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VENTURA COUNTY WATERSHED PROTECTION DISTRICT

Lower Santa Clara River Salt and Nutrient Management Plan

prepared by

LARRY WALKER ASSOCIATES, CAROLLO, HYDROMETRICS WRI

RINCON CONSULTING, DR. NORM BROWN

prepared for

CITY OF VENTURA

CITY OF FILLMORE

CITY OF SANTA PAULA

VENTURA COUNTY WATER WORKS DISTRICT 16

UNITED WATER CONSERVATION DISTRICT

FARM BUREAU OF VENTURA COUNTY

VENTURA COUNTY PUBLIC WORKS AGENCY/WATERSHED PROTECTION DISTRICT

LARRY WALKER ASSOCIATES

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Acknowledgements

The Lower Santa Clara River Salt (LSCR) and Nutrient Management Plan (SNMP) is the result of the collaborative effort of the Watersheds Coalition of Ventura County (WCVC) under the WCVC Integrated Regional Watershed Management Plan (IRWMP). The regional planning efforts included this special study to enhance the IRWMP and overall water resource management in Ventura County. The WCVC sought and obtained Proposition 84 Grant funding to support the SNMP development.

The grant and project was directed by the Ventura County Public Works Agency's Watershed Protection District. The development of the SNMP was overseen by a Technical Advisory Group (TAG) of agencies and entities that will be directly affected by the SNMP.

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TECHNICAL ADVISORY GROUP

Organization	Staff	
Ventura County Water Works District 16	Al Sexton Susan Pan	Reddy Pakala Eric Keller
City of Santa Paula	Brian Yanez	Caesar Hernandez
Farm Bureau of Ventura County	Dale Zurawski	
City of Ventura	Dan Pfeifer Shana Epstein	Susan Rungren
City of Fillmore	David Burkhart	Stephen Stuart
Ventura County Public Works Agency Watershed Protection District	Gerhardt Hubner	Zoe Carlson
United Water Conservation District	Dan Detmer	

CONSULTANT TEAM

The LSCR SNMP was prepared by a team led by Larry Walker Associates in association with Hydrometrics WRI, Carollo, Rincon Consultants, and Dr. Norm Brown.

Executive Summary

In February 2009 the State Water Resources Control Board (State Water Board) adopted the Recycled Water Policy[1], which requires the development of regional or sub-regional salt and nutrient management plans (SNMPs) for groundwater basins in California. The purpose of the Recycled Water Policy is to increase the use of recycled water from municipal wastewater sources consistent with state and federal water quality laws. Since recycled water contains salts and nutrients that may cause or contribute to exceedances of water quality objectives, management of these constituents in recycled water projects is important. This document provides the SNMP for the Lower Santa Clara River (LSCR) Watershed, located in Ventura County. The LSCR SNMP covers the Piru, Fillmore, Santa Paula, Mound and Oxnard Forebay sub-basins within the Lower Santa Clara River Groundwater Basin.

The SNMP area includes the cities of Fillmore, Santa Paula, and San Buenaventura (Ventura) and small unincorporated communities in Ventura County, and includes seven wastewater treatment plants (WWTPs). Five of the WWTPs have actively participated in the SNMP development and provided input into potential future plans for recycled water projects.

The LSCR SNMP has been developed as a comprehensive planning document that provides all of the key technical information necessary to meet the requirements of the Recycled Water Policy. The SNMP has also been developed as a flexible planning document that can guide the management and regulation of discharges of salts and nutrients in the context of the unique characteristics of the watershed and the current status of recycled water project planning. While all of the participating wastewater agencies have plans to recycle water, only a few specific recycled water project locations have been identified. Most of the plans are more general, including goals for volumes of recycled water to be used, but the specific project locations for the recycled water applications are still being identified.

To accommodate the range of stages of recycled water planning in the SNMP area, the SNMP includes required background information and an assessment of the groundwater basins, providing a description of water recycling and stormwater recharge goals and objectives, quantification of sources, identification of loading estimates, estimates of assimilative capacity, and description of fate and transport of salts and nutrients. Based on this technical information, a list of project scenarios encompassing the potential projects found in the recycled water planning documents and management measures was identified. The SNMP provides an evaluation of the future scenarios, develops a structure for evaluating specific projects as they are implemented in the future, and identifies management measures where appropriate. The SNMP builds on a range of water quality management policies and mechanisms already in place or being implemented, and is accordingly focused on management of increased recycled water utilization to benefit the study area.

WATER QUALITY ANALYSIS AND ASSIMILATIVE CAPACITY

All available groundwater quality data were compiled and reviewed. A data period of 1996 to 2012 was selected for analysis. Groundwater data were evaluated for trends, summary statistics were prepared, and wells were grouped by sub-basin for comparison to objectives. For wells with

[1] State Water Resources Control Board Resolution No. 2009-0011

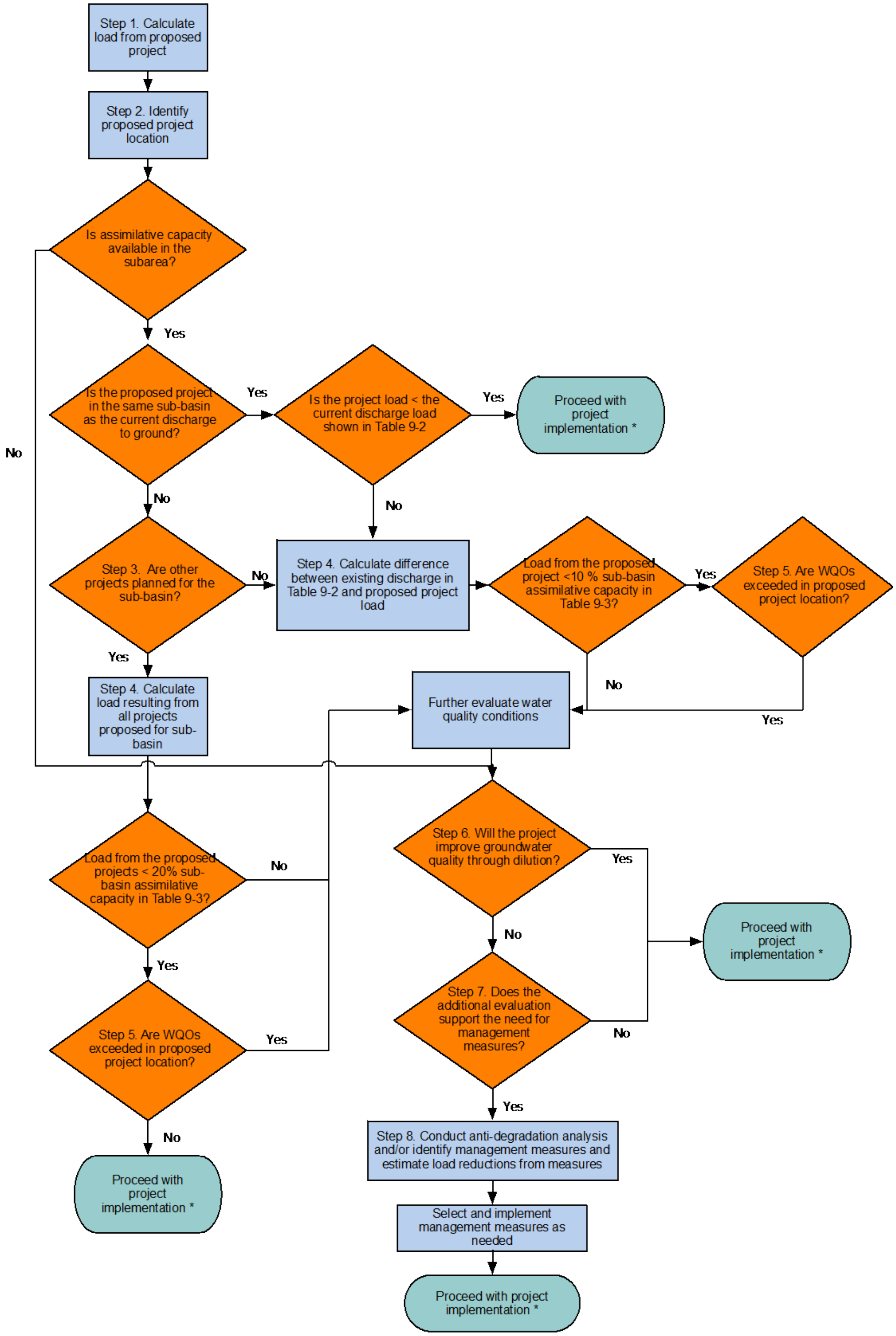
more than 10 data points, median and 90th percentile concentrations were calculated to assess the variability of the data. The analysis showed that generally basin water quality is not very variable and is not significantly influenced by hydrologic conditions. No significant difference was observed between dry and wet years in the data. Additionally, surface water recharge is the largest driver of water quality in most sub-basins and surface loadings are generally not large enough to greatly influence water quality in the sub-basins as a whole. However, in some cases single wells or small subareas exceed water quality objectives or have discernable trends. The water quality analysis is summarized in **Section 4**.

Based on the water quality analysis, the assimilative capacity of the sub-basins was calculated. To calculate the assimilative capacity, the existing water quality was calculated and compared to the water quality objective. The difference between the existing water quality and the objective is the available assimilative capacity. Existing water quality was calculated by taking the median of all wells in the dataset and plotting them on maps. From the spatial distribution of the median concentrations, zones of similar water quality were hand-delineated. The median concentrations for all the wells located within each zone of the sub-basin were averaged to provide an overall average concentration for the zone. The acreage of the zone between contours and its average concentrations were used to estimate an area-weighted average concentration for each subarea. Summary statistics for the area-weighted averages are provided to support the analysis. The area-weighted average concentrations are regarded as the existing groundwater quality. The assimilative capacity analysis demonstrated that assimilative capacity is available in all sub-basins within the planning area except for TDS in the Mound basin (**Section 5**).

PROJECT EVALUATION

A spreadsheet model was used to estimate the amount of loading that would need to be added to the groundwater basins over a 17 year period to use up 20% of the available assimilative capacity. This load estimate is considered the assimilative capacity loading threshold. The loading threshold is used in the SNMP to define the amount of allowable loading that could be added by future recycled water projects and not result in degradation of the sub-basins (**Section 7**).

Project scenarios were developed to bracket the low and high volumes of potential recycled water use based on recycled water planning documents. Planned projects were included as a scenario where information was available and other scenarios were developed to account for the range of potential future projects that were included in planning documents. The net loading from the project scenarios to the groundwater basins were compared to the assimilative capacity thresholds to provide an initial assessment of the range of potential projects. Although the initial assessment provides a good indication of whether or not a proposed project would meet the SNMP requirements, individual projects will need to be evaluated to determine their feasibility under the plan. **Section 9** provides a detailed procedure for evaluating projects. A flow chart of the project evaluation process is shown in **Figure ES-1**.



*Contingent upon compliance with other regulatory requirements

Figure ES-1. Project Evaluation Process

MANAGEMENT MEASURES

The process outlined in the **Figure ES-1** is utilized to determine if additional management measures are necessary to implement the project. Stakeholders in the planning area have a strong commitment to actively protecting the groundwater sub-basins and managing salts and nutrients. A number of management measures have already been implemented in the planning area to manage salts and nutrients and significant reductions in nutrient discharges from wastewater treatment plants have been observed as result of the actions. Some of the key management measures include:

1. Prohibitions on water softener installation in the Cities of Fillmore and Santa Paula.
2. Incentive programs to remove existing water softeners in the City of Fillmore.
3. Upgrades to and construction of new wastewater treatment plants for Piru, Fillmore, and Santa Paula to include nutrient removal.
4. Ban on commercial and industrial discharges of brine or saltwater in the City of Ventura.
5. Implementation of agricultural best management practices (BMPs) to control nutrients and salts, including fertilizer and irrigation management.
6. New development and redevelopment requirements to infiltrate stormwater where feasible.
7. Requirements to tie into the sewer within the City of Santa Paula if within 200 feet of a sewer line (septic tank policy).
8. Treatment of municipal supply within the City of Ventura to improve water quality (reducing salts) prior to providing it to customers.
9. Groundwater protection programs in the City of Fillmore to provide wellhead protection, overdraft mitigation, and replenishment of extracted groundwater.

These existing management measures have resulted in reductions in discharges of salts and nutrients in the planning area, particularly from wastewater treatment plants. Average concentrations of salts and nutrients in effluent following the upgrades have decreased compared to the concentrations prior to the upgrades. Additionally, management measures to control salts and nutrients in agricultural areas have been implemented on the majority of the acreage in the planning area. The existing management measures that have already been implemented in the watershed cover the majority of the source control and treatment activities that can be implemented at wastewater treatment plants to address salts and nutrients, with the exception of reverse osmosis treatment.

If additional management measures are needed to offset loads from a proposed project, the project proponent can select from a list of potential management measures shown in **Section 9**.

Section 10 provides a basin-wide monitoring program with provisions for monitoring constituents of emerging concern. **Section 11** provides analysis of consistency with the anti-degradation policies. The approach used to evaluate the potential projects has been designed to provide compliance with the anti-degradation policy.

List of Acronyms

AF	Acre Feet
AFY	Acre Feet Per Year
AWPF	Advanced Water Purification Facility
BGS	Below Ground Surface
BMP	Best Management Practice
BPTC	Best Practicable Treatment or Control
CDPH	California Department of Public Health
CECs	Constituents of Emerging Concern
CFR	Code of Federal Regulations
CFS	Cubic Feet Per Second
CoC	Chain of Custody
DWR	Department of Water Resources
FCGMA	Fox Canyon Groundwater Management Agency
FWRP	Fillmore Wastewater Reclamation Plant
GAMA	Groundwater Ambient Monitoring and Assessment Program
GIS	Geographical Information System
IRWMP	Integrated Regional Watershed Management Plan
LAS	Lower Aquifer System
LID	Low Impact Development
LSCR	Lower Santa Clara River
MBR	Membrane Bioreactor
MGD	Million Gallons Per Day
MS/MSDs	Matrix Spike/Matrix Spike Duplicates
MSL	Mean Sea Level
MS4	Municipal Separate Storm Sewer System
NA	Not Applicable
NMFS	National Marine Fisheries Service
NPDES	National Pollutant Discharge Elimination System
POTW	Publically Owned Treatment Works
PTP	Pumping Trough Pipeline
PV	Pleasant Valley Delivery System
QA/QC	Quality Assurance / Quality Control

RO	Reverse Osmosis
RWQCB	Regional Water Quality Control Board
SCR	Santa Clara River
SCRWC	Santa Clara River Watershed Committee
SNMP	Salt and Nutrient Management Plan
SPWRF	Santa Paula Water Recycling Facility
TAG	Technical Advisory Group
TDS	Total Dissolved Solids
TMDL	Total Maximum Daily Load
TN	Total Nitrogen
UAS	Upper Aquifer System
UWCD	United Water Conservation District
USGS	United States Geological Survey
UV	Ultraviolet
VCAILG	Ventura County Irrigated Lands Group
VWRF	Ventura Water Reclamation Facility
WCVC	Watersheds Coalition of Ventura County
WDRs	Waste Discharge Requirements
WQOs	Water Quality Objectives
WRF	Water Reclamation Facility
WWTP	Wastewater Treatment Plant

1 Introduction and Goals

In February 2009 the State Water Resources Control Board (State Water Board) adopted the Recycled Water Policy[2], which requires the development of regional or sub-regional salt and nutrient management plans (SNMPs) for groundwater basins in California by 2014. The purpose of the Recycled Water Policy is to increase the use of recycled water from municipal wastewater sources consistent with state and federal water quality laws. Since recycled water contains salts and nutrients that may cause or contribute to exceedances of water quality objectives, management of these constituents in recycled water projects is important. However, the policy recognizes that recycled water projects are not the only source of salts and nutrients to groundwater basins. As a result, the policy states:

> *"It is the intent of this Policy that salts and nutrients from all sources be managed on a basin-wide or watershed-wide basis in a manner that ensures attainment of water quality objectives and protection of beneficial uses. The State Water Board finds that the appropriate way to address salt and nutrient issues is through the development of regional or subregional salt and nutrient management plans rather than through imposing requirements solely on individual recycled water projects."*

This document provides the SNMP for the Lower Santa Clara River (LSCR) Watershed, located in Ventura County. The LSCR SNMP covers the Piru, Fillmore, Santa Paula, Mound, and Oxnard Forebay sub-basins within the Santa Clara River Groundwater Basin, as shown in **Figure 1-1**.

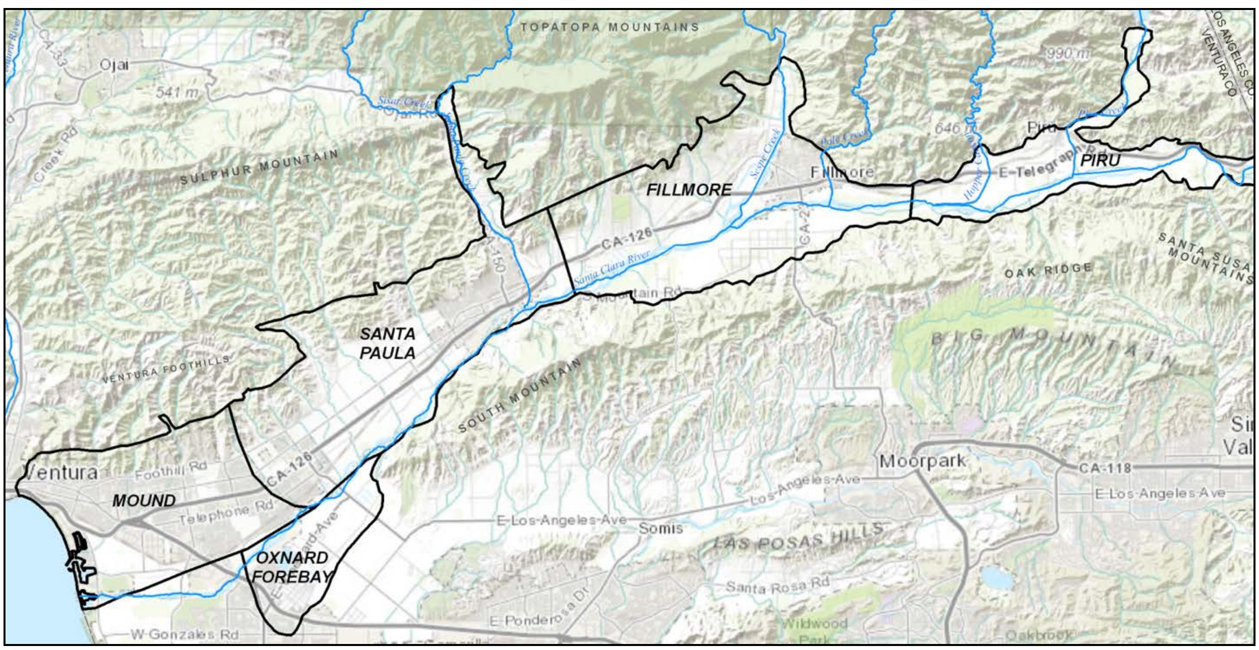


Figure 1-1 Lower Santa Clara River SNMP Area

[2] State Water Resources Control Board Resolution No. 2009-0011

The groundwater and surface water in the SNMP area are strongly interconnected. Surface water and groundwater both flow from the Upper Santa Clara River into the Lower Santa Clara River planning area and the groundwater basins are interconnected with flow generally moving from the upper portions of the watershed to the lower portion of the watershed. Surface water recharge strongly influences groundwater quality, particularly in the Piru basin.

The SNMP area includes the cities of Fillmore, Santa Paula, and San Buenaventura (Ventura), small unincorporated communities in Ventura County, and seven wastewater treatment plants (WWTPs). Five of the WWTPs have actively participated in the SNMP development and provided input into potential future plans for recycled water projects. A summary of the WWTPs is provided in **Table 1-1**.

Table 1-1 Wastewater Treatment Plants located in SNMP Planning Area

Facility	Design Flow	Sub-Basin and Subarea	Participated in SNMP
Piru Wastewater Treatment Plant	0.5 mgd	Piru-Lower Area West of Piru Creek	Yes
Fillmore Wastewater Reclamation Facility	2.4 mgd	Fillmore-Pole Creek Fan Area	Yes
Santa Paula Water Recycling Facility	3.4 mgd	Santa Paula-West of Peck	Yes
Saticoy Wastewater Treatment Plant	0.24 mgd	Santa Paula-West of Peck	
Limoneira and Olivelands Sewer Farms	0.05 mgd	Santa Paula-West of Peck	
Todd Road Jail Wastewater Treatment Plant	0.085 mgd	Santa Paula-West of Peck	Yes
Ventura Wastewater Reclamation Facility	14 mgd	Mound	Yes

1.1 PLANNING AREA BACKGROUND

Stakeholders in the planning area have a strong commitment to actively protecting the groundwater basins and managing salts and nutrients. With the exception of the western portion of the City of Ventura, all of the SNMP planning area is reliant on groundwater for their water supply. As a result, the stakeholders in the watershed have a vested interest in protecting the groundwater basins to maintain that water supply. Additionally, a chloride Total Maximum Daily Load (TMDL) and nutrient TMDL in the watershed have resulted in wastewater and agricultural dischargers implementing additional control measures to reduce salt and nutrient concentrations. As will be discussed in more detail in **Section 9**, a number of management measures have already been implemented in the planning area to manage salts and nutrients. Some of the key management measures include:

1. Prohibitions on water softener installation in the Cities of Fillmore and Santa Paula.
2. Incentive programs to remove existing water softeners in the City of Fillmore.
3. Upgrades to and construction of new WWTPs for Piru, Fillmore, and Santa Paula to include nutrient removal.

4. Ban on commercial and industrial discharges of brine or saltwater in the City of Ventura.
5. Implementation of agricultural best management practices (BMPs) to control nutrients and salts, including fertilizer and irrigation management.
6. New development and redevelopment requirements to infiltrate stormwater where feasible.
7. Requirements to tie into the sewer within the City of Santa Paula if within 200 feet of a sewer line (septic tank policy).
8. Treatment of municipal supply within the City of Ventura to improve water quality prior to providing it to customers.
9. Groundwater protection programs in the City of Fillmore to provide wellhead protection, overdraft mitigation, and replenishment of extracted groundwater.

These existing management measures have resulted in reductions in discharges of salts and nutrients in the planning area, particularly from WWTPs. Average concentrations of salts and nutrients in effluent following the upgrades have decreased compared to the concentrations prior to the upgrades. Additionally, management measures to control salts and nutrients in agricultural areas have been implemented on the majority of the acreage in the planning area (see **Section 9**).

1.2 STAKEHOLDERS

The Recycled Water Policy and the Integrated Regional Watershed Management Plan (IRWMP) grant include requirements related to public outreach and stakeholder involvement. Therefore a stakeholder process was developed to create an open locally driven and controlled, collaborative process and to provide outreach to disadvantaged communities, agricultural interests, the local communities that will benefit from the plan, the various entities that have been promoting recycled water use to improve Ventura River estuary water quality, and the Los Angeles Regional Water Quality Control Board (RWQCB).

Using a tiered stakeholder process, which included a Technical Advisory Group (TAG), the Santa Clara River Watershed Committee (SCRWC), and the RWQCB, the LSCR SNMP was developed with broad-based local community involvement.

The TAG consists of the funding agencies and stakeholders responsible for management of salts and nutrients in the watershed with representatives from agricultural, water suppliers, municipalities, including disadvantaged communities, and watershed managers. The following organizations participated on the TAG:

- Ventura County Public Works Agency Watershed Protection District;
- Cities of Ventura, Santa Paula, and Fillmore;
- United Water Conservation District (UWCD);
- Ventura County Water Works District 16; and
- Farm Bureau of Ventura County.

The SCRWC is one of three watershed groups organized under the umbrella of the Watersheds Coalition of Ventura County.

> *The Santa Clara River Watershed Committee (SCRWC) was formed in July 2006 as a coalition of stakeholders addressing issues critical to the watershed. The SCRWC is engaged in a variety of local planning efforts including development and implementation of an integrated regional water management plan (IRWMP), implementation of integrated projects identified in the IRWMP with Prop. 50 funds, and development of future project ideas to address the objectives developed by the Committee.*

As an existing and well-established watershed group that represented the stakeholders[3] in the watershed, the SCRWC served as the second tier of the LSCR SNMP stakeholder process. Updates on the progress and status of the SNMP were provided at SCRWC meetings, and the Ventura County Watershed Protection District staff served as a liaison between the SCRWC and the TAG. Documents presented on the SNMP were posted on the SCRWC website.

The final component of the stakeholder process was participation of the RWQCB. Once the TAG was established and preliminary work products were developed, the TAG engaged with the RWQCB staff, holding technical discussions meetings and invited the RWQCB staff to participate in the TAG meetings. RWQCB staff also participate in the SCRWC meetings.

1.3 SNMP GOALS AND OBJECTIVES

A key reason for developing the LSCR SNMP is to streamline requirements and encourage use of recycled water as an alternative water supply to help the state meet increasing water demands. Agencies in the region are planning for and implementing such recycling programs. Stakeholders in the LSCR watershed are reliant on groundwater for almost all of the local water supply. Significant agricultural users of groundwater also exist in the LSCR. In addition to water recycling, stormwater management practices to implement low impact development (LID) will support groundwater recharge to supplement the groundwater supply. The overarching goal of the LSCR SNMP is to: protect, conserve, and augment water supplies and to improve water supply reliability. This goal is supported by objectives of:

- Protecting Agricultural and Municipal Drinking Water Beneficial Uses of groundwater;
- Supporting increased recycled water use in the basin;
- Facilitating long-term planning and balancing use of assimilative capacity and management measures across the basin;
- Encouraging groundwater recharge in the Santa Clara River (SCR) valley; and
- Collecting, treating, and infiltrating stormwater runoff in new development and redevelopment projects.

The SNMP has been developed to support these general goals and objectives. Additionally, the stakeholders have identified recycled water and stormwater use and recharge goals for the SNMP.

[3] A list of the participants in the WCVC is available at: http://www.ventura.org/wcvc/participants.htm.

1.1.1 Recycled Water Goals

Recycling water is one key method local agencies are using to augment local water supplies. Within the LSCR basin several local agencies are currently recycling water and planning for increased future water recycling. **Table 1-2** provides a summary of current and projected recycled water projects in the basin.

Table 1-2 Current and Future Recycled Water Use

Stakeholder	Current Recycled Water Use (AFY)	Projected Recycled Water Use (AFY)
City of Fillmore	280	2,651 (by 2020)
City of Ventura	672	Up to 11,500 (by 2035)
City of Santa Paula	NA	1,622 (by 2035)
Piru (District 16)	NA	225-560 (Beginning 2016)

1.1.2 Stormwater Recharge Goals

Stormwater recharge is a component of water supply augmentation strategy. Stormwater recharge through LID techniques mimics the natural hydrologic process and encourages infiltration of stormwater throughout the urban landscape. The Ventura County stormwater permit and municipal planning processes require the implementation of LID techniques as well as source control measures to protect stormwater quality for new development and redevelopment projects. Additionally, the general plan encourages the incorporation of natural drainage features that allow for infiltration of runoff in the stormwater conveyance system and flood control features. Implementation planning efforts for TMDLs and other stormwater resource plans being developed in the watershed will identify potential stormwater recharge projects that will be considered as potential management measures under this plan. The SNMP supports the use of stormwater recharge as a management measure where appropriate.

1.4 SNMP APPROACH

The LSCR SNMP area has a number of key characteristics that provide context for the SNMP approach provided in this document.

1. The plan area is reliant on groundwater for almost all of the local water supply. As a result, groundwater management and protection has been a priority in the plan area for many years.
2. The watershed is primarily open space and agricultural land. Urban development within the plan area is currently restricted to existing urban planning areas and it is anticipated that these restrictions will remain in place and the primarily rural nature of the plan area will be maintained into the future.
3. With the exception of the Ventura Wastewater Reclamation Facility (VWRF), all of the treatment plants listed in **Table 1-1** currently either recycle their treated water or discharge all of their treated water to percolation ponds.

4. Given that land uses have been and will remain relatively unchanged and that most recycled water uses in the plan area would not represent new salt or nutrient loads to the groundwater basin, the salt and nutrient sources covered by this plan have remained fairly consistent for years and are anticipated to be similar into the future. The exceptions would be any future use of recycled water from the VWRF and any increased flows from the other treatment plants within the plan area.
5. While the WWTPs have set goals for the volume of wastewater to be reused, specific locations and plans for recycled water projects for most projects are still in development. As a result, the SNMP needs to be flexible to allow for the development and implementation of projects over time.

Based on the key characteristics outlined above, the SNMP has been developed as a flexible planning document that can guide the management and regulation of discharges of salts and nutrients as projects are implemented in the future. The SNMP builds on a range of water quality management policies and mechanisms already in place or being implemented, and is accordingly focused on management of increased recycled water utilization to benefit the study area.

In pursuit of this goal, the SNMP includes required background information and an assessment of the groundwater basins, providing a description of water recycling and stormwater recharge goals and objectives, quantification of sources, identification of loading estimates, estimates of assimilative capacity, and description of fate and transport of salts and nutrients. This assessment has led to the identification of a list of project scenarios encompassing the currently planned projects found in the recycled water planning documents and future projects that could be implemented to achieve the recycled water goals and potential management measures for both planned and potential future projects. The SNMP provides an evaluation of the scenarios, develops a structure for evaluating specific projects as they are implemented in the future, and identifies management measures where appropriate. The SNMP is organized as follows:

Section 1.	Introduction and Goals
Section 2.	Regulatory Framework
Section 3.	Basin Setting
Section 4.	Basin Water Quality
Section 5.	Assimilative Capacity Analysis
Section 6.	Salt and Nutrient Source Identification and Loading Estimates
Section 7.	Fate and Transport Analysis
Section 8.	Project Scenarios
Section 9.	Implementation Measures to Manage Salt and Nutrient Loading in the Groundwater Basin on a Sustainable Basis
Section 10.	Basin/Sub-Basin Wide Monitoring Plan
Section 11.	Anti-Degradation Analysis

2 Regulatory Framework

The LSCR SNMP was developed to meet the requirements of the State Water Board's Recycled Water Policy. As such, the SNMP includes the following required elements outlined in Section 6.b.3 of the Recycled Water Policy:

(a) A basin/sub-basin wide monitoring plan that includes an appropriate network of monitoring locations. (**Section 10** of this SNMP).

(b) A provision for annual monitoring of Constituents of Emerging Concern (CECs) (e.g., endocrine disrupters, personal care products or pharmaceuticals). (**Section 10** of this SNMP).

(c) Water recycling and stormwater recharge/use goals and objectives. (**Section 1** of this SNMP).

(d) Salt and nutrient source identification **(Section 6** of this SNMP), basin/sub-basin assimilative capacity (**Section 5** of this SNMP) and loading estimates (**Section 6** of this SNMP), together with fate and transport of salts and nutrients (**Section 7** of this SNMP).

(e) Implementation measures to manage salt and nutrient loading in the basin on a sustainable basis (**Section 9** of this SNMP).

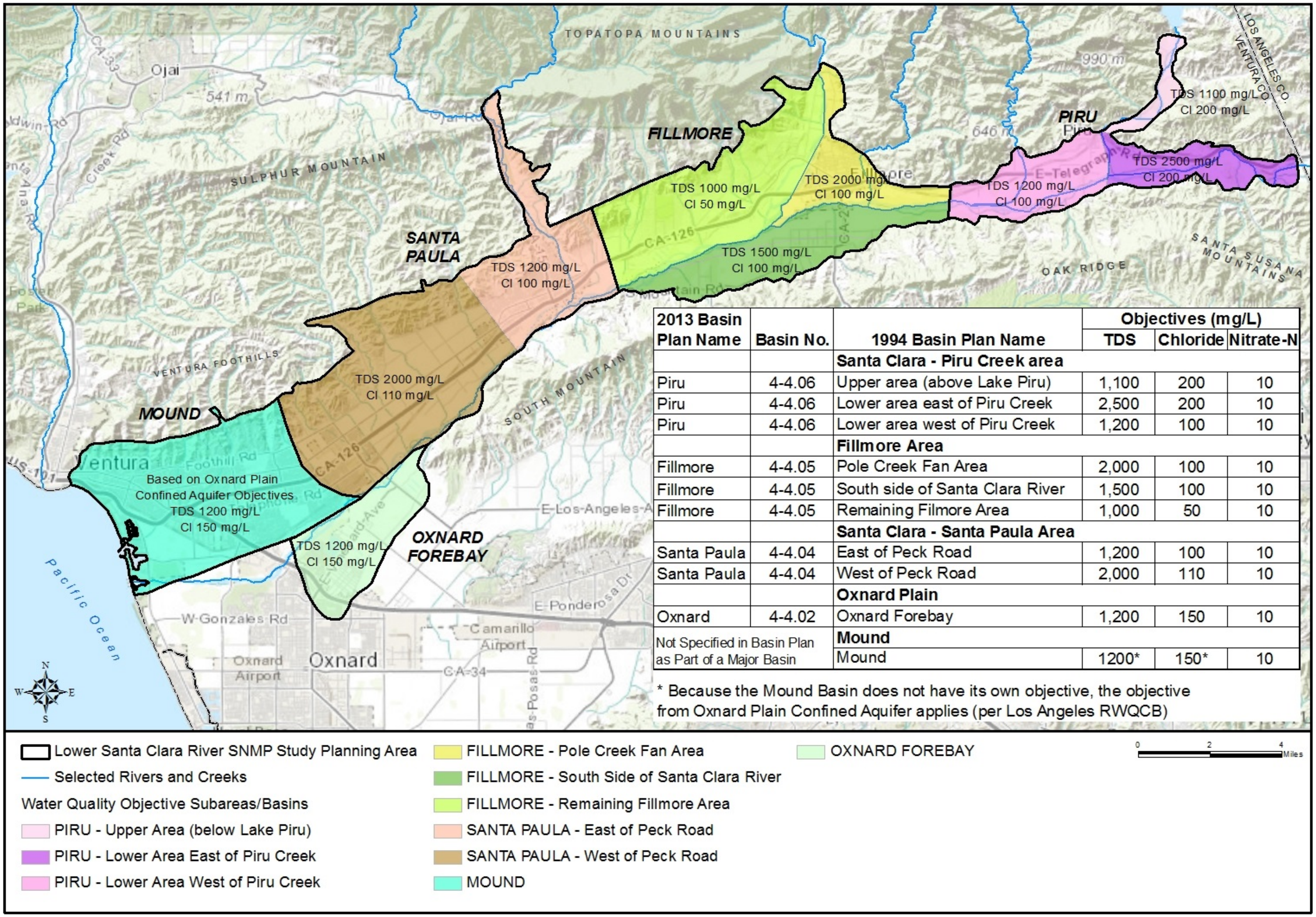
(f) An antidegradation analysis demonstrating that the projects included within the plan will, collectively, satisfy the requirements of Resolution No. 68-16 (**Section 11** of this SNMP).

In addition, the RWQCB's document *Assistance in Guiding Salt and Nutrient Management Plan Development in the Los Angeles Region* was used to support the development of the SNMP.

2.1 GROUNDWATER QUALITY OBJECTIVES

The *Basin Plan for the Coastal Watersheds of Los Angeles and Ventura Counties* (1994) (Basin Plan) includes water quality objectives for many constituents in the groundwater basins of the LSCR. For the SNMP, Total Dissolved Solids (TDS), chloride, and nitrate-N were determined to be the appropriate constituents to represent salts and nutrients for planning purposes. No other constituents of concern were identified. This section provides a discussion of the TDS, chloride, and nitrate-N objectives that apply to the sub-basins.

For many of the sub-basins within the SNMP area, the Basin Plan describes different TDS and chloride water quality objectives for specific areas within a sub-basin. Throughout the SNMP, these divisions of the sub-basins are referred to as subareas. **Table 2-1** summarizes the groundwater quality objectives for all sub-basins and subareas and **Figure 2-1** shows the water quality objectives on a map of the LSCR SNMP planning area.



2013 Basin Plan Name	Basin No.	1994 Basin Plan Name	Objectives (mg/L) TDS	Chloride	Nitrate-N
		Santa Clara - Piru Creek area			
Piru	4-4.06	Upper area (above Lake Piru)	1,100	200	10
Piru	4-4.06	Lower area east of Piru Creek	2,500	200	10
Piru	4-4.06	Lower area west of Piru Creek	1,200	100	10
		Fillmore Area			
Fillmore	4-4.05	Pole Creek Fan Area	2,000	100	10
Fillmore	4-4.05	South side of Santa Clara River	1,500	100	10
Fillmore	4-4.05	Remaining Filmore Area	1,000	50	10
		Santa Clara - Santa Paula Area			
Santa Paula	4-4.04	East of Peck Road	1,200	100	10
Santa Paula	4-4.04	West of Peck Road	2,000	110	10
		Oxnard Plain			
Oxnard	4-4.02	Oxnard Forebay	1,200	150	10
Not Specified in Basin Plan as Part of a Major Basin		**Mound**			
		Mound	1200*	150*	10

* Because the Mound Basin does not have its own objective, the objective from Oxnard Plain Confined Aquifer applies (per Los Angeles RWQCB)

Figure 2-1 Groundwater Quality Objectives for LSCR Basins and Subareas

Table 2-1 Water Quality Objectives for the Lower Santa Clara River Groundwater Basins

2013 Basin Plan Name	Basin No.	1994 Basin Plan Name	Objectives (mg/L)		
			TDS	Chloride	Nitrate-N
Piru	4-4.06	Santa Clara – Piru Creek Area			
	4-4.06	Upper area (above Lake Piru)	1,100	200	10
	4-4.06	Lower area east of Piru Creek	2,500	200	10
	4-4.06	Lower area west of Piru Creek	1,200	100	10
Fillmore	4-4.05	Fillmore Area			
	4-4.05	Pole Creek Fan Area	2,000	100	10
	4-4.05	South side of Santa Clara River	1,500	100	10
	4-4.05	Remaining Fillmore Area	1,000	50	10
Santa Paula	4-4.04	Santa Clara – Santa Paula Area			
	4-4.04	East of Peck Road	1,200	100	10
	4-4.04	West of Peck Road	2,000	110	10
Oxnard	4-4.02	Oxnard Plain			
	4-4.02	Oxnard Forebay	1,200	150	10
	4-4.02	Confined aquifers[1]	1,200	150	10
	4-4.02	Unconfined and perched aquifers	3,000	500	10
Mound[1]		Use Oxnard confined aquifers[1]	1,200	150	10

[1] As part of the non-regulatory amendments to administratively update Chapter 3 of the Basin Plan in 2013, the Mound basin was called out separately from the Oxnard Plain for the first time. Prior the update, the Mound basin was included as part of the Oxnard Plain basin. Based on review of previous Basin Plans and associated technical documents, the RWQCB determined that the objectives for the confined aquifers in the Oxnard basin apply to the Mound basin.

During development of the SNMP, questions were raised about the applicability of the selected objectives for the Mound basin. While the Basin Plan's administrative record is clear that the Mound basin has historically been considered part of the Oxnard Plain basin, the data and information that was used to develop the objectives does not appear to have included much if any information from the Mound basin. Since more recent information indicates that the Mound basin has distinct characteristics from the Oxnard Plain, and the Basin Plan now recognizes it as a separate sub-basin, consideration of alternative water quality objectives is appropriate. It would be consistent with the SNMP to consider site-specific objectives to support recycled water use in the Mound basin if the appropriate information were to be developed in the future to justify site-specific objectives.

Additionally, the Mound basin is located near the ocean and poor groundwater quality has existed historically in the sub-basin, likely due to marine sediments. A variance provision is included in the Basin Plan for consideration during permitting in coastal groundwater basins. Consideration of the variance provision during evaluation of the recycled water projects would be consistent with the SNMP. The Coastal Aquifer Variance Provision for Mineral Quality Objectives states:

> *In coastal aquifers where elevated concentrations of minerals are caused by natural sources due to an aquifer's proximity to the ocean, the Regional Board may grant a variance from implementing the mineral quality objectives specified in Table 3-13 when issuing waste discharge requirements (WDRs) or enforcement orders. Any variance granted pursuant to this variance provision shall be for no more than five years, and may be extended not more than once for an additional period of up to five years. Any further relief should be in the form of a Basin Plan amendment. A decision to issue or to extend a variance will be based upon the Regional Board's evaluation of the evidence submitted concerning the granting of the variance.*
>
> *A discharger must submit to the Executive Officer a written request for a variance from compliance with the mineral quality objectives for groundwater. The request must include recent data and analysis that provide clear and convincing evidence that elevated mineral concentrations are natural in origin and result from the aquifer's proximity to the ocean. The discharger's request must include clear and convincing evidence and analysis that:*
>
> *1. The aquifer's proximity to the ocean leads to one or more of the following:*
>
> > *a) seawater intrusion;*
> >
> > *b) the presence of marine sediments high in mineral content;*
> >
> > *c) tidal fluctuations that regularly influence the chemistry of the aquifer.*
>
> *2. The source of the elevated mineral concentrations is natural and not induced by current or past discharge of pollutants.*
>
> *3. A discharge of minerals in excess of the mineral quality objectives in the coastal aquifer will not degrade adjacent, inland aquifers.*
>
> *4. The discharger has not caused or significantly contributed to the elevated Mineral concentrations from which it seeks relief.*

Information provided in the SNMP includes a discussion of the sources of salts and nutrients to the sub-basins and information about fate and transport of salts and nutrients that could be utilized to support adoption of a variance if necessary to support recycled water uses in the Mound basin.

3 Basin Setting

The LSCR is the lower reach of the Santa Clara River that flows through Ventura County. The river flows in a westerly direction and discharges to the Pacific Ocean near the Ventura Harbor. **Figure 3-1** provides a conceptual model of water movement within the LSCR. The LSCR basin is composed of five groundwater sub-basins:

- Piru basin;
- Fillmore basin;
- Santa Paula basin;
- Mound basin; and
- Oxnard Forebay basin.

This section provides the setting for the SNMP study area, including the characterization of factors that have bearing on the salt and nutrient loads in the basin: basin physiography, geology, and hydrogeology, climate, surface water hydrology, land use and land cover; and water sources.

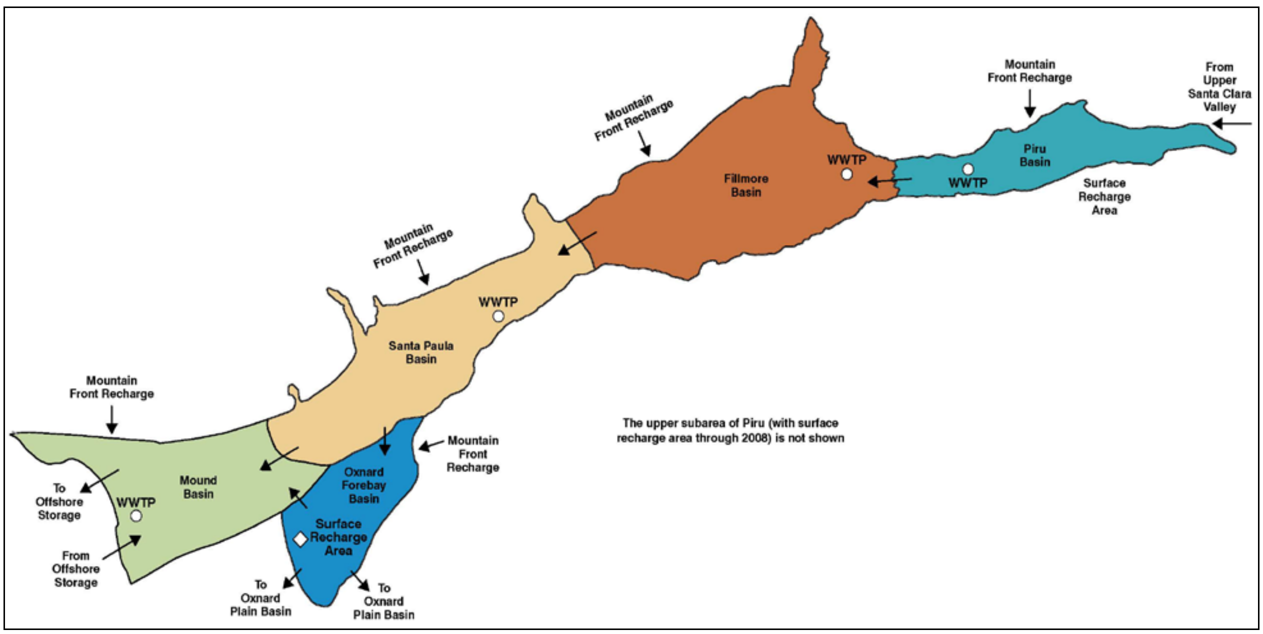


Figure 3-1 Conceptual Model of Water Movement between LSCR Sub-Basins

3.1 GROUNDWATER BASIN DESCRIPTION

The groundwater basin description provides the geologic, hydrogeologic, and hydrologic framework for the SNMP and in particular, provides the basis for the analytical flow and transport assessment required by the SNMP. Key sources of information used to establish the study area boundaries and develop the groundwater basin description include the California Department of Water Resources (DWR) and UWCD.

The California DWR Bulletin 118 delineations of groundwater basins for the Lower Santa Clara Valley used in the current Basin Plan differ from the basin delineations used by UWCD for their groundwater management. The primary difference between the two sources is UWCD's exclusion of the partially consolidated San Pedro formation and parts of the lower canyons. Additionally, the UWCD basins have different upgradient and downgradient boundaries compared to the DWR delineation, and UWCD separates DWR's Oxnard sub-basin into two: the Oxnard Forebay and Oxnard Plain basins. The Oxnard Forebay basin is included in the LSCR SNMP, however, the Oxnard Plain basin has been omitted at the request of the Oxnard stakeholders. **Figure 3-2** shows an overlay map of the DWR and UWCD basin boundaries. Given the lack of hydrogeologic data in the area between the DWR and UWCD boundaries, the LSCR SNMP uses the DWR defined basins with UWCD's Oxnard Forebay basin for the study planning area, and the UWCD basin boundaries are used for the salt and nutrient loading analysis.

The SCR valley occurs within the Ventura Basin, which is a well-defined east to west trending structurally complex sedimentary syncline within the Transverse Range province (Yeats, et al., 1981). The five groundwater sub-basins are hydrologically connected and delineated based on topographic and hydrogeologic features described in the following sections.

As part of the Transverse Ranges geologic province, the SCR valley is an east-west orientated valley that is bordered by active thrust and reverse faults. These faults have caused uplift of the adjacent mountains relative to the SCR valley (UWCD, 2012b). The valley occurs in the Transverse Range geomorphic province's Ventura Basin, which is a major sedimentary basin that formed within the structurally complex Ventura syncline. Both terrestrial and marine Tertiary and Quaternary sedimentation contributed to valley filling. The Piru, Fillmore, and Santa Paula basins are bounded by the San Cayetano and Oak Ridge faults. The Mound and Oxnard Plain basins extend offshore as a gently sloping submarine shelf of the Santa Barbara Channel (Hanson et al., 2003). The Oxnard Forebay basin is delineated as the unconfined portion of the Oxnard Plain basin (UWCD, 2008).

The water-bearing sediments in the LSCR groundwater basins are both recent and older alluvium overlying the San Pedro formation (**Figure 3-3**). The Santa Barbara formation underlies the San Pedro formation. The valley groundwater basins include the surface outcrop of San Pedro formation along their northern boundaries (**Figure 3-3**). The groundwater basins are underlain by a mostly non-water bearing basement of upper Cretaceous and Tertiary sediments and volcanics that are exposed in the surrounding mountains.

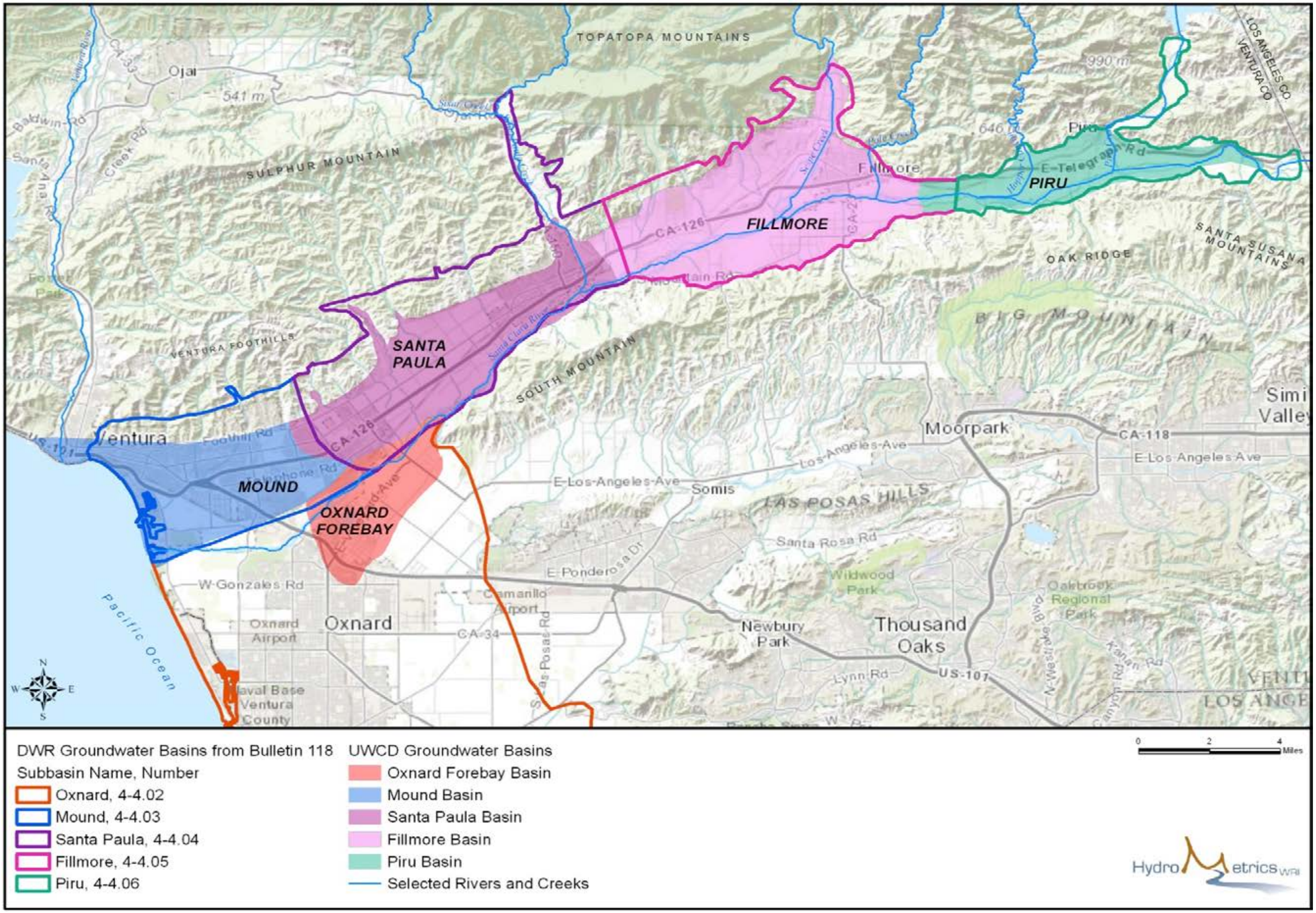


Figure 3-2 Comparison of DWR and UWCD Groundwater Basin Delineations

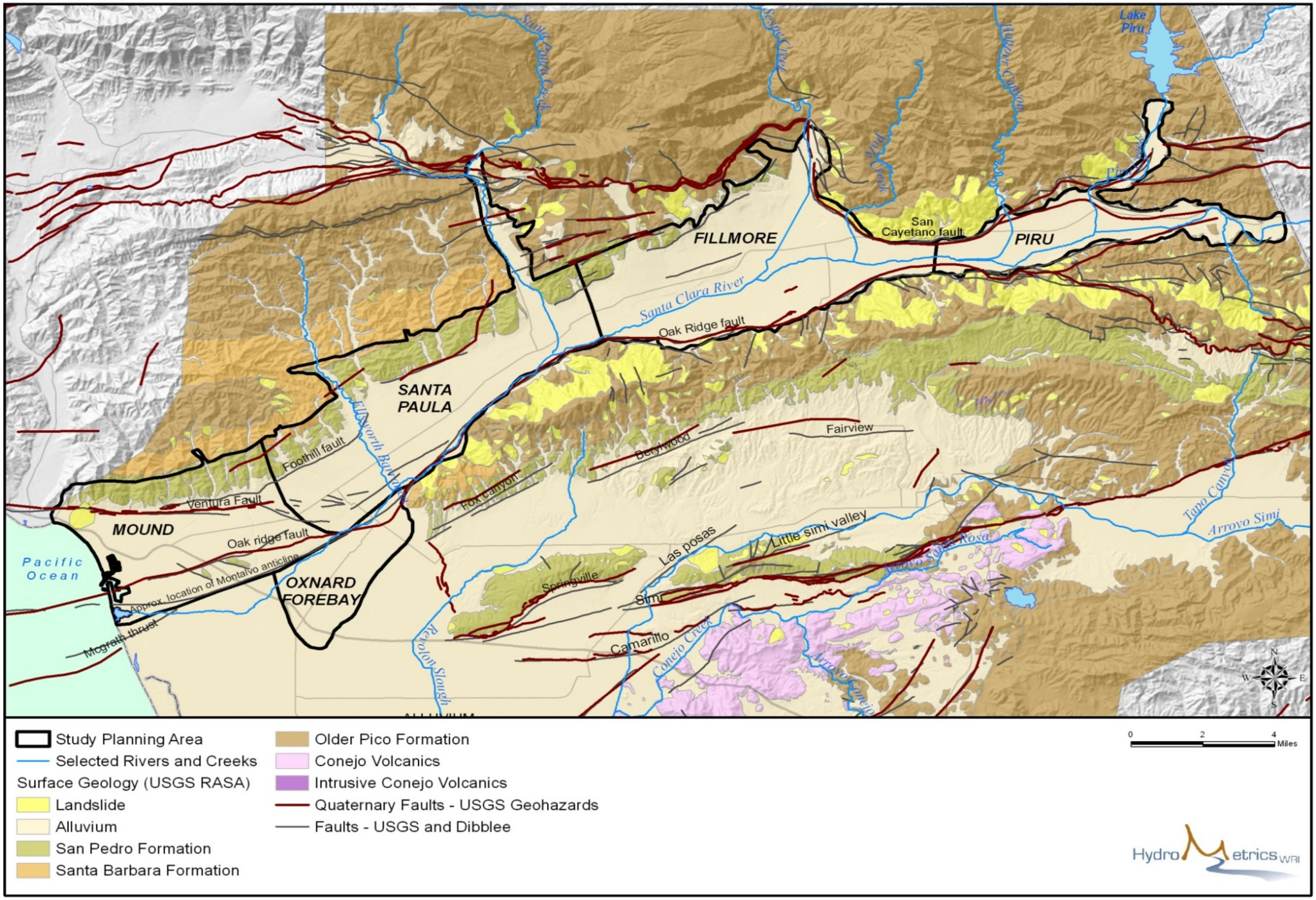


Figure 3-3 Lower Santa Clara River Surface Geology

The aquifers occurring in the study planning area can be classified as part of an Upper Aquifer System (UAS) and Lower Aquifer System (LAS) (Turner, 1975; Mukae and Turner, 1975). **Figure 3-4** illustrates the hydrostratigraphic and geologic relationship of the UAS and LAS with the regional geology.

Recent alluvium of the Oxnard aquifer and older alluvium of the Mugu aquifer comprise the UAS (**Figure 3-4**). The Oxnard aquifer generally occurs at a depth of 100 to 250 feet below ground surface (bgs) (UWCD, 2012b). Separating the two UAS aquifers is an unconformity and discontinuous clay layer. The Mugu aquifer below the Oxnard aquifer can reach a thickness of 250 feet.

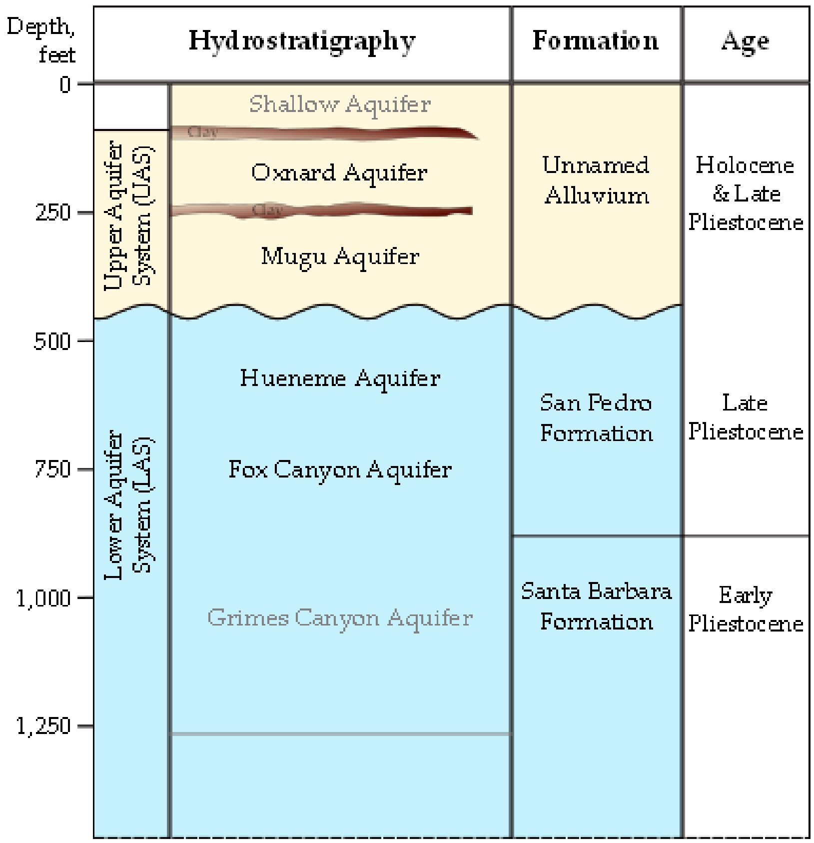


Figure 3-4 Lower Santa Clara River Aquifer Systems (UWCD, 2012b)

An unconformity separates the UAS and LAS. Below the UAS, the LAS comprises the Hueneme, Fox Canyon, and Grimes Canyon aquifers which are part of the San Pedro and Santa Barbara formations (**Figure 3-4**). The Hueneme aquifer is the uppermost aquifer of the LAS and occurs extensively across the study area. It is generally considered to be the San Pedro formation in the valley basins and the Saugus formation more inland (UWCD, 2012b). The Fox Canyon aquifer, comprised of marine shallow regressive sands and some clays, underlies the Oxnard Forebay basin but is not present in other portions of the study area (UWCD, 2012b). It is the lowermost aquifer unit in the San Pedro formation. The Grimes aquifer which underlies the Fox Canyon Aquifer shown in **Figure 3-4** does not occur in the study area.

The LSCR aquifers are primarily recharged by a combination of streambed percolation, managed aquifer recharge from diverted stream flow, mountain front recharge, deep percolation of precipitation into the alluvial sediments and rock outcrops, and irrigation return flow.

3.1.1 Piru Basin

The Piru basin is the uppermost groundwater basin in the LSCR. Its upstream or eastern extent is just downstream of the Ventura/Los Angeles County (**Figure 3-5**). The Piru basin is narrower than downstream basins and is confined to the north by the Topatopa Mountains and to the south by the Oak Ridge and Santa Susana Mountains. The basin's western extent is marked by an area of groundwater discharge into the SCR, approximately two miles east of the City of Fillmore. Locally this is referred to as "rising water", which does not mean groundwater is actually rising up but rather the groundwater level intersects the streambed and causes migrating groundwater to discharge into the river channel. The change in surface elevation on the SCR from east to west in the Piru basin is 315 feet, or on average 32 feet per mile. The Piru basin is approximately 9.8 miles long and 1.8 miles wide at its widest point at the Piru Creek/SCR confluence, and covers an area of approximately 8,915 acres.[1]

Recent and older alluvium consisting of 60 to 80 feet of coarse sand and gravel covers almost the entire Piru basin (UWCD, 2005). Underlying almost all of the recent and older alluvium are permeable sands and gravels of the San Pedro formation. The San Pedro formation persists to an approximate depth of 8,800 feet, with only the top portion of this being useable for groundwater extraction. Impermeable Pico formation underlies the older alluvium in the very eastern portion of the basin (UWCD, 2013b). The basin is structurally bound by the San Cayetano fault to the north and Oak Ridge fault to the south (**Figure 3-3)**.

During dry and normal SCR flow conditions, surface water percolates completely below the streambed between just downstream of the County line and Piru Creek (**Figure 3-5**). As a result of the complete percolation, surface water quality has a strong influence on groundwater quality in the Piru basin.

Groundwater discharges to the SCR approximately two miles east of the City of Fillmore where the basin narrows at the boundary of the Piru and Fillmore basins. Groundwater level fluctuations are much less in the area of rising groundwater than in other areas (**Figure 3-6**). The SCR in the Piru basin is in direct connection with the underlying aquifer and there are no laterally continuous confining layers to impede percolation (UWCD, 2005). This results in groundwater levels that respond rapidly to recharge from streambed percolation and rainfall events (**Figure 3-6**). When the basin fills in high precipitation years, the percolation rate decreases and surface flows are able to reach the Fillmore basin (UWCD, 2005).

Groundwater in the alluvium flows mostly parallel to the river channel (**Figure 3-6**). In the San Pedro formation, the predominant flow direction is also parallel to the river channel but also includes some north to south flow perpendicular to the axis of the Ventura syncline (UWCD, 2012b). Groundwater levels in **Figure 3-6** display data from wells screened either in the alluvium or in the San Pedro formation because there is almost no vertical hydraulic gradient between deep and shallow wells, as seen in the hydrograph displaying groundwater elevations

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[1] Other authors have listed different areas for the Piru basin based on different extents (UWCD, 1996; DWR, 2003). The area presented here is the surface area of the study planning area basin depicted in **Figure 3-2.**

for UWCD monitoring wells (wells 04N18W31D03S and 04N18W31D07S, screened from 590 to 610 feet bgs and 50 to 70 feet, respectively.

Groundwater levels in the area of rising water in wet and average years intersect the streambed causing flow in the SCR, and occur at approximately 60 feet below the streambed west of the Piru Creek confluence. In dry years, groundwater levels in the eastern part of the discharge area can fall to 50 feet below the streambed elevation, which means that rising water does not occur at that location, and occurs at 150 feet below the streambed west of Piru Creek (UWCD, 2005). The basin is considered full when the area of rising water extends eastwards to the Hopper Creek confluence (UWCD, 2005).

Streambed recharge from the SCR and Piru Creek (from both natural flows and water released from Santa Felicia Dam) are major sources of groundwater recharge, with other sources from smaller streams, mountain front recharge from the upland areas to the north and south, irrigation return flow, septic tanks, and underflow from the upstream Eastern Santa Clara River Valley basin in Los Angeles County. Historically, there has also been diverted Piru Creek water recharged at the Piru Spreading Grounds (**Figure 3-5**).

The Piru spreading grounds are not used at present due to the diversion structure not being in compliance with National Marine Fisheries Service (NMFS) standards. When the structure is permitted in the future, it will be used again for managed aquifer recharge.

Sources of discharge from the basin include groundwater pumping, rising groundwater that becomes surface water in the SCR, and subsurface groundwater outflow to the Fillmore basin.

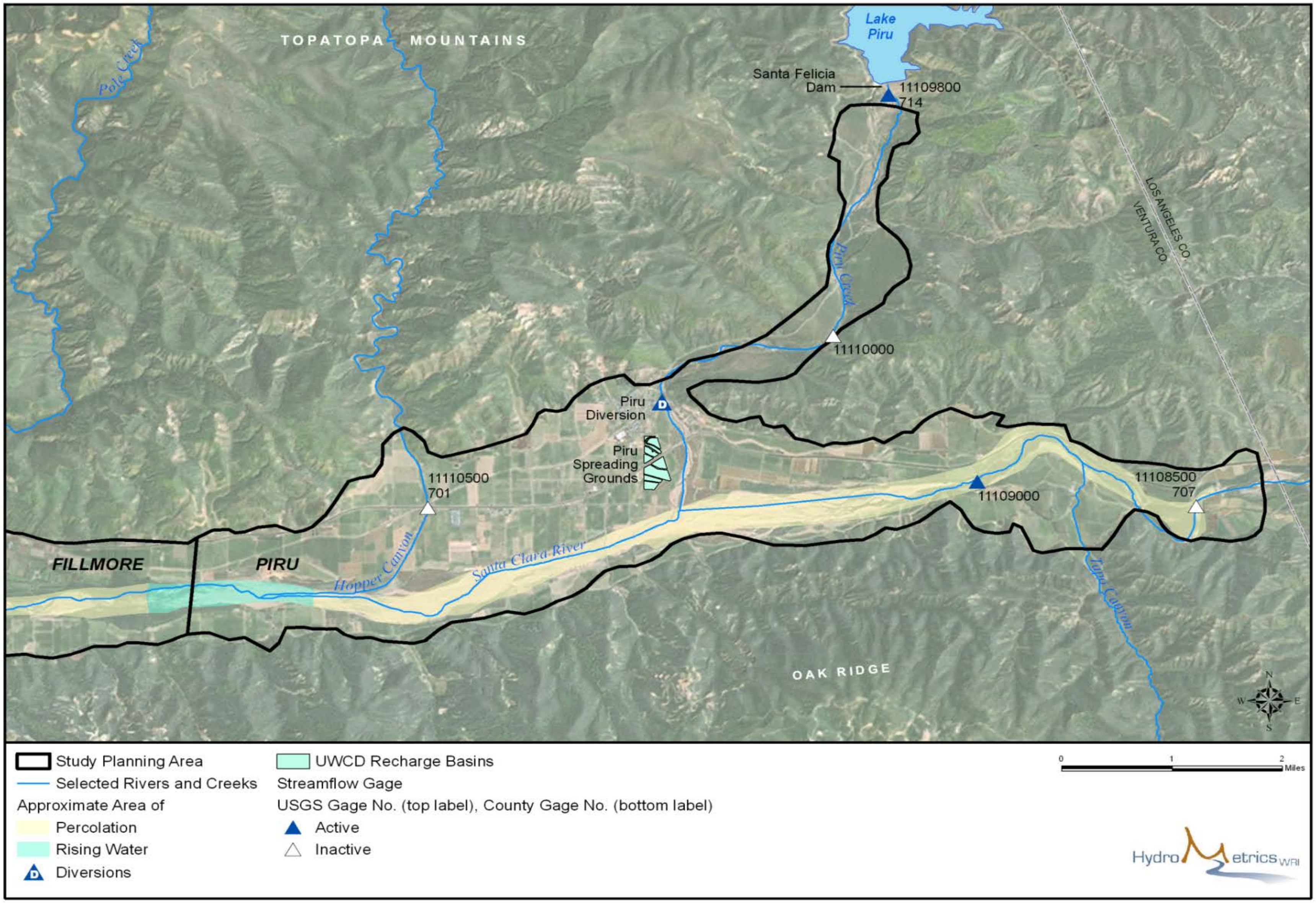

Figure 3-5 Piru Basin

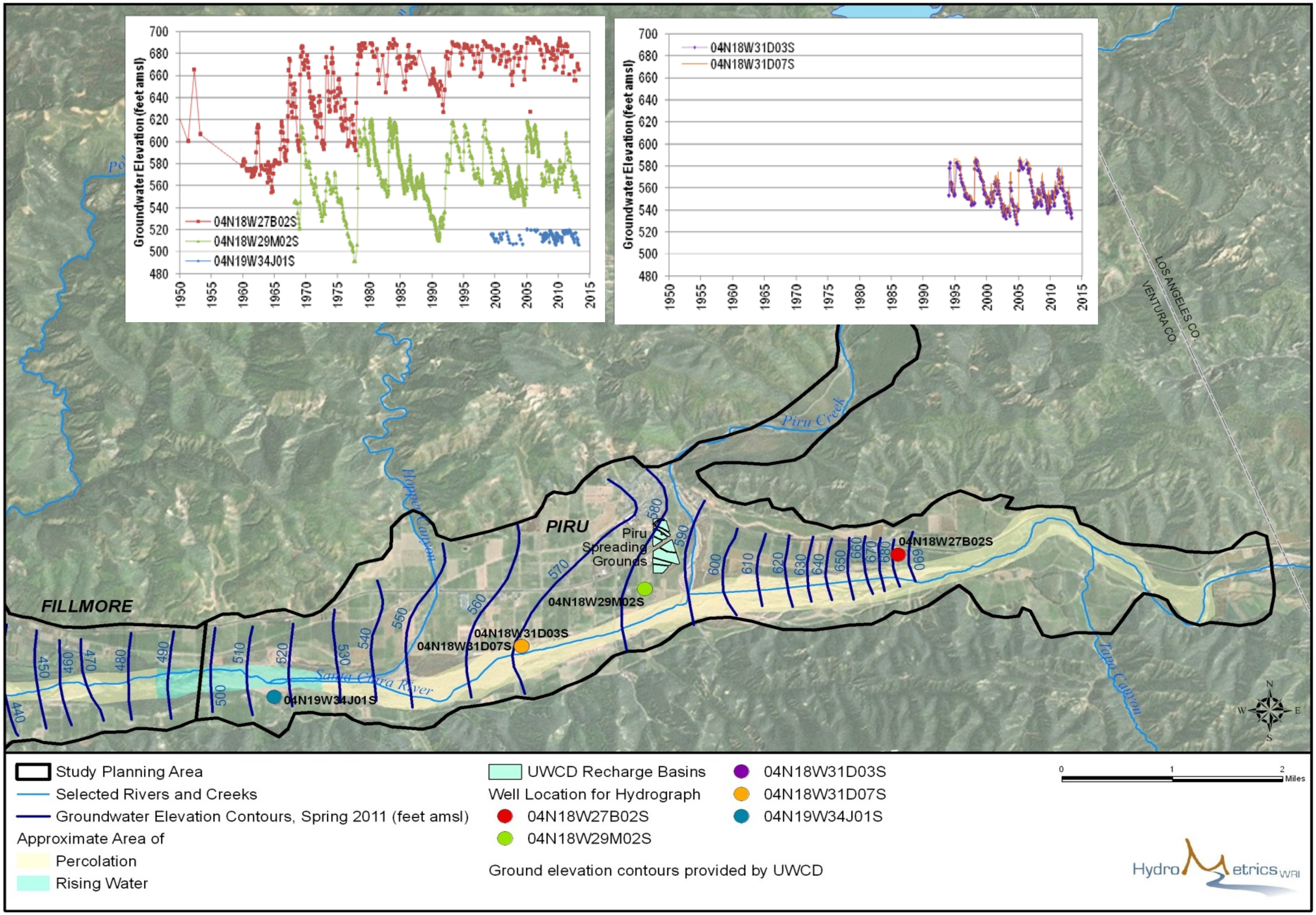

Figure 3-6 Piru Basin Groundwater Elevations

3.1.2 Fillmore Basin

The Fillmore basin is immediately downstream of the Piru basin, sharing its eastern boundary with the Piru basin's western boundary (**Figure 3-7**). It is confined to the SCR valley by the Topatopa Mountains on the north, and Oak Ridge to the south. Its widest width is 5.2 miles across due to coarse-grained southward-sloping alluvial fan sediments deposited by the Sespe Creek in an area called the Sespe Uplands. The basin is approximately 9.8 miles long and covers an area of approximately 20,840 acres[2]. The basin's western boundary occurs where narrowing of the valley just northeast of the City of Santa Paula, at Willard Road, constricts groundwater flow causing groundwater levels to flatten and to intersect the streambed (rising water). Rising water is clearly seen in aerial photographs where the streambed is highly vegetated. The area of rising water varies based on how full the basin is at any particular time. The change in surface elevation on the SCR from the east to the west of the Fillmore basin is 240 feet, at an average gradient of 25 feet per mile.

The Fillmore basin contains sediments that have filled the Ventura syncline. Younger alluvial sediments comprising recent sands and gravels deposited by the SCR and Sespe Creek overlie the southern and eastern portions of the basin. The Pole Creek Fan area, between Sespe Creek and the SCR (**Figure 3-7**), overlies the northern portion of the basin, and comprises typical alluvial fan materials. The Sespe Uplands, which includes the areas north of Sespe Creek and the SCR (**Figure 3-7**), are comprised of complex terrace deposits, older alluvial fan deposits, and recent alluvial fan deposits (UWCD, 2013b). Up to 120 feet of alluvial and fan deposits unconformably overlie the San Pedro formation. The basin is structurally bound by the San Cayetano and Oak Ridge faults, to the north and south, respectively (**Figure 3-3**).

The basin is considered an unconfined aquifer system. Groundwater generally flows from east to west down the axis of the basin, with southwesterly flow occurring in the Sespe Creek area. Within the San Pedro formation there is a southerly flow component as groundwater moves from the northern part of the basin towards the valley axis. Once at the axis, flow continues in a westerly direction. A contour map showing typical groundwater elevations throughout the basin is shown in **Figure 3-8**. Similar to the Piru basin, vertical hydraulic gradients in this basin are very small, therefore alluvium and San Pedro formation groundwater elevations are displayed on the graph.

The streambed percolation from the SCR and Sespe Creek, and underflow from Piru basin are major sources of recharge to the Fillmore basin. Minor sources of recharge include percolation through smaller streambeds, mountain front recharge from the upland areas to the north and south, irrigation return flow, septic tanks, and percolation of treated wastewater. Discharge from the basin includes groundwater pumping, rising water that becomes surface water in the SCR, and subsurface outflow to the Santa Paula basin.

[2] Other authors have listed different areas for the Fillmore basin based on different extents (UWCD, 1996; DWR, 2003). The areas presented here are the surface area of the study planning area basins depicted in **Figure 3-2**.

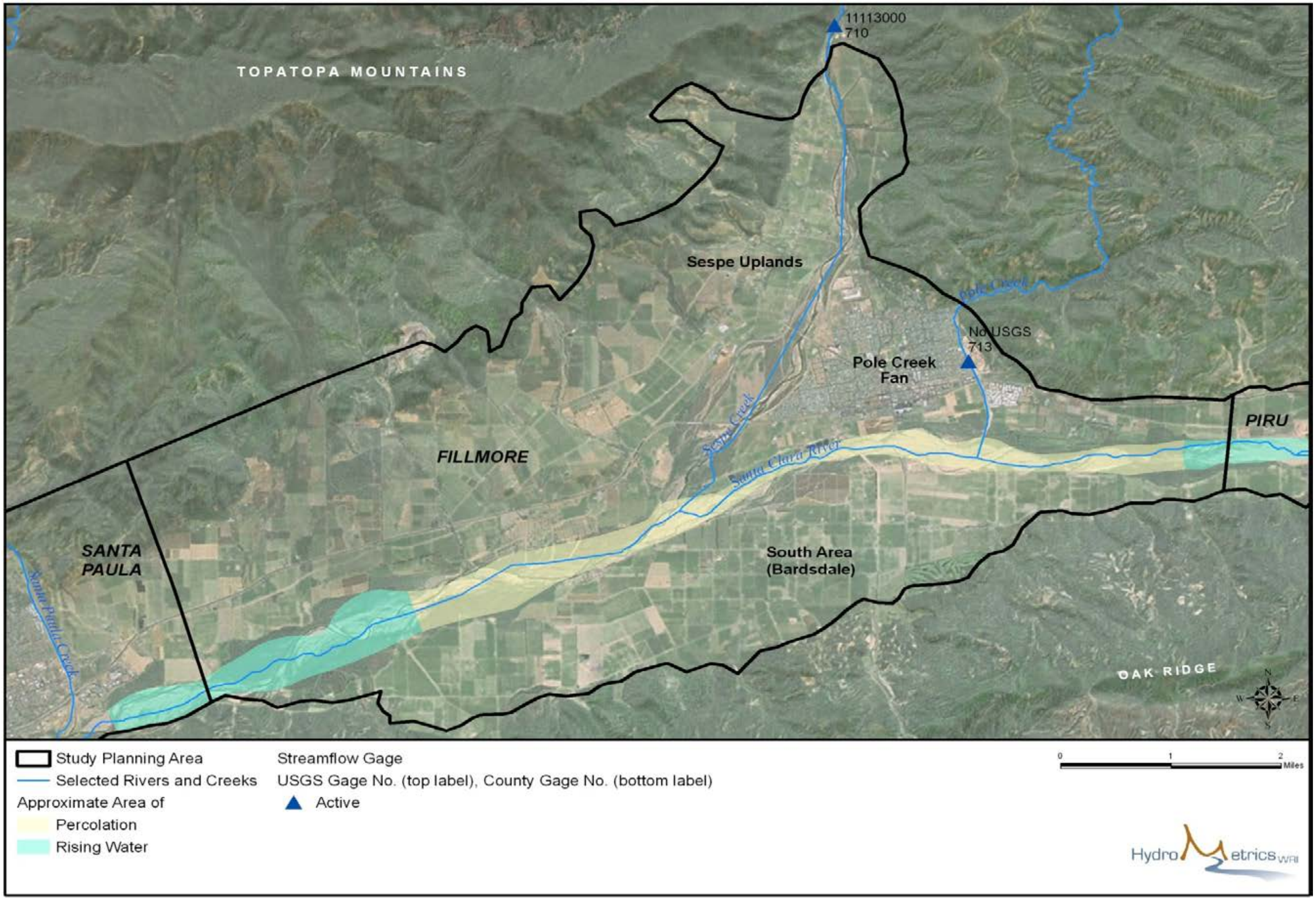

Figure 3-7 Fillmore Basin

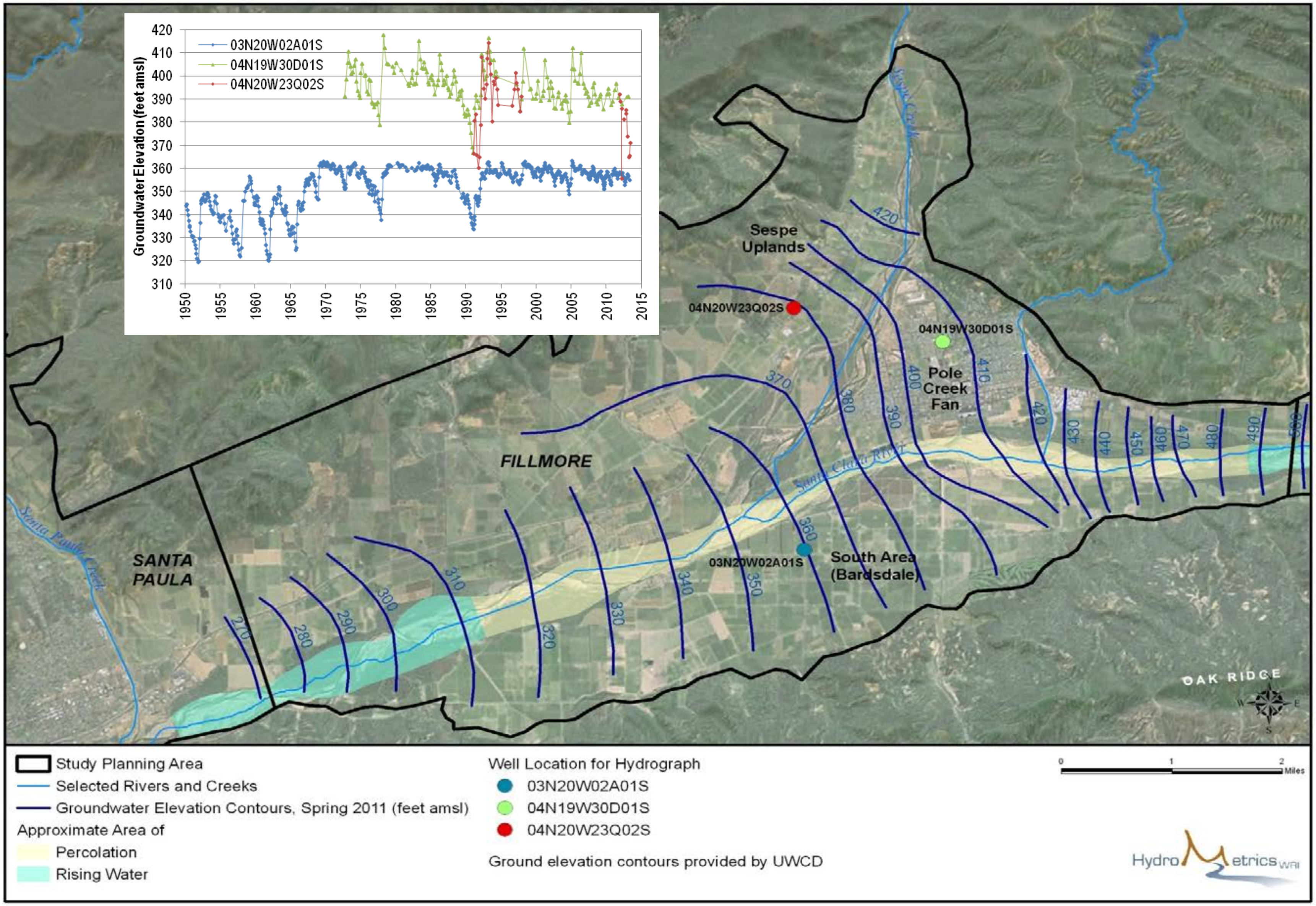

Figure 3-8 Fillmore Basin Groundwater Elevation

3.1.3 Santa Paula Basin

The Santa Paula basin is downstream of the Fillmore basin, sharing its eastern boundary with Fillmore basin's western boundary (**Figure 3-9**). The basin is bounded by the Sulphur Mountain foothills on the north and South Mountain on the south. It is approximately 10.5 miles long and borders the Mound basin to the west and the Oxnard Forebay basin to the south.[3] The western boundary is geologically complex and the aquifers in this portion of the basin are locally uplifted and faulted, with artesian conditions mapped by some investigators (UWCD, 2013a). Hydraulic connection is believed to exist between Santa Paula basin and the down-gradient Mound basin and Oxnard Forebay, but flow between these basins remains unquantified. (UWCD, 2013a). The area of the Santa Paula basin covers approximately 22,900 acres. Surface elevation over the length of the SCR changes 170 feet, which equates to a gradient of approximately 16 feet per mile.

The Santa Paula basin contains the San Pedro Formation and overlying alluvial sediments deposited by the SCR and its tributaries (**Figure 3-3**). An alluvial fan associated with the Santa Paula Creek occurs in the northeast portion of the basin.

A recent study by UWCD (2013c) of groundwater levels in Santa Paula basin concluded that wells with shallow screens near the SCR had the least variability in levels, as shown by the hydrograph in **Figure 3-10**. This is likely due to the buffering effect of the SCR as a recharge source. Wells located farther from the SCR and in deeper portions of the aquifer had more variable groundwater levels and greater dry-year responses. The report also documented a long-term decline of approximately 20 feet over the last 67 years in wells screened in the San Pedro Formation and older alluvium sediments located farther away from the SCR. The contour map in **Figure 3-10** displays alluvium and San Pedro formation groundwater levels.

The Santa Paula basin is primarily recharged by percolation of surface water from the SCR and Santa Paula Creek, direct percolation of precipitation on the exposed San Pedro Formation, and underflow from Fillmore basin. Other sources of recharge include irrigation return flow and septic tanks.

Discharge from the Santa Paula basin includes groundwater pumping and outflow to the Mound and Oxnard Forebay basins. Some rising water occurs in the eastern portion of the basin, although this could be considered groundwater that is discharged from the upstream Fillmore basin.

[3] Other authors have listed different areas for the Santa Paula basin based on different extents (UWCD, 1996; DWR, 2003). The areas presented here are the surface area of the study planning area basins depicted in **Figure 3-2**.

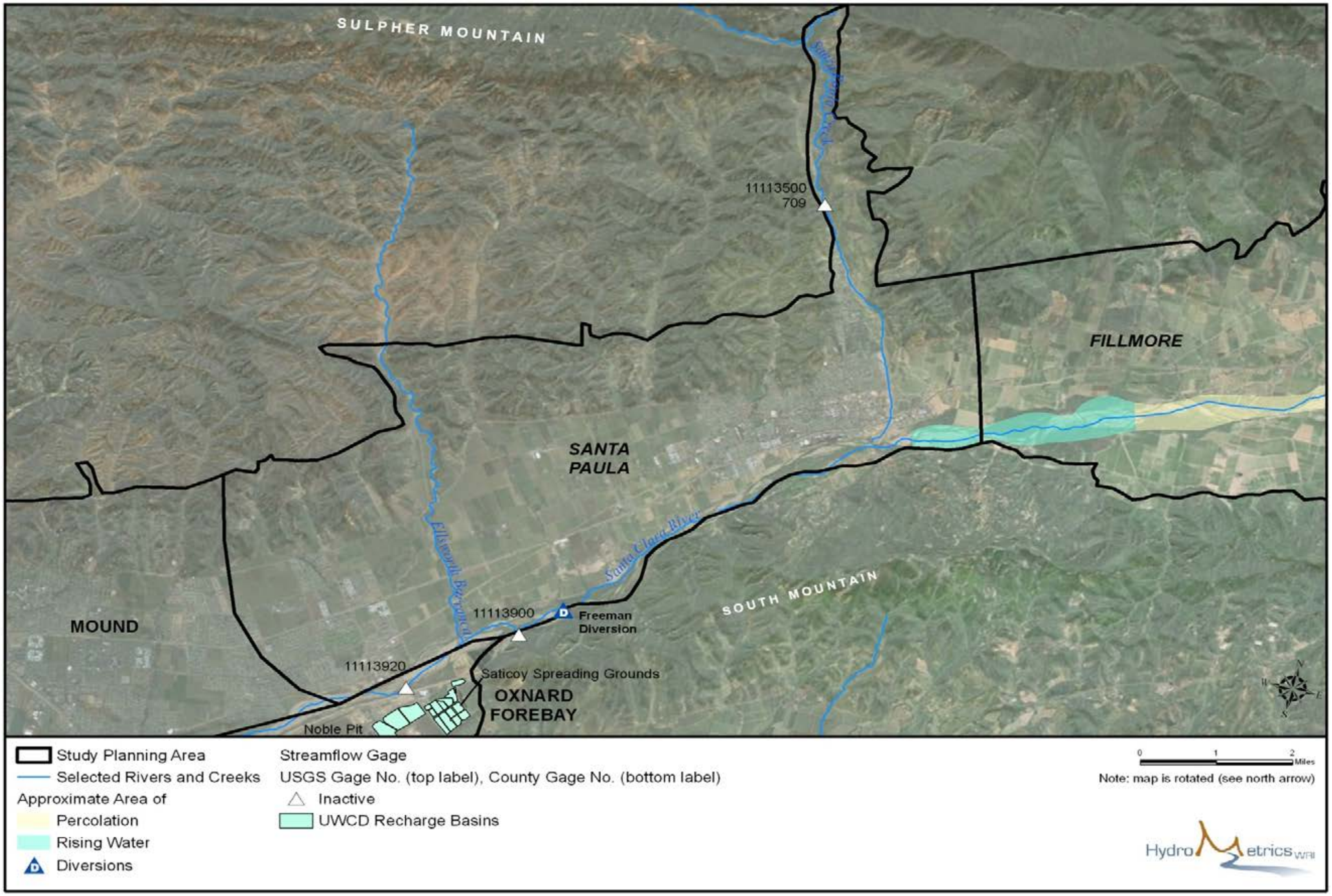

Figure 3-9 Santa Paula Basin

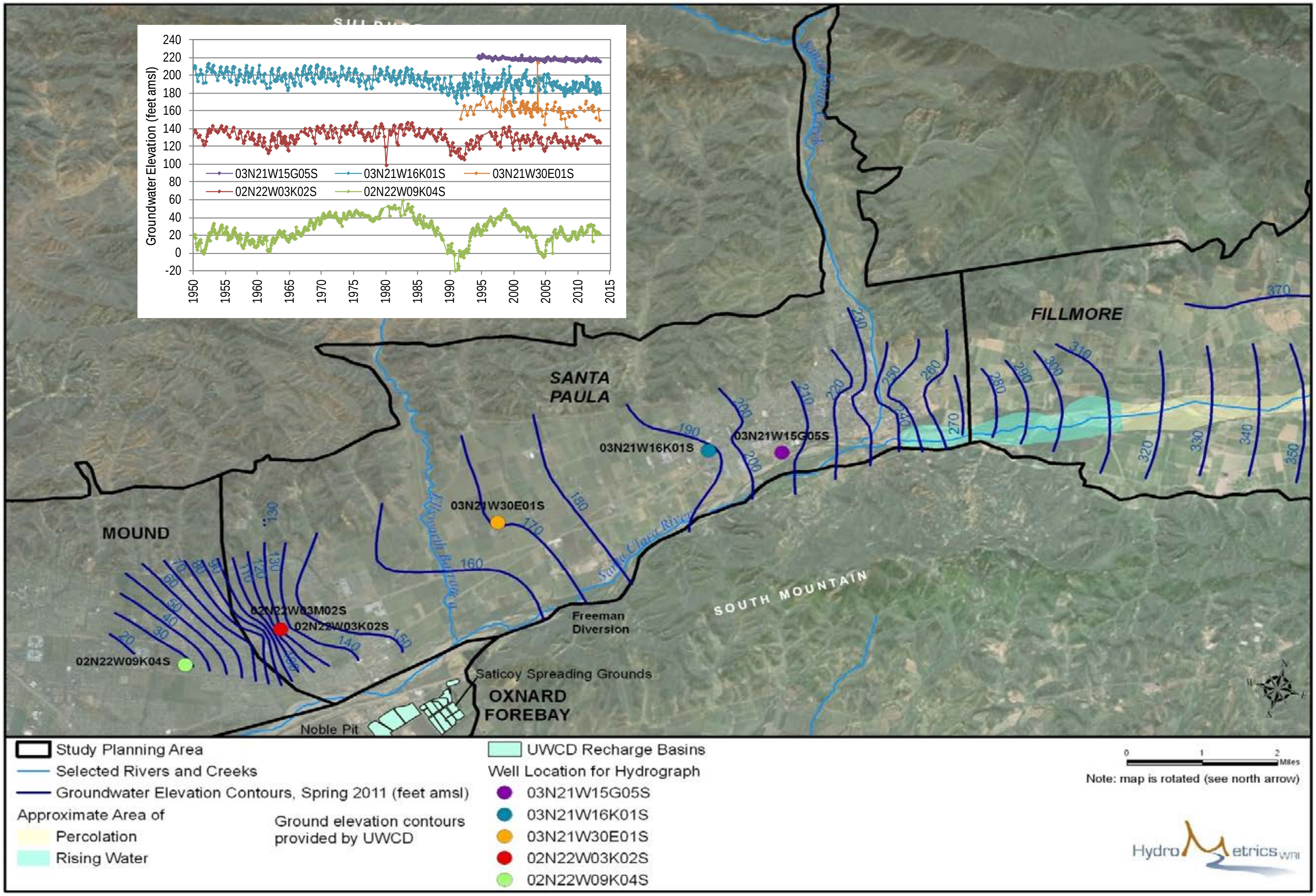

Figure 3-10 Santa Paula Basin Groundwater Elevations

3.1.4 Mound Basin

The Mound basin, overlying a low lying alluvial plain, is immediately downstream of the Santa Paula basin and shares its eastern boundary with Santa Paula basin's western boundary (**Figure 3-11**). The basin's northern boundary is confined to the valley by the Ventura Foothills, north of the City of Ventura. Its southern boundary coincides approximately with the Montalvo anticline (UWCD, 2012b), which separates it from the Oxnard Forebay and Oxnard Plain basins to the south (**Figure 3-11**). The lowermost portion of the SCR transects the southern boundary of the Mound basin; this is the only part of the SCR that flows through the Mound basin. The Pacific Ocean bounds the basin on the west. The Mound basin is approximately 5.5 miles long by 4 miles wide, with an area of 14,850 acres.[4] Surface elevation along the SCR changes approximately 100 feet over its length, resulting in a gradient of approximately 18 feet per mile.

The Mound basin fills a portion of the east-west trending, west plunging Ventura syncline (UWCD, 2012a). The northern basin boundary extends to include the exposed area of the San Pedro formation in the Ventura foothills, and its southern boundary coincides with the axis of the Montalvo anticline (**Figure 3-3**). There are several faults in and around the Mound basin, but none have displacements large enough to juxtapose the San Pedro formation against the low-permeability Santa Barbara formation (UWCD, 2012a). UWCD believes that groundwater flow across the Oak Ridge and Ventura faults is probable (UWCD, 2012a).

The Mound basin contains Quaternary sediments deposited on a wide delta complex that formed at the terminus of the SCR. This depositional environment has resulted in a wide variety of alluvial sediments comprising lagoonal, beach, flood plain, alluvial fan, terrace, and marine terrace deposits (UWCD, 2012a). The underlying San Pedro formation comprises marine and continental clays, silts, sands and gravels. The San Pedro formation is exposed at surface outcrops along the northern boundary of the basin and in two mounds in the south-central portion of the basin. These mounds are the namesake of the Mound basin (UWCD, 2012a).

The alluvium and San Pedro formation contain the basin's primary aquifers. The UAS comprises undifferentiated younger alluvium (Oxnard aquifer) and older alluvium (Mugu aquifer). The younger alluvium is made up of interbedded clays with some silts, sands, and gravels deposited in active river plain and fan environments (UWCD, 2012a). Coarser sediments are sparse and occur as lenticular deposits within the predominantly finer-grained materials.

Up to 450 feet of undifferentiated older alluvium unconformably underlies the younger alluvium and unconformably overlies the San Pedro formation. The upper portion of the older alluvium is predominantly fine-grained and the lower portion is predominantly coarse-grained (UWCD, 2012a). It is within this coarse-grained unit, which is considered the Mugu aquifer, that the majority of the Mound basin's productions wells are screened (UWCD, 2012a). Lateral facies changes in the UAS result in the sediments becoming more finely bedded and fine-grained in a northerly direction from the basin's southern boundary (UWCD, 2012a).

The LAS is comprised of the San Pedro formation which has a maximum thickness of approximately 4,500 feet in the center of the Ventura syncline (UWCD, 2012a). Its thickness

[4] Other authors have listed different areas for the Mound and Oxnard Forebay basins based on different extents (UWCD, 1996; DWR, 2003). The areas presented here are the surface area of the study planning area basins depicted in **Figure 3-2**.

decreases towards the sides of the syncline (i.e., north and south boundaries of the basin), with the southern boundary having considerably less thickness due to a history of folding, faulting, and subsequent erosion (UWCD, 2012a). The upper San Pedro formation contains the Hueneme aquifer, which comprises a series of interconnected water-bearing sands which are limited to the northern portion of the basin (UWCD, 2012a). The lower portion of the San Pedro formation is primarily sands and gravels that comprise the Fox Canyon aquifer which extends to the Oxnard Plain. The nature of these sediments changes across the Mound basin, with beds becoming thinner and more lenticular to the north.

Groundwater flows parallel to the basin axis, from east to west, and has a relatively gentle gradient. Because of a lack of wells and groundwater level records in the northern and eastern portions of the basin, there is an "imperfect understanding of groundwater source and movement in some locations" (UWCD, 2012a). Where data are available, they show that groundwater elevations decrease from east to west across the basin, and there can be variability in groundwater levels between wells close together. The groundwater gradient across the basin is relative flat during dry periods, and increases slightly following periods of above-average precipitation (UWCD, 2012b). Due to the lack of groundwater data and poor distribution of available data, groundwater elevation maps have not been prepared for this basin. **Figure 3-12** provides hydrographs for representative wells in the basin.

Sources of recharge to the Mound basin include underflow from adjacent basins (Santa Paula, Oxnard Plain, and Oxnard Forebay), mountain front recharge from the Ventura Foothills, irrigation return flow, and direct percolation of precipitation on the San Pedro formation exposed along the basin's northern boundary.

Sources of discharge from the Mound basin include groundwater production and outflow to the ocean.

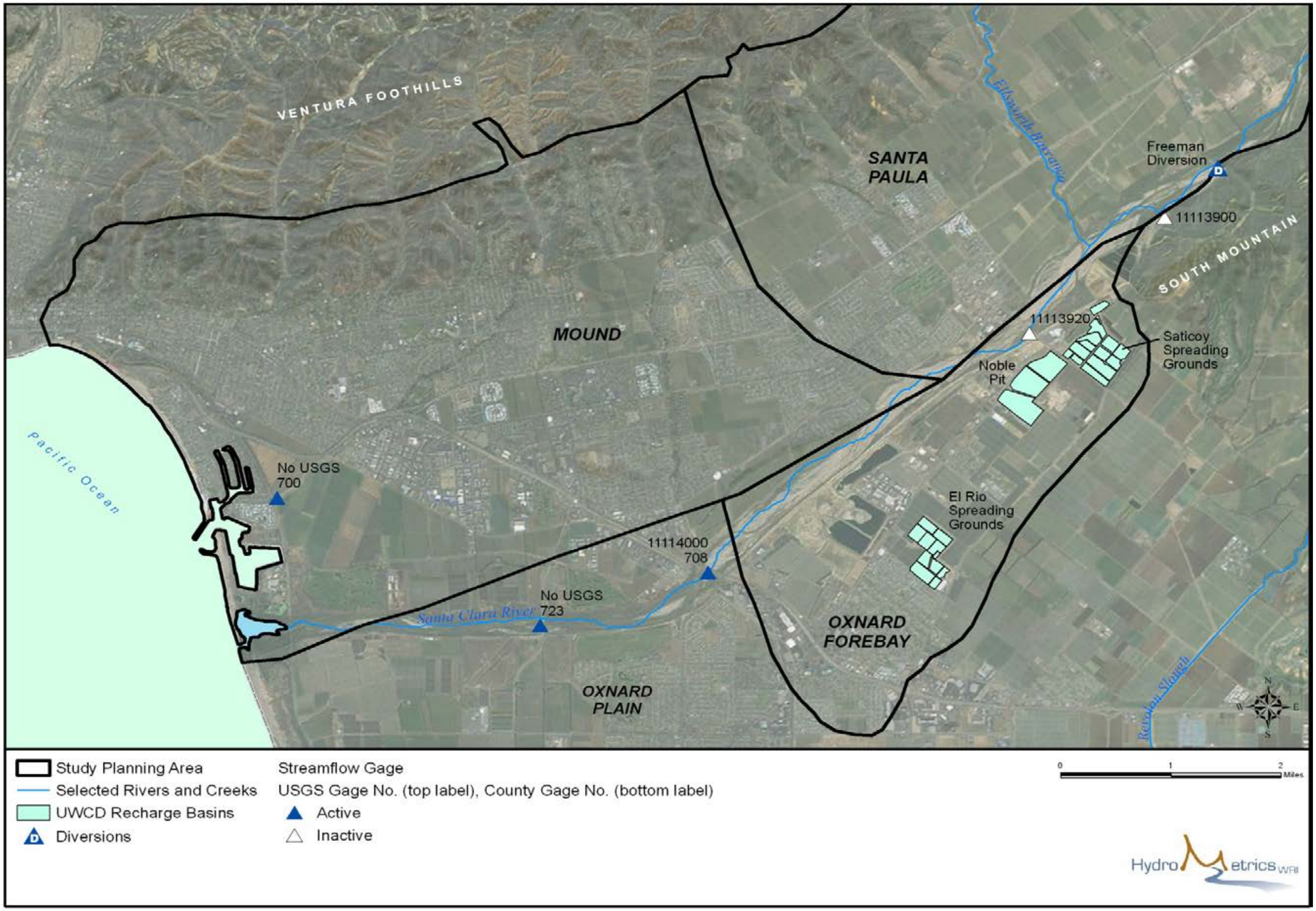

Figure 3-11 Mound and Oxnard Forebay Basins

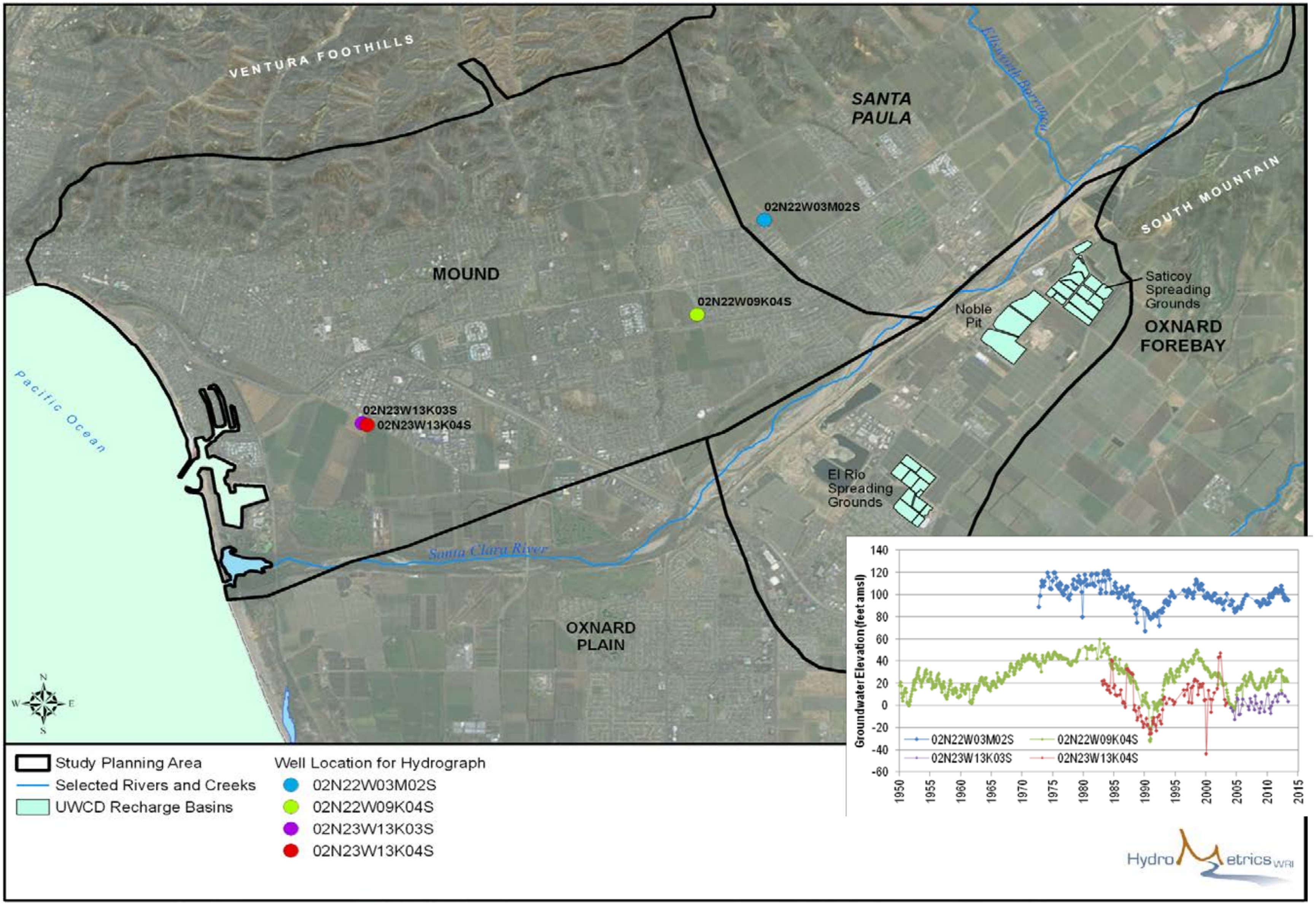

Figure 3-12 Mound Basin Groundwater Hydrographs

3.1.5 Oxnard Forebay Basin

The Oxnard Forebay is bordered by the Santa Paula and Mound basins on its northern boundary and surrounded by the Oxnard Plain basin on its west and south boundary (**Figure 3-11**). The nose of the South Mountain occurs at the northeastern extent of the basin. The Oxnard Forebay is delineated as the unconfined portion of the Oxnard Plain basin (UWCD, 2008), and is the main source of recharge to the Oxnard Plain. The Oxnard Forebay basin has an approximate area of 5,370 acres[5] with a length of approximately 5.5 miles and width of 2.4 miles. Surface elevation along the SCR changes approximately 40 feet over its length within the basin, resulting in a gentle gradient of approximately 7 feet per mile.

The unconfined Oxnard Forebay contains both the UAS and LAS (**Figure 3-13**). As the Oxnard Forebay basin aquifers are in direct hydraulic connection with the confined aquifer of the Oxnard Plain basin, it is the primary source of recharge to that basin (**Figure 3-13**). The Oxnard Forebay basin is also a source of recharge to other adjacent and regional basins: Mound, West Las Posas, and Pleasant Valley, but the majority of its groundwater underflow is downgradient to the Oxnard Plain basin (UWCD, 2012b).

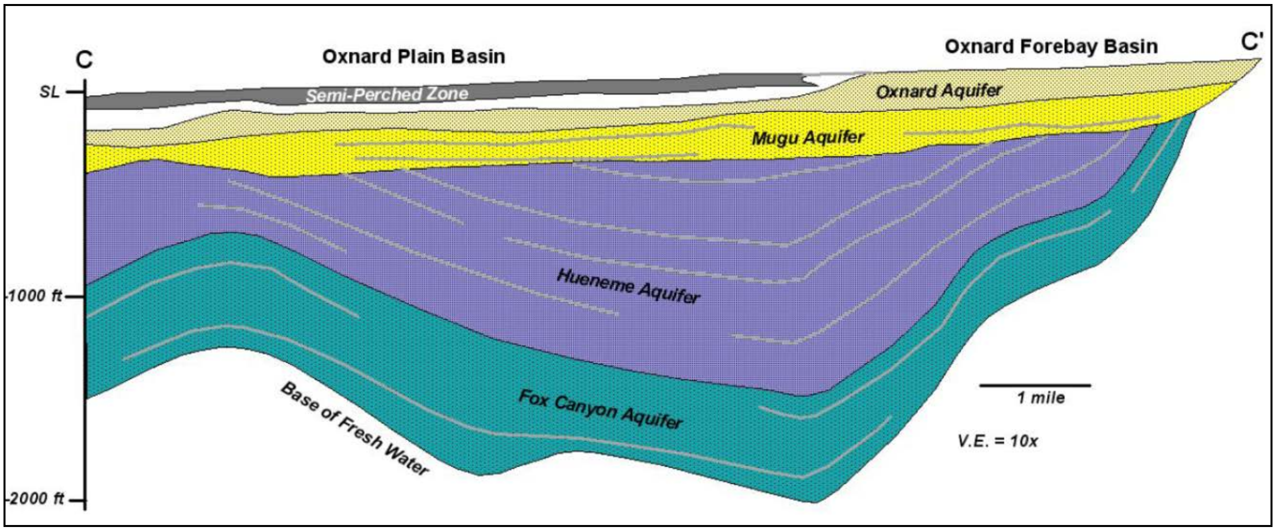

Figure 3-13 Schematic Cross Section of Aquifer Systems of the Oxnard Plain and Forebay Basin (from UWCD, 2012a)

The UAS (Oxnard and Mugu aquifers) in the Oxnard Forebay basin consists primarily of coarse-grained alluvium deposited by the ancestral Santa Clara River and is laterally extensive over the entire basin. A geophysical investigation in the basin has shown the Oxnard aquifer to range in thickness from roughly 200 to 280 feet (UWCD, 2013c). The UAS lies unconformably over the LAS. Along the Montalvo anticline, the LAS in the area between the El Rio and Saticoy spreading grounds has been uplifted and truncated along its contact with the UAS (UWCD, 2013c). It is estimated that 20% of surface recharge in this area percolates into the LAS, with the remainder recharging the UAS (UWCD, 2012b).

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[5] Other authors have listed different areas for the Mound and Oxnard Forebay basins based on different extents (UWCD, 1996; DWR, 2003). The areas presented here are the surface area of the study planning area basins depicted in **Figure 3-2**.

Groundwater flows from the Santa Paula basin into the Oxnard Forebay basin. From the Oxnard Forebay basin groundwater flows out to the adjacent Mound, Oxnard Plain, and Las Posas basins. **Figure 3-14** shows groundwater elevation contours for both the UAS and LAS for the Oxnard Forebay basin. The LAS contour map only partially covers the Oxnard Forebay basin due to a lack of data. Representative hydrographs are also included with the elevation map.

Percolation of SCR flows between the UWCD SCR surface water diversion (Freeman Diversion) and the 101 bridge, managed aquifer recharge, irrigation return flows, and direct percolation of precipitation are major sources of groundwater recharge to the Oxnard Forebay basin, with minor sources from mountain front recharge generated from the nose of South Mountain and underflow from adjacent basins (UWCD, 2012b and UWCD, 2013c).

Groundwater in the basin is discharged by groundwater pumping and outflow to the adjacent Mound and Oxnard Plain basins.

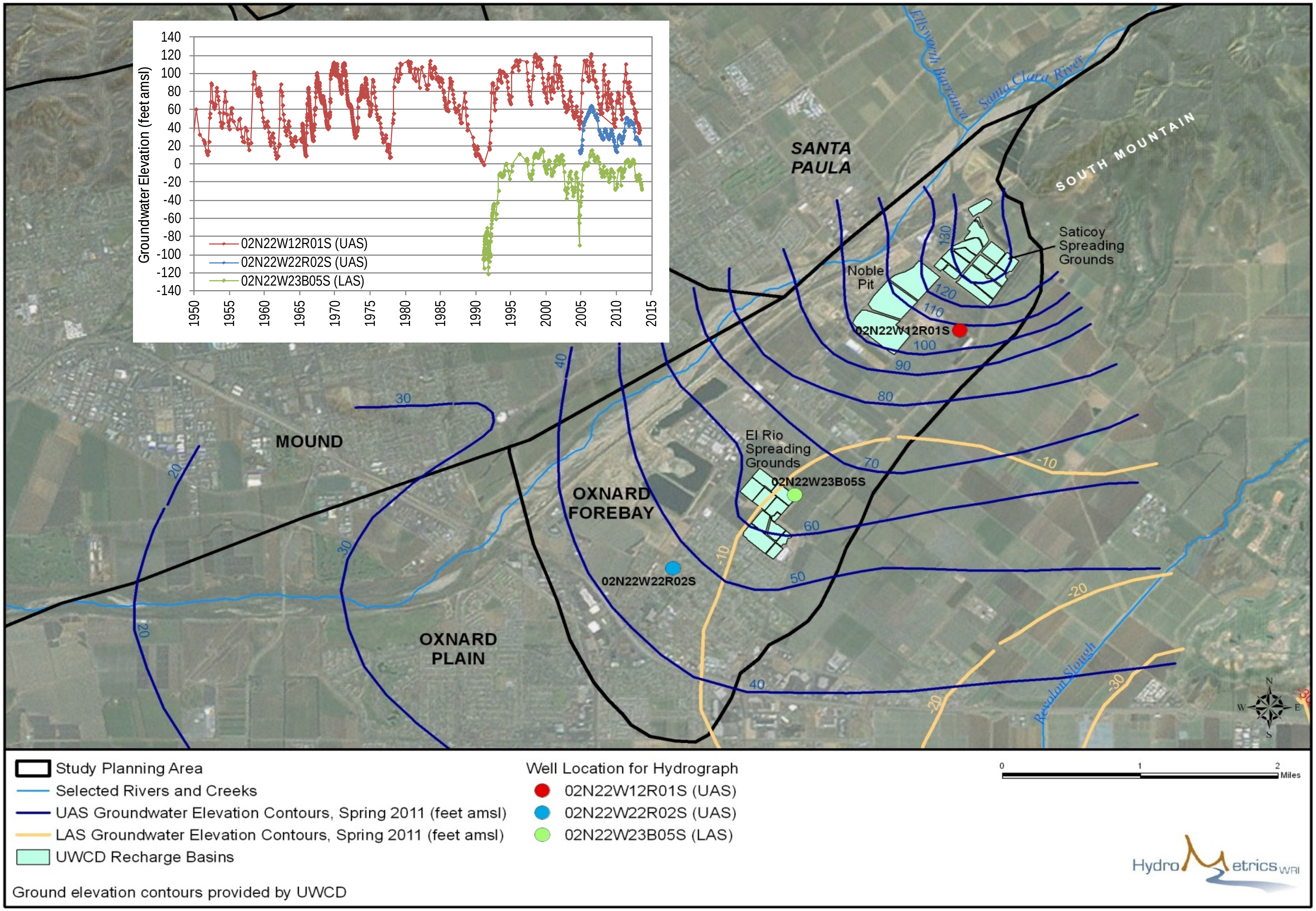


Figure 3-14 Oxnard Forebay Basin Groundwater Elevations

3.2 CLIMATE

The LSCR area experiences a Mediterranean climate, with mild wet winters and hot dry summers. Seventy-five percent of the annual precipitation falls between December and March (**Figure 3-15**). Rainfall generally increases with elevation. The average monthly distribution of precipitation is shown in **Figure 3-16**. Within the study area, precipitation ranges from 14 inches per year at the coast to over 20 inches per year at higher elevations. Of all the study area basins, the Fillmore basin receives the greatest amount of precipitation. Precipitation close to 40 inches per year falls in the high elevation headwaters of the SCR's northern tributaries. Precipitation declines in an inland direction beginning at the eastern end of the Piru basin. **Table 3-1** characterizes the precipitation stations included in **Figure 3-16**.

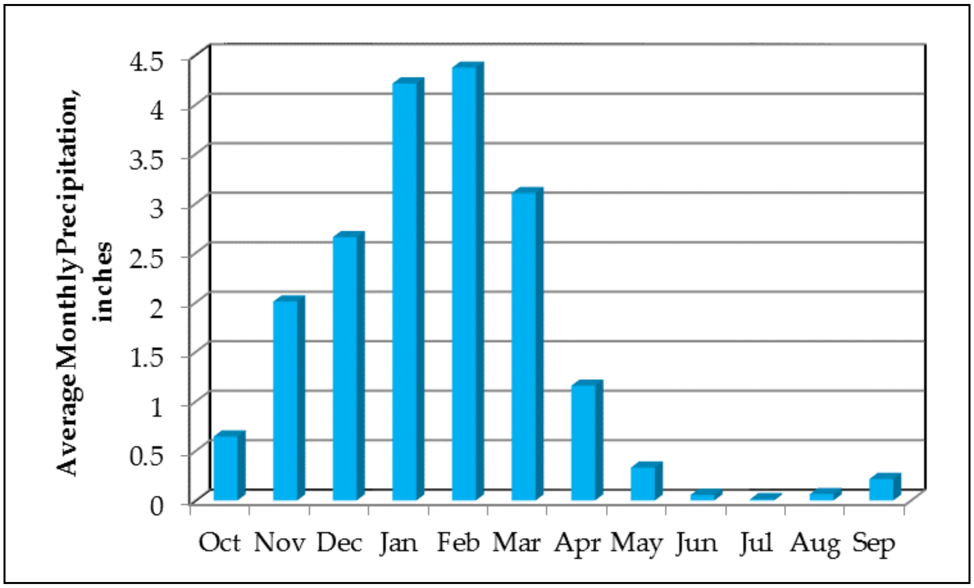


Figure 3-15 Average Monthly Precipitation at Fillmore - Fish Hatchery (Station 171), Water Year 1957 through 2012.

A cumulative departure from mean annual precipitation chart is shown in **Figure 3-17** for the Fillmore Fish Hatchery station. The cumulative departure curve depicts the dry and wet cycles experienced since 1957. The area is currently experiencing a dry cycle that started after nearly record high precipitation in 2005. Some of the driest years on record were recorded in 2007, 2013, and 2014.

Table 3-1 Summary of Active Precipitation Stations

Ventura County Watershed Protection District Station Name and Number	Elevation (feet above MSL)	Period of Record	Mean Precipitation Water Year 1980 – 2012 (inches)
El Rio-UWCD Spreading Grounds #239	105	09/30/1972 – 05/20/2012	15.8
Ventura-Hall Canyon #167	180	10/01/1956 – 06/05/2013	16.9
Santa Paula-UWCD #245	260	10/01/1960 – 09/30/1986	18.9[1]
Santa Paula-UWCD A #245A	300	10/01/1986 – 10/27/2010	

Table 3-1 Summary of Active Precipitation Stations

Ventura County Watershed Protection District Station Name and Number	Elevation (feet above MSL)	Period of Record	Mean Precipitation Water Year 1980 – 2012 (inches)
Santa Paula - Wilson Ranch #245B	410	10/01/2010 – 05/15/2013	
Ventura-County Government Center #222A	280	10/01/1977 – 02/27/2013	16.9
Fillmore-Fish Hatchery #171	465	10/01/1956 – 05/10/2013	19.6
Piru-Newhall Ranch #025	825	10/01/1927 – 09/30/2013	18.4
Piru-Temescal Guard Station #160	1,080	10/01/1949 – 09/30/2012	21.5

[1] Mean precipitation for the Santa Paula station was obtained by combining the data for Station #245, #245A, and #245B.

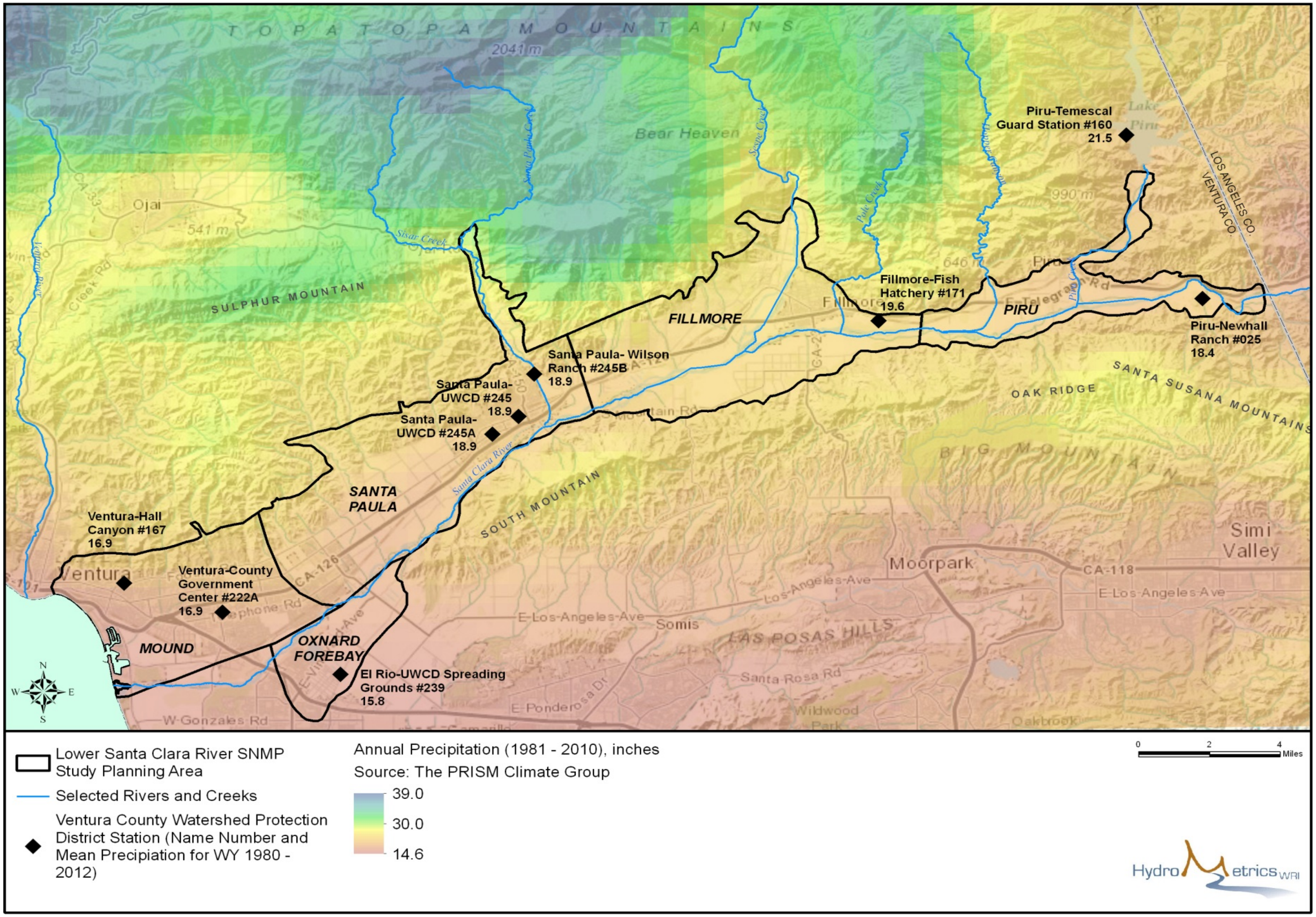


Figure 3-16 Precipitation Distribution in the Lower Santa Clara River Area

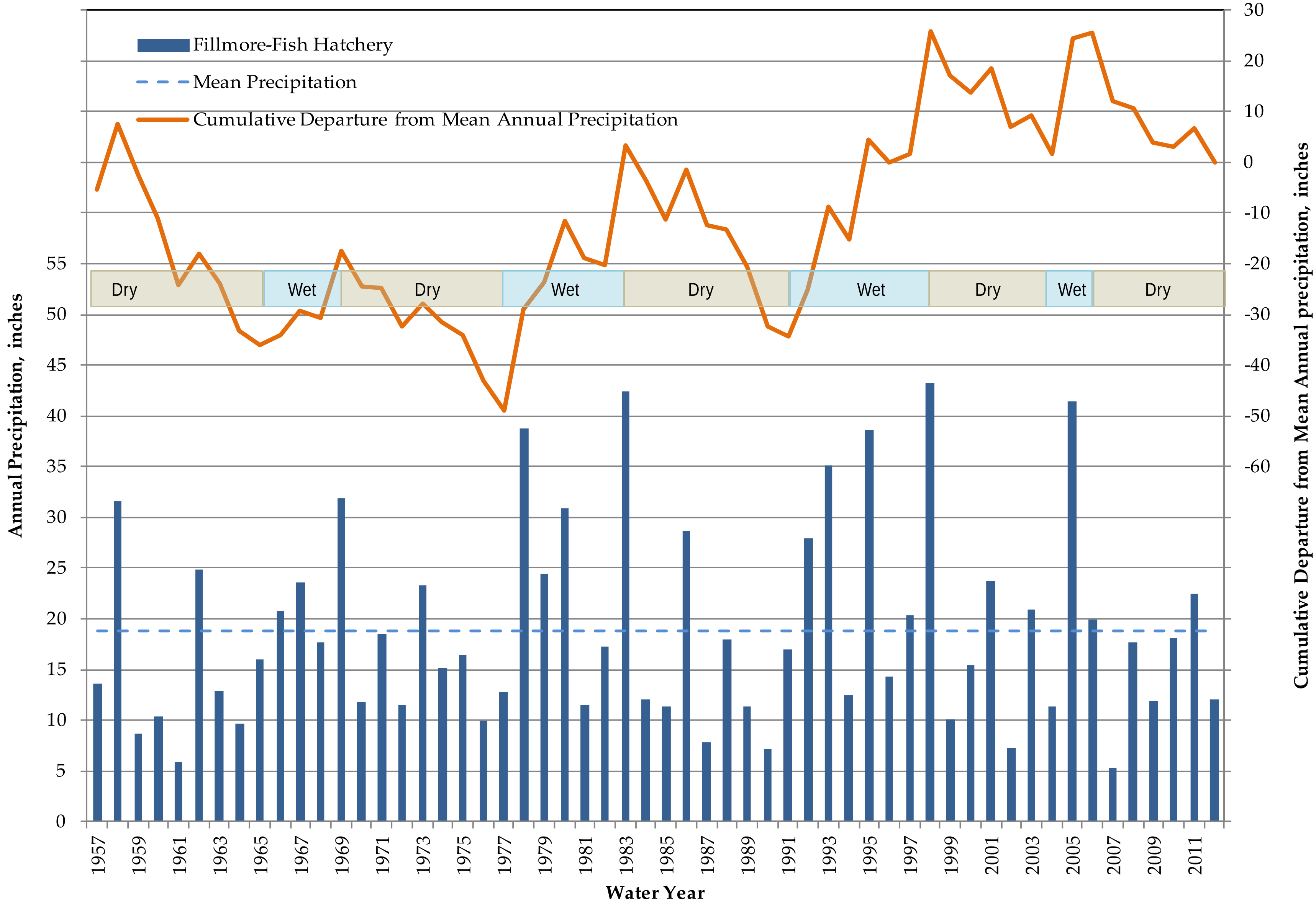


Figure 3-17 Cumulative Departure from Mean Annual Precipitation - Fillmore Fish Hatchery

3.3 SURFACE HYDROLOGY

The SCR is the predominant river in the study area (**Figure 3-18**). Extending 84 miles from its headwaters in Los Angeles County's San Gabriel Mountains to the Pacific Ocean, it is one of the largest river systems in southern California (Ventura County, 2006). The SCR's catchment covers an area of 1,634 square miles of which 60 percent is located in Ventura County. The catchment includes Lake Piru and Pyramid Lake, which are two major surface water bodies tributary to the LSCR that are used for water storage and have regulated releases. Both these water bodies are located on Piru Creek, with Pyramid Lake located approximately 13 miles upstream of Lake Piru (**Figure 3-18**).

Due to the climatic precipitation pattern, natural streamflow in the SCR and major tributaries is intermittent to ephemeral, with streamflow occurring primarily during December to April. Most streamflow occurs as floodflow (United States Geological Survey [USGS], 2003). Flow in the LSCR study area is influenced by upstream SCR flow from Los Angeles County, flow from its tributaries, and the permeability of its riverbed alluvium. Major tributaries of the LSCR include the Piru, Sespe, and Santa Paula Creeks (**Figure 3-18**). The nature of the LSCR catchment and climate produces intermittent flow, which can increase rapidly in response to high intensity rainfall (AMEC Earth & Environmental, 2005). LSCR flows are supplemented by controlled releases of stored Piru Creek winter runoff behind Lake Piru's Santa Felicia Dam, thereby decreasing the number of days with no flow in the LSCR (USGS, 2003). State Water Project releases from Pyramid Lake are also transported down the Piru Creek channel to users in the valley or Oxnard Plain.

The majority of flow in the SCR is generated from the LSCR catchment. Flow from Los Angeles County accounts for only 20% of the total river flow, despite the Los Angeles catchment making up 40% of the SCR's total catchment area (UWCD, 2012b). Dry-season base flows from Los Angeles are comprised of wastewater discharges from WWTPs, irrigation runoff, and groundwater discharge to the SCR. Since 1978, increasing wastewater discharge to the SCR in Los Angeles County has increased the base flow across the county line from 10 cubic feet per second (cfs) to approximately 20 cfs (USGS, 2003). This is shown in the first hydrograph in **Figure 3-19.**

Hydrographs of daily mean streamflow for selected gages in the LSCR are included in Figure 3-19 and Figure 3-20.

Streambed percolation of surface flows is a major source of natural recharge to the LSCR groundwater basins. During dry and normal flows, percolation of SCR flow into the permeable riverbed alluvium causes surface flows to cease in the Piru basin between just downstream of the County line and Piru Creek. Groundwater discharge (rising groundwater) approximately two miles east of the City of Fillmore restores flow to the LSCR. This is visible on aerial photographs where the riverbed becomes vegetated at the Piru/Fillmore basin boundary (**Figure 3-21**).

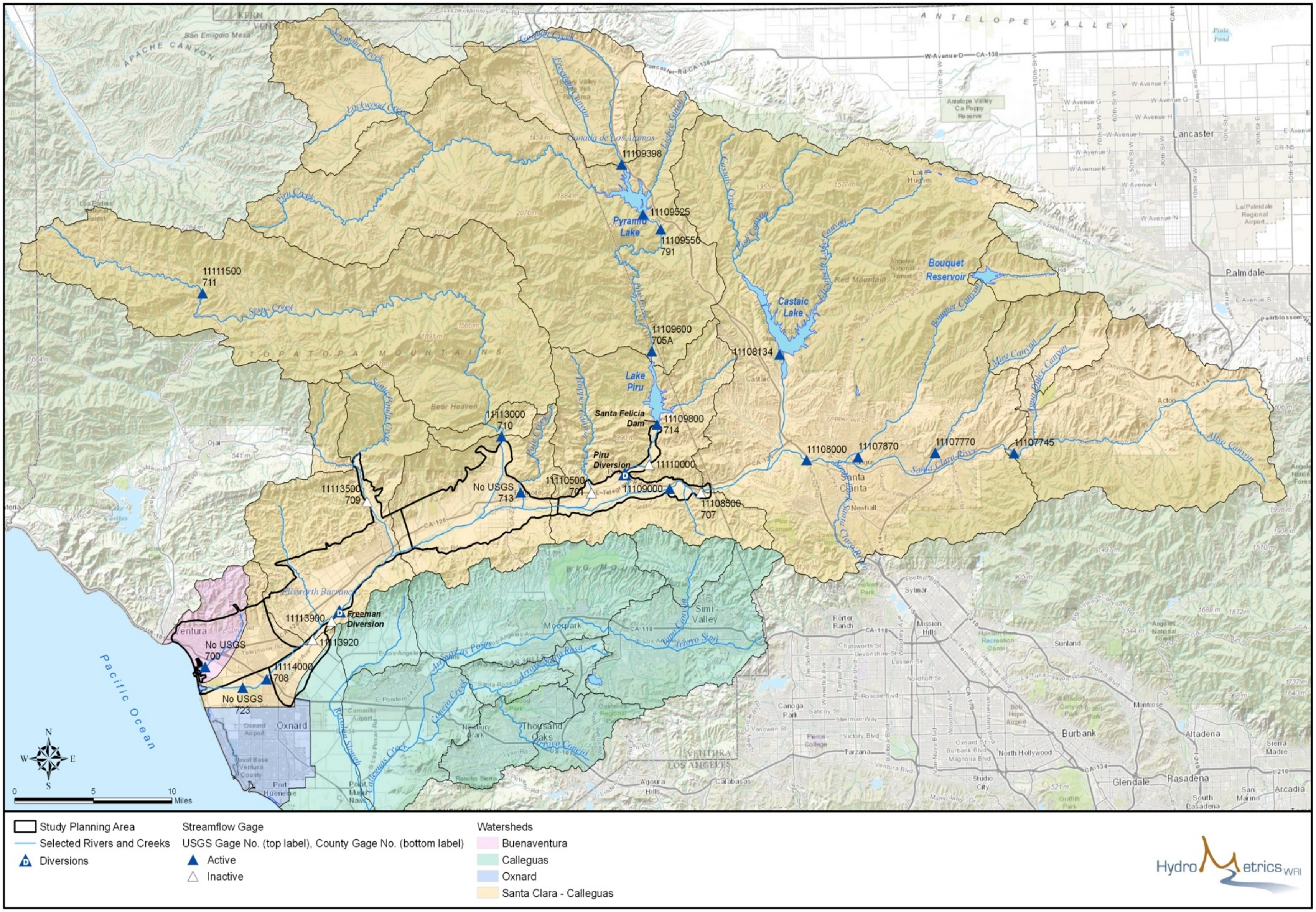


Figure 3-18 Santa Clara River Catchment

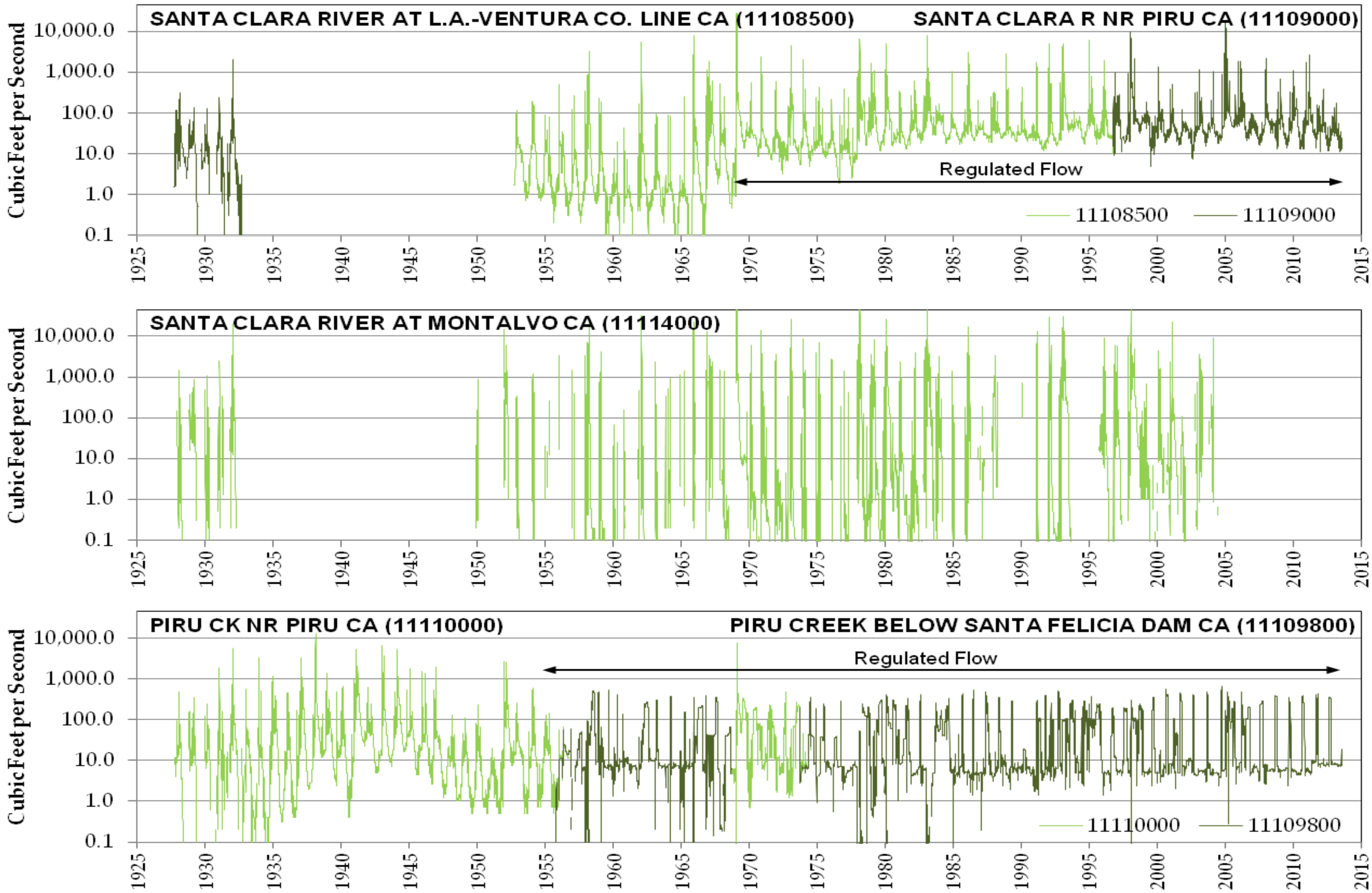


Figure 3-19 Daily Mean Streamflow for the Lower Santa Clara River and Piru Creek

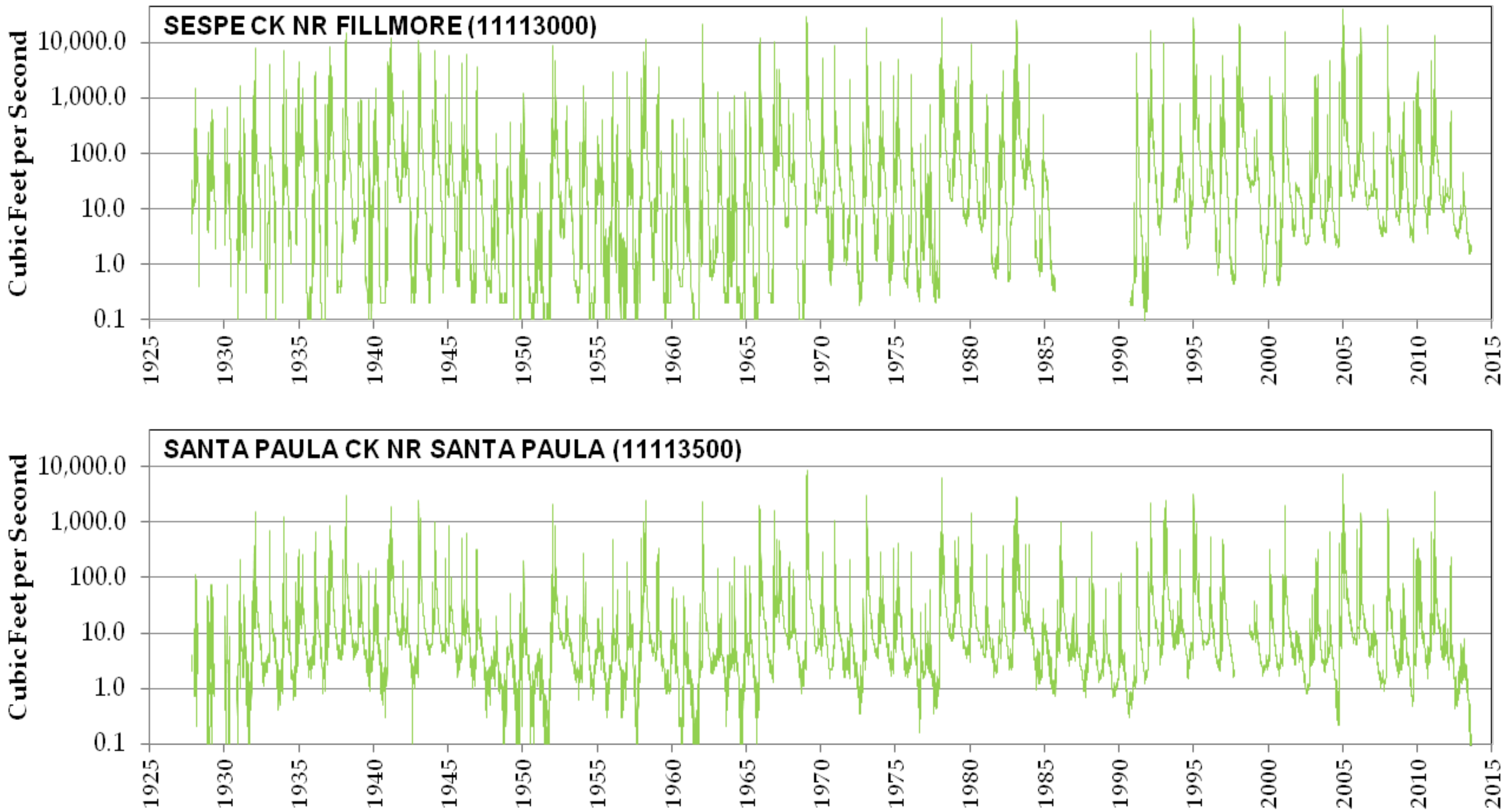


Figure 3-20 Daily Mean Streamflow for Sespe and Santa Paula Creeks

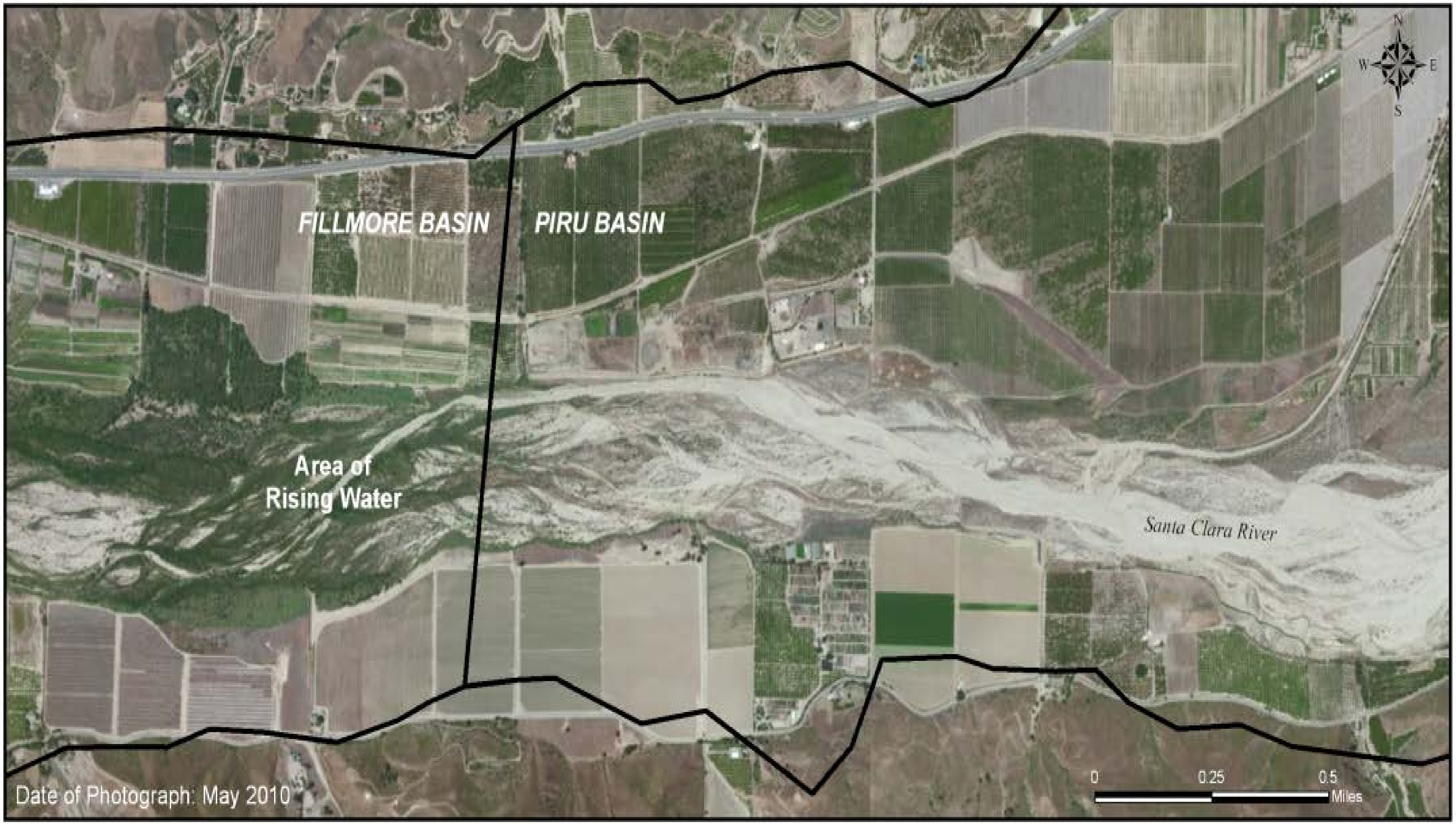


Figure 3-21 Rising Groundwater at the Piru/ Fillmore Basin Boundary

3.4 WATER SOURCES

Water purveyors supply water within the LSCR area from a number of sources. Surface and groundwater have been used and managed conjunctively for many years in the LSCR basin, both for water supply and managed aquifer recharge operations.

3.4.1 Surface Water

The SCR and Piru Creek are the primary sources of surface water to the LSCR area. Diversion structures are used to remove water from the channel for various uses. The Piru Diversion on the lower Piru Creek is currently not in use by UWCD (**Figure 3-5** and **Figure 3-18**). When it is operational, it diverts water from Piru Creek into the Piru Spreading Grounds for groundwater recharge **Figure 3-5** and **Figure 3-22** provides a chart of UWCD's diversions since 1955. Several mutual water companies using water for agricultural irrigation operate small diversions located on Piru Creek, Sespe Creek, Santa Paula Creek, and the SCR for agricultural irrigation. For the most part, the amounts of water diverted at these locations are unknown.

Releases from Piru Reservoir at Santa Felicia Dam and natural runoff in the SCR percolates naturally into the Piru, Fillmore, and Santa Paula basins. SCR flow in the Santa Paula basin can be diverted at UWCD's Freeman Diversion, ten miles upstream from the river mouth at the Pacific Ocean (**Figure 3-18**). Water diverted at this facility is delivered to UWCD's Saticoy, El Rio, and Noble recharge basins, and delivered directly for agricultural irrigation to groundwater basins outside the study area through the Pumping Trough Pipeline and Pleasant Valley Delivery System.

Table 3-2 summarizes estimates of downstream water use from Santa Felicia Dam releases. These values include imported water amounts that are summarized in **Table 3-3**. Surface water is not diverted for any other purpose aside from groundwater recharge and agricultural irrigation.

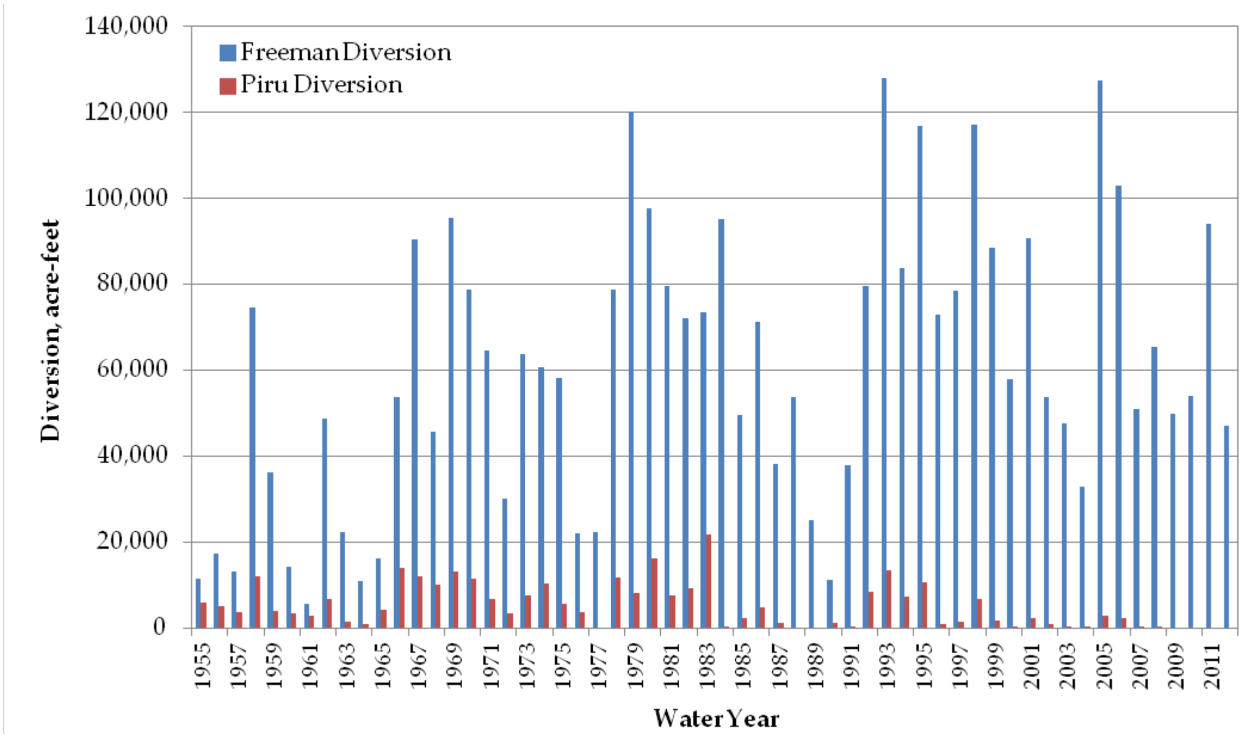


Figure 3-22 History of Surface Water Diversions by UWCD

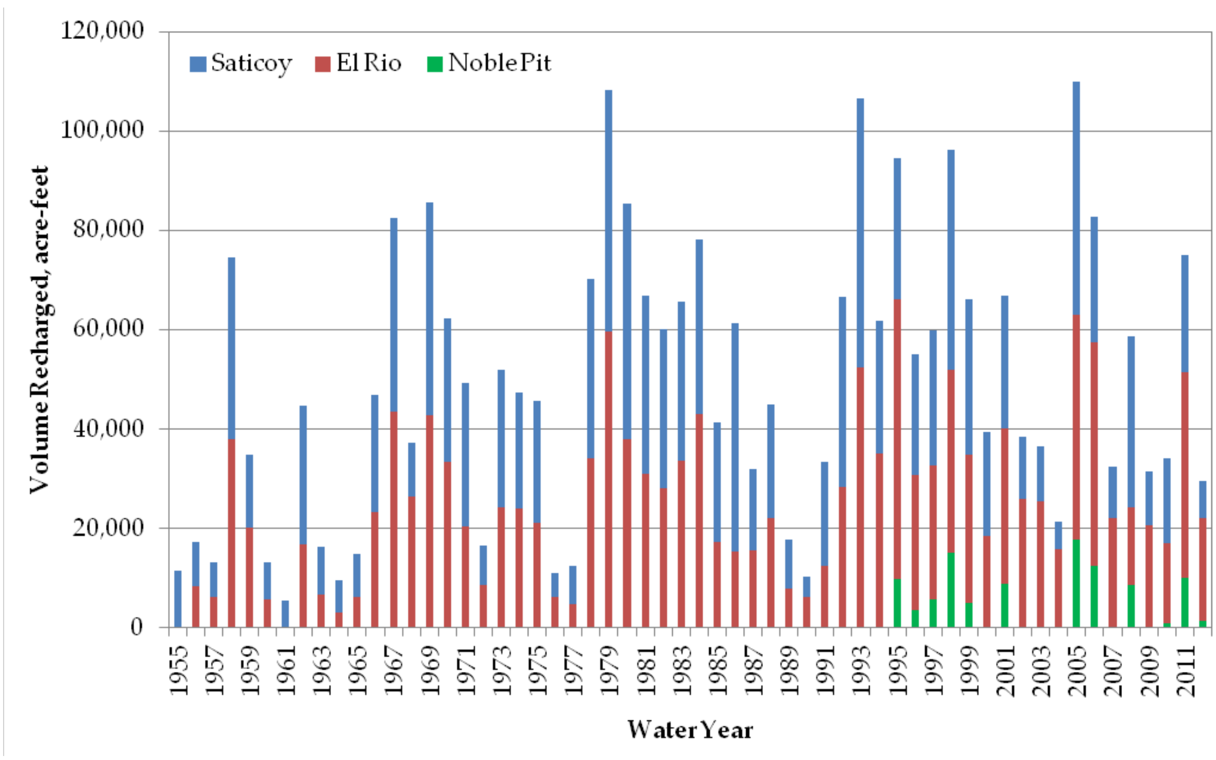


Figure 3-23 History of UWCD Oxnard Forebay Basin Managed Aquifer Recharge

Table 3-2 Summary of Conservation Releases from Santa Felicia Dam

Year	Acre-Feet				
	Total Released From Santa Felicia Dam	Natural Percolation		Released to Santa Paula and Coastal Basins	
		Released to Piru Basin	Released to Fillmore Basin	Groundwater Recharge in Santa Paula & Oxnard Forebay Basins	Delivered to PV and PTP
1999	22,800	5,700	3,500	11,200	2,400
2000	47,200	13,800	6,100	24,150	3,150
2001	47,400	14,000	2,900	28,300	2,200
2002	20,200	8,000	5,100	6,530	570
2003	29,000	21,000	3,500	3,600	900
2004	12,200	8,000	2,150	1,600	550
2005	32,500	9,600	1,000	21,700	150
2006	30,900	11,100	1,000	17,200	1,600
2007	40,700	15,900	6,300	12,200	6,400
2008	44,400	15,400	5,700	17,400	5,800
2009	26,700	13,200	4,700	5,200	3,000
2010	33,000	14,500	4,800	10,700	3,200
2011	31,700	12,400	3,300	14,100	1,600
2012	35,200	13,600	8,600	9,300	3,700
Total	453,900	176,200	58,650	183,180	35,220

Notes: 2005 had two conservation releases. A portion of the release includes spill water when the lake was full. These values include imported water from Pyramid Lake.

PV - Pleasant Valley Delivery System

PTP - Pumping Trough Pipeline

Source of data: UWCD

3.4.2 Imported Water

State Water Project water has been imported by UWCD since 1991. Ventura County has been allocated 20,000 acre-feet (AF) of State Water Project water. Of this amount, 3,150 AF is purchased and delivered to Pyramid Lake and sent to Lake Piru by UWCD (UWCD, 2012b). The amount of water allocated to UWCD each year depends on availability, and delivery is only allowed from November 1 through the end of February. Each year, UWCD plans water releases from Santa Felicia Dam that take into account the lake’s minimum pool and the timing of State Water Project deliveries. The water released from Santa Felicia Dam flows down Piru Creek into the SCR overlying the Piru Basin (**Figure 3-18**). Under low release rates, the majority of released water percolates through the SCR streambed into the groundwater basins. Higher flow rates allow for the creation of channels in the alluvium that convey the released water farther down the SCR. **Table 3-3** provides an estimate of the fate of State Water Project releases from Santa Felicia Dam.

Table 3-3 Summary of State Water Project Releases from Santa Felicia Dam

Year of Purchase	Acre-Feet			
	Natural Percolation		Recharged to Santa Paula and Coastal Basins	
	Released From Santa Felicia Dam	Released to Fillmore and Piru Basins	Groundwater Recharge in Santa Paula & Oxnard Forebay Basins	Delivered to PV and PTP
1991	4,836	3,603	1,233	0
1992	988	84	904	0
2000	2,200	406	1,725	69
2002	3,150	1,455	1,503	192
2003	3,150	2,041	1,039	70
2004	4,047	3,348	472	228
2007	1,890	844	930	116
2008	1,980	673	1,001	306
2009	3,150	1,045	1,381	724
2010	3,150	917	1,674	559
2011	2,520[1]	1,770	2,803	1,097
2012	3150			
Total	34,212	16,186	18,026	3,361

Notes: State Water Project water has not been purchased every year.
PV - Pleasant Valley Delivery System
PTP - Pumping Trough Pipeline
[1] released in 2012 conservation release
Source of data: UWCD.

3.4.3 Groundwater

Groundwater pumping for agricultural irrigation, municipal and domestic, and industrial use occurs in each of the groundwater basins of the study area. Within its service area, UWCD estimates production data from reported metered readings, pump electrical records, or crop type and acreage. **Figure 3-24** shows the location of production wells in the study area. Production data for each of the study planning area basins were provided by UWCD.

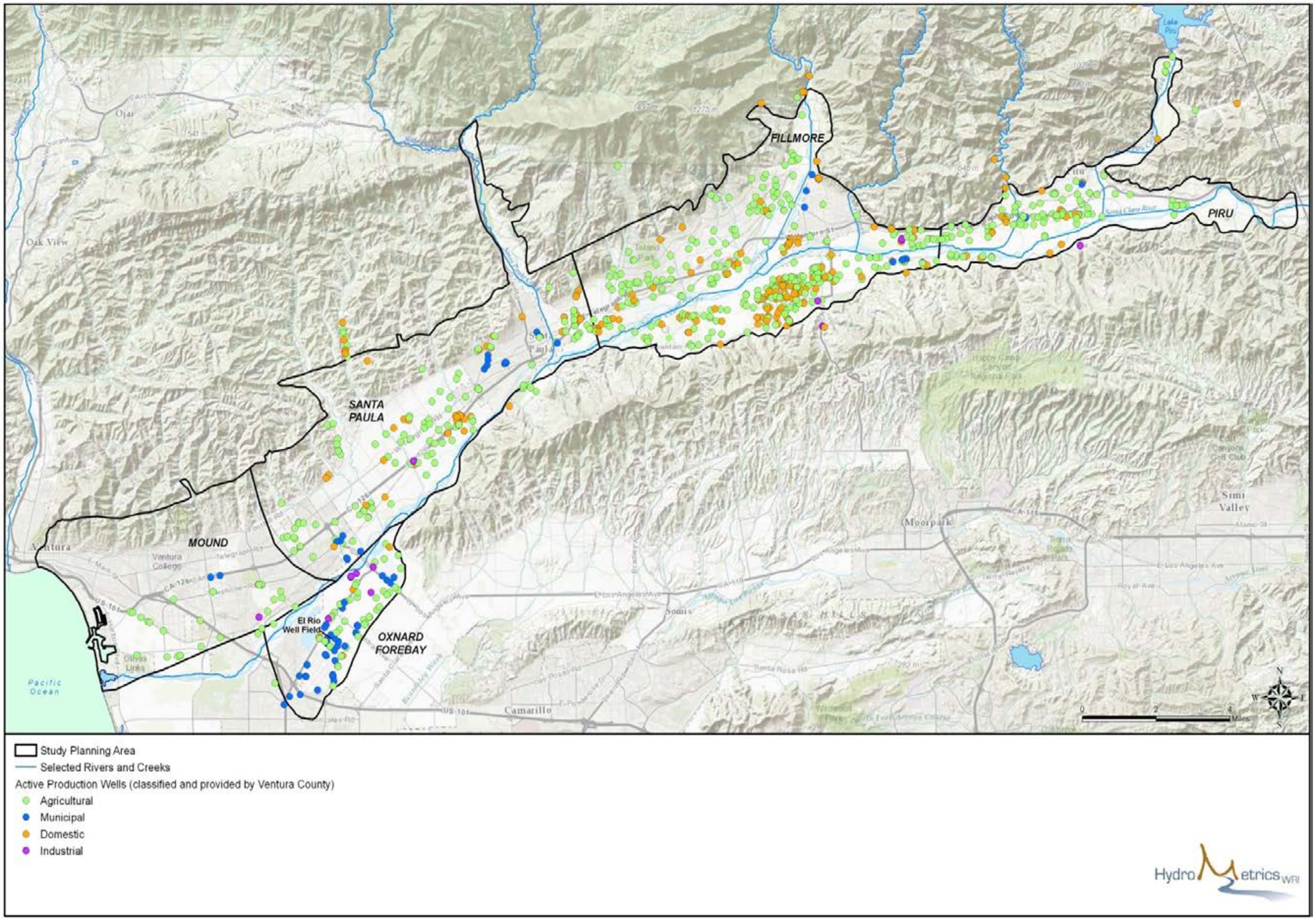


Figure 3-24 Location of Active Production Wells

3.4.3.1 Piru Basin

Groundwater production in the Piru basin is predominantly for agricultural irrigation (**Figure 3-25**). In comparison, approximately 4% of groundwater pumped is used for municipal and industrial purposes. While the distribution of pumping throughout the basin is fairly uniform, the southeastern portion of the basin has very few active wells (UWCD, 2012b).

3.4.3.2 Fillmore Basin

Averaging 44,900 acre-feet per year (AFY) from 1996 through 2012, the Fillmore basin produces the greatest amount of groundwater of all the study area basins. Consistent with land use, agricultural pumping accounts for over 92% of groundwater production (**Figure 3-25**). The Fillmore Fish Hatchery, near the eastern basin boundary, is one of the major agricultural users of groundwater in the basin; in 2011 it used 22% of all groundwater pumped from the basin (UWCD, 2012b). There are 12 mutual water companies that serve water primarily to agricultural users. The area south of the SCR (**Figure 3-24**), called the Bardsdale area, does not have any mutual water companies and therefore has a high density of private agricultural wells pumping relatively small volumes (UWCD, 2012b). The City of Fillmore is one of the larger municipal suppliers in the basin; its three wells are located in the northern Pole Creek fan area (**Figure 3-24**).

3.4.3.3 Santa Paula Basin

The Santa Paula basin uses approximately 20% of its average 27,900 AFY (from 1996 through 2012) groundwater production for municipal and industrial purposes (**Figure 3-25**). The City of Santa Paula is one of the main municipal producers. Several irrigation companies operate in the Santa Paula basin distributing irrigation water to areas that have groundwater of relatively poorer quality (i.e., high mineral content of the ambient groundwater), such as in the canyons and foothills in the northern portion of the basin (UWCD, 2012b), subsequently this area has few wells. **Figure 3-24** shows the northern portion of the Santa Paula basin.

3.4.3.4 Mound Basin

Fifty-five percent of the Mound basin’s groundwater extraction is for agricultural irrigation (**Figure 3-26**). The majority of the municipal and industrial production is by the City of Ventura (UWCD, 2012b). Production in the Mound basin varies annually due to operational and water quality issues. Over the period from 1996 through 2012, annual production in the Mound basin varied from 4,700 to 9,100 AF, with an average of 7,100 AFY.

3.4.3.5 Oxnard Forebay Basin

The Oxnard Forebay basin produces groundwater primarily for municipal and industrial consumption. Agricultural pumping accounts for approximately 30% of the 22,000 AFY pumped from the basin (**Figure 3-26**). The El Rio well field supplies water to the Oxnard-Hueneme area: the City of Oxnard, the Port Hueneme Water Agency, and a number of mutual water companies in the Oxnard Forebay and the northern Oxnard Plain. Production from the well field is variable depending on demand which can change considerably as the City of Oxnard has alternative sources of water it can use depending on availability. The well field extracts from both the UAS and LAS, but mostly from the UAS.

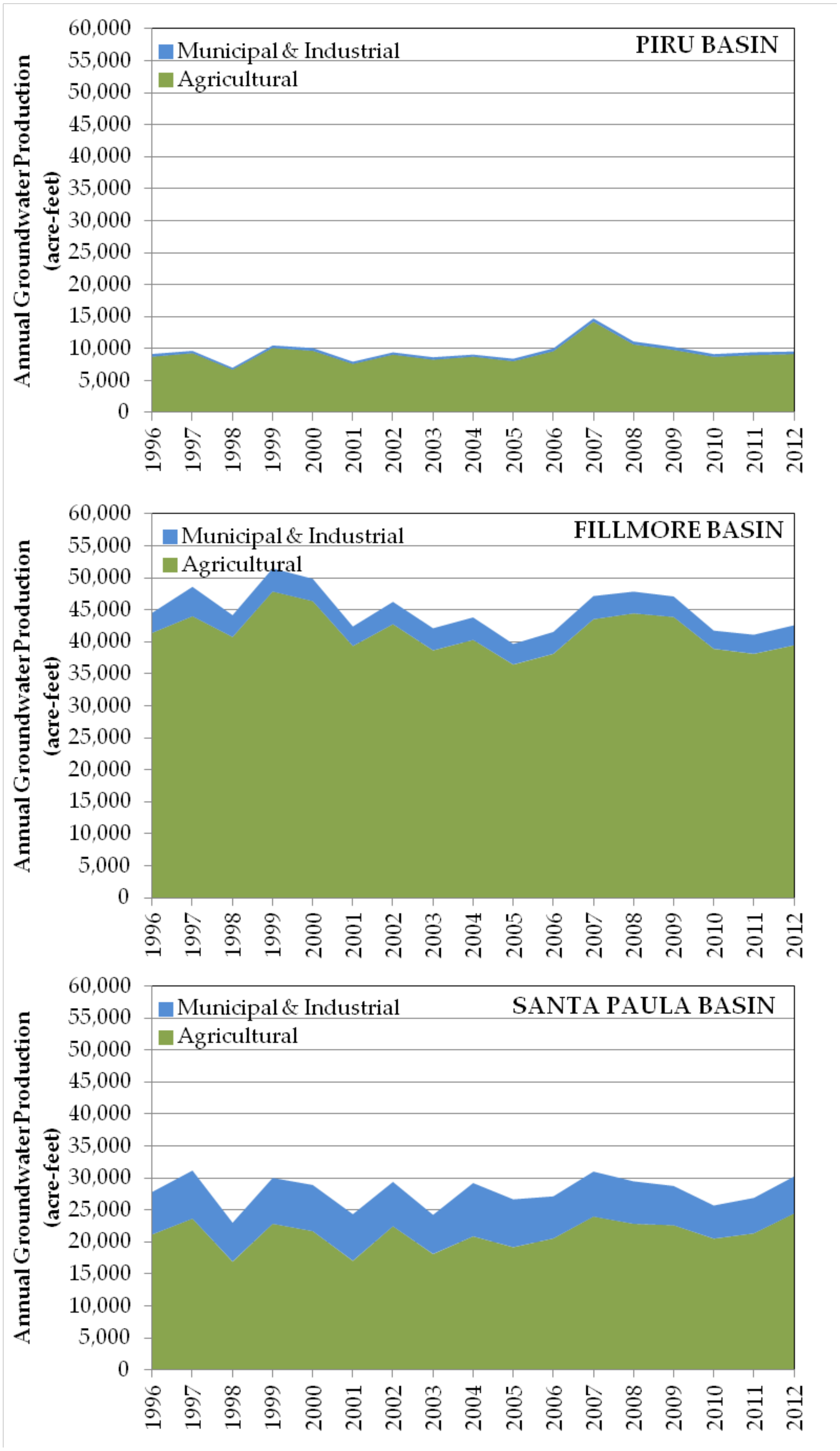


Figure 3-25 Groundwater Production in the Piru, Fillmore, and Santa Paula Basins

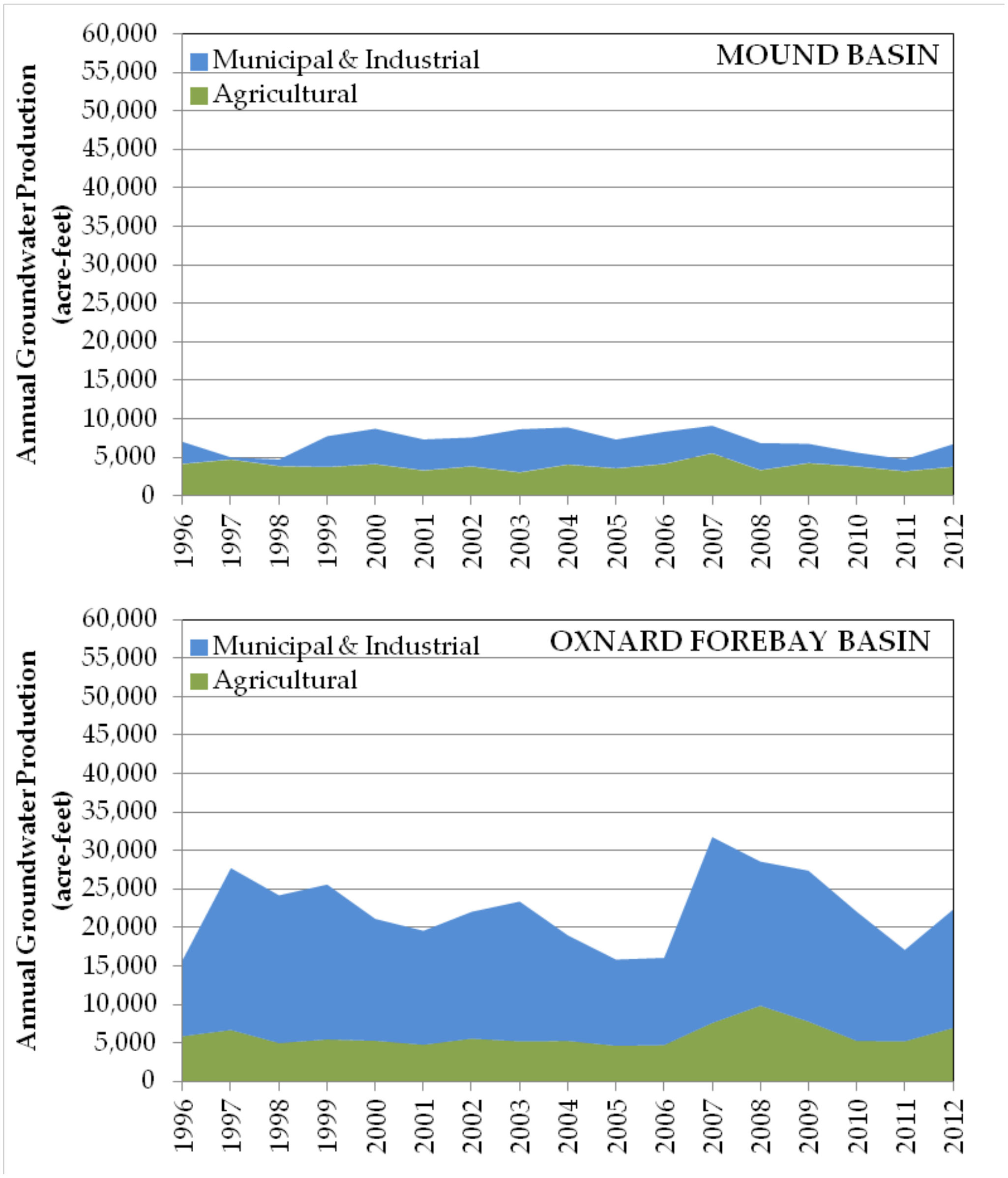


Figure 3-26 Groundwater Production in the Mound and Oxnard Forebay Basins

3.4.4 Recycled Water

District 16's WWTP (completed in 2010) produces secondary treated effluent. The facility consisting of an influent pump station, screenings facility, oxidation ditches for biological nitrogen removal, secondary clarifiers, aerobic digesters, sludge pumping and drying, and an effluent pump station for discharge to percolation ponds. There are plans to use the recycled water for agricultural irrigation. Currently treated wastewater is percolated in ponds near the confluence of Hopper Canyon and the SCR.

The City of Fillmore's new WWTP completed in 2009 was designed with a membrane bioreactor (MBR) system and an ultraviolet (UV) disinfection system that produces recycled water suitable for irrigation. This recycled water is delivered to nearby recharge basins and subsurface irrigation systems in parks and schools throughout the city.

The City of Santa Paula water recycling facility, completed in 2010, produces tertiary treated recycled water that is recharging 13 acres of percolation ponds located to the east of the facility. There are currently plans for the City of Santa Paula to reuse the water in other ways.

The Saticoy Sanitation District operates a small WWTP that percolates treated wastewater into ponds located on the southern edge of the Santa Paula basin. Other small WWTPs such as Limoneira and Olivelands sewer farms, and Todd Road Jail, also percolate treated wastewater into ponds. There are plans for these plants to produce recycled water for irrigation in the future as discussed in **Section 8**.

The City of Ventura's VWRF produces tertiary treated municipal wastewater that is used to irrigate Marina Park, on the north side of the Ventura harbor, Ventura Municipal golf course, Olivas Links golf course, and other landscaped areas located in the vicinity of the SCR in the Mound basin.

The locations of percolation ponds described above are shown on **Figure 3-27**.

A potential future use of recycled water in the Oxnard Forebay basin would supplement diverted surface flows with reverse osmosis (RO) treated wastewater from the City of Oxnard Advanced Water Purification Facility (AWPF) for irrigation and/or managed aquifer recharge in the basin's spreading basins.

3.5 LAND USE AND LAND COVER

The Ventura County General Plan (County of Ventura, 2011) describes the land use overlying the LSCR groundwater basins. **Figure 3-27**shows the land use and crop cover for the study area.

Piru basin's land use is primarily agricultural and open space in the flood plain of the SCR and alongside Piru Creek (**Table 3-4** and **Figure 3-27**). The major crops that are grown in the Piru basin are: row crops, oranges, and nurseries (Table 3-5). Urban areas only account for 3% of the land use.

The Fillmore basin has a similar land use distribution to the Piru basin, with the majority of land used for agriculture, followed by open space along the SCR and Sespe Creek, and along the flanks of the Topatopa Mountains (**Table 3-4**). There is a larger urban area (City of Fillmore) than in the Piru basin. Crops grown in the Fillmore basin are primarily citrus, avocado, row crops, and nurseries (**Table 3-5**).

Urbanization increases westwards in the LSCR. The Santa Paula basin has almost as much urban area as open space (**Table 3-4**). The City of Santa Paula and the eastern portion of the City of Ventura overlie the basin but agriculture is the basin's primary land use. The majority of agricultural acreage in the basin is taken up by lemon and avocado orchards (**Table 3-5**). Row crops, strawberries, and cut flowers together utilize 17% of the agricultural land.

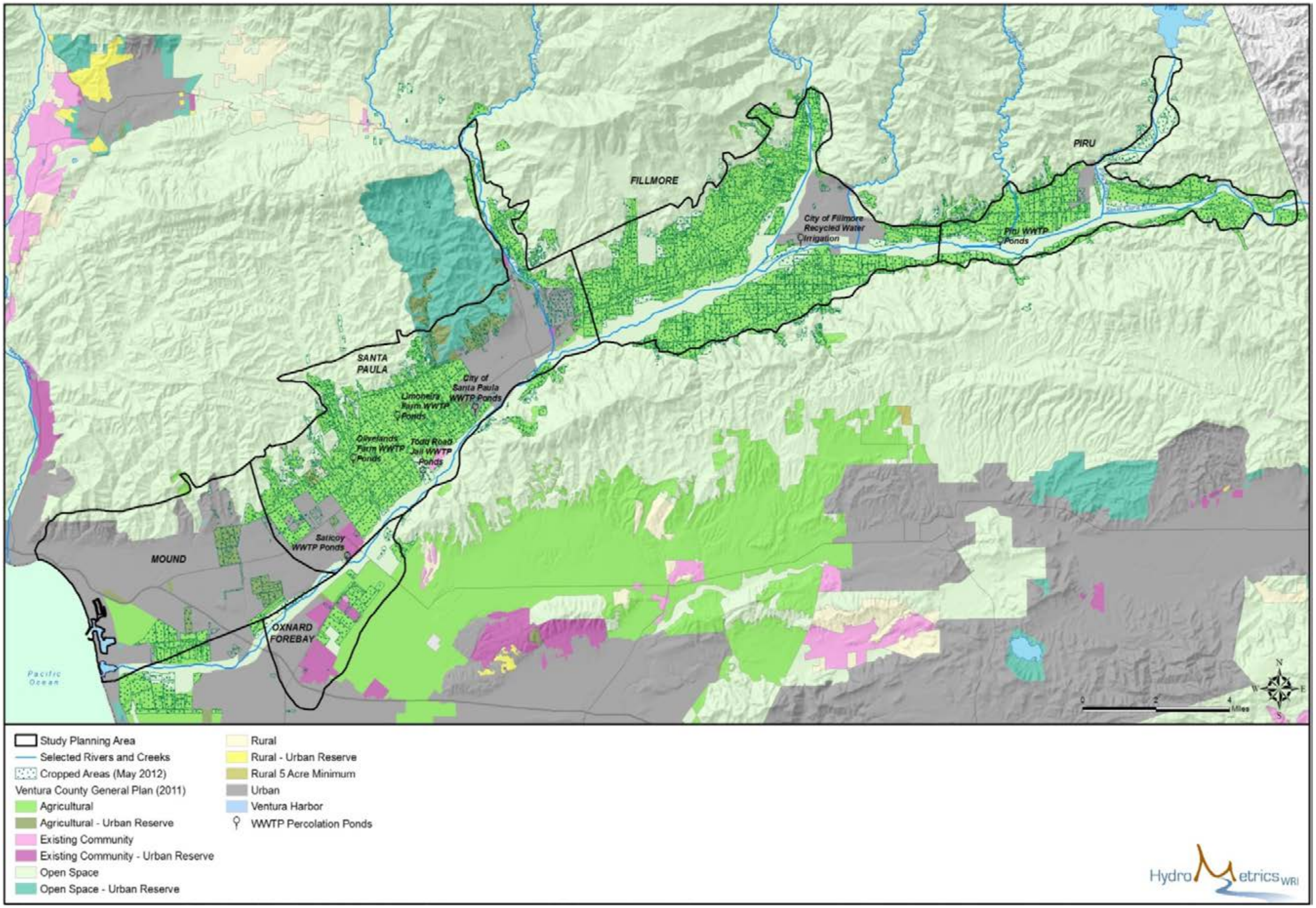


Figure 3-27 Lower Santa Clara River Land Use and Crop Cover

The Mound basin underlies the majority of the City of Ventura, with 69% urban land use in the basin (**Table 3-4**). Open space along the flanks of the Ventura Foothills is the second largest use of land in the basin, followed by 10% agricultural use. The primary crops grown in the Mound basin in decreasing order are: lemons, strawberries, avocado, and row crops. Almost 13% of agricultural land in the Mound basin was fallow in 2012 when the crop data used for this basin description was collected.

Urban/residential land use is predominant in the Oxnard Forebay basin, with strawberries, lemons, row crops, and nurseries comprising the majority of agricultural crops (**Table 3-5)**. Open space along the SCR accounts for 24% of the basin's land use (**Table 3-4**).

Overall, in the five basins comprising the study planning area, the most predominant land use is agriculture, with open space and urban areas taking up the remainder of the area in approximately equal amounts (**Table 3-4**).

Table 3-4 Distribution of Land Use by Basin

Land Use	Percent Acreage in Groundwater Basin					Study Planning Area
	Piru	Fillmore	Santa Paula	Mound	Oxnard Forebay	
Agricultural	53%	61%	42%	10%	34%	42%
Agricultural – Urban Reserve	-	<1%	4%	6%	1%	2%
Existing Community	<1%	-	<1%	-	<1%	<1%
Existing Community – Urban Reserve	-	-	1%	-	15%	2%
Open Space	44%	30%	25%	15%	24%	27%
Open Space – Urban Reserve	-	<1%	4%	<1%	-	1%
Rural	-	-	<1%	-	-	<1%
Rural – Urban Reserve	-	-	<1%	-	-	<1%
Rural 5 Acre Minimum	-	-	<1%	-	-	<1%
Urban	3%	9%	22%	69%	26%	26%
Ventura Harbor	-	-	-	<1%	-	<1%

Source of data: Ventura County General Plan (2011)
Note: The urban reserve classification is applied to all unincorporated land within a city's adopted Sphere of Influence.

Table 3-5 Distribution of Agricultural Activities by Basin (May 2012)

Crop/ Agricultural Type	Percent of Agricultural Land Use					
	Piru	Fillmore	Santa Paula	Mound	Oxnard Forebay	Study Planning Area
Apple	-	<0.1%	<0.1%	-	-	<0.1%
Apricot	-	-	<0.1%	-	-	<0.1%
Artichoke	2.6%	-	-	-	-	0.4%
Avocado	4.7%	30.3%	32.8%	15.9%	0.3%	25.3%
Barley	-	-	-	1.1%	-	0.1%
Basil	-	<0.1%	-	-	-	<0.1%
Beet	-	-	0.2%	-	-	0.1%
Blueberry	-	-	0.1%	-	-	<0.1%
Bok Choy	-	-	-	0.3%	-	<0.1%
Cabbage	-	-	0.6%	-	-	0.2%
Celery	1.0%	0.4%	1.1%	4.2%	-	0.9%
Chard	-	0.2%	-	-	-	0.1%
Cilantro	-	-	-	1.1%	-	0.1%
Cut Flowers	0.2%	0.5%	3.1%	2.4%	1.0%	1.5%
Dill	-	<0.1%	-	-	-	<0.1%
Endive	-	<0.1%	-	-	-	<0.1%
Fallow	-	1.6%	0.9%	12.5%	-	1.7%
Fennel	0.8%	<0.1%	-	-	-	0.1%
Fig	-	-	0.2%	-	-	0.1%
Flower Seed	-	-	0.4%	-	-	0.1%
Grape	-	-	<0.1%	-	-	<0.1%
Grapefruit	2.0%	0.1%	-	-	-	0.4%
Greens	-	0.3%	0.1%	1.0%	-	0.2%
Herbs	-	0.1%	-	1.3%	-	0.1%
Horse	-	<0.1%	-	-	-	<0.1%
Interplanted	0.3%	-	<0.1%	-	-	<0.1%
Kale	-	0.2%	<0.1%	-	-	0.1%
Lemon	6.2%	20.5%	42.0%	28.4%	16.9%	26.2%
Lettuce	-	0.5%	0.4%	0.4%	-	0.4%
Lime	-	<0.1%	-	-	-	<0.1%
Macadamia	-	-	<0.1%	-	-	<0.1%
Mango	-	-	<0.1%	-	-	<0.1%
Mint	-	0.1%	-	-	-	<0.1%
Mixed Citrus	-	<0.1%	<0.1%	-	-	<0.1%
Mushroom	-	-	-	1.5%	-	0.1%

Table 3-5 Distribution of Agricultural Activities by Basin (May 2012)

Crop/ Agricultural Type	Percent of Agricultural Land Use					
	Piru	Fillmore	Santa Paula	Mound	Oxnard Forebay	Study Planning Area
Mustard	-	-	0.1%	-	-	<0.1%
Nursery	15.9%	5.0%	0.9%	0.9%	8.2%	5.1%
Olive	-	<0.1%	-	-	-	<0.1%
Orange	19.6%	21.4%	0.9%	-	-	11.9%
Orchard	-	-	<0.1%	-	-	<0.1%
Out	0.2%	0.3%	0.1%	-	-	0.2%
Parsley	-	0.4%	-	-	-	0.2%
Pasture	-	<0.1%	-	-	-	<0.1%
Pepper	6.4%	-	0.9%	-	-	1.3%
Persimmon	-	-	<0.1%	-	-	<0.1%
Pomegranate	-	0.1%	<0.1%	-	-	<0.1%
Raspberry	-	-	0.2%	-	0.3%	0.1%
Rose	-	-	<0.1%	-	-	<0.1%
Row Crops	35.5%	13.4%	9.0%	8.2%	16.5%	15.1%
Sage	-	<0.1%	-	-	-	<0.1%
Sod	-	-	<0.1%	-	-	<0.1%
Spinach	-	-	0.2%	-	-	0.1%
Stone Fruit	-	-	<0.1%	-	-	<0.1%
Strawberry	-	-	5.1%	20.9%	56.8%	4.9%
Sudan Grass	0.8%	-	-	-	-	0.1%
Tangerine	3.8%	3.1%	0.3%	-	-	1.9%
Tarragon	-	<0.1%	-	-	-	<0.1%
Tilled	-	<0.1%	-	-	-	<0.1%
Tomato	-	-	0.3%	-	-	0.1%
Vegetable Seed	-	0.1%	<0.1%	-	-	<0.1%
Watercress	-	1.3%	-	-	-	0.5%
Xmas Tree	0.2%	-	-	-	-	<0.1%
Agricultural Area of Basin (acres)	4,748.2	11,806.2	10,549.8	1,866.6	939.1	29,909.9

Source of data: Ventura County Office of the Agricultural Commissioner (May 2012)

4 Basin Water Quality

4.1 DATA SOURCES

Groundwater and surface water data were compiled for the SNMP from the following sources of data:

- UWCD provided Geographical Information System (GIS) shapefiles for their monitoring wells, production wells, and surface water sampling sites. Well depth characterization, upper aquifer system or lower aquifer system, was provided included in the UWCD GIS files for UWCD monitoring wells and production wells.
- Ventura County provided GIS shapefiles for their monitoring wells, and wells registered with the County.
- UWCD provided groundwater data (1996 to 2012) collected by UWCD as well as other entities, including Ventura County and data submitted to the California Department of Public Health (CDPH) by municipal/community water purveyors.
- UWCD provided surface water quality data associated with their sampling locations. In addition, UWCD provided the data that they have compiled for a variety of sources including Ventura County, municipal water suppliers, and data provided by growers.
- Larry Walker Associates provided stormwater quality data collected as part of the Ventura Countywide Stormwater Quality Management Program.

The groundwater and surface water quality data included nitrate, TDS and chloride. Since the data were compiled from a variety of sources, there were some issues to resolve related to the analytical methods and reporting of the results, including

- TDS data – EPA Method 1601 and Standard Methods 2540C are included as approved methods in the Code of Federal Regulations (CFR) (40 CFR 136) for TDS (or total filterable residue). The majority of the TDS data were determined by one of these methods. However, some TDS values in the data set were determined by summation. These values are included in the database, but were not used in the analysis or presentation of results since summation is not an approved method.
- Nitrate data – Most of the nitrate data were reported as nitrate as nitrogen. However, some data were only reported as nitrate. In this analysis the calculated nitrate as N values were used, except in cases where the calculated values differed from the reported values. For these exceptions, the reported nitrate as N values were used.

4.2 GROUNDWATER QUALITY OVERVIEW

Detailed analysis of groundwater quality is provided in **Subsections 4.3** through **4.8**. To provide an initial overview of groundwater concentration time series and the variability of groundwater concentrations within a sub area, box and whisker plots were developed. These plots show the minimum, 25th percentile, median, 75th percentile, and maximum values from a specific basin within a specific year. The box and whisker plots are included in **Appendix A**.

4.3 HISTORIC DATA TRENDS AND EXISTING GROUNDWATER QUALITY

4.3.1 Methodology

Existing groundwater quality is estimated by subarea within sub-basins, or for the sub-basin, if it is not divided into subareas. The Piru, Fillmore and Santa Paula basins are divided into subareas pursuant to the Basin Plan. Based on descriptions in the Basin Plan, approximate subarea boundaries were developed with input from the Los Angeles RWQCB (**Figure 1-1**).

The method used to determine existing groundwater quality relies on a 17-year groundwater quality dataset (1996-2012) from monitoring, agricultural, and domestic/municipal wells. This period was selected because:

1) the more recent five year period (2008-2012) yielded a lower number of wells to use for analysis (**Table 4-1**);
2) the 5-year and 17-year dataset have a similar range of results, indicating the longer dataset is representative of conditions in the more recent period **(Table 4-2**); and
3) the 1996-2012 period is representative of the long-term precipitation record (**Table 4-3**).

Because of the absence of well depth information, an approach was taken to include all wells, regardless of depth, to identify areas of similar groundwater quality. By including wells that pump groundwater from different aquifers, there will be significant variability in some of the data, producing a corresponding measure of averaging and uncertainty in some of the analysis. Median concentrations for each well and constituent for the entire dataset (1996-2012) were calculated and plotted on maps. From the spatial distribution of median concentrations, zones of similar water quality were hand delineated. The aggregation of water quality data results in generalized water quality zones that cannot accommodate all median water quality values. Also, subarea and sub basin boundaries are sometimes assigned as contours in order to contain zones where needed.

The median concentrations for all the wells located within each zone of the subarea or sub-basin were averaged to provide an overall average concentration for the zone, shown as the larger bold numbers on the maps. Where possible, all wells were included in the averaging calculation. Only those wells that clearly stood out as having different water quality from nearby wells were excluded. Excluded wells are identified on the maps. The acreage of the zone between contours, and its average concentrations were used to estimate an area-weighted average concentration for each subarea/basin. The area-weighted average concentrations are regarded as the existing groundwater quality. The existing groundwater quality concentrations for each subarea or sub-basin are included in a table on each of the sub-basin maps that shows the distribution of water quality data and contour zones.

4.3.2 Data Statistics and Trends

To test the validity of using the median statistic, a comparison was made between the 90th percentile and the median for wells with more than 10 records. **Figure 4-1** through **Figure 4-3** show the difference between the 90th percentile and the median concentrations as relatively sized dots. These maps show that for the most part, the difference is small, except in a few localized areas, some of which are associated with WWTP percolation ponds. Those wells with the largest differences are included as charts on **Figure 4-1** through **Figure 4-3**. In some cases, the higher values occurred historically and there has since been a decreasing trend. The maps also show a lack of wells in the Mound basin because there are few wells with more than 10 water quality records. Based on the evaluation of the 90th percentile, the use of median statistics as overall existing water quality is representative.

To evaluate whether there are localized or regional groundwater quality trends, chloride, TDS, and nitrate-N concentrations for wells with more than 10 data records over the 1996-2012 period were plotted on charts. **Table 4-4** summarizes the wells identified with visually discernable chloride trends. Most wells in the LSCR are fairly stable or fluctuate without a visually discernable trend. Only 7 out of 329 wells (2% of the wells) used in the analysis had a visually discernable chloride trend and the trends were a mix of increasing and decreasing trends. The Oxnard Forebay basin has the most wells with decreasing chloride concentrations. This is because of the managed aquifer recharge operated by UWCD that has, over time, diluted salts in the basin. The locations of the wells with trends are shown on **Figure 4-4** along with the charts depicting the trend. In general, other than the Oxnard Forebay basin, no other subarea or basin has an overall increasing or decreasing trend, however, there may be localized areas of increasing or decreasing concentrations.

Table 4-1. Summary of Total Number of Wells and Data Points (in parentheses) Available for Water Quality Analysis

Basin	Subarea	TDS		Chloride		Nitrate-N	
		2008-2012	1996-2012	2008-2012	1996-2012	2008-2012	1996-2012
Piru	Below Lake Piru	0	0	0	0	0	0
	East of Piru Creek	5 (30)	5 (57)	5 (33)	6 (63)	5 (25)	6 (53)
	West of Piru Creek	17 (148)	38 (332)	36 (213)	44 (406)	36 (171)	43 (229)
Fillmore	Pole Creek Fan	10 (57)	20 (144)	13 (63)	23 (149)	13 (92)	24 (217)
	Remaining Fillmore	11 (47)	23 (144)	20 (68)	30 (166)	21 (100)	32 (262)
	South Fillmore	3 (19)	15 (72)	10 (44)	19 (99)	10 (48)	19 (108)
Santa Paula	East of Peck Rd	6 (26)	37 (638)	33 (221)	39 (656)	33 (204)	39 (625)
	West of Peck Rd	7 (57)	46 (456)	32 (234)	46 (445)	28 (171)	41 (229)
Mound		19 (139)	19 (139)	20 (139)	27 (139)	13 (92)	21 (217)
Oxnard Forebay		16 (124)	100 (2809)	77 (793)	95 (2231)	71 (658)	98 (8718)
	Total	**94 (647)**	**303 (4791)**	**246 (1808)**	**329 (4354)**	**230 (1607)**	**323 (10,859)**
Percent of 1996-2012 Wells		**31%**		**75%**		**71%**	

Table 4-2. Range of Medians in Wells for 1996-2012 and 2008-2012 Data Periods

Basin	Subarea	TDS		Chloride		Nitrate-N	
		2008-2012	1996-2012	2008-2012	1996-2012	2008-2012	1996-2012
Piru	Below Lake Piru	-	-	-	-	-	-
	East of Piru Creek	892-1250	892-1180	108-141	108-146	1.58-3.32	1.58-3.96
	West of Piru Creek	660-1435	660-2360	38-129	36-125	0.84-22	0.82-22
Fillmore	Pole Creek Fan	760-1855	660-1660	40-75	35-72	1.11-7.59	0.09-7.59
	Remaining Fillmore	640-1030	490-1290	12-64	6-64	0.79-20.89	0.79-22.18
	South Fillmore	961-1580	940-2280	51-190	40-195	0.5-20.07	0.5-20.07
Santa Paula	East of Peck Rd	650-1620	390-2305	11-116	5-120	0.1-11.44	0.1-11.97
	West of Peck Rd	660-1435	660-2360	46-184	47-164	0.05-6.91	0.05-7.59
Mound		900-6180	910-6180	45-498	44-482	0.13-47.52	0.16-38.14
Oxnard Forebay		724-1970	530-1970	0-155	36-155	0.18-24.61	0.14-22.81

Table 4-3. Precipitation Averages for 1996-2012 and Full Record Periods

Station	Period of Data Record	Full Record Average (inches)	Water Year 1980-2012 Average (inches)	Water Year 1996-2012 Average (inches)
El Rio-UWCD Spreading Grounds #239	10/01/1972 - 09/30/2012	15.8	15.8	15.6
Ventura-Hall Canyon #167	10/01/1956 - 09/30/2012	16.2	16.9	16.9
Santa Paula-UWCD #245, 245A, 245B	10/01/1960 - 09/30/1986	18.4	18.9	18.5
Ventura-County Government Center #222A	10/01/1977 - 09/30/2012	17.5	16.9	16.6
Fillmore-Fish Hatchery #171	10/01/1956 - 09/30/2012	18.8	19.6	18.6
Piru-Newhall Ranch #025	10/01/1927 - 09/30/2012	17.4	18.4	17.3
Piru-Temescal Guard Station #160	10/01/1949 - 09/30/2012	20.5	21.5	20.7

Table 4-4. Summary of Chloride Concentration Trends,1996-2012

Basin	Well	Chloride Concentration Trends	
		Decreasing	Increasing
Piru	04N18W20M03S	X	
	04N18W20P02S		X
	04N18W20R01S	X	
Fillmore	No wells with trends		
Santa Paula	02N22W02K09S		X
Mound	No wells with trends		
Oxnard Forebay	02N22W23B03S	X	
	02N22W14F03S	X	
	02N22W14G04S	X	

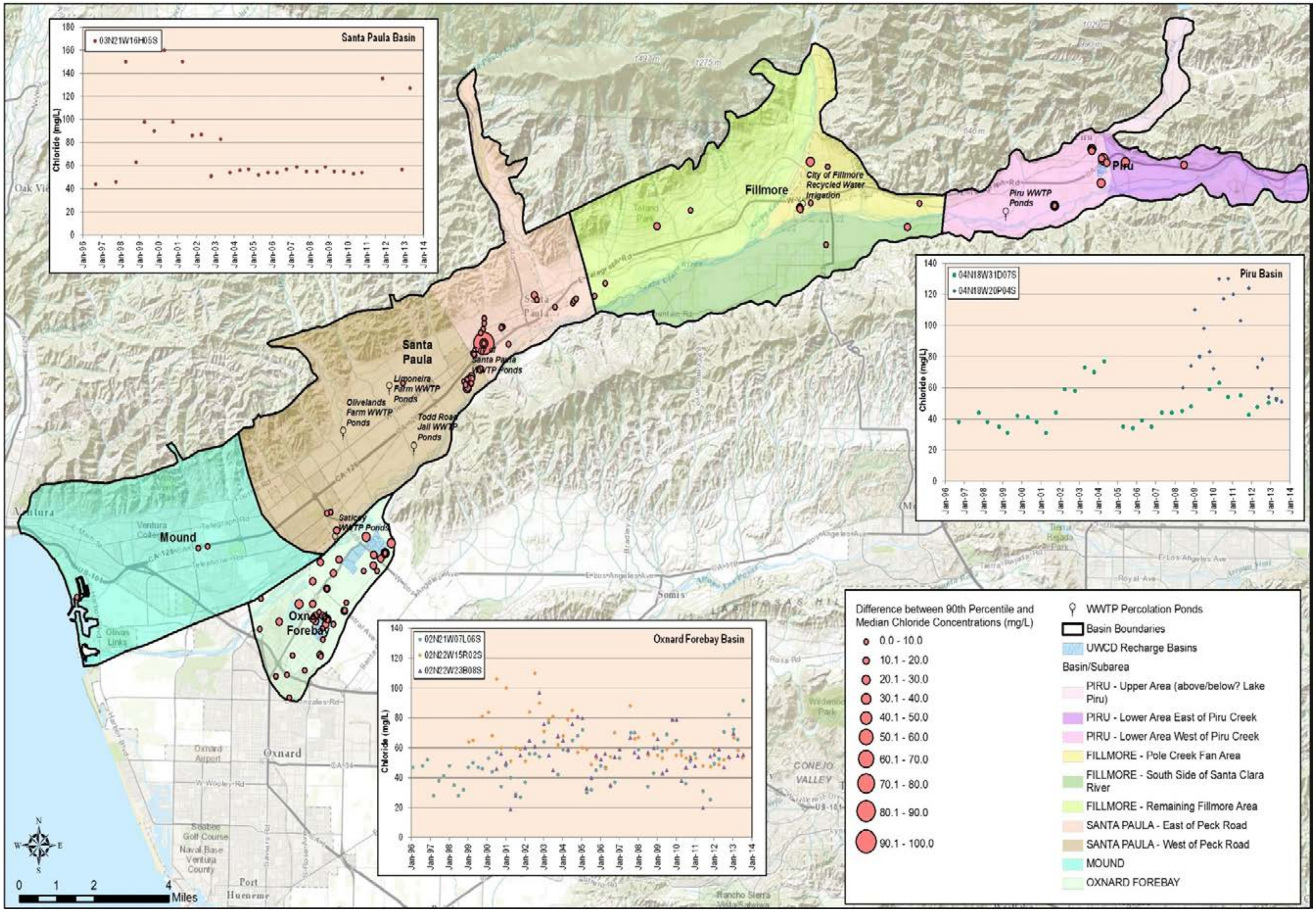


Figure 4-1 Difference between Chloride 90th Percentile and Median Concentrations

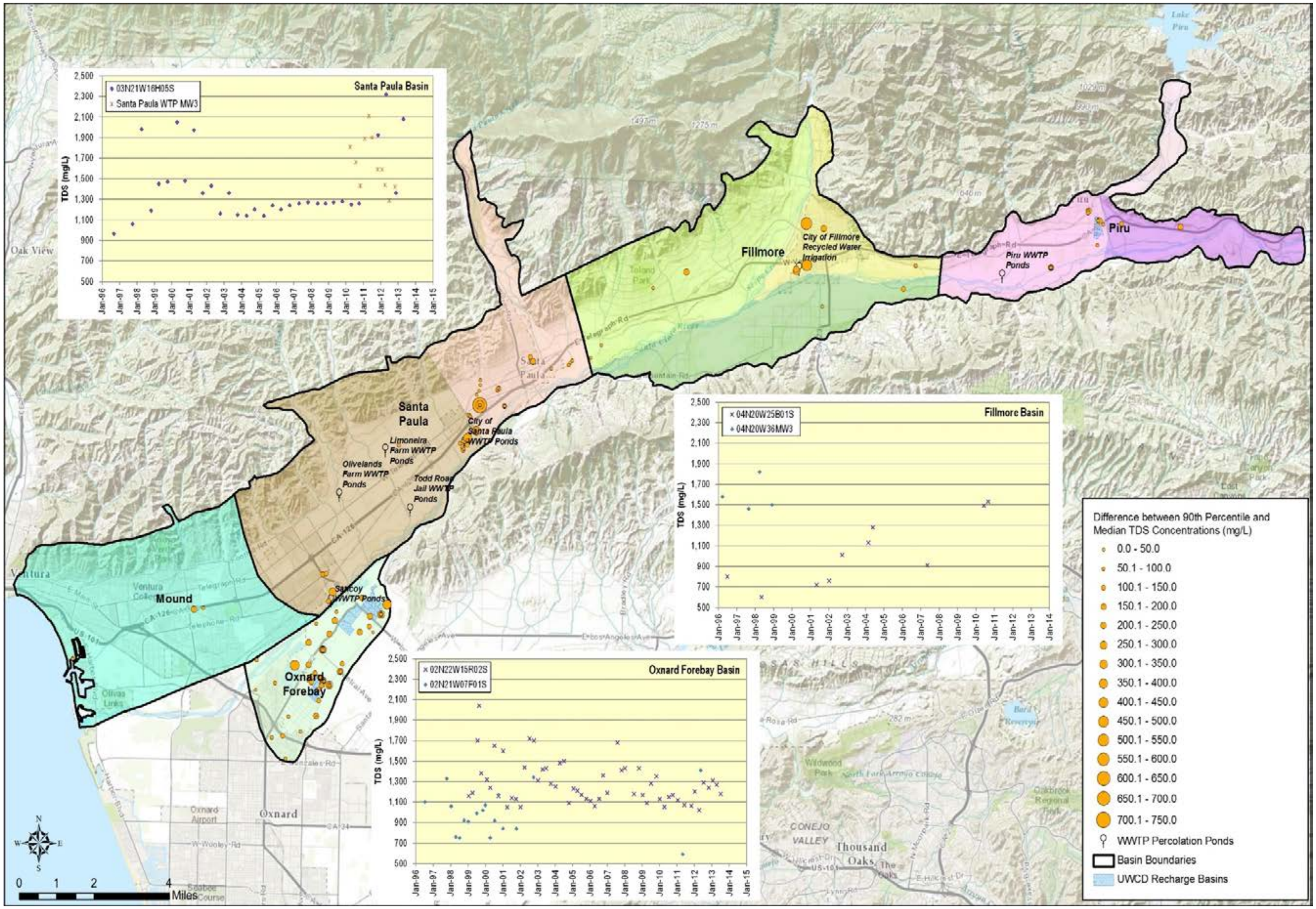


Figure 4-2 Difference between TDS 90th Percentile and Median Concentrations

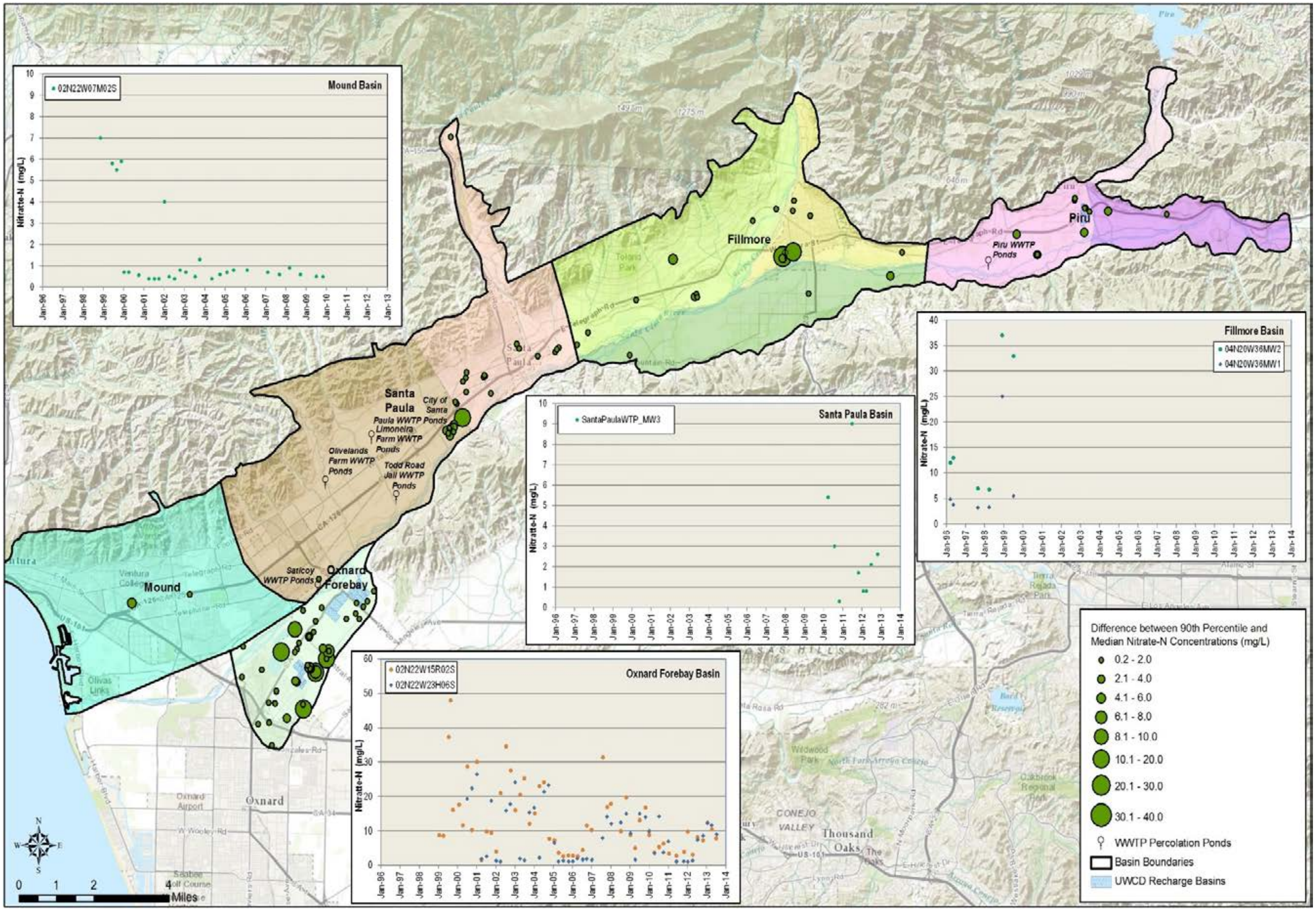


Figure 4-3 Difference between Nitrate-N 90th Percentile and Median Concentrations

Table 4-5 summarizes the wells identified with visually discernible TDS trends. Most wells in the LSCR are fairly stable or fluctuate without a visually discernible trend. Only 8 out of 303 wells (2.6% of the wells) used in the analysis had a visually discernable TDS trend and the trends were a mix of increasing and decreasing trends. The Oxnard Forebay basin has the most wells with decreasing TDS concentrations. This is because of the managed aquifer recharge operated by UWCD that has, over time, diluted salts in the basin. The locations of the wells with trends are shown on **Figure 4-5** along with the charts depicting the trend. In general, other than the Oxnard Forebay basin, no other subarea or basin has an overall increasing or decreasing trend, however, there may be localized areas of increasing or decreasing concentrations.

Table 4-5: Summary of TDS Concentration Trends, 1996-2012

Basin	Well	TDS Concentration Trends	
		Decreasing	Increasing
Piru	none		
Fillmore	04N19W30D01S		X
	04N19W33B01S	X	
Santa Paula	02N22W02K09S		X
Mound	02N22W08F01S		X
Oxnard Forebay	02N22W23B06S	X	
	02N22W15R02S	X	
	02N22W11J01S		X
	02N22W14G04S	X	

Table 4-6 summarizes the wells identified with visually discernible nitrate-N trends. The locations of wells with trends are shown on **Figure 4-6**. Only 13 out of 323 wells (4%) of the wells used in the analysis had a visually discernable nitrate-N trend and the trends were a mix of increasing and decreasing trends. In the Oxnard Forebay basin, many wells exhibit nitrate-N concentration fluctuations that correlate with groundwater levels, as shown on **Figure 4-21**. This figure shows nitrate-N concentrations increasing when groundwater levels are low and concentrations decreasing when groundwater levels rise during active recharge at the UWCD recharge basins. The nitrate-N fluctuations are seasonal and respond rapidly to changes in recharge. In general, no subarea or basin has an overall increasing or decreasing trend, however, there may be localized areas of increasing or decreasing concentrations.

Table 4-6 Summary of Nitrate-N Concentration Trends, 1996-2012

Basin	Well	Nitrate-N Concentration Trends	
		Decreasing	Increasing
Piru	04N18W31D03S		X
	04N18W31D05S	X	
Fillmore	03N20W06N02S	X	
	04N19W33B01S		X
	04N20W25B01S		X
Santa Paula	03N21W16A02S		X
	03N21W16H06S	X	
	03N21W15G01S	X	
	03N21W15C04S		X
	03N21W16H07S	X	
	03N21W11F03S		X
Mound	02N22W08G01S		X
Oxnard Forebay	02N22W15R02S	X	

The following subsections discuss the development of existing water qualities for each subarea or basin in more detail.

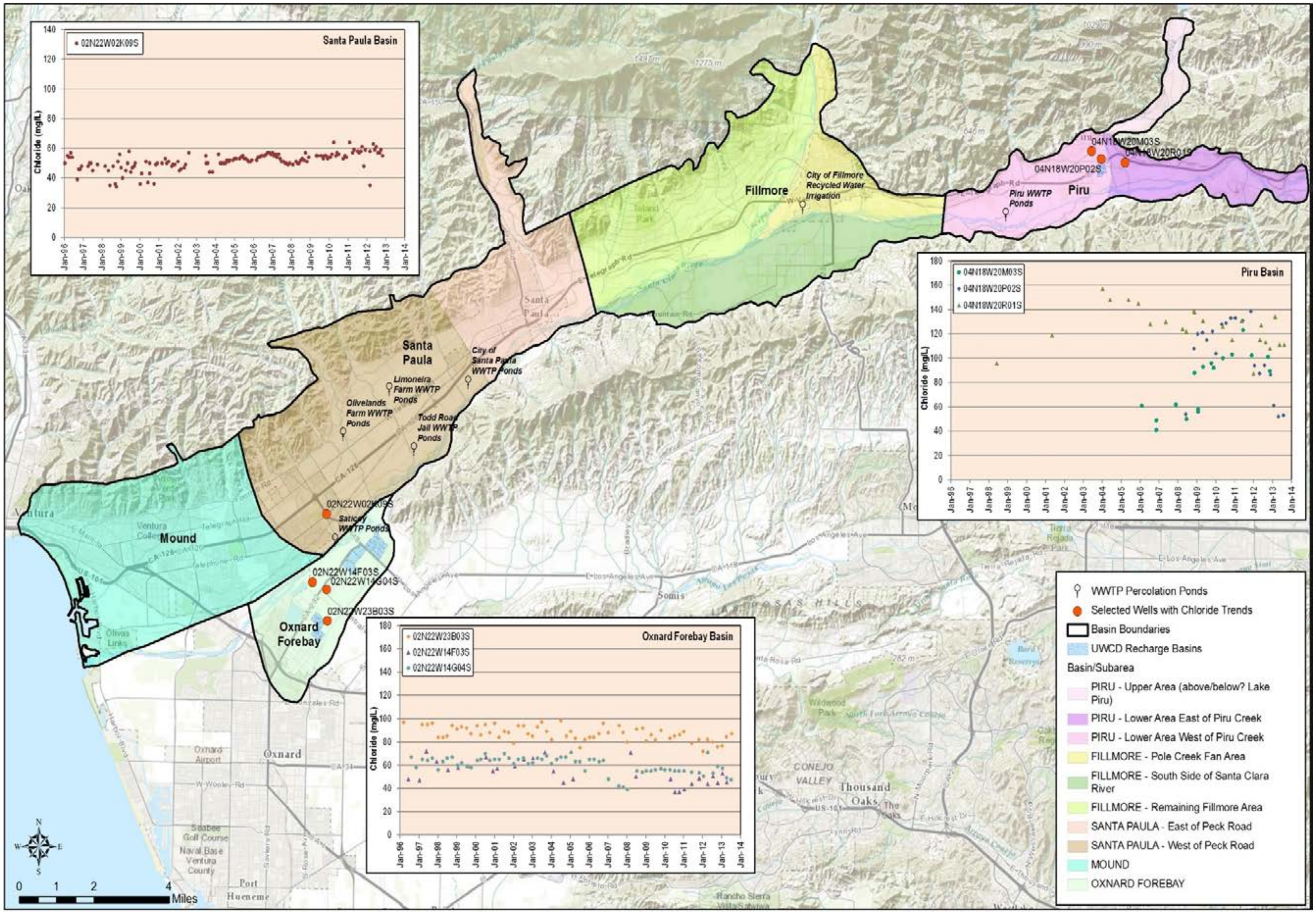


Figure 4-4 Wells with Chloride Trends

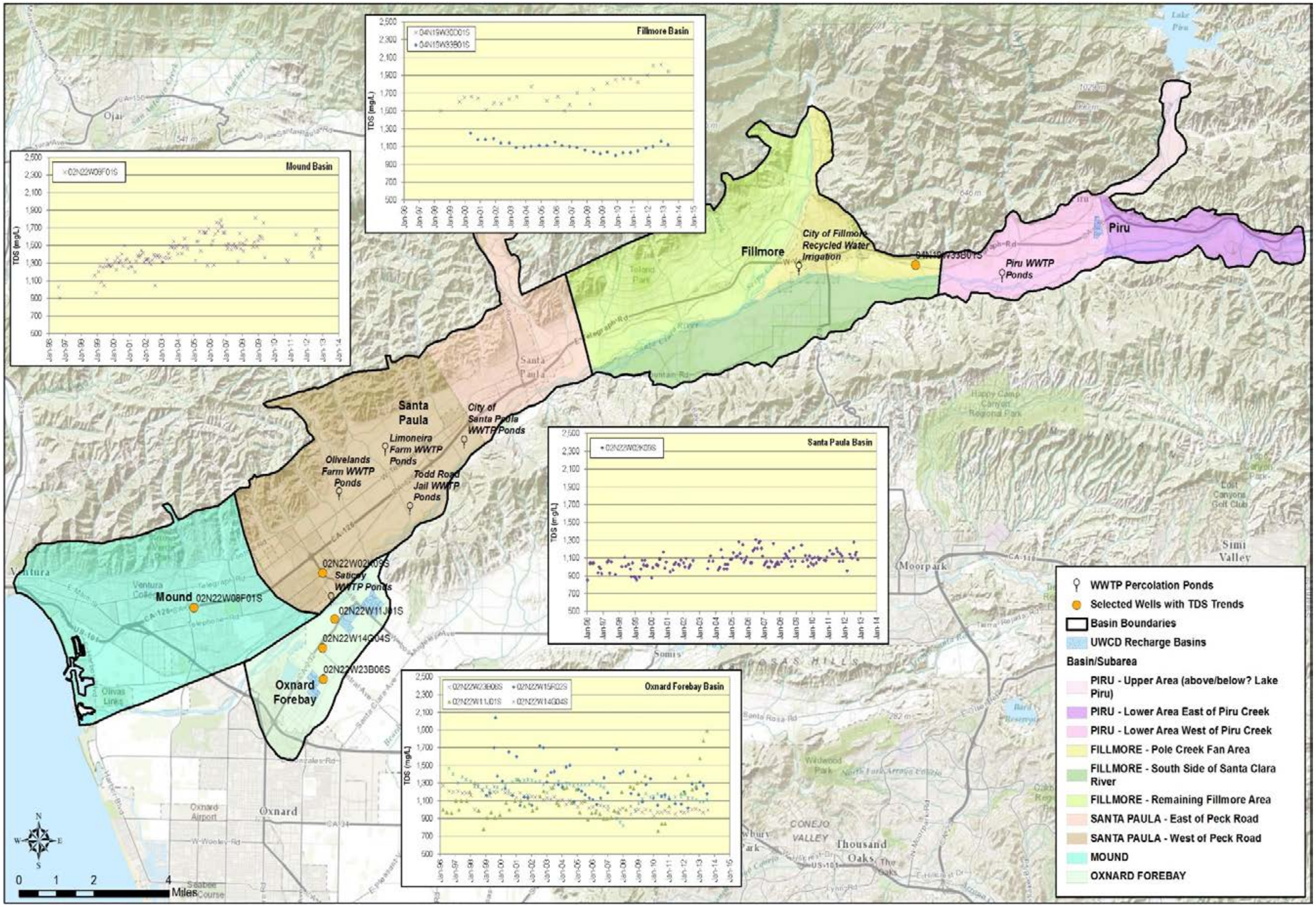


Figure 4-5 Wells with TDS Trends

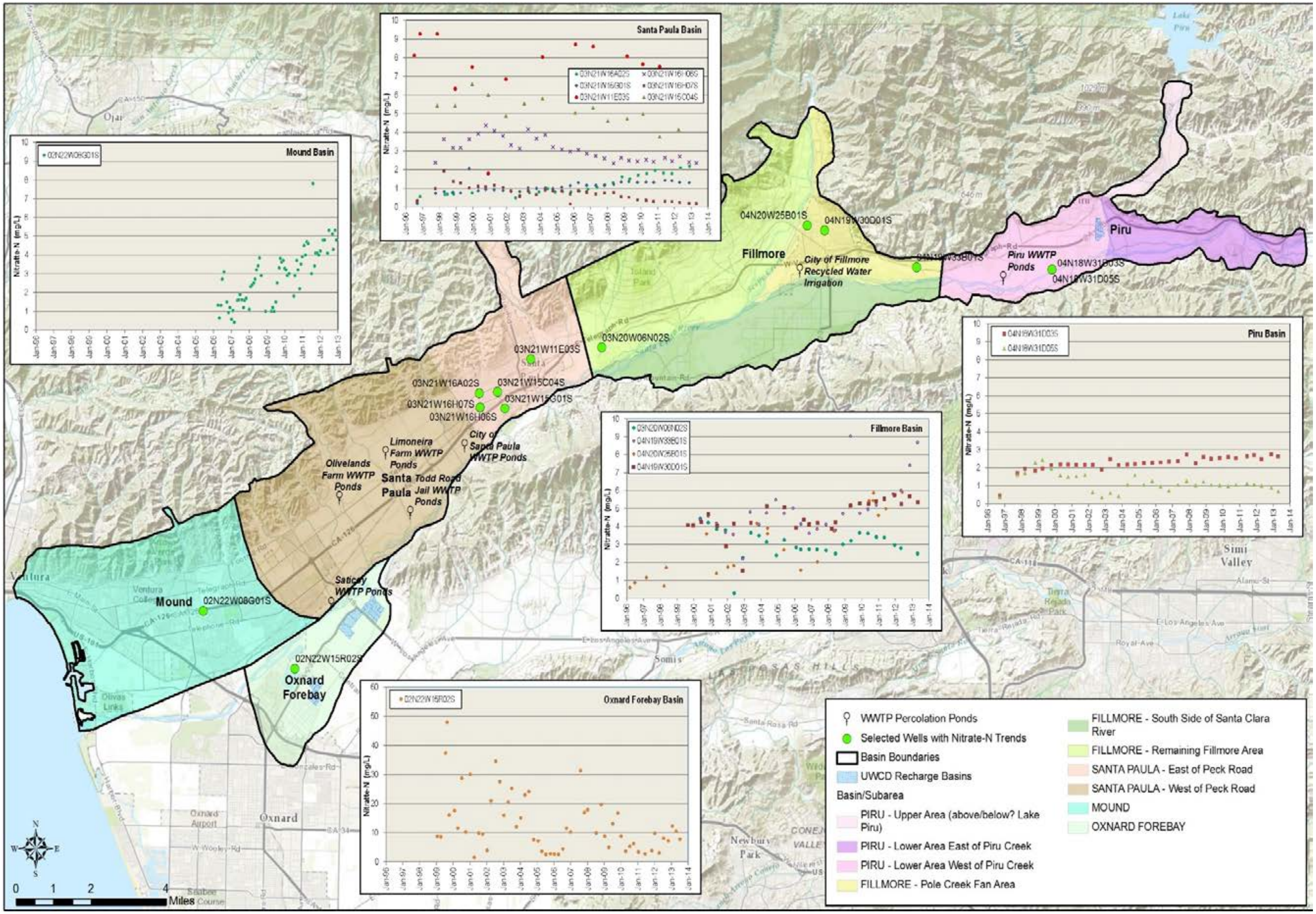


Figure 4-6 Wells with Nitrate-N Trends

4.4 PIRU BASIN

The Piru basin has three subareas: east of Piru Creek, west of Piru Creek, and below Lake Piru. **Figure 4-7** through **Figure 4-9** show the groundwater quality for the Piru basin. A table listing the existing groundwater quality of the constituents is included on each map

4.4.1 Piru Basin – East of Piru Creek Subarea

4.4.1.1 Chloride Existing Water Quality

As shown by the distribution of wells in the east of Piru Creek subarea, data are limited to the western portion of the subarea (**Figure 4-7**). To fill in the area where no wells exist to provide water quality control, water quality from the SCR adjacent to that area was used to extend the groundwater quality zones to the east. Santa Clara River water chloride and TDS in the far eastern Piru Basin has been found to correlate directly with chloride and TDS in wells in the Camulos Ranch area (UWCD, 2006). Surface water in this location and upstream to the county line is the sole significant source of recharge to the underlying groundwater (UWCD, 2006), which supports the assumption that the surface water quality can be used to define existing groundwater quality in the eastern part of the subarea. A time-series plot of SCR chloride concentrations in the eastern portion of Piru basin at Newhall Crossing is provided in **Figure 4-10**.

In general, the highest chloride concentrations in the east of Piru Creek subarea occur in the northwestern and eastern portions of the subarea, with lower concentrations in the southern portion (**Figure 4-7**). The source of elevated chloride concentrations in the subarea is predominantly from streambed percolation of SCR water that flows from Los Angeles County. Most of the subarea's groundwater pumping takes place in the area with the highest chloride concentrations. Tributary flow introduces low chloride recharge water which is the cause of lower chloride in the eastern portion of the subarea. The estimated existing groundwater quality of chloride for the east of Piru Creek subarea of the Piru basin is 118 mg/L.

4.4.1.2 TDS Existing Water Quality

Similar to chloride, in the absence of wells in the eastern portion of the subarea, TDS groundwater concentrations were correlated from surface water quality. **Figure 4-11** provides a time-series plot of TDS in the SCR at Newhall Crossing.

The distribution of TDS similarly follows the distribution of chloride in the subarea; highest concentrations occurring in the northern and eastern portions of the subarea and lower concentrations in the south. The estimated existing groundwater quality of TDS for the east of Piru Creek subarea of the Piru basin is 1,000 mg/L.

4.4.1.3 Nitrate-N Existing Water Quality

Nitrate-N data for the subarea is limited to the western portion with only five well locations available (**Figure 4-9**). Nutrient sources other than the SCR occur in the eastern portion of the subarea. This precludes the use of surface water to provide control for contouring nitrate-N where groundwater control is lacking, as was done for chloride and TDS. In general, nitrate-N concentrations in the east of Piru Creek subarea are less than 5 mg/L with a range between 1.6 and 4.0 mg/L. The estimated existing groundwater quality of nitrate-N for the east of Piru Creek subarea of the Piru basin is 2.6 mg/L.

4.4.2 Piru Basin – West of Piru Creek Subarea

4.4.2.1 Chloride Existing Water Quality

Chloride concentrations decrease westward as Piru Creek recharge dilutes higher concentrations from the eastern portion of the subarea and the east of Piru Creek subarea (**Figure 4-8**). At the western edge of the subarea, chloride concentrations are approximately 60 mg/L. The estimated existing groundwater quality of chloride for the west of Piru Creek subarea of the Piru basin is 69 mg/L.

4.4.2.2 TDS Existing Water Quality

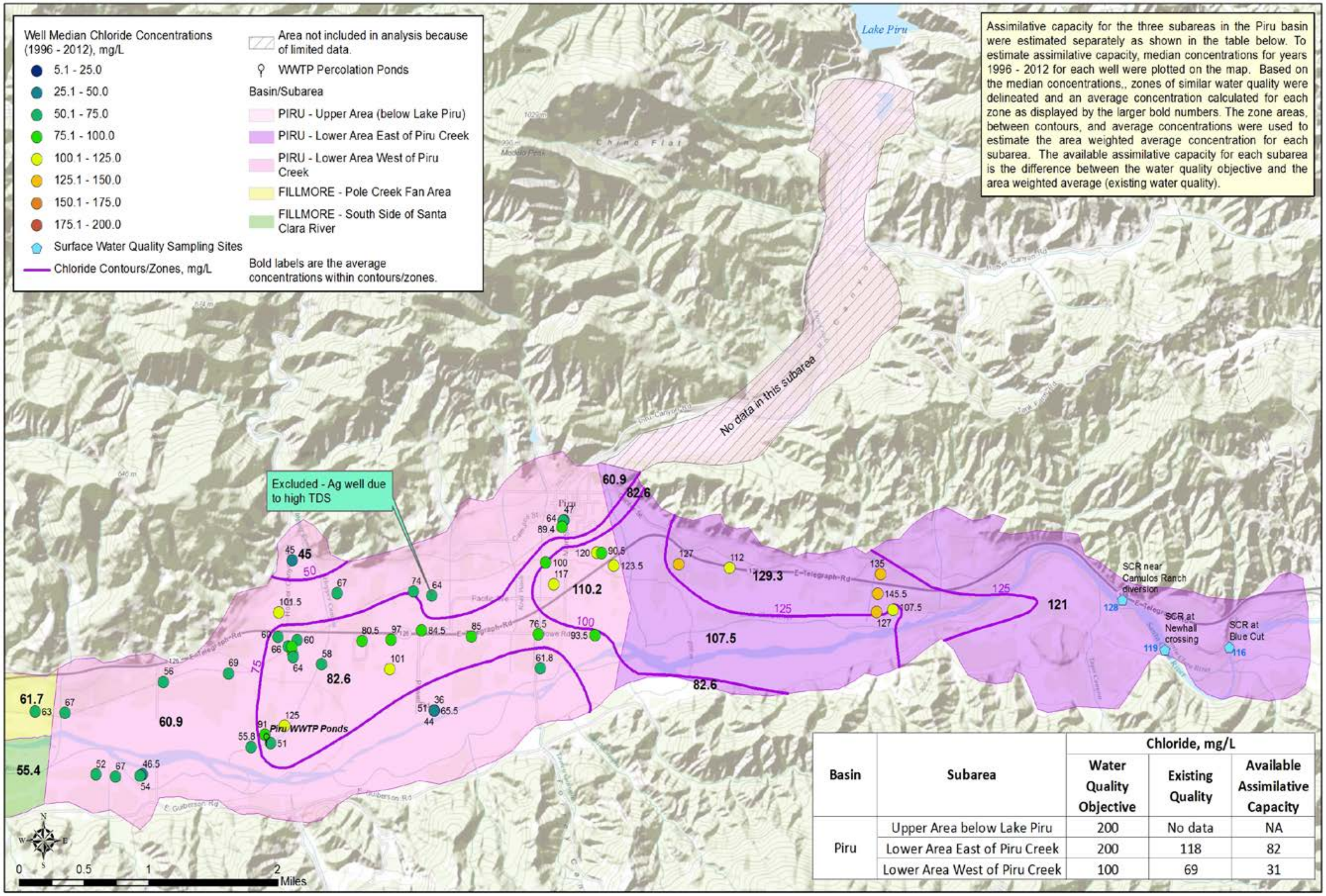
TDS in the west of Piru Creek subarea is generally less than 1,000 mg/L, except in the central portion of the subarea and in focused areas just west of Hopper Canyon and in the area where Piru WWTP percolates its recycled wastewater north of the SCR (**Figure 4-8**). The largest area of TDS concentrations greater than 1,000 mg/L is north of the SCR. The cause of localized high TDS west of Hopper Canyon is unknown. The estimated existing groundwater quality of TDS for the west of Piru Creek subarea of the Piru basin is 992 mg/L.

4.4.2.3 Nitrate-N Existing Water Quality

The greatest nitrate-N concentrations are found in the central portion of the subarea where concentrations are still relatively low and generally range between 4 and 10 mg/L (**Figure 4-9**). Nitrate-N concentrations decrease away from the central area towards the basin edges, where concentrations are generally 1 to 2 mg/L or less. The estimated existing groundwater quality of nitrate-N for the west of Piru Creek subarea of the Piru basin is 3.6 mg/L.

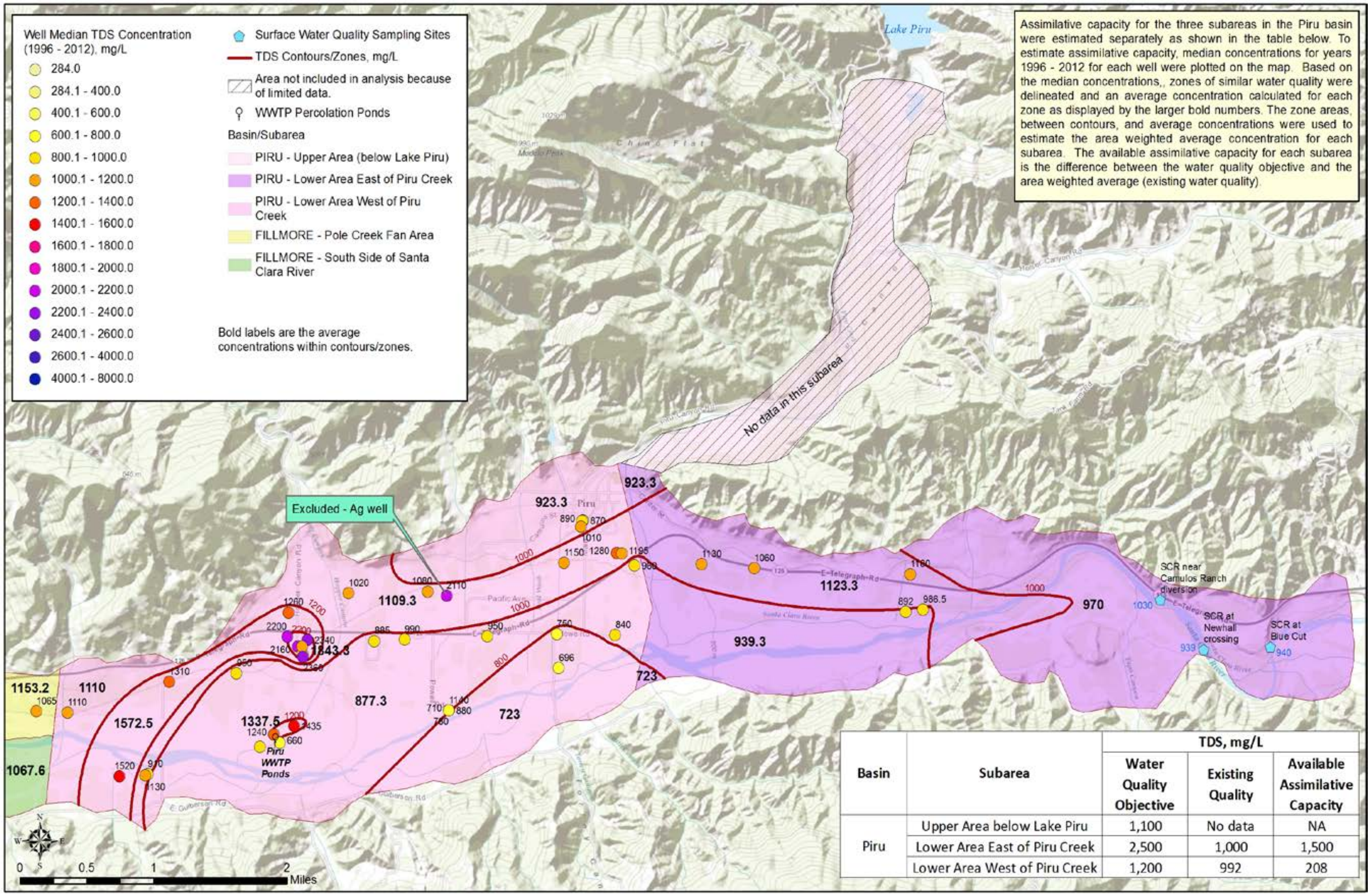
4.4.3 Piru Basin – Below Lake Piru Subarea

No groundwater quality data exist for this subarea for the period between 1996 and 2012. Existing monitoring well information will be further reviewed with stakeholders to determine if there is an appropriate location to use to extend the spatial distribution for water quality analysis. If there is not an existing appropriate location, data from the lower area west of Piru Creek will be used to assess the water quality in this subarea.



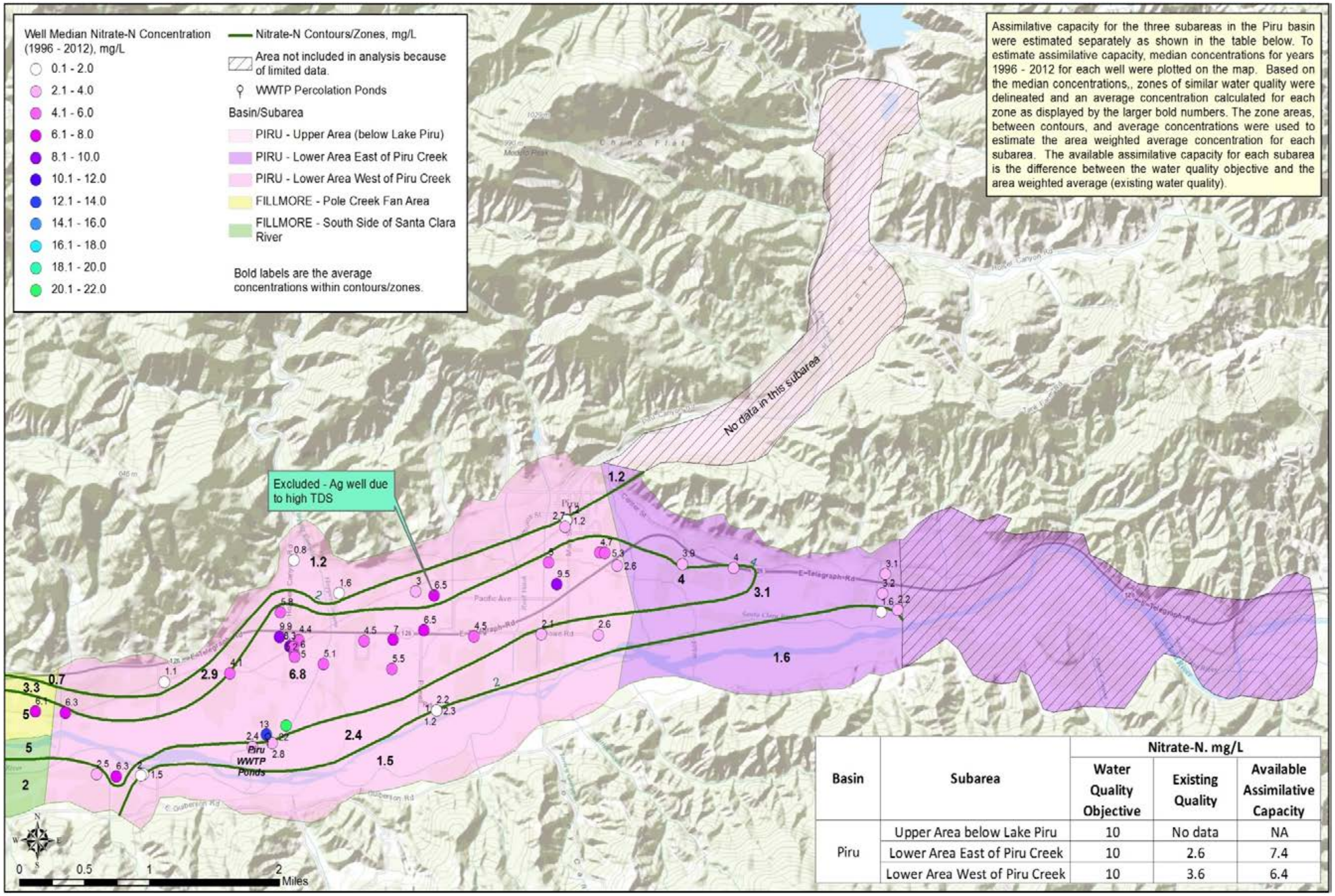
Basin	Subarea	Chloride, mg/L Water Quality Objective	Existing Quality	Available Assimilative Capacity
Piru	Upper Area below Lake Piru	200	No data	NA
	Lower Area East of Piru Creek	200	118	82
	Lower Area West of Piru Creek	100	69	31

Figure 4-7 Chloride Existing Water Quality of Piru Basin



Basin	Subarea	TDS, mg/L		
		Water Quality Objective	Existing Quality	Available Assimilative Capacity
Piru	Upper Area below Lake Piru	1,100	No data	NA
	Lower Area East of Piru Creek	2,500	1,000	1,500
	Lower Area West of Piru Creek	1,200	992	208

Figure 4-8 TDS Existing Water Quality of Piru Basin



Basin	Subarea	Nitrate-N. mg/L		
		Water Quality Objective	Existing Quality	Available Assimilative Capacity
Piru	Upper Area below Lake Piru	10	No data	NA
	Lower Area East of Piru Creek	10	2.6	7.4
	Lower Area West of Piru Creek	10	3.6	6.4

Figure 4-9 Nitrate-N Existing Water Quality of Piru Basin

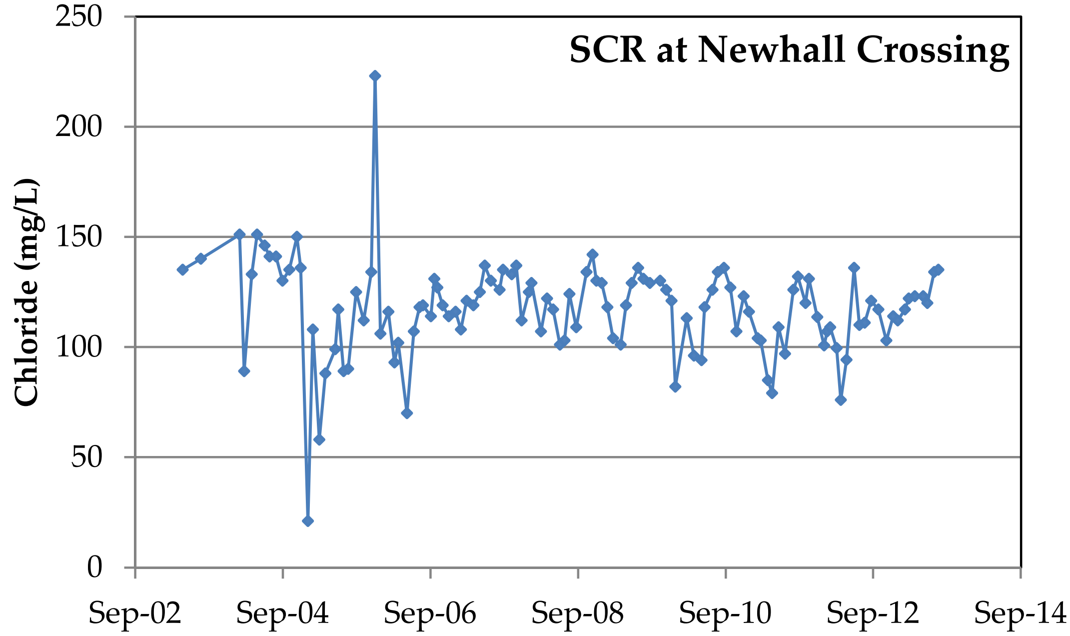


Figure 4-10 Historical Chloride Concentrations at Santa Clara River at Newhall Crossing

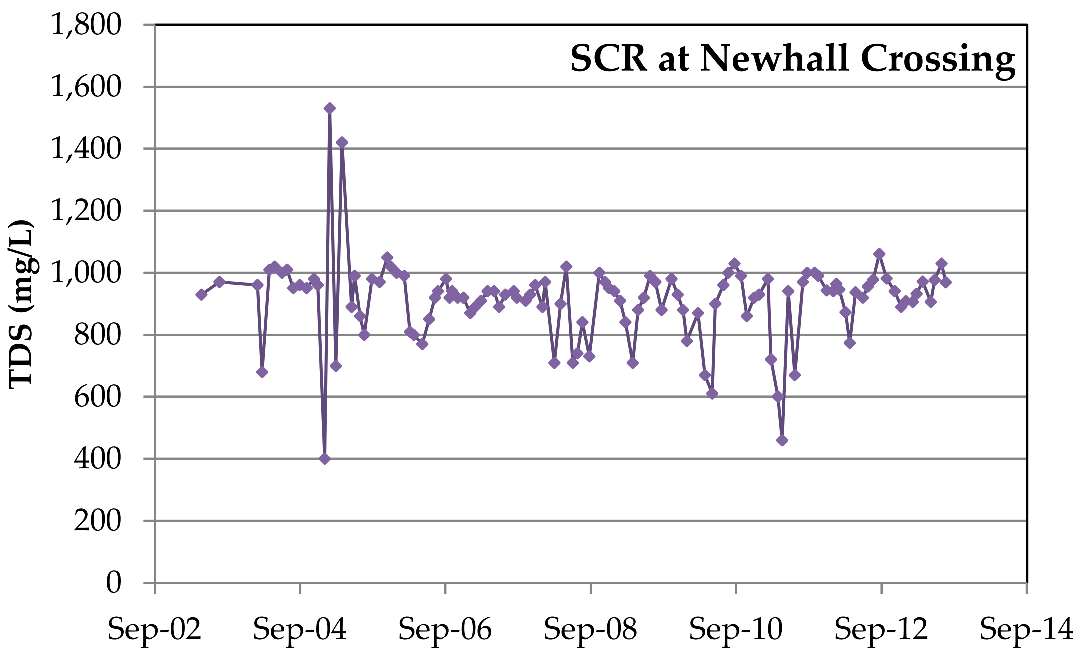


Figure 4-11 Historical TDS Concentrations at Santa Clara River at Newhall Crossing

4.5 FILLMORE BASIN

The Fillmore basin has three subareas: Pole Creek Fan Area, south side of Santa Clara River, and remaining Fillmore area. **Figure 4-12** through **Figure 4-14** show the groundwater quality for the Fillmore basin. A table listing the existing groundwater quality of the constituents is included on each map.

4.5.1 Fillmore Basin – Pole Creek Fan Area Subarea

4.5.1.1 Chloride Existing Water Quality

Chloride concentrations in the Pole Creek Fan area are fairly consistent and range between 46 and 72 mg/L (**Figure 4-12)**. There is one small area in the western portion of the subarea that straddles Sespe Creek which has lower chloride concentrations than the rest of the subarea. The estimated existing groundwater quality of chloride for the Pole Creek Fan Area subarea of the Fillmore basin is 59 mg/L.

4.5.1.2 TDS Existing Water Quality

The subarea generally has uniform TDS ranging between 900 and 1,300 mg/L (**Figure 4-13**). The exception is a small area in the north, defined by just two wells, that overlaps somewhat with the low chloride area described above and overlies the urban area of the City of Fillmore. The TDS concentration in this area is higher than the surrounding areas, unlike the chloride concentrations which are lower than the surrounding area. The estimated existing groundwater quality of TDS for the Pole Creek Fan Area subarea of the Fillmore basin is 1,101 mg/L.

4.5.1.3 Nitrate-N Existing Water Quality

Nitrate-N concentrations across the Pole Creek Fan subarea increase towards the southwest from just under 1 mg/L to approximately 4 mg/L (**Figure 4-14**). Much of the subarea is underlain by the urban landscape of the City of Fillmore. Higher nitrate-N concentrations in the central portion of the Piru basin extend across the Piru/Fillmore boundary into a small area of the easternmost portion of the Pole Creek Fan area subarea. None of the median concentrations in the subarea exceed 7 mg/L. The estimated existing groundwater quality of nitrate-N for the Pole Creek Fan Area subarea of the Fillmore basin is 2.9 mg/L.

4.5.2 Fillmore Basin – South Side of Santa Clara River Subarea

4.5.2.1 Chloride Existing Water Quality

The highest chloride concentrations of the subarea are found along the southern boundary of the subarea (**Figure 4-12**). Here concentrations are in excess of 190 mg/L. Because only the southern portion of the subarea has elevated chloride despite similar land use across the subarea, connate water that was trapped during deposition of the basin’s sediments is its most likely cause.

Chloride concentrations decrease northwards towards the SCR where concentrations generally range between 50 and 70 mg/L. Recharge of lower chloride surface water by streambed percolation in the SCR has most likely diluted the connate water occurring in the aquifers of the subarea closer to the river. The estimated existing groundwater quality of chloride for the South Side of Santa Clara River subarea of the Fillmore basin is 74 mg/L.

4.5.2.2 TDS Existing Water Quality

Similar to chloride concentrations, TDS concentrations are highest along the southern boundary of the subarea and decrease towards the SCR (**Figure 4-13**). The dilution mechanisms for TDS are the same as those described above for chloride. The estimated existing groundwater quality of TDS for the South Side of Santa Clara River subarea of the Fillmore basin is 1,411 mg/L.

4.5.2.3 Nitrate-N Existing Water Quality

From east to west, nitrate-N concentrations increase towards the central portion of the south side of SCR subarea (**Figure 4-14**) here concentrations can reach 12 mg/L. West of central portion of elevated concentrations, nitrate-N in the subarea decreases again towards the subarea's western boundary to just over 2 mg/L. The estimated existing groundwater quality of nitrate-N for the South Side of Santa Clara River subarea of the Fillmore basin is 5.6 mg/L.

4.5.3 Fillmore Basin – Remaining Fillmore Area Subarea

4.5.3.1 Chloride Existing Water Quality

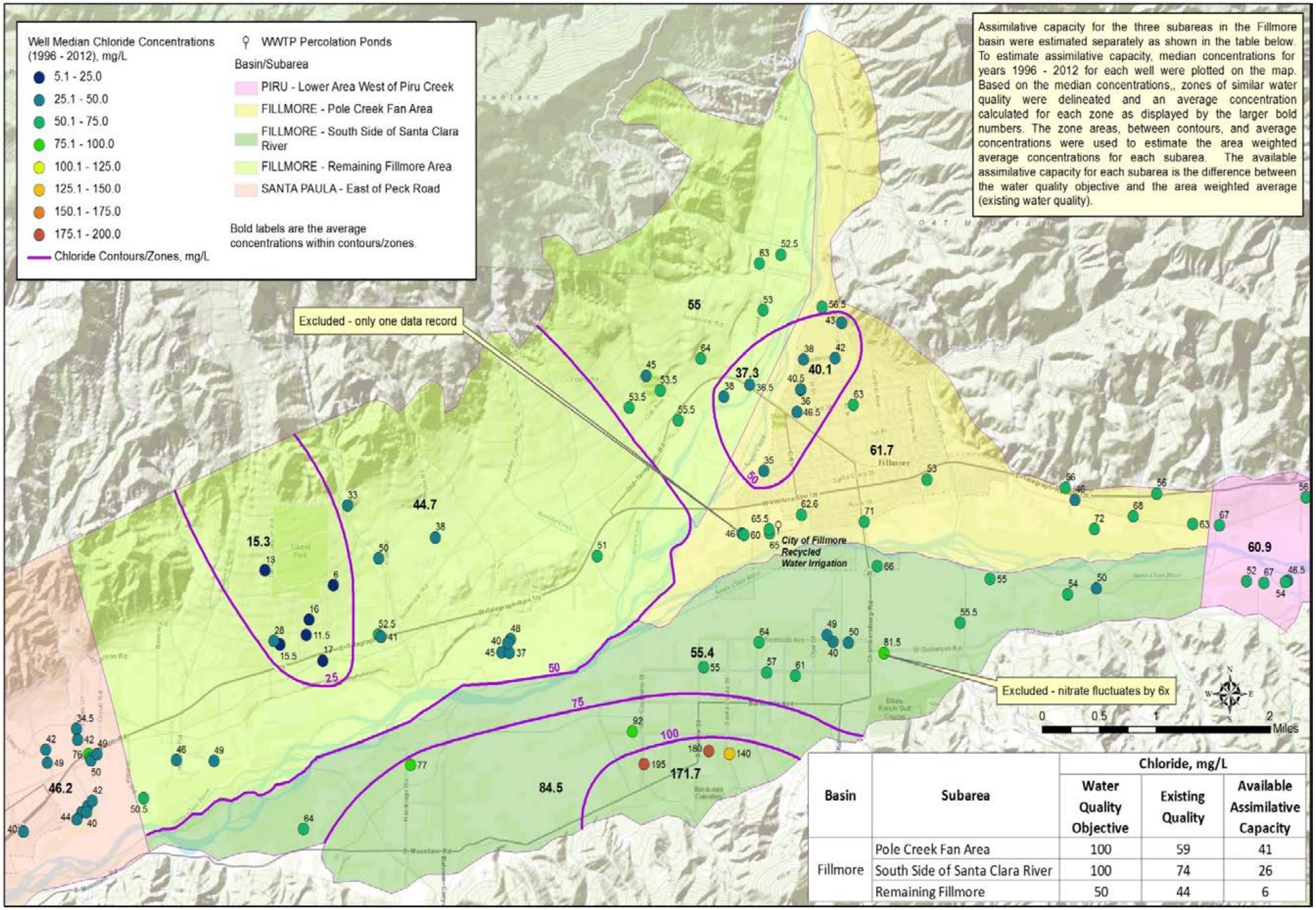
The northeastern portion of the subarea has the highest median chloride concentrations in the subarea, but does not exceed 65 mg/L (**Figure 4-12**). Tributary flow from Hopper Canyon in the western portion of the subarea dilutes chloride concentrations to approximately 15 mg/L. The majority of the subarea has an average concentration below 45 mg/L. The estimated existing groundwater quality of chloride for the Remaining Fillmore Area subarea of the Fillmore basin is 44 mg/L.

4.5.3.2 TDS Existing Water Quality

The TDS concentrations of the subarea are fairly uniform and range between 600 and 1,000 mg/L (**Figure 4-13**). From the limited data available, TDS concentrations appear to increase southwards towards the SCR. The estimated existing groundwater quality of TDS for the Remaining Fillmore Area subarea of the Fillmore basin is 846 mg/L.

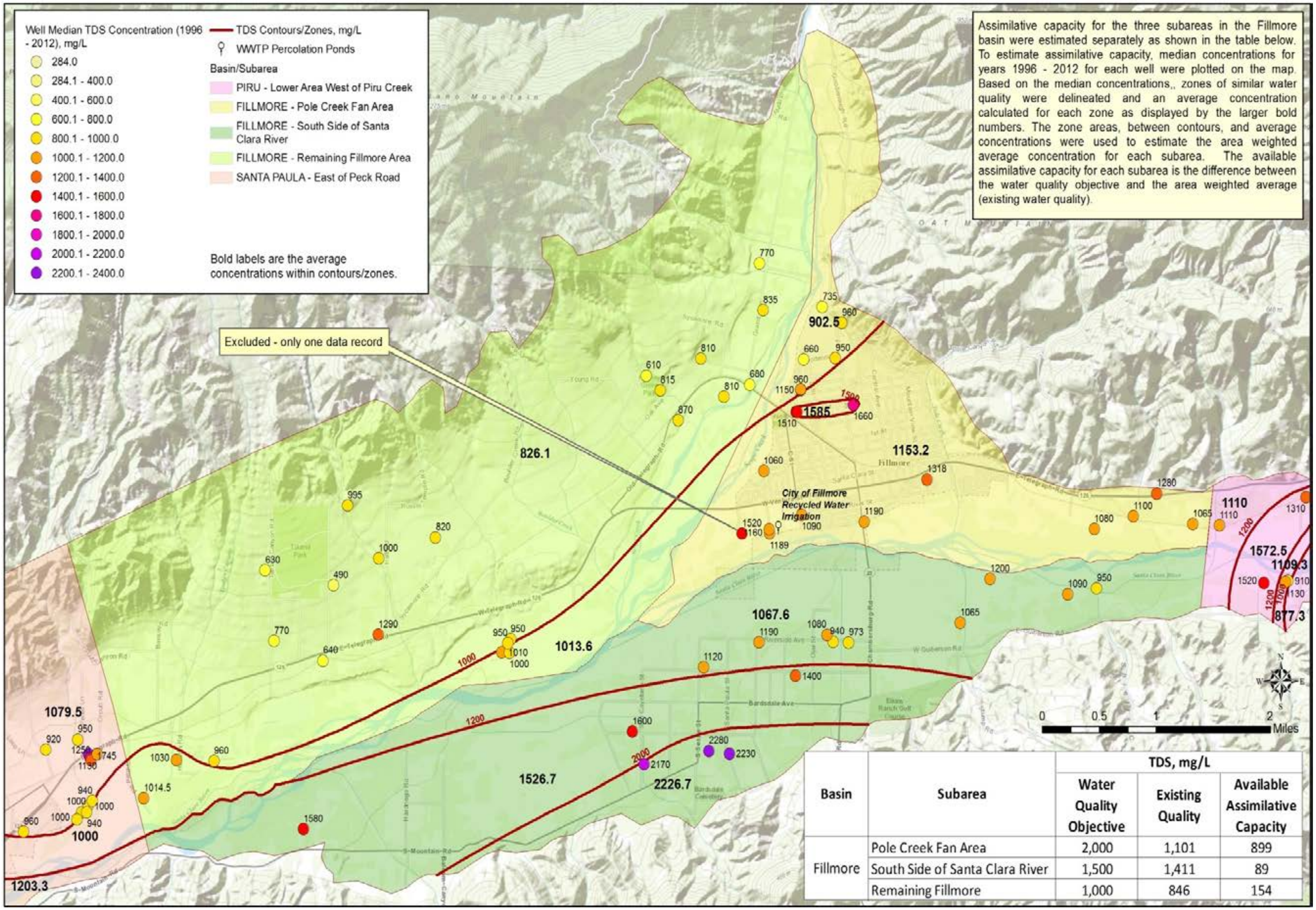
4.5.3.3 Nitrate-N Existing Water Quality

Similar to the south side of Santa Clara River subarea, the highest nitrate-N concentrations occur in the central portion of the subarea (**Figure 4-14**). From the northeast of the subarea, concentrations increase towards the center of the subarea to a maximum of 22 mg/L, and decrease towards the subarea's western boundary to just over 2 mg/L. The Fillmore WWTP percolation ponds have a diluting effect around them with the median nitrate-N concentrations at the monitoring wells not exceeding 6 mg/L. The estimated existing groundwater quality of nitrate-N for the Remaining Fillmore Area subarea of the Fillmore basin is 6.7 mg/L.



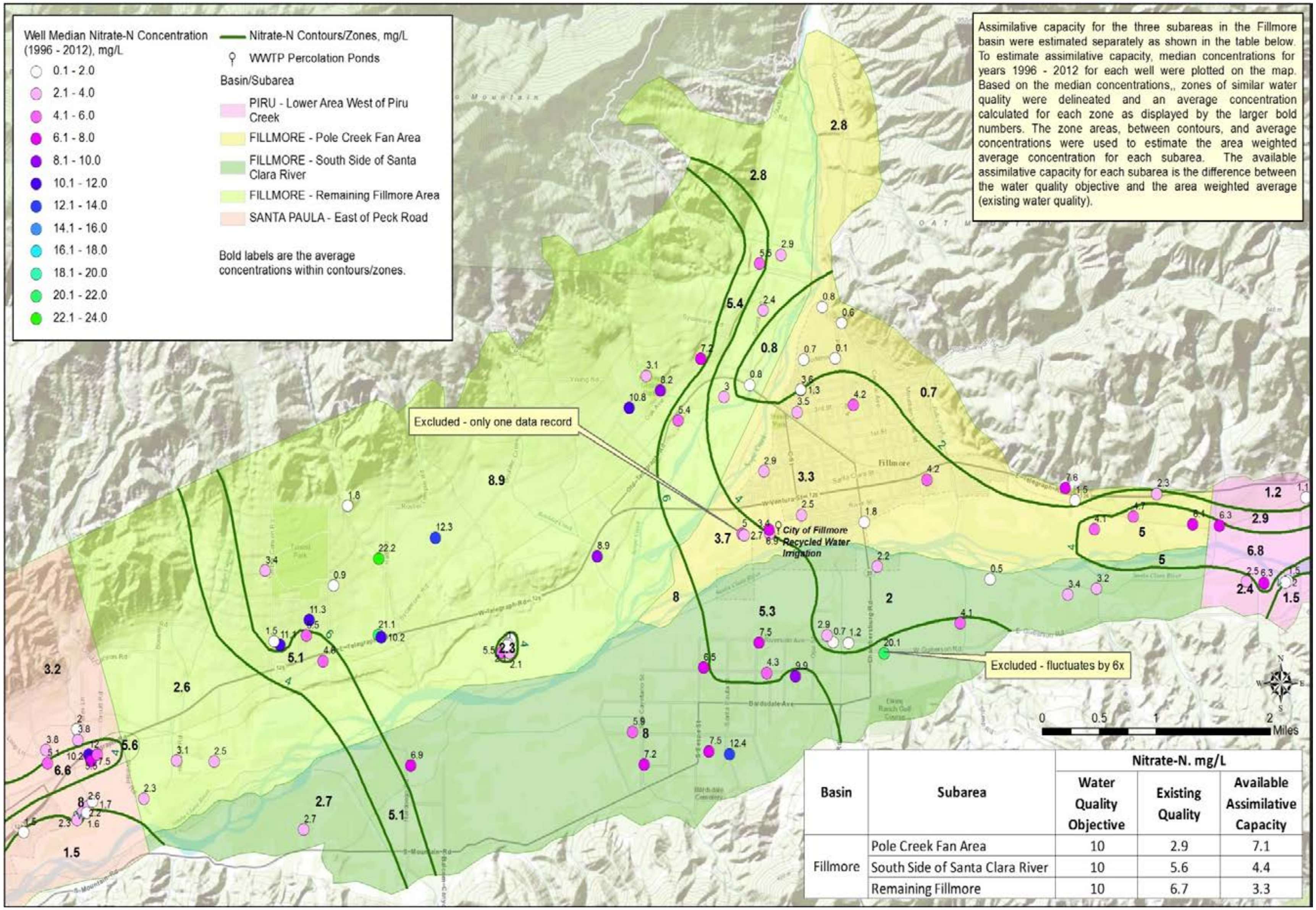
Basin	Subarea	Chloride, mg/L Water Quality Objective	Existing Quality	Available Assimilative Capacity
Fillmore	Pole Creek Fan Area	100	59	41
	South Side of Santa Clara River	100	74	26
	Remaining Fillmore	50	44	6

Figure 4-12 Chloride Existing Water Quality of Fillmore Basin



Basin	Subarea	TDS, mg/L Water Quality Objective	Existing Quality	Available Assimilative Capacity
Fillmore	Pole Creek Fan Area	2,000	1,101	899
	South Side of Santa Clara River	1,500	1,411	89
	Remaining Fillmore	1,000	846	154

Figure 4-13 TDS Existing Water Quality of Fillmore Basin



Basin	Subarea	Nitrate-N. mg/L Water Quality Objective	Existing Quality	Available Assimilative Capacity
Fillmore	Pole Creek Fan Area	10	2.9	7.1
	South Side of Santa Clara River	10	5.6	4.4
	Remaining Fillmore	10	6.7	3.3

Figure 4-14 Nitrate-N Existing Water Quality of Fillmore Basin

4.6 SANTA PAULA BASIN

The Santa Paula basin is split into two subareas: east of Peck Road and west of Peck Road. **Figure 4-15** through **Figure 4-17** show the groundwater quality for the Santa Paula basin. A table listing the existing groundwater quality of the constituents is included on each map.

4.6.1 Santa Paula Basin - East of Peck Road Subarea

4.6.1.1 Chloride Existing Water Quality

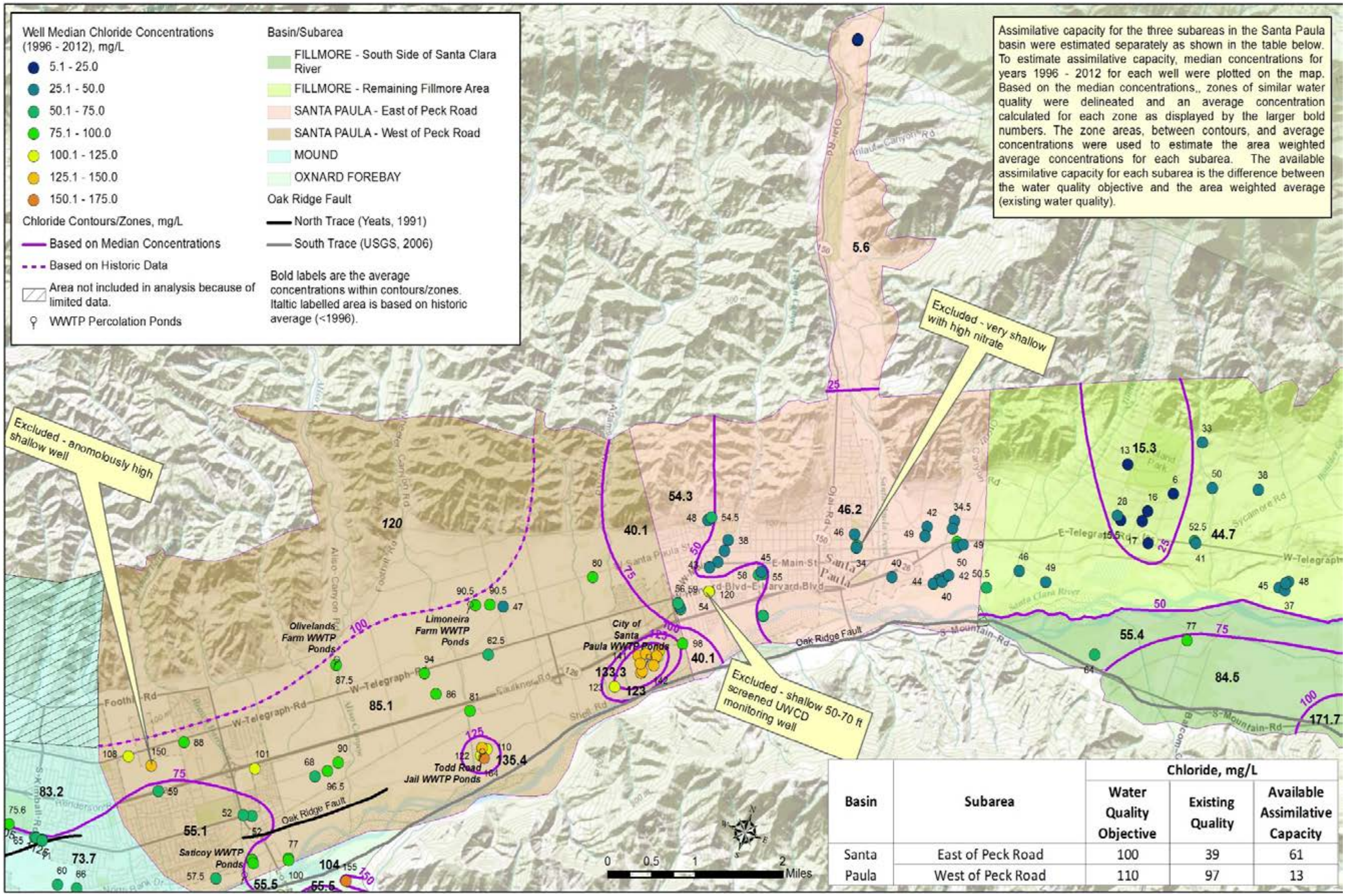
Median chloride concentrations in the majority of the subarea do not exceed 50 mg/L (**Figure 4-15)**. The western portion of the subarea marks where concentrations increase slightly across into the west of Peck Road subarea. The estimated existing groundwater quality of chloride for the east of Peck Road subarea of the Santa Paula basin is 39 mg/L.

4.6.1.2 TDS Existing Water Quality

The distribution of TDS in groundwater in the subarea does not follow the distribution of chloride as well as in other subareas. The majority of the subarea generally has TDS concentrations of approximately 1,000 mg/L (**Figure 4-16**) but an increase occurs in the lower third of the subarea where concentrations increase to approximately 1,200 mg/L at the southern subarea boundary. The estimated existing groundwater quality of TDS for the east of Peck Road subarea of the Santa Paula basin is 953 mg/L.

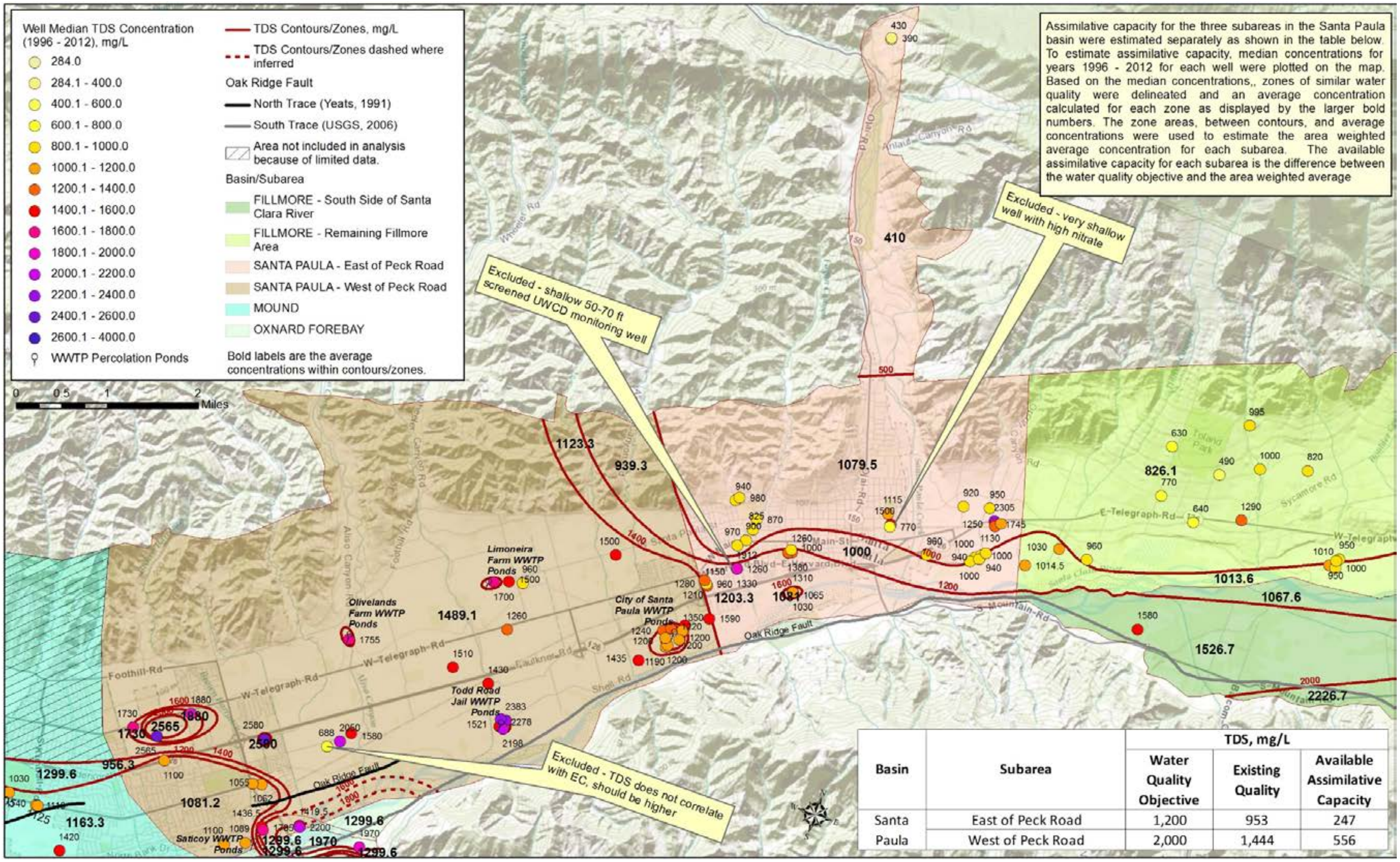
4.6.1.3 Nitrate-N Existing Water Quality

For the most part, nitrate-N concentrations throughout the subarea are less than 3 mg/L (**Figure 4-17**). The central portion of the subarea, like many other subareas, is where the highest nitrate-N concentrations occur. The average concentrations in this portion of the subarea are approximately 6 mg/L. Overall, the estimated existing groundwater quality of nitrate-N for the east of Peck Road subarea of the Santa Paula basin is 5 mg/L.



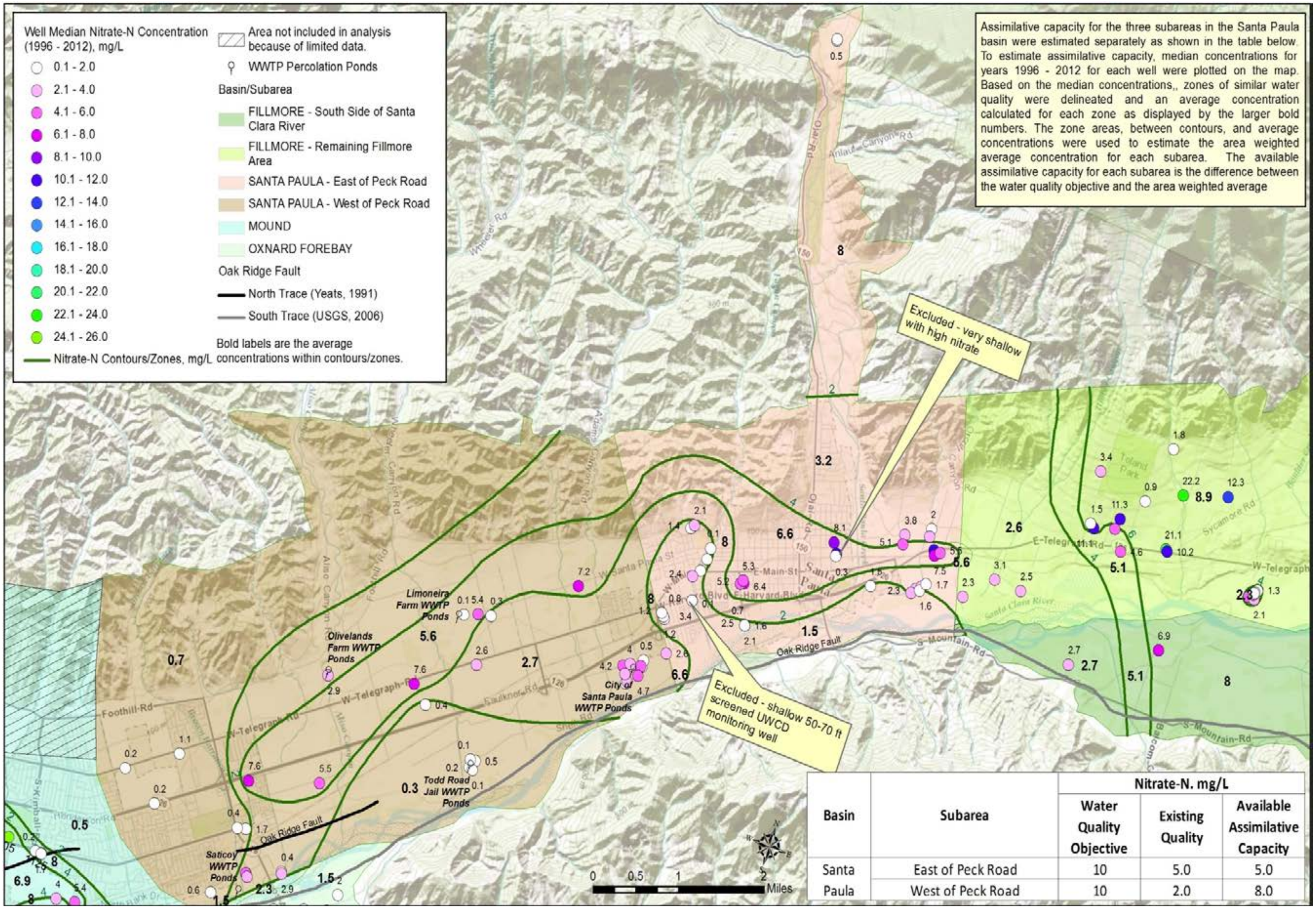
Basin	Subarea	Chloride, mg/L Water Quality Objective	Existing Quality	Available Assimilative Capacity
Santa	East of Peck Road	100	39	61
Paula	West of Peck Road	110	97	13

Figure 4-15 Chloride Existing Water Quality of Santa Paula Basin



Basin	Subarea	TDS, mg/L Water Quality Objective	Existing Quality	Available Assimilative Capacity
Santa	East of Peck Road	1,200	953	247
Paula	West of Peck Road	2,000	1,444	556

Figure 4-16 TDS Existing Water Quality of Santa Paula Basin



Basin	Subarea	Nitrate-N. mg/L Water Quality Objective	Existing Quality	Available Assimilative Capacity
Santa Paula	East of Peck Road	10	5.0	5.0
	West of Peck Road	10	2.0	8.0

Figure 4-17 Nitrate-N Existing Water Quality of Santa Paula Basin

4.6.2 Santa Paula Basin - West of Peck Road Subarea

There are no wells in the northern portion of the subarea (**Figure 4-15** through **Figure 4-17**). This is due to the naturally high mineral content of the groundwater. Farmers rely on water distributed from the eastern part of the basin. Data from 1923 through 1995 were reviewed to determine if any additional data points in this area could be used to extrapolate groundwater quality to the north. The subsections below discuss use of these historic data.

4.6.2.1 Chloride Existing Water Quality

The majority of the subarea has chloride concentrations between 50 and 100 mg/L (**Figure 4-15**). Its eastern and western margins have slightly lower concentrations. Areas of elevated chloride occur at the City of Santa Paula and Todd Road Jail WWTP percolation ponds.

Data older than 1996 showed higher historic chloride concentrations occurring in the northern portion of the subarea. A greater than 100 mg/l chloride concentration contour was added based on these data, which are regarded as reliable because the elevated chloride in this area is regarded as naturally occurring and not man-made. This contour is dashed on **Figure 4-15** because it was not derived from the 1996-2012 median dataset used for the rest of the subarea. The estimated existing groundwater quality of chloride for the west of Peck Road subarea of the Santa Paula basin is 97 mg/L.

4.6.2.2 TDS Existing Water Quality

TDS concentrations in the majority west of Peck Road subarea are relatively high averaging almost 1,500 mg/L (**Figure 4-16**). There are several localized areas of even higher concentrations that are typically associated with WWTP percolation ponds. An agricultural area, near the subarea western boundary with the Mound basin has TDS concentrations greater than 1,800 mg/L.

TDS concentrations decrease in the southwestern portion of the subarea although there is an area of elevated TDS in the northern portion of the Oxnard Forebay basin, north and west of the Saticoy recharge basins, extending across the basin boundary slightly into the west of Peck Road subarea of the Santa Paula basin. The cause of this area of elevated TDS concentrations appears to be connate water confined by the north trace of the Oak Ridge fault and beyond the influence of recharge activities by UWCD.

The data reveal that historic TDS concentration in the northern portion of the subarea generally fall within the 1,400 to 1,600 mg/L groundwater quality zone developed from 1996-2012 median data.

The estimated existing groundwater quality of TDS for the west of Peck Road subarea of the Santa Paula basin is 1,438 mg/L.

4.6.2.3 Nitrate-N Existing Water Quality

Similar to the upgradient subarea (Santa Paula basin's east of Peck Road subarea), the central portion of the west of Peck Road subarea has the highest nitrate-N concentrations in the subarea (less than 8 mg/L, see **Figure 4-17**). Concentrations decrease away from the center of the subarea.

Historic data revealed that nitrate-N concentrations in the northern portion of the subarea were less than 2 mg/L near the foothills and increased slightly towards the south and the 4 mg/L contour delineated from 1996-2012 median data. This information was used to adjust the 2 mg/L contour to be parallel to the 4 mg/L contour.

The estimated existing groundwater quality of nitrate-N for the West of Peck Road subarea of the Santa Paula basin is 2 mg/L.

4.7 OXNARD FOREBAY BASIN

The Oxnard Forebay basin does not have any subareas delineated. **Figure 4-18** through **Figure 4-20** provide maps of the groundwater quality of the basin. A table listing the existing groundwater quality of the constituents is included on each map. Water quality in the Oxnard Forebay is influenced strongly by the water quality of recharge water diverted from the SCR at the Freeman Diversion.

4.7.1 Chloride Existing Water Quality

Chloride concentrations are generally less than 60 mg/L (**Figure 4-18**). Upgradient of the UWCD's Saticoy recharge basins there is a monitoring well with a median concentration of 155 mg/L; this is the highest concentration in the basin. The cause of this elevated concentration is likely due to connate water that was trapped in the underlying sediments during deposition, which is beyond the influence of the downgradient managed aquifer recharge operations and therefore has not been diluted.

The estimated existing groundwater quality of chloride for the Oxnard Forebay basin is 57 mg/L.

4.7.2 TDS Existing Water Quality

TDS concentrations throughout the basin average approximately 1,000 mg/L, with a typical range between 800-1,200 mg/L (**Figure 4-19**). In the northern portion of the basin and across into Santa Paula basin's subarea west of Peck Road, an area of high TDS concentrations of up to 2,200 mg/L occurs west of the Saticoy recharge basins. Because this area is upgradient and cross-gradient of the recharge basins, the connate water thought to be responsible for the high concentrations has not been flushed by the cleaner recharge water.

Figure 4-19 summarizes several wells in the Oxnard Forebay that have decreasing TDS concentrations. These decreases are due to the managed aquifer recharge of SCR water diverted at the Freeman diversion by UWCD. There was only one well with an increasing trend in the basin which was located cross-gradient and southeast of the Saticoy recharge basins.

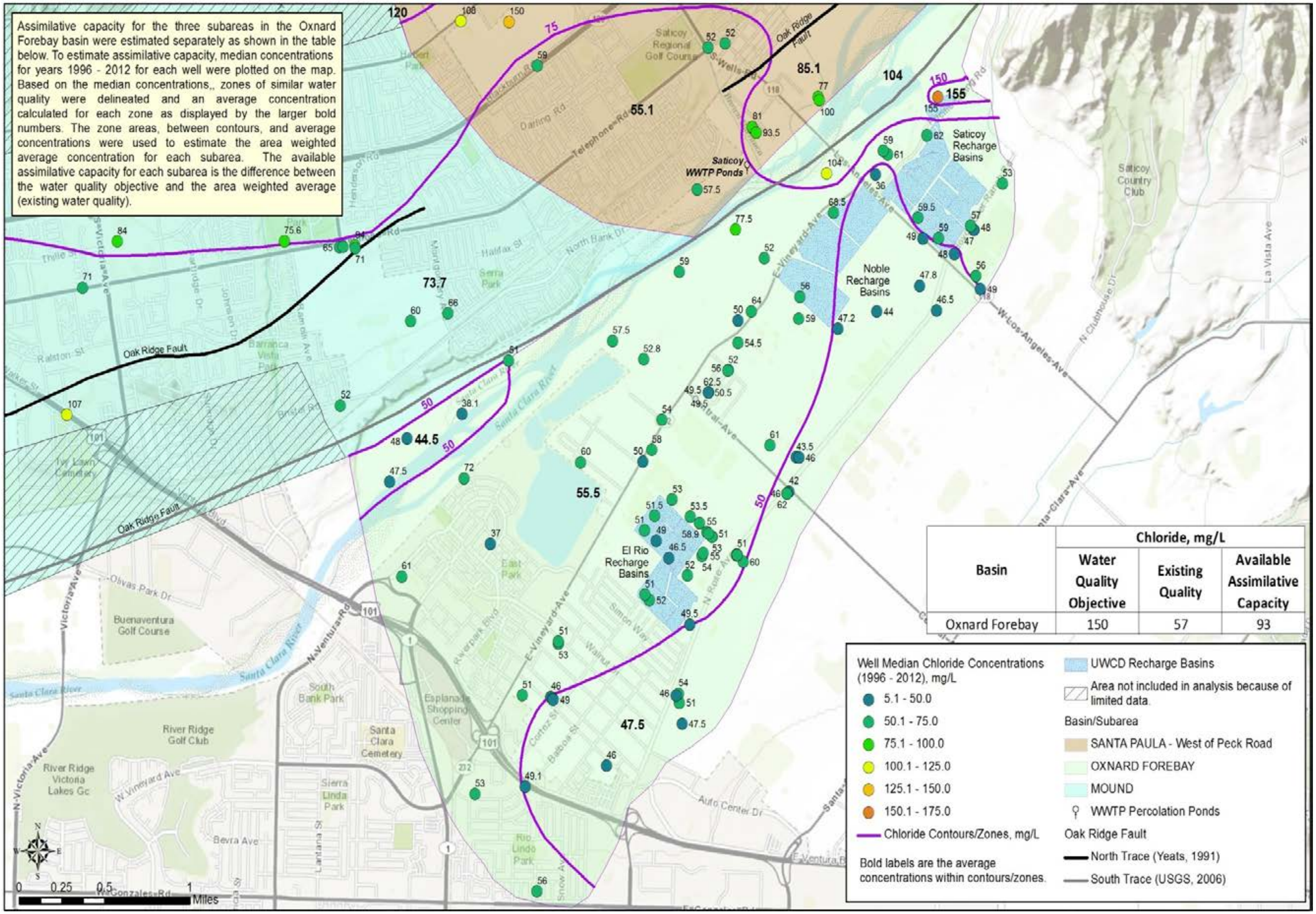
The estimated existing groundwater quality of TDS for the Oxnard Forebay basin is 1,059 mg/L.

4.7.3 Nitrate-N Existing Water Quality

Nitrate-N concentrations are lower (<2 mg/L) in the upgradient portion of the basin in areas influenced by natural recharge from the SCR and Saticoy and Noble recharge basins (**Figure 4-20**). Concentrations increase very slightly towards the south but generally do not exceed 4 mg/L. One area of elevated concentrations (average of 8 mg/L) occurs around the southern mining pits (**Figure 4-20**).

In 2008, UWCD published a report on nitrate observations from 1995-2006 in the Oxnard Forebay and vicinity. This report noted that there were some locations where increasing trends were observed in shallow wells (e.g., well 02N22W13N07S). Nitrate in groundwater is commonly highest when groundwater levels are low and there is less recharge to dilute nutrients in the basin (UWCD, 2008). **Figure 4-21** provides an example of this behavior. The UWCD report noted that nitrate concentrations in deeper wells are consistently low. **Figure 4-20** represents a combination of shallow and deep wells.

The estimated existing groundwater quality of nitrate-N for the Oxnard Forebay basin is 4.5 mg/L.



Basin	Chloride, mg/L		
	Water Quality Objective	Existing Quality	Available Assimilative Capacity
Oxnard Forebay	150	57	93

Figure 4-18 Chloride Existing Water Quality of Oxnard Forebay Basin

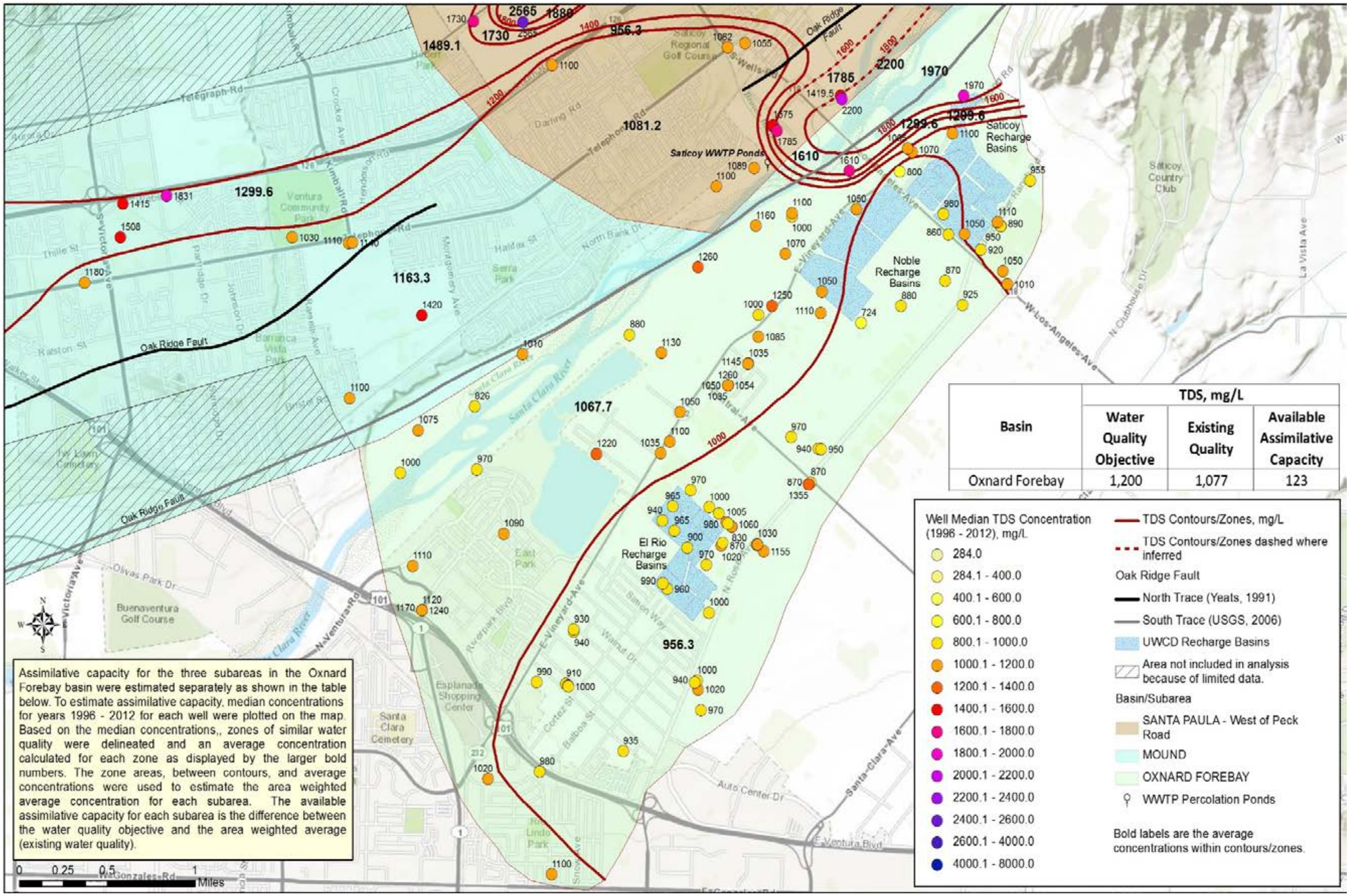


Figure 4-19 TDS Existing Water Quality of Oxnard Forebay Basin

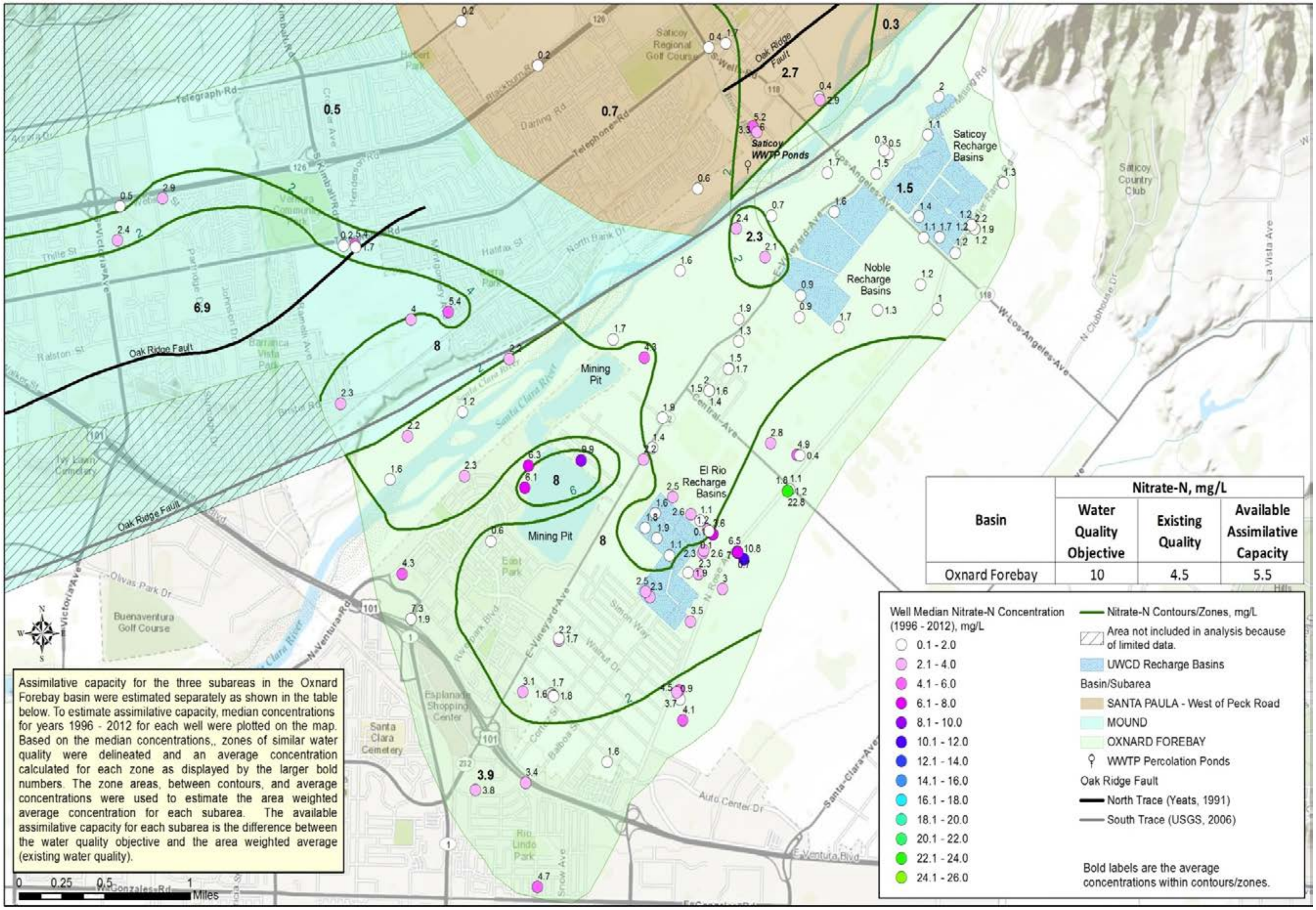


Figure 4-20 Nitrate-N Existing Water Quality of Oxnard Forebay Basin

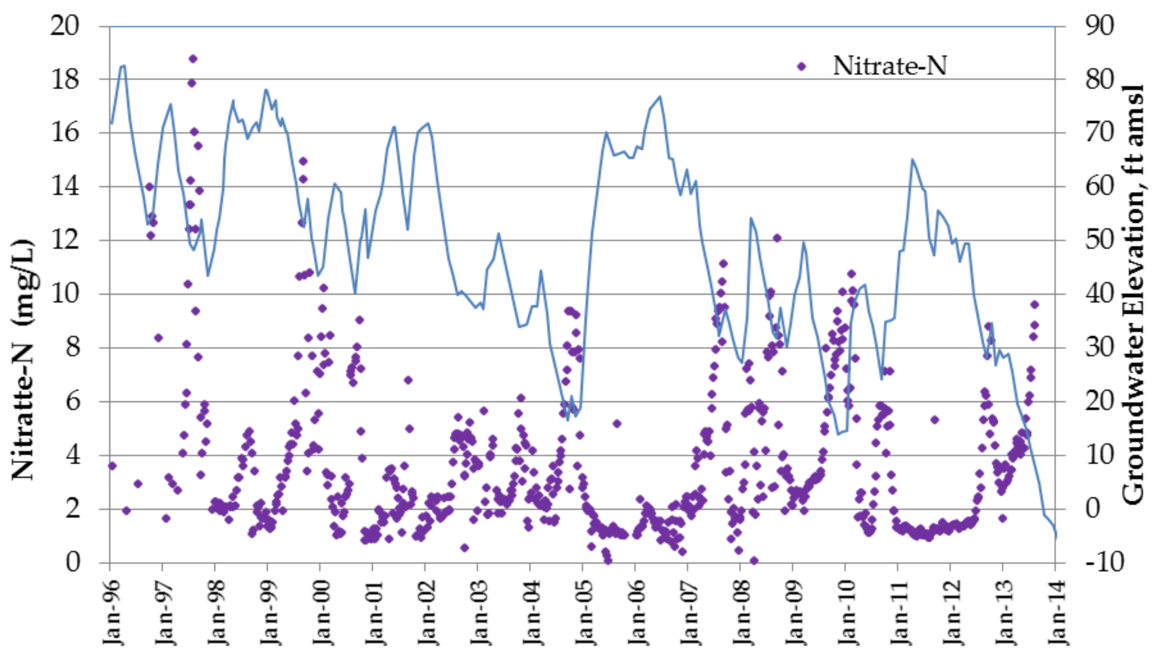


Figure 4-21 Example of Oxnard Forebay Nitrate-N Concentrations Relationship with Groundwater Elevations (02N22W23B02S)

4.8 MOUND BASIN

The Mound basin does not have any subareas. **Figure 4-22** through **Figure 4-24** provide maps of the groundwater quality of the Mound basin. A table listing the existing groundwater quality of the constituents is included on each map.

The dataset available for determining existing groundwater quality in the Mound basin is very limited. **Figure 4-22** through **Figure 4-24** show that there is well control in less than half of the basin. The scarcity of data is described in UWCD's hydrogeologic assessment of the Mound basin (UWCD, 2012). Areas where no well data exist are hatched in the water quality maps.

4.8.1 Chloride Existing Water Quality

Connate water trapped in marine sediments has been suggested as the source of higher chloride concentrations found in the Mound basin (Geotechnical Consultants, 1972). Complex structural deformation and the lenticular nature of the sediments limit the amount of flushing of these poorer quality waters compared to the other basins (UWCD, 2012). This hypothesis is supported by the fact that long-term well records show stable water quality, and that high variability between well locations is common (UWCD, 2012). Available well data do not indicate seawater intrusion (UWCD, 2012).

Chloride concentrations in the basin, except in the perched aquifer, range between 50 and 100 mg/L (**Figure 4-22**). The estimated existing groundwater quality of chloride for the Mound basin is 76 mg/L. One agricultural well in the south of the basin was excluded from the analysis because, although well completion data were not available, the high chloride concentration suggests this well is completed in the perched aquifer.

There are only three known monitoring wells that monitor the perched aquifer above the main water supply aquifers in the Mound basin (**Figure 4-25**). These wells were not included in the analysis of existing groundwater quality of chloride, TDS, or nitrate-N. The perched shallow aquifer is not used for groundwater production because its quality exceeds drinking water standards and many crop irrigation standards. These monitoring wells provide the only data on this perched zone as there are no production wells completed in this zone. The lateral extent of the perched zone has not been mapped because there are too few data points. The three wells on **Figure 4-25** do show however, that the perched zone may extend at least four miles across the basin, but it is unknown whether it is laterally continuous, like the perched zone in the Oxnard Plain basin. Chloride concentrations in the perched aquifer range from 100 to 480 mg/L.

4.8.2 TDS Existing Water Quality

TDS concentrations in the Mound basin range between 910 and 1,830 mg/L (**Figure 4-23**). As described for chloride, connate water is thought to be the reason behind the higher TDS concentrations in the Mound basin. The estimated existing groundwater quality of TDS for the Mound basin is 1,230 mg/L.

4.8.3 Nitrate-N Existing Water Quality

For the areas where data are available in the Mound basin and excluding the perched aquifer wells, nitrate-N does not exceed 10 mg/L (**Figure 4-24**). Concentrations increase from north to south. The area south of Telegraph Road generally has the basin’s highest average concentration of approximately 7 mg/L. The estimated existing groundwater quality of nitrate-N for the Mound basin is 4 mg/L.

4.9 METHOD LIMITATIONS

The method used in this report to estimate existing groundwater quality relies heavily on the spatial distribution of wells with groundwater quality data. As has been seen in the description of groundwater quality for individual subareas and basins, some areas have limited data. When more spatial locations with water quality data are added to the dataset in the future, maps of existing groundwater quality can be enhanced.

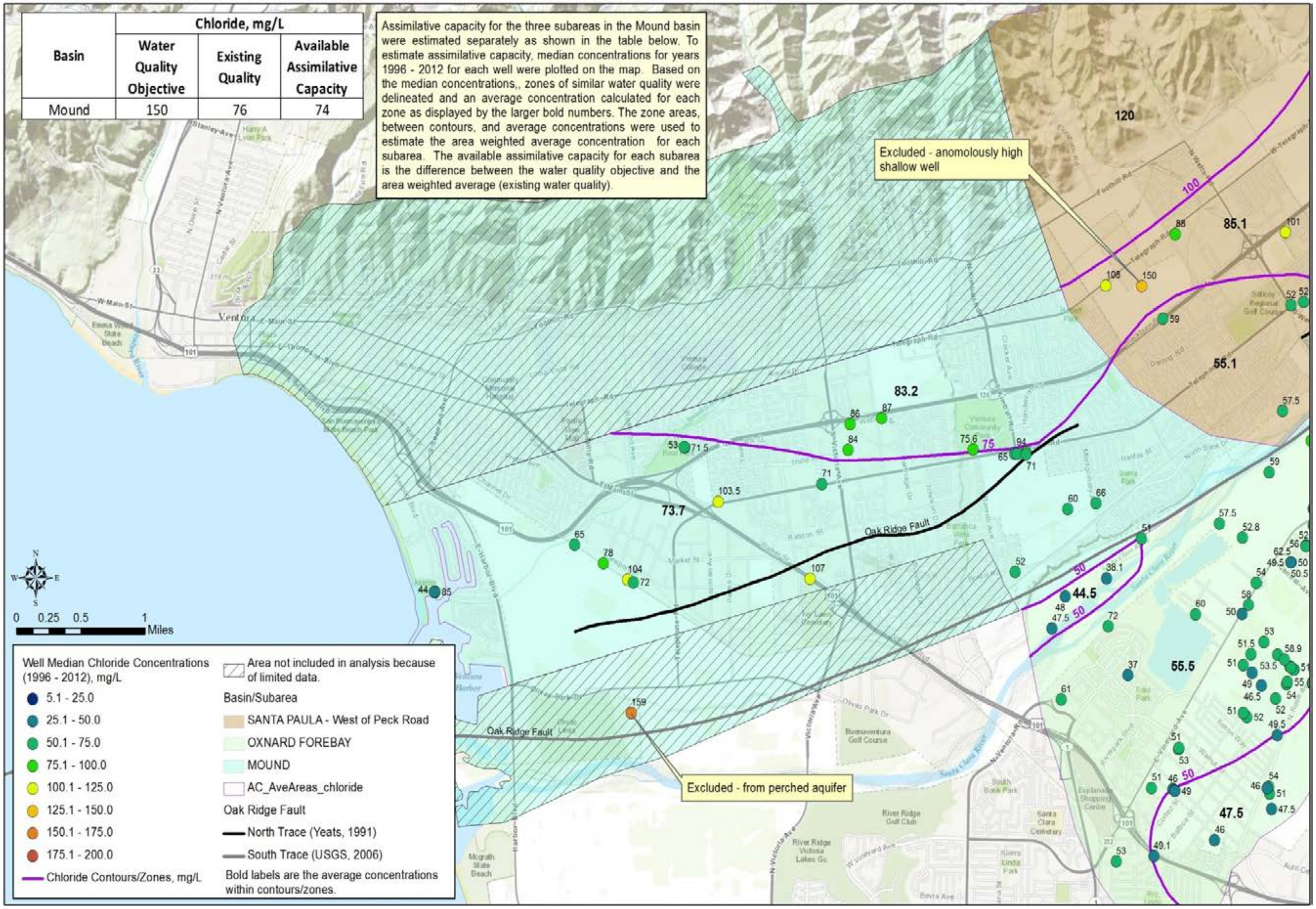
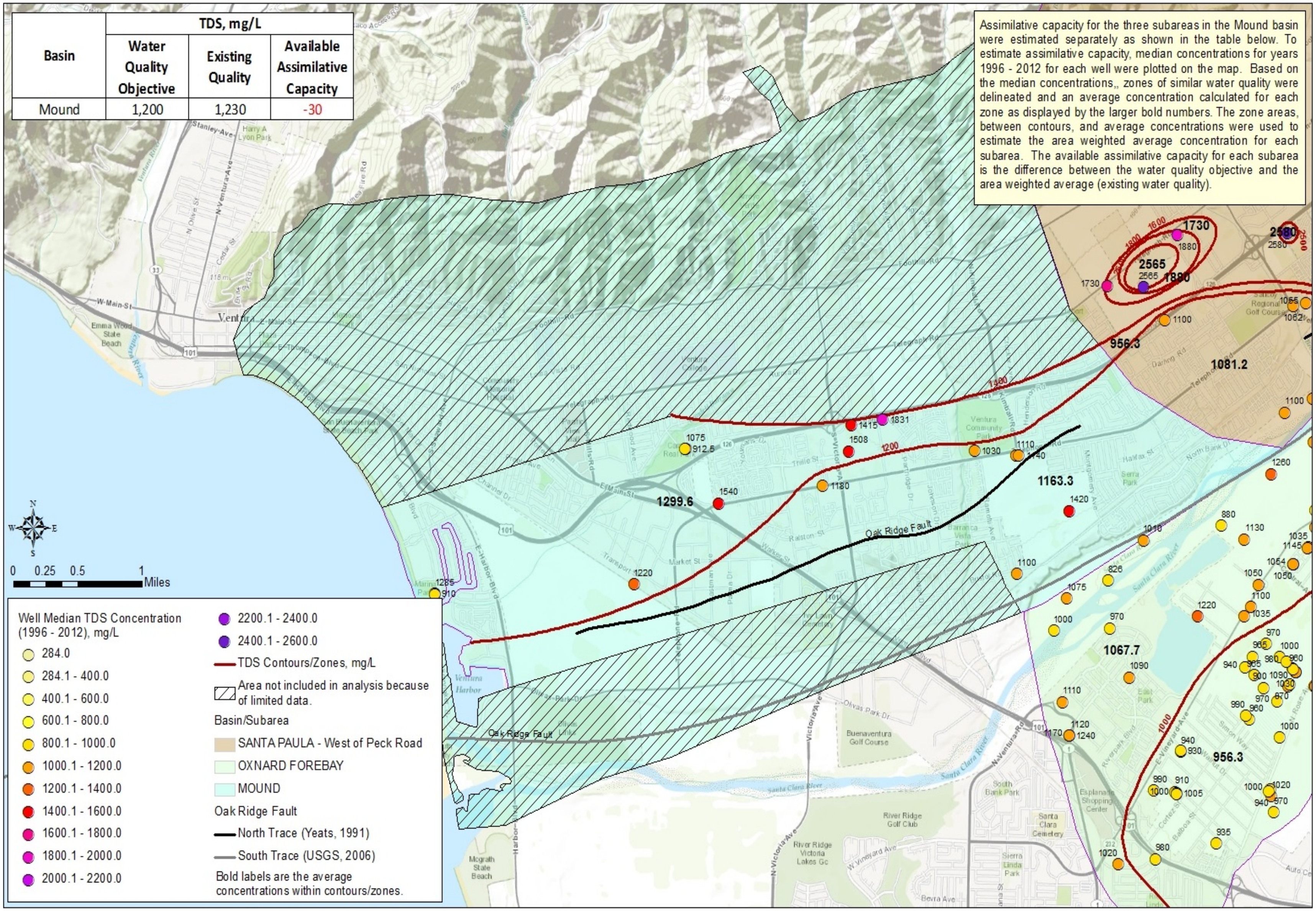


Figure 4-22 Chloride Existing Water Quality of Mound Basin



Basin	TDS, mg/L		
	Water Quality Objective	Existing Quality	Available Assimilative Capacity
Mound	1,200	1,230	-30

Figure 4-23: TDS Existing Water Quality of Mound Basin

Basin	Nitrate-N, mg/L		
	Water Quality Objective	Existing Quality	Available Assimilative Capacity
Mound	10	4.0	6.0

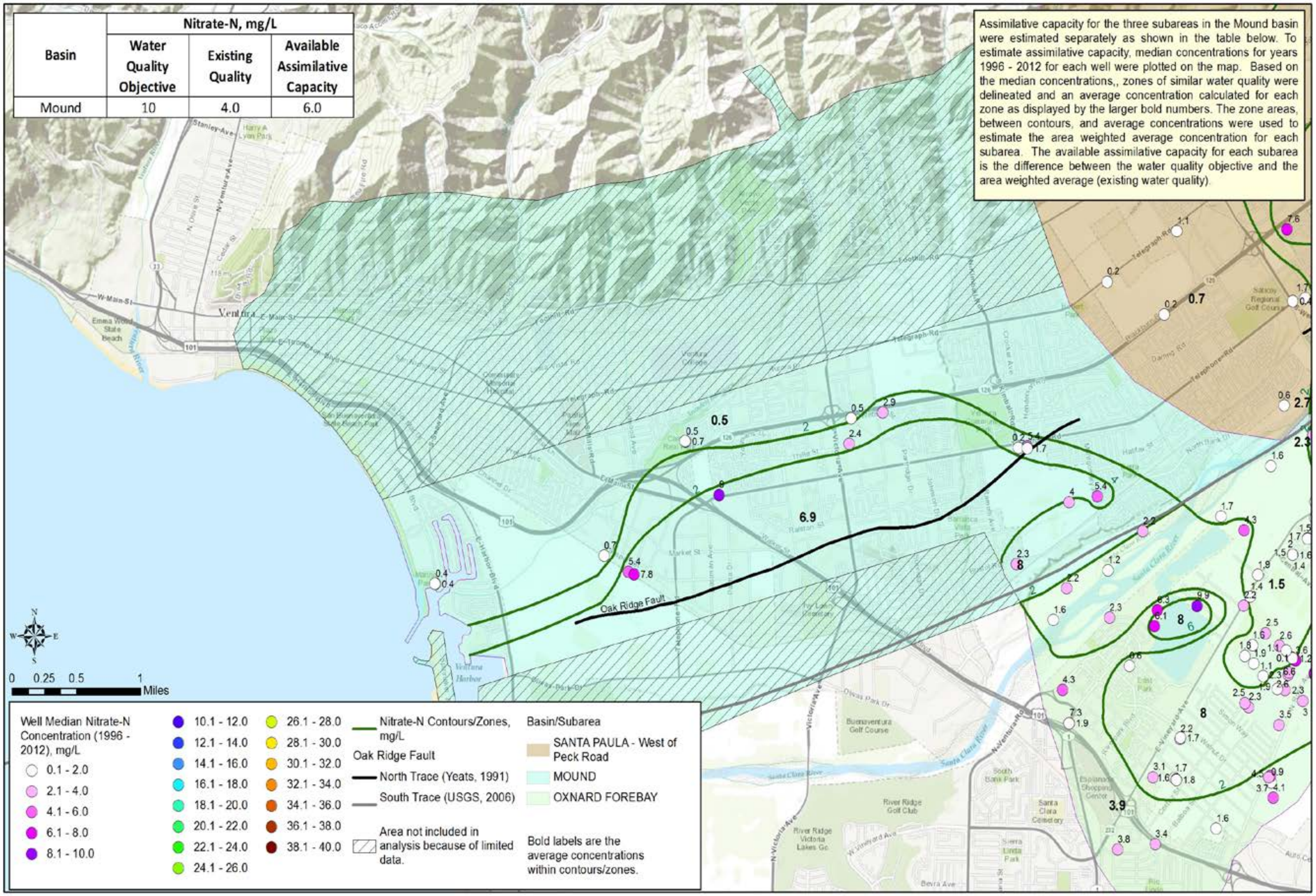


Figure 4-24: Nitrate-N Existing Water Quality of Mound Basin

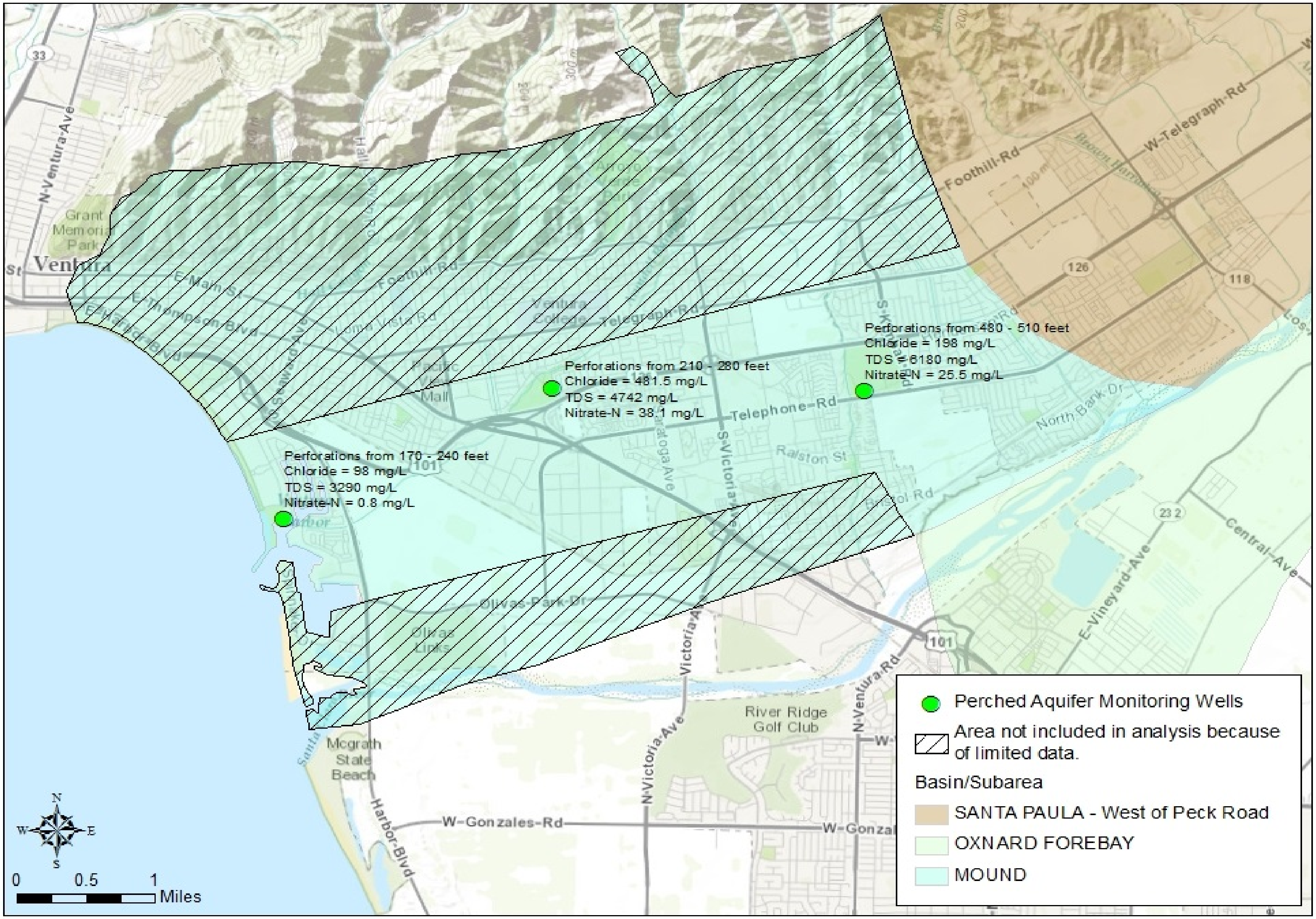


Figure 4-25: Perched Aquifer Wells and Groundwater Quality

5 Assimilative Capacity Analysis

As described in **Section 4**, the data period used for the assimilative capacity analysis is from 1996 through 2012, which captures both wet and dry hydrologic conditions. The longer data period was selected to ensure sufficient data were available for analysis and adequate spatial coverage was obtained for the analysis. The surface water and groundwater databases compiled for the study include the primary constituents identified for this study, TDS, chloride, and nitrate as N. The database includes other parameters, including sulfate, boron, and other nitrogen species. While available data for these constituents have been compiled in the databases and are available for use if needed, this analysis focuses on TDS, chloride and nitrate-N.

Assimilative capacity is estimated as the difference between the water quality objectives and the existing groundwater quality for each basin/subarea as described in **Section 4**. A summary of all assimilative capacity estimates is provided in **Table 5-1**. Summary statistics for the well medians used to calculate the existing water quality (area weighted averages of the well medians) are shown in **Table 5-2** through **Table 5-4**.

The only area with no assimilative capacity is the Mound basin where the existing TDS groundwater quality exceeds the water quality objectives. As discussed in previous sections, the lack of assimilative capacity is most likely due to natural causes, such as connate water, and the objectives for the Mound basin may not have based on information that accurately reflected these natural conditions. However, chloride and nitrate-N do have assimilative capacity in the Mound basin. All the other basins and subareas have available assimilative capacity for chloride, TDS, and nitrate-N.

Table 5-1 Available Assimilative Capacity for Lower Santa Clara River Groundwater Basins

Basin	Subarea	TDS, mg/L			Chloride, mg/L			Nitrate-N, mg/L		
		Water Quality Objective	Current Quality	Available Assimilative Capacity	Water Quality Objective	Current Quality	Available Assimilative Capacity	Water Quality Objective	Current Quality	Available Assimilative Capacity
Piru	Upper Area below Lake Piru	1,100	No data	NA	200	No data	NA	10	No data	NA
	Lower Area East of Piru Creek	2,500	1,000	1,500	200	118	82	10	2.6	7.4
	Lower Area West of Piru Creek	1,200	992	208	100	69	31	10	3.6	6.4
Fillmore	Pole Creek Fan Area	2,000	1,101	899	100	59	41	10	2.9	7.1
	South Side of Santa Clara River	1,500	1,411	89	100	74	26	10	5.6	4.4
	Remaining Fillmore	1,000	846	154	50	44	6	10	6.7	3.3
Santa Paula	East of Peck Road	1,200	953	247	100	39	61	10	5.0	5.0
	West of Peck Road	2,000	1,444	556	110	97	13	10	2.0	8.0
Oxnard Forebay		1,200	1,077	123	150	57	93	10	4.5	5.5
Mound		1,200	1,230	-30	150	76	74	10	4.0	6.0

Table 5-2 Assimilative Capacity Summary Statistics for TDS in Lower Santa Clara River Groundwater Basins

Basin	Subarea	TDS, mg/L					
		25th Percentile	50th Percentile	75th Percentile	Interquartile Range[1]	Existing Water Quality (Area Weighted Average)	Average Absolute Deviation[2]
Piru	East of Piru Creek	987	1,060	1,130	144	1,000	98
	West of Piru Creek	885	1,010	1,240	355	992	289
Fillmore	South Fillmore	1,073	1,190	1,590	518	1,411	394
	Remaining Fillmore	770	835	998	228	846	141
	Pole Creek Fan	993	1,090	1,190	197	1,101	162
Santa Paula	East of Peck Rd	940	1,000	1,200	260	953	206
	West of Peck Rd	1,210	1,500	1,785	575	1,444	350
Mound	Mound	971	1,075	1,350	379	1,230	262
Forebay	Forebay	950	1,005	1,090	140	1,077	117

[1]Interquartile range calculated based on well medians in subarea with no areal weighting
[2]Average absolute deviation calculated based on deviation of well medians in subarea from area-weighted existing water quality for subarea.

Table 5-3 Assimilative Capacity Summary Statistics for Chloride in Lower Santa Clara River Groundwater Basins

Basin	Subarea	Chloride, mg/L					
		25th Percentile	50th Percentile	75th Percentile	Interquartile Range[1]	Existing Water Quality (Area Weighted Average)	Average Absolute Deviation[2]
Piru	East of Piru Creek	116	127	133	17	118	13
	West of Piru Creek	56	67	92	36	69	19
Fillmore	South Fillmore	54	59	74	20	74	31
	Remaining Fillmore	34	45	52	18	44	12
	Pole Creek Fan	44	56	63	19	59	10
Santa Paula	East of Peck Rd	42	45	55	13	39	11
	West of Peck Rd	81	99	134	53	97	27
Mound	Mound	62	76	86	23	76	13
Forebay	Forebay	49.0	52.0	57.8	8.8	56.9	8.2

[1]Interquartile range calculated based on well medians in subarea with no areal weighting
[2]Average absolute deviation calculated based on deviation of well medians in subarea from area-weighted existing water quality for subarea.

Table 5-4 Assimilative Capacity Summary Statistics for Nitrate-N in Lower Santa Clara River Groundwater Basins

Basin	Subarea	Nitrate-N, mg/L					
		25th Percentile	50th Percentile	75th Percentile	Interquartile Range[1]	Existing Water Quality (Area Weighted Average)	Average Absolute Deviation[2]
Piru	East of Piru Creek	2.4	3.1	3.7	1.3	2.6	0.9
	West of Piru Creek	2.2	4.3	5.7	3.6	3.6	2.6
Fillmore	South Fillmore	2.8	4.2	7.1	4.4	5.6	2.8
	Remaining Fillmore	2.1	3.3	8.4	6.3	6.7	4.4
	Pole Creek Fan	1.7	2.7	4.1	2.5	2.9	1.5
Santa Paula	East of Peck Rd	1.1	2.1	3.8	2.7	5.0	3.1
	West of Peck Rd	0.3	1.1	4.0	3.7	2.0	2.0
Mound	Mound	0.5	2.2	5.0	4.5	4.0	2.6
Forebay	Forebay	1.2	1.7	2.5	1.3	4.5	2.8

[1]Interquartile range calculated based on well medians in subarea with no areal weighting
[2]Average absolute deviation calculated based on deviation of well medians in subarea from area-weighted existing water quality for subarea.

6 Salts and Nutrient Source Identification and Loading Estimates

6.1 CONCEPTUAL MODEL

Various sources contribute salts and nutrients to the basin. Sources include non-land use based flows (such as stream percolation, managed aquifer recharge) and land use based flows (such as agriculture, wastewater percolation). **Figure 6-1** provides a conceptual model of the salt and nutrient contributions to the LSCR basin. These concepts will be detailed in this section.

6.2 SUMMARY OF SALT AND NUTRIENT SOURCES

Table 6-1 summarizes the land use and non-land use sources evaluated in the development of the LSCR SNMP. Loading for the sources were derived from existing information and is described in this section. This loading information and assumptions were built into the fate and transport analysis described in **Section 7**.

Table 6-1 Summary of Salt and Nutrient Sources

Non-Land Use Based Inflows	Land Use Based Inflows
Percolation of stream flows	Irrigation
Managed aquifer recharge	Agricultural irrigation with surface water
Recharge of precipitation	Agricultural irrigation with groundwater
Mountain front recharge	Urban irrigation with municipal supply
Groundwater underflow from outside the LSCR basin	Urban irrigation with recycled water
Groundwater flow between subareas, with net flow from east to west	Septic systems
Groundwater flow between Upper Aquifer System and Lower Aquifer System	Wastewater treatment percolation ponds
Naturally occurring salts	

6.2.1 Non-Land Use Based Sources and Loadings

6.2.1.1 Percolation of Stream Flows

Percolation of stream flows are based on UWCD's Lower Santa Clara River Routing and Percolation model (McEachron, 2005). UWCD provided updated results for water years 1996-2012. The model results include estimates of percolation for the following stream reaches (**Figure 6-2**):

- SCR from Newhall to Torrey Road
- Piru Creek
- SCR from Torrey Road to Cavin Road
- Hopper Creek
- SCR from Cavin Road to Sespe Creek
- Sespe Creek
- Santa Paula Creek

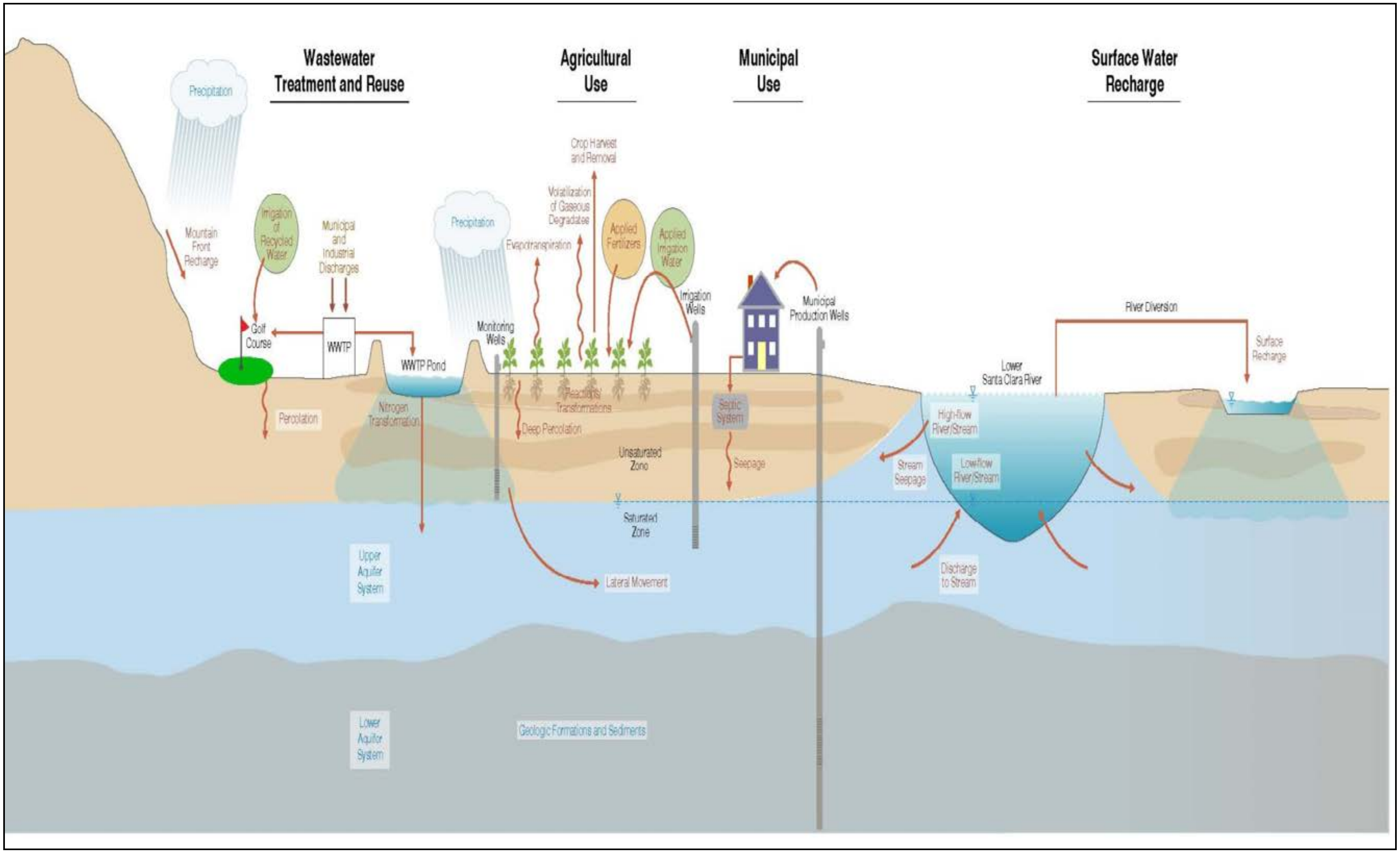


Figure 6-1 Conceptual Model of Salt and Nutrient Contributions

The Routing and Percolation model does not provide results for percolation in Pole Creek so percolation was estimated based on Hopper Creek and the ratio of the watershed areas. The Pole Creek watershed area is approximately 39% of the Hopper Creek watershed area (VCWPD, 2006). The Routing and Percolation model also provides an estimate for discharge of rising groundwater to the SCR when it occurs between Torrey Road and Cavin Road. The discharge of rising groundwater to the SCR between Sespe Creek and Willard Road can be calculated from Sespe Creek flow data and Routing and Percolation model results for Sespe Creek percolation and flow in the SCR above Sespe Creek and at Willard Road. The discharge flows to the SCR are used as part of the water balance to calculate groundwater flows between subareas (**Subsection 6.2.1.7**) and between the UAS and LAS (**Subsection 6.2.1.8**).

There are significant losses in SCR flow between Willard Road and the Freeman Diversion. It is likely that some percolation occurs in the Santa Paula basin upstream of the Freeman Diversion, but it is difficult to estimate because of the diversions along this reach (McEachron, 2014). Therefore, no percolation in this reach is included as input. The Routing and Percolation model does not estimate percolation downstream of the Freeman Diversion in the Oxnard Forebay, but UWCD has provided estimates for this percolation for Water Years 1996-2012 (McEachron, 2014b).

Percolation from the stream reaches need to be distributed as inflows to subareas for inclusion in the mass balance model. In order to distribute these flows, reaches are divided into subareas based on reach length. Also, in cases where the reach defines the boundary between upgradient and downgradient subareas, flow from the reaches are distributed to the downgradient subarea. The proportional distribution of percolation from stream reaches to subareas is shown in **Table 6-2**.

Table 6-2 Proportional Distribution of Percolation from Reaches to Subareas

Percolation Reach	Lower Piru		Fillmore			Santa Paula
	East of Piru Creek	West of Piru Creek	Pole Creek Fan	South of SCR	Remaining	East of Peck Road
SCR Newhall to Torrey	89%	11%	0%	0%	0%	0%
Piru Creek	0%	100%	0%	0%	0%	0%
SCR Torrey to Cavin	0%	100%	0%	0%	0%	0%
Hopper Creek	0%	100%	0%	0%	0%	0%
SCR Cavin to Sespe	0%	14%	43%	43%	0%	0%
Sespe Creek	0%	0%	0%	0%	100%	0%
Santa Paula Creek	0%	0%	0%	0%	0%	100%
Pole Creek	0%	0%	100%	0%	0%	0%

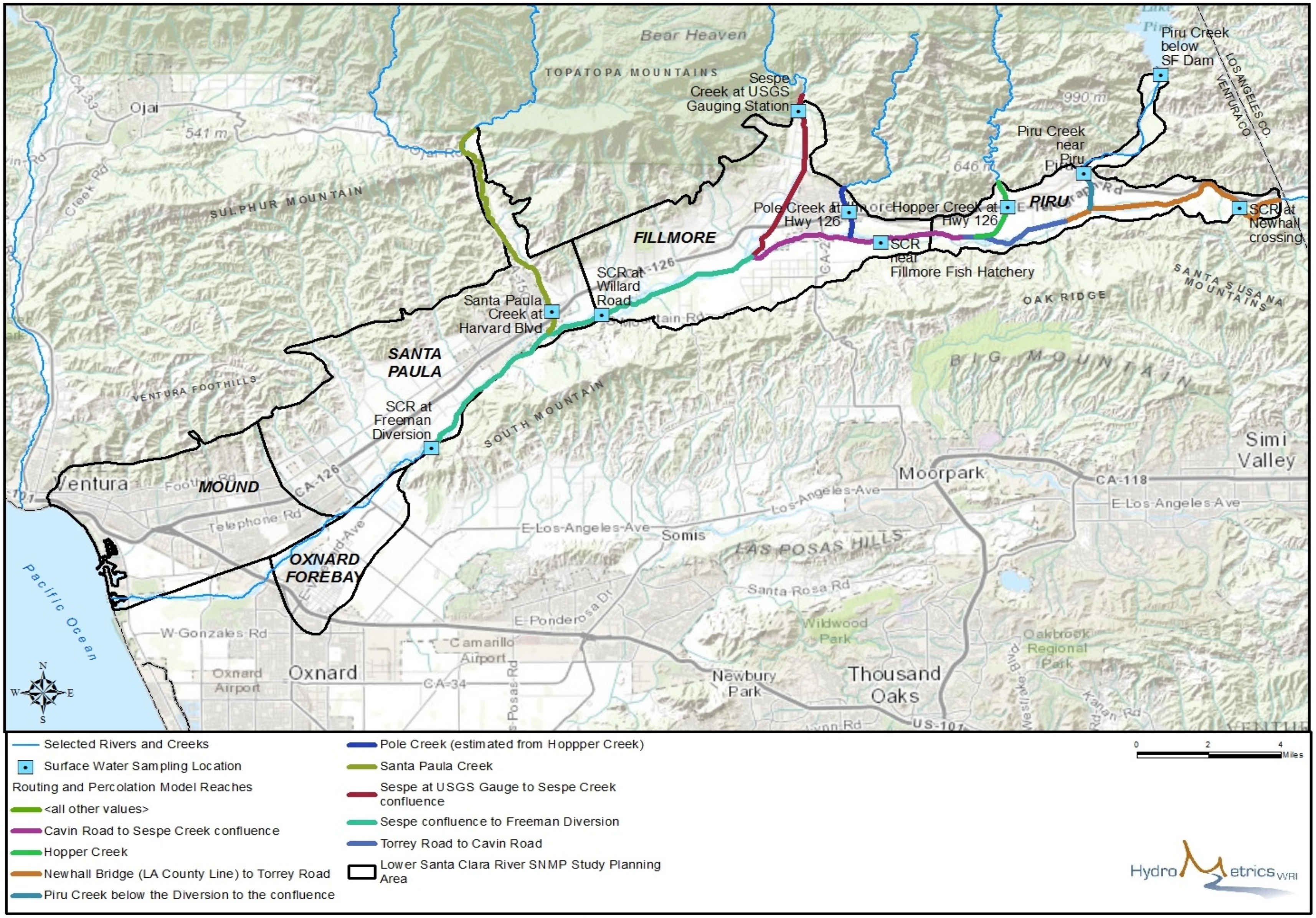


Figure 6-2 Lower Santa Clara River Routing and Percolation Model Reaches and Surface Water Quality Sampling

Concentrations for the percolation inflows are based on available surface water quality data from 1996-2012. Median concentrations for each water year are used. For years without sampling results, concentrations are based on whether the water year was classified as wet, dry, or average. The average concentrations for years with the same classification were used in years without sampling results. The assignment of water years (1996-2012) as wet, dry, and average was based on precipitation at the Fillmore Fish Hatchery (**Figure 6-3**).

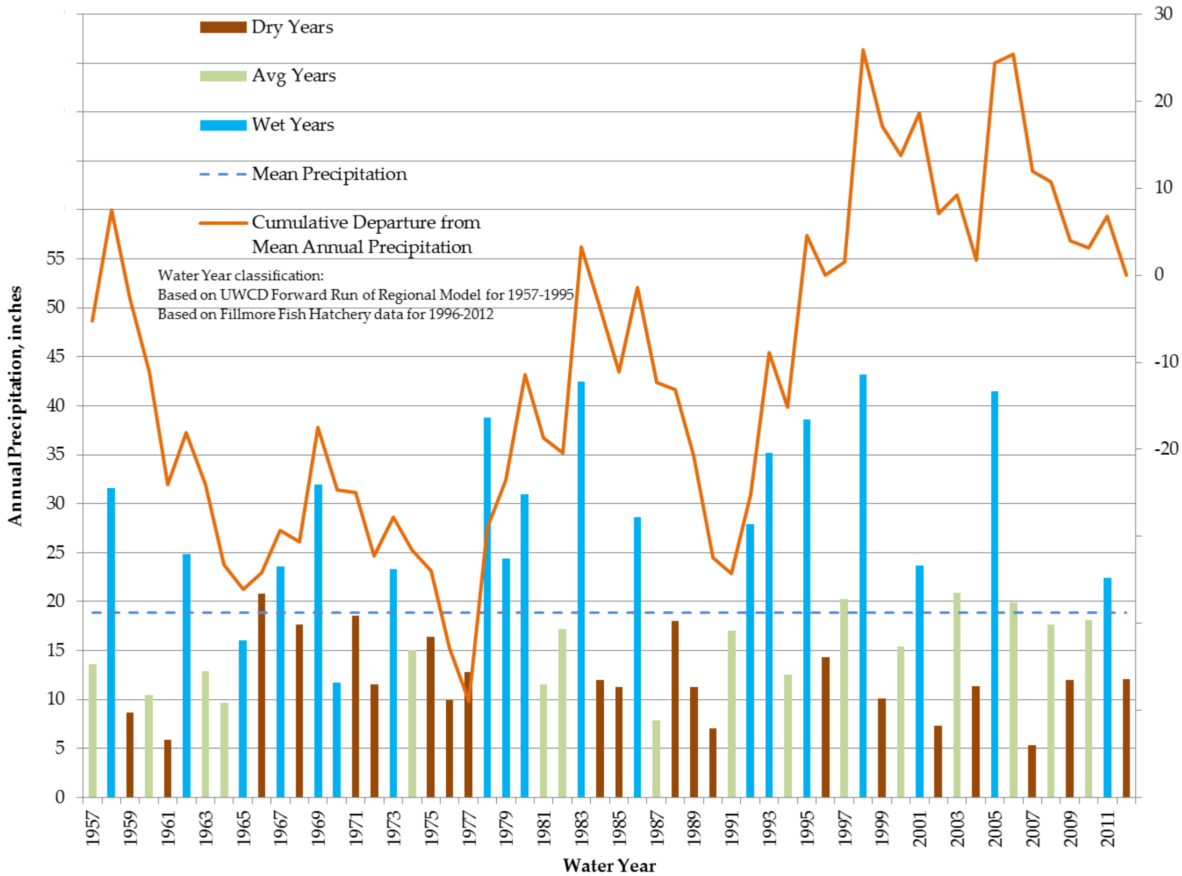


Figure 6-3 Water Year Classification Used for Regional Groundwater Model and Mass Balance Model

Table 6-3 shows the assignment of surface water quality sampling locations (**Figure 6-2**) to each percolation reach along with the range of concentrations for 1996-2012. The water quality for SCR reach from Torrey Road to Cavin Road is calculated based on concentrations from Piru Creek near Piru and the SCR at Newhall. The weighted average concentration is based on percentage of SCR at Torrey Road stream flow coming from Piru Creek (53% in 2011 and 90% in 2012). Concentrations from the Piru Creek near Piru station are used for this reach and the Piru Creek reach instead of concentrations just below Santa Felicia Dam because loading from percolation is the largest loading in the Piru Basin. Groundwater concentrations in the Piru Basin indicate that surface water concentrations are higher than what is measured just below Santa Felicia Dam. Concentrations in percolation into each subarea (**Table 6-4**) are based on the distribution in **Table 6-3**.

Table 6-3 Assignment of Surface Water Quality Sampling Locations to Percolation Reaches

Percolation Reach	Surface Water Quality Sampling Location
Santa Clara River Newhall to Torrey Rd.	Santa Clara River Newhall
Piru Creek	Piru Creek near Piru
SCR Torrey to Cavin	Calculated for SCR downstream of Piru Creek
Hopper Creek	Hopper Creek
SCR Cavin Rd to Sespe Creek	SCR at Fillmore Fish Hatchery
Sespe Creek	Sespe Creek
Santa Paula Creek	Santa Paula Creek
Pole Creek	Pole Creek
Oxnard Forebay	SCR at Freeman Diversion

Table 6-4 Average Concentrations of Stream Percolation to Subareas by Water Year Classification (1996-2012)

Subarea	1996-2012 Concentrations (mg/L)		
	TDS Wet-Avg-Dry	Chloride Wet-Avg-Dry	Nitrate as N Wet-Avg-Dry
Lower Piru East of Piru Creek	938-925-942	105-123-126	2.1-2.4-2.1
Lower Piru West of Piru Creek	851-914-897	57-72-71	1.1-1.1-1.0
Fillmore Pole Creek Fan	886-957-952	53-59-57	2.4-2.4-2.4
Fillmore South of Santa Clara River	886-7	53-59-57	2.4-2.4-2.4
Fillmore Remaining	620-651-638	52-45-59	0.1-0.1-0.4
Santa Paula East of Peck Road	428-598-709	14-29-38	0.4-1.2-1.0
Oxnard Forebay	969-1129-1183	51-63-66	1.1-1.4-1.2

6.2.1.2 Managed Aquifer Recharge

UWCD's records for diversions to the Piru Spreading Grounds and from the Freeman Diversion to the Saticoy, El Rio, and Noble recharge basin are used for inflows to the mass balance spreadsheet. Diversions from Piru Creek to the Piru Spreading Grounds occurred from 1996-2008 before the Piru Diversion was taken out of use. This inflow is applied to the Upper Piru subarea. Managed aquifer recharge from the Freeman Diversion on the SCR occurs in the Oxnard Forebay subarea.

Surface water quality for each year is based on 1996-2012 median results with years missing data using the averages for wet, dry, and average years in the same manner as stream percolation concentrations (**Table 6-5**). Managed aquifer recharge in the Upper Piru subarea is based on surface water quality sampled in Piru Creek below Piru Dam. Managed aquifer recharge in the Oxnard Forebay is based on surface water quality sampled in the SCR at the Freeman Diversion.

Table 6-5 Average Concentrations for Managed Aquifer Recharge to Subareas (1996-2012)

Subarea	Surface Water Quality Sampling Location	1996-2012 Concentrations (mg/L)		
		TDS Wet-Avg-Dry	Chloride Wet-Avg-Dry	Nitrate as N Wet-Avg-Dry
Upper Piru	Piru Creek below Dam	603-640-618	40-47-47	0.4-0.4-0.9
Oxnard Forebay	Santa Clara River at Freeman Diversion	969-1,130-1,183	51-63-66	1.1-1.2-1.4

6.2.1.3 Recharge of Precipitation

Recharge inflows from precipitation are based on input to the Forward run of the regional groundwater model updated in 2006 (HydroMetrics LLC, 2006). The regional groundwater model covers Las Posas Basins, Pleasant Valley, and Oxnard Plain in addition to the LSCR. The Forward run is based on climatic conditions throughout the region from 1944 to 1998 with each year classified as wet, dry, or average. The average recharge from precipitation is calculated for each subarea by climatic classification. The average wet, dry, and average recharge from precipitation is applied to the classification of water years 1996-2012 based on rainfall at the Fillmore Fish Hatchery as shown in **Figure 6-3**.

The concentration of TDS precipitation recharge is assigned 10 mg/L based on the State Water Board Groundwater Ambient Monitoring and Assessment (GAMA) Program's groundwater information sheet on salinity (SWRCB, 2010).

The concentration of chloride and nitrate precipitation recharge is based on data from the National Atmospheric Deposition Program. Data from Chuchupate (CA 98, NADP, 2014a) in Ventura County are only available 1983-1995, but correlations with data from Tarbank Flat (CA 42, NADP, 2014b) in Ventura County allow for extrapolation of the Chuchupate data to 1996-2012. Average concentrations for chloride and nitrate and N for the extrapolated period were approximately 0.1 mg/L so that is the value used for calculating loading.

6.2.1.4 Mountain Front Recharge

Inflows representing mountain front recharge are based on output of the Forward run of the regional groundwater model updated in 2006 (HydroMetrics LLC, 2006). Mountain front recharge is represented in the groundwater model as injection wells along the model boundary. The USGS program ZONEBUDGET was used to extract flows from the model results for 1944-1998 and average flows for the wet, dry, and average years as defined for the Forward run of the regional groundwater model were calculated. The average wet, dry, and average mountain front recharge is applied to water years 1996-2012 based on the classification shown in **Figure 6-3**. These flows were adjusted to improve fit of calculated subarea concentrations with existing water quality.

There are no available data or references for the water quality of mountain front recharge. The mountain front recharge inflows were assigned concentrations equaling precipitation.

6.2.1.5 Groundwater Underflow from Basins Outside Lower Santa Clara River area: Upper Santa Clara River Basin

Inflows representing underflow from the SCR East sub-basin to the lower Piru subarea east of Piru Creek are based on output of the Forward run of the regional groundwater model updated in 2006 (HydroMetrics LLC, 2006). Flow from the Upper SCR basin into the lower Piru subarea east of Piru Creek is represented in the groundwater model as injection wells along the model boundary. The USGS program ZONEBUDGET was used to extract flows from the model results for 1944 to 1998 and average flows for the wet, dry, and average years as defined for the Forward run of the regional groundwater model were calculated. The average wet, dry, and average underflow from the SCR East sub-basin is applied to water years 1996-2012 based on the classification shown in **Figure 6-3**.

In the absence of groundwater concentration data at this boundary surface water concentrations used to define existing water quality near the boundary (**Subsection 4.4.1**), are used as concentrations of this inflow. The TDS concentration assigned to this inflow is 970 mg/L (**Figure 4-8**). The chloride concentration assigned to this inflow is 121 mg/L (**Figure 4-7**). Nitrate concentrations were assigned the average groundwater in lower Piru subarea east of Piru Creek.

6.2.1.6 Groundwater Underflow from Basins Outside Lower Santa Clara River area: Oxnard Plain and Offshore

Inflows representing underflow from the Oxnard Plain basin and offshore to the Mound basin are adjusted to balance inflows and outflows in each subarea supplemented by output of the Forward run of the regional groundwater model updated in 2006 (HydroMetrics LLC, 2006). Total groundwater outflow from a subarea is calculated so that total outflows equal inflows. The total outflow is distributed to other subareas and basins outside the study area based on the distribution in the Forward run results. The distributed outflows to other subareas are used as inflows to those downgradient subareas. UWCD considers inter-basin flows to be a weakness in the regional groundwater model and is developing a new model, but the existing regional model is currently the best available tool for estimating flows between basins. Flows from the outside the LSCR area into the Mound basin are represented in the groundwater model as calculated flows between model cells. The USGS program ZONEBUDGET was used to extract flows at the boundaries of the Mound and offshore from the model results. Average flows for the wet, dry, and average years as defined for the Forward run of the regional groundwater model were calculated. For years with net inflow into the Mound basin from the Oxnard Plain and offshore, the net inflow is applied based on the classification of water years 1996-2012 based as shown in **Figure 6-3**.

Water quality for inflow from the Oxnard Plain is based on the average of median concentrations of TDS, chloride, and nitrate at the City of Ventura golf course wells 5 and 6 for water years 1996-2012. Water quality for inflow from offshore is based on the median concentration for water years 1996-2012 for the deepest completion at the Marina coastal well, which has higher concentrations than the medium completion (**Table 6-6**). The shallow completion was not used in the assimilative capacity analysis because it is in a perched aquifer. The concentrations observed in the deepest completion at the Marina coastal well do not indicate any seawater intrusion occurring in the Mound.

Table 6-6 Concentrations Used for Inflow from Outside Lower Santa Clara River Area into Mound Subarea

Inflow From	TDS (mg/L)	Chloride (mg/L)	Nitrate as N (mg/L)
Oxnard Plain	1,174	57	12
Offshore	1,285	85	0.4

6.2.1.7 Groundwater Flow Between Subareas

Inflows from each upgradient subarea are adjusted to balance inflows and outflows in each subarea supplemented by output of the Forward run of the regional groundwater model updated in 2006 (HydroMetrics LLC, 2006). Total groundwater outflow from a subarea is calculated so that total outflows equal inflows. The total outflow is distributed to other subareas and basins outside the study area based on the distribution in the Forward run results. The distributed outflows to other subareas are used as inflows to those downgradient subareas. UWCD considers inter-basin flows to be a weakness in the regional groundwater model and is developing a new model, but the existing regional model is currently the best available tool as guidance for estimating flows between basins. Flows between subareas are represented in the groundwater model as calculated flows between model cells. The USGS program ZONEBUDGET was used to extract flows at the boundaries between subareas from the model results. Average flows for the wet, dry, and average years were calculated. The distribution of flows between subareas is applied based on the classification of water years 1996-2012 as shown in **Figure 6-3**.

The concentrations used for these inflows are based on the calculated concentrations for the upgradient subarea from the previous year.

A specific area of controversy with using output of the regional groundwater model to estimate flows between subareas is the distribution of flows into the Mound basin. The regional groundwater model simulates the main inflow into the Mound basin as groundwater flow from the Oxnard Forebay basin. The City of Ventura has concluded that primary inflow is from the Santa Paula basin based on degraded water quality in the Mound basin and east to west flow of groundwater that parallels the basin axis (Hopkins, 2014). The implications of this alternative distribution of flow are discussed along with the results of the mass balance model for the Mound basin.

6.2.1.8 Groundwater Flow Between Upper Aquifer System and Lower Aquifer System

Vertical flows between the UAS and LAS are adjusted as part of the balance of inflows and outflows discussed above in **Subsection 6.2.1.7**. As discussed in **Section 7**, subarea concentrations are modeled based on the volume of the UAS for each subarea. The inflows equal the outflows for the UAS in each subarea in a water balance that includes the inflows from or outflows to the LAS. The direction of flow is based on output of the Forward run of the regional groundwater model updated in 2006 (HydroMetrics LLC, 2006). The magnitude of flow is based on the proportion of the vertical flow relative to horizontal flows between subareas (**Subsection 6.2.1.7)** in the output of the Forward run.

The concentrations used for inflows into the UAS from the LAS are the calculated concentration in the LAS from the previous year.

6.2.1.9 Naturally Occurring Salts

As noted in **Section 4**, in some localized areas, higher TDS and chloride concentrations were observed that are likely naturally occurring. In the Fillmore basin-south side of the Santa Clara River subarea, high chloride concentrations are found along the southern boundary of the subarea Here concentrations are in excess of 190 mg/L. Because only the southern portion of the subarea has elevated chloride despite similar land use across the subarea, connate water that was trapped during deposition of the basin's sediments is its most likely cause.

A similar situation exists in the Santa Paula basin-west of Peck Road subarea and Oxnard Forebay basin. There is an area of elevated TDS in the northern portion of the Oxnard Forebay basin, north and west of the Saticoy recharge basins, extending across the basin boundary slightly into the west of Peck Road subarea of the Santa Paula basin. The cause of this area of elevated TDS concentrations appears to be connate water confined by the north trace of the Oak Ridge fault and beyond the influence of recharge activities by UWCD.

Finally, connate water trapped in marine sediments has been suggested as the source of higher chloride and TDS concentrations found in the Mound basin (Geotechnical Consultants, 1972).

While loadings from connate water are not included in the mass balance analysis discussed in **Section 7**, the mass balance spreadsheet model sets initial concentrations based on existing concentrations for each subarea. Therefore, historical loadings from connate water are reflected in the modeled initial conditions. It is assumed that on-going loadings are not significant at the time scale of the analysis.

6.2.2 Land Use Based Sources and Loadings

6.2.2.1 Irrigation

Irrigation contributes salts and nutrients in agricultural and urban areas in the following ways:

- Urban landscape irrigation with potable or recycled water – Infiltration contributes to transport to groundwater. Runoff is collected in stormwater collection systems, and discharged to surface waters that may recharge groundwater basins.
- Agricultural irrigation with untreated groundwater or surface water – Infiltration contributes to transport to groundwater. Runoff is conveyed to surface water discharges.

Agricultural and urban landscape irrigation volumes were estimated based on land and crop use data. Irrigation rates were adapted from Ventura County (2009). Land use based irrigation volumes were checked and adjusted based on well data and may be further modified based on agricultural and production well data.

Ventura County 2012 Crop Layer was used to estimated crop type and acreages. Some crops were aggregated into more general categories for the purpose of applying irrigation and fertilization rates.

Ventura County General Plan Land Use data were used to estimate urban area boundaries. DWR (2000) Land Use data were used to estimate cemeteries and golf courses. The acreages of these uses were assumed to be the same as in 2000. Other irrigated areas within urban boundaries were estimated based on USGS estimates of pervious surfaces and an approximate percentage of the pervious surfaces that would be subject to irrigation. This percentage was adjusted based on the production well volumes.

6.2.2.1.1 Source Water Quality

The source water quality for agricultural irrigation was revised to be consistent with water quality used for non-land use based inflows. Source water quality for surface water is made equivalent to concentrations calculated for percolation and managed recharge in the subarea (**Table 6-4** and **Table 6-5**). Source water quality for groundwater is made equivalent to concentrations calculated for the subarea mixing cell the previous year.

6.2.2.1.2 Groundwater Irrigation Consistent with Pumping Records

Groundwater irrigation volumes were made consistent with pumping records by using the higher value for any subarea, except where there is a known transfer of water between subareas. There is a known transfer of groundwater pumped in the Lower Piru subarea west of Piru Creek to the Lower Piru subarea east of Piru Creek and of groundwater pumped in the Santa Paula subarea west of Peck Road to the Santa Paula subarea east of Peck Road.

Applied water quality of groundwater irrigated in the subareas receiving a transfer of groundwater is based on the groundwater concentrations calculated for the UAS of the source subareas and the proportions shown in **Table 6-7**. Using water quality of groundwater in the UAS for application of groundwater is conservative because it results in greater accumulation of salts and nutrients calculated for the UAS, which will be used in the fate and transport analysis to evaluate the effect of loadings on water quality of the subarea (**Subsection 7.1.1**)

The groundwater pumping values were applied as outflows for the UAS in the subarea to be consistent with using water quality from the UAS for application groundwater quality. Groundwater production is used as part of the water balance to calculate groundwater flows between subareas (**Subsection 6.2.1.7**) and between the UAS and LAS (**Subsection 6.2.1.8**).

Table 6-7 Proportion of Applied Irrigation Water Source for Subareas Receiving Groundwater Transfer

	Lower Piru East of Piru Creek	Lower Piru West of Piru Creek	Santa Paula East of Peck Road	Santa Paula West of Peck Road
Lower Piru East of Piru Creek	53%	47%		
Santa Paula East of Peck Road			32%	68%

6.2.2.1.3 Infiltration of Applied Irrigation

Only a fraction of applied irrigation volumes return to groundwater, as water is lost to evapotranspiration from plants. This return fraction is the inverse of irrigation efficiency. Irrigation efficiency of 70% is used for agricultural irrigation and application of recycled water, the same value used in development of the regional groundwater model (Hanson et al., 2003). More recent estimates of irrigation efficiency have not been developed for Ventura County, although distribution uniformity has been estimated as 80% (ITRC, 2010). Distribution uniformity can be considered an upper limit on overall irrigation efficiency so it is consistent with using 70% for irrigation efficiency. For 70% irrigation efficiency, 30% of applied water infiltrates.

The percentage of municipal irrigation that infiltrates was adjusted downward to 50% to better match model results with existing groundwater concentrations, particularly in the Mound basin.

The concentration of salts in the infiltration of applied water is complex. While water is lost to evapotranspiration, salt mass can be conserved resulting in higher concentrations in infiltrating water than applied water. For this analysis, it is assumed that all salt mass is conserved from application to infiltration. Based on this analysis, concentrations are 233% greater in infiltration than application for the irrigation efficiency of 70% used for agricultural irrigation and recycled water application. Concentrations will be 100% greater in infiltration than application for the irrigation efficiency of 50% used for municipal irrigation. However, there exists the potential that salt mass will not be entirely conserved as salts may be removed by plant uptake or other attenuation processes which would reduce the load to groundwater.

For nitrates, the calculation assumes that nitrates in source water are taken up by plants along with fertilizer. This assumption only applies to nitrates from the source water.

6.2.2.2 Fertilizer Application

Fertilizer application on urban, residential and agricultural areas contributes nitrate loads (after transformations and losses) in the following ways:

- Fertilization in urban areas – Loads from fertilizers are transported with water from irrigation or precipitation.
- Fertilization in agricultural areas – Loads from fertilizers are transported with water from irrigation or precipitation.

Fertilizer application was assumed for crops and landscaped areas (lawns, parks, golf courses, cemeteries). Fertilizer was assumed to only contribute nitrate to the groundwater. Application rates, as well as losses to harvest and atmosphere were estimated using the rates in UC Davis (2012).

The calculation for the load of nitrate to groundwater in UC Davis (2012):

NGW = NDEPOSIT + NIRRIG + NAPPLIED - NHARVEST - NLOSS - NRUNOFF

N GW =	N loading to groundwater
Assumptions:	
NDEPOSIT =	Atmospheric deposition
NRUNOFF =	Runoff from fields
N IRRIG =	N in irrigation water
N APPLIED =	N applied
N HARVEST =	Amount taken up by crop and removed in harvest
N LOSS =	Losses to atmosphere, gaseous emission

6.2.2.3 Septic Systems

Salt and nutrient loads from septic systems are transported to the basin though outflows or leaky septic tanks are transported directly into the groundwater through infiltration.

The number of septic systems (outside sewered areas) was based on data from Ventura County. Loading rates and flows were based on the assumptions of 2.82 persons/dwelling unit.

Wastewater reclamation facility effluent concentrations were assumed for the concentrations of septic systems.

6.2.2.4 Wastewater Treatment Percolation Ponds

Salt and nutrient loads from wastewater treatment plants are transported to the basin through the discharge of treated effluent into infiltration ponds. Loads from WWTPs were estimated based on effluent flow rates and average concentrations.

The locations of WWTP percolation ponds are shown on the maps in **Section 4**. The Saticoy WWTP is located near the boundary between the Santa Paula basin and the Oxnard Forebay basin, but within the Santa Paula basin as defined for the water quality objectives used in this plan (**Figure 4-15** through **Figure 4-20**). However, the discharge permit for the Saticoy WWTP identifies receiving basin as the Oxnard Forebay basin. In addition to being consistent with the permit, loads from the Saticoy WWTP are assigned to the Oxnard Forebay basin because they are more likely to affect average water quality in the Oxnard Forebay basin due to the ponds' location just upgradient of that basin

7 Fate and Transport Analysis

The fate and transport analysis for the SNMP provides a tool that will be used to assess the effect of salt and nutrient loadings on average concentrations on each subarea with salt and nutrient water quality objectives. The effect loadings have on the average concentration in the subarea depends on flows into the subarea and other existing loadings.

Section 9 includes a comparison of effects of additional loadings on subarea concentrations to assimilative capacity for salt and nutrients in each subarea. Subareas have assimilative capacity where average concentrations for the salt and nutrient constituents (TDS, chlorides, and nitrates as N) are less than the subarea's water quality objectives. Assimilative capacity in these subareas is the difference between the average concentration for the salt and nutrient constituent and the water quality objective. Additional loadings will use up assimilative capacity. The mass balance model will be used to evaluate additional loadings from proposed future projects based on the percentage of assimilative capacity used by the loadings. The mass balance model can also be used to evaluate impacts of management measures based on how reductions in existing loadings changes assimilative capacity

7.1 MASS BALANCE SPREADSHEET MODEL

The mass balance model is implemented in a series of spreadsheets. The mass balance model treats each hydrostratigraphic unit in each subarea as a single mixing cell. Inputs to the mass balance model are time series of hydrologic/hydrogeologic inflows and outflows for 1996-2012, as well as salt concentrations and loadings. The model calculates the subarea groundwater concentration for each year based on the estimated annual flows and loadings and the previous year's concentration. Estimated flows are adjusted to maintain a balance between inflows and outflows each year.

7.1.1 Mixing Cell Concentration Calculation

Part of the model calculation of the mixing cell concentration is the steady state concentration. This is the steady state concentration if loadings and flows do not change over the long term. It is essentially the loadings divided by the inflow as in the following equation where $C_{t=\infty}$ is the steady state concentration in the subarea mixing cell, C_i is salt or nutrient concentration of any inflow and Q is inflow:

$$C_{t=\infty} = \frac{\sum_{i=1}^{n} C_i Q_i}{\sum_{i=1}^{n} Q_i}$$

Only the inflows and loadings are considered in the calculation because the assumption for the mixing cell concentration is total outflows equal total inflows and discharge of salts are based on the concentration in the subarea mixing cell.

The steady state concentration is modeled for annual inflows and loadings each year but how close the concentration approaches the steady state concentration in the year depends on the residence time for mass in the subarea mixing cell, which is the water volume in the subarea mixing cell divided by the flow through the subarea mixing cell. The following equation is used to calculate transient concentrations C(t) where V is the water volume, t is the time interval of 1 year, and C_o is the subarea mixing cell concentration from the previous year:

$$C(t) = C_{t=\infty} + (C_o - C_{t=\infty})e^{-\frac{\sum_{i=1}^{n} Q_i}{V}t}$$

Data used in the assimilative capacity analysis did not have well depth information so estimated existing water quality represents both the UAS and the LAS. To be conservative, concentrations are modeled based on the volume of the UAS instead of the combined volume of the UAS and LAS.

7.1.2 Subarea Mixing Cell Volume Calculation

The change in subarea mixing cell concentration from year to year depends on size of the subarea volume. The subarea volumes for the UAS and the LAS were calculated based on the regional groundwater model updated in 2006 (HydroMetrics LLC, 2006). In the model, the Piru, Fillmore, and Santa Paula basins have three layers with layers 1 and 2 defining the UAS and layer 3 defining the LAS. In the Oxnard Forebay and Mound basins, there are only two layers with layer 1 defining the UAS and layer 2 defining the LAS.

The volumes are calculated based on average heads for the Forward run of the regional groundwater model. Total saturated volumes of the model layers are multiplied by an estimate of porosity. Porosity of 0.35 is used for the UAS and 0.1 for the LAS based on calibrated values in the Upper Santa Clara River Chloride TMDL GSWIM model (CH2M Hill, 2008). Only UAS volumes (**Table 7-1**) are used to evaluate assimilative capacity with the mass balance model.

Table 7-1 Estimated Water Volumes for Upper Aquifer System by Subarea

Subarea	Volume (AF)
Upper Piru Below Lake Piru	6,700
Lower Piru East of Piru Creek	270,000
Lower Piru West of Piru Creek	580,000
Fillmore Pole Creek Fan	600,000
Fillmore South of Santa Clara River	930,000
Fillmore Remaining	980,000
Santa Paula East of Peck Road	610,000
Santa Paula West of Peck Road	1,500,000
Oxnard Forebay	830,000
Mound	2,300,000

7.1.3 Initial Concentrations

The initial concentrations used in the mass balance model for each subarea are set so that median concentrations in the results match the average existing concentrations estimated for each subarea in the assimilative capacity analysis.[1] The assimilative capacity analysis does not distinguish between the UAS and the LAS based on lack of available well depth information so the initial concentrations are applied to both the UAS and the LAS.

In the Piru basin, for the Upper Area below Lake Piru subarea, there are no data to estimate average existing concentrations. Initial concentrations for this subarea are selected so that the overall trend in the results from 1996-2008 is steady. After 2008, the water balance changed as the Piru spreading grounds was no longer used to add managed recharge to the subarea

7.2 DISCUSSION OF OVERALL MODEL RESULTS

The analysis of historic groundwater quality data trends (**Subsection 4.3**) shows that there is no observed overall trend in average concentrations for basins and subareas except for a decreasing chloride trend in the Oxnard Forebay. However, the model results for some subareas show a trend. This is primarily due to the steady state concentration that would result from the loads and inflows being different from the estimated average existing concentrations for a subarea. This reflects uncertainty in both the estimates of existing groundwater quality and the inflows and loadings. The model results generally show variation over the 1996-2012 period that are within a likely error range of the estimated water quality concentration. The model results show groundwater quality could change over time based on the best available estimates of loadings and flow. Modeled concentrations generally show little response to variations in hydrologic conditions.

Table 7-2 summarizes the groundwater concentration results modeled for the 1996-2012 period and compares it to the existing groundwater quality based on 1996-2012 data.

[1] Median concentrations for years 1996 through 2012 for each well and constituent were calculated and plotted on maps. From the spatial distribution of median concentrations, zones of similar water quality were hand delineated. Concentrations for all the wells located within each zone of the subarea or basin were averaged to provide an overall average concentration for the zone. The acreage of the zone between contours, and its average concentrations were used to estimate an area weighted average concentration for each subarea/basin.

Table 7-2 Summary of Groundwater Concentrations Modeled for 1996-2012 and Existing Groundwater Quality Based on 1996-2012 Data

Mixing Model Average Loadings for Piru Basin - Upper Area below Lake Piru							
		TDS		Chloride		Nitrate as N	
	Inflow (AFY)	Concentration (mg/L)	Load (lbs/d)	Concentration (mg/L)	Load (lbs/d)	Concentration (mg/L)	Load (lbs/d)
Non Land Use Surface Flows							
Managed Recharge	1,150	650	5,590	40	300	0.5	4
Precipitation	20	10	2	0.1	0	0.1	0
Mountain Front Recharge	140	10	10	0.1	0	0.1	0
Land Use Surface Flows							
Agricultural Irrigation with Surface Water	360	2,070	5,540	150	400	30	80
Agricultural Irrigation with Groundwater	50	3,140	1,280	200	80	40	15
Septic Systems	2	1,260	16	160	2	40	0
Inflow Totals1							
Non Land Use Surface Flows	1,320		5,600		300		4
Land Use Surface Flows	420		6,830		490		100
Total Inflows and Loads	1,730		12,430		790		100
Outflows	**Outlow (AFY)**		**Flux (lbs/d)**		**Flux (lbs/d)**		**Flux (lbs/d)**
Groundwater Flows							
Piru - Lower Area East of Piru Creek	-1,300		-8,640		-510		-60
Lower Aquifer (Piru Upper)	-260		-1,710		-100		-11
Groundwater Production	-180		-1,290		-80		-10
Total Outflows and Loads	-1,740		-11,640		-690		-81
Note: Data may include rounding error							

7.3 DISCUSSION OF RESULTS BY SUBAREA/BASIN

Groundwater concentrations modeled with the mass balance model by subarea or basin for the UAS are summarized below. Concentrations are modeled based on the volume of the UAS instead of the combined volume of the UAS and LAS in order to be conservative. For each subarea or basin, a table and four figures are displayed. The table shows average flows, concentrations, and loads for different sources of TDS, chloride, and nitrate-N. There is a figure that shows estimated annual flows by year. The figures show estimated annual loads and modeled groundwater concentrations by year. There is one figure each for TDS, chloride, and nitrate-N loads and concentrations.

7.3.1 Piru Basin – Upper Area Below Lake Piru

In this subarea, the main non-land use based inflow and loads are from the managed aquifer recharge at the Piru spreading grounds and the main land use based load is agricultural irrigation with surface water **(Table 7-3**). Groundwater concentrations of TDS and chloride are higher than surface water concentrations because concentrations in infiltrating irrigation water are higher than in source water as it is assumed that none of the salts are taken up by plants as water demand is met. The load for nitrates from fertilizers in the agricultural irrigation results in concentrations that are substantially higher than surface water concentrations.

After water year 2008, water was not recharged to the Piru spreading grounds resulting in no managed aquifer recharge inflow (**Figure 7-1**). After 2008, inflows are reduced to 25% of the inflows from 1996-2008 and loadings are dominated by agricultural irrigation. Groundwater concentrations based on these annual loads and smaller inflows for the later period raise concentrations for TDS, chloride, and nitrate-N due to higher concentrations in infiltration of agricultural irrigation than the source water. The modeled annual groundwater concentrations for TDS (**Figure 7-2**), chloride (**Figure 7-3**), and nitrate-N (**Figure 7-4)** show increases in concentrations during years with little to no managed aquifer recharge. The percentage change in these years is greatest for nitrate-N. Based on the estimated loadings for this subarea after water year 2008, modeled groundwater concentrations rise to and above the water quality objectives for TDS (1,100 mg/L) and nitrate-N (10 mg/L) by 2012. Modeled concentrations for chloride remain below the water quality objective for chloride (200 mg/L). However, existing groundwater concentrations for this subarea have not been calculated due to a lack of data and the availability of assimilative capacity cannot be assessed.

Table 7-3 Mass Balance Model Average Loads for Piru Basin – Upper Area below Lake Piru

	Inflow (AFY)	TDS Concentration (mg/L)	TDS Load (lbs/d)	Chloride Concentration (mg/L)	Chloride Load (lbs/d)	Nitrate as N Concentration (mg/L)	Nitrate as N Load (lbs/d)
Non Land Use Surface Flows							
Managed Recharge	1,150	650	5,590	40	300	0.5	4
Precipitation	20	10	2	0.1	0	0.1	0
Mountain Front Recharge	140	10	10	0.1	0	0.1	0
Land Use Surface Flows							
Agricultural Irrigation with Surface Water	360	2,070	5,540	150	400	30	80
Agricultural Irrigation with Groundwater	50	3,140	1,280	200	80	40	15
Septic Systems	2	1,260	16	160	2	40	0
Inflow Totals[1]							
Non Land Use Surface Flows	1,320		5,600		300		4
Land Use Surface Flows	420		6,830		490		100
Total Inflows and Loads	1,730		12,430		790		100
Outflows	**Outlow (AFY)**		**Flux (lbs/d)**		**Flux (lbs/d)**		**Flux (lbs/d)**
Groundwater Flows							
Piru - Lower Area East of Piru Creek	-1,300		-8,640		-510		-60
Lower Aquifer (Piru Upper)	-260		-1,710		-100		-11
Groundwater Production	-180		-1,290		-80		-10
Total Outflows and Loads	-1,740		-11,640		-690		-81

[1] May include rounding error

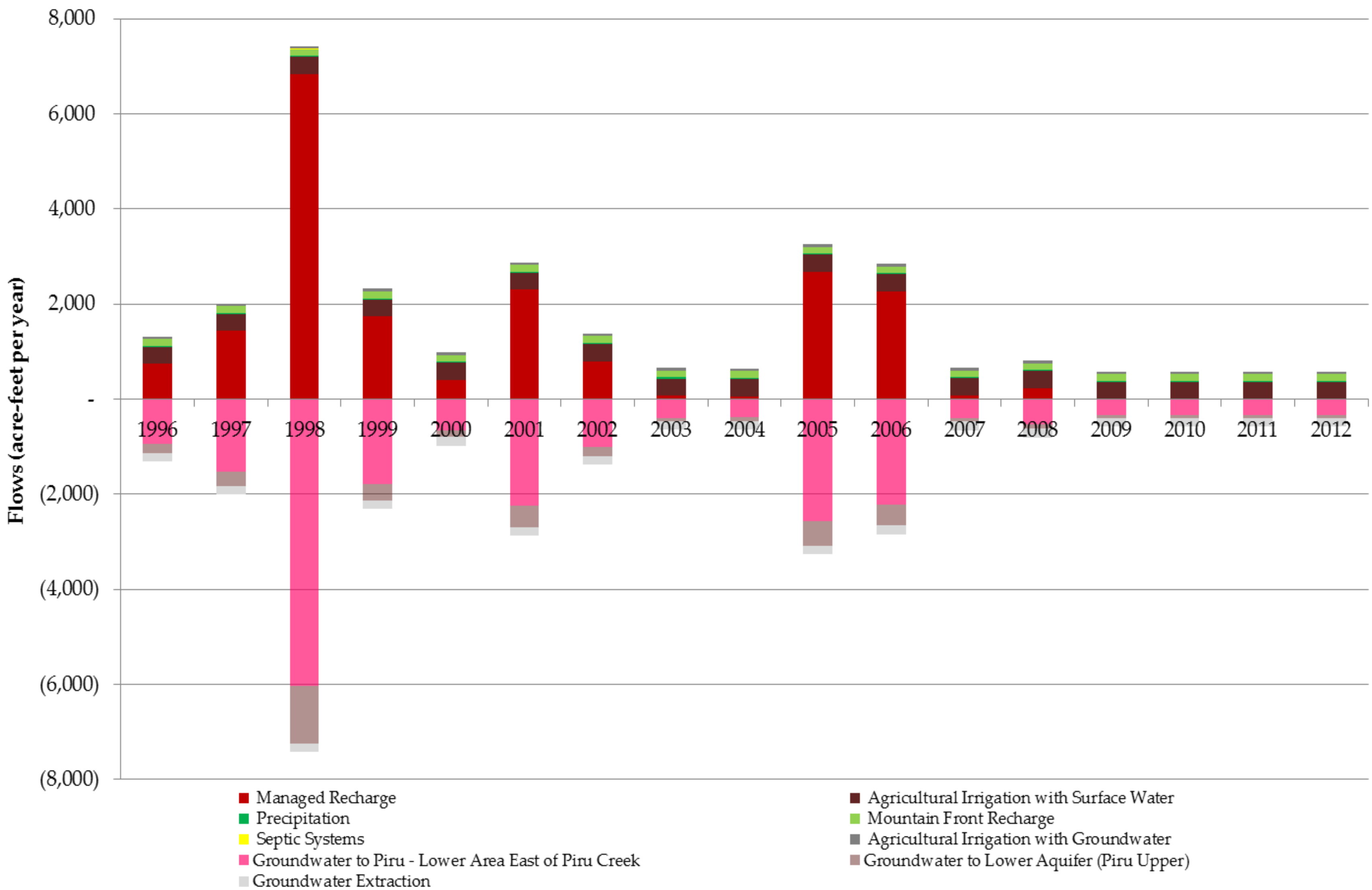


Figure 7-1 Modeled Annual Inflows and Outflows for Piru Basin – Upper Area

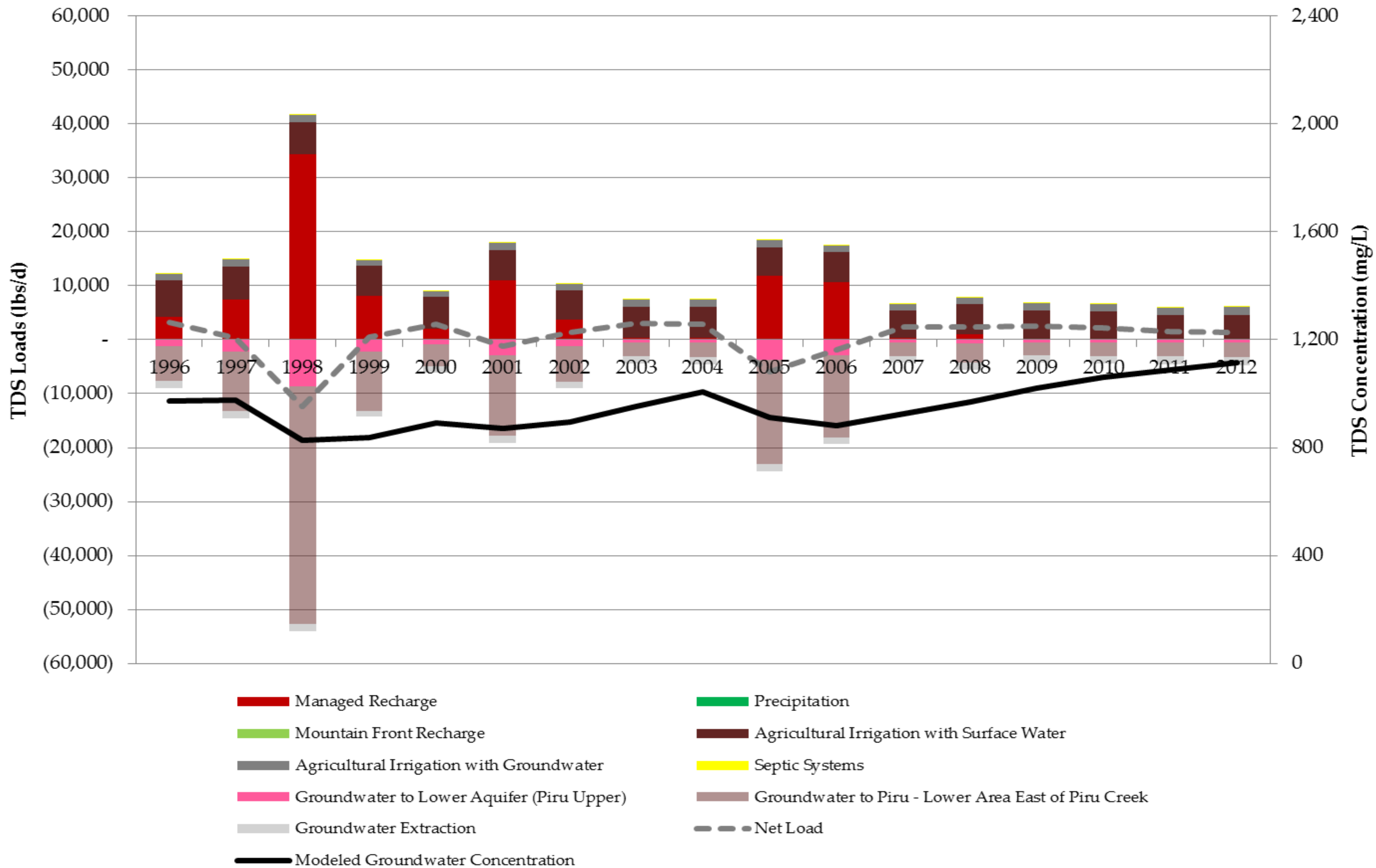


Figure 7-2 Modeled Annual TDS Loads and Concentrations in Groundwater for Piru Basin – Upper Area below Lake Piru

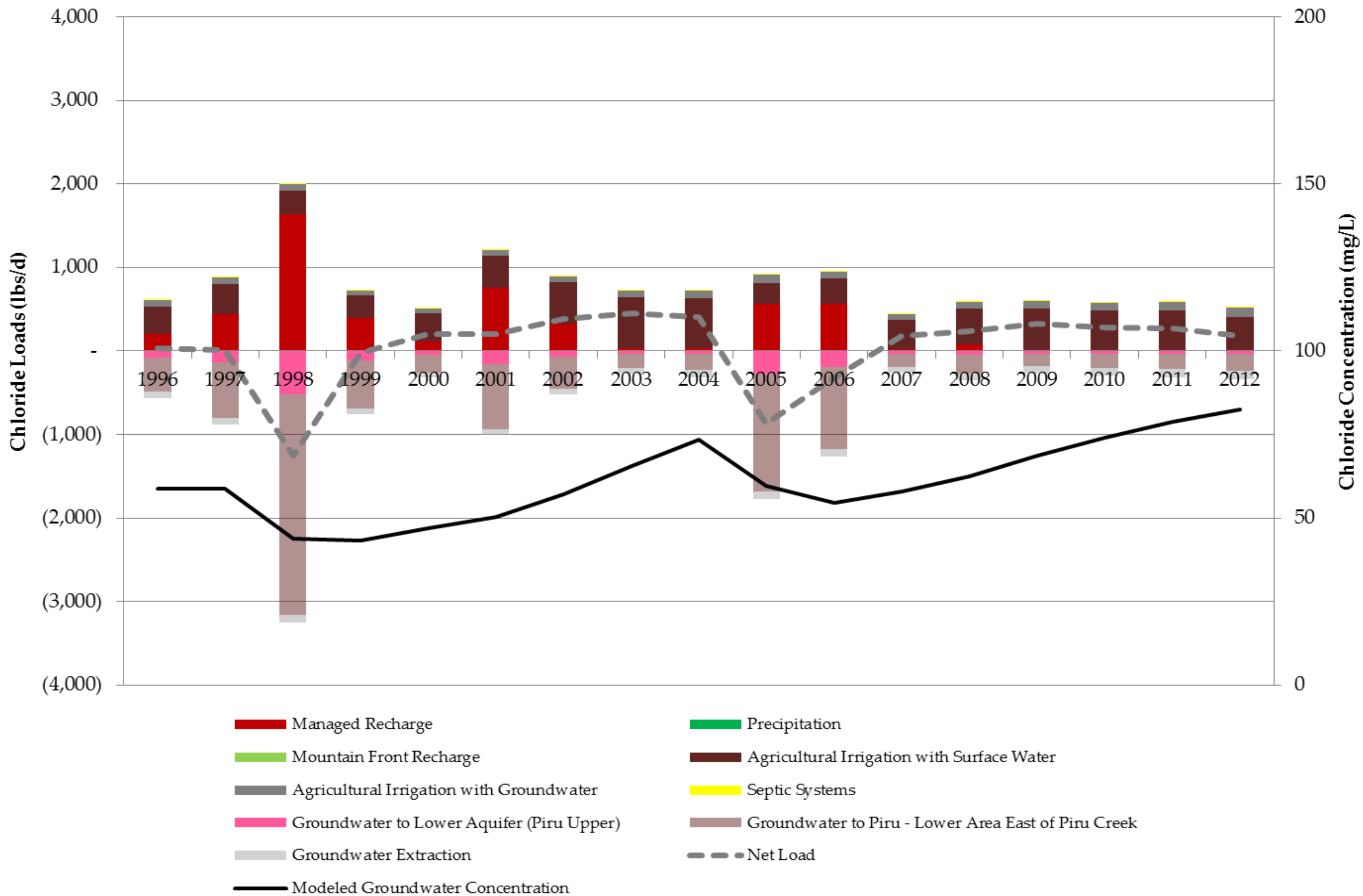


Figure 7-3 Modeled Annual Chloride Loads and Concentrations in Groundwater for Piru Basin – Upper Area below Lake Piru

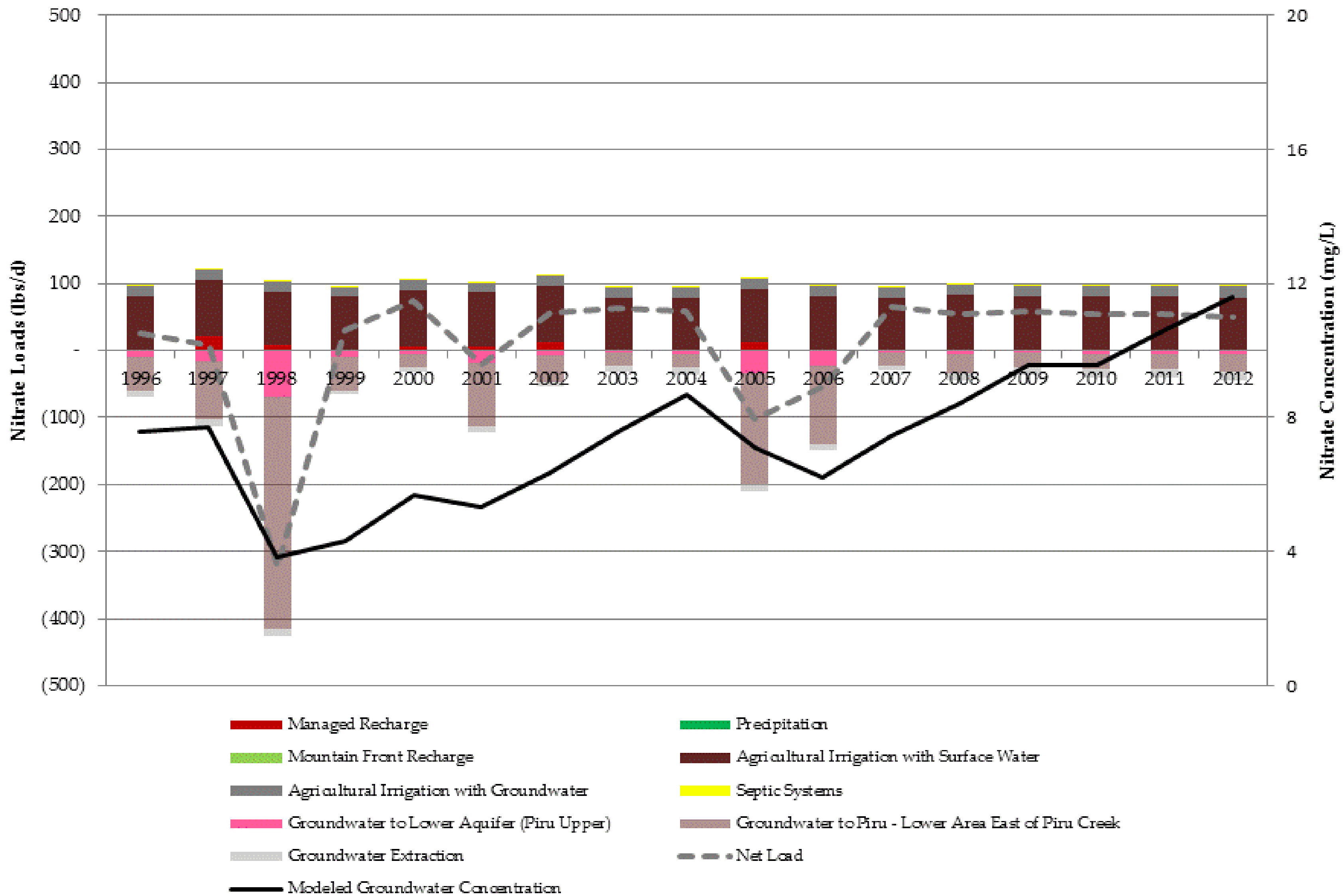


Figure 7-4 Modeled Annual Nitrate-N Loads and Concentrations in Groundwater for Piru Basin – Upper Area below Lake Piru

7.3.2 Piru Basin – Lower Area East of Piru Creek

In this subarea, the main non-land use based inflow and loads are from streambed percolation from the SCR and Piru Creek (**Figure 7-5**). The main land use based loads are agricultural irrigation with surface water and groundwater. The high percentage of overall inflow from streambed percolation results in groundwater concentrations for TDS and chloride calculated as similar to surface water concentrations. The nitrate-N load from fertilizer results in nitrate-N concentrations higher than surface water quality, however the large amount of streambed percolation results in calculated groundwater concentrations closer to surface water quality than irrigation infiltration water quality (**Table 7-4**).

The mass balance model shows that existing loads in this subarea result in concentrations in groundwater (**Table 7-2)** that are below water quality objectives for TDS (2,500 mg/L), chloride (200 mg/L) and nitrate-N (10 mg/L). The model results are consistent with the finding that the subarea has assimilative capacity for all three constituents based on groundwater quality data.

The modeled concentrations for TDS (**Table 7-6)** are similar to the estimated existing concentration for the subarea. The modeled concentrations for chloride (**Figure 7-5)** and nitrate-N (**Figure 7-8**) are in groundwater show a trend that increases concentrations above the estimated existing concentration for the subarea. For chloride, this is due to the dominant inflow of stream percolation having a chloride concentration greater than the estimated existing concentration for the subarea. The high nitrate-N modeled result may be due to estimates of relatively high use of fertilizer in irrigation water in the subarea. Existing nitrate-N concentrations are estimated to be higher in the lower area of Piru basin west of Piru Creek subarea than east of Piru Creek, but fertilizer use is lower west of Piru Creek where the largest irrigated area grows oranges versus east of Piru Creek where the largest irrigated area grows row crops. Modeled annual TDS concentrations in the subarea show little variation in response to hydrologic conditions (**Figure 7-6**). Modeled chloride (**Figure 7-7**) and nitrate-N (**Figure 7-8**) show small variations in response to hydrologic conditions over the water years 1996-2012.

Table 7-4 Mass Balance Model Average Loads for Piru Basin – Lower Area East of Piru Creek

		TDS		Chloride		Nitrate as N	
	Inflow (AFY)	Concentration (mg/L)	Load (lbs/d)	Concentration (mg/L)	Load (lbs/d)	Concentration (mg/L)	Load (lbs/d)
<u>Groundwater Flows</u>							
Upper Santa Clara River Underflow	360	970	2,580	120	320	3.4	9
Piru - Upper Area below Lake Piru	1,300	940	9,070	60	560	7.0	70
<u>Non Land Use Surface Flows</u>							
Santa Clara River and Tributaries	34,540	940	240,680	120	30,410	2.2	560
Precipitation	580	10	40	0.1	0	0.1	0
Mountain Front Recharge	990	10	70	0.1	1	0.1	1
<u>Land Use Surface Flows</u>							
Agricultural Irrigation with Surface Water	550	3,120	12,700	400	1,630	30	130
Agricultural Irrigation with Groundwater	1,120	3,340	27,890	310	2,590	30	270
Septic Systems	5	1,260	50	160	7	40	2
<u>Inflow Totals</u>[1]							
Groundwater Flows	1,650		11,650		880		80
Non Land Use Surface Flows	36,110		240,790		30,410		560
Land Use Surface Flows	1,670		40,630		4,230		390
Total Inflows and Loads	39,430		293,070		35,530		1,030
Outflows	**Outlow (AFY)**		**Flux (lbs/d)**		**Flux (lbs/d)**		**Flux (lbs/d)**
<u>Groundwater Flows</u>							
Lower Aquifer (Piru East)	-26,170		-195,210		-22,880		-510
Piru - Lower Area West of Piru Creek	-11,290		-84,190		-9,860		-220
Groundwater Production	-1,980		-14,760		-1,730		-40
Total Outflows and Loads	-39,440		-294,160		-34,470		-770

[1] May include rounding error

Figure 7-5 Modeled Annual Inflows and Outflows for Piru Basin – Lower Area East of Piru Creek

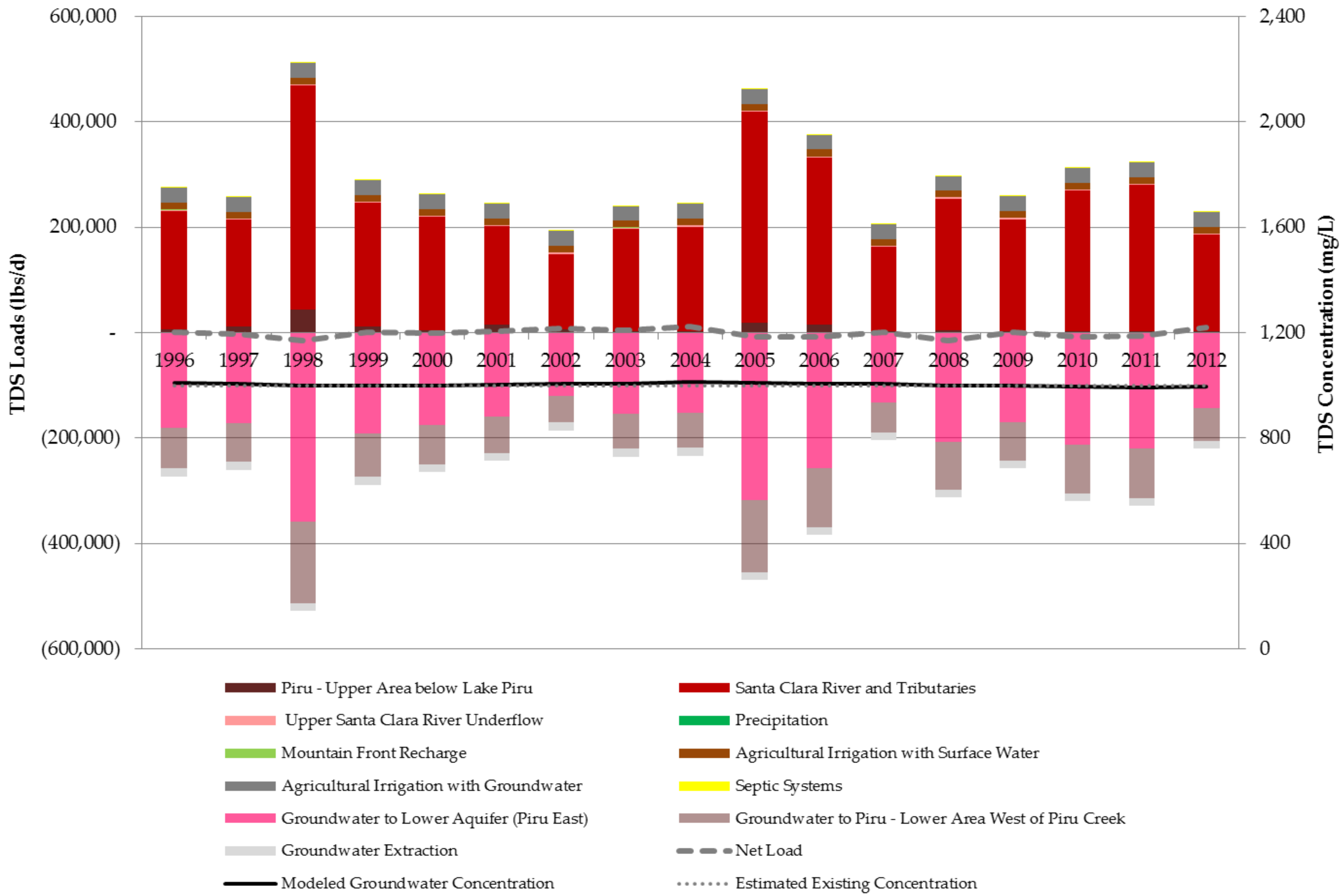


Figure 7-6 Modeled Annual TDS Loads and Concentrations in Groundwater for Piru Basin – Lower Area East of Piru Creek

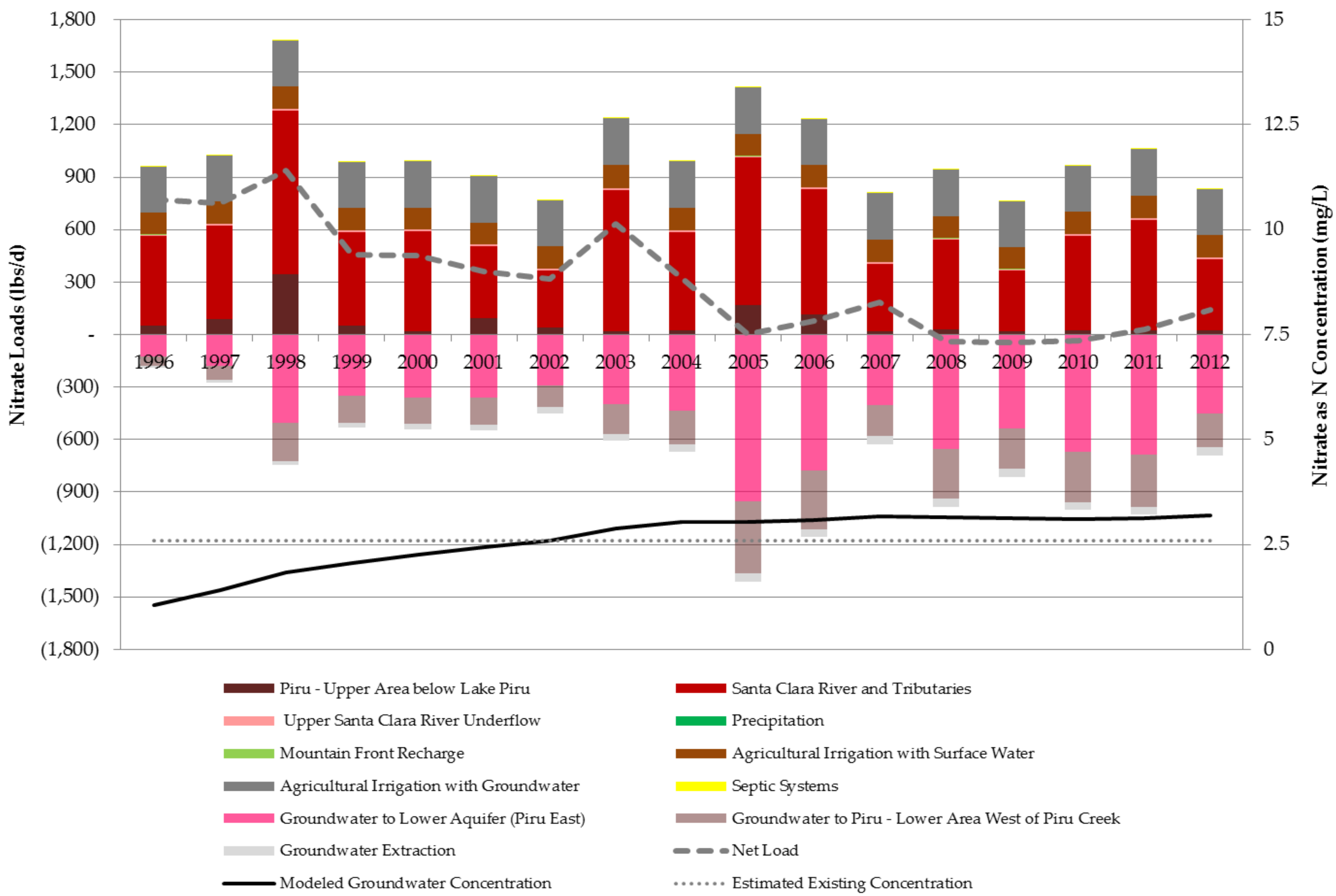


Figure 7-7 Modeled Annual Chloride Loads and Concentrations in Groundwater for Piru Basin – Lower Area East of Piru Creek

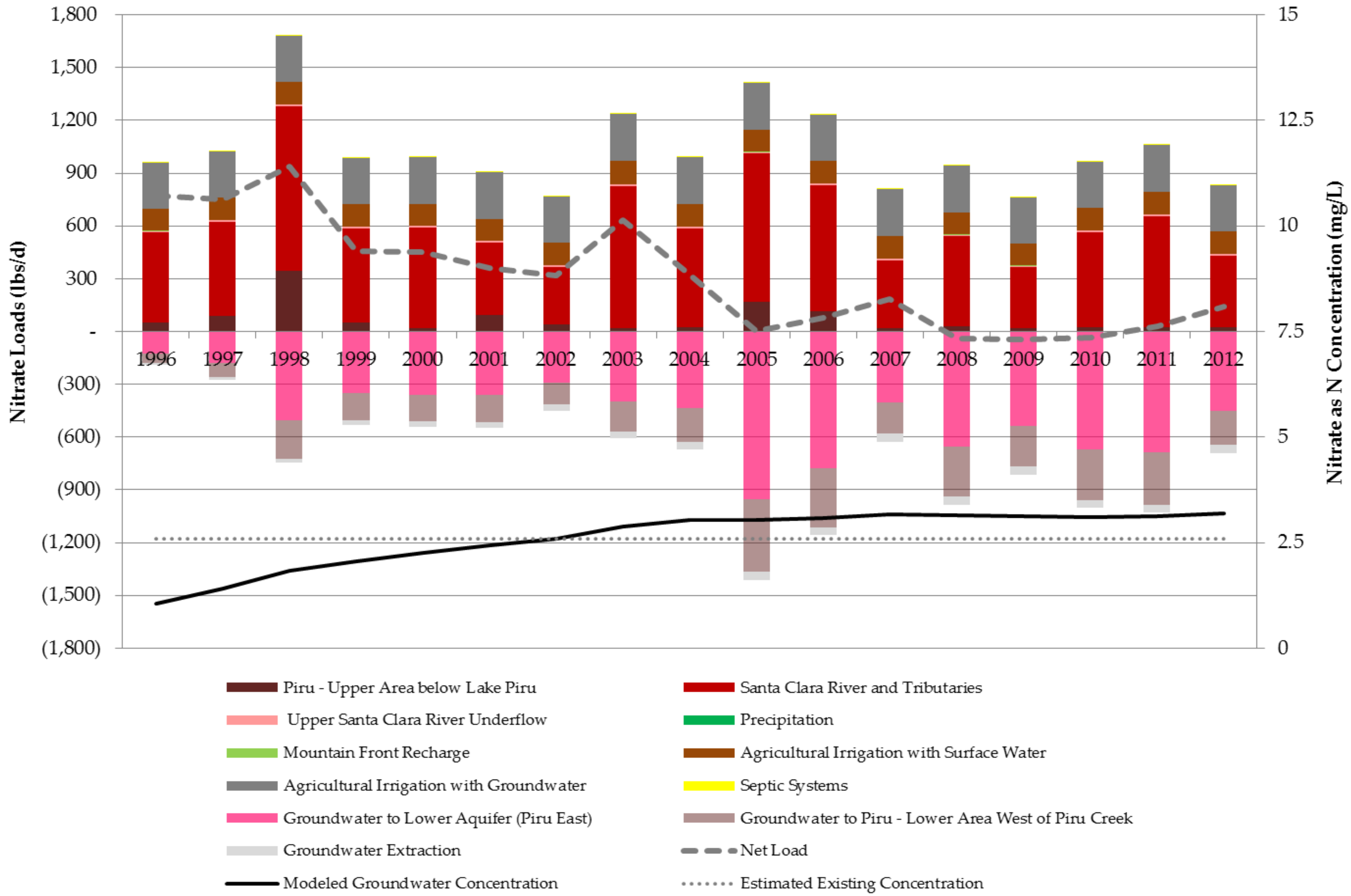


Figure 7-8 Modeled Annual Nitrate-N Loads and Concentrations in Groundwater for Piru Basin – Lower Area East of Piru Creek

7.3.3 Piru Basin – Lower Area West of Piru Creek

In this subarea, the main non-land use based inflow and loads are from streambed percolation from the SCR and Piru Creek, but there is also a large amount of underflow from the subarea east of Piru Creek (**Figure 7-9**). The main land use based load is agricultural irrigation with groundwater (**Table 7-5**). The high percentage of overall inflow from streambed percolation results in groundwater concentrations for TDS and chloride modeled as similar to surface water concentrations. The nitrate-N load from fertilizer results in modeled nitrate-N concentrations higher than surface water quality, however the large amount of streambed percolation results in calculated groundwater concentrations closer to surface water quality than irrigation infiltration water quality

The mass balance model shows that existing loads in this subarea result in modeled concentrations in groundwater (**Table 7-2**) that are below water quality objectives for TDS (1,200 mg/L), chloride (100 mg/L) and nitrate-N (10 mg/L). This is consistent with the finding that the subarea has assimilative capacity for all three constituents based on groundwater quality data.

The modeled concentrations for TDS are similar to the estimated existing concentration for the subarea (**Figure 7-10**). The modeled concentrations for chloride show a trend that increases concentrations above the estimated existing concentration for the subarea (**Figure 7-11**). This is due to the high concentration of chloride in groundwater flowing from the subarea east of Piru Creek. The modeled concentrations for nitrate-N in groundwater show a trend that decreases concentrations below the estimated existing concentration for the subarea (**Figure 7-12**). The decreasing nitrate-N modeled result may be due to estimates of relatively low use of fertilizer in irrigation water in the subarea. Existing nitrate-N concentrations are estimated to be higher in the lower area of Piru basin west of Piru Creek subarea than east of Piru Creek, but fertilizer use is lower west of Piru Creek where the largest irrigated area grows oranges versus east of the Piru Creek where the largest irrigated area grows row crops.

Modeled annual concentrations in the subarea show little variation in response to hydrologic conditions over the water years 1996-2012.

Table 7-5 Mass Balance Model Loads and Steady State Concentrations for Piru Basin – Lower Area West of Piru Creek

	Inflow (AFY)	TDS Concentration (mg/L)	TDS Load (lbs/d)	Chloride Concentration (mg/L)	Chloride Load (lbs/d)	Nitrate as N Concentration (mg/L)	Nitrate as N Load (lbs/d)
Groundwater Flows							
Piru - Lower Area East of Piru Creek	11,290	1,000	84,310	120	9,850	2.5	210
Non Land Use Surface Flows							
Santa Clara River and Tributaries	26,130	880	171,590	70	12,890	1.1	210
Precipitation	1,390	10	100	0.1	1	0.1	1
Mountain Front Recharge	1,490	10	110	0.1	1	0.1	1
Land Use Surface Flows							
Agricultural Irrigation with Surface Water	330	2,970	7,360	230	560	15	40
Agricultural Irrigation with Groundwater	1,590	3,340	39,520	220	2,620	18	210
Wastewater Treatment Percolation Ponds	210	1,260	1,950	160	250	1.0	2
Septic Systems	60	1,260	540	160	70	40	17
Inflow Totals[1]							
Groundwater Flows	11,290		84,310		9,850		210
Non Land Use Surface Flows	29,000		171,810		12,890		210
Land Use Surface Flows	2,220		49,360		3,510		260
Total Inflows and Loads	42,510		305,480		26,250		680
Outflows	**Outlow (AFY)**		**Flux (lbs/d)**		**Flux (lbs/d)**		**Flux (lbs/d)**
Groundwater Flows							
Lower Aquifer (Piru West)	-22,990		-171,230		-11,550		-620
Fillmore - Pole Creek Fan Area	-6,730		-50,160		-3,380		-180
Fillmore - South Side of Santa Clara River	-3,750		-27,930		-1,880		-100
Seepage to Santa Clara River	-1,990		-14,880		-1,000		-50
Groundwater Production	-7,050		-52,490		-3,550		-190
Total Outflows and Loads	-42,510		-316,690		-21,360		-1,140

[1] May include rounding error

Figure 7-9 Modeled Annual Inflows and Outflows for Piru Basin – Lower Area West of Piru Creek

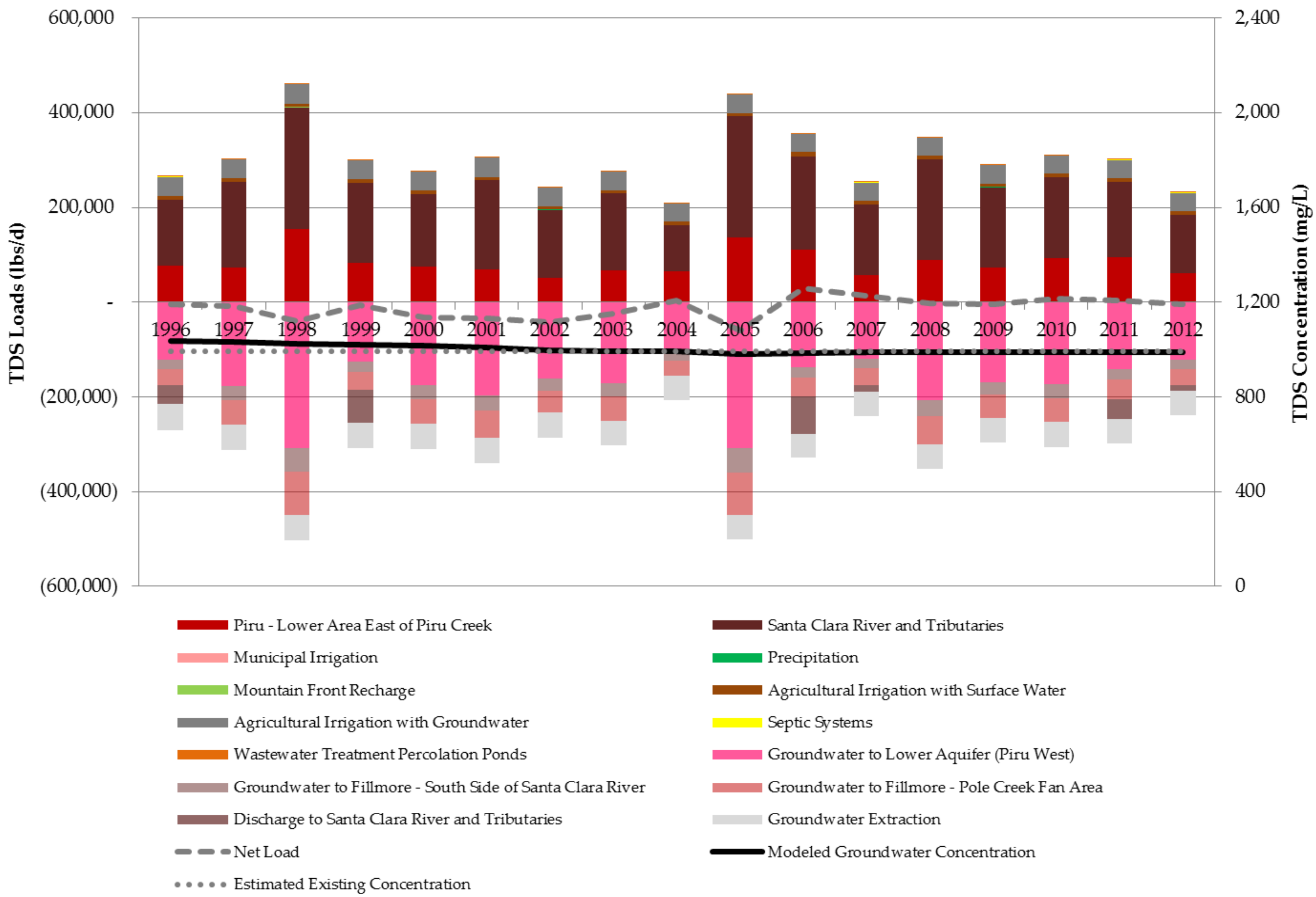


Figure 7-10 Modeled Annual TDS Loads and Concentrations in Groundwater for Piru Basin – Lower Area West of Piru Creek

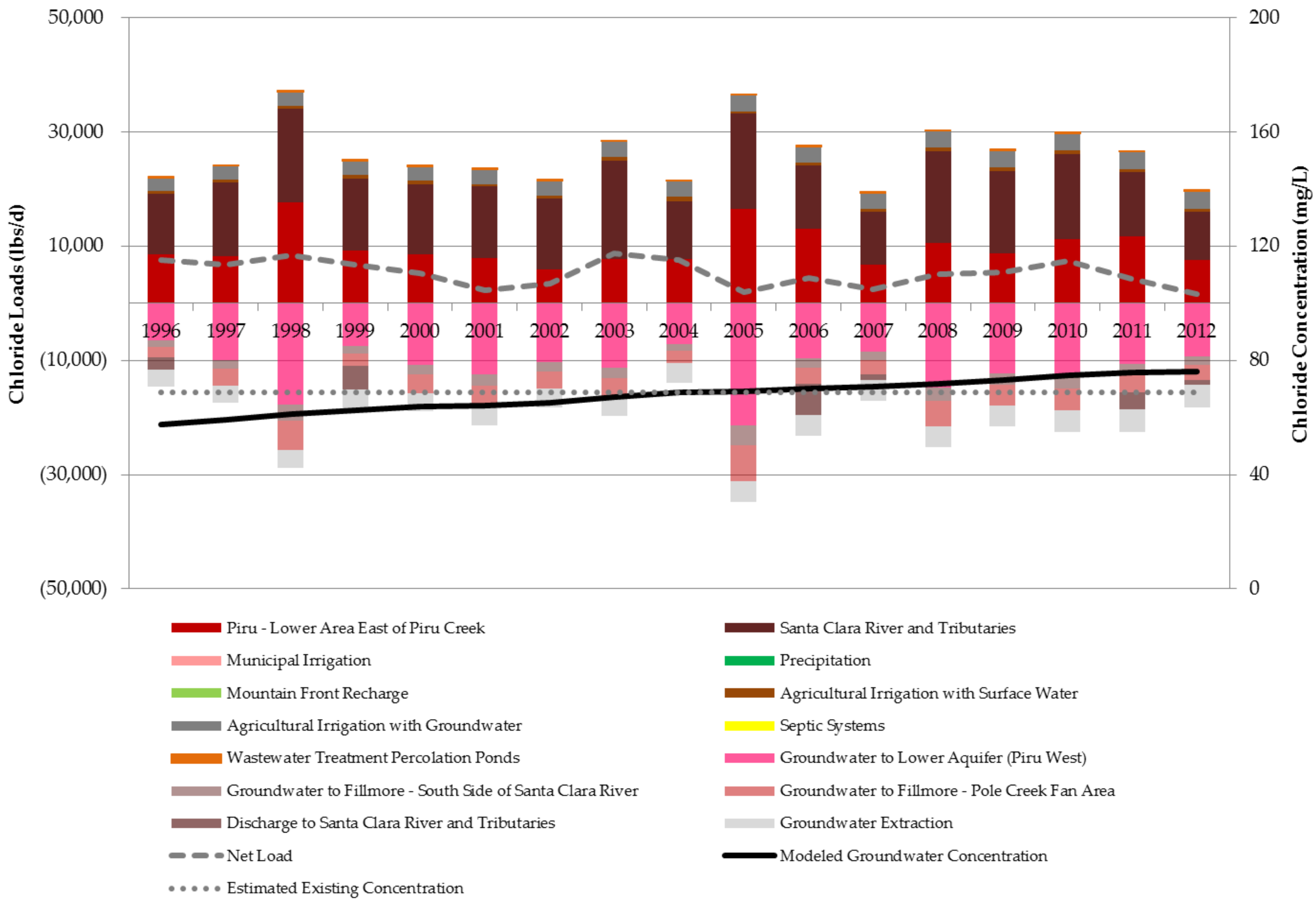


Figure 7-11 Modeled Annual Chloride Loads and Concentrations in Groundwater for Piru Basin – Lower Area West of Piru Creek

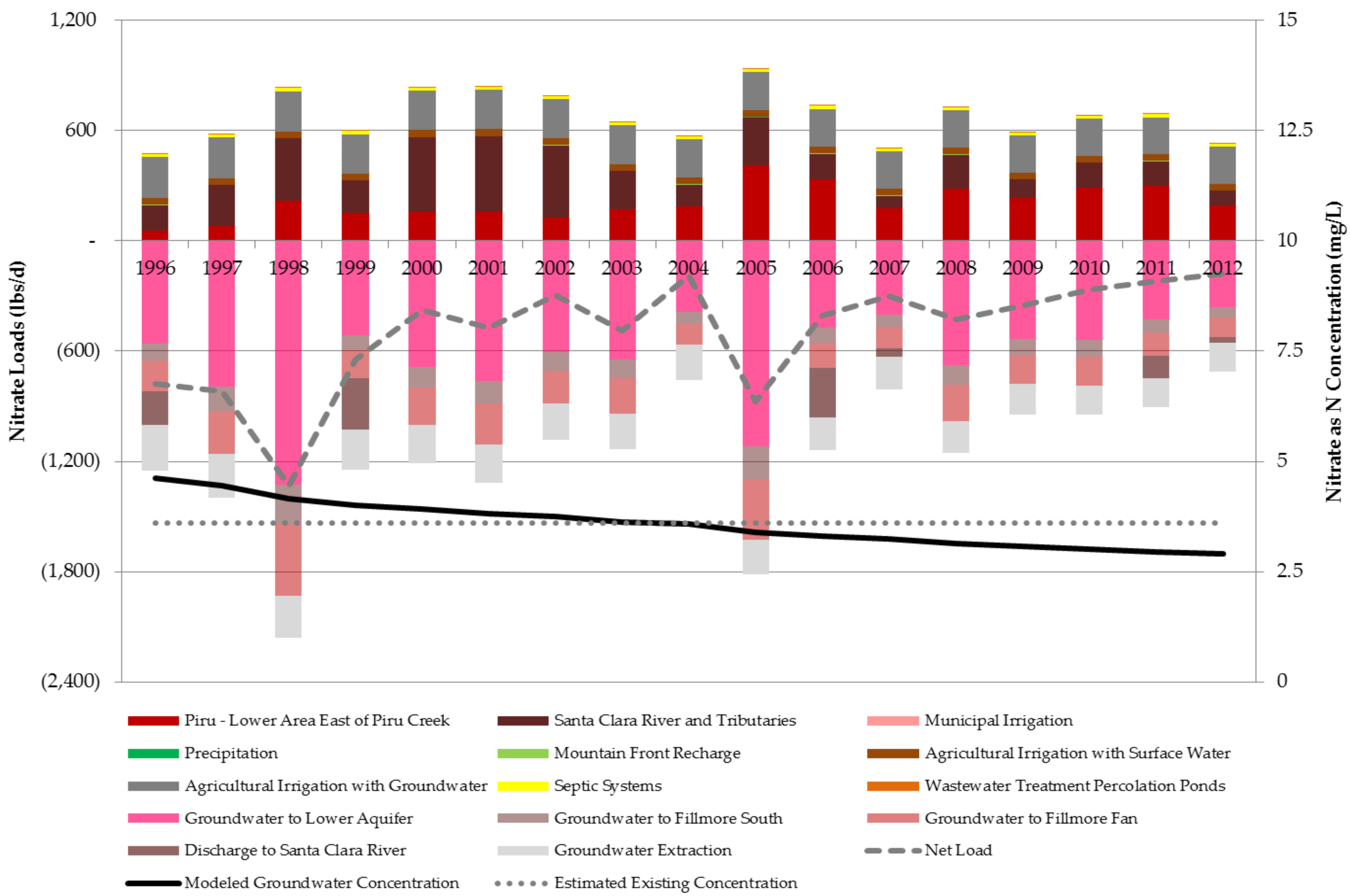


Figure 7-12 Modeled Annual Nitrate-N Loads and Concentrations in Groundwater for Piru Basin – Lower Area West of Piru Creek

7.3.4 Fillmore Basin – Pole Creek Fan Area

In this subarea, the largest non-land use based groundwater inflow and load is from streambed percolation from the SCR and Pole Creek, but there are also large amounts of underflow from the Piru basin to the west and from the LAS (**Figure 7-13**). The large amount of underflow from the LAS is consistent with rising groundwater discharging to the Santa Clara River in this subarea. The main land use based loads are wastewater percolation ponds, agricultural irrigation, and municipal irrigation. Streambed percolation is the largest inflow and is estimated to have concentrations that dilute calculated groundwater concentrations for all three constituents (**Table 7-6**).

The mass balance model shows that existing loads in this subarea result in modeled concentrations in groundwater (**Table 7-2**) that are below water quality objectives for TDS (2,000 mg/L), chloride (100 mg/L) and nitrate-N (10 mg/L). This is consistent with the finding that the subarea has assimilative capacity for all three constituents based on groundwater quality data.

The modeled concentrations for TDS (**Figure 7-14**), chloride (**Figure 7-15**) and nitrate-N (**Figure 7-16**) are similar to the estimated existing concentrations for the subarea. Modeled annual concentrations in the subarea show little variation in response to hydrologic conditions.

Table 7-6 Mass Balance Model Average Loads and Steady State Concentrations for Fillmore Basin – Pole Creek Fan Area

		TDS		Chloride		Nitrate as N	
	Inflow (AFY)	**Concentration (mg/L)**	**Load (lbs/d)**	**Concentration (mg/L)**	**Load (lbs/d)**	**Concentration (mg/L)**	**Load (lbs/d)**
Groundwater Flows							
Piru - Lower Area West of Piru Creek	6,730	1,000	50,350	70	3,320	3.7	190
Lower Aquifer (Fillmore Fan)	15,590	1,090	125,970	60	7,260	3.2	370
Non Land Use Surface Flows							
Santa Clara River and Tributaries	3,540	930	24,530	60	1,480	2.4	60
Precipitation	1,830	10	140	0.1	1	0.1	1
Mountain Front Recharge	170	10	13	0.1	0	0.1	0
Land Use Surface Flows							
Municipal Irrigation	190	1,670	2,320	80	110	4.7	7
Agricultural Irrigation with Groundwater	930	3,660	25,340	200	1,350	12.9	90
Wastewater Treatment Percolation Ponds	1,040	1,190	9,200	100	770	3.4	30
Septic Systems	30	1,190	240	100	20	40.0	8
Inflow Totals[1]							
Groundwater Flows	22,320		176,320		10,580		560
Non Land Use Surface Flows	5,540		24,680		1,480		70
Land Use Surface Flows	2,180		37,090		2,250		130
Total Inflows and Loads	30,040		238,090		14,310		750
Outflows	**Outlow (AFY)**		**Flux (lbs/d)**		**Flux (lbs/d)**		**Flux (lbs/d)**
Groundwater Flows							
Fillmore - South Side of Santa Clara River	-10,040		-82,050		-4,390		-210
Fillmore - Remaining Northwest	-9,030		-73,810		-3,950		-190
Groundwater Production	-10,970		-89,630		-4,810		-230
Total Outflows and Loads	-30,040		-245,490		-13,150		-630

[1] May include rounding error

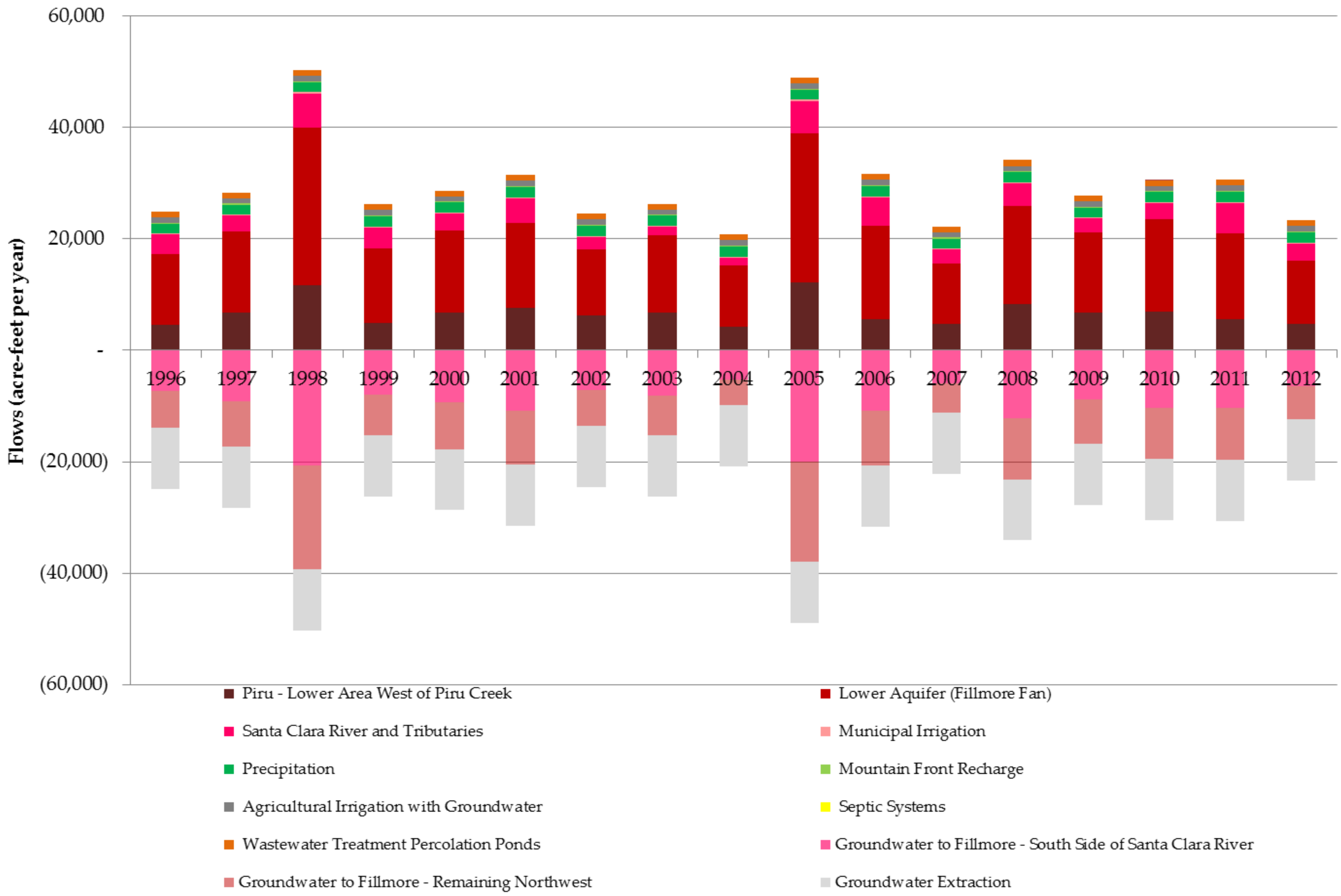


Figure 7-13 Modeled Annual Inflows and Outflows for the Fillmore Basin – Pole Creek Fan Area

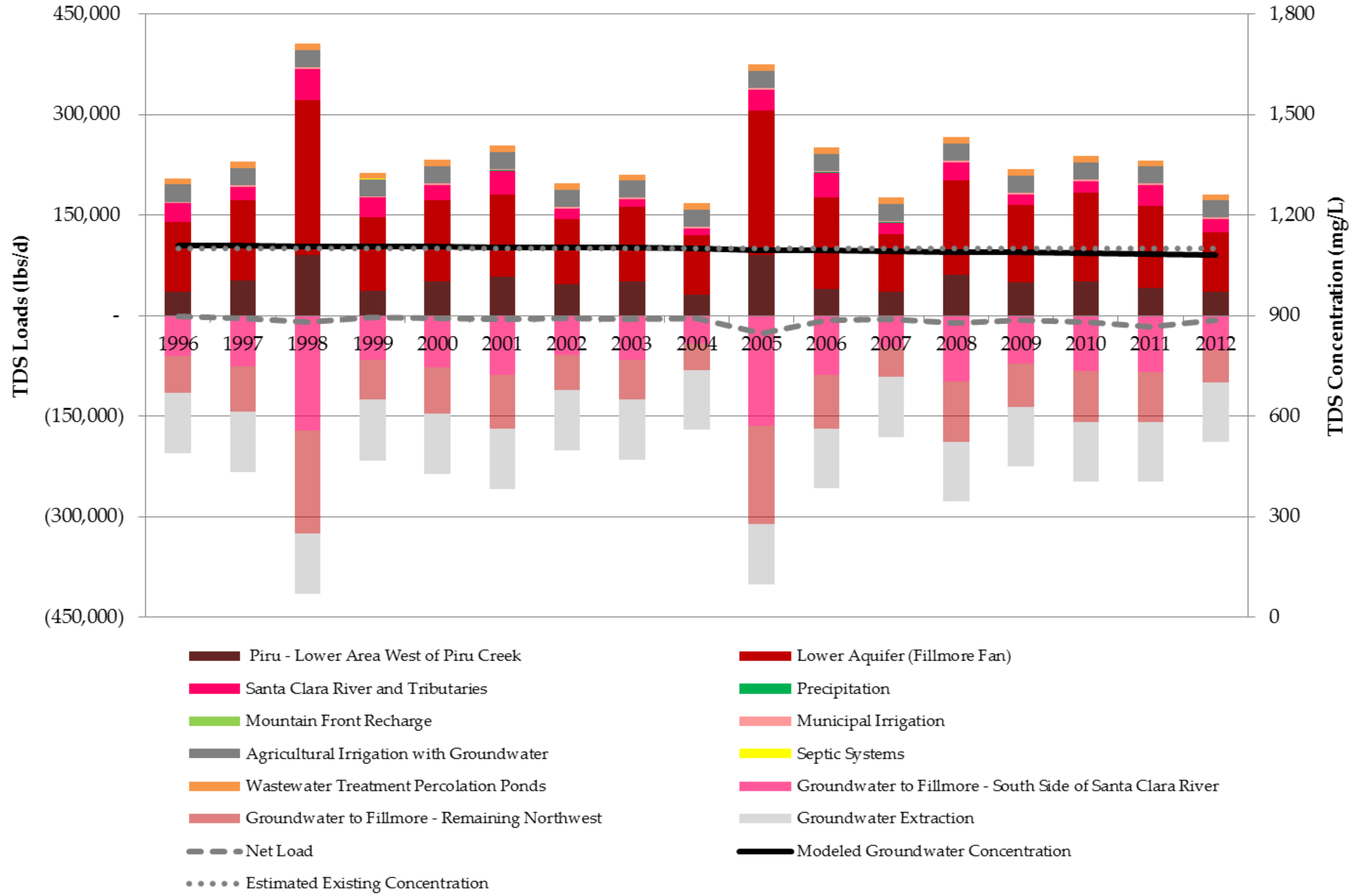


Figure 7-14 Modeled Annual TDS Loads and Concentrations in Groundwater for Fillmore Basin – Pole Creek Fan Area

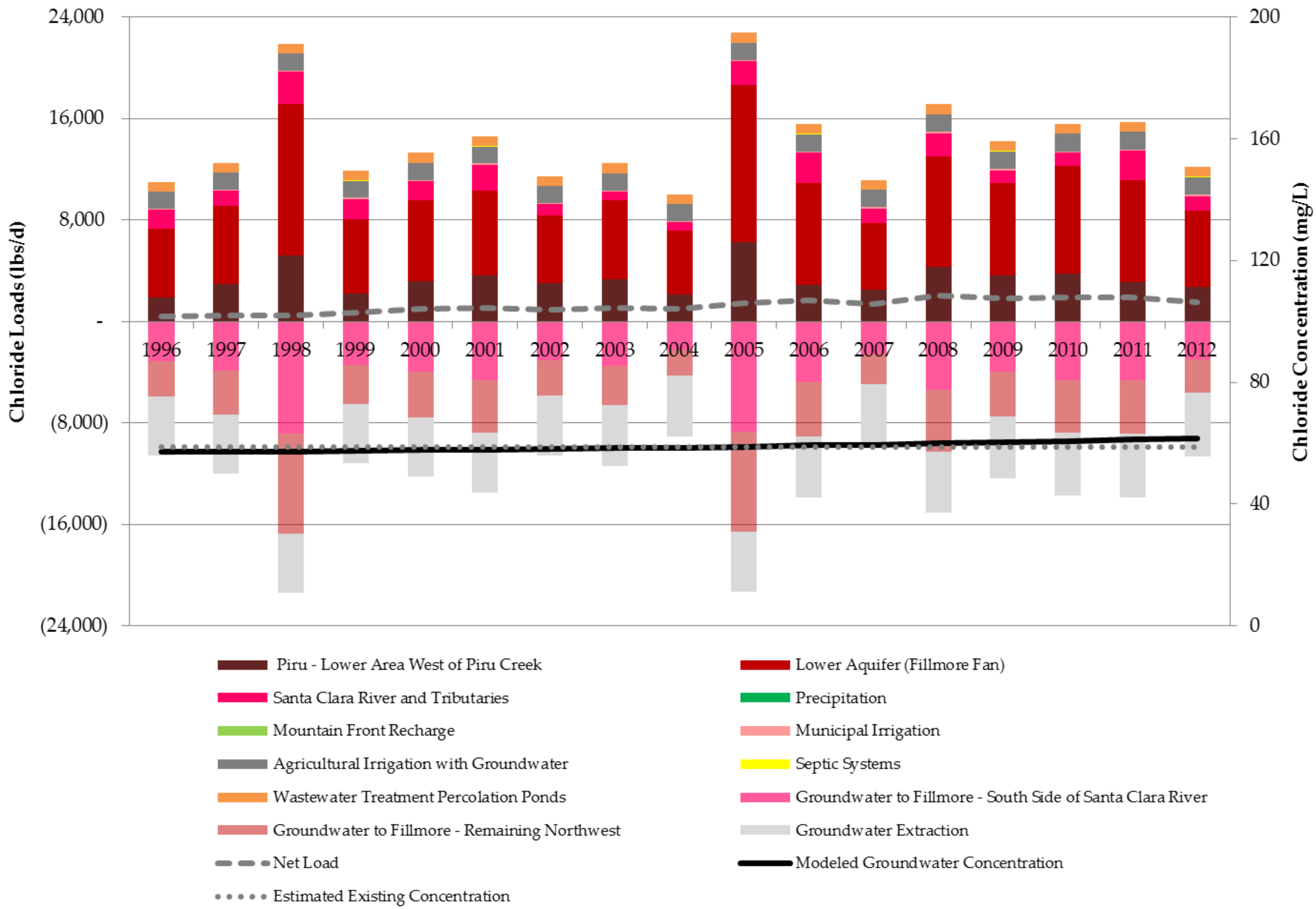


Figure 7-15 Modeled Annual Chloride Loads and Concentrations in Groundwater for Fillmore Basin – Pole Creek Fan Area Creek

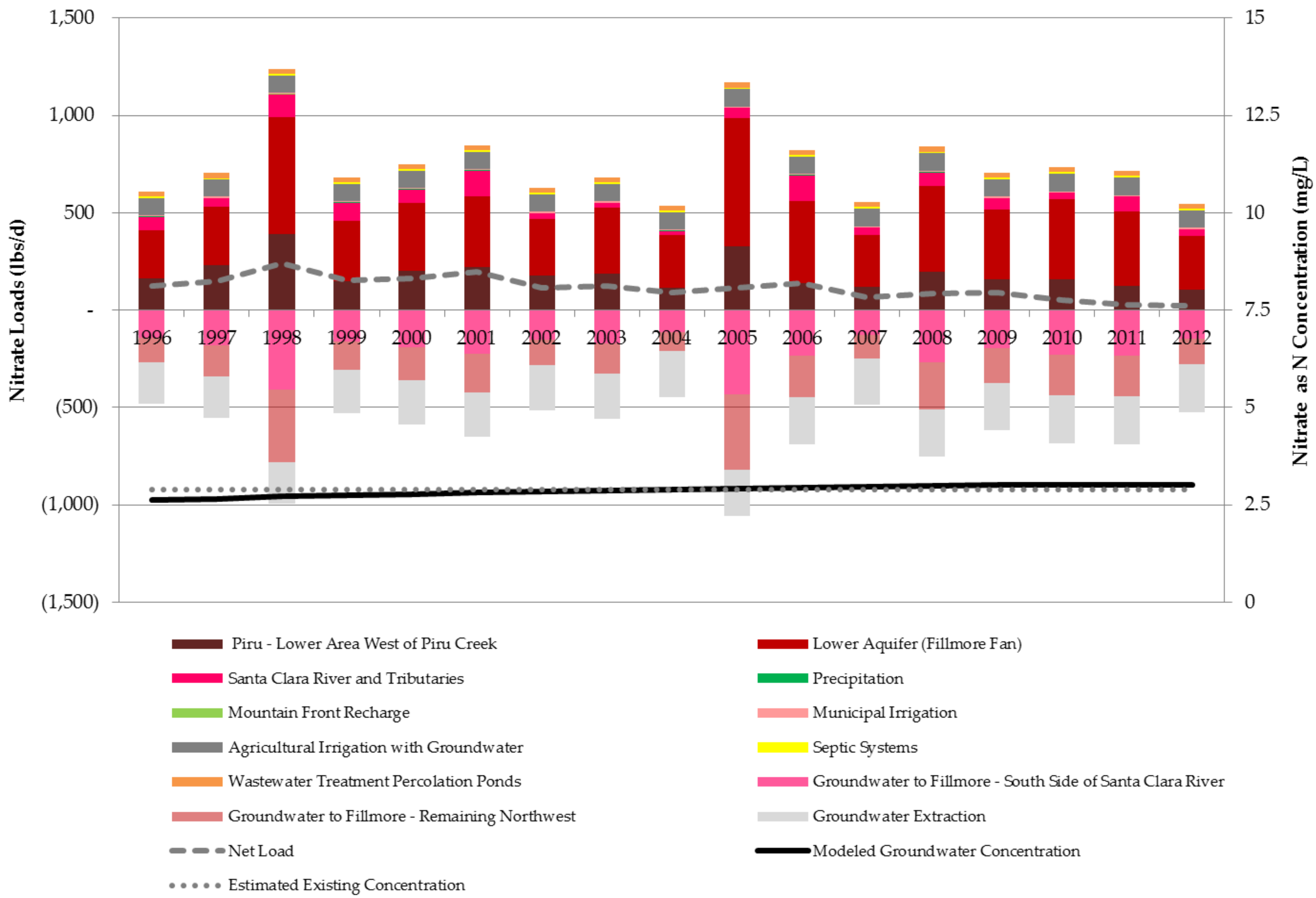


Figure 7-16 Modeled Annual Nitrate-N Loads and Concentrations in Groundwater for Fillmore Basin – Pole Creek Fan Area

7.3.5 Fillmore Basin – South of Santa Clara River

In this subarea, the largest non-land use based inflow and load is from underflow from the Pole Creek Fan Area, but there are also large amounts of underflow from Piru Basin and the LAS as well as streambed percolation from the SCR (**Figure 7-17**). The large amount of underflow from the LAS is consistent with rising groundwater discharging to the Santa Clara River in this subarea. The main land use based load is agricultural irrigation with groundwater (**Table 7-7**).

The mass balance model shows that existing loads in this subarea result in modeled concentrations in groundwater that are below water quality objectives for TDS (1,500 mg/L), chloride (100 mg/L) and nitrate-N (10 mg/L). This is consistent with the finding that the subarea has assimilative capacity for all three constituents based on groundwater quality data.

The modeled concentrations for TDS (**Figure 7-18**), chloride (**Figure 7-19**), and nitrate-N (**Figure 7-20**) are similar to the estimated existing concentrations for the subarea. Modeled annual concentrations in the subarea show little variation in response to hydrologic conditions.

Table 7-7. Mass Balance Model Average Loads and Steady State Concentrations for Fillmore Basin – South of Santa Clara River

		TDS		Chloride		Nitrate as N	
	Inflow (AFY)	**Concentration (mg/L)**	**Load (lbs/d)**	**Concentration (mg/L)**	**Load (lbs/d)**	**Concentration (mg/L)**	**Load (lbs/d)**
Groundwater Flows							
Piru - Lower Area West of Piru Creek	3,750	1,000	28,040	70	1,850	3.7	100
Lower Aquifer (Fillmore South)	4,740	1,340	47,290	70	2,570	5.2	190
Fillmore - Pole Creek Fan Area	10,040	1,100	82,200	60	4,370	2.8	210
Non Land Use Surface Flows							
Santa Clara River and Tributaries	3,100	930	21,490	60	1,300	2.4	60
Precipitation	2,910	10	220	0.1	2	0.1	2
Mountain Front Recharge	1,820	10	140	0.1	1	0.1	1
Land Use Surface Flows							
Municipal Irrigation	40	1,670	440	80	20	4.7	1
Agricultural Irrigation with Groundwater	3,390	4,690	118,540	250	6,240	30.0	640
Recycled Water	50	4,960	1,910	970	370	8.0	3
Septic Systems	70	1,190	610	100	50	40.0	20
Inflow Totals[1]							
Groundwater Flows	18,530		157,530		8,800		500
Non Land Use Surface Flows	7,820		21,850		1,300		60
Land Use Surface Flows	3,550		121,500		6,690		660
Total Inflows and Loads	29,900		300,870		16,790		1,230
Outflows	**Outlow (AFY)**		**Flux (lbs/d)**		**Flux (lbs/d)**		**Flux (lbs/d)**
Groundwater Flows							
Fillmore - Remaining Northwest	-8,120		-85,050		-4,490		-340
Santa Paula - East of Peck Road	-3,260		-34,090		-1,800		-140
Seepage to Santa Clara River	-7,210		-75,470		-3,980		-300
Groundwater Production	-11,310		-118,400		-6,250		-470
Total Outflows and Loads	-29,900		-313,010		-16,520		-1,250

[1] May include rounding error

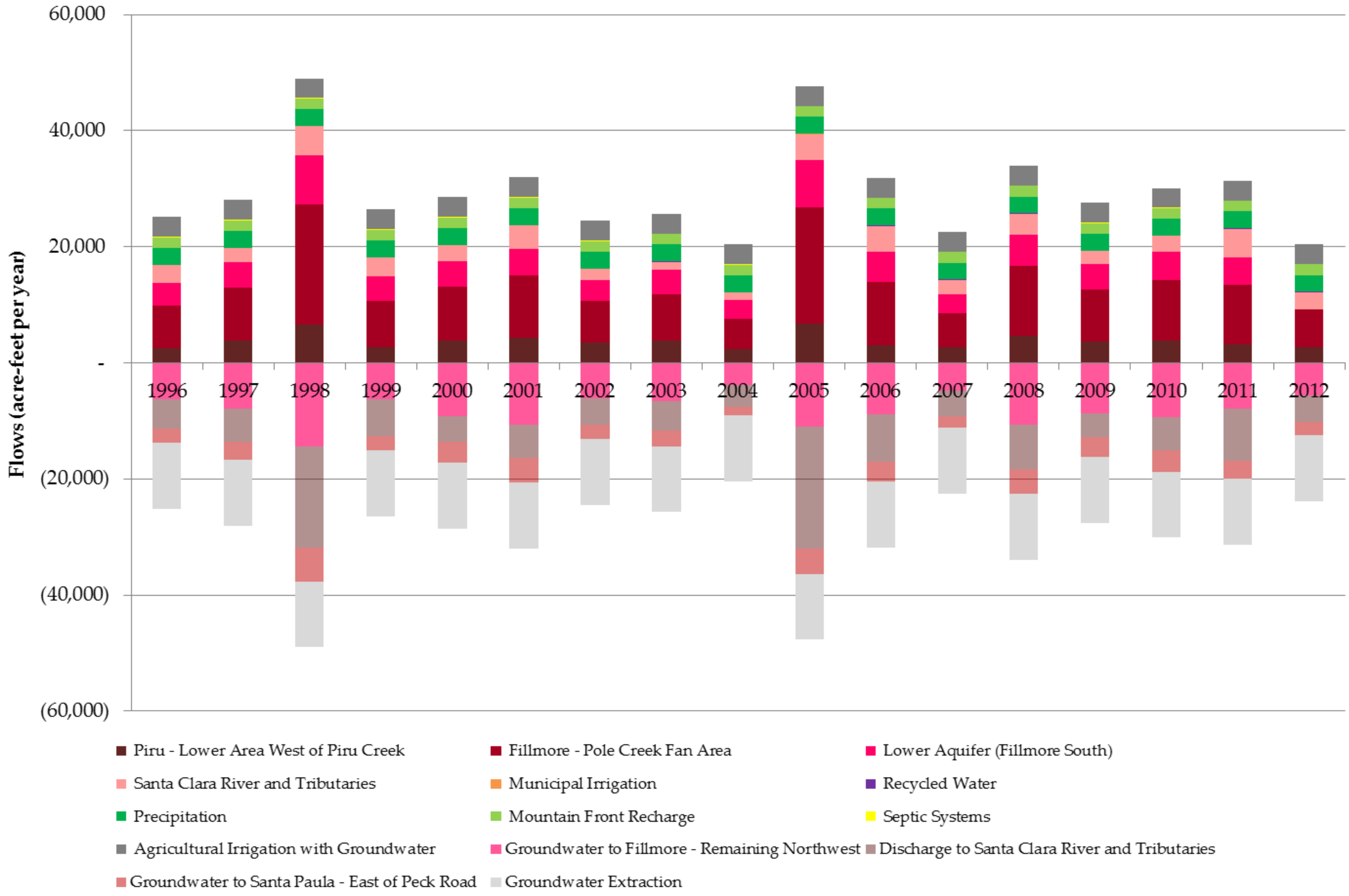


Figure 7-17 Modeled Annual Inflows and Outflows for Fillmore Basin – South of the Santa Clara River

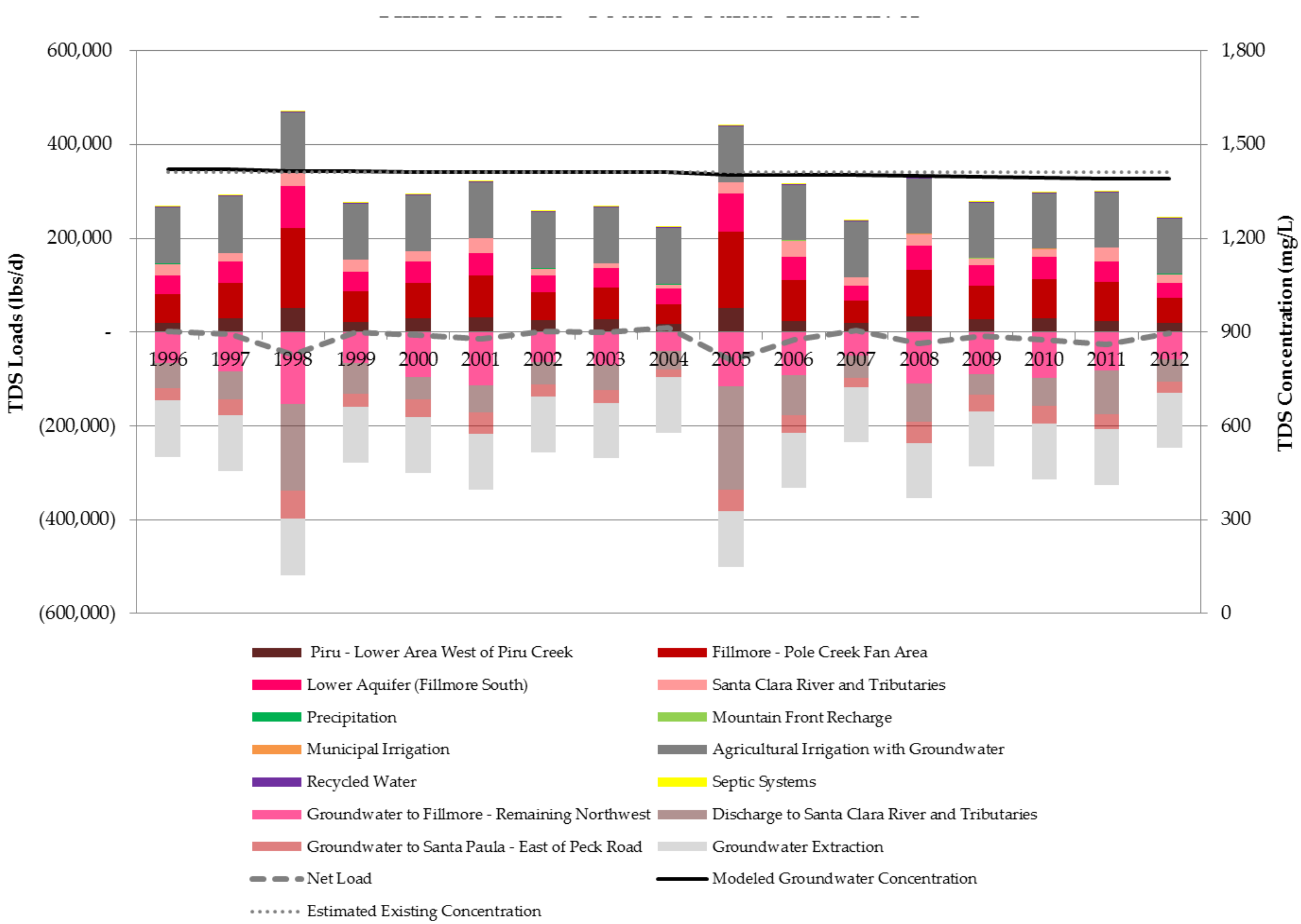


Figure 7-18 Modeled Annual TDS Loads and Concentrations in Groundwater for Fillmore Basin – South of Santa Clara River

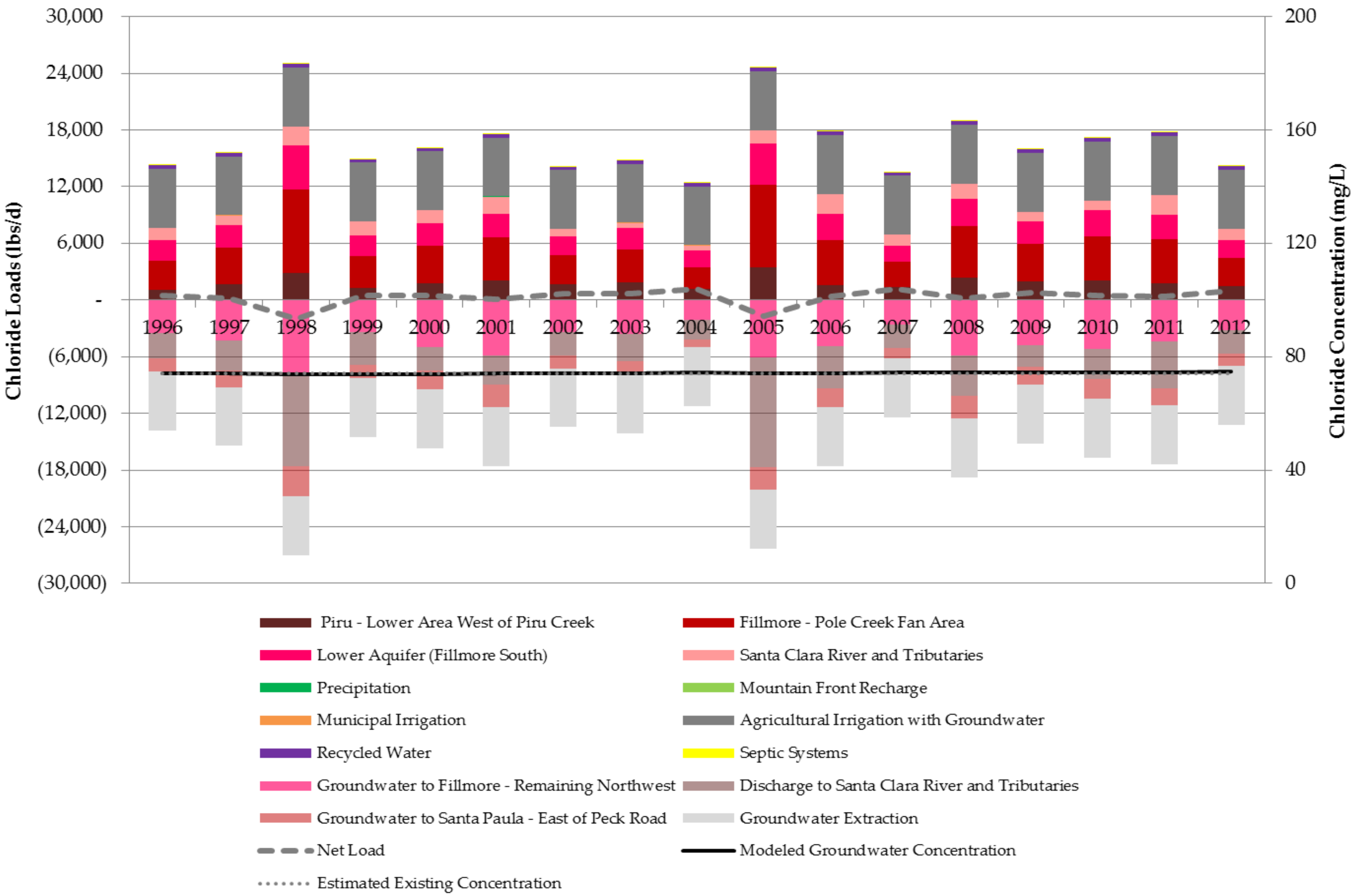


Figure 7-19 Modeled Annual Chloride Loads and Concentrations in Groundwater for Fillmore Basin – South of Santa Clara River

Figure 7-20 Modeled Annual Nitrate-N Loads and Concentrations in Groundwater for Fillmore Basin – South of Santa Clara River

7.3.6 Fillmore Basin – Remaining Area

In this subarea, the largest non-land use based inflow and load is from underflow from the other two Fillmore basin subareas and the LAS but there are also large amounts from streambed percolation from the Sespe Creek (**Figure 7-21**). The large amount of underflow from the LAS is consistent with rising groundwater discharging to the Santa Clara River in this subarea. The main land use based load is agricultural irrigation from groundwater (**Table 7-8**).

The mass balance model shows that existing loads in this subarea result in modeled concentrations in groundwater (**Table7-2**) that are below water quality objectives for TDS (1,000 mg/L) and nitrate-N (10 mg/L). This is consistent with the finding that the subarea has assimilative capacity for these two constituents based on groundwater quality data. However, the mass balance model shows that existing chloride loads result in modeled concentrations in groundwater approaching the water quality objective for chloride (50 mg/L), while the average subarea concentration based on groundwater quality data is just below the water quality objective.

The modeled concentrations for TDS (**Figure 7-22**) and chloride (**Figure 7-23**) in groundwater show a trend that increases concentrations above the estimated existing concentration for the subarea. The modeled steady state concentrations for nitrate-N are similar to the estimated existing concentration. Modeled annual concentrations in the subarea show little variation in response to hydrologic conditions.

Table 7-8 Mass Balance Model Average Loads and Steady State Concentrations for Fillmore Basin – Remaining Area

		TDS		Chloride		Nitrate as N	
	Inflow (AFY)	**Concentration (mg/L)**	**Load (lbs/d)**	**Concentration (mg/L)**	**Load (lbs/d)**	**Concentration (mg/L)**	**Load (lbs/d)**
Groundwater Flows							
Fillmore - Pole Creek Fan Area	9,030	1,100	73,950	60	3,940	2.8	190
Fillmore - South Side of Santa Clara River	8,120	1,410	85,200	70	4,490	5.6	340
Lower Aquifer (Fillmore Northwest)	3,870	830	23,930	40	1,230	6.0	170
Non Land Use Surface Flows							
Santa Clara River and Tributaries	5,830	630	27,540	50	2,240	0.2	9
Precipitation	4,430	10	330	0.1	3	0.1	3
Mountain Front Recharge	1,540	10	110	0.1	1	0.1	1
Land Use Surface Flows							
Agricultural Irrigation with Groundwater	5,160	2,780	106,780	140	5,510	30	1,220
Septic Systems	110	1,190	970	100	80	40	30
Inflow Totals[1]							
Groundwater Flows	21,030		183,080		9,650		700
Non Land Use Surface Flows	11,800		27,980		2,240		14
Land Use Surface Flows	5,300		108,120		5,610		1,260
Total Inflows and Loads	38,130		319,180		17,500		1,970
Outflows	**Outlow (AFY)**		**Flux (lbs/d)**		**Flux (lbs/d)**		**Flux (lbs/d)**
Groundwater Flows							
Santa Paula - East of Peck Road	-13,730		-86,460		-4,480		-680
Seepage to Santa Clara River	-7,210		-45,280		-2,340		-360
Groundwater Production	-17,190		-108,210		-5,600		-860
Total Outflows and Loads	-38,130		-239,950		-12,420		-1,900

[1] May include rounding error

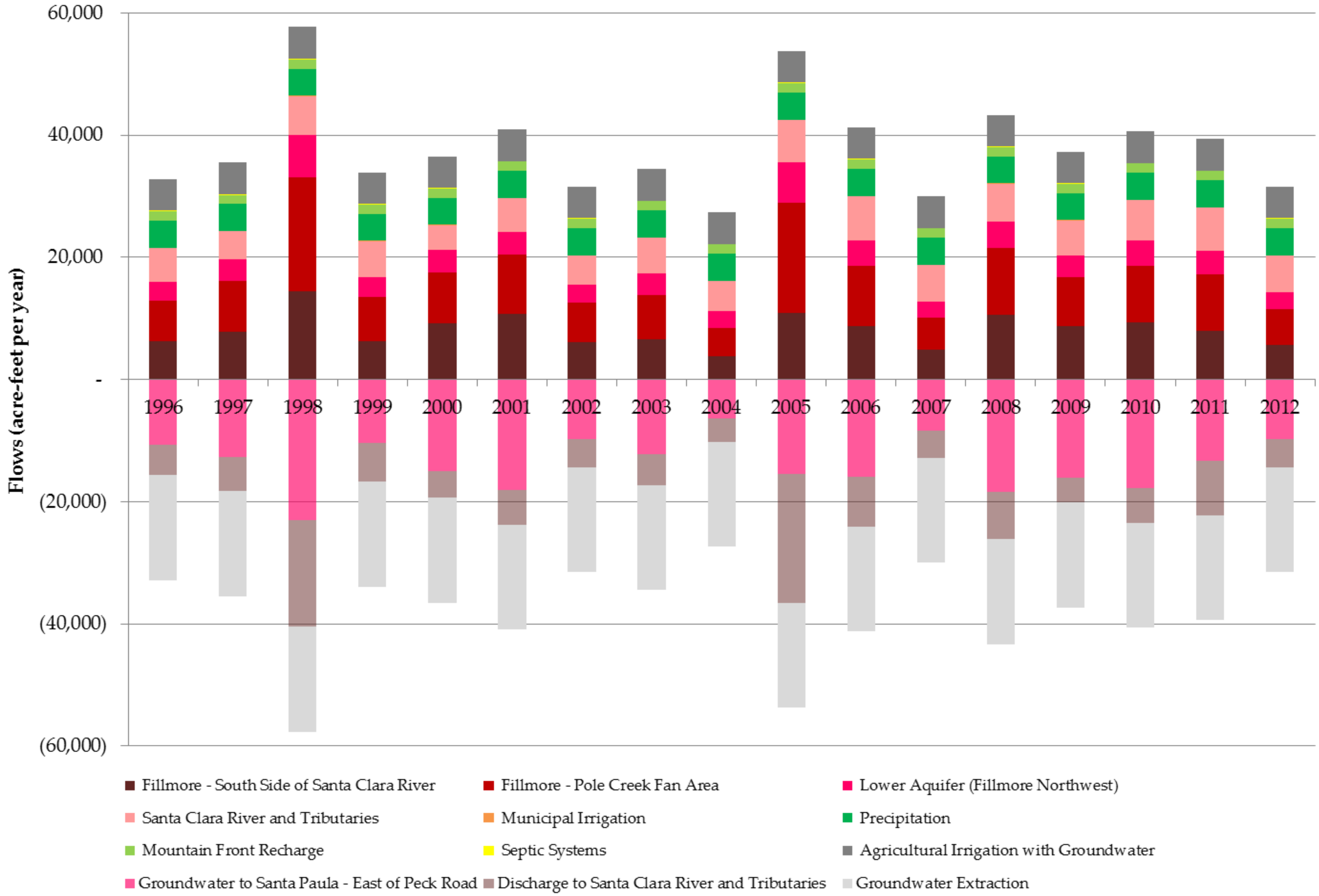


Figure 7-21 Modeled Annual Inflows and Outflows for Fillmore Basin – Remaining Area

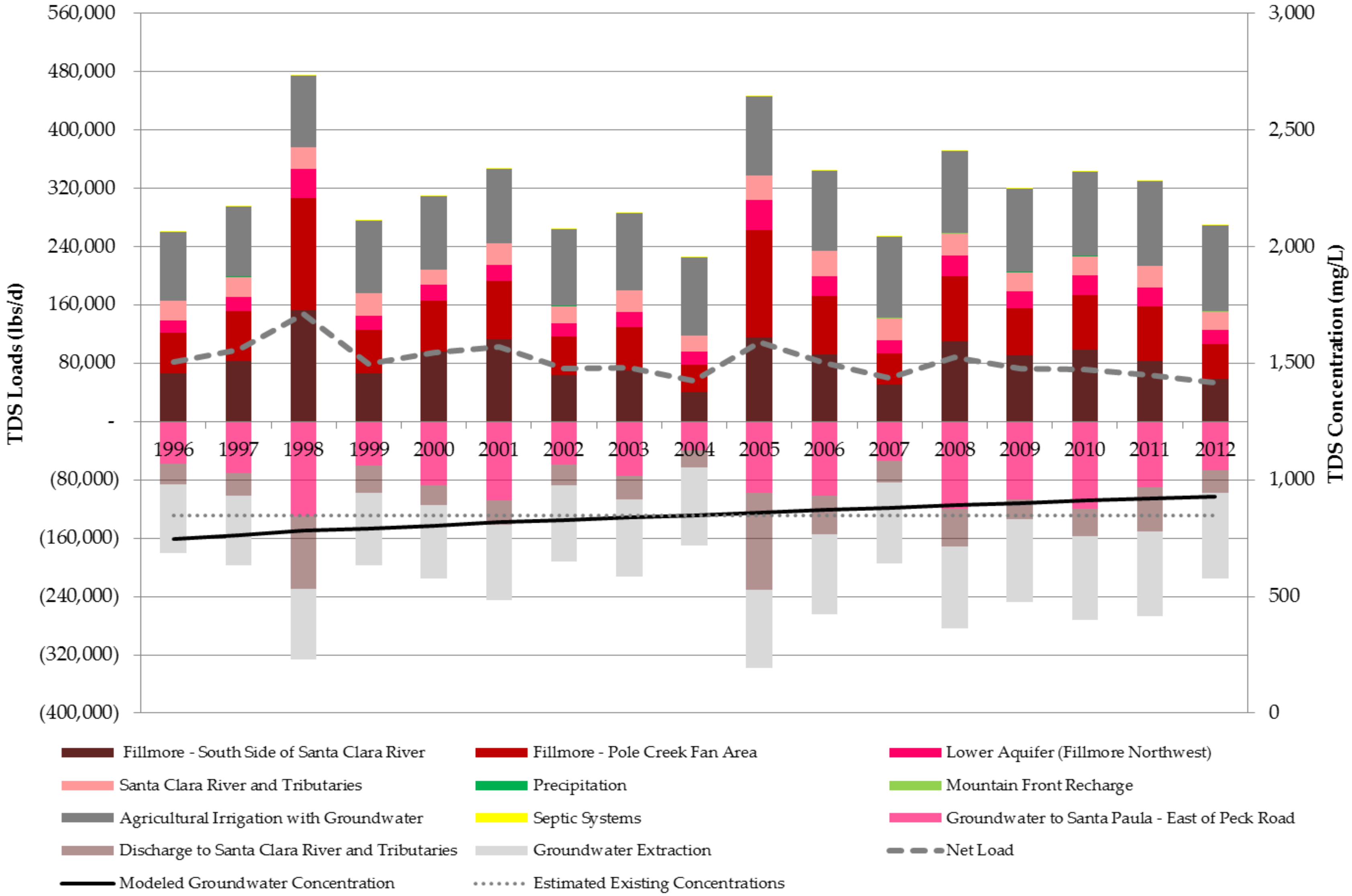


Figure 7-22 Modeled Annual TDS Loads and Concentrations in Groundwater for Fillmore Basin – Remaining Area

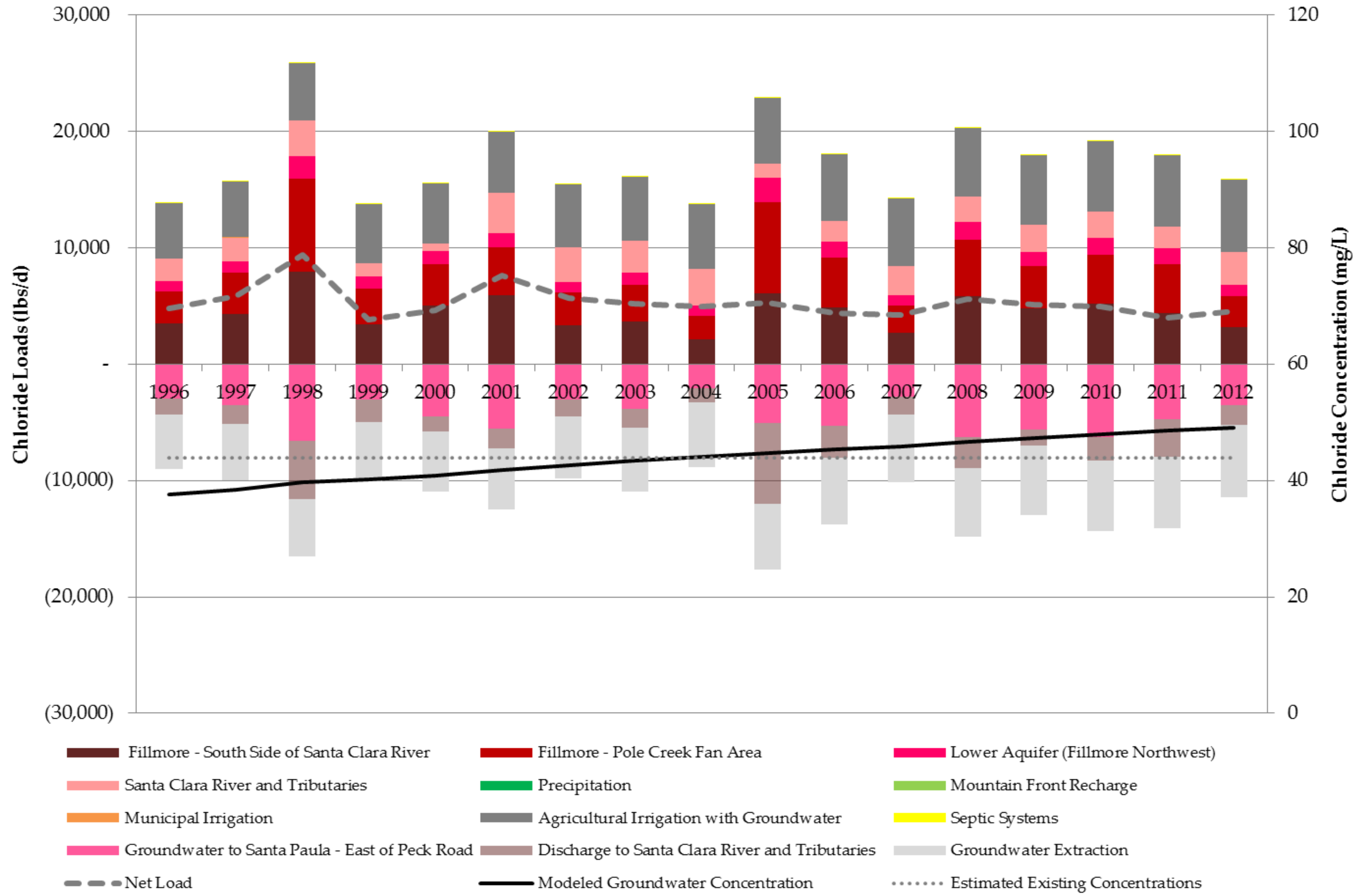


Figure 7-23 Modeled Annual Chloride Loads and Concentrations in Groundwater for Fillmore Basin – Remaining Area

Figure 7-24 Modeled Annual Nitrate-N Loads and Concentrations in Groundwater for Fillmore Basin – Remaining Area

7.3.7 Santa Paula Basin – East of Peck Road

In this subarea, the largest non-land use based inflow and load is from underflow from the Fillmore basin (**Figure 7-25**). The main land use based loads are agricultural irrigation from groundwater and municipal irrigation (**Table 7-9**).

The mass balance model shows that existing loads in this subarea result in modeled concentrations in groundwater (**Table7-2**) that are below water quality objectives for TDS (1,200 mg/L), chloride (100 mg/L) and nitrate-N (10 mg/L). This is consistent with the finding that the subarea has assimilative capacity for all three constituents based on groundwater quality data.

The modeled concentrations for TDS (**Figure 7-26**) and chloride (**Figure 7-27**) are similar to the estimated existing concentration for the subarea. The modeled concentrations for nitrate-N in groundwater show a trend that increases concentrations above the estimated existing concentration for the subarea. This is due to the higher nitrate-N concentrations in groundwater flowing from the Fillmore basin, the largest inflow into the subarea. The high calculated concentration for nitrate-N is also related to the high fertilizer loads assumed for avocados, the crop with the most acreage in the subarea.

Modeled annual concentrations in the subarea show little variation in response to hydrologic conditions.

Table 7-9 Average Loads and Steady State Concentrations for Santa Paula Basin – East of Peck Road

	Inflow (AFY)	TDS Concentration (mg/L)	TDS Load (lbs/d)	Chloride Concentration (mg/L)	Chloride Load (lbs/d)	Nitrate as N Concentration (mg/L)	Nitrate as N Load (lbs/d)
Groundwater Flows							
Fillmore - Remaining Northwest	13,730	830	85,250	40	4,400	6.7	680
Fillmore - South Side of Santa Clara River	3,260	1,410	34,150	70	1,800	5.6	140
Lower Aquifer (Santa Paula East)	2,560	950	18,010	40	760	4.9	90
Non Land Use Surface Flows							
Santa Clara River and Tributaries	1,370	680	6,950	30	310	1.0	10
Precipitation	2,530	10	190	0.1	2	0.1	2
Mountain Front Recharge	2,070	10	150	0.1	2	0.1	2
Land Use Surface Flows							
Municipal Irrigation	390	1,840	5,280	80	240	7.2	20
Agricultural Irrigation with Surface Water	90	2,010	1,410	100	70	30	20
Agricultural Irrigation with Groundwater	1,210	3,190	28,880	130	1,180	40	330
Septic Systems	60	1,270	520	110	40	40	16
Inflow Totals[1]							
Groundwater Flows	19,540		137,410		6,960		910
Non Land Use Surface Flows	5,970		7,300		310		13
Land Use Surface Flows	1,750		36,090		1,530		390
Total Inflows and Loads	27,260		180,790		8,800		1,310
Outflows	**Outlow (AFY)**		**Flux (lbs/d)**		**Flux (lbs/d)**		**Flux (lbs/d)**
Groundwater Flows							
Santa Paula - West of Peck Road	-16,650		-118,430		-4,880		-620
Groundwater Production	-10,620		-75,530		-3,110		-390
Total Outflows and Loads	-27,270		-193,960		-7,990		-1,010

[1] May include rounding error

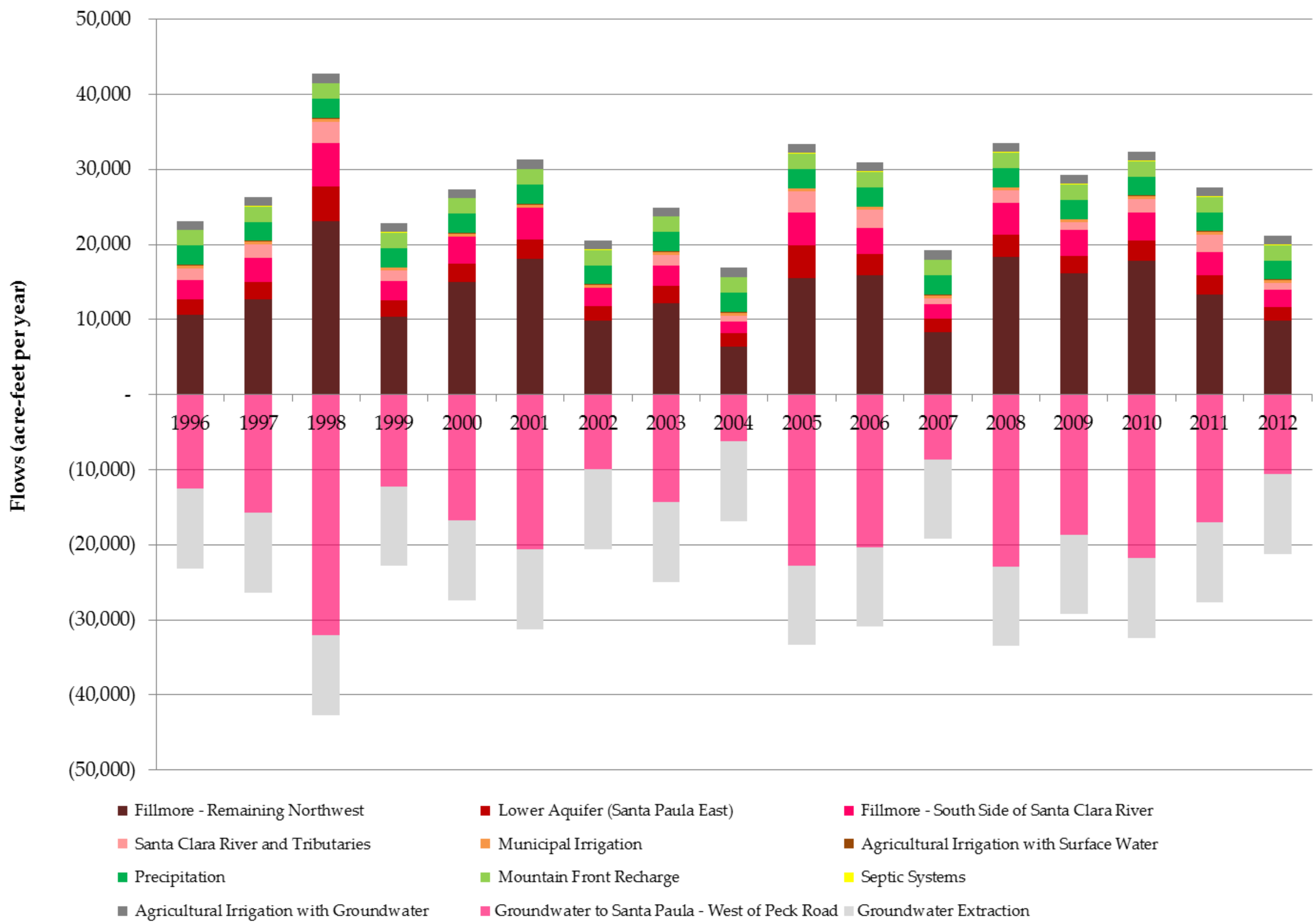


Figure 7-25 Modeled Annual Inflows and Outflows for Santa Paula Basin – East of Peck Road

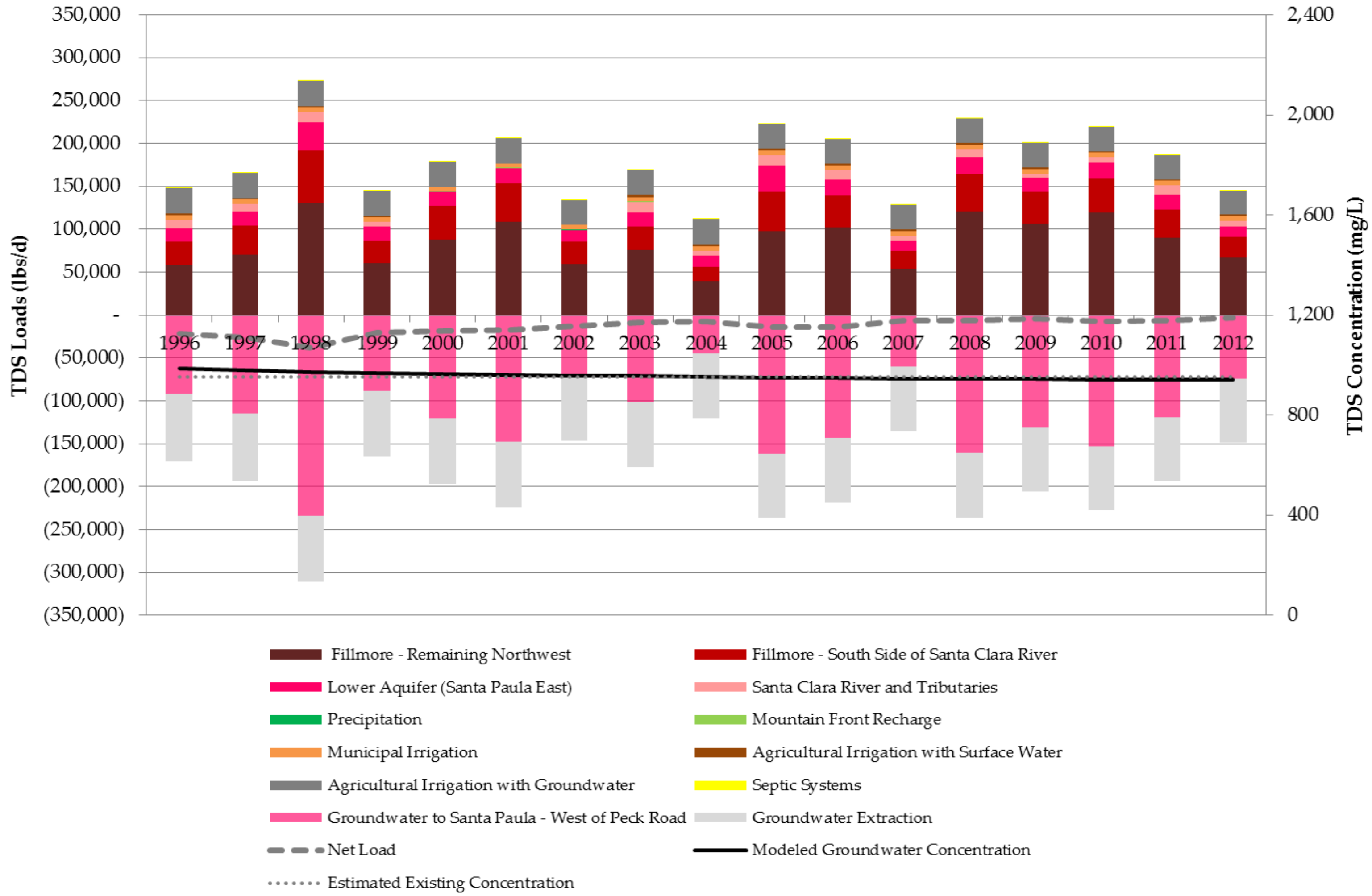


Figure 7-26 Modeled Annual TDS Loads and Concentrations in Groundwater for Santa Paula Basin – East of Peck Road

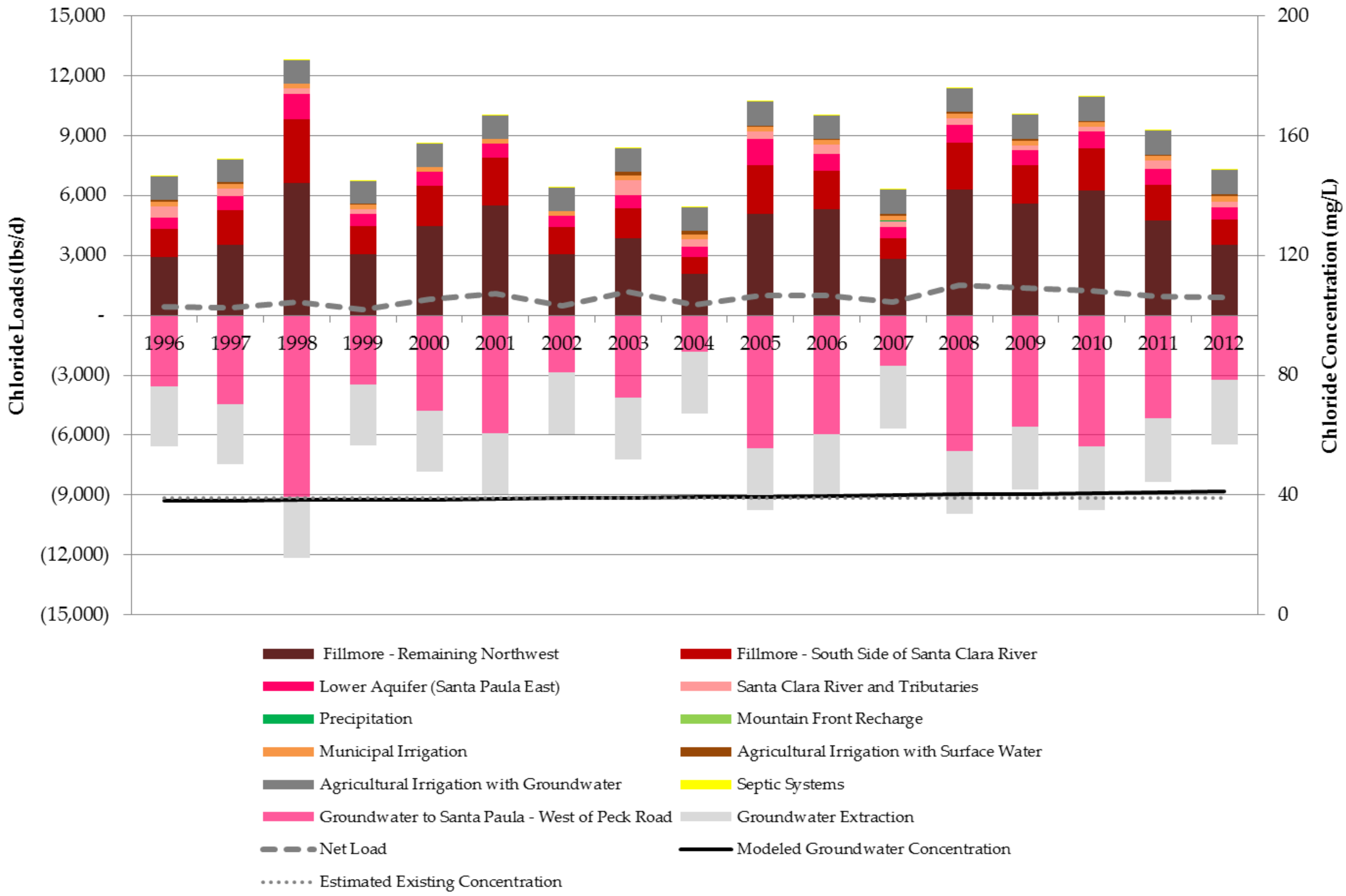


Figure 7-27 Modeled Annual Chloride Loads and Concentrations in Groundwater for Santa Paula Basin – East of Peck Road Area

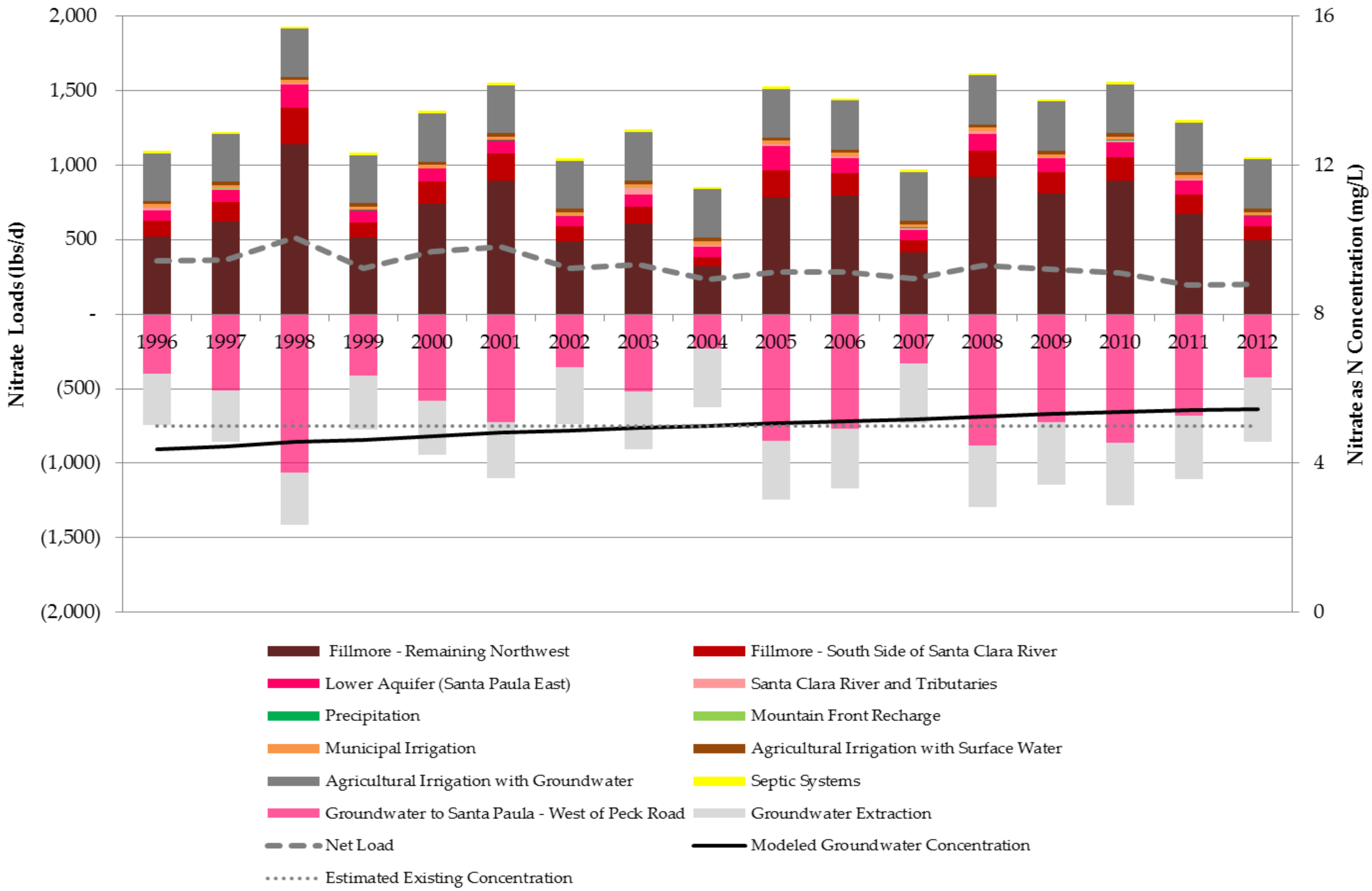


Figure 7-28 Modeled Annual Nitrate-N Loads and Concentrations in Groundwater for Santa Paula Basin – East of Peck Road Area

7.3.8 Santa Paula Basin – West of Peck Road

In this subarea, the largest non-land use based inflow and load is from underflow from Santa Paula basin's east of Peck Road subarea (**Figure 7-29**). The main land use based loads are agricultural irrigation from groundwater and wastewater treatment percolation plants (**Table 7-10**).

The mass balance model shows that existing loads in this subarea result in modeled concentrations in groundwater (**Table7-2**) that are below water quality objectives for TDS (2,000 mg/L), chloride (110 mg/L), and nitrate (10 mg/L). This is consistent with the finding that the subarea has assimilative capacity based on groundwater quality data.

The average modeled steady state concentrations for TDS and chloride are similar to the estimated existing concentrations for the subareas. The modeled concentrations for nitrate-N in groundwater show a trend that increases concentrations above the estimated existing concentration for the subarea. Nitrate-N concentrations in underflow from east of Peck Road subarea are higher than existing concentrations in this subarea. Increasing concentrations modeled for nitrate-N are also related to the high fertilizer loads assumed for avocados, the crop with the 2nd most acreage in the subarea behind lemons.

Modeled annual concentrations in the subarea show little variation in response to hydrologic conditions.

Table 7-10 Average Loads and Steady State Concentrations for Santa Paula Basin – West of Peck Road

	Inflow (AFY)	TDS Concentration (mg/L)	TDS Load (lbs/d)	Chloride Concentration (mg/L)	Chloride Load (lbs/d)	Nitrate as N Concentration (mg/L)	Nitrate as N Load (lbs/d)
Groundwater Flows							
Santa Paula - East of Peck Road	16,650	960	118,830	40	4,860	4.9	610
Non Land Use Surface Flows							
Precipitation	6,240	10	460	0.1	5	0.1	5
Mountain Front Recharge	1,530	10	110	0.1	1	0.1	1
Land Use Surface Flows							
Municipal Irrigation	570	1,840	7,800	80	350	7.2	30
Agricultural Irrigation with Groundwater	6,100	4,300	195,210	260	11,950	30	1,350
Wastewater Treatment Percolation Ponds	2,230	1,300	21,690	150	2,550	6.7	110
Septic Systems	120	1,270	1,130	110	90	40	40
Inflow Totals[1]							
Groundwater Flows	16,650		118,830		4,860		610
Non Land Use Surface Flows	7,770		580		6		6
Land Use Surface Flows	9,030		225,830		14,950		1,530
Total Inflows and Loads	33,440		345,250		19,810		2,140
Outflows	**Outlow (AFY)**		**Flux (lbs/d)**		**Flux (lbs/d)**		**Flux (lbs/d)**
Groundwater Flows							
Oxnard Forebay	-8,090		-86,870		-5,840		-120
Lower Aquifer (Santa Paula West)	-7,110		-76,300		-5,130		-110
Mound	-1,010		-10,870		-730		-16
Seepage to Santa Clara River	-3,460		-37,240		-2,530		-40
Groundwater Production	-13,770		-147,970		-9,970		-200
Total Outflows and Loads	-33,440		-359,250		-24,200		-486

[1] May include rounding error

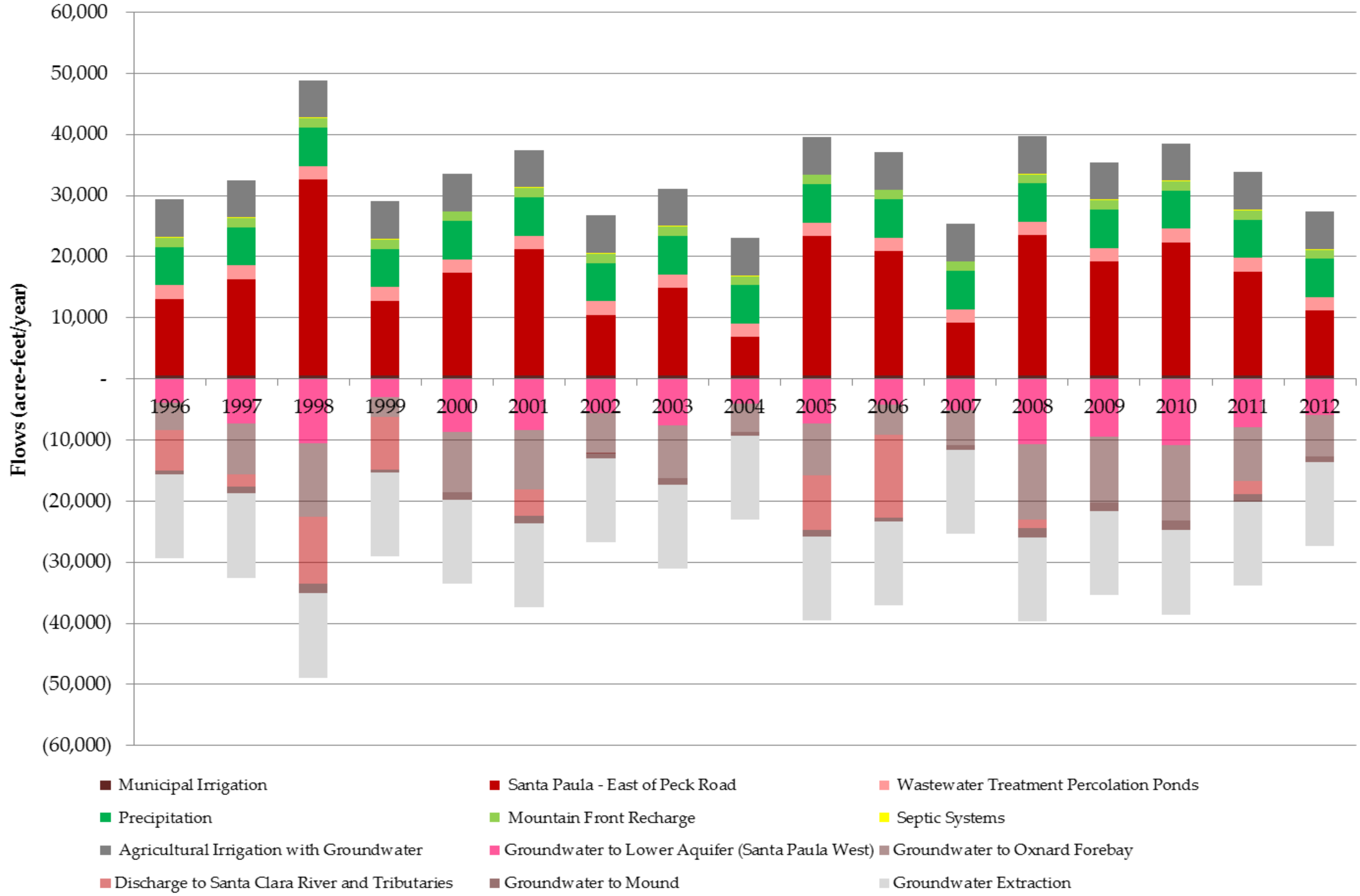


Figure 7-29 Modeled Annual Inflows and Outflows for Santa Paula Basin – West of Peck Road

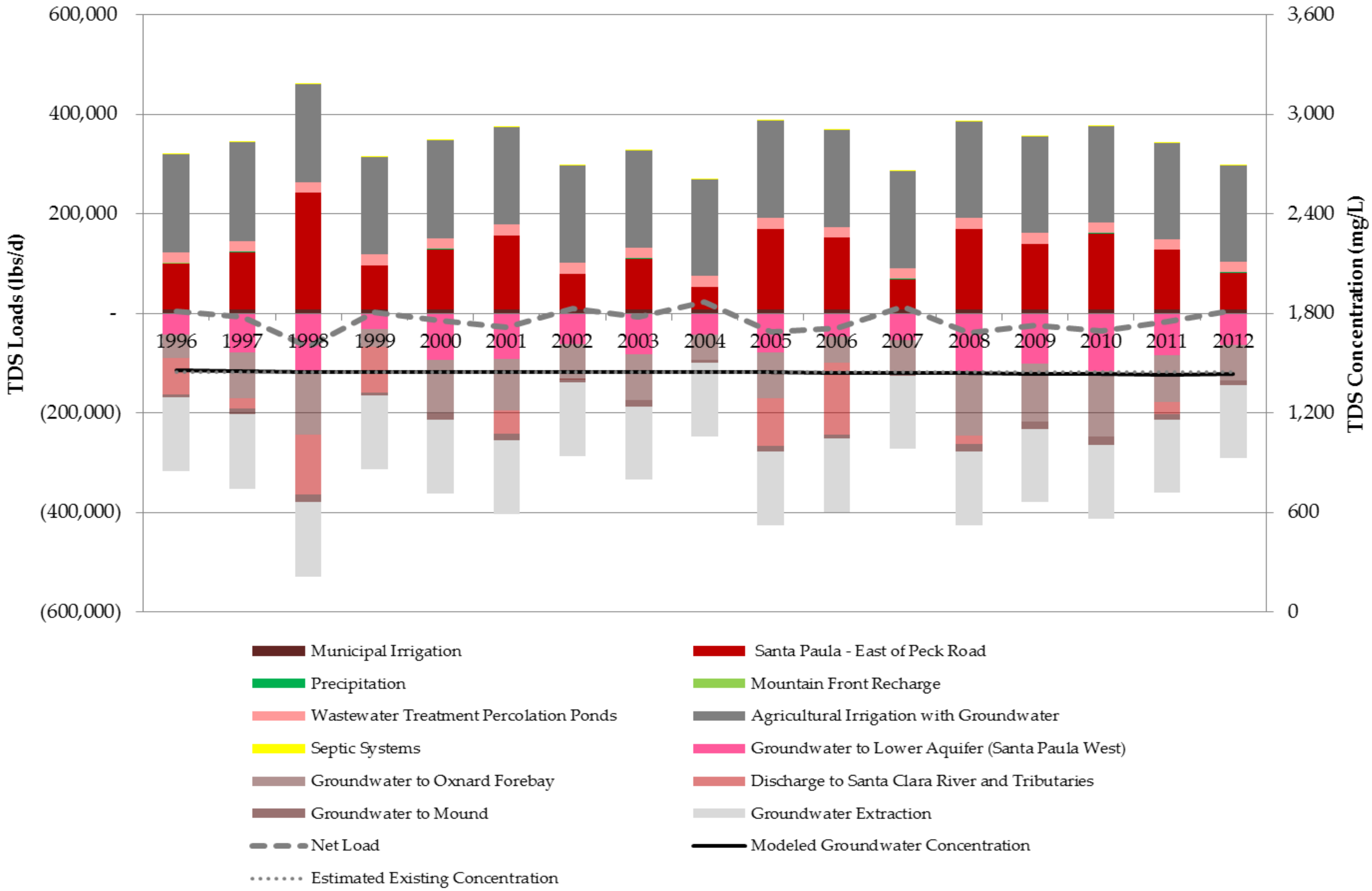


Figure 7-30 Modeled Annual TDS Loads and Concentrations in Groundwater for Santa Paula Basin – West of Peck Road

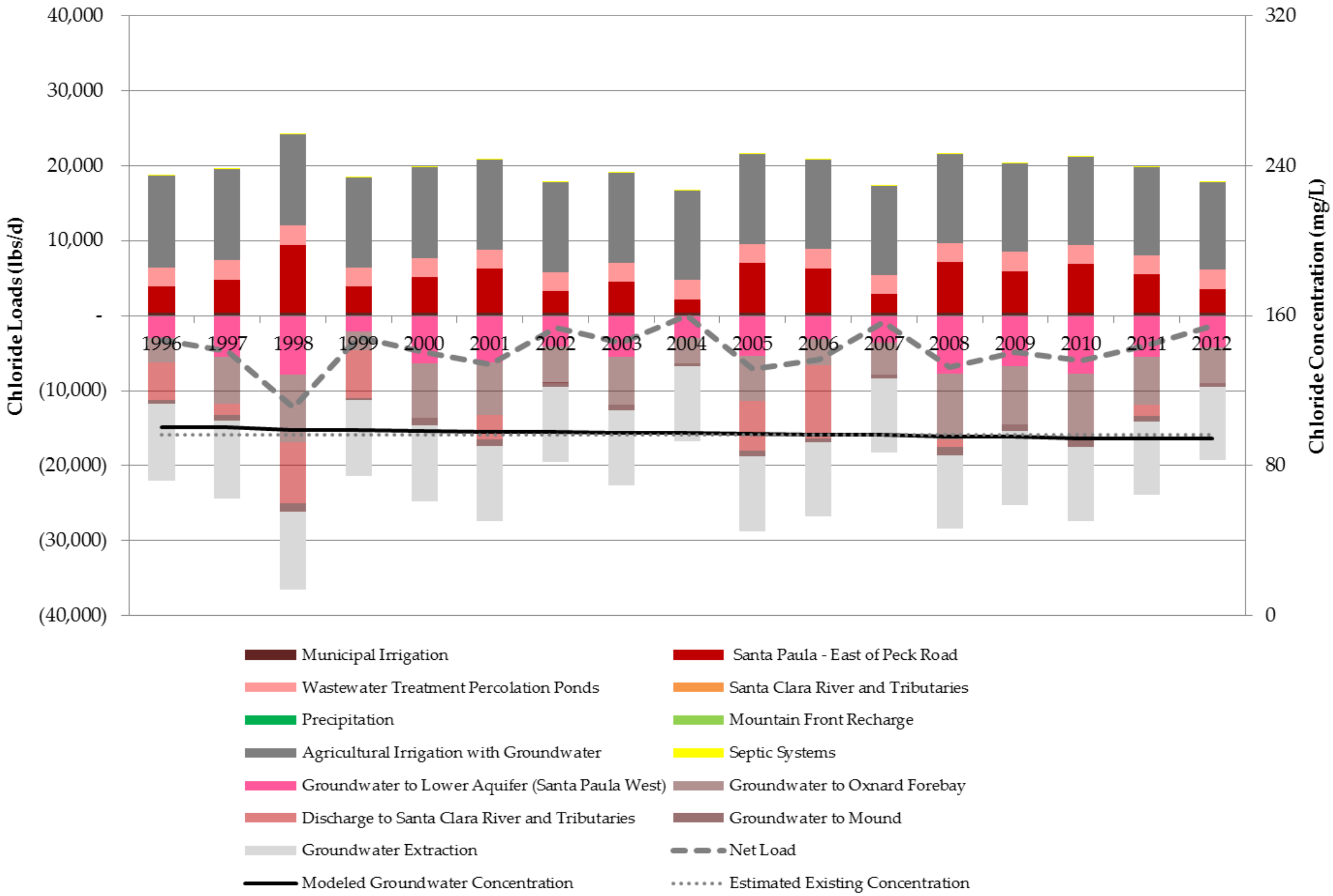


Figure 7-31 Modeled Annual Chloride Loads and Concentrations in Groundwater for Santa Paula Basin – West of Peck Road

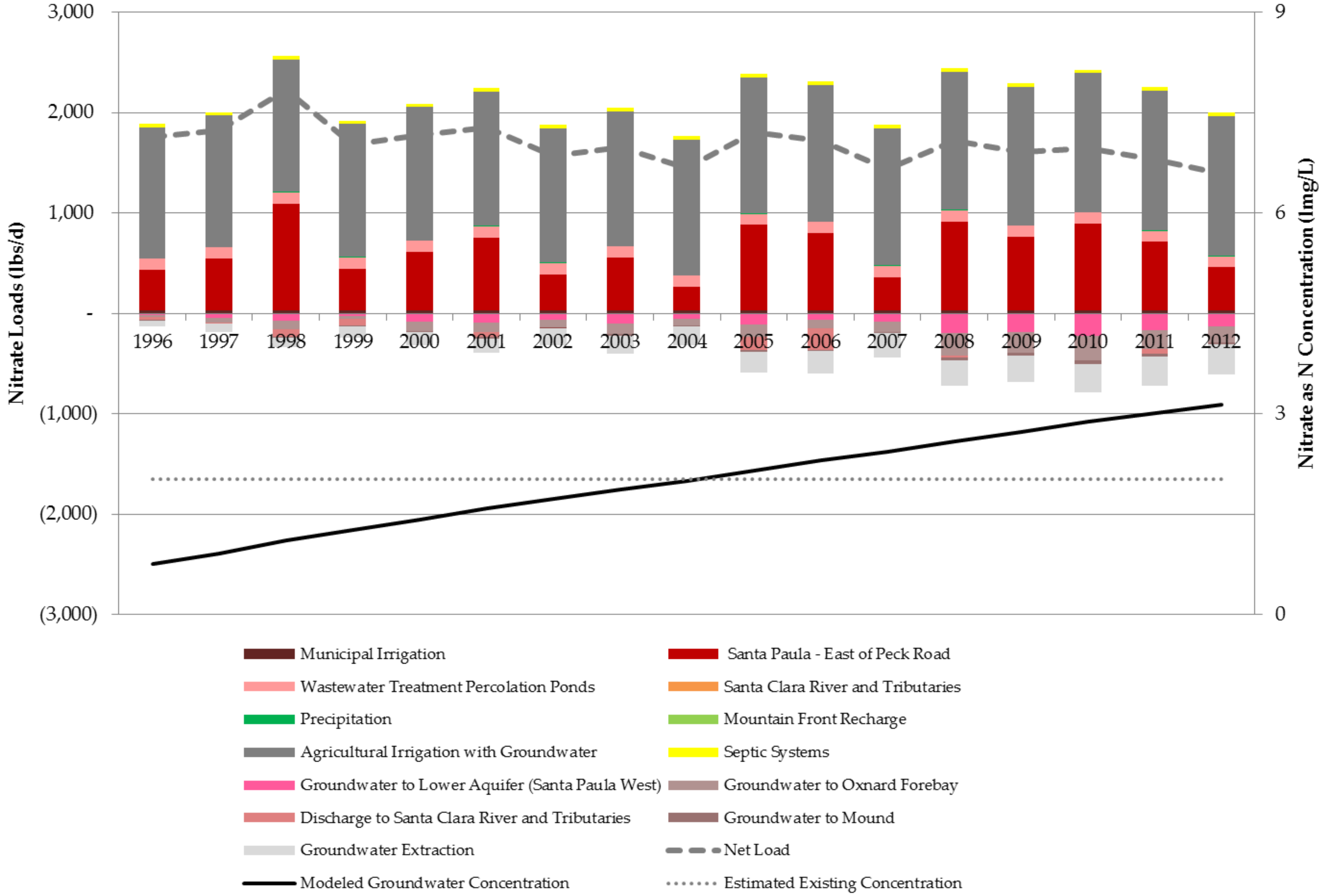


Figure 7-32 Modeled Annual Nitrate-N Loads and Concentrations in Groundwater for Santa Paula Basin – West of Peck Road

7.3.9 Oxnard Forebay Basin

In this basin, the largest non-land use based inflow and load is from managed aquifer recharge of SCR flow diverted at the Freeman diversion and recharged at the Saticoy, El Rio and Noble recharge basins by UWCD (**Figure 7-33**). The main land use based load is agricultural irrigation from groundwater. The high percentage of overall inflow from percolation results in modeled groundwater concentrations for TDS and chloride calculated as similar to surface water concentrations. The nitrate-N load from fertilizer results in modeled concentrations for nitrate-N higher than surface water quality but the large amount of managed aquifer recharge results in modeled groundwater concentrations closer to surface water quality than irrigation infiltration water quality (**Table 7-11)**.

The mass balance model shows that existing loads in this subarea result in modeled concentrations in groundwater **(Table7-2)** that are below water quality objectives for TDS (1,200 mg/L), chloride (150 mg/L) and nitrate-N (10 mg/L). This is consistent with the finding that the subarea has assimilative capacity for all three constituents based on groundwater quality data.

The modeled concentrations for TDS (**Figure 7-34**) and chloride (**Figure 7-35**) are similar to the estimated existing concentrations for the subareas. The modeled steady state concentrations for nitrate-N (**Figure 7-36**) in groundwater show a trend that decreases concentrations below the estimated existing concentration for the subarea. Infiltration concentrations for nitrate-N are relatively high to account for fertilization of strawberries, the crop with the most acreage in the subarea. It is possible that irrigation inflows are underestimated for the area.

Modeled annual concentrations in the subarea show little variation in response to hydrologic conditions. There have been observations of nitrate concentrations increasing for time periods of less a few months or less with little managed aquifer recharge. The mass balance modeled likely does not show that variation because there is enough managed aquifer recharge each year so that calculated annual concentrations for the basin do not increase substantially from year to year.

Table 7-11 Average Loads and Steady State Concentrations for Oxnard Forebay Basin

		TDS		Chloride		Nitrate as N	
	Inflow (AFY)	Concentration (mg/L)	Load (lbs/d)	Concentration (mg/L)	Load (lbs/d)	Concentration (mg/L)	Load (lbs/d)
Groundwater Flows							
Santa Paula - West of Peck Road	8,090	1,440	86,980	100	5,870	1.9	110
Non Land Use Surface Flows							
Santa Clara River and Tributaries	9,710	1,050	75,600	60	4,180	1.1	80
Managed Recharge	54,880	1,080	439,510	60	23,460	1.3	510
Precipitation	3,310	10	250	0.1	2	0.1	2
Mountain Front Recharge	2,070	10	150	0.1	2	0.1	2
Land Use Surface Flows							
Municipal Irrigation	1,230	0	0	0	0	0.0	0
Agricultural Irrigation with Groundwater	2,090	3,590	55,800	190	2,950	16	250
Septic Systems	18	1,200	160	100	14	40	5
Inflow Totals[1]							
Groundwater Flows	8,090		86,980		5,870		110
Non Land Use Surface Flows	69,960		515,510		27,640		600
Land Use Surface Flows	3,450		57,520		3,080		260
Total Inflows and Loads	81,500		660,010		36,600		970
Outflows	**Outlow (AFY)**		**Flux (lbs/d)**		**Flux (lbs/d)**		**Flux (lbs/d)**
Groundwater Flows							
Oxnard Plain	-35,370		-283,850		-15,080		-1,210
Mound	-20,160		-161,320		-8,540		-710
Lower Aquifer (Oxnard Forebay)	-19,020		-152,160		-8,060		-670
Groundwater Production	-6,960		-55,850		-2,970		-240
Total Outflows and Loads	-81,510		-653,180		-34,650		-2,830

[1] May include rounding error

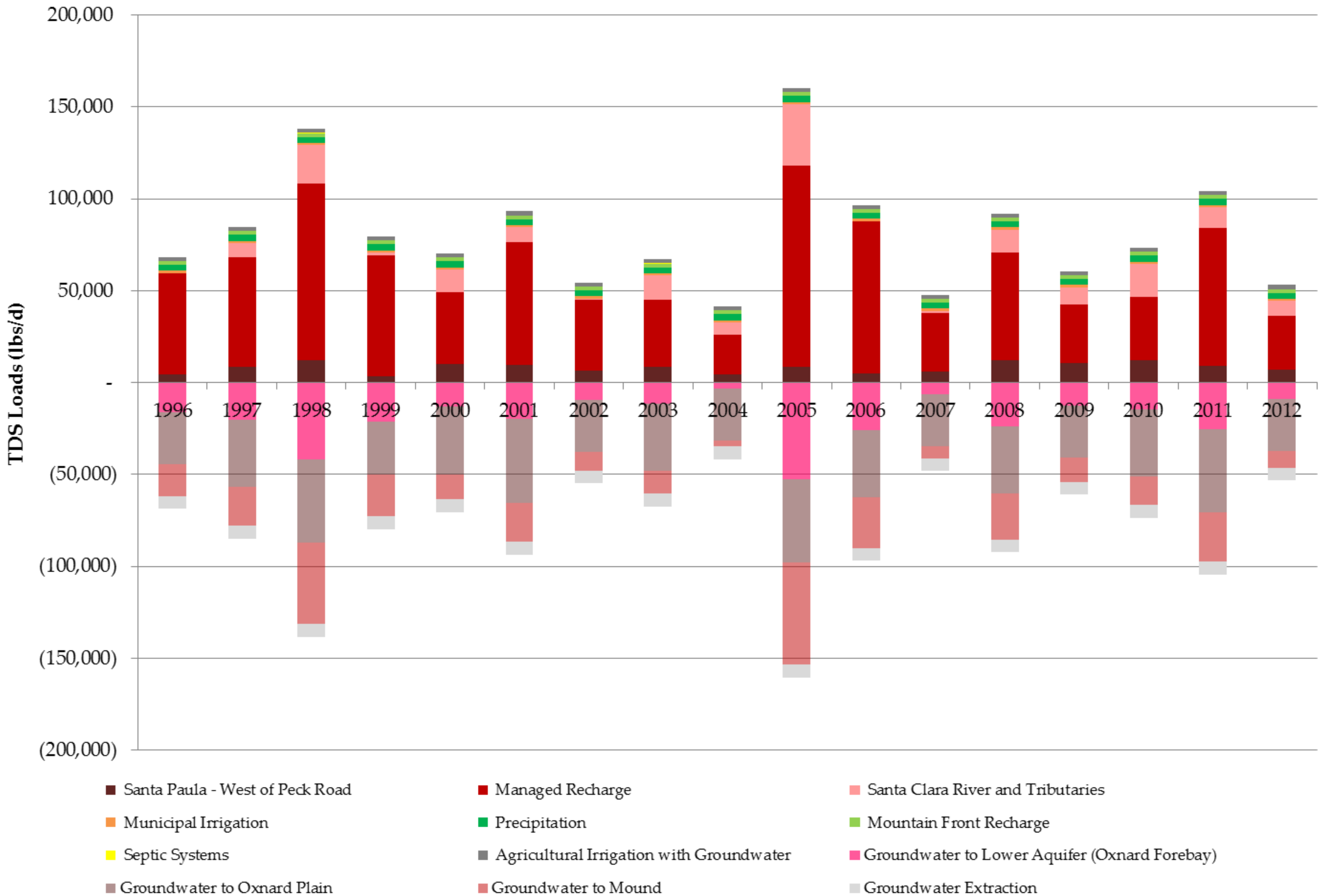


Figure 7-33 Modeled Annual Inflows and Outflows for Oxnard Forebay Basin

Figure 7-34 Modeled Annual TDS Loads and Concentrations in Groundwater for Oxnard Forebay Basin

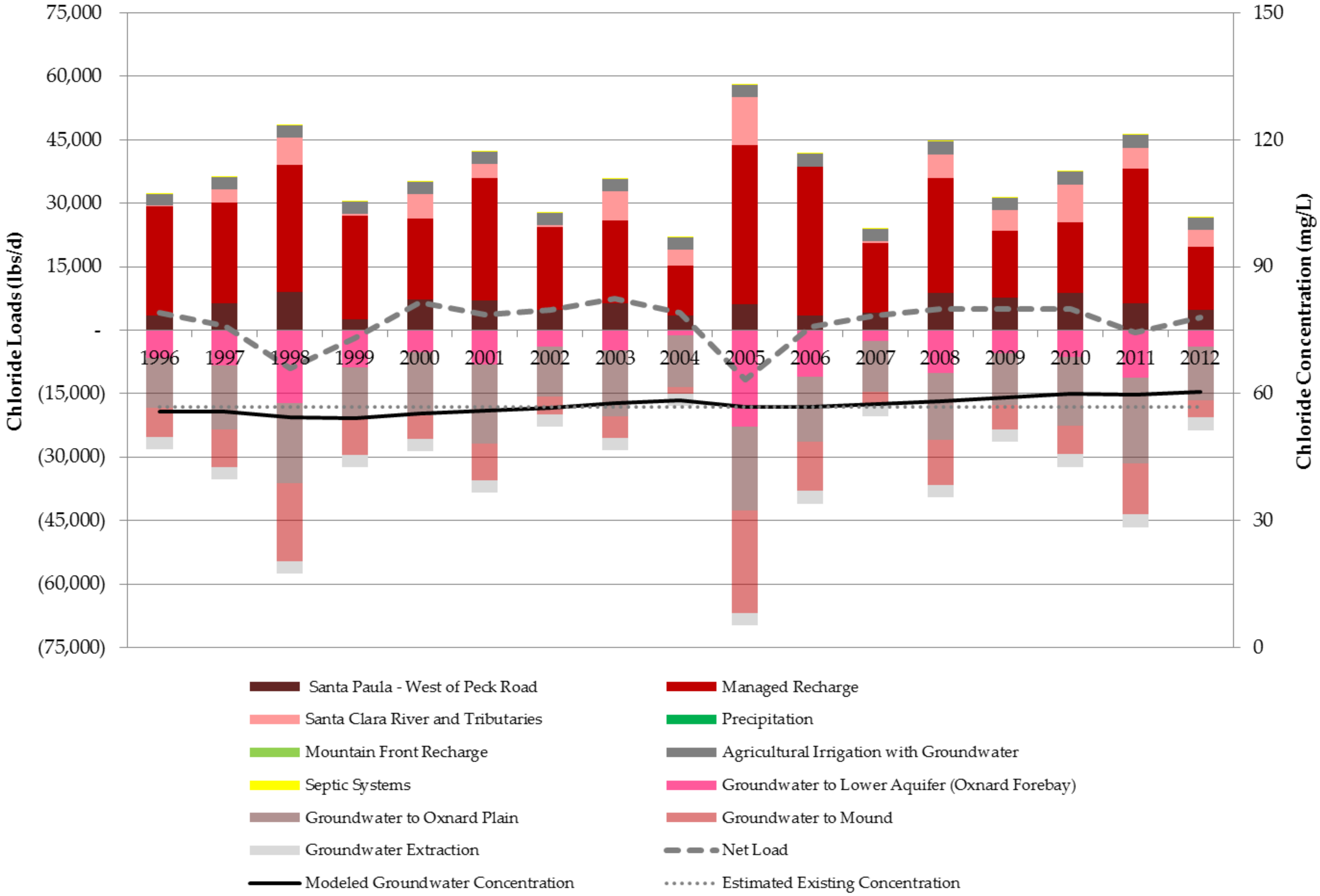


Figure 7-35 Modeled Annual Chloride Loads and Concentrations in Groundwater for Oxnard Forebay Basin

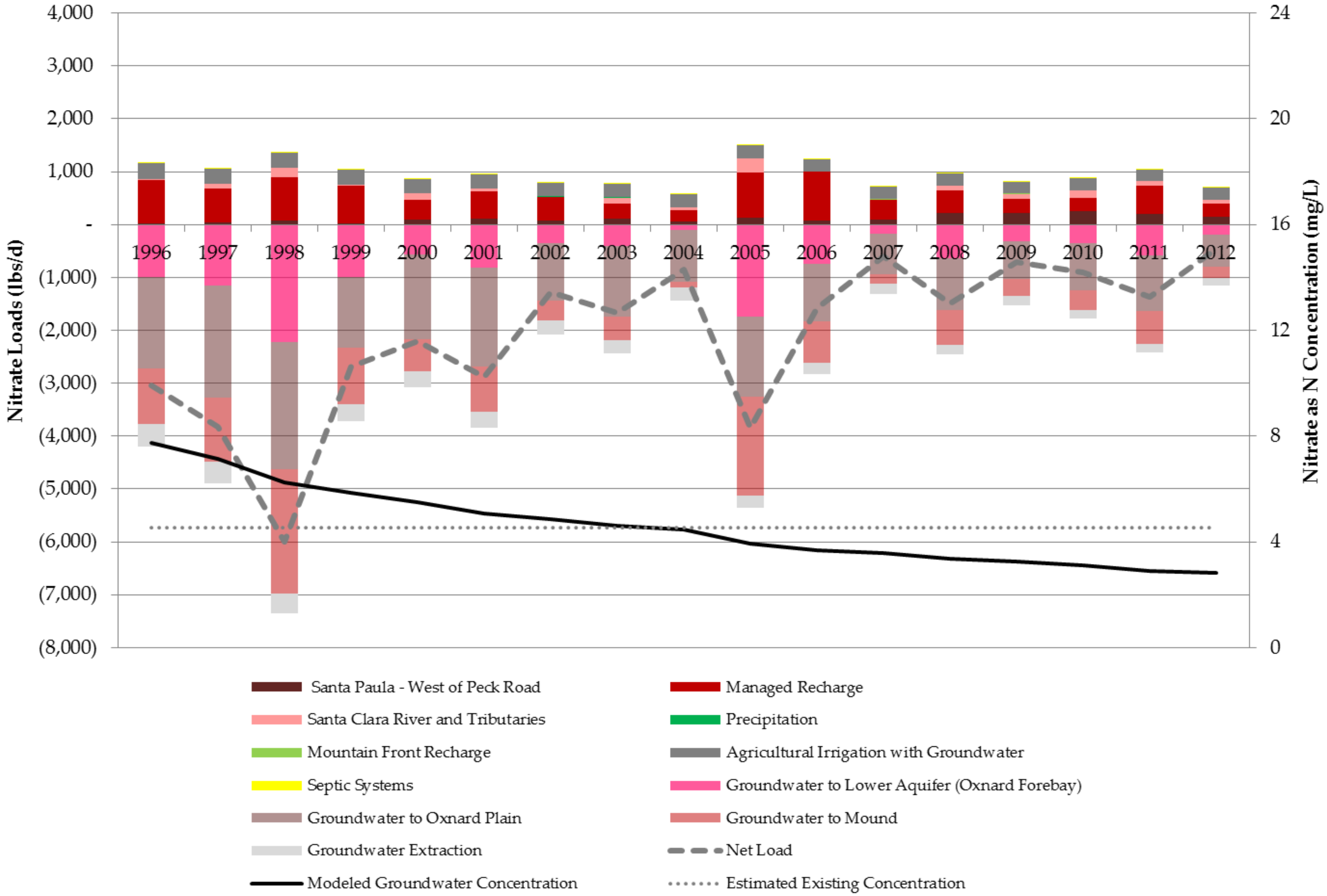


Figure 7-36 Modeled Annual Nitrate-N Loads and Concentrations in Groundwater for Oxnard Forebay Basin

7.3.10 Mound Basin

In this basin, the largest non-land use based inflow and load is underflow from the Oxnard Forebay basin (**Figure 7-37**). The main land use based loads are municipal irrigation and agricultural irrigation from groundwater (**Table 7-12**).

The mass balance model shows that existing loads in this subarea result in modeled concentrations in groundwater that are above water quality objectives for TDS (1,200 mg/L), but below water quality objectives for chloride (150 mg/L) and nitrate-N (10 mg/L). This is consistent with the finding that the subarea has assimilative capacity for chloride and nitrate-N but not TDS based on groundwater quality data.

The modeled concentrations for TDS (**Figure 7-38**), chloride (**Figure 7-39**), and nitrate-N (**Figure 7-40**) are similar to the estimated existing concentrations for the subarea.

In the Mound basin, the small amount of inflow relative to groundwater volume results in stable concentrations even if there are net loads as estimated for TDS and nitrate-N. It is possible that existing concentrations represent historical conditions as opposed to more recent inflows and loads. Additionally, the presence of a perched zone of poor quality water over a confined basin likely results in a small influence of surface loading in the Mound basin on water quality in the deeper confined aquifers used for groundwater production.

As discussed above, the distribution of inflow into the Mound basin is controversial. While output from the regional groundwater model used for the mass balance model indicates the largest inflow is underflow from the Oxnard Forebay basin, the City of Ventura has concluded that the primary inflow is underflow from the Santa Paula basin. If the alternate flow distribution is assumed, concentrations for TDS and chloride would be greater than presented in **Table 7-12** because TDS and chloride concentrations are higher in the Santa Paula basin than the Oxnard Forebay basin. However, concentrations would also be stable assuming the alternate flow distribution because total inflow would still be small relative to groundwater volume.

Table 7-12 Average Loads and Steady State Concentrations for Mound Basin

	Inflow (AFY)	TDS Concentration (mg/L)	TDS Load (lbs/d)	Chloride Concentration (mg/L)	Chloride Load (lbs/d)	Nitrate as N Concentration (mg/L)	Nitrate as N Load (lbs/d)
Groundwater Flows							
Santa Paula - West of Peck Road	1,010	1,440	10,890	100	730	1.9	14
Oxnard Forebay	20,160	1,080	162,040	60	8,560	5.1	770
Non Land Use Surface Flows							
Precipitation	80	10	6	0.1	0	0.1	0
Mountain Front Recharge	1,410	10	100	0.1	1	0.1	1
Land Use Surface Flows							
Municipal Irrigation	2,630	2,570	50,240	130	2,580	3.6	70
Agricultural Irrigation with Groundwater	1,380	4,090	42,170	250	2,610	30	300
Recycled Water	100	4,960	3,640	970	710	8.0	6
Septic Systems	18	1,490	200	290	40	40	5
Inflow Totals1							
Groundwater Flows	21,170		172,930		9,290		780
Non Land Use Surface Flows	1,490		110		1		1
Land Use Surface Flows	4,130		96,250		5,940		390
Total Inflows and Loads	26,790		269,290		15,230		1,170
Outflows	**Outlow (AFY)**		**Flux (lbs/d)**		**Flux (lbs/d)**		**Flux (lbs/d)**
Groundwater Flows							
Lower Aquifer (Mound)	-18,100		-165,460		-10,230		-530
Oxnard Plain	-2,650		-24,210		-1,500		-80
Coast	-2,260		-20,630		-1,280		-70
Groundwater Production	-3,790		-34,700		-2,140		-110
Total Outflows and Loads	-26,800		-245,000		-15,150		-790

[1] May include rounding error

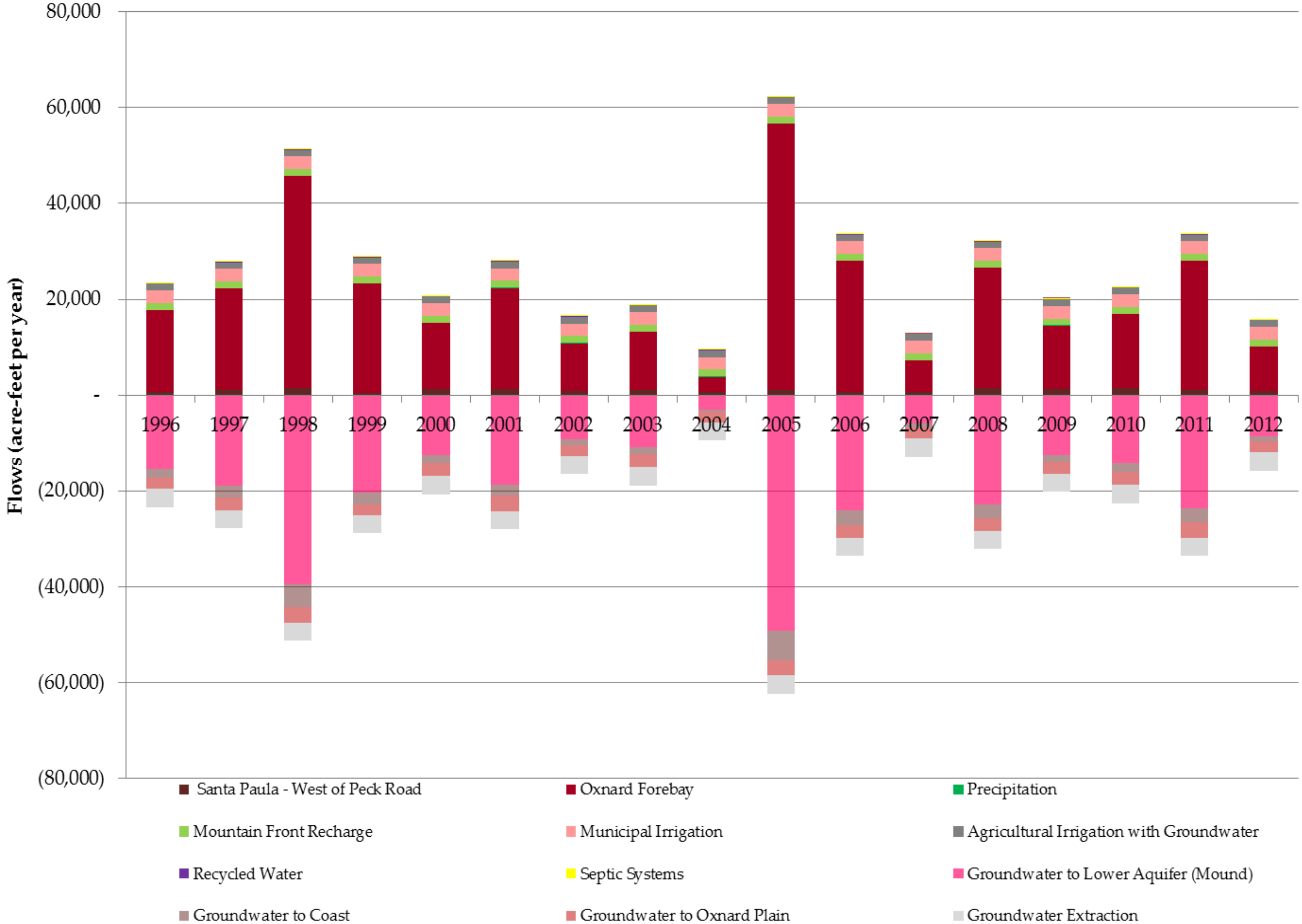


Figure 7-37 Modeled Annual Inflows and Outflows for Mound Basin

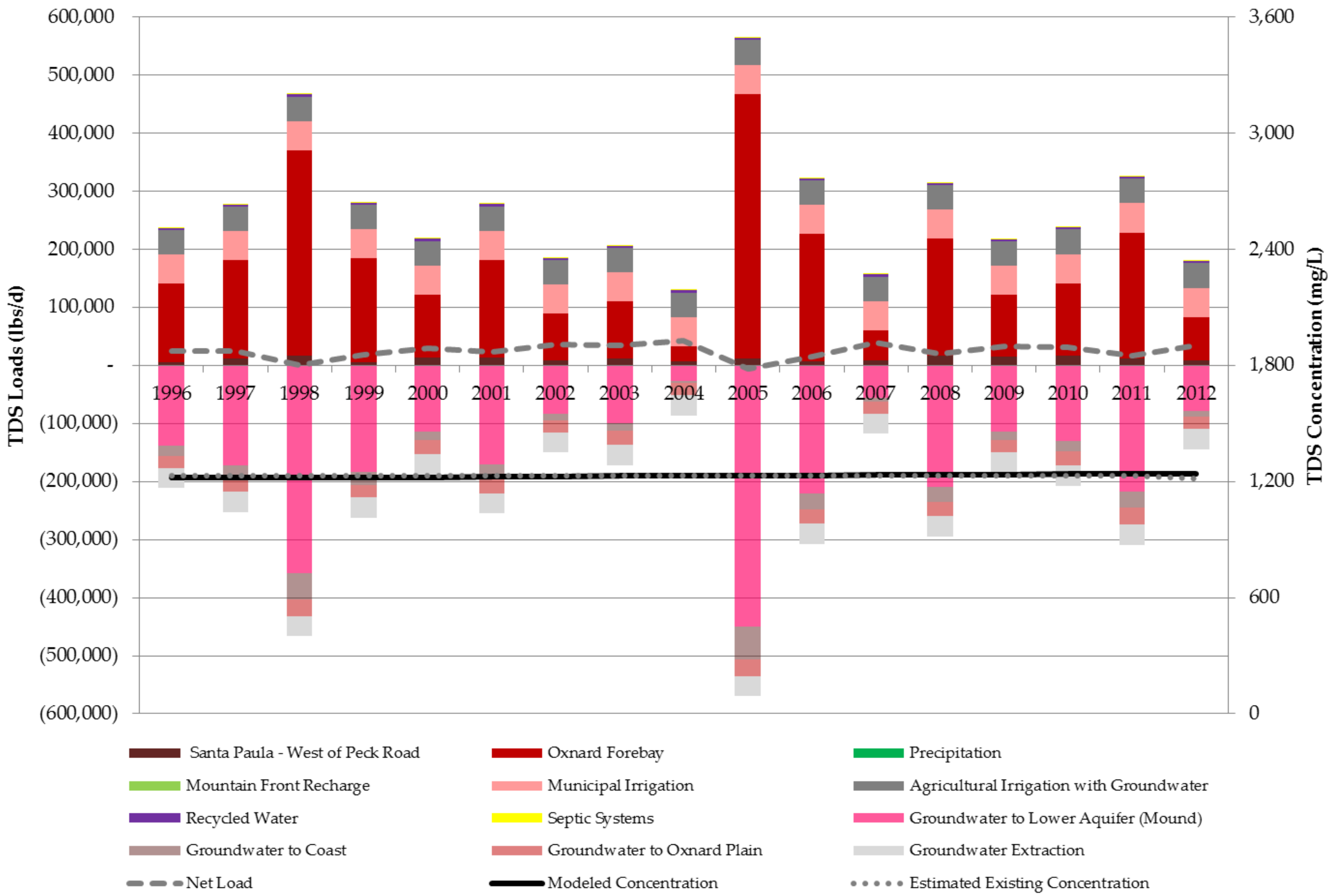


Figure 7-38 Modeled Annual TDS Loads and Concentrations in Groundwater for Mound Basin

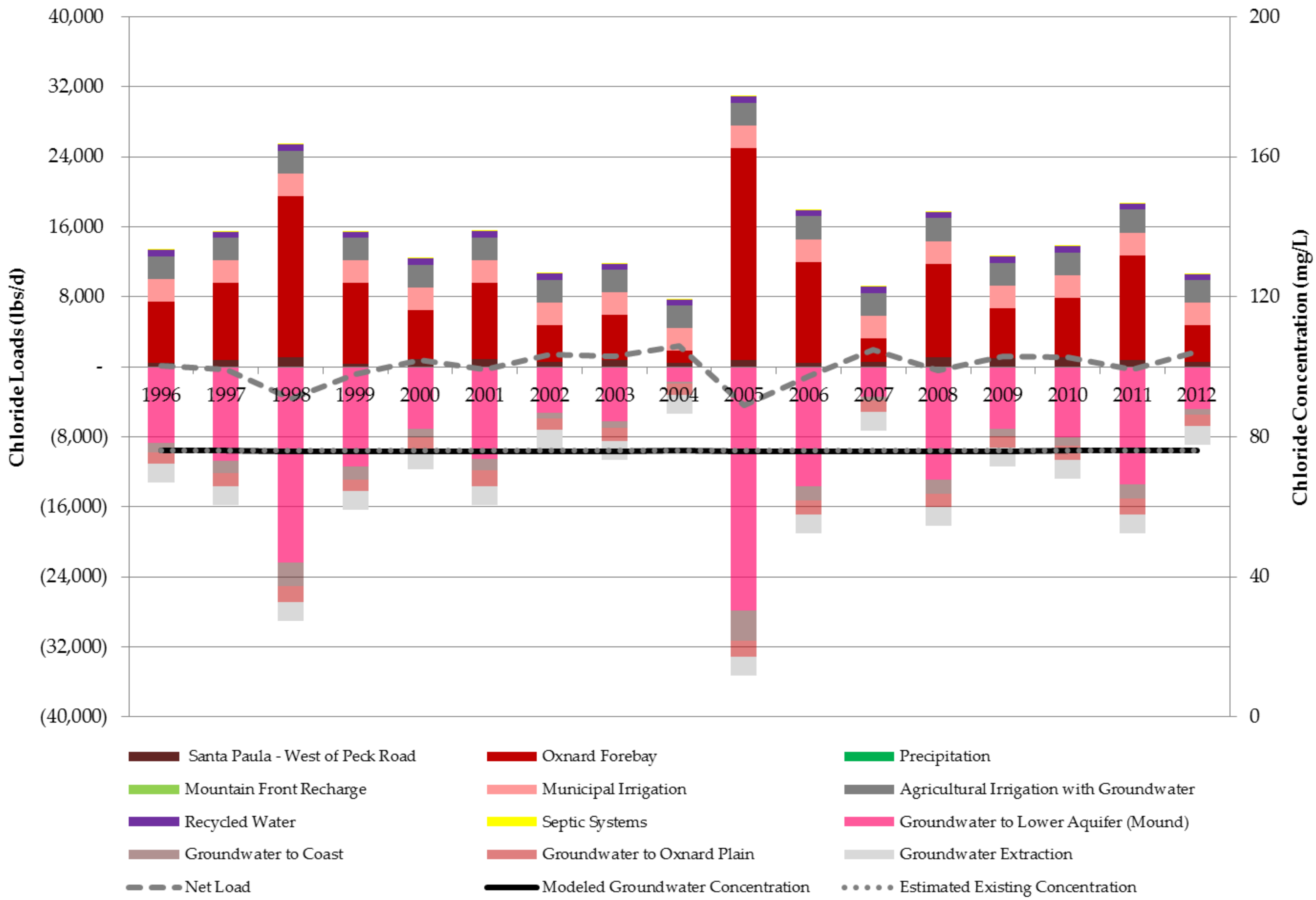


Figure 7-39 Modeled Annual Chloride Loads and Concentrations in Groundwater for Mound Basin

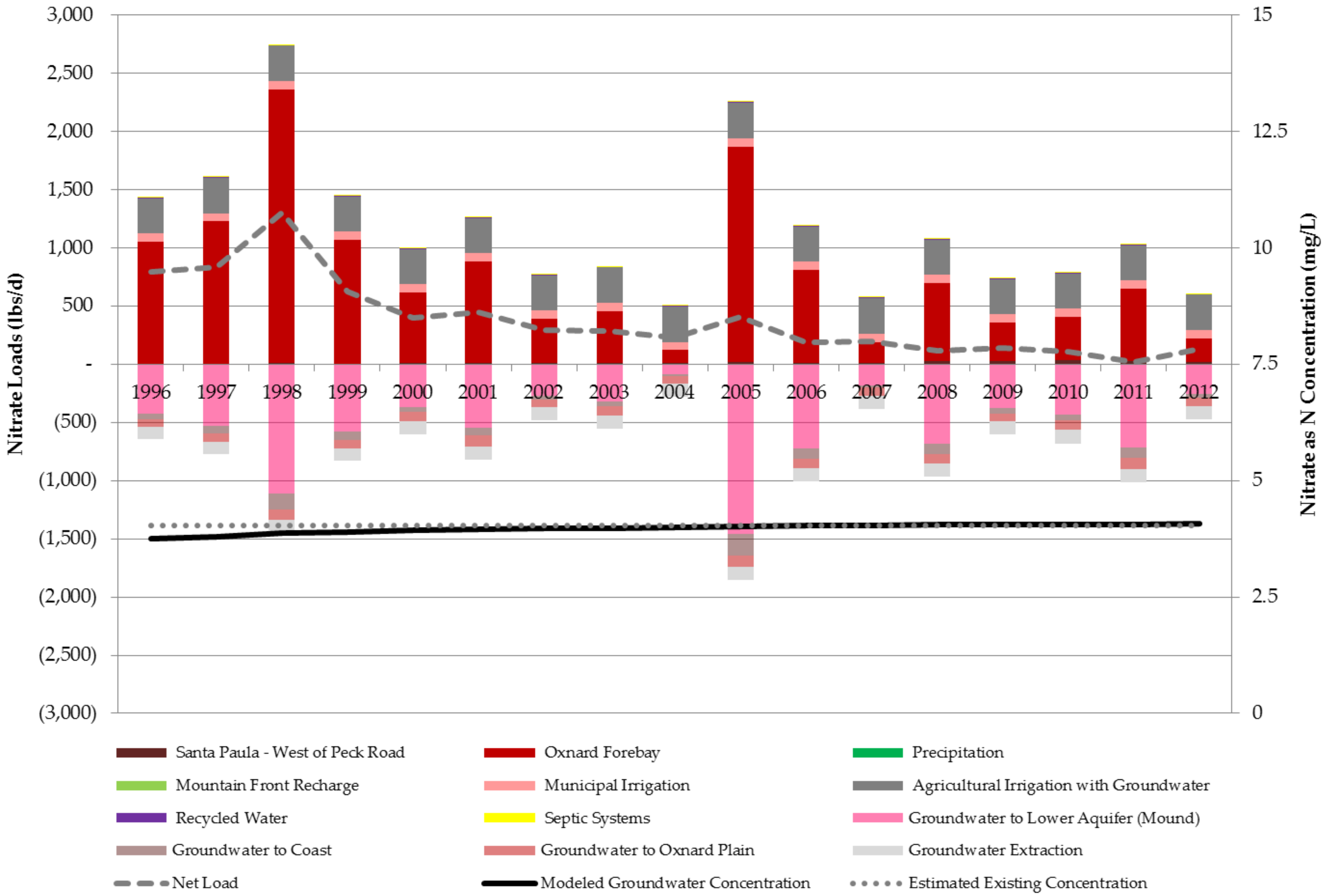


Figure 7-40 Modeled Annual Nitrate-N Loads and Concentrations in Groundwater for Mound Basin

7.4 USE OF MASS BALANCE SPREADSHEET MODEL TO ESTIMATE THRESHOLD LOADINGS FOR AVAILABLE ASSIMILATIVE CAPACITY

As described in **Section 9**, projects will be evaluated based on the amount of available assimilative capacity that will be used up by the projects or group of projects. The thresholds that are used to evaluate whether projects require additional management measures are 10% of available assimilative capacity for a single project and 20% of available assimilative capacity for a group of projects. The mass balance spreadsheet is used to calculate the additional load in a subarea that will use up threshold percentage of available assimilative capacity so that projected loads from projects can be evaluated.

7.4.1 Methodology

The mass balance model is set up to repeat the 1996-2012 hydrology to evaluate future loadings. The initial concentrations are set at the existing concentrations estimated for the subarea in **Section 4**. A loading is added to the model for the subarea so that 20% of available assimilative capacity as estimated in **Section 5** is used up by the end of the 17-year period. This loading represents the threshold for evaluating a group of projects. Half of this loading represents the threshold for evaluating a single project. No flow is added to the model along with the additional loading so this is a conservative estimate of the effect of the additional load on subarea groundwater concentrations.

Besides the additional loading to estimate threshold loading, the loadings or flows in the subarea are the same as the 1996-2012 model with one exception discussed below. The baseline concentrations are based on the 1996-2012 results so the baseline concentrations change over time and may use up or increase assimilative capacity without additional loadings. For evaluating threshold loading, the loadings or flows in upgradient subareas are assumed to be the same as the 1996-2012 model so the effect of additional projects in upgradient subareas are not considered.

The exception to using the 1996-2012 model setup for all loadings and flows besides the threshold loading is the chloride concentration used for recharge in the Santa Clara River percolation reaches from Newhall to Torrey Road and from Torrey Road to Cavin Road in the Piru basin. These concentrations are expected to change with reduced chloride concentrations in the Santa Clara River as a result of the Upper Santa Clara River chloride TMDL. Chloride concentrations projected from the Groundwater Surface Water Interaction Model for the Santa Clara River after the chloride TMDL is fully implemented are used to estimate recharge concentrations for these percolation reaches. There is typically a dry gap towards the west of these percolation reaches so downstream concentrations of surface water recharge are not changed based on the Upper Santa Clara River chloride TMDL.

7.4.2 Effect of Future Changes to Flows and Loadings

Future conditions may differ from existing conditions independent of new projects that add salt and nutrient loadings. Changes in future conditions that are most likely to change mass balance calculations relate to flows from surface water, wastewater and recycled water discharges, and irrigation practices. The largest source of water to most subareas is surface water, either percolation from streams or managed recharge. Concentrations in surface water are generally lower than concentration in groundwater so surface water inflows generally have a diluting effect. Changes in management of surface water flows in the LSCR could change the spatial distribution of surface water inflows and therefore the spatial distribution of groundwater concentrations.

The largest land-use based loading of salts and nutrients is irrigation. Changes in irrigation volumes will change the loading and result in different modeled groundwater concentrations. For nitrates, the fertilizer load is the major load source so changes in fertilizer practices would result in changes to modeled groundwater concentrations.

There are three potential future changes to the water balance from the 1996-2012 period. First, the Piru spreading grounds ceased operation in 2009 and are not expected to be used in the future. Therefore, the managed recharge modeled in the subarea of the Piru basin below Lake Piru for 1996-2008 is not expected to occur. However, loads to use up additional assimilative capacity are not calculated for this subarea because there are no data to estimate existing groundwater quality. In addition, the effect of this change is not evaluated downstream because most Piru Creek flows recharge in the Piru basin so the flow and load is added to the lower subareas of the Piru basin as surface water recharge instead of groundwater. The total flow and load into those subareas should not change much.

There is the potential for a reduction in flows in the Santa Clara River due to the Upper Santa Clara River chloride TMDL with new wastewater treatment processes implemented in Los Angeles County. However, the flows projected after the chloride TMDL is fully implemented are similar to the modeled flows used for most years in the1996-2012 time frame. Therefore, the use of the 1996-2012 water balance is a good approximation of future conditions.

Additionally, the Newhall Ranch development may result in additional flows due to the potential for a new wastewater treatment plant discharge. It is currently anticipated that all of the water from the Newhall Ranch wastewater treatment plant will be recycled or discharged to land and will not increase flows to the receiving water.

7.5 ESTIMATED THRESHOLD LOADING RESULTS

Table 7-13 shows the preliminary results for threshold loads that use up 20% of available assimilative capacity in each subarea.[2] These results are based on existing water quality of the SCR as it crosses into Ventura County. The results will be updated based on projected water quality after the Upper Santa Clara River chloride TMDL is fully implemented. The lower chloride concentrations projected for the Upper Santa Clara River chloride TMDL will increase the 20% threshold loads for chloride in all subareas except for the Piru basin Upper Area below Lake Piru. The lower chloride concentrations for Santa Clara River recharge in the Piru basin will affect downgradient subareas.

Table 7-13 shows 20% threshold loads of zero for chloride in the Piru basin – lower area west of Piru Creek and for TDS and chloride in the Fillmore basin – remaining northwest area. There is available assimilative capacity for these constituents in these subareas, but the mass balance spreadsheet shows 20% of the available assimilative capacity being used up by estimated

[2] Preliminary results are provided so that RWQCB can review methodology and planned documentation.

existing loads in the 17-year period. There is no assimilative capacity for TDS in the Mound basin so the threshold load is zero for TDS in that basin.

Table 7-13 Threshold Loads Using Up 20% of Available Assimilative Capacity Estimated by Mass Balance Model

Basin	Subarea	TDS				Chloride				Nitrate-N			
		WQO (mg/L)	Existing Quality (mg/L)	20% Available Assimilative Capacity Concentration (mg/L)	20% Threshold Load based on 17-Yr Trend (lbs/d)	WQO (mg/L)	Existing Quality (mg/L)	20% Available Assimilative Capacity Concentration (mg/L)	20% Threshold Load based on 17-Yr Trend (lbs/d)	WQO (mg/L)	Existing Quality (mg/L)	20% Available Assimilative Capacity Concentration (mg/L)	20% Threshold Load based on 17-Yr Trend (lbs/d)
Piru	Upper Area below Lake Piru	1,100	No data	NA	NA	200	No data	NA	NA	10	No data	NA	NA
	Lower Area East of Piru Creek	2,500	1,000	1300	96,000	200	118	134	14,100	10	2.6	4.1	230
	Lower Area West of Piru Creek	1,200	992	1034	26,000	100	69	75	1,100	10	3.6	4.9	970
Fillmore	Pole Creek Fan Area	2,000	1,101	1281	83,000	100	59	67	1,000	10	2.9	4.3	480
	South Side of Santa Clara River	1,500	1,411	1429	26,000	100	74	79	1,900	10	5.6	6.5	510
	Remaining Fillmore	1,000	846	877	0	50	44	45	0	10	6.7	7.3	300
Santa Paula	East of Peck Road	1,200	953	1002	22,000	100	39	51	3,000	10	5.0	6.0	60
	West of Peck Road	2,000	1,444	1555	106,000	110	97	99	6,300	10	2.0	3.6	0
Oxnard Forebay		1,200	1,077	1102	20,000	150	57	75	11,000	10	4.5	5.6	2,490
Mound		1,200	1,230	1224	0	150	76	91	16,300	10	4.0	5.2	1,270

7.5.1 Piru Basin – Lower Area East of Piru Creek

Figure 7-41 shows the additional loading of 96,000 lbs/d TDS that results in TDS concentrations increasing to 300 mg/L above existing concentrations using up 20% available assimilative capacity. Modeled baseline concentrations based on estimated existing loads show no trend over time.

Figure 7-42 shows the additional loading of 14,100 lbs/d chloride that results in chloride concentrations increasing to 16 mg/L above existing concentrations using up 20% available assimilative capacity. Modeled baseline concentrations based on estimated existing loads show a significant decrease over time increasing the available assimilative capacity.

Figure 7-43 shows the additional loading of 230 lbs/d nitrate-N that results in nitrate-N concentrations increasing to 1.5 mg/L above existing concentrations using up 20% available assimilative capacity. Modeled baseline concentrations based on estimated existing loads show an increase over time decreasing the available assimilative capacity.

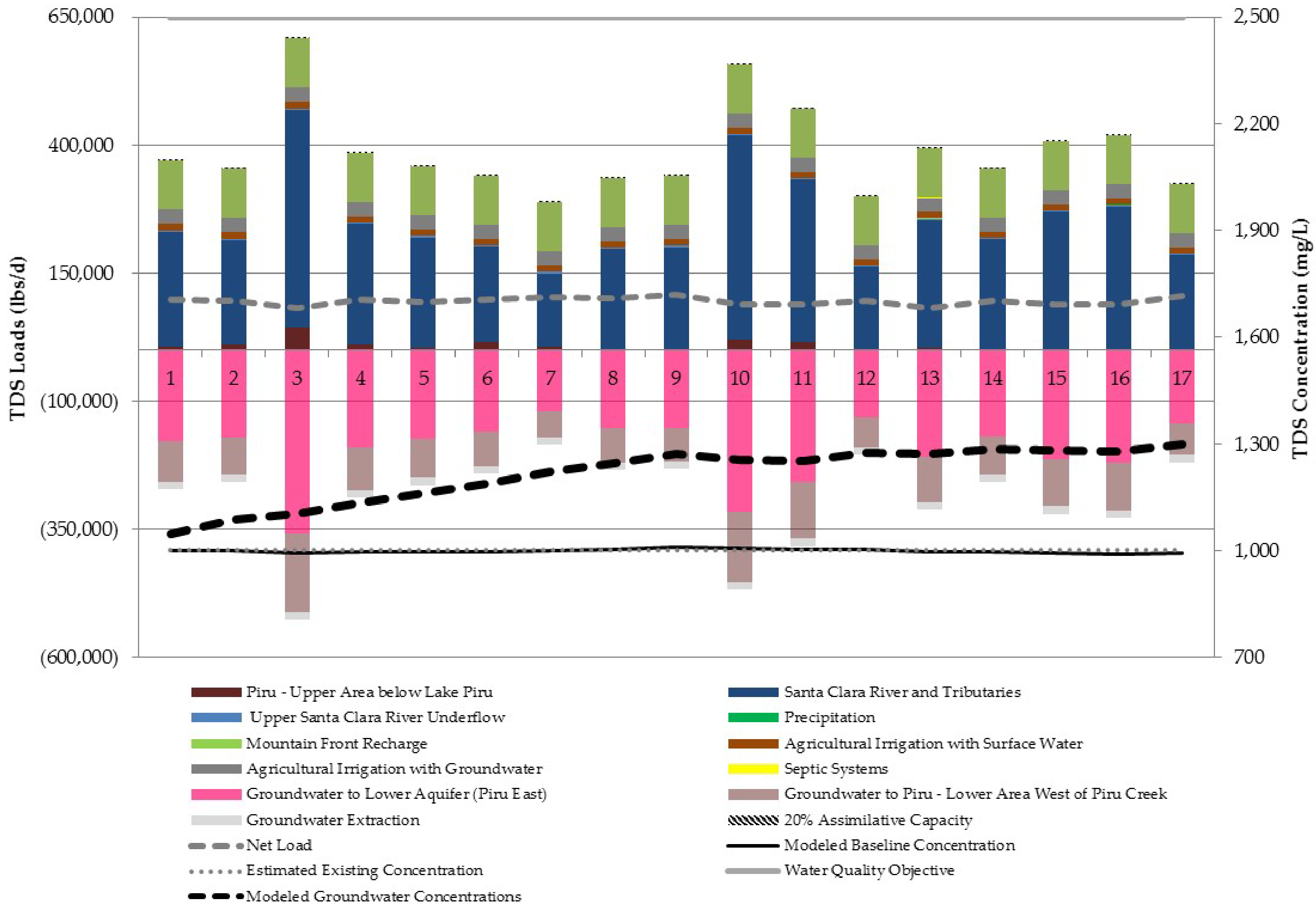


Figure 7-41 Modeled TDS 20% Threshold Load and Annual Concentrations for Piru Basin – Lower Area East of Piru Creek

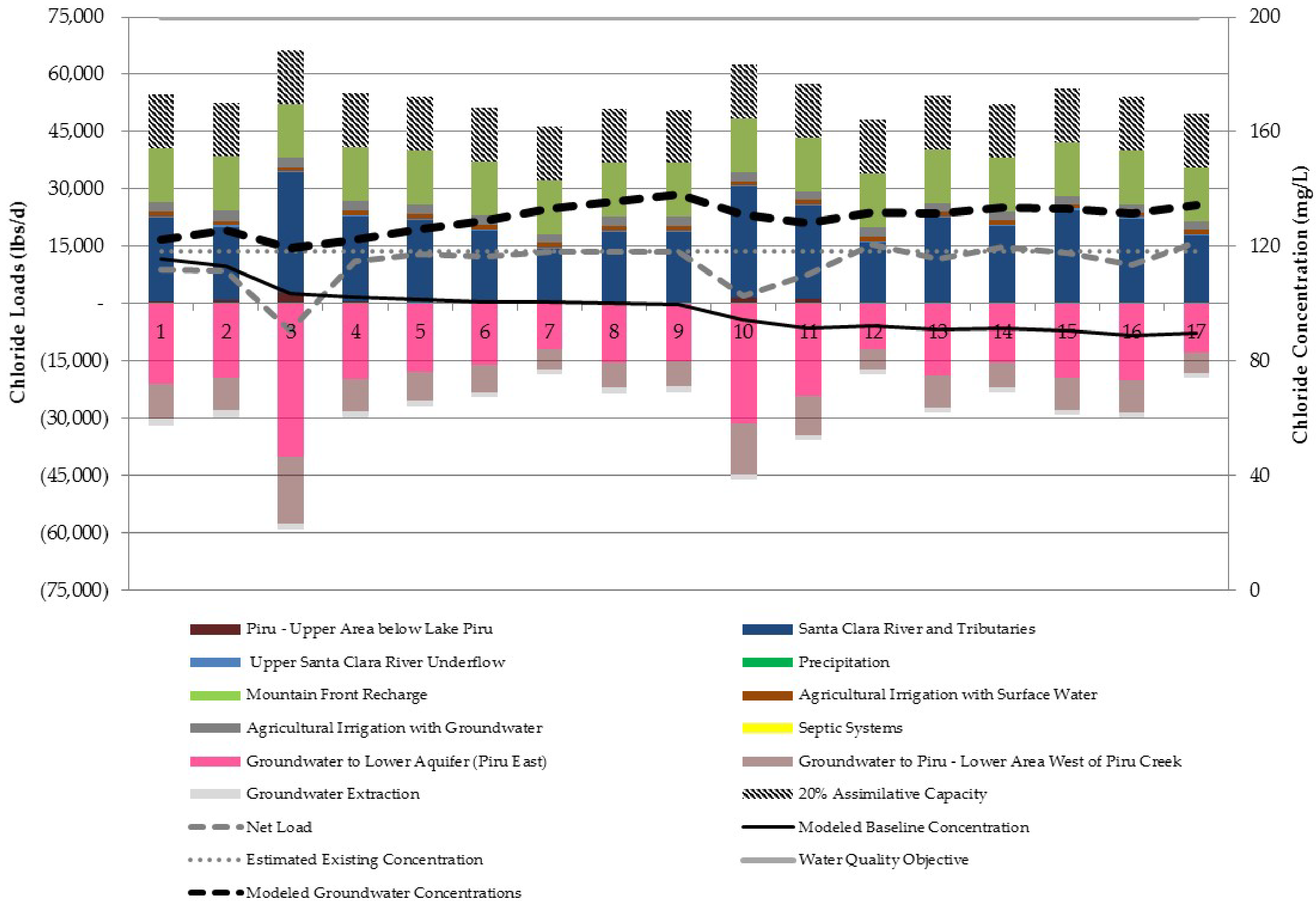


Figure 7-42 Modeled Chloride 20% Threshold Load and Annual Concentrations for Piru Basin – Lower Area East of Piru Creek

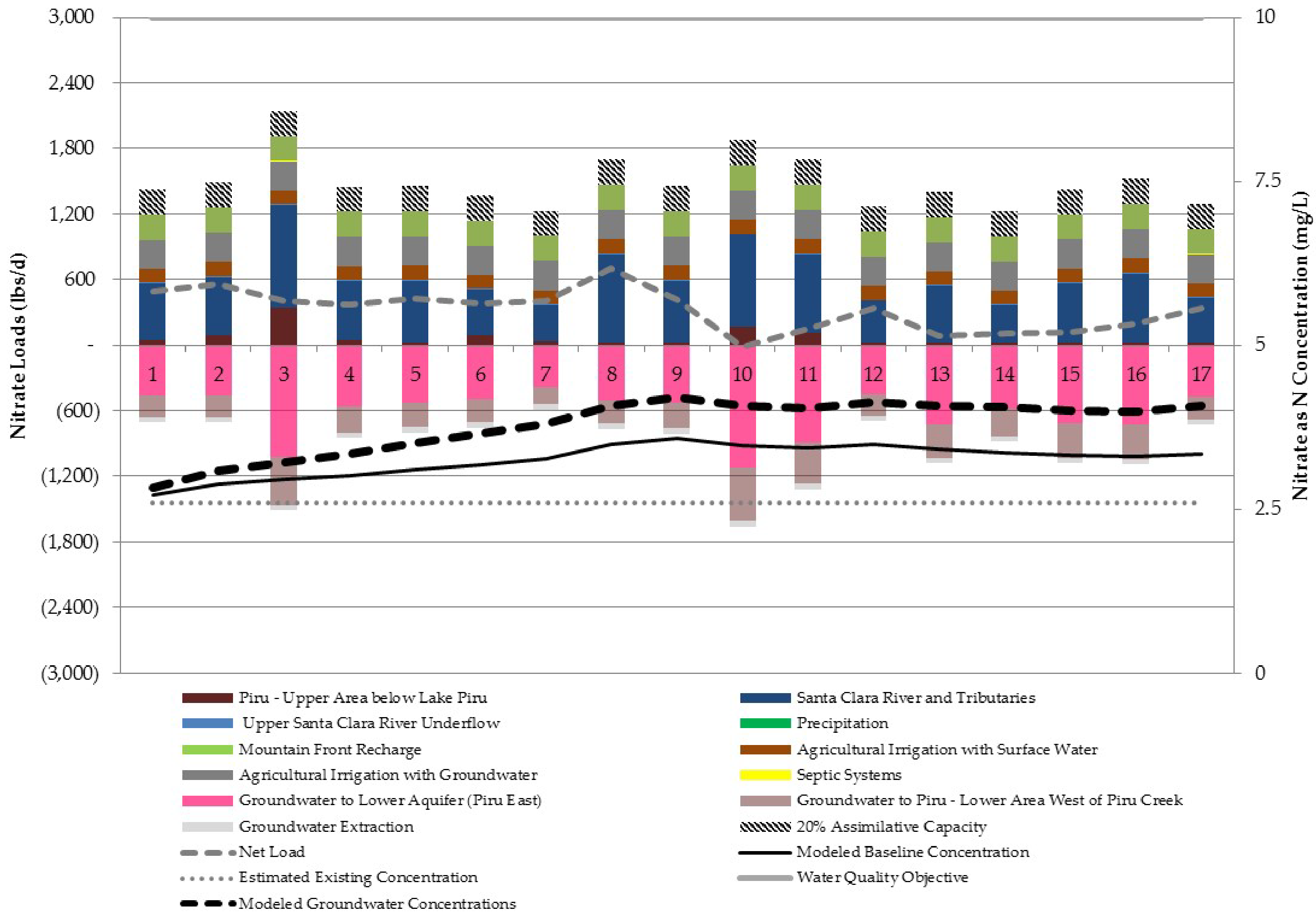


Figure 7-43 Modeled Nitrate 20% Threshold Load and Annual Concentrations for Piru Basin – Lower Area East of Piru Creek

7.5.2 Piru Basin – Lower Area West of Piru Creek

Table 7-44 shows the additional loading of 26,000 lbs/d TDS that results in TDS concentrations increasing to 42 mg/L above existing concentrations using up 20% available assimilative capacity. Modeled baseline concentrations based on estimated existing loads decrease over time increasing the available assimilative capacity.

Figure 7-45 shows the additional loading of 1100 lbs/d chloride that results in chloride concentrations increasing to 6 mg/L above existing concentrations using up 20% available assimilative capacity. Modeled baseline concentrations based on estimated existing loads show a slight increase over time decreasing the available assimilative capacity.

Figure 7-46 shows the additional loading of 970 lbs/d nitrate-N that results in nitrate-N concentrations increasing to 1.3 mg/L above existing concentrations using up 20% available assimilative capacity. Modeled baseline concentrations based on estimated existing loads decrease over time increasing the available assimilative capacity.

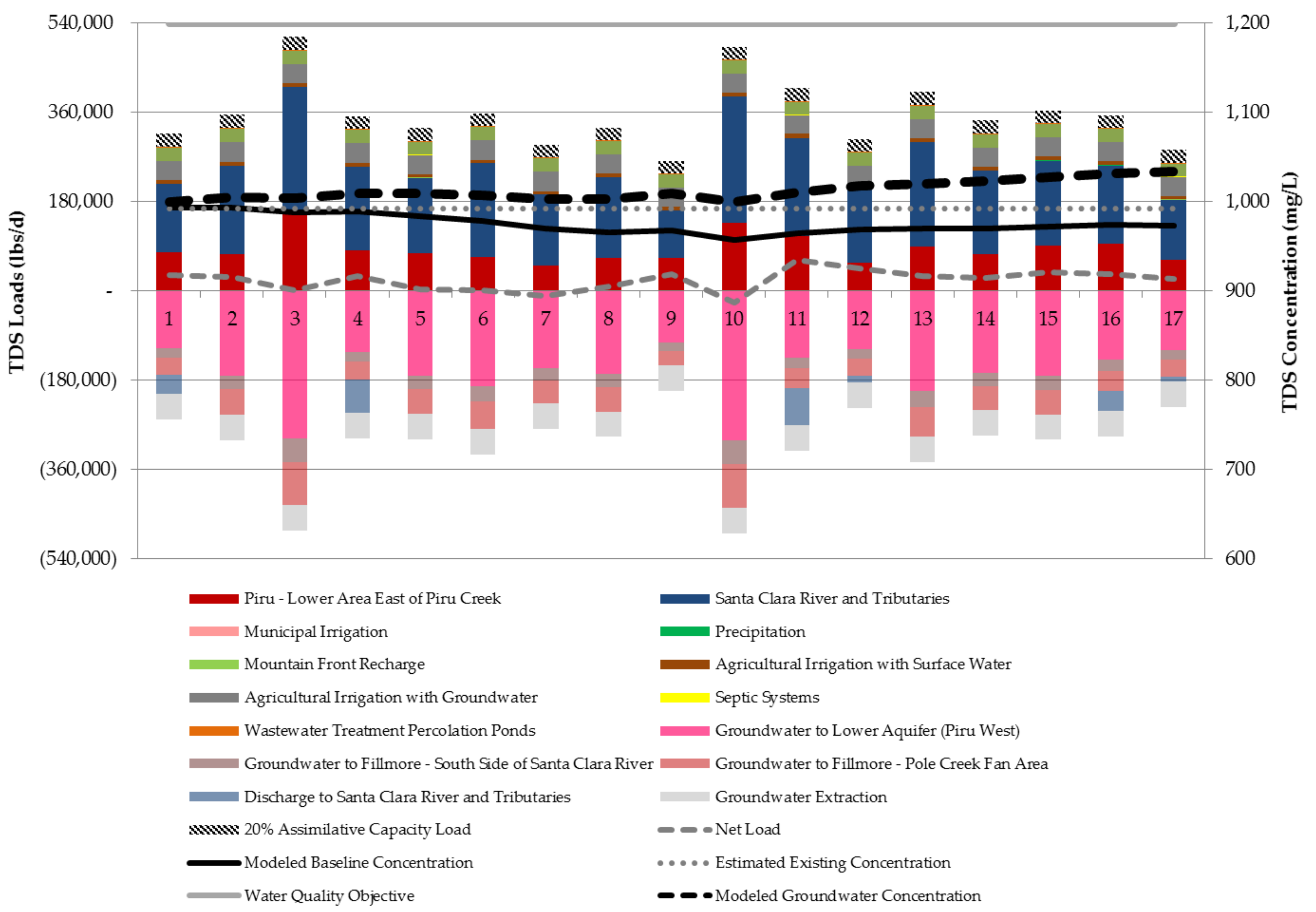


Figure 7-44 Modeled TDS 20% Threshold Load and Annual Concentrations for Piru Basin – Lower Area West of Piru Creek

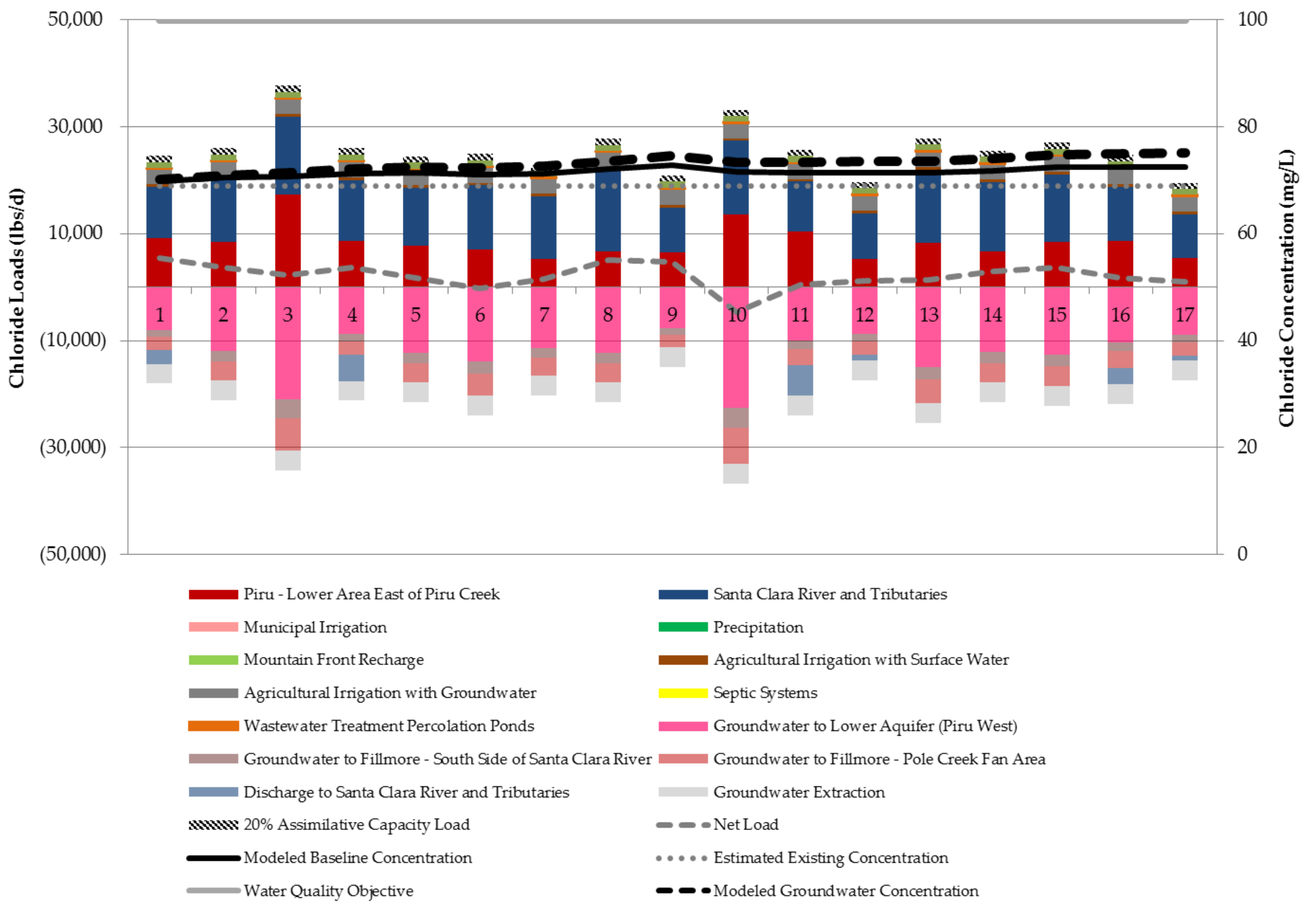


Figure 7-45 Modeled Chloride 20% Threshold Load and Annual Concentrations for Piru Basin – Lower Area West of Piru Creek

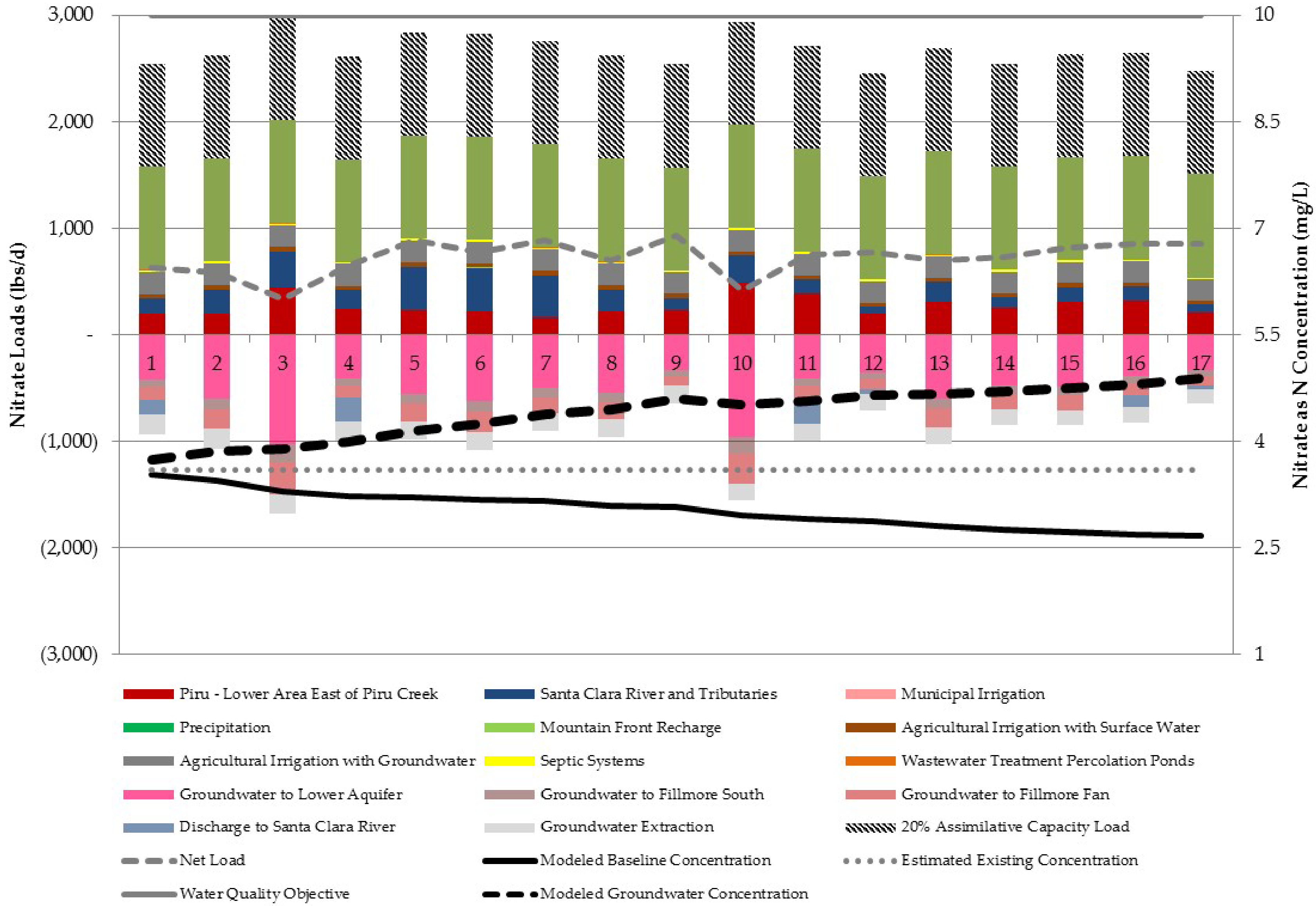


Figure 7-46 Modeled Nitrate 20% Threshold Load and Annual Concentrations for Piru Basin – Lower Area West of Piru Creek

7.5.3 Fillmore Basin – Pole Creek Fan Area

Figure 7-53shows the additional loading of 83,000 lbs/d TDS that results in TDS concentrations increasing to 180 mg/L above existing concentrations using up 20% available assimilative capacity. Modeled baseline concentrations based on estimated existing loads show a slight decrease over time increasing the available assimilative capacity.

Figure 7-54 shows the additional loading of 1,000 lbs/d chloride that results in chloride concentrations increasing to 8 mg/L above existing concentrations using up 20% available assimilative capacity. Modeled baseline concentrations based on estimated existing loads show a slight increase over time decreasing the available assimilative capacity.

Figure 7-49 shows the additional loading of 480 lbs/d nitrate-N that results in nitrate-N concentrations increasing to 1.4 mg/L above existing concentrations using up 20% available assimilative capacity. Modeled baseline concentrations based on estimated existing loads show a slight increase over time decreasing the available assimilative capacity.

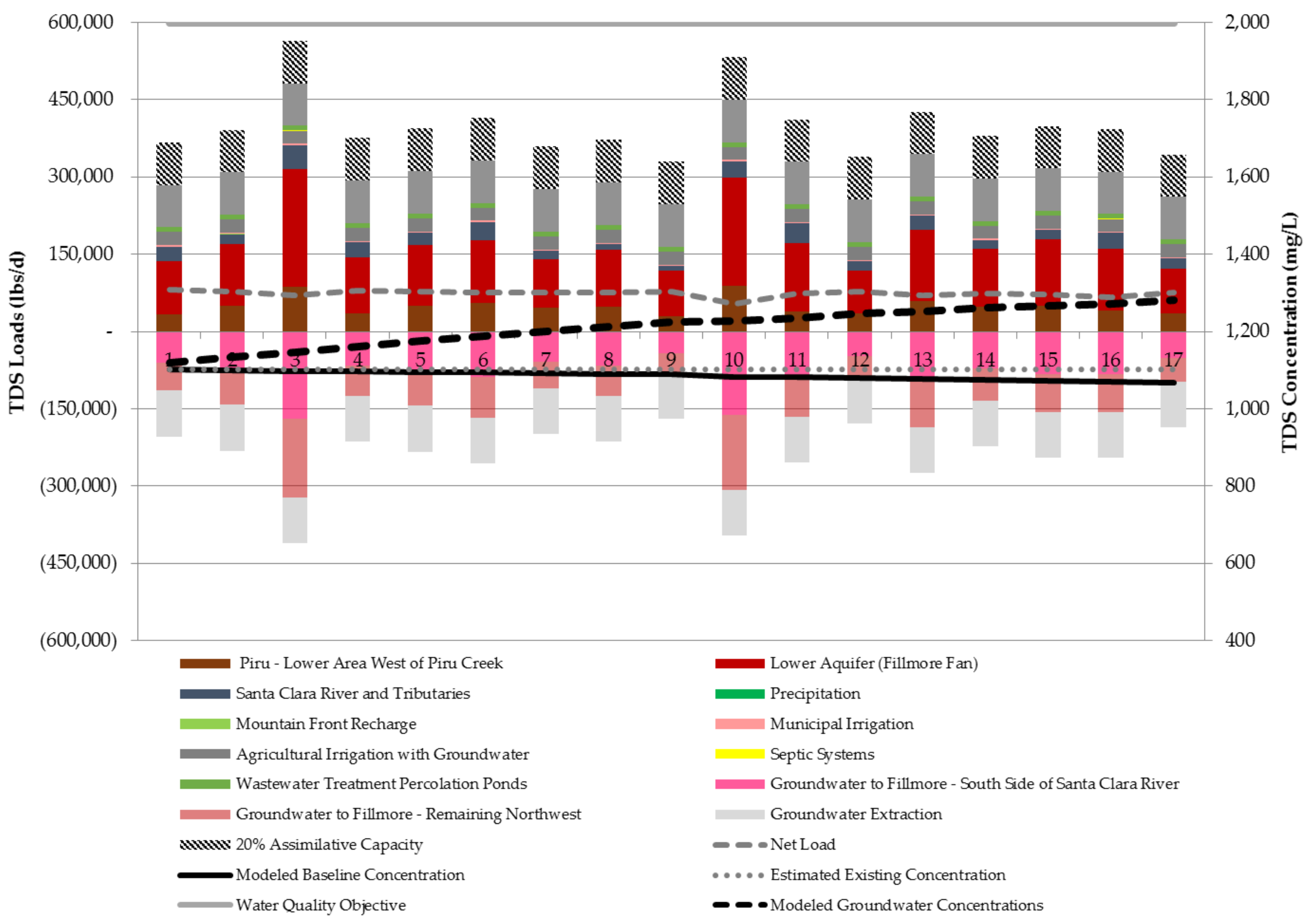


Figure 7-47 Modeled TDS 20% Threshold Load and Annual Concentrations for Fillmore Basin – Pole Creek Fan Area

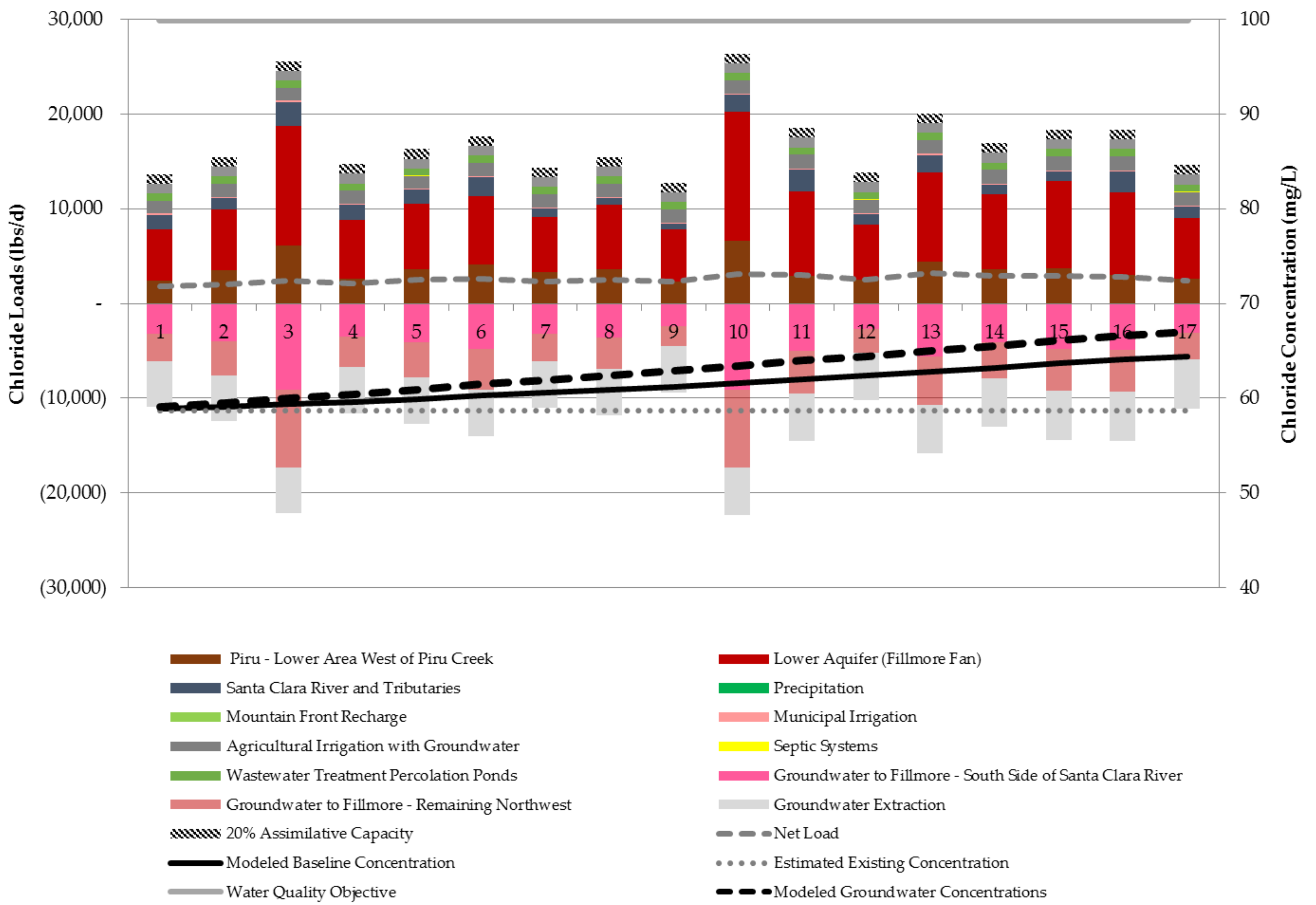


Figure 7-48 Modeled Chloride 20% Threshold Load and Annual Concentrations for Fillmore Basin - Pole Creek Fan Area

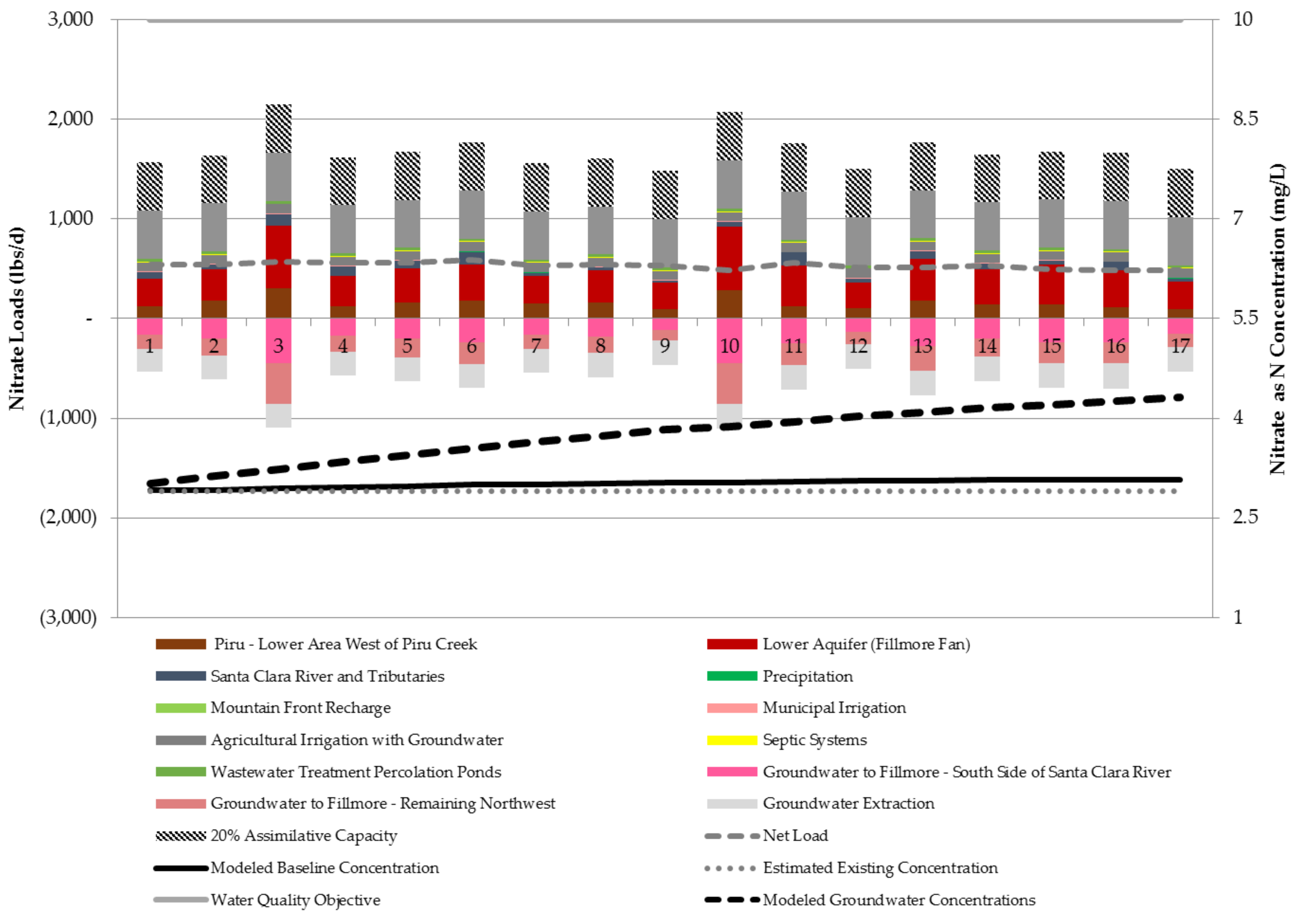


Figure 7-49 Modeled Nitrate 20% Threshold Load and Annual Concentrations for Fillmore Basin – Pole Creek Fan Area

7.5.4 Fillmore Basin – South of Santa Clara River

Table 7-50 shows the additional loading of 26,000 lbs/d TDS that results in TDS concentrations increasing to 18 mg/L above existing concentrations using up 20% available assimilative capacity. Modeled baseline concentrations based on estimated existing loads show a decrease over time increasing the available assimilative capacity.

Figure 7-51 shows the additional loading of 1,900 lbs/d chloride that results in chloride concentrations increasing to 5 mg/L above existing concentrations using up 20% available assimilative capacity. Modeled baseline concentrations based on estimated existing loads show a slight increase over time decreasing the available assimilative capacity.

Figure 7-52 shows the additional loading of 510 lbs/d nitrate-N that results in nitrate-N concentrations increasing to 0.9 mg/L above existing concentrations using up 20% available assimilative capacity. Modeled baseline concentrations based on estimated existing loads show no trend over time.

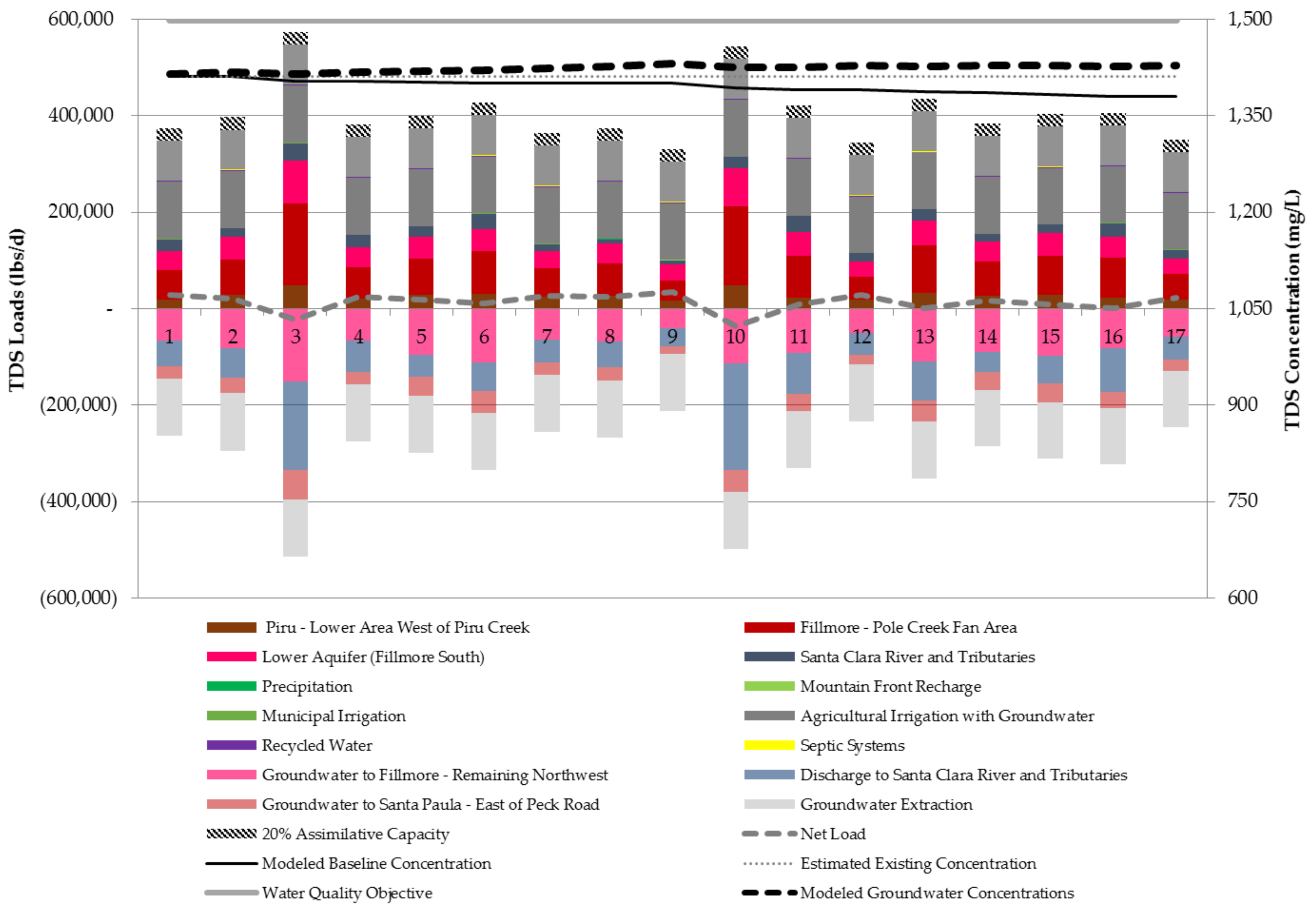


Figure 7-50- Modeled TDS 20% Threshold Load and Annual Concentrations for Fillmore Basin – South of Santa Clara River

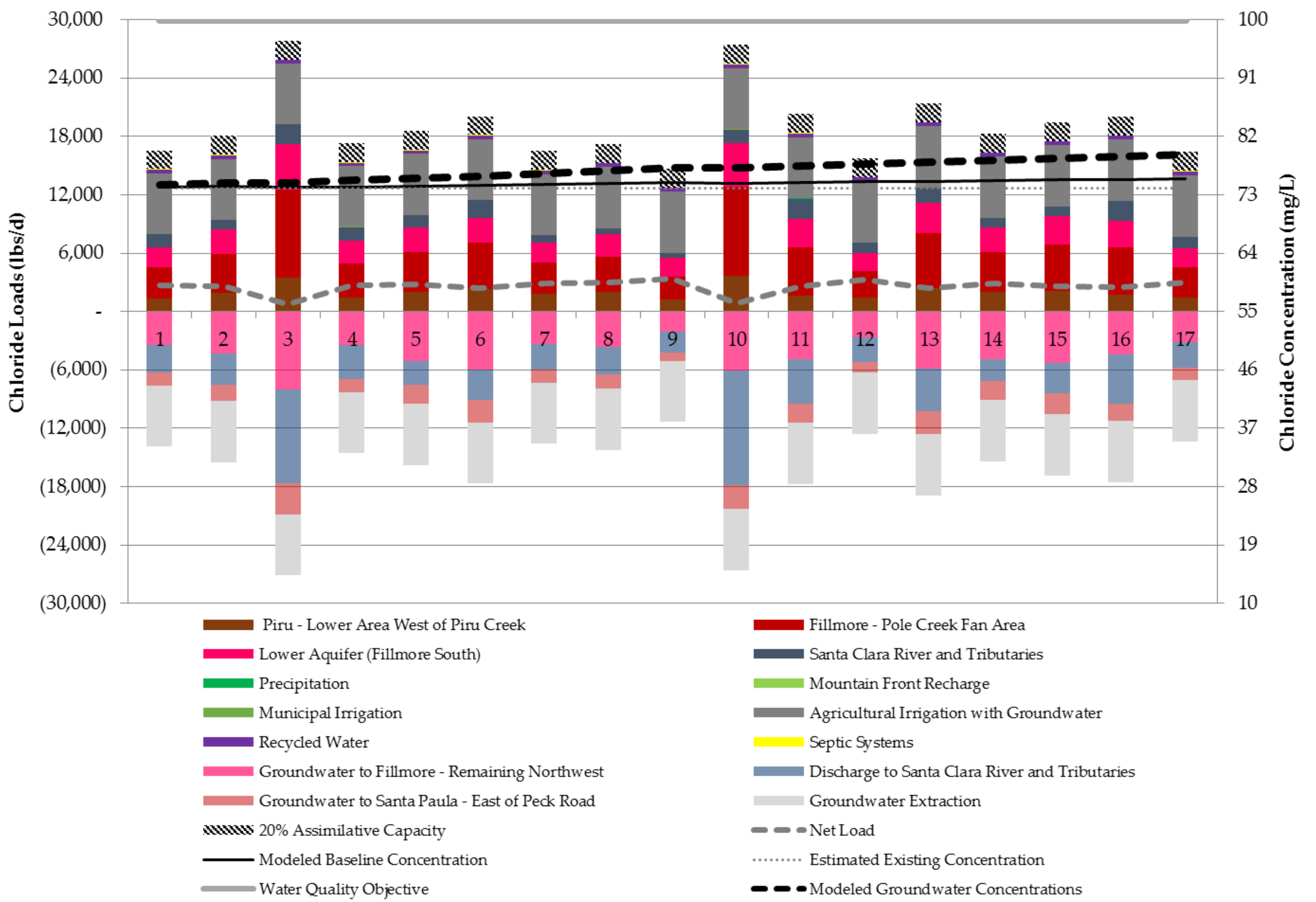


Figure 7-51- Modeled Chloride 20% Threshold Load and Annual Concentrations for Fillmore Basin – South of Santa Clara River

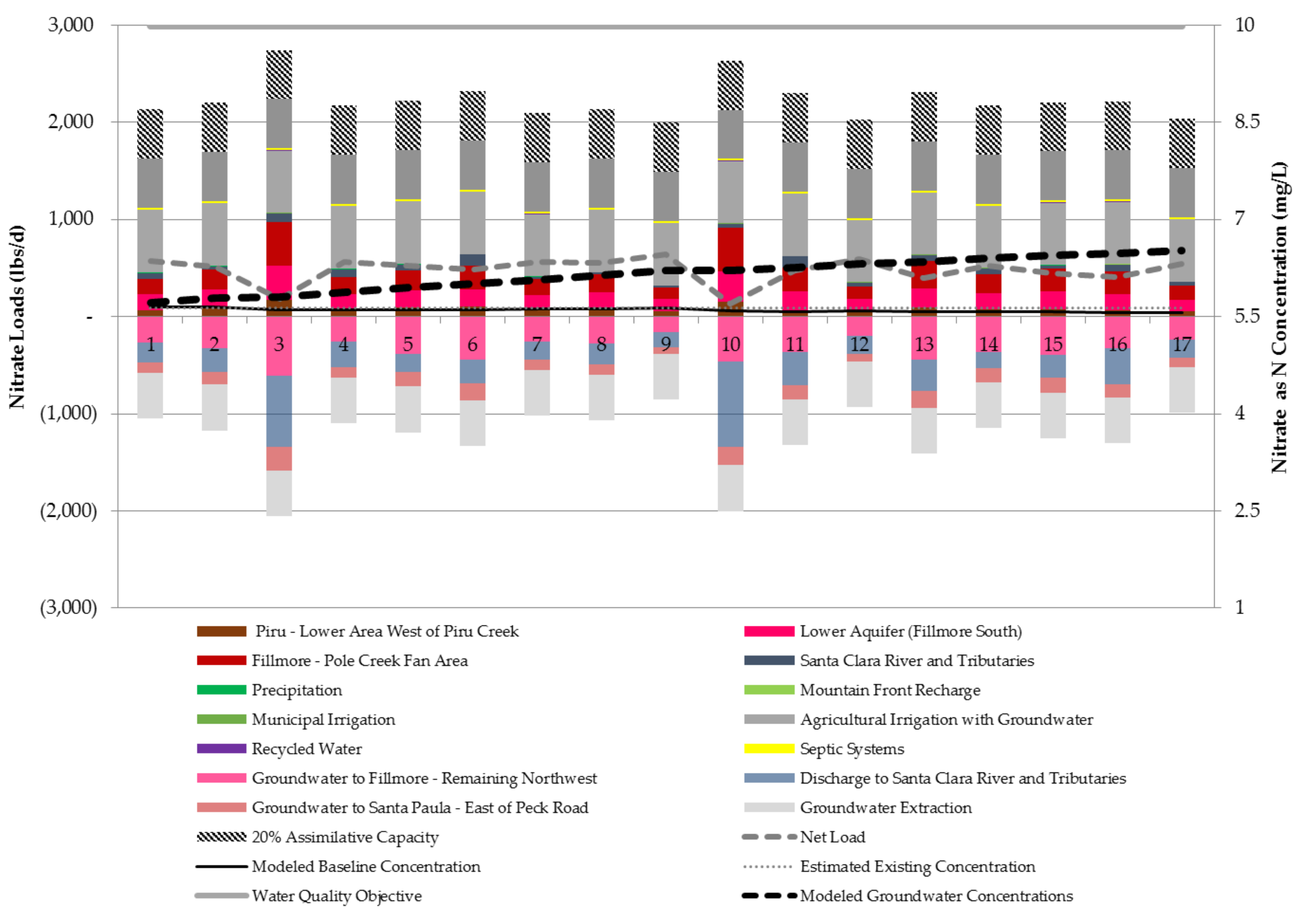


Figure 7-52 Modeled Nitrate 20% Threshold Load and Annual Concentrations for Fillmore Basin – South of Santa Clara River

7.5.5 Fillmore Basin – Remaining Area

Figure 7-53 shows no additional loading since the baseline TDS concentrations increasing to the water quality objective. Modeled baseline concentrations based on estimated existing loads increase over time, decreasing available assimilative capacity until the water quality objective is exceeded and assimilative capacity is no longer available.

Figure 7-54 shows no additional loading since the baseline chloride concentrations increasing to higher than the water quality objective. Modeled baseline concentrations based on estimated existing loads increase over time, decreasing available assimilative capacity until the water quality objective is exceeded and assimilative capacity is no longer available.

Figure 7-55 shows the additional loading of 300 lbs/d nitrate-N that results in nitrate-N concentrations increasing to 0.7 mg/L above existing concentrations using up 20% available assimilative capacity. Modeled baseline concentrations based on estimated existing loads show a slight increase over time decreasing the available assimilative capacity.

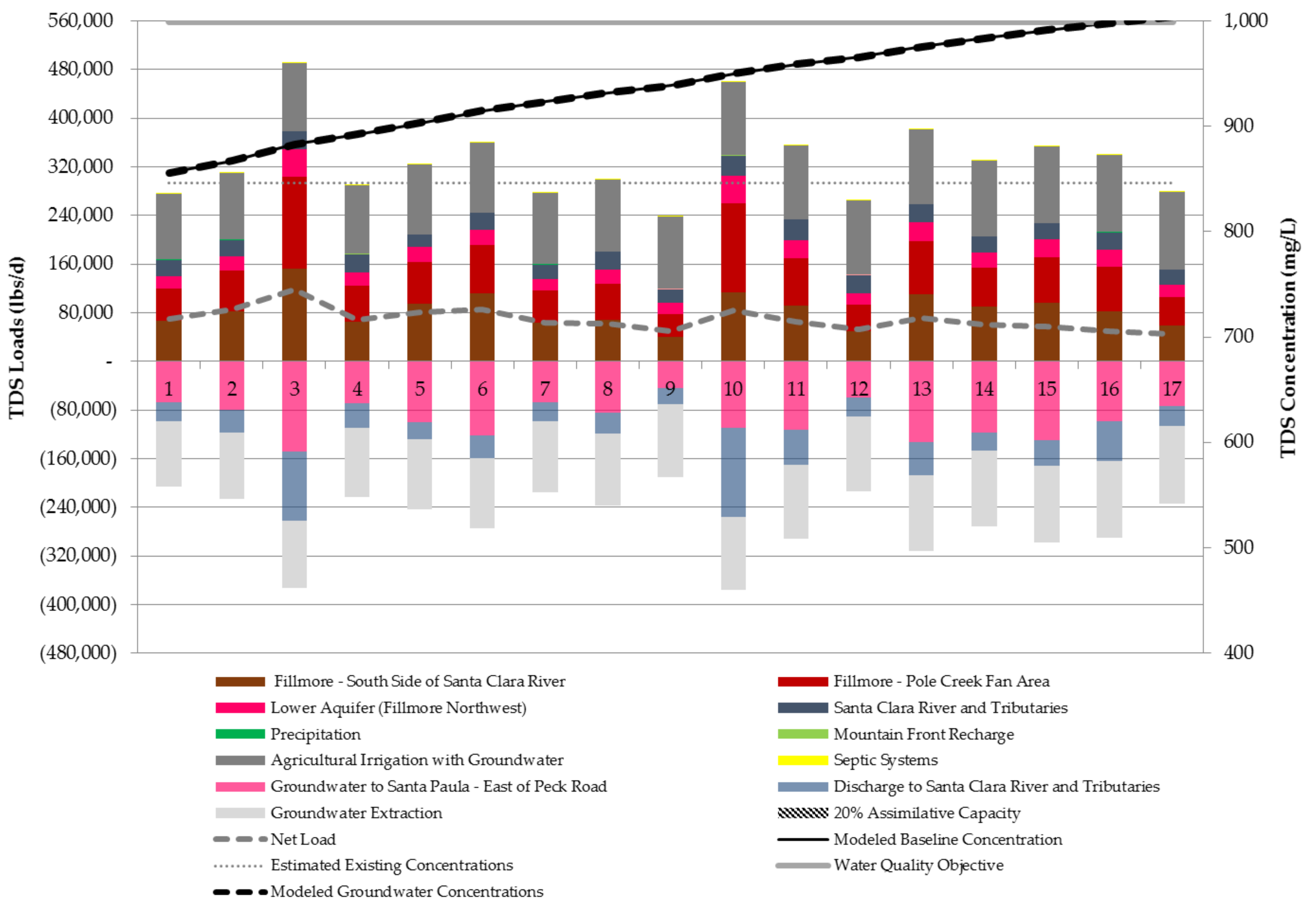


Figure 7-53 Modeled TDS 20% Threshold Load and Annual Concentrations for Fillmore Basin – Remaining Area

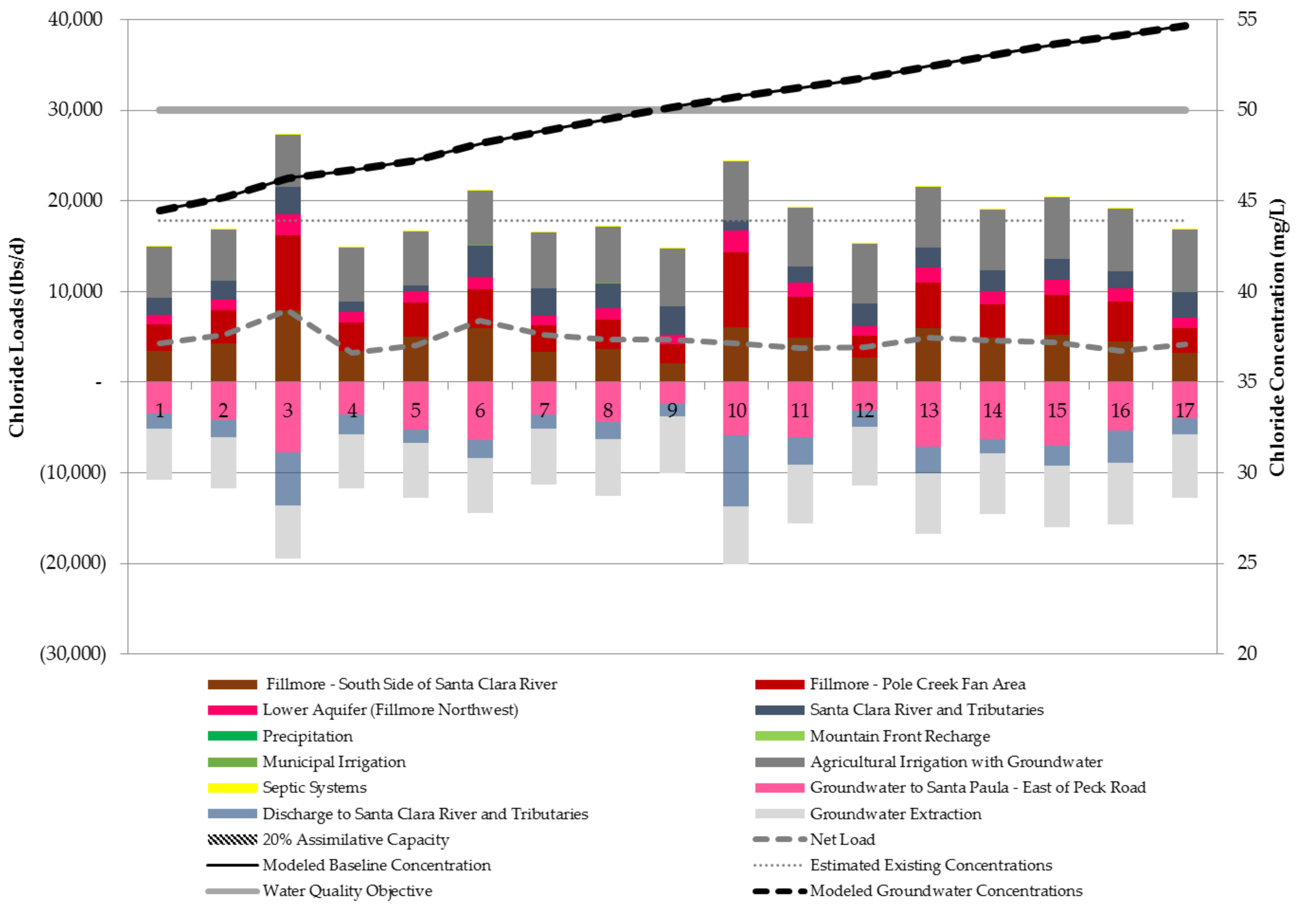


Figure 7-54 Modeled Chloride 20% Threshold Load and Annual Concentrations for Fillmore Basin – Remaining Area

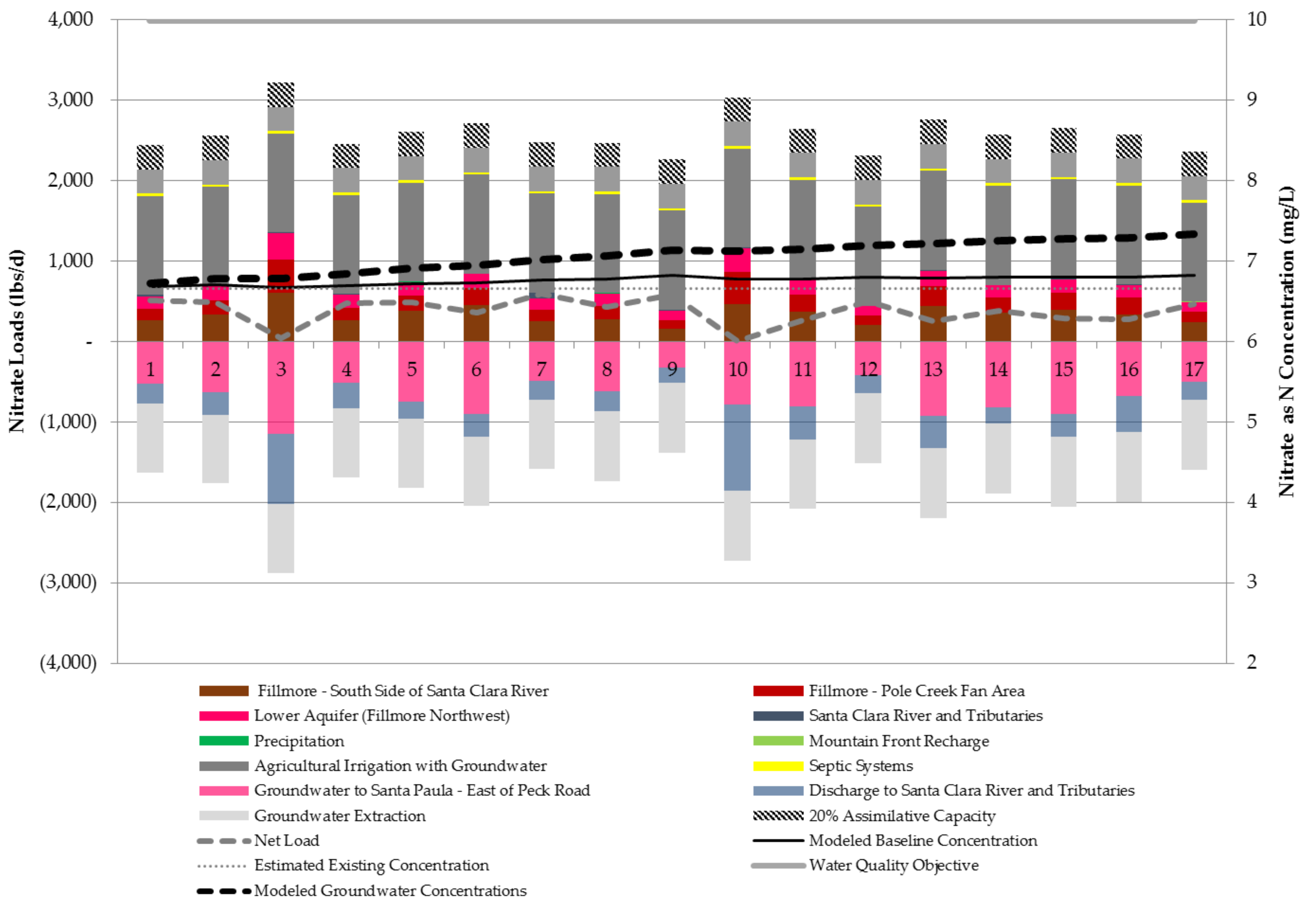


Figure 7-55 Modeled Nitrate 20% Threshold Load and Annual Concentrations for Fillmore Basin – Remaining Area

1.1.1 Santa Paula Basin – East of Peck Road

Figure 7-56 shows the additional loading of 22,000 lbs/d TDS that results in TDS concentrations increasing to 49 mg/L above existing concentrations using up 20% available assimilative capacity. Modeled baseline concentrations based on estimated existing loads show a slight decrease over time increasing the available assimilative capacity.

Figure 7-57 shows the additional loading of 3,000 lbs/d chloride that results in chloride concentrations increasing to 12 mg/L above existing concentrations using up 20% available assimilative capacity. Modeled baseline concentrations based on estimated existing loads show an increase over time decreasing the available assimilative capacity.

Figure 7-61 shows the additional loading of 60 lbs/d nitrate-N that results in nitrate-N concentrations increasing to 1 mg/L above existing concentrations using up 20% available assimilative capacity. Modeled baseline concentrations based on estimated existing loads show an increase over time decreasing the available assimilative capacity.

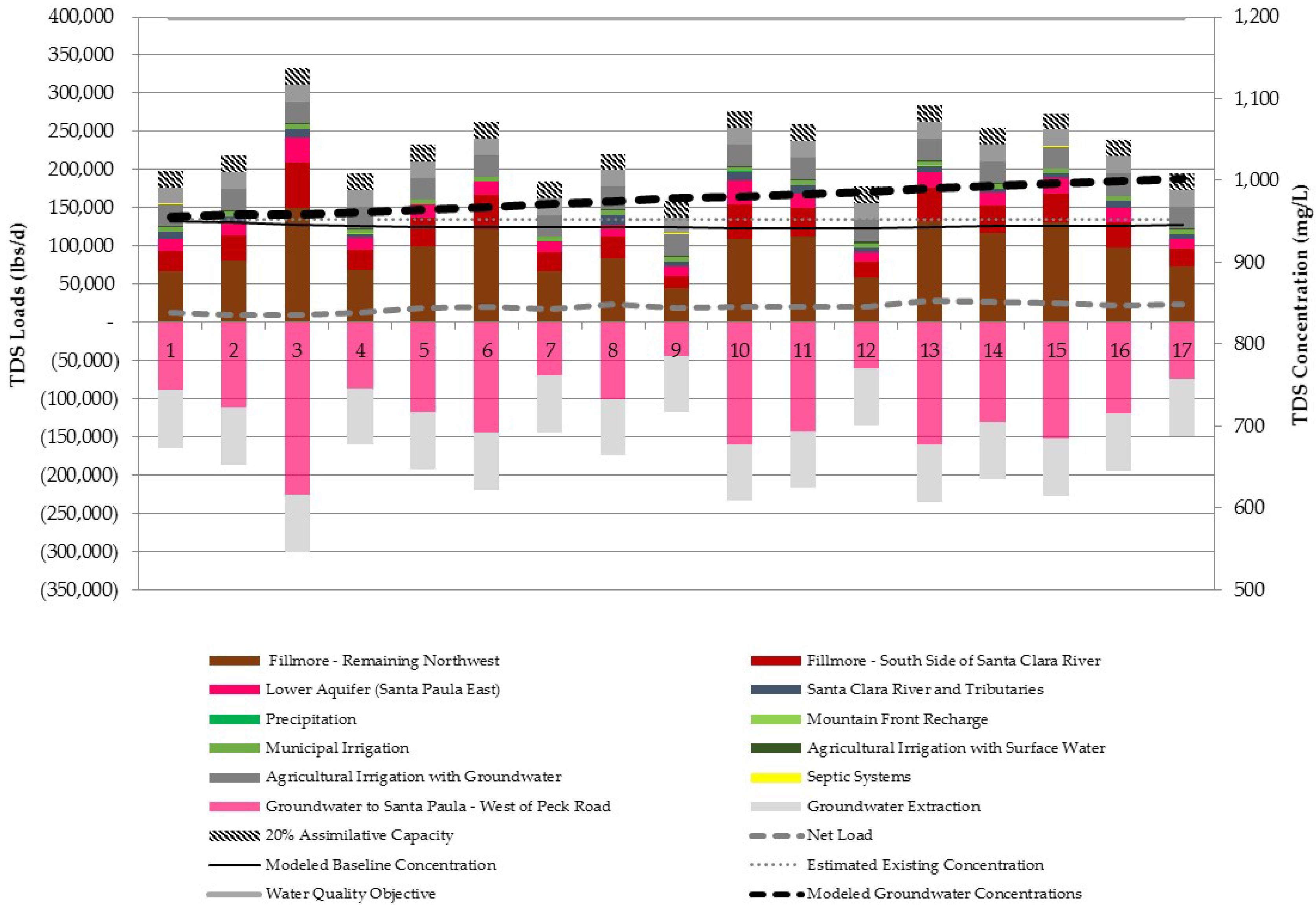


Figure 7-56 Modeled TDS 20% Threshold Load and Annual Concentrations for Santa Paula Basin – East of Peck Road

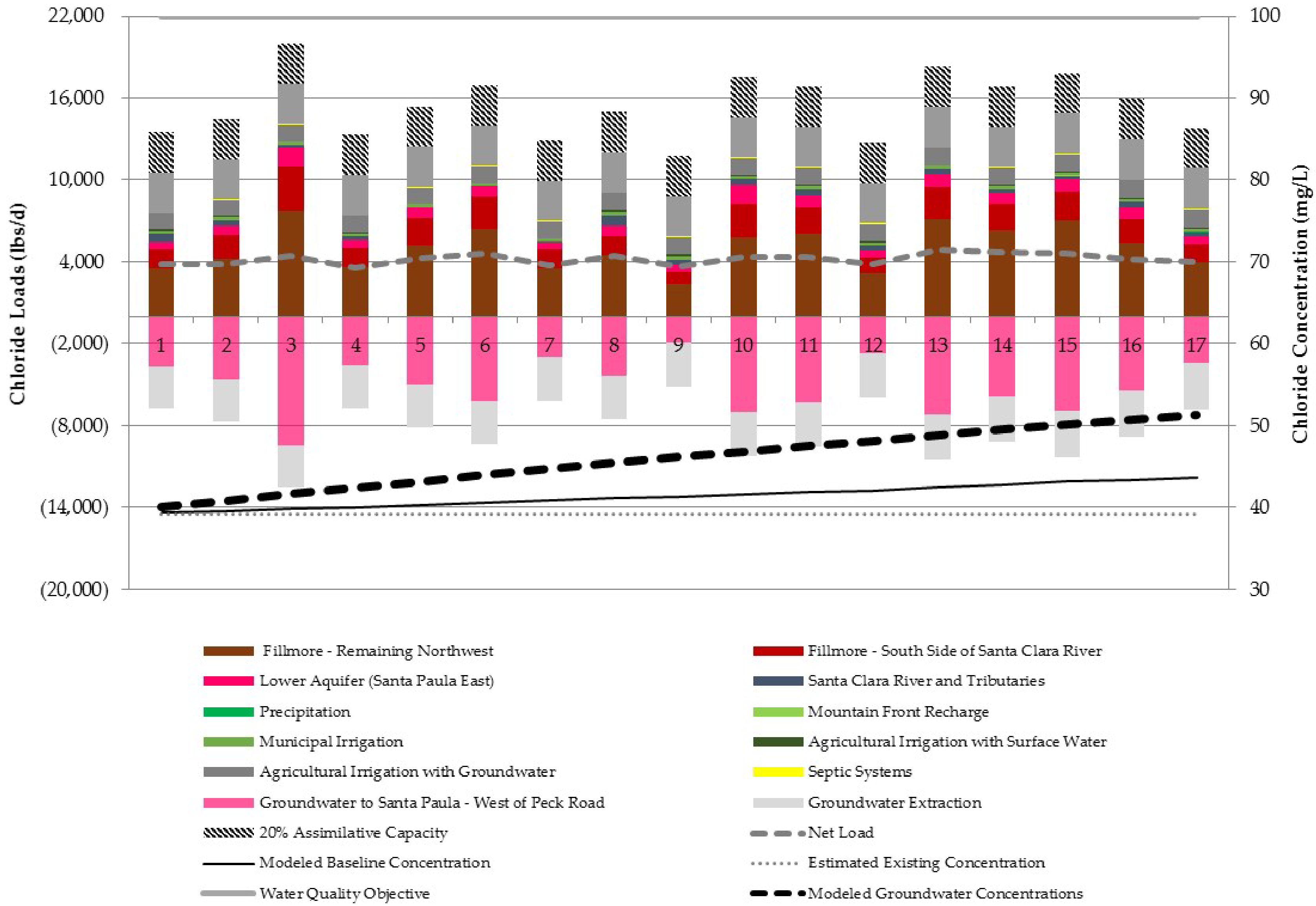


Figure 7-57 Modeled Chloride 20% Threshold Load and Annual Concentrations for Santa Paula Basin – East of Peck Road

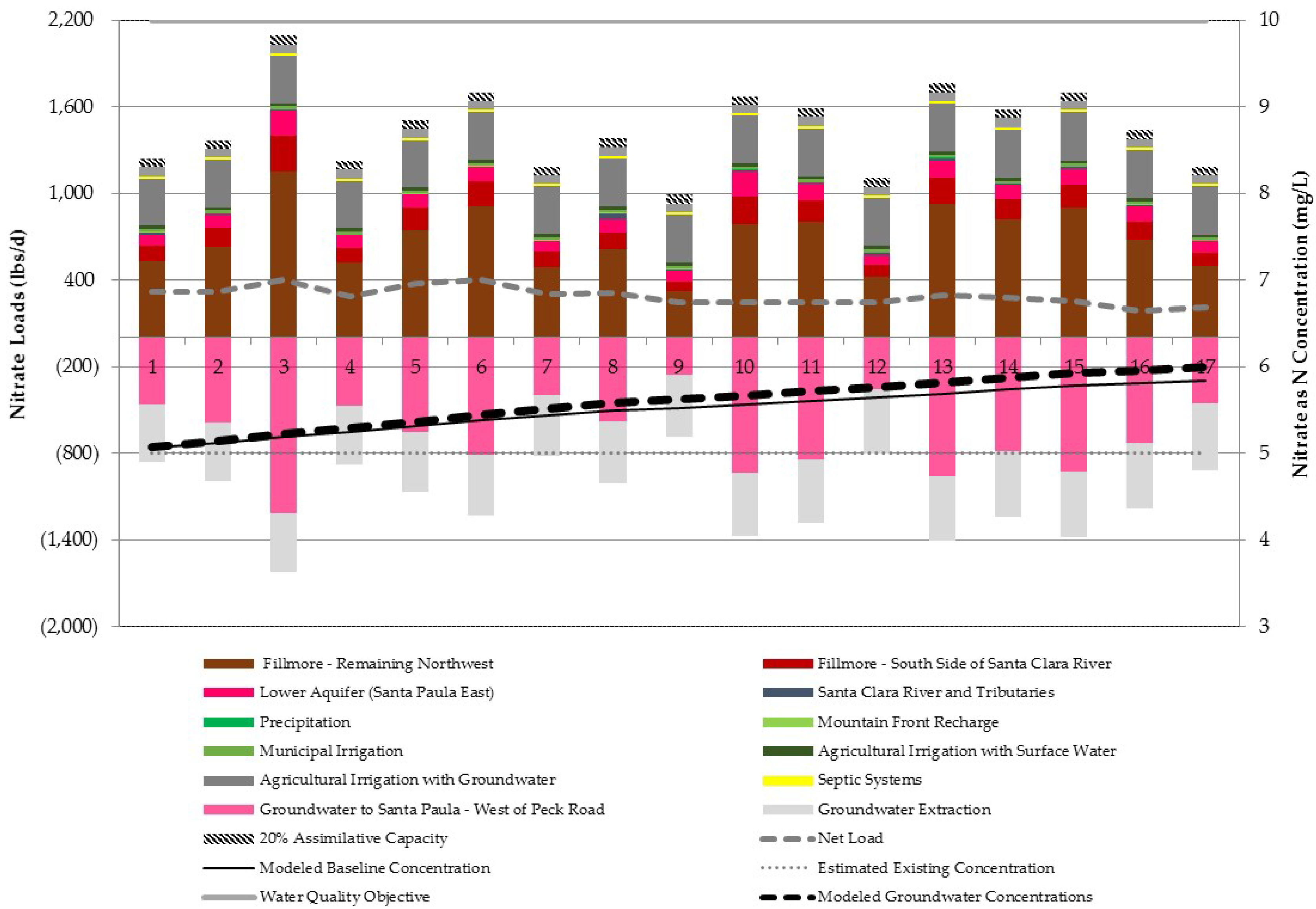


Figure 7-58 Modeled Nitrate 20% Threshold Load and Annual Concentrations for Santa Paula Basin – East of Peck Road

7.5.6 Santa Paula Basin – West of Peck Road

Figure 7-59 shows the additional loading of 106,000 lbs/d TDS that results in TDS concentrations increasing to 111 mg/L above existing concentrations using up 20% available assimilative capacity. Modeled baseline concentrations based on estimated existing loads show a slight decrease over time increasing the available assimilative capacity.

Figure 7-60 shows the additional loading of 6,300 lbs/d chloride that results in chloride concentrations increasing to 2 mg/L above existing concentrations using up 20% available assimilative capacity. Modeled baseline concentrations based on estimated existing loads show a decrease over time increasing the available assimilative capacity.

Figure 7-61 shows no additional loading since the baseline nitrate-N concentrations increase more than 2 mg/L above existing concentrations using up more than 20% available assimilative capacity. Modeled baseline concentrations based on estimated existing loads increase over time, decreasing available assimilative capacity more than 20%.

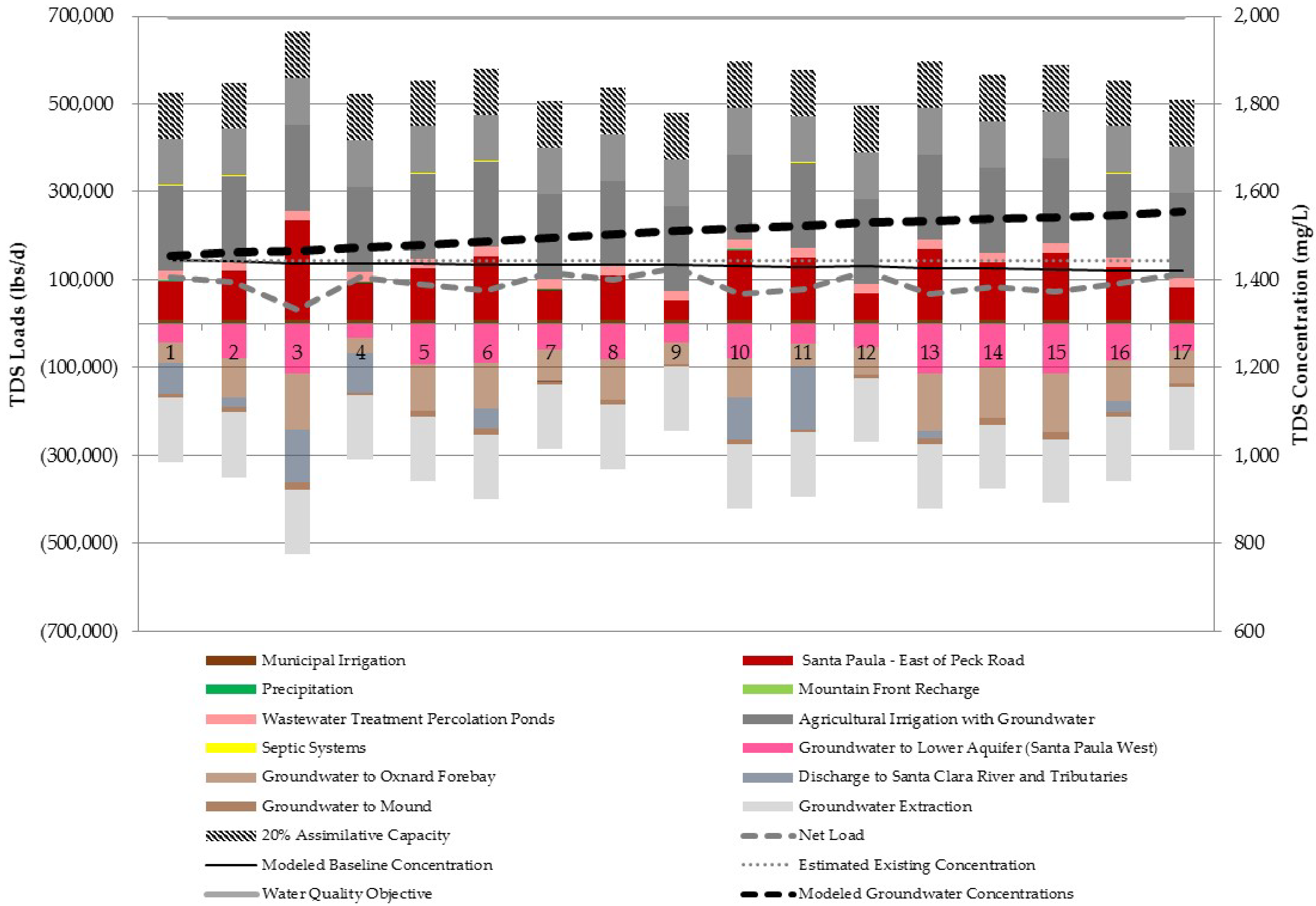


Figure 7-59 Modeled TDS 20% Threshold Load and Annual Concentrations for Santa Paula Basin – West of Peck Road

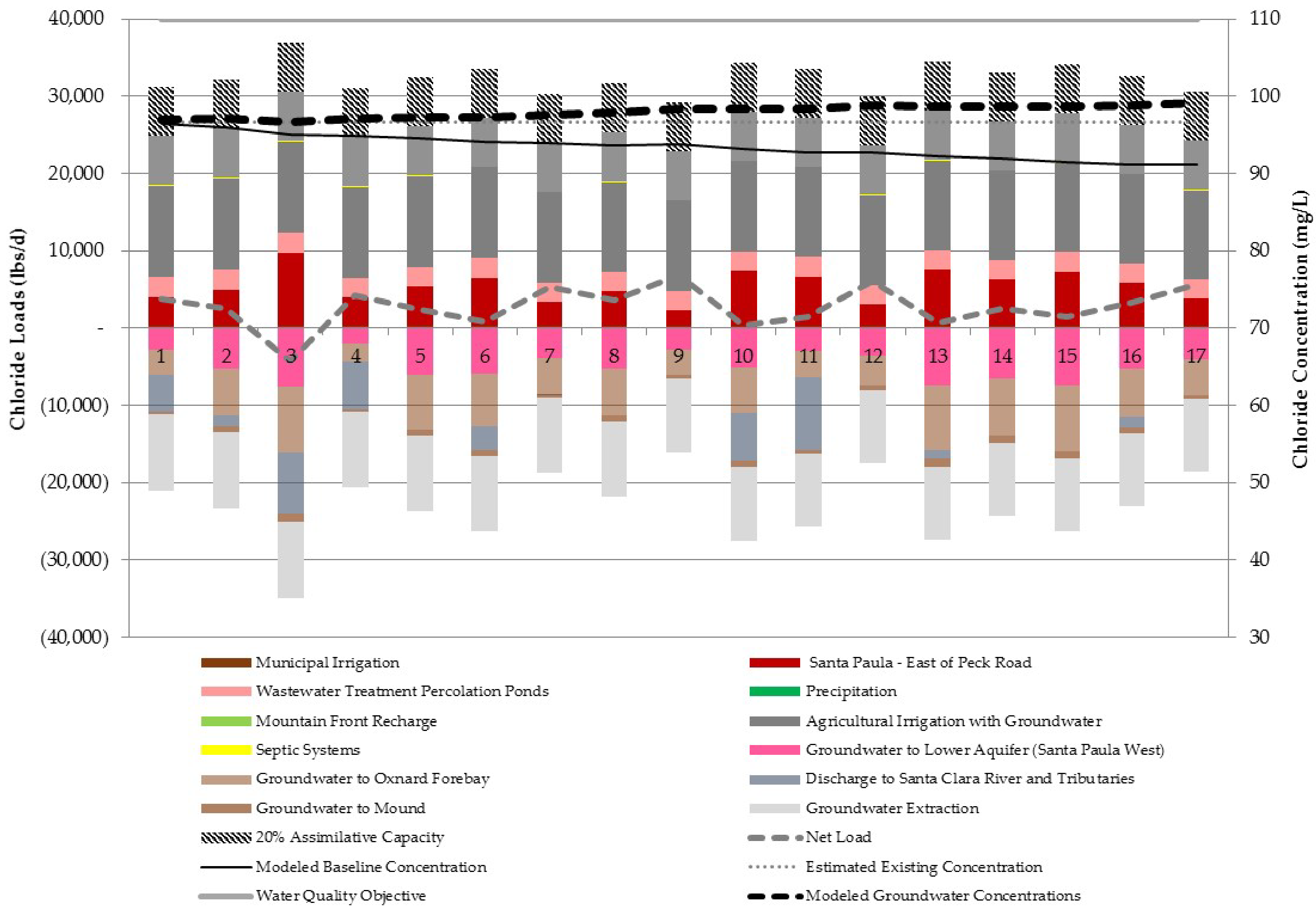


Figure 7-60 Modeled Chloride 20% Threshold Load and Annual Concentrations for Santa Paula Basin – West of Peck Road

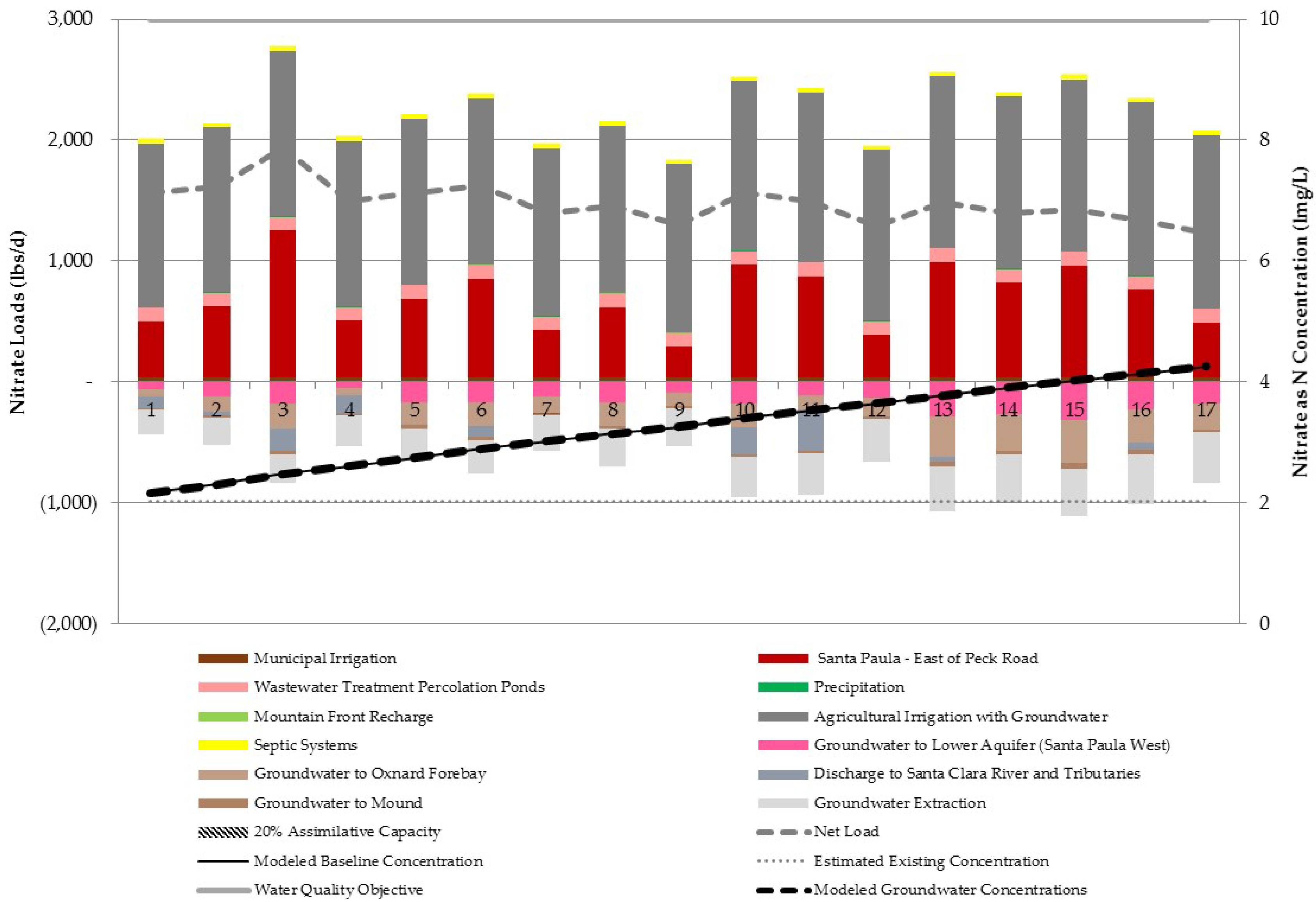


Figure 7-61 Modeled Nitrate 20% Threshold Load and Annual Concentrations for Santa Paula Basin – West of Peck Road

7.5.7 Oxnard Forebay Basin

Figure 7-62 shows the additional loading of 20,000 lbs/d TDS that results in TDS concentrations increasing to 25 mg/L above existing concentrations using up 20% available assimilative capacity. Modeled baseline concentrations based on estimated existing loads show a slight decrease over time increasing the available assimilative capacity.

Figure 7-63 shows the additional loading of 11,000 lbs/d chloride that results in chloride concentrations increasing to 18 mg/L above existing concentrations using up 20% available assimilative capacity. Modeled baseline concentrations based on estimated existing loads show a slight increase over time decreasing the available assimilative capacity.

Figure 7-64 shows the additional loading of 2,490 lbs/d nitrate-N that results in nitrate-N concentrations increasing to 0.9 mg/L above existing concentrations using up 20% available assimilative capacity. Modeled baseline concentrations based on estimated existing loads show a decrease over time increasing the available assimilative capacity.

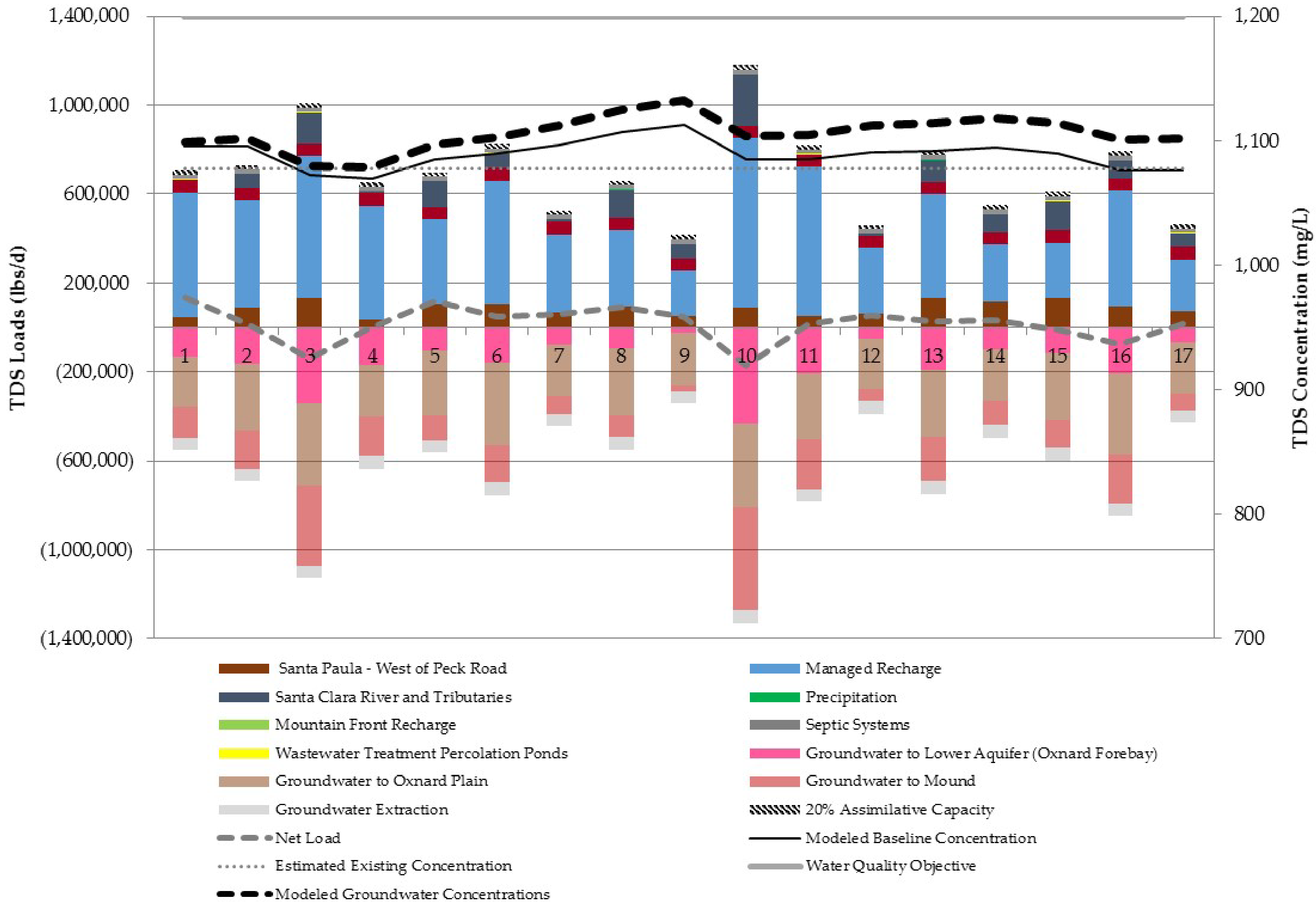


Figure 7-62 Modeled TDS 20% Threshold Load and Annual Concentrations for Oxnard Forebay Basin

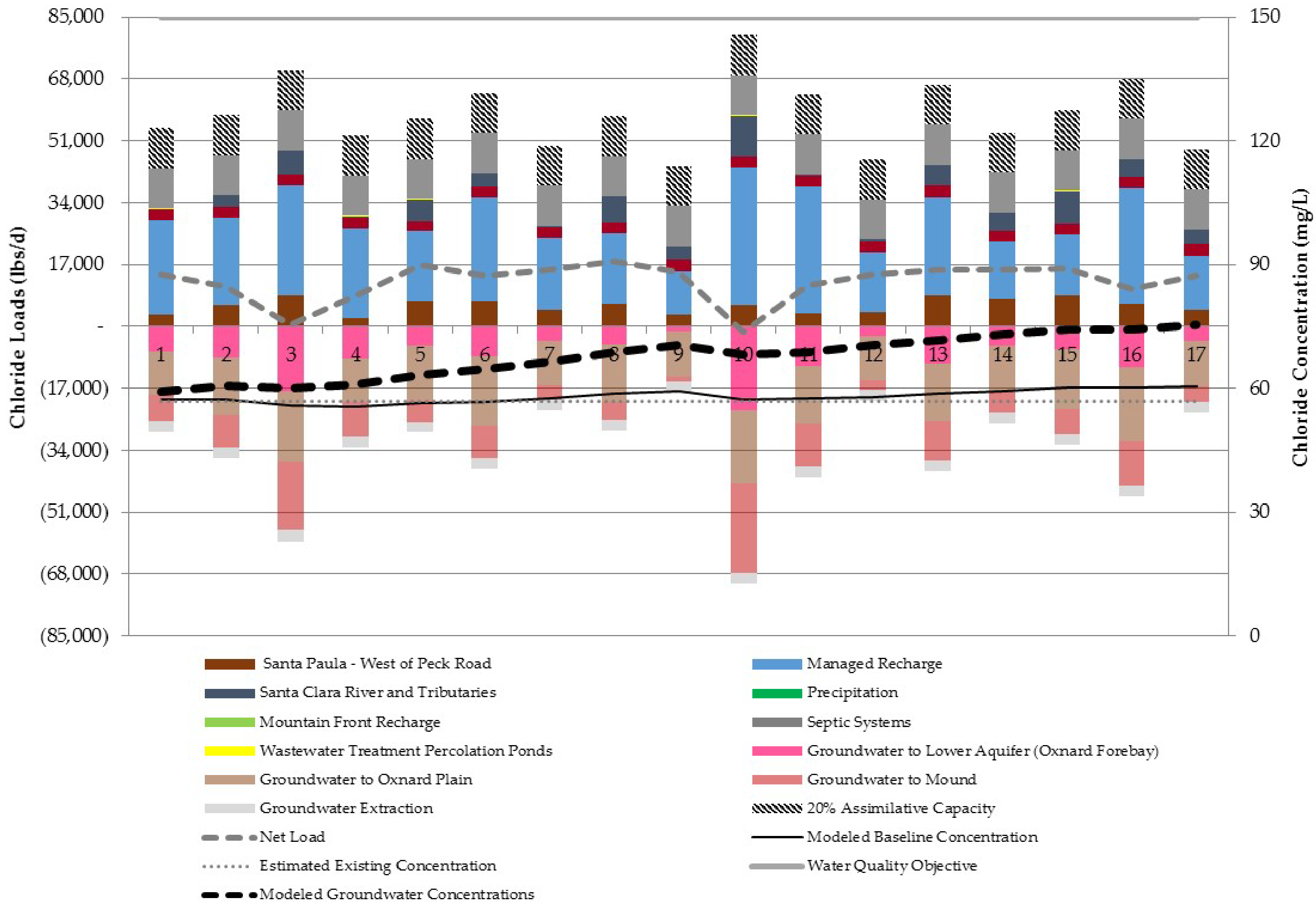


Figure 7-63 Modeled Chloride 20% Threshold Load and Annual Concentrations for Oxnard Forebay Basin

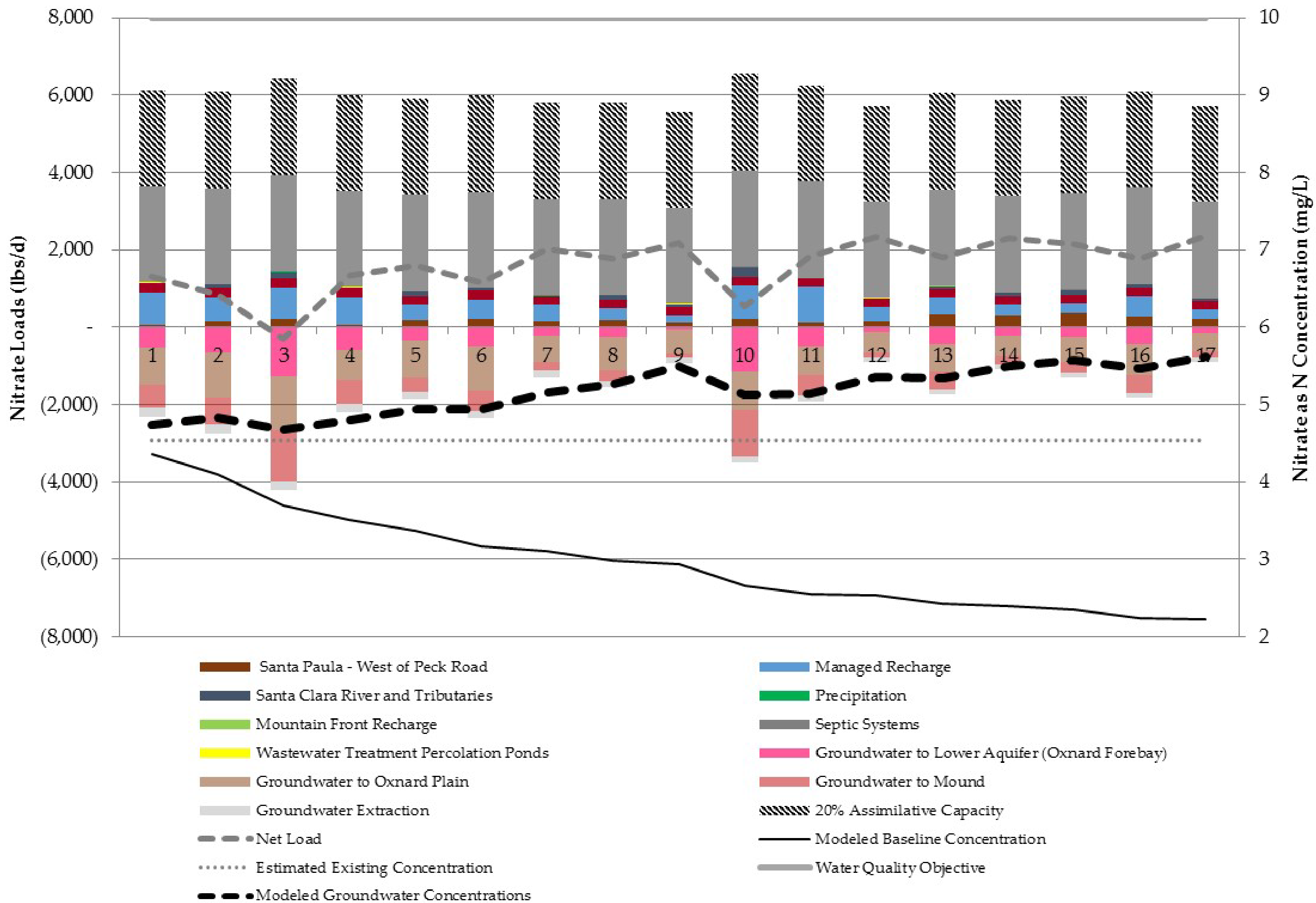


Figure 7-64 Modeled Nitrate 20% Threshold Load and Annual Concentrations for Oxnard Forebay Basin

7.5.8 Mound Basin

Figure 7-65 shows no additional loading since the estimated existing TDS concentration is higher than the water quality objective. Modeled baseline concentrations based on estimated existing loads show a slight increase over time.

Figure 7-66 shows the additional loading of 16,300 lbs/d chloride that results in chloride concentrations increasing to 15 mg/L above existing concentrations using up 20% available assimilative capacity. Modeled baseline concentrations based on estimated existing loads show no trend over time.

Figure 7-67 shows the additional loading of 1,270 lbs/d chloride that results in chloride concentrations increasing to 1.2 mg/L above existing concentrations using up 20% available assimilative capacity. Modeled baseline concentrations based on estimated existing loads show no trend over time.

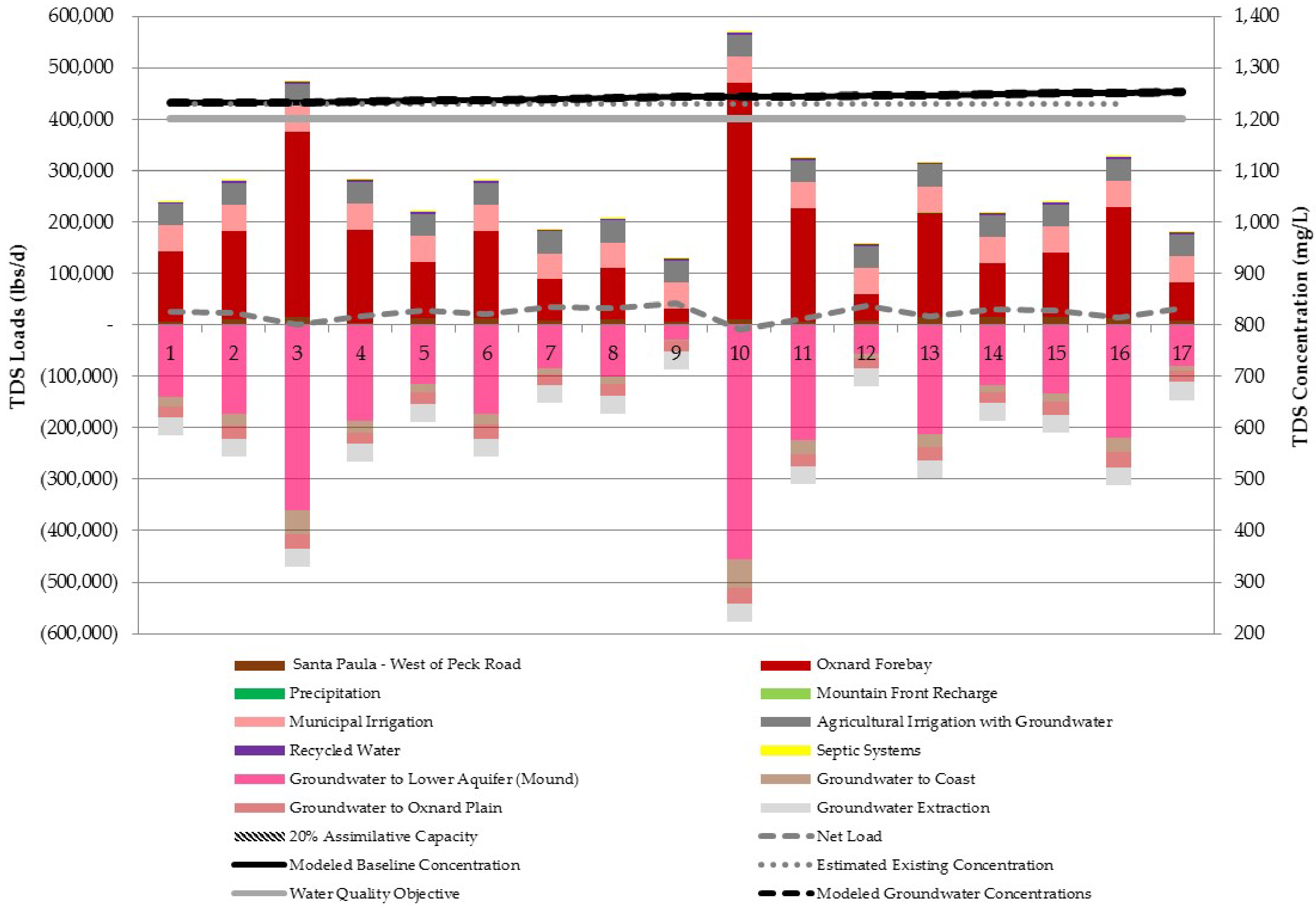


Figure 7-65 Modeled TDS 20% Threshold Load and Annual Concentrations for Mound Basin

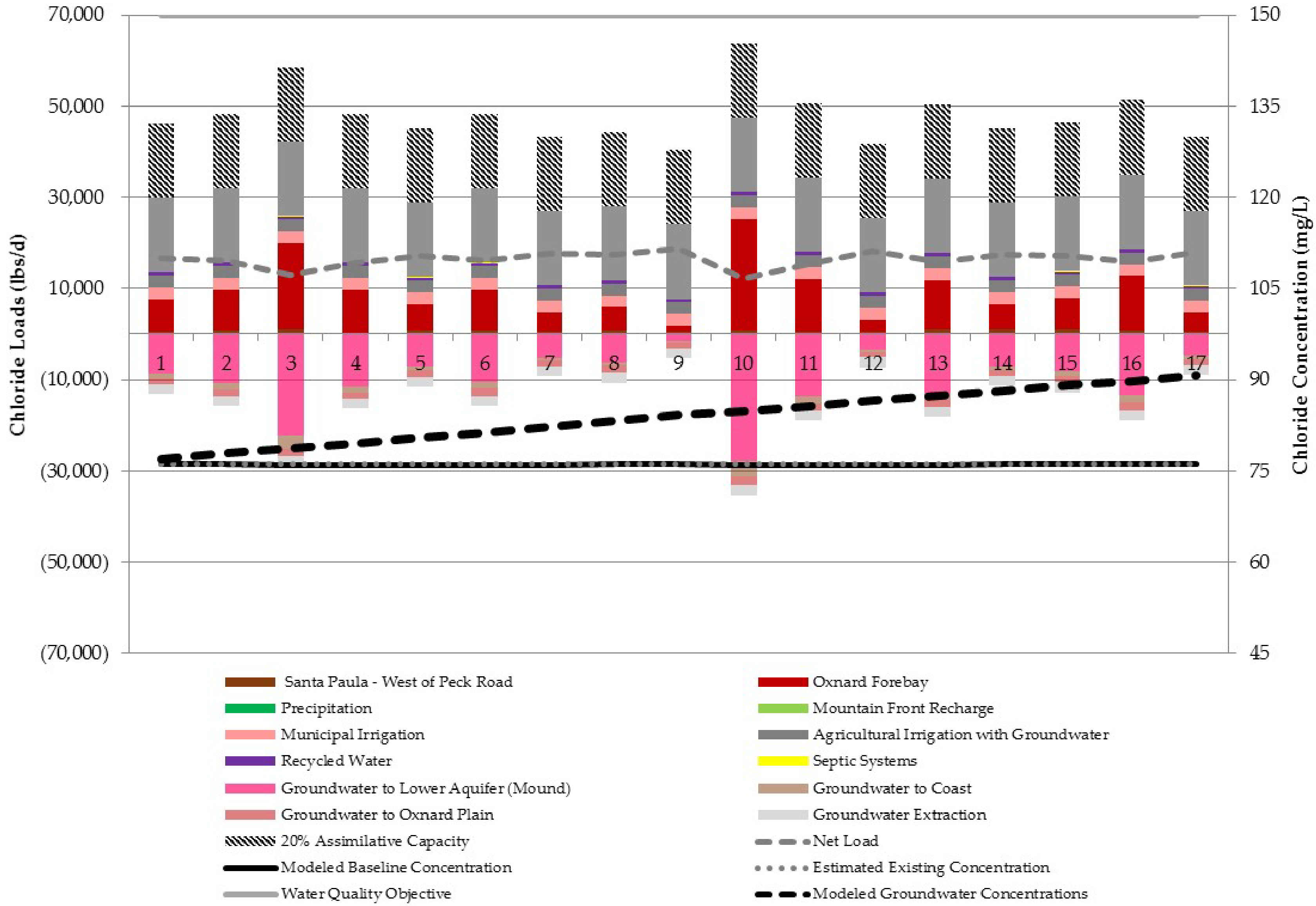


Figure 7-66 Modeled Chloride 20% Threshold Load and Annual Concentrations for Mound Basin

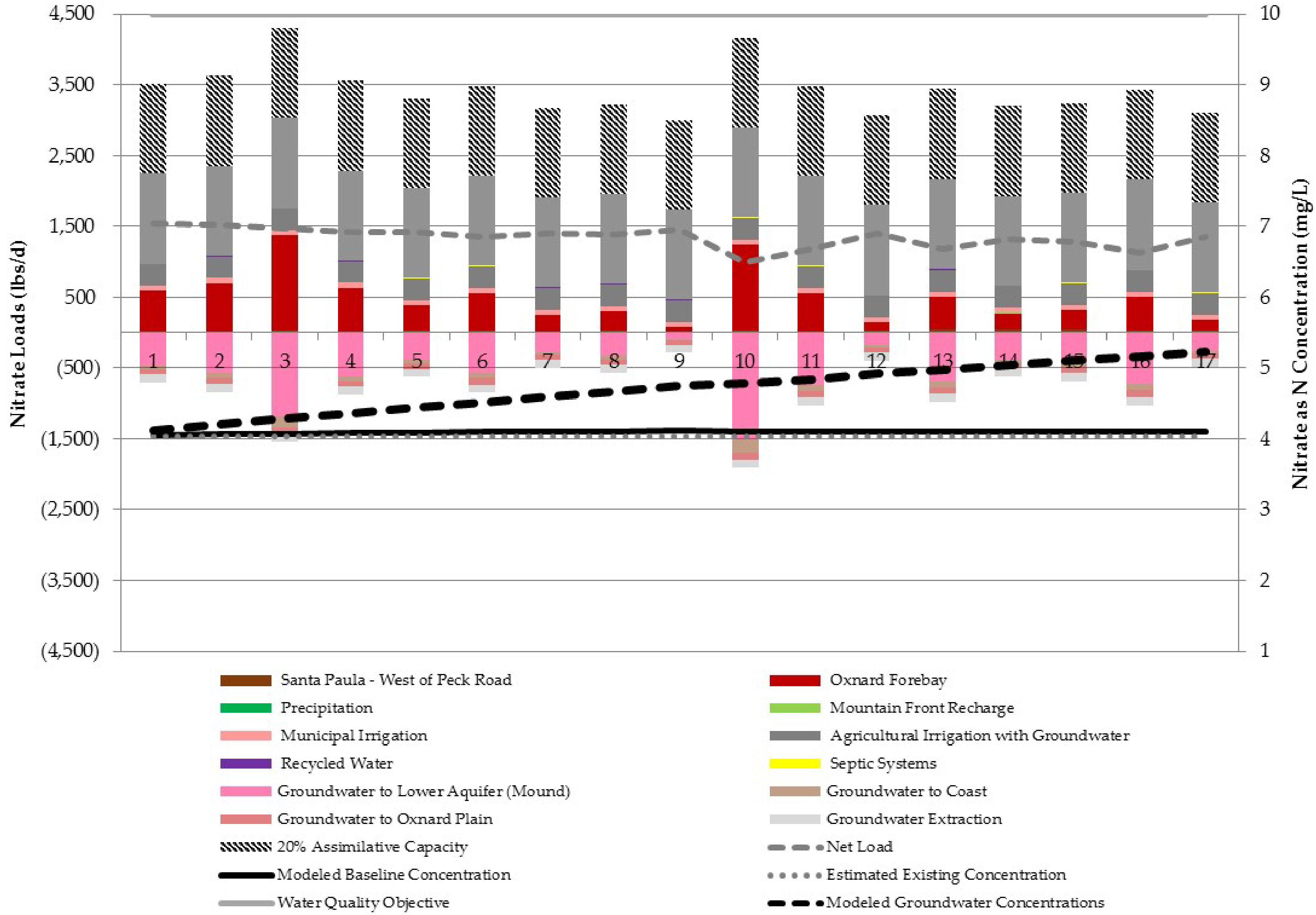


Figure 7-67 Modeled Nitrate 20% Threshold Load and Annual Concentrations for Mound Basin

8 Project Scenarios

As discussed in previous sections, rural and open space dominate the watershed (>69%; see **Table 3-4**), the sources of salts and nutrients that can be managed have been and are expected to be consistent over time, and no trends in the constituents of concern have been observed in most wells in the SNMP area. As a result, the development of project scenarios for evaluation in the SNMP focused on recycled water projects. The recycled water purveyors in the watershed are in various stages of developing recycled water projects. A number of planned projects have been identified but only the Ventura County Waterworks District 16 - Piru WWTP has advanced to the point of identifying specific project locations. As a result, the description of the planned recycled water projects are primarily from planning documents and conversations with stakeholders and the level of detail presented is reflective of the early planning stages for the planned projects. The planned projects are shown in **Table 8-1**.

While the projects shown in **Table 8-1** are currently planned, the recycled water goals outlined in **Section 1** are higher than the currently planned projects. Most of the stakeholders would like to find ways to recycle all of their current wastewater effluent volume and any additional volume that may be treated in the future, up to the design capacities of the treatment plants. To cover the range of possible recycled water scenarios that may need to be covered by the SNMP, three volumes of recycled water were considered plus one additional scenario:

1. Scenario 1. This scenario represents the *low* estimates of *planned* recycled water project volume as presented in **Table 8-2**.
2. Scenario 2. This scenario represents the *high* estimates of *planned* recycled water project volume as presented in **Table 8-2**.
3. Scenario 3. This scenario represents the maximum amount of recycled water that could be used in the SNMP area (**Table 8-2**). The maximum volume scenario would meet or exceed the recycled water use goals.
4. Scenario 4. This is an additional scenario for the City of Ventura that only considers the use of partially treated recycled water in the Mound basin (**Table 8-2**).

In addition to the recycled water volume and associated water quality, the location of the recycled water use is important. As discussed previously, all of the wastewater discharges, except for the VWRF, either recycle or discharge all of their effluent to the groundwater through percolation ponds. If the recycled water will be used in the same subarea as the current discharge, then any recycled water projects up to the current discharge volume would not be new loads to the groundwater subarea. However, if the recycled water is applied in a different subarea, it may be a new load to that subarea and a reduction in load in the subarea currently receiving the load. Therefore, the location of the recycled water project scenarios is also important. Santa Paula is considering recycled water projects in the same subarea to which they currently discharge and in adjacent subareas. As a result, the SNMP also includes consideration of scenarios for Santa Paula that involve discharges to different subareas and the same subarea. The specific project location for the initial District 16 - Piru WWTP project is included in Figure 8-1**.** Generalized locations of the remaining planned and potential future recycled water projects are shown in **Figure 8-2** to **Figure 8-6.**

The City of Ventura is considering groundwater recharge projects for indirect potable use and direct potable reuse projects. Development of indirect potable use and direct potable reuse projects will likely require treatment of the effluent prior to use of the water and disposal of brine outside of the planning area. If direct potable reuse is selected as the preferred option, the project would not involve discharge to the groundwater basins. As a result, direct potable reuse is not evaluated in the SNMP, but indirect groundwater recharge is included in the analysis.

The City of Ventura is planning to extend their existing recycled water pipeline to provide recycled water for landscape irrigation and may also provide recycled water for landscape irrigation to other users in the City. In addition, the City of Ventura may provide recycled water to agricultural users. To provide acceptable recycled water quality for agricultural irrigation, the tertiary effluent would likely undergo partial RO treatment. Landscape irrigation and agricultural irrigation are evaluated in the SNMP.

Table 8-1 Planned Recycled Water Projects

Groundwater Basin	Subarea	Agency	Type of Future Use	Volume of Use	Timing of Use	Reference Source
Piru	Lower Area West of Piru Creek	Ventura County Water Works District 16 – Piru Wastewater Treatment Plant[1]	Farm land located to the north, east, and south of the treatment plant	Phased implementation from 225 AFY to 560 AFY (0.2 mgd to 0.5 mgd)	Delivery of 225 AFY (0.2 mgd), current treatment plant flows, will begin in 2016	Personal communication with County staff.
Fillmore	Pole Creek Fan Area	City of Fillmore[2] – Fillmore Wastewater Reclamation Facility	Heritage Valley Park Development – 20 acre park, 10 acre school sports field	60 AFY (0.05 mgd)	Unknown – Depends on pipeline construction	Personal communication with City staff and Fillmore Recycled Water Delivery Report 2010 & 2011. Based on 2 AF/acre irrigation rate.
			Panam Sat Orchard – 20 acres avocado orchard	147 AFY (0.13 mgd)	Unknown – may depend on developing competitive pricing for recycled water	Personal communication with City staff and Fillmore Recycled Water Delivery Report 2010 & 2011. Based on 2.1 AF/acre irrigation rate.
			Baldwin Towne Plaza – 5 acre turf	10 AFY (0.01 mgd)	Unknown – may depend on developing competitive pricing for recycled water	Personal communication with City staff and Fillmore Recycled Water Delivery Report 2010 & 2011. Based on 2 AF/acre irrigation rate.
			Agricultural area located east of the City limits – No defined acreage	Unknown	Unknown	Personal communication with City staff.

Table 8-1 Planned Recycled Water Projects

Groundwater Basin	Subarea	Agency	Type of Future Use	Volume of Use	Timing of Use	Reference Source
Santa Paula	West of Peck Road	City of Santa Paula – Santa Paula Water Recycling Facility	Landscape irrigation	Phase implementation from 400 AFY to 1,622 AFY (0.4 mgd to 1.45 mgd)	Phase implementation from 2015 to 2035	City of Santa Paula Urban Water Management Plan 2011, City of Santa Paula Recycled Water Facilities Planning Final Report 2010
	West of Peck Road	City of Ventura VWRF	Landscape Irrigation	Possible upper range of 100 AFY	Not permitted and demands not currently well defined	Personal communication with staff
	West of Peck Road	Saticoy Wastewater Treatment Plant	None	NA	NA	NA
	West of Peck Road	Limoneira and Olivelands Sewer Farms	None	NA	NA	NA
		Todd Road Jail Wastewater Treatment Plant	None	NA	NA	NA
Mound	Mound	Montalvo Community Services District Wastewater Treatment Plant	None	NA	NA	NA
	Mound	City of Ventura – Ventura Wastewater Reclamation Facility	Groundwater recharge to Mound basin for indirect potable reuse.	2,200 – 7,100 AFY (2-6.3 mgd). Possible upper range of 9,700 AFY (8.7 mgd)	2025 Implementation at 9,700 AFY would depend on outcome of additional feasibility studies	2013 RW Facility Plan
			Landscape irrigation in the City's Recycled Water Focus Area	60 AFY (0.05 mgd)	Already permitted, but timing of implementation unknown – Will be implemented with new development	2012 RW Market Study

Table 8-1 Planned Recycled Water Projects

Groundwater Basin	Subarea	Agency	Type of Future Use	Volume of Use	Timing of Use	Reference Source
Mound (continued)		City of Ventura – Ventura Wastewater Reclamation Facility	Landscape irrigation	Possible upper range of 1,500 AFY (1.3 mgd)	Not permitted and demands not currently well defined	Personal communication with staff
			Agricultural irrigation	Possible upper range of 7,300 AFY (6.5 mgd)	Not permitted and demands not currently well defined	Personal communication with staff
Oxnard Forebay	Oxnard Forebay	City of Oxnard	Recharge of recycled water (from the Oxnard AWPF, which includes RO) in surface spreading basins and/or direct use for Ag irrigation.	Unknown	Unknown	Personal communication with staff

[1] The County plans to implement 100% reuse of effluent from the Piru Wastewater Treatment Facility. Upgrades to the treatment facility to produce Title 22 recycled water are currently being designed. It is anticipated that the citrus farm will provide sufficient demands for all of the recycled water from the treatment facility (from current treatment plant flows of 0.2 mgd, up to 0.5 mgd, which is the buildout flow of the treatment facility).

[2] The City of Fillmore's goal is to implement reuse of 100% of their effluent. Annual average effluent flows are approximately 1 mgd (1,120 AFY). Approximately 25% (0.25 mgd, 280 AFY) of the effluent is currently being recycled. Therefore the City would need to implement 0.75 mgd (840 AFY) of reuse in the future, provided that there is not a significant increase in WWTP effluent flow.

Table 8-2 Project Scenarios

Discharger	Subarea	Scenario 1	Scenario 2	Scenario 3	Scenario 4
Piru	Lower Area West of Piru Creek	225 AFY	560 AFY	560 AFY	
Fillmore	Pole Creek Fan Area	217 AFY	1,040 AFY	2,651 AFY	
Santa Paula	West of Peck Road and/or East of Peck Road	400 AFY	1,622 AFY	3,088 AFY	
Ventura[1]	Mound	60 AFY (landscape irrigation)	1,500 AFY (landscape irrigation)	1,500 AFY (landscape irrigation) 7,300 AFY (agricultural irrigation)	7,300 AFY (agricultural irrigation)

[1] Landscape irrigation is assumed to occur at existing discharge quality. Agricultural irrigation would consist of partially reverse osmosis treated effluent with assumed quality of 597 mg/L TDS, 117 mg/L chloride, and 3 mg/L nitrate. If indirect groundwater recharge is implemented, the project would consist of highly treated effluent with low salt and nutrient concentrations that would be well below the existing concentrations in the Mound basin. The use of highly treated wastewater for indirect groundwater recharge is a management measure that would likely reduce salt and nutrient concentrations in the Mound basin and is therefore not considered as an added load for the scenario analysis.

Figure 8-1 District 16-Piru WWTP Planned Project Location in Piru Basin-Lower Area West of Piru Creek

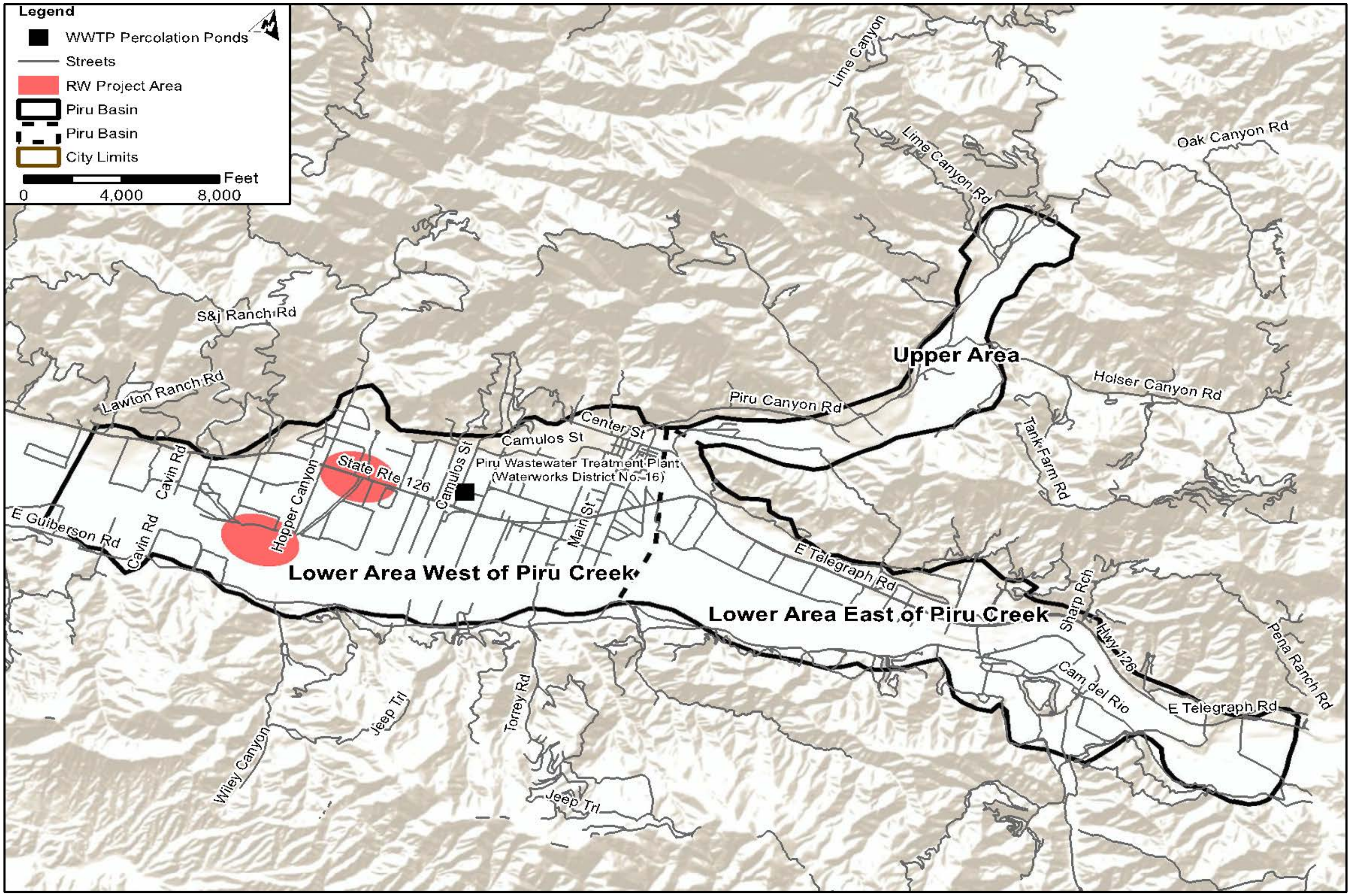


Figure 8-2 Potential Recycled Water Project Areas in Piru Basin

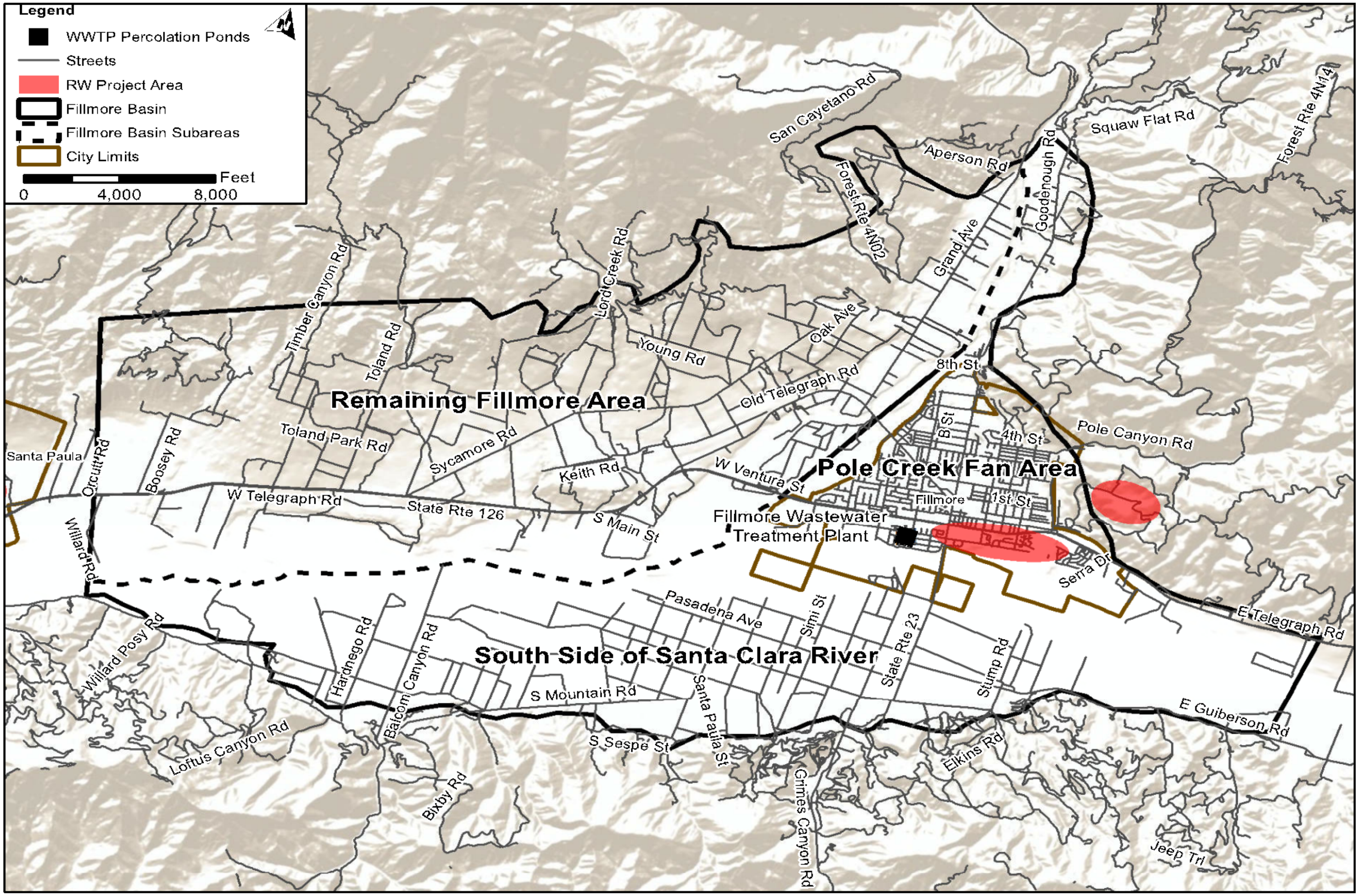


Figure 8-3 Potential Recycled Water Project Areas in Fillmore Basin

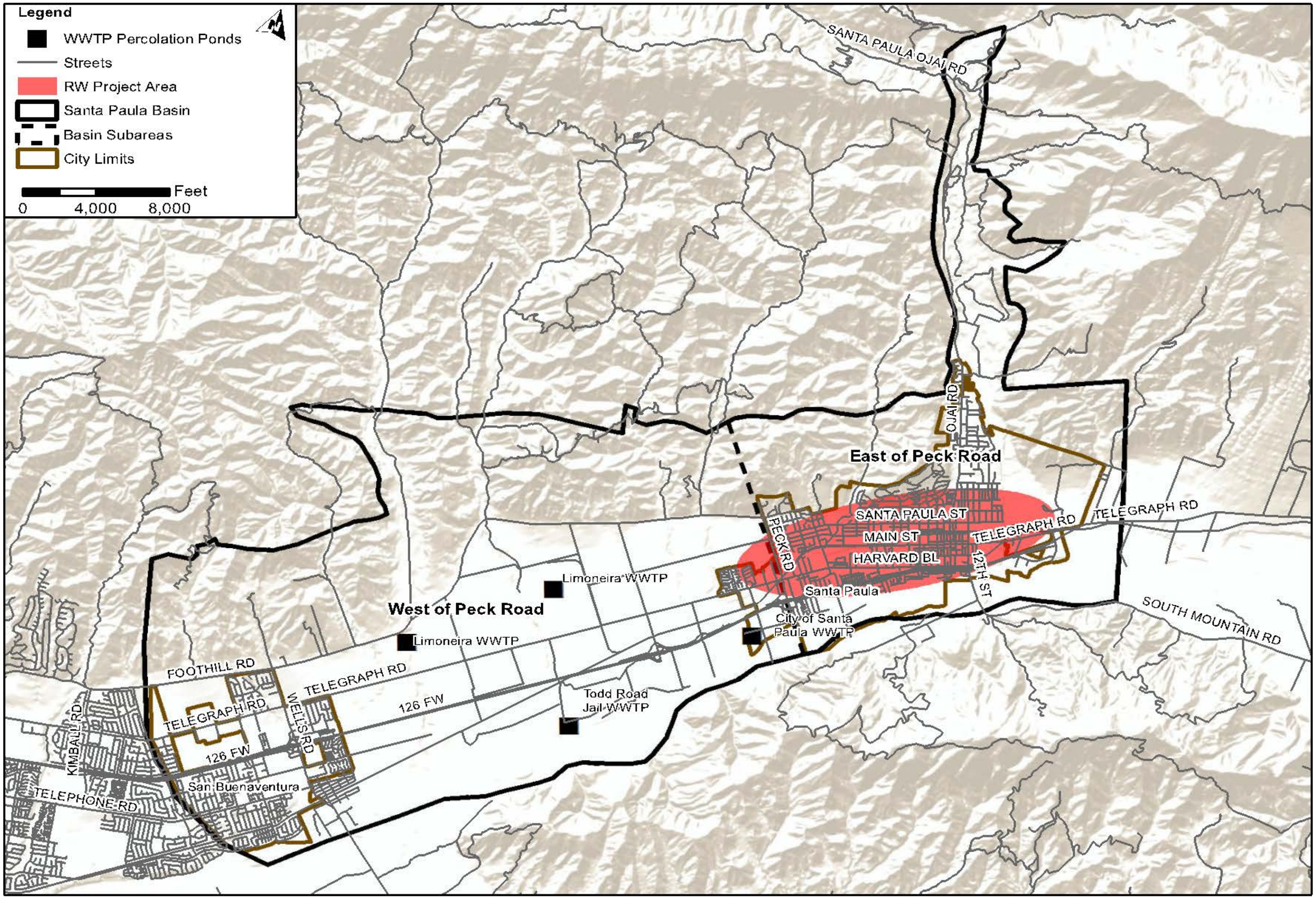


Figure 8-4 Potential Recycled Water Project Areas in Santa Paula Basin

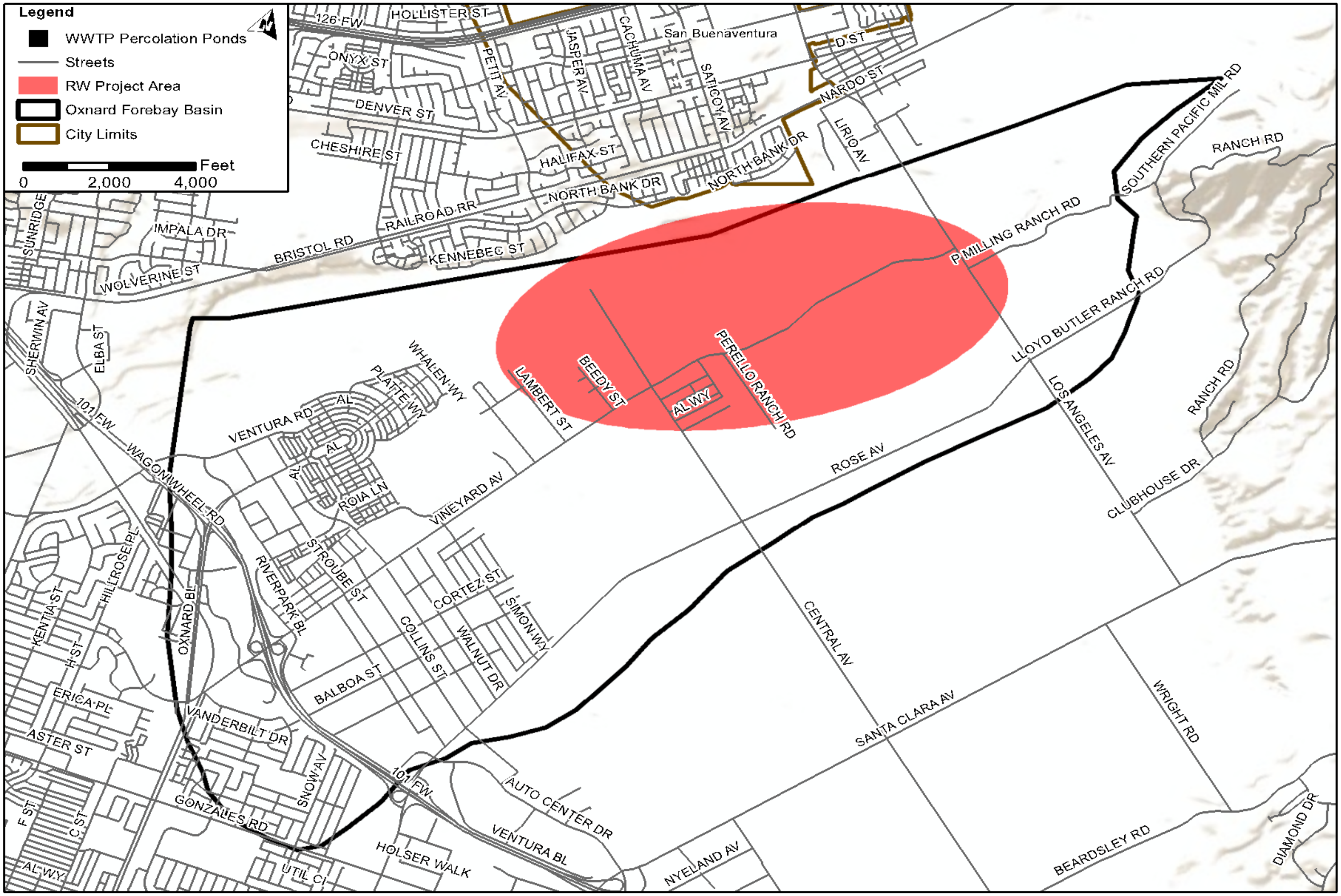


Figure 8-5 Potential Recycled Water Project Areas in Oxnard Forebay Basin

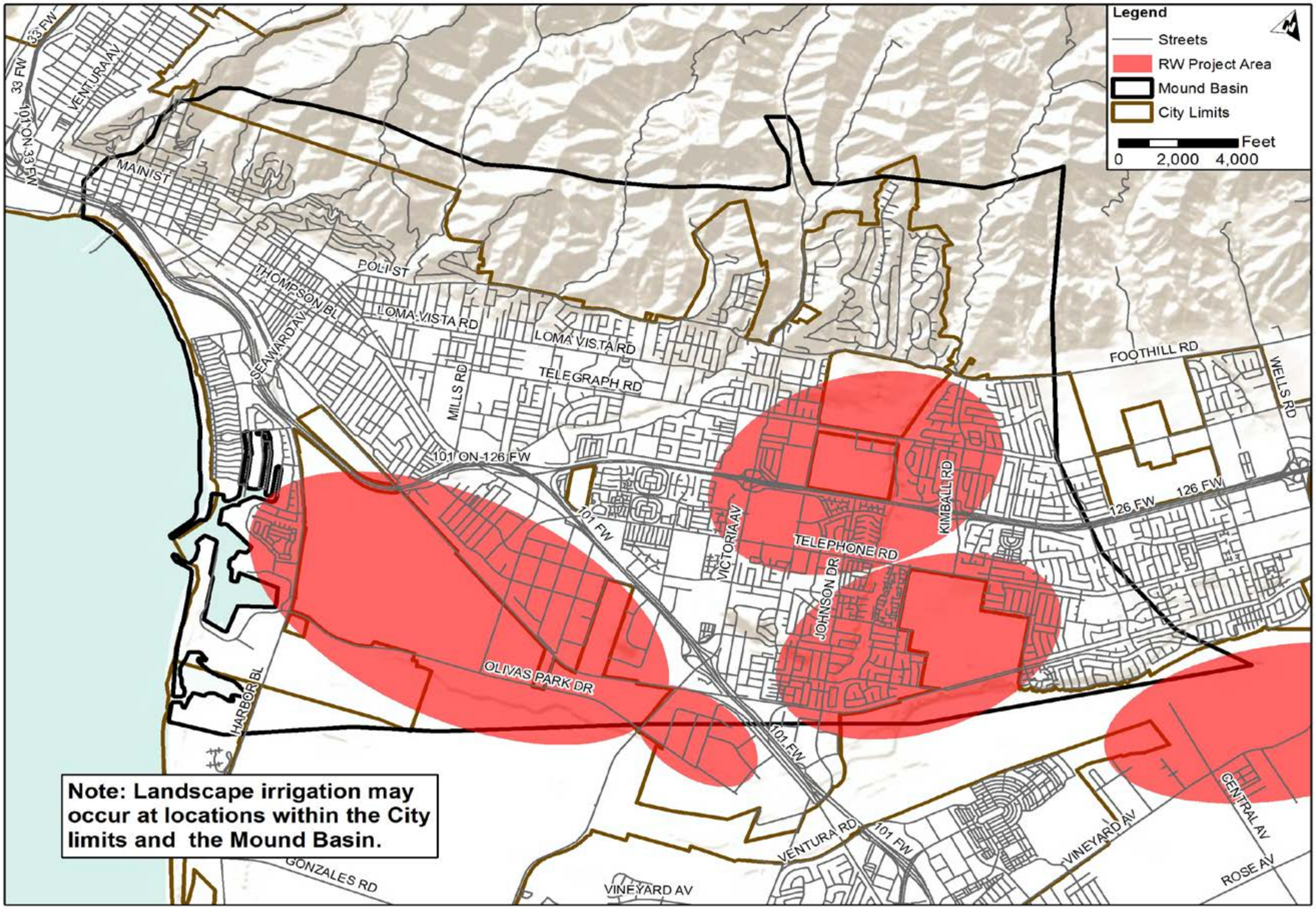


Figure 8-6 Potential Recycled Water Project Areas in Mound Basin

9 Implementation Measures to Manage Salt and Nutrient Loading in the Groundwater Basin on a Sustainable Basis

The primary goal of the SNMP is to protect, conserve, and augment water supplies and improve water supply reliability. Recycled water projects serve a key role in the SNMP area to support water supply reliability. However, the implementation of the projects needs to be done in a way that ensures the protection of the groundwater basin. This section outlines existing management measures that are currently in place in the SNMP area that will be maintained under any future scenario and outlines a process for evaluating recycled water projects and determining whether additional management measures are needed. Potential future management measures are identified that can be selected if needed to implement a planned project.

9.1 EXISTING MANAGEMENT MEASURES

The objective of SNMP implementation measures is to manage salt and nutrient loadings on a sustainable basis and to maintain long term supply for multiple beneficial uses. Per the guidance provided in the document, *Regional Water Board Assistance in Guiding Salt and Nutrient Management Plan Development in the Los Angeles Region*, these strategies should be tailored to basin specific characteristics and conditions, but should be generally focused on:

- Pollution prevention;
- Source load reductions to groundwater basins;
- Treatment and management of areas of impaired water quality;
- Boosting or stabilizing declining water levels where water quality is not affected;
- Increasing groundwater recharge by stormwater; and
- Increasing recycled water use.

In the LSCR planning area, salt and nutrient management has been ongoing for a number of years. There are a number of existing management measures and activities that contribute to reducing loads and improving groundwater quality. Salt and nutrient load pathways are described in **Section 6** and shown in **Figure 6-1**. Understanding these source pathways is helpful in tailoring implementation measures to the LSCR planning area.

The existing management measures are categorized by source and pathway for reducing salt and nutrient contributions to the groundwater. For example, some management measures prevent loads from entering the basin (e.g., water conservation or water softener bans), others offset loads from another source (e.g., changing the source water for an irrigation project), and others remove loading from the basin (e.g., groundwater treatment). The categories used to describe the management measures are:

- Improve wastewater and reclaimed water quality;
- Improve municipal water quality;
- Reduce septic system leachate and improve quality;
- Manage urban stormwater runoff to support basin water quality;
- Improve non-stormwater discharge control and quality;

- Improve agricultural runoff control and quality;
- Increase recycled water use;
- Increase aquifer recharge with lower concentration water sources;
- Improve urban and agricultural water efficiency/conservation;
- Reduce saltwater intrusion and protect groundwater quality; and
- Manage groundwater pumping and water levels.

Table 9-1 summarizes the existing management measures. The table of existing measures was developed from existing documents and through communication with stakeholders.

Implementation of the existing management measures has resulted in reductions in the discharges of salts and nutrients to the groundwater basins. Average effluent concentrations from the wastewater treatment plants for chloride, TDS and total nitrogen has decreased as a result of the existing management measures shown in **Table 9-1**. Estimated annual effluent concentrations prior to the treatment plant upgrades and water softener bans are shown in **Table 9-2.** For Piru, Fillmore, and Santa Paula, the installation of new treatment facilities have reduced the discharge of total nitrogen into the watershed by over 75%. For salts, the water softener bans appear to have reduced total dissolved solids and chloride concentrations from Fillmore and Santa Paula.

Table 9-1 Existing Management Measures

Category	Specific Measure	Agency/Action	Description	Effect
Wastewater and reclaimed water quality	Source control - salts	City of Santa Paula – Water Softener Ban	Prohibits replacement or enlargement any apparatus for treating the water supply to a property if the apparatus is of a kind that produces any wastewater with a mineral content higher than that of the water supply of the property.	Fewer self-regenerating water softeners (or other treatment devices that produce a high mineral waste) will reduce the salt load in residential wastewater.
Wastewater and reclaimed water quality	Source control – salts	City of Fillmore - Water softener rebate program	Outreach and rebate program aimed at reducing the number of self-regenerating water softeners in the Fillmore community. Approximately 85 rebates completed to date.	Fewer self-regenerating water softeners will reduce the salt load in residential wastewater.
Wastewater and reclaimed water quality	Source control – salts	City of Fillmore	Prohibits self-regenerating water softeners discharging to the sanitary sewer.	Prohibits the additional salt load wastewater from water softener brine.
Wastewater and reclaimed water quality	Source control – salts and nutrients	City of Santa Paula – Industrial Discharge Ordinance	Local limits for TDS (2,000 mg/L), chloride (110 mg/L) and ammonia nitrogen (30 mg/L).	Provides an upper limit on the concentration of salts and nutrients in industrial contributions to wastewater.
Wastewater and reclaimed water quality	Source control – salts	City of Ventura – Local Limits	Local limit for TDS (4,270 mg/L).	Provides an upper limit on the concentration of salts in industrial contributions to wastewater.
Wastewater and reclaimed water quality	Source control – salts	City of Ventura – Ordinances on Industrial discharges	Prohibits discharge of saltwater or brine from commercial or industrial activities. Establishes local limits for industrial/commercial facilities. Establishes permit requirements for non-domestic wastewater discharges.	Prohibits the additional salt load to wastewater from saltwater or brine from commercial or industrial activities.
Wastewater and reclaimed water quality	Treatment control – nutrients	City of Santa Paula – Upgraded treatment facilities	Construction of new wastewater treatment facilities with nutrient removal to replace secondary treatment facility.	Reduction in total nitrogen concentrations in effluent.

Table 9-1 Existing Management Measures

Category	Specific Measure	Agency/Action	Description	Effect
Wastewater and reclaimed water quality	Treatment control – nutrients	City of Fillmore – Upgraded treatment facilities	Construction of new wastewater treatment facilities with nutrient removal to replace secondary treatment facility.	Reduction in total nitrogen concentrations in effluent.
Wastewater and reclaimed water quality	Treatment control – nutrients	Ventura County Waterworks District 16 – Upgraded treatment facilities	Construction of new wastewater treatment facilities with nutrient removal and subsequent upgrade to tertiary treatment.	Reduction in total nitrogen concentrations in effluent.
Septic system leachate volume and quality	Leachate volume reduction	City of Santa Paula – Septic tank policy	Prohibits installation of new septic tanks in service area and requires tie-in of a septic tank to the sewer if located within 200 feet of a sewer line. County areas adjacent to the service area also are required to tie in.	Reduces the volume of septic system leachate that percolates into shallow groundwater. Tie-in to a treatment plant ultimately leads to a treated waste stream with a lower nutrient load.
Municipal water quality	Provide treatment of a compromised supply	City of Ventura – Water Conditioning Facilities	City of Ventura has two water condition facilities that treat extracted groundwater from the Mound basin before potable use. The conditioning facilities are designed to reduce iron and manganese in the extracted groundwater and help comply with secondary drinking water standards. The City's current (interim) approach to continued use of this supply is to blend the water from the Mound basin with water from the Oxnard Plain prior to delivery to customers.	Reduces salt concentration in municipal water supply.

Table 9-1 Existing Management Measures

Category	Specific Measure	Agency/Action	Description	Effect
Stormwater runoff management	Increase stormwater recharge through LID and improve quality through BMPs	Ventura County – MS4 permit	Requires specified New Development and Redevelopment projects to control pollutants, pollutant loads, and runoff volume emanating from impervious surfaces through infiltration, storage for reuse, evapotranspiration, or bioretention/ bioinfiltration by reducing Effective Impervious Area to 5% or less of the total project area.	Promotes infiltration of rainwater (low in salt and nutrients) into the groundwater. Through treatment, reduces pollutant loads to groundwater and surface waters (that may recharge groundwater basins).
Stormwater runoff management	Increase stormwater recharge and improve water quality through BMPs	Ventura County – Green Street Demonstrations	Demonstration projects to illustrate stormwater capture and treatment BMPs.	Promotes infiltration of rainwater (low in salt and nutrients) into the groundwater. Through treatment, reduces pollutant loads to groundwater and surface waters (that may recharge groundwater basins).
Non-stormwater discharge control and quality	Source control of non-stormwater discharges	Ventura County – MS4 permit	Requires discharges of debrominated/ dechlorinated swimming pool water to meet water quality standards for salts.	Provides an upper limit on the concentration of salts in non-stormwater contributions to stormwater.
Agricultural runoff control and quality	Source control through fertilizer BMPs	VCAILG – Conditional Waiver of Waste Discharge Requirements for Discharges from Irrigated Lands within the Los Angeles Region	Fertilizers are applied in multiple smaller applications, as opposed to one large application. Fertilizer applications are adjusted to account for other nutrient sources, such as: irrigation water, cover crops, and residuals from previous fertilizations. Fertilization rates are adjusted based on the results of soil fertility measurements.	Reduces the load of nitrogen that is transported by runoff to surface waters and by infiltration to groundwater.

Table 9-1 Existing Management Measures

Category	Specific Measure	Agency/Action	Description	Effect
Agricultural runoff control and quality	Source control through salinity/leaching BMPs	VCAILG – Conditional Waiver of Waste Discharge Requirements for Discharges from Irrigated Lands within the Los Angeles Region	Leaching is performed only when necessary, as determined by measuring soil solution electrical conductivity. Saline or high selenium wells are decommissioned and other sources of water are used. Fertilizers and amendments with low salt index are used.	Reduces the load of salts to the groundwater from leaching activities.
Wastewater Reuse	Offset supply with reclaimed wastewater	City of Ventura	Urban irrigation of golf courses and landscaping. Recycled water permit establishes nitrate plus nitrite limit of 10 mg/L as N.	Limits the nitrate concentration in the applied irrigation water.
Wastewater Reuse	Offset supply with reclaimed wastewater	City of Fillmore	Urban irrigation of schools, parks and other locations. Recycled water permit establishes concentration limits for irrigation water, including; 5 mg/L as N for nitrate plus nitrite 2,000 mg/L for TDS, and 155 mg/L for chloride.	Limits the concentrations of salts and nitrate in irrigation water.
Agricultural Water Conservation	Conservation through efficiency criteria	FCGMA – Agricultural Pumpers Use Irrigation Efficiency Criteria	Agricultural users may use “Efficiency Criteria” in place of historical groundwater allocations. Must have 20% or less of applied water going to leaching, deep percolation or runoff.	Through conservation, reduces the load of salt associated with irrigation water that is ultimately conveyed in irrigation runoff or in percolation.
Agricultural Water Conservation	Conservation through irrigation management practices	VCAILG – Conditional Waiver of Waste Discharge Requirements for Discharges from Irrigated Lands within the Los Angeles Region	Irrigation is varied to accommodate plant growth stage and weather. Irrigation conducted by personnel who understand and practice irrigation practices related to runoff management. Irrigation is halted if significant runoff occurs.	Through conservation, reduces the load of salt associated with irrigation water that is ultimately conveyed in irrigation runoff or in percolation.

Table 9-1 Existing Management Measures

Category	Specific Measure	Agency/Action	Description	Effect
Saline intrusion and groundwater quality	Groundwater quality improvement	City of Fillmore, Piru basin – Control of Saline Intrusion and protect groundwater quality	Current programs to achieve basin management goals include: Management of wellhead protection areas, well abandonment and destruction program, overdraft mitigation measures, replenishment of extracted groundwater	Improvement in groundwater quality protection.

Table 9-2 Estimated Reduction in Effluent Salt and Nutrient Concentrations Resulting from Existing Management Measures

Facility	Estimated concentrations pre-management measures[1]			Current average concentrations		
	TDS	Chloride	TN	TDS	Chloride	TN
Piru	1,200	162	43[2]	1,261	165	2
Santa Paula	1,321			1,202	150	8
Fillmore	1,286	132	29	1,189	100	6

[1] Estimated average concentrations prior to treatment plant upgrades.
[2] Estimated maximum concentration for Total Nitrogen (TN).

While quantification of the impact of agricultural management measures on loading reductions is more challenging, significant implementation of management measures to reduce irrigation and fertilizer discharges to surface and groundwater has occurred in the SCR watershed. The following summarizes the "yes" responses to implementing BMPs that fall into the irrigation and salinity management and nutrient management categories. These percent implementation rates consider all survey data collected in 2014, which covers 82.71% of the irrigated acres enrolled in VCAILG within the SCR watershed. Overall, there are 27,493 irrigated acres in the SCR watershed enrolled in VCAILG and the surveys cover 22,740.5 irrigated acres. As shown in **Table 9-3**, management measures for salts and nutrients have been implemented on the majority of agricultural acreage in the watershed, and over half of the management measures have been implemented on more than 70% of the watershed acreage.

Table 9-3 Percent Implementation of Agricultural Management Measures for Nutrients and Salts

Management Practice Question		% SCR Watershed Acres Enrolled in VCAILG Implementing this Practice [1]	% Surveyed SCR Watershed Acres Implementing this Practice [2]
Irrigation and Salinity Management			
1	Sprinkler irrigation runoff is captured or kept on the property.	46.92%	56.73%
2	At least every 5 years, the irrigation system is tested for distribution uniformity by monitoring water delivery or pressure differences within a block.	63.11%	76.30%
3	Regular maintenance is performed on the irrigation system to maintain distribution uniformity and prevent runoff caused by leaks or clogged lines.	80.87%	97.78%
4	Pressure regulators or pressure compensating emitters are used.	68.80%	83.18%
5	Sprinkler heads and drip emitters of the same flow rate are used within each block and replaced with the same heads or emitters, when necessary.	79.00%	95.5%

Table 9-3 Percent Implementation of Agricultural Management Measures for Nutrients and Salts

	Management Practice Question	% SCR Watershed Acres Enrolled in VCAILG Implementing this Practice [1]	% Surveyed SCR Watershed Acres Implementing this Practice [2]
6	Soil moisture is measured using any of the following: • Sensors • Tensiometers • Probes • Irrigation monitoring service	59.61%	72.06%
7	Flow meters are used to measure actual water use and are coupled with known crop use values or other measurements to match irrigation to plant needs.	61.77%	74.68%
8	Irrigation water quality is tested for parameters of interest including: • Nitrate • pH • Electrical Conductivity (EC) • Sodium • Chloride • Bicarbonate • Boron	71.83%	86.84%
9	Water use for plant establishment has been reduced by adopting more efficient irrigation methods such as: • Early drip use • Intermittent sprinklers • Microsprinklers	73.00%	88.26%
10	Irrigation decisions are made by trained personnel who understand appropriate irrigation management.	80.25%	97.02%
11	Salt leaching is performed only when necessary, as determined by measuring soil solution electrical conductivity (EC).	38.28%	46.28%
Nutrient Management			
12	Soil or leaf/petiole tests are conducted to determine fertilization needs and the minimum amount necessary is applied based on the results.	76.25%	92.18%
13	Fertilizer applications are split into multiple smaller applications to maximize plant uptake.	79.93%	96.63%
14	Fertilizer levels in fertigation water are tested to ensure that injectors are correctly calibrated.	54.21%	65.54%
15	Fertilizer applications are timed to consider irrigation and potential rain events.	80.19%	96.95%
16	Fertilizer applications are adjusted to account for other nutrient sources, such as: irrigation water, cover crops, and residuals from previous fertilizations.	77.01%	93.11%

Table 9-3 Percent Implementation of Agricultural Management Measures for Nutrients and Salts

Management Practice Question		% SCR Watershed Acres Enrolled in VCAILG Implementing this Practice [1]	% Surveyed SCR Watershed Acres Implementing this Practice [2]
17	Fertilizer decisions are made by trained personnel who understand the "4R's" of nutrient management: • Right fertilizer source • Right time • Right rate • Right place	80.50%	97.33%
18	Fertilizers are stored where they are protected from rain and on an impermeable pad with a curb to contain spills.	73.24%	88.54%
19	Backflow prevention devices are installed and maintained.	73.99%	89.45%

[1] Denominator used was 27,493 ac. for conservative estimate.
[2] Denominator used was 22,740.5 ac., thus considering only the acres that were surveyed.

The existing management measures that have already been implemented in the watershed cover the majority of source control and treatment activities that can be implemented at wastewater treatment plants to address salts and nutrients, with the exception of costly reverse osmosis treatment. Most of the agricultural acres have implemented management measures and continued implementation of additional management measures is required by the conditional waiver for irrigated lands. The existing management measures represent significant efforts to improve water quality and reduce salt and nutrient discharges in the planning area.

Sources of salts and nutrients in the planning area are expected to remain similar into the future. Land uses in the planning area have remained relatively constant for the past 20 years and local ordinances are designed to maintain existing urban boundaries and minimize the conversion of agricultural lands to other land uses. Maintaining existing management measures will support sustainable management of the sub-basins. As a result, the management measures outlined in this table will be maintained to support management of salts and nutrients in the SNMP area. Additionally, management measures for agricultural and stormwater discharges identified in the table that result from conditional waivers of permit requirements[1] or permit requirements[2] will over time be implemented in larger portions of the SNMP area, resulting in additional reductions in salt and nutrient loadings from these sources over time.

9.2 APPROACH FOR EVALUATING PROJECTS AND IDENTIFYING NEED FOR POTENTIAL FUTURE MANAGEMENT STRATEGIES

As described in **Section 7**, assimilative capacity is available in all subareas except for TDS in the Mound basin. The overall approach to evaluating projects is based on evaluating the amount of assimilative capacity that would be used by a project or group of projects and determining whether the amount of assimilative capacity used would result in degradation of the basin as outlined in the antidegradation analysis. If a project would result in degradation of the basin, management measures can be selected from the list of potential future management measures to

[1] Such as the Conditional Waiver for Discharge from Irrigated Lands (Order No.R4-2010-0186.)

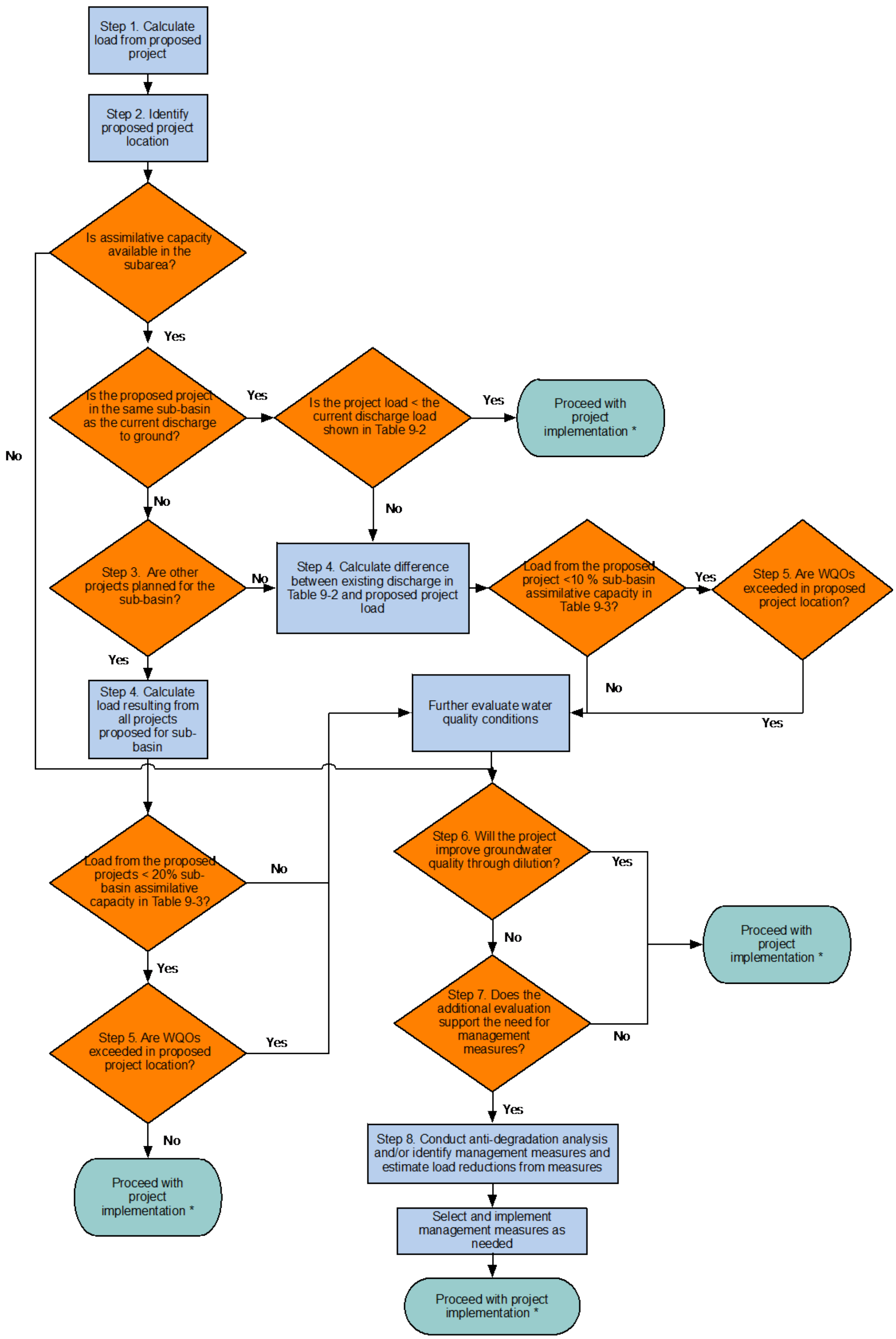
[2] Such as the Ventura County MS4 Permit, Order No. R4-2010-0108.

offset the additional loading. Alternatively, a full antidegradation analysis could be conducted for the project to determine if the degradation is offset by important social and economic benefits to the people of the state.[3] This section outlines the process for evaluating projects and determining if additional management measures are needed or if a full antidegradation analysis is needed.

It is important to remember that the implementation of recycled water projects in the LSCR SNMP is in and of itself a management measure for sustainable management of the groundwater basins. In the LSCR SNMP project area, the groundwater is the primary source of agricultural and municipal water supply. Recycled water projects provide a mechanism to offset groundwater use and therefore contribute to the availability of groundwater supplies. Additionally, using recycled water to irrigate vegetation instead of disposing of the effluent in percolation ponds reduces the loading, particularly of nutrients, that reaches the groundwater through uptake of nutrients and salts by the plants.

The procedure for evaluating projects is shown in **Figure 9-1** and described in detail in this section.

[3] Water Code Section 13000; California Antidegradation Policy Resolution 68-16.



*Contingent upon compliance with other regulatory requirements

Figure 9-1 SNMP Project Evaluation Process

9.2.1 Calculate Loading from the Proposed Recycled Water Project

The first step in the evaluation process is to calculate the loading that will result from the proposed recycled water project.

Step 1. Multiply the volume of water to be recycled by the average concentration of the discharge and any applicable conversion factor to calculate the load (in pounds per day) applied to the ground. For volume in AFY and concentrations in mg/L, the equation would be:

$$AFY*mg/L*0.00745=lbs/d$$

Step 2. Determine whether assimilative capacity exists in the subarea where the project is proposed to be located and whether the recycled water project is in the same subarea as the effluent is currently discharged.

a. If no assimilative capacity is available in the subarea, proceed to the analysis outlined in **Subsection 9.2.4**.

b. If the project is in the same subarea, compare the load calculated in Step 1 to the current load being discharged to percolation ponds outlined in **Table 9-4**.

i. If the calculated load is less than the load in **Table 9-4**, the project is not adding any new load to the groundwater basin and no further evaluation or management measures are needed.

ii. If the calculated load is higher than the load in **Table 9-4**, determine the difference between the two loads. The difference is the project load for evaluation.

c. If the project is in a different subarea, all of the load calculated in step 1 is considered a new load to the subarea.

Step 3. Determine if any other recycled water projects are existing or proposed for the subarea.

a. If other projects are existing or proposed, the loadings from all planned projects in the subarea must be considered together in the evaluation. Calculate the total loading from all the projects using the steps in this section. (See **Subsection 9.2.6** for other considerations.)

Table 9-4 Summary of Current Wastewater Loadings to Percolation Ponds

POTW	Piru	Fillmore	Santa Paula	Todd Road	Saticoy	Limoneira	Olive Lands
TDS (lbs/d)	1,945	9,221	18,843	350	1,531	842	69
Cl (lbs/d)	255	772	2,351	29	117	45	5
NO_3 (lbs/d)	2	26	103	0	3	4	1

9.2.2 Compare Loading to Available Assimilative Capacity

Once the loading from the project(s) has been determined, a comparison of the project loading to the available assimilative capacity needs to be conducted.

Step 4. Compare the project loadings calculated to the available assimilative capacity loads shown in **Table 9-5**.

a. If there is no assimilative capacity in the subarea, go to the next step for further evaluation.

b. If the project loads are **less than** the 10% assimilative capacity threshold, no degradation is expected from the project.[4] Proceed to the next step.

c. If the project loads are **less than** the 20% assimilative capacity threshold for multiple projects, no degradation is expected from the project. Proceed to the next step.

d. If the percent of assimilative capacity used is **greater than** these thresholds or there is no available assimilative capacity, further evaluation or implementation of management measures is needed. Proceed to the analysis outlined in **Subsection 9.2.4**.

9.2.3 Evaluate Local Conditions

Although a project may be below the assimilative capacity thresholds, the thresholds were developed based on a sub-basin analysis. In some cases, individual wells or small portions of the sub-basin were identified in the analysis as exceeding water quality objectives. If a project is to be implemented in the vicinity of areas that currently exceed water quality objectives, further evaluation is needed to determine if management measures are warranted even if the project loading is below the assimilative capacity thresholds.

Step 5. To conduct this evaluation, the location of the project should be compared to the maps of localized higher water quality, shown in **Figure 9-2** and **Figure 9-3**.

a. If the project is located near an area of localized water quality objective exceedances, proceed to the analysis outlined in **Subsection 9.2.4**.

b. If the project is not located near an area of localized water quality objective exceedances, no management measures are necessary and the project may proceed as planned, contingent upon compliance with other regulatory requirements.

The generalized locations of the potential planned recycled water projects are shown in **Section 8**. For Fillmore, the potential locations of the recycled water projects are not in the vicinity of areas that currently exceed water quality objectives. For Santa Paula and Piru, the majority of the potential recycled water project is not near an area that currently exceeds water quality objectives, but some areas could be in the vicinity so specific project evaluation may be necessary depending on the specific project location.

[4] Justification for the 10% and 20% thresholds is discussed in the Antidegradation Analysis in **Section 11**.

Table 9-5 Assimilative Capacity Thresholds

Basin	Subarea	TDS 10% Threshold (lbs/d)	TDS 20% Threshold (lbs/d)	Chloride 10% Threshold (lbs/d)	Chloride 20% Threshold (lbs/d)	Nitrate-N 10% Threshold (lbs/d)	Nitrate-N 20% Threshold (lbs/d)
Piru	Upper Area below Lake Piru	NA	NA	NA	NA	NA	NA
	Lower Area East of Piru Creek	48,000	96,000	7,050	14,100	115	230
	Lower Area West of Piru Creek	13,000	26,000	550	1,100	485	970
Fillmore	Pole Creek Fan Area	41,500	83,000	500	1,000	240	480
	South Side of Santa Clara River	13,000	26,000	950	1,900	255	510
	Remaining Fillmore [1]	0	0	0	0	150	300
Santa Paula	East of Peck Road	11,000	22,000	1,500	3,000	30	60
	West of Peck Road [1]	53,000	106,000	3,150	6,300	0	0
Oxnard Forebay		10,000	20,000	5,500	11,000	1,245	2,490
Mound		0	0	8,150	16,300	635	1,270

[1] Zeros in the table indicate that the model predicts that existing loads will use up 20% of available assimilative capacity over the 17-year period. As a result, any new loads from recycled water projects in these areas would require further evaluation and could not be considered under the assimilative capacity thresholds. A discussion of the model analysis that resulted in the assimilative capacity thresholds is presented in Section 7.

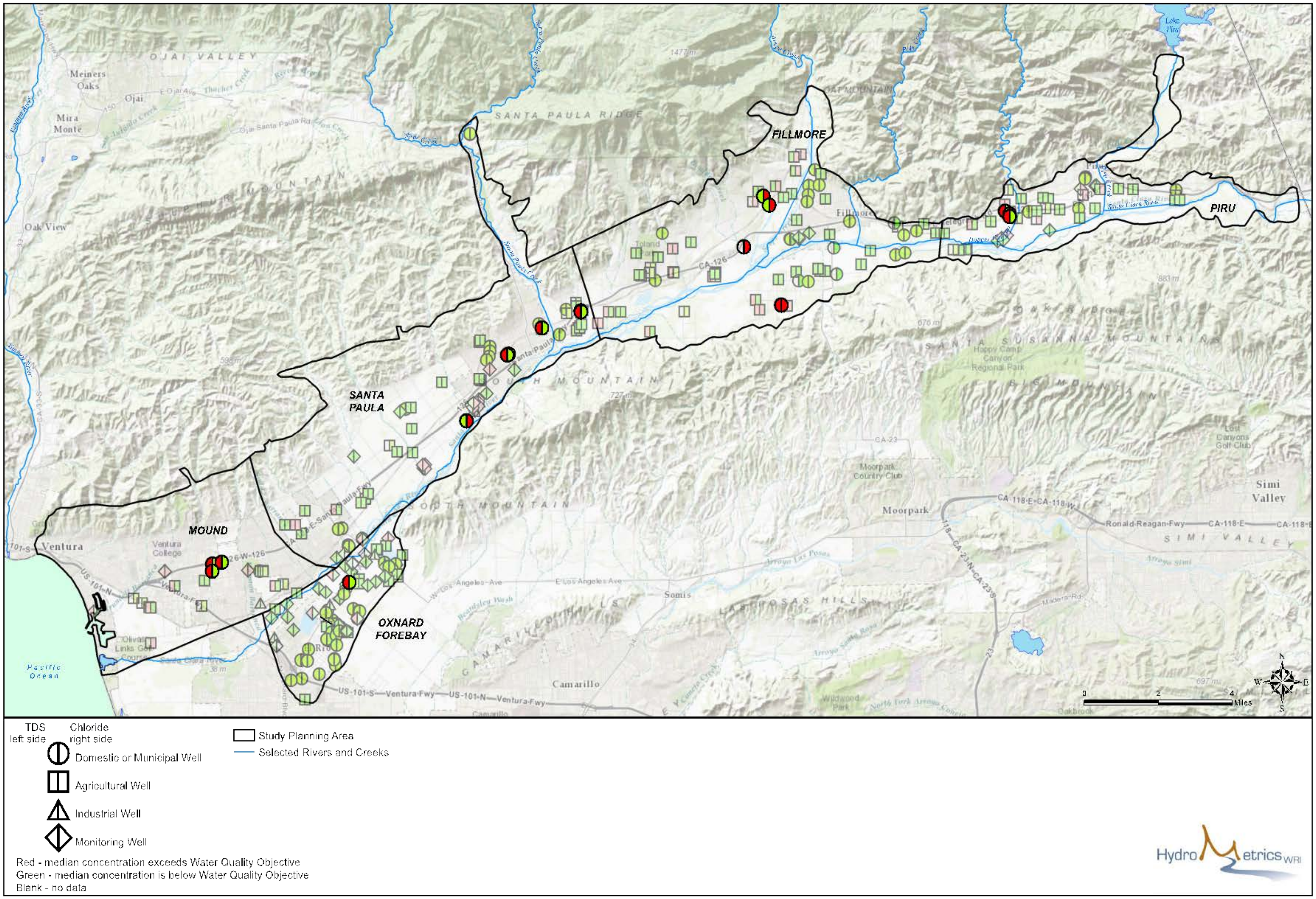


Figure 9-2 LSCR SNMP Wells with Identification of Wells Exceeding Chloride and TDS Water Quality Objectives

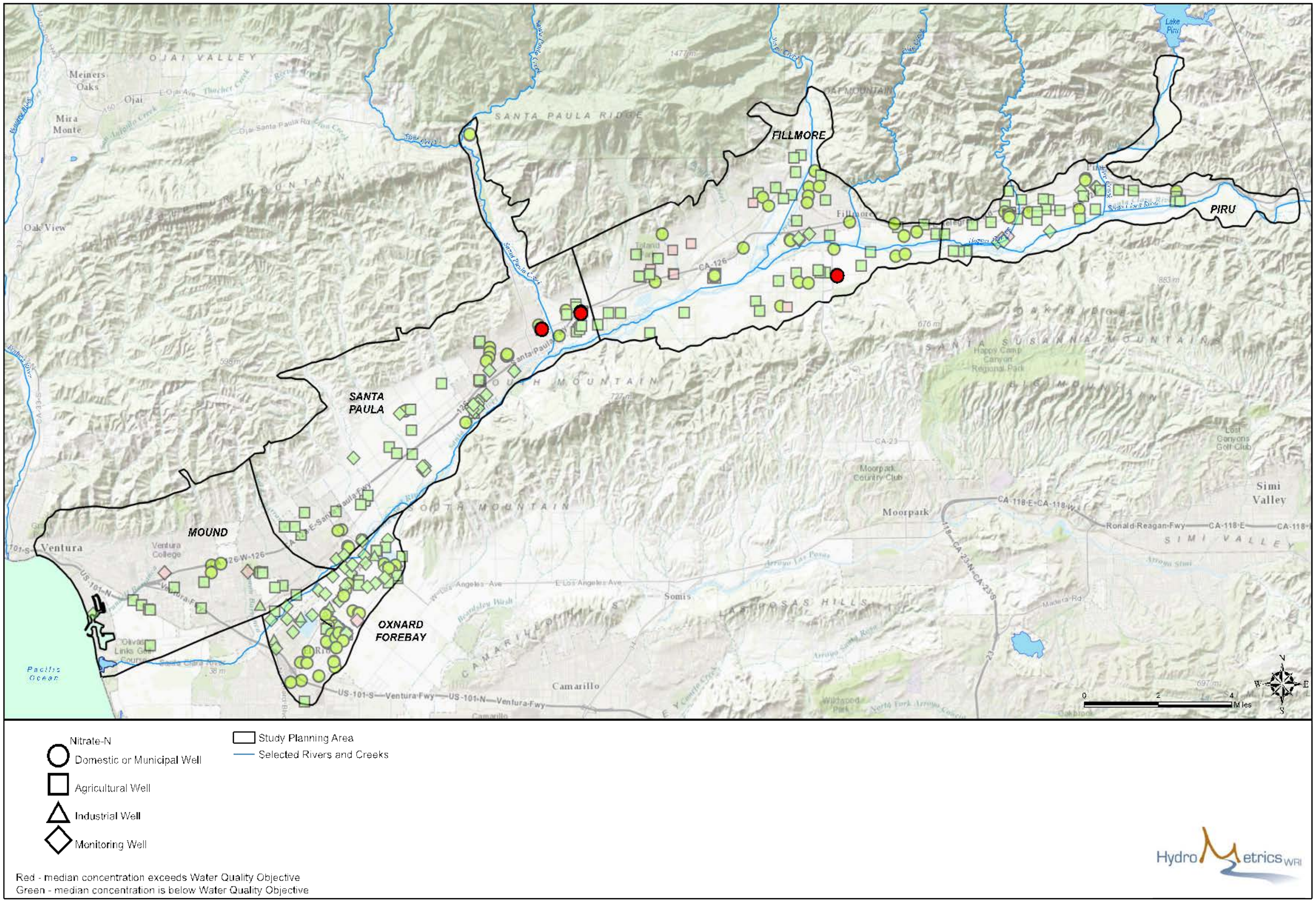


Figure 9-3 LSCR SNMP Wells with Identification of Wells Exceeding Nitrate Water Quality Objectives

9.2.4 Further Evaluation

If the project will exceed the thresholds, further evaluation may be warranted prior to the implementation of management measures.

Step 6. If there is no assimilative capacity in the subarea or if the project is in an area of local water quality objective exceedances, determine if the proposed project will create assimilative capacity in the subarea through dilution. This will ideally be done using a model, but also could be done by comparing the concentrations in the recycled water to the concentrations in the groundwater basin.

a. If the project will create assimilative capacity, proceed with the project, contingent upon compliance with other regulatory requirements.

b. If the project will not create assimilative capacity, either conduct further analysis as outlined in Step 7 or select management measures to offset the load.

Step 7. If the project will not create dilution, additional analysis could be conducted as follows or management measures could be selected in accordance with the next step.

a. Utilize more recent data collected through the SNMP monitoring program or other available data to recalculate the assimilative capacity.

b. If the analysis is needed for a localized water quality objective exceedance, further evaluation of the monitoring data specific to the wells could be conducted (particularly if only one well is showing higher concentrations). This analysis could include evaluation of the depth and type of well to assess if the data are reflective of conditions in the groundwater that could be impacted by the proposed project.

c. Evaluate model results to determine if modifications are appropriate. Conservative assumptions were included in the model to calculate the available assimilative capacity that could be modified with additional information and modeling.

9.2.5 Selection of Management Measures

Step 8. If the need for management measures is identified after completing the analysis in Steps 1 through 7, the project proponent will need to do one of the following:

1. Conduct a full antidegradation analysis to demonstrate that the additional loading from the project or the project with identified management measures to offset part of the additional loading would be allowed under the antidegradation policy.
2. Select from the list of potential future management measures to reduce the loading from the project below the thresholds.
3. Work with other sources of salts and nutrients in the subarea to reduce their loading to offset the loading above the thresholds through implementation of potential future management measures.

a. If this method is selected, the project proponent will need to identify potential management measures that can be implemented within the same subarea to offset the load.

b. During the permit process, the project proponent must provide a calculation of the estimated loading reduction to be provided by the proposed management measures.

Potential future management measures are provided in **Table 9-7**.

All management actions taken at the treatment plant to reduce salt or nutrients loads are a direct loading reduction for the proposed recycled water project. Estimates of the amount of load reduced from the management measure should be subtracted from the estimated project load to evaluate if the assimilative capacity thresholds will now be met.

If management measures being implemented by another entity are to be used to offset the excess load from a project, the following steps must be taken to provide reasonable assurance that the management measures will be implemented.

1. Calculate the estimated load reduction from the proposed management measure. Effectiveness for treatment management measures will utilize design parameters or peer reviewed effectiveness information when available.
2. Develop a map that shows the location of the management measure implementation as compared to the recycled water project implementation to demonstrate the management measures will occur within the same sub-basin.
3. Develop a comparison of the implementation period for the management measure and the proposed recycled water project. Demonstrate that the management measure will be in place for the same period of time as the recycled water project.

9.2.6 Other Considerations

Within some sub-basins, multiple treatment plants are present that could propose projects within the same subarea. To the extent a project utilizes available assimilative capacity it will reduce the amount available to other projects. As a result, the SNMP identifies the following procedure to be used:

1. Projects identified in the project scenarios receive priority over other projects for the subarea.
2. If the project is not identified in the project scenarios, the project proponent would need to notify the other facilities within the sub-basin to identify if any conflicts would arise.

One sub-basin, Mound, was determined to be exceeding water quality objectives for one constituent, TDS. During SNMP development, potential additional management measures were considered to support a reduction in loadings to the Mound basin. The primary controllable sources to the basin are municipal and agricultural irrigation. TDS in these sources comes primarily from the water supply. Irrigation management and water conservation measures that are already being implemented will support loading reductions in the sub-basin. As discussed in previous sections, the presence of naturally occurring salts from connate water that were likely not considered during objective development are likely to be causing or contributing to the exceedances. The exceedances are currently not impacting the beneficial use of the water as a drinking water supply as the water is conditioned and blended with other water sources prior to use. Additionally, a potential future management measure to treat the municipal supply to reduce salts is included in the SNMP. Finally, as discussed in **Section 2**, it would be consistent with the SNMP to consider site-specific objectives or consider variances to support recycled water use in the Mound basin if the appropriate information were to be developed in the future to justify the action.. Combined, all of these efforts will support improving water quality and sustainable management of the Mound basin.

9.3 PROJECT SCENARIO EVALUATION

For the project scenarios identified in the plan in **Section 8**, the evaluation of the projects has been completed through the identification of the assimilative capacity used. The following table summarizes the results of the analysis. Based on this analysis, an identification of which scenarios would require additional analysis or selection of management measures was identified. This analysis was used to support the California Environmental Quality Act evaluation for the SNMP. However, since none of these projects have been clearly defined, projects may be modified or revised to avoid the need to conduct further analysis or implement management measures, consistent with the procedures outlined in the SNMP.

Table 9-6 Preliminary Comparison of Recycled Water Project Scenarios to Assimilative Capacity Thresholds

		Scenario 1 (lbs/d)/% assimilative capacity used		Scenario 2 (lbs/d)/% assimilative capacity used		Scenario 3 (lbs/d)/% assimilative capacity used		Scenario 4 (lbs/d)/% assimilative capacity used
		Piru Basin-Lower Area West of Piru Creek						
Piru Estimated Project Load	**TDS**	**167 / 0.1%**		**3,312 / 2.5%**		**3,312 / 2.5%**		
	Chloride	**22 / 0.4%**		**433 / 7.9%**		**433 / 7.9%**		
	Nitrate	**0.1 / 0.003%**		**3 / 0.1%**		**3 / 0.1%**		
		Fillmore Basin-Pole Creek Fan Area						
Fillmore Estimated Project Load	**TDS**	**0 / 0%**		**0 / 0%**		**12,724 / 3.1%**		
	Chloride	**0 / 0%**		**0 / 0%**		**1,066 / 21%**		
	Nitrate	**0 / 0%**		**0 / 0%**		**36 / 1.5%**		
		Santa Paula Basin						
		West of Peck Road	East of Peck Road	West of Peck Road	East of Peck Road	West of Peck Road	East of Peck Road	
Santa Paula Estimated Project Load	**TDS**	**0 / 0%**	**3,580 / 3.3%**	**0 / 0%**	**14,515 / 13%**	**15,235 / 2.9%**	**34,078 / 31%**	
	Chloride	**0 / 0%**	**447 / 3.0%**	**0 / 0%**	**1,811 / 12%**	**1,901 / 6.0%**	**4,253 / 28%**	
	Nitrate	**0 / 0%**	**20 / 6.6%**	**0 / 0%**	**80 / 27%**	**84 / -[3]**	**187 / 62%**	
		Mound Basin						
Ventura Estimated Project Load	**TDS**	**665**		**16,629**		**49,076**		**32,447**
	Chloride	**130 / 0.2%**		**3,239 / 4.0%**		**9,598 / 12%**		**6,359 / 7.8%**
	Nitrate	**4 / 0.1%**		**89 / 1.4%**		**252 / 4.0%**		**163 / 2.6%**
		Oxnard Forebay						
Oxnard Estimated Project Load	**TDS**	**TBD [1]**						
	Chloride	**TBD [1]**						
	Nitrate	**TBD [1]**						

Notes: Green boxes indicate the project load is below the 10% assimilative capacity threshold.
Yellow boxes indicate the project load is between the 10% and 20% assimilative capacity thresholds.
Orange boxes indicate the project load is above the 20% assimilative capacity threshold.
Red boxes indicate that no assimilative capacity is available.

[1] While the volume and quality of water that could be applied in the Forebay from the Oxnard AWPF is unknown at this time, the highly treated water will be of better quality than the existing concentrations in the Forebay and will therefore likely create additional assimilative capacity in the basin rather than using assimilative capacity. When a specific project is identified, it will need to be evaluated through the process outlined in this section to confirm this assumption.

[2] For Scenarios 3 and 4, the application of partially RO treated water for agricultural irrigation would be at concentrations that are below existing concentrations in the Mound Basin for salts and nutrients. As a result, the agricultural irrigation may increase the available assimilative capacity, particularly for TDS and could be considered as a management measure to offset loads from any landscape irrigation at current discharge concentrations.

[3] The existing loads are anticipated to use more than 20% of the assimilative capacity.

Based on the analysis presented in the **Table 9-6**, projects with loadings less than or equal to the loadings presented in the analysis above for the same sub-basin can proceed without further analysis or management measures.

- Piru-all scenarios;
- Fillmore-planned low and planned high scenarios; and
- Santa Paula-planned low and planned high if applied west of Peck Road and planned low east of Peck Road.

For Piru, the analysis assumes implementation of projects by the Los Angeles County Sanitation Districts to reduce chloride concentrations in the discharge from the Valencia and Saugus WRPs to meet applicable effluent limitations will result in concentrations at or below 100 mg/L as a three month, flow weighted average at the County line will by 2019. If these projects do not occur, the model predicts that increasing trends in the Piru basin resulting from upstream chloride discharges will use up 20% of the available assimilative capacity within the next 17 years. If the upstream discharges are not reduced within the predicted time frame, recycled water projects within the Piru basin may require additional evaluation to determine if management measures are necessary.

9.4 POTENTIAL FUTURE MANAGEMENT MEASURES

The potential future management measures include those that were identified as potential measures in planning studies, as well as other measures tailored to the site specific conditions in the LSCR SNMP study area. The potential future management measures represent a menu of potential management measures that could be implemented if needed to manage salts and nutrients on a sustainable basis. The list is intended to represent a wide-range of potential options that could be considered based on the project specific evaluation listed above and do not represent management measures that will definitely be implemented.

In addition to the management measures outlined in this document, the SNMP considers the potential impact of management measures identified for the Upper Santa Clara River Chloride TMDL and in the Upper Santa Clara River SNMP in the evaluation of assimilative capacity for the Piru basin. The Upper Santa Clara River SNMP includes a basin objective to:

> *"…manage groundwater levels associated with groundwater discharge to the Santa Clara River at the west end of the basin, and thus not adversely impact surface and groundwater discharges to the downstream basins(s)."*

As a result it is anticipated that the Upper Santa Clara River SNMP will not impact the analysis done for the LSCR SNMP potential projects.

As discussed in **Section 1**, the LSCR SNMP has a goal to support the use of stormwater recharge as a management measure where appropriate. Specific regional stormwater recharge projects have not been identified in the plan, but will be considered if management measures are needed for a project. Additionally, when development and redevelopment projects occur, stormwater recharge will result from implementation of required low impact development techniques.

Table 9-7 Other Potential Future Management Measures

Category	Specific Measure	Agency/Action	Description	Effect
Wastewater and reclaimed water quality	Source control – salts	Ventura County - Water softener outreach and rebate program	Implementation of outreach, removal and incentive program aimed at reducing the number of self-regenerating water softeners in unincorporated areas of Ventura County within the LSCR SNMP project area.	Fewer self-regenerating water softeners will reduce the salt load in residential wastewater.
Wastewater and reclaimed water quality	Source control – salts	Ventura County – Water Softener Ban	Implementation of a water softener ban in the City of Ventura, and the unincorporated areas of the County that are within the LSCR SNMP project area.	Fewer self-regenerating water softeners will reduce the salt load in residential wastewater.
Wastewater and reclaimed water quality	Source control – industrial control, pretreatment program	Ventura County and Municipalities	Consideration of modified local limits to improve influent wastewater quality.	Limits the pollutant concentrations in influent wastewater.
Septic system leachate	Provide connections to sewer systems	Ventura County and Municipalities	Consideration of a septic system conversion program to reduce the number of septic systems in the basins	Reduces the volume of septic system leachate that percolates into shallow groundwater. Tie-in to a treatment plant ultimately leads to a treated waste stream with a lower nutrient load.
Non-stormwater discharge control and quality	Source control of non-stormwater discharges	Ventura County – MS4 permit	Ordinance banning installation and discharges of debrominated/dechlorinated swimming pool water.	Reduce primary source of salts in non-stormwater discharges.
Municipal Water Quality	Replace/augment compromised groundwater supplies with surface water sources	Ventura County and Municipalities	Consideration of using SWP allocations to replace or augment compromised groundwater supplies.	Through use of an alternative supply, reduces salt load in potable water that is pass through to wastewater. Reduces need for residential water softeners.

Table 9-7 Other Potential Future Management Measures

Category	Specific Measure	Agency/Action	Description	Effect
Municipal Water Quality	Softening of groundwater supplies	Water Purveyors	Consideration of water softening to reduce hardness.	Reduces need for the self-regenerating residential water softeners. Fewer self-regenerating water softeners will reduce the salt load in residential wastewater.
Municipal Water Quality	Advanced treatment of compromised groundwater supplies	Water Purveyors	Consideration of RO treatment to remove salts from groundwater supplies, with likely participation in development of a regional brine line.	Through treatment, reduces salt load in potable water that is pass through to wastewater. Reduces need for residential water softeners.
Municipal Water Quality	Desalination	Water Purveyors	Consideration of desalination to replace existing groundwater supplies	Through use of an alternative supply, reduces salt load in potable water that is pass through to wastewater. Reduces need for residential water softeners.
Agricultural Supply	Improve agricultural irrigation water quality	Ventura County	Consideration of drilling deeper wells to access water with lower salt concentrations.	Improves irrigation water quality through use of an alternative supply. Reduces the load of salt and nutrients attributed to irrigation water.
Stormwater Recharge	Additional groundwater recharge with stormwater	Ventura County and Municipalities	Consideration of capture and recharge of stormwater, including opportunities identified in TMDL implementation plans and other stormwater resource plans developed for the planning area.	Provides dilution of groundwater through recharge of water with potentially low salt and low nutrient concentrations.
Municipal Water Quality	Improves municipal water quality	Ventura – RO of Mound Groundwater	If other alternatives including groundwater recharge or direct potable reuse are not implemented, then additional treatment, RO, will be provided water extracted from the Mound basin.	Improves potable water quality through treatment. Reduces salt load in potable water that is pass through to wastewater. Reduces need for residential water softeners.

10 Basin/Sub-Basin Wide Monitoring Plan

10.1 MONITORING PROGRAM APPROACH

The Recycled Water Policy requires the development of a monitoring program with the primary objectives to characterize the basin and to provide targeted monitoring.

- Basin-Wide Characterization (Recycled Water Policy Section 6.b.(3)(a))
  "A basin/sub-basin wide monitoring plan that includes an appropriate network of monitoring locations."
- Targeted Monitoring (Recycled Water Policy Section 6.b.(3)(a)(i))
  "…focus on basin water quality near water supply wells and areas proximate to large water recycling projects, particularly groundwater recharge projects… where appropriate target groundwater and surface waters where groundwater has connectivity with adjacent surface waters."

Consistent with the requirements of the Recycled Water Policy, this monitoring program: identifies a network of wells to characterize water quality in the basin and establishes a framework for targeted monitoring; identifies stakeholders responsible for implementing the monitoring program, and addresses monitoring of CECs.

The goals of the LSCR SNMP Monitoring Program are to:

1. Assess spatial and temporal changes in salt and nutrient concentrations and characterize groundwater quality; and
2. Assess the impact of future large recycled water and groundwater recharge projects on groundwater quality.

Using the preferred approach in the Recycled Water Policy, the program relies on existing groundwater wells to fulfill the goals of the monitoring program.

The five sub-basins of the LSCR Basin (Piru, Fillmore, Santa Paula, Mound and the Oxnard Forebay) are further subdivided into one or more subareas based on the water quality objectives established in the Basin Plan (**Figure 2-1).**

Basin-wide characterization monitoring will establish one to two monitoring locations within each water quality objective subarea. Where groundwater movement is ambiguous additional monitoring locations in each subarea are established to increase spatial resolution. Well locations are selected to maximize efficiency, maximize quality, and minimize costs.

Targeted monitoring will focus on water quality priorities and Recycled Water Policy requirements within the LSCR Basin. Priorities and requirements in the basin may change over time; therefore a framework for designing targeted monitoring has been created to allow all the stakeholders to adaptively manage the monitoring program to meet future needs.

10.2 EXISTING MONITORING PROGRAMS

Groundwater quality is currently monitored throughout the LSCR Basin as part of regional groundwater resource assessment and management and to meet regulatory requirements such as drinking water regulations and waste discharge requirements. Appendix B provides a summary of all the current monitoring programs within the LSCR Basin. The summary documents current monitoring programs, monitored constituents, frequency of monitoring, and the agency in charge of the monitoring program.

The proposed LSCR SNMP monitoring program primarily relies on wells monitored by the Ventura County (County) Groundwater Monitoring Program and UWCD's Water Quality Monitoring Program, supplemented by wells monitored under water reclamation and wastewater treatment facilities that discharge to percolation ponds. Wells monitored by other programs in the LSCR basin are used to supplement the monitoring program in subareas without appropriate County or UWCD wells.

As shown in Appendix B, existing monitoring programs also include surface water and discharge quality monitored by the Ventura Countywide Stormwater Management Program, VCAILG, City of Ventura, and UWCD. While a specific network of surface water monitoring locations is not being proposed for the LSCR Basin, these existing programs will be used to provide information regarding surface water inputs to the groundwater. It is recommended that a network of surface water monitoring locations be maintained in the study area to characterize surface water quality that may recharge groundwater. The existing monitoring programs are sufficient for this purpose at this time, but modifications to those programs should consider the SNMP data needs.

10.3 PROPOSED WATER QUALITY CONSTITUENTS

The Recycled Water Policy requires monitoring of salts, nutrients, and consideration of monitoring for constituents other than salt and nutrients that adversely affect groundwater quality. In addition, monitoring for CECs is discussed in several places in Attachment A of the Recycled Water Policy and is specifically required in recycled water used for groundwater recharge reuse[1].

- Water Quality Constituents (Recycled Water Policy Section 6.b.(3)(a))
  "…shall be adequate to provide a reasonable, cost-effective means of determining whether the concentrations of salt, nutrients, and other constituents of concern as identified in the salt and nutrient plans are consistent with applicable water quality objectives."
- Recycled Water Policy Section 6.b.(3)(b):
  "A provision for annual monitoring of Constituents of Emerging Concern (e.g., endocrine disrupters, personal care products or pharmaceuticals) (CECs) consistent with recommendations by CDPH and consistent with any actions by the State Water Board taken pursuant to paragraph 10(b) of this Policy."

[1] Use of recycled water for groundwater recharge reuse has the same meaning as indirect potable reuse for groundwater recharge as defined in Water Code section 13561(c), where it is defined as the planned use of recycled water for replenishment of a groundwater basin or an aquifer that has been designated as a source of water supply for a public water system.

- Recycled Water Groundwater Recharge Projects (Recycled Water Policy Section 8.b.(2))
  "Implementation of a monitoring program for CECs…Groundwater recharge projects shall include monitoring of recycled water for priority pollutants…"
- Constituents of Emerging Concern (Recycled Water Policy Section (Recycled Water Policy Section 10.b.(1)(c))
  "The State Water Board considered the panel report and the comments received and adopted an amendment to the Policy establishing monitoring requirements for CECs in recycled water. These monitoring requirements are prescribed in Attachment A."

Proposed water quality constituents were selected to meet the needs of basin-wide or targeted monitoring goals and requirements:

- **Basin-wide monitoring –** Constituents were selected for the LSCR SNMP Monitoring Program based on the established salt and nutrient water quality objectives, historic monitoring that establishes a baseline, and constituents of interest in the basin. The proposed water quality constituents for all basin-wide monitoring locations are TDS, Sulfate, Chloride, Boron, and Nitrate as N.

  Basin-wide monitoring of CECs is not being proposed at this time. Surveys of pharmaceuticals in groundwater conducted by USGS have shown a low detection rate in groundwater samples.[2] Additionally, widespread applications of recycled water are not being proposed at this time and are not anticipated at levels that will necessitate regular basin-wide monitoring. Instead CEC monitoring will be conducted in specified instances as part of the targeted monitoring program.

  CEC effluent monitoring is also likely to be required by the monitoring programs for the wastewater treatment plants. As a result, monitoring data on CECs in recycled water should be available for consideration. It is recommended that the effluent monitoring for CECs occur as required by permits.

  The Basin Plan identifies groundwater water quality objectives for sub-basins and subareas within the LSCR Basin. As a result, the monitoring plan is developed to assess the sub-basins and subareas. **Table 10-1** summarizes the groundwater water quality objectives.

Table 10-1 Water Quality Objectives for the Lower Santa Clara River Groundwater Basins

Basin	1994 Basin Plan Name	Objectives (mg/L)				
		TDS	Chloride	Nitrate-N	Sulfate	Boron
Piru 4-4.06	**Santa Clara - Piru Creek area**					
	Upper area (above Lake Piru)	1,100	200	10	400	2.0
	Lower area east of Piru Creek	2,500	200	10	1200	1.5
	Lower area west of Piru Creek	1,200	100	10	600	1.5

[2] 2011, Fram, Miranda S.; Belitz, Kenneth. *Occurrence and concentrations of pharmaceutical compounds in deep groundwater used for public drinking-water supply in California Science of the Total Environment*, 409: 3409 - 3417

Table 10-1 Water Quality Objectives for the Lower Santa Clara River Groundwater Basins

Basin	1994 Basin Plan Name	Objectives (mg/L)				
		TDS	Chloride	Nitrate-N	Sulfate	Boron
Fillmore 4-4.05	**Fillmore Area**					
	Pole Creek Fan Area	2,000	100	10	800	1.0
	South side of Santa Clara River	1,500	100	10	800	1.1
	Remaining Fillmore Area	1,000	50	10	400	0.7
Santa Paula 4-4.04	**Santa Clara - Santa Paula Area**					
	East of Peck Road	1,200	100	10	600	1.0
	West of Peck Road	2,000	110	10	800	1.0
Oxnard 4-4.02	**Oxnard Plain**					
	Oxnard Forebay	1,200	150	10	600	1.0
	Confined aquifers[1]	1,200	150	10	600	1.0
	Unconfined and perched aquifers	3,000	500	10	600	
Mound	Use Oxnard Forebay[1]	1,200	150	10	600	1.0

[1] As part of the non-regulatory amendments to administratively update Chapter 3 of the Basin Plan in 2013, the Mound Basin was called out separately from the Oxnard Plain for the first time. Prior the update, the Mound Basin was included as part of the Oxnard Plain Basin. Based on review of previous Basin Plans and associated technical documents, the RWQCB determined that the objectives for the confined aquifers in the Oxnard basin apply to the Mound basin.

- **Targeted monitoring –** The constituents collected during targeted monitoring may vary depending on the goal of the monitoring. In general, any targeted monitoring should include constituents monitored as part of the basin-wide monitoring (TDS, Sulfate, Chloride, Boron, and Nitrate as N). Additionally, CECs will be included for specified types of targeted monitoring as required by Attachment A of the Recycled Water Policy and consistent with recommendations by CDPH.

  The Recycled Water Policy provides a list of required health based, and performance based parameters that are required for all recycled water monitoring programs specific to recycled water used for groundwater recharge reuse by surface and subsurface application methods **Table 10-2**.[3] Health based CECs are of toxicological relevance to human health. Performance based CECs do not have relevance to human health but are useful for monitoring treatment process effectiveness because the removal of these CECs from a treatment process provides an indication of remove of CECs with similar properties. Various surrogate parameters are also required depending on if the groundwater recharge is being applied to the surface or subsurface. **Table 10-3** presents a list of surrogates that shall be considered for monitoring. Surrogates shall be proposed for a project on a case-by-case basis appropriate for the treatment process or processes. A surrogate is a measurable physical or chemical property that can be used to measure the effectiveness of trace organic compound removal.

[3] Groundwater recharge by surface application is the controlled application of water to a spreading area for infiltration resulting in the recharge of a groundwater basin. Subsurface application is the controlled application of water to a groundwater basin or aquifer by a means other than surface application, such as direct injection through a well. Monitoring of CECs is not required for recycled water used for landscape irrigation.

Table 10-2 Chemicals Identified as Health or Performance CECs

Compound	Relevance/Indicator Type	Performance indicator MRL (ng/L)
17beta-estradiol[a]	Health	1
NDMA[1]	Health	2
Caffeine[1]	Health & Performance	50
Triclosan[1]	Health	50
Sucralose[1]	Performance	100
Iopromide[2]	Performance	50
DEET[1]	Performance	50
Gemfibrozil[2]	Performance	50

[1] Groundwater recharge reuse surface and subsurface application projects
[2] Groundwater recharge reuse surface application projects only

Table 10-3 Chemicals Identified as Surrogate Parameters

Surrogates	Groundwater Recharge Reuse
Ammonia	Surface application
Total Organic Carbon	Surface application Subsurface application
Nitrate	Surface application
UV Light Absorption	Surface application
Electrical Conductivity	Subsurface application

Parameters for CECs as identified in **Table 10-2** and **Table 10-3** will be monitored at all targeted area monitoring sites corresponding to groundwater recharge projects using surface or subsurface application projects as specified.

In addition, targeted monitoring locations for areas of interest may also add constituents to measure based on project needs. This may include monitoring for CECs in areas other than those corresponding to groundwater recharge applications if other information indicates monitoring is warranted. For example, if the monitoring of WWTP effluent contains levels of CECs that could impact groundwater basins, targeted monitoring near recycled water projects using the water could be warranted.

10.4 BASIN-WIDE MONITORING LOCATIONS AND FREQUENCY

Proposed wells for basin-wide monitoring are summarized in **Table 10-4** and **Table 10-5** and in **Figure 10-2** through **Figure 10-5**. These wells were selected to provide sampling locations that characterize the subareas based on groundwater gradients and flow paths in the sub-basin and subarea.

Three basins, Piru, Fillmore, and Santa Paula contain existing water reclamation or wastewater treatment plant that discharge treated effluent and reclaimed water to percolation ponds. Monitoring in these basins will be supplemented by the monitoring conducted pursuant to waste discharger and water reclamation permits issued to these facilities.

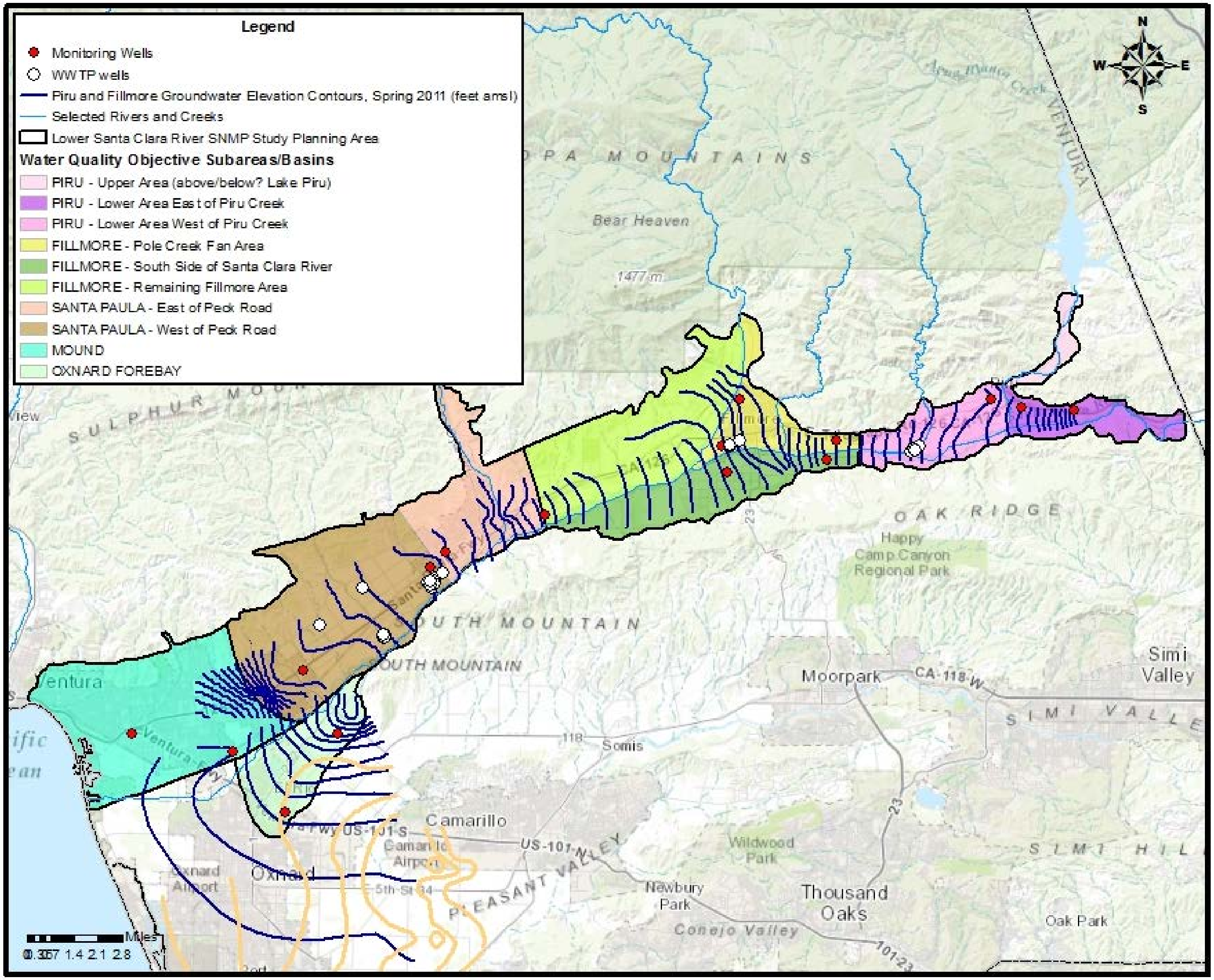


Figure 10-1 LSCR SNMP Monitoring Locations Overview Map

Table 10-4 Basin-Wide Monitoring Locations – General Wells

Well ID	Groundwater Basin	Sub-basin
04N18W27B01S	Piru	Lower Area West of Piru Creek
04N18W20R01S	Piru	Lower Area West of Piru Creek
04N18W20M03S	Piru	Lower Area East of Piru Creek
04N19W33M07S	Fillmore	South Side of Santa Clara River
04N20W36N03S	Fillmore	South Side of Santa Clara River
04N19W33B01S	Fillmore	Pole Creek Fan Area
04N20W36D07S	Fillmore	Pole Creek Fan Area
04N20W24Q04S	Fillmore	Pole Creek Fan Area
03N21W12H01S	Fillmore	Remaining Fillmore Area
03N21W16H07S	Santa Paula	East of Peck Road
03N22W35Q01S	Santa Paula	West of Peck Road
03N21W16P02S	Santa Paula	West of Peck Road
02N22W09K05S	Mound	Mound
02N23W13K03S	Mound	Mound
02N22W12Q06S	Oxnard Plain Forebay	Oxnard Forebay
02N22W26E01S	Oxnard Plain Forebay	Oxnard Forebay

Table 10-5 Basin-Wide Monitoring Locations – WWTP and WRP Wells

Well ID	Groundwater Basin	Sub-basin
Piru_WTP_MW1	Piru	West of Piru Creek
Piru_WTP_MW2	Piru	West of Piru Creek
Piru_WTP_MW3	Piru	West of Piru Creek
Piru_WTP_MW4	Piru	West of Piru Creek
04N20W36MW1	Fillmore	Pole Creek Fan
04N20W36MW2	Fillmore	Pole Creek Fan
04N20W36MW3	Fillmore	Pole Creek Fan
03N21W29MW1	Santa Paula	West of Peck Rd
03N21W29MW11	Santa Paula	West of Peck Rd
03N21W29MW17	Santa Paula	West of Peck Rd

Table 10-5 Basin-Wide Monitoring Locations – WWTP and WRP Wells

Well ID	Groundwater Basin	Sub-basin
03N21W29MW8	Santa Paula	West of Peck Rd
SantaPaulaWTP_MW1	Santa Paula	West of Peck Rd
SantaPaulaWTP_MW2A	Santa Paula	West of Peck Rd
SantaPaulaWTP_MW3	Santa Paula	West of Peck Rd
SantaPaulaWTP_MW4	Santa Paula	West of Peck Rd
SantaPaulaWTP_MW5	Santa Paula	West of Peck Rd
SantaPaulaWTP_MW6	Santa Paula	West of Peck Rd
SantaPaulaWTP_MW7	Santa Paula	West of Peck Rd
SantaPaulaWTP_MW8	Santa Paula	West of Peck Rd
Limoneria_Lower2Well	Santa Paula	West of Peck Rd
Limoneria_OrchardFarmWell	Santa Paula	West of Peck Rd

Within each subarea, at least one well was selected to characterize the subarea and to provide multiple points for analyzing a sub-basin. In sub-basins not divided into multiple water quality objective areas, at least two wells were selected. A well at the upstream portion of the LSCR Basin will be selected to provide a baseline water quality for groundwater entering the basin from the Upper Santa Clara River Basin. Wells upgradient and downgradient of WWTPs and WRPs were selected based on their Waste Discharger Requirements monitoring programs.

Monitoring wells were selected based on the following considerations:

- Ease of access;
- Well is monitored by UWCD or Ventura County;
- Type of well use (preference for municipal, monitoring, agricultural wells);
- Depths corresponding to main aquifer regions as opposed to perched aquifers;
- Whether the well is currently being monitored as part of another program;
- The range and extensiveness of the water quality record;
- Ability to representative potential impacts on beneficial uses; and
- Use of well as representative monitoring location by USGS and GAMA.

The baseline recommended sampling frequency for basin-wide monitoring sites is annual. The annual sampling frequency has been identified based on the lack of seasonal trends identified in the data analysis. The proposed baseline sampling frequency should be reviewed after five years of data collection or after sufficient data is collected to evaluate potential trends. After evaluation, data showing no significant trends will be considered for monitoring on a less frequent basis. A summary of the proposed basin-wide monitoring is in **Table 10-6.**

Table 10-6 Proposed Basin-Wide Monitoring Program

Type of Monitoring	Constituents		Frequency
Basin-Wide Monitoring	TDS Sulfate Chloride	Boron Nitrate as N	• Baseline: Annual • May be reduced following baseline evaluation

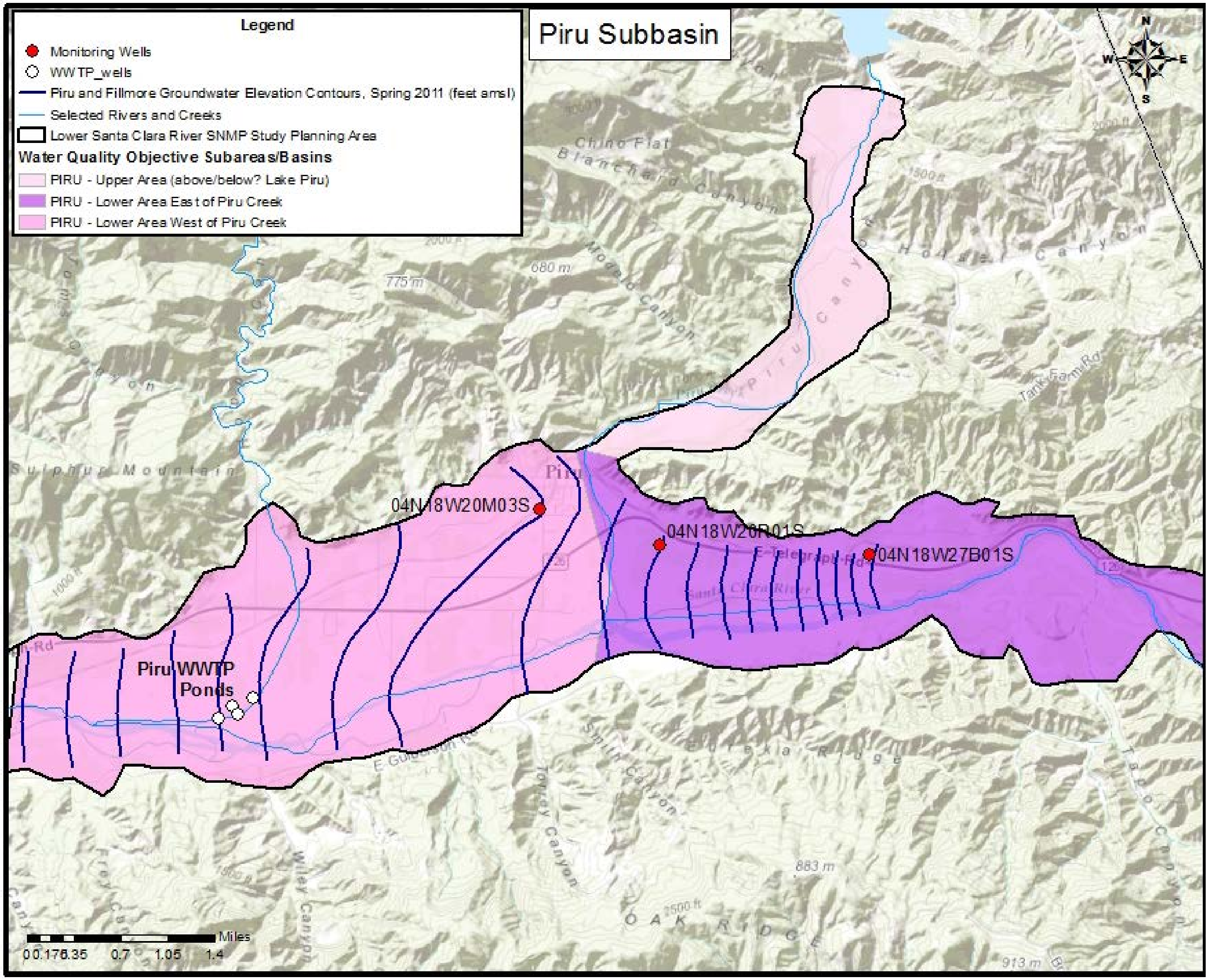


Figure 10-2 Piru Basin Monitoring Well Locations

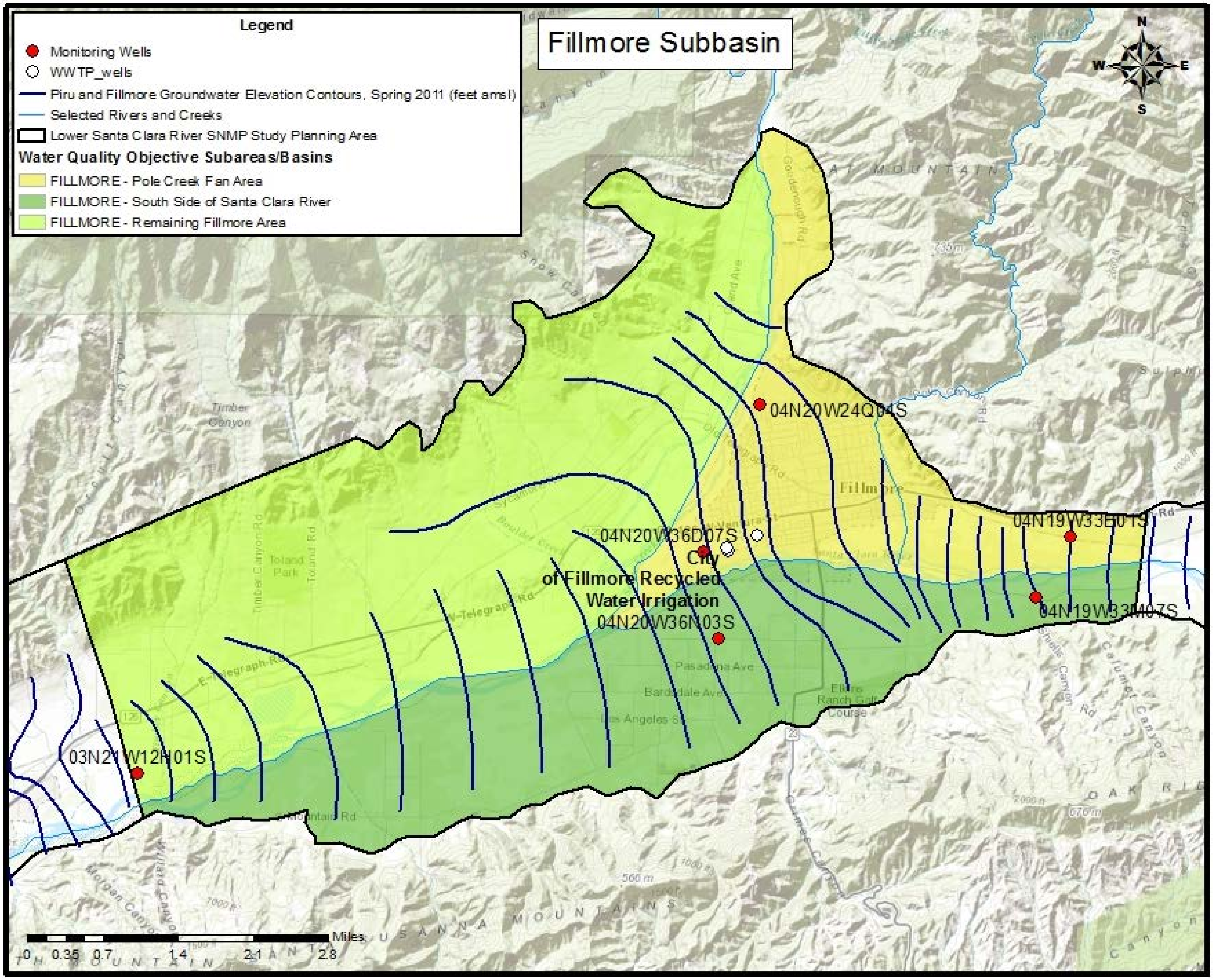


Figure 10-3 Fillmore Basin Monitoring Well Locations

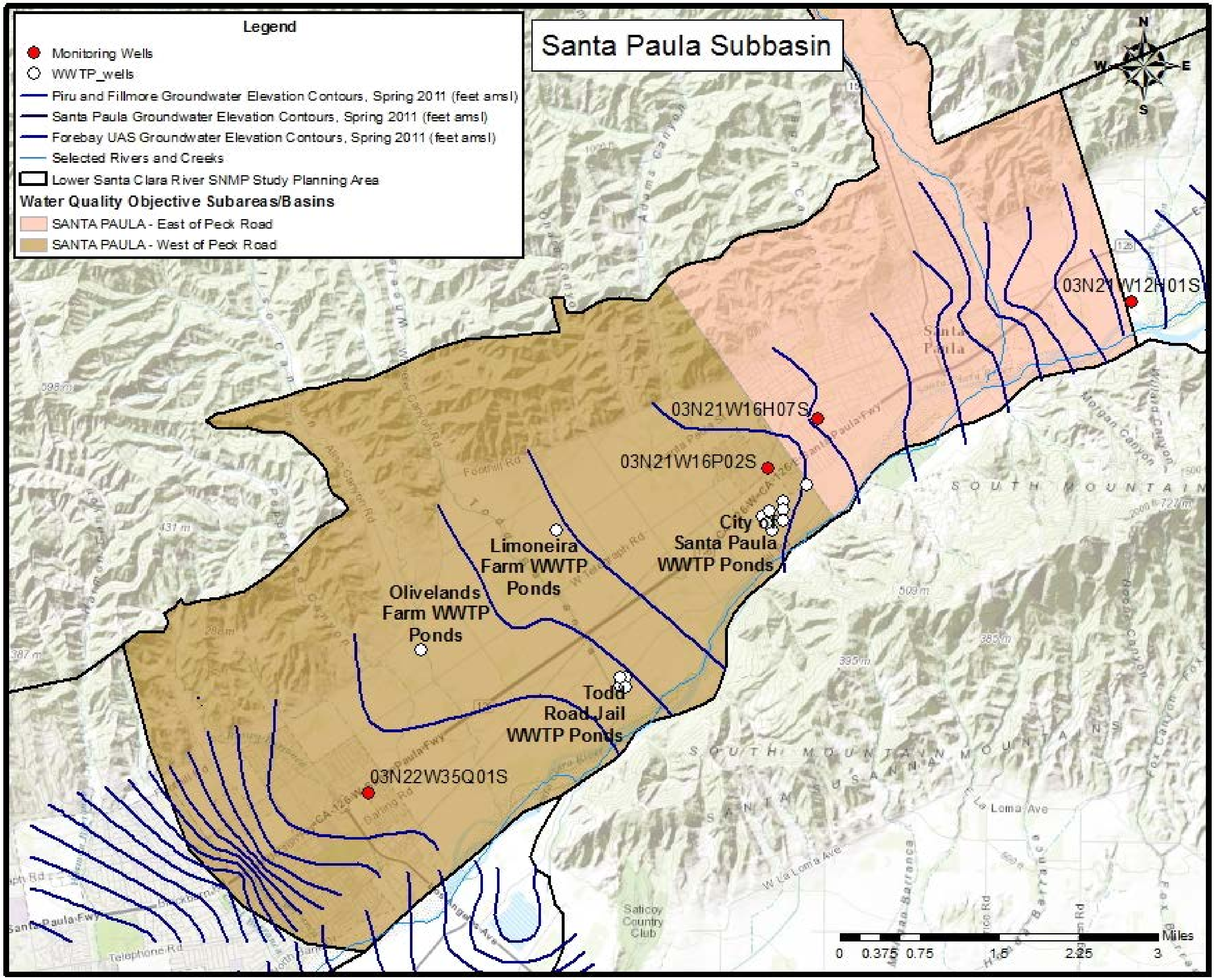


Figure 10-4 Santa Paula Basin Monitoring Well Locations

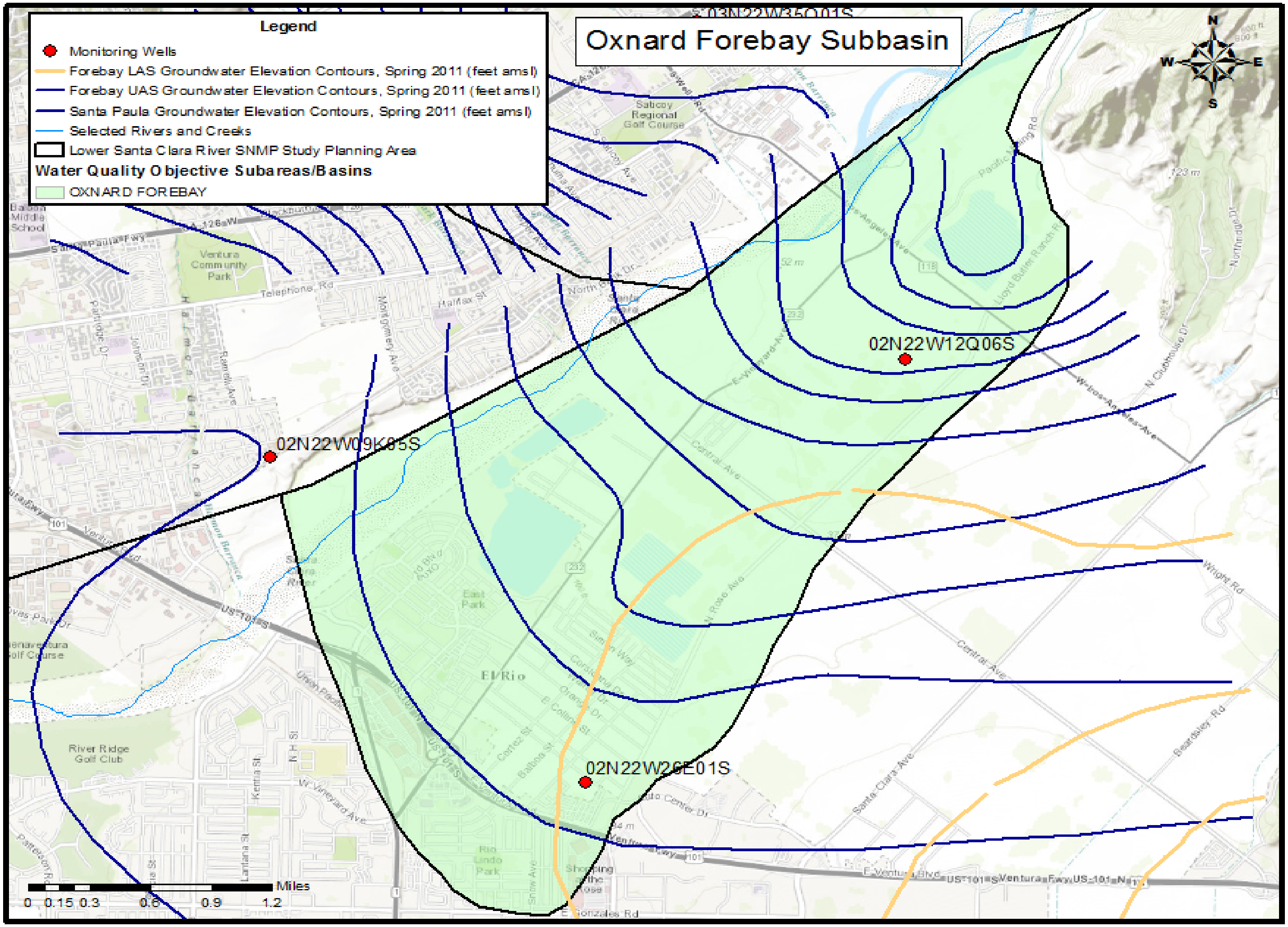


Figure 10-5 Mound and Oxnard Forebay Basin Monitoring Well Locations

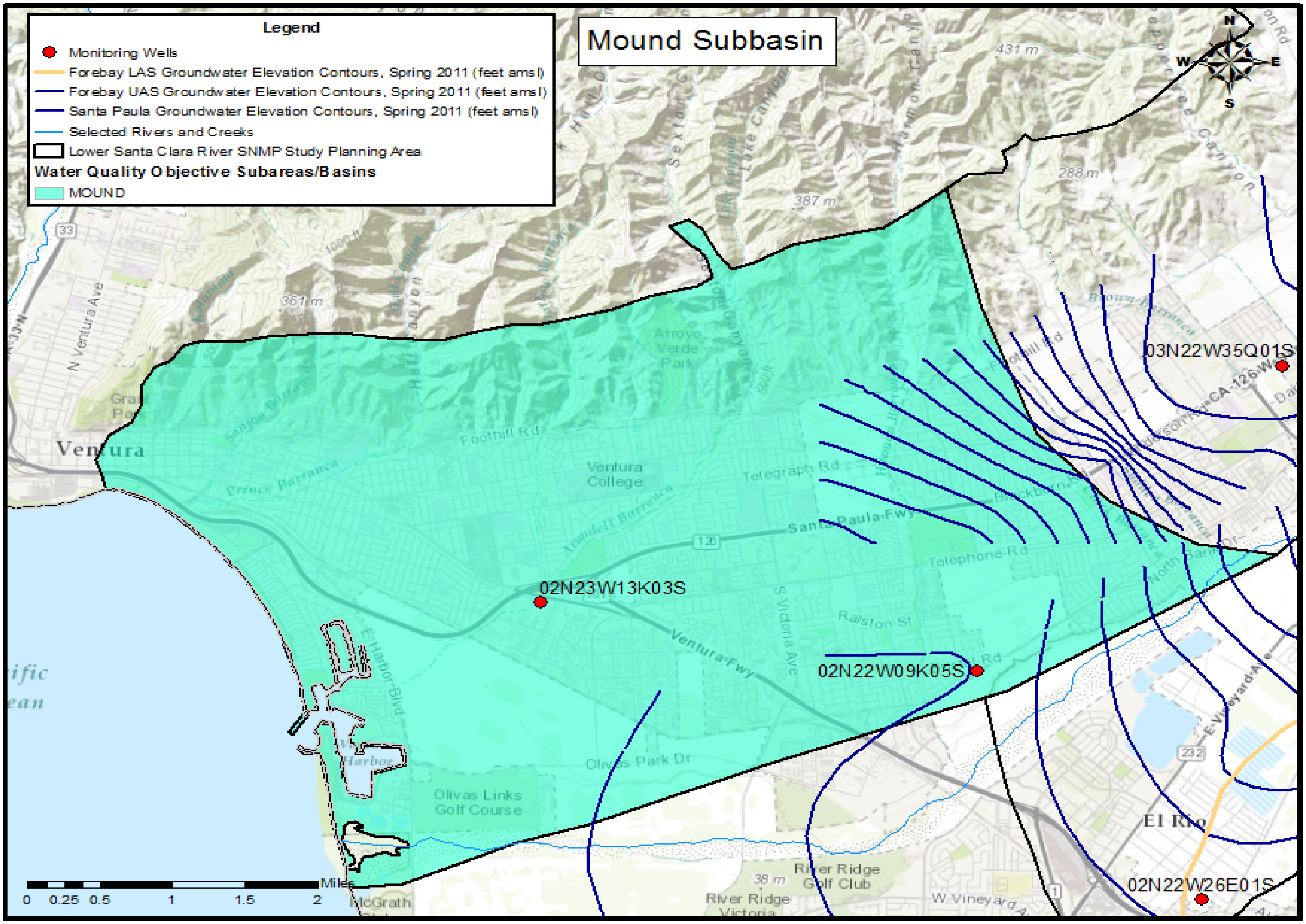


Figure 10-6 Mound Basin Monitoring Well Locations

10.5 TARGETED MONITORING LOCATIONS AND FREQUENCY

10.5.1 Recycled Water Projects and Groundwater Recharge Projects

The Recycled Water Policy requires monitoring proximate to large water recycling projects, particularly groundwater recharge projects. Salts, nutrients, and CECs will be part of the targeted monitoring for these projects. As noted, TDS, sulfate, chloride, boron, and nitrate as N will be monitored at all the targeted monitoring locations for large water recycling project and groundwater recharge projects. Each project will identify wells upgradient and downgradient of the surface or subsurface application areas. Additionally, the Recycled Water Policy provides requirements for the monitoring of CECs in recycled water used for groundwater recharge reuse as surface application and subsurface application. This monitoring, which is further described in this section, will be accomplished through the permits, such as WDRs, issued for the projects.

Targeted monitoring of CECs has three phases:

- Initial Assessment Phase – monitoring for a period of one year. Applies to the start-up of new facilities, piloting of new unit processes at existing facilities, and existing facilities where CECs and surrogates have not been assessed.
- Baseline Phase – monitoring for a period of three years following the initial assessment phase.
- Standard Operation Phase – standard monitoring following baseline phase

Groundwater recharge and reuse projects with surface application during the initial assessment phase will monitor health-based, performances based, and surrogate CECs on a quarterly basis following tertiary treatment prior to application to surface spreading area and at a monitoring well 30 days downgradient from the site. Groundwater recharge and reuse projects with subsurface applications during the initial assessment phase will monitor health based CECs on a quarterly basis following treatment prior to release to the aquifer. Performance indicator and surrogate CECs during the initial assessment phase monitored on a quarterly basis prior to Reverse Osmosis treatment and following treatment prior to release to the aquifer.

After enough data has been gathered during the initial assessment phase, the monitoring requirements shall be re-evaluated and monitoring may be reduced to semi-annually during the baseline phase. After the baseline phase of three years, the findings will again be evaluated and sampling frequency may be reduced to semi-annually or annually during the standard operation phase.

10.5.2 Areas of Interest

Targeted monitoring can be implemented for certain areas of interest to stakeholders within the LSCR Basin such as areas near municipal supply wells, areas of surface water and groundwater connectivity, or agricultural regions. When new projects are proposed in areas with exceedances of water quality objectives, targeted monitoring will be considered for implementation. Targeted monitoring for areas of interest would cater to the needs and goals of the specific project. For example, areas of surface water and groundwater connectivity can include surface water monitoring locations to help analyze the connection with groundwater.

Within areas of interest, an appropriate number of proposed monitoring wells would be selected based on the needs of the projects. A minimum number of wells would be chosen to provide sampling locations both upgradient and downgradient of the areas of interest in order to characterize water quality changes. Baseline monitoring locations will be utilized if possible with additional targeted wells selected as needed. The upgradient and downgradient wells would be monitored on a semi-annual or quarterly basis in order to allow for evaluation of seasonal wet weather and dry weather effects on groundwater quality. After sufficient data is collected, sampling frequency may be reduced to annual dependent on the needs of the project.

Table 10-7 Proposed Targeted Monitoring Program

Type of Monitoring	Constituents		Frequency
Targeted Monitoring for Recycled Water Projects and Groundwater Recharge Projects *Salts and Nutrients*	TDS Sulfate Chloride	Boron Nitrate as N	• Semi Annual • May be reduced to annual following baseline evaluation
Targeted Monitoring for Recycled Water Projects and Groundwater Recharge Projects *CECs*	<u>CECs</u> 17beta-estradiol NDMA Caffeine Triclosan Sucralose Iopromide DEET Gemfibrozil	<u>Surrogates</u>[1] Ammonia Total Organic Carbon Nitrate Ultraviolet Light Absorption Electrical Conductivity	• Initial assessment phase: Quarterly • Baseline phase: may be reduced to semi-annual after one year of initial monitoring • Standard operation phase: may be reduced to semi-annual or annual after three years of baseline monitoring
Targeted Monitoring for Areas of Interest	TDS Sulfate Chloride	Boron Nitrate as N	• Semi-annual or Quarterly based on target of interest • May be reduced to annual based on project needs

[1] Surrogates will be selected on a project-specific basis.

10.6 QA/QC AND REPORTING

A Quality Assurance/Quality Control (QA/QC) plan shall be implemented to ensure that analytical data can be used with confidence. QA/QC measures shall be used for both collection of samples and laboratory analysis. QA/QC procedures to be initiated include the following:

- Field Logs;
- Clean sampling techniques;
- Chains of Custody (CoCs);
- QA/QC samples; and
- Data verification.

Field logs will be used to record sampling information and field observations during monitoring that may explain any uncharacteristic analytical results. Sampling information to be included in the field log include the date and time of water quality sample collection, sampling personnel, sample container identification numbers, and types of samples that were collected. Field observations should be noted in the field log for any abnormalities (e.g., color, odor).

Clean sampling techniques will be used to ensure that samples are not contaminated. This involves the use of certified clean containers for sample collection, appropriate containers for the constituents, use of clean sampling equipment, and clean powder-free nitrile gloves during sample collection and handling.

CoCs will be used to track samples from collection through analysis and help ensure the validity of the sample. As part of the process, containers will be properly labeled, CoC forms will be used for all samples, and samples will be delivered to the analytical laboratory promptly to meet hold times.

QA/QC of samples will include field duplicates, field blanks, and Matrix Spike/Matrix Spike Duplicates (MS/MSDs). The USGS NAWQA program[4] provides guidance on the number and types of replicates, and blanks to be collected in the field.

Table 10-8 Quality Control Samples

Constituent	Field Duplicate[1]	Field Blank[1]	MS/MSD[1]
TDS			
Sulfate	X		
Chloride			
Boron	X		
Nitrate as N	X	X	
CECs	X	X	X

[1] Minimum of one monitoring site per basin per sampling event.

Field duplicates will be collected, handled, and analyzed using the same protocols as environmental samples and collected immediately after the environmental sample has been collected. Field blanks assess potential sample contamination levels that occur during field sampling activities. De-ionized water field blanks will be taken to the field, transferred to the appropriate container, and treated the same as the corresponding environmental sample type during the course of a sampling event. MS/MSDs that are required for a specified analyte will have additional volume collected directly after the environmental sample is collected. MS/MSDs require the collection of three times the standard sample volume.

Analytical methods for constituents will be selected to achieve EPA reporting limits and based on methods published by the EPA or methods certified by the CDPH as seen in **Table 10-1**.

[4] U.S. Geological Survey, 1997 to present, National field manual for the collection of water-quality data: U.S. Geological Survey Techniques of Water-Resources Investigations. 2003, National Water-Quality Assessment (NAWQA) protocol: accessed at: http://water.usgs.gov/nawqa/protocols/doc_list.html.

Analytical methods for laboratory analysis of CECs shall be selected to achieve the reporting limits presented in **Table 10-2**.

Table 10-9 Method and Detection Limits for Salts and Nutrients[5]

Constituent	Typical Test Method(s)	Detection Limit for Reporting (mg/L)[1]
TDS	EPA General Methods	10
Sulfate	Anions by EPA Method 300	0.5
Chloride	Anions by EPA Method 300	1
Boron	EPA Method 200.7	0.1
Nitrate as N	EPA 353.2, EPA Method 9210; Anions by EPA Method 300	2.0

[1] The testing procedure must be able to resolve concentrations at this level in order for the results to be acceptable.

After results are received from the analytical laboratory, the data will be analyzed to ensure that it is complete, accurate, and the appropriate QA/QC requirements were met. Data must be verified as soon as the data reports are received and will include checking the CoC and laboratory reports, verifying hold times and reporting levels were met, and checking QA/QC samples. For any exceedances of these criteria for QA/QC samples, the stakeholder will investigate possible sources of error and contamination. If feasible, samples will be re-analyzed. Results still not meeting these criteria will be qualified in the data submittal.

For QA/QC samples:

- Blank Samples should be below the analytical Reporting Limit;
- Duplicate measurements should be less than 25% Relative Percent Difference; and
- Matrix spikes and matrix spike duplicates should be within 75% to 125% recovery.

Data for this project will largely be in the form of lab reports of analytical sample concentrations. A SNMP groundwater monitoring report and results will be submitted to the RWQCB every three years through the GAMA Program. The SNMP report will include the following:

- Water quality summary tables;
- Time concentration plots to assess trends;
- Comparison of detections with water quality objectives; and
- Status of recycled water use and stormwater capture projects and implementation measures.

Data generated from the monitoring program will be submitted to the SWRCB's online groundwater information system – GeoTracker. Monitoring of WWTP and WRP wells are submitted routinely by the permitted entities to the RWQCB according to the reporting requirements for the individual Waste Discharge Requirements. The stakeholders responsible for conducting the sampling will also be responsible for reporting of the monitoring data.

[5] State Water Resource Control Board, Division of Water Quality Gama Program, Domestic Wells: Chemicals and Test Methods: accessed: http://www.waterboards.ca.gov/gama/docs/test_method.pdf.

11 Anti-Degradation Analysis

11.1 REGULATORY BACKGROUND

The Recycled Water Policy requires recycled water projects included within SNMPs to satisfy the requirements of State Water Board Resolution No. 68-16, the State antidegradation policy adopted in 1968 to protect and maintain existing water quality in California. Resolution No. 68-16 is interpreted to incorporate the federal antidegradation policy and satisfies the federal regulation requiring states to adopt their own antidegradation policies. Resolution No. 68-16 states in part:

1. Whenever the existing quality of water is better than the quality established in policies as of the date on which such policies become effective, such existing high quality 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 uses of such water and will not result in water quality less than that prescribed in the policies.
2. Any activity which produces or may produce a waste or increased volume or concentration of waste and which discharges or proposes to discharge to existing high quality water will be required to meet waste discharge requirements which will result in the best practicable treatment or control of the discharge necessary to assure that (a) a pollution or nuisance will not occur and (b) the highest water quality consistent with maximum benefit to the people of the State will be maintained.

Entities that carry out actions that involve the disposal of wastes that could impact high quality waters are subject to the State's antidegradation policy and required to implement best practicable treatment or control (BPTC) of the discharge to avoid producing a pollution or nuisance and maintain the highest water quality consistent with maximum benefit to the people of the State. The Recycled Water Policy finds that use of recycled water in accordance with the Policy is presumed to have a beneficial impact. The Policy requires that SNMPs be tailored to address the discharge of salts, nutrients, and other constituents that could impact water quality in a groundwater basin/sub-basin. SNMPs are required to address and implement provisions, as appropriate, to control sources of salts and/or nutrients to groundwater basins, including those associated with recycled water irrigation projects and groundwater recharge reuse projects.

With regard to Resolution No. 68-16 and the potential degradation of groundwater quality with the implementation of a recycled water project that results in groundwater recharge and/or landscape irrigation, the Recycled Water Policy finds the following:

- Groundwater recharge with recycled water for later extraction and use in accordance with this Policy and state and federal water quality law is to the benefit of the people of the state of California. Nonetheless, the State Water Board finds that groundwater recharge projects using recycled water have the potential to lower water quality in a basin. The proponent of a groundwater recharge project must demonstrate compliance with Resolution No. 68-16. Until such time as a salt/nutrient management plan is in effect, such compliance may be demonstrated as follows:
    1. A project that utilizes less than 10% of the available assimilative capacity in a basin/sub-basin (or multiple projects utilizing less than 20% of the available

assimilative capacity in a basin/sub-basin) need only conduct an antidegradation analysis verifying the use of the assimilative capacity. For those basins/sub-basins where the RWQCBs have not determined the baseline assimilative capacity, the baseline assimilative capacity shall be calculated by the initial project proponent, with review and approval by the RWQCB, until such time as the salt/nutrient plan is approved by the RWQCB as is in effect. For compliance with this sub-paragraph, the available assimilative capacity shall be calculated by comparing the mineral water quality objective with the average concentration of the basin/sub-basin, either over the most recent five years of data available or using a data set approved by the RWQCB Executive Officer. In determining whether the available assimilative capacity will be exceeded by the project or projects, the RWQCB shall calculate the impacts of the project or projects over at least a ten year time frame.

2. In the event a project or multiple projects utilize more than the fraction of the assimilative capacity designated in subparagraph (1) [above], then a RWQCB-deemed acceptable antidegradation analysis shall be performed to comply with Resolution No. 68-16. The project proponent shall provide sufficient information for the RWQCB to make this determination. An example of an approved method is the method used by the State Water Board in connection with Resolution No. 2004-0060 and the RWQCB in connection with Resolution No. R8-2004-00041. An integrated approach (using surface water, groundwater, recycled water, stormwater, pollution prevention, water conservation, etc.) to the implementation of Resolution No. 68-16 is encouraged.

- Landscape irrigation with recycled water in accordance with this Policy is to the benefit of the people of the State of California. Nonetheless, the State Water Board finds that the use of water for irrigation may, regardless of its source, collectively affect groundwater quality over time. The State Water Board intends to address these impacts in part through the development of salt/nutrient management plans described in paragraph 6 of the Recycled Water Policy (see Appendix 1 of the Recycled Water Policy).

    1. A project that meets the criteria for a streamlined irrigation permit and is within a basin where a salt/nutrient management plan satisfying the provisions of paragraph 6(b) [of the Recycled Water Policy; see Appendix 1] is in place may be approved without further antidegradation analysis, provided that the project is consistent with the plan.

    2. A project that meets the criteria for a streamlined irrigation permit and is within a basin where a salt/nutrient management plan satisfying the provisions of paragraph 6(b) is being prepared may be approved by the RWQCB by demonstrating through a salt/nutrient mass balance or similar analysis that the project uses less than 10% of the available assimilative capacity as estimated by the project proponent in a basin/sub-basin (or multiple projects using less than 20% of the available assimilative capacity as estimated by the project proponent in a basin/sub-basin).

In the issuing of WDRs and National Pollutant Discharge Elimination System (NPDES) permits, RWQCBs are required under the Clean Water Act section 301(b)(1)(C) and its implementing regulations (40 CFR 122.4(a); 40 CFR 122.4(d); 40 CFR 122.44(d)) to establish conditions in WDRs and NPDES permits that ensure compliance with state water quality standards, including antidegradation requirements.

The federal antidegradation policy (40 CFR 131.12(a)(1)) requires that:

> "*existing instream water uses and the level of water quality necessary to protect the existing uses shall be maintained and protected."* As defined in 40 CFR 131.3(e), *"[e]xisting uses are those uses actually attained in the water body on or after November 28, 1975, whether or not they are included in the water quality standards."*

The conditions established in WDRs and NPDES permits that ensure compliance with antidegradation requirements are effluent limitations, discharge specifications, and individual tasks (e.g., special studies) for assuring BPTC of the discharge and the highest water quality consistent with the maximum benefit to the people of the State will be achieved. The adoption of WDRs and NPDES permits by a RWQCB signifies that the discharge permitted by a given Order (a) will not produce degradation that results in water quality less than that prescribed in a Basin Plan, and (b) is consistent with the antidegradation provisions of 40 CFR part 131.12 and Resolution 68-16 *up to the permitted discharge capacity specified in the Order with compliance with effluent limitations* (emphasis added). RWQCBs also maintain the authority to reopen a given Order to reconsider effluent limitations, discharge specifications, and other requirements as means to ensure compliance with Resolution No. 68-16.

11.2 APPROACH

Existing groundwater quality and available assimilative capacity for TDS, chloride, and nitrate-N for the basins/subareas of the LSCR were estimated (see **Sections 4** and **5**), along with a characterization of planned recycled water projects (see **Section 9**), to determine how such future projects will potentially impact groundwater quality in the areas in which recycled water is intended to be applied. The current analysis evaluated if future estimated degradation to groundwater quality, vis-à-vis the use of available assimilative capacity in a basin/sub-basin, with implementation of a planned recycled water project is consistent with provisions of the Recycled Water Policy and state and federal antidegradation policies. Consistent with these policies, the use of assimilative capacity was utilized to determine compliance with the antidegradation policy by evaluating if projects are:

> (1) subject only to verification of its use of available assimilative capacity as it individually, or in combination with other projects in the same basin/subarea, is estimated to use less than 10% (single project) or less than 20% (multiple projects) of available assimilative capacity; or

(2) subject to a ‘complete’[1] antidegradation analysis due to its estimated use of available assimilative capacity in excess of either the 10% (single project) or 20% (multiple projects) thresholds specified in the Recycled Water Policy.

Additionally, the planned recycled water projects were evaluated to assess if the loading would be considered a “new load” to the subarea. Several of the wastewater treatment plants currently discharge to groundwater through percolation ponds. Discharges to the percolation ponds that are in compliance with the prescribed effluent limitations are considered to be in compliance with the antidegradation policy up to the design flow of the treatment plant (as outlined in the findings for the waste discharge requirements). As a result, any recycled water projects that occur in the same subarea as the current effluent discharges are not considered a new load to the subarea and are consistent with the antidegradation policy if they are below the allowable load.

As discussed in **Section 9**, while the volume of some recycled water projects have been planned, the exact locations and specifications for the projects are still in development. As a result, the procedures provided in **Section 9** have been developed to ensure degradation of the groundwater basins does not occur at levels above those allowed under the Recycled Water Policy. The procedures require that any projects with loadings of salts and nutrients above the assimilative capacity thresholds implement management measures to offset the loading above the threshold. The thresholds were set consistent with the antidegradation policy to meet condition 1 above. Therefore, projects implemented in accordance with the procedures outlined in **Section 9** are deemed to be in compliance with the antidegradation policy.

If no assimilative capacity is available or a project exceeds the assimilative capacity thresholds and management measures are not proposed, the project would be subject to a ‘complete’ antidegradation analysis prior to implementation. No projects in the SNMP planning area have been developed in sufficient detail to allow a complete antidegradation analysis to be completed.

Based on the analysis in **Section 9**, compliance with the antidegradation policy for planned recycled water projects defined in **Section 8** are provided below by basin/subarea.

11.3 ASSESSMENT OF POTENTIAL WATER QUALITY IMPACTS

11.3.1 Piru Basin

11.3.1.1 Piru Basin – Upper Area below Lake Piru

No recycled water projects are currently planned that will apply recycled water to this subarea of the Piru basin.

11.3.1.2 Piru Basin – Lower Area East of Piru Creek

No recycled water projects are currently planned that will apply recycled water to this subarea of the Piru basin.

[1] A complete antidegradation analysis must include a socioeconomic analysis to establish the balance between the proposed action and the public interest.

11.3.1.3 Piru Basin – Lower Area West of Piru Creek

Recycled water produced at the Piru WWTP is intended to be used for irrigation of farm land located to the north, east, and south of the treatment plant beginning in 2016. Initial recycled water use is estimated to be 0.2 mgd (current treatment plant flow rate) and is anticipated to increase up to 0.5 mgd over time. The Piru WWTP currently discharges its effluent to percolation ponds in the subarea and is permitted to discharge up to 0.5 mgd in this manner. Although the Piru WWTP discharge currently exceeds the chloride limit of the Waste Discharge Permit, the District is participating in the development of this SNMP and the implementation of the Watershed-wide Monitoring Program. The analysis provided in **Section 9** indicates that there is sufficient assimilative capacity in the Lower Area West of Piru Creek sub-basin for the current chloride loading discharged from the Piru WWTP and the full range of planned recycled water projects. Furthermore, the chloride concentrations in the groundwater wells downstream of the plant discharge percolation pond are less than the water quality objective of 100 mg/L of chloride.

The use of recycled water produced by the WWTP for irrigation on land nearby the facility will not result in a net increase in pollutant loading to the groundwater in the subarea above the assimilative capacity thresholds. These planned recycled water projects are therefore consistent with the Recycled Water Policy and state and federal antidegradation policies.

11.3.2 Fillmore Basin

11.3.2.1 Fillmore Basin – Pole Creek Fan Area

There are four recycled water projects currently planned for implementation in the Pole Creek Fan Area of the Fillmore basin. Recycled water in this subarea will be produced by the City of Fillmore's Wastewater Reclamation Plant (FWRP). Two of these projects are planned to deliver recycled water for landscape irrigation and two are planned for agricultural irrigation in the subarea. Recycled water delivery volumes have been determined for three of the projects, totaling 0.19 mgd. The agricultural irrigation project scheduled to deliver recycled water to an area located east of the City limits currently has no defined acreage. First delivery dates for recycled water have not been established for any of these projects. The FWRP currently produces an average of 0.93 mgd of treated effluent that is discharged to percolation ponds and delivered as recycled water to local parks and schools in the subarea. The FWRP has a permitted discharge capacity of 2.4 mgd.

Based on the analysis in **Section 9**, the use of recycled water produced by the FWRP for landscape and agricultural irrigation on nearby land will not result in a net increase in pollutant loading to the groundwater above the assimilative capacity thresholds for the planned projects. Therefore, the planned recycled water projects for the FWRP are consistent with the Recycled Water Policy and state and federal antidegradation policies.

11.3.2.2 Fillmore Basin – South Side of Santa Clara River

No recycled water projects are currently planned that will apply recycled water to this subarea of the Fillmore basin.

11.3.2.3 Fillmore Basin – Remaining Fillmore

No recycled water projects are currently planned that will apply recycled water to this subarea of the Fillmore basin.

11.3.3 Santa Paula Basin

11.3.3.1 Santa Paula Basin – West of Peck Road

The City of Santa Paula intends to deliver recycled water for landscape irrigation purposes from its Santa Paula Water Recycling Facility (SPWRF), located in the West of Peck Road subarea, to a recycled water project area that may be located in the East of Peck Road subarea. The SPWRF currently produces an average of 1.88 mgd of treated effluent that is discharged to percolation ponds. The facility has an annual average flow limitation of 2.6 mgd, as evaluated monthly, that applies to all discharges to percolation ponds. The City intends to begin applying 0.4 mgd of recycled water for landscape irrigation beginning in 2015, with projections of applying up to 1.45 mgd for landscape irrigation by 2035. Because potential impacts to groundwater quality due to the application of recycled water produced by the SPWRF may occur in the East of Peck Road subarea, those impacts are discussed in the subsection below.

Based on the analysis in **Section 9**, the planned use of recycled water produced by the SPWRF for landscape irrigation will not result in a net increase in pollutant loading above the assimilative capacity thresholds for the planned projects. Therefore, the planned recycled water projects for the SPWRF are consistent with the Recycled Water Policy and state and federal antidegradation policies.

Three other agencies (Saticoy WWTP, Limoneira and Olivelands Sewer Farms, and Todd Road Jail WWTP) anticipate the production of recycled water at some point in the future. However, current recycled water demand in their service areas is not sufficient to begin developing specific water reuse projects. When such future recycled water projects are planned, they will need to undergo an evaluation to confirm that they are consistent with the Recycled Water Policy, the LSCR SNMP, and state and federal antidegradation policies in accordance with the procedures outlined in **Section 9**.

11.3.3.2 Santa Paula Basin – East of Peck Road

Should the Santa Paula's recycled water be applied in the East of Peck Road subarea, it represents a change in the location of salt and nutrient loading to the Santa Paula basin as a whole from the current discharge of treated effluent to percolation ponds in the West of Peck Road subarea to a future application of recycled water to the East of Peck Road subarea. Based on the average annual concentration of salts and nitrate-N currently discharged to percolation ponds in the West of Peck Road subarea, groundwater loading of these parameters to the East of Peck Road subarea with implementation of the planned recycled water project was estimated in **Section 9**. Under an initial scenario where 0.4 mgd of recycled water is applied in the subarea, the loadings will not exceed the assimilative capacity thresholds and the project is consistent with the Recycled Water Policy and state and federal antidegradation policies. However for the maximum planned recycled water use, the estimated nitrate loading exceeds the assimilative capacity thresholds. As a result, prior to implementation of the full project volume, a full antidegradation analysis for the City of Santa Paula planned recycled water project will be required unless salinity and nutrient management strategies can be employed to reduce the assimilative capacity increment used by nitrate to below the thresholds as outlined in **Section 9**.

It should be noted that the redistribution of salt and nutrient loading to the East of Peck Road subarea will produce a reduction of pollutant loading to the West of Peck Road subarea, as compared to existing conditions, which should improve groundwater quality for the parameters under consideration in that sub-basin.

11.3.4 Oxnard Forebay Basin

UWCD may purchase recycled water from the City of Oxnard's AWPF for groundwater recharge of the Oxnard Forebay basin and/or agricultural irrigation purposes. Because the AWPF is located in the Oxnard Plain, outside of the LSCR SNMP project area, the delivery of recycled water into the Oxnard Forebay constitutes a new groundwater loading to this subarea. The AWPF features advanced wastewater treatment technologies that include microfiltration, reverse osmosis, and UV disinfection. The AWPF produces treated effluent that meets Title 22 requirements for recycled water. The quality of the water produced by the AWPF is significantly better than the existing groundwater quality in the Oxnard Forebay. UWCD has not yet determined the amount of water it plans to deliver to the Oxnard Forebay or the estimated quality of the water, but it has identified a recycled water project area.

The planned recycled water project area may overlay a region where exceedances of the TDS water quality objective have been observed. However, on a subarea-wide basis, available assimilative capacity exists for TDS, as well as chloride and nitrate-N. The Oxnard Forebay shows a decreasing concentration trend for chloride and nitrate-N across all monitoring wells analyzed, and a decreasing concentration trend for TDS in three of the four wells evaluated. The intent of the Recycled Water Policy is to allow variability in salt and nutrient concentrations within a defined groundwater basin or sub-basin, to the extent that groundwater quality in certain areas can exceed water quality objectives, with the overriding requirement that groundwater quality averaged across the defined area remains below relevant water quality objectives and can be used for the beneficial uses for which it has been identified. The recycled water project area also extends to a small area within the Mound basin.

With respect to the Oxnard Forebay, the recycled water produced by the AWPF and intended for application in the basin is anticipated to improve overall groundwater quality by having a diluting effect on existing groundwater concentrations. The additional mass of water added to the basin likely would more than offset the mass of salt added by this project; however, the analysis could not be conducted at this point because estimates of the volume and water quality of the potential projects have not been determined. The evaluation of impacts will follow the procedures outlined in **Section 9**. If the analysis demonstrates that the projects will not use more than 10 % of the assimilative capacity or have a diluting effect on the sub-basin, the project will meet the requirements of the antidegradation policy and this plan and can proceed. If the proposed loading will use more than 10% of the available assimilative capacity, the project proponent would need to conduct a full antidegradation analysis or follow the procedures outlined in **Section 9** to do further evaluation or implement management measures to meet the requirements of the SNMP.

11.3.5 Mound Basin

In preparing this SNMP it was determined that the Mound basin on average exceeds its water quality objective for TDS of 1,200 mg/L by 30 mg/L. In contrast, it was determined that the basin has assimilative capacity for chloride and nitrate-N. Because no assimilative capacity exists for TDS, planned recycled water projects cannot demonstrate compliance with the antidegradation policy through verification that assimilative capacity use is below the thresholds.

The City of Ventura is evaluating a number of potential plans to deliver recycled water from its Ventura WRF to the Mound basin. The City has identified a planned recycled water project area where up to 0.05 mgd of recycled water for landscape irrigation will be supplied as the area is developed. This planned project has been permitted and the infrastructure for delivering the recycled water is being developed. However, development must occur for the project to be implemented. Because this project has already been permitted, it is considered an existing project even though the water is not yet being delivered. Although assimilative capacity for TDS is not available, as long as the recycled water application meets permit requirements, implementation of this project is allowed. The use of recycled water consistent with the permit requirements in this area will be consistent with the antidegradation policy as the use of the water will not result in degradation beyond that which is already permitted. As a result, this recycled water project is considered to be consistent with the Recycled Water Policy and state and federal antidegradation policies.

Other recycled water projects that could be implemented in the Mound basin could be subject to either implementation of management measures or a complete antidegradation analysis pending the results of further investigations. Because the effluent is not currently discharged to the groundwater basin, the planned recycled water projects would be considered new loads to the basin. As described in **Section 9**, additional recycled water projects that would occur at existing discharge concentrations would meet the thresholds for use of assimilative capacity for chloride and nitrate-N. However, no assimilative capacity is available for TDS. If management measures are implemented in accordance with **Section 9**, the projects would be consistent with the Recycled Water Policy and state and federal antidegradation policies. Alternatively, further evaluation could be conducted.

As discussed in the SNMP, questions about the applicability of the water quality objectives for the Mound basin exist. Naturally occurring salts in the Mound basin result from its location near the coast, resulting in poor groundwater quality, particularly in the shallow aquifer system. In the existing water reclamation requirements for the City of Ventura, the permit acknowledges that the *"groundwaters of the shallow semiperched zone are of very poor quality and are not beneficially used in any significant amounts."* As a result, effluent limitations included in the permit for recycled water are 3,000 mg/L of TDS, which is equal to the objective for the unconfined and perched aquifers in the Oxnard Plain. Implementation of additional recycled water projects would meet the effluent limitations in the existing recycled water permit for the City of Ventura. Documentation that the recycled water projects are occurring in areas where the shallow semiperched zone exists and will not impact other portions of the Mound basin could potentially be used to demonstrate that assimilative capacity exists in the recycled water project area to demonstrate consistency with the antidegradation policy.

Additionally, implementation of additional recycled water projects from the City of Ventura may provide benefits for the Santa Clara River Estuary by removing some effluent discharges from the estuary. A 2012 settlement agreement between the City of Ventura, Heal the Bay, and Wishtoyo Foundation's Ventura Coastkeeper Program regarding the potential impacts of the discharge in the Estuary includes a provision to create opportunities to use between 50-100 % of the effluent for landscaping, agricultural, or other reclamation uses to stretch water supplies and reduce or eliminate the amount of effluent released into the Estuary. Ongoing studies being conducted by the City of Ventura in response to the settlement agreement and other permit requirements are designed to evaluate whether removal of effluent from the Santa Clara River

Estuary will be beneficial. The results of these studies may be used to support the development of additional recycled water projects by demonstrating that the additional degradation resulting from the projects is in the maximum benefit of the people of the state.

In addition to potential recycled water projects at current discharge concentrations, other projects under consideration include delivering 2-7 mgd for either indirect potable reuse or direct potable reuse within the Mound basin. Both indirect and direct potable reuse would almost certainly require treatment that would significantly reduce the concentrations of salts and nutrients in the recycled water. Treatment of the water is considered to be a management measure under the SNMP. The future application of Ventura WRF recycled water after treatment in the Mound basin would likely act to lower existing groundwater concentrations in the basin, and while not analyzed, the additional mass of water added to the basin likely would more than offset the mass of salt added, thus increasing the assimilative capacity for TDS in the basin. Consistent with the procedures outline in **Section 9**, if the proposed project creates assimilative capacity through dilution, no additional management measures would be needed and the project would be consistent with the Recycled Water Policy and state and federal antidegradation policies.

11.4 EVALUATION OF CONSISTENCY WITH ANTIDEGRADATION POLICY

The approach used in this antidegradation analysis for proposed recycled water use in the groundwater basins/sub-basins of the LSCR is to evaluate the planned recycled water projects and determine if they are:

> (1) subject only to verification of its use of available assimilative capacity as it individually, or in combination with other projects in the same basin/subarea, is estimated to use less than 10 % (single project) or less than 20 % (multiple projects) of available assimilative capacity; or
>
> (2) subject to a 'complete'[2] antidegradation analysis due to its estimated use of available assimilative capacity in excess of either the 10% (single project) or 20% (multiple projects) thresholds specified in the Recycled Water Policy.

Based on the analysis above, the planned recycled water projects for the Piru WWTP, FWRP, and SPWRF if the projects occur in the West of Peck Road subarea are subject only to verification of the use of available assimilative capacity and are compliant with state and federal antidegradation policies. As such and in accordance with the procedures outlined in **Section 9**, these projects may proceed without further analysis or management measures.

Based on the analysis above, the planned recycled water projects for the SPWRF if applied in the subarea East of Peck Road and Ventura WRF require further analysis. In accordance with the procedures in **Section 9**, project proponents have the option to evaluate and modify their projects to reduce the use of assimilative capacity or implement management measures to offset the loading above the thresholds for use of assimilative capacity. If either of these steps is taken, the proposed projects would be in compliance with the antidegradation policies. Alternatively, the project proponents could elect to conduct further study and/or conduct a complete

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[2] A complete antidegradation analysis must include a socioeconomic analysis to establish the balance between the proposed action and the public interest.

antidegradation analysis. Should a complete antidegradation analysis be conducted, the analysis will adhere to the tenets of Resolution No. 68-16 and demonstrate that the projects will result in:

- Water quality consistent with the water quality prescribed in the Basin Plan
- Water quality changes that will not unreasonably affect present and anticipated beneficial uses
- Water quality changes that are consistent with the maximum benefit to the people of the State
- Projects that are consistent with the use of best practicable treatment or control to avoid pollution or nuisance and maintain the highest water quality consistent with maximum benefit to the people of the State
- Projects that are necessary to accommodate important economic or social development

If the complete antidegradation analysis, does not demonstrate these factors, the project will need to be modified or implementation measures will be need to be implemented to reduce the loading of salts and nutrients to the sub-basin.

Based on the above, recycled water projects implemented in accordance with the procedures outlined in **Section 9** are consistent with state and federal antidegradation policies.

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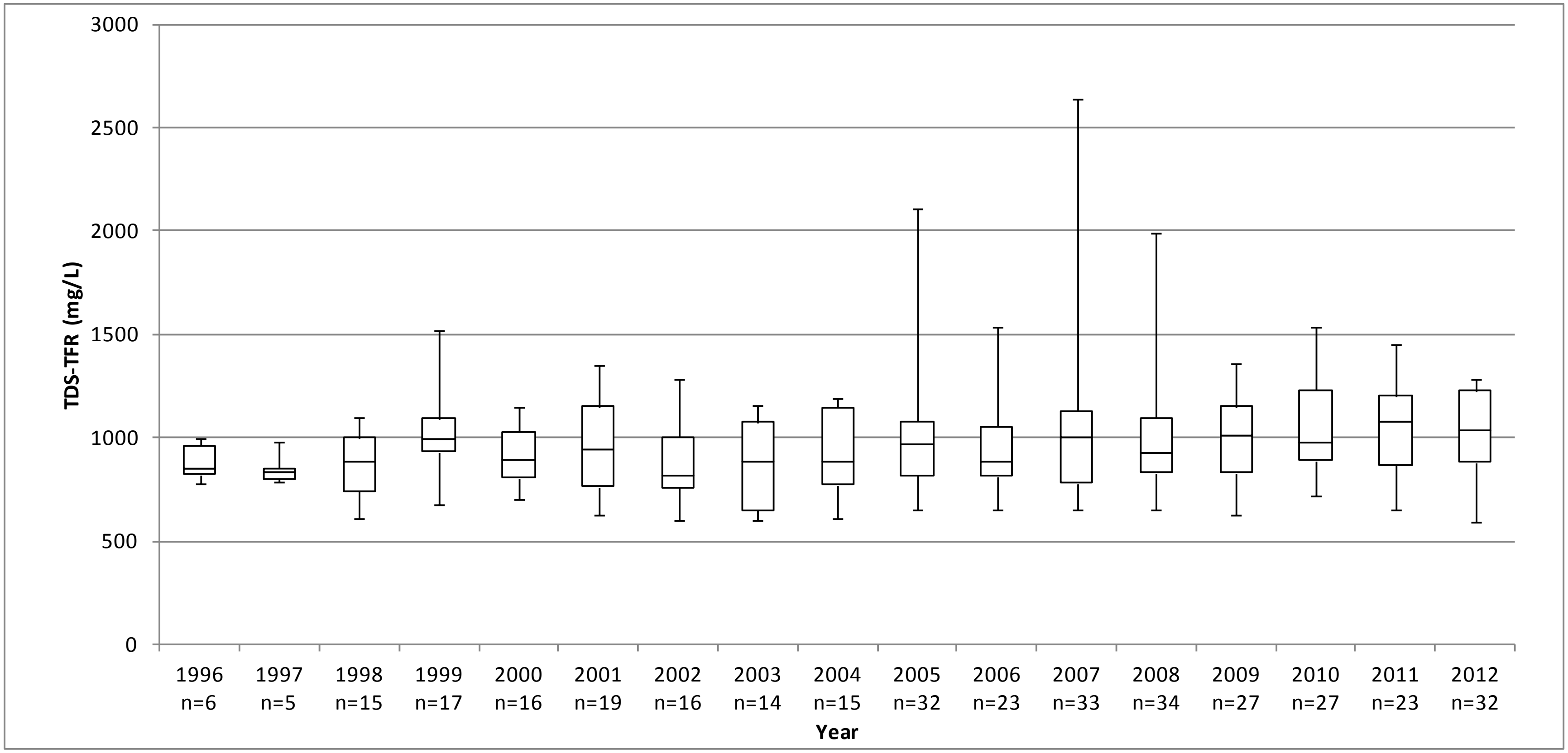
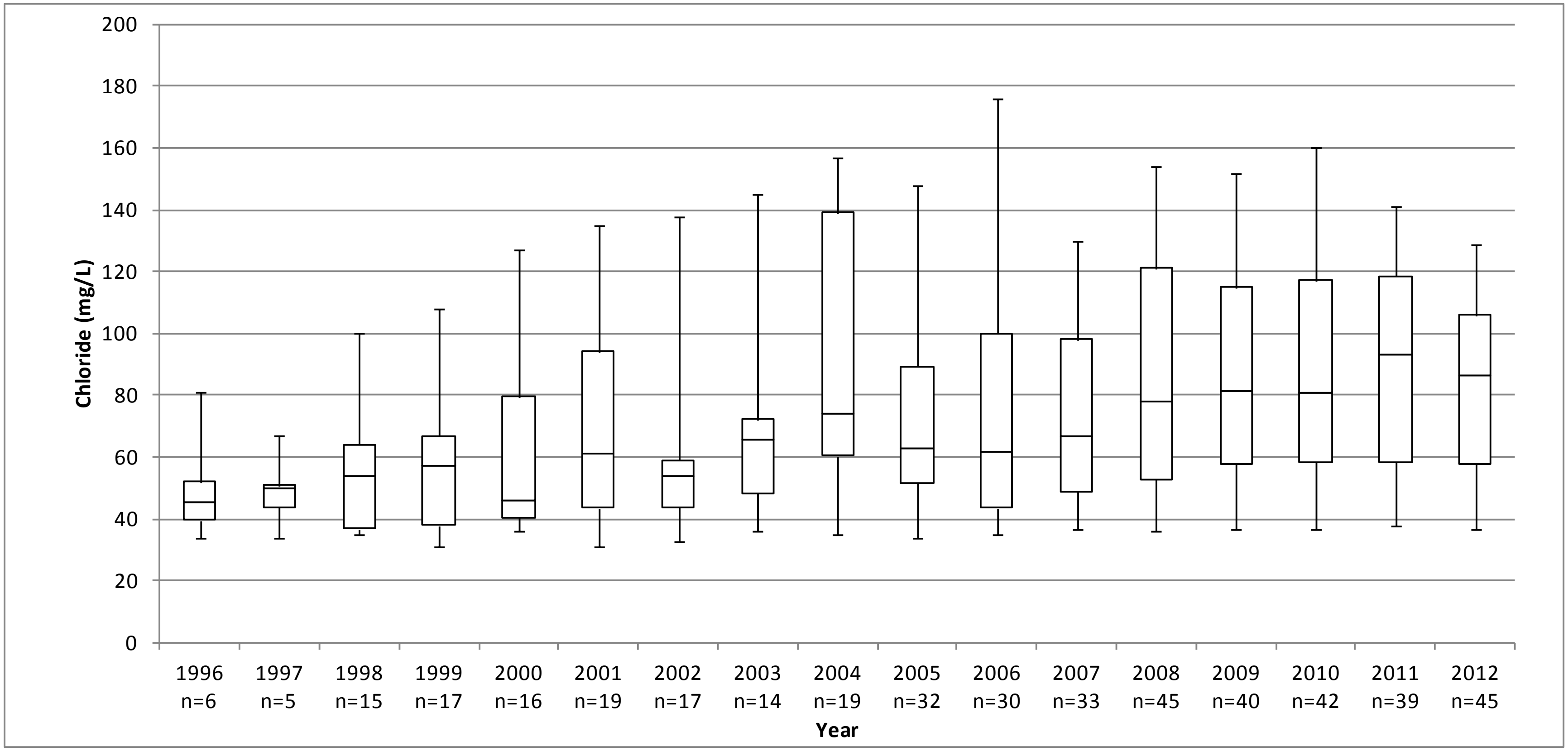
Appendix A. Box and Whisker Plots

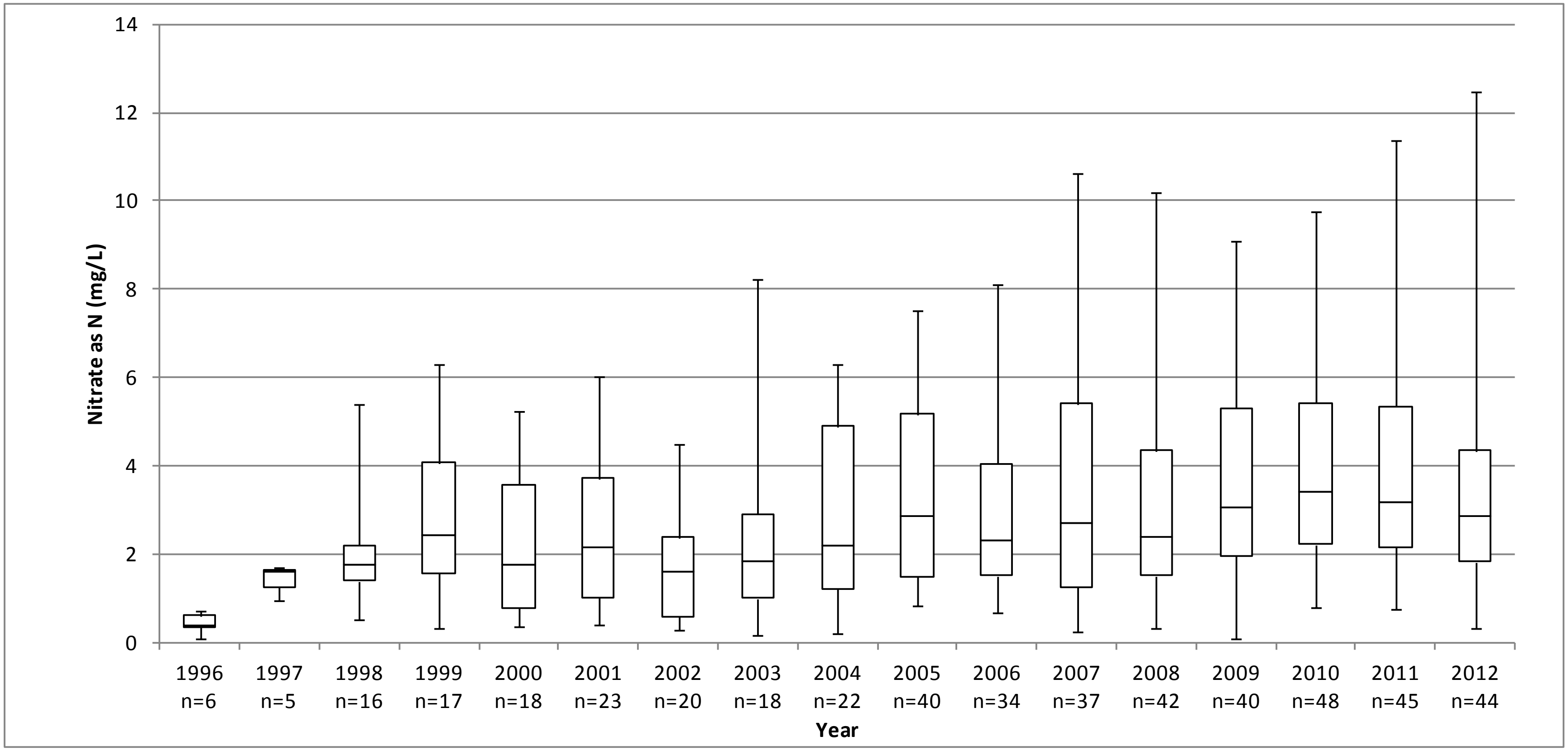
Box and Whisker Plots are provided for data available from most groundwater wells in the LSCR planning area, including data not used in the analyses presented in the SNMP, including data for wells with limited data sets and data points determined to be outliers. Data from groundwater wells associated with WWTP percolation ponds is not included in the plots. See **Section 4** for a discussion of the data used for the analyses.



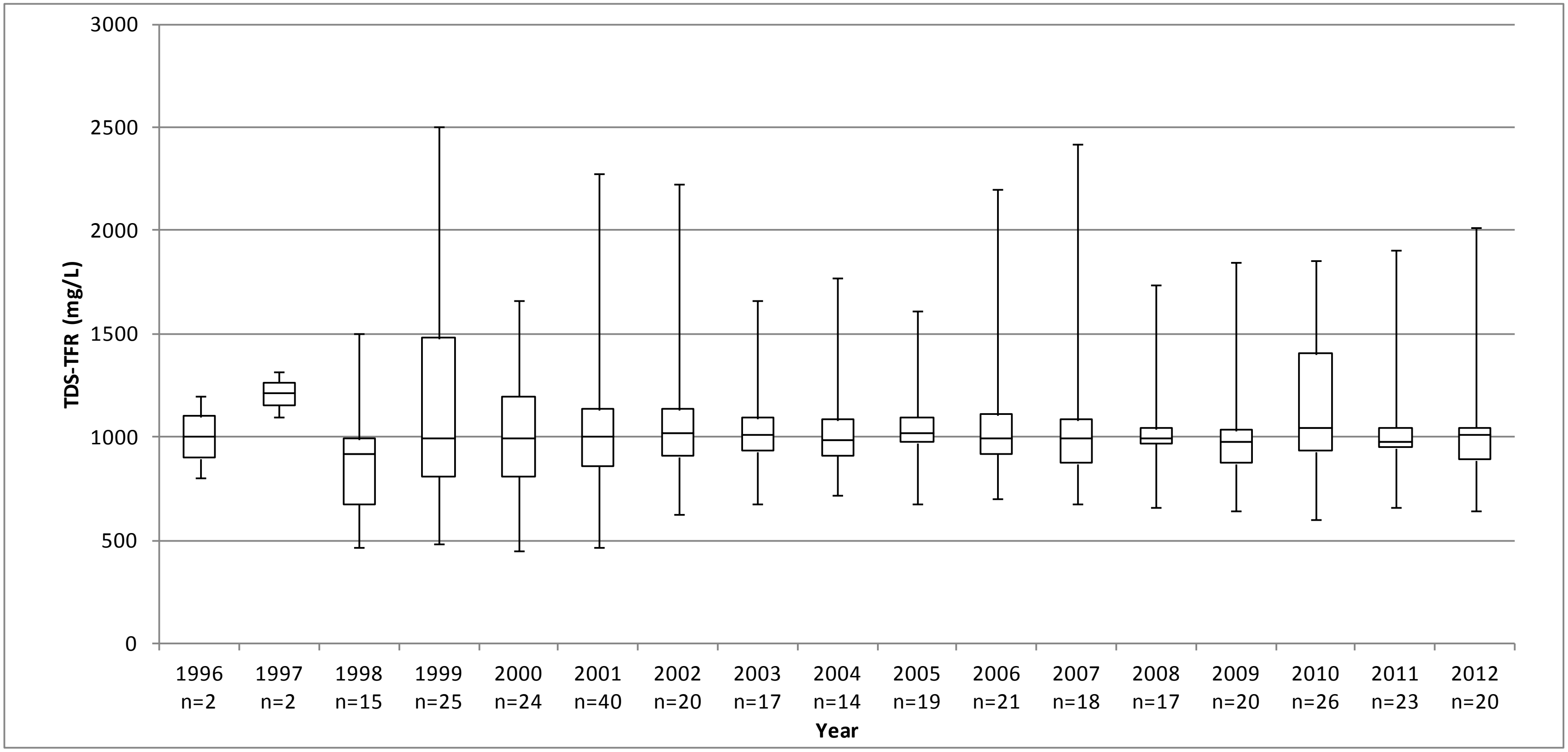
Appendix A Figure 1 TDS Box and Whisker Plot for the Piru Basin



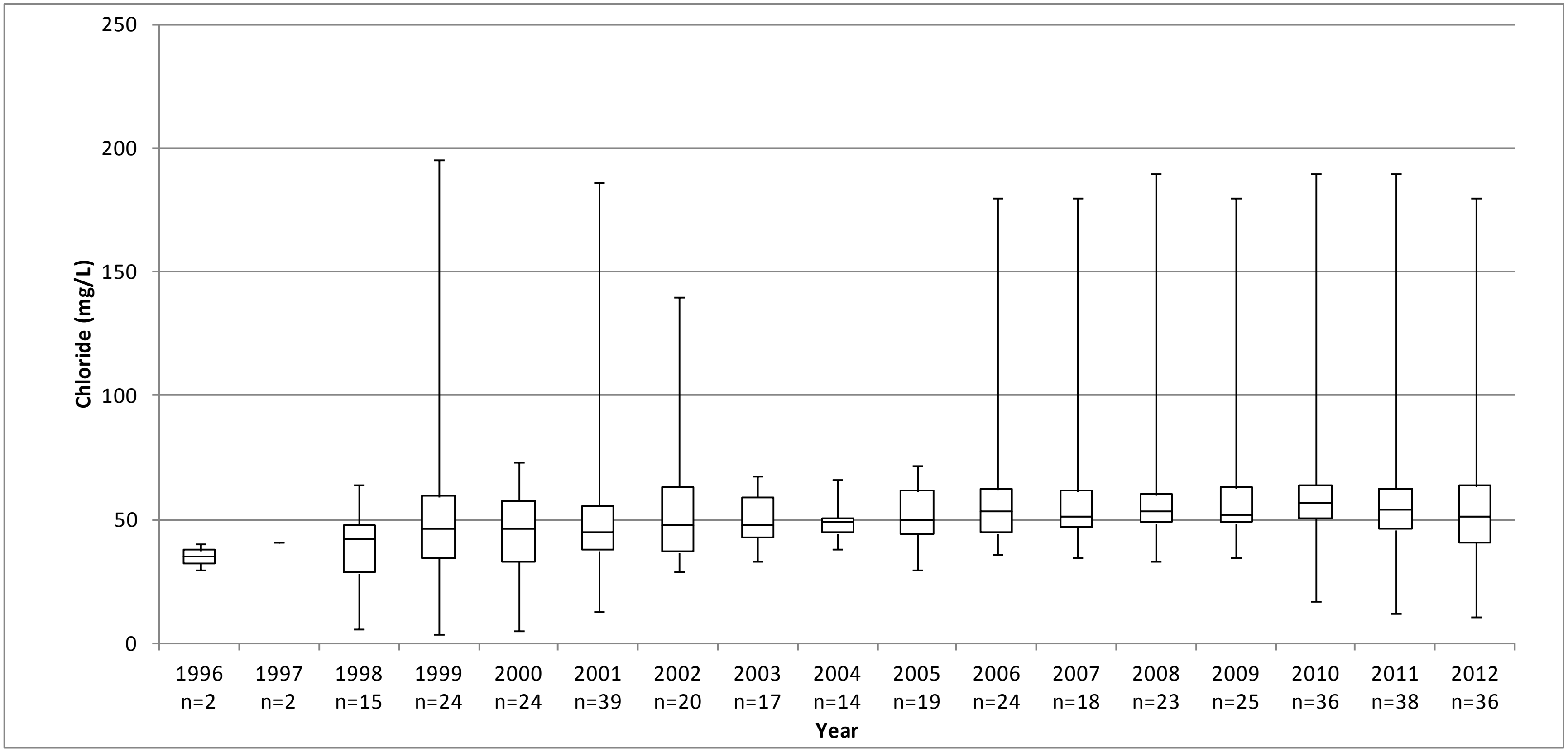
Appendix A Figure 2 Chloride Box and Whisker Plot for the Piru Basin



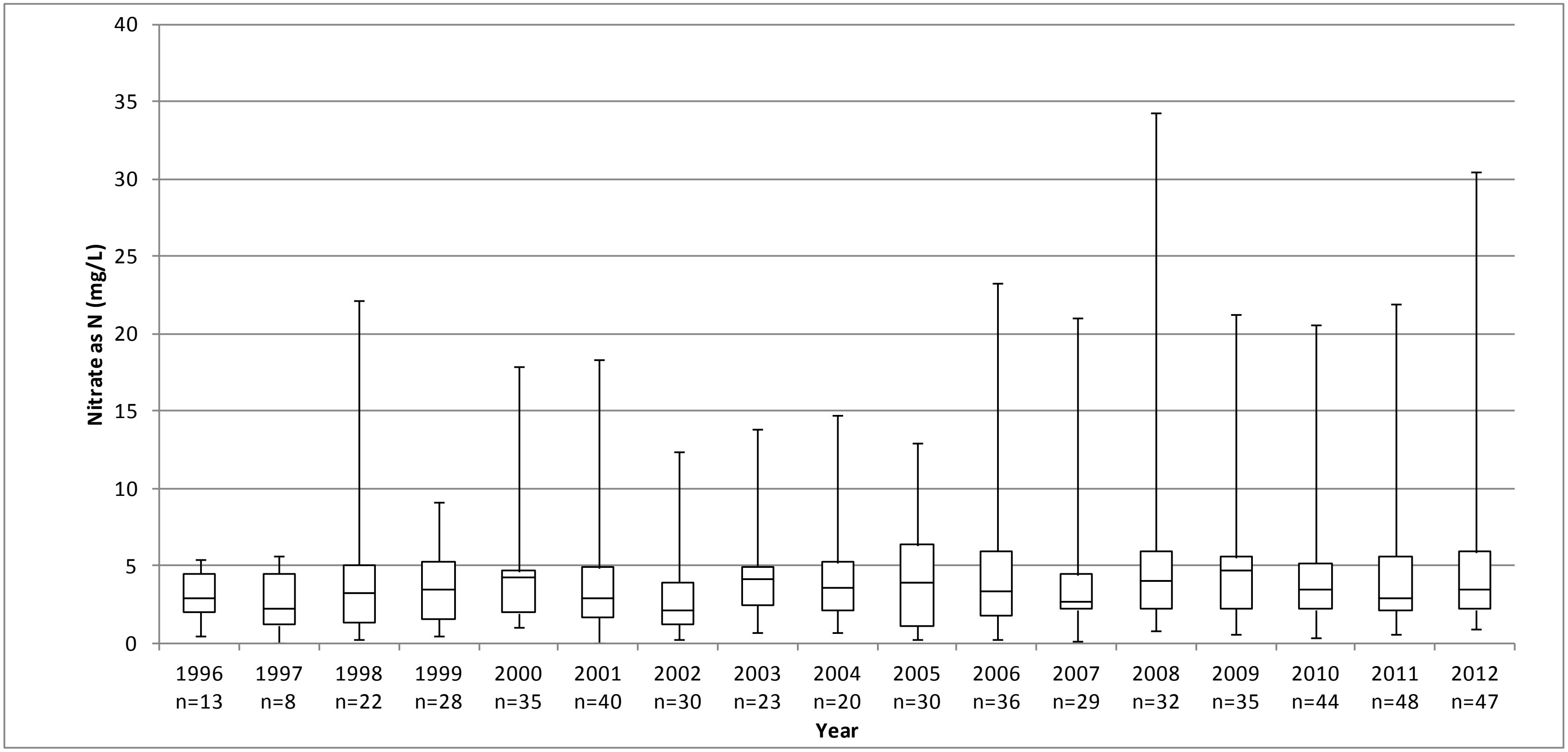
Appendix A Figure 3 Nitrate as N Box and Whisker Plot for the Piru Basin



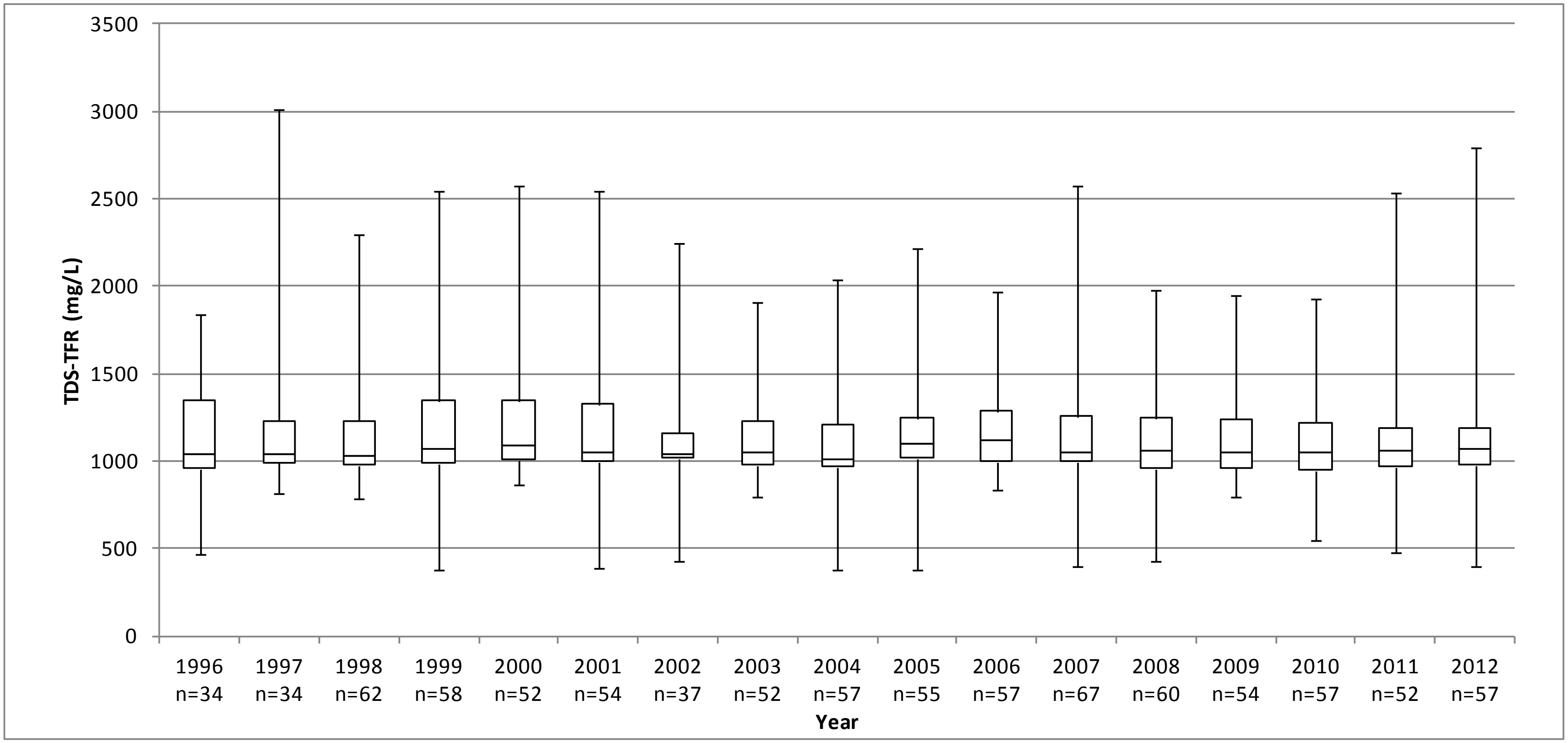
Appendix A Figure 4 TDS Box and Whisker Plot for the Fillmore Basin



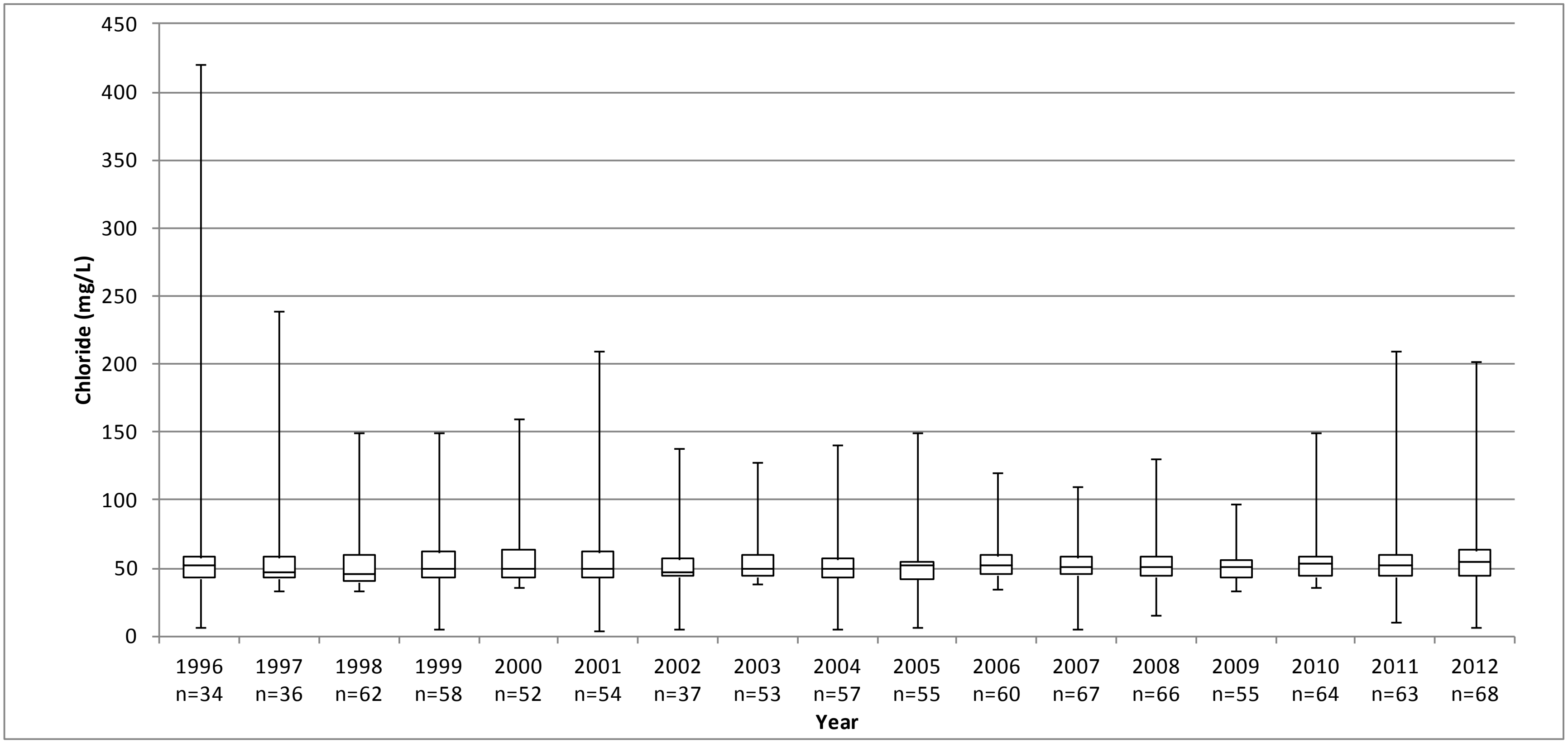
Appendix A Figure 5 Chloride Box and Whisker Plot for the Fillmore Basin



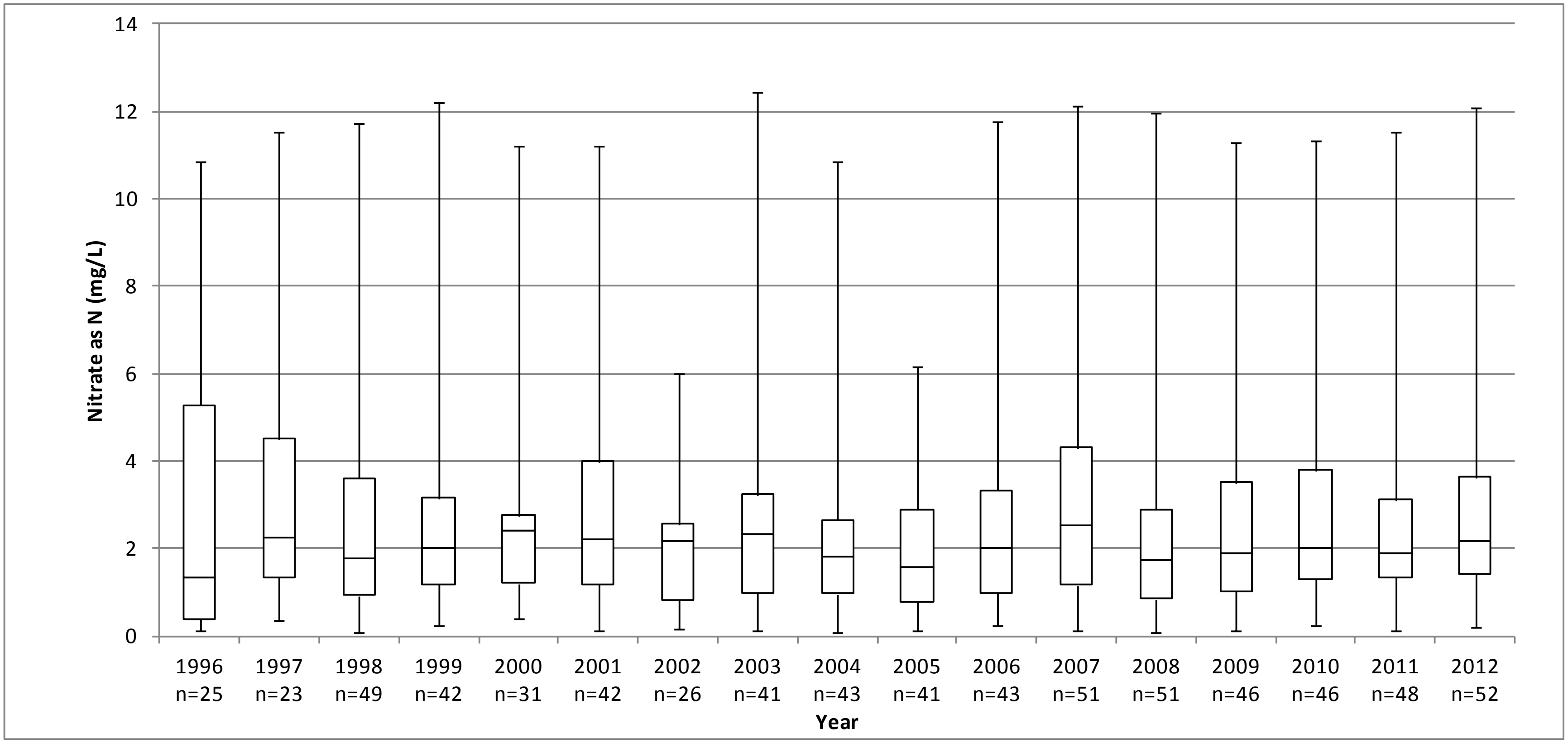
Appendix A Figure 6 Nitrate as N Box and Whisker Plot for the Fillmore Basin



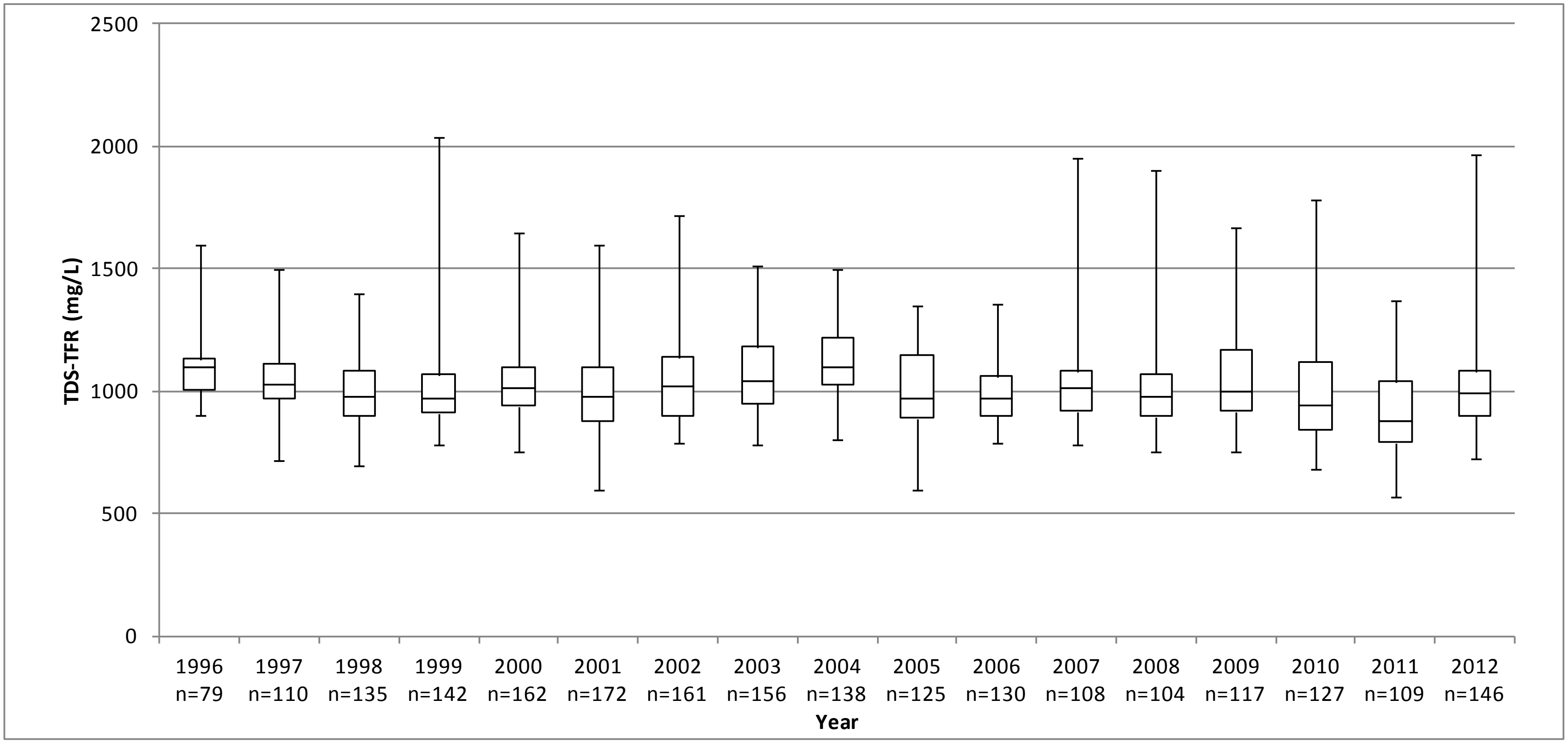
Appendix A Figure 7 TDS Box and Whisker Plot for the Santa Paula Basin



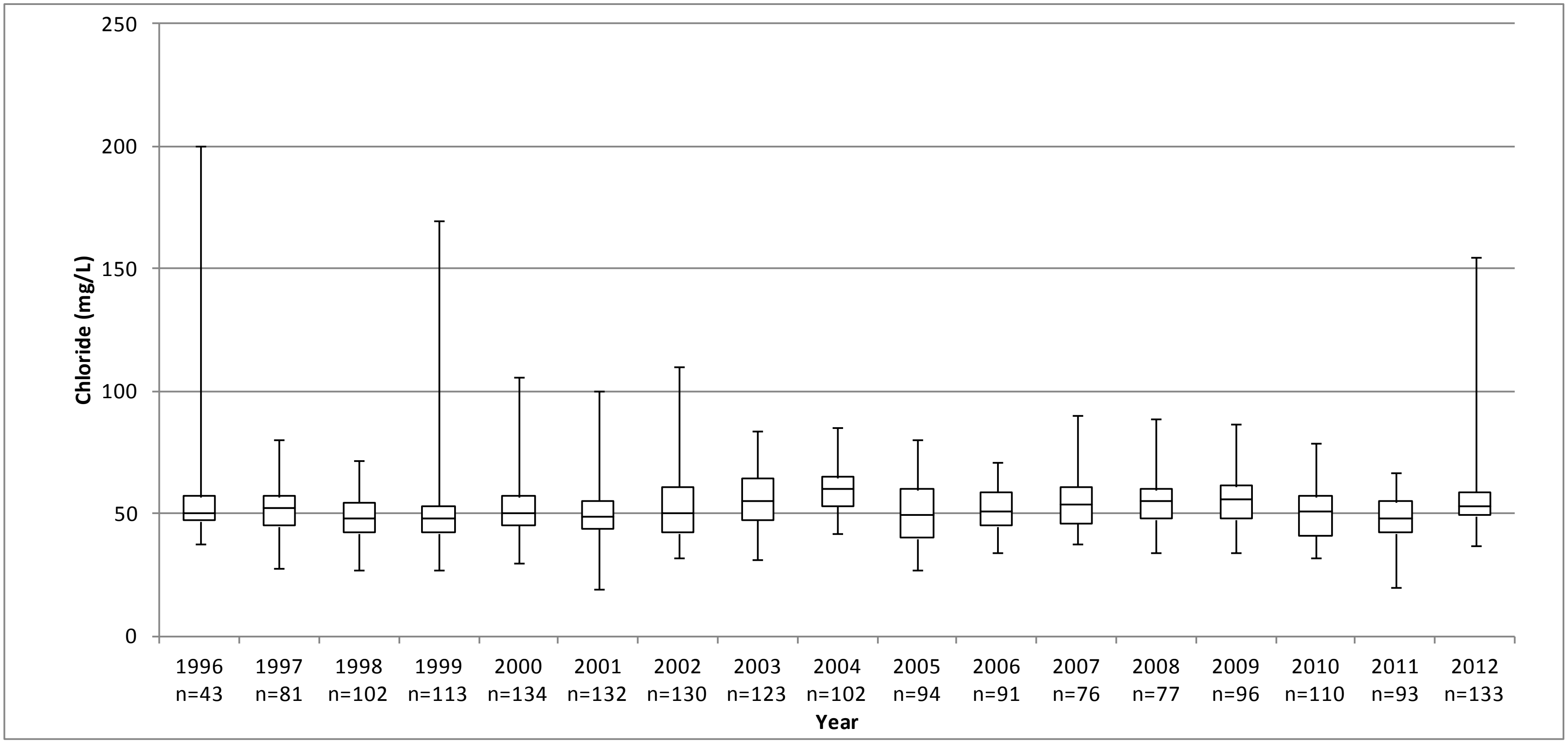
Appendix A Figure 8 Chloride Box and Whisker Plot for the Santa Paula Basin



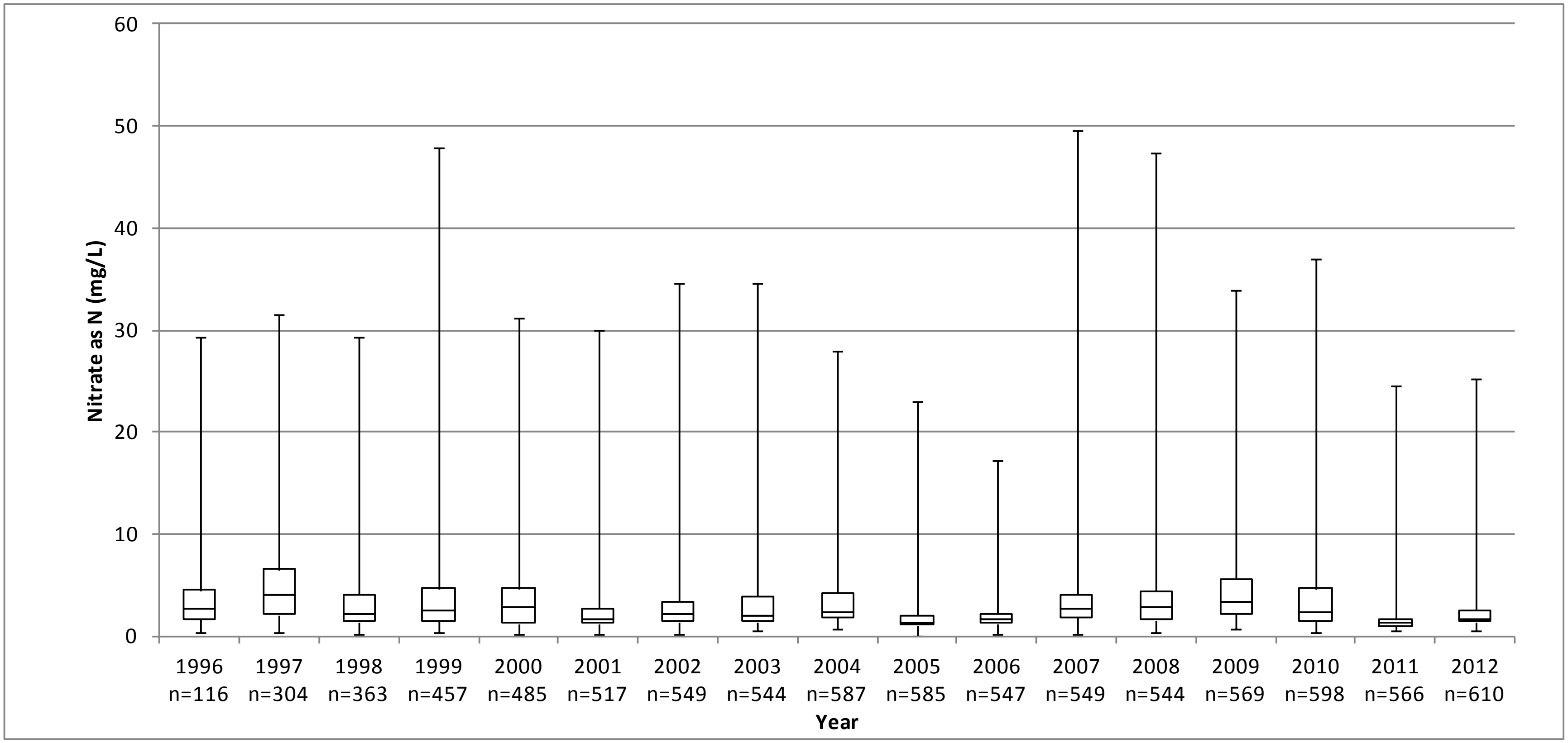
Appendix A Figure 9 Nitrate as N Box and Whisker Plot for the Santa Paula Basin



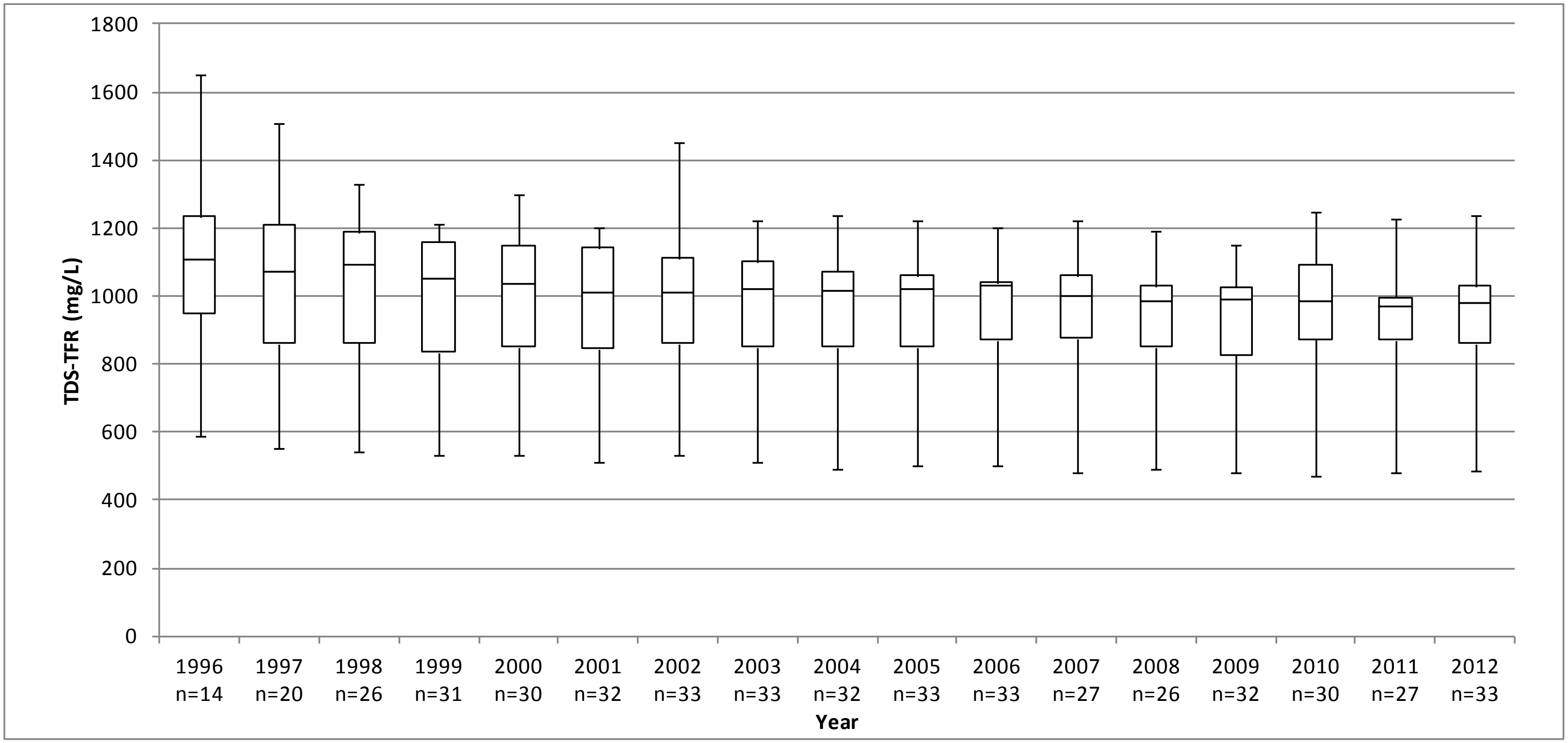
Appendix A Figure 10 TDS Box and Whisker Plot for the Upper Forebay Basin



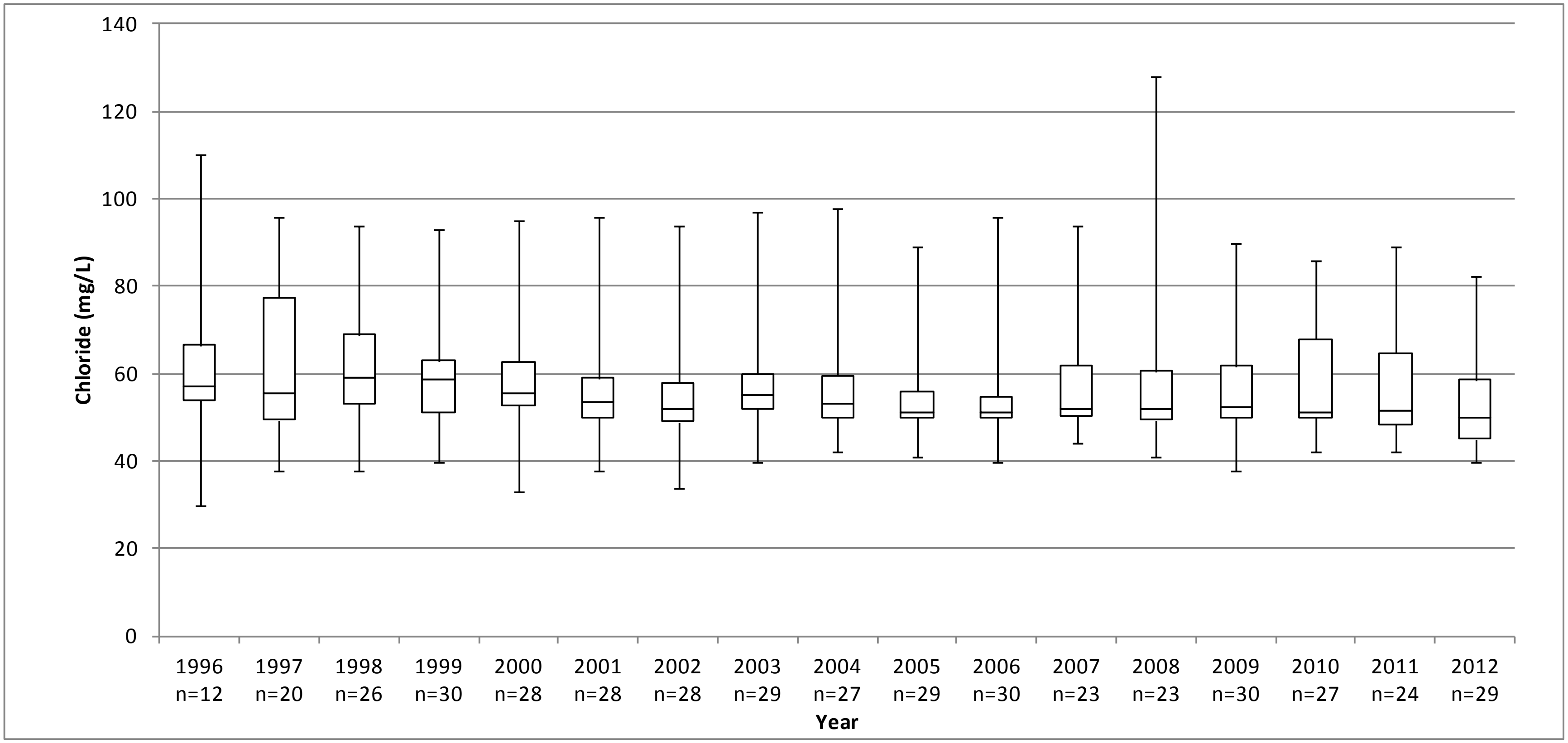
Appendix A Figure 11 Chloride Box and Whisker Plot for the Upper Forebay Basin



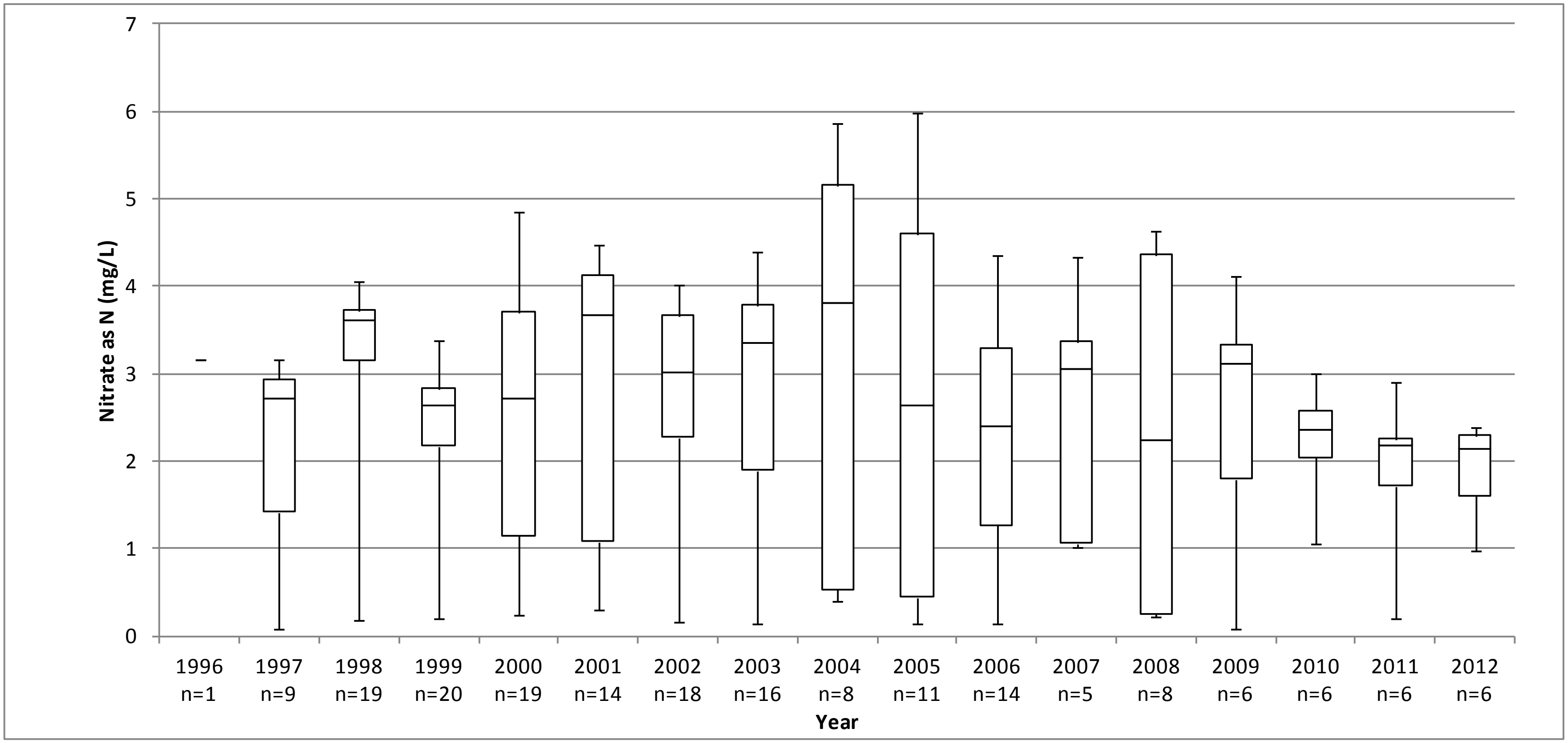
Appendix A Figure 12 Nitrate as N Box and Whisker Plot for the Upper Forebay Basin



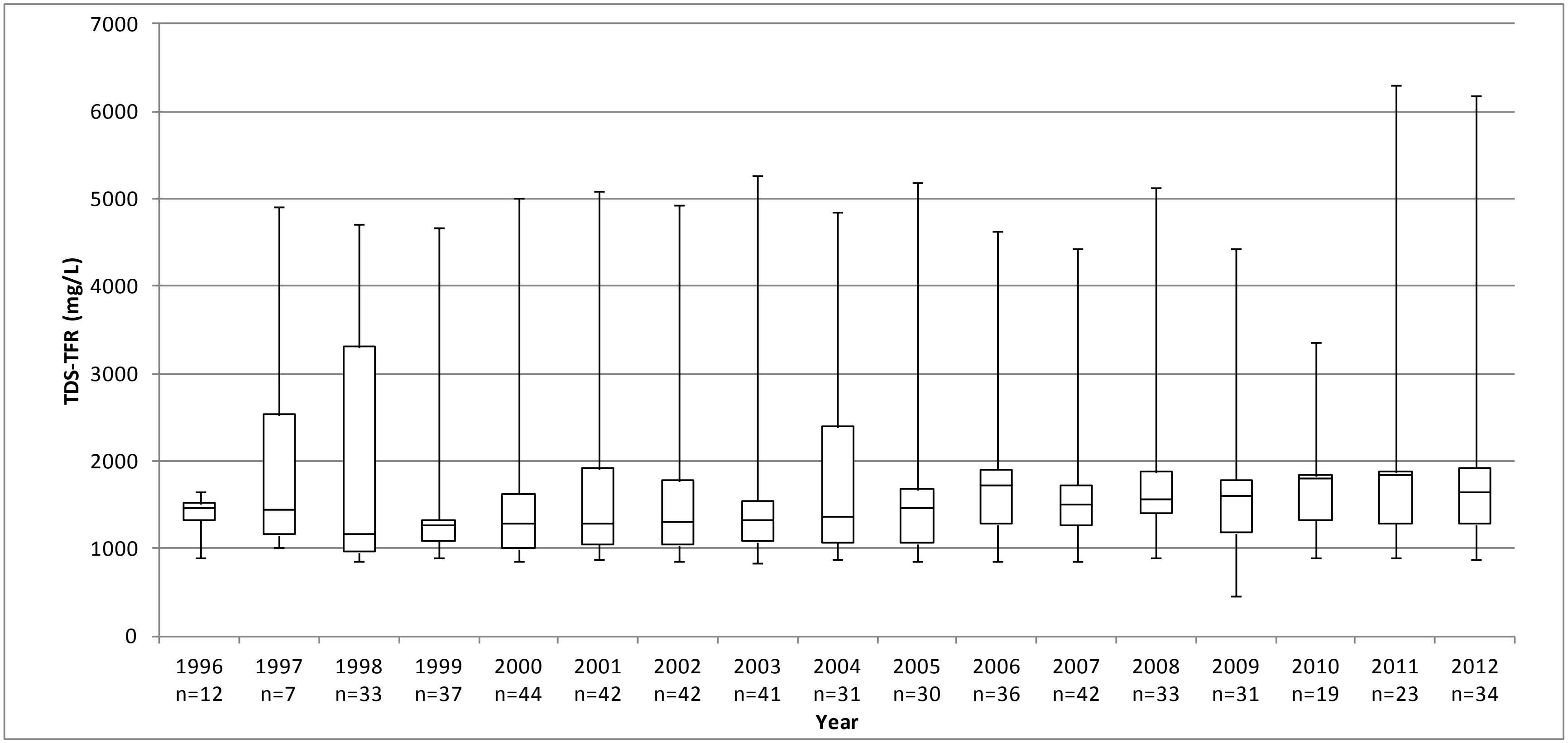
Appendix A Figure 13 TDS Box and Whisker Plot for the Lower Forebay Basin



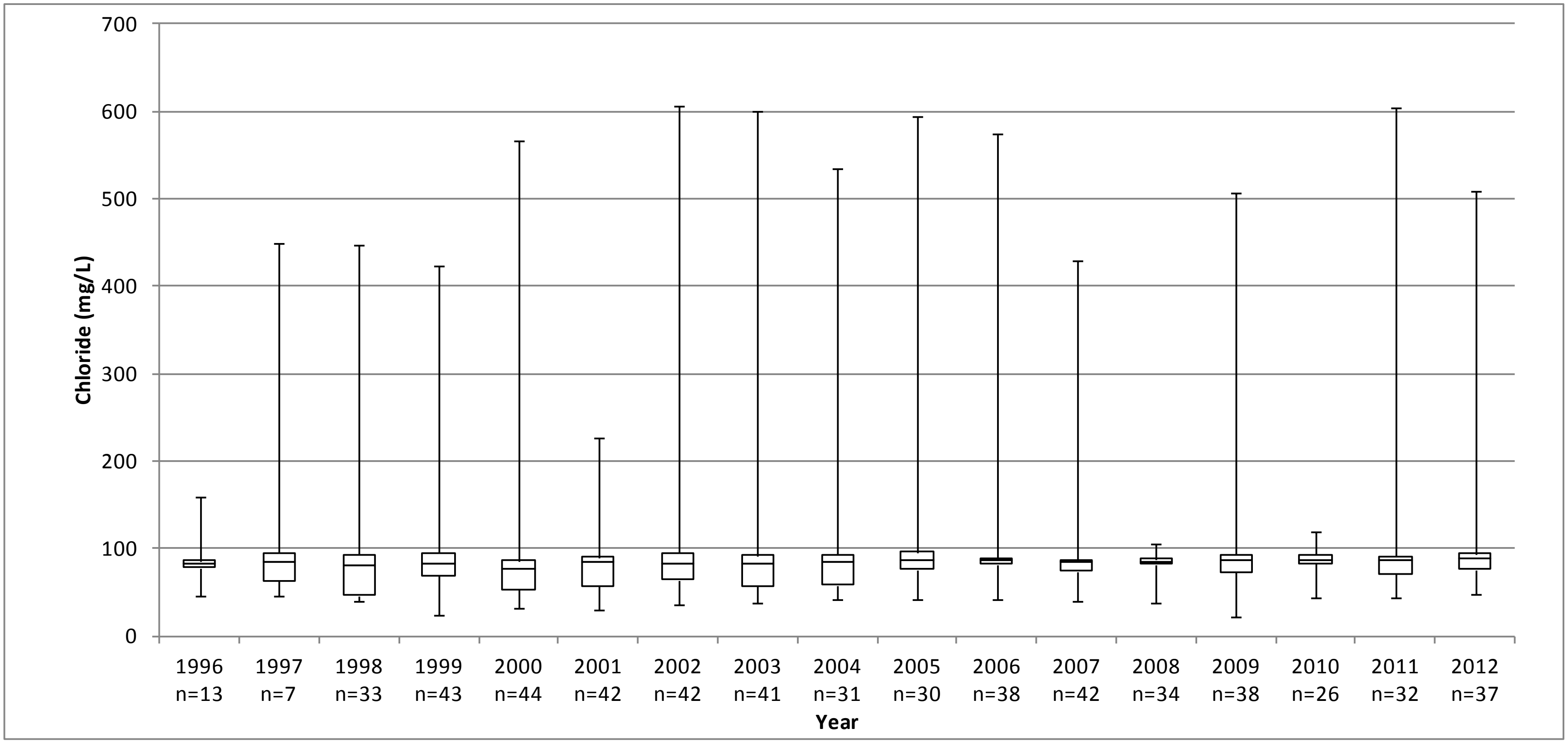
Appendix A Figure 14 Chloride Box and Whisker Plot for the Lower Forebay Basin



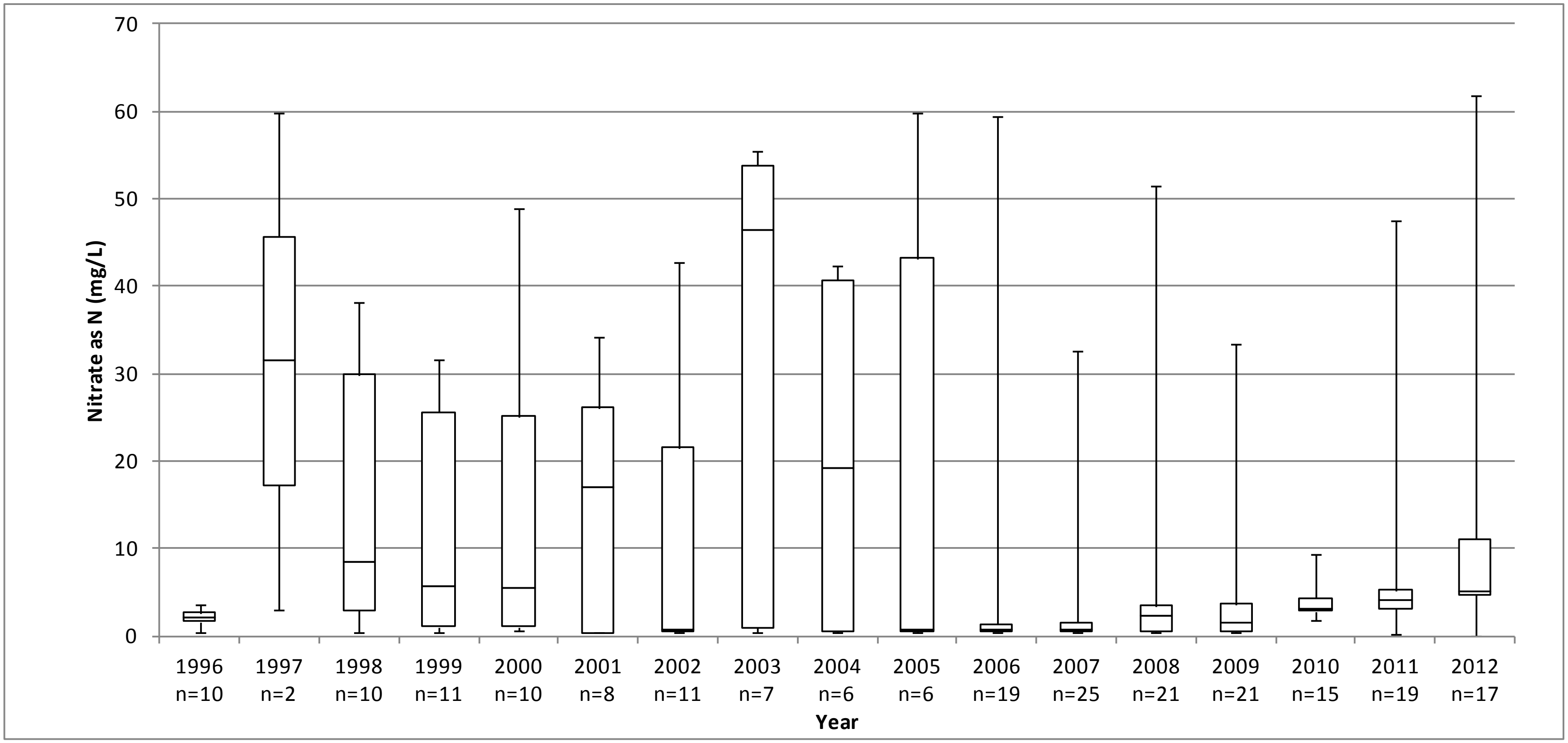
Appendix A Figure 15 Nitrate as N Box and Whisker Plot for the Lower Forebay Basin



Appendix A Figure 16 TDS Box and Whisker Plot for the Mound Basin



Appendix A Figure 17 Chloride Box and Whisker Plot for the Mound Basin



Appendix A Figure 18 Nitrate as N Box and Whisker Plot for the Mound Basin

Appendix B. Summary of Existing Monitoring Programs

Appendix B Table 1 Summary of Monitoring Programs in the Lower Santa Clara River SNMP Study Area

Data Type	Agency	Frequency	Parameter														No. of Locations	Program
			EC	TDS	Salinity	Cl^-	SO_4	B	Total N	Organic N	TKN	NH_3	NO_3	NO_2	NO_3 + NO_2	CECs		
Ground-water	Ventura County	Annually	■	■	■	■	■						■				Varies by year	Ventura County Groundwater Monitoring Program
Description: This program includes annual monitoring of groundwater wells for the purposes of groundwater resource assessment and management. The number of wells varies annually. For example in 2011 and 2012 there were 199 and 168 wells sampled throughout the County, respectively.																		
Ground-water	UWCD	Quarterly	■	■		■	■	■*					■				61	UWCD Water Quality Monitoring Program
Ground-water	UWCD	Semi-Annually	■	■		■	■	■*					■				33	UWCD Water Quality Monitoring Program
Description: UWCD conducts water quality monitoring of production wells and dedicated monitoring wells. In addition, UWCD uses groundwater monitoring data collected by Ventura County and water purveyors (data submitted to CPDH) to characterize groundwater quality within the District. In the Piru and Fillmore Basins the monitoring and production wells are sampled quarterly and semi-annually, respectively. In the Santa Paula Basin both the monitoring and production wells are sampled semi-annually. In the Mound Basin, the monitoring wells are sampled semi-annually, and no production wells are sampled. In the Forebay both the monitoring and production wells are generally sampled quarterly. The 11 new monitoring wells in the Forebay are sampled annually. *For the quarterly sampling events, an abbreviated suite of general minerals are analyzed twice per year. For the semi-annual sampling events, an abbreviated suite of general minerals are analyzed once per year. The abbreviated suite of general minerals does not include boron.																		
Ground-water	City of Santa Paula	Quarterly		■		■	■	■				■	■	■			3	WWTP WDR Monitoring requirements
Description: The City samples upgradient and downgradient of percolation ponds.																		
Ground-water	City of Santa Paula	Annually											■				5	CDPH Monitoring Requirements
Ground-water	City of Santa Paula	Other - Every 3 Years	■	■		■	■							■			5	CDPH Monitoring Requirements
Description: The City conducts water quality monitoring of raw groundwater from their potable water supply wells.																		
Ground-water	City of Fillmore	Semi-Annually		■		■	■	■				■	■	■			3	WWTP WDR Monitoring requirements
Description: The City samples upgradient and downgradient of percolation ponds																		

Appendix B Table 1 Summary of Monitoring Programs in the Lower Santa Clara River SNMP Study Area

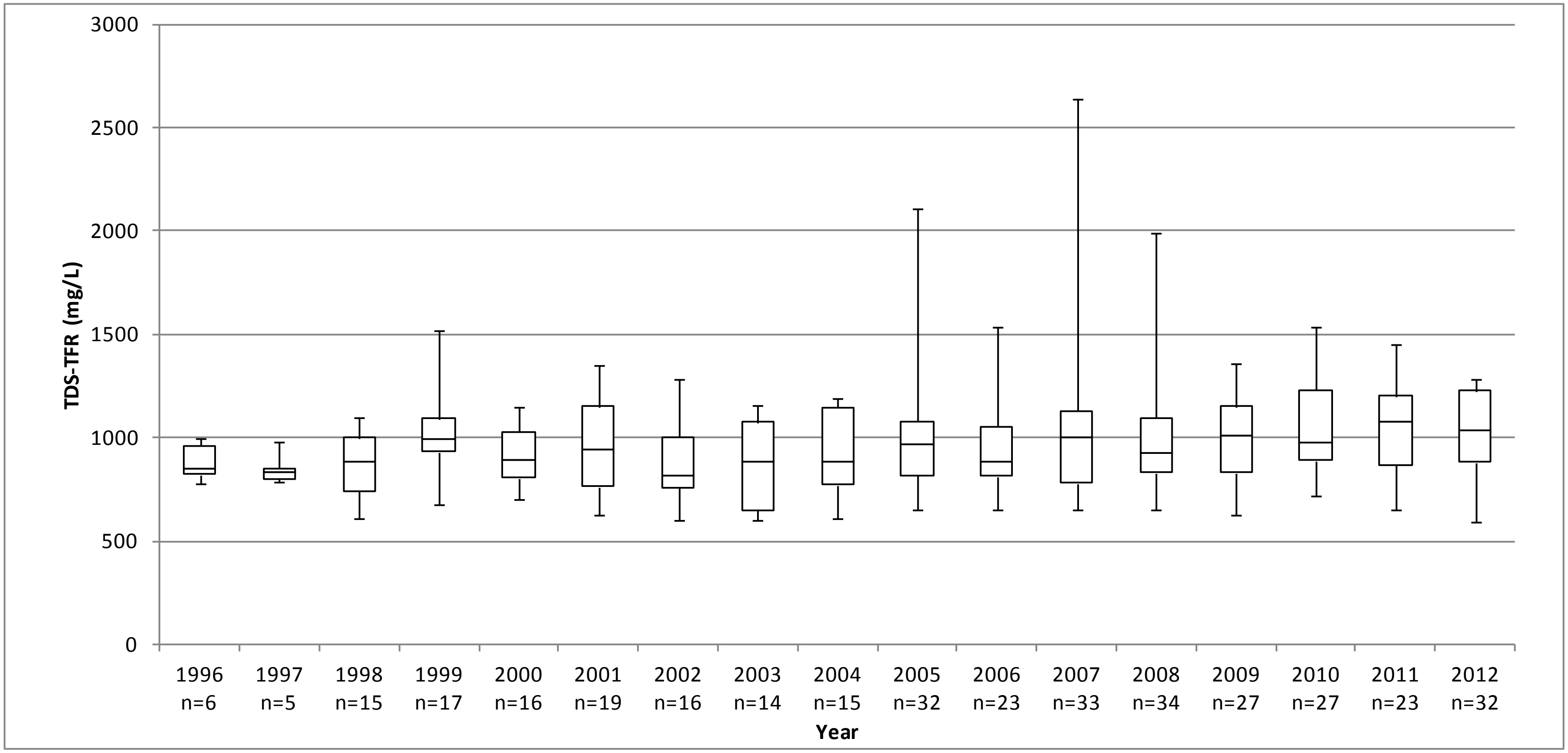
Data Type	Agency	Frequency	Parameter														No. of Locations	Program
			EC	TDS	Salinity	Cl^-	SO_4	B	Total N	Organic N	TKN	NH_3	NO_3	NO_2	NO_3 + NO_2	CECs		
Ground-water	City of Fillmore	Annually											■				3	CDPH Monitoring Requirements
		Other - Every 3 Years	■	■		■	■							■				
Description: The City conducts water quality monitoring of raw groundwater from their potable water supply wells																		
Ground-water	Ventura County Water Works	Quarterly		■		■	■	■		■		■	■	■			4	WWTP WDR Monitoring requirements
Description: The County conducts sampling from wells upgradient and downgradient of percolation ponds.																		
Ground-water	City of Ventura	Annually											■				6	CDPH Monitoring Requirements
		Other - Every 3 Years	■	■		■	■							■				
Description: The City conducts water quality monitoring of raw groundwater from their potable water supply wells.																		
Surface Water	UWCD	Quarterly	■	■		■	■	■*					■				5	UWCD Water Quality Monitoring Program
		Quarterly	■	■		■	■	■					■				7	
		Other	■	■		■	■	■**					■				2	
Description: UWCD conducts water quality monitoring of the Santa Clara River and tributaries. *For the quarterly sampling events, an abbreviated suite of general minerals are analyzed twice per year. The abbreviated suite of general minerals does not include boron. ** At two locations monitoring is conducted more frequently than quarterly. At Newhall Crossing, the general minerals suite (includes boron) is measured quarterly, and an abbreviated suite of minerals is measured on a monthly basis. At Freeman diversion, the general minerals suite (includes boron) is measured quarterly, and an abbreviated suite of minerals does not include boron) is measured twice per month.																		
Surface Water	City of Ventura	Weekly			■												5	WWTP NPDES Permit Monitoring Requirements
		Monthly								■	■	■	■	■			5	
Description: Upstream and downstream of WWTP discharge																		

Appendix B Table 1 Summary of Monitoring Programs in the Lower Santa Clara River SNMP Study Area

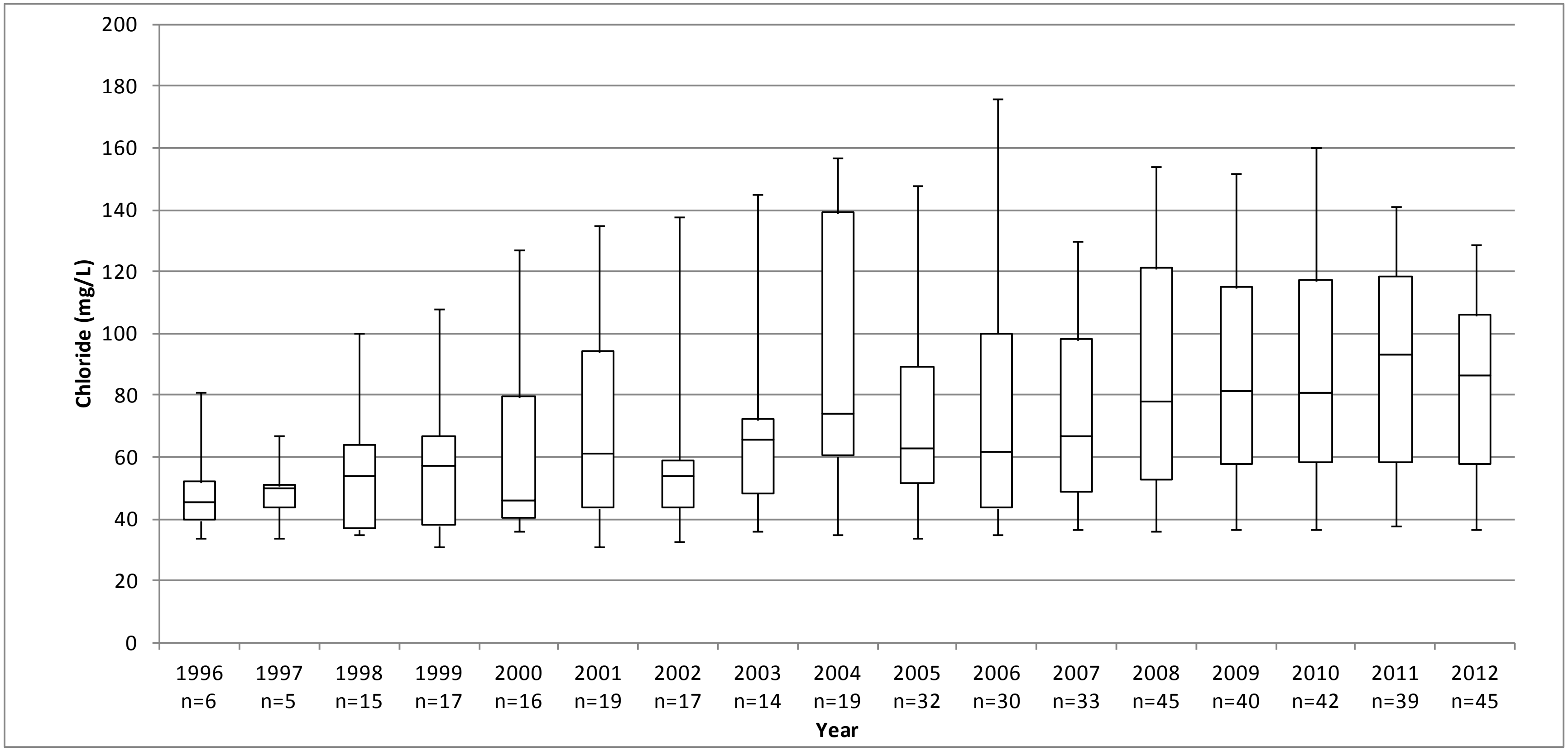
Data Type	Agency	Frequency	Parameter														No. of Locations	Program
			EC	TDS	Salinity	Cl^-	SO_4	B	Total N	Organic N	TKN	NH_3	NO_3	NO_2	$NO_3 + NO_2$	CECs		
Surface Water	VCAILG	Other - 1 to 2 dry events, and 1-2 wet events per year	■	■		■	■					■	■				7-8	Conditional Waiver of Waste Discharge Requirements for discharges from Irrigated Lands within the Los Angeles Region
Description: The VCAILG conducts monitoring per the requirements of the conditional waiver. Monitoring locations include several tributaries to the Santa Clara River, on agricultural drainage ditch and one background site.																		
Surface Water/ Storm-water	Ventura County	Annually	■		■	■		■			■	■			■		4	SCCWRP Bioassessment Study
Description: This 5-year bioassessment study is complete. The monitoring program for this study included water quality analyses at the monitoring locations. The 4 monitoring locations varied over the 5 year monitoring program. It is unknown if additional monitoring will be conducted in the future .																		
Surface Water/ Storm-water	Ventura County	Other	■	■	■			■			■	■			■		5	Ventura County Stormwater Quality Management Program
Description: This program includes monitoring of mass emissions stations and major outfalls. Within the project study area there is one mass emission station, Santa Clara River, and 4 major outfall stations. The mass emission and major outfall stations are monitored 4 times per year, 3 wet events and 1 dry event.																		

Appendix A. Box and Whisker Plots

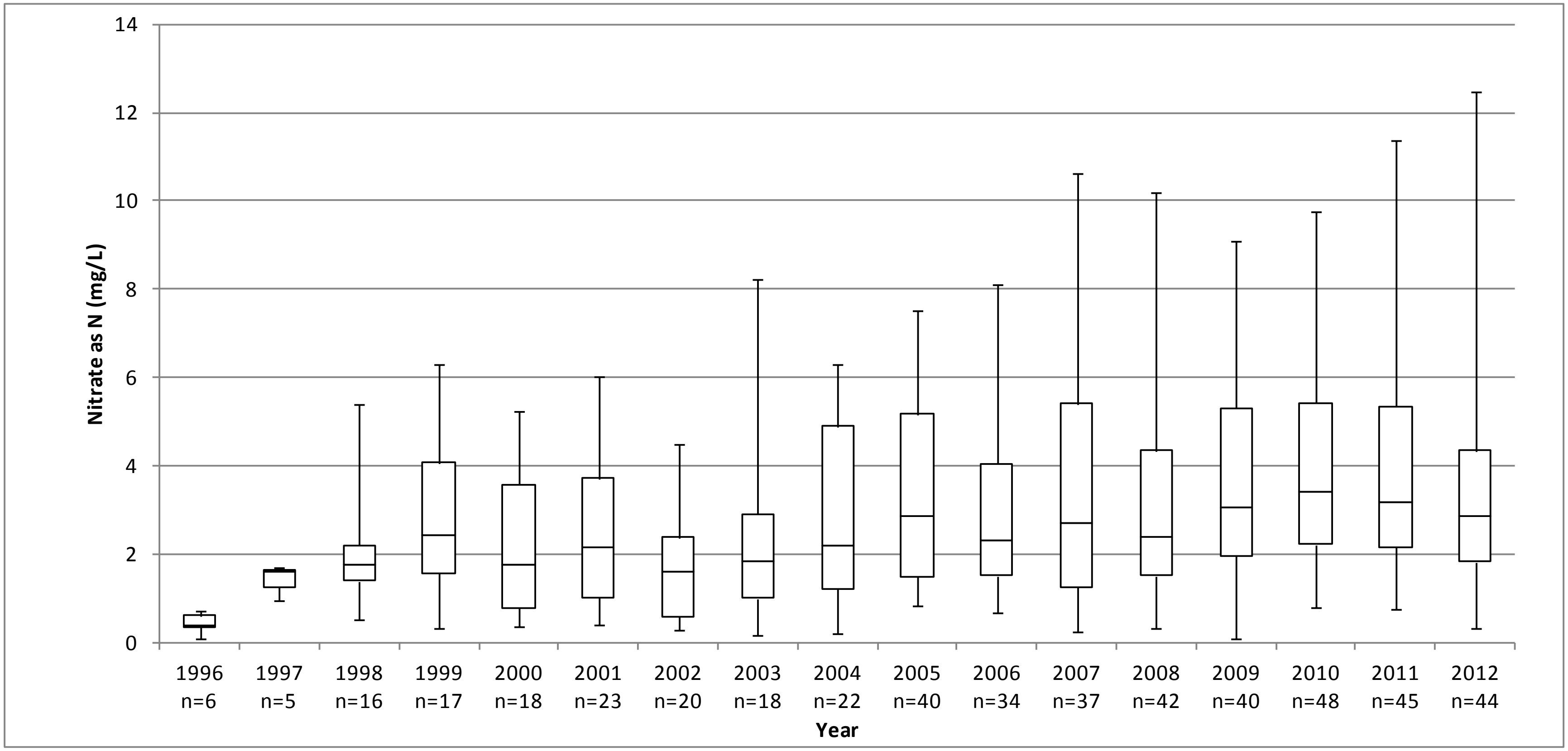
Box and Whisker Plots are provided for data available from most groundwater wells in the LSCR planning area, including data not used in the analyses presented in the SNMP, including data for wells with limited data sets and data points determined to be outliers. Data from groundwater wells associated with WWTP percolation ponds is not included in the plots. See **Section 4** for a discussion of the data used for the analyses.



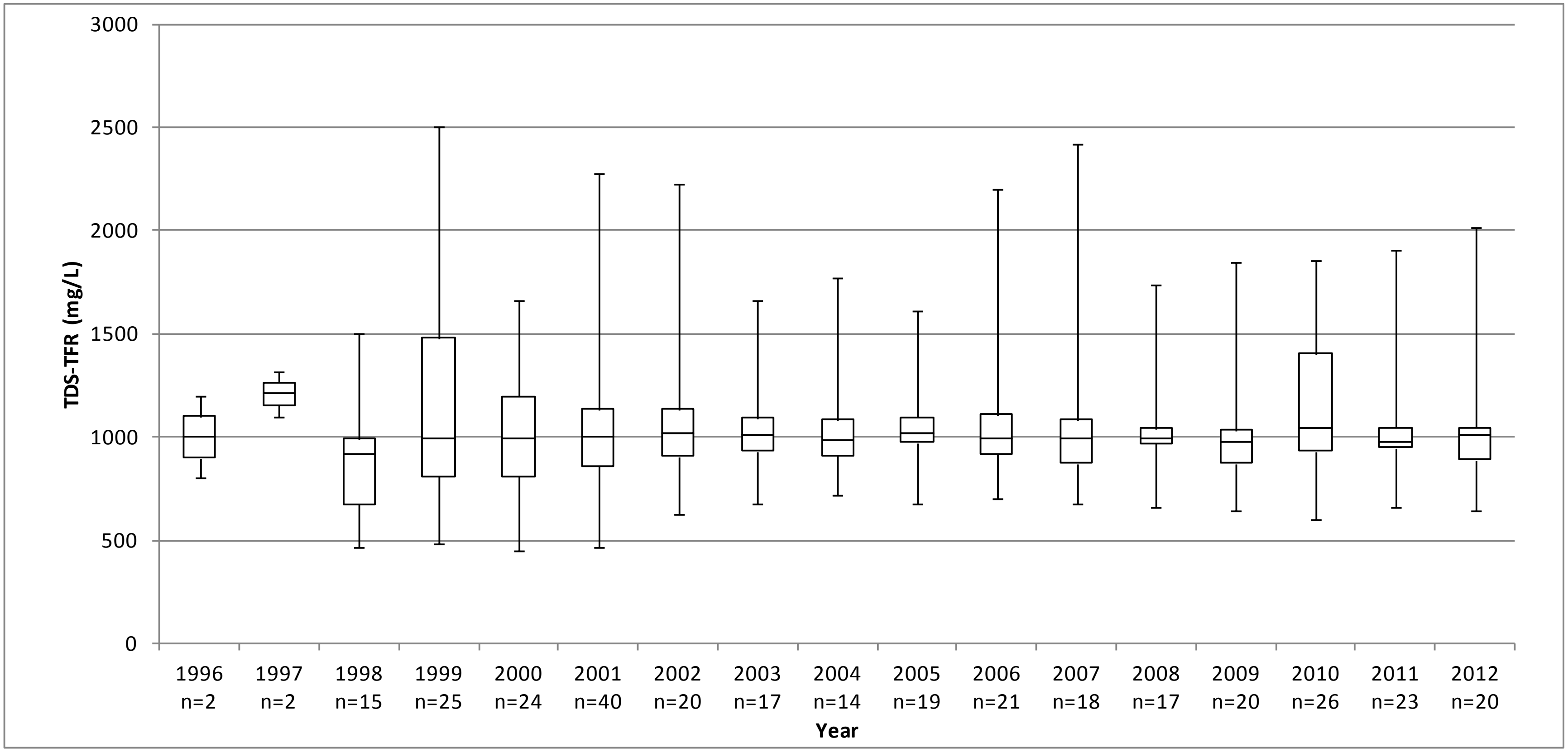
Appendix A Figure 1 TDS Box and Whisker Plot for the Piru Basin



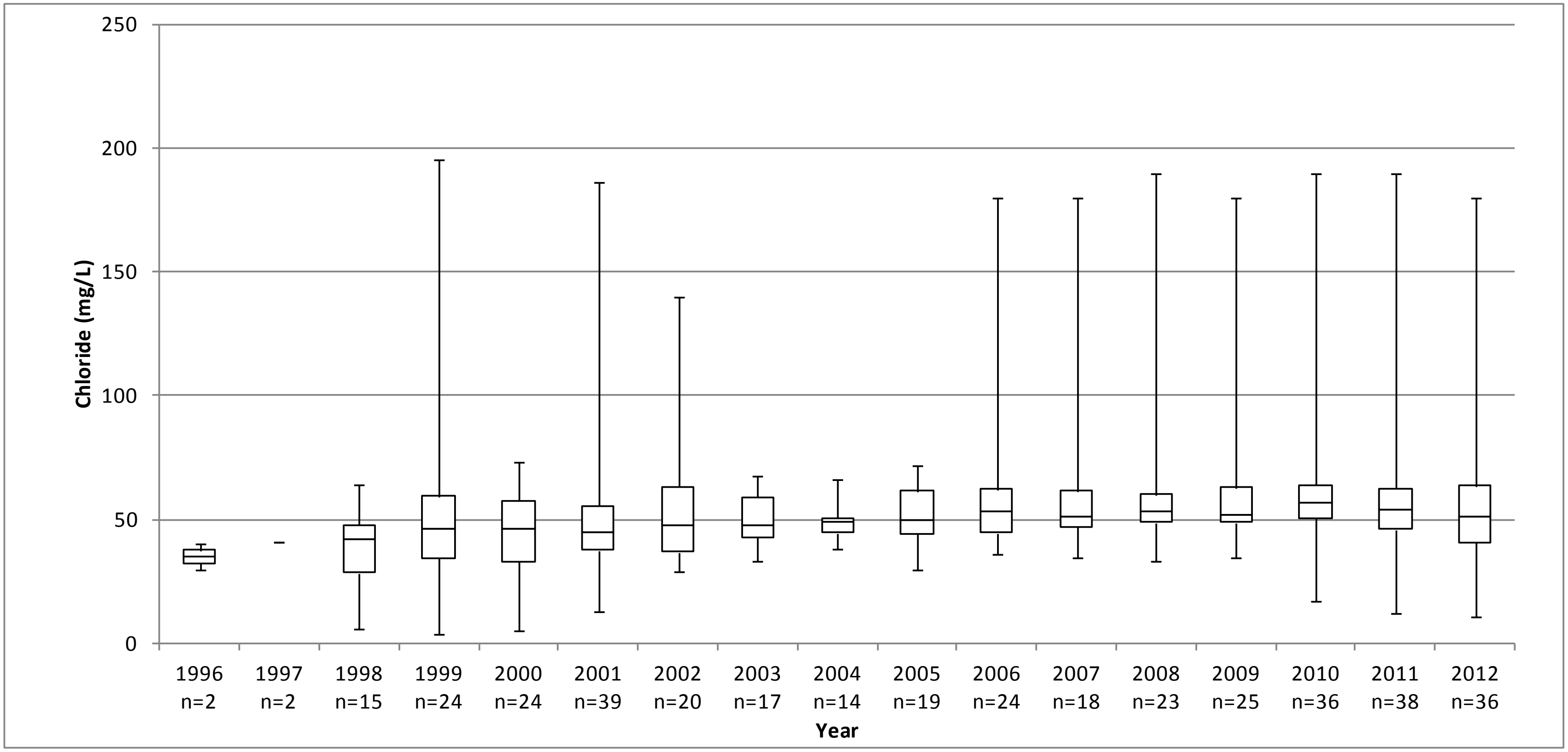
Appendix A Figure 2 Chloride Box and Whisker Plot for the Piru Basin



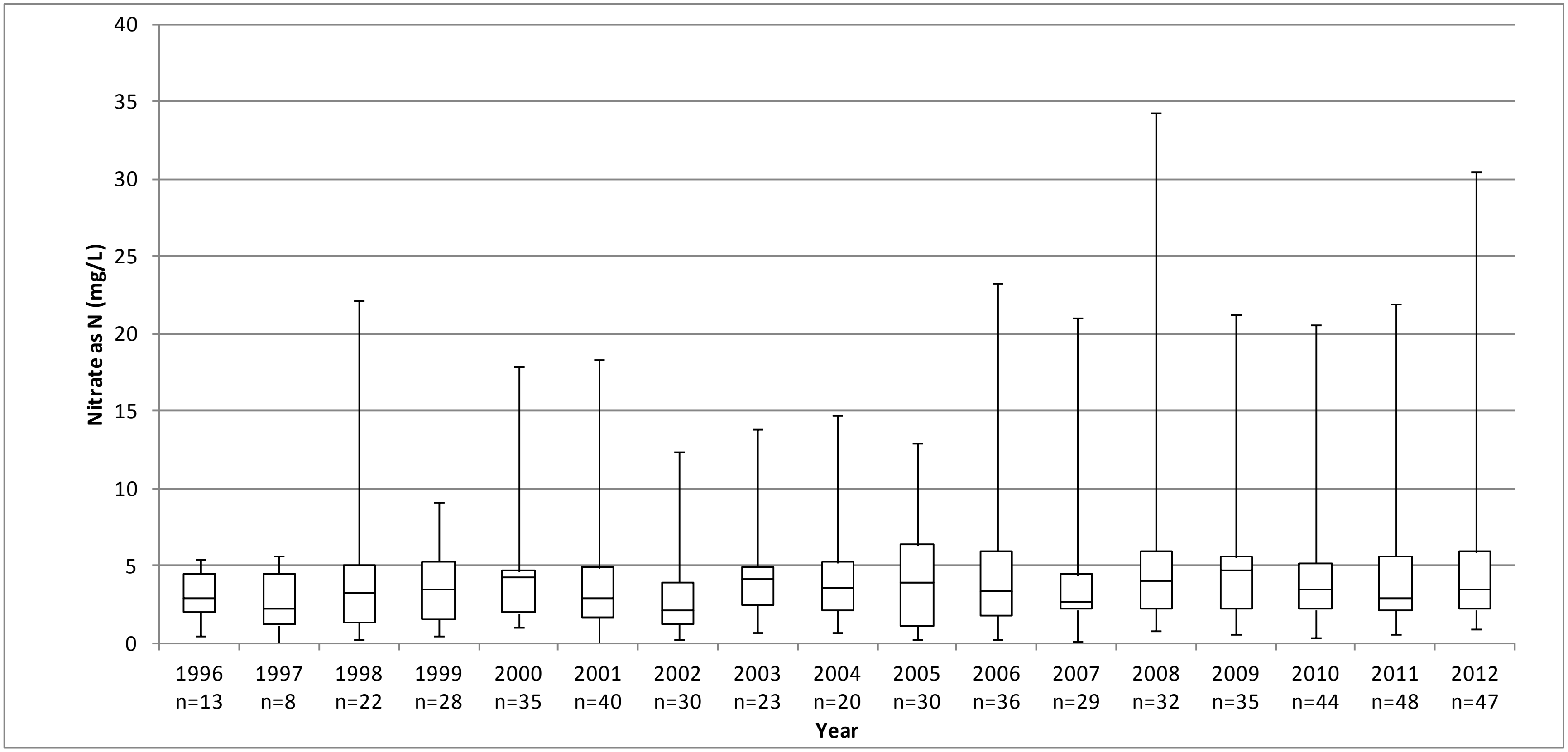
Appendix A Figure 3 Nitrate as N Box and Whisker Plot for the Piru Basin



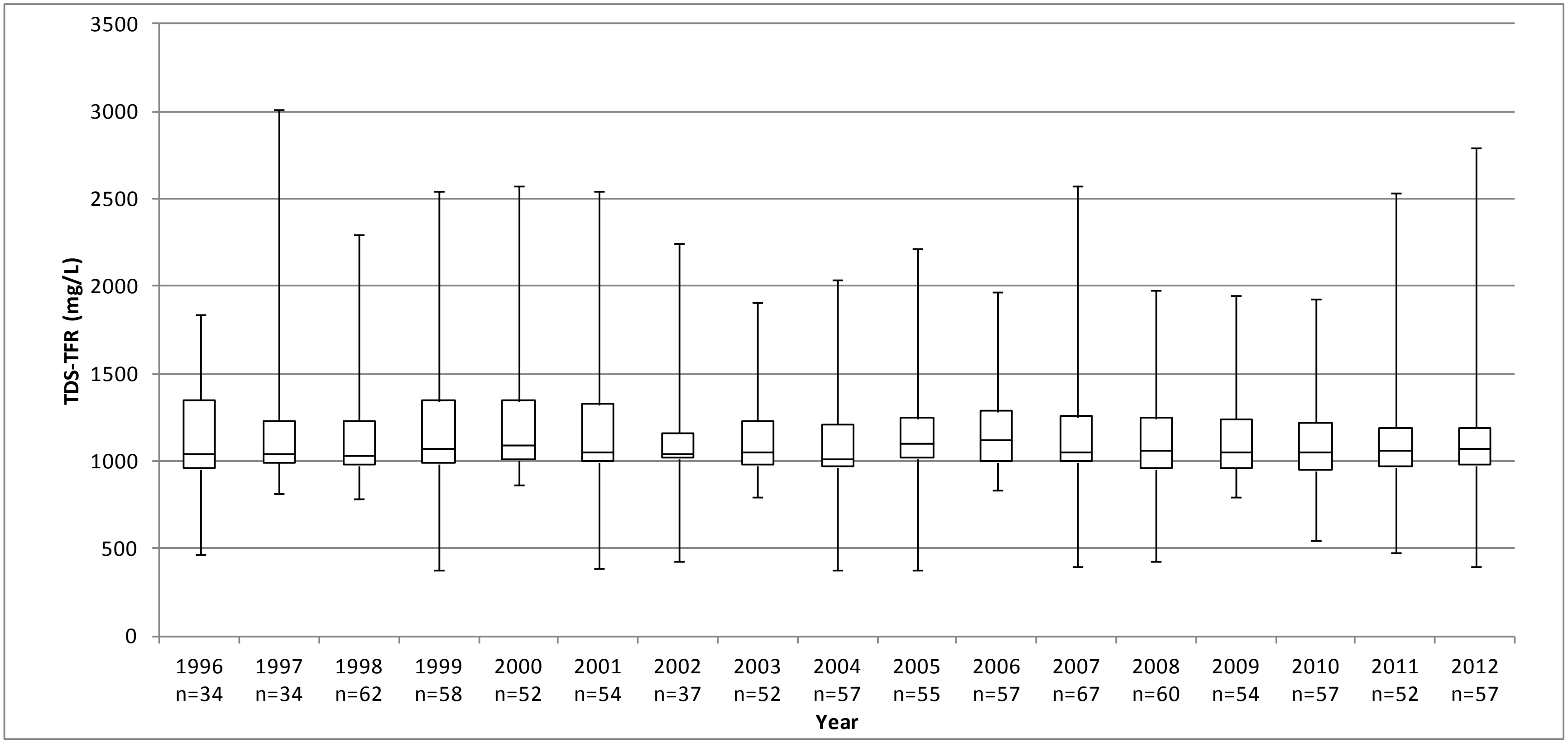
Appendix A Figure 4 TDS Box and Whisker Plot for the Fillmore Basin



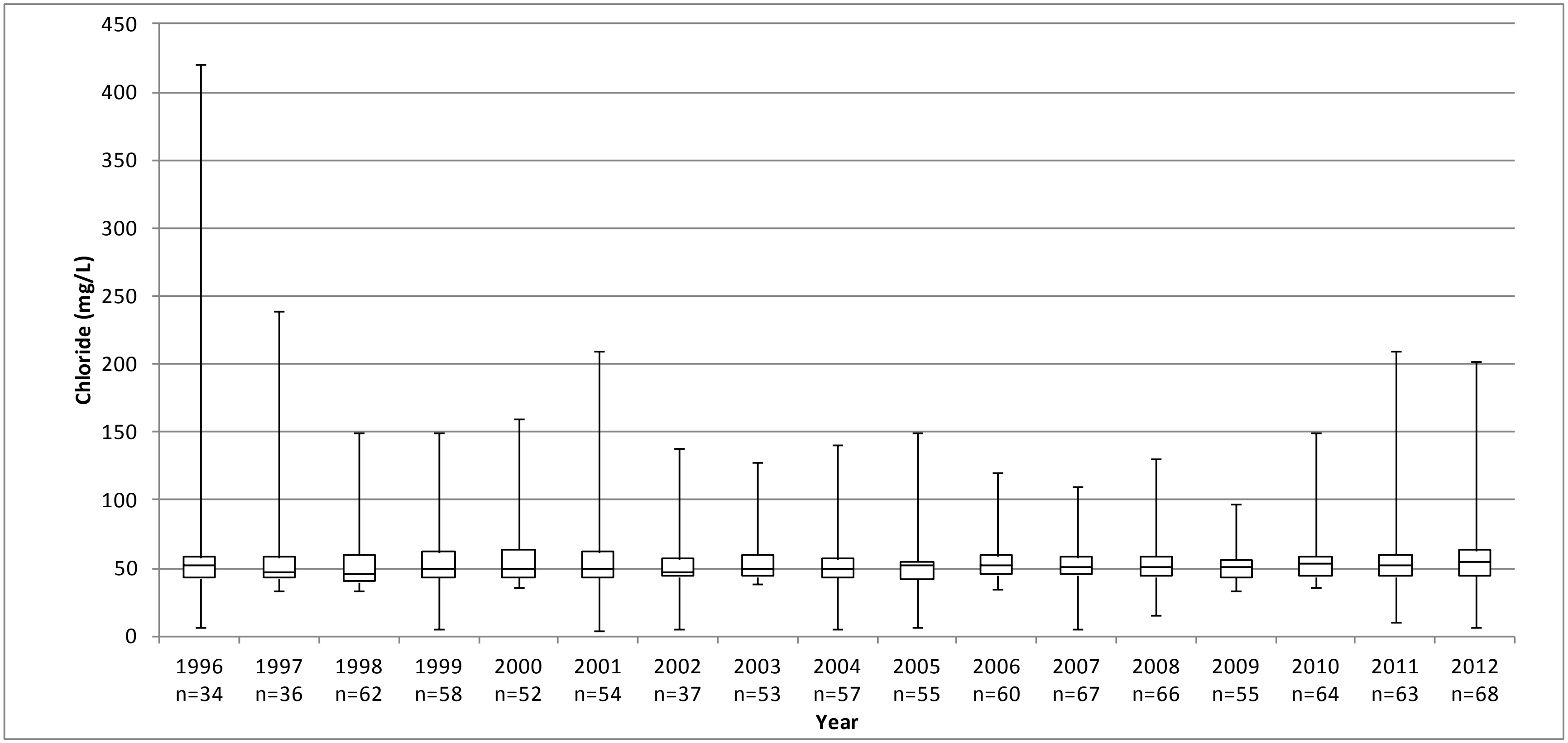
Appendix A Figure 5 Chloride Box and Whisker Plot for the Fillmore Basin



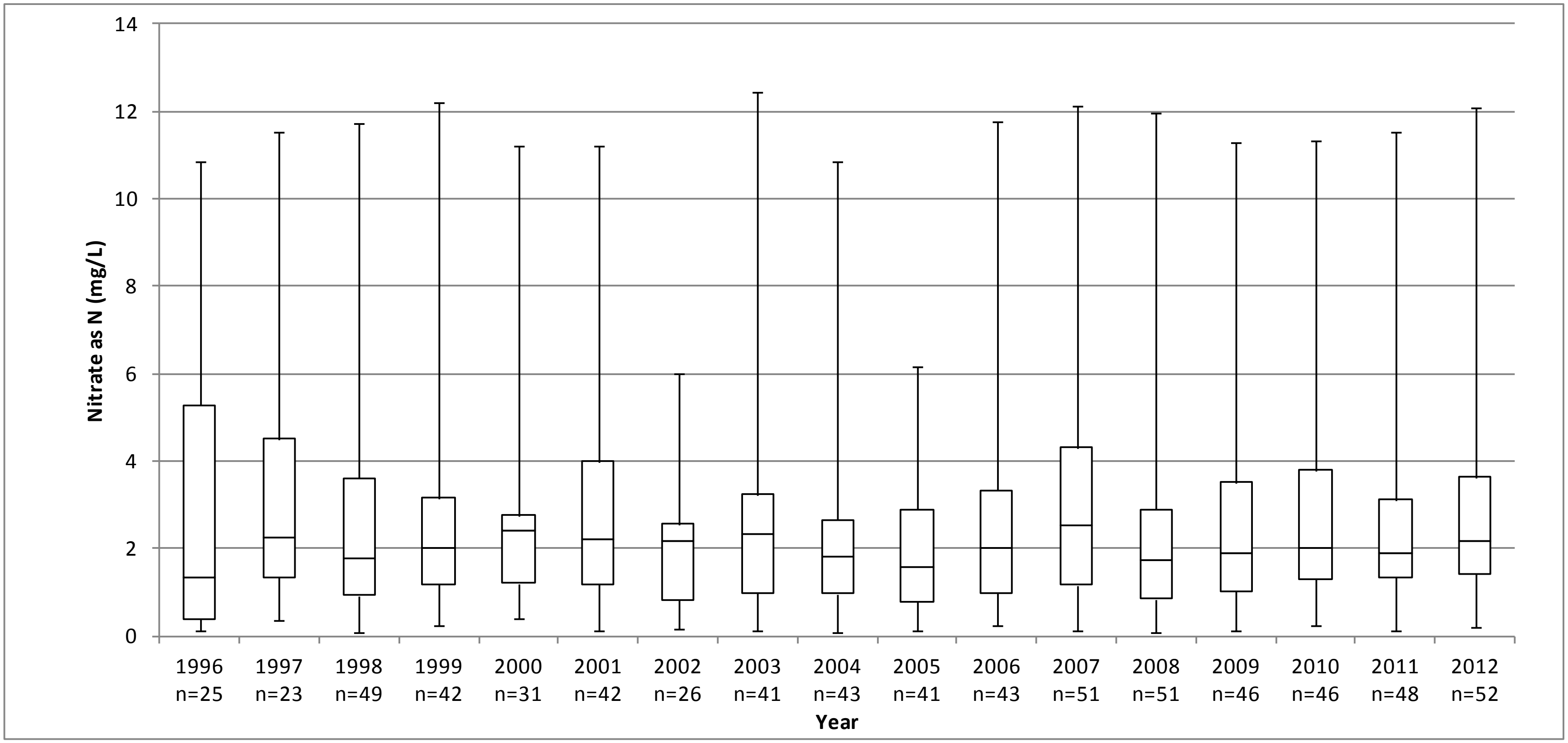
Appendix A Figure 6 Nitrate as N Box and Whisker Plot for the Fillmore Basin



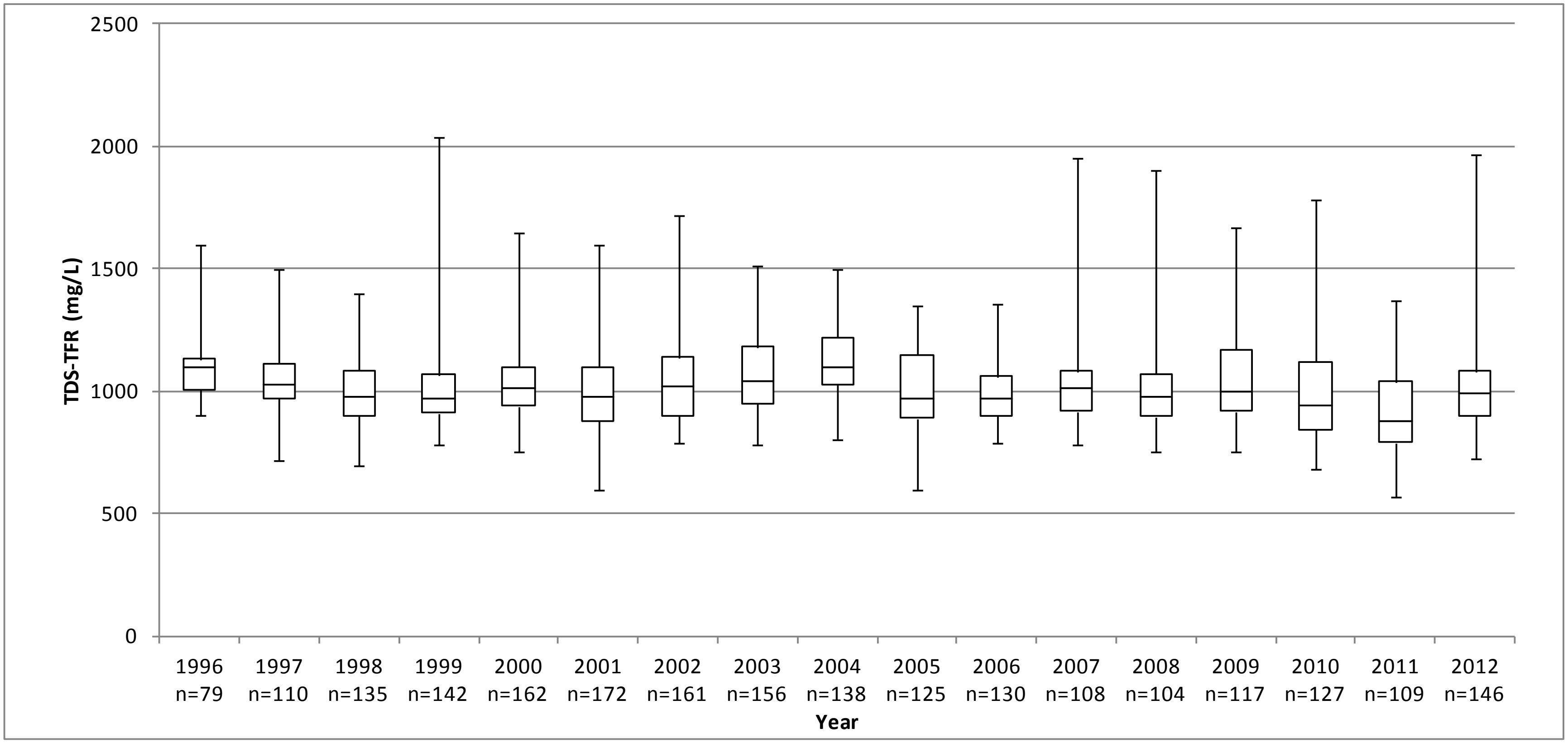
Appendix A Figure 7 TDS Box and Whisker Plot for the Santa Paula Basin



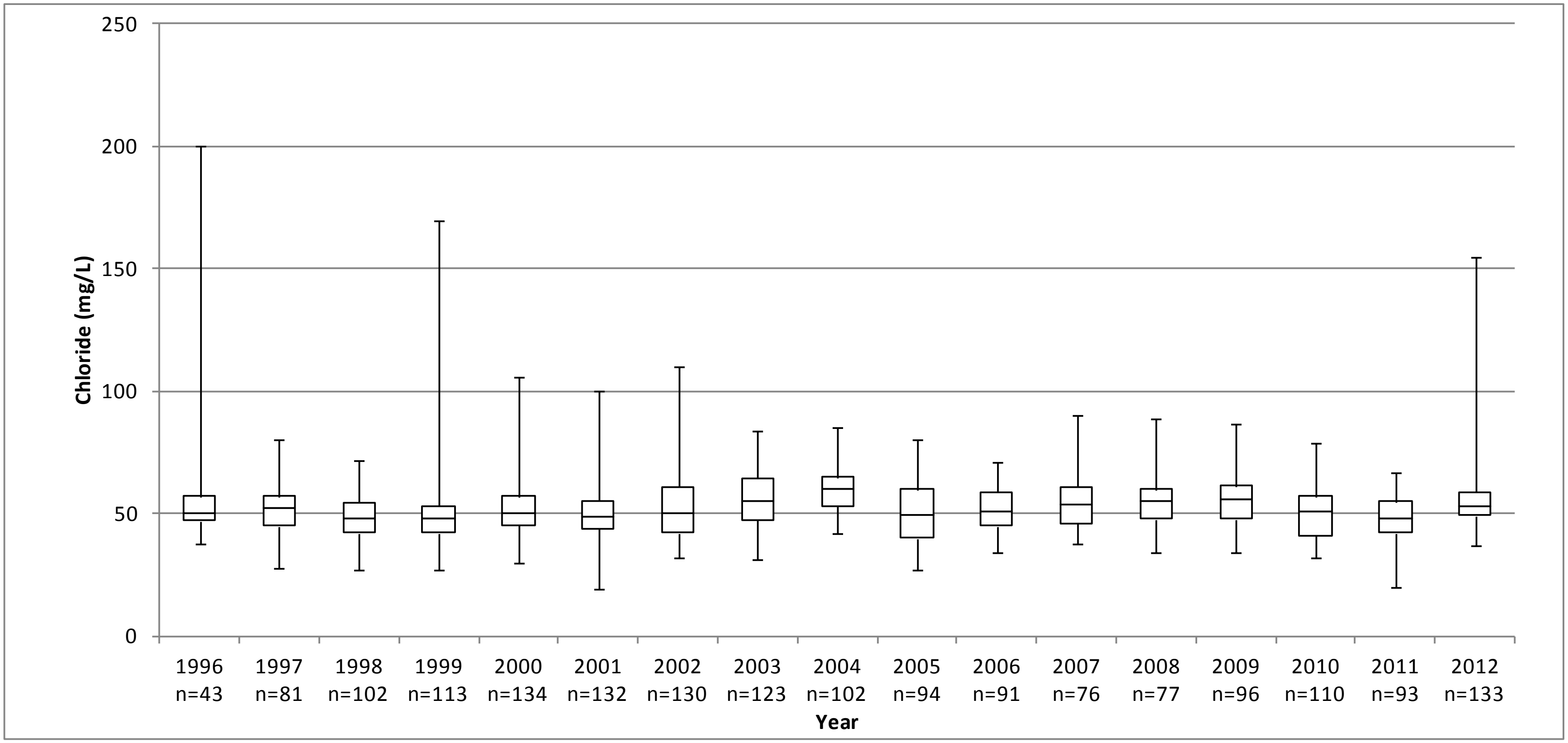
Appendix A Figure 8 Chloride Box and Whisker Plot for the Santa Paula Basin



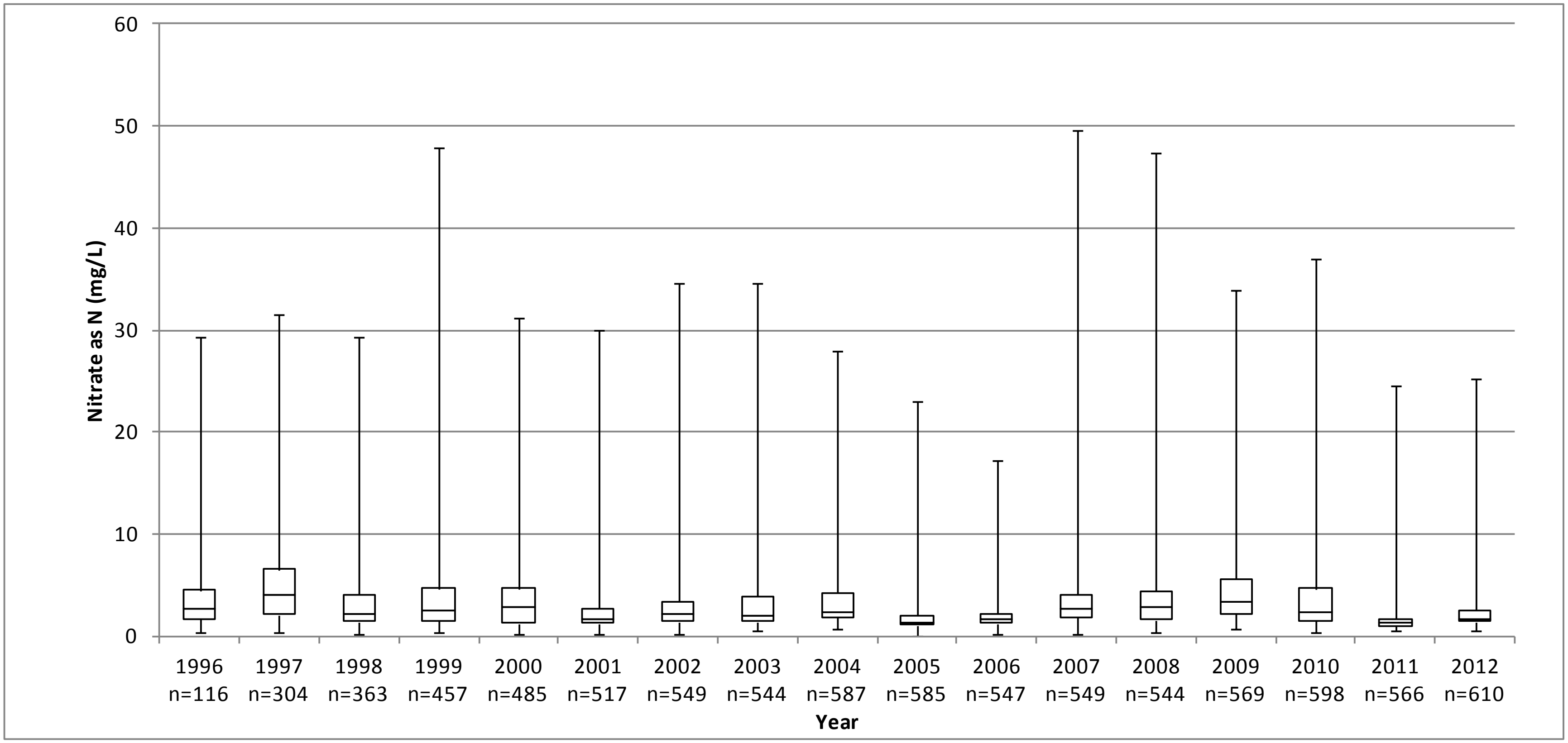
Appendix A Figure 9 Nitrate as N Box and Whisker Plot for the Santa Paula Basin



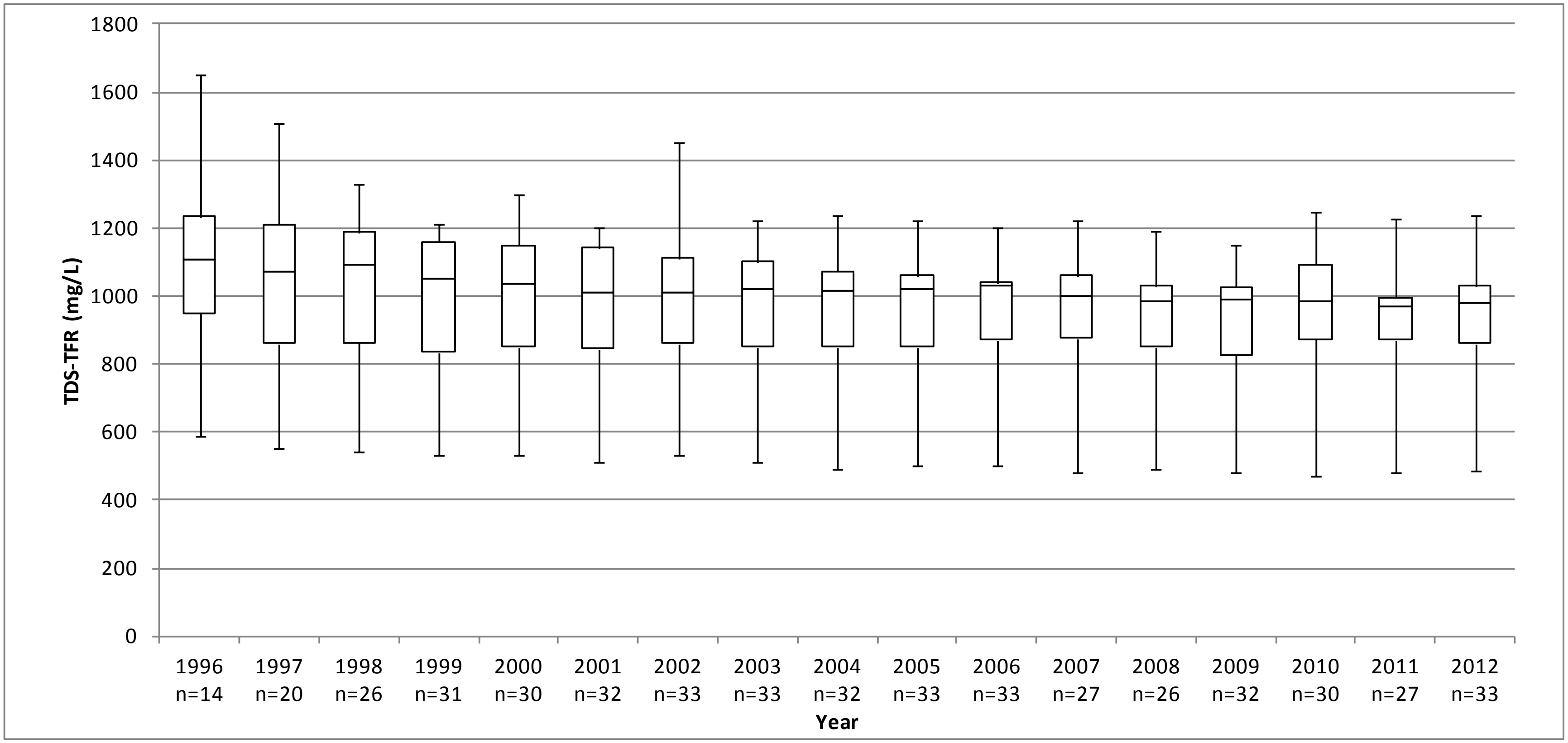
Appendix A Figure 10 TDS Box and Whisker Plot for the Upper Forebay Basin



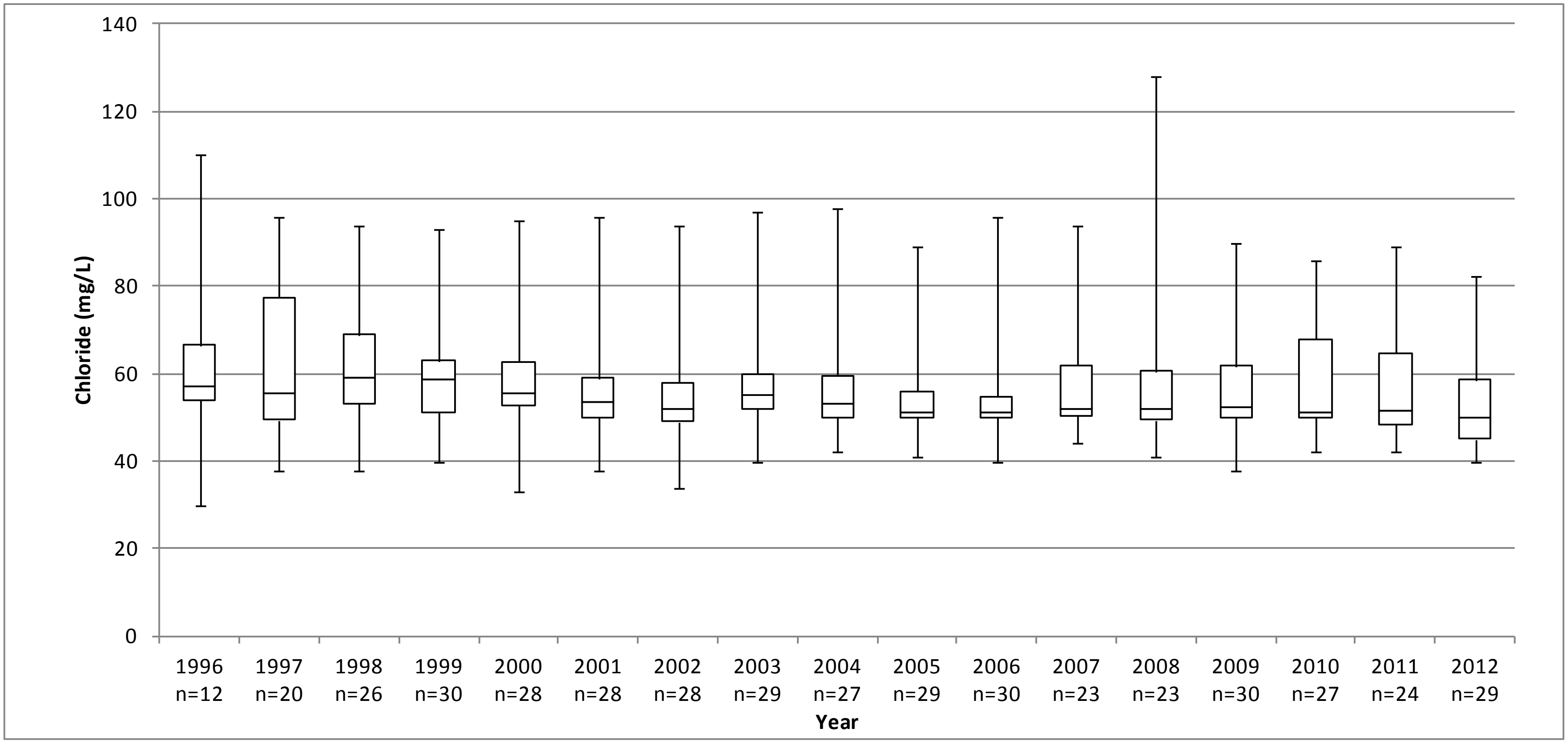
Appendix A Figure 11 Chloride Box and Whisker Plot for the Upper Forebay Basin



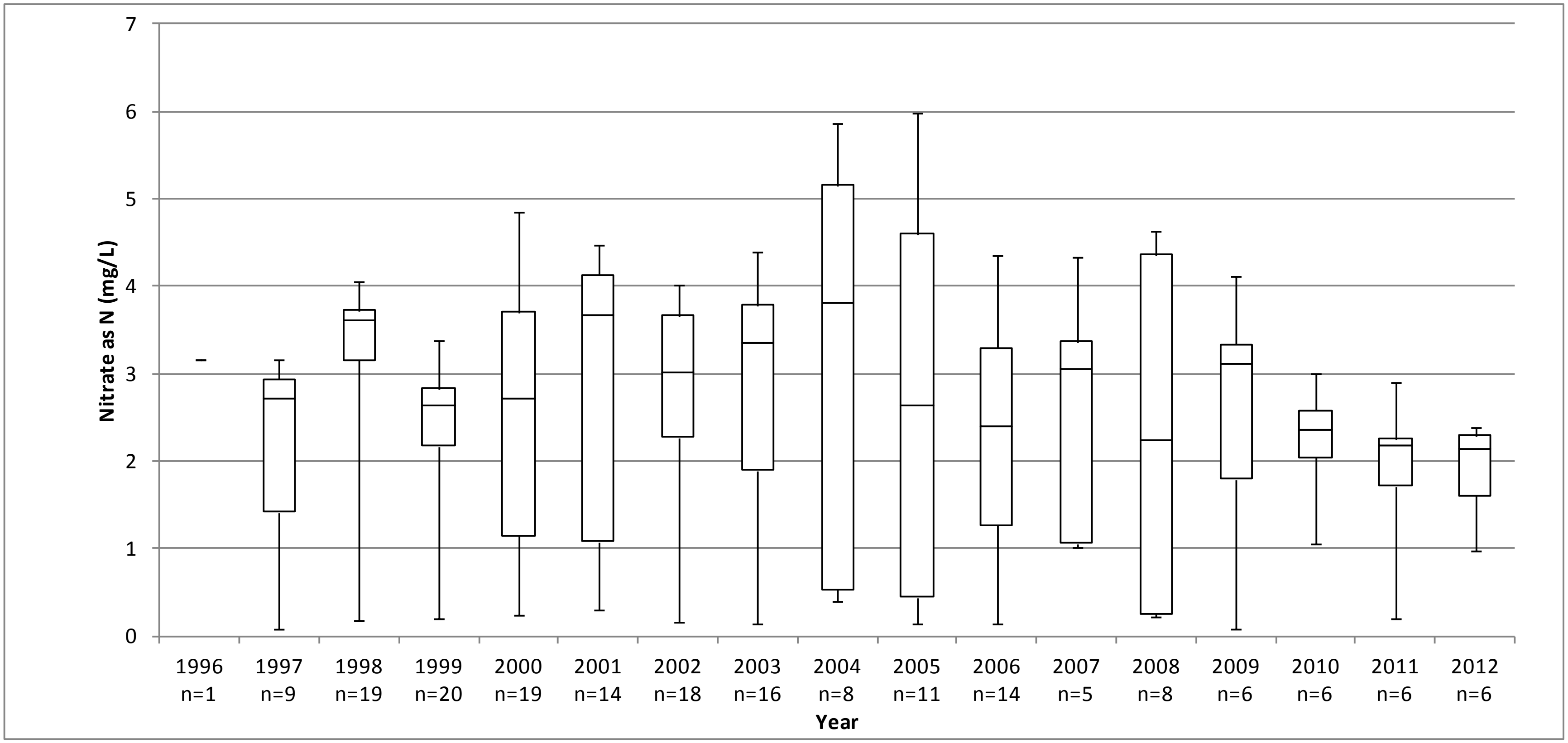
Appendix A Figure 12 Nitrate as N Box and Whisker Plot for the Upper Forebay Basin



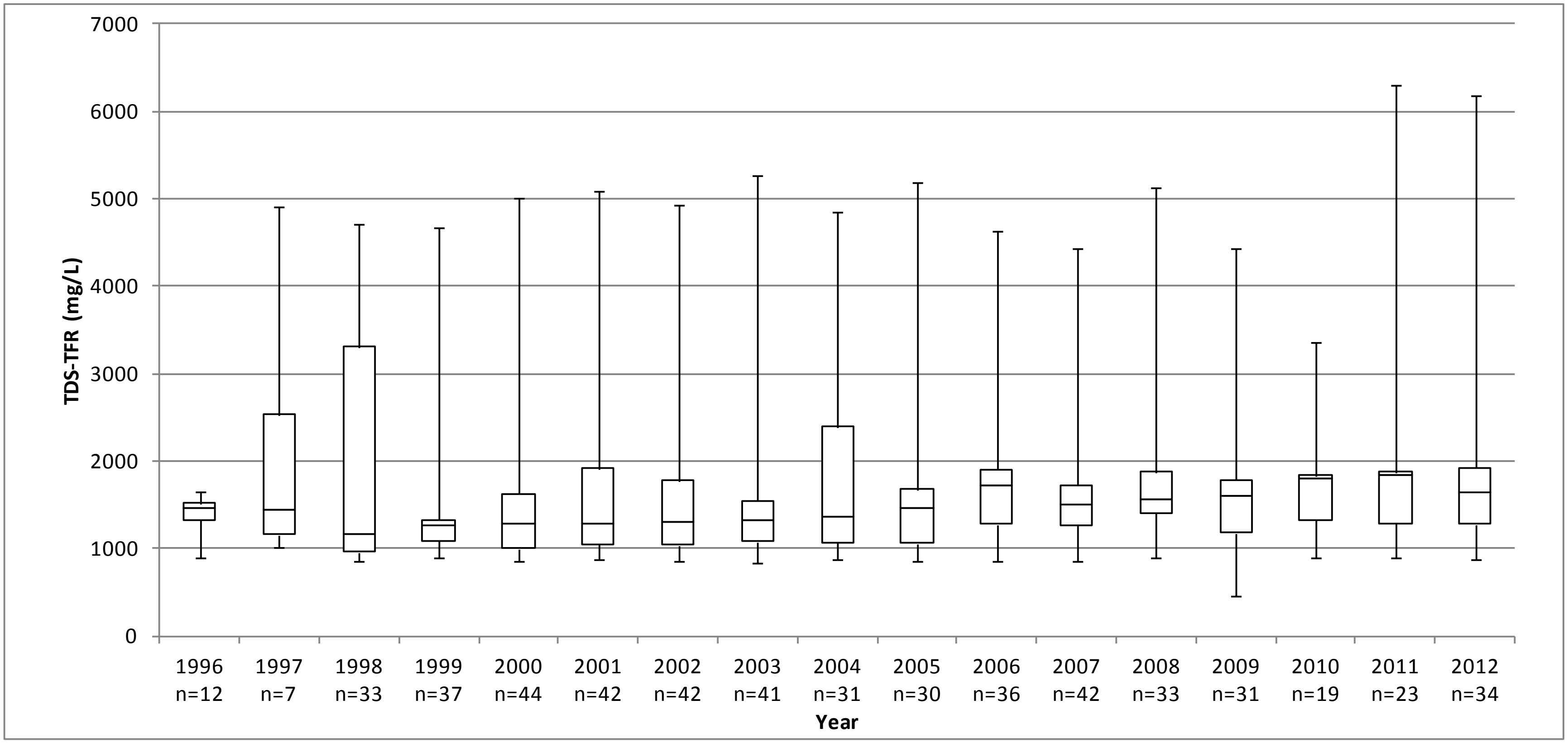
Appendix A Figure 13 TDS Box and Whisker Plot for the Lower Forebay Basin



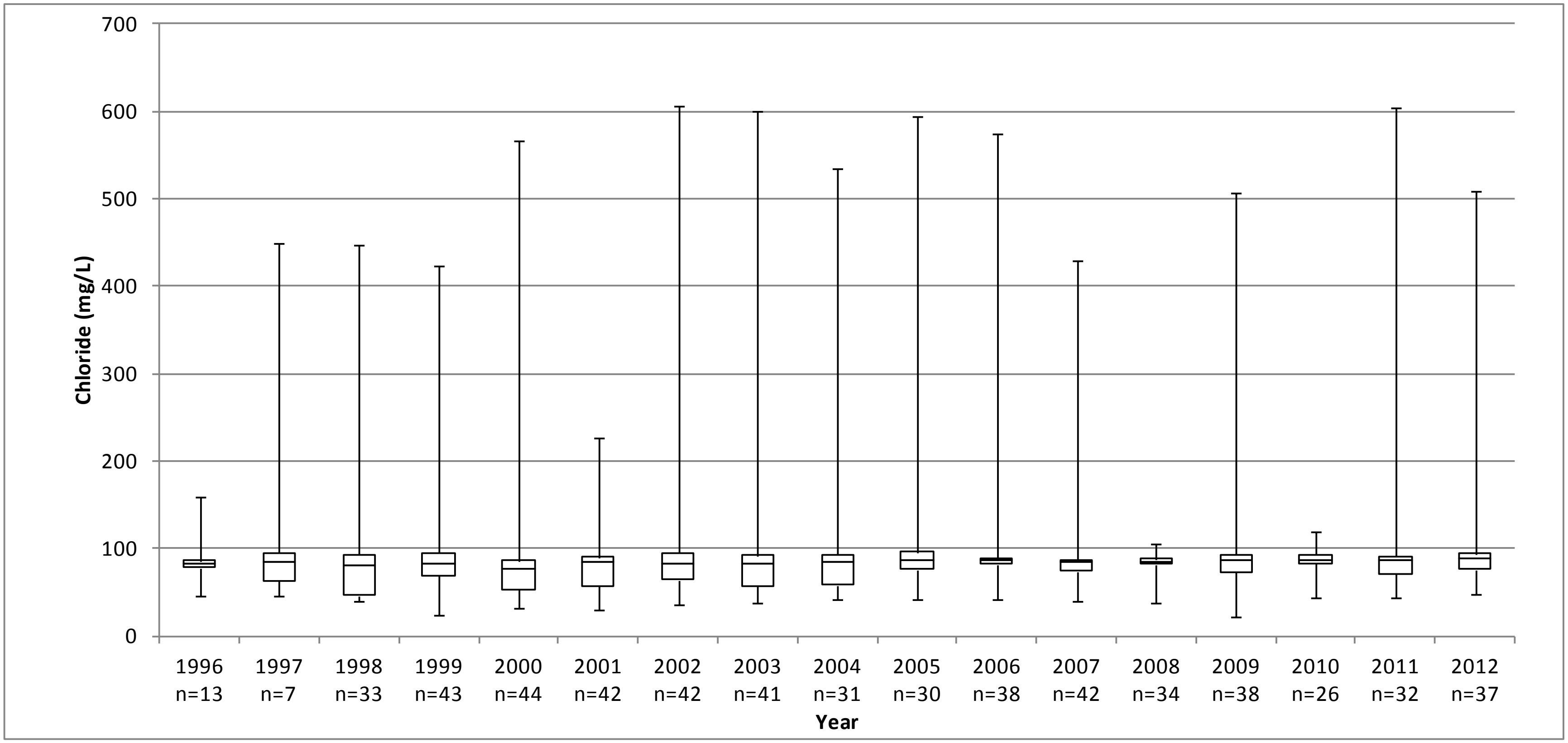
Appendix A Figure 14 Chloride Box and Whisker Plot for the Lower Forebay Basin



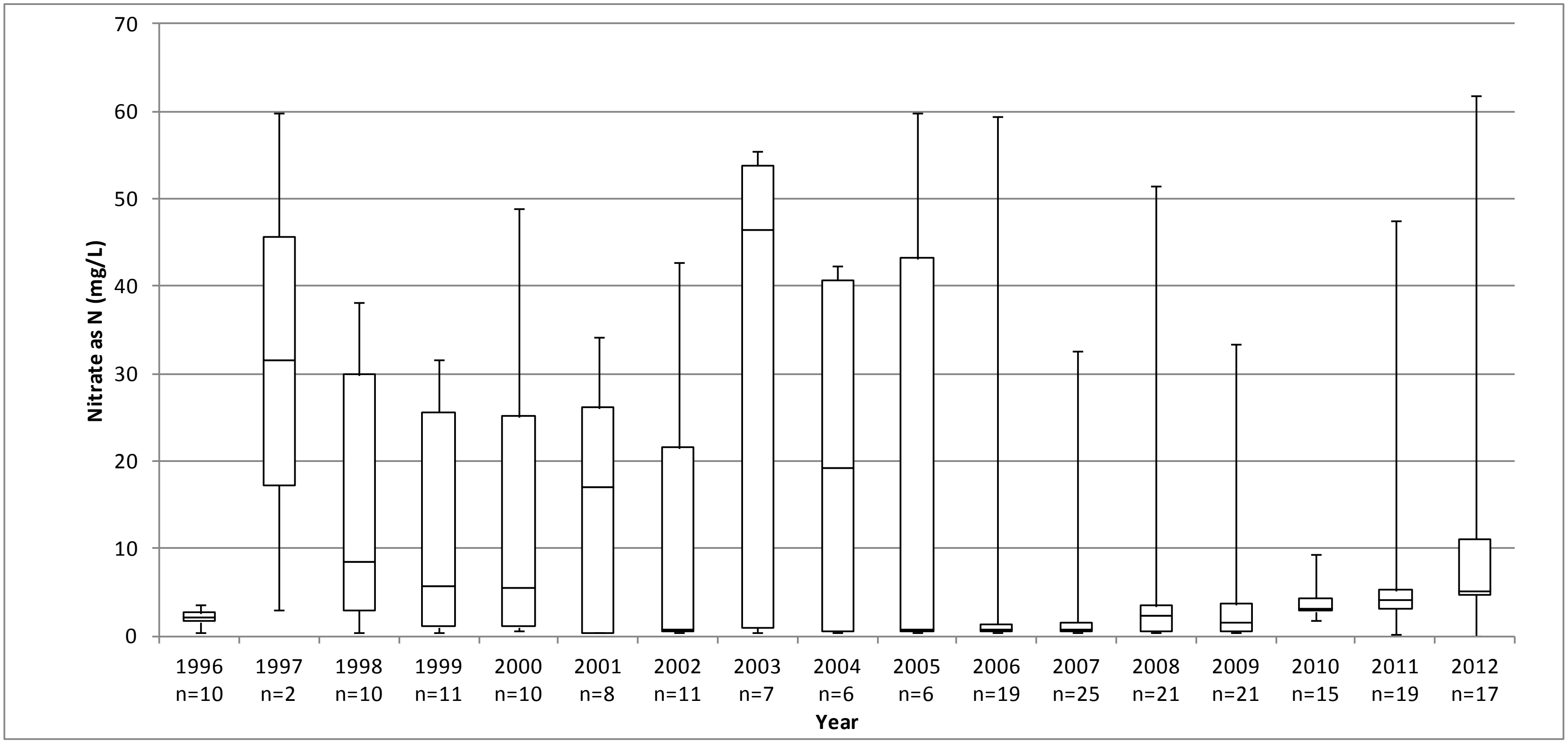
Appendix A Figure 15 Nitrate as N Box and Whisker Plot for the Lower Forebay Basin



Appendix A Figure 16 TDS Box and Whisker Plot for the Mound Basin



Appendix A Figure 17 Chloride Box and Whisker Plot for the Mound Basin



Appendix A Figure 18 Nitrate as N Box and Whisker Plot for the Mound Basin

Appendix B. Summary of Existing Monitoring Programs

Appendix B Table 1 Summary of Monitoring Programs in the Lower Santa Clara River SNMP Study Area

Data Type	Agency	Frequency	Parameter														No. of Locations	Program
			EC	TDS	Salinity	Cl^-	SO_4	B	Total N	Organic N	TKN	NH_3	NO_3	NO_2	NO_3 + NO_2	CECs		
Ground-water	Ventura County	Annually	■	■	■	■	■						■				Varies by year	Ventura County Groundwater Monitoring Program
Description: This program includes annual monitoring of groundwater wells for the purposes of groundwater resource assessment and management. The number of wells varies annually. For example in 2011 and 2012 there were 199 and 168 wells sampled throughout the County, respectively.																		
Ground-water	UWCD	Quarterly	■	■		■	■	■*					■				61	UWCD Water Quality Monitoring Program
		Semi-Annually	■	■		■	■	■*					■				33	
Description: UWCD conducts water quality monitoring of production wells and dedicated monitoring wells. In addition, UWCD uses groundwater monitoring data collected by Ventura County and water purveyors (data submitted to CPDH) to characterize groundwater quality within the District. In the Piru and Fillmore Basins the monitoring and production wells are sampled quarterly and semi-annually, respectively. In the Santa Paula Basin both the monitoring and production wells are sampled semi-annually. In the Mound Basin, the monitoring wells are sampled semi-annually, and no production wells are sampled. In the Forebay both the monitoring and production wells are generally sampled quarterly. The 11 new monitoring wells in the Forebay are sampled annually. *For the quarterly sampling events, an abbreviated suite of general minerals are analyzed twice per year. For the semi-annual sampling events, an abbreviated suite of general minerals are analyzed once per year. The abbreviated suite of general minerals does not include boron.																		
Ground-water	City of Santa Paula	Quarterly		■		■	■	■				■	■	■			3	WWTP WDR Monitoring requirements
Description: The City samples upgradient and downgradient of percolation ponds.																		
Ground-water	City of Santa Paula	Annually											■				5	CDPH Monitoring Requirements
		Other - Every 3 Years	■	■		■	■							■				
Description: The City conducts water quality monitoring of raw groundwater from their potable water supply wells.																		
Ground-water	City of Fillmore	Semi-Annually		■		■	■	■				■	■	■			3	WWTP WDR Monitoring requirements
Description: The City samples upgradient and downgradient of percolation ponds																		

Appendix B Table 1 Summary of Monitoring Programs in the Lower Santa Clara River SNMP Study Area

Data Type	Agency	Frequency	Parameter														No. of Locations	Program
			EC	TDS	Salinity	Cl^-	SO_4	B	Total N	Organic N	TKN	NH_3	NO_3	NO_2	$NO_3 + NO_2$	CECs		
Ground-water	City of Fillmore	Annually											■				3	CDPH Monitoring Requirements
		Other - Every 3 Years	■	■		■	■							■				
Description: The City conducts water quality monitoring of raw groundwater from their potable water supply wells																		
Ground-water	Ventura County Water Works	Quarterly		■		■	■	■		■		■	■	■			4	WWTP WDR Monitoring requirements
Description: The County conducts sampling from wells upgradient and downgradient of percolation ponds.																		
Ground-water	City of Ventura	Annually											■				6	CDPH Monitoring Requirements
		Other - Every 3 Years	■	■		■	■							■				
Description: The City conducts water quality monitoring of raw groundwater from their potable water supply wells.																		
Surface Water	UWCD	Quarterly	■	■		■	■	■*					■				5	UWCD Water Quality Monitoring Program
		Quarterly	■	■		■	■	■					■				7	
		Other	■	■		■	■	■**					■				2	
Description: UWCD conducts water quality monitoring of the Santa Clara River and tributaries. *For the quarterly sampling events, an abbreviated suite of general minerals are analyzed twice per year. The abbreviated suite of general minerals does not include boron. ** At two locations monitoring is conducted more frequently than quarterly. At Newhall Crossing, the general minerals suite (includes boron) is measured quarterly, and an abbreviated suite of minerals is measured on a monthly basis. At Freeman diversion, the general minerals suite (includes boron) is measured quarterly, and an abbreviated suite of minerals does not include boron) is measured twice per month.																		
Surface Water	City of Ventura	Weekly			■												5	WWTP NPDES Permit Monitoring Requirements
		Monthly								■	■	■	■	■			5	
Description: Upstream and downstream of WWTP discharge																		

Appendix B Table 1 Summary of Monitoring Programs in the Lower Santa Clara River SNMP Study Area

Data Type	Agency	Frequency	Parameter														No. of Locations	Program
			EC	TDS	Salinity	Cl^-	SO_4	B	Total N	Organic N	TKN	NH_3	NO_3	NO_2	$NO_3 + NO_2$	CECs		
Surface Water	VCAILG	Other - 1 to 2 dry events, and 1-2 wet events per year	■	■		■	■					■	■				7-8	Conditional Waiver of Waste Discharge Requirements for discharges from Irrigated Lands within the Los Angeles Region
Description: The VCAILG conducts monitoring per the requirements of the conditional waiver. Monitoring locations include several tributaries to the Santa Clara River, on agricultural drainage ditch and one background site.																		
Surface Water/ Storm-water	Ventura County	Annually	■		■	■		■			■	■			■		4	SCCWRP Bioassessment Study
Description: This 5-year bioassessment study is complete. The monitoring program for this study included water quality analyses at the monitoring locations. The 4 monitoring locations varied over the 5 year monitoring program. It is unknown if additional monitoring will be conducted in the future .																		
Surface Water/ Storm-water	Ventura County	Other	■	■	■			■			■	■			■		5	Ventura County Stormwater Quality Management Program
Description: This program includes monitoring of mass emissions stations and major outfalls. Within the project study area there is one mass emission station, Santa Clara River, and 4 major outfall stations. The mass emission and major outfall stations are monitored 4 times per year, 3 wet events and 1 dry event.																		