2009-0011 establishing a statewide Recycled Water Policy. The policy encourages increased use of recycled water and local stormwater capture and reuse. It also requires local water and wastewater entities, together with local salt- and nutrient-contributing stakeholders, to develop an SNMP for each groundwater basin or subbasin in California. The Paso Robles SNMP was developed through a collaborative process initiated in January 2013.

As outlined in the Recycled Water Policy, the required elements of an SNMP are the following:

- A basin/sub-basin wide monitoring plan that includes an appropriate network of monitoring locations.
- A provision for annual monitoring of constituents of emerging concern (CECs) consistent with recommendations by California Department of Public Health (now the Division of Drinking Water under the SWRCB) and SWRCB.
- Water recycling and stormwater recharge/use goals and objectives.
- Salt and nutrient source identification, basin/sub-basin assimilative capacity and loading estimates, together with fate and transport of salts and nutrients.
- Implementation measures to manage salt and nutrient loading in the basin on a sustainable basis.

- An anti-degradation analysis demonstrating that the projects included within the plan will, collectively, satisfy the requirements of the SWRCB's *Statement of Policy with Respect to Maintaining High Quality of Waters in California* (also referred to as Resolution No. 68-16).

The degree of specificity of the SNMP is dependent on the complexity of the groundwater basin, source water quality, stormwater recharge, and other factors. Each SNMP is tailored toward local water conditions, and may address other constituents beyond salts and nutrients that adversely affect groundwater quality.

1.2 Purpose of the SNMP

Excessive concentrations of salts and nutrients in groundwater can damage the Paso Robles Groundwater Basin's resources and impact the region's economy. Groundwater from the Paso Robles Groundwater Basin supplies domestic, industrial, and agricultural uses throughout parts of San Luis Obispo and Monterey Counties. Poor groundwater quality could threaten the ability to use this valuable resource, impact crop productivity, potentially impact public health, and require additional treatment of groundwater prior to use. While some concentrations of salt and nutrients are normal, human activities, such as water softeners and fertilizer use, can add too much to the system. These increases in concentrations can reach groundwater through percolation and sediment leaching. Sources of salt and nutrient loading can include recycled water, imported water, groundwater, agricultural activity, septic systems, as well as other sources. The Paso Robles Groundwater Basin is bounded by Temblor, La Panza, and Santa Lucia Ranges, and the Upper Valley Aquifer Subbasin. It drains to the north and contains one subbasin (Atascadero) and seven sub-areas. Presently, there are elevated levels of total dissolved solids (TDS), nitrate, and chloride in parts of the basin.

The objective of the SNMP is to manage salts and nutrients from all sources "…on a basin-wide or watershed-wide basis in a manner that ensures attainment of water quality objectives and protection of beneficial uses." The Plan also presents a baseline picture of groundwater quality, establishes a framework under which salt and nutrient issues can be managed, and streamlines the permitting process of new recycled water projects while meeting water quality objectives and protecting beneficial uses.

1.3 Preparation and Participation

The San Luis Obispo County Integrated Regional Water Management (IRWM) Region received a $1 million grant from the California Department of Water Resources (DWR) IRWM Program through Proposition 84. A portion of the grant award ($100,000) was for the purpose of developing a SNMP for the Paso Robles Groundwater Basin. This SNMP includes a series of strategies and actions that, when implemented, will reduce the future contribution of salts and nutrients to the groundwater basin. Water quality improvements resulting from implementation of the SNMP will benefit everyone overlying the basin and using the groundwater. Therefore, the Paso Robles SNMP was prepared with stakeholder participation and collaboration of interested parties throughout the planning area.

The known issues affecting the Basin were considered during development of the SNMP. These include:

- Declining groundwater elevations in portions of the basin.
- Increasing TDS and chloride concentrations in shallow aquifers the central portion of Atascadero subbasin.
- Increasing chloride concentrations in deep aquifer northeast of Creston.
- Increasing TDS and chloride concentrations near San Miguel.
- Increasing nitrate concentrations in the area north of Highway 46 between Salinas River and Huer Huero Creek.
- Increasing nitrate levels in the area south of San Miguel.

- Increasing TDS and chloride concentrations in deeper aquifer near the confluence of Salinas and Nacimiento Rivers.

This SNMP was prepared using an iterative process under which each step of the SNMP preparation was conducted and documented in a technical memorandum (TM). These technical memoranda were reviewed and serve as the basis for the chapters of this SNMP.

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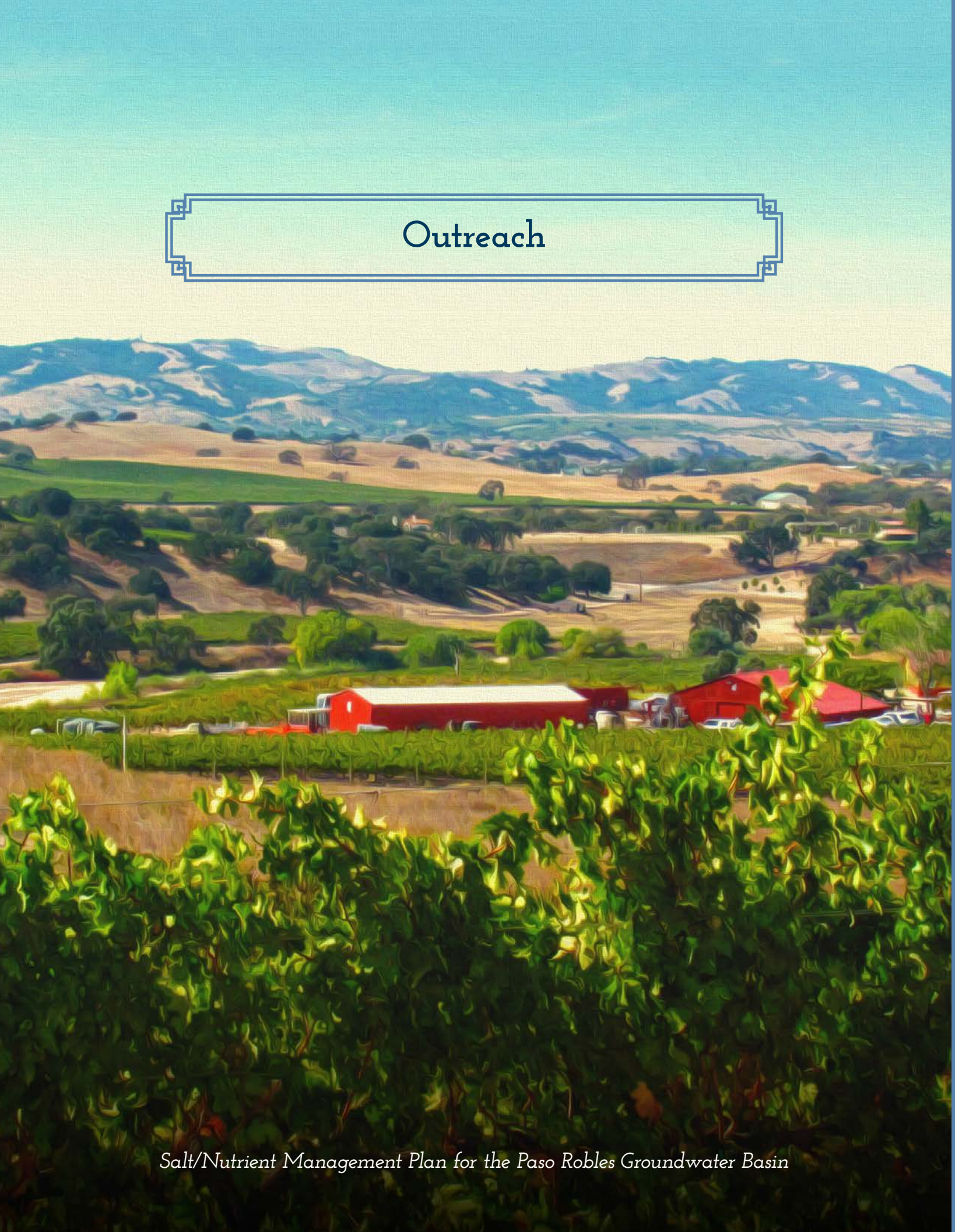
Outreach



Chapter 2 Outreach

2.1 Outreach and the SNMP Process

Development of the Paso Robles Salt and Nutrient Management Plan was a stakeholder-driven process allowing for transparency and inclusiveness throughout the planning process. In order to engage the public and basin stakeholders, a variety of outreach mechanisms were used, including stakeholder/public workshops, creation of a SNMP-specific website, informational handouts, and the opportunity to review and comment on draft technical memoranda that would ultimately contribute toward completion of the SNMP. These mechanisms, and the overall outreach processes, are described in the following sections.

2.2 Stakeholders

In order to effectively engage a variety of stakeholders and interested parties, the stakeholders were divided into two groups: primary and secondary. Primary stakeholders are those entities with direct water management authority and include the following:

- City of Paso Robles
- City of Atascadero
- San Luis Obispo County
- Templeton Community Service District
- San Miguel Community Service District
- Heritage Ranch Community Service District
- California Army National Guard: Camp Roberts
- California Regional Water Quality Control Board

These entities also funded the SNMP development with assistance from a Proposition 84 Integrated Regional Water Management grant and have been heavily involved in management of the Paso Robles Groundwater Basin over the years.

Secondary stakeholders were identified through past groundwater management planning efforts for the Basin, as well as brainstorming amongst the primary stakeholders to identify agencies, local businesses, environmental groups, and other organizations that may be interested in participating in the SNMP process. Additionally, attendees at the workshops (described in Section 2.3.2) who expressed an interest were also added to the list, resulting in continual updates to the list of stakeholders and interested parties. Many of the secondary stakeholders involved in the development of the Paso Robles SNMP include, but are not limited to, the San Luis Obispo County Farm Bureau, the University of California Cooperative Extension, the Central Coast Vineyard Team, and the Paso Robles Wine County Alliance. The stakeholder list, including the primary and secondary stakeholders, is included as 9.5Appendix A -. Both groups of stakeholders were vital in developing a thorough and comprehensive SNMP for the Paso Robles Groundwater Basin.

The primary method for engaging the SNMP stakeholders was through email. Draft TMs, meeting announcements, and other SNMP-related information were emailed to the primary and secondary stakeholders to keep them informed throughout the process. This information was also uploaded to the SNMP-specific website (see Section 2.3.1). Hard copies were mailed via the U.S. Postal Service to those who requested that method of communication.

In addition to the primary and secondary stakeholder groups, the City of Paso Robles, acting as project manager for the SNMP development, regularly coordinates with several federal, state and local agencies in

addition to numerous public, private and non-profit organizations to provide information regarding various aspects of the SNMP and to solicit feedback.

2.3 Outreach Mechanisms

2.3.1 Paso Robles SNMP Website

A website specific to the Paso Robles SNMP planning process was prepared and regularly updated. The website, which can be accessed here: http://pr.saltnutrient.com/, includes the following tabs and information:

- **Home:** provides general information about the purpose and need of the SNMP.
- **Documents & References:** the draft TMs prepared for the SNMP were uploaded to the website at this location, allowing viewers to review the TMs and provide input throughout the planning process. Other reference documents (such as the basin's groundwater management plan) were also included at this location.
- **Contact Us**: allows a viewer to email the City with comments and questions, or to be added to the distribution email list or stakeholder list.
- **Participation**: includes the current list of stakeholders, as well as announcements of upcoming workshops, and workshop materials (e.g. agenda, handouts).

The website also includes links to local agencies and stakeholders and other useful SNMP-related links such as the Paso Robles SNMP Handout and the State Water Resources Control Board (SWRCB) Recycled Water Policy. Additionally, links to this SNMP website are posted on the primary stakeholders' website. As draft TMs were completed, they were uploaded to the website and a posting announcement distributed to the stakeholder contact list. The posting announcements are included as 9.5Appendix B -. This communication mode helped to ensure that the technical analyses prepared as part of the SNMP were vetted and reviewed by a variety of stakeholders, ensuring an accurate and thorough evaluations and results.

2.3.2 Stakeholder Workshops

Stakeholder workshops were conducted at key milestones of the Paso Robles SNMP planning process. Upon completion of the SNMP, a total of four workshops were conducted. Table 2-1 summarizes the workshops, topics, and dates they were conducted. All of the workshops were publically noticed and conducted at the Paso Robles City Hall located at 1000 Spring Street in Paso Robles. Invitations to all of the workshops were emailed to the stakeholder list and posted to the Paso Robles SNMP website.

Four workshops have been conducted to date with portions of the SNMP analyses presented at each workshop. The final workshop, Workshop 4, was conducted on April 17, 2015, presenting the culmination of analyses resulting in the Draft SNMP. A final opportunity for input, comments, and questions was provided at this workshop and during a 30-day public comment period. Additional workshops may be conducted in the future, as needed, to continue groundwater management planning in the basin and will likely be completed concurrently with ongoing efforts to comply with the Sustainable Groundwater Management Act of 2014. The meeting presentations, handouts, and attendees list for each workshop are included in Appendices C, D, E and F.

Table 2-1: Paso Robles SNMP Stakeholder Workshops

Workshop No.	Topic	Date
1	Introduction to SNMP process, definitions, concepts, approach, and data needs	1/24/2013
2	Conceptual model and source identification	5/2/2013
3	Future water quality, assimilative capacity, anti-degradation analysis, and recycled water goals and objectives	6/20/2014
4	SNMP Report	4/17/2015

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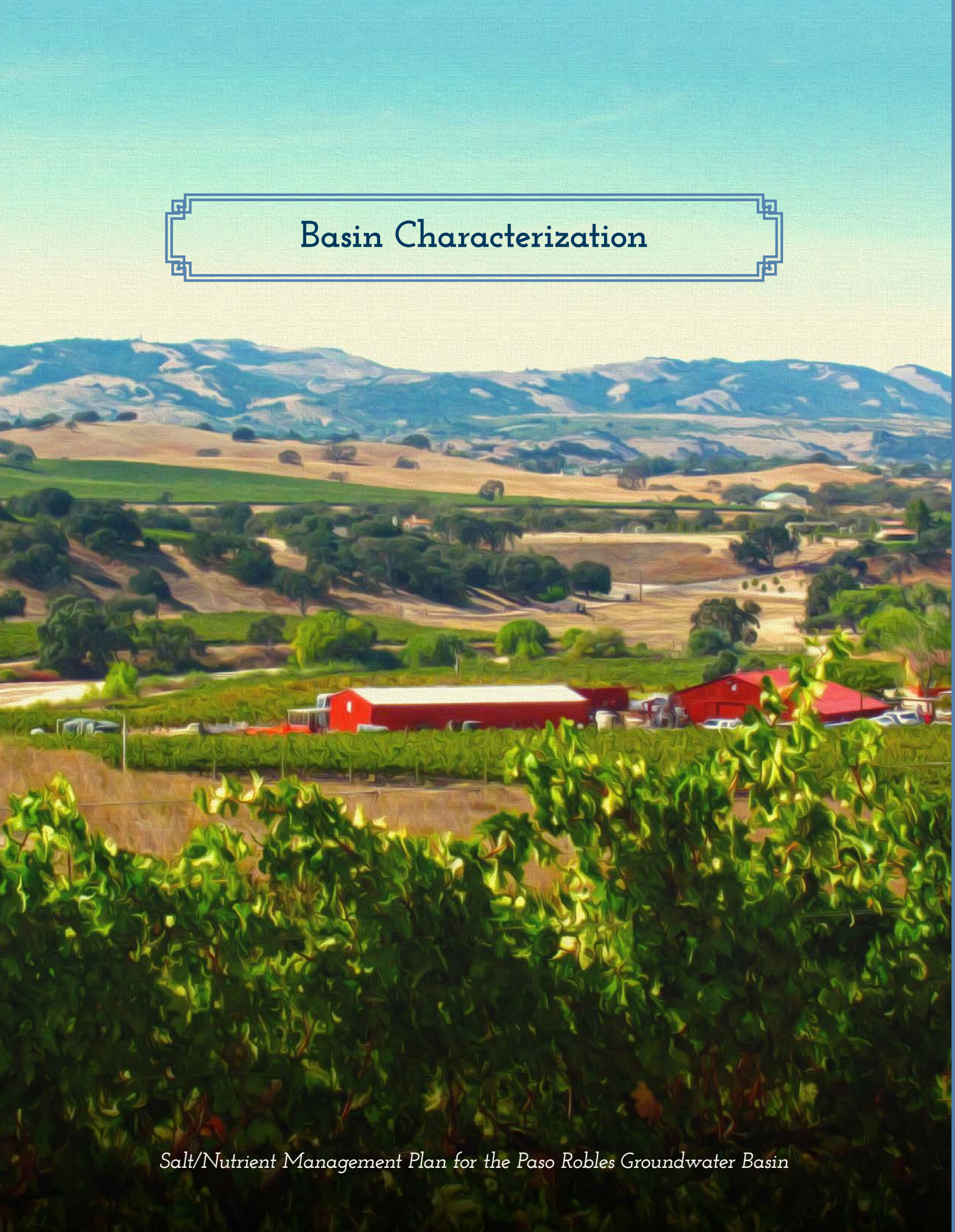
Basin Characterization



Salt/Nutrient Management Plan for the Paso Robles Groundwater Basin

Chapter 3 Basin Characteristics

This chapter presents the findings of the Basin Characterization task for the development of a Salt & Nutrient Management Plan for the Paso Robles Groundwater Basin (Basin). The major objectives of this task are the following:

1. Collect data necessary to quantify, characterize, and describe the setting, land use, climate, hydrology, geology, and hydrogeology of the Basin.
2. Organize the collected data into a Geographical Information System (GIS) database in a format that is accessible for future use by project stakeholders and that is compatible with the existing County GIS data management system.
3. Establish the baseline conditions (i.e., current spatial distributions) for each of the water quality constituents chosen to be addressed in the SNMP.
4. Estimate a water balance for the study areas of the Basin for use in the assimilative capacity and anti-degradation analyses to be conducted in later tasks of this project.

The features of the Basin characterized in this report are consistent with the list of groundwater basin characteristics suggested by the California Regional Water Quality Control Board (RWQCB) for inclusion in a SNMP. Data used to characterize the Basin were collected from various local, state, and federal agencies, and from previous hydrogeologic reports. Three studies in particular were significant sources of data and information for the characterization of the Basin. The first study was the Paso Robles Groundwater Basin Study (Basin Study) performed by Fugro and Cleath (2002). That study consisted of data collection, conceptualization of Basin hydrogeology, and estimation of a water balance over the study base period of 1981 to 1997. The second study was Phase II of the Basin Study which consisted of the development of a numerical groundwater flow model for the Basin used to evaluate several future scenarios of water supply and demand in the Basin (Fugro et. al, 2005). The third study consisted of the estimation of groundwater pumping from the major sources in the Basin for the 2006 water year (Todd, 2009).

Development of the GIS database under Objective No. 2 is not documented in this report but was provided to the City of Paso Robles as a separate project deliverable. This report presents the findings associated with Objective Nos. 1, 3, and 4.

3.1 Setting

The Paso Robles Groundwater Basin is formally recognized by the Department of Water Resources as a subbasin to the greater Salinas Valley Groundwater Basin and is identified as Groundwater Basin Number 3-4.06 in DWR Bulletin 118 (DWR, 2003). The Basin is approximately 505,000 acres (790 square miles) in size with approximately 72 percent (363,600 acres) of its area located in San Luis Obispo County and the remaining 28 percent (141,400 acres) located in Monterey County (Figure 3-1). The Basin is located in a large inland valley bounded on the north by the Upper Valley Aquifer Subbasin, on the west by the Santa Lucia Range (which separates the North County area from the Pacific Ocean coastal region), on the south by the La Panza Range, and on the east by the Temblor and Diablo ranges.

In the Basin Study, the Paso Robles Groundwater Basin was divided into eight study areas (see Figure 3-1):

1. Atascadero Groundwater Subbasin (15,181 acres),
2. Bradley Area (55,162 acres),
3. Creston Area (57,347 acres),
4. Estrella Area (81,822 acres),
5. North Gabilan Area (65,630 acres),
6. San Juan Area (84,027 acres),
7. Shandon Area (82,986 acres), and
8. South Gabilan Area (58,391 acres).

With the exception of the Atascadero Subbasin, none of the study areas is defined as a function of geology or hydrogeology. Instead, the study areas were defined for analysis and discussion purposes only in the Basin Study. The four most populated urban areas in the Basin are the incorporated cities of Paso Robles (2010 Census population of 29,793) and Atascadero (pop. 28,310) and the unincorporated Census-designated places of Templeton (pop. 7,674) and San Miguel (pop. 2,336). Other smaller unincorporated Census-designated places in the Basin include the communities of Shandon, Creston, Whitley Gardens, Garden Farms, and Bradley.

The Central Coast Region of the California Regional Water Quality Control Board includes all of Santa Cruz, San Benito, Monterey, San Luis Obispo, and Santa Barbara counties as well as the southern one-third of Santa Clara County and small portions of San Mateo, Kern, and Ventura counties. The Central Coast Region is also divided into fourteen hydrologic units. The Paso Robles Groundwater Basin spans regions of both the Salinas Hydrologic Unit and the Estrella River Hydrologic Unit of the Central Coast Region. Water quality objectives for groundwater in the Paso Robles Groundwater Basin are defined separately for each of seven general sub-areas of the Basin in the Water Quality Control Plan for the Central Coastal Basin (hereafter referred to as 'Basin Plan') (RWQCB, 2011) and are described in more detail later in Section 3.5.1. The precise boundaries of those sub-areas were not rigorously defined in the Basin Plan but are approximated in this SNMP and are displayed on Figure 3-1 relative to the boundaries of the study areas.

The seven Basin Plan sub-areas shown on Figure 3-1 are:

1. Central Basin Sub-area (35,750 acres)
2. San Miguel Sub-area (18,786 acres)
3. Paso Robles Sub-area (21,834 acres)
4. Templeton Sub-area (6,858 acres)
5. Atascadero Sub-area (6,944 acres)
6. Estrella Sub-area (14,296 acres)
7. Shandon Sub-area (5,267 acres)

The San Miguel, Paso Robles, Templeton, and Atascadero sub-areas correspond respectively to those cities or communities for which those sub-areas are named and are all located along the Salinas River corridor. Similarly, the Shandon Sub-area corresponds to the community of Shandon and the Estrella Sub-area corresponds to the stretch of the Estrella River corridor between the communities of Shandon

and San Miguel. Lastly, the Central Basin Sub-area corresponds to the remaining areas in the central region of the Paso Robles Groundwater Basin not already defined by the other six Basin Plan sub-areas.

Relative to the study areas, the Basin Plan Atascadero and Templeton sub-areas together comprise the majority of the Atascadero Subbasin area (Figure 3-1). The Shandon Sub-area is located entirely within the Shandon Area and the Estrella Sub-area spans the Estrella Area and the Shandon Area. The San Miguel and Paso Robles sub-areas are located entirely within the Estrella Area and the Central Basin Sub-area covers the eastern region of the Estrella Area and smaller regions of the Creston and Shandon study areas (Figure 3-1).

The primary source of water in the Basin for all land uses (e.g., urban, agricultural, rural residential) is pumped groundwater from the underlying aquifer system. The City of Paso Robles is the water purveyor to its resident population and also operates the associated wastewater treatment plant. The Atascadero Mutual Water Company (AMWC) is the water purveyor to the City of Atascadero with wastewater treatment provided by the City of Atascadero. The Templeton Community Services District (CSD) and the San Miguel CSD each provide both potable water service and wastewater treatment for their respective communities. The community of Shandon is served by County Service Area (CSA) 16-1. Water service to other unincorporated Census-designated places is provided by small community water systems and wastewater treatment is handled by onsite septic systems. A secondary source of water is surface water from the Nacimiento Water Project (NWP). At present, the City of Paso Robles, Templeton CSD, and AMWC have contract amounts of NWP water of 4,000, 250, and 2,000 acre-feet per year (AFY), respectively (GEI, 2011). Templeton CSD and AMWC have facilities in place to accept NWP water and have taken portions of their contracted amounts; NWP water will not be delivered to the City of Paso Robles until 2015. Shandon (via CSA 16-1) is the only contractor of State Water Project (SWP) surface water in the Basin but has not yet accessed that supply (GEI, 2011).

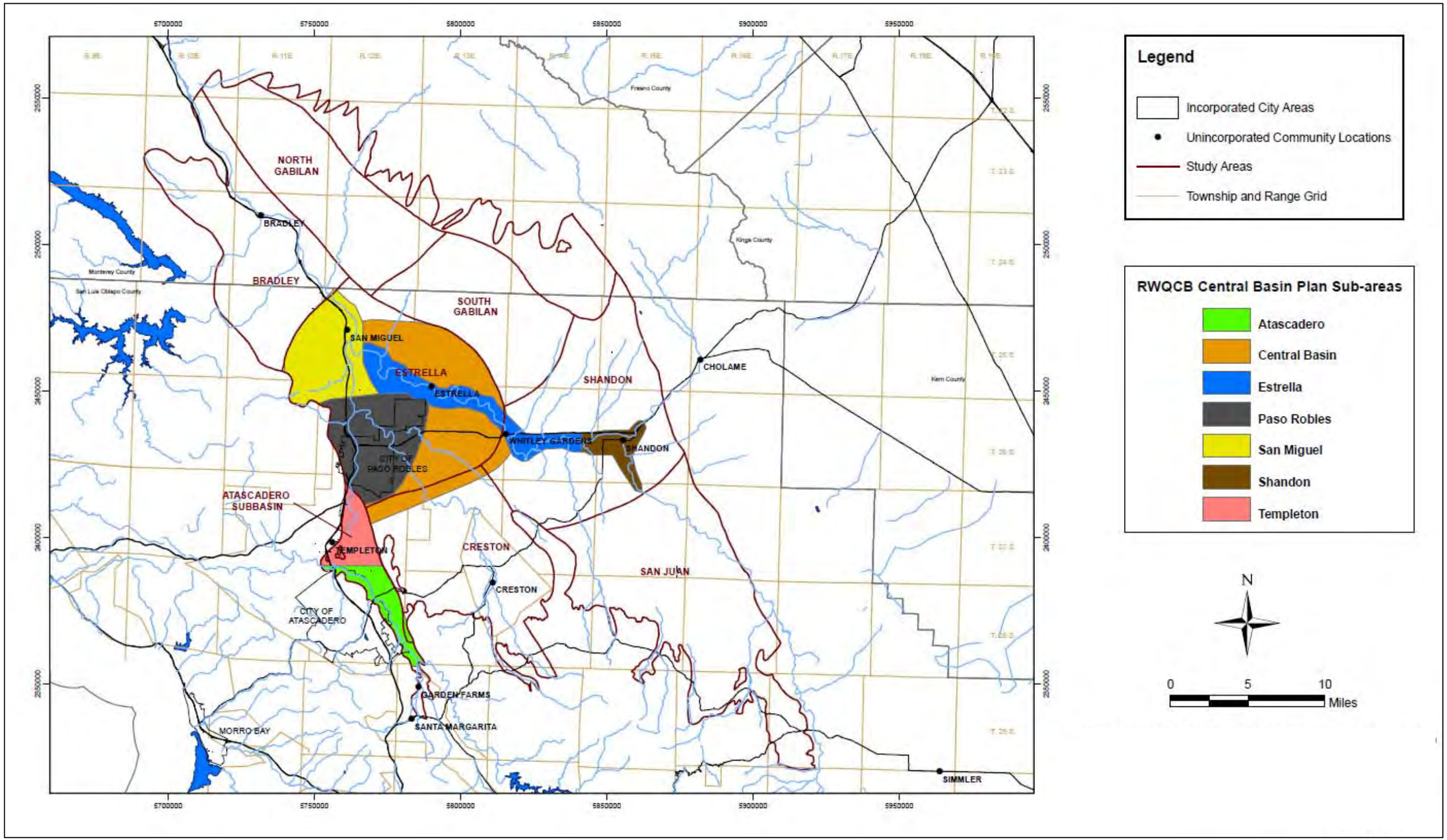
3.2 Land Use

Recent land use information for the Paso Robles Groundwater Basin was collected from the San Luis Obispo County and Monterey County Ag Commissioner Offices and from other County departments. Current land use in the Basin is summarized by group in Table 3-1. Overall, grassland/barren areas, agricultural crops, farmsteads, urban land use, and paved areas comprise about 72, 13, 9, 4, and 2 percent of the Basin area, respectively. Approximately 69 percent of agricultural land is irrigated while the other 31 percent is considered non-irrigated (Table 3-1).

Table 3-1: Major Land Use Group

Land Use Group	Irrigated (I)/ Non-irrigated (N)	Monterey County Area (acres)	San Luis Obispo County Area (acres)	Total Area (acres)	Percent of Total Area
Farmsteads	I/N	39	43,232	43,271	9%
Field Crops	I	5,937	334	6,271	1%
Flowers and Nursery	I	0	69	69	0%
Grassland/Barren	N	120,990	240,092	361,082	72%
Non-irrigated Field Crops	N	5,259	16,796	22,055	4%
Non-irrigated Orchards	N	0	44	44	0%
Orchard	I	59	851	909	0%
Other Row Crops	I	145	1,466	1,610	0%
Pasture	I	72	3,987	4,059	1%
Paved Areas	N	0	8,095	8,095	2%
Urban Commercial & Industrial (low impervious surface)	I/N	0	383	383	0%
Urban Commercial & Industrial	I/N	2,983	7,003	9,986	2%
Urban Landscape	I	0	358	358	0%
Urban Residential	I/N	589	11,098	11,687	2%
Vineyards	I	3,845	30,222	34,067	7%
Total		**139,918**	**364,030**	**503,946**	**100%**

Figure 3-1: Paso Robles Groundwater Basin Location Map



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3.3 Climate and Hydrology

The climate of the Basin area is characterized as semi-arid, with warm dry summers and cool wet winters. Average monthly and annual precipitation data for several weather stations located in the Basin were collected from the San Luis Obispo County Water Resources Division of Public Works database and are presented in Table 3-2. Average annual precipitation varies widely in the Basin from 9.8 inches per year (in/yr) at Canyon Ranch Station No. 138 in the San Juan Area to 30.9 in/yr at the Santa Margarita Booster Station located just south of the Basin southern boundary (Table 3-2). On average, at least 80 percent of annual precipitation occurs from November through March. Average monthly reference evapotranspiration (ETo) data was collected from the California Irrigation Management Information System (CIMIS) weather station located in Atascadero (Station No. 163) and is presented in Table 3-3. Monthly ETo ranges from 2.2 inches in January to 6.4 inches in July, with an annual average of 52.1 inches.

The Salinas River is the largest natural channel in the Basin. It begins in the Pozo Groundwater Basin just south of the Basin at the base of the Santa Margarita Reservoir dam and exits or drains the Basin at the northern end of the Bradley Area. The Salinas River receives surface water inflows from a number of tributary rivers and creeks, the major ones being the Nacimiento River, San Antonio River, Estrella River, and Huer Huero Creek. The headwaters of these tributaries begin either within the Basin (e.g., Estrella River) or in the watershed surrounding the Basin (e.g., San Antonio and Nacimiento rivers).

Annual surface water flows from 1981 to 1997 in the Nacimiento River, San Antonio River, Estrella River, Huer Huero Creek, and in the Salinas River as measured at two gage stations (i.e., Paso Robles and Bradley) along its stretch in the Basin are presented in Table 3-4. As the Salinas River flows from south to north, it receives surface water inflows from its tributaries. As shown in Table 3-4, the average annual flow in the Salinas River at Paso Robles (USGS Gage Station No. 11147500) was 93,108 AFY and increased downstream at Bradley (USGS Gage Station No. 11150500) to 405,914 AFY. The measured flow in the Salinas River at the Bradley station accounts for nearly 100 percent of the total surface water drainage from the Basin through its northern boundary.

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Table 3-2: Average Monthly Precipitation at Weather Stations

Station Name	Station No.	Planning Area	Period of Record	Monthly Precipitation (inches)												Total
				Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	
Paso Robles	10	Estrella	1886-2012	0.02	0.05	0.19	0.60	1.29	2.51	3.29	3.14	2.63	0.95	0.37	0.05	15.1
Shandon	73.0	Shandon	1937-2009	0.02	0.03	0.22	0.46	0.94	1.68	2.16	2.15	1.87	0.88	0.24	0.04	10.7
Atascadero MWC	34.0	Atascadero	1931-2012	0.01	0.03	0.18	0.70	1.57	3.15	3.81	3.71	2.85	1.30	0.29	0.05	17.7
Canyon Ranch	138.0	San Juan	1952-2012	0.00	0.03	0.24	0.46	1.07	1.45	1.92	2.02	1.74	0.73	0.15	0.01	9.8
Sinclair	125	Estrella	1949-2012	0.02	0.05	0.20	0.54	1.11	1.86	2.43	2.30	1.97	0.93	0.24	0.05	11.7
PR County Road Yard	177.3	Estrella	1956-2012	0.02	0.04	0.22	0.73	1.42	2.20	3.47	3.27	2.50	1.04	0.27	0.03	15.2
Holzinger	205.2	Creston	1981-2012	0.00	0.02	0.31	0.96	1.73	3.03	3.92	4.21	3.39	1.15	0.41	0.04	19.2
Santa Margarita Booster Station	95	outside of Basin	1948-2009	0.03	0.04	0.35	1.26	3.22	5.22	6.96	6.55	4.41	2.19	0.59	0.07	30.9
Erickson Ranch	52.1	Creston	1928-2010	0.02	0.03	0.24	0.47	1.04	1.96	2.59	2.59	2.00	0.92	0.22	0.02	12.1

Table 3-3: Average Monthly Reference Evapotranspiration

CIMIS Station Name	CIMIS Station No.	Evapotranspiration (inches)												
		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Atascadero	163	2.21	2.5	3.8	5.08	5.7	6.19	6.43	6.09	4.87	4.09	2.89	2.28	52.1

Table 3-4: Measured Streamflow for Major Rivers and Creeks

Water Year	San Antonio River (acre-feet)	Nacimiento River (acre-feet)	Salinas River at Paso Robles (acre-feet)	Estrella River (acre-feet)	Huer Huero Creek (acre-feet)	Salinas River at Bradley (acre-feet)
1981	38,738	179,126	35,755	460	49	253,163
1982	65,303	136,381	95,420	2,274	610	315,085
1983	277,285	780,472	394,500	56,685	16,715	1,510,259
1984	85,894	195,831	32,055	2,637	485	321,887
1985	20,371	162,245	8,963	202	4	210,789
1986	88,277	143,380	127,841	7,562	2,098	401,578
1987	74,231	126,569	4,008	230	5	189,427
1988	49,715	160,573	7,175	445	9	213,511
1989	145,343	70,034	4,682	0	0	222,487
1990	2,174	2,525	262	216	5	6,943
1991	21,896	82,161	29,577	19,630	5,836	168,207
1992	16,887	115,697	56,874	9,885	2,828	207,612
1993	15,895	267,503	204,972	26,272	7,648	568,434
1994	83,466	153,557	5,431	0	0	251,735
1995	26,418	183,451	273,989	68,827	20,456	758,423
1996	35,920	296,886	96,050	3,704	928	448,141
1997	149,066	438,606	205,279	59,209	17,591	852,861
Average	**70,404**	**205,588**	**93,108**	**15,190**	**4,427**	**405,914**
Percent Total Flow	**17**	**49**	**24**	**7**	**2**	**100**
Percent Total Drainage Area	**14**	**14**	**15**	**38**	**6**	**100**

3.4 Geology and Hydrogeology

3.4.1 Geology

A map displaying the Basin boundaries and surficial geology is shown in Figure 3-2. The Basin boundaries were originally defined by DWR (1958) and later refined by Fugro and Cleath (2002) using information from oil well and geothermal well logs, water well logs, geologic maps, and fault investigations. The surficial geologic units in the Basin are comprised predominantly of Quaternary (younger) alluvium (Qa or Qal) of Holocene age, older alluvium (Qoa) of Pleistocene age, and Paso Robles Formation (QTp) of Pliocene-Pleistocene age (Figure 3-2). Six geologic cross sections (i.e., cross section A-A' to cross section G-G') were developed by Fugro and Cleath (2002). The transect locations of cross sections B-B' (east to west direction) and G-G' (southeast to northwest direction) are shown on Figure 3-3 and the cross sections are reproduced on Figure 3-4, Figure 3-5 and Figure 3-6, respectively.

Geologic cross section B-B' extends from the City of Paso Robles along the western Basin boundary to just east of the community of Shandon along the eastern Basin boundary (Figure 3-3). The younger alluvium (Qa or Qal) shown on Figure 3-2, Figure 3-4, Figure 3-5 and Figure 3-6 is associated with floodplains of the Salinas River, Huer Huero Creek, Estrella River, and other smaller creeks. The alluvium is comprised of unconsolidated, fine- to coarse-grained sand with pebbles and boulders. It reaches a maximum thickness of about 100 feet in areas along the Salinas River and is shallower along other rivers and creeks in the Basin.

The Paso Robles Formation (QTp) shown on Figure 3-2, Figure 3-4, Figure 3-5 and Figure 3-6, respectively is comprised of unconsolidated, poorly sorted sand, silt, gravel, and clay. The formation extends from either the ground surface or beneath the alluvium to depths as much as 2,500 feet below ground surface (bgs) in the Basin. Along cross section B-B', the thickness of the Paso Robles Formation generally increases from the western Basin boundary beneath the Salinas River to the eastern Basin Boundary (Figure 3-4).

The Paso Robles Groundwater Basin is comprised predominantly of sedimentary layers of the Paso Robles Formation. The alluvium and Paso Robles Formation therefore form the aquifer system in the Basin. The base of permeable sediments of the aquifer system in the area beneath the Salinas River corridor is defined by the contact between the Paso Robles Formation and the underlying Monterey Formation (Tm) (Figure 3-4). The base of permeable sediments beneath most of the Estrella Area and the western region of the Shandon Area is defined by the contact between the Paso Robles Formation and the underlying Pancho Rico Formation (Tp) (Figure 3-4). Nearer the eastern boundary of the Basin, the base of permeable sediments is defined by the contact between the Paso Robles Formation and the underlying Santa Margarita Formation (Tsm) (Figure 3-4).

Geologic cross section G-G' extends from the northwestern end of the Bradley Area where the Salinas River exits the Basin to the southern Basin boundary in the Creston Area (Figure 3-5 and Figure 3-6). Cross section G-G' illustrates how the thickness of the Paso Robles Formation is greatest near the middle of the Estrella Area and decreases in the northern and southern directions away from the central Basin area.

Several fault systems are located within the Basin. The most significant is the San Marcos-Rinconada fault system which traverses the western part of the Basin. The Rinconada fault defines the eastern boundary of the Atascadero Subbasin (Subbasin). Between the Subbasin and the Creston Area, the Rinconada fault juxtaposes less permeable Monterey Formation rocks with Paso Robles Formation sediments. South of the City of Paso Robles, the Paso Robles Formation is found on both sides of the Rinconada fault; however, the fault is believed to act as a leaky hydraulic barrier to groundwater flow between the main part of the Basin and the Subbasin. Hydrogeologic characteristics of the aquifer system in the Basin and Subbasin are described in the next section.

3.4.2 Hydrogeology

The alluvium and Paso Robles Formation sedimentary layers are the major water bearing sediments in the Paso Robles Basin and Atascadero Subbasin and together form an aquifer system. The alluvium is an unconfined aquifer and the Paso Robles Formation is conceptualized as a semi-confined to confined aquifer. The most productive and reliable source of groundwater in the alluvium is that associated with the Salinas River. The thickness of the Salinas River alluvium generally varies from about 50 to 100 feet. Although the Paso Robles Formation attains a thickness of as much as 2,500 feet in some areas, the primary water- producing portion of the formation has a thickness between about 700 to 1,200 feet (Figure 3-4, Figure 3-5 and Figure 3-6).

Aquifer Characteristics

A summary of aquifer properties and well information for the study areas was obtained from Fugro and Cleath (2002) and is presented in Table 3-5. Within the aquifer system, three general production zones are identified: (younger) alluvium (Qa or Qal), Paso Robles Formation below alluvium (Qa/QTp), and deeper Paso Robles Formation (QTp).

The unconfined alluvium is associated predominantly with the Salinas River and to a lesser degree with the thinner alluvium of other rivers and creeks in the Basin. The alluvium is comprised mostly of highly permeable sands and gravels with hydraulic conductivities in the range of 200 to 2,000 feet/day (Table 3-5). Wells located in the alluvium tend to have maximum depths less than 100 feet bgs and high water production rates in the range of 100 to 1,000 gallons per minute (gpm).

In some areas along the Salinas River corridor, the sedimentary layers separating the alluvium from the deeper water-bearing portions of the Paso Robles Formation have transmissivities high enough to result in significant hydraulic communication (i.e., leakage or groundwater exchange) between the alluvium and the underlying formation. These areas are prominent along the Salinas River between the Atascadero Subbasin and the Bradley Area and are noted in Table 3-5 in those areas by the Qa/QTp designation. Wells screened in the Paso Robles Formation in these areas tend to have higher transmissivities than wells penetrating portions of the Paso Robles Formation not in direct contact with the alluvium. In the Atascadero Subbasin and Bradley Area, Table 3-5 shows hydraulic conductivities for Qa/QTp areas in the range of about 10 to 140 feet/day.

The majority of the Paso Robles Formation is located east of the Salinas River and its sediments do not have a significant direct hydraulic connection (i.e., highly transmissive connection) to any overlying alluvium in that region. From the Salinas River area to just east of the community of Shandon exists a laterally extensive, low permeable aquitard that underlies the entire Estrella River and extends away in the north and south directions from the river for several miles. The aquitard underlies large regions of the Estrella, South Gabilan, and Shandon study areas. The aquitard separates the Estrella River alluvium and outcropping Paso Robles Formation from the deeper water-bearing regions of the formation. Aquifer characteristics for the Paso Robles Formation beneath the aquitard and elsewhere in the Basin where wells are screened in deeper regions of the formation are presented in Table 3-5 with an associated aquifer type designation of QTp. Hydraulic conductivities in the QTp areas range from about 5 to 15 feet/day. Well pumping capacities in the deeper Paso Robles Formation may range from 300 to 1,300 gpm; such high pumping rates are achieved predominantly by constructing wells with long screens (i.e., 200 to 400 feet or greater in length).

For the assimilative capacity and anti-degradation analyses, average hydrogeologic properties of the alluvium and Paso Robles Formation (i.e., confined aquifer) were estimated for each study area using data from the Basin groundwater flow model (Fugro et. al, 2005) and are presented in Table 3-6 and Table 3-7, respectively. The hydrogeologic properties of the alluvium and Paso Robles Formation underlying each

study area include average aquifer thickness, average horizontal hydraulic conductivity, average storage coefficient, and estimated groundwater in storage (Table 3-6 and Table 3-7).

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Figure 3-2: Surficial Geology

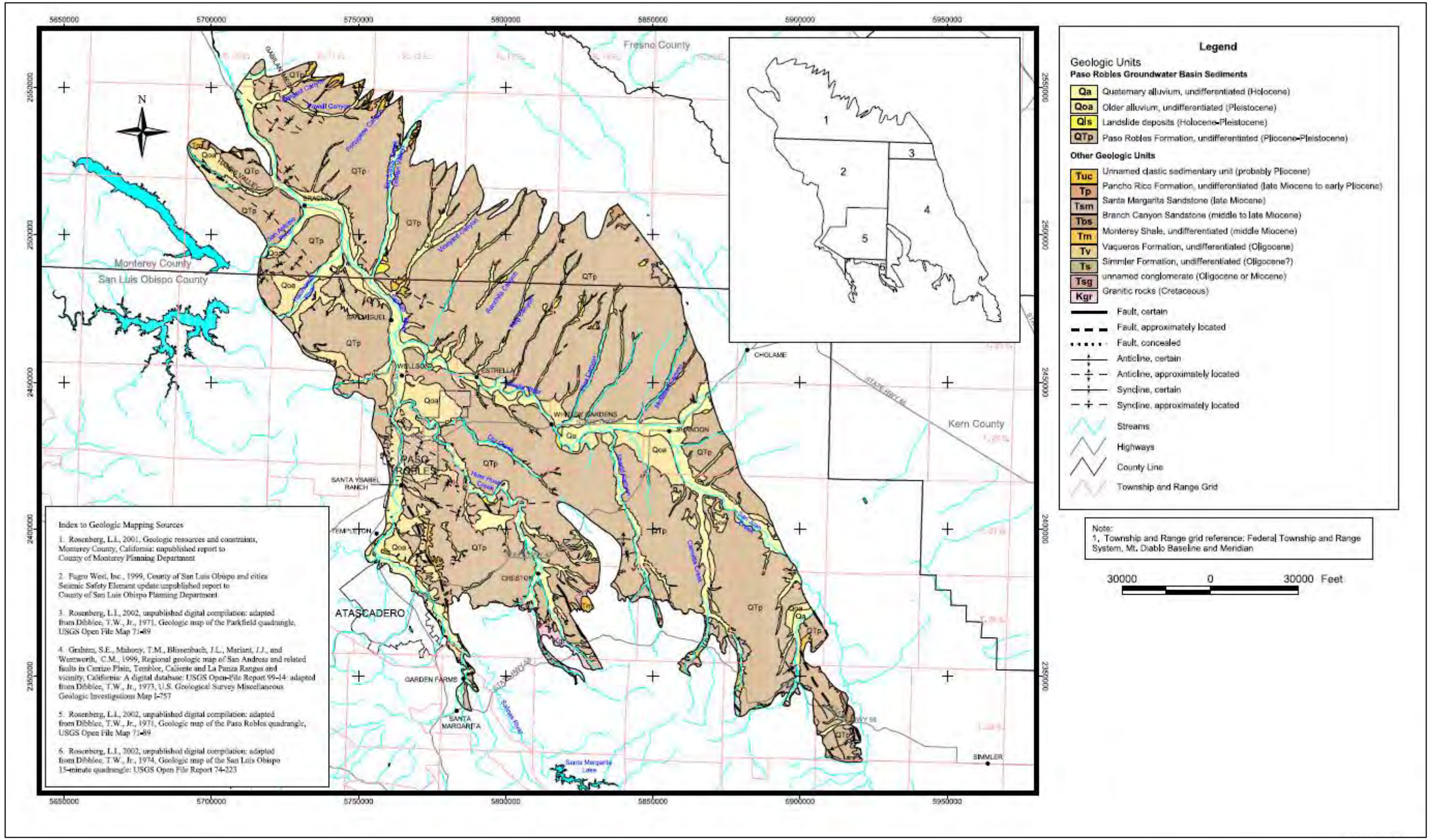

Figure 3-3: Locations of Geologic Cross Sections

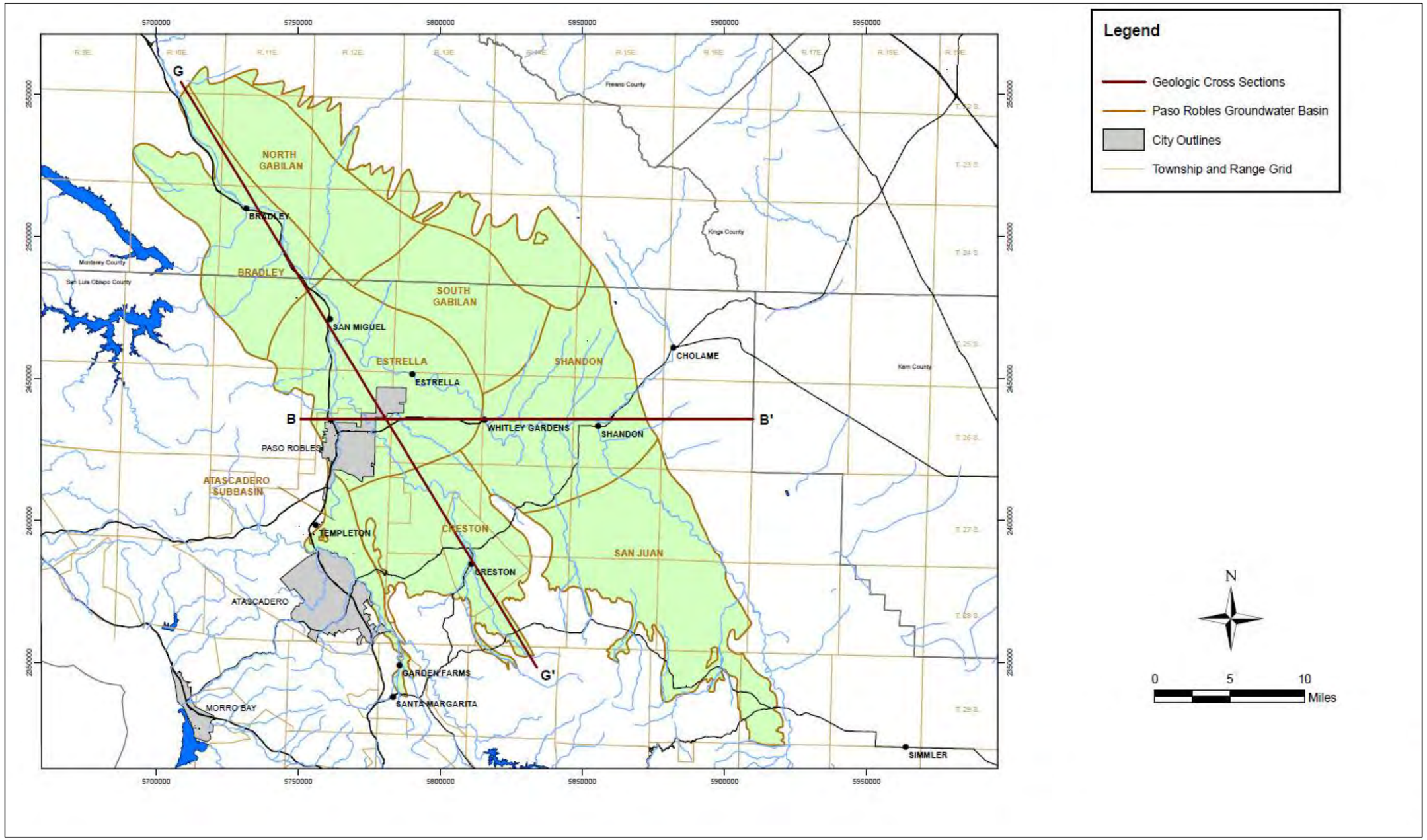

Figure 3-4: Geological Cross Section B-B'

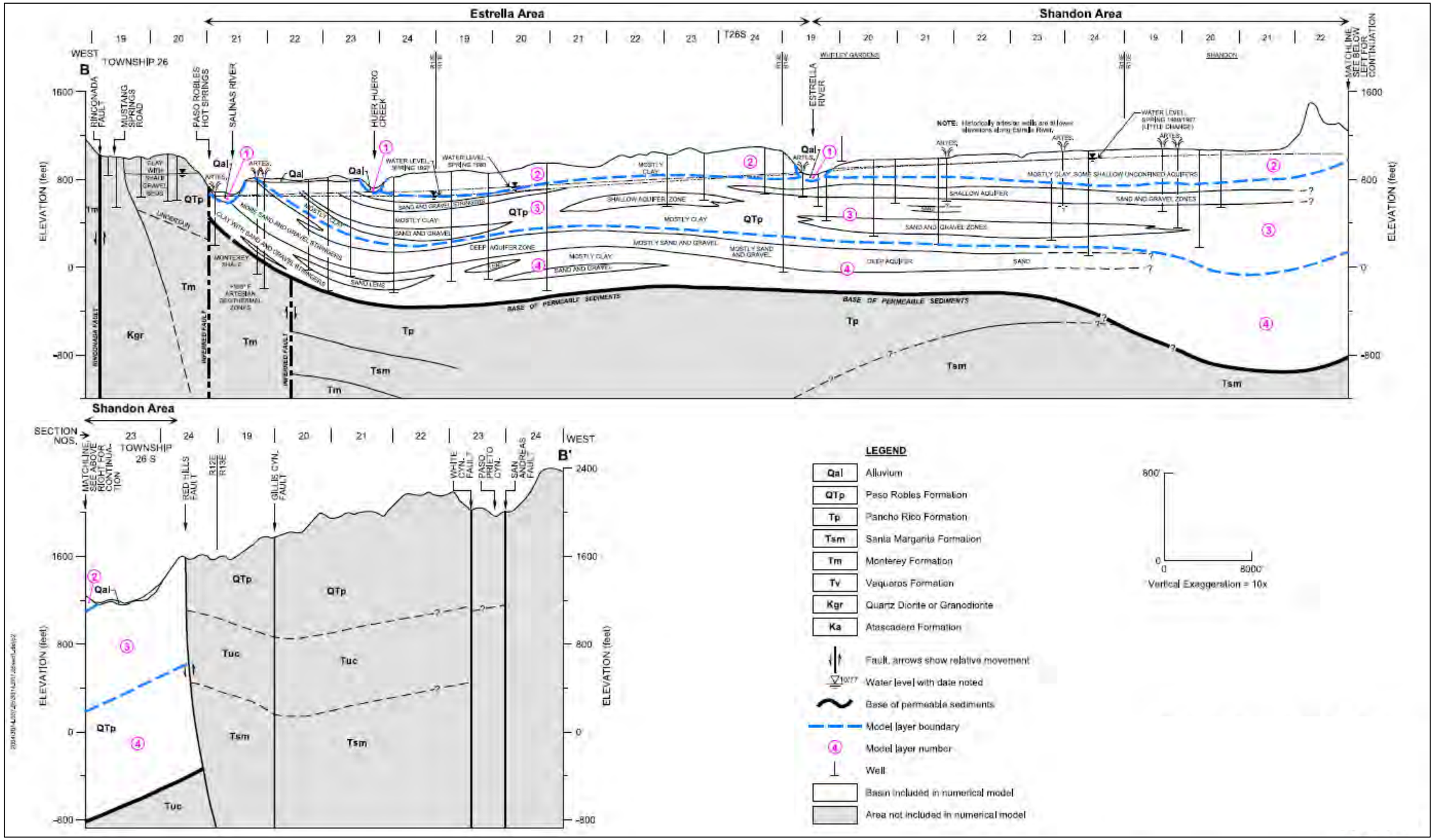

Figure 3-5: Geologic Cross Section G-G

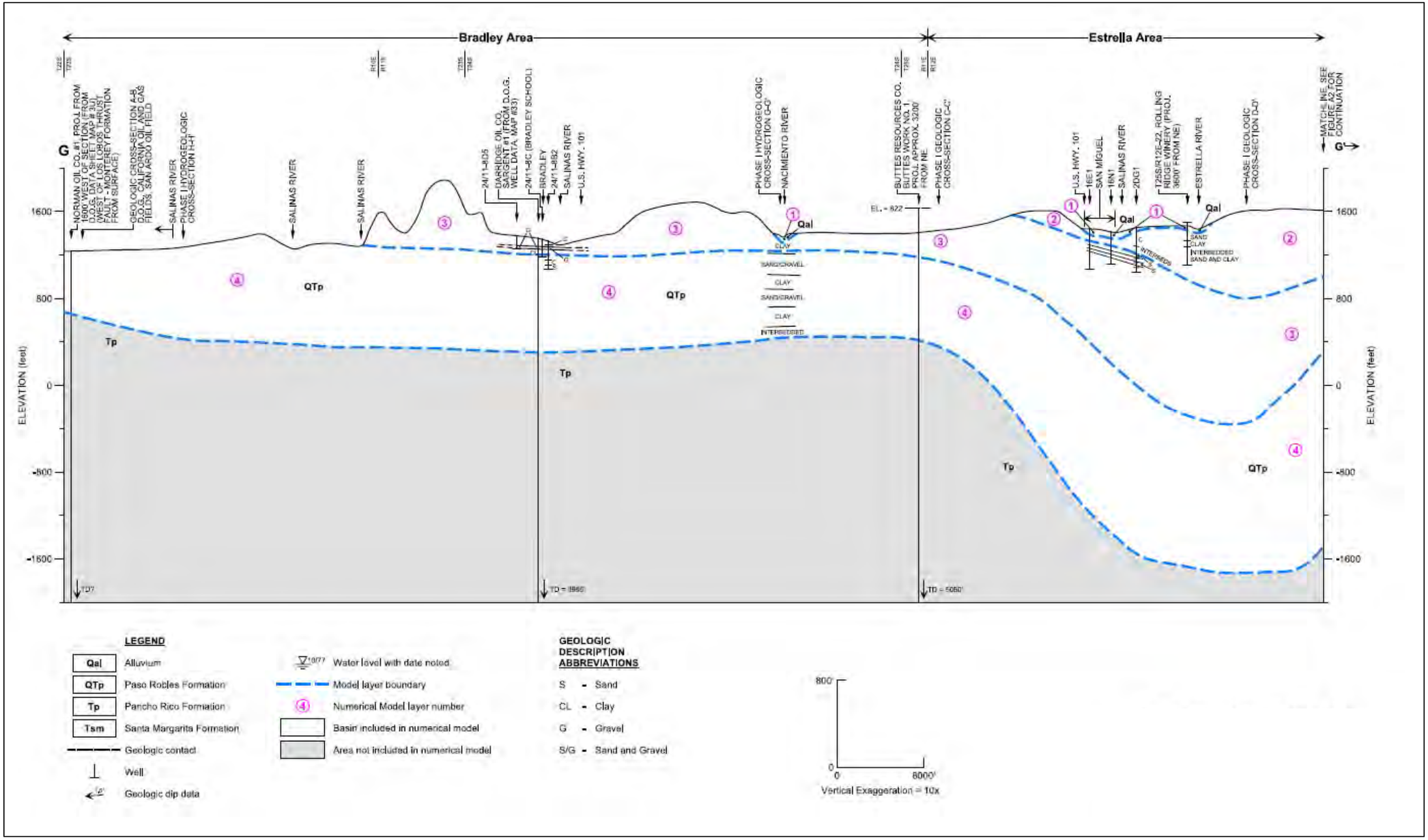

Figure 3-6: Geologic Cross Section G-G' (continued)

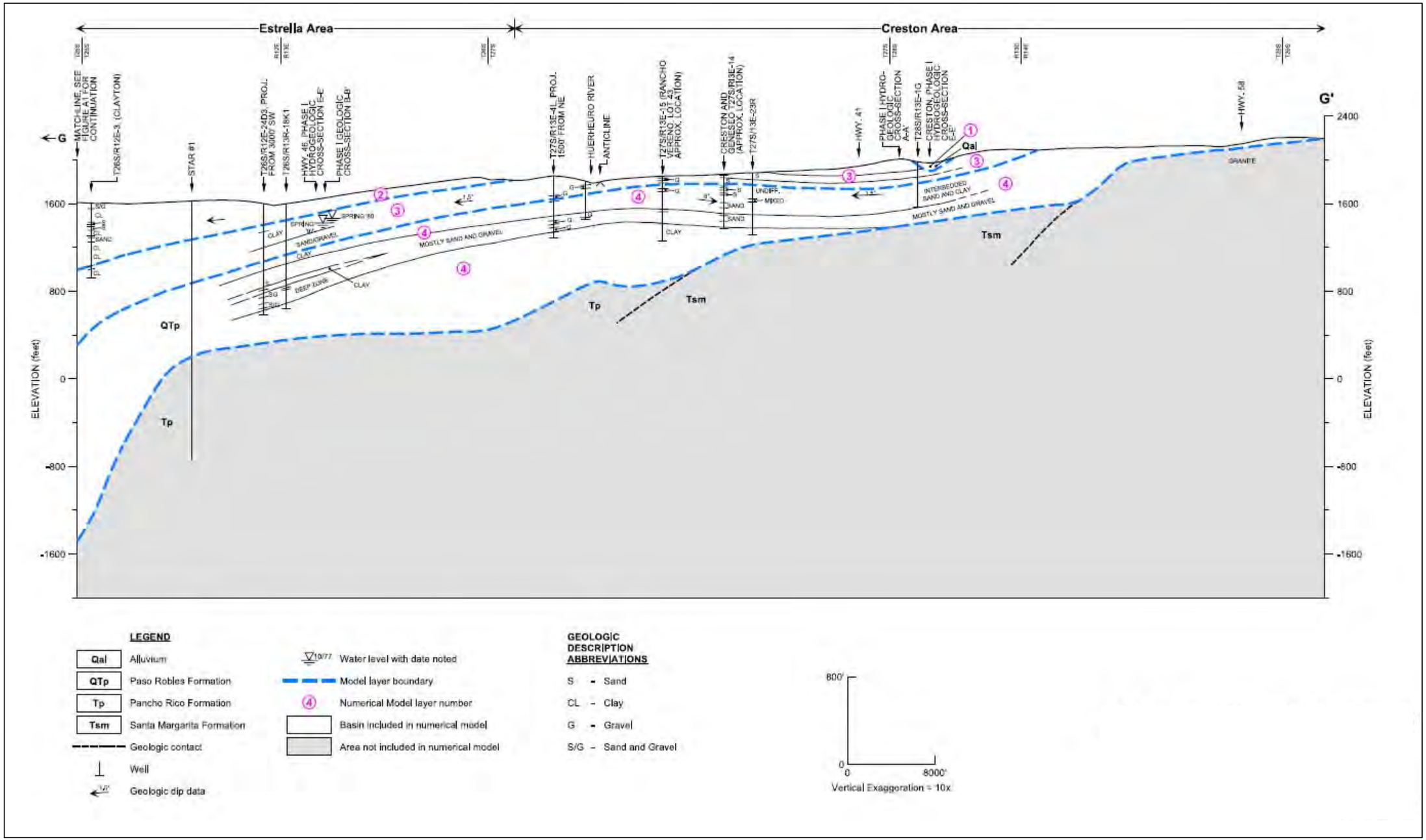

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Table 3-5: Average Aquifer Properties and Well Information from Historic Field Data

Study Area	Aquifer Type	Well Depth (feet)	Well Screened Interval (feet)	Aquifer Hydraulic Conductivity (feet/day)	Well Production Capacity (gpm)
Atascadero	Qa (Salinas River)	58	28	1,963	415
Atascadero	Qa (other creeks)	43	15	187	118
Atascadero	Qa/QTp	399	242	42	471
Atascadero	QTp	450	212	4	367
Creston	Qa (other creeks)	75	30	400	484
Creston	QTp	369	290	4	319
San Juan	QTp	600	400	12	1,254
Estrella	Qa/QTp	630	330	11	250
Estrella	QTp	540	240	5	340
Shandon	QTp	385	250	6	673
North Gabilan	QTp	290	50	15	475
Bradley	Qa (Salinas River)	35	17	400	1,000
Bradley	Qa/QTp	190	50	141	140
Bradley	QTp	538	303	4	647

Data Source: Fugro and Cleath (2002)

Table 3-6: Average Alluvium Properties Computed from Basin Groundwater Model

Study Area	Surface Area (acres)	Average Thickness (feet)	Average Horizontal Hydraulic Conductivity (feet/day)	Average Storage Coefficient (dimensionless)	Groundwater in Storage (acre-feet)
Atascadero	10,120	77	370	0.17	131,887
Creston	--	--	--	--	--
San Juan	--	--	--	--	--
Estrella	17,170	74	254	0.17	216,225
Shandon	9,110	90	50	0.17	139,453
North Gabilan	370	107	500	0.17	6,718
South Gabilan	--	--	--	--	--
Bradley	12,730	87	410	0.17	187,692
Total	**49,500**				**681,975**

Source: properties extracted from Paso Robles Groundwater Basin groundwater flow model (Fugro et. al, 2005)

Table 3-7: Average Confined Aquifer Properties Computed from Basin Groundwater Model

Study Area	Maximum Surface Area (acres)	Average Thickness (feet)	Average Horizontal Hydraulic Conductivity (feet/day)	Average Storage Coefficient (dimensionless)	Groundwater in Storage (acre-feet)
Atascadero	15,181	322	4.6	0.00009	341,208
Creston	57,347	511	3.2	0.00008	1,852,949
San Juan	84,027	710	6.3	0.00015	3,775,597
Estrella	81,822	1,310	1.5	0.00009	6,658,994
Shandon	82,986	1,086	4.9	0.00008	5,152,382
North Gabilan	65,630	856	1.0	0.00006	2,863,124
South Gabilan	58,391	1,028	1.1	0.00005	2,952,293
Bradley	55,162	687	7.3	0.00025	2,445,591
Total	**500,546**				**26,042,138**

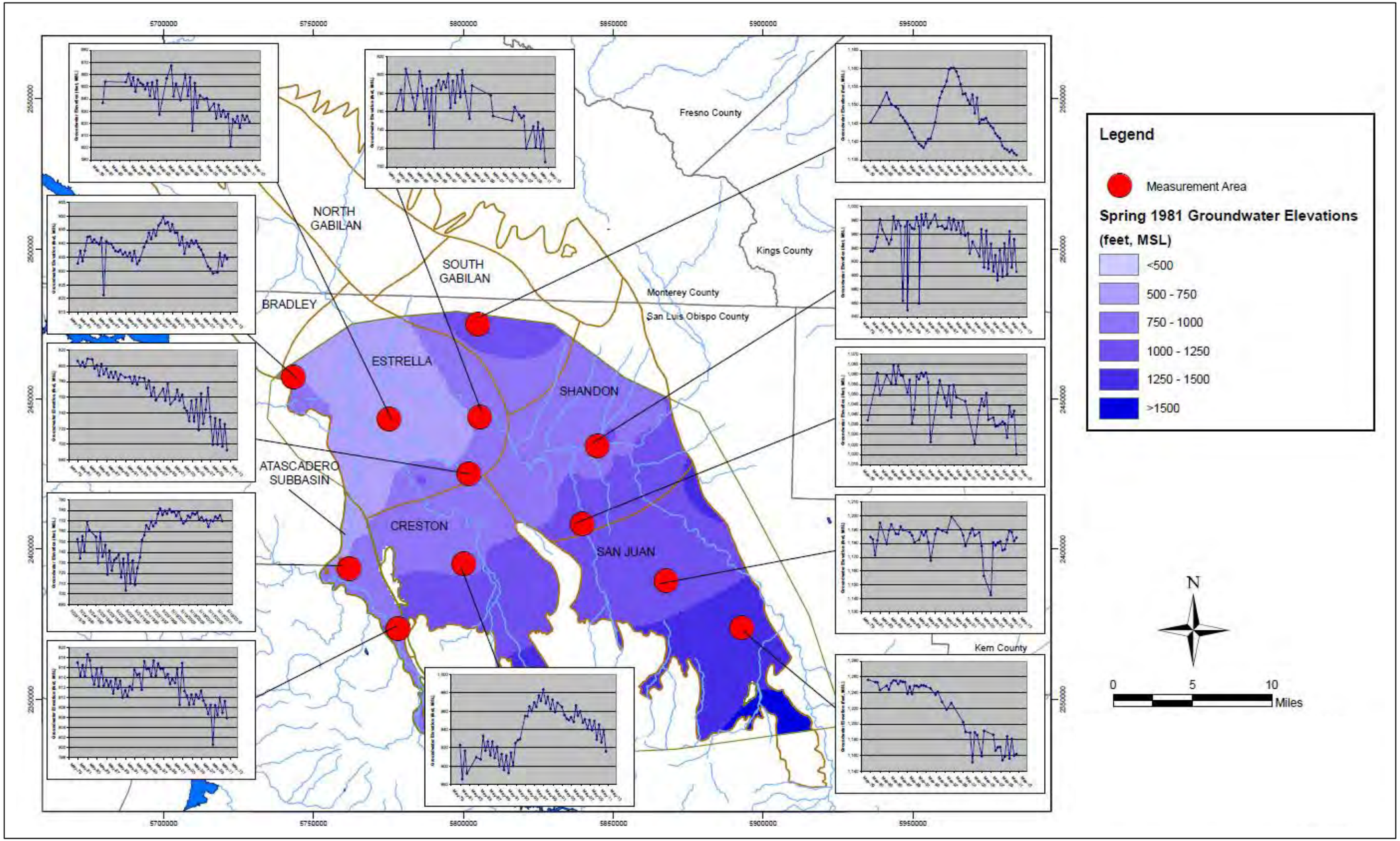
Source: properties extracted from Paso Robles Groundwater Basin groundwater flow model (Fugro et. al, 2005)

Groundwater Levels and Storage

A map displaying hydrographs of measured groundwater elevations for 12 general areas in the Basin is illustrated in Figure 3-7. The base period of the Basin groundwater model (Fugro et al., 2005) was 1981 to 1997. The time period of the hydrographs in Figure 3-7 was extended to show measured groundwater elevations from 1981 to 2012. Although the 12 selected hydrographs display different patterns of fluctuation over time, groundwater elevations at most locations over the approximate 30-year period have either remained about the same from 1981 to 2012 (i.e., no net change) or have experienced a net decline. Groundwater levels in the eastern region of the Estrella Area, in particular, have experienced overall declines between 50 to 100 feet (or more) from 1981 to 2012. The regional pattern of groundwater elevations during the fall season of 2012 is also displayed in Figure 3-7. In general, groundwater elevations are regionally lowest near the middle of the Estrella Area and increase radially in all directions from that area. As demonstrated later in the subsection of Section 3.6.1 on the groundwater flow between study areas, the regionally lower groundwater levels in the Paso Robles Formation underlying the Estrella Area result in significant horizontal groundwater flow into the Estrella Area from surrounding study areas. The regionally lower groundwater levels in the Paso Robles Formation in the Estrella Area are due to higher groundwater pumping volumes that occur in the Estrella Area relative to those of the surrounding study areas, described later in the Groundwater Pumping Section.

Groundwater in storage in the alluvium and in the Paso Robles Formation was estimated for each study area and is presented in Table 3-6 and Table 3-7, respectively. In the study areas where the alluvium is present, groundwater in storage ranged from 6,718 to 216,225 AF for the North Gabilan and Estella areas, respectively. Total groundwater in storage in the alluvium for the entire Basin was 681,975 AF (Table 3-6). For the Paso Robles Formation, groundwater in storage ranged from 341,208 AF in the Atascadero Subbasin to 6,658,994 AF in the Estrella Area. Total groundwater in storage in the Paso Robles Formation for the entire Basin was 26,042,138 AF (Table 3-7). The perennial yields of the Paso Robles Groundwater Basin and Atascadero Subbasin were previously estimated to be 97,700 and 16,400 AFY, respectively (Fugro et. al, 2005).

Figure 3-7: Groundwater Elevation Hydrographs



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3.5 Water Quality

The three chemical constituents to be addressed in the SNMP as indicators of salt and nutrient loadings to the Basin are Total Dissolved Solids (TDS), nitrate (as Nitrogen (N)), and chloride. Recent and historic measured concentrations of TDS, nitrate (as NO3), and chloride at different locations in the Basin were collected and used to establish the baseline conditions (i.e., estimated spatial distribution of constituent concentration representative of current conditions). The nitrate (as NO3) data were converted to nitrate (as N) for the SNMP. The baseline conditions for the three constituents were derived using water quality data from two different databases: 1) the Basin Study by Fugro and Cleath (2002), and 2) the State Water Resources Control Board GeoTracker GAMA (Groundwater Ambient Monitoring & Assessment Program) database. The maps of baseline conditions were then used to estimate average constituent concentrations in each of the study areas. The baseline conditions for TDS, nitrate (as N), and chloride are required for performing the assimilative capacity and anti-degradation analyses in the Basin SNMP.

The major objectives of the water quality analysis described in this section include:

1. Review of the RWQCB water quality objectives and drinking water standards for the Basin;
2. Description of the water quality databases used in the analysis;
3. Discussion of historical trends for the three indicator constituents and estimation of the baseline conditions for each constituent; and
4. Presentation of the ranges of measured constituent concentrations and estimated average constituent concentrations for each study area.

3.5.1 RWQCB Water Quality Objectives

Water quality objectives (i.e., maximum acceptable concentrations) for organic and inorganic constituents in the Basin were developed by the Regional Water Quality Control Board (Central Coast Division) both for water source and beneficial water use (RWQCB, 2011). The water sources for which water quality objectives were developed are surface water and groundwater. The beneficial water uses for which water quality objectives were developed are domestic and municipal use and agricultural use.

The RWQCB water quality objectives for water source and beneficial use in the Basin are listed in Table 3-8 through Table 3-10. As previously noted, the SNMP for the Basin will address TDS, nitrate (as N), and chloride as indicator constituents of salt and nutrient loadings to the Basin. The median water quality objectives for TDS and chloride in surface water associated with the Salinas River and some major tributaries to the Salinas River (e.g., San Antonio River, Nacimiento River) are presented in Table 3-8. Median water quality objectives for TDS, nitrate (as N), and chloride in groundwater for the seven Basin Plan sub-areas defined by the Central Coast RWQCB and delineated in Figure 3-1 are presented in Table 3-9. The median water quality objectives for groundwater defined in the Basin Plan were based on a study performed by the Coastal Resources Institute (1993). Also included in Table 3-9 are the study areas that in part or wholly intersect the Basin Plan sub-areas shown in Figure 3-1.

In terms of beneficial use, the water quality objectives for nitrate (as N) in municipal and domestic water supplies and for agricultural water use (i.e., irrigation supply and livestock watering) are listed in Table 3-10. Primary and secondary drinking water standards for TDS, nitrate (as N), and chloride as established by the California Department of Health Services, Code of Regulations, Title 22, Sections 64435 and 64473, are presented for reference in Table 3-11.

Table 3-8: Median Surface Water Quality Objectives

Measurement Point/Tributary	Total Dissolved Solids (mg/L)	Chloride (mg/L)
Salinas River Above Bradley	250	20
Salinas River Above Spreckles	600	80
Gabilan Tributary	300	50
Diablo Tributary	1,200	80
Nacimiento River	200	20
San Antonio River	250	20

Table 3-9: Median Groundwater Quality Objectives

Basin Plan Subarea	Associated Study Areas	Total Dissolved Solids (mg/L)	Chloride (mg/L)	Nitrate (as N) (mg/L)
Central Basin	Estrella/Shandon/Creston	400	60	3.4
San Miguel	Estrella	750	100	4.5
Paso Robles	Estrella	1,050	270	2.3
Templeton	Atascadero Subbasin	730	100	2.7
Atascadero	Atascadero Subbasin	550	70	2.3
Estrella	Estrella/Shandon	925	130	3.2
Shandon	Shandon	1,390	430	2.3

Table 3-10: Nitrate (as N) Water Quality Objectives for Municipal and Domestic Supply, and Agricultural Water Use

Constituent	Municipal and Domestic Supply Maximum Contaminant Level (MCL) (mg/L)	Agricultural Water Use Irrigation Supply Maximum Concentration (mg/L)	Agricultural Water Use Livestock Watering Maximum Concentration (mg/L)
Nitrate (as N)	10	--	90

Table 3-11: Title 22 Drinking Water Standards for TDS, Nitrate (as N), and Chloride

Water Quality Constituent	Primary Drinking Water Standard Recommended MCL (mg/L)	Secondary Drinking Water Standard Recommended MCL (mg/L)	Secondary Drinking Water Standard Upper Limit (mg/L)	Secondary Drinking Water Standard Short Term (mg/L)
Total Dissolved Solids	–	500	1,000	1,500
Nitrate (as N)	10	--	–	--
Chloride	–	250	500	600

3.5.2 Data Sources

Two different sets of recent and historic water quality measurements were collected and used to generate the baseline conditions for TDS, nitrate (as N), and chloride for this study. As previously stated, the first

dataset comes from the Basin Study (Fugro and Cleath, 2002) and the second dataset is the State Water Resources Control Board GeoTracker GAMA database. In this section, the two databases are described.

Drinking water quality in the Basin was extensively characterized in the Basin Study (Fugro and Cleath, 2002). During October 2001, water samples were obtained from the 73 locations (65 wells, 5 springs, 3 surface water locations) displayed in Figure 3-7 and analyzed for the following constituents:

- Carbonate
- Bicarbonate
- Total alkalinity (as CaCO3)
- Chloride
- Electrical conductance (EC)
- Anionic surfactants (MBAS)
- Nitrate (as N)
- Nitrate (as NO3)
- pH
- Sulfate
- Total dissolved solids (TDS)
- Boron
- Calcium
- Hardness
- Sodium adsorption ratio (SAR)
- Copper
- Iron
- Potassium
- Magnesium
- Manganese
- Sodium
- Zinc

Tables from the Basin Study displaying the measured concentrations for these constituents at the 73 locations are presented in 9.5Appendix G - and in 9.5Appendix H - (Fugro and Cleath, 2002).

Water quality data for TDS, nitrate (as NO3), and chloride was also collected from the GeoTracker GAMA database (SWRCB, 2009). The GeoTracker GAMA information system integrates water quality data from numerous sources including cleanup sites, well logs, California Department of Public Health public supply drinking water quality, Department of Pesticide Regulation, USGS GAMA Priority Basin Project, and GAMA Domestic Well Project. Rather than explicitly identifying the locations of wells from which groundwater samples were collected and subjected to water quality analysis, the GeoTracker GAMA database assigns time series of water quality measurements from one or more actual sampled well locations to a single georeferenced point location (i.e., defined by assigned coordinates of latitude and longitude) in the general area where those sampled wells are located. These unique georeferenced point locations are displayed along with the sampled well locations from the Fugro and Cleath (2002) dataset in Figure 3-7. The georeferenced point location associated with those multiple time series of constituent concentrations from sampled wells can be thought to represent the general location from which those concentrations were measured.

3.5.3 Historic Water Quality Trends and Baseline Condition

Water quality data in the GeoTracker GAMA database in some wells extends from as early as 1984 through early to late 2012. In general, water quality data in most wells was available from the late 1990s and early 2000s through 2012. To generate a map of baseline conditions for TDS, all of the TDS measurements associated with each unique georeferenced point location (see Figure 3-8 for locations) in the GeoTracker GAMA database were grouped and averaged over time. This process amounted to estimating a single TDS concentration at each point location that represented an average of all the measurements from the sampled wells associated with that point location over the time periods in which those measurements were collected. The average TDS concentrations for the locations shown on Figure 3-8 were then combined with the measured TDS concentrations during October 2001 from the Fugro and Cleath (2002) dataset to generate a single map of TDS concentration point values in the Basin (see Figure 3-9 for the spatial distribution of combined point-value data for TDS). An interpolation method in GIS was then used to generate a continuous distribution of TDS concentration across the Basin

(Figure 3-9). The same process was repeated to generate similar maps for nitrate (as N) and chloride which are shown in Figure 3-10 and Figure 3-11, respectively.

To justify averaging TDS, nitrate (as N), and chloride measurement data temporally, time series of measurements at a number of locations throughout the Basin were plotted to assess historical trends in these constituents. Time-series plots of measured TDS at nine different locations are presented on Figure 3-9. In most areas of the Basin, these plots show that TDS concentrations have been relatively stable over time and do not exhibit either significant increasing or decreasing trends in those levels. Similar time-series plots were created for nitrate (as N) and chloride and are displayed in Figure 3-10 and Figure 3-11, respectively. Similar to TDS, time-series plots for nitrate (as N) and chloride do not exhibit either significant increasing or decreasing trends in their respective levels. The lack of significant trends in TDS, nitrate (as N), and chloride provided justification to average measurement values for those constituents at the unique locations in the GeoTracker GAMA database and to combine them with the measurement values from the Fugro and Cleath (2002) database.

The estimated continuous spatial distributions of TDS, nitrate (as N), and chloride (shown in Figure 3-9, Figure 3-10 and Figure 3-11, respectively), represent the baseline conditions for those constituents in groundwater of the semi-confined to confined Paso Robles Formation for the SNMP. The ranges of the measured concentrations in the Fugro and Cleath (2002) and GeoTracker GAMA databases used to generate these maps and average constituent concentrations for each study area derived from the maps are discussed in the following sections. Also reviewed are measured concentrations of TDS and chloride in surface water samples collected from rivers and creeks in each study area and presented in 9.5Appendix G - and in 9.5Appendix H - (Fugro and Cleath, 2002).

Atascadero Subbasin

Surface water chemistry of the Salinas River where it intersects Highway 58 in the Atascadero Subbasin was analyzed for two samples and those results are presented in 9.5Appendix G - (Fugro and Cleath, 2002). Measured TDS concentrations in the two samples were 172 and 211 mg/L and were both below the median surface water quality objective of 250 mg/L for TDS in the Salinas River above Bradley (Table 3-8). Measured chloride concentrations in the two samples were 6 and 7 mg/L and were also both below the median surface water quality objective of 20 mg/L for chloride in the Salinas River above Bradley (Table 3-8).

The baseline conditions for TDS, nitrate (as N), and chloride for the Atascadero Subbasin are shown in Figure 3-9, Figure 3-10 and Figure 3-11, respectively. The ranges of measured concentrations for TDS, nitrate (as N), and chloride in the Subbasin at the discrete locations shown in Figure 3-9, Figure 3-10 and Figure 3-11, respectively, are summarized in Table 3-12. Also included in Table 3-12 are the area-averaged concentrations for TDS, nitrate (as N), and chloride for the Subbasin computed from the interpolated values of those constituents shown in Figure 3-9, Figure 3-10 and Figure 3-11, respectively. Within the Subbasin, measured concentrations of TDS at discrete locations ranged from 330 to 828 mg/L, with an areal average of 573 mg/L; measured concentrations of nitrate (as N) ranged from 0.1 to 6.7 mg/L, with an areal average of 1.8 mg/L; and measured concentrations of chloride ranged from 19 to 208 mg/L, with an areal average of 77.5 mg/L.

The Atascadero Subbasin includes the Basin Plan Atascadero Sub-area and Templeton Sub-area (Figure 3-1). The median groundwater objectives for the Basin Plan Atascadero Sub- area for TDS, nitrate (as N), and chloride are 550, 2.3, and 70 mg/L, respectively, and for the Basin Plan Templeton Sub-area for TDS, nitrate (as N), and chloride are 730, 2.7, and 100 mg/L, respectively (Table 3-9). The areal average TDS concentration of 573 mg/L is slightly above the objective concentration of 550 mg/L for the Basin Plan Atascadero Sub-area and below the objective concentration of 730 mg/L for the Basin Plan Templeton Sub-area. Similarly, the areal average chloride concentration of 77.5 mg/L is slightly above the objective concentration of 70 mg/L for the Basin Plan Atascadero Sub-area and

below the objective concentration of 100 mg/L for the Basin Plan Templeton Sub-area. The areal average nitrate (as N) concentration of 1.8 mg/L was below the objective concentrations for both the Basin Plan Atascadero Sub-area and Templeton Sub-area.

The upper limit of the range of measured TDS concentrations at discrete locations (828 mg/L) was above the Title 22 secondary drinking water standard recommended MCL for TDS of 500 mg/L and below the secondary drinking water standard upper limit of 1,000 mg/L (Table 3-11). The entire range of measured nitrate (as N) concentrations at discrete locations (0.1 to 6.7 mg/L) was below the Title 22 primary drinking water standard recommended MCL for nitrate (as N) of 10 mg/L (Table 3-11). Similarly, the entire range of measured chloride concentrations at discrete locations (19 to 208 mg/L) was below the Title 22 secondary drinking water standard recommended MCL for chloride of 250 mg/L (Table 3-11). (It's important to note that exceedances of measured constituent concentrations above their respective Title 22 drinking water standards at either sampled locations from the Fugro and Cleath (2002) dataset or at point locations from the GAMA database do not imply that pumped water from nearby potable water supply wells is currently or has historically exceeded those drinking water standards. Water quality of groundwater used for potable use needs to be assessed in the specific supply wells from which it was extracted. Comparison of the ranges of measured constituent concentrations to Title 22 drinking water standards was performed as an additional assessment of water quality in local regions of the aquifer system in each study area. The comparison merely indicates the existence (or non-existence) of regions of the aquifer system in each study area where measured constituent concentrations may deviate from their respective Title 22 drinking water standards.)

Groundwater in the Atascadero Subbasin is predominantly calcium and magnesium bicarbonate water (Figure 3-12). The Santa Ysabel hot spring located at 27S/12E-16G01 has a sodium-bicarbonate water type that is characteristic of geothermal waters arising from the Monterey Formation that underlies the Paso Robles Formation along the Salinas River (Figure 3-4). TDS and chloride concentrations at 27S/12E-16G01 were 828 and 141 mg/L, respectively. The high mineralization and predominance of sodium as a major cation in the geothermal waters may contribute to elevation of TDS concentrations in the Paso Robles Formation that exceed the median groundwater objectives. A second well of unknown depth located at 27S/12E-22N possessed a sodium-calcium-bicarbonate-chloride water type, and measured TDS and chloride concentrations of 786 and 107 mg/L, respectively. Observed water types characteristic of geothermal waters and associated high concentrations of TDS and chloride together suggest that the water quality of the Paso Robles Formation in the Atascadero Subbasin may be changed due to mixing with upwelling geothermal water (Fugro and Cleath, 2002).

Creston Area

Surface water chemistry of the Huer Huero Creek in the Creston Area was analyzed for five samples and those results are presented in 9.5Appendix G - (Fugro and Cleath, 2002). Measured TDS concentrations in the five samples ranged from 83 to 224 mg/L and were all below the median surface water quality objective of 250 mg/L for TDS in the Salinas River above Bradley for which the Huer Huero Creek is tributary (Table 3-8). Measured chloride concentrations in the five samples ranged from 9 to 29.8 mg/L and were also all below the median surface water quality objective of 20 mg/L for chloride in the Salinas River above Bradley (Table 3-8).

The baseline conditions for TDS, nitrate (as N), and chloride for the Creston Area are shown in Figure 3-9, Figure 3-10 and Figure 3-11, respectively. The ranges of measured concentrations for TDS, nitrate (as N), and chloride in the Creston Area at the discrete locations shown in Figure 3-9, Figure 3-10 and Figure 3-11, respectively, are summarized in Table 3-12. Also included in Table 3-12 are the area-averaged concentrations for TDS, nitrate (as N), and chloride for the Creston Area computed from the interpolated values of those constituents shown in Figure 3-9, Figure 3-10 and Figure 3-11, respectively. Within the Creston Area, measured concentrations of TDS at discrete locations ranged from 186 to 590

mg/L, with an areal average of 388 mg/L; measured concentrations of nitrate (as N) ranged from 0.8 to 9.2 mg/L, with an areal average of 3.2 mg/L; and measured concentrations of chloride ranged from 25 to 175 mg/L, with an areal average of 69.4 mg/L.

The Creston Area and the Basin Plan Central Basin Sub-area overlap in the northern region of the Creston Area (Figure 3-1). The median groundwater objectives for the Basin Plan Central Basin Sub-area for TDS, nitrate (as N), and chloride are 400, 3.4, and 60 mg/L, respectively (Table 3-9). The areal average TDS concentration of 388 mg/L is just below the objective concentration of 400 mg/L for the Basin Plan Central Basin Sub-area. Similarly, the areal average nitrate (as N) concentration of 3.2 mg/L was also just below the objective concentration of 3.4 mg/L for the Basin Plan Central Basin Sub-area. Conversely, the areal average chloride concentration of 69.4 mg/L is slightly above the objective concentration of 60 mg/L for the Basin Plan Central Basin Sub-area. Increasing chloride concentrations over time in the deeper Paso Robles Formation in the northwest region of the Creston Area were noted by Fugro and Cleath (2002) although an explanation for the increases was not apparent from analysis of local water types and geology.

The upper limit of the range of measured TDS concentrations at discrete locations (590 mg/L) was above the Title 22 secondary drinking water standard recommended MCL for TDS of 500 mg/L and below the secondary drinking water standard upper limit of 1,000 mg/L (Table 3-11). The entire range of measured nitrate (as N) concentrations at discrete locations (0.8 to 9.2 mg/L) was below the Title 22 primary drinking water standard recommended MCL for nitrate (as N) of 10 mg/L (Table 11). Similarly, the entire range of measured chloride concentrations at discrete locations (25 to 175 mg/L) was below the Title 22 secondary drinking water standard recommended MCL for chloride of 250 mg/L (Table 3-11).

Table 3-12: Measured and Average Water Quality Constituent Concentrations for Study Areas

Study Area	TDS Concentration Range of Measurements (mg/L)	TDS Concentration Area Average (mg/L)	TDS Groundwater Objective Range (mg/L)	Nitrate (as N) Concentration Range of Measurements (mg/L)	Nitrate (as N) Concentration Area Average (mg/L)	Nitrate (as N) Groundwater Objective Range (mg/L)	Chloride Concentration Range of Measurements (mg/L)	Chloride Concentration Area Average (mg/L)	Chloride Groundwater Objective Range (mg/L)
Atascadero	330-828	573	550-730	0.1-6.7	1.8	2.3-2.7	19-208	77.5	70-100
Creston	186-590	388	400	0.8-9.2	3.2	3.4	25-175	69.4	60
San Juan	160-1700	425	--	0.1-5.8	2.8	--	13-390	64.2	--
Estrella	310-1920	552	400-1050	0.0-16.2	2.5	2.3-4.5	28-614	94.2	60-270
Shandon	270-3160	563	400-1390	1.2-12.1	4.6	2.3-3.4	31-451	80.0	60-430
North Gabilan	371-1320	856	--	5.0-9.8	8.4	--	35-209	112.9	--
South Gabilan	634	451	--	15.8	6.3	--	38	37.2	--
Bradley	234-1343	751	--	0.0-5.8	2.7	--	27.5-400	84.4	--

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Figure 3-8: Water Quality Data Locations

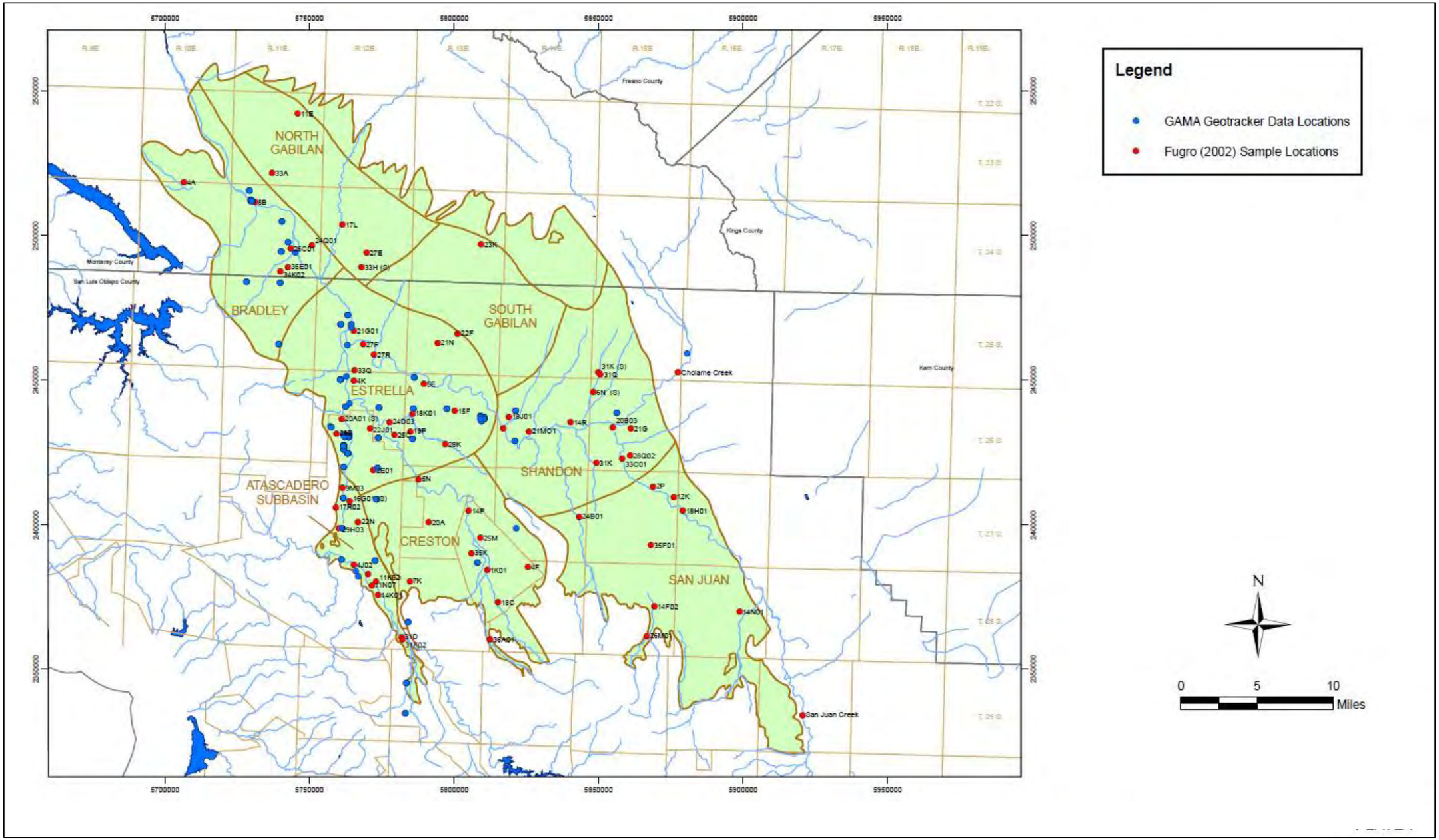


Figure 3-9: Total Dissolved Solids (TDS)

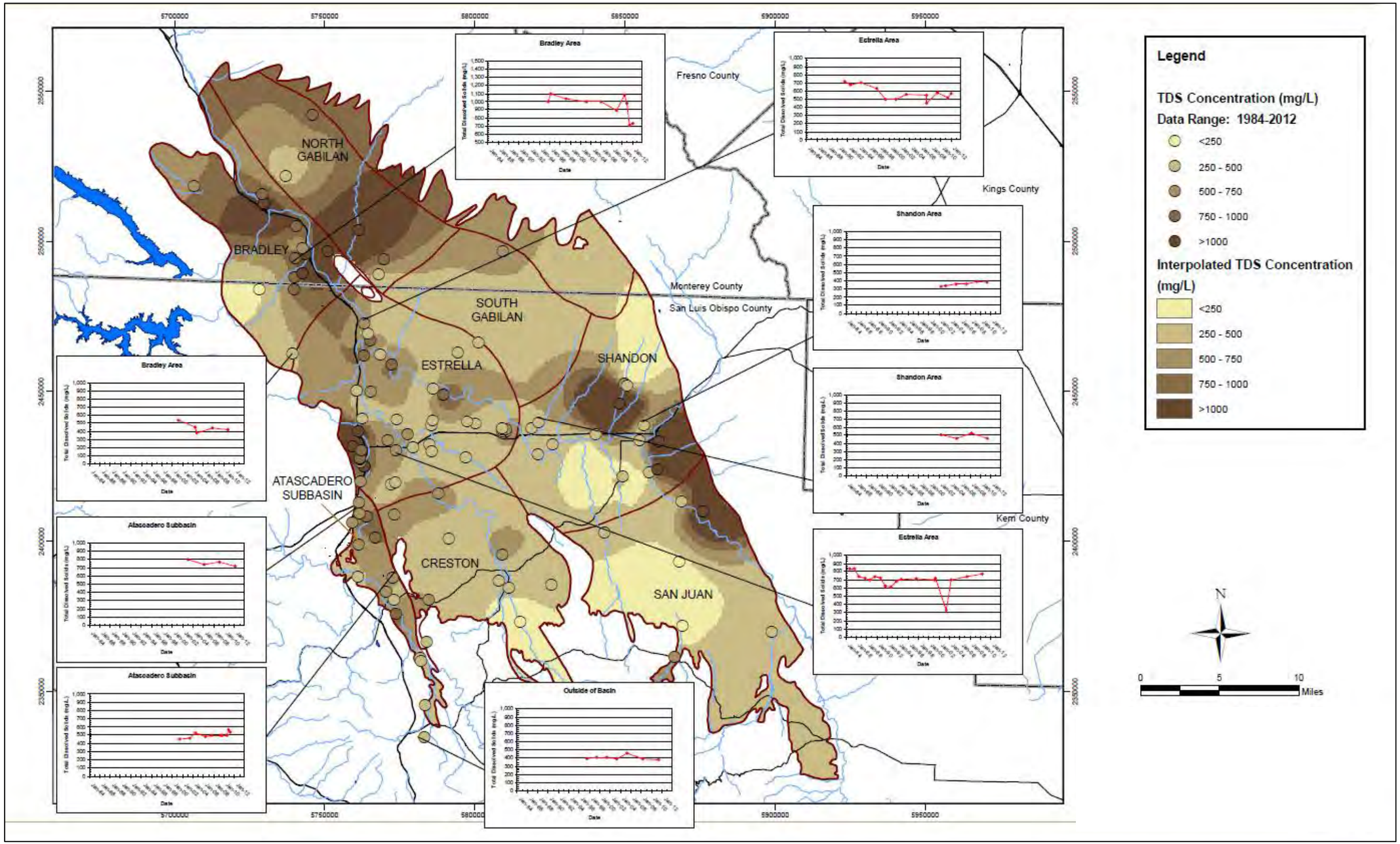


Figure 3-10: Nitrate (as N)

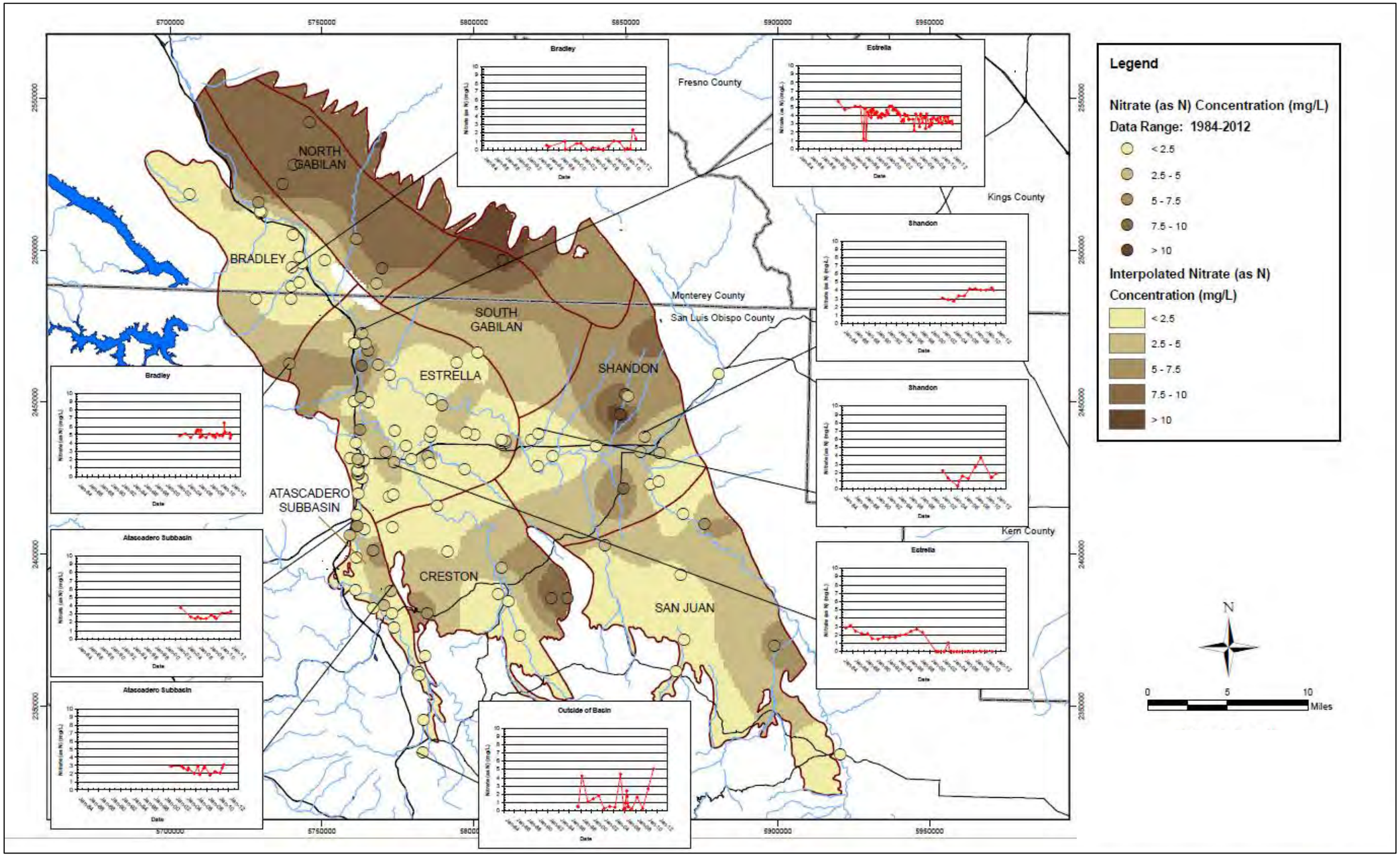


Figure 3-11: Chloride

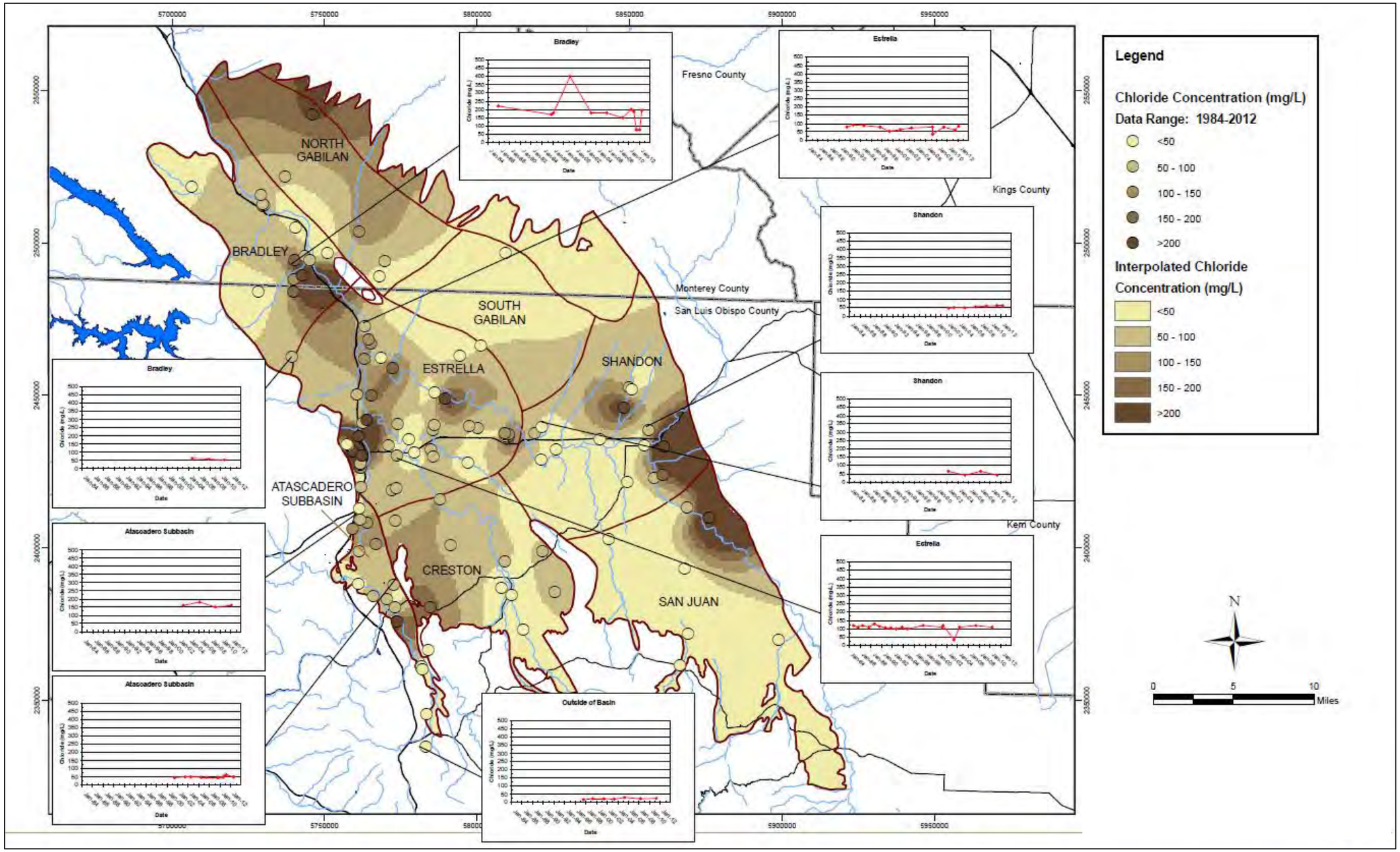
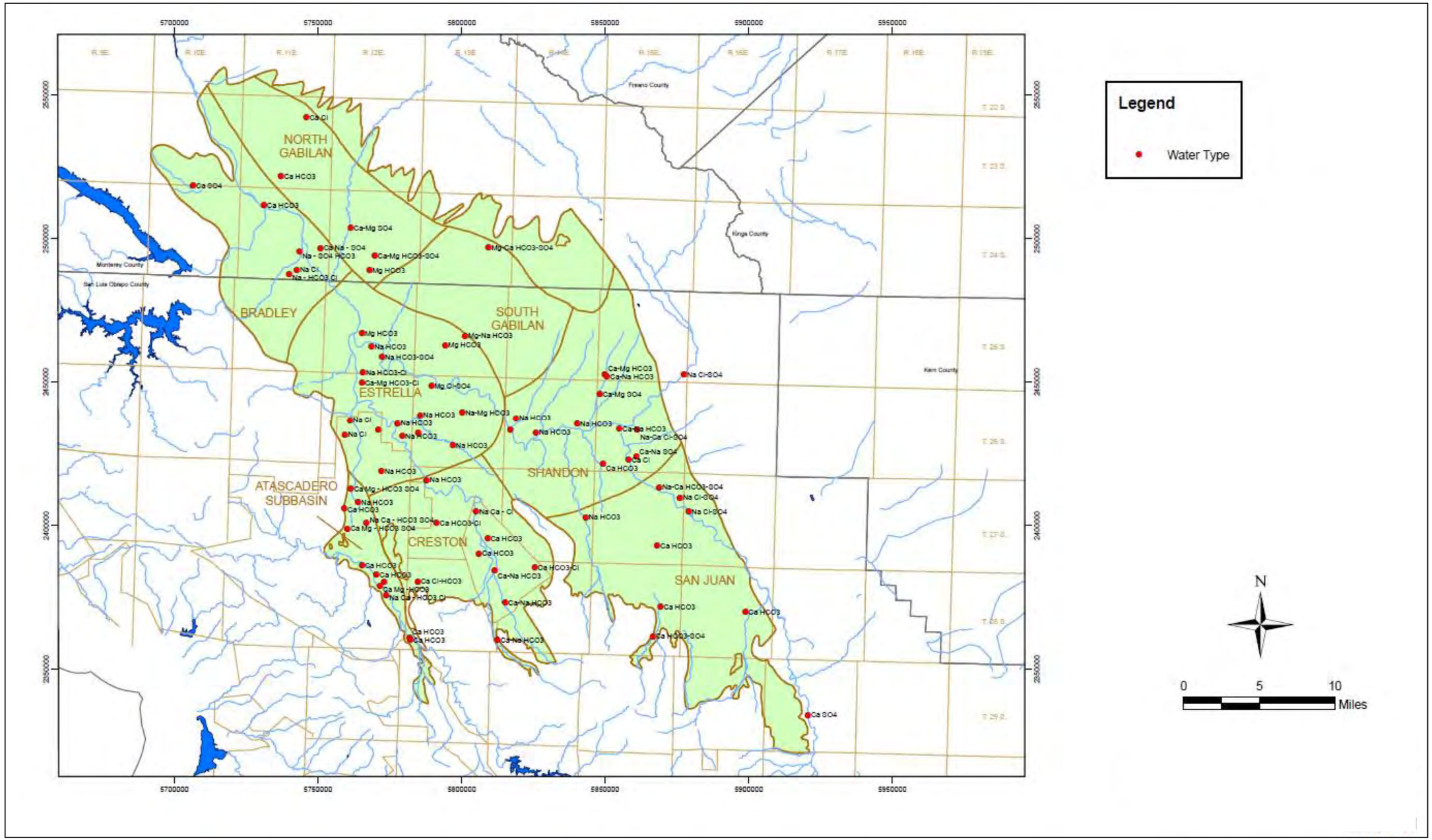


Figure 3-12: Water Type



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San Juan Area

Surface water chemistry of five creeks (Indian, Shell, Camatta, Navajo, San Juan) in the San Juan Area was analyzed for ten samples and those results are presented in 9.5Appendix G - (Fugro and Cleath, 2002). None of the five creeks are direct tributaries to the Salinas River for which surface water objectives are defined. The San Juan Creek is, however, a major tributary to the Estrella River which in turn is a major tributary to the Salinas River above Bradley. Measured TDS concentrations in samples from the Indian, Shell, Camatta, and Navajo creeks ranged from 63 to 215 mg/L and were all below the median surface water quality objective of 250 mg/L for TDS in the Salinas River above Bradley (Table 3-8). Measured TDS concentrations in three samples from San Juan Creek were 145, 560, and 968 mg/L and exceeded the surface water quality objective for TDS in two of those samples.

Measured chloride concentrations in samples from the Indian, Shell, Camatta, and Navajo creeks ranged from 3 to 20 mg/L and were at or below the median surface water quality objective of 20 mg/L for chloride in the Salinas River above Bradley (Table 3-8). Measured chloride concentrations in three samples from San Juan Creek were 7, 30, and 58 mg/L and exceeded the surface water quality objective for chloride in two of those samples.

The baseline conditions for TDS, nitrate (as N), and chloride for the San Juan Area are shown in Figure 3-9, Figure 3-10 and Figure 3-11, respectively. The ranges of measured concentrations for TDS, nitrate (as N), and chloride in the San Juan Area at the discrete locations shown in Figure 3-9, Figure 3-10 and Figure 3-11, respectively, are summarized in Table 3-12. Also included in Table 3-12 are the area-averaged concentrations for TDS, nitrate (as N), and chloride for the San Juan Area computed from the interpolated values of those constituents shown in Figure 3-9, Figure 3-10 and Figure 3-11, respectively. Within the San Juan Area, measured concentrations of TDS at discrete locations ranged from 160 to 1,700 mg/L, with an areal average of 425 mg/L; measured concentrations of nitrate (as N) ranged from 0.1 to 5.8 mg/L, with an areal average of 2.8 mg/L; and measured concentrations of chloride ranged from 13 to 390 mg/L, with an areal average of 64.2 mg/L.

The San Juan Area does not overlap any of the Basin Plan sub-areas (Figure 3-1). The nearest Basin Plan sub-area to the San Juan Area is the Shandon Sub-area. The median groundwater objectives for the Basin Plan Shandon Sub-area for TDS, nitrate (as N), and chloride are 1,390, 2.3, and 430 mg/L, respectively (Table 3-9). The areal average TDS concentration of 425 mg/L is below the objective concentration of 1,390 mg/L for the Basin Plan Shandon Sub-area. Similarly, the areal average chloride concentration of 64.2 mg/L is below the objective concentration of 430 mg/L for the Basin Plan Shandon Sub-area. Conversely, the areal average nitrate (as N) concentration of 2.8 mg/L slightly exceeds the objective concentration of 2.3 mg/L for the Basin Plan Shandon Sub-area.

The upper limit of the range of measured TDS concentrations at discrete locations (1,700 mg/L) was above the Title 22 secondary drinking water standard recommended MCL for TDS of 500 mg/L, the secondary drinking water standard upper limit of 1,000 mg/L, and the secondary drinking water standard short term limit of 1,500 mg/L (Table 3-11). The entire range of measured nitrate (as N) concentrations at discrete locations (0.1 to 5.8 mg/L) was below the Title 22 primary drinking water standard recommended MCL for nitrate (as N) of 10 mg/L (Table 3-11). The upper limit of the range of measured chloride concentrations at discrete locations (390 mg/L) was above the Title 22 secondary drinking water standard recommended MCL for chloride of 250 mg/L and below the secondary drinking water standard upper limit of 500 mg/L (Table 3-11).

Groundwater in the San Juan Area is characterized by calcium-bicarbonate water in wells along Camatta, Shell, and Navajo creeks and by sodium-dominant water in wells along the lower San Juan Valley and in Shedd Canyon (Plate 11). Elevated levels of TDS and chloride in the northeastern region of the San Juan Area as illustrated in Figure 3-9 and Figure 3-11, respectively, correlate with the highly

mineralized sodium-chloride waters observed in the same areas (Figure 3-12). Sodium-chloride waters enter San Juan Creek between Highway 58 and Long Canyon, and continue downstream in the San Juan Valley past the confluence with Camatta Canyon. Below the confluence, sodium-chloride waters persist in the southeastern region of the Shandon Area (Fugro and Cleath, 2002).

Estrella Area

Surface water chemistry of the Salinas and Estrella rivers, and Huer Huero Creek in the Estrella Area was analyzed for eight samples and those results are presented in 9.5Appendix G - (Fugro and Cleath, 2002). The Estrella River and Huer Huero Creek are direct tributaries to the Salinas River. Measured TDS concentrations in two samples from Huer Huero Creek were 214 and 224 mg/L and were both below the median surface water quality objective of 250 mg/L for TDS in the Salinas River above Bradley (Table 3-8). Measured TDS concentration in three samples in the Estrella River ranged from 172 to 665 mg/L, exceeding the surface water quality objective for TDS in one of three samples. Similarly, measured TDS concentration in three samples in the Salinas River ranged from 130 to 553 mg/L, exceeding the surface water quality objective for TDS in two of three samples. Measured chloride concentrations in the Estrella River, Huer Huero Creek, and Salinas River ranged from 6 to 130 mg/L, 9 to 22 mg/L, and 18 to 46 mg/L, respectively. Each of the three channels contained at least one sample that exceeded the median surface water quality objective of 20 mg/L for chloride in the Salinas River above Bradley (Table 3-8).

The baseline conditions for TDS, nitrate (as N), and chloride for the Estrella Area are shown in Figure 3-9, Figure 3-10 and Figure 3-11, respectively. The ranges of measured concentrations for TDS, nitrate (as N), and chloride in the Estrella Area at the discrete locations shown in Figure 3-9, Figure 3-10 and Figure 3-11, respectively, are summarized in Table 3-12. Also included in Table 3-12 are the area-averaged concentrations for TDS, nitrate (as N), and chloride for the Estrella Area computed from the interpolated values of those constituents shown in Figure 3-9, Figure 3-10 and Figure 3-11, respectively. Within the Estrella Area, measured concentrations of TDS at discrete locations ranged from 310 to 1,920 mg/L, with an areal average of 552 mg/L; measured concentrations of nitrate (as N) ranged from 0.0 to 16.2 mg/L, with an areal average of 2.5 mg/L; and measured concentrations of chloride ranged from 28 to 614 mg/L, with an areal average of 94.2 mg/L.

The Estrella Area intersects the Basin Plan Central Basin, San Miguel, Paso Robles, and Estrella sub-areas. Each of the four Basin Plan sub-areas has different median groundwater objectives for TDS, nitrate (as N), and chloride. Among those four sub-areas, the median groundwater objectives for TDS, nitrate (as N), and chloride range from 400 to 1,050 mg/L, 2.3 to 4.5 mg/L, and 60 to 270 mg/L, respectively. The spatial variation in TDS as shown in Figure 3-9, for example, indicates that areas with high levels of measured TDS generally have relatively high (i.e., less restrictive) median groundwater objectives. For instance, the area in the vicinity of the City of Paso Robles in Figure 3-9 has TDS concentrations in the range of 750 to 1,000 mg/L and the Basin Plan Paso Robles Sub-area has a median groundwater objective for TDS of 1,050 mg/L. Similarly, the regions delineated as the Basin Plan Central Basin Sub-area (Figure 3-1) are shown in Figure 3-9 to have TDS concentrations in the range of 250 to 500 mg/L and the Basin Plan Central Basin Sub-area has a median groundwater objective for TDS of 400 mg/L. The spatial variation of nitrate (as N) concentration (Figure 3-10) and chloride concentration (Figure 3-11) are also consistent with the spatial variation of median groundwater objectives for those two constituents amongst the four Basin Plan sub-areas in the Estrella Area.

The entire range of measured TDS concentrations at discrete locations (310 to 1,920 mg/L) was above the Title 22 secondary drinking water standard recommended MCL for TDS of 500 mg/L. The upper limit of the range of measured TDS concentrations at discrete locations (1,920 mg/L) was also above both the secondary drinking water standard upper limit of 1,000 mg/L and the secondary drinking water standard

short term limit of 1,500 mg/L (Table 3-11). The upper limit of the range of measured nitrate (as N) concentrations at discrete locations (16.2 mg/L) was above the Title 22 primary drinking water standard recommended MCL for nitrate (as N) of 10 mg/L (Table 3-11). The upper limit of the range of measured chloride concentrations at discrete locations (614 mg/L) was above the Title 22 secondary drinking water standard recommended MCL for chloride of 250 mg/L, the secondary drinking water standard upper limit of 500 mg/L, and the secondary drinking water standard short term limit of 600 mg/L (Table 3-11).

A recent study conducted by the United States Geological Survey (USGS) in the Paso Robles Groundwater Basin found significant evidence in the Estrella Area of geothermal upwelling from the Monterey Formation into the overlying Paso Robles Formation (Rytuba and Goldstein, 2013). Geothermal water from the Monterey Formation generally enters the Paso Robles Formation along the Rinconada fault zone and as cross formational flow through fractures. Mixing of meteoric water (e.g., deep percolation of recent rainfall and surface runoff) in the Paso Robles Formation with upwelling geothermal water from the underlying Monterey Formation was studied by the USGS in the Estrella Area by conducting isotope analyses of water samples from springs and City of Paso Robles water supply wells. In the sampled water supply wells in the Estrella Area, geothermal water was found to comprise between 16 to 60 percent of the water in the analyzed samples. In the sampled springs, geothermal water was found to comprise between 65 to 100 percent of the water in the analyzed samples. In terms of the geothermal upwelling impact on the three indicator constituents of the SNMP (i.e., TDS, nitrate (as N), and chloride), the study found undiluted geothermal water to have chloride levels of about 110 mg/L (i.e., approximately equivalent to the areal average of 94.2 mg/L).

Shandon Area

Surface water chemistry of the Cholame and San Juan creeks in the Shandon Area was analyzed for four samples and those results are presented in 9.5Appendix G - (Fugro and Cleath, 2002). The Cholame and San Juan creeks are not direct tributaries to the Salinas River for which surface water objectives are defined. Both creeks are tributary to the Estrella River, however, which in turn is a major tributary to the Salinas River above Bradley. Measured TDS concentrations ranged from 440 to 2,380 mg/L and were all above the median surface water quality objective of 250 mg/L for TDS in the Salinas River above Bradley (Table 3-8). Measured chloride concentrations ranged from 57 to 550 mg/L and were also all above the median surface water quality objective of 20 mg/L for chloride in the Salinas River above Bradley (Table 3-8).

The baseline conditions for TDS, nitrate (as N), and chloride for the Shandon Area are shown in Figure 3-9, Figure 3-10 and Figure 3-11, respectively. The ranges of measured concentrations for TDS, nitrate (as N), and chloride in the Shandon Area at the discrete locations shown in Figure 3-9, Figure 3-10 and Figure 3-11, respectively, are summarized in Table 3-12. Also included in Table 3-12 are the area-averaged concentrations for TDS, nitrate (as N), and chloride for the Shandon Area computed from the interpolated values of those constituents shown in Figure 3-9, Figure 3-10 and Figure 3-11, respectively. Within the Shandon Area, measured concentrations of TDS at discrete locations ranged from 270 to 3,160 mg/L, with an areal average of 563 mg/L; measured concentrations of nitrate (as N) ranged from 1.2 to 12.1 mg/L, with an areal average of 4.6 mg/L; and measured concentrations of chloride ranged from 31 to 451 mg/L, with an areal average of 80.0 mg/L.

The Shandon Area includes the entire Basin Plan Shandon Sub-area and portions of the Estrella and Central Basin sub-areas. Each of the three Basin Plan sub-areas has different median groundwater objectives for TDS, nitrate (as N), and chloride. For the Shandon Sub-area, in particular, the median groundwater objectives for TDS, nitrate (as N), and chloride are 1,390, 2.3, and 430 mg/L, respectively. The areal average TDS concentration of 563 mg/L is below the objective concentration of 1,390 mg/L for the Basin Plan Shandon Sub-area. Similarly, the areal average chloride concentration of 80 mg/L is below the

objective concentration of 430 mg/L for the Basin Plan Shandon Sub-area. Conversely, the areal average nitrate (as N) concentration of 4.6 mg/L is above the objective concentration of 2.3 mg/L.

The upper limit of the range of measured TDS concentrations at discrete locations (3,160 mg/L) was above the Title 22 secondary drinking water standard recommended MCL for TDS of 500 mg/L, the secondary drinking water standard upper limit of 1,000 mg/L, and the secondary drinking water standard short term limit of 1,500 mg/L (Table 3-11). The upper limit of the range of measured nitrate (as N) concentrations at discrete locations (12.1 mg/L) was also above the Title 22 primary drinking water standard recommended MCL for nitrate (as N) of 10 mg/L (Table 3-11). The upper limit of the range of measured chloride concentrations at discrete locations (451 mg/L) was above the Title 22 secondary drinking water standard recommended MCL for chloride of 250 mg/L and below the secondary drinking water standard upper limit of 500 mg/L (Table 3-11).

North Gabilan Area

Although the North Gabilan Area contains several upland canyons that generate some degree of surface runoff, no surface water chemistry data was available for this study area. The baseline conditions for TDS, nitrate (as N), and chloride for the North Gabilan Area, however, are shown in Figure 3-9, Figure 3-10 and Figure 3-11, respectively. The ranges of measured concentrations for TDS, nitrate (as N), and chloride in the North Gabilan Area at the discrete locations shown in Figure 3-9, Figure 3-10 and Figure 3-11, respectively, are summarized in Table 3-12. Also included in Table 3-12 are the area-averaged concentrations for TDS, nitrate (as N), and chloride for the North Gabilan Area computed from the interpolated values of those constituents shown in Figure 3-9, Figure 3-10 and Figure 3-11, respectively. Within the North Gabilan Area, measured concentrations of TDS at discrete locations ranged from 371 to 1,320 mg/L, with an areal average of 856 mg/L; measured concentrations of nitrate (as N) ranged from 5.0 to 9.8 mg/L, with an areal average of 8.4 mg/L; and measured concentrations of chloride ranged from 35 to 209 mg/L, with an areal average of 113 mg/L.

The North Gabilan Area does not overlap any of the Basin Plan sub-areas (Figure 3-1). The nearest Basin Plan sub-area to the South Gabilan Area is the San Miguel Sub-area, which is located southwest of the North Gabilan Area boundary. The median groundwater objectives for the Basin Plan San Miguel Sub-area for TDS, nitrate (as N), and chloride are 750, 4.5, and 100 mg/L, respectively (Table 3-9). The areal average TDS concentration of 856 mg/L exceeds the objective concentration of 750 mg/L and the areal average nitrate (as N) concentration of 8.4 mg/L similarly exceeds the objective concentration of 4.5 mg/L. Similarly, the areal average chloride concentration of 113 mg/L slightly exceeds the objective concentration of 100 mg/L (Table 3-9).

The upper limit of the range of measured TDS concentrations at discrete locations (1,320 mg/L) was above both the Title 22 secondary drinking water standard recommended MCL for TDS of 500 mg/L and the secondary drinking water standard upper limit of 1,000 mg/L, but below the secondary drinking water standard short term limit of 1,500 mg/L (Table 3-11). The entire range of measured nitrate (as N) concentrations at discrete locations (5.0 to 9.8 mg/L) was below the Title 22 primary drinking water standard recommended MCL for nitrate (as N) of 10 mg/L (Table 3-11). Similarly, the entire range of measured chloride concentrations at discrete locations (35 to 209 mg/L) was below the Title 22 secondary drinking water standard recommended MCL for chloride of 250 mg/L (Table 3-11).

South Gabilan Area

Although the South Gabilan Area also contains several upland canyons that generate a level of surface runoff, no surface water chemistry data was available for this study area. The baseline conditions for TDS, nitrate (as N), and chloride for the South Gabilan Area are shown in Figure 3-9, Figure 3-10 and Figure 3-11, respectively. Water quality results for only one sample in the South Gabilan Area were available from the combined Fugro and Cleath (2002) and GAMA databases (Table 3-12). Within the South

Gabilan Area, the measured concentrations of TDS, nitrate (as N), and chloride were 634, 15.8, and 38 mg/L, respectively. Interpolated values and areal averages of TDS, nitrate (as N), and chloride were still estimated in the South Gabilan Area. The areal averages of TDS, nitrate (as N), and chloride were 451, 6.3, and 37.2 mg/L, respectively.

The South Gabilan Area does not overlap any of the Basin Plan sub-areas (Figure 3-1). The nearest Basin Plan sub-area to the South Gabilan Area is the Central Basin Sub-area, which is located southwest of and adjacent to the South Gabilan Area boundary. The median groundwater objectives for the Basin Plan Central Basin Sub-area for TDS, nitrate (as N), and chloride are 400, 3.4, and 60 mg/L, respectively (Table 3-9). The areal average TDS concentration of 451 mg/L slightly exceeds the objective concentration of 400 mg/L and the areal average nitrate (as N) concentration of 6.3 mg/L similarly exceeds the objective concentration of 3.4 mg/L. Conversely, the areal average chloride concentration of 37.2 mg/L is below the objective concentration of 60 mg/L.

The single measurement of TDS concentration of 634 mg/L was above the Title 22 secondary drinking water standard recommended MCL for TDS of 500 mg/L and below the secondary drinking water standard upper limit of 1,000 mg/L (Table 3-11). The single measurement of nitrate (as N) concentration of 15.8 mg/L was above the Title 22 primary drinking water standard recommended MCL for nitrate (as N) of 10 mg/L (Table 3-11). Conversely, the single measurement of chloride concentration of 37.2 mg/L was below the Title 22 secondary drinking water standard recommended MCL for chloride of 250 mg/L (Table 3-11).

Bradley Area

The Bradley Area receives surface water inflows from the Salinas River on the south, and the Nacimiento and San Antonio rivers on the west. Surface water chemistry of six total samples collected from the Salinas, Nacimiento, and San Antonio rivers was analyzed and those results are presented in 9.5Appendix G - (Fugro and Cleath, 2002). Measured TDS concentrations were 198 mg/L in the San Antonio River; 300 and 767 mg/L in the Salinas River; and 163, 168, and 202 mg/L in the Nacimiento River. Measured TDS concentrations of all six samples were below the median surface water quality objective for TDS of 1,390 mg/L in the Salinas River above Bradley. Measured chloride concentrations were 10 mg/L in the San Antonio River; 27 and 113 mg/L in the Salinas River; and 6, 6.5, and 7 mg/L in the Nacimiento River. Measured chloride concentrations of the four samples collected from the San Antonio and Nacimiento rivers were below the median surface water quality objective for chloride of 20 mg/L in the Salinas River above Bradley; however, measured chloride concentrations of the two samples in the Salinas River both exceeded the water quality objective.

The baseline conditions for TDS, nitrate (as N), and chloride for the Bradley Area are shown in Figure 3-9, Figure 3-10 and Figure 3-11, respectively. The ranges of measured concentrations for TDS, nitrate (as N), and chloride in the Bradley Area at the discrete locations shown in Figure 3-9, Figure 3-10 and Figure 3-11, respectively, are summarized in Table 3-12. Also included in Table 3-12 are the area-averaged concentrations for TDS, nitrate (as N), and chloride for the Bradley Area computed from the interpolated values of those constituents shown in Figure 3-9, Figure 3-10 and Figure 3-11, respectively. Within the Bradley Area, measured concentrations of TDS at discrete locations ranged from 234 to 1,343 mg/L, with an areal average of 751 mg/L; measured concentrations of nitrate (as N) ranged from 0.0 to 5.8 mg/L, with an areal average of 2.7 mg/L; and measured concentrations of chloride ranged from 27.5 to 400 mg/L, with an areal average of 84.4 mg/L.

The Bradley Area does not overlap any of the Basin Plan sub-areas (Figure 3-1). The nearest Basin Plan sub-area to the Bradley Area is the San Miguel Sub-area, which is located directly south of the Bradley Area southern boundary in the Estrella Area. The median groundwater objectives for the Basin Plan San Miguel Sub-area for TDS, nitrate (as N), and chloride are 750, 4.5, and 100 mg/L, respectively (Table 3-9). The areal average TDS concentration of 751 mg/L is nearly identical to the objective

concentration of 750 mg/L for the Basin Plan San Miguel Sub-area. The areal average chloride concentration of 84.4 mg/L is below the objective concentration of 100 mg/L for the Basin Plan San Miguel Sub-area. Similarly, the areal average nitrate (as N) concentration of 2.7 mg/L is below the objective concentration of 4.5 mg/L for the Basin Plan San Miguel Sub-area.

The upper limit of the range of measured TDS concentrations at discrete locations (1,343 mg/L) was above both the Title 22 secondary drinking water standard recommended MCL for TDS of 500 mg/L and the secondary drinking water standard upper limit of 1,000 mg/L, but below the secondary drinking water standard short term limit of 1,500 mg/L (Table 3-11). The entire range of measured nitrate (as N) concentrations at discrete locations (0.0 to 5.8 mg/L) was below the Title 22 primary drinking water standard recommended MCL for nitrate (as N) of 10 mg/L (Table 3-11). The upper limit of the range of measured chloride concentrations at discrete locations (400 mg/L) was above the Title 22 secondary drinking water standard recommended MCL for chloride of 250 mg/L and below the secondary drinking water standard upper limit of 500 mg/L (Table 3-11).

The water type of groundwater in the Bradley Area is predominantly calcium- bicarbonate, with magnesium as the secondary cation in most cases (Figure 3-12). In general, surface water quality in the Bradley Area is characterized by low TDS and chloride concentrations. By contrast, elevated levels of TDS and chloride in groundwater samples in the central-eastern region of the Bradley Area (see Figure 3-9 and Figure 3-11) are likely due to the overall subsurface geologic structure in the area that brings older, less permeable Paso Robles Formation deposits to the ground surface. These older deposits possess higher salinity and provide sources of dissolved sodium, chloride, and sulfate ions to the aquifers (Fugro and Cleath, 2002). Wells completed in the older, less permeable Paso Robles Formation deposits contain highly mineralized groundwater (e.g., sodium-chloride, sodium-bicarbonate-chloride) as seen in Figure 3-12.

3.6 Water Balance Estimation

Average annual water balances for the eight study areas were estimated using results from the Basin groundwater flow model (Fugro et. al, 2005), the Basin groundwater pumping study performed by Todd (2009), and from the Basin water balance update and review study performed by Fugro (2010). The water balances for the study areas consist of the major groundwater recharge and discharge processes that occur in the Basin.

The major groundwater recharge components are:

1. Basin subsurface inflows
2. Deep percolation of precipitation
3. Streambed seepage in rivers and creeks
4. Agricultural irrigation return flows
5. Wastewater discharge

The major groundwater discharge components are:

1. Basin subsurface outflows
2. Groundwater pumping
3. Groundwater discharge to rivers and creeks
4. Phreatophyte extraction of shallow groundwater

In general, the recharge and discharge components can be categorized as either predominantly natural or anthropogenic. Natural recharge and discharge processes include Basin subsurface inflows and outflows, deep percolation of precipitation, streambed seepage in rivers and creeks, groundwater discharge to the rivers and creeks, and phreatophyte extraction of shallow groundwater. Anthropogenic processes include agricultural irrigation return flows, wastewater discharge, and groundwater pumping. The Basin groundwater flow model was developed for a base period of 1981 to 1997 (Fugro et. al, 2005). That base period was chosen because it was determined by a cumulative departure analysis of historic precipitation in the Basin to be hydrologically balanced (i.e., the base period contained a relatively even balance of water year types). As such, the natural recharge and discharge components in the water balances for each study area were estimated from the results of the Basin groundwater flow model (Fugro et al., 2005). Groundwater pumping for each study area was also estimated from results of the Basin model. Treated wastewater effluent discharges were estimated on an annual basis from data presented in the Basin water balance update and review study performed by Fugro (2010). Agricultural irrigation return flows and wastewater discharges from septic systems were estimated from results of the Basin groundwater pumping study performed by Todd (2009).

The Basin groundwater flow model was developed in MODFLOW and consisted of four model layers. The first model layer was defined as an unconfined aquifer in MODFLOW and represented the alluvium associated with the Salinas River, Estrella River, and portions of the Nacimiento and San Antonio rivers. The second model layer was also defined as an unconfined aquifer in MODFLOW and represented both the low permeable sediments that underlie the base of the alluvium and the laterally extensive, low permeable aquitard that underlies the entire Estrella River and extends away in the north and south directions from the river for several miles that was described in the Aquifer Characteristics section. Model layers 3 and 4 were defined as confined aquifers and represented the major water-bearing regions of the Paso Robles Formation.

The Basin model simulated groundwater flow in both the unconfined and confined model layers. For the purposes of the SNMP, average annual recharge and discharge components were calculated for both the unconfined aquifer (i.e., combined model layers 1 and 2) and the confined aquifer (i.e., combined model layers 3 and 4) in each study area. The unconfined aquifer includes both the alluvium associated with rivers and creeks (model layer 1) and also areas of outcropping Paso Robles Formation that are unsaturated yet transmit recharge from various sources applied to the ground surface to the aquitard (model layer 2) that separates the overlying unconfined alluvium and unsaturated sediments from the deeper Paso Robles Formation. Similarly, the confined aquifer includes both outcropping Paso Robles Formation and deeper water-bearing sediments of the Paso Robles Formation. In addition to subsurface inflows and outflows through the Basin boundaries, net horizontal groundwater inflows between adjacent study areas and net vertical groundwater flow between the unconfined aquifer and confined aquifer were also extracted from the Basin model.

3.6.1 Groundwater Recharge

Estimated annual groundwater recharge components in the unconfined and confined aquifers for each of the study areas are presented in Tables Table 3-13 through Table 3-17 and described in the following sections.

Basin Subsurface Inflow

Annual subsurface inflow to the Basin through the unconfined aquifer and confined aquifer for each study area was estimated from the Basin groundwater flow model as the average of the simulated annual subsurface inflows over the 1981 to 1997 model base period (Table 3-13 and

Table 3-14). Annual subsurface inflow through the unconfined aquifer of the Bradley Area was 4 AFY and for the other seven study areas was 0 AFY (Table 3-13). Annual subsurface inflow through the confined aquifer ranged from 700 AFY for the Bradley Area to 6,319 AFY for the Creston Area (Table 3-14). Overall, estimated annual subsurface inflow to the entire Basin was 25,026 AFY.

Deep Percolation of Precipitation

Aerially-distributed recharge was inputted as a single variable in the groundwater flow model and represented the aggregation of deep percolation of precipitation, agricultural irrigation return flow, and discharged wastewater from septic systems. Agricultural irrigation return flow and discharged wastewater from septic systems were estimated outside of the model and are described in the sections on Agricultural Irrigation Return Flow and Wastewater Discharge, respectively. Annual aerially-distributed recharge in the unconfined aquifer and confined aquifer was estimated from the Basin model as the average of the simulated aerially-distributed recharge in each study area over the 1981 to 1999 model base period. Annual agricultural irrigation return flow and annual discharged wastewater from septic systems were then subtracted from the annual aerially-distributed recharge to obtain an estimate of annual recharge from deep percolation of precipitation.

Estimated annual deep percolation of precipitation in the unconfined aquifer ranged from 0 AFY for the Creston Area to 3,215 AFY for the Shandon Area (Table 3-13). Estimated annual deep percolation of precipitation in the confined aquifer (i.e., outcropping Paso Robles Formation) ranged from 25 AFY for the Atascadero Subbasin to 4,394 AFY for the Creston Area (Table 3-14). Overall, estimated annual deep percolation of precipitation for the entire Basin was 26,706 AFY. It's important to note when interpreting zero or very small values of annual deep percolation of precipitation in Table 3-12 and Table 3-13 that precipitation in the model also becomes aquifer recharge through the process of rainfall runoff into natural channels and subsequent streambed seepage in those rivers and creeks. As such, recharge from precipitation should be conceptually viewed as the sum of deep percolation of precipitation and streambed seepage in rivers and creeks.

Streambed Seepage from Rivers and Creeks

Annual streambed seepage from rivers and creeks into the unconfined aquifer and confined aquifer (i.e., outcropping Paso Robles Formation) for each study area was estimated from the Basin groundwater flow model as the average of the simulated annual streambed seepage over the 1981 to 1997 model base period. Estimated annual streambed seepage into the unconfined aquifer ranged from 0 AFY for the Creston and North Gabilan areas to 14,047 AFY for the Atascadero Subbasin (Table 3-13). Estimated annual stream bed seepage into the confined aquifer ranged from 0 AFY for the Atascadero Subbasin to 10,624 AFY for the San Juan Area (Table 3-14). Overall, estimated annual streambed seepage for the entire Basin was 60,449 AFY.

Agricultural Irrigation Return Flow

Annual agricultural irrigation return flow into the unconfined aquifer and confined aquifer (i.e., outcropping Paso Robles Formation) for each study area was estimated using a 1996/1997 land-use map for the Basin, gross irrigation water requirements for different crops grown in the Basin (Todd, 2009), and irrigation efficiencies used for development of the San Luis Obispo County Master Water Report (Carollo, 2012). Estimated annual agricultural irrigation return flow into the unconfined aquifer ranged from 0 AFY for the Creston, North Gabilan, and South Gabilan areas to 3,587 AFY for the Estrella Area (Table 3-13). Estimated annual agricultural irrigation return flow into the confined aquifer ranged from 0 AFY for the South Gabilan Area to 1,277 AFY for the Creston Area (Table 3-14). Overall, estimated annual agricultural irrigation return flow for the entire Basin was 9,781 AFY.

Wastewater Discharge

Wastewater discharge includes discharge of treated wastewater effluent from municipal wastewater treatment plants and wastewater discharge from septic systems associated with small community water systems, small commercial businesses, and rural residences. The City of Paso Robles, City of Atascadero, Templeton CSD, and San Miguel CSD each discharge treated wastewater effluent in the Salinas River alluvium from their respective treatment facilities. The City of Paso Robles and San Miguel CSD discharge to areas in the Salinas River alluvium located in the Estrella Area. The City of Atascadero and Templeton CSD discharge treated wastewater to areas of the alluvium in the Atascadero Subbasin. The discharged effluent by Templeton CSD is recovered downstream of its percolation ponds by district wells located in the alluvium. Annual discharge volumes of treated wastewater from 1998 to 2009 from the four municipal treatment facilities were reported in Fugro (2010). Annual municipal wastewater discharge by each of the four facilities was estimated for this study as the maximum annual wastewater discharge volume from 1998 to 2009. Annual municipal wastewater discharge in the alluvium portion of the unconfined aquifer is zero in all study areas except the Atascadero Subbasin where it was 1,569 AFY and in the Estrella Area where it was 3,565 AFY (Table 3-13). Annual municipal wastewater discharge for the entire Basin was 5,134 AFY.

Annual wastewater discharge from septic systems associated with small community water systems, small commercial businesses, and rural residences was estimated using calculated groundwater pumping rates for those three sources for the 2006 water year (Todd, 2009). For this study, it was assumed that annual wastewater discharge from those three sources equals 50 percent of their respective annual groundwater pumping rates (Fugro, 2010). Furthermore, septic system wastewater discharge was distributed between the unconfined aquifer and the confined aquifer (i.e., outcropping Paso Robles Formation) in proportion to the approximate areas occupied by those geologic units at the land surface in the Basin model. Estimated annual wastewater discharge from small community water systems, small commercial businesses, and rural residences in the unconfined aquifer and confined aquifer are presented in Table 3-13 and Table 3-14, respectively.

Annual wastewater discharge from small community water systems overlying the unconfined aquifer was estimated to be 0 AFY for the Creston, San Juan, Shandon, North Gabilan, and Bradley areas and ranged elsewhere from 14 AFY for the Estrella Area to 69 AFY for the Atascadero Subbasin (Table 3-13). Annual wastewater discharge from small community water systems overlying the confined aquifer was estimated to be 0 AFY for the Creston, Shandon, North Gabilan, and Bradley areas and ranged elsewhere from 3 AFY for the San Juan Area to 89 AFY for the South Gabilan (Table 3-14). Overall, annual wastewater discharge from small community water systems for the entire Basin was 238 AFY.

Annual wastewater discharge from small commercial businesses overlying the unconfined aquifer was estimated to be 0 AFY for the Creston, Shandon, North Gabilan, and Bradley areas and ranged elsewhere from 1 AFY for the San Juan Area to 540 AFY for the Estrella Area (Table 3-13). Annual wastewater discharge from small commercial businesses overlying the confined aquifer was estimated to be 0 AFY for the Shandon, North Gabilan, and Bradley areas and ranged elsewhere from 15 AFY for the Atascadero Subbasin to 210 AFY for the Estrella Area (Table 3-14). Overall, annual wastewater discharge from small commercial businesses for the entire Basin was 938 AFY.

Annual wastewater discharge from rural residences overlying the unconfined aquifer was estimated to be 0 AFY for the Creston and North Gabilan areas and ranged elsewhere from 1 AFY for the Shandon Area to 1,900 AFY for the Estrella Area (Table 3-13). Annual wastewater discharge from rural residences overlying the confined aquifer ranged from 24 AFY for the Shandon to 1,084 AFY for the San Juan Area (Table 3-14). Overall, annual wastewater discharge from rural residences for the entire Basin was 5,446 AFY.

Groundwater Flow between Study Areas

Annual net horizontal groundwater inflow in the unconfined aquifer between adjacent study areas and in confined aquifer between adjacent study areas was calculated using the Basin groundwater flow model as the average of the simulated annual net horizontal groundwater inflow over the 1981 to 1997 model base period. In general, the regional direction of groundwater flow in the alluvium portion of the unconfined aquifer associated with the Salinas and Estrella rivers and the major tributaries to these rivers is the same as the direction of surface water flow in these rivers and creeks.

Annual net horizontal groundwater inflow in the unconfined aquifer between adjacent study areas is presented in Table 3-15. Annual net horizontal groundwater inflow from the Atascadero Subbasin to the Estrella Area was 3,354 AFY and represents downgradient groundwater flow in the Salinas River alluvium from the Atascadero Subbasin to the Estrella Area. The Estrella Area also receives net horizontal groundwater inflows of 348 and 403 AFY from the unconfined aquifer in the South Gabilan and Shandon areas (Table 3-15). The Bradley Area receives net horizontal groundwater inflows of 2,458 AFY from the Salinas River alluvium in the Estrella Area and 137 AFY from a small section of the Salinas River alluvium located in the North Gabilan Area. Elsewhere, the Shandon Area receives net horizontal groundwater inflows of 26 AFY from the South Gabilan Area and 40 AFY from the San Juan Area (Table 3-15).

Net horizontal groundwater inflow in the confined aquifer between adjacent study areas is a function of the natural regional groundwater flow direction in the Paso Robles Formation and differences in pumping from the Paso Robles Formation between study areas (see the subsection in Section 3.6.2 on Groundwater Pumping). Annual net horizontal groundwater inflow in the confined aquifer between adjacent study areas is presented in Table 3-16. The Estrella Area receives net horizontal inflows of 5,079, 3,066, and 10,184 AFY from the Creston, Shandon, and South Gabilan areas, respectively. The Shandon Area receives net horizontal inflows of 11,355 and 2,533 AFY from the San Juan and South Gabilan areas, respectively. The Bradley Area receives net horizontal inflows of 765 and 6,369 AFY from the Estrella and North Gabilan areas, respectively.

Groundwater Flow between Unconfined and Confined Aquifers

Annual net vertical groundwater flow between the unconfined aquifer and the confined aquifer in each study area was calculated using the Basin groundwater flow model as the average of the simulated annual net vertical groundwater flow over the 1981 to 1997 model base period (Table 3-17). For the southern and central study areas of the Basin (i.e., Atascadero Subbasin, and Creston, San Juan, Estrella, Shandon, and South Gabilan areas), the direction of net vertical groundwater flow is from the unconfined aquifer to the underlying confined aquifer. Annual net vertical groundwater flow in the southern and central study areas ranged from 0 AFY for the Creston Area to 4,204 AFY for the Atascadero Subbasin (Table 3-17). Drainage from the Basin into the Upper Valley Aquifer Subbasin occurs as surface water flow in the Salinas River and as groundwater flow in the Salinas River alluvium. The direction of net vertical groundwater flow in the northern study areas of North Gabilan and Bradley is from the confined aquifer to the overlying unconfined aquifer (e.g., Salinas River alluvium in the Bradley Area). Annual net vertical groundwater flow from the confined aquifer to the overlying unconfined aquifer in the North Gabilan and Bradley areas was 121 and 9,216 AFY, respectively (Table 3-17).

Table 3-13: Average Annual Groundwater Recharge in the Unconfined Aquifer

Study Area	Basin Subsurface Inflows (acre-feet)	Deep Percolation of Precipitation (acre-feet)	Stream Recharge (acre-feet)	Agricultural Irrigation Return Flows (acre-feet)	Municipal Wastewater Discharge (acre-feet)	Small Community Wastewater Discharge (acre-feet)	Small Commercial Wastewater Discharge (acre-feet)	Rural Residential Wastewater Discharge (acre-feet)
Atascadero	0	10	14,047	549	1,569	69	28	591
Creston	0	0	0	0	0	0	0	0
San Juan	0	222	68	24	0	0	1	82
Estrella	0	117	4,719	3,587	3,565	14	540	1,900
Shandon	0	3,215	2,392	2,155	0	0	0	1
North Gabilan	0	16	0	0	0	0	0	0
South Gabilan	0	761	148	0	0	20	6	89
Bradley	4	1,366	5,269	46	0	0	0	27
Total Recharge	**4**	**5,708**	**26,643**	**6,361**	**5,134**	**103**	**575**	**2,689**

Table 3-14: Average Annual Groundwater Recharge in the Confined Aquifer

Study Area	Basin Subsurface Inflows (acre-feet)	Deep Percolation of Precipitation (acre-feet)	Stream Recharge (acre-feet)	Agricultural Irrigation Return Flows (acre-feet)	Small Community Wastewater Discharge (acre-feet)	Small Commercial Wastewater Discharge (acre-feet)	Rural Residential Wastewater Discharge (acre-feet)
Atascadero	784	25	0	198	37	15	318
Creston	6,319	4,394	5,796	1,277	0	92	55
San Juan	3,032	3,210	10,624	685	3	17	1,084
Estrella	6,215	2,609	1,933	235	5	210	739
Shandon	2,618	2,254	3,168	106	0	0	24
North Gabilan	1,462	2,857	3,705	540	0	0	53
South Gabilan	3,893	1,805	6,151	0	89	28	405
Bradley	700	3,843	2,429	379	0	0	80
Total Recharge	**25,022**	**20,998**	**33,805**	**3,420**	**135**	**362**	**2,757**

Table 3-15: Average Annual Net Horizontal Subsurface Inflows in the Unconfined Aquifer between Study Areas

Study Area	Net Subsurface Inflows from Atascadero (acre-feet)	Net Subsurface Inflows from Creston (acre-feet)	Net Subsurface Inflows from San Juan (acre-feet)	Net Subsurface Inflows from Estrella (acre-feet)	Net Subsurface Inflows from Shandon (acre-feet)	Net Subsurface Inflows from North Gabilan (acre-feet)	Net Subsurface Inflows from South Gabilan (acre-feet)	Net Subsurface Inflows from Bradley (acre-feet)
Atascadero	--	0	0	-3,354	0	0	0	0
Creston	0	--	0	0	0	0	0	0
San Juan	0	0	--	0	-40	0	0	0
Estrella	3,354	0	0	--	403	0	348	-2,458
Shandon	0	0	40	-403	--	0	26	0
North Gabilan	0	0	0	0	0	--	0	-137
South Gabilan	0	0	0	-348	-26	0	--	0
Bradley	0	0	0	2,458	0	137	0	--

Table 3-16: Average Annual Net Horizontal Subsurface Inflows in the Confined Aquifer between Study Areas

Study Area	Net Subsurface Inflows from Atascadero (acre-feet)	Net Subsurface Inflows from Creston (acre-feet)	Net Subsurface Inflows from San Juan (acre-feet)	Net Subsurface Inflows from Estrella (acre-feet)	Net Subsurface Inflows from Shandon (acre-feet)	Net Subsurface Inflows from North Gabilan (acre-feet)	Net Subsurface Inflows from South Gabilan (acre-feet)	Net Subsurface Inflows from Bradley (acre-feet)
Atascadero	--	477	0	114	0	0	0	0
Creston	-477	--	0	-5,079	697	0	0	0
San Juan	0	0	--	0	-11,335	0	0	0
Estrella	-114	5,079	0	--	3,066	0	10,184	-765
Shandon	0	-697	11,335	-3,066	--	0	2,533	0
North Gabilan	0	0	0	0	0	--	-104	-6,369
South Gabilan	0	0	0	-10,184	-2,533	104	--	0
Bradley	0	0	0	765	0	6,369	0	--

Table 3-17: Average Annual Net Vertical Groundwater Flow from Unconfined to Confined Aquifer

Study Area	Net Vertical Flow from Unconfined Aquifer to Confined Aquifer (acre-feet)
Atascadero	4,204
Creston	0
San Juan	344
Estrella	3,817
Shandon	1,841
North Gabilan	-121
South Gabilan	565
Bradley	-9,216

3.6.2 Groundwater Discharge

Estimated annual groundwater discharge components in the unconfined and confined aquifers for each of the study areas are presented in Table 3-18 and Table 3-19, respectively, and described in the following sections.

Basin Subsurface Outflow

Drainage of the Basin generally occurs along the northern boundary of the Bradley Area where the Salinas River, Salinas River alluvium, and Paso Robles Formation abut the downgradient Upper Valley Aquifer Subbasin. Annual subsurface outflows from the Basin through the unconfined aquifer (i.e., alluvium) and confined aquifer for each study area were estimated from the Basin groundwater flow model as the average of the simulated annual subsurface outflows over the 1981 to 1997 model base period. Annual subsurface outflow through the unconfined aquifer in the Bradley Area was 1,083 AFY and was 0 AFY through the unconfined aquifer in the other seven study areas (Table 3-18). Annual subsurface outflow through the confined aquifer ranged from 0 AFY in the Atascadero Subbasin and Creston, San Juan, Estrella, and North Gabilan areas to 464 AFY in the Bradley Area (Table 3-19). Overall, estimated annual subsurface outflow from the entire Basin was 1,602 AFY.

Groundwater Pumping

Annual groundwater pumping in the unconfined aquifer and confined aquifer for each study area was estimated from the Basin groundwater flow model as the average of the simulated annual groundwater pumping over the 1981 to 1997 model base period. In general, the five major sources of groundwater pumping are:

1. Agricultural
2. Municipal
3. Small community water systems
4. Small commercial
5. Rural residential

Annual groundwater pumping in the unconfined aquifer and confined aquifer from the fives sources was aggregated in the model and is presented for each study area in Table 3-18 and Table 3-19. In the unconfined aquifer, annual groundwater pumping ranged from 0 AFY in the Creston, San Juan, Shandon, North Gabilan, and South Gabilan areas to 5,397 and 8,413 AFY in the Estrella Area and Atascadero Subbasin, respectively (Table 3-18). In the confined aquifer, annual groundwater pumping ranged from 386 AFY in the South Gabilan Area to 33,741 AFY in the Estrella Area (Table 3-19). Overall, estimated annual groundwater pumping for the entire Basin was 99,954 AFY.

Groundwater Discharge to Rivers and Creeks

Groundwater discharge to the major rivers and creeks in the Basin was simulated by the Basin groundwater flow model. The Salinas, Estrella, Nacimiento, and San Antonio rivers and a number of tributary creeks to the Salinas and Estrella rivers were modeled as overlying the alluvium (i.e., unconfined aquifer). Other creeks and canyon channels in the upland regions of North Gabilan, South Gabilan, Shandon, San Juan, and Creston areas were modeled as overlying outcropped Paso Robles Formation (i.e., confined aquifer). Annual groundwater discharge to rivers and creeks in the alluvium and Paso Robles Formation for each study area was estimated from the Basin groundwater flow model as the average of the simulated annual groundwater discharge to rivers and creeks over the 1981 to 1997 model base period (Table 3-18 and Table 3-19). In the unconfined aquifer, annual groundwater discharge to rivers and creeks ranged from 0 AFY in the Creston, San Juan, North Gabilan, and South Gabilan areas to 12,161 AFY in the Bradley Area (Table 3-18). In the confined aquifer, annual groundwater discharge to rivers and creeks ranged from 0 AFY in the Atascadero Subbasin, and in the Shandon and South Gabilan areas to 596 AFY in the San Juan Area (Table 3-19). Overall, estimated annual groundwater discharge to rivers and creeks for the entire Basin was 29,213 AFY.

Table 3-18: Average Annual Groundwater Discharge in the Unconfined Aquifer

Study Area	Basin Subsurface Outflows (acre-feet)	Groundwater Discharge to Streams (acre-feet)	Groundwater Pumping (acre-feet)	Evapotranspiration (acre-feet)
Atascadero	0	2,062	8,413	269
Creston	0	0	0	0
San Juan	0	0	0	5
Estrella	0	7,625	5,397	88
Shandon	0	5,227	0	325
North Gabilan	0	0	0	0
South Gabilan	0	0	0	0
Bradley	1,083	12,161	492	5,132
Total Recharge	**1,083**	**27,075**	**14,301**	**5,817**

Table 3-19: Average Annual Groundwater Discharge in the Confined Aquifer

Study Area	Basin Subsurface Outflows (acre-feet)	Groundwater Discharge to Streams (acre-feet)	Groundwater Pumping (acre-feet)	Evapotranspiration (acre-feet)
Atascadero	0	0	6,077	5
Creston	0	407	11,672	981
San Juan	0	596	9,904	353
Estrella	0	260	33,741	137
Shandon	5	0	18,538	0
North Gabilan	0	146	1,775	111
South Gabilan	50	0	386	0
Bradley	464	728	3,559	167

3.7 Summary

This chapter provides a characterization of the Paso Robles Groundwater Basin for the SNMP for the Basin. The characterization includes basic descriptions of the Basin setting, land use, climate, hydrology, and hydrogeology. The three water quality constituents to be addressed in the SNMP for the Basin are TDS, nitrate (as N), and chloride. A major objective of this study was to collect recent and historic measured concentrations of TDS, nitrate (as N), and chloride at different locations in the Basin and use them to establish the baseline conditions (i.e., estimated spatial distribution of constituent concentration representative of current conditions) for each of the three constituents. The baseline conditions for the three constituents were derived using water quality data from the Fugro and Cleath (2002) and GeoTracker GAMA databases. The maps of baseline conditions were used to estimate average constituent concentrations in each of the study areas. The baseline conditions for TDS, nitrate (as N), and chloride are required for performing the assimilative capacity and anti-degradation analyses in the Basin SNMP.

Another major objective of this study was to develop average annual water balances for the unconfined and confined aquifers in the eight study areas. The water balances for the study areas consist of the major groundwater recharge and discharge processes that occur in the Basin. The major groundwater recharge components are:

1. Subsurface inflows
2. Deep percolation of precipitation
3. Streambed seepage from rivers and creeks
4. Agricultural irrigation return flows
5. Wastewater discharge

The major groundwater discharge components are:

1. Subsurface outflows
2. Groundwater pumping
3. Groundwater discharge to rivers and creeks
4. Phreatophyte extraction of shallow groundwater.

The study area water balances were estimated using results from the Basin groundwater flow model (Fugro et. al, 2005), the Basin groundwater pumping study performed by Todd (2009), and from the Basin water balance update and review study performed by Fugro (2010).

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Loading Analysis

Salt/Nutrient Management Plan for the Paso Robles Groundwater Basin

Chapter 4 Loading Analysis

To prepare the assimilative capacity analysis (Chapter 5), one must first understand the current and projected future loading of salts and nutrients to the groundwater basin. In essence, one must understand the land use types overlying the groundwater basin, and the activities that occur on that land - such as irrigation, soil amendment application, agricultural practices - that have the potential to allow for salts and/or nutrients to migrate down to the groundwater table. These loading factors are then used in a GIS-based model to determine the portion of the applied material (fertilizer, water, etc.) that can leach to groundwater. These data are then utilized with groundwater volumetric inflows and outflows in a spreadsheet mixing model to estimate future groundwater quality trends. (The initial volumes of groundwater and salt/nutrient mass present in the basin have been estimated to provide a reference point for predicting groundwater volume [and water levels] and chemical mass changes over time.)

Salt and nutrient loading from surface activities to the Paso Robles Groundwater Basin is presently due to numerous sources, including:

- Irrigation water (e.g., potable water, groundwater, and future recycled water);
- Agricultural inputs (e.g., fertilizer and amendments);
- Septic system recharge;
- Infrastructure (e.g., percolation from treated wastewater ponds, leaking pipes); and
- Rainfall infiltration, mountain front recharge, and natural stream losses.

The purpose of this chapter is to document the sources of salts and nutrients (above), and present the methodology and assumptions used to estimate the impact of those sources on the groundwater basin.

4.1 Selection of Baseline and Future Planning Period

In accordance with Section 9.c.(1) of the SWRCB Recycled Water Policy, the water quality averaging period to establish the baseline (present) groundwater quality or representative current concentrations of salts and nutrients in groundwater is the most recent 5-year period for which data are available. If these data are not available, a data set approved by the California Regional Water Quality Control Board (RWQCB) may be used. At present, there are limited groundwater quality data available for the Paso Robles groundwater basin, the majority of which was compiled and analyzed in the 2002 *Paso Robles Groundwater Basin Study* (Fugro West, Inc., 2002). As this is the most comprehensive study completed for the Paso Robles Groundwater Basin, and as the baseline period utilized in this study incorporates the analysis from this report, the baseline period for establishing background water quality for the Paso Robles Groundwater Basin is from 2001 to 2012.

The goal for the salt and nutrient inflow and outflow analysis is to define a basin water balance on an annual time-step basis based on water year (October 1 to September 30) or fiscal year (July 1 to June 30). Because some agencies collect and present data on a fiscal year basis, while data are compiled on a water year or calendar year basis, there will be some mixing of water year, fiscal year and calendar year in the annual loading estimates. The groundwater basin water balance will, however, be based on the water balance prepared for the numerical groundwater model documented in the report entitled *Final Report, Paso Robles Groundwater Basin Study, Phase II, Numerical Model Development, Calibration and Application* (Fugro West, Inc. 2005). This model simulated a 17-year period for the Paso Robles Groundwater Basin, extending from 1981 to 1997. Therefore, the 'average' annual water balance to be used in the salt and nutrient loading analysis will be based on this period. Current land uses, however, will be used to simulate land use and management practices that may contribute salts and/or nutrient to the groundwater basin.

The future planning period utilized in this plan is based on existing planning documents, including General Plans and Urban Water Management Plans. Therefore, the future planning period for the Paso Robles Groundwater Basin loading analyses will extend from 2013 to 2030.

4.2 Identification of Salt and Nutrient Indicator Constituents

The major dissolved ions potentially included in recycled water that reflect its salinity and nutrient content are many and varied, and include sulfate, chloride, nitrate, iron, boron and manganese. Simulation of each constituent is beyond the scope of this study; therefore indicators of salt and nutrient loading to the Paso Robles Groundwater Basin were selected for further study.

4.2.1 Selection of Indicator Parameters of Salts and Nutrients

In choosing which constituents to consider in this SNMP, the following criteria/questions were used to identify a select number of constituents for further consideration:

1. Is the constituent regularly monitored and detected in source waters?
2. Is the constituent representative of other salts and nutrients?
3. Is the constituent conservative and mobile in the environment?
4. Is the constituent found in source waters at concentrations above those found in ambient groundwater?
5. Does the constituent have high toxicity for human health or will otherwise affect beneficial use?
6. Is the constituent a known contaminant in groundwater in the Study Area?
7. Have the concentrations of the constituents been shown to be increasing in the Study Area?
8. Is the constituent subject to a water quality objective (WQO) within the Basin Plan?

Each selected indicator constituent of salts and nutrients is not required to meet all the criteria, but as a group, at least one should meet each criterion. Table 4-1 summarizes the results of the assessment conducted for the anions and cations that compose general groundwater quality.

Table 4-1: Evaluation of Potential Indicator Constituents

Indicator Question	Constituent											
	Iron	Calcium	Magnesium	Sodium	Potassium	Bicarbonate	Chloride	Sulfate	Nitrate	Manganese	Boron	Total Dissolved Solids
1. Is the constituent regularly monitored and detected in source waters?	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
2. Is the constituent representative of other salts and nutrients?		✓		✓	✓		✓		✓			✓
3. Is the constituent conservative and mobile in the environment?	✓	✓	✓	✓	✓		✓	✓		✓	✓	✓
4. Is the constituent found in source waters at concentrations above those found in ambient groundwater?							✓	✓				✓
5. Does the constituent have high toxicity for human health or will otherwise affect beneficial use?							✓	✓	✓	✓	✓	✓
6. Is the constituent a known contaminant in groundwater in the Study Area?	✓						✓	✓	✓	✓	✓	✓
7. Have the concentrations of the constituents been shown to be increasing in the Study Area?							✓		✓			✓
8. Is the constituent subject to a water quality objective (WQO) within the Basin Plan?				✓			✓	✓	✓		✓	✓

As seen in this table, both chloride and TDS, as salts, meet all the criteria, while sodium, sulfate and boron did not. However, TDS, as a compilation of general minerals, provides a good relative indicator of concentrations trends in the groundwater basin for these other constituents. Nitrate, as a nutrient, meets most of the criteria and has the most water quality data available in the groundwater basin. The selection of chloride, TDS and nitrate as indicator constituents also correlates well with the average percentage of the different general minerals found in each subarea of the groundwater basin (Table 4-2). Based on an analysis of analytical sampling data presented in the *Final Report, Paso Robles Groundwater Basin Study* (Fugro West, 2002), chloride, sulfate and bicarbonate compose the largest percentage of general minerals (and therefore are the largest components of TDS) in the groundwater basin.

Table 4-2: Average Percentage of General Minerals in TDS

Subbasin	Constituent										
	Calcium	Magnesium	Sodium	Potassium	Bicarbonate	Chloride	Sulfate	Nitrate	Iron	Manganese	Boron
Atascadero	16%	5%	13%	0%	58%	14%	21%	2%	--	--	0%
Creston	16%	5%	14%	0%	47%	23%	14%	3%	0%	0%	0%
San Juan	10%	2%	21%	0%	26%	22%	28%	3%	0%	0%	0%
Shandon	12%	4%	13%	0%	25%	15%	39%	2%	0%	0%	0%
Estrella	9%	4%	20%	0%	40%	24%	19%	2%	0%	0%	0%
Gabilan	12%	7%	8%	0%	42%	11%	28%	5%	0%	--	0%
Bradley	11%	3%	26%	0%	31%	15%	33%	2%	0%	0%	0%
Average Surface Water	8%	6%	17%	0%	36%	16%	32%	--	--	0%	0%

Of the possible constituents comprising the salt and/or nutrient chemical categories, the ones with WQOs, per the Central Coast RWQCB's Basin Plan, to be included for discussion in this SNMP are TDS, chloride and nitrate (measured as nitrogen). Table 4-3 shows the list of constituents and the applicable water quality objectives as documented in the Central Coast Basin Plan. Table 4-4 shows the water quality objectives and the range and average concentrations of constituents commonly monitored in all source waters.

It should be noted that the basin sub-areas as defined by the Central Coast Basin Plan do not coincide with the hydrogeologic subareas used in this study. Figure 4-1 shows the Paso Robles Groundwater Basin subareas utilized herein. Figure 4-2 shows the Paso Robles Groundwater Basin subareas as defined by the Central Coast Basin Plan. Table 4-5 relates the two, allowing for appropriate use of the basin water quality objectives.

Available groundwater quality data from the USGS, SWRCB Division of Drinking Water (DDW, formerly California Department of Public Health [CDPH]), DWR, the GAMA Program, and local and county agencies were collected for this effort. Based on these available data and the sub-area specific water quality objectives presented in the Central Coast Basin Plan, indicator constituents were selected and analyzed to develop a single estimate of basin-wide concentration. Data was also collected for other constituents, where available, including general minerals, phosphorous and arsenic. Guidance on monitoring of CECs was developed by a statewide panel of experts (the Blue Ribbon Panel). Per the Panel's findings, no additional

monitoring of CECs was recommended based on the types of recycled water to be used in the basin (irrigation only).

Table 4-3: Water Quality Objectives[a] for Groundwater in the Paso Robles Groundwater Basin[b]

Constituent	Groundwater Objective by RWQCB Sub-Basin/Sub-Area (mg/L)						
	Central Basin	San Miguel	Paso Robles	Templeton	Atascadero	Estrella	Shandon
TDS	400	750	1,050	730	550	925	1,390
Chloride	60	100	270	100	70	130	430
Sulfate	45	175	200	120	85	240	1,025[c]
Boron	0.3	0.5	2.0	0.3	0.3	0.75	2.8
Sodium	80	105	225	75	65	170	730
Nitrogen (as N)	3.4	4.5	2.3	2.7	2.3	3.2	2.3

Source: Central Coast RWQCB Basin Plan

a. Water quality objectives are median ground water objectives. These objectives are median values based on data averages; objectives are based on preservation of existing quality or water quality enhancement believed attainable by the Central Coast RWQCB following control of point sources.

b. Basis for objectives was the report entitled *A Study of the Paso Robles Ground Water Basin to Establish Best Management Practices and Establish Salt Objectives* (Coastal Resources Institute, June 1993).

c. Standard exceeds the California Secondary Drinking Water Standard contained in Title 22 of the Code of Regulations. Water Quality standard is based on existing water quality (per the Central Coast Basin Plan). If water quality degradation occurs, the Regional Board may consider salt limits on appropriate discharges.

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Table 4-4: Water Quality Objectives and Water Concentrations for Applied Waters

Selected Constituents (in mg/L)	Water Quality Objectives[a,b]	Groundwater			Nacimiento Water[c]		Recycled Water[d]	
			Range	Average	Range	Average	Range	Average
Total Dissolved Solid (TDS)	--	North Gabilan	370 – 1,320	856	150 - 300	200	700 – 1,100	944
	--	Bradley	400 – 1,280	751				
	400 – 1,050	Estrella	350 – 1,560	552				
	--	South Gabilan	370 – 1,320	451				
	400 – 1,390	Shandon	270 – 3,160	563				
	440 - 730	Atascadero	330 - 830	573				
	400	Creston	190 – 1,620	388				
	--	San Juan	160 – 2,170	425				
Chloride	--	North Gabilan	35 - 209	1139	8 – 12	6	240 - 340	296
	--	Bradley	40 - 400	84				
	60 - 270	Estrella	32 - 572	94				
	--	South Gabilan	35 - 209	37				
	60 - 430	Shandon	31 - 550	80				
	70 - 100	Atascadero	19 - 208	78				
	60	Creston	25 - 508	69				
	--	San Juan	13 - 699	64				
Sulfate	--	North Gabilan	9 - 648	194	21 – 38	29	120-180	137
	--	Bradley	30 - 704	296				
	45 - 240	Estrella	11 - 375	129				
	--	South Gabilan	9 - 648	194				
	45 – 1,025	Shandon	14 – 2,010	360				
	85 - 120	Atascadero	72 - 217	122				
	45	Creston	7 - 353	67				
	--	San Juan	24 - 722	248				
Boron	--	North Gabilan	0.11 – 0.44	0.24	--	--	--	--
	--	Bradley	0.12 – 0.18	0.15				
	0.3 – 2.0	Estrella	0.13 – 5.66	1.8				
	--	South Gabilan	0.11 – 0.44	0.24				
	0.3 – 2.8	Shandon	0.08 – 2.97	0.81				
	0.3	Atascadero	0.36 – 1.47	0.9				
	0.3	Creston	0.06 – 0.31	0.14				
	--	San Juan	0.08 – 2.29	0.74				
Sodium	--	North Gabilan	29 - 132	58	6-10	8	120 - 250	218
	--	Bradley	36 - 529	237				
	80 - 225	Estrella	37 - 357	136				
	--	South Gabilan	29 - 132	58				
	80 - 730	Shandon	26 - 469	148				
	65 - 75	Atascadero	28 - 302	302				
	80	Creston	21 - 280	70				
	--	San Juan	16 - 551	154				

Table 4-4: Water Quality Objectives and Water Concentrations for Applied Waters (cont'd)

Selected Constituents (in mg/L)	Water Quality Objectives[a,b]	Groundwater			Nacimiento Water[c]		Recycled Water[d]	
			Range	Average	Range	Average	Range	Average
Nitrate (as N)	--	North Gabilan	11 - 71	8.58	<2	0.13	2.2 – 5.9	--
	--	Bradley	1 - 55	2.73				
	2.3 – 4.6	Estrella	5 - 30	2.57				
	--	South Gabilan	11 - 71	6.39				
	2.3 – 3.4	Shandon	6 - 54	4.70				
	2.3 – 2.7	Atascadero	4 - 30	1.87				
	3.40	Creston	2 - 41	3.23				
	--	San Juan	6 - 56	2.87				

Notes:
-- No Water Quality Objective has been specified for this sub-area
a. Central Coast RWQCB Basin Plan
b. Defined as primary and/or secondary Maximum Contaminant Level (MCL) where no area-specific water quality objective exists.
c. Anticipated future treated surface water quality based on raw Lake Nacimiento water quality as presented in *City of El Paso de Robles Water & Wastewater Quality Concerns – Water Quality Strategy* (Malcolm Pirnie, March 2003).
d. Anticipated future recycled water quality based on wastewater treatment effluent limitations per *Final Waste Discharge Requirements, Order No. R3-2011-0002, National Pollutant Discharge Elimination System (NPDES) Permit No. CA0047953, The City of El Paso de Robles Wastewater Treatment Plant, San Luis Obispo County,* WDID 3 400105001 (May 5, 2011) and per *Final Report, Groundwater Flow and Solute Transport Modeling in Support of the City of Paso Robles' Proposed Revisions to Waste Discharge Requirements Related to the Wastewater Treatment Plant (Fugro, 2009)*

Figure 4-1: Hydrogeologic Definition of Paso Robles Groundwater Basin Subareas

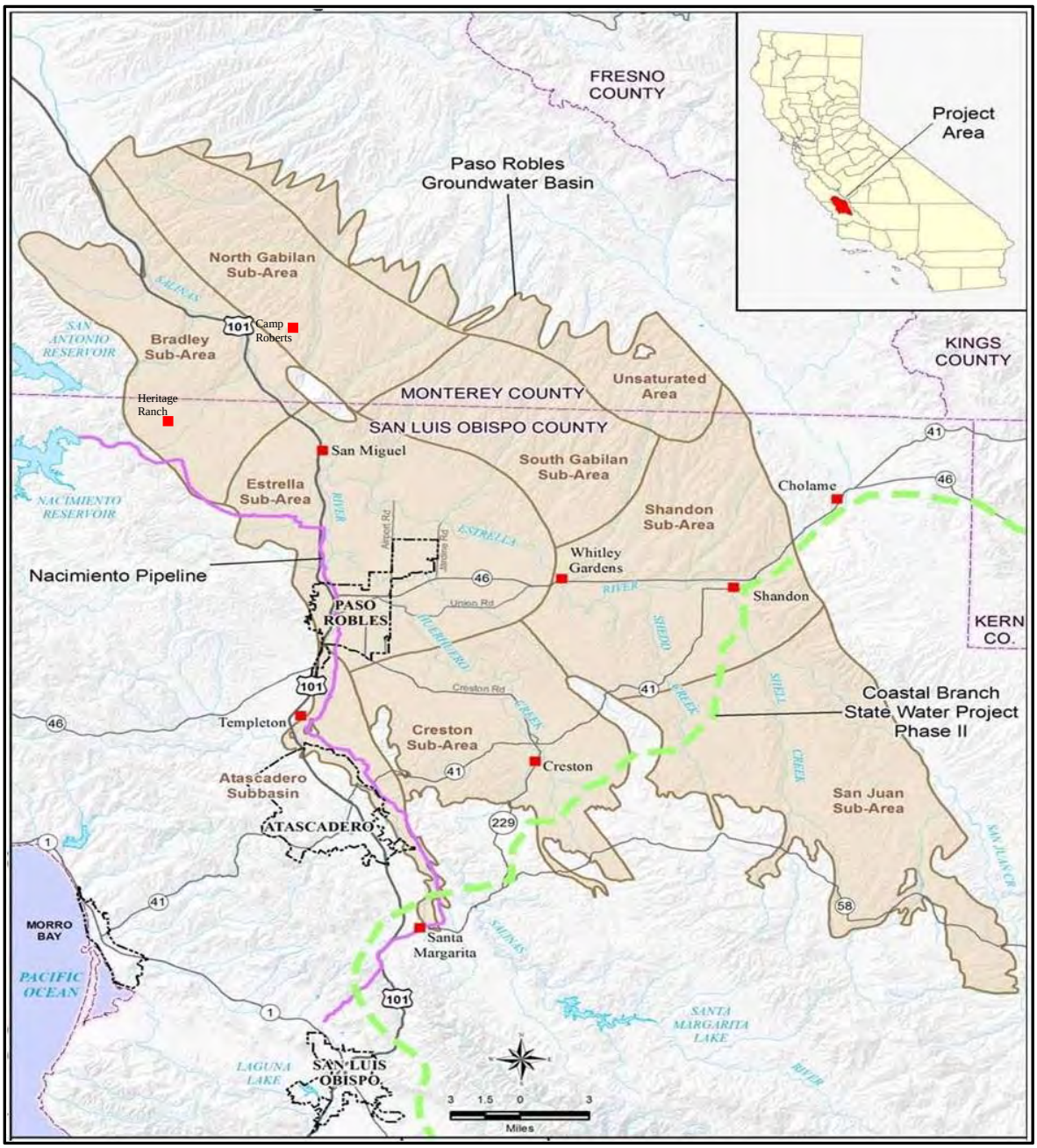

Figure 4-2: Central Coast Basin Plan Definition of Paso Robles Groundwater Basin Subareas

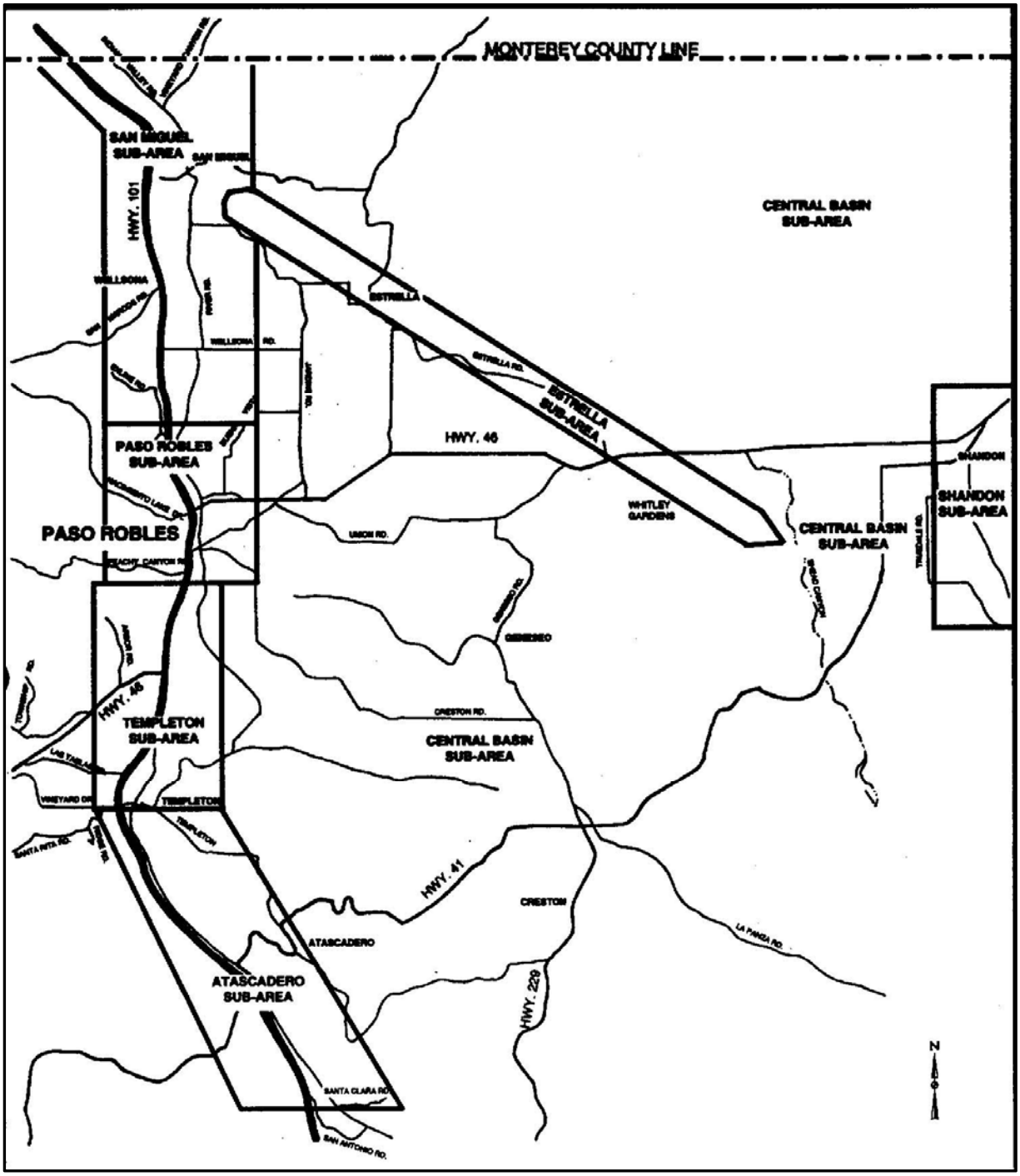

Table 4-5: Comparison of Sub-Area Definitions

Hydrogeologic Sub-Area	Central Coast Basin Plan Sub-Area
North Gabilan Sub-Area	--
Bradley Sub-Area	--
Estrella Sub-Area	San Miguel, Estrella, Central and Paso Robles Sub-Areas
South Gabilan Sub-Area	--
Shandon Sub-Area	Estrella, Central Basin, and Shandon Sub-Areas
Atascadero Subbasin	Templeton and Atascadero Sub-Areas
Creston Sub-Area	Central Basin Sub-Area
San Juan Sub-Area	--

4.2.2 Indicator Parameters of Salt and Nutrients in the Paso Robles Groundwater Basin

Based on the criteria described in 4.2.1 and as further explained in this section, TDS, chloride and nitrate are the most appropriate indicators of salts and nutrients in the Paso Robles Groundwater Basin.

As noted before, the sub-areas defined in the Central Coast Basin Plan are not the same as the sub-areas defined based on basin hydrogeology. Table 4-5 correlates the two sets of sub-area definitions. Using this correlation, the lowest of the water quality objectives were selected for the hydrogeologically-defined subareas using the Basin Plan sub-area water quality objectives and Secondary Maximum Contaminant Levels (MCLs) for sub-areas and/or water quality parameters where numerical water quality objectives were not specified for groundwater in the Basin Plan. These sub-area-specific water quality objectives are summarized in Table 4-6.

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Table 4-6: Estimated Water Quality Objectives by Hydrogeologically-Defined Sub-Area

Sub-Area		Range of Median Water Quality Objectives (mg/L)					
Hydrogeologic Sub-Area	Central Coast Basin Plan Sub-Area	TDS	Chloride	Sulfate	Boron	Sodium	Total Nitrogen (as N)
North Gabilan Sub-Area	--	--	--	--	--	--	--
Bradley Sub-Area	--	--	--	--	--	--	--
Estrella Sub-Area	San Miguel, Estrella, and Paso Robles Sub-Areas	400 – 1,050	60 – 270	45 – 240	0.3 – 2.0	80 - 225	2.3 – 4.6
South Gabilan Sub-Area	Central Basin Sub-Area	--	--	--	--	--	--
Shandon Sub-Area	Estrella, Central Basin, and Shandon Sub-Areas	400 – 1,390	60 – 430	45 – 1,025	0.3 – 2.8	80 - 730	2.3 – 3.4
Atascadero Subbasin	Templeton and Atascadero Sub-Areas	550 – 730	70 – 100	85 - 120	0.3	65 - 75	2.3 – 2.7
Creston Sub-Area	Central Basin Sub-Area	400	60	45	0.3	80	3.4
San Juan Sub-Area	Central Basin Sub-Area	--	--	--	--	--	--

Note: To be conservative, where multiple water quality objectives (WQOs) exist in the Central Coast Basin Plan for a hydrogeologically-defined sub-area, the lowest WQO was selected.

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Total Dissolved Solids

TDS is defined as the total amount of mobile charged ions, including minerals, salts or metals, dissolved in a given volume of water and is commonly expressed in terms of milligrams per liter (mg/L). Total salinity is commonly expressed in terms of TDS. Because TDS monitoring data are widely available for source waters, can be measured in the field or using an inexpensive laboratory test, and are a general indicator of total salinity, it is appropriate to use TDS as an indicator for other salts. As shown in Table 3-4, the annual average TDS concentrations exceed the Basin Plan Water Quality Objectives in the four sub-areas (North Gabilan, Bradley, South Gabilan and San Juan), and exceed the Secondary MCL of 500 mg/L in the five sub-areas (North Gabilan, Bradley, Estrella, Shandon and Atascadero). The TDS Secondary MCL has been established for color, odor and taste, rather than human health effects. This Secondary MCL also has, in addition to the recommended standard of 500 mg/L, an upper limit of 1,000 mg/L and a short-term limit of 1,500 mg/L. The water quality objectives for TDS by sub-area (or Secondary MCLs for those basins without correlating WQOs) are summarized in Table 4-7.

While TDS can be an indicator of anthropogenic impacts, there is also a natural background TDS concentration in groundwater. The background TDS concentrations vary based on subsurface rock composition, texture, and porosity, regional structure, source and age of groundwater and many other factors (Hem, 1989). Preliminary calculations of average TDS concentration in groundwater, by sub-area, are summarized in Table 4-7.

Table 4-7: Water Quality Objectives and Average Existing Concentration for TDS

Hydrogeologic Sub-Area	Water Quality Objective	Average Existing TDS Concentration
North Gabilan Sub-Area	None established	856 mg/L
Bradley Sub-Area	None established	751 mg/L
Estrella Sub-Area	400– 1,050 mg/L	552 mg/L
South Gabilan Sub-Area	None established	451 mg/L
Shandon Sub-Area	400 – 1,390 mg/L	563 mg/L
Atascadero Subbasin	550 – 730 mg/L	573 mg/L
Creston Sub-Area	400 mg/L	388 mg/L
San Juan Sub-Area	None established	425 mg/L

These concentrations are also shown in Figure 4-3. The vast majority of the wells with samples analyzed exhibited low TDS concentrations. Most wells used in this analysis were sampled more than once during the period, and 7% of the wells had at least one sample exceeding the Recommended SMCL. Given a 3rd quartile value of 340 mg/L and an interquartile range of 120 mg/L, values of greater than 520 mg/L may be considered outliers. There may be many explanations for these outliers, including unusual screened depth; poor well construction; unusual current or historical land uses; or quality control issues in sampling, analyzing, or recording the data. This small number of exceedances is likely reflective of localized issues rather than regional TDS issues.

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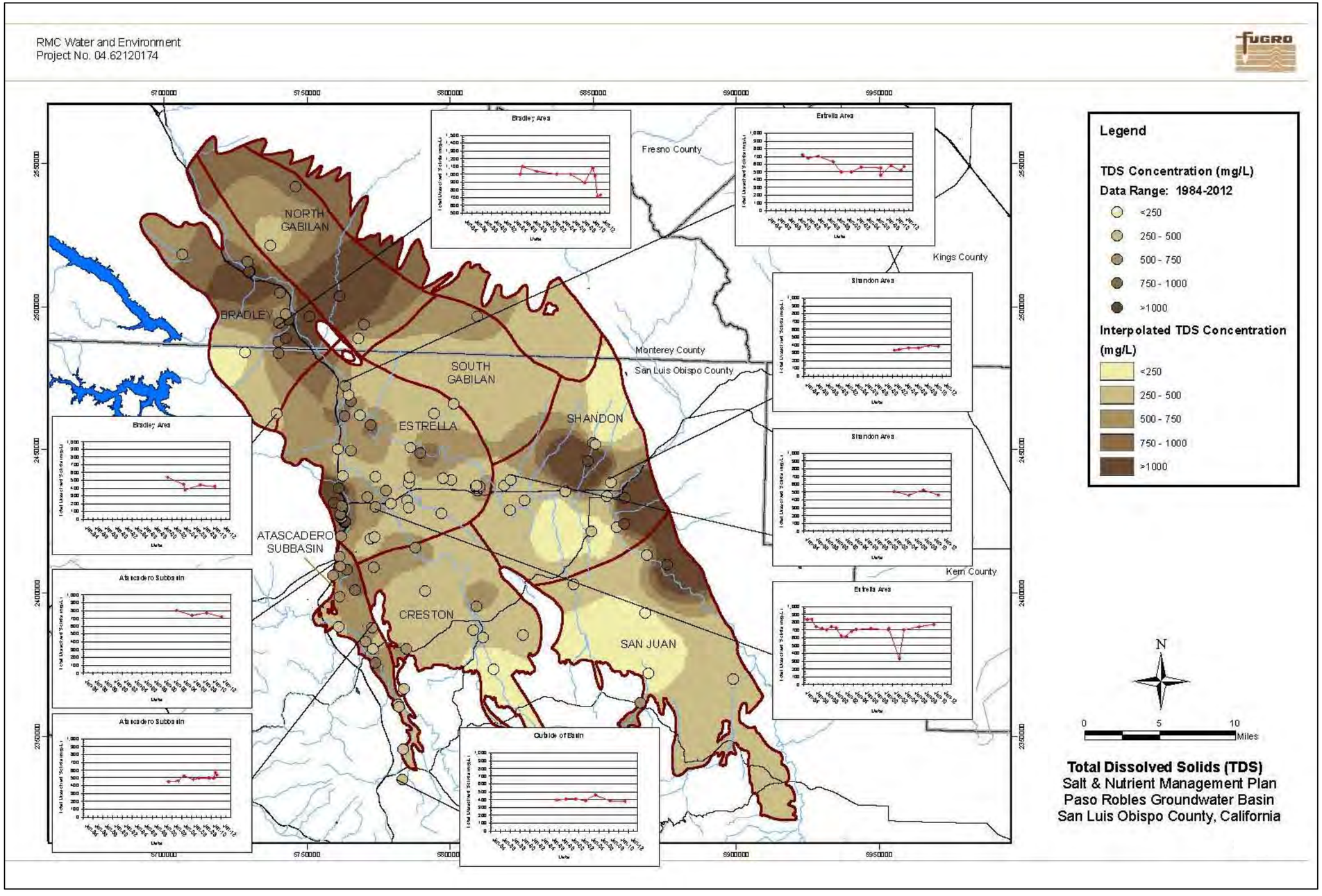
Figure 4-3: Average TDS Concentrations at Wells and Interpolated Between Wells, 1984 – 2012



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Chloride

Geothermal upwelling is a significant source of chloride to the Paso Robles Groundwater Basin, especially in the Atascadero and Paso Robles areas. Chloride is a constituent typically used as a general indicator of seawater intrusion, but in this case, it is an indicator predominantly of the use of regenerative water softeners in the groundwater basin, and therefore is an appropriate indicator of salts. As shown in Table 4-4, the annual average chloride concentrations exceed the Basin Plan Water Quality Objectives in the two sub-areas (Creston and San Juan), and no sub-areas exceeded the Secondary MCL of 250 mg/L.

Elevated TDS and chloride concentrations are undesirable for aesthetic reasons related to taste, odor, or appearance of the water and not for health reasons; however, elevated TDS and/or chloride concentrations in water can damage crops, affect plant growth and damage municipal and industrial equipment. The Secondary MCL established for chloride has a recommended standard of 250 mg/L, an upper limit of 500 mg/L and a short-term limit of 600 mg/L. The water quality objectives for chloride by sub-area (or Secondary MCLs for those basins without correlating WQOs) are summarized in Table 4-8.

TDS and chloride are conservative and mobile in the environment. Conservative in this context means a constituent that does not interact with subsurface media and therefore is not readily attenuated or transformed in the subsurface. Reduced salinity increases the life of plumbing systems and appliances, increases equipment service life, decreases industrial costs for water treatment, increases agricultural yields, reduces the amount of water used for leaching, reduces brine disposal costs, and improves the capability to use recycled water (Bookman-Edmonston, 1999). Preliminary calculations of the average chloride concentration in groundwater, by subarea, are summarized in Table 4-8.

Table 4-8: Water Quality Objectives and Average Existing Concentration for Chloride

Hydrogeologic Sub-Area	Water Quality Objective	Average Existing Chloride Concentration
North Gabilan Sub-Area	None established	113 mg/L
Bradley Sub-Area	None established	84 mg/L
Estrella Sub-Area	60– 270 mg/L	94 mg/L
South Gabilan Sub-Area	None established	37 mg/L
Shandon Sub-Area	60 – 430 mg/L	80 mg/L
Atascadero Subbasin	70 – 100 mg/L	78 mg/L
Creston Sub-Area	60 mg/L	69 mg/L
San Juan Sub-Area	None established	64 mg/L

These concentrations are also shown in Figure 4-4.

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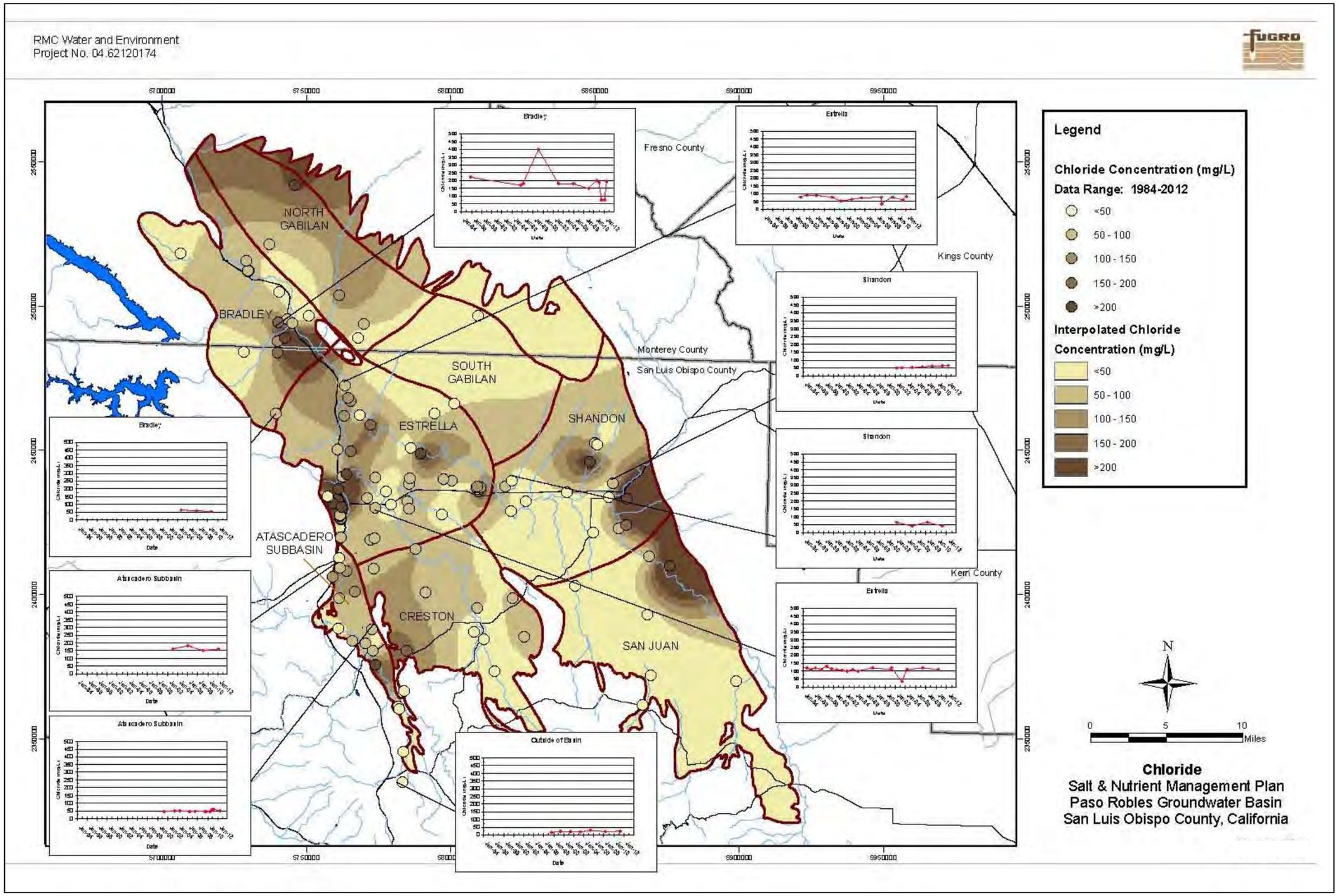
Figure 4-4: Average Chloride Concentrations at Wells and Interpolated Between Wells, 1984 – 2012



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Nitrate

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 fertilizers and wastewater treatment facilities. Additionally, airborne nitrogen compounds discharged from industry and autos are deposited on the land in precipitation and as dry particles, referred to as dry deposition. These sources also contribute to nitrate loading to groundwater.

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. Nitrate can persist in groundwater for decades and accumulate to high levels as more nitrogen is applied to the land surface each year.

Natural nitrate levels in groundwater are generally very low (typically less than 10 mg/L as NO_3) and well below the primary drinking water standard (Primary MCL) of 45 mg/L for nitrate as NO_3 (or 10 mg/L for NO_3 as N). As shown in Table 4-4, the annual average Nitrate-N concentrations exceed the Basin Plan WQOs in the two sub-areas (South Gabilan and Shandon), and no sub-areas exceeded the Primary MCL. Sub-area-specific regulatory limits for total nitrogen (as N) are summarized in Table 4-9 (with Primary MCL values used for sub-areas not covered by the Basin Plan). Preliminary calculations of the average nitrate (as N) concentration in groundwater, by sub-area, are also summarized in Table 4-9.

Table 4-9: Water Quality Objectives and Average Existing Concentration for Nitrate (as N)

Hydrogeologic Sub-Area	Water Quality Objective	Average Existing Nitrate (as N) Concentration
North Gabilan Sub-Area	None established	8.6 mg/L
Bradley Sub-Area	None established	2.7 mg/L
Estrella Sub-Area	2.3– 4.6 mg/L	2.6 mg/L
South Gabilan Sub-Area	None established	6.4 mg/L
Shandon Sub-Area	2.3 – 3.4 mg/L	4.7 mg/L
Atascadero Subbasin	2.3 – 2.7 mg/L	1.9 mg/L
Creston Sub-Area	3.4 mg/L	3.2 mg/L
San Juan Sub-Area	None established	2.9 mg/L

These concentrations are also shown below in Figure 4-5. The vast majority of the wells with samples analyzed exhibited low nitrate concentrations. Overall, only 1% of the samples utilized for this study exceeded the MCL. Most wells were sampled more than once during the period, and 2% of the wells had at least one sample exceeding the MCL. Given a 3rd quartile value of 2.9 mg/L and an interquartile range of 2.3 mg/L, values of greater than 6.4 mg/L may be considered outliers. There may be many explanations for these outliers, including unusual screened depth; poor well construction; unusual current or historical land uses; or quality control issues in sampling, analyzing, or recording the data. This small number of exceedances is likely reflective of localized issues rather than regional nitrate issues.

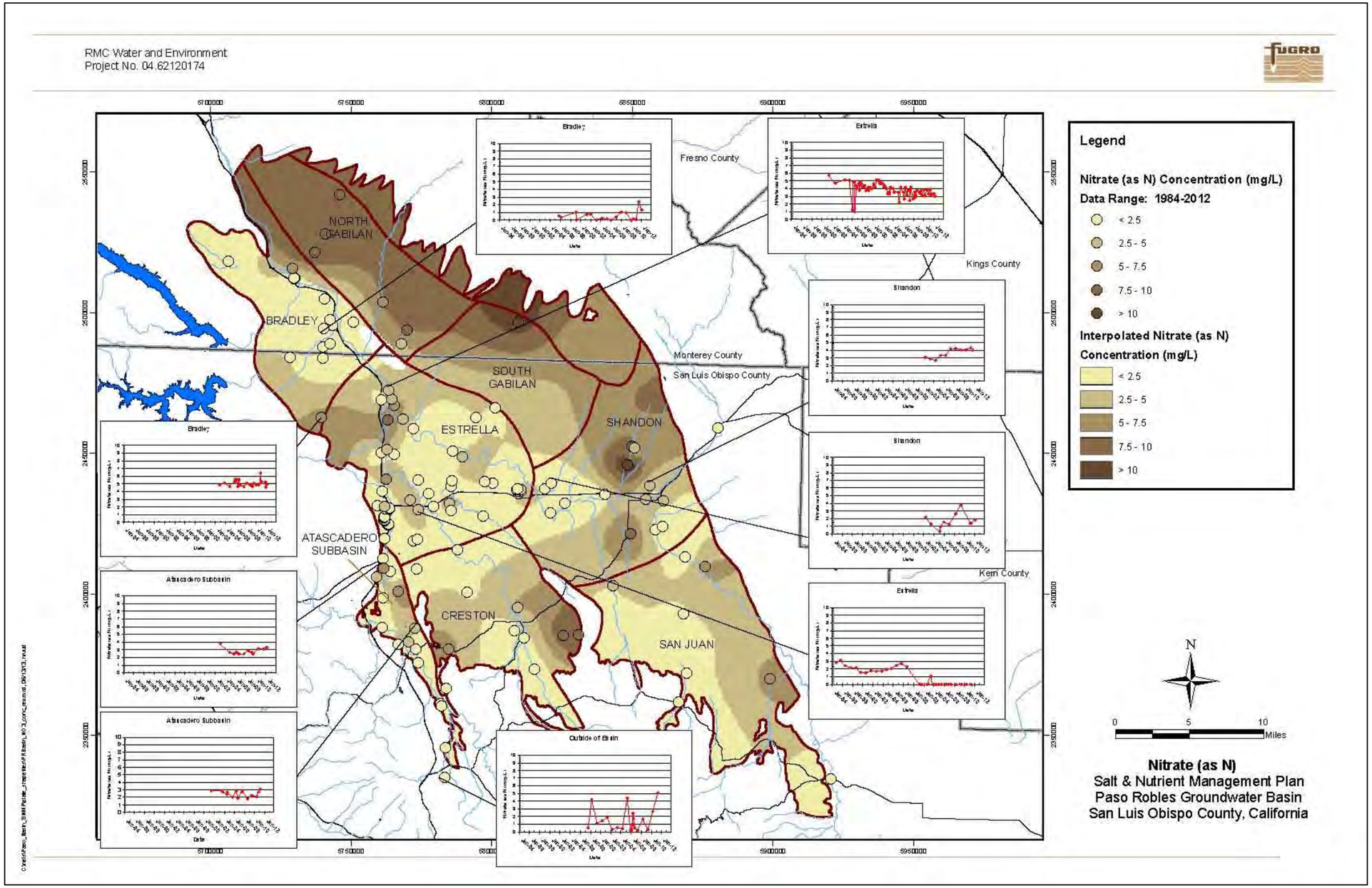
Nitrate in drinking water is a health concern due to methemoglobinemia or “blue baby syndrome” which affects infants (CCRWQCB, 2010). Elevated levels may also be unhealthy from pregnant women (SWRCB, 2010). The fate and transport of nitrogen compounds in the environment is very complex. Nitrate can be removed naturally from water through denitrification. It can also be added to percolating water through

dissolution of formation media. Based on this discussion, it is appropriate for nitrate to be an indicator chemical for nitrogen compounds and other nutrients.

Other Constituents

Other constituents listed in Table 4-2 occur naturally in groundwater and are not typically found at elevated concentrations in source water. And while boron was evaluated in past studies and was found to have generally consistent trends with TDS and chloride, boron was not selected as an indicator constituent as it would duplicate the use of chloride as an indicator constituent for salts, and the laboratory methodology for evaluating anions in groundwater (USEPA Method 300) includes chloride with nitrate and nitrite; boron is not a part of this analysis and would require a separate laboratory analysis. Additionally, modeling work conducted for the groundwater basin to date evaluated the movement of the three selected indicator constituents (TDS, chloride and nitrate), and not boron. Therefore, TDS, chloride, and nitrate were selected as the indicator constituents as they satisfy the indicator selection criteria and are considered representative of other salts and nutrients.

Figure 4-5: Average Nitrate (as N) Concentrations at Wells and Interpolated Between Wells, 1984 - 2012



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4.3 Loading Analysis Tools

To support this Plan and to better understand the significance of various loading factors, a GIS-based loading model was developed to simulate salt and nutrient loadings from surface activities to the groundwater basin. The loading model is a simple, spatially-based mass balance tool that represents TDS, chloride and nitrogen loading on an annual-average basis. It is not a calibrated model, as insufficient data are available to support such an effort, and therefore the model results are more uncertain than results from a fully-calibrated model. Despite the uncalibrated nature of the model, it is considered suitable for this analysis of basin conditions, with the recognition that a more rigorous model, potentially based on the ongoing groundwater numerical modeling update effort, may be developed in a future update to the Plan.

Primary inputs to the model are land use, irrigation water source, recycled water use locations, septic system areas, and surface geology characteristics. These datasets are described in the following sections. The general process used to arrive at the salt and nutrient loads is as follows:

- Identify the analysis unit to be used in the model. In the case of the Paso Robles Groundwater Basin, parcels from the San Luis Obispo County (shapes maintained by ParcelQuest) are used as the analysis unit.
- 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, chloride and nitrogen.
- Apply the septic system assumption to the analysis units.
- Apply the infrastructure assumption to the analysis units.
- Apply the surface 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 assumes that no salt is removed from the system once it enters the system. Other transport mechanisms, such as groundwater extraction or introduction/use of Lake Nacimiento water, could reduce the total quantity of salt in the basin.
- Similar to TDS, estimate the chloride load applied to each parcel based on the land use practices, irrigation water source and quantity, and infrastructure load.
- Estimate the nitrogen load applied to each parcel based on the land use practices, irrigation water source and quantity, septic load, and infrastructure load. The loading model assumes that a portion of the applied nitrogen is used by plants and removed from the system. Additional nitrogen is converted to other species and is lost from the system as well. Hydraulic conductivity is used to reflect the vertical mobility of the nitrogen into the aquifer before being converted or used.

Depending on the analysis being performed, the loading can also be analyzed on a per acre basis so as to be able to compare the relative loading of large and small parcels to one another. The results of the loading model will be used in a spreadsheet-based mixing model along with output from the water balance components of the Paso Robles Groundwater Basin numerical model to simulate water quality changes resulting from projected future basin uses.

4.4 Identification and Quantification of Salt and Nutrient Sources

Salt and nutrient loads result predominantly from urban, irrigation water and agricultural inputs associated with land use. Data synthesized to provide the necessary numerical loading factors are discussed below.

4.4.1 Land Use

Land use data form the basis for estimating many of the salt and nutrient sources, including irrigation water application, agricultural inputs (e.g. fertilizer and amendments), and the location of septic systems. Land use data were obtained from local cities (i.e. Paso Robles, Atascadero, Templeton), San Luis Obispo County's Planning Department and Agricultural Commissioner's office, Monterey County's Department of Public Works and Agricultural Commissioner's office and the California Department of Water Resources. Land use information was compared to assessor land use data to determine the location, if any, of significant land use changes expected in the region. Data were also obtained from the San Luis Obispo County and Monterey County Agricultural Commissioner's offices (2011/2012) regarding existing and planned irrigated crop areas were also used. Staff from the San Luis Obispo and Monterey County planning departments were also consulted to identify any future urbanization that may occur within the analysis period.

The land use datasets were consolidated and normalized into the following land use groups for the Paso Robles groundwater basin area:

- Farmsteads
- Field Crops
- Grasslands/Barren Non-irrigated Field Crops
- Orchard
- Other Row Crops
- Pasture/Paved Areas
- Urban Commercial and Industrial (C&I)
- Urban C&I, Low Impervious Surface
- Urban Landscape
- Urban Residential
- Vines

For the purposes of this analysis, parcels were designated urban residential if the city or county land use category indicated a lot size less than 2½ acres or if the land use was residential and no lot size was indicated. Properties 2½ or more acres in size were designated as farmsteads. Additionally, there were no identified confined animal feeding operations in the Paso Robles Groundwater Basin.

Based on a review of current and projected future land use data, the only notable future land use change identified is the conversion of undeveloped lands/grasslands into vineyards in San Luis Obispo County (see Figure 4-6). The breakdown of current and anticipated future land uses in the Paso Robles Groundwater Basin is shown in Table 4-10. Constituent loading from fertilizer application and irrigation water application rates associated with each land use category are summarized in Table 4-11. A 10-year planning horizon was used to evaluate future land uses.

Table 4-10: Land Use Categories in the Paso Robles Groundwater Basin

Land Use Group	Irrigated (I)/ Non-Irrigated (N)	Current Land Use				Future Land Use	
		Monterey Co.[1] (acres)	SLO Co. (acres)	Total Area (acres)	Percent Total Area	Change	Total Area (acres)
Farmsteads[2]	I/N	757	43,232	43,988	9%		43,988
Field Crops	I	1,621	334	1,954	1%		1,954
Grassland/Barren	N	123,832	240,092	363,924	72%	-2,163	361,761
Non-irrigated Field Crops	N	9,531	16,840	26,371	5%	-741	25,630
Orchard	I	59	851	909	0%		909
Other Row Crops	I	134	1,535	1,668	0%		1,668
Pasture	I	0	3,987	3,987	1%	-29	3,958
Paved Areas[1]	N	0	8,095	8,095	2%		8,095
Urban C&I, Low Impervious Surface	I/N	0	383	383	0%		383
Urban Commercial and Industrial	I/N	142	7,003	7,144	1%		7,144
Urban Landscape	I	0	358	358	0%		358
Urban Residential	I/N	0	11,098	11,098	2%		11,098
Vines	I	3,845	30,222	34,067	7%	+2,936	37,003

Source: Monterey and San Luis Obispo County General Plans, Monterey and San Luis Obispo Agricultural Commissioners Offices, City of Paso Robles and Atascadero General Plans

1. The portion of Monterey County that lies within the Paso Robles Groundwater Basin is, for the most part, barren grassland and is relatively undeveloped.
2. Farmsteads are defined as properties 2½ or more acres in size with residential units.
3. A 10-year planning horizon was used for future land use.

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Figure 4-6: Land Use

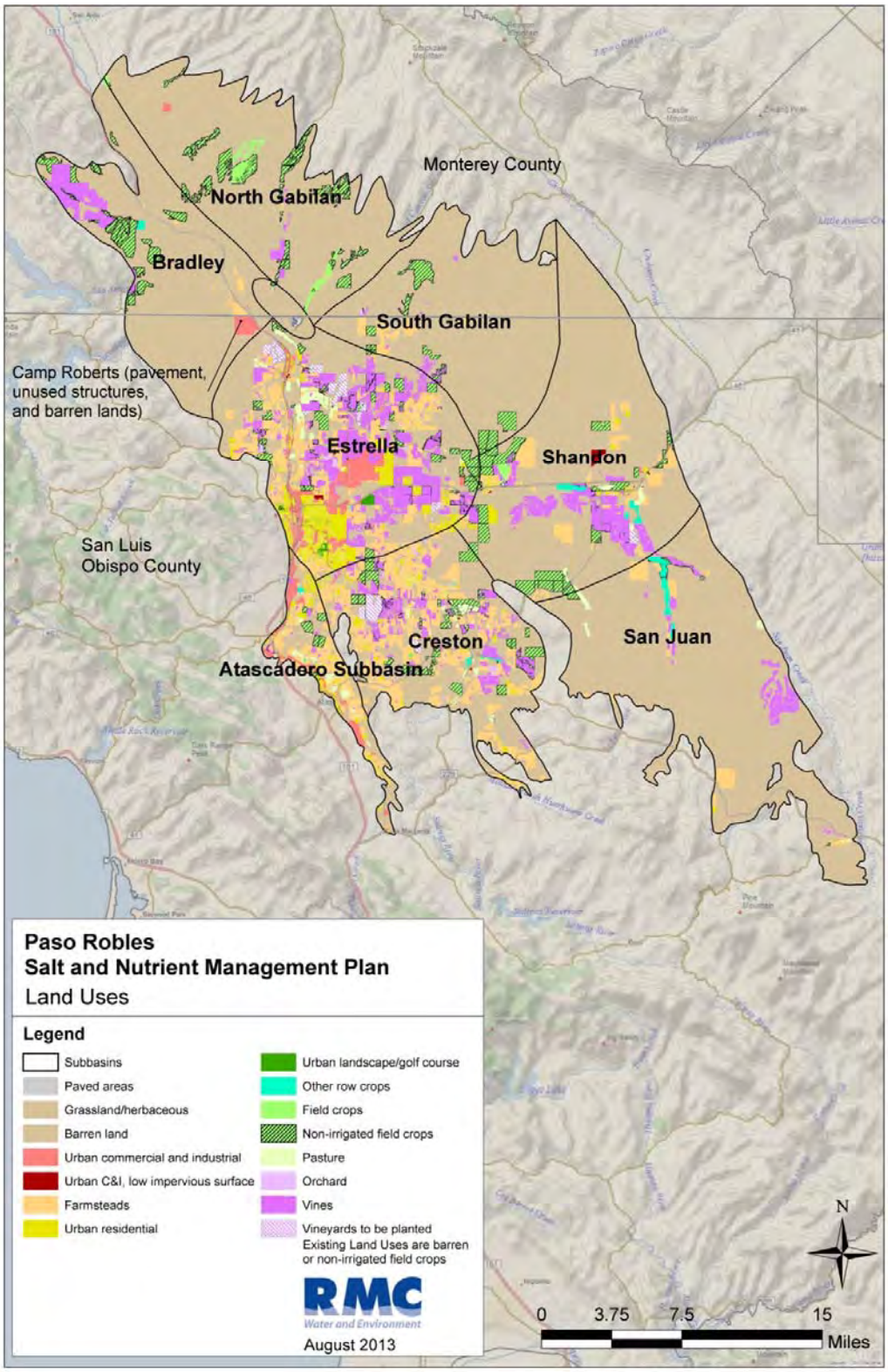


Table 4-11: Land Use Related Loading Factors

Land Use Group	Total Area (acres)	Percent Cultivated[2]	Applied Water[1] (in/yr)	Applied Nitrogen[3] (lbs/acre-yr)	Leachable Nitrogen[4] (lbs/acre-yr)	Applied TDS[5] (lbs/acre-yr)	Applied Chloride[6] (lbs/acre-yr)
Farmsteads[7]	43,271	5%	0	50	9	2	0
Field crops	6,271	100%	14.4	195	53	2	0
Grassland/ Barren	361,082	0%	0	0	0	0	0
Non-irrigated field crops	22,099	100%	0	50	9	2	0
Orchard	909	100%	38.1	110	78	2	0
Other row crops	1,610	100%	12.9	192	91	2	0
Pasture	4,059	100%	45.9	50	9	2	0
Paved Areas	8,095	0%	0	0	0	0	0
Urban Commercial and Industrial	383	5%	39.3	174	55	245	0
Urban C&I, low impervious surface	9,986	30%	39.3	174	55	245	0
Urban landscape	358	75%	39.3	174	55	245	0
Urban residential	11,687	15%	39.3	174	55	245	0
Vines	34,067	100%	15.8	25	12	2	0

Notes:

1 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 Paso Robles area. As the two data sets correspond well, the average DWR applied water values were used.

2 Percent of land area assumed to be cultivated within each class is estimated is based review of aerial photography and professional judgment of a reasonable, broad average for each class. Loading factors are applied only to the percentage of land cultivated in each land use group.

3 Applied nitrogen estimates are based on literature review for individual agricultural land cover classes (Rosenstock et al, 2013; UC Cooperative Extension, 1996) and turfgrass (Henry et al, 2002).

4 Uptake of nitrogen was estimated from available literature (UC Davis 2012) and professional judgment. Leachable Nitrogen estimates for each land cover unit were calculated based on the balance between application, gaseous loss (volatilization and denitrification), and uptake. This leachable amount was then reduced to estimate nitrate loading based on soil conditions mapped for the area, as described in Section 2.6.

5 Applied TDS estimates for agricultural crops (reflecting TDS in fertilizer and amendment applications separate from Nitrogen application) are based on literature review (UC Cooperative Extension, 1996) fertilizer and amendment sales records for San Luis Obispo County (available from the California Department of Food and Agriculture), and correspondence with agricultural representatives in the region. In general, very few fertilizers and amendments that contribute to TDS loading are applied within the region, except for a small amount of gypsum. Significant lime is purchased within the county, however based on correspondence with representatives, no lime is applied within the study area. TDS loads due to application of nitrogen fertilizers are included separately in the model calculations. For applied TDS estimates on turfgrass, it has been assumed that the salt load is not given special attention as it is for agricultural crops. Therefore, salt load for turfgrass is based on typical fertilization practices (USBR, 2003).

6 Based on conversations with agricultural representatives in the area, no fertilizers with chloride inputs are used.

7 Farmstead cultivated areas are assumed to be non-irrigated field crops, based on information provided by the San Luis Obispo Agricultural Commission. In addition, a typical turf area of 0.1 acres per parcel has been included in the loading evaluation.

4.4.2 Water Sources

Potable and Irrigation Water Source

Groundwater is presently the only source for potable and irrigation water for all users overlying the groundwater basin, although Templeton CSD is currently percolating about 250,000 gallons per day (gpd) of raw Lake Nacimiento water into the groundwater basic for downgradient recovery. Starting in 2015, Lake Nacimiento water will be treated and blended with groundwater within the City of Paso Robles service area for potable water use, and additional raw Lake Nacimiento water will be percolated into the alluvium underlying the Templeton and Atascadero areas. This percolation will change local groundwater quality. The quality of these water supplies is summarized in Table 4-12, and Figure 4-7 shows the service areas in the region.

Templeton CSD is presently coordinating with San Luis Obispo County in the preparation of a Regional Recycled Water Strategic Plan; however, this effort is not anticipated to be completed until the end of 2014. Per personal communication with their consultants, Cannon Corporation (2013), Templeton CSD is planning to redirect wastewater presently sent to the City of Paso Robles for treatment and disposal, and will instead treat the influent at its own facilities and percolate the resulting wastewater into the underflow of the Salinas River where it will be retrieved downstream for municipal uses. Under this scenario, an additional 224 AFY of water will be available for retrieval to District wells for municipal use.

Heritage Ranch Community Services District (CSD) lies just outside the Paso Robles Groundwater Basin, near Lake Nacimiento. Unlike the purveyors overlying the groundwater basin, the sole source of water for Heritage Ranch CSD is surface water from Lake Nacimiento/Nacimiento River. As the community lies outside the groundwater basin, waters applied for irrigation will not percolate to the groundwater basin and therefore will not be considered in this analysis.

Water quality data used to establish groundwater quality were from two different datasets of recent and historic water quality measurements: the State Water Resources Control Board GeoTracker GAMA database and the 2002 Basin Study (Fugro and Cleath) and is based on existing water quality in the region. Lake Nacimiento raw water quality information was obtained from the 2003 *Nacimiento Water Project Environmental Impact Report* (EIR) (Marine Research Specialists, December 2003), and the anticipated treated water quality was obtained from the *Final Initial Study/Mitigated Negative Declaration, Paso Robles Water Treatment Project and Main East Pipeline Project* (Padre Associates, Inc., December 2008). In general, the datasets used in this analysis extended from as early as 1984 through early to late 2012. These data were discussed in more detail in Chapter 3.

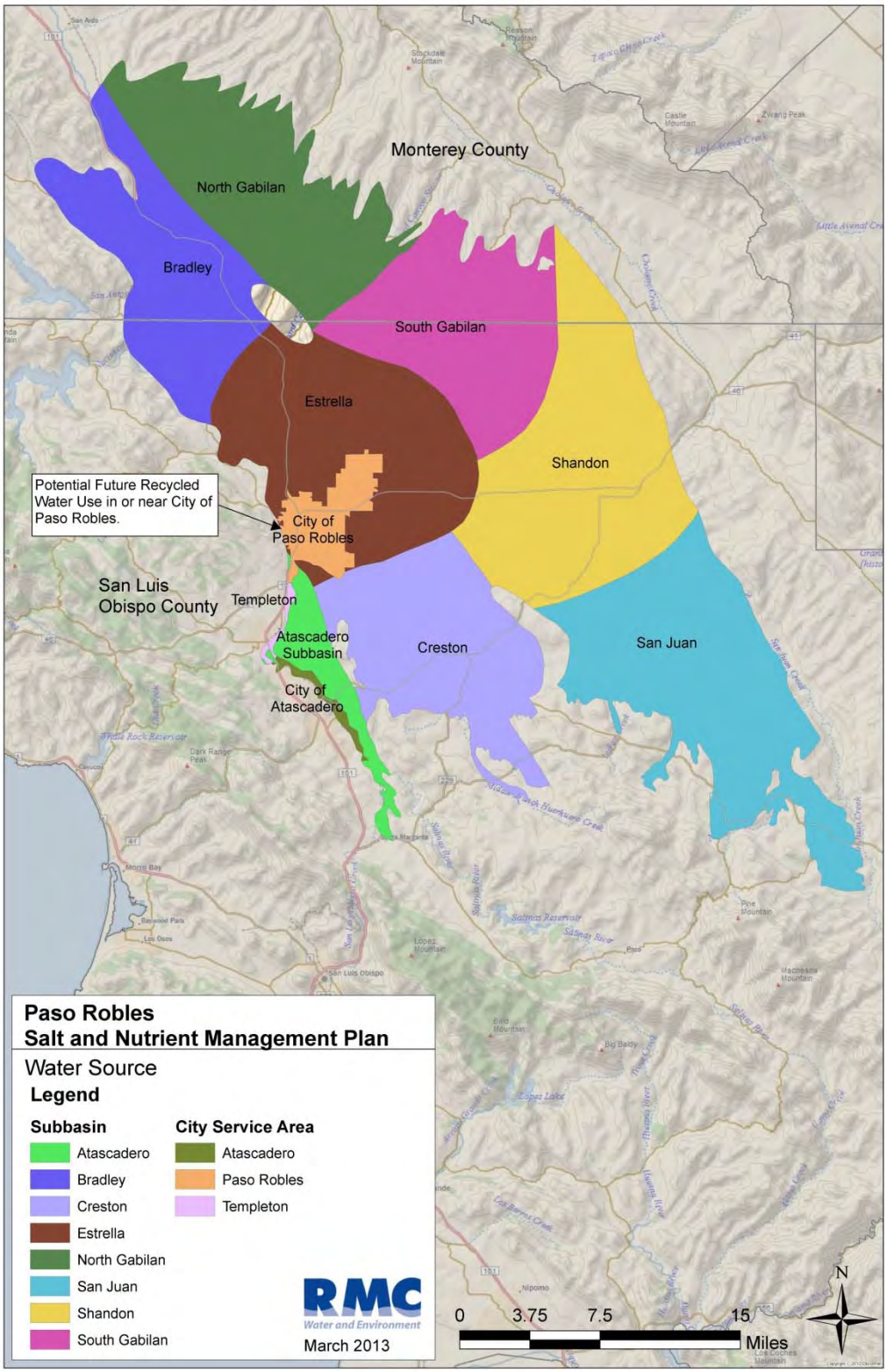
Table 4-12: Water Quality Parameters for Loading Model Water Sources

Source	TDS (mg/L)	Chloride (mg/L)	Nitrate (as N) (mg/L)
Cities and Communities[1]			
City of Paso Robles	**491**	**55**	**1.5**
City of Atascadero	**640**	**92**	**1.5**
Templeton CSD	**748**	**97**	**5**
Groundwater Sub-areas[2]			
North Gabilan	**856**	**112.9**	**8.58**
Bradley	**751**	**84.4**	**2.73**
Estrella	**552**	**94.2**	**2.57**
South Gabilan	**451**	**37.2**	**6.39**
Shandon	**563**	**80.0**	**4.70**
Atascadero	**573**	**77.5**	**1.87**
Creston	**338**	**69.4**	**3.23**
San Juan	**425**	**64.2**	**2.87**
Lake Nacimiento[3]	**200**	**6.3**	**0.13**
Recycled Water[3]	**1,000**	**291**	**7.00**

Notes:

1. Water quality parameters for irrigation within the City of Paso Robles, Atascadero, and Templeton Community Services District are based on their respective 2013 Water Quality Reports/Consumer Confidence Reports.
2. Water quality parameters for irrigation applied outside of the City and CSD service areas was based on constituent concentration estimates described in *Paso Robles Salt and Nutrient Management Plan, Justification of Indicator Constituents for Salts and Nutrients* (RMC Water and Environment, 2013).
3. Used in evaluation of future loading only.

Figure 4-7: Applied Water Sources



Recycled Water

The City of Paso Robles currently discharges its treated wastewater to the Salinas River channel. Recognizing treated effluent is an important resource, the City is currently taking steps to improve its quality and is presently preparing a Recycled Water Master Plan (RWMP) to outline a long-term plan for implementing recycled water use in its service area. The work currently being conducted in preparation of this RWMP is the basis for information regarding future recycled water applications considered in this SNMP.

At this time, the City is implementing a program to upgrade its wastewater treatment plant to an advanced secondary treatment process. The upgraded plant will produce effluent that meets discharge requirements and will have the ability to produce tertiary-treated recycled water with the addition of a filter and additional chlorine contact basin. Recycled water is presently planned for the Paso Robles areas beginning in 2025 in the Paso Robles area.

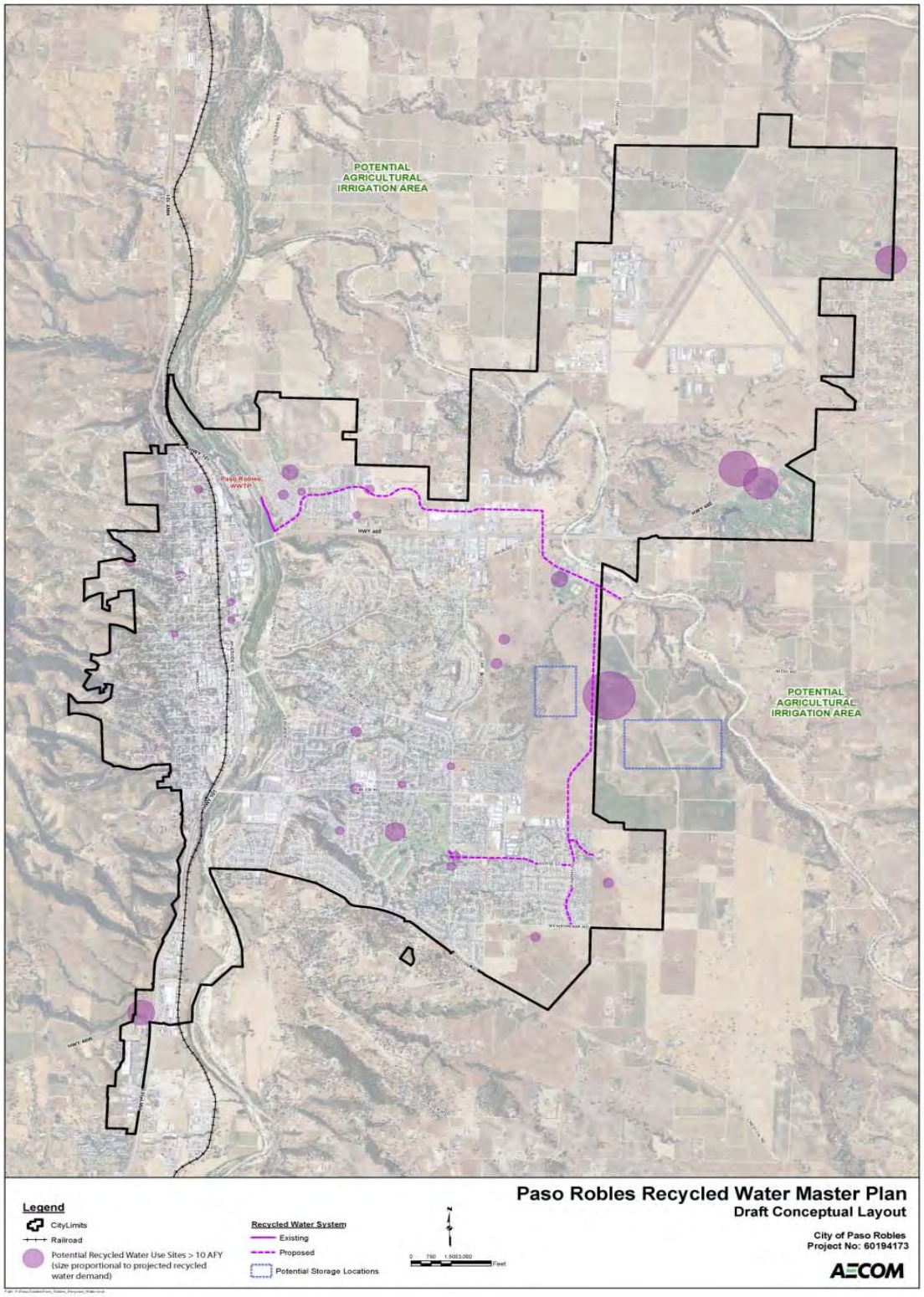
In 2006, the City completed a *Recycled Water Study Update* (Boyle) that reviewed potential users of recycled water, developed a conceptual conveyance system, examined potential sites for groundwater recharge and assessed pumping and winter storage requirements. The City is presently updating this study as part of the RWMP effort and has identified potential recycled water use areas, all of which are within the Estrella Sub-area. The study update has also estimated the average annual demand for recycled water and maximum monthly demand. Average annual demand for identified irrigation uses within the City's jurisdictional area has been estimated at 1,750 AFY, with a maximum monthly demand of 3.39 million gallons per day (mgd). Average annual demand for identified irrigation uses and extended service areas has been estimated to be 2,500 AFY, with a maximum monthly demand of 4.9 mgd.

At present, all initial future recycled water uses within the City of Paso Robles will be for landscape irrigation (parks, schools, roadway landscaping), with 650 AFY of tertiary-treated recycled water available beginning in 2025.

The City of Atascadero is also planning on implementing recycled water irrigation in the future. Per personal communication with the City (Athey, 2013), the City will be looking to replace potable water irrigation with recycled water irrigation in five of its parks, anticipating use of approximately 60 AFY. All of these parks, however, are located outside the Atascadero Groundwater Subbasin.

There are presently no other plans for recycled water use at any other location in or adjacent to the Paso Robles Groundwater Basin, though this water source may be investigated in the future should demand appear.

Figure 4-8: Anticipated Locations of Recycled Water Use in the City of Paso Robles



Lake Nacimiento Water

In 1959, San Luis Obispo County Flood Control and Water Conservation District signed an agreement with Monterey County Water Agency that entitled the District to approximately 17,500 AFY of the annual yield of Lake Nacimiento for uses in San Luis Obispo County. The Nacimiento Water Project (NWP), completed in 2011, consists of approximately 45 miles of pipeline to deliver raw water from Lake Nacimiento to communities in San Luis Obispo County. The supplemental water will be delivered to Paso Robles, Templeton and Atascadero, with Paso Robles receiving up to 4,000 AFY, Atascadero receiving up to 2,000 AFY, and Templeton CSD receiving approximately 250 AFY.

The City of Paso Robles is expected to begin utilizing its Nacimiento surface water entitlement by 2015 when its water treatment plant is scheduled for completion. The treated surface water will be blended with its treated groundwater, effectively reducing the TDS concentration of delivered potable water, in addition to reducing the City's dependence on groundwater as its sole water source.

The City of Atascadero and Templeton CSD are presently planning to percolate the raw Lake Nacimiento into the underlying alluvium. The percolation will both improve groundwater quality in addition to replenishing local groundwater supplies. This will allow the City and Templeton CSD to pump an equivalent amount of water from their river wells.

As previously noted, Heritage Ranch CSD, which lies wholly outside the Paso Robles Groundwater Basin, is fully dependent on Nacimiento surface water for its supply.

4.4.3 Rainfall and Mountain Front Recharge

The Paso Robles Groundwater Basin is recharged naturally by precipitation infiltration and mountain front recharge. Relative to other sources in the groundwater basin, precipitation infiltration and mountain front recharge are relatively minor TDS, nitrate and chloride loading sources. Precipitation quality data were obtained from the National Atmospheric Deposition Program using the station closest to the Paso Robles Groundwater Basin. Station CA66, located in the Pinnacles National Monument – Bear Valley (San Benito County, CA). Precipitation quality data for this station is available from 1999 to 2012, and includes nitrate, chloride and several other ions. A summary of average precipitation quality is shown below in Table 4-13.

Table 4-13: Precipitation Water Quality at Station CA66

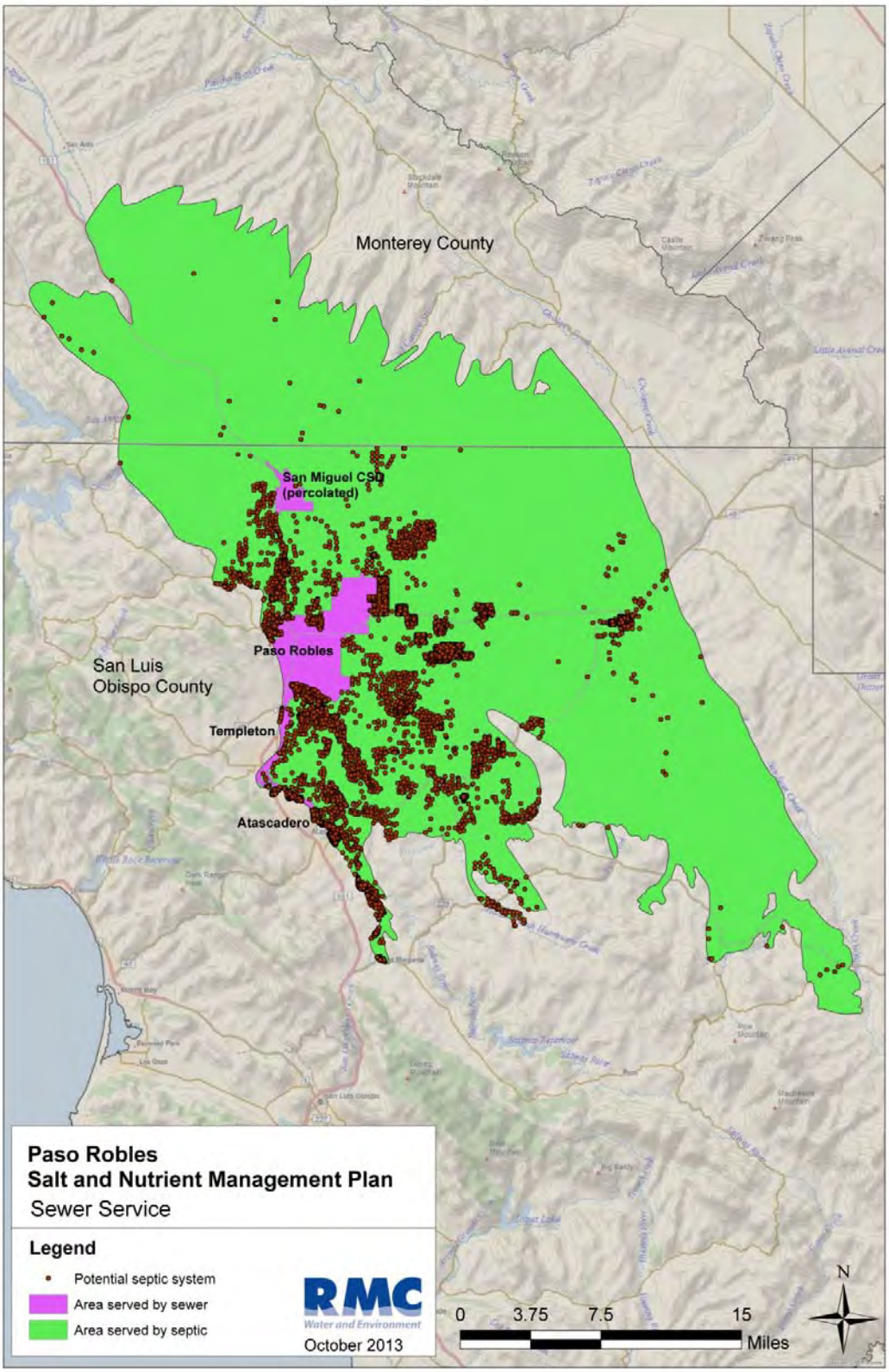
Year	TDS (mg/L)*	Chloride (mg/L)	Nitrate (as N) (mg/L)
1999	3.72	0.152	0.169
2000	5.48	0.654	0.221
2001	5.06	0.474	0.256
2002	4.49	0.517	0.18
2003	4.88	0.385	0.334
2004	4.04	0.301	0.204
2005	3.92	0.347	0.182
2006	4.83	0.448	0.206
2007	5.66	0.743	0.259
2008	4.79	0.536	0.267
2009	4.74	0.486	0.207
2010	3.91	0.328	0.181
2011	4.35	0.446	0.175
Average	4.61	0.447	0.219

Source: National Atmospheric Deposition Program, Station CA66, Pinnacles National Monument
* TDS estimated from conductivity measurements

4.5 Septic and Wastewater Systems

It has been assumed that parcels overlying the Paso Robles Groundwater Basin outside established services areas for the Cities of Paso Robles and Atascadero and for Templeton and San Miguel CSDs are on private septic systems. 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 gpd, based on a factor of 75 gpd/person with 3.5 people per system. The septic waste is assumed to have TDS concentrations of 1,000 mg/L and chloride concentrations of 291 mg/L, based on average values of data collected from Regional Water Quality Control Board monthly reports from 1994 to 1999 for the Paso Robles wastewater treatment plan (February 2001 *City of El Paso de Robles Comprehensive Recycled Water Study*). Nitrogen concentrations were assumed to be 40 mg/L, based on typical concentrations in medium strength wastewater (Metcalf and Eddy, 2003). The locations of parcels assumed to have septic systems are shown in Figure 4-9. In addition to the septic locations indicated in Figure 4-9, there are approximately 101 septic systems located within the San Miguel CSD service area, east of Salinas River; the individual locations of these septic systems were not identified.

Figure 4-9: Septic Systems



Wastewater collected by the City of Paso Robles is treated and discharged to six polishing/infiltration ponds; these ponds are located adjacent to the Salinas River. While some portion of the percolation may join the Salinas River underflow and be carried out of the groundwater basin, it has been conservatively assumed for the purposes of this analysis that all treated wastewater would percolate to the Estrella sub-basin. The City of Paso Robles has improvements planned for the wastewater treatment plant that would reduce nitrogen concentrations in the effluent from 30 mg/L to 8 mg/L; these improvements will be on-line at the end of 2014.

The City of Atascadero also collects and treats wastewater from within a portion of its jurisdictional boundaries. Treated effluent is discharged to infiltration ponds, with reclaimed groundwater collected from below the ponds used for fairway irrigation outside the study area. These ponds are also located adjacent to the Salinas River; as assumed for Paso Robles wastewater, it has been conservatively assumed that all salt and nutrient loads from the City of Atascadero wastewater will percolate to the Atascadero sub-basin.

Templeton CSD sends a portion of its wastewater (~0.2 mgd) to Paso Robles for treatment, and treats and disposes the remainder (~0.15 mgd) via infiltration ponds, located within the study area and adjacent to the Salinas River. TCSD's Meadowbrook WWTP treated effluent discharges into rapid infiltration basins at the Selby Percolation Pond Site (Selby Ponds), where the treated wastewater percolates into the Salinas River underflow. For municipal purposes, TCSD retrieves the amount of water percolated, less 2% for conveyance losses, at TCSD wells located downstream. For the loading analysis, it has conservatively been assumed that wastewater loads go directly to the groundwater basin; based on operator information, this is approximately 130,000 gpd.

San Miguel CSD collects and treats approximately 100,000 gpd of wastewater at the Machado Wastewater Treatment Plant[1], using infiltration ponds to discharge treated effluent. The infiltration ponds are within the study area and have therefore been included in the loading analysis.

As previously noted, Heritage Ranch CSD lies wholly outside the Paso Robles Groundwater Basin. However, as noted by the Central Coast RWQCB in NPDES Order No. R3-2011-0007, treated wastewater discharges from the Heritage Ranch CSD system flows to an ephemeral drainage way that the RWQCB has determined can reach the Nacimiento River during strong rain events. The Nacimiento River flows, in turn, into the Paso Robles Groundwater Basin, and therefore wastewater from the Heritage Ranch CSD may percolate into the underlying streambed. Likewise, Oak Shores Wastewater Treatment plant discharges into Lake Nacimiento, which ultimately may percolate into the underlying streambed of the Nacimiento River. For the purposes of this analysis, the impact of these facilities will be simulated in assumptions regarding Nacimiento River recharges to the groundwater basin.

Existing and future municipal wastewater loads are summarized in Table 4-14.

[1] Fugro, 2009

Table 4-14: Municipal Wastewater Loading

Source	Sub-basin	Volume (AF or AFY)	TDS (mg/L)	Nitrate (mg/L as N)	Chloride (mg/L)
Current					
City of Paso Robles	Estrella	3,297[1]	1,037[2]	30.0[2]	328[2]
Templeton CSD	Atascadero	146[4]	1,460[5]	16[5]	480[5]
City of Atascadero	Atascadero	1,569[6]	960[8]	0.1[6]	225[8]
San Miguel CSD	Estrella	130[7]	980[10]	24.3[10]	251[10]
Future					
City of Paso Robles	Estrella	4,760[1]	1,037[2]	8.0[3]	328[2]
Templeton CSD	Atascadero	258[4]	1,460[5]	16[5]	480[5]
City of Atascadero	Atascadero	1,793[6]	960[8]	0.1[6]	225[8]
San Miguel CSD	Estrella	130[7]	980[9]	24.3[9]	241[9]

Notes:
1 From Paso Robles 2010 Urban Water Management Plan
2 From Paso Robles 2013 Wastewater Division Annual Report
3 Email communication with Matt Thompson (Paso Robles), 2014
4 Email communication with Matt Thompson (Paso Robles) and Tina Mayer (Templeton CSD), 2013. Per email, Templeton CSD currently treats and percolates 150,000 gpd, and diverts 200,000 gpd to Paso Robles. In the future, Templeton CSD will treat and percolate all 330,000 gpd.
5 Templeton CSD October 29, 2013 Effluent monitoring grab sample
6 Email communication with Justin Black (Atascadero), 2014
7 Fugro, 2009. Does not include septic systems within San Miguel CSD service area.
8 Geoscience, 2009
9 San Miguel CSD 2014 Effluent Flow Monitoring Data

4.5.1 Soil Textures

Soil texture significantly impacts the quantity of nitrogen that infiltrates to the aquifer. Soil textures (NRCS, 2013) were obtained from the Soil Survey of San Luis Obispo County (including Carrizo Plan Area, Coastal Part, and Paso Robles Area) as well as Monterey County (SCS, 2003, 1984, 1983, and 1978). 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.

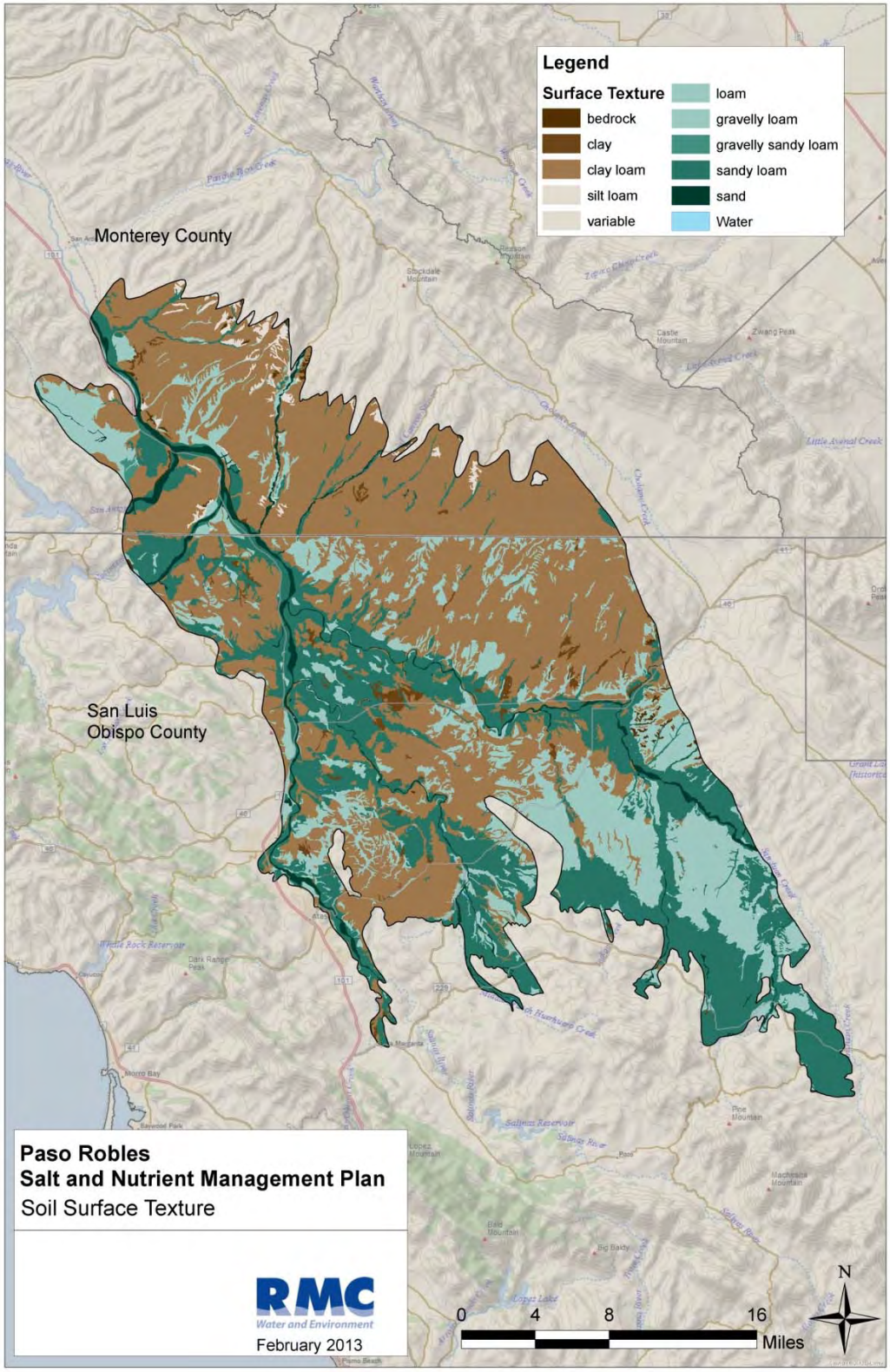
Similar logic is not applied to TDS as salts are mostly not subject to conversion to gaseous forms, and rapidly saturate soil capacity to absorb and retain them. Table 4-15 summarizes soil textures within the basin boundaries and how those textures are represented in the loading model. The spatial distribution of surface textures is shown in Figure 4-10.

Table 4-15: Surface Texture Loading Factors

Surface Soil Texture	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

Note: Adjustment factors are based on permeability classes defined by the USDA-NRCS. The factor linearly scales estimated permeabilities from 0.1 (lowest permeability) to 100 (highest permeability). The adjustment factor is used to represent how likely the nitrogen is to migrate to the aquifer, relative to the other textural classes.

Figure 4-10: Soil Surface Textures



4.6 Summary

Most of the salt and nutrient sources in the Paso Robles groundwater basin are associated with municipal wastewater system discharges to groundwater and the use of regenerative water softeners in the basin. Rural and agricultural land uses (i.e. septic systems and fertilizer use) have also contributed to groundwater basin loadings. Figure 4-11 presents land use by percent as depicted in the loading model, while Figure 4-12 presents the percent of TDS load attributable to each land use and loading type.

At present, there is no recycled water use in the groundwater basin, therefore this is not a current contribution to salts and/or nutrients in the groundwater basin. However, future recycled water use, along with the introduction of surface water from Lake Nacimiento to the groundwater basin (both directly and indirectly), will change groundwater and potable water qualities in the future in the vicinity of the Cities of Paso Robles and Atascadero and the community of Templeton.

Figure 4-11: Land Use Overlying the Paso Robles Groundwater Basin by Percent

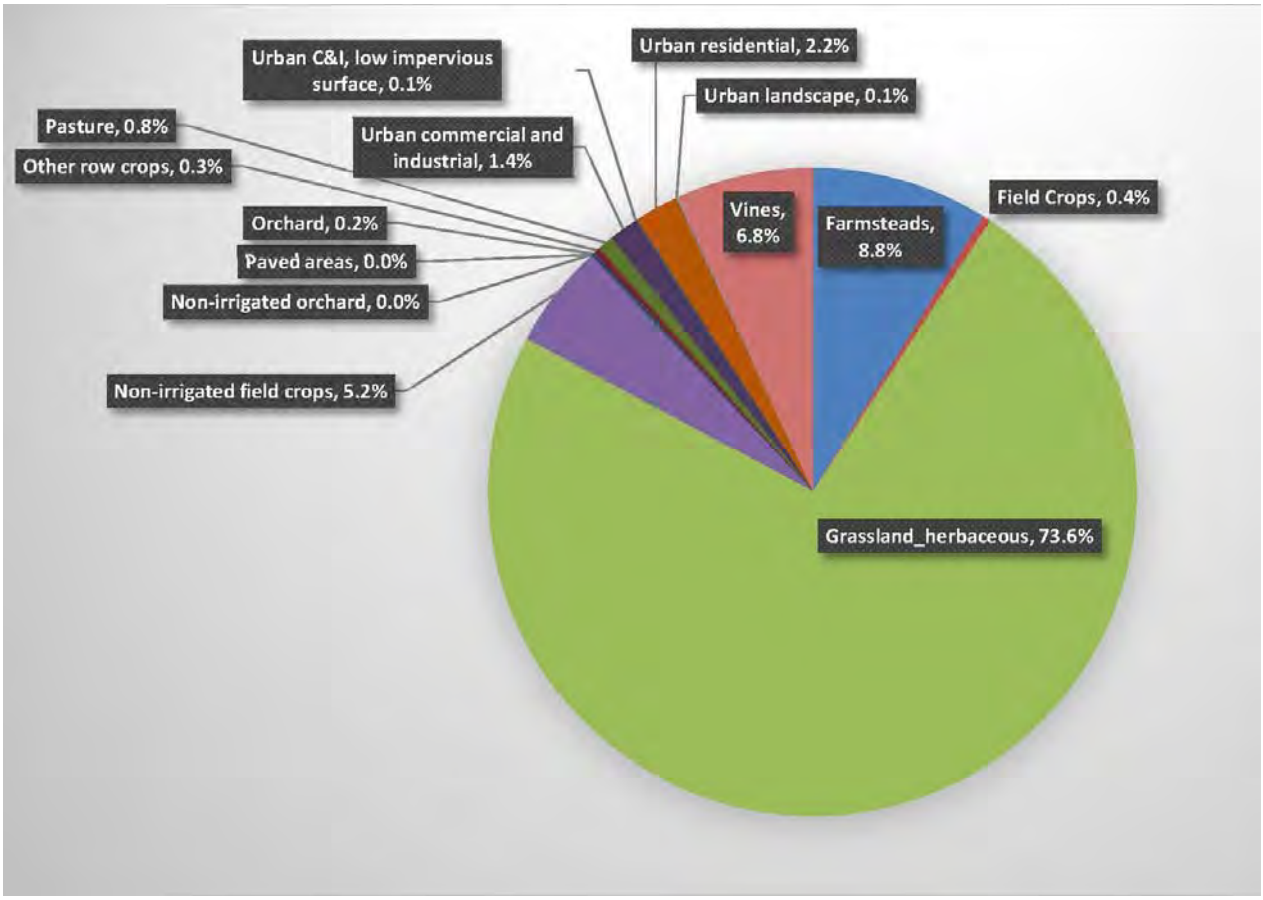
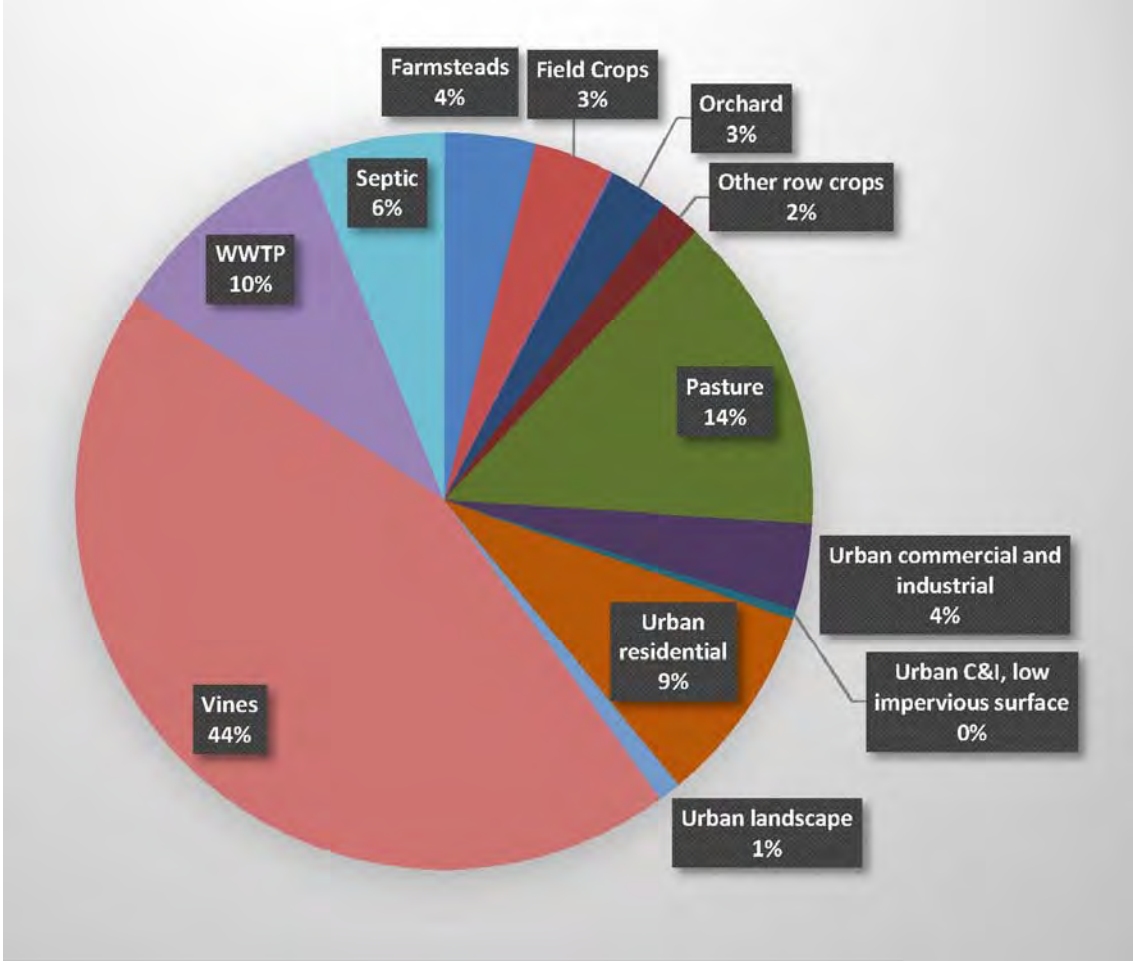
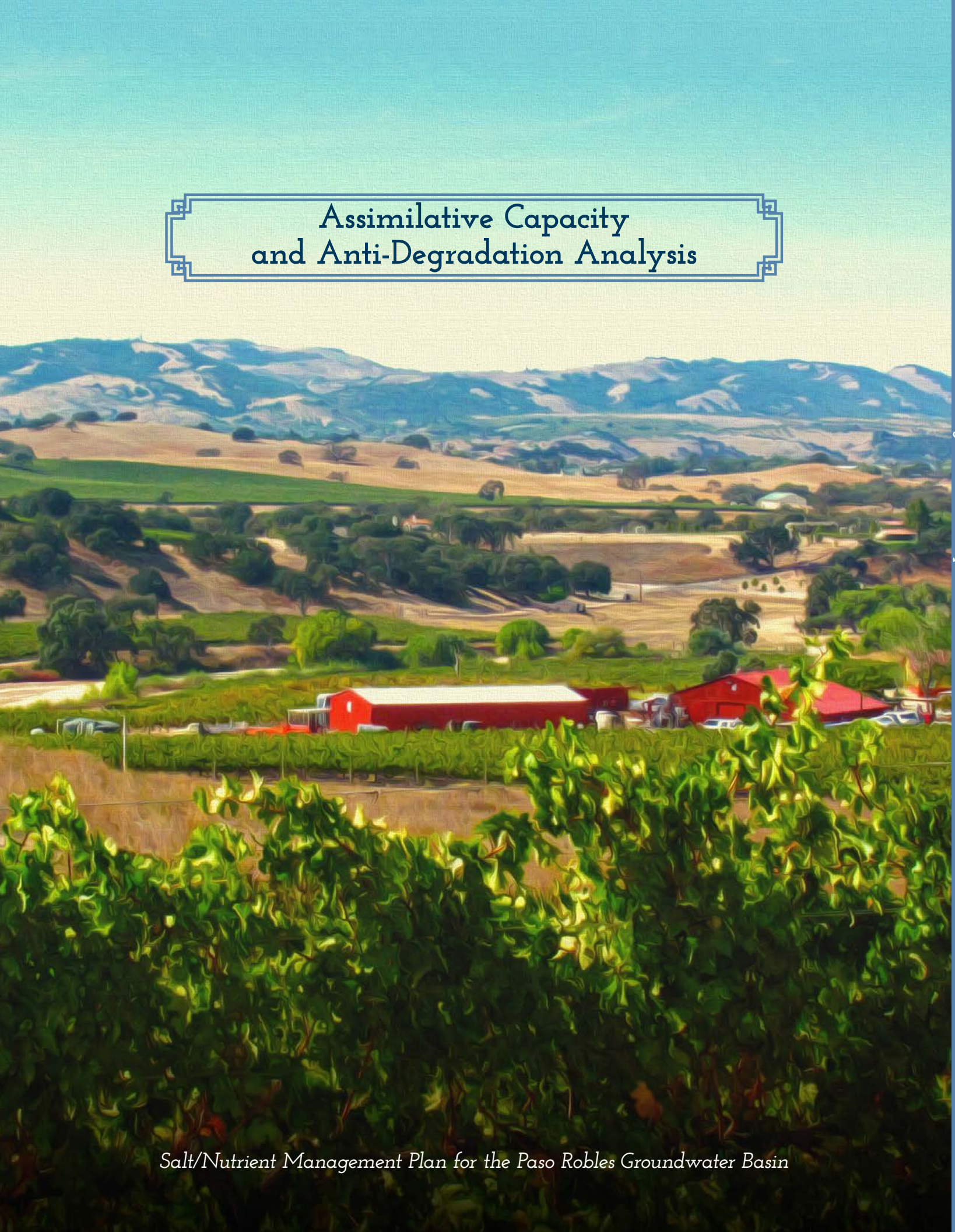


Figure 4-12: Percent TDS Loading to Paso Robles Groundwater Basin by Land Use or Source



Assimilative Capacity and Anti-Degradation Analysis



Salt/Nutrient Management Plan for the Paso Robles Groundwater Basin

Assimilative Capacity and Anti-Degradation Analysis

Chapter 5 Assimilative Capacity and Anti-Degradation Analysis

A primary element of the SNMP is the assimilative capacity analysis of the groundwater basin. In this analysis, the average ambient groundwater quality in the basin, subbasin or management area is compared with the Basin Plan WQOs. The difference between these two values (assuming that the water quality objective concentration is greater than the ambient groundwater quality) represents the assimilative capacity of the groundwater basin, or the additional 'load' which the groundwater basin can accept without exceeding the water quality objectives. This analysis is then repeated using projected future conditions (land use, water usage and type, etc.) to determine if, under projected future conditions, the groundwater quality will remain below the WQOs. To evaluate anticipated future conditions with recycled water use, this analysis is then repeated using projected future conditions (land use, water usage and type, etc.) to determine if, under projected future conditions, the groundwater quality will remain below the water quality objectives.

5.1 Basin Conceptual Model

As described in Chapter 3, the Paso Robles Groundwater Subbasin has been defined as a subbasin of the Salinas Valley Groundwater Basin in the Department of Water Resources (DWR) Bulletin 118 (DWR, 2003). For this SNMP, the eight study areas previously defined for the Paso Robles Groundwater Subbasin in the *Final Report, Paso Robles Groundwater Basin Study* (Fugro and Cleath, 2002) were retained for use herein, as shown in Figure 3-1:

- Atascadero Groundwater Subbasin
- Bradley Area
- Creston Area
- Estrella Area
- North Gabilan Area
- San Juan Area
- Shandon Area
- South Gabilan Area

5.2 Fate and Transport in Groundwater Basin

Salt and nutrient fate and transport describes the way salts and nutrients move through an environment or media. In groundwater, it is determined by groundwater flow direction and rate, the characteristics of individual salts and nutrients, and the characteristics of the aquifers. 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 resources stem 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 constituents from one form to another, such as the conversion of nitrate to gaseous nitrogen. In addition to naturally occurring salts and nutrients, anthropogenic (human-derived) activities can add salts and nutrients.

TDS, chloride and nitrate are contained in source waters that recharge the Paso Robles Groundwater Basin. Groundwater flow directions and fluxes are summarized above, and are presented in more detail in Chapter 3. The addition of new water supply sources, either through intentional or unintentional recharge, can change the groundwater quality for the worse by introducing additional loads, or for the better by diluting some existing constituents in the basin. Another important influence on salts and nutrients in groundwater is unintentional recharge, which can occur, for example, when irrigation water exceeds evaporation and

plant needs and infiltrates into the underlying 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 underlying basin. Similarly, recycled water used for irrigation can also introduce salts and nutrients.

Salts and nutrients in source waters recharging the groundwater basin may be increased through use and movement of the vadose zone and aquifers. This can occur through fertilizer use, which adds nitrogen that is not completely removed by plant uptake. Salts and nutrients in irrigation water can also be concentrated by evapotranspiration. Additionally, dry deposition, the process by which airborne pollutants are deposited to the earth, can contribute to increased salts and nutrients as precipitation and irrigation water picks up and infiltrates the salts and nutrients in the shallow soils. Salts and nutrients also exist in subsurface materials and can be leached via dissolution as water percolates.

Some salts and nutrients, such as TDS and chloride, are considered to be conservative in that they do 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 occurring 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. Nitrate can persist in groundwater for decades and accumulate to high levels as more nitrogen is applied to the land surface every year.

Solute transport modeling has been conducted in several locations of the groundwater basin for TDS and chloride as part of studies relating to urbanized areas around Paso Robles, Atascadero and Templeton. It is important to note that all three of these areas lie adjacent to the Salinas River and overlie the shallow alluvium. In all cases, the modeling was done predominantly to support wastewater permitting and system expansion. Key findings of these studies are summarized below. No other solute fate and transport modeling has been conducted in the groundwater basin as a whole.

5.2.1 Atascadero

The City of Atascadero and Atascadero Mutual Water Company (AMWC) conducted a study in 2009 (Geoscience Support Services) to model the potential impacts of TDS and chloride on underlying groundwater between the City's wastewater treatment plant and AMWC Well 2a. Three scenarios were modeled in the study; the first scenario simulated existing discharges (baseline discharges of 1.4 million gallons per day or mgd) and the associated TDS and chloride concentration trends to 2028. The second scenario modeled TDS and chloride concentrations at full plant effluent discharge of 2.4 mgd, while the third scenario modeled TDS and chloride concentrations at the full effluent discharge rate combined with 650 mgd Nacimiento water recharge in downgradient treatment ponds. Scenarios 2 and 3 represent the worst-case events. The modeling results indicated TDS concentrations at the end of the modeled period ranged from 840 mg/L for the baseline scenario to 945 mg/L for the worst case scenario. Chloride concentrations at the end of the modeled period ranged from 180 mg/L for the baseline scenario to 210 mg/L for the worst case scenario.

5.2.2 Templeton

A study was completed in 2007 for the community of Templeton to evaluate the potential impacts of wastewater treatment plant percolation pond expansion on the underlying groundwater (Fugro). This study found that TDS and chlorides from the effluent percolation ponds migrated to the underlying alluvium, but did not percolate to the deeper Paso Robles Formation. This was the result of thick clay layers that exists between the alluvium and underlying Paso Robles Formation in the Templeton area, limiting the vertical migration of constituents. Additionally, in this area, stream tributary flows were also found to contribute to alluvium water quality.

5.2.3 Paso Robles

A TDS loading analysis conducted for the City of Paso Robles wastewater collection and treatment system in 2003 (Malcolm Pirnie) found that the area's water supply (which is 100% groundwater) was the single largest source of salt to the City's wastewater treatment plant. The study also found that residential water softeners resulted in higher TDS concentrations to wastewater discharges, corresponding with the findings from a 2012 Central Valley Clean Water Association study by Larry Walker Associates that looked at sources of salt loadings to municipal wastewater for 13 cities across California. The City also conducted another study in 2009 to support changes to Waste Discharge Requirements (Fugro). This study found that groundwater in the Paso Robles area was affected by the upwelling of geothermal waters.

5.3 Existing Groundwater Quality

Baseline groundwater quality, with respect to TDS, nitrate, and chloride concentrations, was analyzed and described in Chapter 3. As part of this analysis, average groundwater concentrations were developed for each study area. These concentrations, as well as the volume of groundwater estimated to be in storage in each study area, are summarized in Table 5-1.

Table 5-1: Baseline Groundwater Quality by Study Area

Subbasin/Study Area	Volume (AF)	TDS (mg/L)	Nitrate (mg/L as N)	Chloride (mg/L)
Atascadero	473,095	573	1.8	77.5
Creston	1,852,949	388	3.2	69.4
San Juan	3,775,597	425	2.8	64.2
Estrella	6,875,219	552	2.5	94.2
Shandon	5,291,835	563	4.6	80.0
North Gabilan	2,869,842	856	8.4	112.9
South Gabilan	2,952,293	451	6.3	37.2
Bradley	2,633,283	751	2.7	84.4
Total Volume	**26,724,113**	**--**	**--**	**--**
Volume-Weighted Average Concentration[a]		**566**	**4.1**	**79.9**

Note
a. Weighted-average calculated from average water quality concentrations and storage volumes of the individual study areas.

It is important to remember that this SNMP is a broad regional study of a large groundwater basin with relatively little groundwater quality data. As a result, simplifying assumptions, such as the use of average groundwater quality and the assumption that average groundwater quality represents basin quality to depth, were required in order to complete the required analyses.

Baseline water quality, as used herein, is based on averages over time as described in Chapter 3. As noted in this chapter, TDS, nitrate and chloride concentrations have been stable in most areas of the basin, however, there have been increasing TDS and chloride trends in the shallow Paso Robles Formation in the Atascadero Subbasin and Estrella Study Area, increasing chloride concentrations in the Creston Study Area, and increasing TDS and chloride concentrations in the Bradley Study Area.

The baseline groundwater quality was also evaluated on a broad subarea basis. As noted in the Chapter 3, these values were interpolated across the various study areas; however, there are limitations to the

interpolation/extrapolation method used, related primarily to the limited water quality data set. For example, extrapolated nitrate concentrations in North Gabilan Study Area suggest severe and widespread contamination (as reflected in the average nitrate concentration of 8.4 mg/L shown in Table 5-1, above); however, it is likely that a few sample locations (possibly shallow alluvial wells with nearby septic tanks and canyon-bottom agriculture) actually reflect localized problems. So while some localized areas may be approaching the assimilative capacity, warranting continued monitoring and perhaps management measures, areal interpolation may make local problems appear regional. These localized or regionalized water quality impacts need to be considered in developing and selecting management strategies to be implemented on a basin-wide basis.

Lastly, the baseline water quality assumes mixing in the entire groundwater storage volume. For example, the groundwater quality of the entire depth of the Estrella subarea (up to 2,500 feet deep) is assumed to have a TDS concentration of 552 mg/L; however, salt and nutrient loading occur at the ground surface and typical production wells are on the order of 600 to 700 feet deep. Accordingly, the active loading and mixing occur in the top ~700 feet of the formation. It should be recognized that a private domestic well may be only a few hundred feet deep and thus more vulnerable to surface loading; thus the use of the entire basin depth can mask a shallow problem. However, given the limited data available for the groundwater basin as a whole and the intent of the Statewide Recycled Water Policy that salts and nutrients from all sources be managed on a basin-wide basis, the scope of this analysis is limited to the larger, basin-wide picture.

5.3.1 Assimilative Capacity

The assimilative capacity of a groundwater basin is generally considered to be the difference between the Basin Plan's WQO and the current water quality in the basin. It typically represents the ability of a groundwater basin to accept additional salinity or nutrient loads without causing exceedance of the WQOs. Therefore, in order to determine if assimilative capacity exists, baseline groundwater quality concentrations must be compared to the WQOs. For the Paso Robles Groundwater Subbasin, however, this comparison is impeded by the differing study area definitions as defined herein and as used by the Basin Plan. This issue was discussed in a previous report, TM 3a, entitled *Justification of Indicator Constituents for Salts and Nutrients* (RMC, 2013), resulting in a range of WQOs for each of the study areas. Therefore, in evaluating the assimilative capacity of the study areas, baseline groundwater quality was compared to the lowest WQO for that area. Where no WQOs were available, primary and secondary MCLs were used instead. These MCLs are as follows:

- For TDS – 1,000 mg/L [secondary MCL]
- For nitrate (as N) – 10 mg/L [primary MCL]
- For chloride – 250 mg/L [secondary MCL]

Table 5-2 presents the comparison of baseline groundwater quality with WQOs, and Table 5-3 presents the assimilative capacity of each study area in the basin, assuming the lowest WQO is utilized where available and as compared to the MCLs.

Table 5-2: Comparison of Baseline Water Quality with Water Quality Objectives[a]

Study Area	Total Dissolved Solids		Nitrate (as N)		Chloride	
	Baseline Concentration	WQO	Baseline Concentration	WQO	Baseline Concentration	WQO
Atascadero	573	440 – 730	1.8	2.3 – 2.7	77.5	70 – 100
Creston	388	400	3.2	3.4	69.4	60
San Juan	425	--	2.8	--	64.2	--
Estrella	552	400 – 1,050	2.5	2.3 – 4.6	94.2	60 – 270
Shandon	563	400 – 1,390	4.6	2.3 – 3.4	80.0	60 – 430
North Gabilan	856	--	8.4	--	112.9	--
South Gabilan	451	--	6.3	--	37.2	--
Bradley	751	--	2.7	--	84.4	--
Overall[b]	**566**	**400**	**4.1**	**3.4**	**79.9**	**60**

Source: Central Coast RWQCB Basin Plan (2011)
a. All concentrations are in mg/L.
b. The WQO for 'Central Basin', as defined in the Basin Plan, was used for the overall groundwater basin.

Table 5-3: Assimilative Capacity by Study Area

Study Area	Using Water Quality Objectives			Using MCLs		
	TDS (mg/L)	Nitrate (mg/L as N)	Chloride (mg/L)	TDS (mg/L)	Nitrate (mg/L as N)	Chloride (mg/L)
Atascadero	0	0.5	0	427	8.2	172.5
Creston	12	0.2	0	612	6.8	180.6
San Juan	--	--	--	575	7.2	185.8
Estrella	0	0	0	448	7.5	155.8
Shandon	0	0	0	437	5.4	170.0
North Gabilan	--	--	--	144	1.6	137.2
South Gabilan	--	--	--	549	3.7	212.8
Bradley	--	--	--	249	7.3	165.6
Overall	**0**	**0**	**0**	**427**	**8.2**	**172.5**

5.4 Surface Loading Model

As described in Chapter 4, a GIS-based loading model was developed to support development of this SNMP and to better understand the contribution of various loading factors affecting salt and nutrient concentrations in groundwater. The loading model is briefly described below; more detailed descriptions of the loading model process and inputs, including loading factors, are included in Chapter 4.

The loading model is an analytical, spatially-based mass balance tool that represents TDS, chloride, and nitrogen loading from land use and water applications to groundwater on an annual-average basis. It is not a calibrated numerical model, as insufficient data are presently available to support such an effort. Therefore, the model results contain a greater degree of uncertainty as would result from a fully-calibrated numerical model.

Salt and nutrient loading to the Paso Robles Groundwater Subbasin is presently or projected to be in the future due to numerous sources, including:

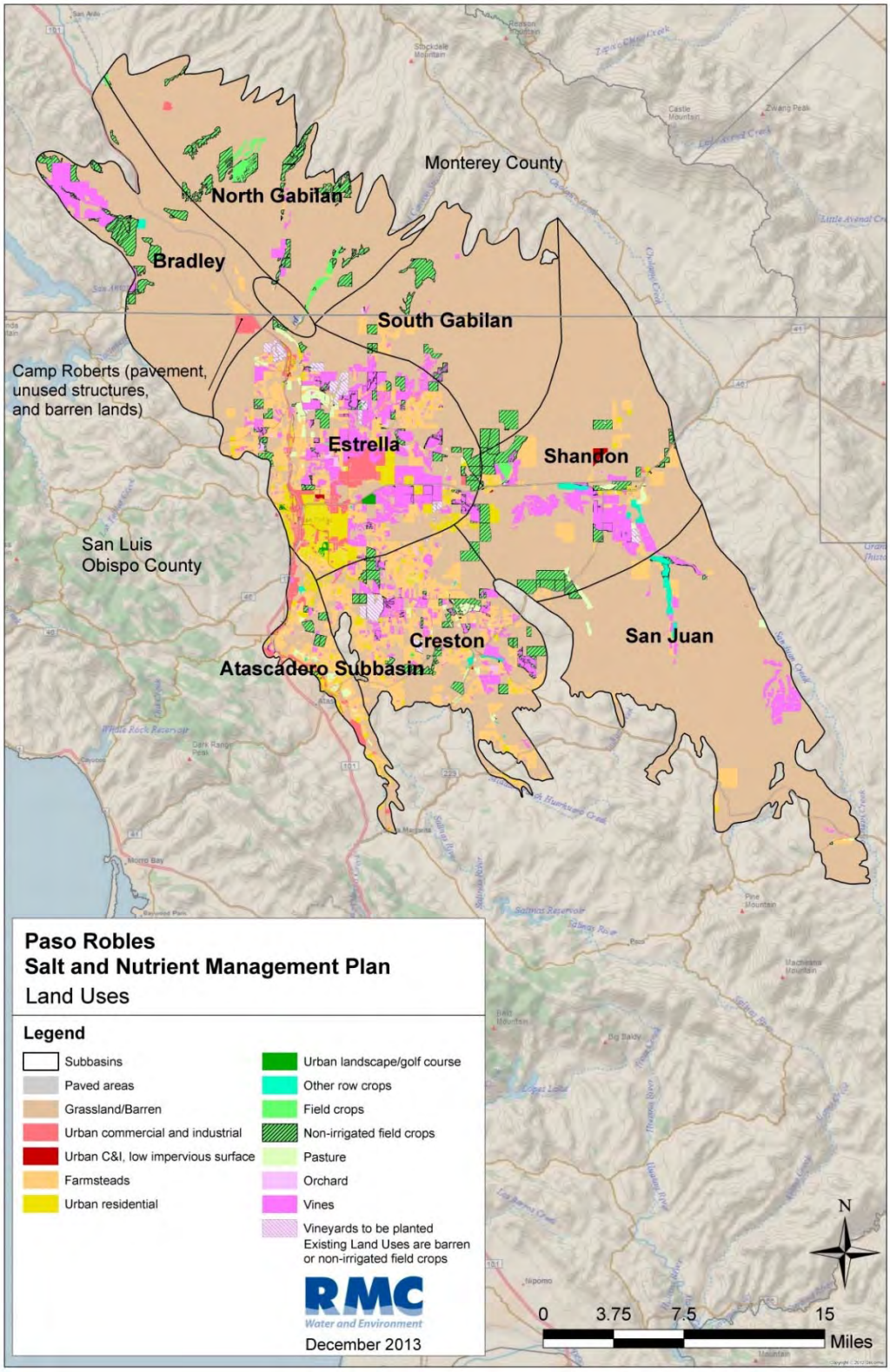
- Irrigation water application (e.g., potable water, groundwater, and future recycled water);

- Agricultural inputs (e.g., fertilizer and soil amendments);
- Septic system recharge;
- Infrastructure (e.g., percolation from treated wastewater ponds);
- Subsurface inflows through the basin boundaries;
- Natural stream losses and rainfall infiltration; and
- Geothermal upwelling.

The GIS loading model was developed to estimate salt and nutrient loads from irrigation water, agricultural inputs, septic system recharge, and infrastructure sources. Primary inputs to the surface loading model are land use, irrigation water, percolation pond locations, septic system areas, and surface geology characteristics. Note that loading sources that contribute to constituent loading in streams that travel through the basin (such as those originating in the Heritage Ranch CSD area), and the resultant mass loading to the basin through natural stream losses, are accounted for in the mass balance model as a part of the stream recharge load, described in Section 5.5.2.

To the extent feasible, the results of the loading model were compared to pumping rates estimated in the Chapter 3, as well as historical water quality trends to confirm the inputs and assumptions used in the model. The source data for the loading model, including all loading factors, are described in more detail as part of Chapter 4. As land use information is of key significance for developing loading estimates, land use categories within the basin are shown in Figure 5-1.

Figure 5-1: Land Use Categories



5.4.1 Surface Loading Results

Using the loading parameters and methodology described above, the loading model was run to develop TDS, nitrate, and chloride mass loading rates across the basin. Table 5-4 summarizes the overall contribution of each land use group to total TDS, nitrate, and chloride loading. The spatial distribution of these TDS, nitrate, and chloride loadings rates are shown in Figure 5-2, Figure 5-3, and Figure 5-4, respectively.

The loading analysis estimates higher loading of TDS, nitrate, and chloride in areas of the basin covered by urban areas and irrigated agriculture (particularly vineyards). As most of these activities occur within the Estrella Study Area and Atascadero Subbasin, these study areas have higher estimates of surface loading than the other areas. Because monitoring data have also shown higher concentrations of TDS, nitrate, and/or chloride concentrations in the same areas, these study areas were evaluated individually in the anti-degradation/groundwater quality trend analysis.

Table 5-4: TDS, Nitrate, and Chloride Loading Results

Land Use Group	Total Area (acres)	Percent of Total Area[a]	Percentage of Total TDS Loading	Percentage of Total Nitrate Loading	Percentage of Total Chloride Loading
Farmsteads[b]	43,943	33%	3%	12%	0%
Field Crops	1,954	1%	5%	3%	2%
Non-irrigated field crops	26,340	20%	0%	5%	14%
Orchard	909	1%	3%	4%	7%
Other row crops	1,668	1%	2%	10%	3%
Pasture	4,027	3%	17%	7%	12%
Urban commercial and industrial	7,144	5%	2%	4%	1%
Urban C&I, low impervious surface	383	0%	0%	0%	0%
Urban residential	11,098	8%	9%	18%	4%
Urban landscape	358	0%	1%	1%	1%
Vines	34,149	26%	57%	36%	56%

a. Percentage does not include undeveloped lands and paved areas.
b. Assumes farmsteads utilize septic systems.

Figure 5-2: Distribution of Estimated TDS Loading

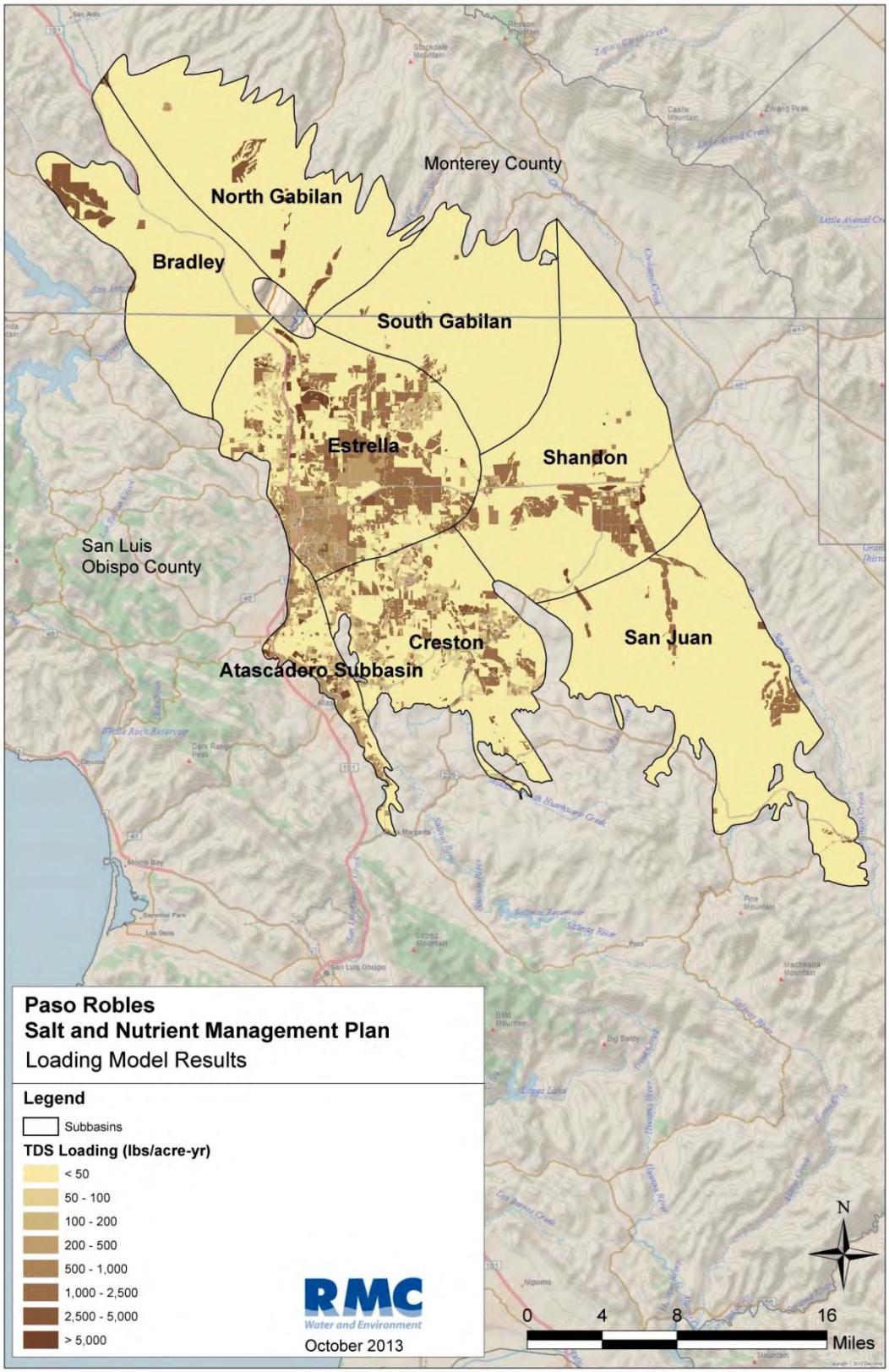


Figure 5-3: Distribution of Estimated Nitrate Loading

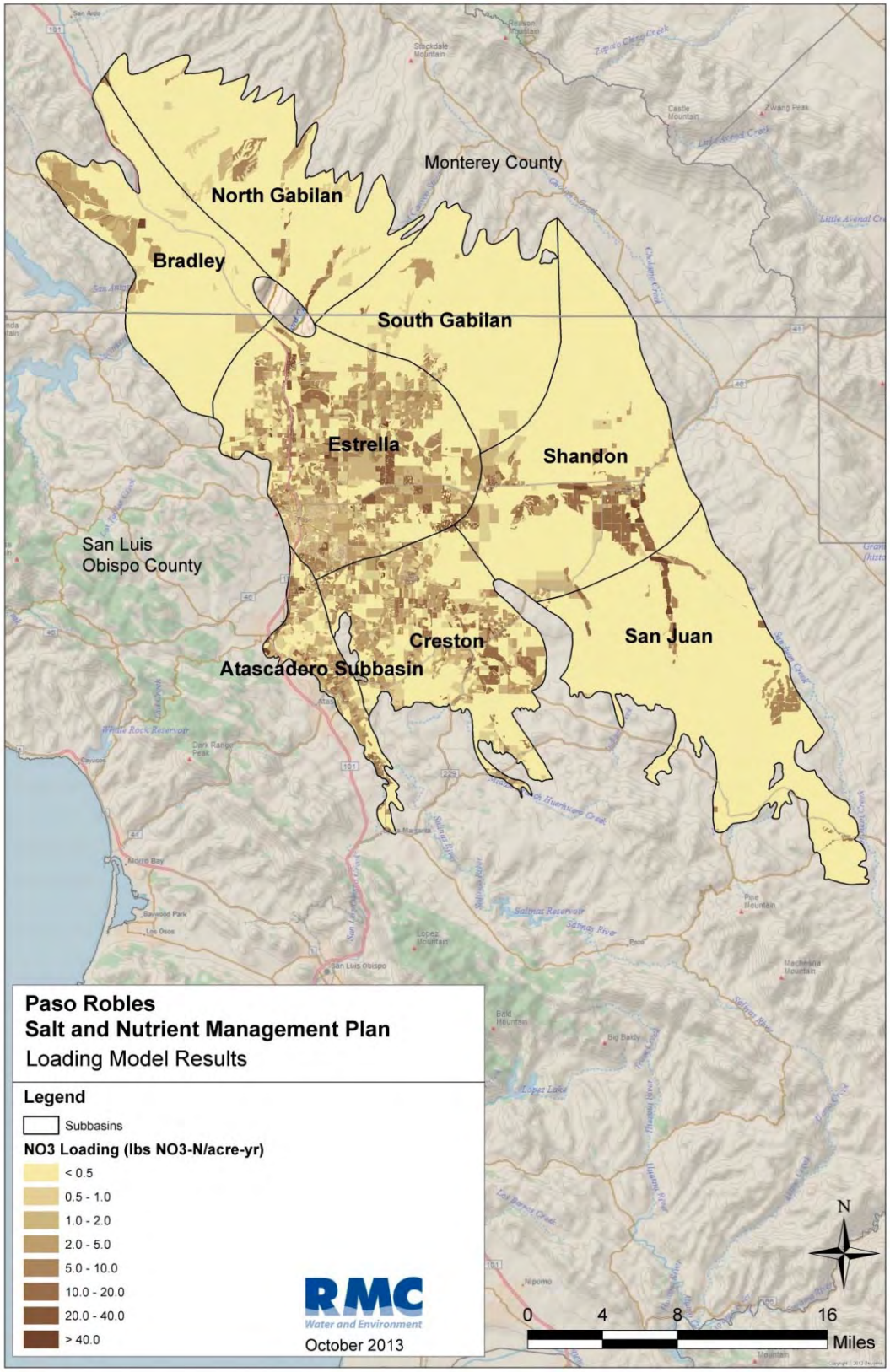
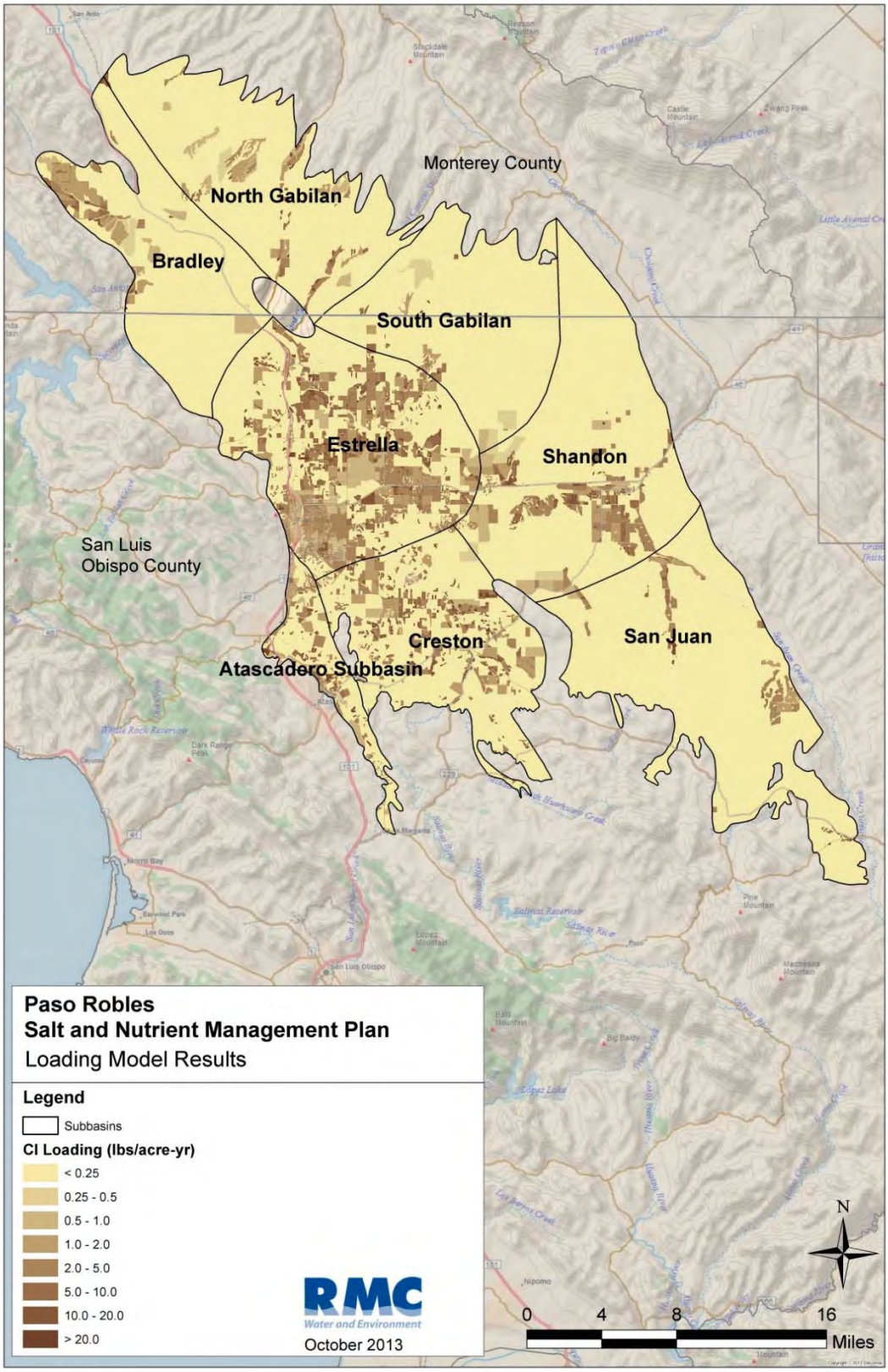


Figure 5-4: Distribution of Estimated Chloride Loading



5.5 Groundwater Quality Trend Analysis

5.5.1 Background

SWRCB Resolution No. 68-16 is the State of California's antidegradation policy which, in summary, establishes the requirement that discharges to waters of the State be regulated to achieve the "highest water quality constituent to the maximum benefit to the people of the State". This resolution essentially establishes a two-step process for compliance. First, if a discharge will degrade high quality water, the discharge may be allowed if any change in water quality (1) will be consistent with the maximum benefit to the people of the State, (2) will not unreasonably affect present and anticipated beneficial uses of such water (as defined in the Basin Plan), and (3) will not result in water quality less than that prescribed in State policies. This point is demonstrated in an antidegradation analysis. The second step requires the use of best practicable treatment or control of the discharge necessary to avoid a pollution or nuisance and to maintain the highest water quality consistent with the maximum benefit to the people of the State. Resolution No. 68-16 was incorporated into the SWRCB's Recycled Water Policy in Section 9, Anti-Degradation, which sets forth the parameters under which recycled water may be used. Specifically, the Recycled Water Policy states that in cases where more than 10% of a basin's assimilative capacity will be used by a project (or more than 20% of a basin's assimilative capacity will be used by multiple projects), an antidegradation analysis consistent with Resolution No. 68-16 must be performed to provide sufficient information to the RWQCB to make a determination that the proposed projects will provide the maximum benefit to the people of the State.

The groundwater quality trend analysis presented herein uses data collected and analyzed as part of this project to address the requirements of the Recycled Water Policy and Resolution No. 68-16. These data were used in a mass balance model to perform the groundwater quality trend analysis.

5.5.2 Mass Balance Model

A mass balance model was developed to evaluate constituent trends in groundwater concentrations over a 25-year planning horizon within the Atascadero Subbasin, Estrella Study Area, and for the groundwater basin as a whole, considering two scenarios – present land and water uses (reflecting baseline or present day conditions) and future conditions (including use of recycled water and Nacimiento water). This model considered the volume of groundwater in storage and water qualities in the existing basin and study areas, and evaluated the impact of the basin inflows and outflows on the groundwater quality in the overall basin or study area.

Basin or subbasin inflows to the model include the following components:

- Deep percolation – includes deep percolation of precipitation, agricultural irrigation return flows, municipal wastewater discharge, and septic discharges
- Stream recharge – includes streambed seepage from the Salinas River and other tributaries
- Subsurface inflows through the basin boundaries
- Subsurface inflows from other subbasins

Basin or subbasin outflows in the model include:

- Pumping outflows
- Subsurface outflows through the basin boundaries
- Subsurface outflows to other subbasins
- Groundwater discharge to rivers and creeks
- Evaporative losses associated with phreatophyte extraction of shallow groundwater.

As previously described in Chapter 3, existing water quality of the basin has been evaluated as part of this Plan. Average constituent concentrations and groundwater storage volumes for each of the study areas are summarized in Table 5-1.

In the mass balance model, inflows and outflows are evaluated on an annual basis and applied to the previous model year basin or subbasin volume and water quality to determine the iterative water quality in the basin or subbasin. Simulations are on a basin-wide or study-area wide basis and do not consider localized hydrogeologic characteristics. Constituent concentrations of each of the inflow components are based on available water quality data or the surface loading estimates described above. As available surface and subsurface water quality data is limited, future revisions of this plan should confirm or revise constituent concentrations based on any additional available data.

Baseline Scenario

Concentrations and volumes of the various inflow and outflow components for the baseline scenario ('present day') were estimated based on the information described above, as well as other data described in the Chapter 3 (Fugro, 2013); this information is summarized in Table 5-5 through Table 5-8 for the overall basin, the Estrella Study Area, and the Atascadero Subbasin, respectively. The baseline scenario represents the predicted concentrations in these study areas without any changes to land use practices or water use. A future scenario was also evaluated to analyze the impact of proposed changes in land use and water supplies.

Estimated inflows in the mass balance model do not include geothermal upwelling, which is known to occur in the western portion of the basin (Atascadero Subbasin and Estrella Study Area, primarily). No studies to date have been conducted to estimate the flux rate of geothermal upwelling into the Paso Robles Formation; however, this source is thought to have a significant impact on groundwater quality in these areas. The approximate quality of the geothermal upwelling has, however, been provided by the United States Geological Survey (USGS) and is summarized in Table 5-5.

Table 5-5: Geothermal Upwelling Water Quality (in mg/L)[a]

	TDS	Nitrate (as N)	Chloride
Geothermal Upwelling	900 – 1,300[b]	ND	110

a. Based on personal communication with and data from Jim Rytuba at USGS.
b. Estimated from specific conductivity data provided by the USGS.

Table 5-6: Estimated Volume and Concentration of Inflows and Outflows for Groundwater Quality Trend Analysis – Basin-wide

Item	Volume (AF or AFY)	TDS (mg/L)	Nitrate (mg/L as N)	Chloride (mg/L)	Basis
Initial Conditions	26,724,113	566	4.07	79.9	Fugro, 2012[a]
Inflows					
Deep Percolation	43,107	1,077	6.07	157.4	Calculated[b]
Stream Recharge	60,449	617	1.79	104.7	Fugro, 2009[c]
Municipal WW Percolation	5,452	982	19.55	283.8	Calculated[d]
Subsurface Inflows	25,027	485	4.00	71.3	Fugro, 2012[d]
Total	**134,035**	**715**	**3.51**	**111.2**	Calculated
Outflows					
Pumping Outflows	99,954	566	4.07	79.9	Fugro, 2012[f]
Subsurface Outflows	1,602				Fugro, 2012[f]
Stream Losses	29,212				Fugro, 2012[f]
Evaporative Losses	7,573				Fugro, 2012[f]
Total	**138,341**	**566**	**4.07**	**79.9**	Calculated

a. Initial Basin volumes and concentrations are based on data provided in Chapter 3.
b. Deep Percolation Concentrations are based on mass loads estimated using the loading model (described above), and deep percolation volumes of precipitation, agricultural irrigation return flows, and wastewater discharges described in Chapter 3.
c. Stream Recharge Concentrations for TDS, Chloride and Nitrate are based on averaged concentrations in the Salinas River, upstream and downstream of the Paso Robles WWTP (samples taken 03/06/09).
d. Municipal wastewater percolation volumes and constituent concentration sources are summarized in Chapter 4.
e. Subsurface inflow concentrations are based on average well data at locations near the edge of the basin, where inflow is likely to occur.
f. Outflow concentrations vary for each year based on the annual calculations estimating basin or subbasin-wide concentrations.

Table 5-7: Estimated Volume and Concentration of Inflows and Outflows for Groundwater Quality Trend Analysis – Estrella Study Area

Item	Volume (AF or AFY)	TDS (mg/L)	Nitrate (mg/L as N)	Chloride (mg/L)	Basis
Initial Conditions	6,875,219	552	2.5	94.2	Fugro, 2012[a]
Inflows					
Deep Percolation	13,521	1,999	9.70	329.6	Calculated[b]
Stream Recharge	6,652	637	2.40	113.0	Fugro, 2009[c]
Municipal WW Percolation	3,457	1,035	30.11	324.7	Calculated[d]
Subsurface Inflows from Outside Basin	6,215	485	4.00	71.3	Fugro, 2012[e]
Subsurface Inflow from Other Subbasins/Study Area	22,434	472	4.66	57.1	Fugro, 2012[f]
Total	**48,714**	**775**	**4.97**	**118.2**	Calculated
Outflows					
Pumping Outflows	39,138				Fugro, 2012[g]
Stream Losses	7,885				Fugro, 2012[g]
Evaporative Losses	225				Fugro, 2012[g]
Subsurface Outflows to Outside Basin	0	552	2.50	94.2	Fugro, 2012[g]
Subsurface Outflow to Other Subbasins/Study Area	3,337				Fugro, 2012[g]
Total	**50,585**	**552**	**2.50**	**94.2**	Calculated

a. Initial Basin volumes and concentrations are based on data provided in Chapter 3.
b. Deep Percolation Concentrations are based on mass loads estimated using the loading model (described above), and deep percolation volumes of precipitation, agricultural irrigation return flows, and wastewater discharges described in Chapter 3.
c. Stream Recharge Concentrations for TDS, Chloride and Nitrate are based on averaged concentrations in the Salinas River, upstream and downstream of the Paso Robles WWTP (samples taken 03/06/09).
d. Municipal wastewater percolation volumes and constituent concentration sources are summarized in the Chapter 4.
e. Subsurface inflow concentrations from outside the basin are based on average well data at locations near the edge of the basin, where inflow is likely to occur.
f. Subsurface inflow concentration from other subbasins is based on the weighted average of concentrations in contributing subbasins.
g. Outflow concentrations vary for each year based on the annual calculations estimating basin or subbasin-wide concentrations

Table 5-8: Estimated Volume and Concentration of Inflows and Outflows for Groundwater Quality Trend Analysis – Atascadero Subbasin

Item	Volume (AF or AFY)	TDS (mg/L)	Nitrate (mg/L as N)	Chloride (mg/L)	Basis
Initial Conditions	473,095	573	1.8	77.5	Fugro, 2012[a]
Inflows					
Deep Percolation	1,840	1,447	9.77	214.7	Calculated[b]
Stream Recharge	14,047	573	0	86	Fugro, 2009[c]
Municipal WW Percolation	1,996	890	1.27	212.9	Calculated[d]
Subsurface Inflows from Outside Basin	784	485	4.00	71.3	Fugro, 2012[e]
Subsurface Inflow from Other Subbasins/Study Area	591	420	3.06	74.2	Fugro, 2012[f]
Total	**18,667**	**594**	**1.43**	**88.9**	Calculated
Outflows					
Pumping Outflows	14,490				Fugro, 2012[g]
Stream Losses	2,062				Fugro, 2012[g]
Evaporative Losses	274				Fugro, 2012[g]
Subsurface Outflows to Outside Basin	0	573	1.80	77.5	Fugro, 2012[g]
Subsurface Outflow to Other Subbasins/Study Area	3,354				Fugro, 2012[g]
Total	**20,180**	**573**	**1.80**	**77.5**	Calculated

a. Initial Basin volumes and concentrations are based on data provided in the Chapter 3.
b. Deep Percolation Concentrations are based on mass loads estimated using the loading model (described above), and deep percolation volumes of precipitation, agricultural irrigation return flows, and wastewater discharges described in Chapter 3.
c. Stream Recharge Concentrations for TDS, Chloride and Nitrate are based on concentrations in the Salinas River, upstream of the Paso Robles WWTP (samples collected on 03/06/09). This analysis assumes that all loads from the WWTP percolate to the groundwater basin; therefore, to avoid double counting WWTP loads, samples collected downstream of the WWTP are not included in the stream recharge concentration.
d. Municipal wastewater percolation volumes and constituent concentration sources are summarized in the Chapter 4.
e. Subsurface inflow concentrations from outside the basin are based on average well data at locations near the edge of the basin, where inflow is likely to occur.
f. Subsurface inflow concentration from other subbasins is based on the weighted average of concentrations in contributing subbasins.
g. Outflow concentrations vary for each year based on the annual calculations estimating basin or subbasin-wide concentrations

Future Scenario

In addition to current activities in the basin, this analysis assumed the following additional changes in source loads:

- Conversion of undeveloped lands/grasslands into vineyards in San Luis Obispo County as described in Chapter 4.
- Percolation of 2,000 AFY of Lake Nacimiento water into the Atascadero Subbasin by the City of Atascadero. This will improve groundwater water quality by providing a source of lower-salt recharge into the groundwater subbasin.
- 4,000 AFY of Lake Nacimiento water added to the City of Paso Robles distribution system, reducing groundwater pumping by an equivalent amount. This would also generally improve water quality in wastewater leaching to the Salinas River, and the subsequent river recharge component of the model, by reducing salt loads associated with effluent recharge. As data were not available to estimate this improvement, it has conservatively been assumed that water quality in the Salinas River would not change.
- Percolation of wastewater (approximately 246 AFY) generated by Templeton CSD into the underflow of the Salinas River in the Atascadero Subbasin. This wastewater is currently discharged by the City of Paso Robles.
- As of 2015, the City of Paso Robles will be implementing a nutrient removal process at their wastewater treatment facility that will result in a reduced effluent Total Nitrogen (as N) discharge concentration from 30 mg/L to 8 mg/L.
- 2,500 AFY of irrigation currently using groundwater to be replaced with recycled water provided by the City of Paso Robles, reducing groundwater pumping by an equivalent amount.
- No additional storm water capture and recharge to groundwater or new BMPs to control nitrogen or salt loading are introduced to the basin.

The analysis also assumed that all recycled water used in the groundwater basin in the future would offset demand on potable water supplies (pumped groundwater and surface water) and thus would result in a net decrease in the overall volume of pumped groundwater and surface water used for irrigation purposes.

Table 5-9: Future Water Source Water Quality (in mg/L)

Item	TDS	Nitrate (as N)	Chloride	Basis
Lake Nacimiento Water	200	0.13	6.3	MRS, 2003[a]
Recycled Water	1,000	7	291	WWTP Effluent Data[b]

a. Average of data presented in Table 5.1.5 for raw Lake Nacimiento water, (Marine Research Specialists, 2003)
b. Paso Robles Wastewater Treatment Plant effluent typical value per 2001 Comprehensive Recycled Water Study (Paso Robles, 2001). Note that, with the introduction of water from Lake Nacimiento into the Paso Robles water distribution system, the TDS concentration of recycled water will likely be less than the value reflected here. Further, additional treatment processes are planned to reduce nitrates in the wastewater effluent. The use of 2001 effluent data is therefore considered to be a conservative estimate, but appropriate without further study on the extent or timing of the reductions. These estimates should be refined in future updates of this report.

Model Results

The model loads and existing concentrations described above were used to estimate the annual change in TDS, chloride and nitrate concentrations in groundwater over a 25-year planning horizon. Figure 5-5 through Figure 5-7 present the projected changes in TDS, nitrate and chloride concentrations, respectively, with the anticipated future additions of recycled water and Lake Nacimiento water use as described in the Future Scenario subsection of Section 5.5.2. The figures compare future groundwater concentrations for the three constituents without future changes to water use (i.e. without the addition of recycled water or Lake Nacimiento water), represented as a dashed line, with changes to future groundwater quality with the introduction of the new water sources (solid line). As previously noted, the Estrella Study Area and the Atascadero Subbasin were modeled individually, as well as part of the groundwater basin as a whole, as these are the two study areas to be most likely affected by future changes in water use. The results of the analysis at the end of the 25-year planning horizon are summarized in Table 5-10.

The modeling results predict a slight increase in TDS concentrations basin-wide and in the two study areas (Atascadero Subbasin and Estrella Study Area). If the MCL is used instead of WQOs in establishing assimilative capacity, less than 10% of the assimilative capacity of the overall groundwater basin would be used over the 25-year planning period under both the baseline and future planning scenarios, and 20% or less of the assimilative capacity of the two respective study areas would be used during the same planning period.

The model also predicts relatively steady nitrate and chloride concentrations over the planning period over the basin as a whole, in addition to the two study areas analyzed. In general, concentrations decrease under the future scenario (relative to the baseline scenario) due to percolation of Lake Nacimiento water and reductions in nitrate concentrations in the Paso Robles wastewater effluent. If calculated using WQOs, only the Atascadero Subbasin has assimilative capacity for nitrate, and the model indicates that none of the assimilative capacity will be used. If the MCL is used instead of WQOs for nitrate, less than 10% of the assimilative capacity is used in the Estrella Study Area under both scenarios, and only 1% of the assimilative capacity is used in the overall basin under the baseline scenario. Assimilative capacity for nitrate is not used in the Atascadero Subbasin, nor in the overall basin under the future scenario.

Chloride concentrations are predicted to increase slightly in all study areas under the baseline and future scenarios; less than 10% of the assimilative capacity of the overall groundwater basin for chloride would be used over the 25-year planning period under both the baseline and future planning scenarios, and 20% or less of the assimilative capacity for chloride would be used for the two study areas during the same planning periods. Chloride concentrations are predicted to decrease in the Atascadero Subbasin and in the overall groundwater basin under the future scenario (relative to the baseline scenario), primarily due to the percolation of Lake Nacimiento water by the Atascadero Mutual Water Company and the Templeton CSD into the relatively small groundwater subbasin. Chloride concentrations increase slightly in the Estrella basin under the future scenario, primarily due to the increased use of recycled water.

A model scenario was also been performed on the overall groundwater basin assuming a mixing depth of 700 feet (rather than the entire Paso Robles Formation depth), and assuming no interaction (mixing) between the shallower portion of the Paso Robles Formation and the deeper portion of the formation. Under this scenario, overall concentrations trends increased from those predicted when the entire basin was assumed to be available for mixing (a result anticipated due to a smaller mixing volume); these results are summarized in Table 5-11. The percentage of MCL-based assimilative capacity used for TDS increased from approximately 8% when the entire Paso Robles Formation depth was used for mixing to approximately 15% when considering a shallower mixing depth, while nitrate and chloride concentrations remained relative steady. This same scenario (reduced mixing volume) was not conducted for the other two study areas analyzed (Estrella Study Area and Atascadero Subbasin) due to the relatively small size of these areas.

Table 5-10: Modeled Changes in Groundwater Quality over Model Period

	Initial Conditions (mg/L)				25-year change Baseline Scenario (mg/L)			25-year change Future Scenario[a] (mg/L)		
	TDS	NO_3-N	Cl		TDS	NO_3-N	Cl	TDS	NO_3-N	Cl
Atascadero Subbasin	573	1.8	77.5	Change in Concentration	+86.06	-0.07	+26.09	+58.16	-0.18	+21.04
	--	--	--	% AC Used – WQO	NAC	--	NAC	NAC	--	NAC
	--	--	--	% AC Used - MCL	20%	--	15%	14%	--	8%
Estrella Study Area	552	2.5	94.2	Change in Concentration	+47.33	+0.73	+7.51	+51.27	+0.50	+8.50
	--	--	--	% AC Used – WQO	NAC	NAC	NAC	NAC	NAC	NAC
	--	--	--	% AC Used - MCL	10.6%	9.7%	4.8%	11.4%	6.6%	3.4%
Overall Basin	566	4.1	79.9	Change in Concentration	+35.03	+0.05	+5.41	+40.22	-0.06	+5.00
	--	--	--	% AC Used – WQO	NAC	NAC	NAC	NAC	NAC	NAC
	--	--	--	% AC Used - MCL	8.1%	1%	3.2%	7.4%	--	2.0%

Notes:

a. Other than the City of Paso Robles, several entities in the groundwater basin are planning to either improve treated effluent quality (i.e., add nitrogen removal treatment processes) and/or change the volume of effluent currently being discharged to the groundwater basin and/or Salinas River in the future. However, as these proposed changes are currently in the planning stages, specific information are not available as to the impacts of these changes on Salinas River water quality.

b. Definitions:
   AC – assimilative capacity
   NAC – No assimilative capacity is available
   WQO – water quality objective, as specified in the *Central Coast Basin Plan* (Central Coast RWQCB, 2011)
   MCL – Maximum Contaminant Level

c. Summary assumes that the upper secondary MCL of 1,000 mg/L is used for TDS, the recommended secondary MCL of 250 mg/L is used for chloride, the primary MCL of 10 mg/L is used for nitrate (as N), and that the lowest WQO is used where a range is specified (see Table 3-2).

d. **Red** denotes a decrease in concentration (improvement in groundwater quality).

Table 5-11: Modeled Changes in Groundwater Quality – 700 feet Mixing Depth

	Initial Conditions (mg/L)				25-year change Baseline Scenario (mg/L)			25-year change Future Scenario (mg/L)		
	TDS	NO_3-N	Cl		TDS	NO_3-N	Cl	TDS	NO_3-N	Cl
Overall Basin	566	4.1	79.9	Change in Concentration	+71.37	-0.25	+14.19	+64.73	-0.31	+12.83
	--	--	--	% AC Used – WQO	NAC	--	--	NAC	--	--
	--	--	--	% AC Used - MCL	15.4%	--	8.34%	15.2%	--	7.54%

Notes:
AC – assimilative capacity
NAC – No assimilative capacity is available
WQO – water quality objective, as specified in the *Central Coast Basin Plan* (Central Coast RWQCB, 2011)
MCL – Maximum Contaminant Level
Summary assumes that the upper secondary MCL of 1,000 mg/L is used for TDS and that the lowest WQO is used where a range is specified (see Table 3-2).
Red denotes a decrease in concentration (improvement in groundwater quality).

Figure 5-5: Projected TDS Concentrations

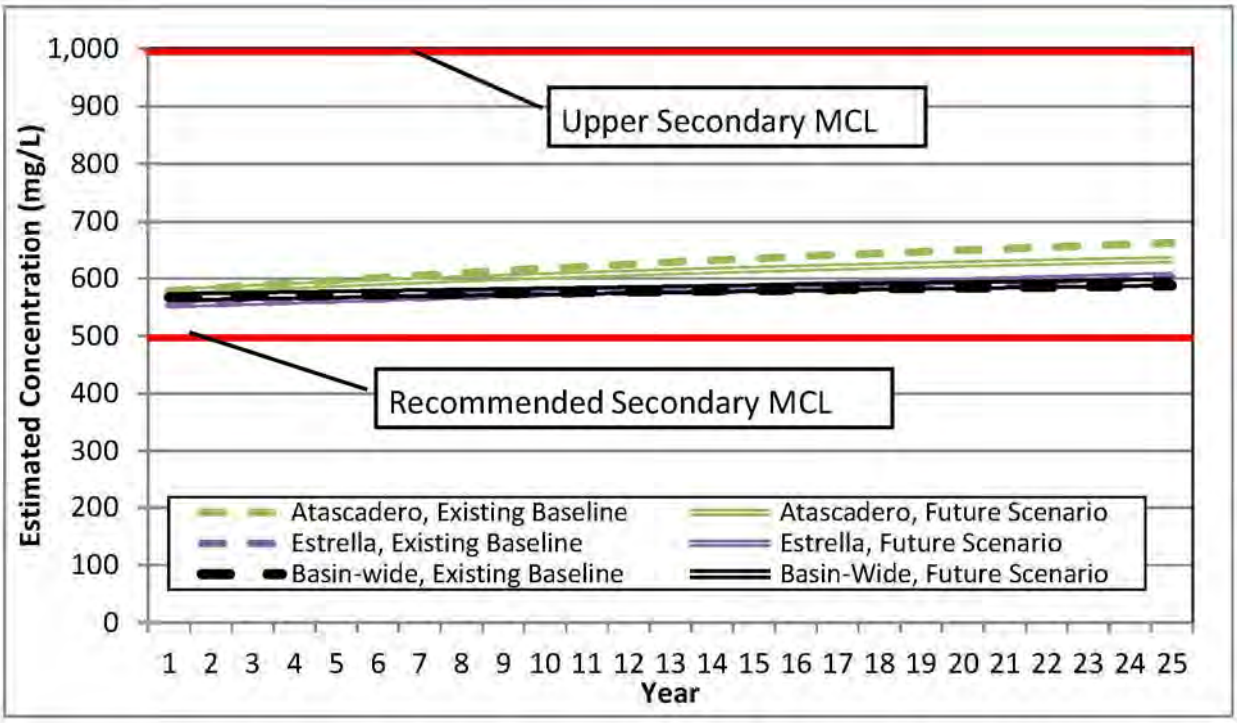


Figure 5-6: Projected Nitrate (as N) Concentrations

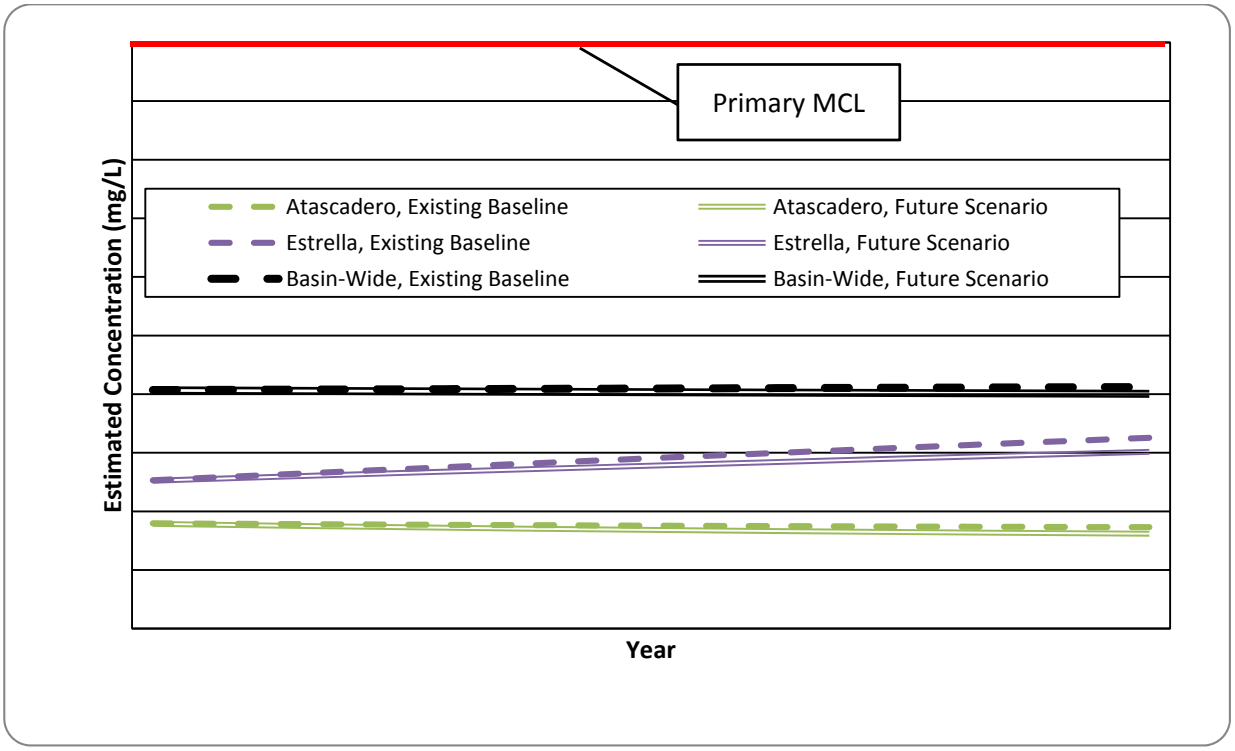
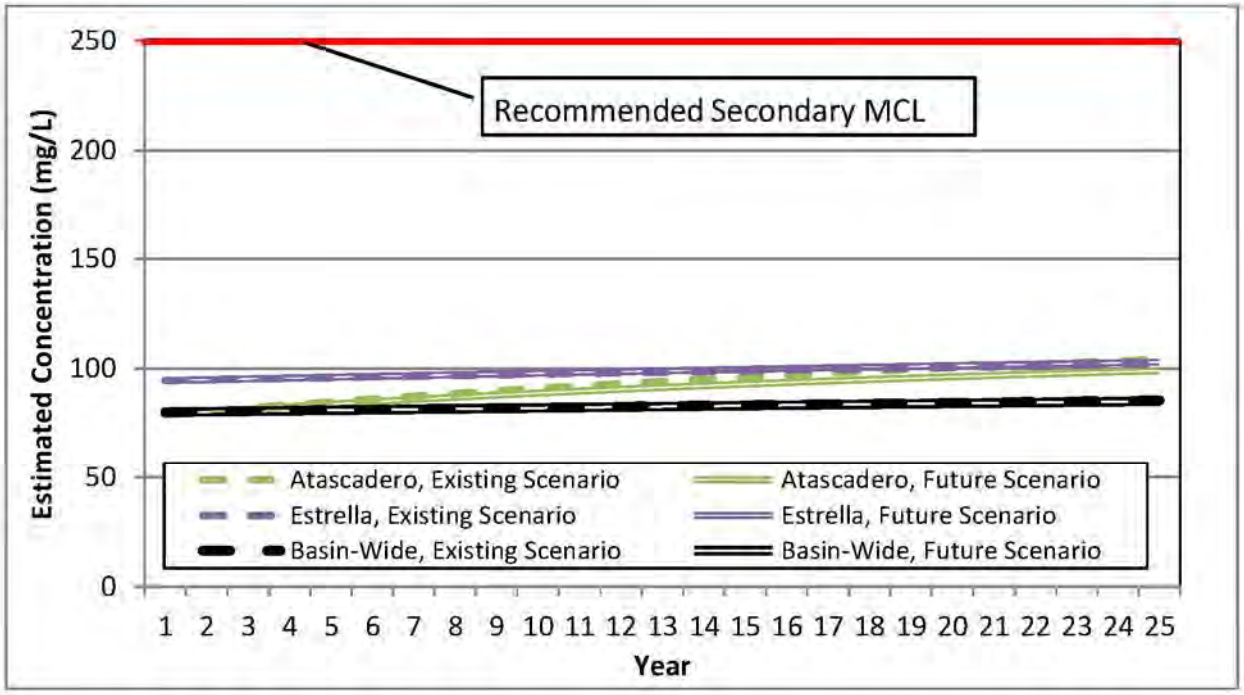


Figure 5-7: Projected Chloride Concentrations



5.6 Antidegradation Assessment

Analysis of existing basin-wide groundwater quality conditions indicates that the existing groundwater quality is generally better than the Water Quality Objectives set forth in the Basin Plan. However, such a comparison is hampered by disparity in study area definitions as generally used to describe the groundwater basin relative to those used in the Basin Plan. If drinking water standards (MCLs) are used for this analysis, there is assimilative capacity remaining in the groundwater basin for chlorides and nitrates. If the recommended MCL for TDS is used (500 mg/L), than assimilative capacity exists only in three study areas in the groundwater basin, whereas assimilative capacity is available throughout the groundwater basin if the upper secondary MCL is used for TDS (1,000 mg/L).

In such situations, Resolution 68-16 states that "such existing high quality water will be maintained until it has been demonstrated to the State that any change will be consistent with maximum benefit to the people of the State, will not unreasonably affect present and anticipated beneficial use of such water and will not result in water quality less than that prescribed in the policies." The results of the groundwater quality trend and loading analyses, based on a series of conservative assumptions and over a 25-year planning horizon, indicate that basin-wide average TDS concentrations will increase over time, but will not exceed the WQOs in those areas where the WQOs are presently met. Nitrate and chloride concentrations are anticipated to be relative stable basin-wide. Given the following:

- Current groundwater elevation trends (the basin moving towards overdraft conditions);
- The economic importance of the existing water supplies that contribute to salt and nutrient loading in the basin;
- Current state mandates to increase recycled water use; and
- The projected continued ability of groundwater to meet present and anticipated beneficial uses.

The qualitative cost-benefit analysis concludes that increases in the indicator constituents (TDS, chloride and nitrate) in the groundwater basin with anticipated future uses are consistent with the maximum benefit to the people of the State of California.

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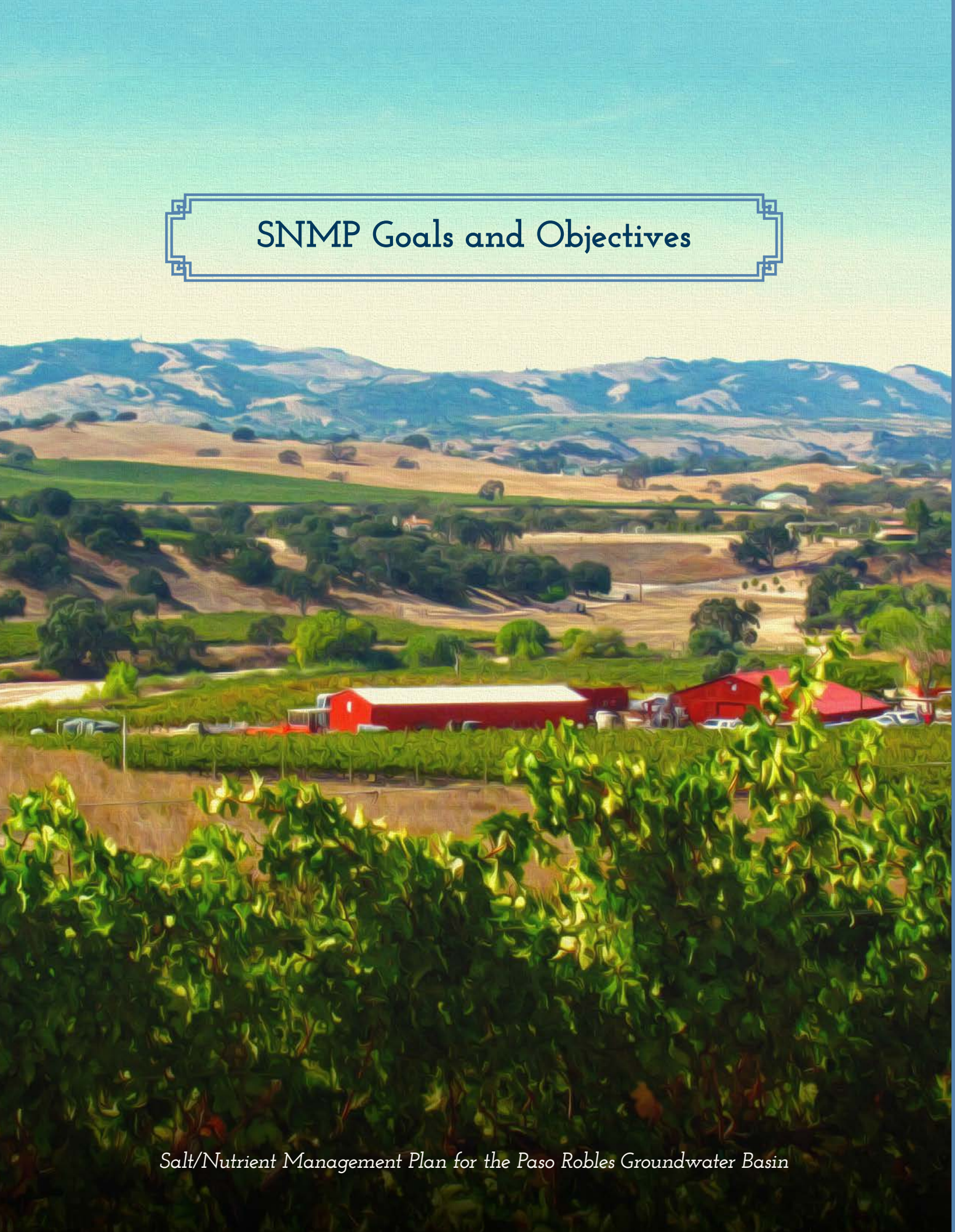
SNMP Goals and Objectives



Salt/Nutrient Management Plan for the Paso Robles Groundwater Basin

Chapter 6 SNMP Goals and Objectives

The completed SNMP technical analysis findings indicate that overall basin groundwater quality will be stable through the projected study period (25 years). Therefore, no new implementation measures or BMPs are recommended as part of the SNMP process. However, the SNMP results indicate that the existing groundwater quality BMPs or measures already in place should continue. In addition, the BMPs or measures already planned for recycled water use should be implemented to allow for recycled water use as irrigation and the long-term protection and sustainability of groundwater quality.

This chapter documents the identified groundwater basin management goals and objectives that will aid in managing salt and nutrient loading to groundwater. Since the preparation of this SNMP began, the Sustainable Groundwater Management Act of 2014 was passed. At present, the enacting legislation and guidance for this act have not yet been formulated. As such, this SNMP (and its associated TMs) are not intended to comply with any new regulations that may result from the passage of this recent act.

6.1 Basin Management Goals and Objectives

Groundwater basin management goals and objectives were developed and vetted during a series of stakeholder workshops held in 2013 and 2014. Identified preferred basin management objectives (BMOs) and goals that the SNMP will aim to achieve were established for future groundwater use, water recycling and stormwater management. These BMOs consider anticipated future development in the Basin in accordance with relevant master plans and other available planning documents. Specific basin management goals and objectives developed for the SNMP through stakeholder meetings include:

- **BMO-1**: Protection of surface water resources
- **BMO-2**: Minimize impacts on local water supply
- **BMO-3**: Minimize impacts on groundwater quality

These qualitative BMOs address issues related to groundwater levels, groundwater quality, and the interaction of groundwater with surface water. The BMOs will likely be further developed and revised in the future as groundwater management efforts in the basin evolve. Ultimately, these goals and their associated objectives will be quantitative with triggers and actions to be considered when thresholds are crossed; however, given the present status of groundwater management in the basin, development of quantitative objectives external to these other groundwater management efforts is inappropriate at this time. It is anticipated that the BMOs will be supported by management actions such as those outlined below, and that the specific objectives for this SNMP will be updated to coordinate with these other efforts as they move towards completion.

- Groundwater monitoring;
- Integration of recycled water resources;
- Well ordinances including construction, abandonment, and destruction policies;
- Identification and mitigation of soil and groundwater contamination; and
- Public education and conservation programs.

6.1.1 Groundwater Management Goals

General groundwater management goals focus on maintaining and improving groundwater levels and groundwater quality. Additional groundwater management goals include:

- Maintain groundwater levels to ensure the long-term reliability of groundwater sources for the economic well-being of the area;

- Protect against adverse impacts to surface water flows;
- Preserve floodplain to promote groundwater recharge;
- Prevent water pollution, including limiting upwelling of geothermal waters into potable groundwater aquifers by maintaining groundwater levels;
- Protect against potential inelastic land surface subsidence.

6.1.2 Recycled Water Goals

Recycled water goals were developed with stakeholders in accordance with the SWRCB Resolution No. 2009-011. Basin stakeholders currently have different plans as to their potential utilization of recycled water. These future use goals are summarized below:

- The City of Paso Robles has its own set of recycled water goals as described in their updated RWMP (AECOM, March 2014). Paso Robles is seeking to maximize the beneficial use of recycled water in their service area, and is planning to meet an average annual recycled water demand for irrigation 1,750 AFY. The City's short-term goal is to provide 650 AFY of tertiary-treated recycled water for landscape irrigation beginning in 2025.
- The City of Atascadero's goal is to replace potable water irrigation with recycled water in five of its parks, and anticipates using approximately 60 AFY of recycled water in the future. The City will evaluate recycled water goals during its wastewater master planning efforts.
- Templeton CSD is presently coordinating with San Luis Obispo County in preparation of a Regional Recycled Water Strategic Plan. While specific recycled water use goals by Templeton CSD are not presently available, they are planning to redirect wastewater currently being sent to the City of Paso Robles and instead treat the influent at its own treatment facilities and percolate the treated effluent into the basin for retrieval downgradient. Under this scenario, the District anticipates recycling up to 224 AFY.
- Like Templeton CSD, San Miguel CSD is currently percolating secondary effluents at its wastewater treatment facility; however, the District is considering using the recycled water for landscape irrigation of parks, streetscapes and open space areas in new developments.
- Heritage Ranch CSD, County Service Area (CSA) 7A and Camp Roberts currently have no plans for recycled water use.

6.1.3 Stormwater Recharge Goals

Stormwater recharge goals for the groundwater basin were established based on current management practices and an understanding of basin hydrostratigraphy (including location of recharge zones). Basin stormwater recharge management goals include:

- Maximization of onsite runoff capture and infiltration through low impact development (LID) techniques and implementation of the Central Coast RWQCB Post-Construction Runoff Control Requirements;
- Maximization of instream infiltration;
- Use of dual-purpose stormwater runoff management facilities for both flood control and groundwater infiltration.

At present, there are no specific stormwater capture and reuse goals for larger-scale projects other than those established in the post-construction runoff control requirements. While LID and post-construction runoff control requirements are presently in place, the benefit of recharging stormwater (which is likely to

be low in TDS) is not included in the SNMP groundwater quality analyses because of uncertainties in the current projected quantity and volumes of stormwater recharge. Not including stormwater in future water quality analysis is a conservative approach as stormwater would likely decrease TDS, chloride and nitrate concentrations basin-wide. Future SBMP analyses will consider stormwater recharge projects as they are developed and implemented. Future SNMP updates could also include quantitative goals for stormwater recharge as they are established through future project efforts.

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Basin Management Strategies

Salt/Nutrient Management Plan for the Paso Robles Groundwater Basin

Chapter 7 Implementation Measures

This chapter documents the implementation measures associated with the goals and objectives described in Chapter 6 that will aid in managing salt and nutrient loading to groundwater.

7.1 Management Strategies

The SNMP technical analysis indicates that overall groundwater quality in the basin is generally stable with general water quality below the Regional Water Board's WQOs. Analysis of future water quality (over the 25 year planning horizon) indicates improving water quality, as Lake Nacimiento water becomes available to the basin, and trends stabilize.

With these trends in mind, several categories of possible implementation/management strategies were considered during Public Workshop 3. These include:

- Stormwater/Runoff Management
- Groundwater Recharge
- Groundwater Basin Management
- Salinas River Underflow Augmentation
- BMPs by Land Use Sector
- Wastewater Salinity/Nutrient Source Control
- Source Water Salinity Control
- Recycled Water
- Institutional
- Public Education
- Other

Those strategies selected for implementation in the groundwater basin are described below.

7.1.1 Stormwater/Runoff Management

Multiple LID and stormwater BMPs are currently being practiced in the Basin and/or are planned for implementation. These include the Central Coast RWQCB's Post-Construction Runoff Control Requirements, which include:

- Minimizing the compaction of highly permeable soils
- Limiting clearing and grading of native vegetation
- Directing roof runoff to cisterns or rain barrels for reuse
- Directing roof runoff onto vegetated areas away from building foundations
- Directing runoff from sidewalks, patios, walkways, driveways and/or uncovered parking lots onto vegetated areas away from building foundations
- Constructing bike lanes, driveways, uncovered parking lots, sidewalks, walkways and patios with permeable surfaces

This chapter endorses these measures and encourages their continued implementation. Additional LID techniques may be implemented in the basin on a site-specific basis.

Other stormwater and/or runoff management measures that aid in groundwater basin management include the use of detention basins, which both manage flooding but also promote groundwater recharge, and rainfall monitoring programs.

7.1.2 Groundwater Basin Management

The Paso Robles Groundwater Management Plan (PRGMP) set forth goals and objectives for basin management (including specific objectives by basin subarea), identified a governmental structure and process for stakeholder involvement, outlined a groundwater monitoring and data collection program, and presented recommendations for ensuring groundwater sustainability. On March 18, 2014, the San Luis Obispo County Board of Supervisors adopted a resolution directing staff to begin drafting amendments to the PRGMP. At present, the County is working with the Paso Basin Advisory Committee and others to evaluate several processes[2] for establishing an overall governance structure to manage the Basin. It is anticipated that the ultimate Basin management authority(ies) will consider the objectives of the SNMP in developing a plan to maintain the health of the groundwater basin. The proponents of this SNMP will continue to participate with the County in the development of the updated PRGMP.

Several additional groundwater basin management measures are currently being implemented in the basin. These include:

- Groundwater elevation and quality monitoring – Groundwater elevation monitoring and reporting to the State's CASGEM system is coordinated by San Luis Obispo County Flood Control and Water Conservation District. Groundwater quality monitoring is conducted by individual groundwater users as required by the state (i.e. for annual Consumer Confidence Reporting).
- Flow modeling – A MODFLOW groundwater model of the groundwater basin was originally prepared in 2005 (Fugro, 2005) and simulated a period from 1981 to 1997. In August of 2012, the County Board of Supervisors awarded a contract to update that model to cover the period from 1981 to 2011, refine the perennial (safe) yield of the basin, assess model input parameters that have the greatest effect on the model's simulation results, and to evaluate the groundwater basin's response to "growth" versus "no-growth" scenarios over the period from 2011 to 2041. This model update is expected to be completed by October of 2014, and will provide additional insights into groundwater basin management in addition to providing a tool for evaluating the impacts of various basin management strategies under a variety of future development scenarios.
- Updated land cover maps – San Luis Obispo County maintains land use cover maps in GIS format. These files are available from the County's website. Additionally, the General Plans of local municipalities include similar mapping for those specific urban areas.

7.1.3 Salinas River Underflow Augmentation

At present, the shallow groundwater basin aquifers and Salinas River underflow is augmented through the percolation of treated effluent from urban wastewater treatment systems. These percolated volumes then travel and mix with Salinas River underflow and are retrieved downgradient. Expansion or continuation of this practice will aid in the management of shallow groundwater elevations.

7.1.4 Best Management Practices

Water management BMPs include practices to conserve water, minimize waste, and protect groundwater quality. Urban BMPs include water conservation programs, water budgeting, ordinances to minimize over-irrigation, and landscape irrigation BMPs. Municipal wastewater treatment facility BMPs include controlling salinity from water softeners and industrial and/or commercial dischargers.

[2] As of the date of this Technical Memorandum, water rights litigation has been initiated and certain land use ordinances related to groundwater management are under development. All of these elements, should they become a part of the overall Basin governance and management structure, would have a role in BMO development.

7.1.5 Wastewater Salinity/Nutrient Source Control

Management of salts and nutrients in wastewater aids in the protection of groundwater quality. Industrial wastewater source controls could include regulation of industrial and commercial discharges, source control program permits, inspection and monitoring of discharges, development of source control and pollution prevention requirements and the enforcement of those requirements.

7.1.6 Source Water Salinity Control

Source water salinity control is key for managing the concentrations of salts in the groundwater basin. A key method for achieving this salt reduction is through the importation and use (either directly or indirectly) of the less-saline Lake Nacimiento water in the groundwater basin. Plans for implementing this measure are currently underway, with receiving entities either treating and using the Nacimiento water directly (thereby reducing the salt levels in the resulting wastewater effluent) or by percolating the Nacimiento water into the groundwater basin and capturing it downstream. Maximizing the use of Lake Nacimiento water in the groundwater basin is anticipated to have a substantial impact on groundwater basin quality in urbanized areas near the Salinas River.

A second method for managing salt loading to the groundwater basin from urban areas could be through the use of ordinances regulating the use of self-regenerating water softeners and/or discharges of wastes with high salt concentrations, and through education programs to discourage the use of water softeners utilizing salts. These programs are currently in place in some areas of the groundwater basin and could be expanded to other locations.

7.1.7 Public Education

Public education about groundwater issues is strong in the Paso Robles Groundwater Basin as it is the primary water supply for urban, industry and agriculture alike. San Luis Obispo County and the various municipalities maintain websites and provide outreach to the public on issues such as water conservation and groundwater protection. The County's website provides access to published groundwater-related data and documents and regular updates as to groundwater management activities in the basin. In addition, landscape management materials discussing the use of fertilizer, appropriate irrigation techniques, etc. are distributed to the public through various outreach programs.

7.1.8 Institutional

As previously discussed in Section 7.1.2, the County is establishing a governance structure to develop solutions for the Robles Groundwater Basin. Furthermore, San Luis Obispo County Flood Control and Water Conservation District currently acts as the designated monitoring entity for CASGEM-required monitoring, and ordinances and regulations are currently utilized to both promote onsite stormwater recharge for groundwater augmentation and to minimize the potential loading of salts and pollutants to the groundwater basin. These measures, and other similar institutional controls, will continue to be used by governmental agencies to protect and sustain groundwater resources.

7.1.9 Recycled Water

The implementation of recycled water is regulated by the Title 22 California Code of Regulations (Title 22). Numerous BMPs and operating procedures are required to be followed when using recycled water for irrigation to ensure safety. The following BMPs are implemented in recycled water operations:

- Water quality monitoring at the treatment plant to ensure regulatory compliance with Title 22, and meet monitoring requirements for indicator emerging contaminants as part of the Recycled Water Policy.
- Irrigation at agronomic rates – irrigation is applied at a rate that does not exceed the demand of the plants and does not exceed the field capacity of the soil.

- Site Supervisor – a site supervisor who is responsible for the system and for providing surveillance at all times to ensure compliance with regulations and Permit requirements is designated for each site. The Site Supervisor is trained to understand recycled water, and supervision duties. In addition to monitoring the recycled water system, the Site Supervisor must also conduct an annual self-inspection of the system.
- Minimize runoff of recycled water from irrigation – Irrigation is not allowed to occur at any time when uncontrolled runoff may occur, such as during times of rainfall or very low evapotranspiration; and any overspray must be controlled.

7.1.10 Need for Additional Implementation Measures

As demonstrated above, a significant number of implementation measures are currently practiced or are planned for implementation in the groundwater basin that will help mitigate and manage salt and nutrient loading. At present, the development of a governance structure that would protect the groundwater basin is underway; however, the results of these actions cannot be determined at this point and have the potential to directly or indirectly modify current and/or planned basin management practices.

Based on this analysis, and those presented in Chapters Chapter 3, Chapter 4 Chapter 5, no additional implementation measures beyond what has been implemented and are planned for the SNMP planning period are currently planned. Further measures may be warranted in the future. However, it is important to recognize that the salt and nutrient management process is intended to be active and ongoing, and additional work may be required to secure grants and other monies to fund measures required by the Sustainable Groundwater Management Act. Salt and nutrient concentrations in groundwater will be monitored to determine if water quality improvement objectives are met in the future and the need for additional implementation measures will be reassessed when the SNMP is updated in the future.

SNMP Monitoring Program

Salt/Nutrient Management Plan for the Paso Robles Groundwater Basin

SNMP Monitoring Program

Chapter 8 Groundwater Quality Monitoring

8.1 Background

8.1.1 Recycled Water Policy Requirements for SNMP Monitoring Program

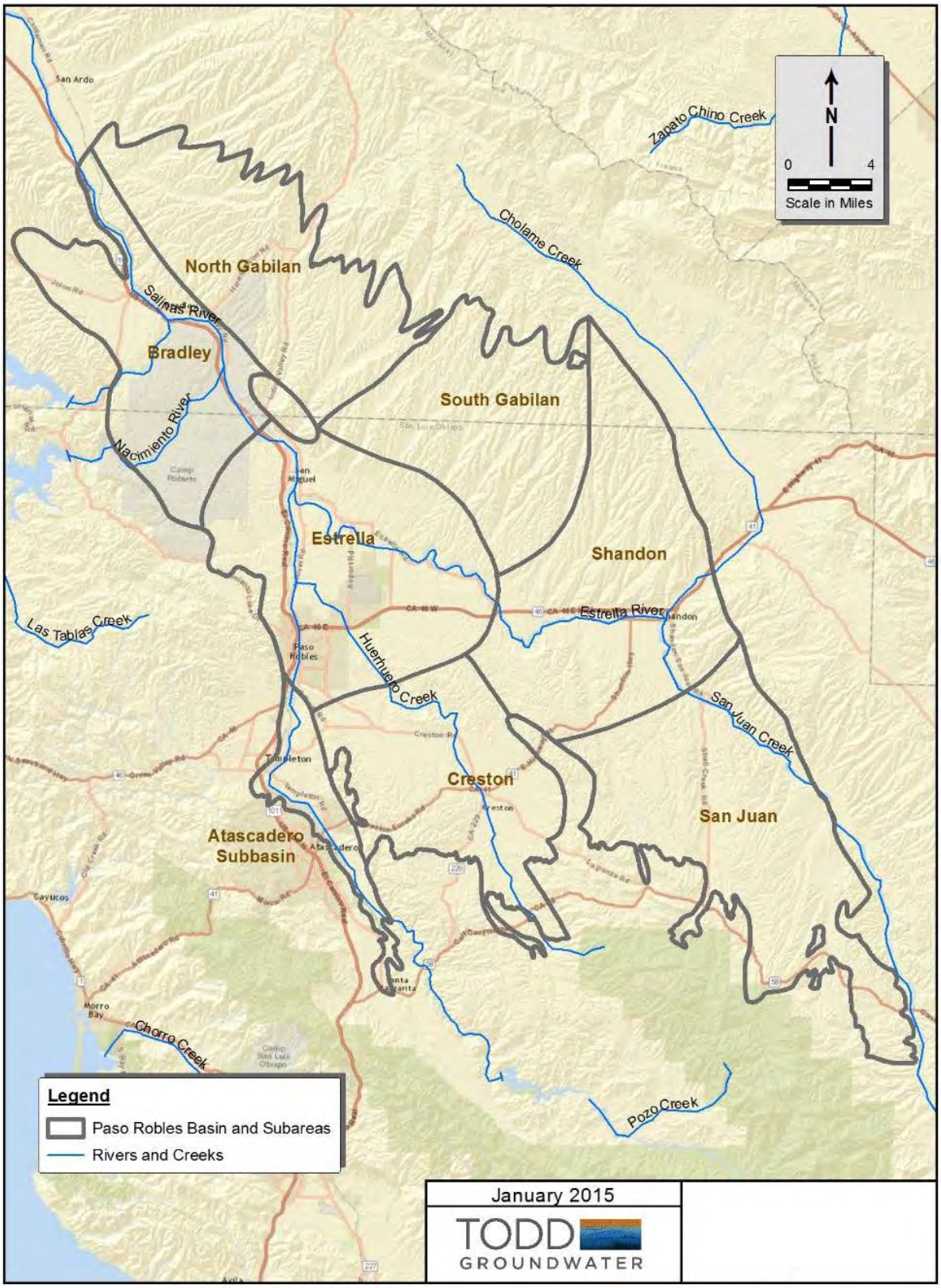
This chapter describes the Paso Robles SNMP Groundwater Quality Monitoring Program. The State Water Resources Control Board (SWRCB) Recycled Water Policy (2009) states that SNMPs should include a monitoring program (SNMP Groundwater Quality Monitoring Program) that consists of a network of groundwater 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 Groundwater Quality Monitoring Program "*….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 SNMP Groundwater Quality Monitoring Plan should identify those stakeholders responsible for conducting, sampling, and reporting the monitoring data. The data shall be reported to the Regional Water Quality Control Board at least every three years. With regard to constituents of emerging concern (CECs), for basins with recycled water recharge projects, the Recycled Water Policy requires that the SNMP include "*….a provision for annual monitoring of Constituents/Constituents of Emerging Concern (e.g., endocrine disruptors, personal care products or pharmaceuticals) consistent with recommendations by DDW and consistent with any actions by the State Water Board….*" ; however, Attachment A of the Policy also 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*." The policy does not discuss CEC monitoring for agricultural irrigation application uses. Because there currently are no recycled water recharge projects and recycled water is not used for irrigation in the Paso Robles Groundwater Basin, monitoring for CECs in groundwater in the Paso Robles Basin is not required under the Recycled Water Policy or other state regulations.

8.1.2 Study Area

The Paso Robles Groundwater Basin is formally recognized by DWR as a subbasin to the greater Salinas Valley Groundwater Basin and is identified as Groundwater Subbasin Number 3-4.06 in DWR Bulletin 118 (DWR, 2003), and referred to as Paso Robles Basin or Basin in the remainder of this chapter. The Basin is approximately 505,000 acres (790 square miles) in size, with approximately 72 percent (363,600 acres) of its area located in San Luis Obispo County and the remaining 28 percent (141,400 acres) located in Monterey County (Figure 8-1).

Figure 8-1: Study Areas



In the *Groundwater Basin Study* (Fugro and Cleath, 2002), the Paso Robles Groundwater Basin was divided into eight study areas or subareas (Figure 8-1):

1. Atascadero Subbasin (15,181 acres),
2. Bradley Subarea (55,162 acres),
3. Creston Subarea (57,347 acres),
4. Estrella Subarea (81,822 acres),
5. North Gabilan Subarea (65,630 acres),
6. San Juan Subarea (84,027 acres),
7. Shandon Subarea (82,986 acres), and
8. South Gabilan Subarea (58,391 acres).

These study areas were defined for analysis and discussion purposes in the Basin Study.

Per the Central Coast Regional Water Quality Control Board's June 2011 *Water Quality Control Plan for the Central Coastal Basin* (Basin Plan), groundwater throughout the Central Coast Basin (except for that found in the Soda Lake Subbasin) is suitable for municipal, domestic and agricultural water supply and industrial use, and therefore afforded the beneficial use designations of MUN, AGR and IND, respectively. Groundwater with the municipal and domestic use (MUN) benefit designation typically is of the highest quality. Based on well data available for the period from 1980 to 2012, there were approximately 4,600 wells in the Paso Robles groundwater basin, of which approximately 1% were municipal supply wells, 65% were domestic wells, 3% were small community wells and 31% were for agricultural supply. No data were available on the number of industrial wells in use during this period, but given the agrarian status of the groundwater basin during this period, this number is expected to be small.

8.1.3 Existing Groundwater Quality and Water Level Monitoring

As described the *Paso Robles Groundwater Basin Management Plan* (GEI, et al., 2011), sources of water quality data include DWR, local municipalities, USGS, and local growers. Groundwater is also monitored by other water purveyors. In addition, an extensive groundwater sampling program was conducted in 2001 by San Luis Obispo County (County) to support the Paso Robles Groundwater Basin Study (Fugro and Cleath, 2002). Groundwater quality is also monitored at environmental release sites; however, these sites typically monitor shallow groundwater and do not typically monitor for the salts and nutrients (S/Ns) addressed in the SNMP, which include TDS, nitrate, and chloride. Of these sources of groundwater quality data, monitoring conducted by water purveyors in accordance with the California Code of Regulations (CCRs), Title 22 Drinking Water Program is currently the only ongoing regular monitoring of shallow and deeper production zones.

Existing Groundwater Quality Monitoring Programs

Title 22 Drinking Water Program

The SWRCB Division of Drinking Water (DDW) regulates public water systems in the State to ensure the delivery of safe drinking water to the public. A public water system is defined as 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, wells associated with drinking water systems with less than 15 residential service connections, industrial and irrigation wells are not regulated by the DDW. County-level public health and well permitting agencies regulate domestic wells and local small (2 to 4 residential service connections) and state small (5 to 14 residential service connections) water system wells to varying degrees. Water quality data associated with these programs are generally not available in electronic formats.

The SWRCB-DDW enforces the monitoring requirements established in Title 22 of the CCRs for public water system wells, and all the data collected must be reported to the SWRCB-DDW, as summarized in Table 8-1. Local compliance also is summarized. Title 22 also designates the regulatory limits (e.g., maximum contaminant levels [MCLs]) for various waterborne contaminants, including volatile organic compounds, non-volatile synthetic organic compounds, inorganic chemicals, radionuclides, disinfection byproducts, general physical constituents, and other parameters. Figure 8-2 depicts the public water system wells with recent (last four years) water quality data in the SWRCB-DDW database.

GAMA and USGS Groundwater Monitoring

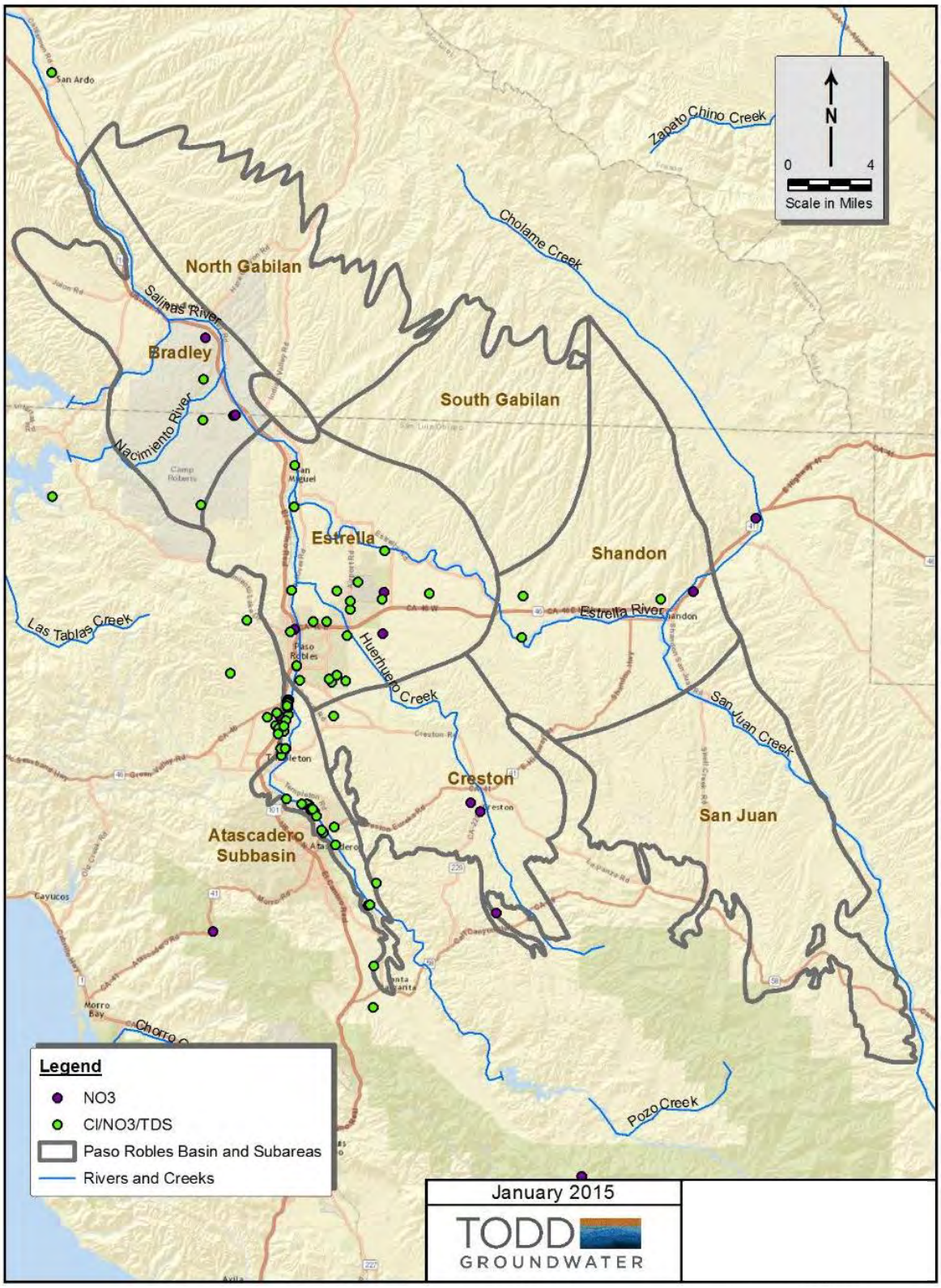
In 2000, the SWRCB established the Groundwater Ambient Monitoring & Assessment (GAMA) Program, California's comprehensive groundwater quality monitoring program (http://www.swrcb.ca.gov/water_issues/programs/gama/). The main goals of GAMA are to improve statewide groundwater monitoring, increase the availability of groundwater quality information to the public, and better understand and identify risks to groundwater resources. There are currently four components to the GAMA Program:

1. Priority Basin Project – To assess California's drinking water aquifers, the USGS collects groundwater samples from public supply wells throughout the State and analyzes the samples for regulated and unregulated chemicals, including emerging constituents such as pharmaceuticals and personal care products, isotopes, and age-dating tracers. Monitoring and assessments are on a 10-year cycle, with trend monitoring more frequent. The Salinas Valley Basin is considered a Category 1 (highest) priority basin. More details on this project can be found at: http://www.swrcb.ca.gov/water_issues/programs/gama/priority_basin_projects.shtml.
2. Domestic Well Project – Private wells in the State are sampled by volunteer well owners, and samples are analyzed for nitrate, trace metals, volatile organic compounds, pesticides, and radionuclides.
3. Special Studies Project – With the Lawrence Livermore National Laboratory as the project lead, specific groundwater quality studies have been conducted using state of the art scientific techniques and methods that help researchers and public policy planners better understand how groundwater contamination occurs and behaves. Studies have included sources of nitrate, wastewater mixing, groundwater recharge, trace detection of pharmaceutical compounds and personal care products, using low-level anthropogenic compounds as tracers, and isotopic composition as a contamination source tool.
4. GeoTracker GAMA – A publicly-accessible, on-line groundwater information system that integrates and displays water quality data on an interactive, searchable map (http://geotracker.waterboards.ca.gov/gama/). Its analytical tools and reporting features help users assess groundwater quality and identify potential groundwater issues. GeoTracker GAMA contains over 125 million data records from different sources such as cleanup sites, well logs, SWRCB-DDW quality data from public water system wells (discussed in the previous section), water levels from the DWR, California Department of Pesticide Regulation, GAMA Priority Basin Project, GAMA Domestic Well Project, and the GAMA Special Studies Project. GeoTracker GAMA also includes water quality compliance monitoring data for on-farm domestic wells and irrigation supply wells associated with the Central Coast Water Board's Agricultural Order (see Section 1.3.14).

Table 8-1: CCR Title 22 Public Water System Well Monitoring

Program Origin	Title 22 of the California Code of Regulations: http://www.cdph.ca.gov/certlic/drinkingwater/Pages/Lawbook.aspx
Responsible Agency	Public water system well owners meeting the regulation connection definitions
Number of Monitoring Points	Groundwater samples from >100 production wells in the Paso Robles Groundwater Basin
Monitoring Locations	Active public water system, wells permitted by the SWRCB-DDW (formerly CDPH) that are located throughout the Paso Robles Basin (see Figure 8-2).
Constituents and Frequency	Public water system wells are sampled for many parameters, including coliform bacteria/e-coli, volatile organic compounds, non-volatile synthetic organic compounds, inorganic chemicals, radionuclides, disinfection byproducts, and other general physical constituents. The constituents monitored and the frequency of monitoring varies based on the well location, size of the water system, and history of water quality results. These programs include the three indicators of salts and nutrients (total dissolved solids, chloride, and nitrate) designated in the Salt and Nutrient Management Plan in most well. {Public water system wells must be sampled in accordance with monitoring schedules (http://www.cdph.ca.gov/certlic/drinkingwater/Pages/Monitoring.aspx) enforced by the SWRCB-DDW.
Other Media Monitored/ Monitoring Locations	Water samples are collected at various locations throughout the distribution system, including: • Raw water at the well, • Service connections to other systems or imported water service connections, • Designated sampling points along the distribution piping, • Effluent of water storage tanks and blending tanks, and • Effluent of treatment plants.
Reporting/ Databases	• Analytical results are submitted directly to the SWRCB-DDW database as Electronic Database Files: http://www.cdph.ca.gov/certlic/drinkingwater/Pages/EDT.aspx • Title 22 monitoring data can be downloaded from the SWRCB-DDW website: http://www.cdph.ca.gov/certlic/drinkingwater/Pages/EDTlibrary.aspx • Title 22 monitoring data as well as other water quality data are available at the Groundwater Ambient Monitoring & Assessment (GAMA) Program website: http://geotracker.waterboards.ca.gov/gama/
Quality Assurance / Quality Control (QA/QC) Program	• Provided by certified laboratories and their established quality assurance and quality control (QA/QC) programs • Laboratories utilize U.S Environmental Protection Agency method acceptance criteria and laboratory internal controls for QC parameters, including preparation blanks, surrogates, spikes, duplicates and laboratory control samples
Compliance Oversight	Data are reviewed for compliance and any necessary corrective actions by groundwater purveyors and the SWRCB-DDW

Figure 8-2: Public Supply Wells



In 2005, as part of the GAMA Priority Basin Project (http://ca.water.usgs.gov/projects/gama/), the USGS sampled wells in the Paso Robles Basin for:

- Volatile organic compounds (VOCs), pesticides, pesticide degradates, nutrients, major and minor ions, trace elements, radioactivity, microbial indicators, and dissolved noble gases (the last in collaboration with Lawrence Livermore National Laboratory).
- Naturally-occurring isotopes (tritium, carbon-14, helium-4, and the isotopic composition of oxygen and hydrogen) also were measured to help identify the source and age of the sampled ground water.
- Synthetic organic constituents – Includes volatile organic compounds, gasoline oxygenates and their degradates, pesticides, polar pesticides and pesticide degradates, pharmaceutical compounds, and potential wastewater indicators) (USGS, 2011a and b).

Paso Robles Groundwater Basin Study

In 2001, to support the Paso Robles Groundwater Basin Study (Fugro and Cleath, 2002), all available groundwater quality data were compiled and groundwater samples from 65 wells were collected and analyzed for the following constituents:

- Carbonate
- Bicarbonate
- Total alkalinity (as $CaCO_3$)
- Chloride
- Electrical conductance (EC)
- Anionic surfactants (MBAS)
- Nitrate (as N)
- Nitrate (as NO_3)
- pH
- Sulfate
- Total dissolved solids (TDS)
- Boron
- Calcium
- Hardness
- Sodium adsorption ratio (SAR)
- Copper
- Iron
- Potassium
- Magnesium
- Manganese
- Sodium
- Zinc

Water quality data from this study were presented in Chapter 3.

Agricultural Order

In 2012, the Central Coast Regional Water Quality Control Board (CCRWQCB) issued Agricultural Order No. R3-2012-001, a Conditional Waiver of Waste Discharge Requirements for Discharges from Irrigated Lands (Agricultural Order). The permit requires that growers implement practices to reduce nitrate leaching into groundwater and improve surface receiving water quality. Specific requirements for individual growers are structured into three tiers based on the relative risk their operations pose to water quality. Growers must enroll, pay fees, and meet various monitoring and reporting requirements according to the tier to which they are assigned.

All growers are required to implement groundwater monitoring, either individually or as part of a cooperative regional monitoring program. Growers electing to implement individual monitoring (i.e., not participating in the regional monitoring program implemented by the Central Coast Groundwater Coalition or CCGC) are required to test all on-farm domestic wells and the primary irrigation supply well for nitrate or nitrate plus nitrite, and general minerals (including, but not limited to, TDS, sodium, chloride and sulfate). These data were recently made available to the public in GeoTracker GAMA with the well locations obfuscated to within a one-half mile radius of their actual location. CCGC groundwater quality data are generally less extensive and have been collected to develop regional assessments including nitrate concentration contour maps consistent with the CCGC workplan. The CCGC data and technical reports are currently not available to the public in GeoTracker GAMA, but can be accessed via a formal public records act request. As of April 2014, the individual and cooperative monitoring data represent water quality analyses from 211 on-farm domestic wells and 294 irrigation supply wells for the Paso Robles Area subbasin. These data were not included in the SNMP given that they were emerging at the time the SNMP was being developed. These data have the potential to significantly change the groundwater quality assessment, assimilative capacity and antidegradation analyses prepared for this SNMP. Consequently, any subsequent analyses should include these data to more accurately reflect existing groundwater quality conditions.

Existing Groundwater Level Monitoring Program

San Luis Obispo County Flood Control and Water Conservation District (County) has been monitoring groundwater levels county-wide on a semi-annual basis (spring and fall) for more than 50 years to support general planning and for engineering purposes. The monitoring takes place from a voluntary network of production wells. The voluntary monitoring network has changed over time as access to wells has been lost or new wells have been added to the network

As of 2010, about 160 wells in the Paso Robles Basin were monitored by the County Department of Public Works, cooperating agencies, and Monterey County Water Resources Agency. The goals of the groundwater level monitoring and reporting program in the Paso Robles Basin include:

- Assessing groundwater elevations on an annual basis including trends, conditions, and adequacy of the groundwater level monitoring network.
- Preparing and distributing annual groundwater level monitoring reports to the public and public officials.
- Developing an outreach program to obtain groundwater level data from private pumpers and private well owners in the Basin.
- Coordinating with local, state, and federal agencies to develop better information on groundwater level monitoring and comply with current monitoring and report requirements such as California Statewide Groundwater Elevation Monitoring (CASGEM) Program.

The *Paso Robles Groundwater Basin Management Plan* (GEI, et al., 2011) recommended that the voluntary groundwater level monitoring program:

- Increase the number of wells in the groundwater level monitoring network in the Paso Robles Basin.
- Obtain well construction data for existing wells included in monitoring network to improve understanding of aquifer being represented by each well.
- Increase groundwater level monitoring frequency from semi-annual to quarterly. If this cannot be done for all wells in the monitoring network, it should at least be done for selected wells (such as the key Basin Management Objectives [BMOs] wells) that have construction information and a historical water level record.

- Expand the monitoring network to include areas experiencing changes in groundwater levels or changing land use conditions.

The current groundwater level monitoring network provides a reference for identifying wells that could potentially be added in the SNMP Groundwater Quality Monitoring Program in the future. Figure 8-3 shows the locations of 158 wells that were monitored for groundwater levels in the Fall of 2012.

8.1.4 Regional Groundwater Basin Management

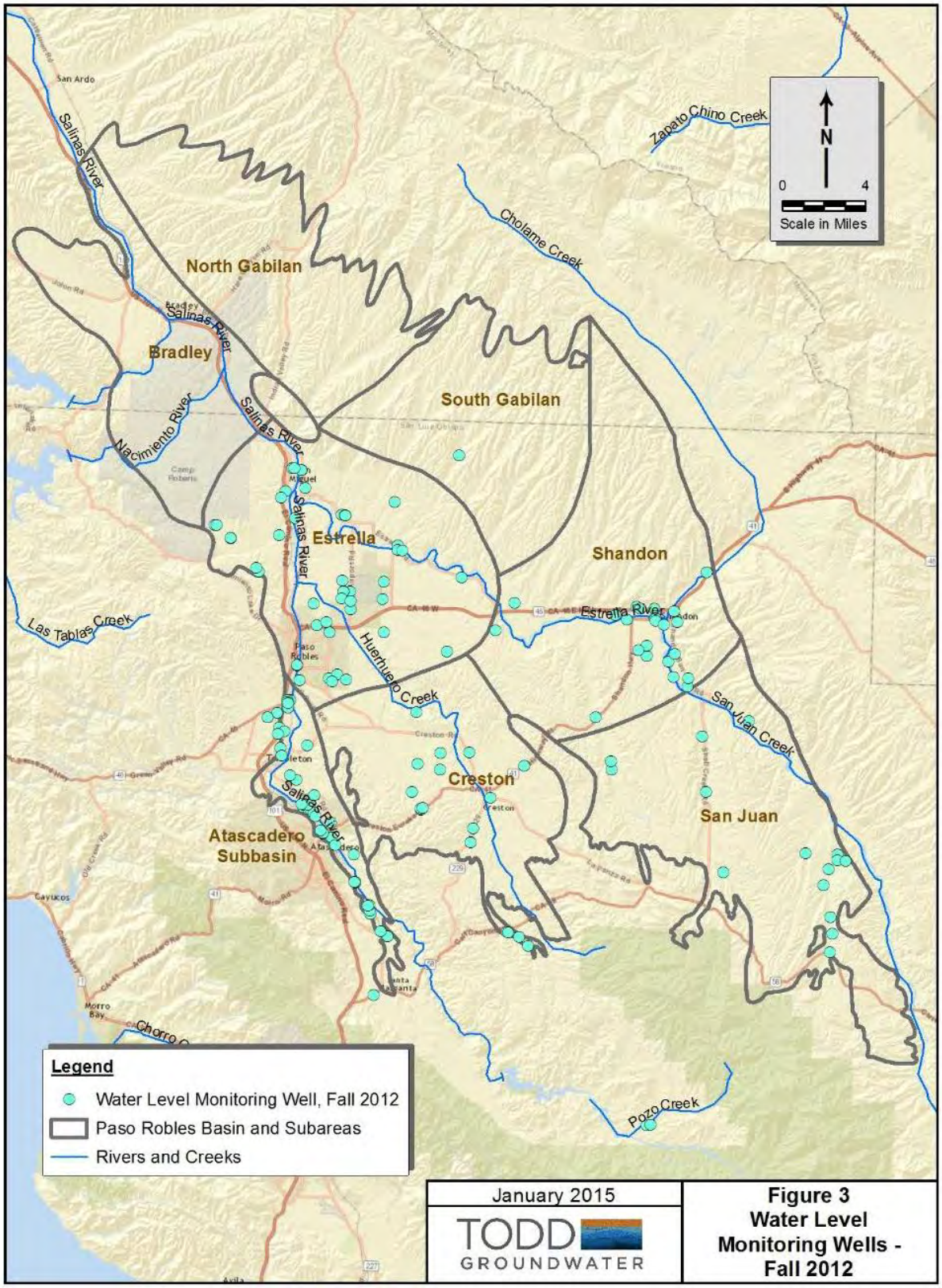
Since 1998, local agencies and stakeholders have worked cooperatively to complete several projects to conduct technical investigations and improve groundwater management of the Paso Robles Basin (GEI, et al., 2011). The City of Paso Robles, in coordination with a Paso Robles Groundwater Basin Groundwater Advisory Committee, prepared and adopted a *Groundwater Management Plan* (GEI, et al, 2011) in accordance with Assembly Bill 3030 to facilitate basin management.

Recent legislation has been passed that encourages active groundwater management. The Sustainable Groundwater Management Act (Act) of 2014 is the first legislation in California to comprehensively regulate groundwater. Building on the recognition that groundwater management in California is best accomplished locally, it provides local water agencies with considerable new powers, most notably the power to regulate pumping. Nonetheless, the Act also imposes substantial responsibility to find solutions for overdraft and to achieve long-term sustainability of groundwater supply, including groundwater quality necessary to support beneficial uses. If local agencies fail to form GSAs, develop acceptable GSPs, or effectively implement GSPs within specified time frames, the State can intervene to develop and implement GSPs.

The Act, defined in three linked legislative bills, is detailed and comprehensive. It provides a priority list of groundwater basins, defines Groundwater Sustainability Agencies (GSAs), outlines the contents of Groundwater Sustainability Plans (GSPs), establishes the roles of State agencies, and sets a timeline with deadlines. Specifically, it mandates the preparation of management plans for more than 100 groundwater basins by 2022 with subsequent achievement of sustainability in another 20 years. While building on previous management legislation, it more than ever requires acknowledgment of multiple benefits and uses of groundwater, including maintenance of stream flows and environmental benefits, and supports collaboration between water agencies and planning agencies.

Although the Act generally applies to all groundwater basins in the State, it imposes groundwater management requirements only on groundwater basins that the DWR has designated as high- or medium-priority pursuant to the CASGEM Program. In its 2014 Final Basin Prioritization, DWR categorized the Paso Robles Groundwater Basin as a high priority basin. Compliance with the Act may result in modifications of the SNMP Groundwater Quality Monitoring Program proposed herein. Accordingly, while recommendations are discussed herein, development of a basin-wide groundwater quality monitoring network and identification of funding mechanisms are appropriately deferred until efforts are undertaken to comply with the Act.

Figure 8-3: Water Level Monitoring Wells (Fall 2012)



8.2 Summary of SNMP Groundwater Quality Monitoring Program

Currently no funding mechanism exists to support a regional groundwater quality monitoring and reporting program; however, possible funding opportunities should be forthcoming in the near future as part of the ongoing county basin management activities and pending water district formation, and as part of the Sustainable Groundwater Management Act requirements. Accordingly, the proposed SNMP Groundwater Quality Monitoring Program is based on the existing Title 22 Drinking Water Program[3].

8.2.1 Monitoring Locations and Construction

Figure 8-2 shows the public water system wells for which water quality data are currently (over the last four years) being reported to the DDW. A total of 127 wells have recent water quality data in the DDW database; these data are also integrated with the GeoTracker GAMA information system along with obfuscated well locations. Well locations are depicted within ½ to one mile of the actual location based on x-y coordinates downloaded from the GAMA GeoTracker database as the DDW database does not include well location information for security reasons.

The County has compiled all available DWR drilling logs and has entered well construction information into a confidential database (Fugro and Cleath, 2002), unless the well owner has agreed to release the well log. The Title 22 wells are typically screened in the shallow alluvium along rivers and streams and/or in the Paso Robles Formation.

As can be observed from Figure 8-2 and Figure 8-3, most wells with water quality or water level data are located proximate to the Salinas River and other primary stream such as Huer Huero Creek and the Estrella River. Few to no wells are monitored in the Bradley, or North and South Gabilan subareas. As such, limited data on groundwater elevation and/or groundwater quality exist in these areas.

8.2.2 Parameters and Frequency

The constituents monitored and the frequency of monitoring varies based on the well location, size of the water system, and history of water quality results. Typically, TDS, chloride, and nitrate are monitored along with other constituents. For some wells, only nitrate sampling is reported in the DDW database. Figure 8-2 shows which wells are monitored for which S/Ns.

8.2.3 Sampling Procedures, Analysis, and Quality Assurance

Sampling is conducted in accordance with industry accepted standard sampling protocols and analyses are conducted by California state certified laboratories.

8.2.4 Data Analysis and Reporting

Data are uploaded by the responsible water purveyors to the DDW quality portal and data are available on the DDW website and via the GAMA GeoTracker site. Responsible parties in the Basin have included water companies, water districts, municipalities/water departments, other government agencies, community

[3] It is recognized that the proposed monitoring program may not be a sufficient surrogate for basin-wide monitoring in the absence of a more robust monitoring program with appropriate temporal and spatial scales. This is because data from municipal supply wells are heavily skewed towards deeper, higher quality wells that are not necessarily representative of the basin as a whole. Using public water system wells to evaluate water quality conditions – and protect drinking water beneficial uses - may not provide sufficient lead time to protect deeper and higher-quality portions of the subbasin. However, given the present implementation status of the Sustainable Groundwater Management Act, it is not appropriate, at this time, to pre-suppose a basin-wide monitoring program under the auspices of a GSA(s) yet to be formed.

services districts, water associations, schools, private companies and businesses, residential developments, camp grounds, golf courses, prisons, and hospitals.

8.3 Conclusions and Recommendations

8.3.1 Conclusions

- All publically available groundwater quality data collected through approximately 2012 were compiled to assess Basin water quality for the SNMP (Fugro, 2013). Ag Order compliance monitoring data were not included in these analyses as these data were emerging at the time of the SNMP development.
- The existing groundwater quality data were found to be adequate to support the Paso Robles Groundwater Basin Study and the SNMP Basin Characterization (Fugro 2013). However, it should be acknowledged that the Ag Order groundwater monitoring compliance data have the potential to change the results of the characterization and analyses included in the SNMP.
- The data from the Title 22 Drinking Water Program, which constitutes the proposed SNMP Groundwater Quality Monitoring Program, are uploaded to the water quality portal of the SWRCB-DDW, and no additional reporting is proposed for the purposes of this SNMP.
- While the SNMP Groundwater Quality Monitoring Program could be improved, there is currently no regular funding mechanism to support such improvements.
- Implementation of regulations stemming from the Sustainable Groundwater Management Act of 2014, including the formation of one or more GSAs and development and implementation of GSPs, may potentially result in improvements to the SNMP Groundwater Quality Monitoring Program.
- Specific improvements to the SNMP Groundwater Quality Monitoring Program are more appropriately developed under the authority of GSA(s), once established.

8.3.2 Recommendations

The following recommendations are provided and should be considered in the context of the Sustainable Groundwater Management Act (i.e., through development of a GSP by a GSA).

Basin-Wide Groundwater Quality Monitoring Program

Consistent with the Sustainable Groundwater Management Act, a comprehensive basin-wide water quality monitoring program should be developed by the GSA(s) and made part of the GSP(s) for the Paso Robles Groundwater Basin. This program would be more comprehensive than the SNMP Groundwater Quality Monitoring Program described below, and ultimately should replace this monitoring plan once it has been developed.

Data Collection and Management

A database of all existing well, water level, and water quality data should be created by a future GSA. This database would build on the County water level database and data available from the SWRCB-DDW, GeoTracker and previous basin studies. The well information would also be based on information from all available well drillers' logs and permits and include locations, construction (including aquifer screened), use and status (i.e., active, abandoned) and whether the well is monitored under the Title 22 Drinking Water Program or monitored for water levels by the County. Locations and elevations of wells ultimately selected for the water quality monitoring program should be determined with a Geographic Position System (GPS) and GIS. Water level and water quality from all available sources should be compiled into a standard database format. An alternative to developing this stand-alone database would be to work with the SWRCB

GAMA program to build tools within GeoTracker GAMA that enable the integration and analysis of regional monitoring data along with the data that is already in GeoTracker.

At present, monitoring for constituents/parameters with secondary MCLs (e.g., TDS, Na, Cl, SO4, etc.) is already required for "community water system" wells once every three years (Title 22, Section 64449 of the CCRs), unless a [nine year] waiver has been granted per section 64449.2. (Note: "community water systems" are a subset of "public water systems;" see definitions in Section 116275 of the Health and Safety Code). TDS data are therefore already available via the DDW and GeoTracker GAMA databases for most public water systems; however, these data are sparse compared to other water quality data. Wells lacking TDS data are shown as purple circles on Figure 8-2. Having TDS data for these wells would provide additional spatial distribution for TDS coverage.

As part of data collection, a review of contamination release sites should be conducted to identify any environmental release sites that have or may have the potential to impact potable water supply aquifers. This information should be considered in determining monitoring well locations and constituents monitored.

Monitoring Program Goals and Objectives

Prior to developing the monitoring program, the program goals and objectives should be identified. Some potential goals include:

- Documenting historical and existing ambient groundwater quality conditions.
- Evaluate and understand the effects of land use practices on groundwater quality.
- Understand spatial and vertical distribution of water quality constituents.
- Conduct ongoing groundwater quality analyses to evaluate trends in water quality.
- Inform and measure the effectiveness of basin management decisions.
- Identify and protect beneficial uses.
- Prevent additional water quality impairments associated with salts and nutrients, particularly nitrates.
- Where practicable, work to restore water quality conditions where salt and nutrient impairment or pollution has already occurred.

Monitoring Well Network

In addition to the Title 22 data, which should be compiled annually and included in the water quality database, a network of wells should be identified that will be monitored regularly by a future GSA. This network of wells would include a subset of the Title 22 wells plus additional existing water supply wells and potentially new dedicated monitoring wells. The monitoring program well network would be monitored regularly for a larger list of constituents of concern than those monitored under the Title 22 program and should monitor groundwater quality at a variety of depths (i.e. be composed of shallow and deeper monitoring wells).

With program goals in mind, the monitoring network will focus on characterizing water quality land use impacts; however, documenting background conditions upgradient of potential land-use impacts is also important, as is addressing vertical variations in groundwater quality.

Figure 8-4 shows existing Title 22 wells monitored for TDS, nitrate and chloride as red circles. Title 22 wells monitored only for nitrate are shown as yellow squares in the figure and wells monitored for water

levels are shown as yellow triangles. Land uses are also shown on the figure. In addition to the wells shown on Figure 8-4, all existing wells (identified from the well database development task) should also be approximately located on a map to identify other wells as potential monitoring sites. Because some well owners have authorized the County to monitor water levels in some wells, they may also agree to allow water quality monitoring; accordingly, these wells should be considered for addition to the monitoring program.

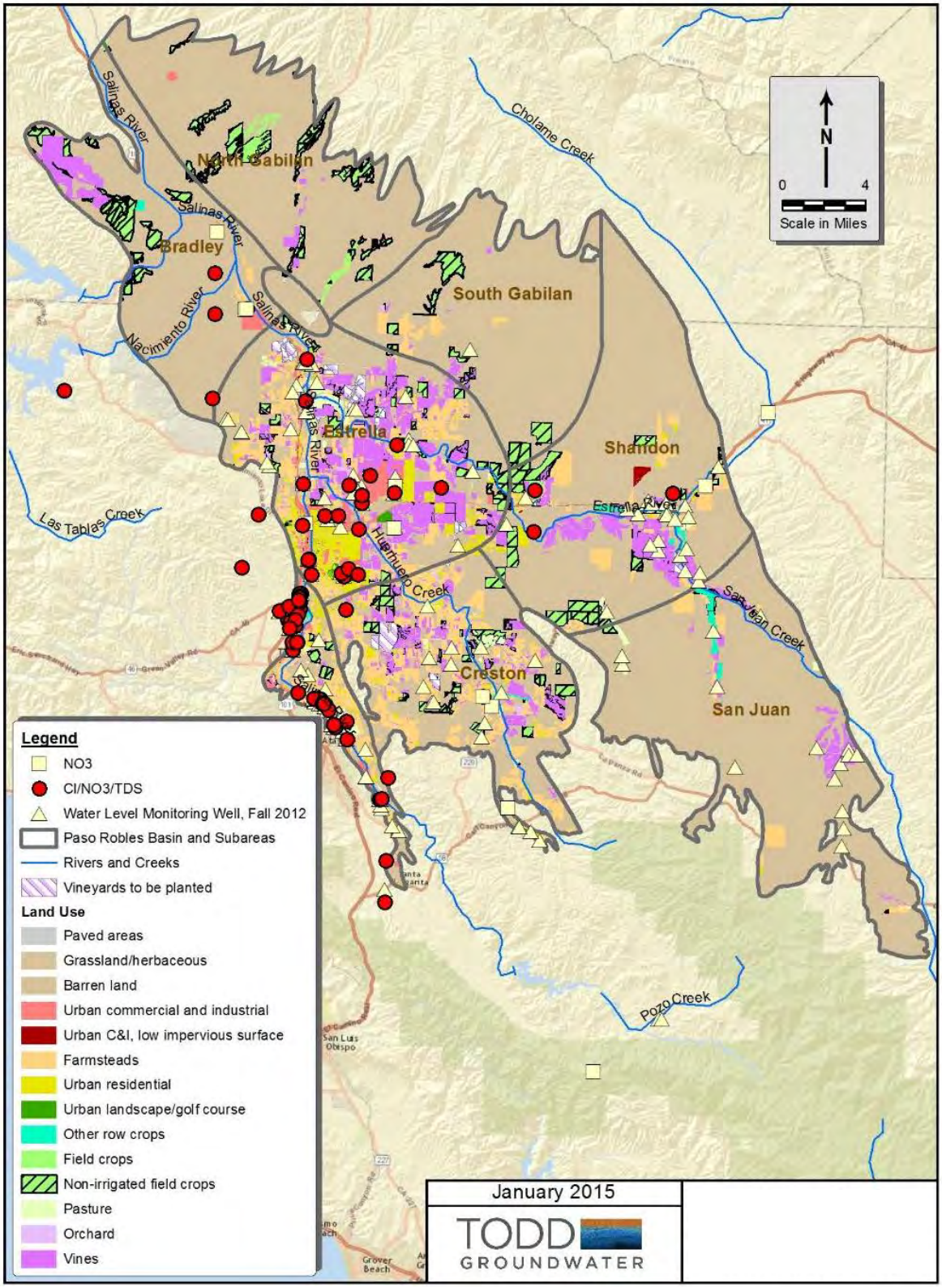
The initial goal for the water quality monitoring program could be to have at least one to two monitoring wells in each subarea. If only one well is identified, it should be located downgradient of existing land uses that may impact groundwater quality such as agriculture. In areas such as Estrella, Creston, and Atascadero (where land use is relatively intensive) more than two wells may be included in the program. Based on Figure 8-4, additional wells need to be identified to fill data gaps in the northwest corner of Bradley in the vicinity of agricultural areas, and downgradient from agricultural areas in North and South Gabilan, Shandon, San Juan and Creston to provide better spatial coverage of the groundwater basin.

Figure 8-5 shows the wells monitored for the Paso Robles Basin Study (Fugro and Cleath, 2002). The distribution of wells meets the general coverage recommendations presented in the previous paragraph. Including the Paso Robles Basin Study wells in the groundwater quality monitoring program would have the added benefit of continuing data for wells with an established baseline.

In addition to considering spatial distribution, well construction should also be considered to provide water quality information for the alluvium, and younger and older Paso Robles Formation.

Once optimal existing well locations are identified, well owners should be contacted to find owners willing to cooperate in the water quality monitoring program.

Figure 8-4: Additional Monitoring Wells Evaluation



Monitoring Frequency

The frequency of monitoring should be defined, noting that groundwater quality monitoring is required as part of a GSP. As a matter of context, GSPs also are required to include measurable objectives with interim reporting milestones in five year increments. Budgetary constraints are recognized, along with established Title 22 small water system requirements involving sampling once every two or three years. Nonetheless, at least annual sampling, as conducted by many water agencies, would allow documentation of water quality trends. Ideally, a comprehensive monitoring event would take place every five years with monitoring for a subset of constituents at least once per year.

Constituents of Concern

The regularly monitored constituents should be determined. Initial sampling may include a larger suite of chemicals to provide baseline information and help determine the constituents that should be part of the regular monitoring program. Some constituents should be monitored in all monitoring wells, while other constituents may only be a concern in localized areas of the basin, such as near wastewater percolation ponds, areas of dense septic systems, areas of geothermal upwelling, and areas of intensive agriculture. At a minimum, the baseline sampling should include general mineral and physical parameters including all major and minor cations and anions; this allows verification of the ionic balance (an accuracy check) plus geochemical plotting of water type. The constituents monitoring for the Paso Robles Groundwater Basin Study were lists in Section 8.1.3.

Baseline sampling should also include metals such as arsenic and chromium (III and VI), which can occur naturally in groundwater at elevated levels. Physical properties such as color and odor are also useful indicators of natural groundwater quality. In addition to the groundwater quality monitoring program, the County may consider collection of field EC during water level monitoring to further support the water quality monitoring program.

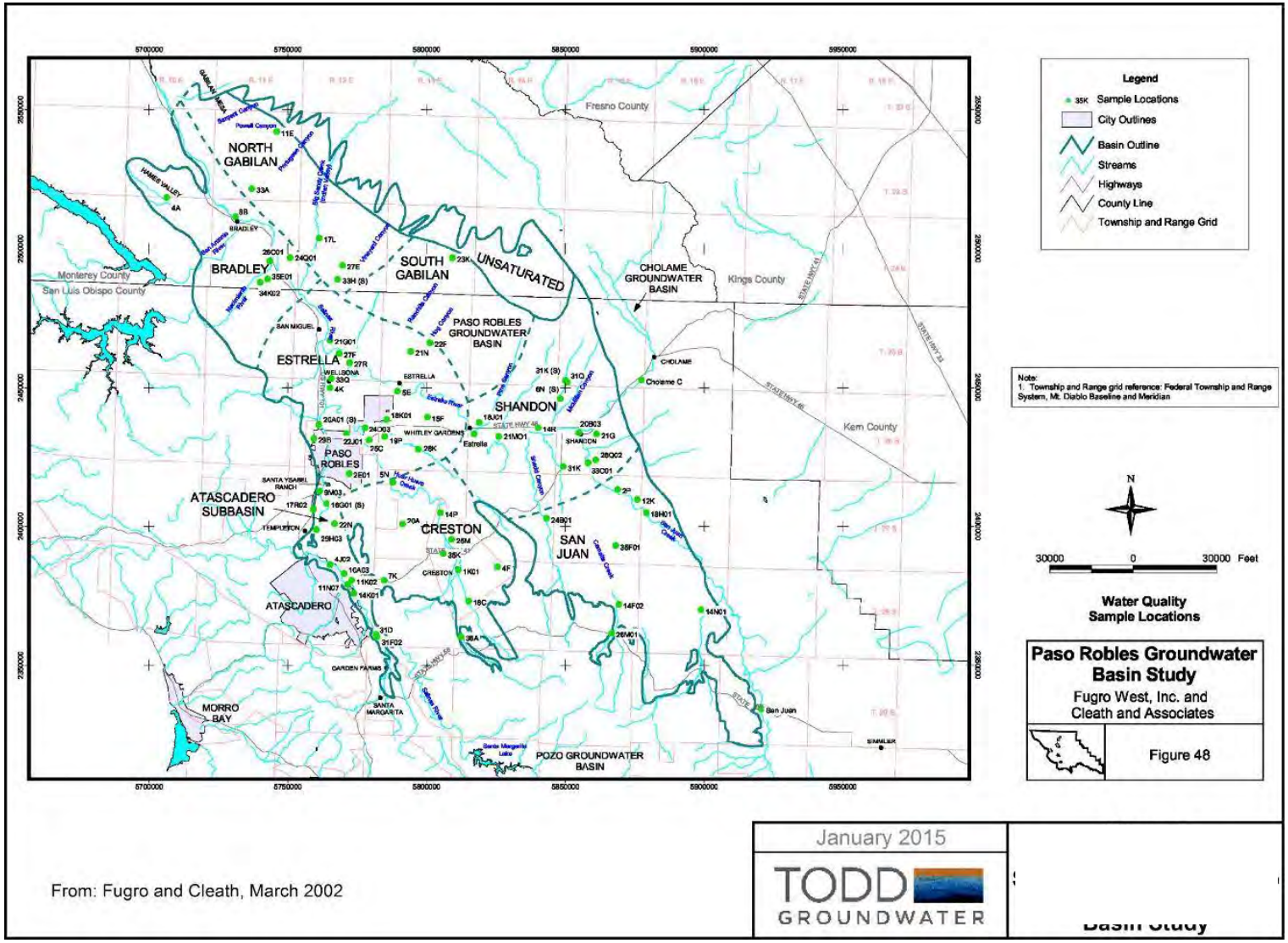
Quality Control/Quality Assurance (QA/QC)

A Quality Assurance Project Plan (QAPP) and associated Sampling and Analysis Plan (SAP) should be prepared to establish standard sample collection procedures, present standard QA/QC requirements for sampling and analysis, and to identify state certified analytical laboratories for use in the program. The QAPP, in part, would identify the appropriate spatial and temporal scales necessary to achieve the program goals and objectives.

Analysis and Reporting

Groundwater quality data should be evaluated on a regular basis for trends and exceedances of water quality objectives. It is recommended that reporting be conducted at least every three to five years.

Figure 8-5: Groundwater Quality Sampling Locations



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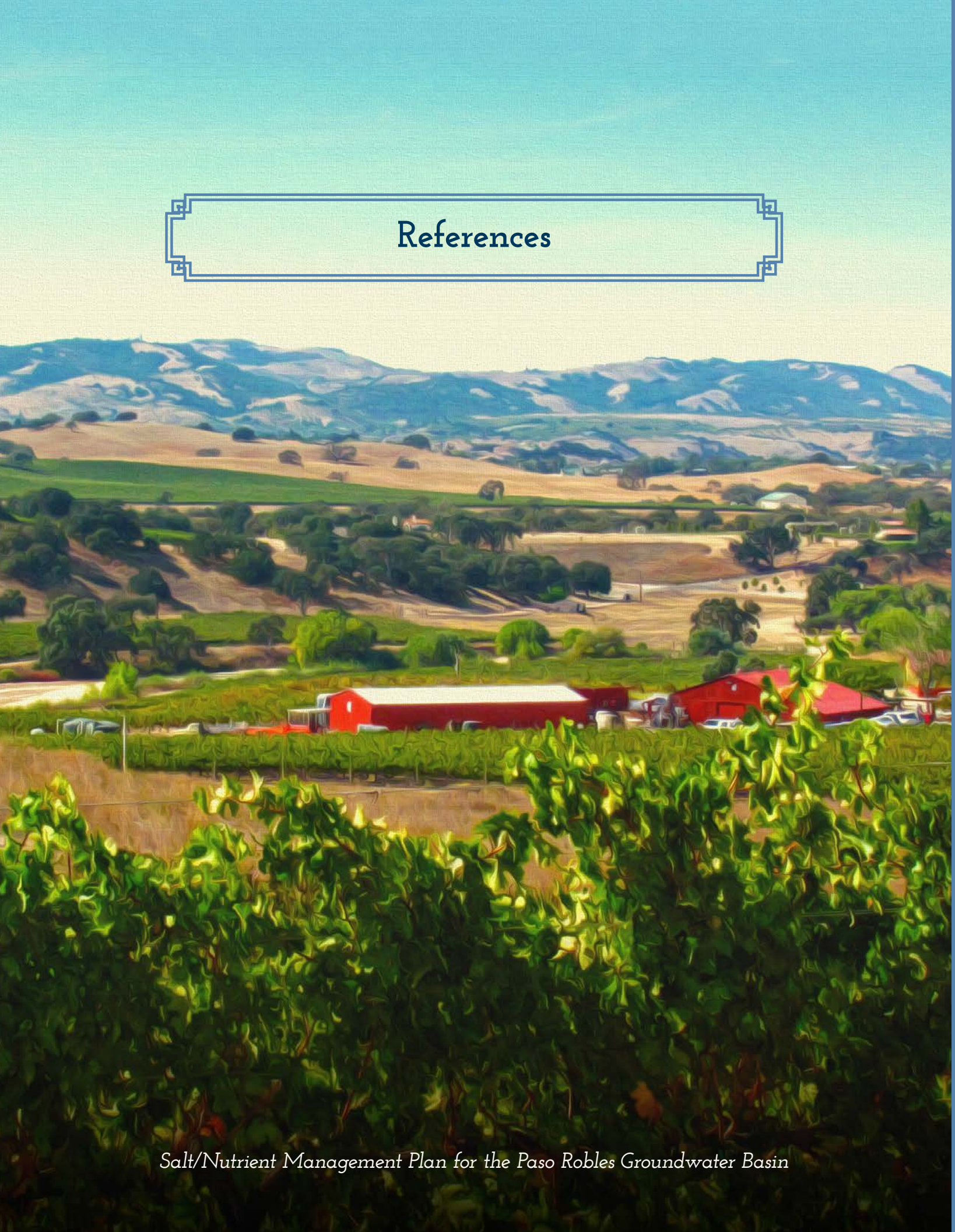

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State Water Resources Control Board (SWRCB), May 2009 Draft, amended September 2012, October 2012, and January 2013, approved January 2013, Recycled Water Policy. (http://www.swrcb.ca.gov/board_decisions/adopted_orders/resolutions/2013/rs2013_0003_a.pdf and http://www.swrcb.ca.gov/water_issues/programs/water_recycling_policy/draft_amendment_to_policy.shtml).

United States Geological Survey (USGS), 2007 and revised 2011a, Ground-Water Quality Data in the Monterey Bay and Salinas Valley Basins, California, 2005 – Results from the California GAMA Program. (http://pubs.usgs.gov/ds/2007/258/pdf/DS_258.pdf).

United States Geological Survey (USGS), 2011b, Status and Understanding of Groundwater Quality in the Monterey Bay and Salinas Valley Basins, 2005: California GAMA Priority Basin Program, Scientific Investigation Report 2011-5058. (http://pubs.usgs.gov/sir/2011/5058/pdf/sir20115058.pdf).

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Appendices

Salt/Nutrient Management Plan for the Paso Robles Groundwater Basin

Appendix A - Stakeholder Contact List

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IRWMP Stakeholder Contact List

4/2/2015

Paso Robles SNMP Stakeholder Contact Database	
Category / Stakeholder	**Contact**
Primary Stakeholders	
City of Paso Robles	Matt Thompson
City of Atascadero	David Athey
San Miguel CSD	Dan Gilmore
Heritage Ranch CSD	John D'Ornellas
San Luis Obispo County	Courtney Howard
Wallace Group	Steve Tanaka
Templeton CSD	Tina Mayer
Camp Roberts - US Army	John Morrow
Secondary Stakeholders	
Bald Eagle Ranch	Donna Tracy
Bald Eagle Ranch	George Tracy
Sauret Vineyards	Richard Sauret
SLO County Farm Bureau	Joy Fitzhugh
Templeton	Lynette Shanahan
Templeton	Evelyn Roth
Templeton	Bob Roos
University of CA Cooperative Extension	Mark Battany
Templeton CSD	Jay Short
Sereno Vista Vineyards	Jerry Reaugh
Neil Olsen Realty	Neil Olsen
Stockman's Energy	Eric Veium
Plummer Vineyards	Joe Plummer
Plummer Vineyards	Karen Plummer
City of Paso Robles, Public Works	Patti Gwathmey
	Mike Cossen
Justin Vineyards	Paul Kaselionis
Central Coast Vineyard Team	Kris Beal
NRCS	Margy Lindquist
Paso Robles	Kathy Barnett
Templeton	Gwen Pelfrey
Pacific Tank Solutions	Matt McCarrick
Paso Robles Wine County Alliance	Jennifer Porter
Paso Robles	Carolyn Fergoda
City of Atascadero	Russ Thompson
Blue Ribbon Steering Committee	Claudia Engel
Upper Salinas-Las Tablas RCD	Laura Edwards
Central Coast RWQCB	Matt Keeling
Central Coast RWQCB	Katie DiSimone
	John Hollenbeck
SLO CoastKeeper	Gordon Hensley
Justin Vineyards	Molly Dow
City of Paso Robles	Duane Picanco
PR GW Blue Ribbon	Sue Luft
Water Tech	Danilu Ramirez
	Mike Cussa
Paso Robles Wine County Alliance	Patricia Witmore
Sunview Vineyards	Willy Conlan
Central Coast Water Quality Preservation (CCWQP), Inc.	Kirk Schmidt
Michael K. Nunley & Associates, Inc.	Eileen Shields
Interested Parties/Notifications	
KPRL News Radio	Mike Mesmer

Last updated 16Jul13

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Appendix B - Technical Memorandum Posting Announcements

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The Paso Robles Salt and Nutrient Management Planning Team has posted two new documents on their website at http://pr.saltnutrient.com for review. These documents are:

- **Technical Memorandum 2 – Basin Characterization**

- **Technical Memorandum 3a – Justification of Indicator Constituents for Salts and Nutrients**

The information contained in these documents will be used in subsequent analyses and sections of the Paso Robles Salt and Nutrient Management Plan.

The team is accepting comments on these documents until:

- **5:00 pm on July 19, 2013**.

Please return any comments or concerns to Leslie Dumas of RMC Water and Environment at:

RMC Water and Environment
2001 North Main Street, Suite 400
Walnut Creek, CA 94596
Ldumas@rmcwater.com
(925) 627-4100

If you have trouble access this website and/or the documents contained on it, please contact Leslie Dumas via the aforementioned information.

The Paso Robles Salt and Nutrient Management Planning Team has posted two new documents on their website at http://pr.saltnutrient.com for review. These documents are:

- **Technical Memorandum 3 – Identify Existing and Forseeable Salt and Nutrient Sources**

- **Technical Memorandum 4 – Assimilative Capacity and Anti-Degradation Analysis**

The information contained in these documents will be used in subsequent analyses and sections of the Paso Robles Salt and Nutrient Management Plan.

The team is accepting comments on these documents until:

- **5:00 pm on June 20, 2014**.

Please return any comments or concerns to Leslie Dumas of RMC Water and Environment at:

RMC Water and Environment
2175 North California Boulevard, Suite 315
Walnut Creek, CA 94596
Ldumas@rmcwater.com
(925) 627-4100

If you have trouble access this website and/or the documents contained on it, please contact Leslie Dumas via the aforementioned information.

The Paso Robles Salt and Nutrient Management Planning Team has posted a new document on their website at http://pr.saltnutrient.com for review. This document is:

- **Technical Memorandum 5 – Implementation Measures, Goals and Objectives**

The information contained in this document will be used in the Paso Robles Salt and Nutrient Management Plan.

The team is accepting comments on these documents until:

- **5:00 pm on October 31, 2014**.

Please return any comments or concerns to Leslie Dumas of RMC Water and Environment at:

RMC Water and Environment
2175 North California Boulevard, Suite 315
Walnut Creek, CA 94596
Ldumas@rmcwater.com
(925) 627-4100

If you have trouble access this website and/or the documents contained on it, please contact Leslie Dumas via the aforementioned information.

The Paso Robles Salt and Nutrient Management Planning Team has posted a new document on their website at http://pr.saltnutrient.com for review. This document is:

- **Technical Memorandum 6 – Salt and Nutrient Groundwater Quality Monitoring Program**

The information contained in this document will be used in the Paso Robles Salt and Nutrient Management Plan.

The team is accepting comments on these documents until:

- **5:00 pm on March 6, 2015**.

Please return any comments or concerns to Leslie Dumas of RMC Water and Environment at:

RMC Water and Environment
2175 North California Boulevard, Suite 315
Walnut Creek, CA 94596
Ldumas@rmcwater.com
(925) 627-4100

If you have trouble access this website and/or the documents contained on it, please contact Leslie Dumas via the aforementioned information.

The Paso Robles Salt and Nutrient Management Planning Team has posted a new document on their website at http://pr.saltnutrient.com for review. This document is:

- **Draft Paso Robles Groundwater Basin Salt and Nutrient Management Plan**

Please be aware that the PDF file for this document is large. Please contact us if you have any trouble downloading the file.

The team is accepting comments on these documents until:

- **5:00 pm on April 30, 2015**.

Please return any comments or concerns to Leslie Dumas of RMC Water and Environment at:

RMC Water and Environment
2175 North California Boulevard, Suite 315
Walnut Creek, CA 94596
Ldumas@rmcwater.com
(925) 627-4100

If you have trouble access this website and/or the documents contained on it, please contact Leslie Dumas via the aforementioned information.

Appendix C - Workshop 1 Materials

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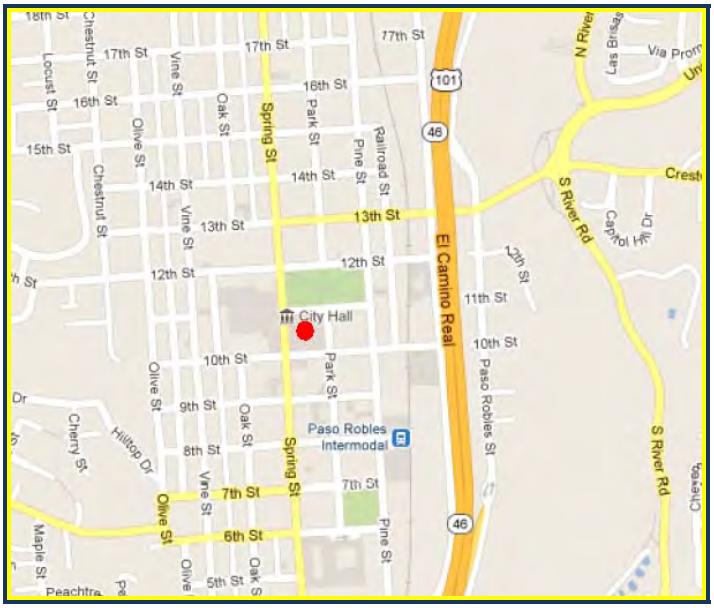
You're invited to a workshop…

Help us prepare the Paso Robles Groundwater Basin Salt and Nutrient Management Plan!

Working together to manage and protect groundwater resources

WHEN: Thursday, January 24th – 1:30 p.m.

WHERE: Paso Robles Library/City Hall Meeting Room, 1000 Spring Street, Paso Robles



- Learn about the State's Recycled Water Policy;
- Hear a presentation on the process for preparing the Salt/Nutrient Management Plan;
- Learn how you can participate.

For more information on the workshop, contact:

Matt Thompson
Public Works Department
City of Paso Robles
(805) 227-7200, ext. 7716 or
MThompson@prcity.com

Paso Robles Plain Salt/Nutrient Management Plan
SALT AND NUTRIENT MANAGEMENT WORKSHOP
January 24th, 2013, 1:30 PM – 3:00 PM
Paso Robles Library Meeting Room
1000 Spring Street, Paso Robles

A G E N D A

1. **Introductions**

2. **Background on the Recycled Water Policy**

3. **Salt/Nutrient Plan Requirements**

4. **Approach for Plan Development**

5. **Stakeholder Advisory Committee**
   - **Group makeup, involvement**

6. **Technical Analysis**
   - **Constituents to be addressed**
   - **Overview of salt/nutrient sources within the groundwater basin**

7. **Plan development schedule and future workshop schedule**

8. **Questions/Input**

We will attempt to reasonably accommodate individuals with disabilities upon request.

Please contact Leslie Dumas at (925) 627-4100 with any questions.

RMC Water and Environment

Meeting Agenda

- Project Team Introductions
- Introduction to Salt and Nutrient Management Plans (SNMPs)
- The Paso Robles Groundwater Sub-basin
- Proposed Approach to SNMP Development
- Next Steps and Schedule

RMC Innovative Solutions for Water and the Environment

Project Team

- City of Paso Robles:
  - Project Manager: Matt Thompson
- RMC Water and Environment (RMC):
  - Project Manager/Team Members: Dave Richardson, Leslie Dumas, Jim Blanke, Chris Van Lienden
- Fugro Consultants
  - Team Members: Paul Sorenson, Nels Ruud
- Technical Review
  - Iris Priestaf – Todd Engineers
  - Christy Kennedy – RMC Water and Environment

RMC Innovative Solutions for Water and the Environment

INTRODUCTION TO SALT AND NUTRIENT MANAGEMENT PLANS

RMC Innovative Solutions for Water and the Environment

Recycled Water Policy 2009-2011

- State Water Resources Control Board (SWRCB) Policy adopted in May 2009
- Amendment to policy proposed 2012; adoption planned for 2013
- Requires stakeholder-driven development
- Developed to streamline permitting and increase use of recycled water
- Plans must be completed by 2014
- May result in update/amendment to Regional Water Board's (RWQCB's) Water Quality Control (Basin) Plan

RMC Innovative Solutions for Water and the Environment

Recycled Water Policy - Drivers

- Protect high quality groundwater basins
- Statewide regulatory consistency
- Streamline permitting
- Promote recycled water use
- Address constituents of concern

RMC Innovative Solutions for Water and the Environment

Purpose of Salt/Nutrient Management Plans

- Address salt and nutrient loading to groundwater basins
  - Loading sources:
    - Recycled Water
    - Imported Water
    - Groundwater
    - Agricultural Activity
    - Septic systems
    - Others

- Evaluate "salt and nutrient balance" in groundwater basins

RMC Innovative Solutions for Water and the Environment RMC

Salt/Nutrient Plan Requirements

Requirements:

- Groundwater Monitoring Plan
- Goals and objectives for water recycling and stormwater recharge
- Salt and nutrient source identification, assimilative capacity, loading estimates and fate & transport
- Implementation measures to manage loading
- Anti-degradation Analysis

Degree of Plan Detail Dependant on:

- Groundwater Basin Size
- Stakeholder Interests
- Usability

RMC Innovative Solutions for Water and the Environment RMC

Salt/Nutrient Plan – Key Tasks

Identify and describe:

- Regulatory and physical setting of basins
- Salt and nutrient sources
- Fate and transport
- Loading and assimilative capacity estimates
- Water recycling and stormwater use/recharge goals and objectives
- Implementation strategies
- Groundwater monitoring plan and annual CEC monitoring
- Anti-degradation analysis

Plan development influenced by stakeholders.

RMC Innovative Solutions for Water and the Environment RMC

THE PASO ROBLES GROUNDWATER BASIN

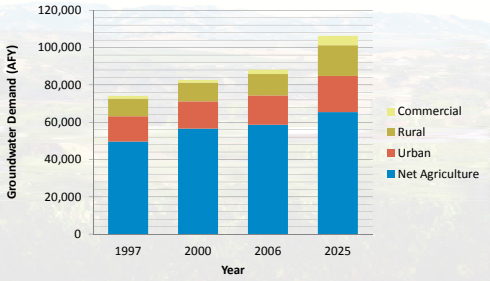
RMC Innovative Solutions for Water and the Environment

Study Area: Paso Robles Basin

- Basin bounded by Temblor, La Panza and Santa Lucia Ranges, and Upper Valley Aquifer Subbasin
- Drains to north
- Contains one subbasin (Atascadero) and seven sub-areas
- Natural and facility recharge
- Storage capacity = 30,400,000 AF (~1,700,000 AF usable)
- Elevated levels of TDS, nitrate and chloride in parts of basin

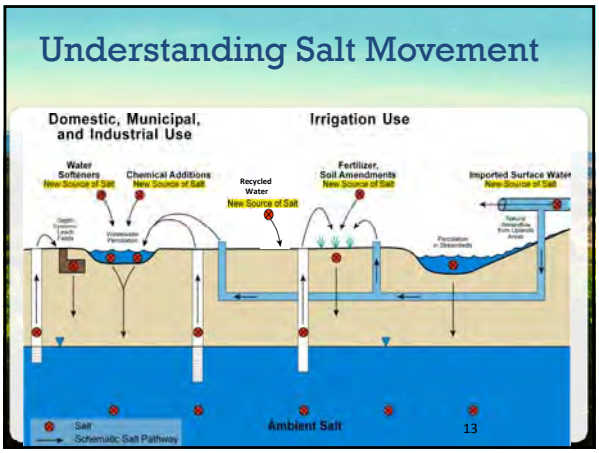
RMC Innovative Solutions for Water and the Environment

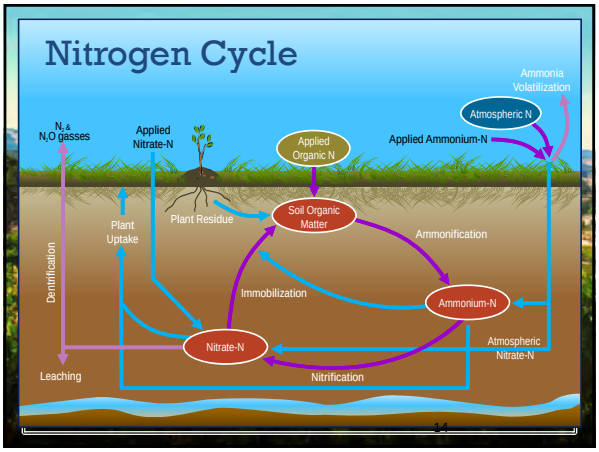
Past and Projected Groundwater Pumping

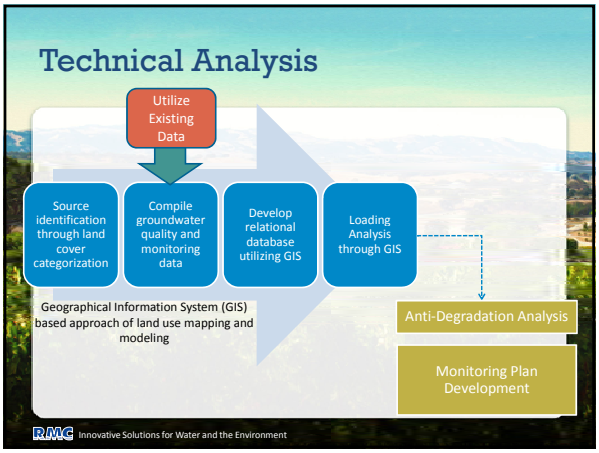


Source: *Evaluation of Paso Robles Groundwater Basin Pumping, Water Year 2006* (Todd Engineers, May 2009)

RMC Innovative Solutions for Water and the Environment


Understanding Salt Movement
Domestic, Municipal, and Industrial Use
Irrigation Use
Water Softeners
New Source of Salt
Chemical Additions
New Source of Salt
Recycled Water
New Source of Salt
Fertilizer, Soil Amendments
New Source of Salt
Imported Surface Water
New Source of Salt
Ambient Salt
Salt
Schematic Salt Pathway
13


Nitrogen Cycle
Ammonia Volatilization
Atmospheric N
N_2 & N_2O gasses
Applied Nitrate-N
Applied Organic N
Applied Ammonium-N
Plant Uptake
Plant Residue
Soil Organic Matter
Ammonification
Denitrification
Immobilization
Ammonium-N
Nitrate-N
Atmospheric Nitrate-N
Leaching
Nitrification
14


Technical Analysis
Utilize Existing Data
Source identification through land cover categorization
Compile groundwater quality and monitoring data
Develop relational database utilizing GIS
Loading Analysis through GIS
Geographical Information System (GIS) based approach of land use mapping and modeling
Anti-Degradation Analysis
Monitoring Plan Development
RMC Innovative Solutions for Water and the Environment

Known Issues Affecting the Paso Robles Basin

- Declining groundwater elevations in portions of the basin
- Increasing TDS and chloride concentrations in shallow aquifers in central portion of Atascadero subbasin
- Increasing chloride concentrations in deep aquifer northeast of Creston
- Increasing TDS and chloride concentrations near San Miguel
- Increasing nitrate concentrations in area north of Highway 46 between Salinas River and Huer Huero Creek
- Increasing nitrate levels in area south of San Miguel
- Increasing TDS and chloride concentrations in deeper aquifers near confluence of Salinas and Nacimiento Rivers

RMC Innovative Solutions for Water and the Environment

Current Basin Monitoring

Groundwater Subarea	Number of Wells (Frequency)
Atascadero Subbasin	51
Bradley	0
Creston	17
Estrella	50
Gabilan (N & S)	1
San Juan	16
Shandon	24

GWMP Monitoring Well Network

RMC Innovative Solutions for Water and the Environment 17

GWMP Recommended Improvements to Monitoring Network

PROPOSED APPROACH TO SNMP DEVELOPMENT

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Salt/Nutrient Management Plan Proposed Approach

RMC Innovative Solutions for Water and the Environment

Stakeholder Participation

- **Based on Recycled Water Policy**
- **Stakeholders include:**
  - Water retailers
  - Wastewater agencies
  - Salt- and nutrient-contributing stakeholders
    - Growers/ Farm Bureau
    - Septic system users
    - Small wastewater treatment plant operations
  - Stormwater agencies
  - Regional Board
  - Interested parties

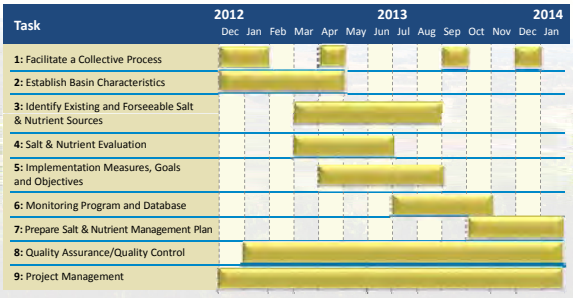
RMC Innovative Solutions for Water and the Environment

Salt/Nutrient Management Plan Key Steps

- **Step 1:** Identify Salt and Nutrient Sources
- **Step 2:** Estimate salt and nutrient loading, fate and transport, and assimilative capacity
- **Step 3:** Develop goals and objectives to manage salt and nutrient loading
- **Step 4:** Develop implementation plan
- **Step 5:** Prepare regional salt and nutrient monitoring plan
- **Step 6:** Submit Salt and Nutrient Management Plan to Regional Water Board

RMC Innovative Solutions for Water and the Environment

Paso Robles Salt/Nutrient Management Plan Schedule



Paso Robles Salt/Nutrient Management Plan Budget

- SNMP development funded by Prop 84 Round 2 Planning Grant
- Required local match funded by local water/wastewater agencies
- RMC team under contract

RMC Innovative Solutions for Water and the Environment

YOUR PARTICIPATION

Role of Stakeholders

- Review and comment on work products
- Attend workshops
- Participate in the development of:
  - goals and objectives related to basin management
  - identification of management strategies
  - implementation activities to manage salt and nutrient loading

Comments on Proposed Approach

- Stakeholders
- Stakeholder Roles
- Scope
- Schedule

Next Meeting

- Purpose
- Timing

RMC Innovative Solutions for Water and the Environment

Questions?

Dave Richardson, RMC Water and Environment
drichardson@rmcwater.com

or

Leslie Dumas, RMC Water and Environment
ldumas@rmcwater.com

925.627.4100

RMC Innovative Solutions for Water and the Environment

Paso Robles Salt-Nutrient Management Plan
Stakeholder Meeting No. 1
January 24, 2013

Name	Organization
Donna R. Tracy	Bald Eagle Ranch
George W Tracy	Bald Eagle Ranch
Richard Sauret	Sauret Vineyards
Joy Fitzhugh	SLO County Farm Bureau
Lynette Shanahan	Templeton
Evelyn Roth	Templeton
Bob Roos	Templeton
Mark Battany	UC Cooperative Extension
Jay Short	Templeton CSD
Jerry Reaugh	Sereno Vista Vineyards
Neil Olsen	Neil Olsen Realty
Eric Veium	Stockman's Energy
Joe and Karen Plummer	
Patti Gwathmey	City of Paso Robles
Mike Cossen	
Paul Kaselionis	
Courtney Howard	San Luis Obispo County
Kris Beal	Central Coast Vineyard Team
Margy Lindquist	NRCS
Katthy Barnett	Paso Robles
Gwen Pelfrey	Templeton
Matt McCarrick	Pacific Tank Solutions
Jennifer Porter	Paso Robles Wine Alliance
Carolyn Fergoda	Paso Robles
Russ Thompson	City of Atascadero
Claudia Engel	Blue Ribbon
Laura Edwards	RCD

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Appendix D - Workshop 2 Materials

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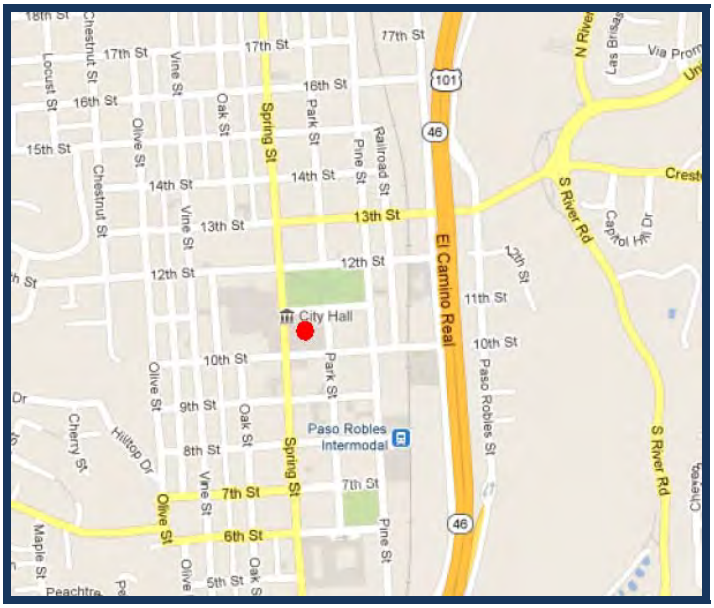
Come join us…

In preparing the Paso Robles Groundwater Basin Salt and Nutrient Management Plan!

Working together to manage and protect groundwater resources

WHEN: Thursday, May 2nd – 2:00 p.m.

WHERE: Paso Robles Library/City Hall Meeting Room, 1000 Spring Street, Paso Robles



- See the final land use information;
- Hear a presentation on the Paso Robles Groundwater Basin Characterization;
- Provide input on the rate at which salts and/or nutrients are applied on the land surface.

For more information on the workshop, contact:

Leslie Dumas
RMC Water and Environment
(925) 627-4113 or
Ldumas@rmcwater.com

Paso Robles Plain Salt/Nutrient Management Plan
SALT AND NUTRIENT MANAGEMENT WORKSHOP No. 2
May 2, 2013, 2:00 PM – 3:30 PM
Paso Robles Library Meeting Room
1000 Spring Street, Paso Robles

A G E N D A

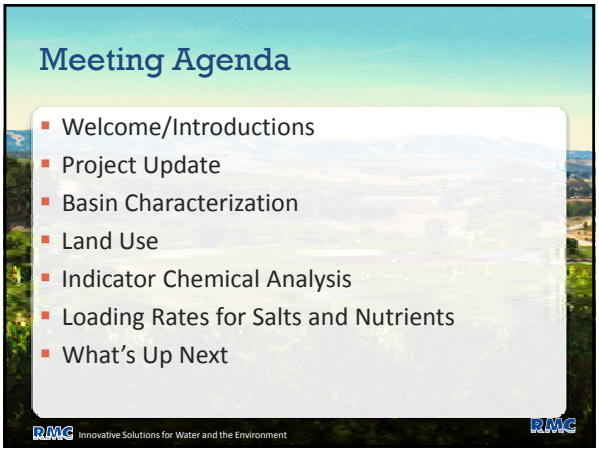
1. **Introductions**
2. **Project Update**
3. **Basin Characterization**
4. **Land Use Delineation**
5. **Salt and Nutrient Indicator Chemical Analysis**
6. **Loading Rates for Salts and Nutrients**
7. **What's Up Next**
8. **Questions/Input**

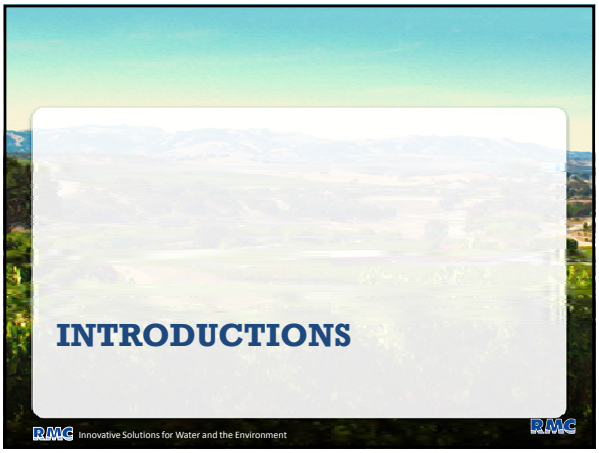
We will attempt to reasonably accommodate individuals with disabilities upon request.

Please contact Leslie Dumas at (925) 627-4100 with any questions.

RMC Water and Environment

Paso Robles Salt/Nutrient Management Plan
Stakeholder Workshop 2
May 2, 2013
RMC
Presenters:
Dave Richardson/RMC
Paul Sorensen/Fugro
FUGRO


Meeting Agenda
Welcome/Introductions
Project Update
Basin Characterization
Land Use
Indicator Chemical Analysis
Loading Rates for Salts and Nutrients
What's Up Next
RMC Innovative Solutions for Water and the Environment
RMC


INTRODUCTIONS
RMC Innovative Solutions for Water and the Environment
RMC

PROJECT UPDATE

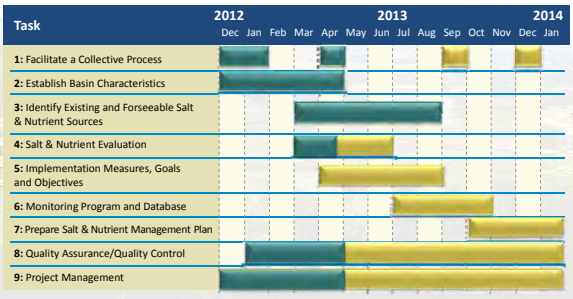
RMC Innovative Solutions for Water and the Environment

Salt/Nutrient Management Plan Key Steps

- Step 1: Identify Salt and Nutrient Sources
- Step 2: Estimate salt and nutrient loading, fate and transport, and assimilative capacity
- Step 3: Develop goals and objectives to manage salt and nutrient loading
- Step 4: Develop implementation plan
- Step 5: Prepare regional salt and nutrient monitoring plan
- Step 6: Submit Salt and Nutrient Management Plan to Regional Water Board

RMC Innovative Solutions for Water and the Environment

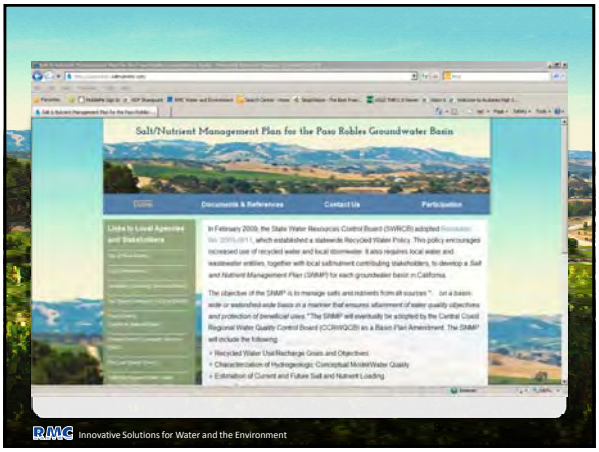
Paso Robles Salt/Nutrient Management Plan Schedule



Project Website

- Found at http://pasorobles.saltnutrient.com/
- Includes:
  - Documents prepared for the project
  - Reference information
  - Links to agencies and stakeholders
  - Outreach information (e.g. workshop materials)
  - SNMP links
  - Link for submitting questions

RMC Innovative Solutions for Water and the Environment



RMC Innovative Solutions for Water and the Environment

SNMP Handout

- Found on the Paso Robles SNMP Website
- Describes need for SNMP and options for participation

RMC Innovative Solutions for Water and the Environment

BASIN CHARACTERIZATION

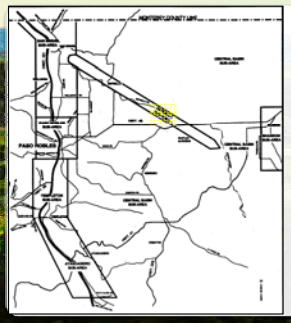
RMC Innovative Solutions for Water and the Environment

Study Area: Paso Robles Basin

- Basin bounded by Temblor, La Panza and Santa Lucia Ranges, and Upper Valley Aquifer Subbasin
- Drains to north
- Contains one subbasin (Atascadero) and seven sub-areas
- Natural and facility recharge
- Elevated levels of TDS, nitrate and chloride in parts of basin

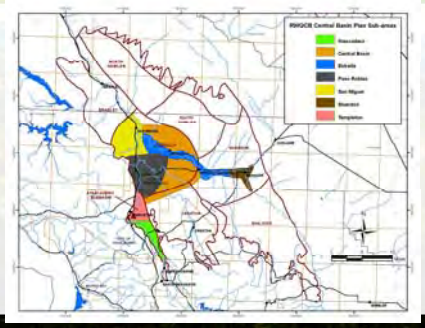
RMC Innovative Solutions for Water and the Environment

RWQCB Basin Delineation



RMC Innovative Solutions for Water and the Environment

Correlation of RWQCB Subareas to Hydrogeologic Subareas



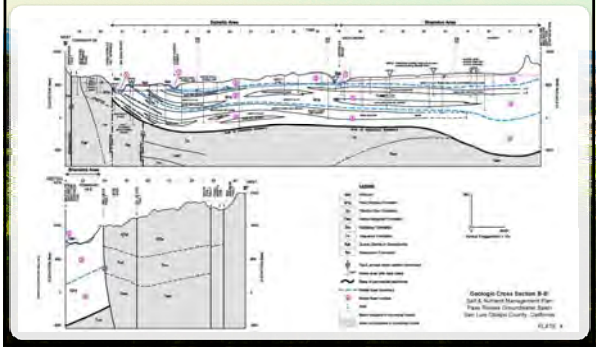
RMC Innovative Solutions for Water and the Environment

Hydrogeology

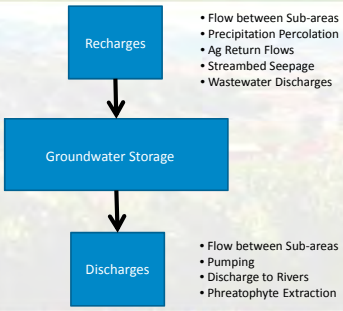
- Two water-bearing formations:
  - Alluvium, associated with streams
  - Paso Robles Formation
- Numerical model developed to simulate groundwater movement
- Alluvium:
  - Associated predominantly with Salinas River
  - Relatively small thickness (50 to 100 feet)
  - Important source of water for communities along River
- Paso Robles Formation:
  - Underlies and is connected to alluvium near River
  - Up to 2,500 feet thick
  - Predominant source of water away from River

RMC Innovative Solutions for Water and the Environment

Hydrogeology



Groundwater Balance Components



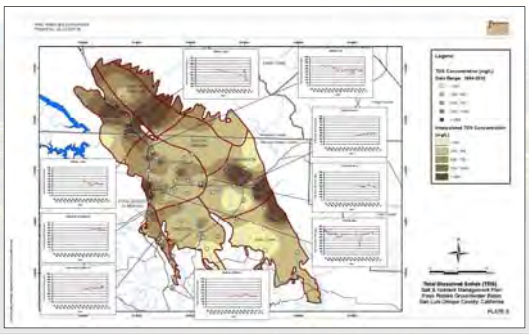
RMC Innovative Solutions for Water and the Environment

Baseline Water Quality Analysis

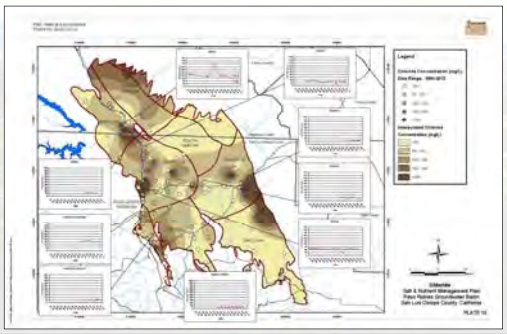
- Data from GeoTracker GAMA database and 2002 Basin Study
- Temporal data averaged at point locations
- Average concentrations were interpolated across basin to generate continuous distribution
- Time-series plots included in figures to support averaging temporal data
- Estimated continuous spatial distributions represent baseline conditions

RMC Innovative Solutions for Water and the Environment

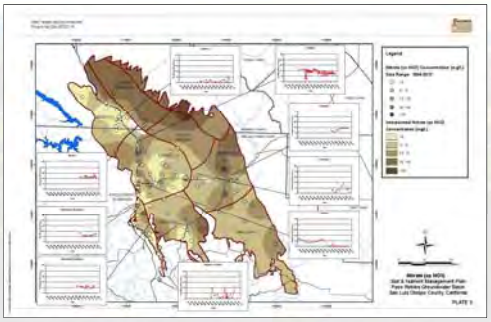
Baseline TDS Distribution



Baseline Chloride Distribution



Baseline Nitrate Distribution



LAND USE

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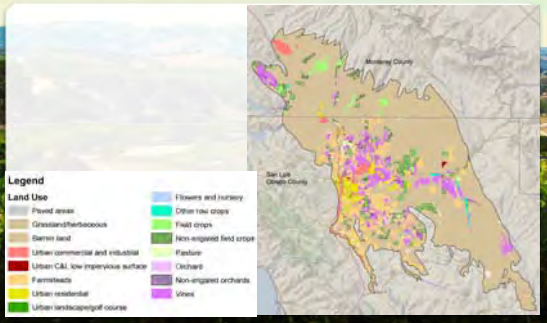
Present Land Use



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Present Land Use Breakdown

Land Use Group	Irrigated (I)/Non-Irrigated (N)	Monterey Area (acres)	SLO Area (acres)	Total Area (acres)	Percent of Total Area
Farmsteads	I/N	39	43,232	43,271	9%
Field crops	I	5,937	334	6,271	1%
Flowers and nursery	I	0	69	69	0%
Grassland/Barren	N	120,990	240,092	361,082	72%
Non-irrigated field crops	N	5,259	16,840	22,099	4%
Orchard	I	59	851	910	0%
Other row crops	I	145	1,466	1,611	0%
Pasture	I	72	3,987	4,059	1%
Paved Areas	N	0	8,095	8,095	2%
Urban C&I, low impervious surface	I/N	0	383	383	0%
Urban commercial and industrial	I/N	2,983	7,003	9,986	2%
Urban landscape	I	0	358	358	0%
Urban residential	I/N	589	11,098	11,687	2%
Vines	I	3,845	30,222	34,067	7%
Total		**139,918**	**364,030**	**503,948**	

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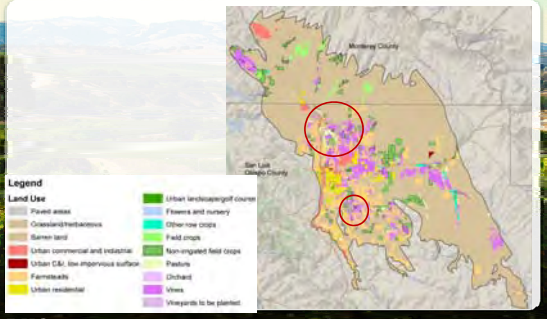
Future Land Use



R.M.C. Innovative Solutions for Water and the Environment

Future Land Use Breakdown

Land Use Group	Irrigated (I)/Non-Irrigated (N)	Monterey Area (acres)	SLO Area (acres)	Total Area (acres)	Percent of Total Area	Change
Farmsteads	I/N	39	43,079	43,118	9%	-192
Field crops	I	5,937	334	6,271	1%	
Flowers and nursery	I	0	69	69	0%	
Grassland/Barren	N	120,990	237,929	358,919	71%	-2,163
Non-irrigated field crops	N	5,259	16,291	21,550	4%	-549
Orchard	I	59	851	910	0%	
Other row crops	I	145	1,466	1,611	0%	
Pasture	I	72	3,958	4,030	1%	-29
Paved Areas	N	0	8,095	8,095	2%	
Urban C&I, low impervious surface	I/N	0	383	383	0%	
Urban commercial and industrial	I/N	2,983	7,003	9,986	2%	
Urban landscape	I	0	358	358	0%	
Urban residential	I/N	589	11,096	11,685	2%	
Vines	I	3,845	33,158	37,003	7%	+2,936
Total		**139,918**	**364,030**	**503,948**		

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INDICATOR CHEMICAL ANALYSIS

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What Are Indicator Constituents?

- Major dissolved ions that reflect the salinity and nutrient content of water
- May include sulfate, chloride, nitrate, boron, iron and manganese
- Subset selected to be representative of the larger set of possible dissolved ions
- Used to efficiently and effectively complete the SNMP

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Questions Considered in Selecting Indicator Constituents

1. Is the constituent regularly monitored and detected in source waters?
2. Is the constituent representative of other salts and nutrients?
3. Is the constituent conservative and mobile in the environment?
4. Is the constituent found in source waters at concentrations above those found in ambient groundwater?
5. Does the constituent have high toxicity for human health or otherwise affect beneficial use?
6. Is the constituent a known contaminant in groundwater in the Study Area?
7. Have the concentrations of the constituents been shown to be increasing in the Study Area?
8. Does the constituent have an effluent limit in a National Pollutant Discharge Elimination (NPDES) permit or a recycled water permit in Waste Discharge Requirements or Water Recycling Requirements

Guided by the CRWQCB

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Selected Indicator Constituents

Total Dissolved Solids (TDS), Chloride and Nitrates selected…

- Based on groundwater quality as measured in wells in the Paso Robles Basin and reported by agencies and State
- Constituents with increasing trends in concentration in the groundwater basin
- Representative of other salts and/or nutrients
- Conservative (TDS And Chloride) and mobile (all three)
- Have established drinking water standards and Water Quality Objectives
- Included in effluent limitations

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Water Quality Objectives for Groundwater in the Paso Robles Basin

Sub-Area		Water Quality Objectives (mg/L)					
Hydrogeologic Sub-Area	Central Coast Basin Plan Sub-Area	TDS	Cl	SO_4	B	Na	Total Nitrogen (as N)
North Gabilan Sub-Area	--	500	250	250	--	--	10
Bradley Sub-Area	--	500	250	250	--	--	10
Estrella Sub-Area	San Miguel, Estrella, Central and Paso Robles Sub-Areas	400	60	45	0.3	80	2.30
South Gabilan Sub-Area	Central Basin Sub-Area	400	60	45	0	80	3.40
Shandon Sub-Area	Estrella, Central Basin, and Shandon Sub-Areas	400	60	45	0.3	80	2.30
Atascadero Subbasin	Templeton and Atascadero Sub-Areas	550	70	85	0.3	65	2.30
Creston Sub-Area	Central Basin Sub-Area	400	60	45	0	80	3.40
San Juan Sub-Area	Central Basin Sub-Area	400	60	45	0	80	3.40

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Selected Indicator Constituents – Total Dissolved Solids (TDS)

- Total amount of mobile charged ions dissolved in a given volume of water
- TDS monitoring data are widely available for source waters
- Can be measured in the field or using an inexpensive laboratory test
- Is a general indicator of total salinity
- Vast majority of the wells exhibited low TDS concentrations.
- The average TDS concentrations exceed the Basin Plan Water Quality Objectives in the 4 sub-areas
- The average TDS concentrations exceed the Secondary MCL in the 5 sub-areas
- Values of greater than 520 mg/L may be considered outliers
- Small number of exceedances is likely reflective of localized issues rather than regional TDS issues

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Selected Indicator Constituents – Chloride

- Geothermal upwelling is key source of chloride
- General indicator of saltwater intrusion but is also linked to regenerative water softeners
- A primary indicator of salts
- Elevated TDS and chloride concentrations are undesirable for aesthetic reasons related to taste, odor, or appearance (not for health reasons)
- Elevated TDS and/or chloride concentrations in water can damage crops, affect plant growth and damage municipal and industrial equipment.
- Is conservative and mobile in the environment
- Average chloride concentrations exceed the Basin Plan Water Quality Objectives in 2 sub-areas
- No sub-areas exceeded the Secondary MCL for chloride

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Selected Indicator Constituents – Nitrate

- Nitrate in groundwater is associated with agricultural activities, septic systems, landscape fertilizers and wastewater treatment facilities
- Primary form of nitrogen detected in groundwater
- Soluble in water and can easily pass through soil to the groundwater table
- Fate and transport of nitrogen compounds in the environment is very complex
- Nitrate in drinking water is a health concern due to “blue baby syndrome” and may be unhealthy to pregnant women
- Average nitrate-N concentrations exceed the Basin Plan Water Quality Objectives in 2 sub-areas
- No sub-areas exceeded the Secondary MCL for nitrate-N
- Values of greater than 6.4 mg/L may be considered outliers.
- Small number of exceedances is likely reflective of localized issues rather than regional nitrate issues

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LOADING RATES

Sources of Indicator Constituents

- Land Use Related Loading
  - Water Application
  - Fertilizers and Amendments
- Septic Systems
- Geothermal upwelling

Land Use Related Loading Factors

Land Use Group	Total Area (acres)	Percent Cultivated	Applied Water (in/yr)	Applied Nitrogen (lbs/acre-yr)	Leachable Nitrogen (lbs/acre-yr)	Applied TDS (lbs/acre-yr)
Farmsteads	43,271	5%	0	50	16	18
Field crops	6,271	100%	14.4	195	53	55
Grassland/Barren	361,082	0%	0	0	0	0
Non-irrigated field crops	22,099	100%	0	50	9	47
Orchard	909	100%	38.1	110	78	80
Other row crops	1,610	100%	12.9	192	91	93
Pasture	4,059	100%	45.9	50	9	11
Urban Commercial and Industrial	383	5%	39.3	92	29	29
Urban C&I, low impervious surface	9,986	30%	39.3	92	29	29
Urban landscape	358	15%	39.3	92	29	29
Urban residential	11,687	75%	39.3	92	29	29
Vines	34,067	100%	15.8	25	12	14

Applied Water Quality

Water Supply	Areal Average (mg/L)			
	TDS	Chloride	Nitrate+Nitrite as NO3	Nitrate+Nitrite as N
Groundwater				
North Gabilan	856	112.9	38.00	8.58
Bradley	751	84.4	12.10	2.73
Estrella	552	94.2	11.40	2.57
South Gabilan	451	37.2	28.30	6.39
Shandon	563	80.0	20.80	4.70
Atascadero	573	77.5	8.30	1.87
Creston	338	69.4	14.30	3.23
San Juan	425	64.2	12.70	2.87
Lake Nacimiento	200	6.3	--	0.13
Recycled Water	1,000	291	--	7.00

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Septic Loads

- Septic loading rates estimated based on Paso Robles effluent monitoring data and cited literature
- Land Use data used to estimate location of septic systems

TDS	1,000 mg/L
Total Nitrogen	40 mg/L

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Future Applied Water – Lake Nacimiento

- Distribution
  - Paso Robles – 4,000 AFY
  - Atascadero – 2,000 AFY
  - Templeton CSD – 250 AFY
- Paso Robles to treat and blend with groundwater. Plant online 2015
- All others to percolation to groundwater

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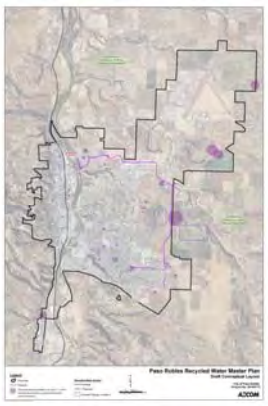
Future Applied Water – Recycled Water

- Paso Robles currently preparing Recycled Water Master Plan
- Estimated future recycled water use ranging between 650 and 2,500 AFY
- Recycled water to be used predominantly for irrigation



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Geothermal Upwelling

- USGS studying source, quality and movement of geothermal waters
- Determined 'average' chloride concentration of geothermal waters is 110 mg/L
- Geothermal waters appear to impact groundwater quality, especially around Rinconada Fault
- Flux rates of upwelling have not been quantified

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Next Step

- 'Apply' soil amendments and applied water in model based on land use type
- On sub-area basis, evaluate changes in groundwater quality based on planned future conditions
- Evaluate projected trends in TDS, chloride and nitrate groundwater concentrations based on model results

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WHAT'S UP NEXT?

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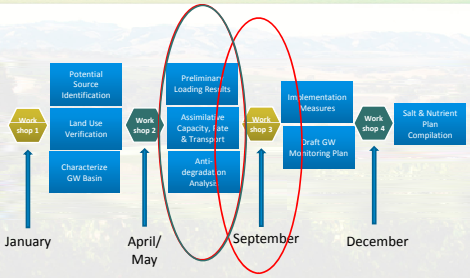
Next Set of Work Items



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Next Meeting – September 2013

- Purpose
  - Brief stakeholders on next work items
- Agenda to cover:
  - Loading Analysis
  - Assimilative Capacity Analysis
  - Fate and Transport Assessment
  - Anti-Degradation Analysis

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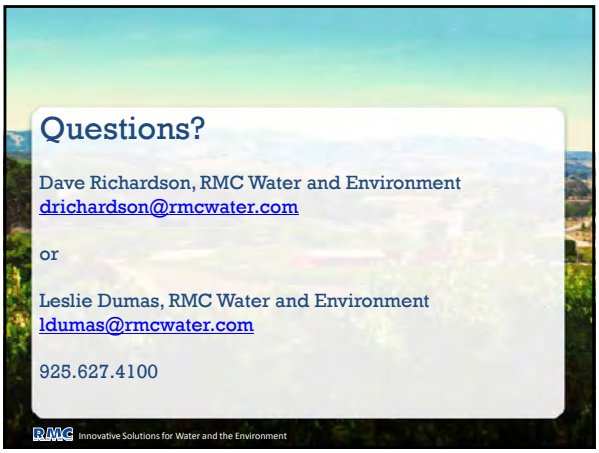
Questions?
Dave Richardson, RMC Water and Environment
drichardson@rmcwater.com
or
Leslie Dumas, RMC Water and Environment
ldumas@rmcwater.com
925.627.4100
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Paso Robles Salt-Nutrient Management Plan
Stakeholder Meeting No. 2
May 2, 2013

Name	Organization
Tina Mayer	Templeton CSD
David Athey	City of Atascadero
Matthew Keeling	Central Coast RWQCB
Rene Solas	San Miguel CSD
Katie DiSimone	Central Coast RWQCB
John Hoffenbeck	citizen
Joy Fitzhugh	SLO County Farm Bureau
Gordon Hensley	SLO Coastkeeper
Molly Dow	Justin Vineyards
Duane Picaneo	City of Paso Robles
Sue Luft	rural resident
Danilu Ramirez	Water Tech
Claudia Engel	Paso Robles Groundwaer Blue Ribbon
John Morrow	Camp Roberts
Mike Cussen	public
Patie Gwathmey	City of Paso Robles
Patricial Witmore	Paso Robles Wine County Alliance
Matt Thompson	City of Paso Robles
Willy Conlan	Sunview Vineyards
Courtney Howard	San Luis Obispo County
Mark Battany	UC Cooperative Extension

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Appendix E - Workshop 3 Materials

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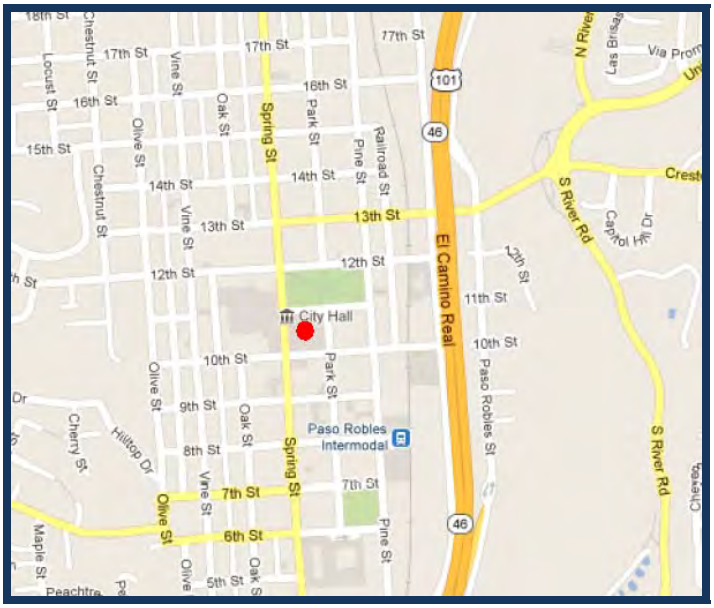
Come join us…

In preparing the Paso Robles Groundwater Basin Salt and Nutrient Management Plan!

Working together to manage and protect groundwater resources

WHEN: Friday, June 20th – 2:00 p.m.

WHERE: Paso Robles Library/City Hall Meeting Room, 1000 Spring Street, Paso Robles



- See the assumptions used in the SNMP loading and mixing analysis;
- Hear a presentation on the assimilative capacity and anti-degradation analyses;
- Provide input on appropriate management strategies for managing salt and nutrient loading to the groundwater basin.

For more information on the workshop, contact:

Leslie Dumas
RMC Water and Environment
(925) 627-4113 or
Ldumas@rmcwater.com

Paso Robles Groundwater Basin
SALT AND NUTRIENT MANAGEMENT WORKSHOP No. 3
June 20, 2014, 2:00 PM – 3:30 PM
Paso Robles Library/City Council Meeting Room
1000 Spring Street, Paso Robles

A G E N D A

1. **Introductions**

2. **Project Update**

3. **Summary of Technical Memoranda 3 and 4**

    - **Loading Analysis Assumptions**
    - **Assimilative Capacity Analysis**
    - **Anti-Degradation Assessment**

4. **Implementation Measures, Goals and Objectives**

    - **Basin Management Goals and Objectives**
    - **Management Strategy Identification**
    - **Management Strategy Evaluation**

5. **What's Up Next**

6. **Questions/Input**

We will attempt to reasonably accommodate individuals with disabilities upon request.

Please contact Leslie Dumas at (925) 627-4100 with any questions.

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Meeting Agenda

- Welcome/Introductions
- Project Update
- Summary of Technical Memoranda 3 and 4
- Implementation Measures, Goals, and Objectives
- What's Up Next
- Questions/Input

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INTRODUCTIONS

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PROJECT UPDATE

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Salt/Nutrient Management Plan Key Steps

- Step 1: Identify Salt and Nutrient Sources
- Step 2: Estimate salt and nutrient loading, fate and transport, and assimilative capacity
- Step 3: Develop goals and objectives to manage salt and nutrient loading
- Step 4: Develop implementation plan
- Step 5: Prepare regional salt and nutrient monitoring plan
- Step 6: Submit Salt and Nutrient Management Plan to Regional Water Board

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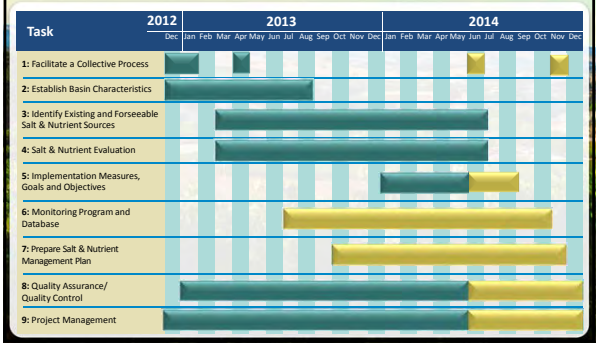
Paso Robles Salt/Nutrient Management Plan Schedule Update



Project Website

- Found at http://pasorobles.saltnutrient.com/
- Includes:
  - Documents prepared for the project
  - Reference information
  - Links to agencies and stakeholders
  - Outreach information (e.g. workshop materials)
  - SNMP links
  - Link for submitting questions

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Presentation of Recent Work: TM3 – Loading Analysis

- Identify sources of salts and nutrients
- Identify indicator constituents
- Determine where loading occurs
- Quantify loads to groundwater basin

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Presentation of Recent Work: TM4 – Assimilative Capacity/Anti-degradation Analysis

- Establish baseline groundwater quality
- Develop current and anticipated future land use scenarios
- Apply loading model results to mixing model for both scenarios
- Compare 'future' groundwater quality to WQOs and MCLs
- Compare benefits of proposed projects to assimilative capacity use

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IDENTIFYING SALT AND NUTRIENT SOURCES

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Steps in Loading Analysis

- Identify Indicator Constituents
- Determine where loading occurs
- Quantify loading rates
- Assess changes to groundwater quality
- Assimilative Capacity Analysis

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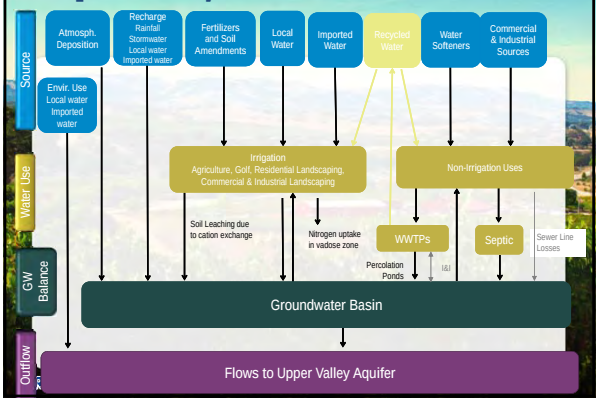
Step 1: Identify Sources of Salt and Nutrient



Indicator Constituent Selection

Indicator Question	Iron	Calcium	Magnesium	Sodium	Potassium	Bicarbonate	Chloride	Sulfate	Nitrate	Manganese	Boron	Total Dissolved Solids
1. Is the constituent regularly monitored and detected in source waters?	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
2. Is the constituent representative of other salts and nutrients?		✓		✓	✓		✓		✓			✓
3. Is the constituent conservative and mobile in the environment?	✓	✓	✓	✓	✓		✓	✓		✓	✓	✓
4. Is the constituent found in source waters at concentrations above those found in ambient groundwater?							✓	✓				✓
5. Does the constituent have high toxicity for human health or will otherwise affect beneficial use?							✓	✓	✓	✓	✓	✓
6. Is the constituent a known contaminant in groundwater in the Study Area?	✓						✓	✓	✓	✓	✓	✓
7. Have the concentrations of the constituents been shown to be increasing in the Study Area?							✓		✓			✓
8. Is the constituent subject to a water quality objective (WQO) within the Basin Plan?				✓			✓	✓	✓		✓	✓

Constituent

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Selected Indicator Constituents

- Total Dissolved Solids (TDS)
  - Provides good indicator of concentration trends
  - Is conservative
  - Have data
- Chloride
  - Same reasons as TDS
- Nitrate
  - Common nutrient in groundwater
  - Has the most water quality data

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Step 2: Determine where Loading Occurs

- Establish baseline groundwater quality
- Determine where loading occurs
- Conducted for groundwater basin as whole and study areas
- Required correlation of past basin sub-area designations with Basin Plan sub-areas

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Selection of Baseline and Future Planning Period

- Data from 2001 to 2012 is used as baseline
- Previous planning period was from 1981 to 1997
- Future planning period is from 2013 to 2030

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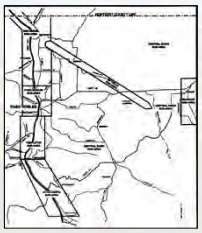
Basin Sub-Area Definitions are not Consistent

Paso Robles Groundwater Basin Sub-areas (used in SNMP)

Central Coast Basin Plan Sub-areas



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Basin Sub-Area Correlation

Hydrogeologic Sub-Area	Central Coast Basin Plan Sub-Area
North Gabilan Sub-Area	--
Bradley Sub-Area	--
Estrella Sub-Area	San Miguel, Estrella, Central and Paso Robles Sub-Areas
South Gabilan Sub-Area	--
Shandon Sub-Area	Estrella, Central Basin, and Shandon Sub-Areas
Atascadero Subbasin	Templeton and Atascadero Sub-Areas
Creston Sub-Area	Central Basin Sub-Area
San Juan Sub-Area	--

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Basin Sub-Area Water Quality Objectives

Sub-Area		Range of Median Water Quality Objectives (mg/L)					
Hydrogeologic Sub-Area	Central Coast Basin Plan Sub-Area	TDS	Chloride	Sulfate	Boron	Sodium	Total Nitrogen (as N)
North Gabilan Sub-Area	--	--	--	--	--	--	--
Bradley Sub-Area	--	--	--	--	--	--	--
Estrella Sub-Area	San Miguel, Estrella, and Paso Robles Sub-Areas	400 – 1,050	60 – 270	45 – 240	0.3 – 2.0	80 - 225	2.3 – 4.6
South Gabilan Sub-Area	Central Basin Sub-Area	--	--	--	--	--	--
Shandon Sub-Area	Estrella, Central Basin, and Shandon Sub-Areas	400 – 1,390	60 – 430	45 – 1,025	0.3 – 2.8	80 - 730	2.3 – 3.4
Atascadero Subbasin	Templeton and Atascadero Sub-Areas	550 – 730	70 – 100	85 - 120	0.3	65 - 75	2.3 – 2.7
Creston Sub-Area	Central Basin Sub-Area	400	60	45	0.3	80	3.4
San Juan Sub-Area	Central Basin Sub-Area	--	--	--	--	--	--

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Establish Baseline Groundwater Quality

- Data from 2001 to 2012 is used as baseline
- Data interpolated across sub-areas
- Average existing groundwater concentrations compared against WQOs

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Total Dissolved Solids

Hydrogeologic Sub-Area	Water Quality Objective	Average Existing TDS Concentration
North Gabilan Sub-Area	None established	856 mg/L
Bradley Sub-Area	None established	751 mg/L
Estrella Sub-Area	400– 1,050 mg/L	552 mg/L
South Gabilan Sub-Area	None established	451 mg/L
Shandon Sub-Area	400 – 1,390 mg/L	563 mg/L
Atascadero Subbasin	550 – 730 mg/L	573 mg/L
Creston Sub-Area	400 mg/L	388 mg/L
San Juan Sub-Area	None established	425 mg/L

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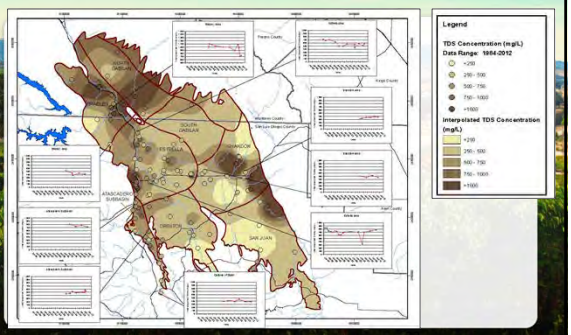
Total Dissolved Solids



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Chloride

Hydrogeologic Sub-Area	Water Quality Objective	Average Existing Chloride Concentration
North Gabilan Sub-Area	None established	113 mg/L
Bradley Sub-Area	None established	84 mg/L
Estrella Sub-Area	60– 270 mg/L	94 mg/L
South Gabilan Sub-Area	None established	37 mg/L
Shandon Sub-Area	60 – 430 mg/L	80 mg/L
Atascadero Subbasin	70 – 100 mg/L	78 mg/L
Creston Sub-Area	60 mg/L	69 mg/L
San Juan Sub-Area	None established	64 mg/L

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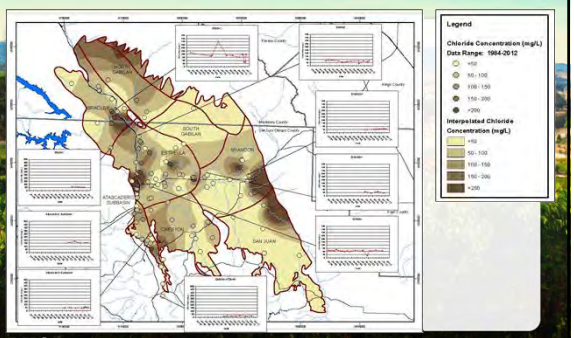
Chloride



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Nitrate (as N)

Hydrogeologic Sub-Area	Water Quality Objective	Average Existing Nitrate (as N) Concentration
North Gabilan Sub-Area	None established	8.6 mg/L
Bradley Sub-Area	None established	2.7 mg/L
Estrella Sub-Area	2.3– 4.6 mg/L	2.6 mg/L
South Gabilan Sub-Area	None established	6.4 mg/L
Shandon Sub-Area	2.3 – 3.4 mg/L	4.7 mg/L
Atascadero Subbasin	2.3 – 2.7 mg/L	1.9 mg/L
Creston Sub-Area	3.4 mg/L	3.2 mg/L
San Juan Sub-Area	None established	2.9 mg/L

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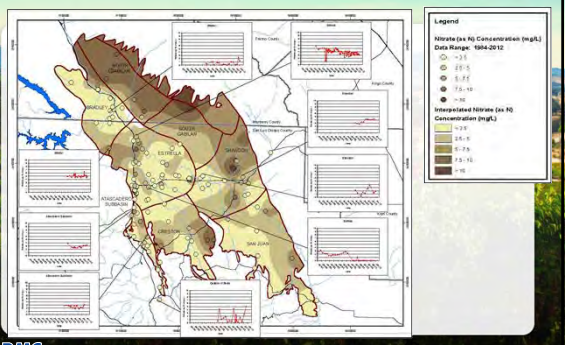
Nitrate (as N)



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Other Constituents

- Other constituents occur naturally in groundwater
- Are not found at elevated concentrations in source water
- Previous models only evaluated TDS, chloride and nitrate

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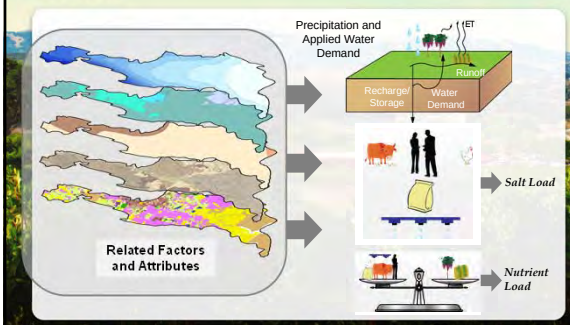
Step 3: Determine Salt & Nutrient Loads



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Analysis Unit Selection

- Basin-wide
- Atascadero Subbasin
- Estrella Study Area

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Land Use Categories

Land Use Group	Irrigated (I)/ Non-Irrigated (N)	Current Land Use: Monterey Co.[1] (acres)	SLO Co. (acres)	Total Area (acres)	Percent Total Area	Future Land Use: Change	Total Area (acres)
Farmsteads[2]	I/N	757	43,232	43,988	9%		43,988
Field Crops	I	1,621	334	1,954	1%		1,954
Grassland/Barren	N	123,832	240,092	363,924	72%	-2,163	361,761
Non-irrigated Field Crops	N	9,531	16,840	26,371	5%	-741	25,630
Orchard	I	59	851	909	0%		909
Other Row Crops	I	134	1,535	1,668	0%		1,668
Pasture	I	0	3,987	3,987	1%	-29	3,958
Paved Areas[1]	N	0	8,095	8,095	2%		8,095
Urban C&I, Low Impervious Surface	I/N	0	383	383	0%		383
Urban Commercial and Industrial	I/N	142	7,003	7,144	1%		7,144
Urban Landscape	I	0	358	358	0%		358
Urban Residential	I/N	0	11,098	11,098	2%		11,098
Vines	I	3,845	30,222	34,067	7%	+2,936	37,003

Source: Monterey and San Luis Obispo County General Plans, Monterey and San Luis Obispo Agricultural Commissioners Offices, City of Paso Robles and Atascadero General Plans

1. The portion of Monterey County that lies within the Paso Robles Groundwater Basin is, for the most part, barren grassland and is relatively undeveloped.
2. Farmsteads are defined as properties 2½ or more acres in size with residential units.
3. A 10-year planning horizon was used for future land use.

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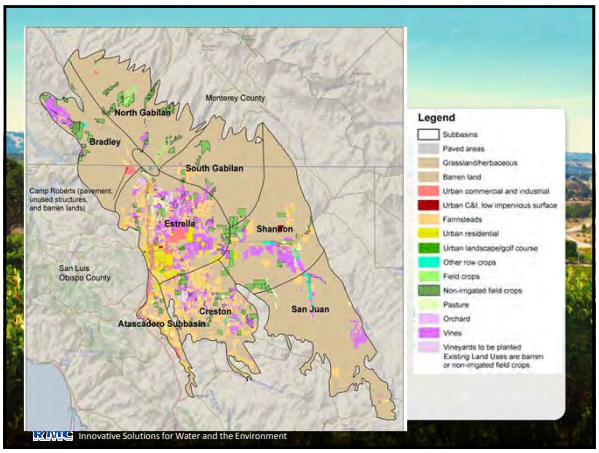

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Land Use Loading Factors

Land Use Group	Total Area (acres)	Percent Cultivated	Applied Nitrogen (lbs/acre-yr)	Leachable Nitrogen (lbs/acre-yr)	Applied TDS (lbs/acre-yr)	Applied Chloride (lbs/acre-yr)
Farmsteads[7]	43,271	5%	50	9	2	0
Field crops	6,271	100%	195	53	2	0
Grassland/ Barren	361,082	0%	0	0	0	0
Non-irrigated field crops	22,099	100%	50	9	2	0
Orchard	909	100%	110	78	2	0
Other row crops	1,610	100%	192	91	2	0
Pasture	4,059	100%	50	9	2	0
Paved Areas	8,095	0%	0	0	0	0
Urban Commercial and Industrial	383	5%	174	55	245	0
Urban C&I, low impervious surface	9,986	30%	174	55	245	0
Urban landscape	358	75%	174	55	245	0
Urban residential	11,687	15%	174	55	245	0
Vines	34,067	100%	25	12	2	0

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Potable and Irrigation Water Source

- Presently, groundwater is only source for most users in basin
- Expanded use of Lake Nacimiento water in future
- Recycled water irrigation planned for future

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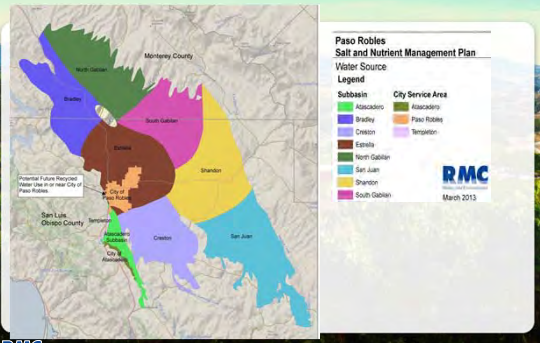
Water Quality Parameters for Loading Model Water Sources

Source	TDS (mg/L)	Chloride (mg/L)	Nitrate (as N) (mg/L)
Cities and Communities[1]			
City of Paso Robles	491	55	1.5
City of Atascadero	640	92	1.5
Templeton CSD	748	97	5
Groundwater Sub-areas[2]			
North Gabilan	856	112.9	8.58
Bradley	751	84.4	2.73
Estrella	552	94.2	2.57
South Gabilan	451	37.2	6.39
Shandon	563	80.0	4.70
Atascadero	573	77.5	1.87
Creston	338	69.4	3.23
San Juan	425	64.2	2.87
Lake Nacimiento[3]	200	6.3	0.13
Recycled Water[3]	1,000	291	7.00

Applied Water Sources



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Recycled Water

- City of Paso Robles
  - Preparing a Recycled Water Master Plan
  - Implementing WWTP upgrade program
  - 650 AFY of initial future recycled water use anticipated
- City of Atascadero
  - Planning recycled water irrigation in 5 parks
  - Parks located outside of Atascadero Subbasin
  - Approximately 60 AFY of initial future recycled water use anticipated
- County recycled water study underway

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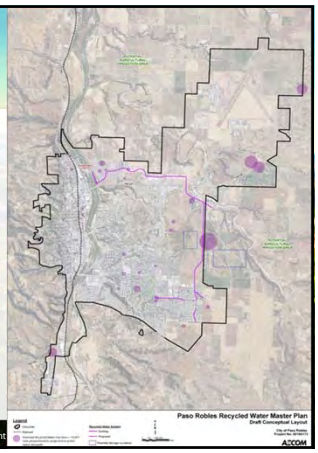
Anticipated Recycled Water Use Paso Robles Area



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Lake Nacimiento Water

- Nacimiento Water Project (NWP) was completed in 2011:

Lake Nacimiento → San Luis Obispo County

  - Supplemental water to be delivered:
    - Paso Robles – 4,000 AFY (treated and used)
    - Templeton – 250 AFY (percolate to groundwater)
    - Atascadero – 2,000 AFY (percolate to groundwater)

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Rainfall and Mountain Front Recharge

- Averaged from data from 1999 to 2011
- Average Concentrations:
  - TDS = 4.61 mg/L
  - Chloride = 0.447 mg/L
  - Nitrate (as N) = 0.219 mg/L

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Septic Systems

- Assume parcels outside of service areas are on private septic system
- Assumptions:
  - 263 gpd/parcel
  - TDS = 1,000 mg/L
  - Chloride = 291 mg/L
  - Nitrogen = 40 mg/L

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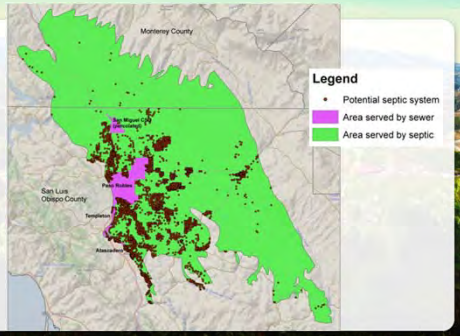
Septic System Locations



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Wastewater Systems

City of Paso Robles	Discharges to Salinas River/underflow; new WWTP upgrades
City of Atascadero	Treat and infiltrate with capture and reuse
Templeton CSD	Treatment by Paso Robles and treat/infiltrate with capture and reuse
San Miguel CSD	Treat and infiltrate
Heritage Ranch CSD	Treat and discharge; outside Paso Robles Basin

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Wastewater Systems Loading

Source	Sub-basin	Volume (AF or AFY)	TDS (mg/L)	Nitrate (mg/L as N)	Chloride (mg/L)
Current					
City of Paso Robles	Estrella	3,297[1]	1,037[2]	30.0[2]	328[2]
Templeton CSD	Atascadero	146[4]	1,460[5]	16[5]	480[5]
City of Atascadero	Atascadero	1,569[6]	960[8]	0.1[6]	225[8]
San Miguel CSD	Estrella	130[7]	980[10]	24.3[10]	251[10]
Future					
City of Paso Robles	Estrella	4,760[1]	1,037[2]	8.0[3]	328[2]
Templeton CSD	Atascadero	258[4]	1,460[5]	16[5]	480[5]
City of Atascadero	Atascadero	1,793[6]	960[8]	0.1[6]	225[8]
San Miguel CSD	Estrella	130[7]	980[9]	24.3[9]	241[9]

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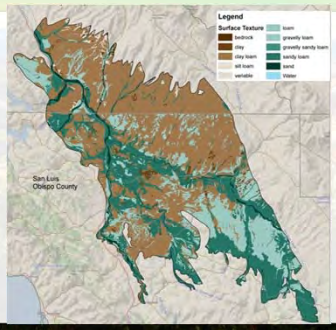
Soil Textures



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ASSIMILATIVE CAPACITY AND ANTI-DEGRADATION ANALYSIS

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Purpose of Analysis

- Estimate basin assimilative capacity
  (assimilative capacity = WQO – baseline concentration)
- Evaluate anticipated future conditions to evaluate future groundwater quality
- Demonstrate benefits of proposed projects

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Existing Groundwater Quality

Subbasin/Study Area	Volume (AF)	TDS (mg/L)	Nitrate (mg/L as N)	Chloride (mg/L)
Atascadero	473,095	573	1.8	77.5
Creston	1,852,949	388	3.2	69.4
San Juan	3,775,597	425	2.8	64.2
Estrella	6,875,219	552	2.5	94.2
Shandon	5,291,835	563	4.6	80.0
North Gabilan	2,869,842	856	8.4	112.9
South Gabilan	2,952,293	451	6.3	37.2
Bradley	2,633,283	751	2.7	84.4
Total Volume	**26,724,113**	--	--	--
Volume-Weighted Average Concentration[a]		**566**	**4.1**	**79.9**

Note
a. Weighted-average calculated from average water quality concentrations and storage volumes of the individual study areas.

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Existing Groundwater Quality

- Increasing TDS and chloride trends in some study areas
- Interpolation/extrapolation was used when water quality data was limited
- Mixing evaluated over entire basin depth and in upper stratum (upper 700 feet)

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Surface Loading Results

Land Use Group	Total Area (acres)	Percent of Total Area[a]	Percentage of Total TDS Loading	Percentage of Total Nitrate Loading	Percentage of Total Chloride Loading
Farmsteads[b]	43,943	33%	3%	12%	0%
Field Crops	1,954	1%	5%	3%	2%
Non-irrigated field crops	26,340	20%	0%	5%	14%
Orchard	909	1%	3%	4%	7%
Other row crops	1,668	1%	2%	10%	3%
Pasture	4,027	3%	17%	7%	12%
Urban commercial and industrial	7,144	5%	2%	4%	1%
Urban C&I, low impervious surface	383	0%	0%	0%	0%
Urban residential	11,098	8%	9%	18%	4%
Urban landscape	358	0%	1%	1%	1%
Vines	34,149	26%	57%	36%	56%

a. Percentage does not include undeveloped lands and paved areas.
b. Assumes farmsteads utilize septic systems.

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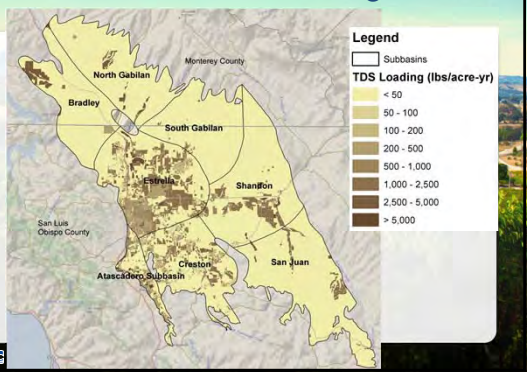
Distribution of TDS Loading



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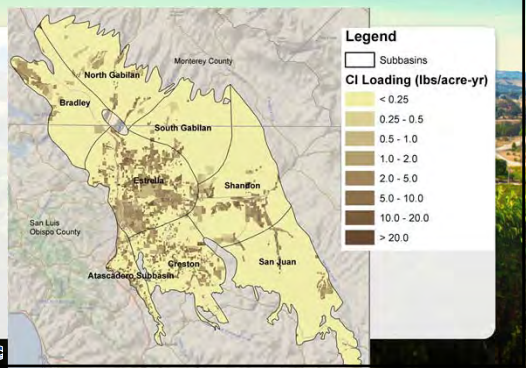
Distribution of Chloride Loading



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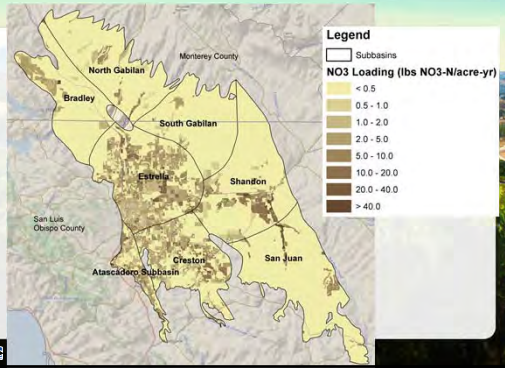
Distribution of Nitrate Loading



Mass Balance-Mixing Model

- 25-year planning period
- Uses Loading Model results as input
- Evaluate three areas:
  - Atascadero Subbasin
  - Estrella Study Area
  - Entire groundwater basin
- Evaluate two scenarios
  - Present and planned land use with current mix of water (baseline)
  - Future conditions (with use of recycled water and Nacimiento Water)

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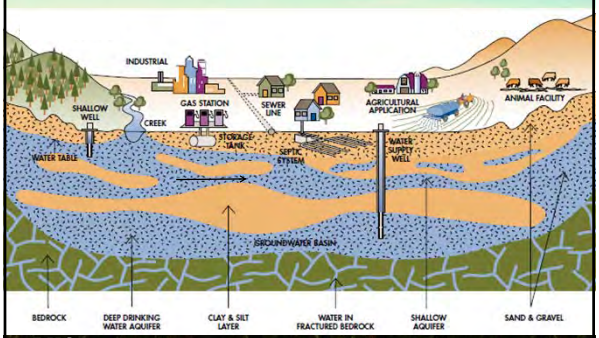
Inflow & Outflow Components



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Baseline Scenario

- Evaluate future groundwater conditions without changes to land use practices or water use
- Geothermal Upwelling
  - Not included in the estimated inflows
  - Is thought to have a significant impact on groundwater quality in affected areas
  - Approximate water quality (USGS)
    - TDS = 900 – 1,300 mg/L
    - Nitrate-N = no data
    - Chloride = 110 mg/L

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Baseline Scenario – Basin-wide

Item	Volume (AF or AFY)	TDS (mg/L)	Nitrate (mg/L as N)	Chloride (mg/L)	Basis
Initial Conditions	26,724,113	566	4.07	79.9	Fugro, 2012[a]
Inflows					
Deep Percolation	43,107	1,077	6.07	157.4	Calculated[b]
Stream Recharge	60,449	617	1.79	104.7	Fugro, 2009[c]
Municipal WW Percolation	5,452	982	19.55	283.8	Calculated[d]
Subsurface Inflows	25,027	485	4.00	71.3	Fugro, 2012[e]
Total	**134,035**	**715**	**3.51**	**111.2**	Calculated
Outflows					
Pumping Outflows	99,954				Fugro, 2012[f]
Subsurface Outflows	1,602	566	4.07	79.9	Fugro, 2012[f]
Stream Losses	29,212				Fugro, 2012[f]
Evaporative Losses	7,573				Fugro, 2012[f]
Total	**138,341**	**566**	**4.07**	**79.9**	Calculated

AF – acre-feet; AFY – acre-feet per year

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Baseline Scenario – Estrella Study Area

Item	Volume (AF or AFY)	TDS (mg/L)	Nitrate (mg/L as N)	Chloride (mg/L)	Basis
Initial Conditions	6,875,219	552	2.5	94.2	Fugro, 2012[a]
Inflows					
Deep Percolation	13,521	1,999	9.70	329.6	Calculated[b]
Stream Recharge	6,652	637	2.40	113.0	Fugro, 2009[c]
Municipal WW Percolation	3,457	1,035	30.11	324.7	Calculated[d]
Subsurface Inflows from Outside Basin	6,215	485	4.00	71.3	Fugro, 2012[e]
Subsurface Inflow from Other Subbasins/Study Area	22,434	472	4.66	57.1	Fugro, 2012[f]
Total	**48,714**	**775**	**4.97**	**118.2**	Calculated
Outflows					
Pumping Outflows	39,138				Fugro, 2012[g]
Stream Losses	7,885				Fugro, 2012[g]
Evaporative Losses	225				Fugro, 2012[g]
Subsurface Outflows to Outside Basin	0	552	2.50	94.2	Fugro, 2012[g]
Subsurface Outflow to Other Subbasins/Study Area	3,337				Fugro, 2012[g]
Total	**50,585**	**552**	**2.50**	**94.2**	Calculated

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Baseline Scenario – Atascadero Subbasin

Item	Volume (AF or AFY)	TDS (mg/L)	Nitrate (mg/L as N)	Chloride (mg/L)	Basis
Initial Conditions	473,095	573	1.8	77.5	Fugro, 2012[a]
Inflows					
Deep Percolation	1,840	1,447	9.77	214.7	Calculated[b]
Stream Recharge	14,047	573	0	86	Fugro, 2009[c]
Municipal WW Percolation	1,996	890	1.27	212.9	Calculated[d]
Subsurface Inflows from Outside Basin	784	485	4.00	71.3	Fugro, 2012[e]
Subsurface Inflow from Other Subbasins/Study Area	591	420	3.06	74.2	Fugro, 2012[f]
Total	**18,667**	**594**	**1.43**	**88.9**	Calculated
Outflows					
Pumping Outflows	14,490				Fugro, 2012[g]
Stream Losses	2,062				Fugro, 2012[g]
Evaporative Losses	274				Fugro, 2012[g]
Subsurface Outflows to Outside Basin	0	573	1.80	77.5	Fugro, 2012[g]
Subsurface Outflow to Other Subbasins/Study Area	3,354				Fugro, 2012[g]
Total	**20,180**	**573**	**1.80**	**77.5**	Calculated

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Future Scenario Assumptions

- Conversion of undeveloped lands/grasslands into vineyards in San Luis Obispo County
- Percolation of 2,000 AFY of Lake Nacimiento water into Atascadero
- 4,000 AFY of Lake Nacimiento water add to City of Paso Robles distribution system
- Percolation of wastewater (~246 AFY) generated by Templeton CSD into Salinas River underflow in Atascadero

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Future Scenario Assumptions

- City of Paso Robles WWTP effluent drops from 30 mg/L to 8 mg/L of Total Nitrogen (as N)
- 2,500 AFY of irrigation water replaced with recycled water
- No additional storm water capture and recharge

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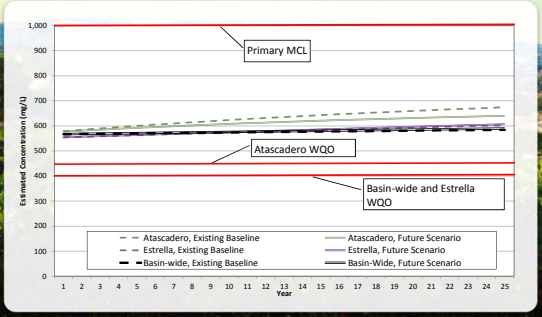
Projected TDS Concentrations



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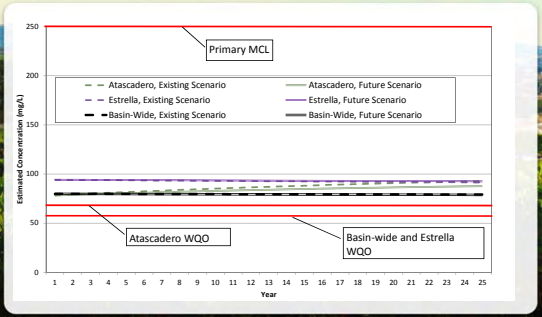
Projected Chloride Concentrations



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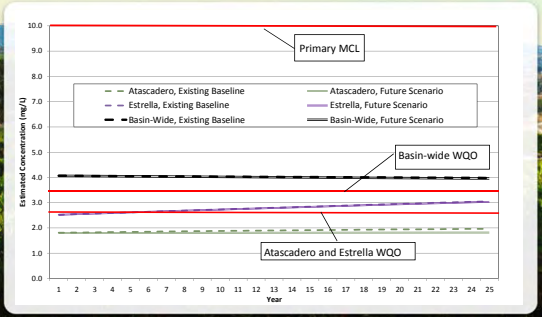
Projected Nitrate-N Concentrations



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Changes over Model Period: 700 feet Mixing Depth vs Full Mixing Depth

	Initial Conditions (mg/L)			25-year Change Baseline Scenario (mg/L)			25-year Change Future Scenario (mg/L)		
	TDS	NO_3	Cl	TDS	NO_3	Cl	TDS	NO_3	Cl
Full Mixing Depth	566	4.1	79.9	+35.03	+0.05	+5.41	+40.22	-0.06	+5.0
700-ft Mixing Depth	566	4.1	79.9	+71.37	-0.25	+14.19	+64.73	-0.31	+12.83

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Antidegradation Assessment

- Existing groundwater quality is better than WQOs
- Using drinking water standards (MCLs):
  - Groundwater basin capacity available for chlorides and nitrates
  - Capacity of TDS depends on which MCL is used
    - Recommended MCL = 500 mg/L –three study areas have assimilative capacity
    - Upper secondary MCL = 1,000 mg/L – assimilative capacity available throughout basin

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Key Analysis Assumptions

- Current groundwater elevation trends
- Economic importance of existing water supplies that contribute to salt and nutrient loading
- Current state mandates increased recycled water use
- Projected continued ability of groundwater to meet present and anticipated beneficial uses

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Antidegradation Assessment Conclusions

- Basin-wide average TDS concentrations will increase over time, but will not exceed the WQOs where presently met
- Nitrate and chloride concentrations are anticipated to be stable basin-wide
- Increases in indicator constituent concentrations with anticipated future uses are consistent with the maximum benefit to the people of the State of California

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IMPLEMENTATION MEASURES, GOALS AND OBJECTIVES

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SNMP Goals and Objectives

- Groundwater
  - Maintain Salinas River in natural state
  - Preserve floodplain to promote groundwater recharge
  - Prevent water pollution
- Recycled Water
  - Initiate use of recycled water for irrigation
- Storm Water
  - All new development incorporate LID techniques
  - Promote stormwater capture and percolation where reasonable

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Basin Management Strategies

- Implemented to mitigate impacts from future use
- Two types of impacts:
  - Impacts to basin salt/nutrient loadings (mass only)
  - Impacts to salt/nutrient concentrations (mass per volume of water)
- Implementation measures – projects or programs to manage loadings on a sustainable basis
- 14 sets of strategies to improve groundwater quality include:
  - Improve stormwater quality
  - Improve wastewater and recycled water quality
  - Increase stormwater recharge
  - Reduce sources of high salt and nutrient loadings improve groundwater quality

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Groundwater Recharge

- Identification basin recharge areas
- Zoning changes to protect recharge areas
- Percolation enhancement
- Recharge of lower-salt waters (including treated effluent of Nacimiento origin)
- New turnout structure
- Sediment removal
- Advanced-treated recycled water recharge

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Groundwater Basin Management

- Water elevation and quality monitoring
- Flow modeling
- Basin-wide groundwater management structure
- Update land cover maps

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Stormwater/Runoff Management

- CCRWQCB Post-Construction Runoff Control Requirements
  - Minimize compaction of highly permeable soils
  - Limit clearing and grading of native vegetation
  - Direct roof runoff to cisterns or rain barrels for reuse
  - Direct roof runoff onto vegetated areas away from building foundations
  - Direct runoff from sidewalks, walkways, patios, driveways and/or uncovered parking lots onto vegetated areas away from building foundations
  - Construct bike lanes, driveways, uncovered parking lots, sidewalks, walkways, and patios with permeable surfaces
- Retention basins
- Storm water capture/infiltration (on and off stream)

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Stormwater/Runoff Management (cont'd)

- Encouraging Low Impact Development (LID) – both for runoff and water quality/runoff treatment
- Rainfall monitoring program
- Protect recharge areas and maximize watersheds
- Biofiltration treatment systems
- Require use of non-retention-based treatment systems

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Salinas River Underflow Augmentation

- Wastewater retrieval/underflow augmentation
- Wastewater retrieval/underflow augmentation expansion
- Nacimiento underflow augmentation

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BMPs for Major Land Use Sectors - Agriculture

- Central Coast RWQCB Ag Waiver Regulations
- irrigation/fertilizer use BMPs; soil monitoring
- Create farm development/conservation plan (RCD/NRCS)
- Irrigation system evaluation to ensure efficient water use
- Install irrigation system retrofits for cost savings and water use efficiency
- Rezoning of ag land to discourage irrigated ag in dry zones

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BMPs for Major Land Use Sectors - Vineyards

- Soil and petiole testing
- Rezoning of ag land to discourage development in no-water zones
- Create farm development/conservation plan (RCD/NRCS)
- Irrigation system evaluation to ensure efficient water use
- Install irrigation system retrofits for cost savings and water use efficiency
- Erosion control implements

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BMPs for Major Land Use Sectors – Vineyards (cont'd)

- Wildlife corridor considerations (currently forced to use waterways due to fencing blockages)
- Avoid development in frost-prone regions (decreases water runoff)
- Maintain diverse and established vegetative cover in some areas (e.g. trees)
- Drip irrigation
- Focused application of fertilizer and soil amendments
- Pursue Sustainability in Practice (SIP) certification from Central Coast Vineyard Team

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BMPs for Major Land Use Sectors - Grazing

- Manage livestock for stable forage (sustainable plant communities and better percolation)
- Develop grazing and/or conservation management plan (RCD/NRCS)
- Perform ranch self-assessment

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BMPs for Major Land Use Sectors - Urban

- Water conservation
- Water budgeting
- Prohibition on water waste to minimized over-irrigation
- Landscape irrigation BMPs
- Source control techniques
- Pollution prevention requirements

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Wastewater Salinity/Nutrient Source Control

- Recycled water nitrogen treatment
- Industrial wastewater sources controls
- Onsite wastewater treatment system management

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Source Water Salinity Control

- Reduce hardness of water supply (import Nacimiento water)
- Implement a Salinity Source Water Control Program
- Manage imported supplies.
- Implement stormwater initial flush policies
- Implement Water softener program
- Industrial waste discharge ordinance

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Public Education and Outreach

- Websites and council for outreach
- Community-based social marketing (interactive)
- Landscape management education

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Institutional

- Groundwater management agency/structure
- Basin-wide monitoring programs
- Program to encourage strategic placement of future wells to reduce contribution from salinity upwelling
- Ordinance and resolutions to:
  - Prevent offsite discharges from events up to the 95th percentile 24-hour rainfall event
  - Delineation of discrete drainage management areas
  - Management of peak flows discharging from sites to prevent exceeding pre-development peak flows

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Recycled Water Irrigation

- Water quality monitoring at treatment plant
- Irrigation at agronomic rates
- Fertilizing based on nutrient content of recycled water
- Site supervisor program
- Irrigator workshop/education
- Runoff minimization

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Other

- Land use regulation
- Ordinances (i.e. Model Water Efficient Landscape Ordinance)
- Landscape conservation incentives
- Land retirement
- Evaporative ponds/mechanical evaporation
- Promote projects that use alternative water supplies (i.e. Lake Nacimiento and SWP water)

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WHAT'S UP NEXT?

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What's Next

- Assess Basin Plan Modification Needs
  - Identify recommended Basin Plan modifications
  - Coordinate with stakeholders and Regional Board staff
  - Outline strategy to achieve recommended Basin Plan amendments
- Assess CEQA/NEPA Compliance
  - Conduct initial, high-level environmental assessment for any necessary CEQA/NEPA compliance
- Groundwater Monitoring Program and Databases
- Compile SNMP

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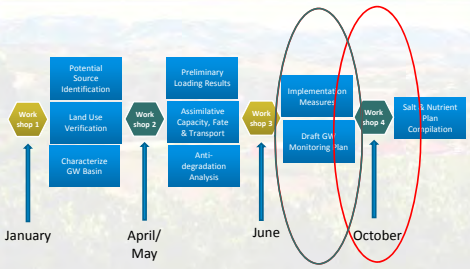
Next Set of Work Items



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Questions?

Dave Richardson, RMC Water and Environment
drichardson@rmcwater.com

or

Leslie Dumas, RMC Water and Environment
ldumas@rmcwater.com

925.627.4100

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Management Strategy	Currently Being Implemented	Planned for Implementation	Unreasonable to Implement	To Be Considered	Notes
Storm water/Runoff Management					
Central Coast RWQCB Post-Construction Runoff Control Requirements					
Minimize compaction of highly permeable soils					
Limit clearing and grading of native vegetation					
Direct roof runoff to cisterns or rain barrels for reuse					
Direct roof runoff onto vegetated areas away from building foundations					
Direct runoff from sidewalks, walkways, patios, driveways and/or uncovered parking lots onto vegetated areas away from building foundations					
Construct bike lanes, driveways, uncovered parking lots, sidewalks, walkways, and patios with permeable surfaces					
Retention basins					
Storm water capture/infiltration (on and off stream)					
Encouraging Low Impact Development (LID) – both for runoff and water quality/runoff treatment					
Rainfall monitoring program					
Protect recharge areas and maximize watersheds					
Biofiltration treatment systems					
Require use of non-retention-based treatment systems					
Groundwater Recharge					
Identification basin recharge areas					
Zoning changes to protect recharge areas					
Percolation enhancement					
Recharge of lower-salt waters (including treated effluent of Naci origin)					
New turnout structure					
Sediment removal					
Advanced-treated recycled water recharge					
Groundwater Basin Management					
Water elevation and quality monitoring					
Flow modeling					
Basin-wide groundwater management struture (oversight agency, regulations, etc.)					
Update land cover maps					
Salinas River Underflow Augmentation					
Wastewater Retrieval/Underflow Augmentation					
Wastewater Retrieval/Underflow Augmentation Expansion					
Nacimiento Underflow Augmentation					
Establish Best Management Practices (BMPs) for the major land use sectors:					
Agriculture					
Central Coast RWQCB Ag Waiver Regulations					
Irrigation/fertilizer use BMPs; soil monitoring					
Create farm development/conservation plan (RCD/NRCS)					
Irrigation system evaluation to ensure efficient water use					
Install irrigation system retrofits for cost savings and water use efficiency					
Rezoning of ag land to discourage irrigated ag in dry zones					
Vineyard					
Soil and petiole testing					
Rezoning of ag land to discourage development in no-water zones					
Create farm development/conservation plan (RCD/NRCS)					
Irrigation system evaluation to ensure efficient water use					
Install irrigation system retrofits for cost savings and water use efficiency					
Erosion control implements					
Wildlife corridor considerations (currently forced to use waterways due to fencing blockages)					
Avoid development in frost-prone regions (decreases water runoff)					
Maintain diverse and established vegetative cover in some areas (e.g. trees)					
Drip irrigation					
Focused application of fertilizer and soil amendments					
Pursue Sustainability in Practice (SIP) certification from Central Coast Vineyard Team					
Dairy					
monitoring and managing waste					
Pavement and cover (roofing) in intensive manure areas to control runoff					
Spreading liquid manure at agronomic rates					
Manure application (solids) on vegetated field					
Organic dairies					
Grazing Sector					
Manage livestock for stable forage (sustainable plant communities and better percolation)					
Develop grazing and/or conservation management plan (RCD/NRCS) addressing range type and condition, range site potential and soil type, plant growth rates, precipitation, stocking rate, type and class of livestorck and off-stream water systems					
Perform ranch self-assessment (http://cesanluisobispo.ucanr.edu/files/136160.pdf)					
Urban Sector – water conservation, water budgeting, water management and prohibition of water waste to minimized over-irrigation, landscape irrigation BMPs.					
Municipal Wastewater management agencies – source control techniques including controlling salinity from water softeners and industrial/commercial dischargers					
Other					
Land retirement					
Seawater Intrusion Control (Not Applicable)					

Management Strategy	Currently Being Implemented	Planned for Implementation	Unreasonable to Implement	To Be Considered	Notes
Wastewater salinity/nutrient source control					
Recycled water nitrogen treatment					
Industrial wastewater sources controls – Regulate industrial and commercial discharges into agencies' wastewater management systems. Source control program permit, inspect and monitor, develop source control and pollution prevention requirements, and take enforcement actions for permit and ordinance violations.					
Onsite wastewater treatment system management – monitoring, maintenance, frequent pumping, site evaluations, setbacks					
Source Water Salinity Control					
Import Nacimiento water, reduce hardness of water supply, thus reduce need for water softeners					
Implement a Salinity Source Water Control Program					
Manage imported supplies through source control measures, collaborative actions with other agencies, distribution system salinity management, and participation with local agencies to protect groundwater and recycled water supplies.					
Implement stormwater initial flush policies (i.e. Los Angeles County Department of Power and Water storm water "First Flush" Policy) – First several hours of flow of the first season's storm water					
Water softener program to reduce use of softeners utilizing salts					
Industrial waste discharge ordinance for regulating discharges of high salt concentrations					
Public Education					
Websites, Council for outreach.					
Community-based social marketing (interactive)					
Landscape management education (fertilizer, irrigation, etc.)					
Institutional					
Groundwater management agency/structure such as that by Water Replenishment District of Southern California					
Basin adjudication					
Basin-wide monitoring programs					
Develop program to encourage strategic placement of future wells to reduce contribution from salinity upwelling					
Ordinances and resolutions such as the CCRWQCB post-construction requirements, that include requirements such as:					
Preventing offsite discharge from events up to the 95th percentile 24-hour rainfall event, with compliance achieved through storage, rainwater harvesting, infiltration and/or evapotranspiration					
Delineation of discrete drainage management areas to suppose a decentralized approach to stormwater management					
Management of peak flows discharging from a site such that they do not exceed pre-project peak flows for the 2- through 10-year storm events					
Land Use Regulation – ordinances such as Model Water Efficient Landscape Ordinance. Ordinances that require city, counties, and charter cites/counties to adopt landscape water conservation ordinances.					
Landscape Conservation incentives such as rebates for weather based irrigation controls and turf removal programs for residential and commercial customers.					
Recycled Water Irrigation					
Water quality monitoring at treatment plant					
Irrigation at agronomic rates					
Practice fertilization based on nutrient content of recycled water					
Site supervisor responsible for system and visual inspections					
Irrigator workshop/education					
Runoff minimization					
Desalination Technology – with options such as:					
Reverse Osmosis (RO)					
Nanofiltration					
Electrodialysis Reversal (EDR)					
Distillation					
Other					
Land retirement					
Evaporation ponds/mechanical evaporation/landfill disposal					
Promote projects to use alternative water supplies such as Lake Nacimiento and SWP water					

Paso Robles Salt-Nutrient Management Plan
Stakeholder Meeting No. 3
June 20, 2014

Name	Organization
Matt Thompson	City of Paso Robles
Tina Mayer	Templeton CSD
Jeff Brittz	Templeton CSD
John Morrow	Camp Roberts
John Hollenbeck	Hollenbeck Consulting/Atascadero resident
Claudia Engel	Basin Advisory Committee
David Athey	City of Atascadero
Courtney Howard	San Luis Obispo County
Dan Gilmore	San Miguel CSD

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Appendix F - Workshop 4 Materials

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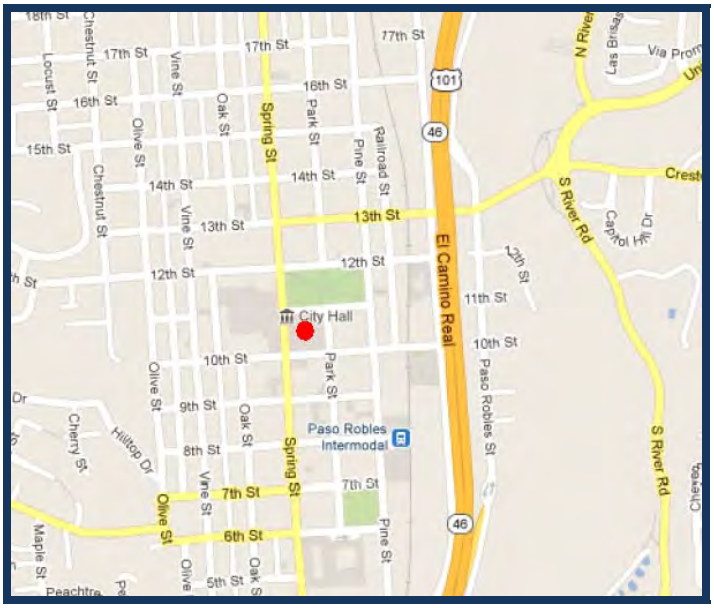
Come join us…

In completing the Paso Robles Groundwater Basin Salt and Nutrient Management Plan!

Working together to manage and protect groundwater resources

WHEN: Friday, April 17th – 2:00 p.m.

WHERE: Paso Robles Library/City Hall Meeting Room, 1000 Spring Street, Paso Robles



- See plans for groundwater monitoring
- Hear a presentation on the completed draft SNMP
- Provide input on the plan

For more information on the workshop, contact:

Leslie Dumas
RMC Water and Environment
(925) 627-4113 or
Ldumas@rmcwater.com

Paso Robles Groundwater Basin
SALT AND NUTRIENT MANAGEMENT WORKSHOP No. 4
April 17, 2015, 2:00 PM – 3:30 PM
Paso Robles Library/City Council Meeting Room
1000 Spring Street, Paso Robles

A G E N D A

1. **Introductions**

2. **Overview of TM 6 – SNMP Monitoring**

3. **Overview of Draft SNMP**

    - **Existing vs New Sections**
    - **Technical Analysis**
    - **Recommendations**

4. **What's Up Next**

5. **Questions/Input**

We will attempt to reasonably accommodate individuals with disabilities upon request.

Please contact Leslie Dumas at (925) 627-4100 with any questions.

RMC Water and Environment

Paso Robles Salt/Nutrient Management Plan
Stakeholder Workshop 4
April 17, 2015
Presenters:
Dave Richardson/RMC
RMC

Meeting Agenda
Welcome/Introductions
Overview of TM 6 – SNMP Monitoring
Overview of Draft SNMP
What's Up Next
Questions/Input
RMC Innovative Solutions for Water and the Environment

INTRODUCTIONS
RMC Innovative Solutions for Water and the Environment

Next Set of Work Items

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Project Website

- Found at http://pr.saltnutrient.com/
- Includes:
  - Documents prepared for the project
  - Reference information
  - Links to agencies and stakeholders
  - Outreach information (e.g. workshop materials)
  - SNMP links
  - Link for submitting questions

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OVERVIEW OF TM 6

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Existing Groundwater Monitoring Programs

- Title 22 Drinking Water Program
- GAMA Groundwater Monitoring
  - Domestic Well project
  - GeoTracker GAMA
- USGS Groundwater Monitoring
  - Priority Basin Project
  - Special Studies project
- CASGEM (groundwater elevation only)

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Groundwater Quality Monitoring Program

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Groundwater Elevation Monitoring Program

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Conclusions

- Not all data were available and therefore not used in analysis
- Existing groundwater quality data were found to be adequate to support study
- Title 22 Drinking Water Program monitoring provides sufficient foundation for monitoring program
- Regular funding mechanism required to expand monitoring program
- Implementation of Sustainable Groundwater Management Act will result in improvements to proposed monitoring program

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Recommendations for Basin-Wide Groundwater Quality Monitoring Program

- Create database of all existing well, water level and water quality data
- Develop monitoring program goals and objectives
- Expand monitoring network - add existing/or new wells
- Re-evaluate monitoring frequency
- Re-evaluate constituents of concern
- Develop a QA/QC Program and Sampling and Analysis Plan
- Prepare regular summary reports
- Program to be revised by GSA(s), once established

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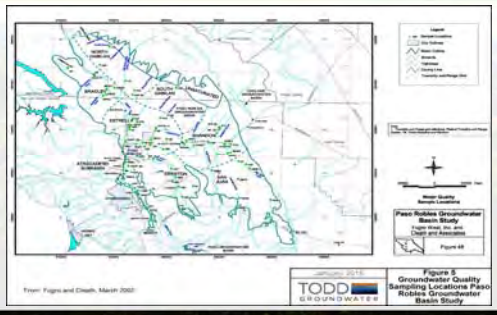
Proposed Sampling Locations



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OVERVIEW OF DRAFT SNMP

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Draft Paso Robles SNMP

- Compilation of Technical Memorandum
  - TM 1 – Outreach (new)
  - TM 2 – Basin Characterization
  - TMs 3 & 4 – Salt and Nutrient Evaluation
  - TM 5 – SNMP Goals and Objectives
  - TM 5 – Basin Management Strategies
  - TM 6 – SNMP Monitoring Program
- New Sections
  - Executive Summary
  - Introduction/Background
  - Summary of References from all TMs

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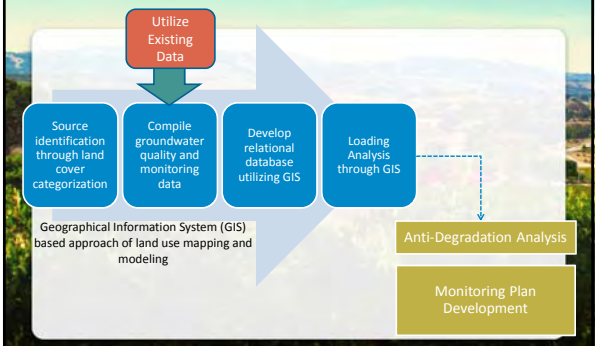
Technical Analysis



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Highlights of TM2 – Basin Characterization

- Identify study areas
- Correlate study areas with Basin Plan Subareas
- Establish background concentrations of TDS, chloride and nitrate
- Develop water balance components

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SNMP Study Areas

- Atascadero Groundwater Subbasin
- Bradley Area
- Creston Area
- Estrella Area
- North Gabilan Area
- San Juan Area
- Shandon Area
- South Gabilan Area

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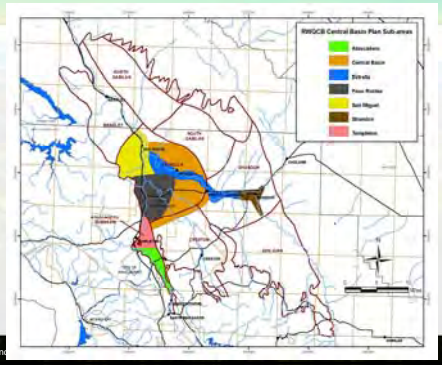
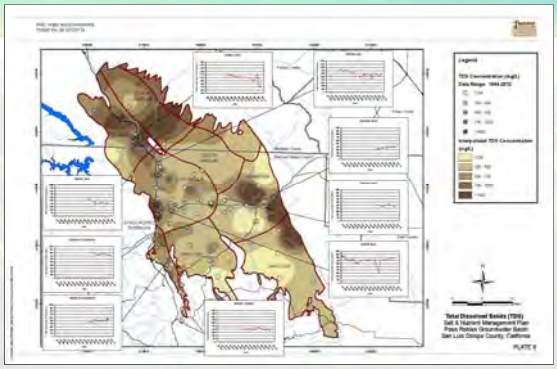
Correlation of RWQCB Subareas to Basin Study Subareas

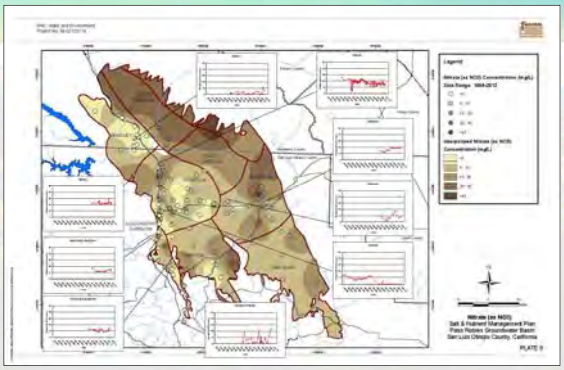


RMC Inno

Baseline TDS Distribution



Baseline Nitrate Distribution



Groundwater Characteristics

- GW elevations have either remained about the same or declined from 1981 to 2012
  - Greatest decline with Estrella Area
  - Lowest near the middle of the Estrella Area and increase radially in all directions due to higher groundwater pumping volumes
- GW quality meets drinking water standard
  - TDS, chloride, and nitrate concentrations have been increasing, especially in highly urbanized areas along Salinas River
  - Upwelling of geothermal waters along impact GW quality

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Highlights of TM3 – Identify Existing & Forseeable Salt and Nutrient Sources

- Identified indicator constituents
- Identified current and future sources of salt and nutrient loading to groundwater basin
- Defined parameters to estimate loading rates
- Used GIS-based model to estimate surface loading results

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Selected Indicator Constituents

- Total Dissolved Solids (TDS)
  - Provides good indicator of concentration trends
  - Is conservative
  - Have data
- Chloride
  - Same reasons as TDS
- Nitrate
  - Common nutrient in groundwater
  - Has the most water quality data

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Estimated Surface Loading to Basin

Parameters used in estimating surface loading include:

- Land use
- Applied water sources
- Current and future recycled water use
- Introduction of surface water sources
- Rainfall
- Mountain front recharge
- Wastewater systems
- Septic systems
- Soil textures

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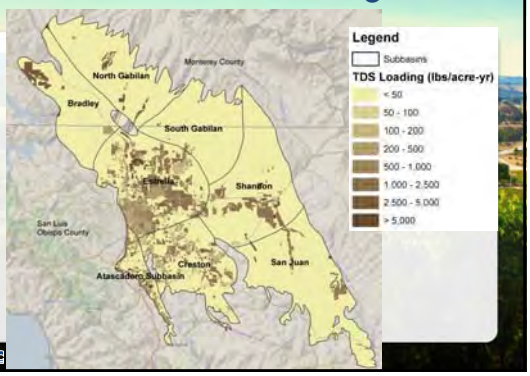
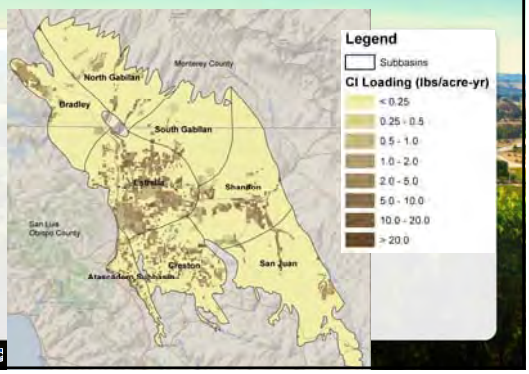
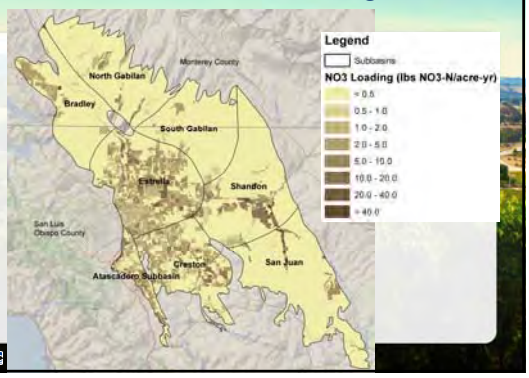
Distribution of TDS Loading



Distribution of Chloride Loading



Distribution of Nitrate Loading



Highlights of TM4 – Assimilative Capacity & Anti-Degradation Analysis

- Used loading results with mixing model to estimate future changes to groundwater quality
- Analysis done for entire basin and for Estrella Study Area and Atascadero Subbasin
- Basin-wide analysis conducted assuming mixing over total depth and over top 700 feet
- Anti-degradation analysis analyzed benefits of recycled water use relatives to anticipated future changes in groundwater quality

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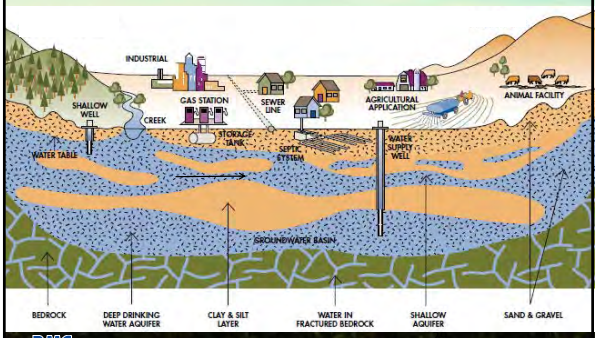
Inflow & Outflow Components



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Baseline Scenario

- Evaluate future groundwater conditions <u>without changes to land use practices or water use</u>
- Geothermal Upwelling
  - Not included in the estimated inflows
  - Is thought to have a significant impact on groundwater quality in affected areas
  - Approximate water quality (USGS)
    - TDS = 900 – 1,300 mg/L
    - Nitrate-N = no data
    - Chloride = 110 mg/L

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Future Scenario Assumptions

- Conversion of undeveloped lands/grasslands into vineyards in San Luis Obispo County
- Percolation of 2,000 AFY of Lake Nacimiento water into Atascadero
- 4,000 AFY of Lake Nacimiento water add to City of Paso Robles distribution system
- Percolation of wastewater (~246 AFY) generated by Templeton CSD into Salinas River underflow in Atascadero

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Future Scenario Assumptions

- City of Paso Robles WWTP effluent drops from 30 mg/L to 8 mg/L of Total Nitrogen (as N)
- 2,500 AFY of irrigation water replaced with recycled water
- No additional storm water capture and recharge

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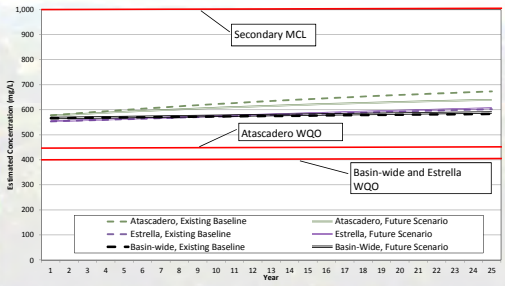
Projected TDS Concentrations



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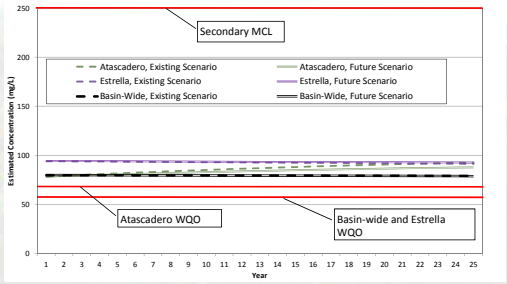
Projected Chloride Concentrations



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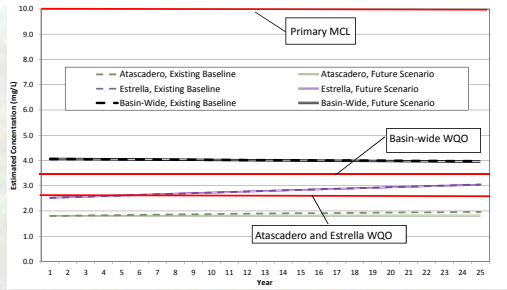
Projected Nitrate-N Concentrations



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Changes over Model Period: 700 feet Mixing Depth vs Full Mixing Depth

	Initial Conditions (mg/L)			25-year Change Baseline Scenario (mg/L)			25-year Change Future Scenario (mg/L)		
	TDS	NO_3	Cl	TDS	NO_3	Cl	TDS	NO_3	Cl
Full Mixing Depth	566	4.1	79.9	+35.03	+0.05	+5.41	+40.22	-0.06	+5.0
700-ft Mixing Depth	566	4.1	79.9	+71.37	-0.25	+14.19	+64.73	-0.31	+12.83

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Antidegradation Assessment Conclusions

- Basin-wide average TDS concentrations will increase over time, but will not exceed the WQOs where presently met
- Nitrate and chloride concentrations are anticipated to be stable basin-wide
- Increases in indicator constituent concentrations with anticipated future uses are consistent with the maximum benefit to the people of the State of California

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Highlights of TM5 – SNMP Goals and Objectives

BMO-1: Protection of surface water resources

BMO-2: Minimize impacts on local water supply

BMO-3: Minimize impacts on groundwater quality

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Groundwater Management Goals

- Maintain groundwater levels
- Protect against adverse impacts to surface water flows
- Preserve floodplain to promote groundwater recharge
- Prevent water pollution
- Protect against potential inelastic land surface subsidence

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Recycled Water Goals

- Paso Robles
  - average annual recycled water demand - 1,750 AFY
  - short-term goal - 650 AFY for landscape irrigation beginning 2025
- Atascadero
  - replace potable water irrigation in five parks
  - use ~60 AFY in the future.
- Templeton CSD
  - coordinate with SLO County in Regional Recycled Water Strategic Plan
  - consider percolation into basin for retrieval downgradient
- San Miguel CSD
  - currently percolating secondary effluents at WWTF
  - Consider use for public landscape irrigation in new developments

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Stormwater Recharge Goals

- Maximization onsite runoff capture and infiltration
  - Low impact development (LID) techniques
  - Central Coast RWQCB Post-Construction Runoff Control Requirements
- Maximization of instream infiltration
- Use dual-purpose stormwater runoff management facilities

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Highlights of TM5 – Basin Management Strategies

- Stormwater Runoff Management
- Groundwater Basin Management
- Salinas River Underflow Augmentation
- Best Management Practices
- Wastewater Salinity/Nutrient Source Control
- Source Water Salinity Control
- Public Education
- Institutional
- Recycled Water

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Summary of Key Findings

- Sustainable Groundwater Management Act of 2014 changes everything
  - SNMP is starting point
  - GSP will incorporate and move basin management forward
- Groundwater quality is generally good
  - Some areas with higher salts and nutrient already exist
  - Groundwater extractions are bigger problem at moment
- Diversifying water sources
  - Use of Lake Nacimiento water will benefit the groundwater basin
  - Recycled water use will offset groundwater use
  - Nitrate and chloride concentrations are anticipated to be relative stable basin-wide
- Existing basin management strategies should be continued

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Summary of Key Findings (cont'd)

- Additional basin management strategies may be considered in the future
- Use existing drinking water well monitoring program to monitor for SNMP impacts
- Expand monitoring program in future to provide greater coverage both aerially and with depth

Implementation of the Sustainable Groundwater Management Act requirements and water district formation will ultimately result in revisions to basin management program and basin-wide monitoring program

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WHAT'S UP NEXT?

RMC Innovative Solutions for Water and the Environment

What's Next

- Public Review of Draft SNMP
  - Can be found on website at: http://pr.saltnutrient.com/
  - Comments due by April 30th
  - Submit comments to Leslie Dumas/RMC at Ldumas@rmcwater.com
- Adoption of SNMP
- Submittal of SNMP to Central Coast RWQCB

RMC Innovative Solutions for Water and the Environment

Questions?

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RMC Innovative Solutions for Water and the Environment

Paso Robles Salt-Nutrient Management Plan
Stakeholder Meeting No. 4
April 17, 2015

Name	Organization
Matt Thompson	City of Paso Robles
R. Brower	Fox N Toad
David LaCaro	City of Paso Robles
Michael Baugh	Paso Robles resident
Ted Gilbert	Rancher
Gwen Pelfrey	Templeton resident

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Appendix G - Water Quality Data for Surface Water Samples (Fugro, 2002)

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Surface Water Quality - Atascadero Subbasin, Salinas River at Highway 58

Water Type	Date	Flow (cfs)	Units	Ca	Mg	Na	K	HCO3	SO4	Cl	TDS
Ca HCO3-SO4	4/10/1962	2000	mg/L	18	7	7.7	2.4	68	32	6	172
			Meq/l	0.9	0.58	0.33	0.06	1.11	0.67	0.17	
Mg-Ca HCO3	2/14/1954	150	mg/L	20	16	8	1.9	98	29	7	211
			Meq/l	1	1.32	0.35	0.05	1.61	0.6	0.2	

Surface Water Quality - Creston Area, Huer Huero Creek

Water Type	Date	Flow (cfs)	Units	Ca	Mg	Na	K	HCO3	SO4	Cl	TDS
Huer Huero @ Hwy 41 Ca HCO3	12/6/1966	500	mg/L	40	6	7	5	143	9.6	9	224
			meq/l	2	0.49	0.3	0.13	2.34	0.2	0.25	
Middle Branch @ Hwy 58 Ca-Na HCO3	1/31/1967	10-15	mg/L	16	5	15	2	83	8	13	116
			meq/l	0.8	0.41	0.65	0.05	1.36	0.17	0.37	
Middle Branch @ Hwy 58 Ca-Na HCO3	4/10/1954	2	mg/L	27	9.1	24	2.5	114	18.2	29.8	170
			meq/l	1.35	0.75	1.04	0.06	1.87	0.38	0.84	
East Branch @ Hwy 58 Ca-Na HCO3	1/31/1967	5	mg/L	18	5	15	3	78	7	16	158
			meq/l	0.9	0.41	0.65	0.08	1.28	0.15	0.45	
East Branch @ Hwy 58 Mg-Na HCO3	4/10/1954	5	mg/L	4.4	9.1	13.6	2	66.5	0	18.1	83
			meq/l	0.22	0.75	0.59	0.05	1.09	0	0.51	

Surface Water Quality - San Juan Area, Various Creeks at Highway 58

Water Type	Date	Flow (cfs)	Units	Ca	Mg	Na	K	HCO3	SO4	Cl	TDS
Indian Creek Na-Ca HCO3	1/31/1967	5-7	mg/L	19	7	25	3	90	27	20	171
			meq/l	0.95	0.58	1.09	0.08	1.48	0.56	0.56	
Shell Creek Ca-Na HCO3	1/24/1969	na (high)	mg/L	10	3	9	2	45	11	7	92
			meq/l	0.5	0.25	0.39	0.05	0.74	0.23	0.2	
Shell Creek Na-Ca HCO3	1/31/1967	10	mg/L	13	6	16	2	71	13	12	130
			meq/l	0.65	0.49	0.7	0.05	1.16	0.27	0.34	
Camatta Creek Ca HCO3	1/24/1969	na (high)	mg/L	10	4	3	4	49		3	65
			meq/l	0.5	0.33	0.13	0.1	0.8	0	0.08	
Camatta Creek Ca HCO3	5/11/1967	1	mg/L	22	10	18	2	113	13	19	189
			meq/l	1.1	0.82	0.78	0.05	1.85	0.27	0.54	
Navajo Creek Ca HCO3	1/24/1969	na (high)	mg/L	10	4	6	4	32	14	5	63
			meq/l	0.5	0.33	0.26	0.1	0.52	0.29	0.14	
Navajo Creek Ca-Mg HCO3	5/11/1967	8	mg/L	33	17	18	1	162	27	19	215
			meq/l	1.65	1.4	0.78	0.03	2.66	0.56	0.54	
San Juan Creek Ca HCO3-SO4	2/9/1962	na (high)	mg/L	18	7	11	2	62	44	7	145
			meq/l	0.9	0.58	0.48	0.05	1.02	0.92	0.2	
San Juan Creek Ca SO4-HCO3	5/11/1957	20	mg/L	75	33	52	2	211	205	30	560
			meq/l	3.74	2.71	2.26	0.05	3.46	4.27	0.85	
San Juan Creek Ca-Na SO4	10/21/2001	0.1	mg/L	130	56	121	1.8	314	523	58	968
			meq/l	6.04	4.61	5.66	0.05	5.15	10.9	1.64	

Surface Water Quality - Shandon Area

Source ID/ Water Type	Date	Flow (cfs)	Units	Ca	Mg	Na	K	HCO3	SO4	Cl	TDS
Cholame Ck. @ Stream gage Na HCO3-SO4	1/7/1965	15	mg/L	33	26	74	7	187	123	57	440
			meq/l	1.65	2.14	3.22	0.18	3.06	2.56	1.61	
Cholame Ck. @ Stream gage Na Cl	2/14/1975	5	mg/L	71	89	340	6.6	247	319	534	1573
			meq/l	3.54	7.32	14.79	0.17	4.05	6.64	15.06	
Cholame Ck. @ Bitterwater Na Cl-SO4	10/4/2000	Ponded	mg/L	127	119	469	5.2	451	740	550	2380
			meq/l	6.34	9.79	20.4	0.13	7.39	15.41	15.52	
San Juan Creek @ Hwy 41 Na-Ca HCO3-SO4	1/11/1953	0.5	mg/L	104	37	173	4.7	418	278	110	848
			meq/l	5.19	3.04	7.53	0.12	6.85	5.79	3.1	

Surface Water Quality - Estrella Area

Source ID/ Water Type	Date	Flow (cfs)	Units	Ca	Mg	Na	K	HCO3	SO4	Cl	TDS
Estrella @ Hwy 46 Ca HCO3-SO4	4/10/1962	2000	mg/L	18	7	7.7	2.4	68	32	6	172
			meq/l	0.9	0.58	0.33	0.06	1.11	0.67	0.17	
Estrella @ Hwy 46 Mg-Ca HCO3	2/14/1954	150	mg/L	20	16	8	1.9	98	29	7	211
			meq/l	1	1.32	0.35	0.05	1.61	0.6	0.2	
Estrella @ Hwy 46 Na-Mg HCO3	10/4/2001	0.2	mg/L	40	52	130	4.5	388	77	130	665
			meq/l	2	4.28	5.66	0.12	6.36	1.6	3.67	
Huer Huero @ Hwy 41 Ca HCO3	12/6/1966	500	mg/L	40	6	7	5	143	9.6	9	224
			meq/l	2	0.49	0.3	0.13	2.34	0.2	0.25	
Huer Huero @ Hwy 46 Ca HCO3	4/25/1967	175	mg/L	33	7	21	3	130	18	22	214
			meq/l	1.65	0.58	0.91	0.08	2.13	0.37	0.62	
Salinas @ Paso Robles Ca HCO3	2/6/1958	1500	mg/L	45	17	20	0.4	180	49	18	270
			meq/l	2.25	1.4	0.87	0.01	2.95	1.02	0.51	
Salinas @ Paso Robles Ca HCO3	3/13/1968	500	mg/L	84	29	55	3	286	137	46	553
			meq/l	4.19	2.39	2.39	0.08	4.69	2.85	1.3	
Salinas @ Paso Robles Ca HCO3	4/2/1965	25	mg/L	71	34	56	1	263	110	39	458
			meq/l	3.54	2.8	1.57	0.03	4.31	2.29	1.1	

Note: Salinas @ Paso Robles location is at 13th Street Bridge.

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Appendix H - Water Quality Data for Groundwater Samples (Fugro, 2002)

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Water Quality - Atascadero Subbasin

Sample Description	Water Type	Sample Date	Well Depth	TDS[1] mg/l	Ca mg/l	Mg mg/l	Na mg/l	K mg/l	HCO3 + CO3 mg/l	Cl[1] mg/l	SO4[1] mg/l	NO_3[2] mg/l	Fe[1] mg/l	Mn[1] mg/l	B mg/l	SAR	EC[1] dS/m	PH units
27S/12E-16G01 (S)	Na HCO3	10/17/2001	spring	830	3.7	1.4	302	2.4	461	141	115	< 0.4	< 0.1	< 0.03	1.47	34.7	1.36	8.7
27S/12E-17R02	Ca - HCO3	9/21/1998	245	720	143	51	49	<1	413	126	136	15	< 0.1	< 0.03	NR	0.9	1.27	7.1
27S/12E-22N	Na Ca - HCO3 SO4	10/17/2001		790	91	37	123	3	350	107	217	30	< 0.1	< 0.03	0.36	2.8	1.25	7.5
27S/12E-29H03	Ca Mg - HCO3 SO4	2/14/2000	65	490	86	38	34	1.3	293	42	149	< 2	< 0.1	< 0.02	NR	0.8	0.81	7.4
27S/12E-9M03	Ca Mg - HCO3 SO4	9/12/2000	210	500	91	37	40	< 1	279	46	145	< 1	< 0.1	< 0.02	NR	0.9	0.83	8.0
28S/12E-10A03	Ca HCO3	10/5/1999	500	540	147	11	36	1	310	57	125	12	< 0.1	< 0.02	NR	0.8	0.93	7.2
28S/12E-11K02	Ca Mg - HCO3	2/22/2000	600	480	87	41	36	3	364	58	72	< 2	< 0.1	< 0.02	NR	0.8	0.86	7.0
28S/12E-11N07	Ca Mg -HCO3	4/11/2000	100	540	80	40	46	3	304	57	112	5.0	< 0.1	< 0.02	NR	1.0	0.83	7.0
28S/12E-4J02	Ca HCO3	2/7/2000	86	450	91	24	38	1.4	284	45	102	9.0	< 0.1	< 0.02	NR	0.9	0.76	7.3
28S/12E-14K01	Na Ca - HCO3 Cl	2/7/2000	105	820	120	36	143	1.9	378	208	123	<2.0	<0.1	<0.02	NR	2.9	1.43	7.1
28S/13E-31D	Ca HCO3	6/13/2001	330	430	90	29	28	1.2	320	29	88	4.0	< 0.1	< 0.02	NR	0.7	0.69	7.0
28S/13E-31F02	Ca HCO3	10/5/1999	310	330	66	19	29	2	227	19	83	< 2	< 0.1	< 0.02	NR	0.8	0.62	7.4
Maximum Contaminant Level Concentrations				1000	-	-	-	-	-	500	500	45	0.3	0.05	-	-	1.60	-

MCL = Maximum Contaminant Level of Primary and Secondary analytes
Shaded areas represent concentrations exceeding MCL (No MCL's were exceeded in this table)
mg/l = milligrams per liter
dS/m = deciSiemens per meter
[1] Secondary drinking water standards analyte
[2] Primary drinking water standards analyte

Water Quality - Creston Area

Sample Description	Water Type	Sample Date	Well Depth	TDS[1] mg/l	Ca mg/l	Mg mg/l	Na mg/l	K mg/l	HCO3 + CO3 mg/l	Cl[1] mg/l	SO4[1] mg/l	NO_3[2] mg/l	Fe[1] mg/l	Mn[1] mg/l	B mg/l	SAR	EC[1] dS/m	PH units
27S/13E-14P	Na Ca - Cl	10/8/2001	85	1620	220	62	280	2.7	386	508	353	25	< 0.1	< 0.03	0.18	4.4	2.6	7
27S/13E-20A	Ca HCO3-Cl	10/8/2001		340	63	24	42	1.5	235	84	18	11	< 0.1	< 0.03	< 0.05	1.2	0.63	7.3
27S/13E-25M	Ca HCO3	10/5/2001	600	540	88	20	56	2.7	244	51	120	22	< 0.1	< 0.03	0.1	1.4	0.7	7.3
27S/13E-35K	Ca HCO3	10/8/2001	100	260	56	22	32	1.7	207	47	34	11	0.5	< 0.03	0.06	0.9	0.53	7.4
27S/13E-5N	Na HCO3	12/17/1999	400	590	48	26	140	1.8	403	100	71	10	0.7	0.2	0.31	4.2	0.96	7.5
28S/13E-1K01	Ca-Na HCO3	10/5/2001	165	290	47	7.3	33	1.8	156	31	28	6.2	< 0.1	< 0.03	0.07	1.2	0.37	7
28S/13E-36A	Ca-Na HCO3	10/5/2001	70	220	28	11	29	0.9	137	29	14	2.0	< 0.1	< 0.03	< 0.05	1.2	0.31	6.8
28S/13E-7K	Ca Cl-HCO3	10/8/2001	150	510	116	34	40	0.7	271	175	8.5	28	< 0.1	< 0.03	< 0.05	0.8	0.99	7.4
28S/14E-18C	Ca-Na HCO3	10/8/2001	200	190	27	4.6	28	2.4	120	25	7.2	3.4	< 0.1	< 0.03	< 0.05	1.3	0.28	7.2
28S/14E-4F	Ca HCO3-Cl	10/8/2001	600	340	80	10	21	1.7	166	65	13	41	< 0.1	< 0.03	< 0.05	0.6	0.55	7.4
Maximum Contaminant Level Concentrations				1000	-	-	-	-	-	500	500	45	0.3	0.05	-	-	1.60	-

MCL = Maximum Contaminant Level of Primary and Secondary analytes
Shaded areas represent concentrations exceeding MCL
mg/l = milligrams per liter
dS/m = deciSiemens per meter
[1] Secondary drinking water standards analyte
[2] Primary drinking water standards analyte

Water Quality - San Juan Area

Sample Description	Water Type	Sample Date	Well Depth	TDS[1] mg/l	Ca mg/l	Mg mg/l	Na mg/l	K mg/l	HCO3 + CO3 mg/l	Cl[1] mg/l	SO4[1] mg/l	NO_3[2] mg/l	Fe[1] mg/l	Mn[1] mg/l	B mg/l	SAR	EC[1] dS/m	PH units
27S/14E-24B01	Na HCO3	10/2/2001		310	29	3.5	66	2.2	195	20	42	12	< 0.1	< 0.03	0.26	3.1	0.43	7.5
27S/15E-12K	Na Cl-SO4	5/22/2001	750	1700	102	30	435	4.0	256	390	500	23	0.71	0.02	1.94	9.7	2.61	7.5
27S/15E-2P	Na-Ca HCO3-SO4	5/22/2001	700	490	62	5.0	76	4.0	146	69	117	5.9	0.06	< 0.01	0.26	2.5	0.7	7.7
27S/15E-35F01	Ca HCO3	10/6/2001		170	44	5.4	23	1.8	137	17	30	10	< 0.1	< 0.03	< 0.05	0.9	0.33	7.6
27S/16E-18H01	Na Cl-SO4	10/2/2001	104	2170	163	44	551	4.0	259	699	722	56	< 0.1	< 0.03	2.29	10	3.15	7.2
28S/15E-14F02	Ca HCO3	10/6/2001		160	22	6.2	16	1.3	82	13	24	8.4	0.1	< 0.03	< 0.05	0.8	0.22	6.9
28S/15E-26M01	Ca HCO3-SO4	10/6/2001		570	80	23	60	4.3	234	41	166	< 0.4	2.5	0.223	0.14	1.5	0.74	7.1
28S/16E-14N01	Ca HCO3	10/2/2001	375	450	83	21	41	1.7	232	46	112	26	2.6	0.032	0.08	1.1	0.65	7.3
San Juan Ck. @ Hwy 58	Ca SO4	10/17/2001	surface	970	130	56	121	1.8	314	58	523	< 0.4	< 0.1	0.145	0.19	2.3	1.46	7.7
Maximum Contaminant Level Concentrations				1000	-	-	-	-	-	500	500	45	0.3	0.05	-	-	1.60	-

MCL = Maximum Contaminant Level of Primary and Secondary analytes
Shaded areas represent concentrations exceeding MCL
mg/l = milligrams per liter
dS/m = deciSiemens per meter
[1] Secondary drinking water standards analyte
[2] Primary drinking water standards analyte

Water Quality - Shandon Area

Sample Description	Water Type	Sample Date	Well Depth	TDS[1] mg/l	Ca mg/l	Mg mg/l	Na mg/l	K mg/l	HCO3 + CO3 mg/l	Cl[1] mg/l	SO4[1] mg/l	NO_3[2] mg/l	Fe[1] mg/l	Mn[1] mg/l	B mg/l	SAR	EC[1] dS/m	PH units
25S/15E-31K (S)	Ca-Mg HCO3	10/11/2001	spring	550	70	37	62	1.2	245	93	92	41	< 0.1	< 0.03	0.35	1.5	0.83	7.1
25S/15E-31Q	Ca-Na HCO3	10/11/2001	700	460	63	18	63	3.2	195	45	105	17	0.1	< 0.03	0.41	1.8	0.65	7.2
26S/14E-14R	Na HCO3	10/4/2001	715	460	36	6.5	121	2.9	251	48	78	7.8	< 0.1	< 0.03	0.63	4.9	0.67	7.7
26S/14E-18J01	Na HCO3	10/2/2001	440	460	39	25	89	2.8	256	64	103	10	< 0.1	< 0.03	0.49	2.8	0.73	7.4
26S/14E-21MO1	Na HCO3	10/4/2001		440	26	7.6	119	2.7	272	31	65	5.6	< 0.1	< 0.03	0.53	5.3	0.61	7.8
26S/15E-6N (S)	Ca-Mg SO4	10/11/2001	spring	3160	339	217	237	3.9	251	240	2010	54	< 0.1	< 0.03	1.31	2.5	3.48	7.0
26S/15E-20B03	Ca-Na HCO3	5/21/2001	400	350	60	4.6	37	NR	159	50	57	14	0.01	< 0.02	NR	1.2	0.5	7.7
26S/15E-21G	Na-Ca Cl-SO4	10/11/2001		1610	176	31	323	5.4	223	451	584	13	0.6	< 0.03	1.26	6.0	2.73	7.2
26S/15E-28Q02	Ca-Na SO4	10/11/2001		1070	167	22	123	3.3	176	182	410	8.3	< 0.1	< 0.03	0.48	2.4	1.5	7.3
26S/15E-31K	Ca HCO3	10/17/2001		270	55	4.7	26	2.0	144	33	14	35	< 0.1	< 0.03	0.08	0.9	0.44	7.6
26S/15E-33C01	Ca Cl	10/2/2001	500	330	87	6.3	36	2.7	120	95	79	8.8	< 0.1	< 0.03	0.11	1.0	0.57	7.3
Cholame Creek	Na Cl-SO4	10/4/2001	surface	2380	127	119	469	5.2	451	550	740	< 0.4	< 0.1	< 0.03	2.97	7.3	2.98	7.6
Estrella River	Na-Mg HCO3	10/4/2001	surface	670	40	52	130	4.5	388	130	77	< 0.4	< 0.1	0.03	0.68	3.2	0.99	8.6
Maximum Contaminant Level Concentrations				1000	-	-	-	-	-	500	500	45	0.3	0.05	-	-	1.60	-

MCL = Maximum Contaminant Level of Primary and Secondary analytes
Shaded areas represent concentrations exceeding MCL
mg/l = milligrams per liter
dS/m = deciSiemens per meter
[1] Secondary drinking water standards analyte
[2] Primary drinking water standards analyte

Water Quality - Estrella Area

Sample Description	Water Type	Sample Date	Well Depth	TDS[1] mg/l	Ca mg/l	Mg mg/l	Na mg/l	K mg/l	HCO3 + CO3 mg/l	Cl[1] mg/l	SO4[1] mg/l	NO_3[2] mg/l	Fe[1] mg/l	Mn[1] mg/l	B mg/l	SAR	EC[1] dS/m	PH units
25S/13E-21N	Mg HCO3	10/15/2001	300	360	33	33	49	2.1	279	41	23	11	< 0.1	< 0.03	0.29	1.5	0.59	7.4
25S/12E-27F	Na HCO3	10/16/2001	750	410	28	21	82	1.4	256	46	60	17	< 0.1	< 0.03	0.48	2.9	0.66	7.7
25S/12E-27R	Na HCO3-SO4	10/16/2001		830	60	54	145	3.2	312	168	240	8.1	< 0.1	< 0.03	0.89	3.3	1.34	7.4
25S/12E-33Q	Na HCO3-Cl	10/16/2001	80	1270	116	71	218	4.0	488	262	342	21	< 0.1	< 0.03	0.78	4.0	1.88	7.0
25S/12E-21G01	Mg HCO3	5/12/1999	400	830	72	69	96	NR	366	120	180	30	0.1	< 0.005	NR	1.9	1.29	7.2
26S/12E-20A01 (S)	Na Cl	10/17/2001	spring	1560	124	29	357	4.7	259	564	375	< 0.4	< 0.1	< 0.03	5.21	7.6	2.55	7.2
26S/12E-22J01	Na-Ca HCO3	9/26/2000	775	530	62	6.0	128	2.0	279	70	107	19	< 0.1	< 0.02	NR	4.2	0.92	8.0
26S/12E-24D03	Na HCO3	8/3/1999	1075	530	31	12	146	2.7	307	48	134	< 2	< 0.1	< 0.02	NR	5.6	0.93	7.4
26S/12E-25C	Na HCO3	1/14/2000	760	490	21	10	140	2.0	293	32	100	< 0.4	0.0	0.048	NR	6.3	0.75	8.1
26S/12E-29B	Na Cl	10/19/2001	400	1260	116	21	355	4.3	195	572	308	< 0.4	0.2	< 0.03	5.66	8.1	2.38	7.2
26S/12E-4K	Ca-Mg HCO3-Cl	10/19/2001		590	77	46	77	2.2	317	153	113	10	< 0.1	< 0.03	0.30	1.8	1.12	7.4
26S/13E-15F	Na-Mg HCO3	6/20/2000	820	380	41	29	60	1.9	256	52	46	4.5	< 0.1	< 0.03	0.31	1.8	0.65	7.9
26S/13E-18K01	Na HCO3	9/26/2000	885	370	43	22	68	2.0	256	70	26	< 1	< 0.1	< 0.02	NR	2.1	0.69	8.0
26S/13E-19P	Ca-Mg HCO3	10/4/2001	580	360	47	27	37	1.5	229	61	11	20	< 0.1	< 0.03	0.13	1.1	0.56	7.6
26S/13E-28K	Na HCO3	10/4/2001		350	28	20	66	1.7	261	38	26	< 0.4	0.9	< 0.03	0.39	2.4	0.52	7.8
26S/13E-5E	Mg Cl-SO4	10/4/2001	490	1000	93	81	115	2.7	277	223	272	14	< 0.1	< 0.03	0.59	2.1	1.42	7.8
27S/12E-2E01	Na HCO3	9/19/2000	600	420	41	25	87	2.0	351	61	31	< 1	< 0.1	< 0.02	NR	2.6	0.78	7
Maximum Contaminant Level Concentrations				1000	-	-	-	-	-	500	500	45	0.3	0.05	-	-	1.60	-

MCL = Maximum Contaminant Level of Primary and Secondary analytes
Shaded areas represent concentrations exceeding MCL
mg/l = milligrams per liter
dS/m = deciSiemens per meter
[1] Secondary drinking water standards analyte
[2] Primary drinking water standards analyte

Water Quality - North and South Gabilan Areas

Sample Description	Water Type	Sample Date	Well Depth	TDS[1] mg/l	Ca mg/l	Mg mg/l	Na mg/l	K mg/l	HCO3 + CO3 mg/l	Cl[1] mg/l	SO4[1] mg/l	NO_3[2] mg/l	Fe[1] mg/l	Mn[1] mg/l	B mg/l	SAR	EC[1] dS/m	PH units
23S/11E-11E	Ca Cl	10/19/2001		870	123	55	76	4.4	279	209	204	39	0.1	< 0.03	0.2	1.5	1.42	7.7
23S/11E-33A	Ca HCO3	10/11/2001		370	48	20	36	1.7	215	57	8.9	44	< 0.1	< 0.03	0.11	1.1	0.57	7.4
24S/12E-17L	Ca-Mg SO4	10/11/2001		1320	142	81	132	4.7	279	120	648	34	< 0.1	< 0.03	0.44	2.2	1.99	7.2
24S/12E-27E	Ca-Mg HCO3-SO4	10/15/2001	450	900	136	66	39	2.9	393	55	256	34	< 0.1	< 0.03	0.22	0.7	1.21	6.9
24S/12E-33H (S)	Mg HCO3	10/15/2001	spring	450	44	47	37	2.5	303	35	50	23	< 0.1	< 0.03	0.18	0.9	0.69	7.4
24S/13E-23K	Mg-Ca HCO3-SO4	10/16/2001	540	630	85	58	29	2.1	309	38	165	71	< 0.1	< 0.03	0.19	0.6	0.94	7.5
25S/13E-22F	Mg-Na HCO3	10/15/2001	350	380	31	37	58	2.3	295	44	29	11	< 0.1	< 0.03	0.37	1.7	0.63	7.5
Maximum Contaminant Level Concentrations				1000	-	-	-	-	-	500	500	45	0.3	0.05	-	-	1.60	-

MCL = Maximum Contaminant Level of Primary and Secondary analytes
Shaded areas represent concentrations exceeding MCL
mg/l = milligrams per liter
dS/m = deciSiemens per meter
[1] Secondary drinking water standards analyte
[2] Primary drinking water standards analyte

Water Quality - Bradley Area

Sample Description	Water Type	Sample Date	Well Depth	TDS[1] mg/l	Ca mg/l	Mg mg/l	Na mg/l	K mg/l	HCO3 + CO3 mg/l	Cl[1] mg/l	SO4[1] mg/l	NO_3[2] mg/l	Fe[1] mg/l	Mn[1] mg/l	B mg/l	SAR	EC[1] dS/m	PH units
24S/10E-4A	Ca SO4	10/11/2001	1100	730	118	35	50	3.2	204	47	348	< 0.4	0.5	0.067	0.18	1.1	1.12	7.5
24S/11E-24Q01	Ca Na - SO4	3/23/1999		1150	208	50	190	4.9	256	40	704	0.8	0.4	< 0.005	NR	3.1	NR	8.1
24S/11E-26L01	Na - SO4 HCO3	3/23/1999	204	1280	153	36	303	NR	299	90	344	1.8	0.4	0.09	NR	5.7	NR	8.4
24S/11E-34K02	Na - HCO3 Cl	3/23/1999	340	780	21	8.9	312	2.0	372	150	94	NR	0.2	0.04	NR	14.5	NR	8.3
24S/11E-35E01	Na Cl	3/23/1999	500	1040	21	6.6	529	2.0	335	400	257	NR	0.1	NR	NR	25.7	NR	8.7
24S/11E-8B	Ca HCO3	10/11/2001	120	400	60	23	36	1.5	207	58	30	55	< 0.1	< 0.03	0.12	1.0	0.63	7.4
Maximum Contaminant Level Concentrations				1000	-	-	-	-	-	500	500	45	0.3	0.05	-	-	1.60	-

MCL = Maximum Contaminant Level of Primary and Secondary analytes
Shaded areas represent concentrations exceeding MCL
mg/l = milligrams per liter
dS/m = deciSiemens per meter
[1] Secondary drinking water standards analyte
[2] Primary drinking water standards analyte

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Surface Water Quality - Bradley Area

Source ID/ Water Type	Date	Flow (cfs)	Units	Ca	Mg	Na	K	HCO3	SO4	Cl	TDS
Salinas @ San Miguel Ca HCO3	03/17/1954	353	mg/L	50	11	16	3.1	168	49	27	300
			meq/l	2.5	0.9	0.7	0.08	2.75	1.02	0.76	
Salinas @ San Miguel Na HCO3	03/26/1954	20	mg/L	78	39	127	3.5	342	180	113	767
			meq/l	3.89	3.21	5.52	0.09	5.61	3.75	3.19	
Nacimiento @ San Miguel Ca-Mg HCO3	03/13/1968	1000	mg/L	30	15	10	1	134	37	6	202
			meq/l	1.5	1.23	0.44	0.03	2.2	0.77	0.17	
Nacimiento @ San Miguel Ca-Mg HCO3	05/07/1968	200	mg/L	30	15	10	1	135	36	7	168
			meq/l	1.5	1.23	0.44	0.03	2.21	0.75	0.2	
Nacimiento @ San Miguel Ca-Mg HCO3	11/18/1974	2	mg/L	27	13	11	1	123	34	6.5	163
			meq/l	1.35	1.07	0.48	0.03	2.02	0.71	0.18	
San Antonio @ G19 Bridge Ca HCO3	02/06/1958	500	mg/L	32	9.1	9.2	1.4	109	34	10	198
			meq/l	1.6	0.75	0.4	0.04	1.79	0.71	0.28	

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