State Water Resources Control Board

Prepared for

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DRAFT DATA COMPILATION REPORT FOR THE DEVELOPMENT OF GROUNDWATER-SURFACE WATER AND NITROGEN TRANSPORT MODELS OF THE VENTURA RIVER WATERSHED

Prepared by

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[1] Tables 2.1 through 2.11 are not embedded in this document. The tables are presented in a companion Microsoft Excel spreadsheet which contains all tables found in Section 2. The spreadsheet is available for download on the State Water Board's California Water Action Plan website. URL: https://www.waterboards.ca.gov/waterrights/water_issues/programs/instream_flows/cwap_enhancing/

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[2] Appendices A through E are not embedded in this document. The appendices are presented in companion files. Appendix A is a Microsoft Excel spreadsheet. Appendices B through E are compiled in a PDF file. The appendices are available for download on the State Water Board's California Water Action Plan website. URL: https://www.waterboards.ca.gov/waterrights/water_issues/programs/instream_flows/cwap_enhancing/

LIST OF ACRONYMS AND ABBREVIATIONS

ac-ft/yr	acre feet per year
ASTM	American Society for Testing and Materials
CDFW	California Department of Fish and Wildlife
CEDEN	California Environmental Data Exchange Network
CIMIS	California Irrigation Management Information System
CMWD	Casitas Municipal Water District
cfs	cubic feet per second
DBS&A	Daniel B. Stephens & Associates, Inc.
DDW	Division of Drinking Water
DEM	digital elevation model
DWR	Department of Water Resources
eWRIMS	electronic Water Rights Information Management System
ET	evapotranspiration
FCGMA	Fox Canyon Groundwater Management Agency
GAMA	Groundwater Ambient Monitoring and Assessment Program
GIS	Graphic Information Systems
gpm	gallons per minute
GSFLOW	Groundwater Surfacewater FLOW
GSWC	Golden State Water Company
HGC	Hopkins Groundwater Consultants, Inc.
HRU	Hydrologic Response Unit
LiDAR	Light Detection and Ranging
LWA	Larry Walker Associates
mgd	million gallons per day
MODFLOW	Modular Ground-Water Flow Model
MOWD	Meiners Oaks Water District
NED	National Elevation Database
NHD	National Hydrography Dataset
NLCD	National Land Cover Database
NPDES	National Pollutant Discharge Elimination System

NRCS	National Resource Conservation Service
OBGMA	Ojai Basin Groundwater Management Agency
OVSD	Ojai Valley Sanitary District
OWTS	Onsite Wastewater Treatment Systems
POI	points of interest
PRMS	Precipitation Runoff Modeling System
RP	reporting-point
SBCK	Santa Barbara Channel Keeper
SCMWC	Senior Canyon Mutual Water Company
SGD	Staal Gardener & Dunne, Inc.
SSURGO	Soil Survey Geographic Database
TMDL	total maximum daily load
USDA	U.S. Department of Agriculture
USEPA	U.S. Environmental Protection Agency
USFS	U.S. Forestry Service
USGS	U.S. Geological Survey
UVRGA	Upper Ventura River Groundwater Agency
VCAC	Ventura County Agricultural Commissioner
VCAILG	Ventura County Agricultural Irrigated Lands Group
VCEHD	Ventura County Environmental Health Division
VCWPD	Ventura County Watershed Protection District
VRW	Ventura River Watershed
VRWD	Ventura River Water District
WAP	Water Action Plan
WWTP	wastewater treatment plant
WY	water year

1. INTRODUCTION

Geosyntec Consultants (Geosyntec) and Daniel B. Stephens & Associates, Inc. (DBS&A) developed this data compilation report to summarize and present the data that will be used to develop groundwater-surface water and nitrogen transport models of the Ventura River Watershed (VRW) for the State Water Resources Control Board (State Water Board) and the Los Angeles Regional Water Quality Control Board (Los Angeles Regional Water Board).

1.1 Background

The Ventura River, predominantly in Ventura County, was identified as one of five priority stream systems in the California Water Action Plan (WAP) enacted in January 2014 by Governor Edmund G. Brown Jr. Action four (4) of the WAP, to “Protect and Restore Important Ecosystems,” contains the following sub-action:

> *The State Water Resources Control Board and the Department of Fish and Wildlife will implement a suite of individual and coordinated administrative efforts to enhance flows statewide in at least five stream systems that support critical habitat for anadromous fish. These actions include developing defensible, cost-effective, and time-sensitive approaches to establish instream flows using sound science and a transparent public process. When developing and implementing this action, the State Water Resources Control Board and the Department of Fish and Wildlife will consider their public trust responsibility and existing statutory authorities such as maintaining fish in good condition.*

The State Water Board and California Department of Fish and Wildlife (CDFW) are currently working to identify potential actions that may be taken to enhance and establish instream flow for anadromous fish in the Ventura River Watershed (and the other four priority watersheds). The groundwater-surface water model developed in this project will provide a better understanding of water supply, water demand, and instream flow in the Ventura River Watershed.

Additionally, in 2012, the Los Angeles Regional Water Board adopted a total maximum daily load (TMDL) for algae, eutrophic conditions, and nutrients in the Ventura River Watershed (Los Angeles Regional Water Board 2012a, 2012b). At the time of Ventura River Watershed Algae TMDL development, Los Angeles Regional Water Board staff did not possess the data or modeling tools to evaluate the contributions of nutrients in groundwater to surface water impairments. The nitrogen transport model described in this document will help inform the TMDL process in the Ventura River Watershed.

The State Water Board and Los Angeles Regional Water Board (Water Boards) recognize that local stakeholders in the Ventura River Watershed are also creating water management tools, gathering new data, and developing water management actions. The Water Boards encourage local dialogue on instream flow and water quality needs to identify solutions that protect public trust resources and best meet the needs of local stakeholders. The Water Boards are committed to developing these publicly available modeling tools that local stakeholders in the Ventura River Watershed can use to understand and manage water resources. The Water Boards are open to coordinating with interested parties to develop water management actions that enhance instream flows, protect water quality, and consider the need for resilient water supplies in Ventura River Watershed.

1.2 Goals and Objectives of the Project

The overall goal of the groundwater-surface water and nitrogen transport models for the Ventura River Watershed is to provide scientifically defensible, cost-effective, time-sensitive, and publicly transparent[3] tools that can be used to support the State Water Board and Los Angeles Regional Water Board instream flow and TMDL efforts, respectively. The model will specifically meet the following objectives:

- Estimate existing instream flows[4] at multiple points of interest (POI) throughout the entire Ventura River Watershed;

[3] Public transparency will be achieved through conducting multiple public outreach meetings with stakeholders, meetings with and reviews by a technical advisory committee (comprised of experts from academia, public agencies, water districts, and local consultants), development of comprehensive modeling documentation, and using an open-source, freely available modeling platform. See project Final Study Plan (Geosyntec and DBS&A, 2019) for additional information related to outreach and technical review opportunities.

[4] For this model, “existing instream flows” are defined as historical flow conditions simulated by the model. The model will estimate flows using the most recent and complete land and water use data available at the time of model development.

- Predict unimpaired flow[5] at each POI that would occur with no water diversions, pumping, or storage;
- Evaluate how water use affects the water balance and instream flows;
- Simulate groundwater pumping and groundwater-surface water interactions to understand groundwater effects on instream flows;
- Ensure that the model simulation period is long enough to reasonably capture the variability of the full range of water year types from drought to flood years;
- Create a nitrogen transport model to inform nitrogen source assessment in the Ventura River Watershed; and
- Simulate the effects of the December 2017-January 2018 Thomas Fire on hydrology, nitrogen transport, groundwater levels, and instream flows.

When evaluating modeling platforms for the current study, the Water Boards considered other model capabilities that may support future studies and planning efforts. Although these capabilities may require future model refinements or linkages to other models, the base hydrologic modeling system will be developed in a manner that supports these potential future upgrades or linkages. Additional capabilities of interest include:

- Support assessments of habitat for important species;
- Represent the water rights priority system to evaluate water management scenarios;
- Simulate climate change and future water demands scenarios; and

[5] Unimpaired flow is the flow that would have occurred had the natural flow regime remained unaltered in rivers instead of being stored in reservoirs, imported, exported, pumped, or diverted. Unimpaired flow is a modeled flow generally based on historical gage data with factors applied to primarily remove the effects of dams, diversion, and pumping within the watersheds. Unimpaired flow differs from full natural flow in that the modeled unimpaired flow does not remove changes that have occurred such as channelization and levees, loss of floodplain and wetlands, deforestation, and urbanization. Where no diversion, storage, or consumptive use exists in the watershed, the historical gage data are often assumed to represent unimpaired flow.

- Model water temperature, other water quality characteristics, or have the ability to link the integrated groundwater-surface water model to separate water temperature or water quality models.

As described in the project Final Study Plan (Geosyntec and DBS&A, 2019), the USGS Groundwater Surfacewater FLOW (GSFLOW) model was selected to simulate the watershed surface water and groundwater hydrology. GSFLOW consists of the U.S. Geological Survey (USGS) Precipitation Runoff Modeling System (PRMS) for surface water coupled to Modular Ground-Water Flow Model (MODFLOW) for groundwater. Additionally, the MT3D-USGS model was selected to separately model transport and fate of nitrogen within the groundwater. The GSFLOW model calibration and validation period will comprise a total of 24 years from water year (WY[6]) 1994 through WY2017, as described in the project Final Study Plan (Geosyntec and DBS&A, 2019).

1.3 Overview of Watershed Report

The primary objective of this report is to identify and summarize the watershed data that will be used to develop the GSFLOW and MT3D-USGS models, including data to be used directly or indirectly as model input, and data to be used to calibrate and validate the models. Gaps in data to be used for model input are identified. Possible methods that may be used to fill these gaps are discussed. Additional details of the overall approach are provided in the project Final Study Plan (Geosyntec and DBS&A, 2019).

Section 2 provides a summary of the watershed data related to the groundwater portion of the GSFLOW model, while Section 3 summarizes data and information relevant to the surface water portion of the GSFLOW model. Section 4 includes data and information that are relevant to the nitrogen transport, or MT3D-USGS, model.

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[6] WY = water year, defined as October 1 through September 30. For example, WY1995 is from October 1, 1994 through September 30, 1995.

2. DATA COMPILATION FOR GROUNDWATER MODEL

This section describes data that have been collected to be used primarily to develop the groundwater (MODFLOW) portion of the GSFLOW model. The GSFLOW model will be developed to represent groundwater flow throughout the entire Ventura River Watershed, including groundwater extraction from pumping wells, in the alluvial groundwater basins (i.e., Bulletin-118 groundwater basins; see DWR, 2016), additional areas of saturated alluvium (e.g., the area underlying San Antonio Creek south of the Ojai Valley Basin), and bedrock geologic units currently used in the VRW for water supply (“bedrock aquifers”).

The groundwater model will be established with monthly stress periods and daily time steps. In MODFLOW, a stress-period defines periods of time with constant values of all model stresses (e.g., extraction rates), and time-steps define the period of time for which all model calculations (e.g., groundwater flow rates, streamflow discharge rates) are performed and reported. Therefore, for time-variable model inputs (e.g., groundwater extraction) monthly average inputs will be used where available and will otherwise be extrapolated based on annual average values or other available data using methods as described in the project Final Study Plan (Geosyntec and DBS&A, 2019).

Many datasets will be used to develop the initial groundwater model input. This project’s Geologic Analysis (DBS&A, 2020) presents geologic data that will be used to develop a hydrogeologic conceptual model. The hydrogeologic conceptual model will contain model layers that represent the extent and thickness of alluvial and bedrock aquifers. The hydrogeological conceptual model will represent the presence and orientation of faults that may comprise barriers to groundwater flow. Other datasets that will be used to develop the initial groundwater model input include groundwater extraction, recharge (e.g., from Onsite Wastewater Treatment Systems (OWTS), water distribution systems and sewer-line leakage, deep percolation of irrigation and precipitation, and spreading grounds), and riparian evapotranspiration.

When MODFLOW and PRMS are coupled into GSFLOW, some groundwater recharge and discharge components that were initially used to develop the initial groundwater model inputs, including deep percolation of irrigation and precipitation, recharge from spreading grounds, and riparian evapotranspiration, will come from the PRMS model. These data sources are described in subsequent sections of this report.

Calibration of the MODFLOW portion of the GSFLOW model will consist primarily of adjusting aquifer hydraulic conductivity and storage coefficients[7] to match simulated groundwater levels to observed groundwater levels.

Section 2.1 summarizes available groundwater extraction data that will be used to inform model input extraction rates. Section 2.2 summarizes available observed groundwater level data that will be used for model calibration. Section 2.3 summarizes available aquifer test results that will be used to inform initial assigned aquifer properties and constrain model calibration.

2.1 Groundwater Extraction

Groundwater is extracted in the VRW for municipal, industrial, agricultural, and domestic purposes. Groundwater wells are also present in the watershed for monitoring and cathodic protection. Information were obtained on groundwater wells in the VRW from Ventura County Watershed Protection District (VCWPD) (VCWPD, 2018b), on monitoring wells in the VRW from the State Water Board GeoTracker[8] website, and two local hydrogeologic consulting reports (Fugro, 2002; HGC, 2007). Appendix A[9] lists information on all known wells in the VRW, including (based on data availability) well location, depth, main use, year constructed/destroyed, diameter and perforation depths. A total of 1,432 wells in the VRW have been identified, of which 597 are currently active and used for groundwater supply. Figure 2.1 displays the locations and indicates the depth of known active groundwater supply wells.

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[7] Modeling of fractured bedrock systems will be conducted using the Equivalent Porous Medium approach (see e.g., Botros et al., 2008).

[8] GeoTracker is the State Water Boards' data management system for sites that impact, or have the potential to impact, water quality in California, with emphasis on groundwater. GeoTracker contains records for sites that require cleanup, such as Leaking Underground Storage Tank (LUST) Sites, Department of Defense Sites, and Cleanup Program Sites. GeoTracker also contains records for various unregulated projects as well as permitted facilities including: Irrigated Lands, Oil and Gas production, operating Permitted USTs, and Land Disposal Sites.

[9] Appendix A is not embedded in this document. Appendices A through E are presented in companion files. Appendix A is a Microsoft Excel spreadsheet. The appendices are available for download on the State Water Board's California Water Action Plan website. URL: https://www.waterboards.ca.gov/waterrights/water_issues/programs/instream_flows/cwap_enhancing/

Of the 597 active supply wells in the VRW, 266 are primarily used for agricultural supply (locations shown on Figure 2.2), 280 for domestic supply (locations shown on Figure 2.3), 41 for municipal supply (locations shown on Figure 2.4), and 9 for industrial supply (locations shown on Figure 2.5).

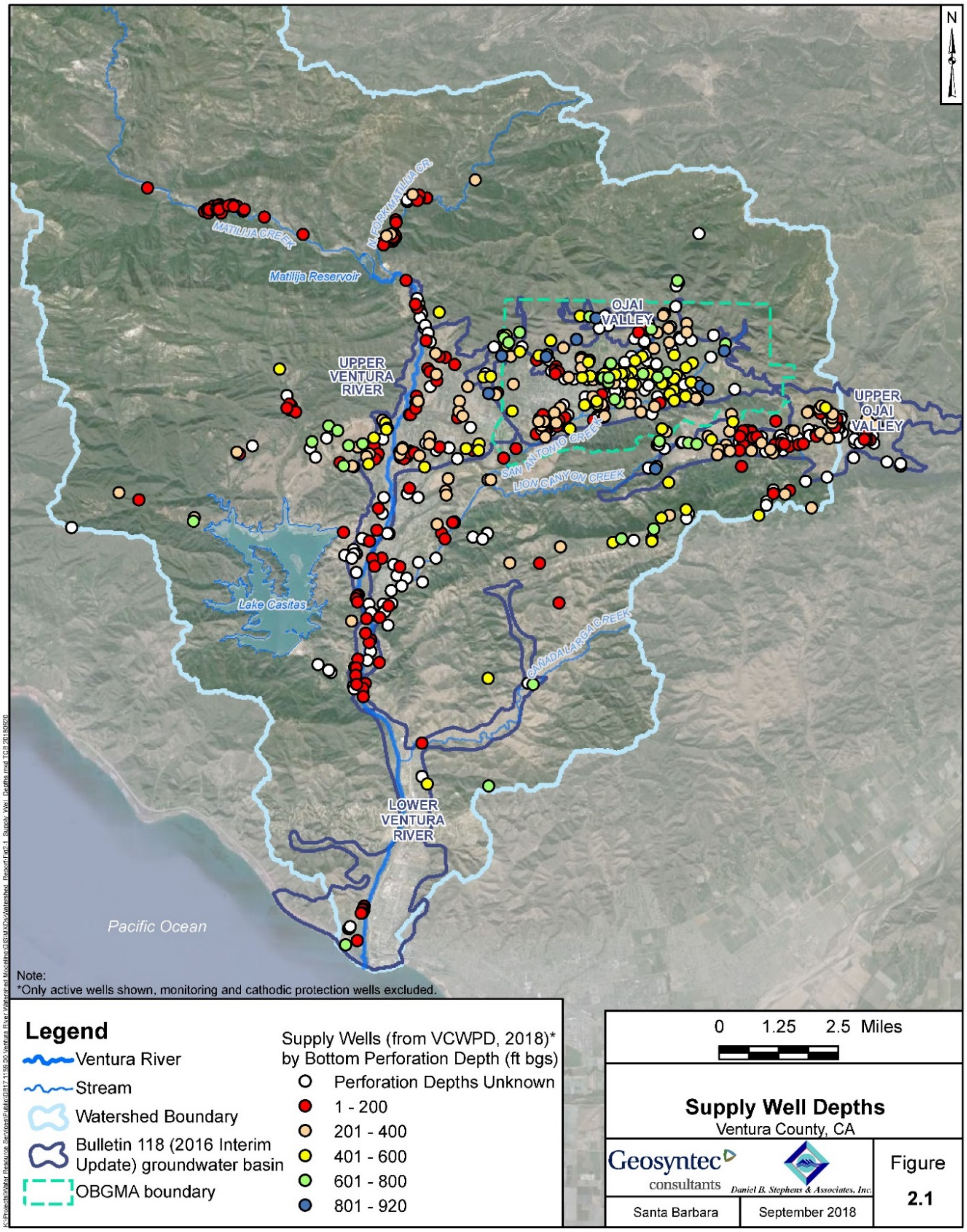

Figure 2.1 Supply Well Depths

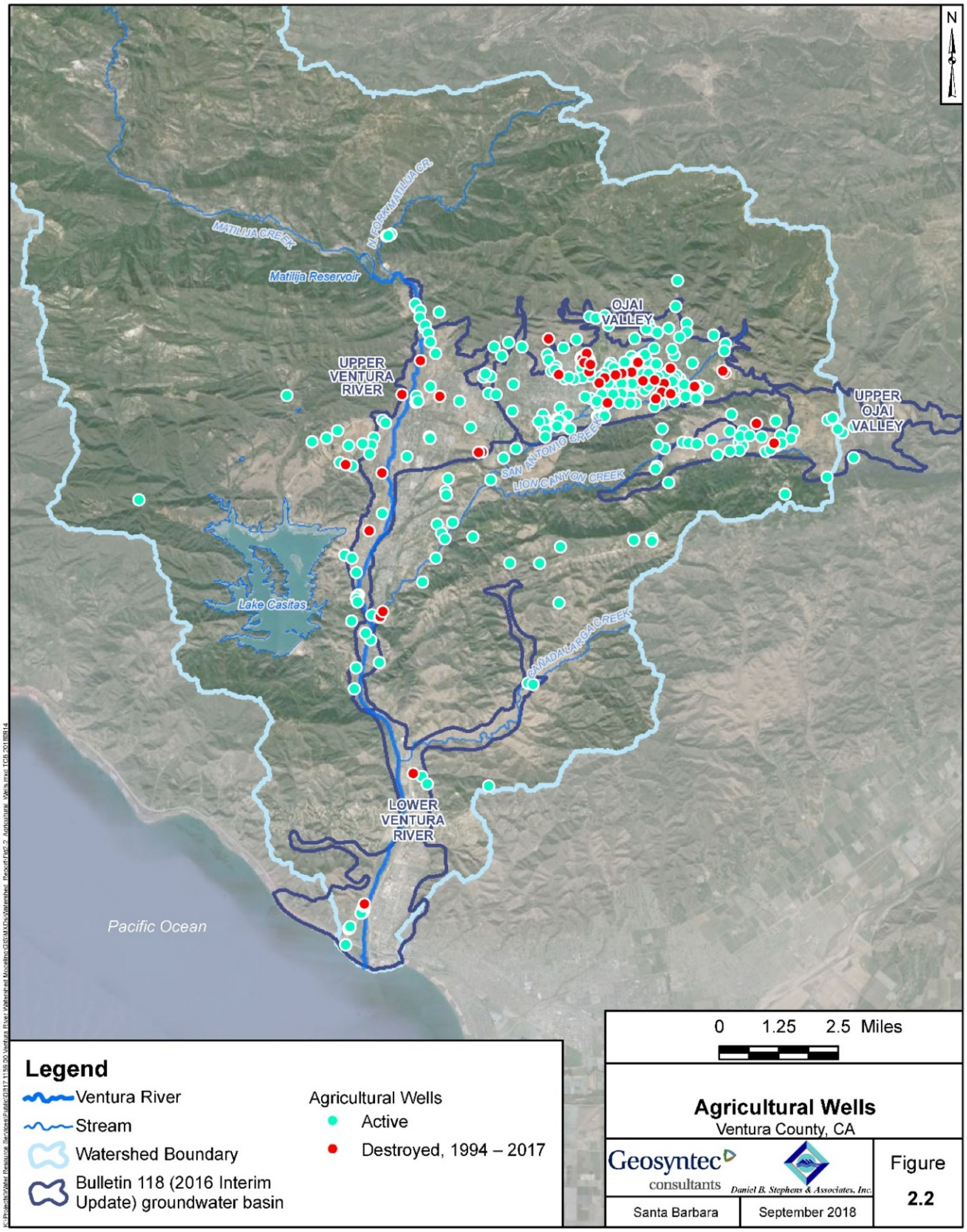

Figure 2.2 Agricultural Wells

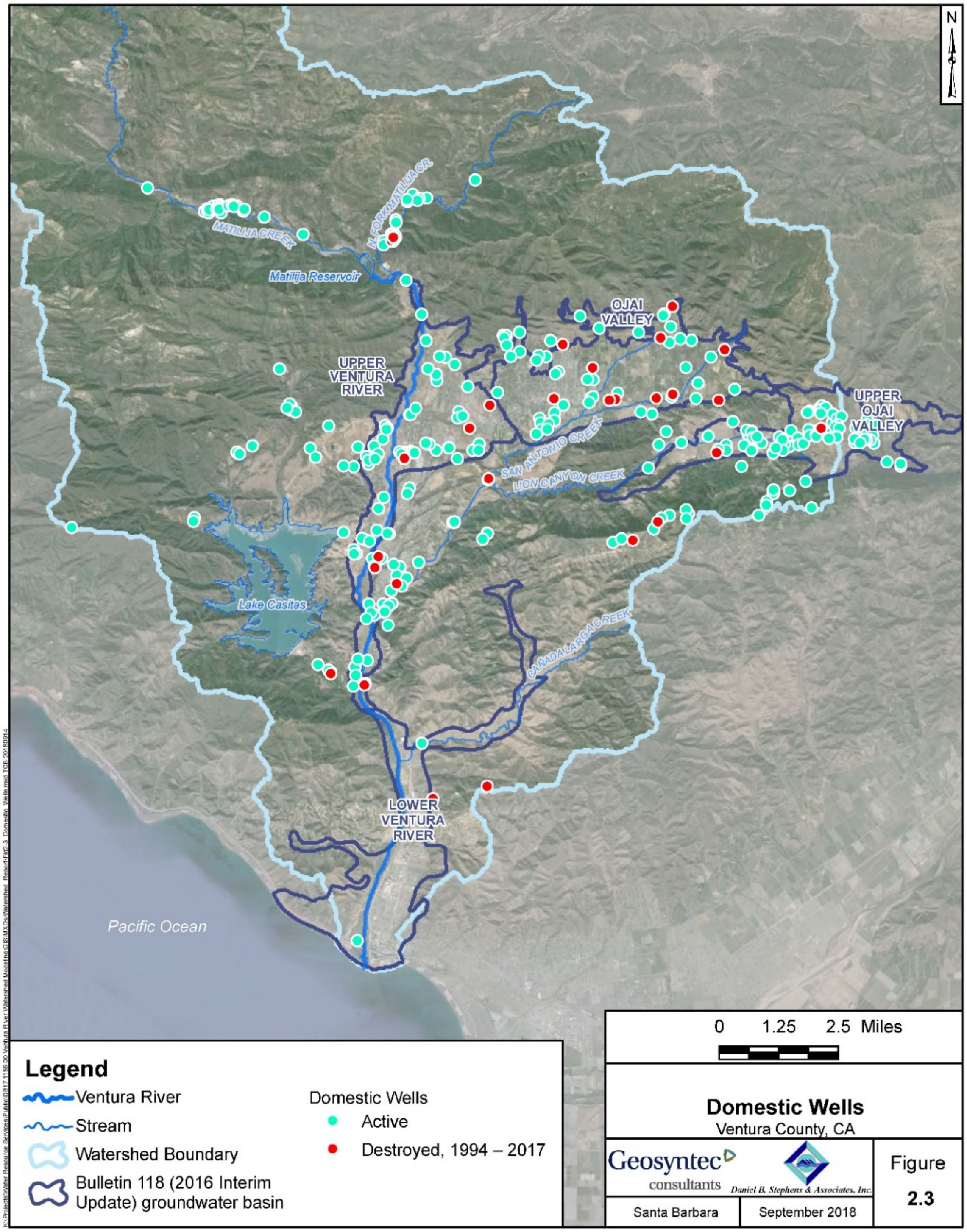

Figure 2.3 Domestic Wells

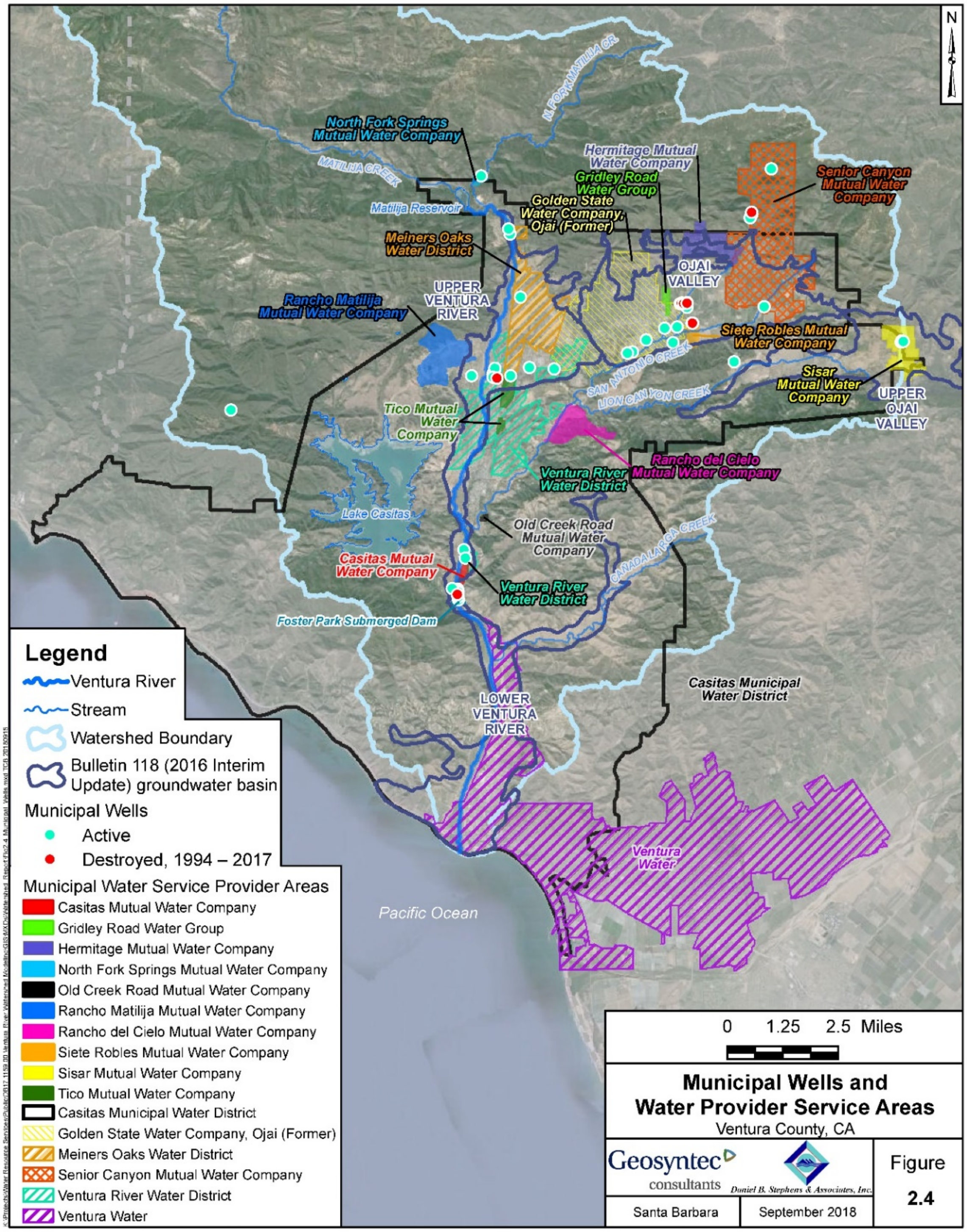

Figure 2.4 Municipal Wells and Water Provider Service Areas

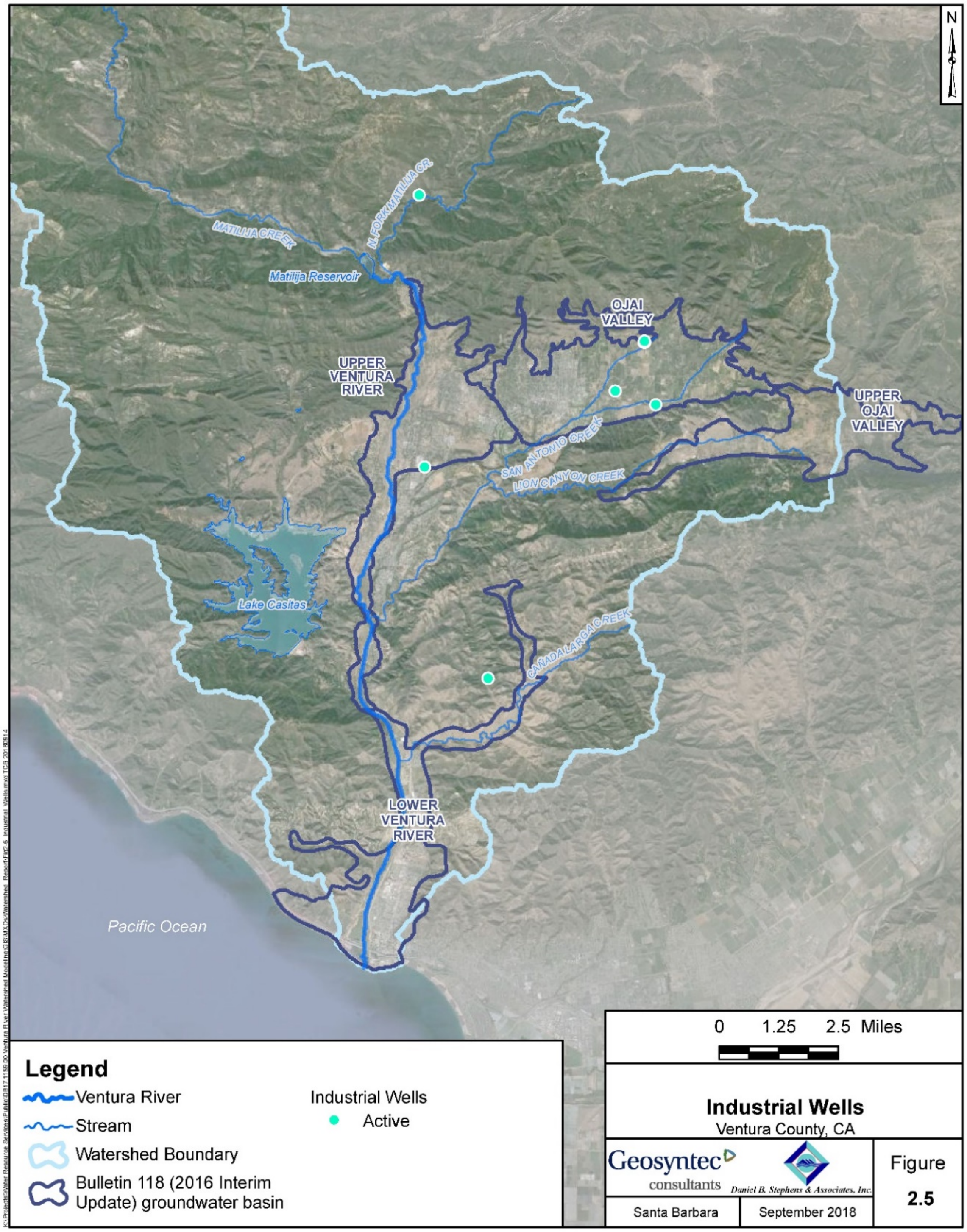

Figure 2.5 Industrial Wells

The primary use is unknown for one active supply well in the VRW. Figure 2.2 through Figure 2.5 also indicate the location of supply wells that are no longer active, but were active during part of the modeling period (WY1994 – WY2017) and therefore will be represented in the groundwater model during the years the well was active. Monitoring well locations are shown on Figure 2.6.

Groundwater extraction data are available for several municipal water providers in the VRW, and for all well users within the Ojai Basin Groundwater Management Agency (OBGMA) boundary (see Figure 2.1). There are also limited self-reported groundwater extraction data in the State Water Board's Division of Water Right's electronic Water Rights Information Management System (eWRIMS). Groundwater extraction for remaining wells is recognized as a data gap, and for the purpose of groundwater modeling, will be estimated using methods described in the project Final Study Plan (Geosyntec and DBS&A, 2019).

2.1.1 Municipal Groundwater Extraction

There are currently 15 municipal water providers in the VRW, and Table 2.1[10] lists information regarding each (Golden State Water Company (GSWC) operations in Ojai were transferred to Casitas Municipal Water District (CMWD) in June 2017). Municipal water providers obtain water from a combination of groundwater extraction, purchases from CMWD, and from surface-water diversions. The larger water providers in the VRW (population served >500) include CMWD, Meiners Oaks Water District (MOWD), Senior Canyon Mutual Water Company (SCMWC), Ventura River Water District (VRWD), and Ventura Water. Figure 2.4 displays the service area for each of the municipal water providers in the VRW.

The State Water Board and DBS&A requested groundwater extraction data from the municipal water providers. Extraction data were also obtained from publically available reports and data previously provided to DBS&A and reported in DBS&A (2010), and from the State Water Board's Division of

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[10] Table 2.1 is not embedded in this document. The table is presented in a companion Microsoft Excel spreadsheet which contains all tables found in Section 2. The spreadsheet is available for download on the State Water Board's California Water Action Plan website. URL: https://www.waterboards.ca.gov/waterrights/water_issues/programs/instream_flows/cwap_enhancing/

Drinking Water (DDW) data. Available compiled annual groundwater extraction data for municipal providers are summarized in Table 2.2 through Table 2.10[11].

CMWD has historically obtained water primarily from Lake Casitas; however extraction from their Mira Monte Well has been used to supplement supply since 2000. Monthly extraction data for the Mira Monte Well are available from records received from CMWD, and from publically available reports, for 1994 – 2011 and 2014 – 2016, and are summarized in Table 2.2. Extraction from the Mira Monte well for 2012 – 2013 and 2017 is currently identified as a data gap.

[11] Tables 2.2 through 2.10 are not embedded in this document. The tables are presented in a companion Microsoft Excel spreadsheet which contains all tables found in Section 2. The spreadsheet is available for download on the State Water Board's California Water Action Plan website. URL: https://www.waterboards.ca.gov/waterrights/water_issues/programs/instream_flows/cwap_enhancing/

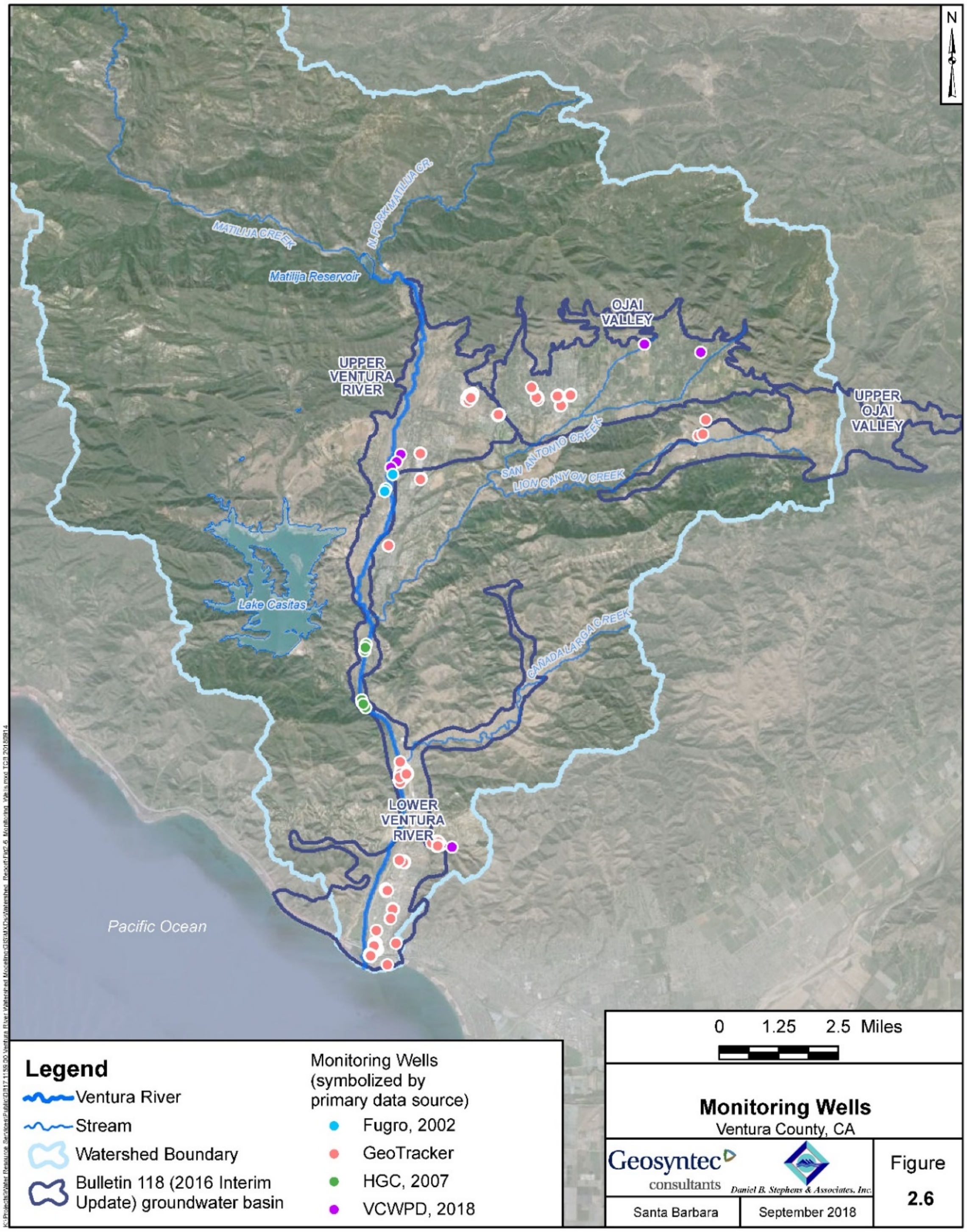


Figure 2.6 Monitoring Wells

GSWC (formerly Southern California Water Company) provided municipal supply in the Ojai Valley, in part from a municipal wellfield, from the 1920s until June 2017 when operations were transferred to CMWD (hereafter referred to as the CMWD Ojai wellfield or CMWD Ojai extraction). CMWD Ojai extraction for individual supply wells is reported to the OBGMA on a semi-annual basis from 1996 to 2014 and a quarterly basis thereafter, and records are available in the OBGMA database (a copy of which DBS&A has obtained; OBGMA, 2017). Total annual CMWD Ojai extraction is also reported in the OBGMA Groundwater Management Plan (OBGMA, 2018). Table 2.2 summarizes available groundwater extraction data for the CMWD Ojai wellfield. In cases where total annual CMWD Ojai extraction obtained from the OBGMA database (OBGMA, 2017) varied from total CMWD Ojai extraction reported in the OBGMA Groundwater Management Plan (OBGMA, 2018) by more than 15 percent, annual values reported in the Groundwater Management Plan are assumed to be correct and are reported in Table 2.2. Monthly extraction for each CMWD Ojai well for 1994 – 1995, 1998 – 1999, and 2006 is recognized as a current data gap.

MOWD provides municipal supply in part from groundwater extraction from several wells located in the Upper Ventura River Basin, and Table 2.3 summarizes available MOWD extraction rates. Annual groundwater extraction data for all MOWD wells combined was previously provided to DBS&A for 1994 – 1999 (DBS&A, 2010), and was provided to State Water Board for 2000 – 2017. In addition, monthly extraction for each individual MOWD well was also previously provided to DBS&A for 2009. For this study, MOWD provided monthly extraction data for each individual MOWD well for the full time period, 1994 – 2017.

VRWD provides municipal supply in part from groundwater extraction from several wells located in the Upper Ventura River Basin, and Table 2.4 summarizes VRWD extraction rates. Total monthly extraction for all VRWD wells combined was previously provided to DBS&A for 2000 – 2003 (VRWD, 2010). For this study, VRWD provided monthly extraction rates for each individual well for 1994 – 2003 and daily extraction rates for each individual well for 2004 – 2016.

Ventura Water provides municipal supply in part from groundwater extraction from a wellfield and subsurface intake located in the vicinity of the Foster Park Submerged Dam in the Ventura River (Figure 2.4). Table 2.5 summarizes Ventura River groundwater extraction at Foster Park. For this study, Ventura Water provided monthly extraction data for each individual well at Foster Park from 1994 – 2009, and daily extraction data for each individual well from 2010 – 2017.

SCMWC provides municipal supply to residential and agricultural users in the northeast end of the Ojai Valley from a combination of groundwater, surface-water diversion and CMWD purchase (SGD, 1992; Walter, 2015; VCWPD, 2006). Total SCMWC extraction is reportedly approximately 720 acre feet per year (ac-ft/yr), with one-third (240 ac-ft/yr) from CMWD (SGD, 1992; VCWPD, 2006). SCMWC operates six wells that are located within and north of the Ojai Valley Basin. Extraction for five of the six wells are reported to OBGMA (2017), and these extraction rates are summarized in Table 2.6. One SCMWC well (05N22W21L01) is reported as a “gallery tunnel” by VCWPD (2006) and a horizontal well by SGD (1992). The horizontal well is located approximately 1.5 miles north of the Ojai Valley Basin, and extraction for this well is annually reported to the State Water Board under appropriative water right (Application ID A006399). Monthly extraction data from the horizontal well is available for 2010-2018. The horizontal well was reportedly initially drilled 1,550 feet long in 1929 and was subsequently lengthened to 2,650 feet (Bristol, 1946), and as of 1992 produced approximately 70 gallons per minute (gpm) (113 ac-ft/yr if well operated continuously at 70 gpm; SGD, 1992). Personal communication with SCMWC (2018) indicates that 70 gpm is the high end of production and the horizontal well production declines substantially in the summer. Monthly SCMWC extraction from the SCMWC horizontal well from 1994 – 2010 is recognized as a current data gap.

Gridley Road Water Group is reported to operate well 04N22W06M01S in the Ojai Valley by VCWPD (2006) and well 04N22W06E03S in the Ojai Valley by SGD (1992) and OBGMA (2017). Extraction for these wells is reported to OBGMA (2017), and annual summaries are included in Table 2.7 along with other wells in the Ojai Valley, as discussed in Section 2.1.2 below.

Siete Robles Mutual Water Company has historically provided municipal supply from several wells located in the Ojai Valley; as of 2000 only one of these wells (04N22W07A05S) has been active (OBGMA, 2017). Extraction for this well has been reported to OBGMA since 2000, and annual summaries are included in Table 2.7 along with other wells in the Ojai Valley, as discussed in Section 2.1.2 below.

Extraction data for 2013 – 2017 was also obtained for Casitas Mutual Water Company, Sisar Mutual Water Company, and Tico Mutual Water Company from State Water Board’s DDW data (Tables 2.8 through 2.10). Currently, limited extraction data are available for the remaining municipal water providers in the VRW (Table 2.1), and this is recognized as a current data gap.

2.1.2 Ojai Valley Basin Groundwater Extraction

Within the OBGMA boundary, which encompasses the Ojai Valley Basin (see Figure 2.1), no extraction facility may be operated or otherwise utilized so as to extract groundwater unless that facility is permitted and all extractions reported to OBGMA (OBGMA, 2018). Well owners within the OBGMA boundary report extraction based on either well metering or an estimate based on irrigated acreage and assumed OBGMA crop irrigation factors. Semi-annual extraction for wells reporting to OBGMA are available from 1996 to 2014, and quarterly extraction is available from 2015 to 2017 (OBGMA, 2017). Table 2.7 summarizes extraction reported to OBGMA (separate from the CMWD wellfield and SCMWC wells, for which extraction is reported in Table 2.2 and Table 2.6, respectively).

2.2 Groundwater levels

Groundwater level data will be used as a basis for groundwater model calibration. VCWPD staff manually measure groundwater levels on a semi-annual basis in a network of wells within the VRW, and data were provided by VCWPD. In addition, both the Upper Ventura River Groundwater Agency (UVRGA) and OBGMA collect groundwater levels at a 90-minute interval with dedicated pressure-transducer data loggers within several wells (including some wells also manually monitored by VCWPD). Transducer data are available beginning in 2017 and 2010 for UVRGA and OBGMA, respectively. UVRGA and OBGMA provided transducer data; however, transducer emplacement depth is not currently available for several of the OBGMA transducer-equipped wells and therefore the associated transducer data cannot currently be used for model calibration (this is recognized as a current data gap).

Manual groundwater-level measurements were also obtained from GeoTracker for several environmental cleanup sites in the Lower Ventura River Basin, an area with limited additional groundwater level data (VCWPD monitoring of two wells in the Lower Ventura River Basin began in April 2012).

Figure 2.7 displays the location of wells with available groundwater level data, and Appendix B[12] presents hydrographs of groundwater elevation at each location over time. For VCPWD manually measured data, data were excluded

[12] Appendix B is not embedded in this document. Appendices A through E are presented in companion files. Appendices B through E are compiled in a PDF file. The appendices are available for download on the State Water Board's California Water Action Plan website. URL: https://www.waterboards.ca.gov/waterrights/water_issues/programs/instream_flows/cwap_enhancing/

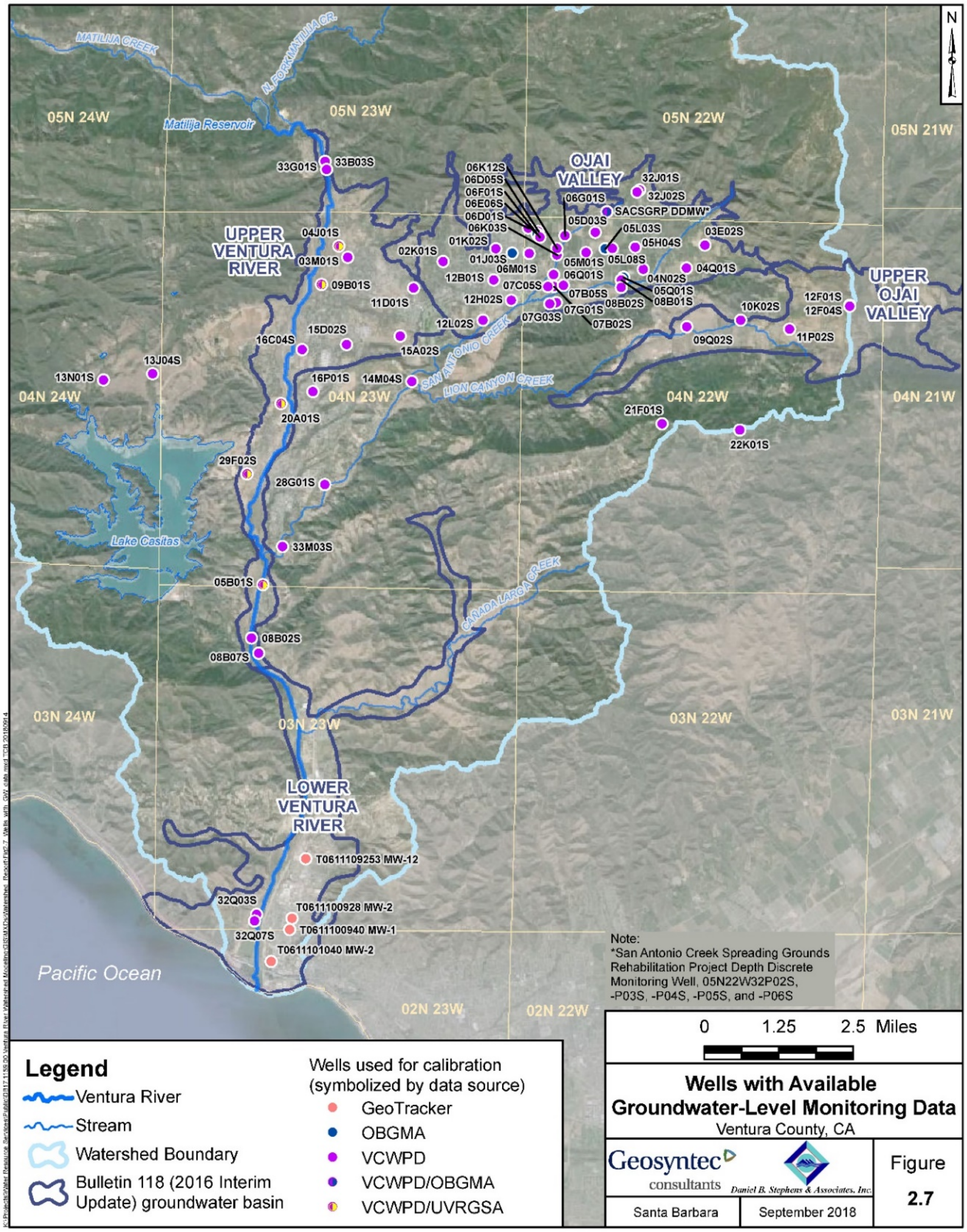


Figure 2.7 Wells with Available Groundwater-Level Monitoring Data

(not plotted) in Appendix B if associated data qualifiers noted that the groundwater level measurement could not be taken (e.g., due to the well not being accessible), or if the data were influenced by the well being actively pumped during the time of the groundwater-level measurement. If VCPWD staff noted that the well was flowing artesian, the groundwater level was plotted as equal to the reporting-point (RP) elevation. For OBGMA and UVRGA transducer data, data were excluded if the groundwater level value changed significantly and reversibly within a period of a few hours, indicating that the transducer was temporarily taken out of the well.

Well construction data for wells with groundwater level data are reported in Appendix A, based on data availability.

2.3 Aquifer Tests

Parameters adjusted during the calibration process (i.e., calibration parameters) will include hydraulic conductivity and storage coefficient of each model layer. Values of hydraulic conductivity from available aquifer tests and specific capacity measurements will be used to set initial conditions and constrain calibration.[13] For example, for the Ojai Basin Groundwater Model, the calibrated hydraulic conductivity and storage coefficient values were within the range of available aquifer test results (DBS&A 2011). In general, values of these parameters in the model should be similar, but do not have to be identical to field observations as field observations may have errors themselves (often an order of magnitude). There are also differences in the associated scale of aquifer-tests (i.e., the volume of aquifer stressed) versus a regional groundwater model (ASTM, 2008).

Aquifer transmissivity has been reported from aquifer tests for several wells in the Ojai Valley Basin perforated within the Basin alluvium (Kear, 2005; DBS&A, 2011), for the Foster Park wellfield area in the Upper Ventura River Basin (HGC, 2007), and for a portion of the Lower Ventura River Basin (Numeric Solutions, 2018) and results are summarized in Table 2.11[14]. Aquifer-test data

[13] In an aquifer test, a well is pumped and the rate of decline of the water level in the well or nearby observation wells is noted; the time-drawdown data are then interpreted to yield the aquifer hydraulic parameters (Fetter, 2001).
[14] Table 2.11 is not embedded in this document. The table is presented in a companion Microsoft Excel spreadsheet which contains all tables found in Section 2. The spreadsheet is available for download on the State Water

for additional areas of the VRW, including within the bedrock units, is recognized as a current data gap.

Board's California Water Action Plan website. URL: https://www.waterboards.ca.gov/waterrights/water_issues/programs/instream_flows/cwap_enhancing/

3. DATA COMPILATION FOR SURFACE WATER MODEL

This section presents data that are primarily used to develop the surface water (PRMS) portion of the GSFLOW model. As described in the project Final Study Plan (Geosyntec and DBS&A, 2019), the GSFLOW model will run on a daily time-step. The PRMS portion of the model will use gridded Hydrologic Response Units (HRUs) that match the MODFLOW grid.

3.1 Rainfall

Daily precipitation is a critical component of the PRMS model as it drives the flows and water balance for the entire model.

The locations of the rainfall stations to be used in the model are shown in Figure 3.1. A summary of the total annual precipitation during the modeling period, at the Ojai County Fire Station (gage 030D), is shown in Figure 3.2. Plots showing the daily precipitation for each rainfall station are included in Appendix C[15]. The upper frames of these plots show the raw data for each rain gage station, including data gaps, while the lower frames show the filled data that will be used as input to the model. The gaps in the daily data at each rain gage were filled by using data from the nearest available rain gage that was then scaled based upon comparison of the overlapping records between the rain gage pairs.

These filled rainfall data will be distributed over the gridded HRUs using spatial interpolation procedures described in the project Final Study Plan (Geosyntec and DBS&A, 2019).

3.2 Temperature

PRMS uses maximum and minimum daily air temperatures to estimate evapotranspiration and other hydrologic processes. The locations of weather stations in and near the VRW that measure air temperatures are shown in Figure 3.3. Plots of the daily maximum and minimum temperatures at these

[15] Appendix C is not embedded in this document. Appendices A through E are presented in companion files. Appendices B through E are compiled in a PDF file. The appendices are available for download on the State Water Board's California Water Action Plan website. URL: https://www.waterboards.ca.gov/waterrights/water_issues/programs/instream_flows/cwap_enhancing/

stations are provided in Appendix D[16]. These temperature data will be spatially distributed onto the gridded HRU's using interpolation procedures available in PRMS.

3.3 Land Use

PRMS requires land use information, such as the predominant vegetative cover within each HRU (i.e., bare soil, grasses, shrubs, and coniferous or deciduous trees) and the summer/winter plant canopy density and interception, to calculate the amount of precipitation that is intercepted by vegetation, the evaporation of intercepted precipitation, and the amount of net precipitation that reaches the soil.

In addition, there are several datasets that represent land use within the VRW. The main datasets that characterize land use across the VRW include the 2011 National Land Cover Database (NLCD) (Figure 3.4), which also includes imperviousness[17] (Figure 3.5), and the U.S. Forestry Service (USFS) Landfire dataset (Figure 3.6), which provides more detail on vegetation types in natural areas. Agricultural areas are better represented by spatial crop data from the 2016 Ventura County Agricultural Commissioner (VCAC) (Figure 3.7), which provides detailed characterization of different crop types. *Arundo donax* distribution and evapotranspiration datasets (California Invasive Plant Council, 2011) will be assessed to determine if the invasive reed can be incorporated into the model as a land use type.

Additional details on these data and how they will be used in the PRMS model are provided in the project Final Study Plan (Geosyntec and DBS&A, 2019).

[16] Appendix D is not embedded in this document. Appendices A through E are presented in companion files. Appendices B through E are compiled in a PDF file. The appendices are available for download on the State Water Board's California Water Action Plan website. URL: https://www.waterboards.ca.gov/waterrights/water_issues/programs/instream_flows/cwap_enhancing/

[17] Visual comparisons between NLCD 2001 and NLCD 2011 imperviousness data indicate minimal changes in the watershed, at least at the scale of the watershed, and as such the use of the 2011 data should be reasonably representative of much of the modeling period.

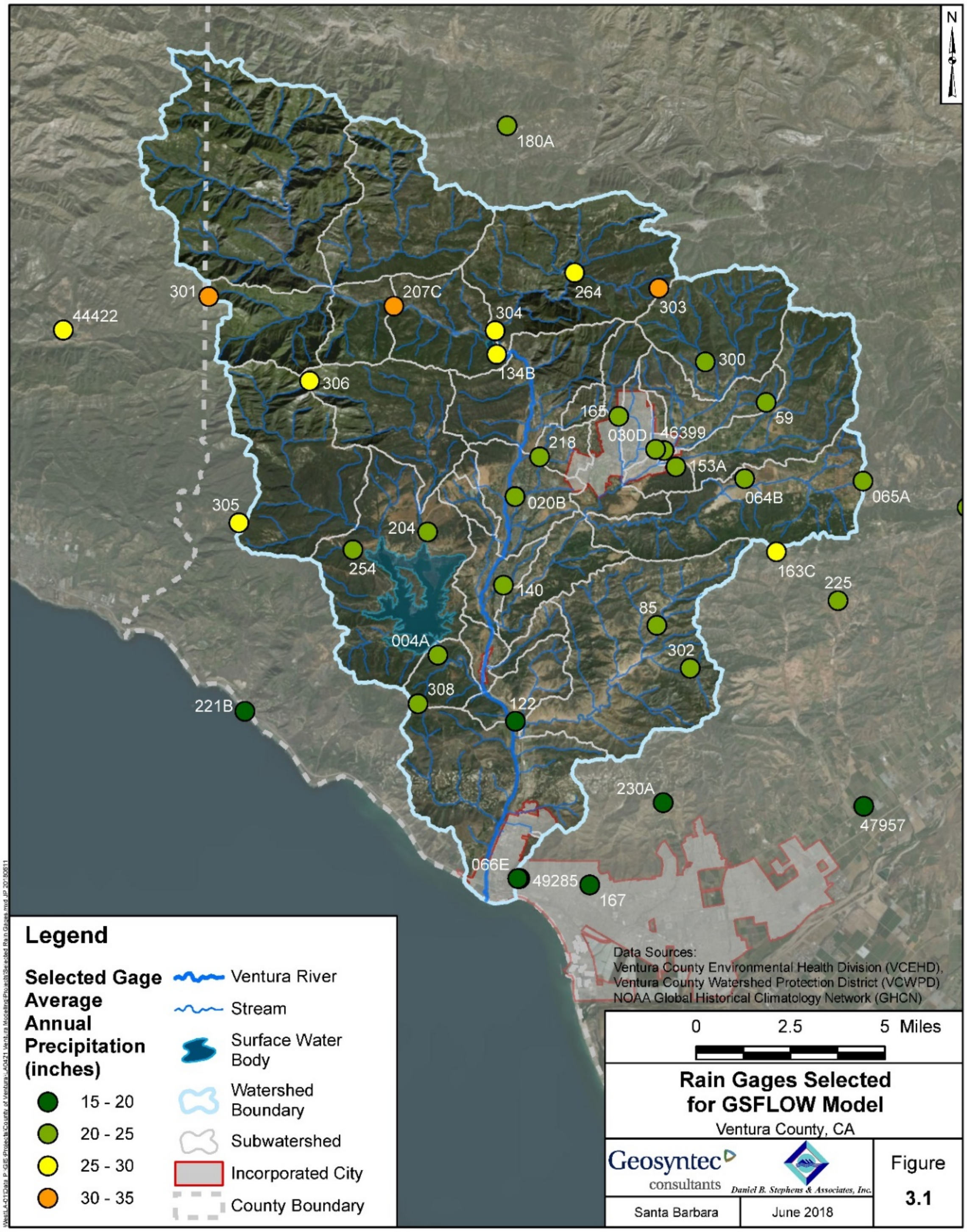
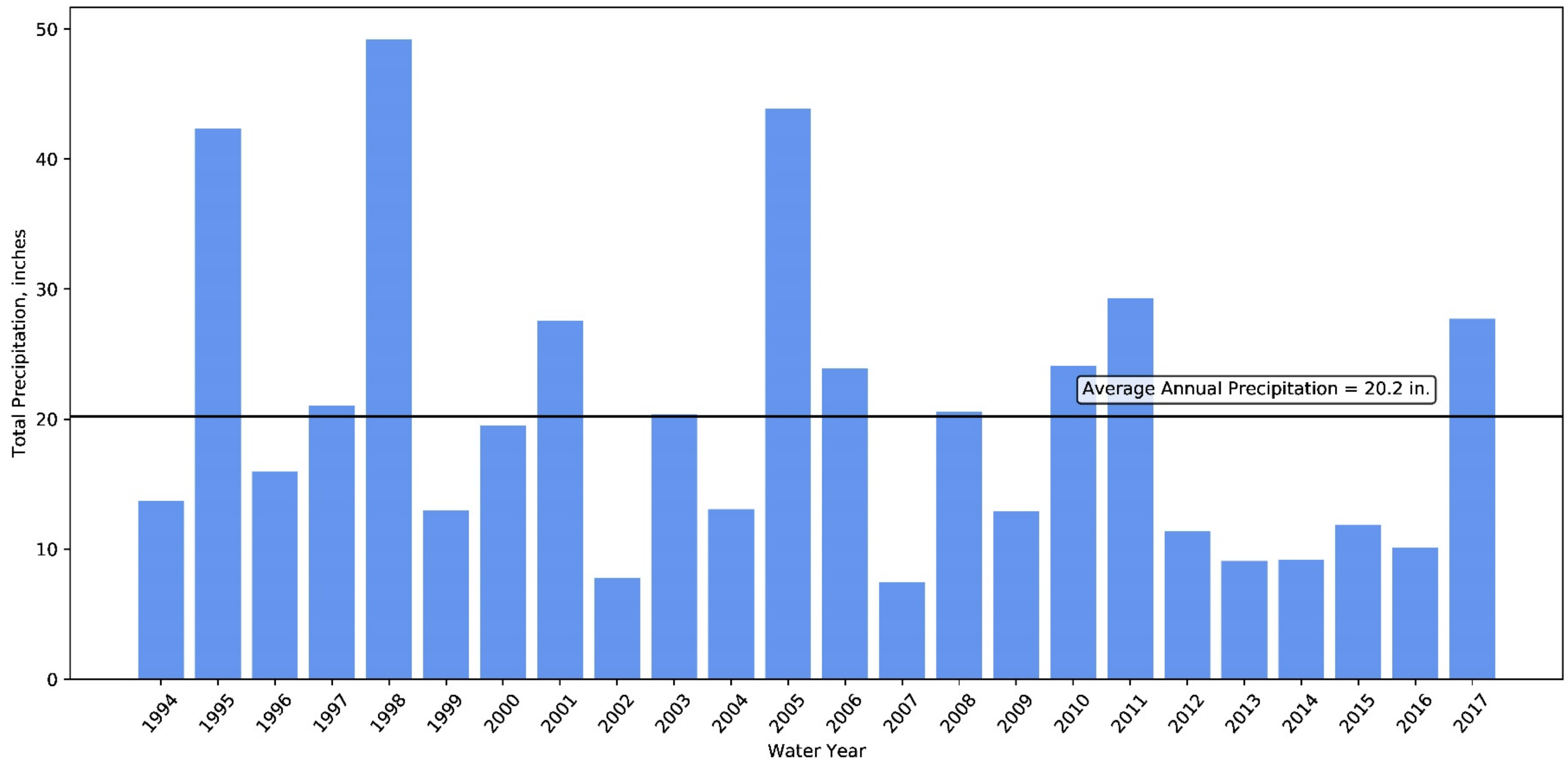


Figure 3.1 Rain Gages Selected for GSFLOW Model



Ojai County Fire Station (Gage 030D)
Annual Total Precipitation
Ventura County, CA

Geosyntec consultants

Santa Barbara	June 2018	**Figure** 3.2

Source: P:Project Folders\LA0421 - SWRCB Ventura River Modeling\400 Technical\Task 3 - PRMS Model and GSFLOW\Technical Analysis\Python\1 - Rainfall Data Processing\5 - Plot annual total precip

Figure 3.2 Ojai County Fire Station (Gage 030D) Annual Total Precipitation

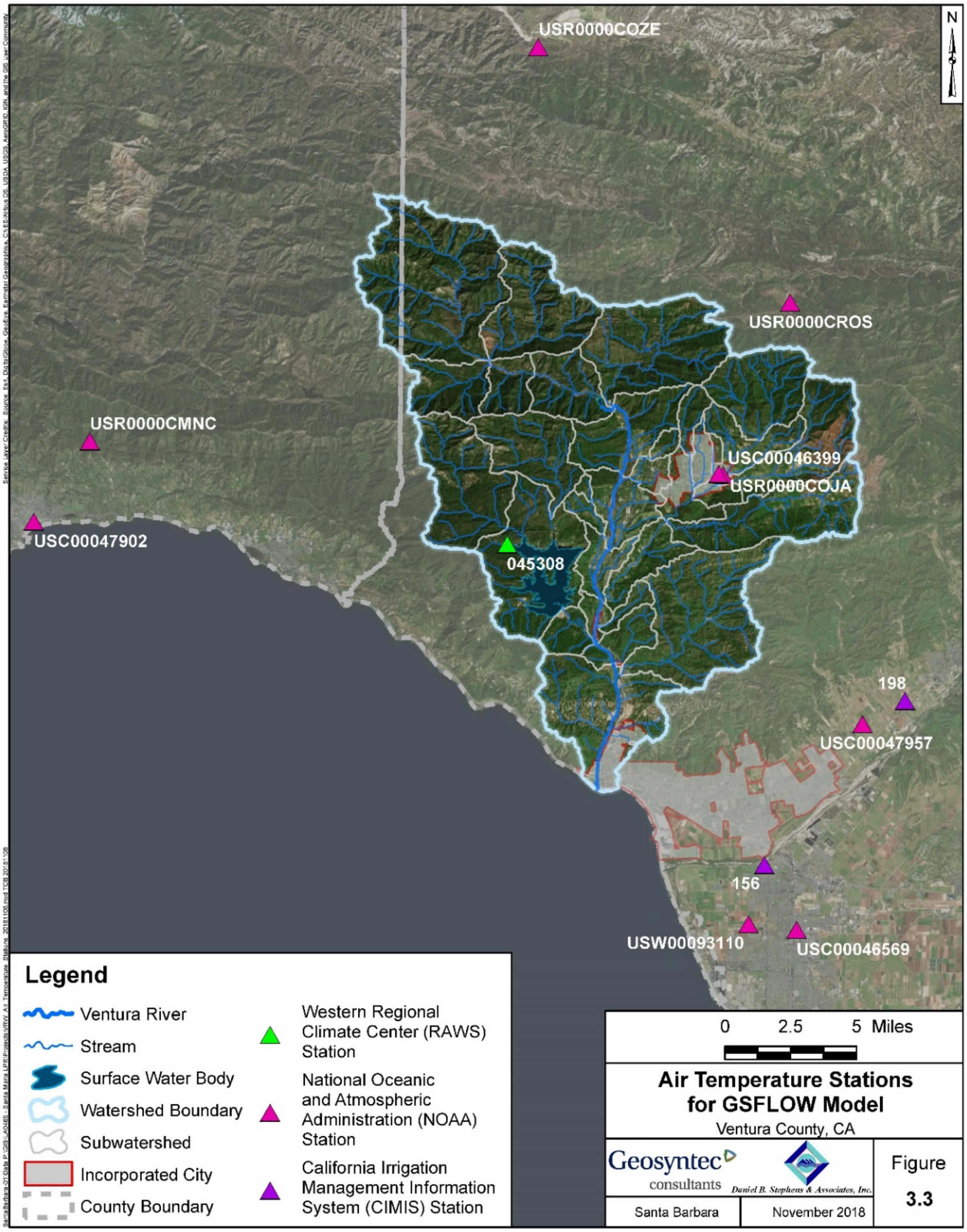


Figure 3.3 Air Temperature Stations for GSFLOW Model

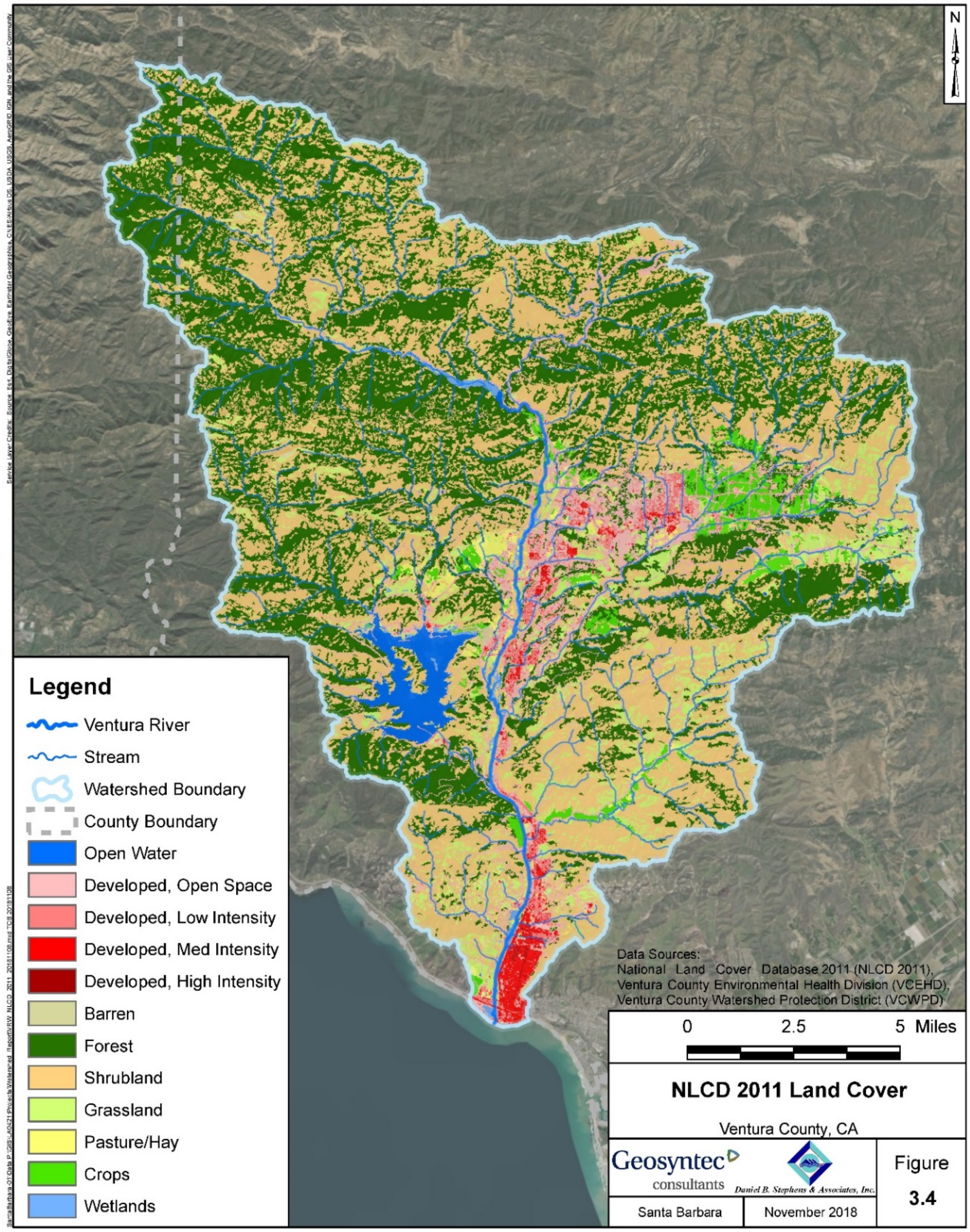


Figure 3.4 NLCD 2011 Land Cover

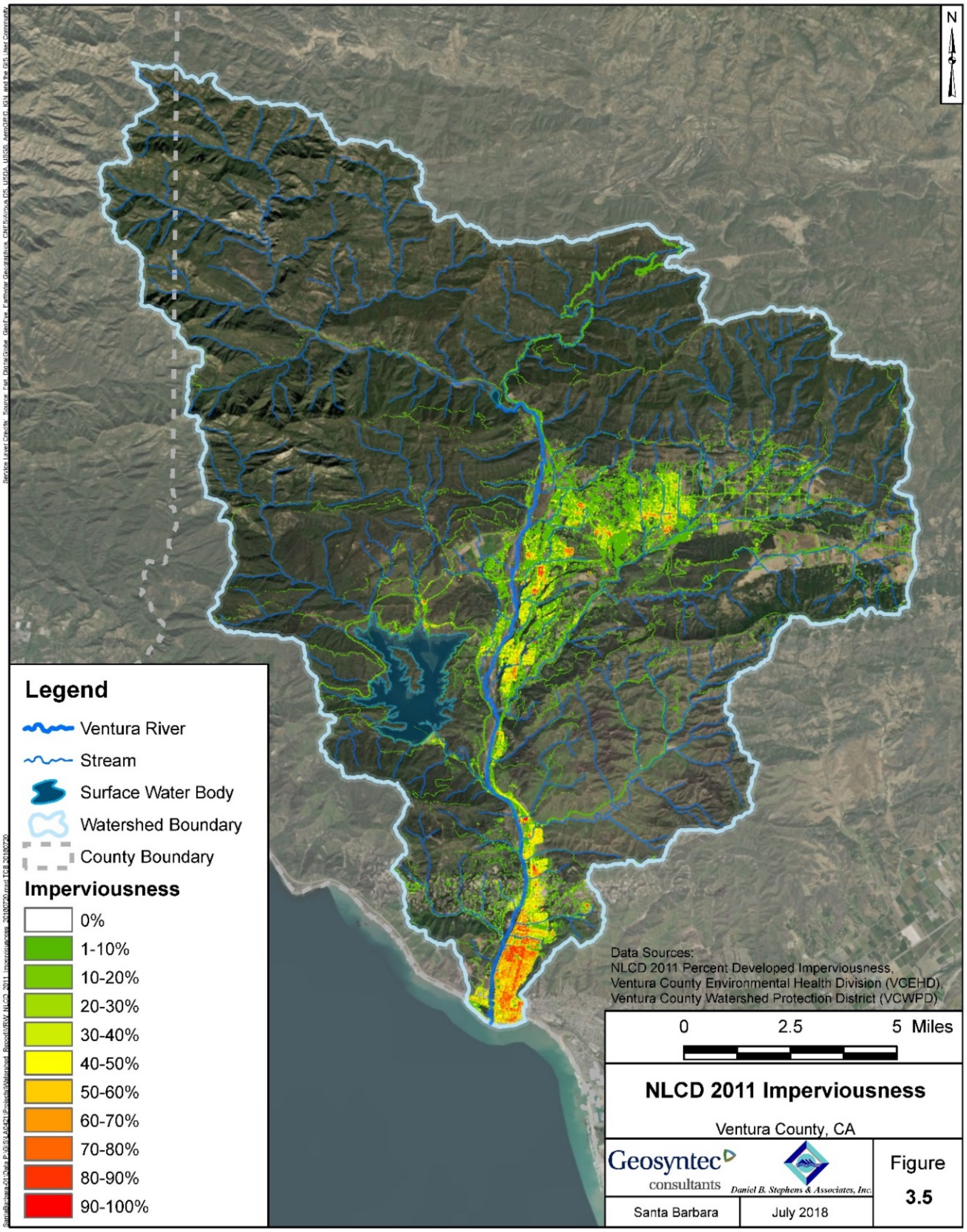


Figure 3.5 NLCD 2011 Imperviousness

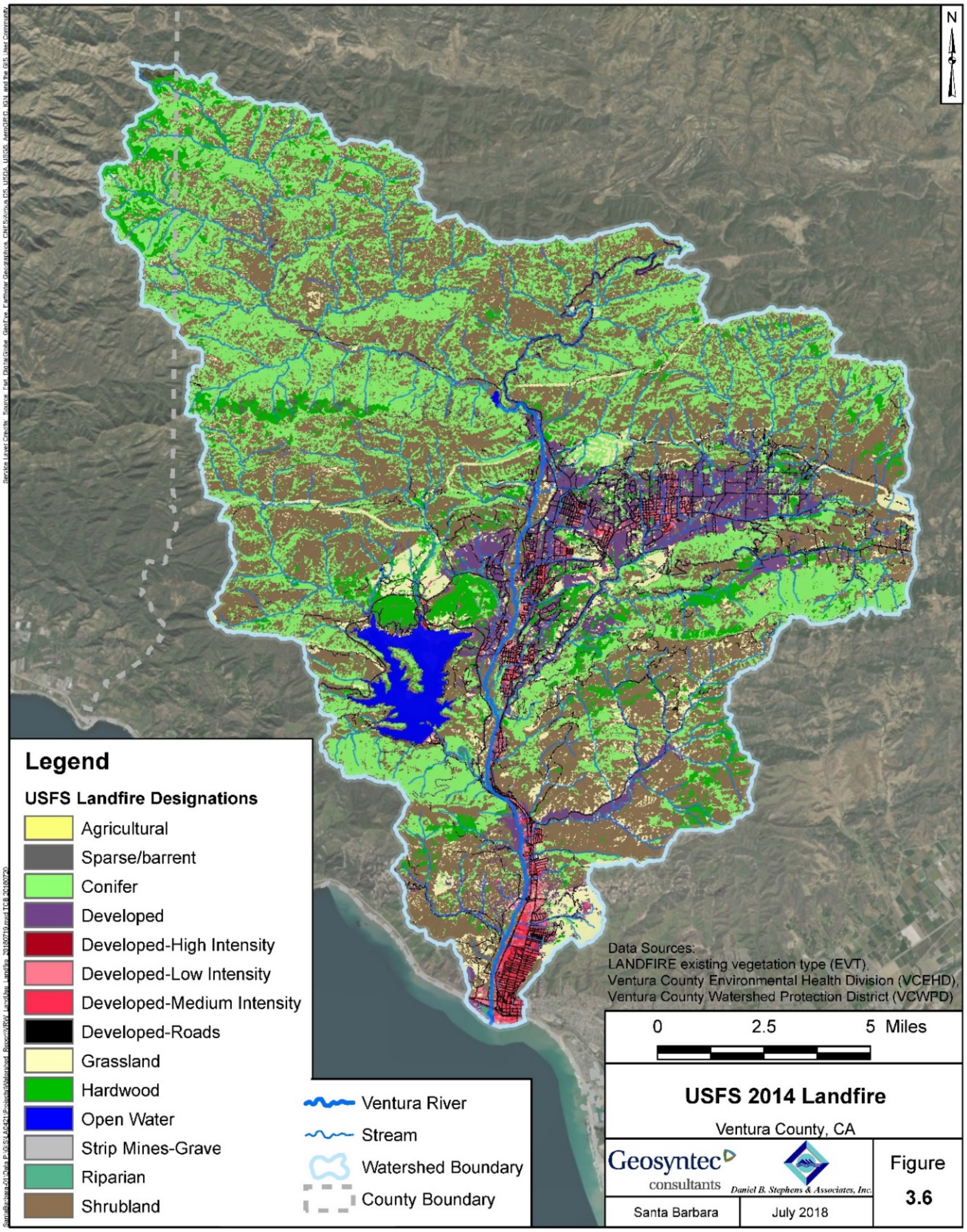


Figure 3.6 USFS 2014 Landfire

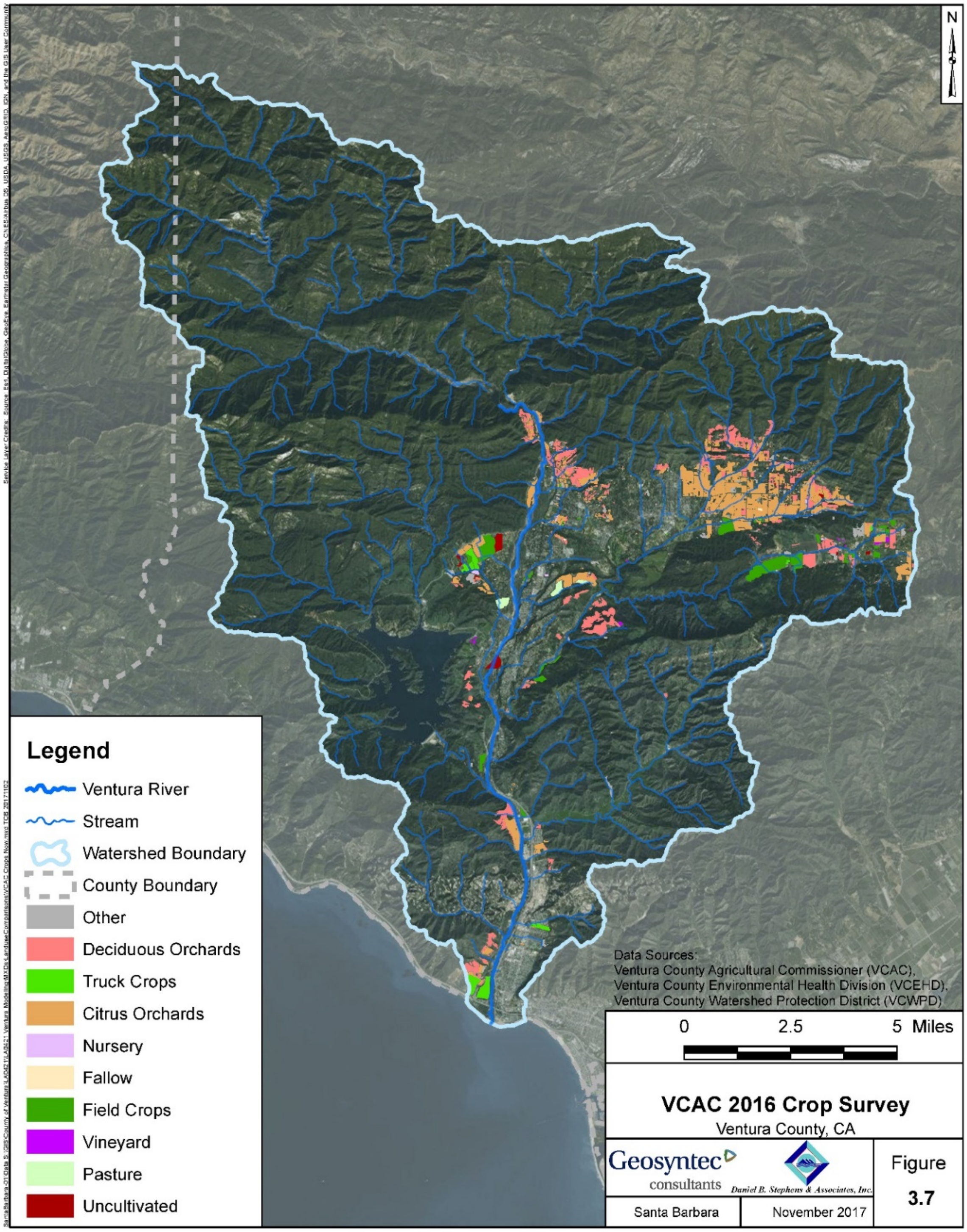


Figure 3.7 VCAC 2016 Crop Survey

3.4 Soils

Soil data for the VRW were available from the United States Department of Agriculture (USDA) National Resource Conservation Service (NRCS) Soil Survey Geographic Database (SSURGO) [18]. Soil information, including the available water capacity, percent of sand, silt, and clay, and the saturated hydraulic conductivity, are used to determine soil zone parameters that influence surface runoff and infiltration for each HRU. SSURGO data were used to characterize the necessary soil properties for the VRW.

Figure 3.8 through Figure 3.13 illustrate the major soil-based characteristics of the VRW, to be used as input to PRMS.

[18] Soil Survey Geographic Database (SSURGO 2.2) - Digital soil survey that is generally the most detailed level of soil geographic data developed at the National Cooperative Soil Survey.

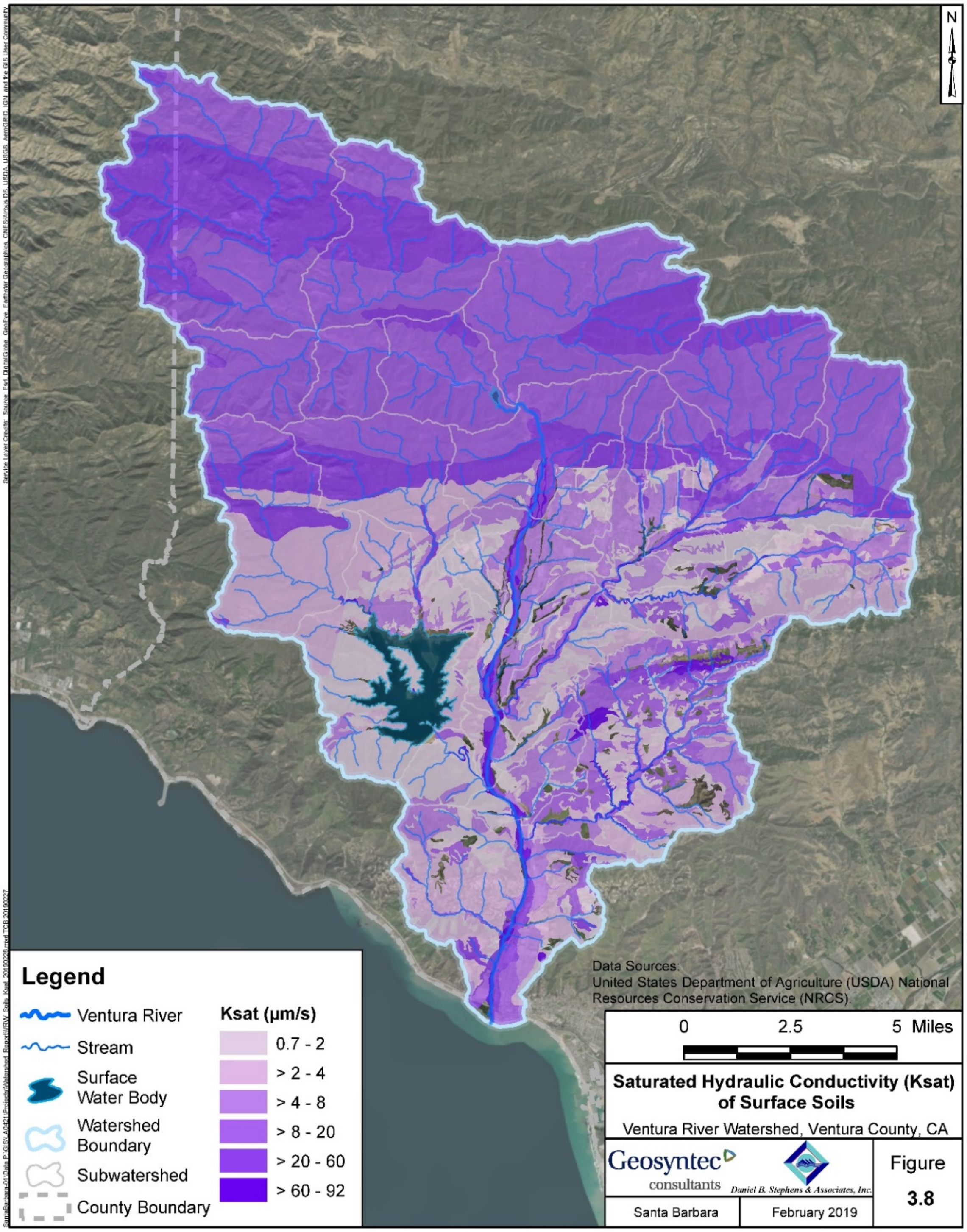


Figure 3.8 Saturated Hydraulic Conductivity (Ksat) of Surface Soils

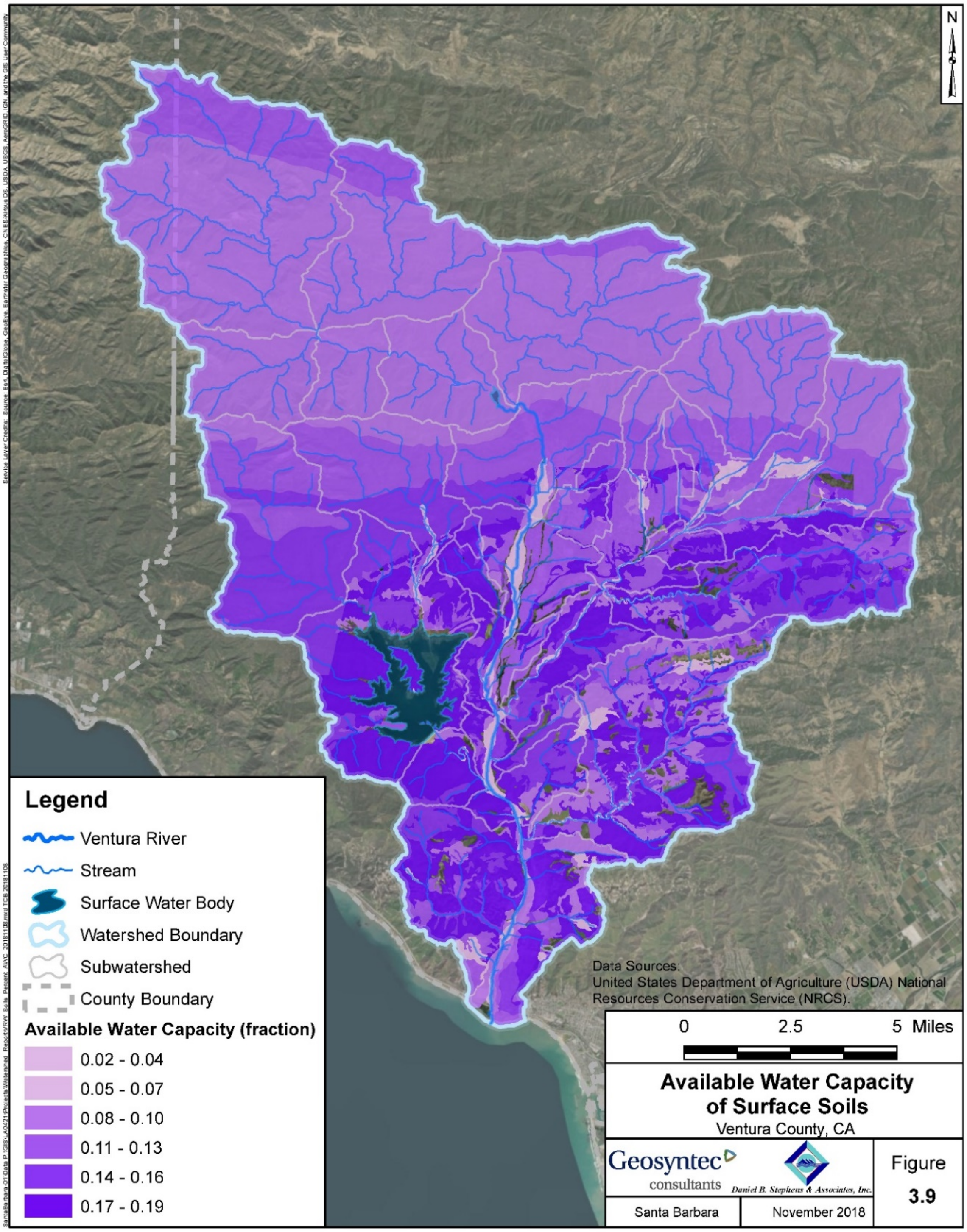


Figure 3.9 Available Water Capacity of Surface Soils

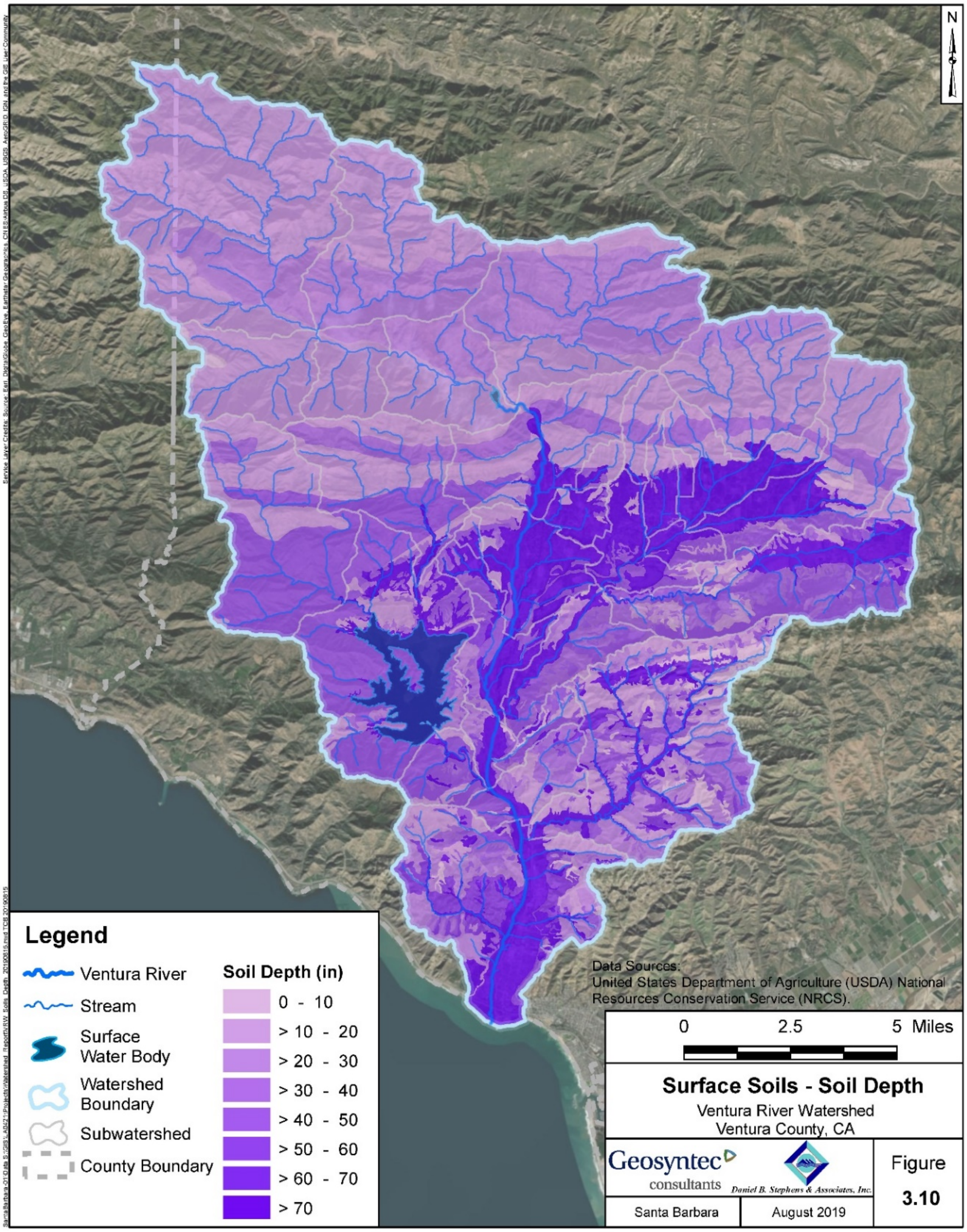


Figure 3.10 Surface Soils – Soil Depth

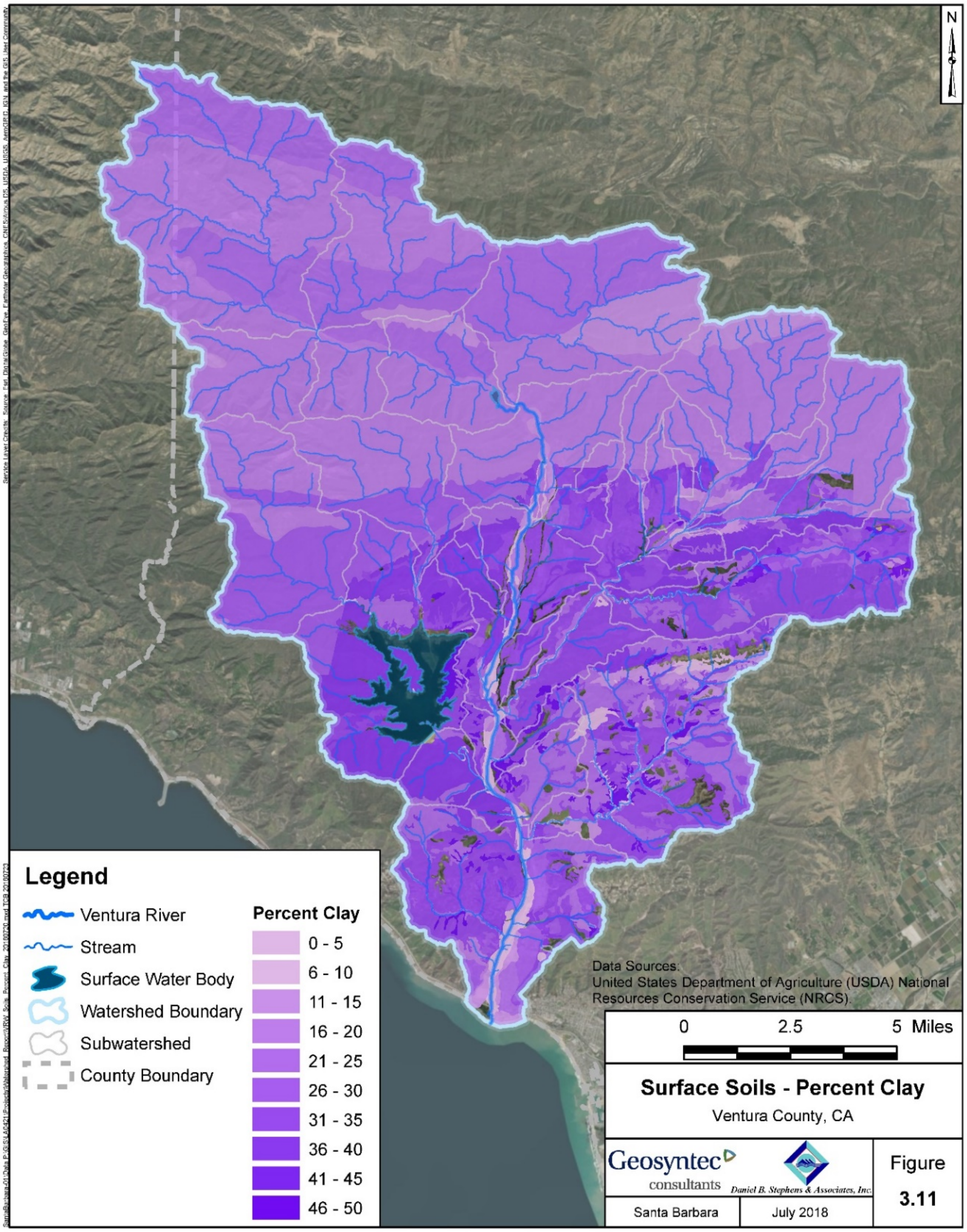


Figure 3.11 Surface Soils – Percent Clay

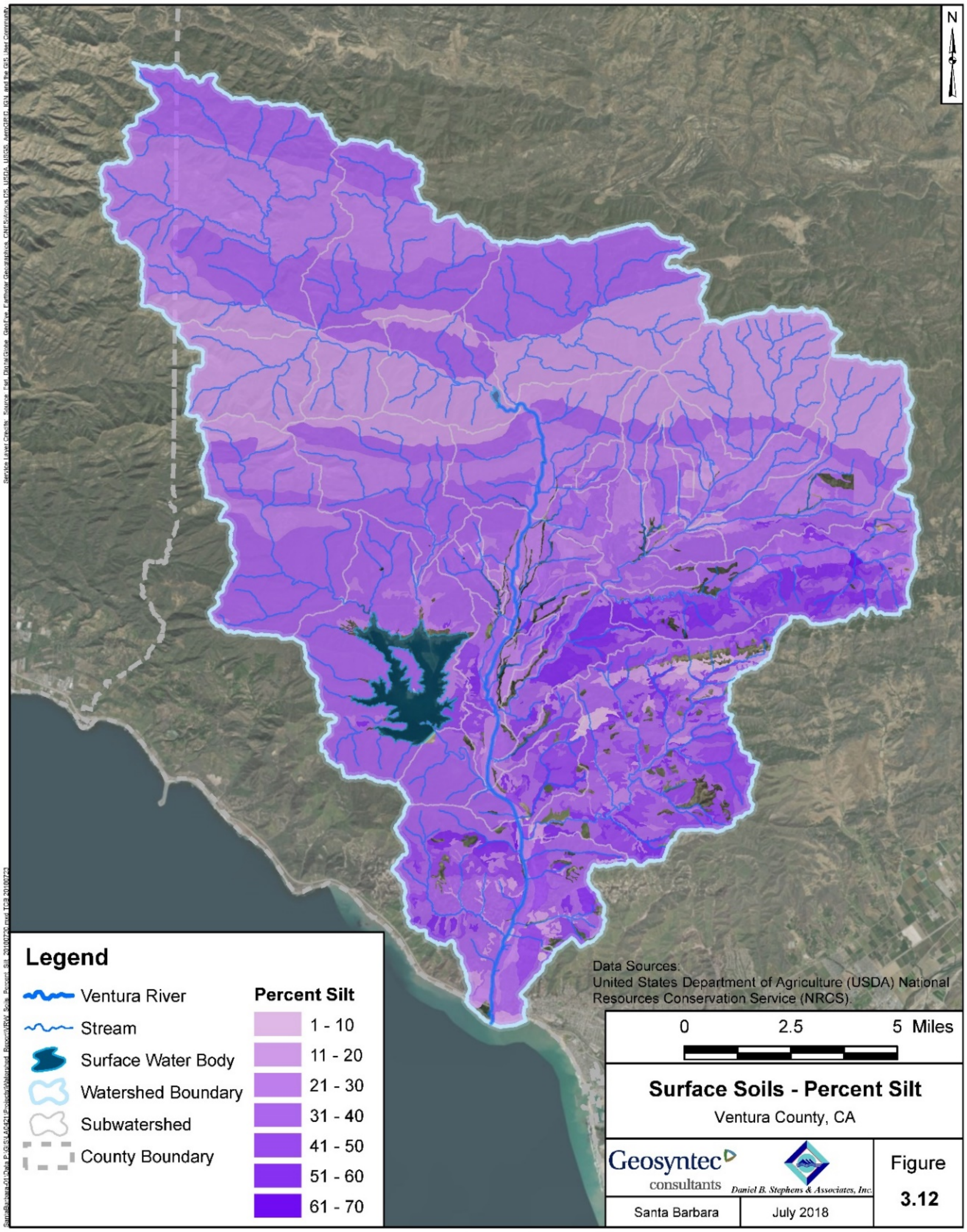


Figure 3.12 Surface Soils – Percent Silt

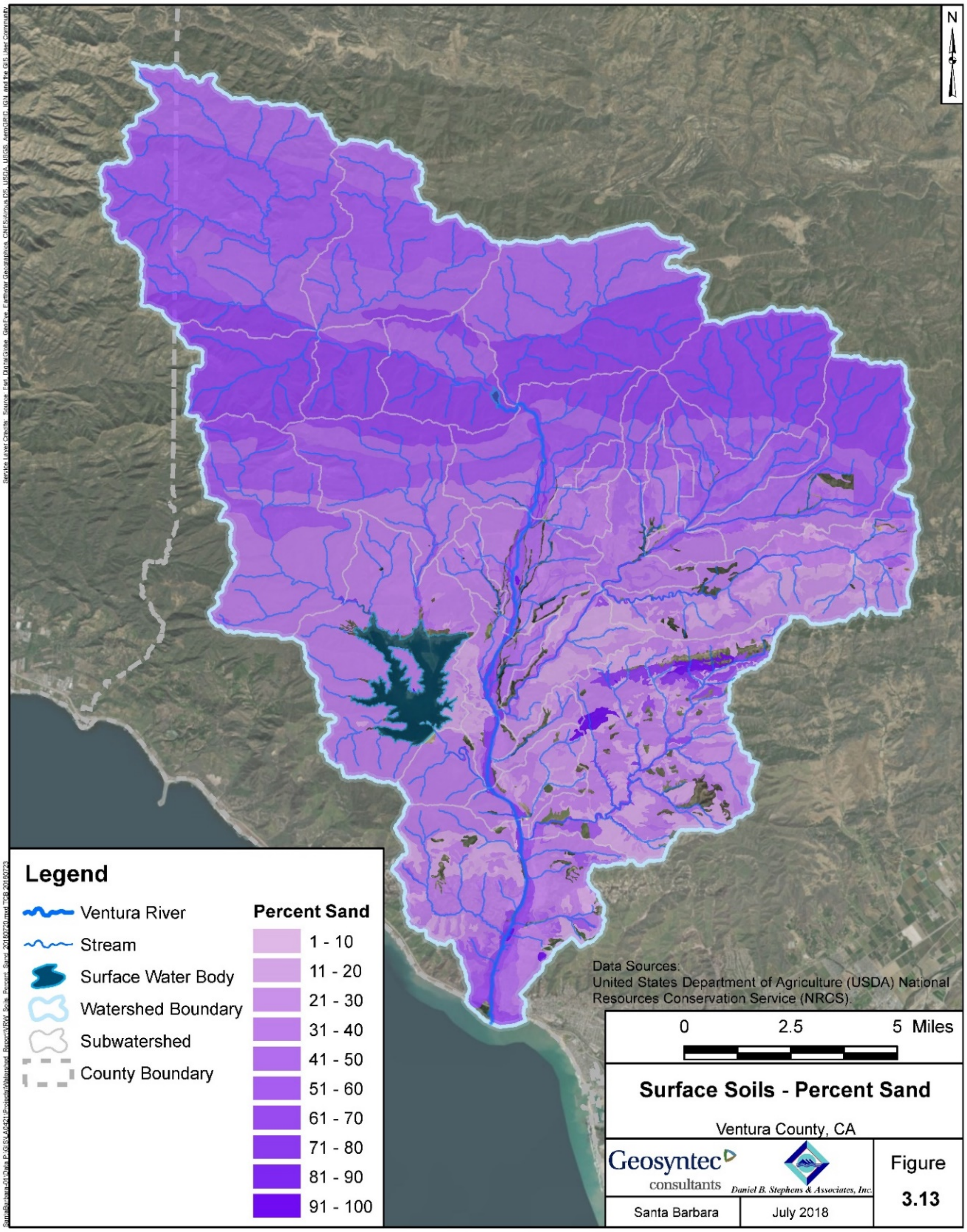


Figure 3.13 Surface Soils – Percent Sand

3.5 Topography

The land surface elevations throughout the VRW are shown in Figure 3.14, and a characterization of average slope is shown in Figure 3.15. These are based on a combination of a USGS National Elevation Database (NED) digital elevation model (DEM) (USGS, 2018) and Light Detection and Ranging (LiDAR) data (Ventura County Public Works Agency, 2005). The USGS DEM is at a 1/3 arc-second resolution, which are grids approximately 10 meters by 10 meters, and the LiDAR data consists of 10-foot by 10-foot cells. LiDAR data are used for a portion of the VRW, where available, and the USGS DEM is used to fill in remaining areas.

Elevation data are used to determine a mean land surface altitude and slope for each HRU, in addition to determining the stream network and connectivity (as discussed in the project Study Plan).

3.6 Lakes and Reservoirs

There are two major lakes/reservoirs in the VRW: Lake Casitas and Matilija Reservoir (Figure 3.16).

Lake Casitas was created in 1959 by the construction of Casitas Dam on Coyote Creek. Lake Casitas has an estimated active capacity of 251,000 acre-ft and storage capacity of 254,000 acre-ft (Tetra Tech, 2009) and provides irrigation, municipal, and industrial water to CMWD. The lake also serves as a popular recreation area. In addition to flow from Coyote Creek, both Santa Ana and North Fork Coyote creeks flow into the lake. The Ventura River may also be diverted into the lake via the Robles-Casitas Canal (see Section 3.7).

CMWD records daily data for Lake Casitas, including elevation (Figure 3.17), surface area, storage volume (Figure 3.18), inflow (through direct inflow and diversion from the Ventura River), evaporation, precipitation, releases (to the main system for use, to the river, and spills over the dam), and a calculated storage change. These daily information will be used to model the inflow and outflow to Lake Casitas throughout the modeling period.

Matilija Creek drains the Santa Ynez mountains and is impounded by the Matilija Dam to create the Matilija Reservoir. Matilija Dam was constructed by the Ventura County Flood Control District in 1947 for flood control and water supply purposes. The original storage capacity behind the dam was 7,018 acre-ft. Due to sedimentation and lowering of the dam (because of corrosion), the original storage capacity provided by the dam has been reduced significantly.

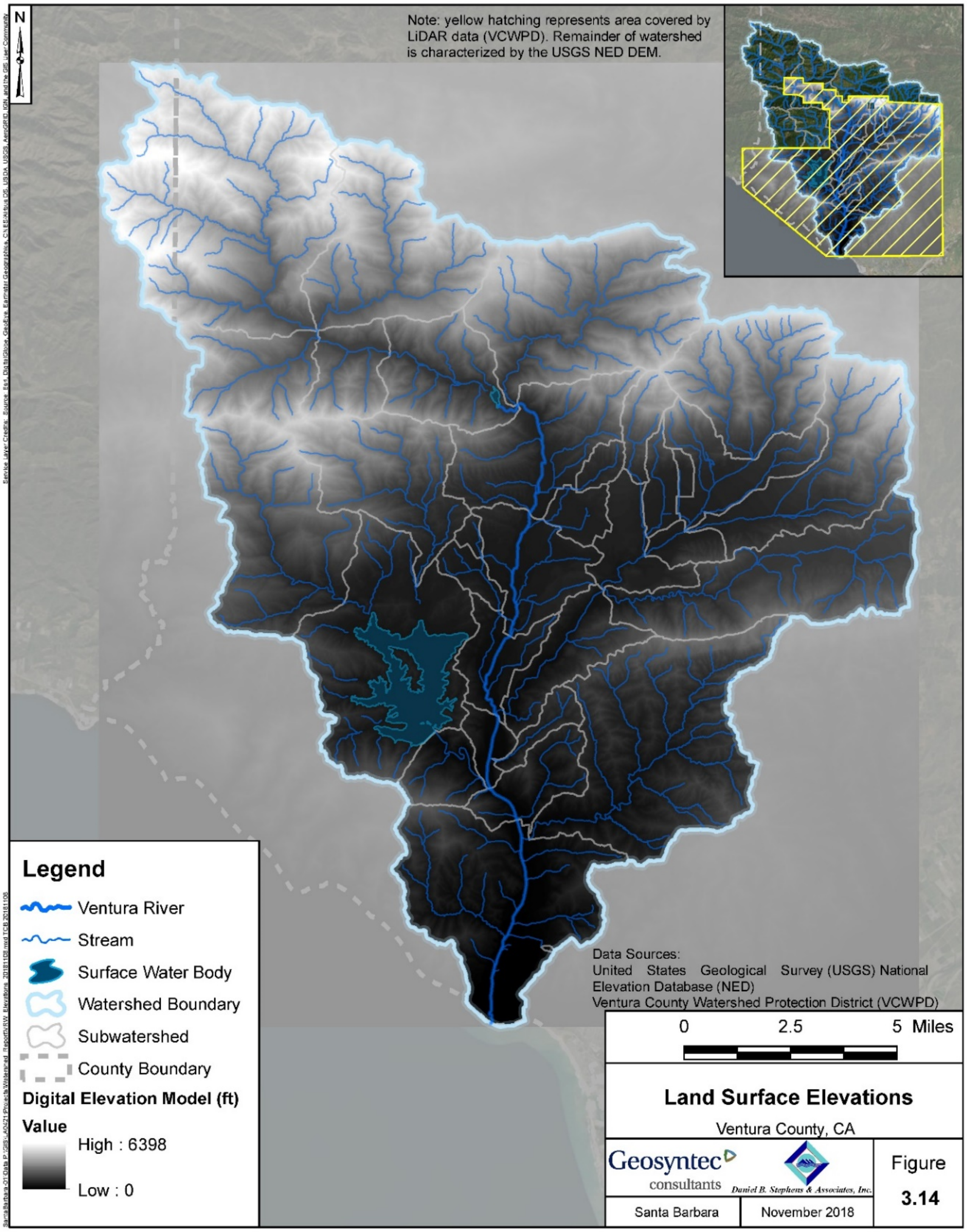


Figure 3.14 Land Surface Elevations

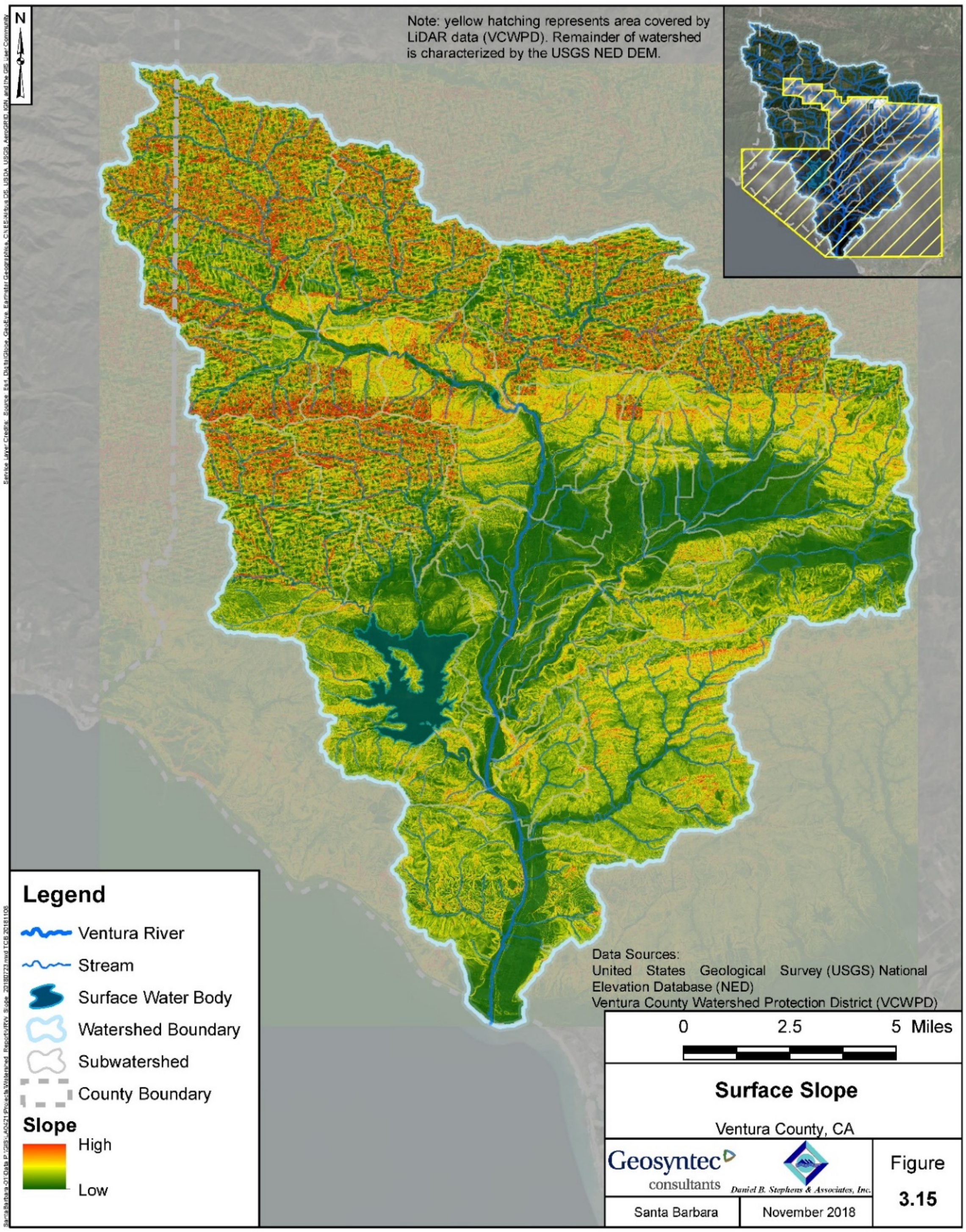


Figure 3.15 Surface Slope

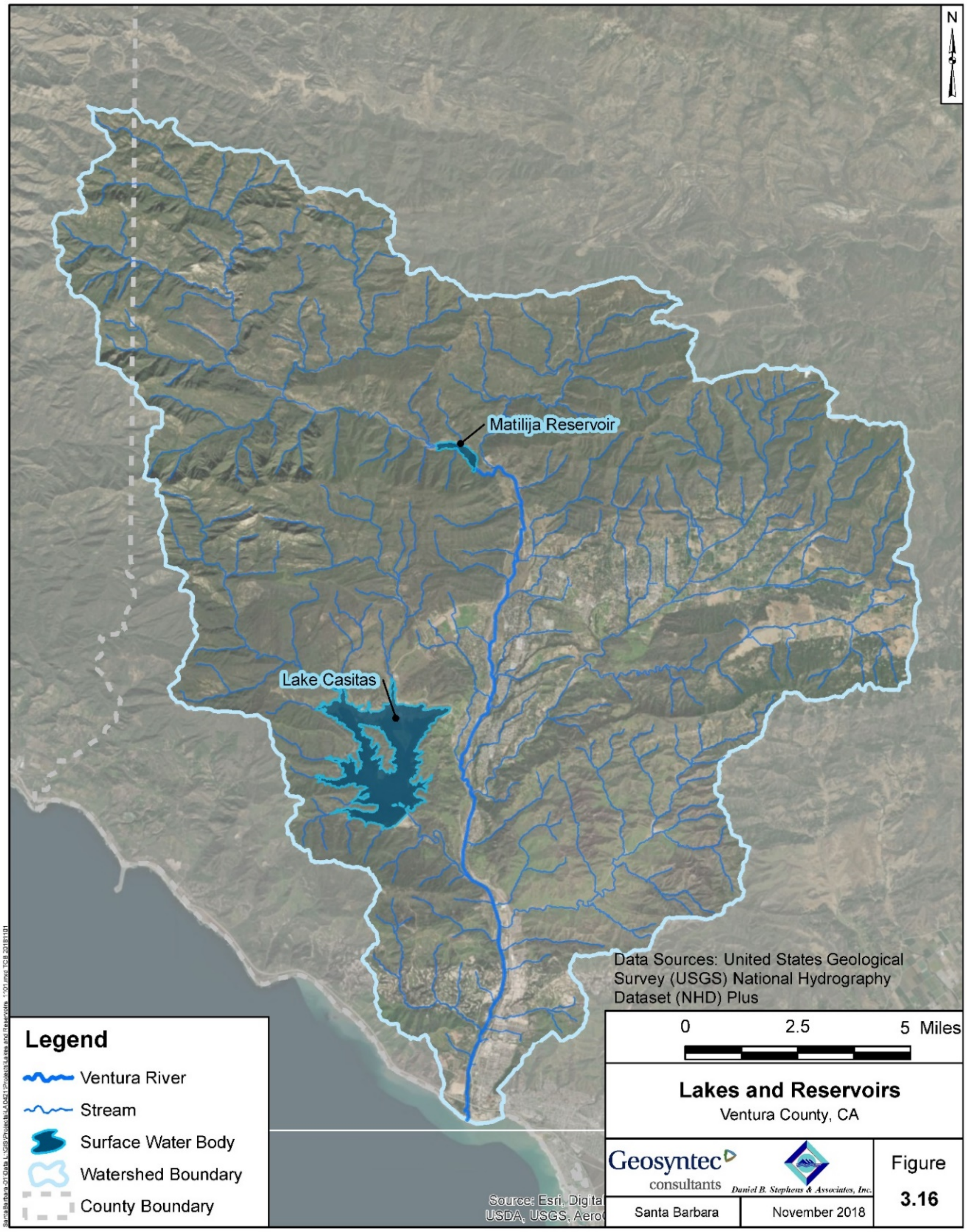
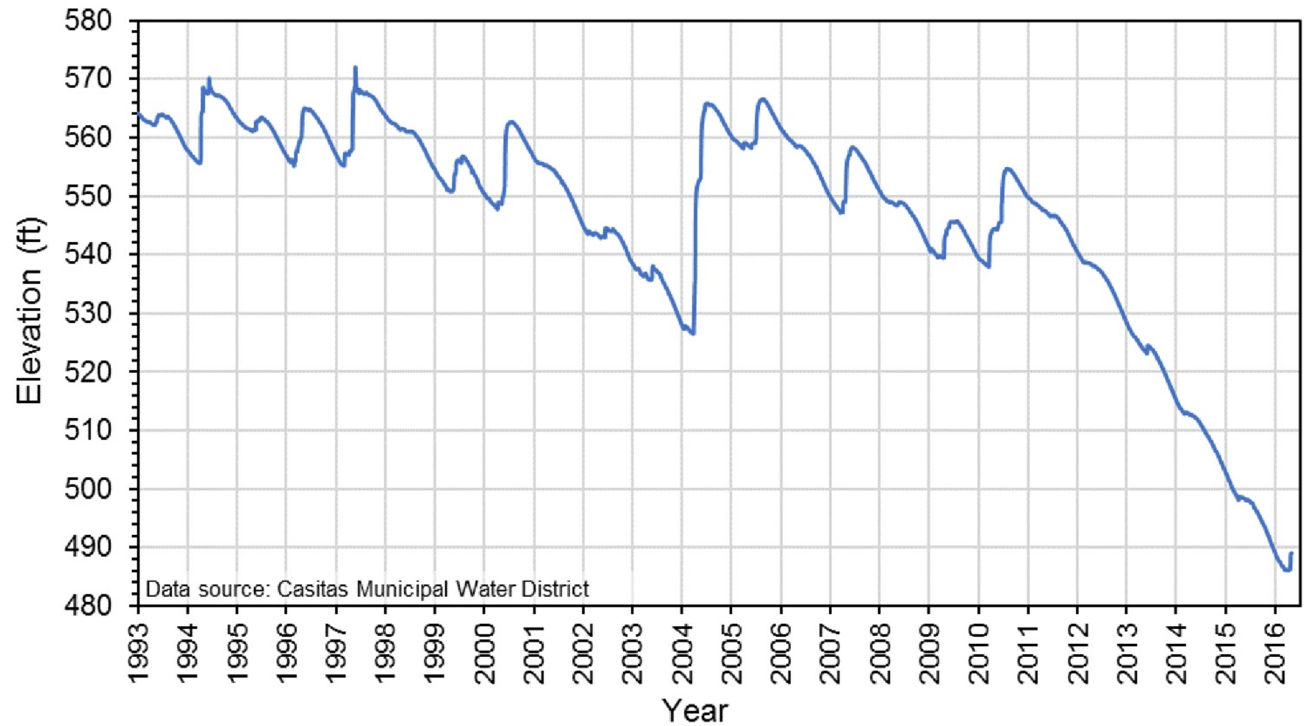
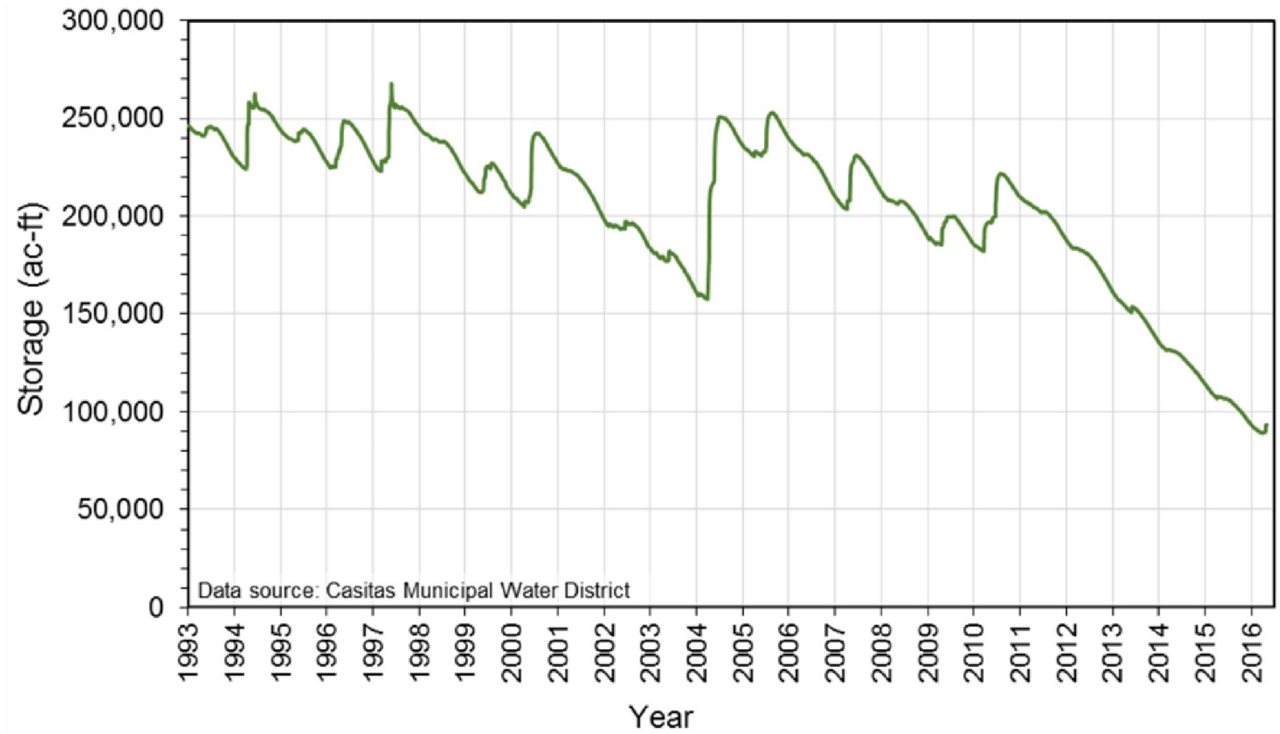


Figure 3.16 Lakes and Reservoirs



Lake Casitas Elevation Ventura County, CA		
Geosyntec consultants / Daniel B. Stephens & Associates, Inc.		Figure **3.17**
Santa Barbara	November 2018	

Figure 3.17 Lake Casitas Elevation



Lake Casitas Storage Ventura County, CA		
Geosyntec consultants / Daniel B. Stephens & Associates, Inc.		Figure **3.18**
Santa Barbara	November 2018	

Figure 3.18 Lake Casitas Storage

The current dam capacity is estimated to be approximately 500 acre-ft (USEPA Region 9, 2012; VCWPD, 2018a). The total effective storage, which includes both surface water and a volume of shallow groundwater storage that can be slowly drained, in Matilija Reservoir is approximately 3,200 acre-ft (Tetra Tech, 2009). Data availability for storage and discharge of the Matilija Reservoir is somewhat limited. Water surface elevations are reported by the CMWD (but with many missing records) for a portion of the modeling period and data are only available in hardcopy format before 2003. The elevations for available electronic records at the Matilija reservoir are shown in Figure 3.19.

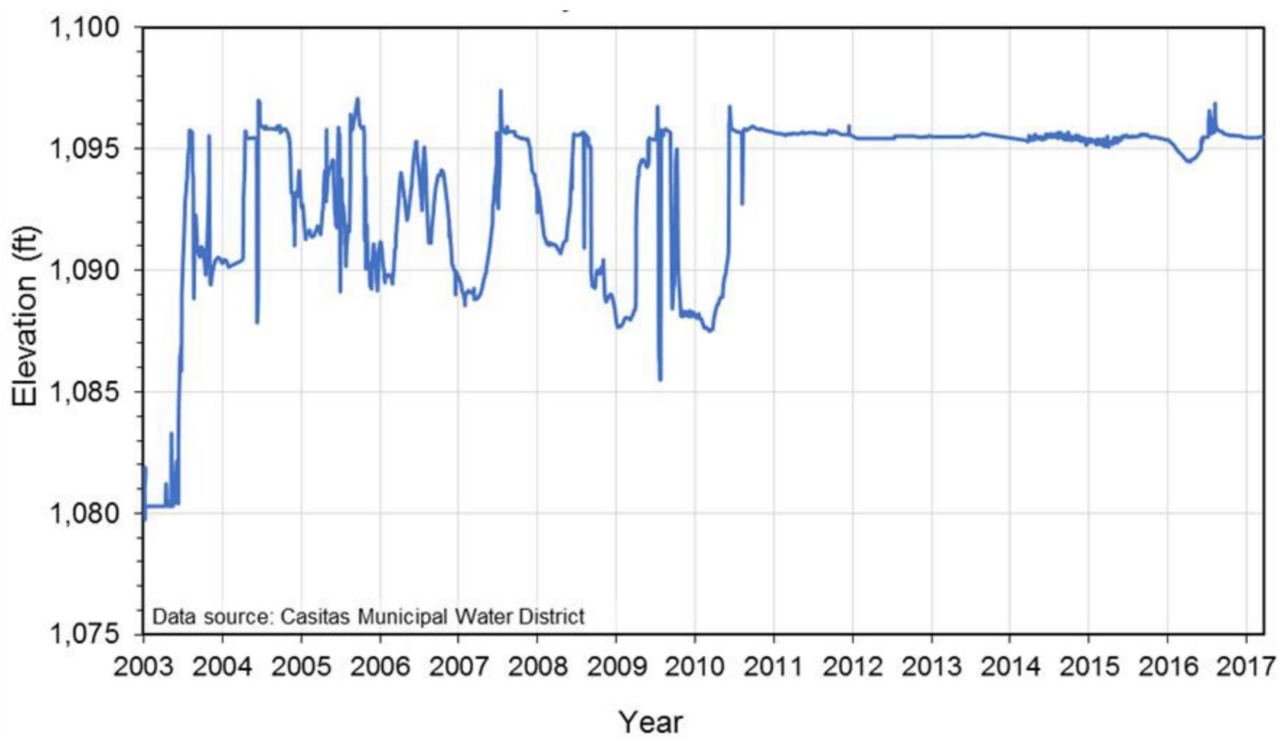
PRMS requires the boundaries or extent of waterbodies to be defined so that the HRUs within the waterbodies can be designated as “lake” HRUs. The average water surface elevations of 546 feet for Lake Casitas (based on data from October 1993 to January 2017) and 1,093 feet for Matilija Reservoir (based on available data from July 2003 through September 2017) were used to define these boundaries as illustrated in Figure 3.20 (Lake Casitas) and Figure 3.21 (Matilija Reservoir).

3.7 Diversions

The Robles Diversion Dam and Robles-Casitas Canal were constructed during 1958-1959 and are located two miles downstream of the Matilija Dam. The Robles diversion is operated by the CMWD and routes flow from the Ventura River to Lake Casitas through the Robles-Casitas Canal.

The bypass flow pattern at the Robles Diversion closely duplicates the surge of water with large storms and follows with a gradual reduction in flow in the days following a rain event (USEPA Region 9, 2012). The CMWD operates a streamflow gage station at the Robles-Casitas Canal. Measured daily flow data in the canal are available for the entire modeling period and are summarized in Figure 3.22 (as daily total volume diverted). The model will account for the diversion as an outflow from the Ventura River, based on this measured historical data, and the diverted water will be added into Lake Casitas as inflow.

The Live Oak and Rancho Matilija diversions both reroute flow in upper Live Oak Creek to the Ventura River. The Rancho Matilija Diversion was constructed in 1983, and the Live Oak diversion started redirecting flow to the Ventura River in 2002. No streamflow gaging data are available for these diversions. However, all flow from the reach is assumed to be diverted to the Ventura River at the diversion. Starting in late 2002, the Live Oak diversion diverted flows between 20 and 800 cubic feet per second (cfs) to the Ventura River via a



Matilija Reservoir Elevations Ventura County, CA		
Geosyntec consultants / Daniel B. Stephens & Associates, Inc.		Figure **3.19**
Santa Barbara	November 2018	

Figure 3.19 Matilija Reservoir Elevations

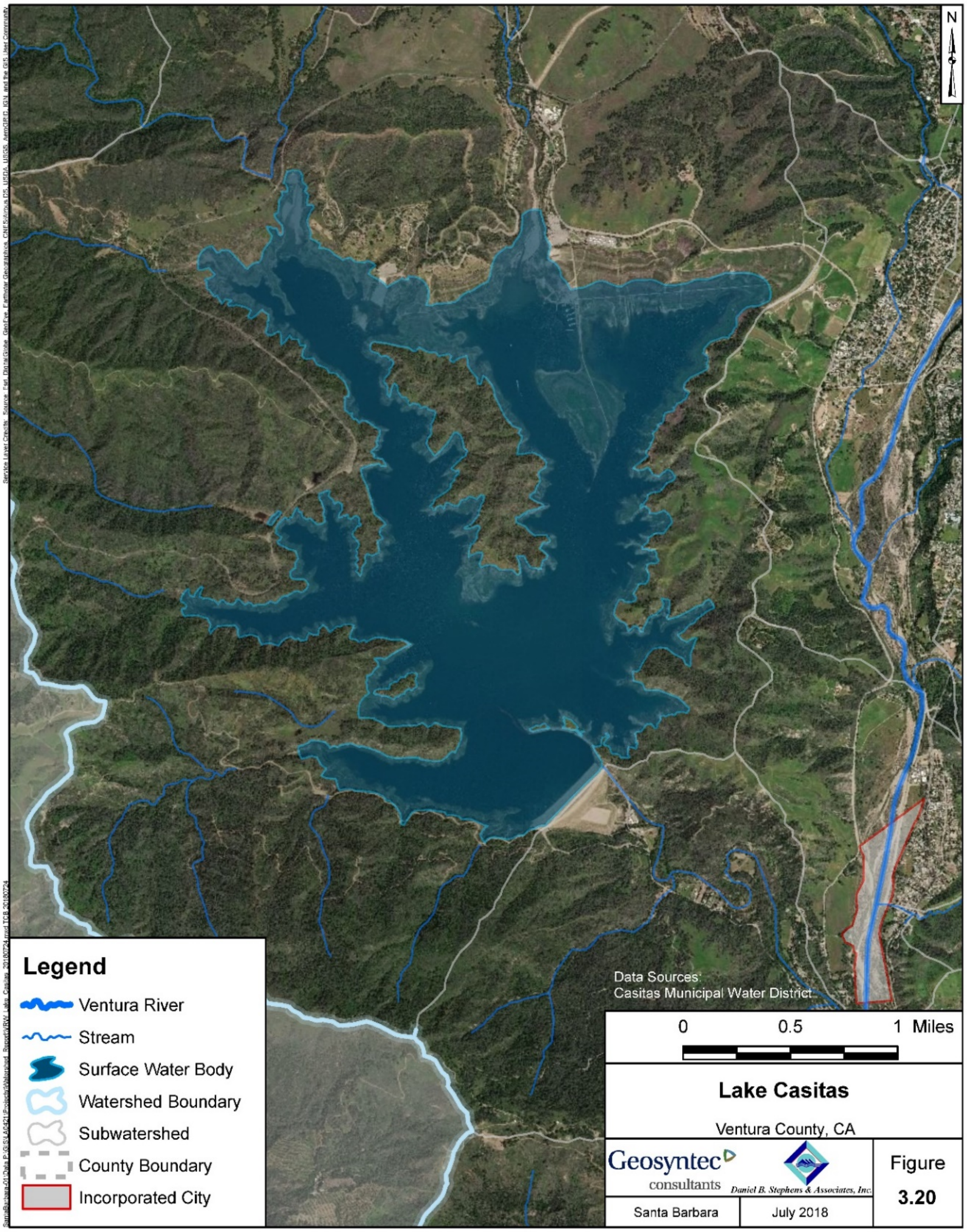


Figure 3.20 Lake Casitas

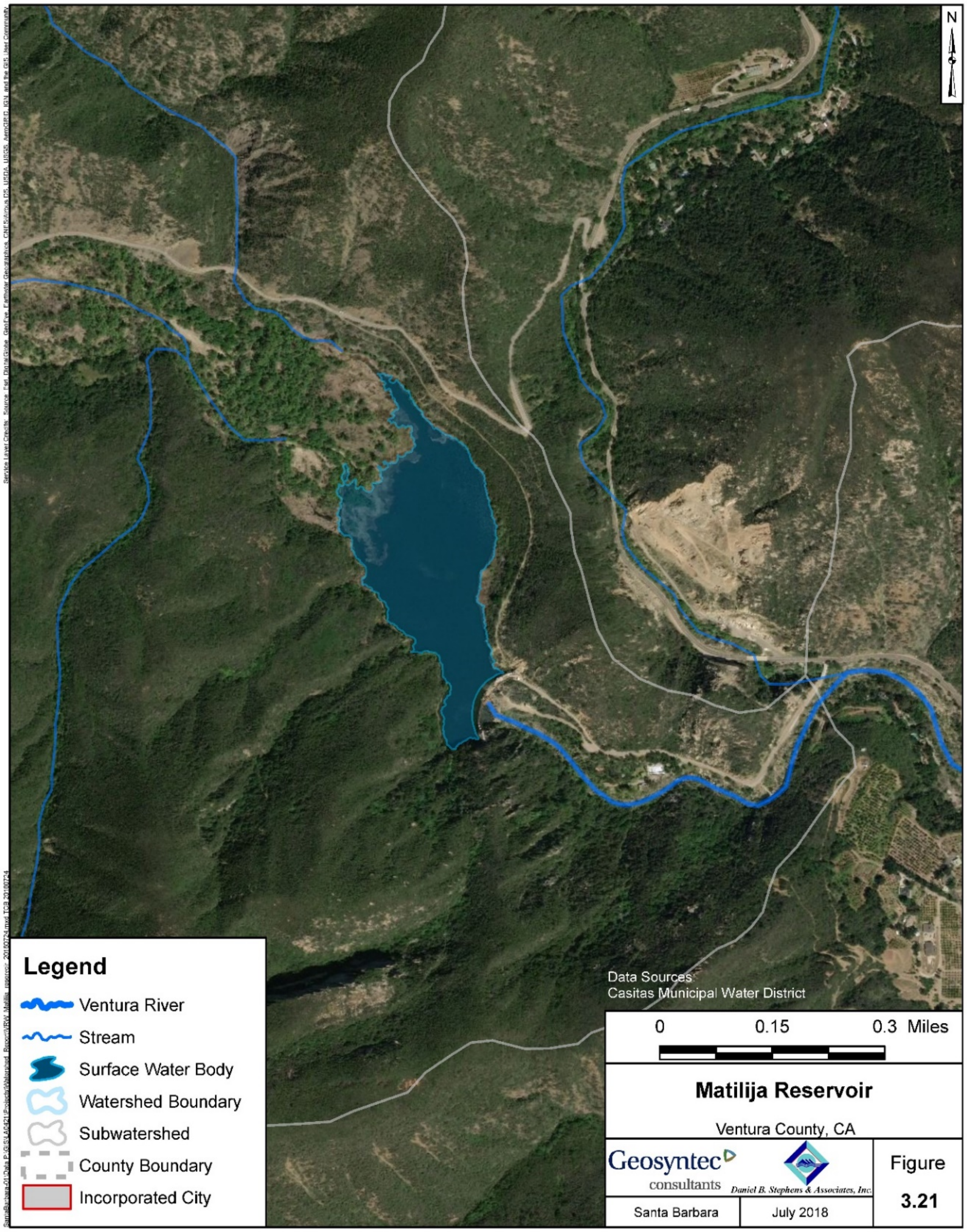
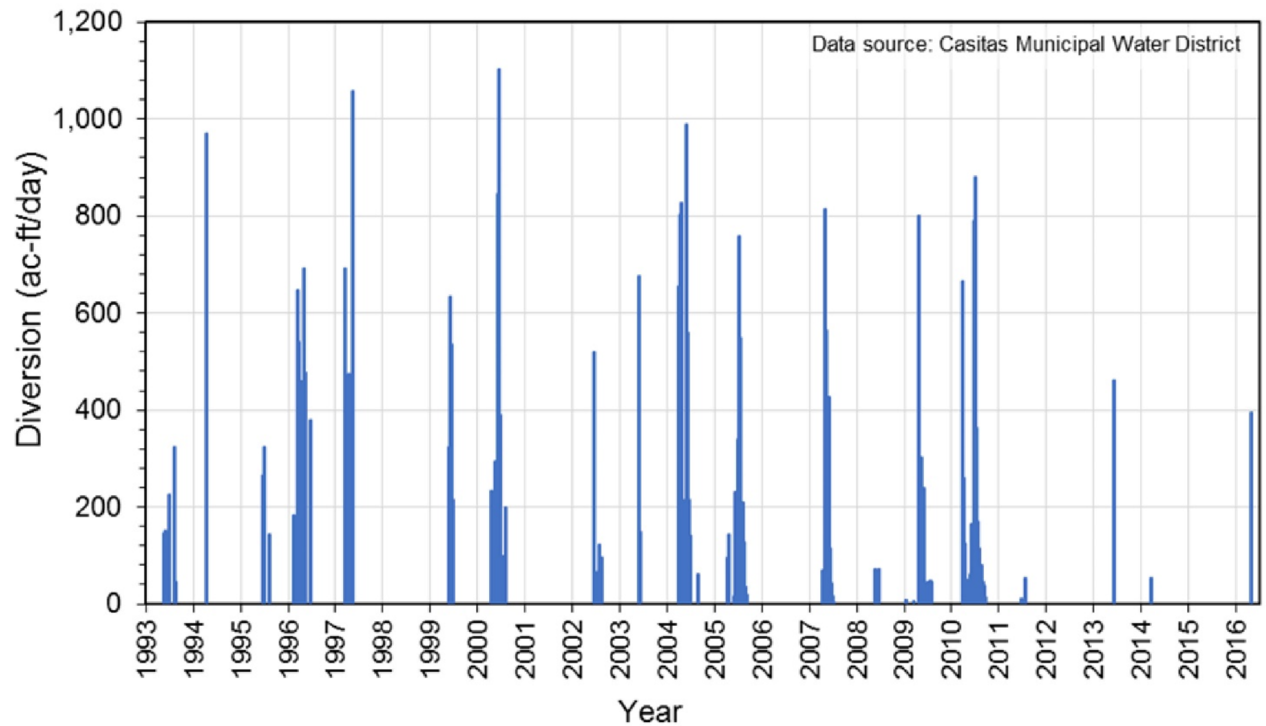


Figure 3.21 Matilija Reservoir



Diversion from the Ventura River to Lake Casitas Ventura County, CA		
Geosyntec consultants	Daniel B. Stephens & Associates, Inc.	Figure **3.22**
Santa Barbara	November 2018	

Figure 3.22 Diversion from the Ventura River to Lake Casitas

detention basin. Flows that are less than 20 cfs and greater than 800 cfs are not diverted (Tetra Tech, 2009).

In addition to these major diversions, there are 29 surface water diversions within the VRW. The State Water Board's Division of Water Right's eWRIMS database (Figure 3.23) contains self reported monthly direct diversion, water storage, and water use volumes for each of the surface water diversions in the VRW. These data are available from 2010 through 2017. Surface water diversion will be implemented into the PRMS model as withdrawals from streams. Data prior to 2010 will be estimated based on comparisons of pumping records and irrigation demands.

The State Water Board's Division of Water Right's eWRIMS data will be cross-checked and augmented with data from the State Water Board's DDW. The DDW data include self reported monthly volumes for surface water diversions, groundwater pumping, purchases, and sales for municipal water suppliers[19].

3.8 Stream Network

The major tributaries of the Ventura River include Matilija Creek, North Fork Matilija Creek, San Antonio Creek, Coyote Creek, and Cañada Larga. The stream network to be used for the model will be developed based upon the topographic data as described in the project Final Study Plan (Geosyntec and DBS&A, 2019). Comparisons of the network to the USGS National Hydrography Dataset (NHD) Plus stream file (Figure 3.24) will be made to ensure consistency with known channel locations, particularly within flatter areas.

3.9 Evapotranspiration

PRMS utilizes potential evapotranspiration (ET) with other model components (e.g., soil moisture) to compute the actual ET. There are limited direct ET data within the VRW, with California Irrigation Management Information System (CIMIS) measurements only available outside the watershed. Therefore, the

[19] Meiners Oaks Water District, Golden State Water Company, Ventura Water Department, Ventura River Water District, Casitas Mutual Water Company, Senior Canyon Mutual Water Company, Siete Robles Mutual Water Company, Sisar Mutual Water Company, Tico Mutual Water Company, and Krotona Institute.

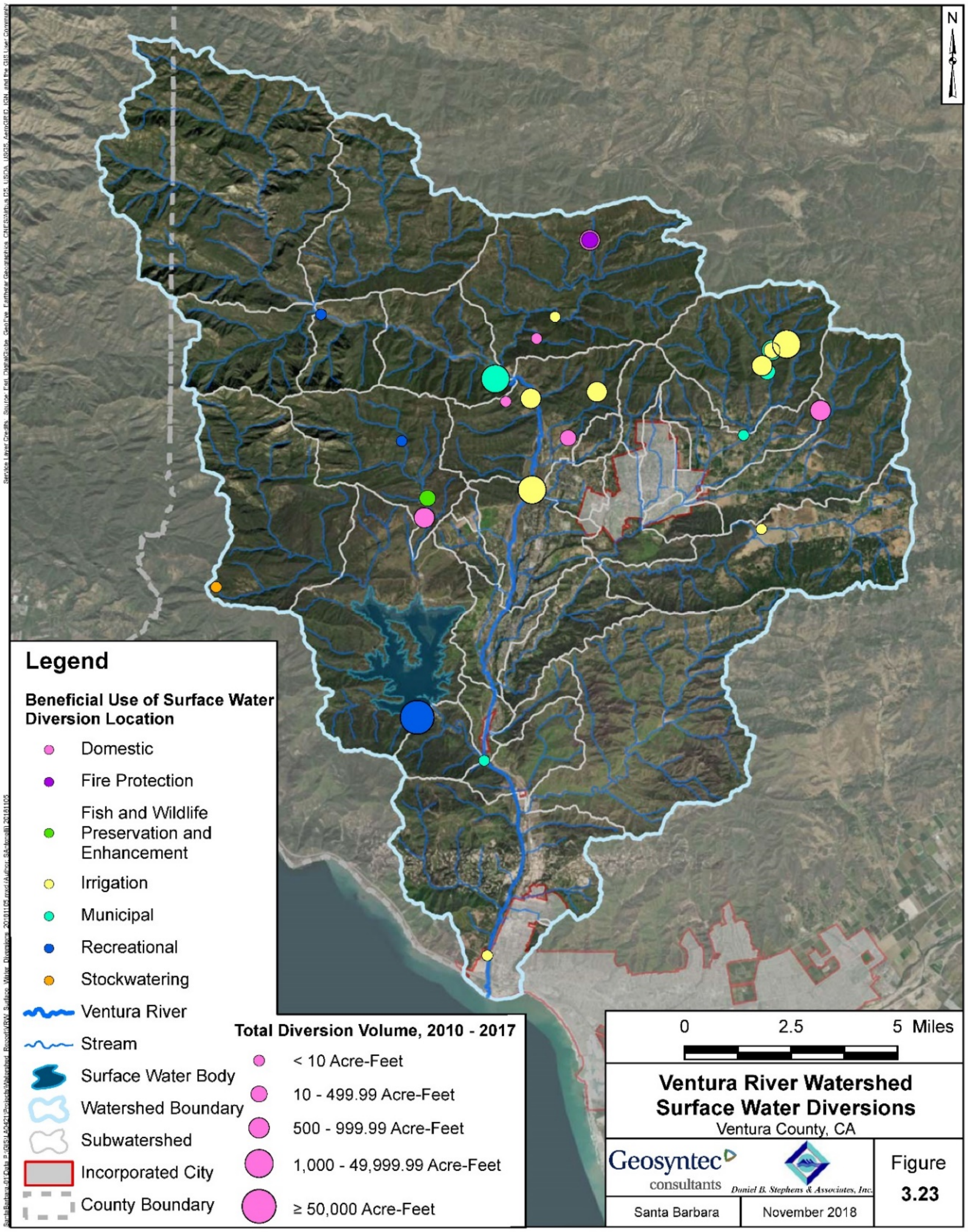


Figure 3.23 Ventura River Watershed Surface Water Diversions

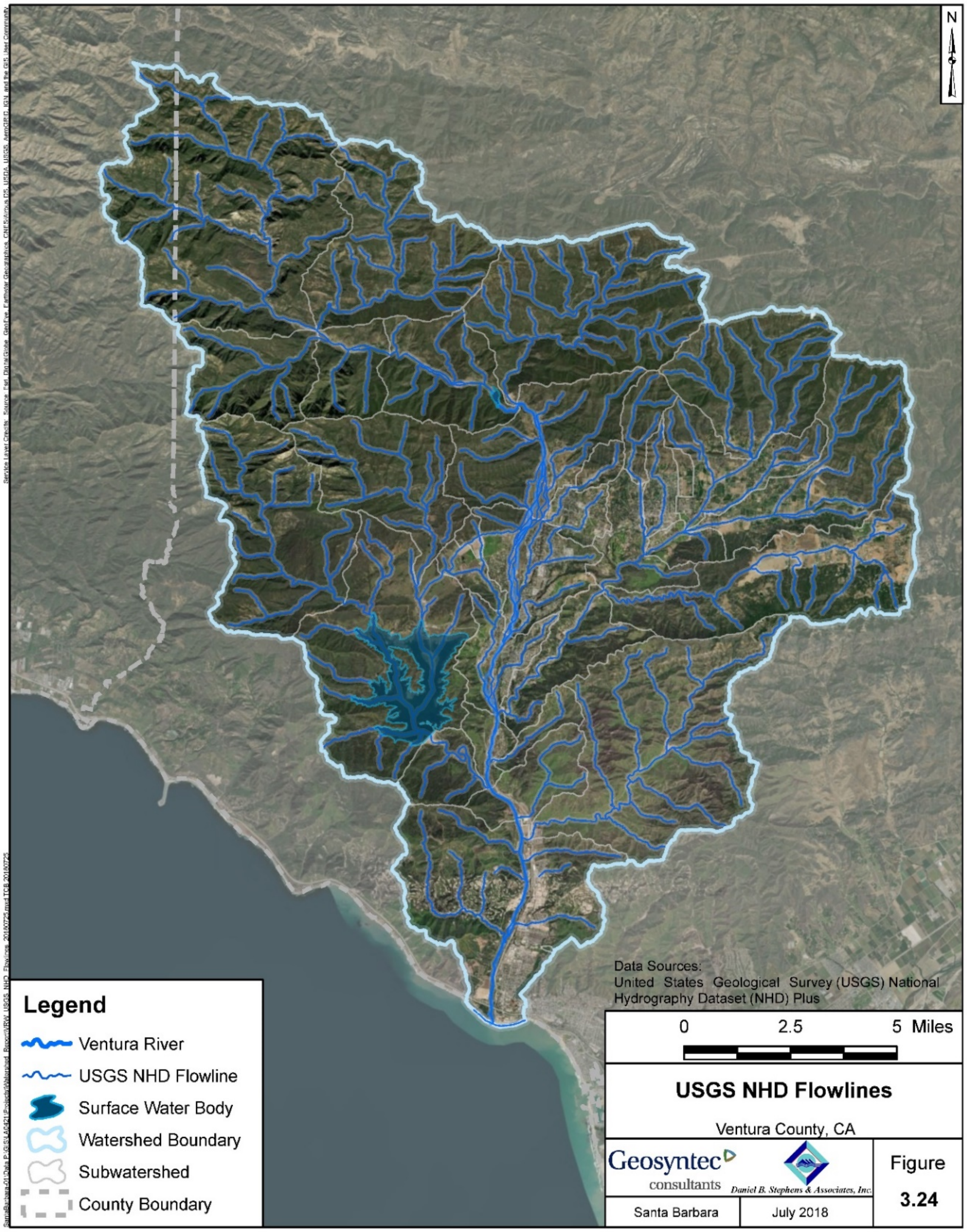


Figure 3.24 USGS NHD Flowlines

model will estimate potential ET using methods provided in PRMS and as discussed in the project Final Study Plan (Geosyntec and DBS&A, 2019).

The VRW falls predominantly within the CIMIS Eto Zone 10, with smaller parts of the watershed to the East in Zone 14 and to the South in Zone 4, as indicated in Figure 3.25. The monthly average values for Eto are also provided in the figure, and these reference ET values will be used as checks on the PRMS model algorithms and inputs.

3.10 Debris and Detention Basins

There are four major debris and detention basins in the VRW to help alleviate risks from flash flood and debris flows (especially near the steep headwaters of the Ventura River). These include the McDonald Canyon detention basin, the San Antonio Creek debris basin, Stewart Canyon debris basin, and the Dent debris basin (Tetra Tech, 2009). The Dent debris basin has a very small drainage area. The San Antonio Creek debris basin was constructed in the 1980's following a fire and has not been maintained since. The basin has filled in to the point where it is unrecognizable and deemed obsolete by VCWPD (Tetra Tech, 2009). Therefore, these two basins are not included in the model.

The McDonald Canyon debris basin was constructed in 1998 by VCWPD and has an approximate flood storage capacity of 14.5 acre-ft above the debris storage volume. The surface area encompasses 2.6 acres and drains an area of approximately 573 acres. The Stewart Canyon debris basin was constructed in 1963 by the US Army Corps of Engineers. It has approximately 65 acre-ft of flood storage (to the emergency spillway), encompasses a footprint of 10 acres, and drains approximately 1,266 acres. Both basins have stage-storage and stage-discharge data available (VCWPD, 2018a), and their locations are shown in Figure 3.26. These basins are expected to have minimal effect on hydrology and limited to during extreme flood events only.

3.11 National Pollutant Discharge Elimination System Discharges to Surface Water

The Ojai Valley Wastewater Treatment Plant (WWTP) discharges into the Ventura River in the Lower Ventura River Basin. The WWTP discharge is permitted through National Pollutant Discharge Elimination System (NPDES) permit No. CA0053961 and discharges into the Ventura River approximately 3,000 feet upstream of the river's confluence with Cañada Larga (shown in Figure 3.27). The WWTP has a capacity of three million gallons per day (mgd)

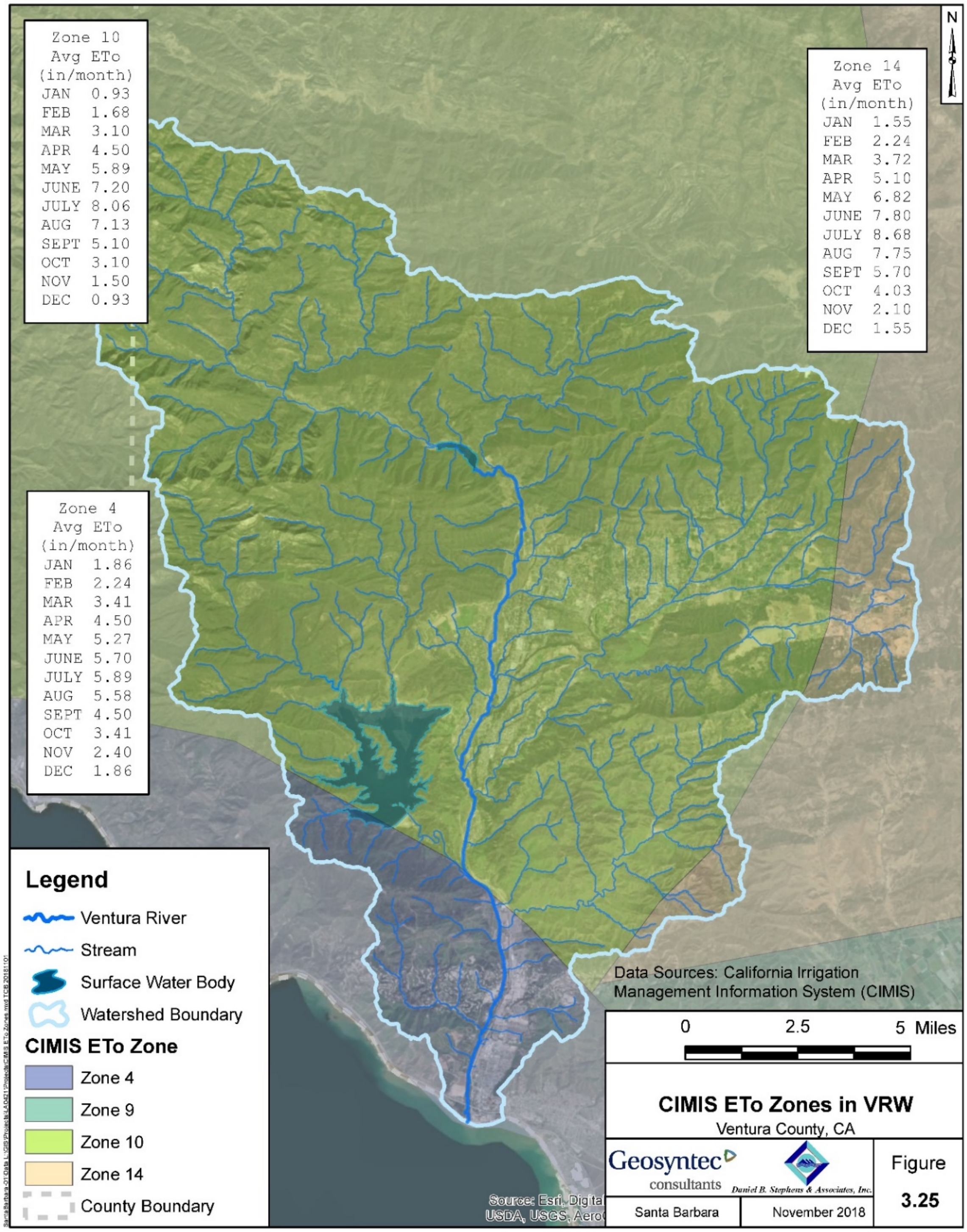


Figure 3.25 CIMIS ETo Zones in VRW

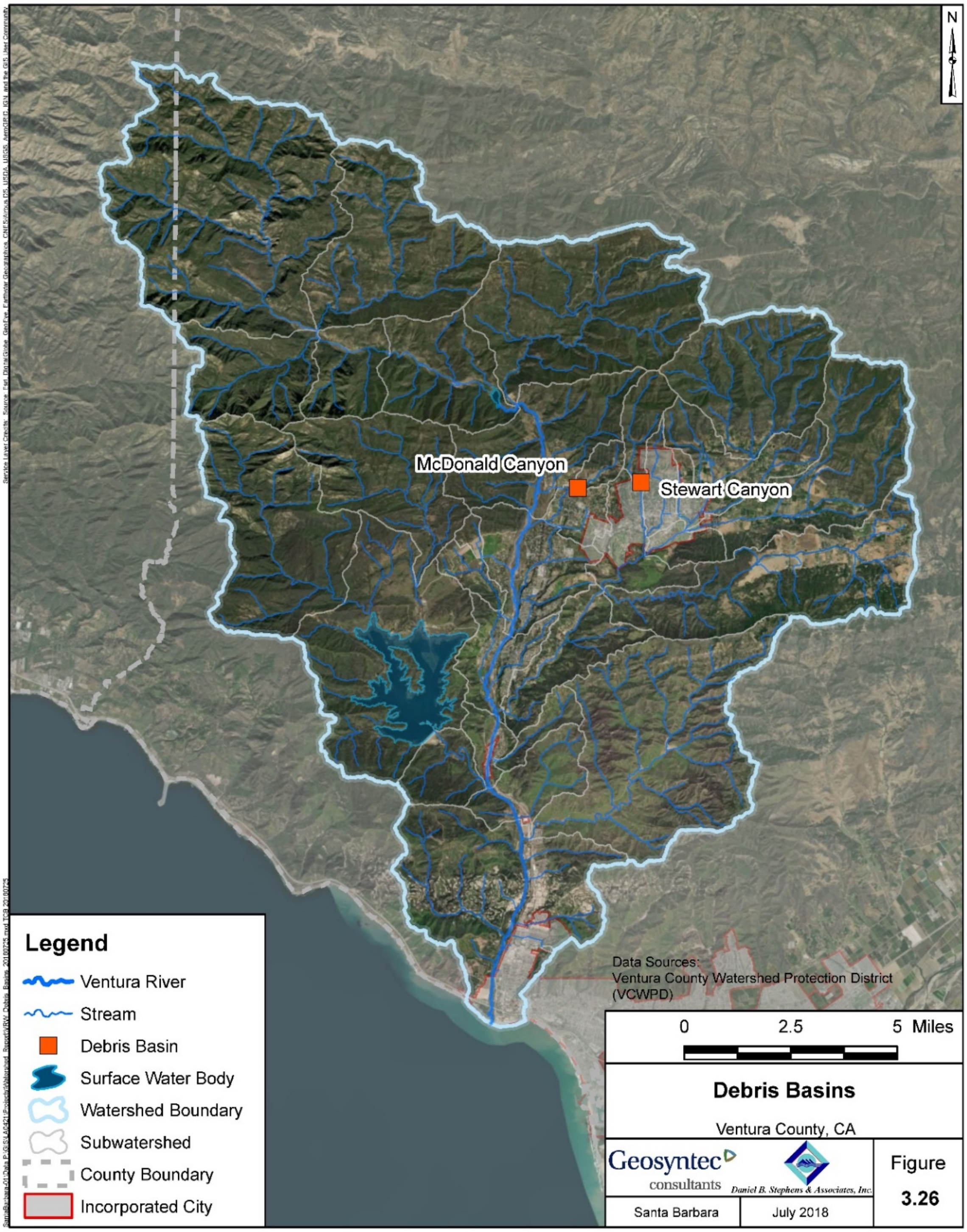


Figure 3.26 Debris Basins

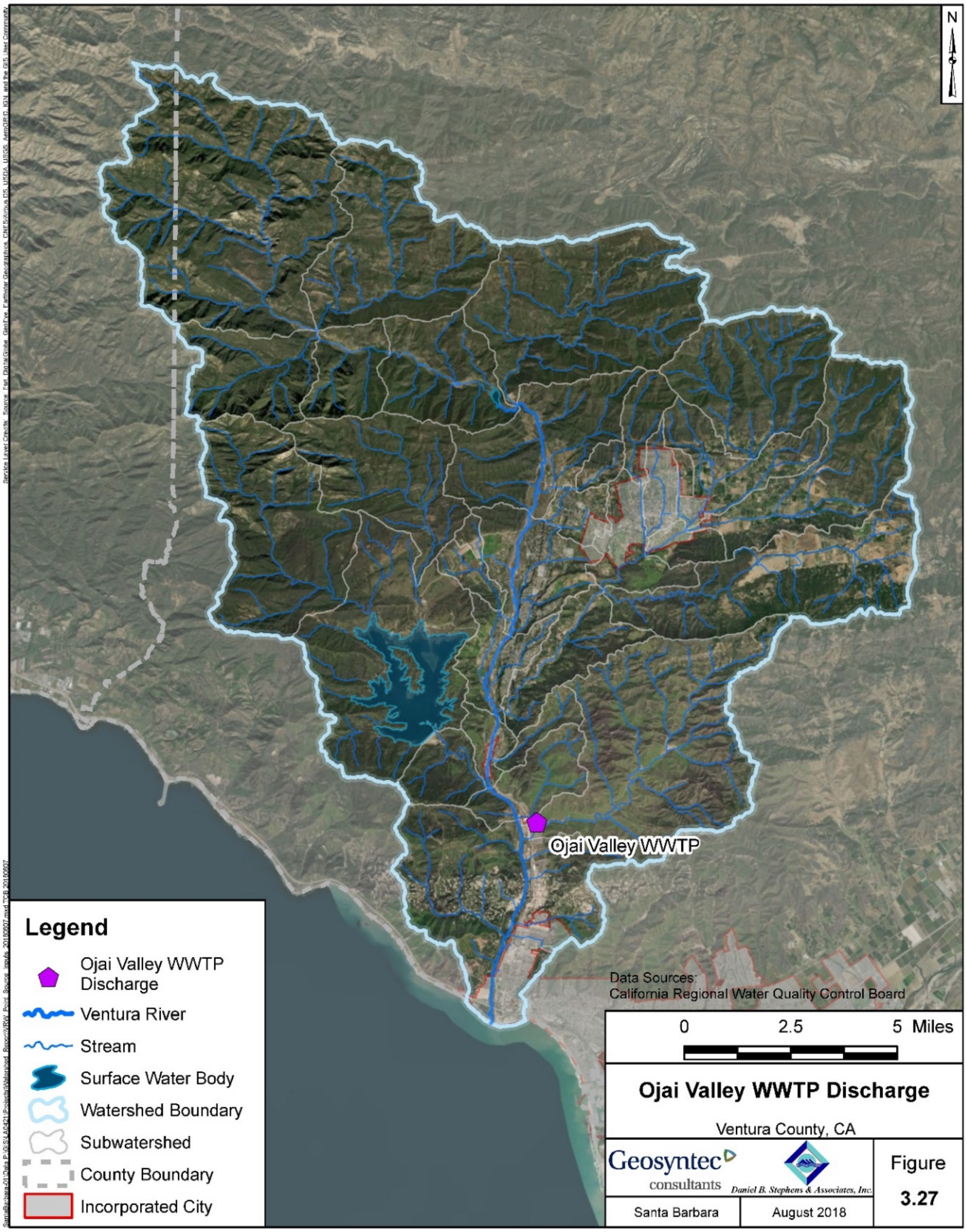


Figure 3.27 Ojai Valley WWTP Discharge

and serves Ojai and the communities of Meiners Oaks, Mira Monte, Oak View, Casitas Springs, and Foster Park; an average of 2.1 mgd was discharged from 2000 through 2012 (USEPA Region 9, 2012). The Ojai Valley Sanitation District provided daily effluent flow data from the WWTP for 2006 through 2015, as shown in Figure 3.28.

Monthly average flows from the available effluent flow data will be used to estimate flows from the remainder of the modeling period. Because a noticeable shift in effluent flows was observed post-2011, flow data from 2006-2011 will be used to approximate missing flows prior to 2006 in the modeling period, and flow data from 2012-2015 will be used to estimate flows post-2015 in the modeling period. These average monthly flows are shown in Figure 3.29.

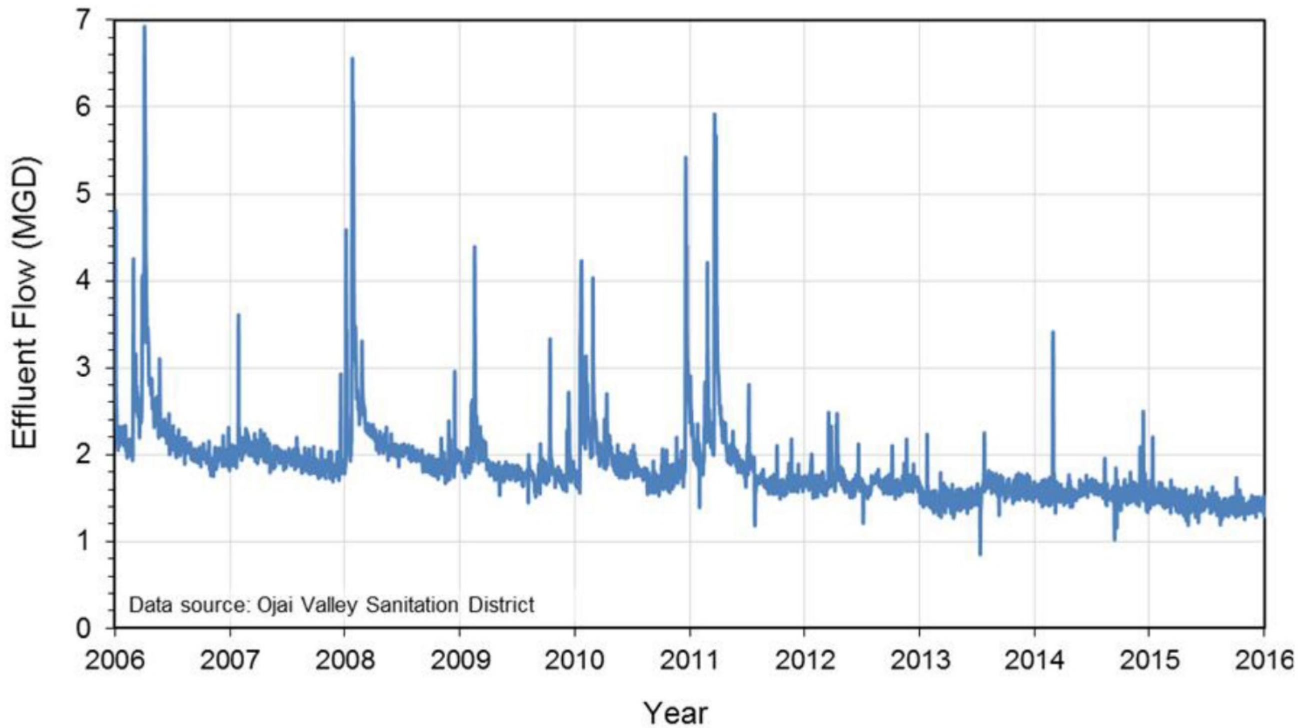
There are four general non-stormwater NPDES permits as well[20], plus other general stormwater NPDES permits (countywide municipal separate storm sewer system permit, industrial general permit, construction general permit), but these are considered minor and negligible.

3.12 Irrigation

Irrigation rate estimates are available from several sources, including the following:

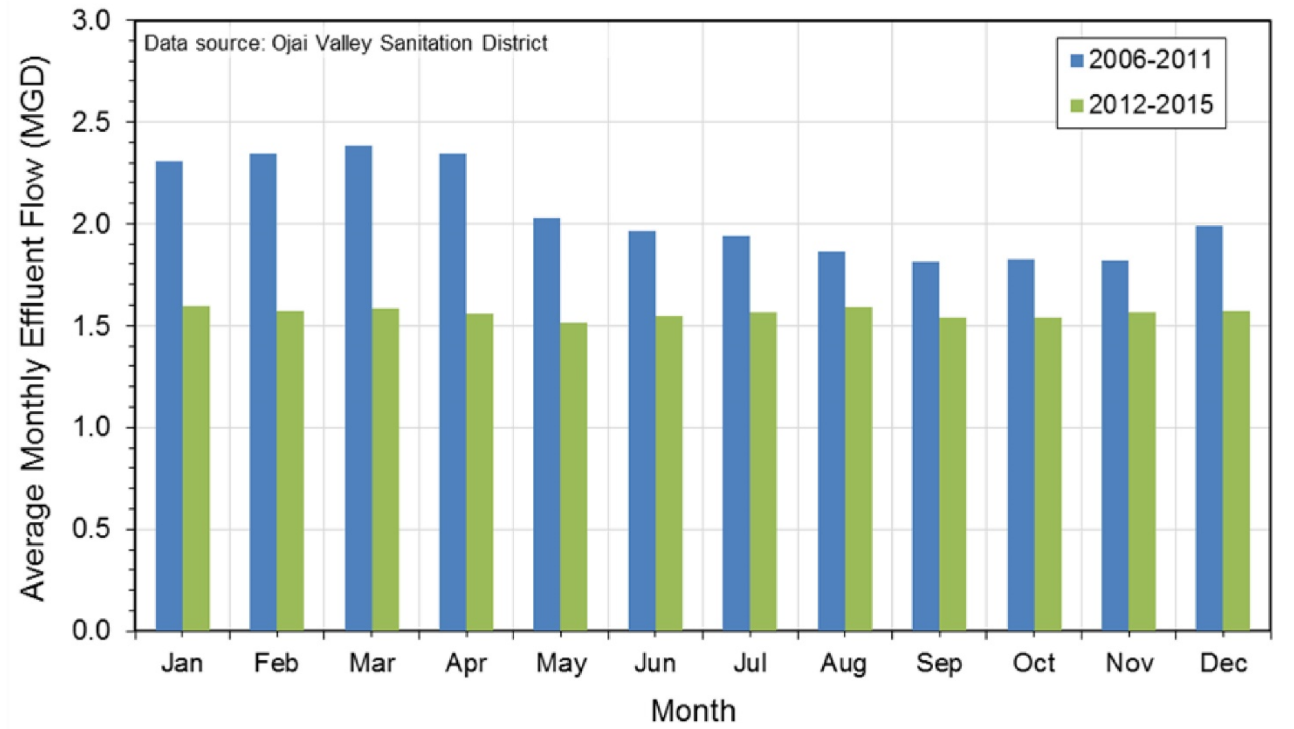
- OBGMA semi-annual groundwater extraction statements: estimated irrigation volumes by crop type;
- Fox Canyon Groundwater Management Agency (FCGMA): crop year irrigation allowance by dry, typical, and wet crop years for a variety of crop types and seasons (if applicable);
- OBGMA irrigation-practices survey (SGD, 1992): annual crop duty factors for a variety of crop types; and
- Department of Water Resources (DWR): applied irrigation rates specific to Ventura County, which are based on evapotranspiration and evaporation, in addition to crop coefficients, soil characteristics, rooting depths, timing of precipitation, etc., for 1998 through 2010.

[20] Foster Park Well Field, Development and Startup Project Well #2 Aquifer Testing, San Antonio Filter Plant, and Golden State Water Company Ojai-Mutual Plant (USEPA Region 9, 2012).



Daily Discharge from the Ojai Valley WWTP Ventura County, CA		
Geosyntec consultants / Daniel B. Stephens & Associates, Inc.		Figure **3.28**
Santa Barbara	November 2018	

Figure 3.28 Daily Discharge from the Ojai Valley WWTP



Average Monthly Discharges from the Ojai Valley WWTP Ventura County, CA		
Geosyntec consultants	Daniel B. Stephens & Associates, Inc.	Figure 3.29
Santa Barbara	November 2018	

Figure 3.29 Average Monthly Discharges from the Ojai Vally WWTP

For the purposes of applying irrigation rates, three major crop types were assumed: citrus, avocado, and “other” (see project Final Study Plan (Geosyntec and DBS&A, 2019)). A summary of irrigation information, by crop type, is shown in Table 3.1.

Spatial crop data are available from the DWR (2014) and the VCAC (2016). These files were compared and found to be very similar; therefore, the VCAC file, as shown in Figure 3.30, will be used to characterize agricultural areas since it was more recently updated.

Table 3.1. Summary of Irrigation Data

Source	Crop Type	Crop Factor (acre-ft of irrigation per irrigated acre)
OBGMA	Citrus/avocado	1.7
OBGMA	Other crops	2.0
DWR (1998-2010) [21]	Citrus/avocado (subtropical)	3.2 (2.8 - 3.7)
DWR (1998-2010) [20]	Other (Other Truck)	1.8 (1.4 - 2.1)
SGD, 1992	Citrus	2.9
SGD, 1992	Avocados	2.9
SGD, 1992	Other	2.0
Murray et al., 1988	Citrus	2.4
Murray et al., 1988	Avocados	2.0
Murray et al., 1988	Other	2.0
DWR, 1970	Citrus	1.6
DWR, 1970	Avocados	1.6
DWR, 1970	Other	1.5
State Water Board, 1991	Citrus	2.0 - 2.5
State Water Board, 1991	Avocados	2.0 - 2.5
State Water Board, 1991	Other	1.0 - 2.0
FCGMA, 2013 [22]	Avocado - 20% ground shading	2.3 (2.1 - 2.5)
FCGMA, 2013	Avocado - 50% ground shading	3.3 (3.0 - 3.7)
FCGMA, 2013	Avocado - 70% ground shading	4.5 (4.3 - 5.1)
FCGMA, 2013	Citrus - 20% ground shading	2.3 (2.2 - 2.6)
FCGMA, 2013	Citrus - 50% ground shading	3.1 (2.9 - 3.3)
FCGMA, 2013	Citrus - 70% ground shading	4.3 (3.9 - 4.4)

DWR = Department of Water Resources
FCGMA = Fox Canyon Groundwater Management Agency
OBGMA = Ojai Basin Groundwater Management Agency

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[21] Values shown represent an average of annual data from 1998 - 2010, and the range shows one standard deviation of the yearly data from 1998 - 2010.
[22] Values reflect data for Zone 3 (Santa Paula). Source also contains data for Zone 1 (Oxnard) and Zone 2 (Camarillo). Range of values shown reflects a typical rainfall year (wet rainfall year, dry rainfall year).

SGD = Staal Gardener & Dunne, Inc.

3.13 Streamflow data

Streamflow data will be used in the calibration to compare model-predicted flows to the available measured flows. The streamflow gages to be used in the calibration process are shown in Figure 3.31 (labeled with their VCWPD ID). Daily and monthly average flow rates for these locations are plotted in Appendix E[23]. The temporal gaps in these data are not required to be filled, since these data will not be used for model input.

3.14 Wet-Dry Maps

CDFW and several other local water agencies (e.g., MOWD, CMWD, and OBGMA) conduct observations and surveys of the river and stream channels in the VRW to generate wet-dry maps.

Data are available from CMWD identifying wet, dry, and intermittent reaches (defined by river kilometer) for specific days for both the San Antonio Creek (from the confluence of Gridley Creek and Senior Creek to the confluence of San Antonio Creek and the Ventura River) and the Ventura River (from confluence of North Fork Matilija Creek and Matilija Creek to the Pacific Ocean). Specifically, there are 165 days of observations from 2/20/2008 through 6/27/2017 for the Ventura River and 87 days of observations from 2/11/2010 through 6/20/2017 for San Antonio Creek. An example of these data for the Ventura River on a specific day (8/4/2011) is shown in Figure 3.32. Automated routines and scripts will be developed to generate maps for additional days from these provided data.

Example wet-dry maps available from CDFW are shown in Figure 3.33. These will be digitized to enable comparison to GSFLOW model output.

MOWD provide geographic coordinates of the “leading edge of river” (i.e., where the wet portion of the Ventura River becomes dry) in the vicinity of Meiners Oaks for years 2014 through 2017. Approximately 30 to 50 observations were made within each year. Figure 3.34 provides an example

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[23] Appendix E is not embedded in this document. Appendices A through E are presented in companion files. Appendices B through E are compiled in a PDF file. The appendices are available for download on the State Water Board’s California Water Action Plan website. URL: https://www.waterboards.ca.gov/waterrights/water_issues/programs/instream_flows/cwap_enhancing/

map for WY2016 and illustrates how the location changes seasonally and dynamically in response to rain events.

These data and maps will be used in the calibration process to verify model predicted reaches as being wet, dry, or intermittent at periods in the observations. Additional details are provided in the project Final Study Plan (Geosyntec and DBS&A, 2019).

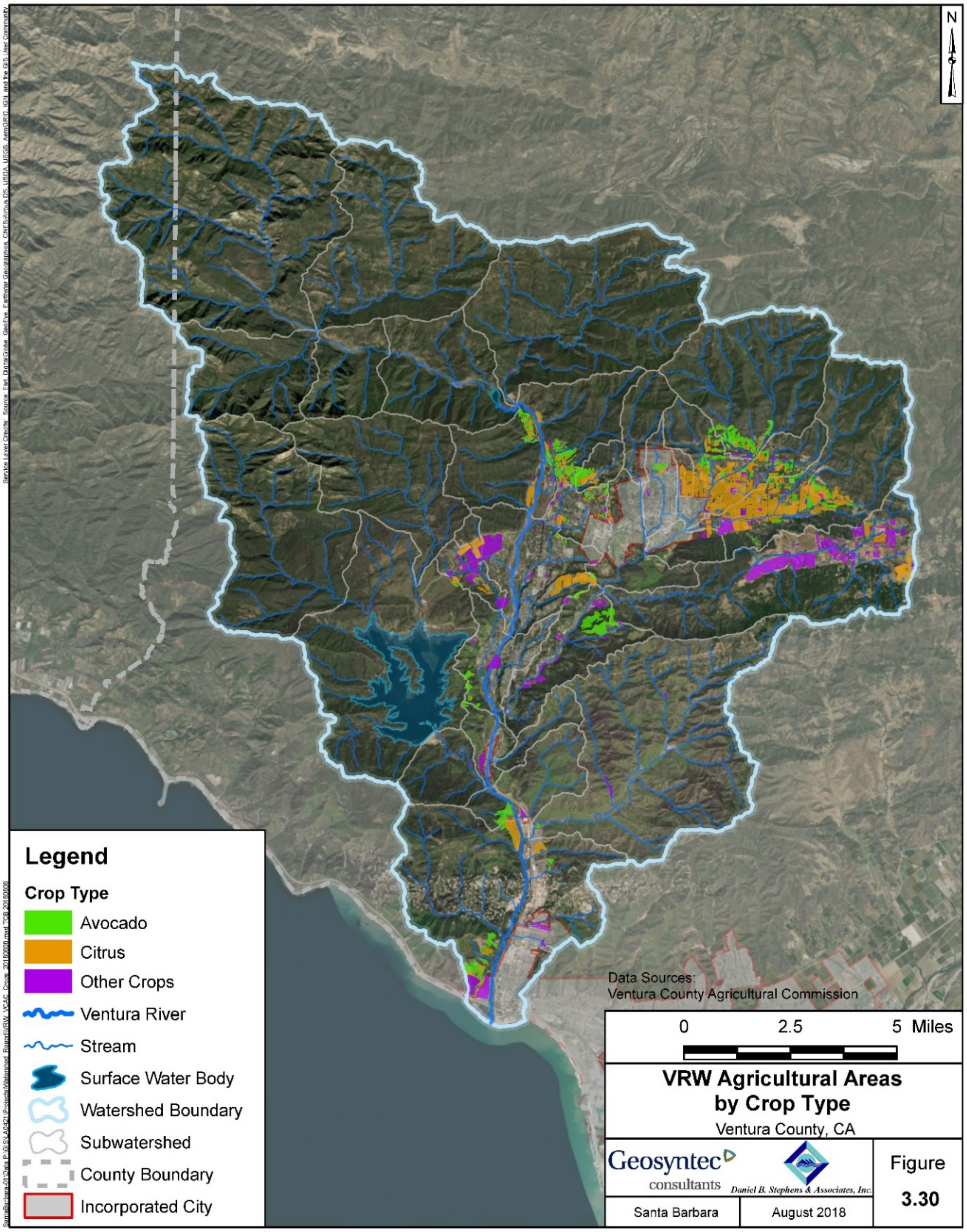

Figure 3.30 VRW Agricultural Areas by Crop Type

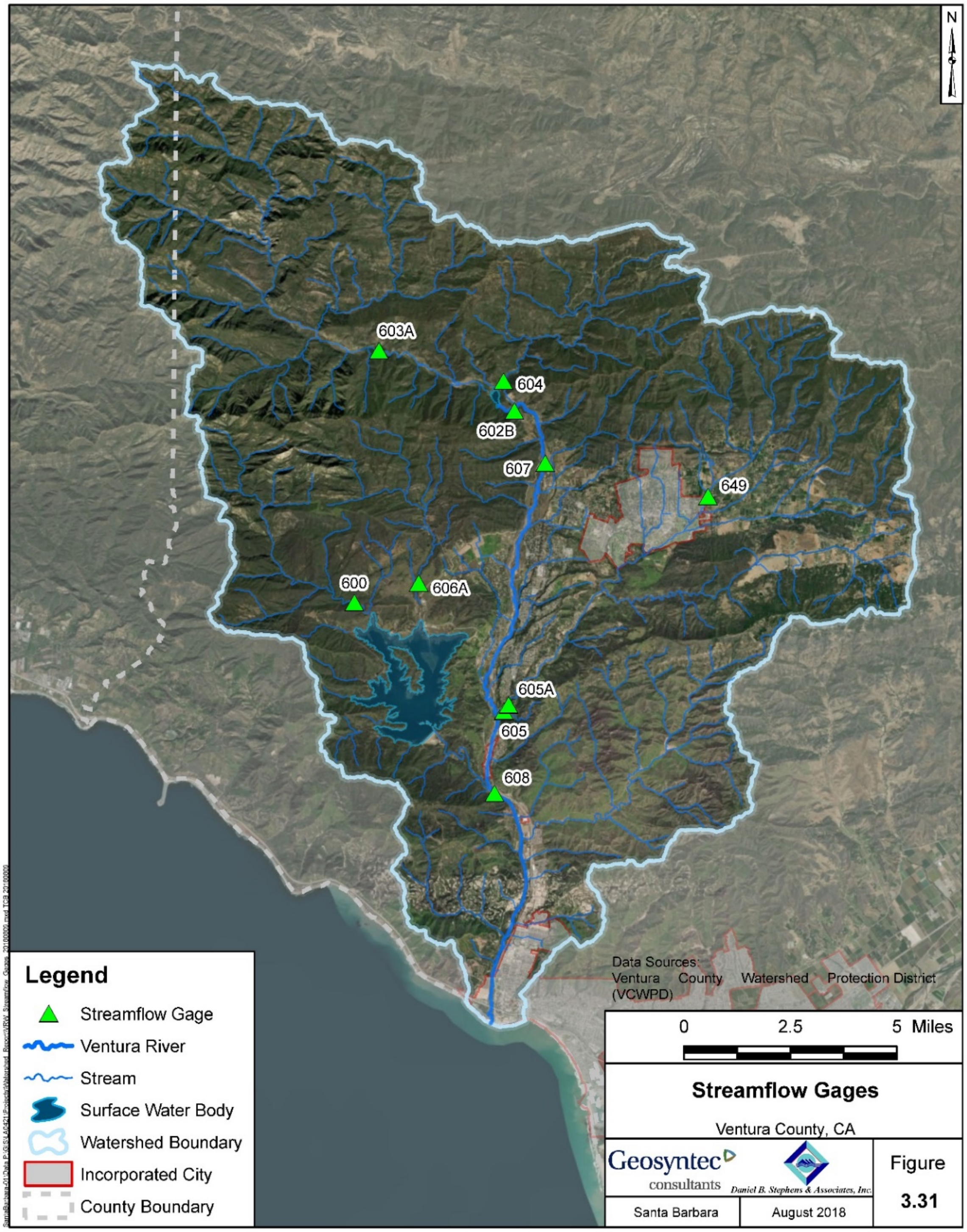

Figure 3.31 Streamflow Gages

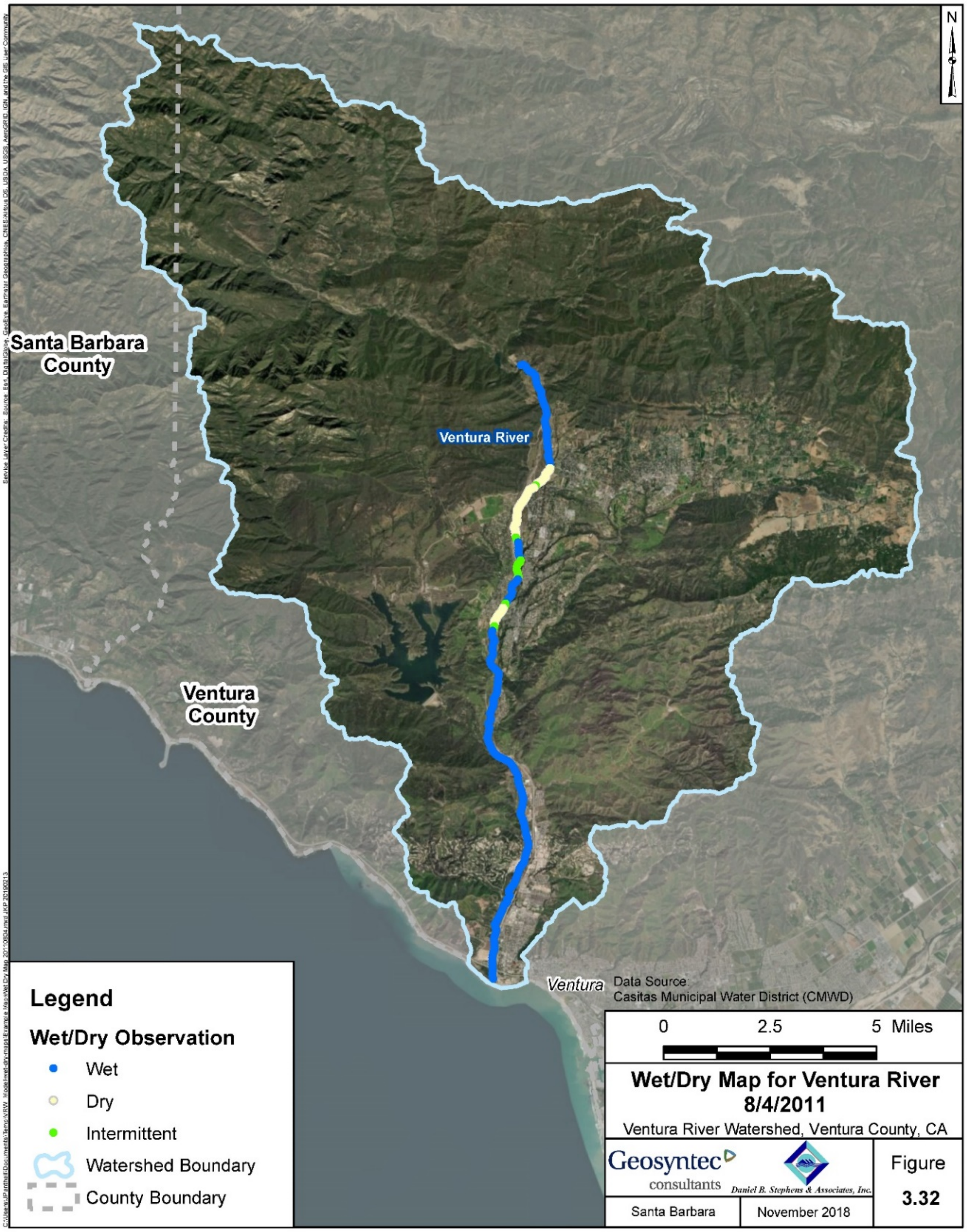

Figure 3.32 Wet/Dry Map for Ventura River 8/4/2011

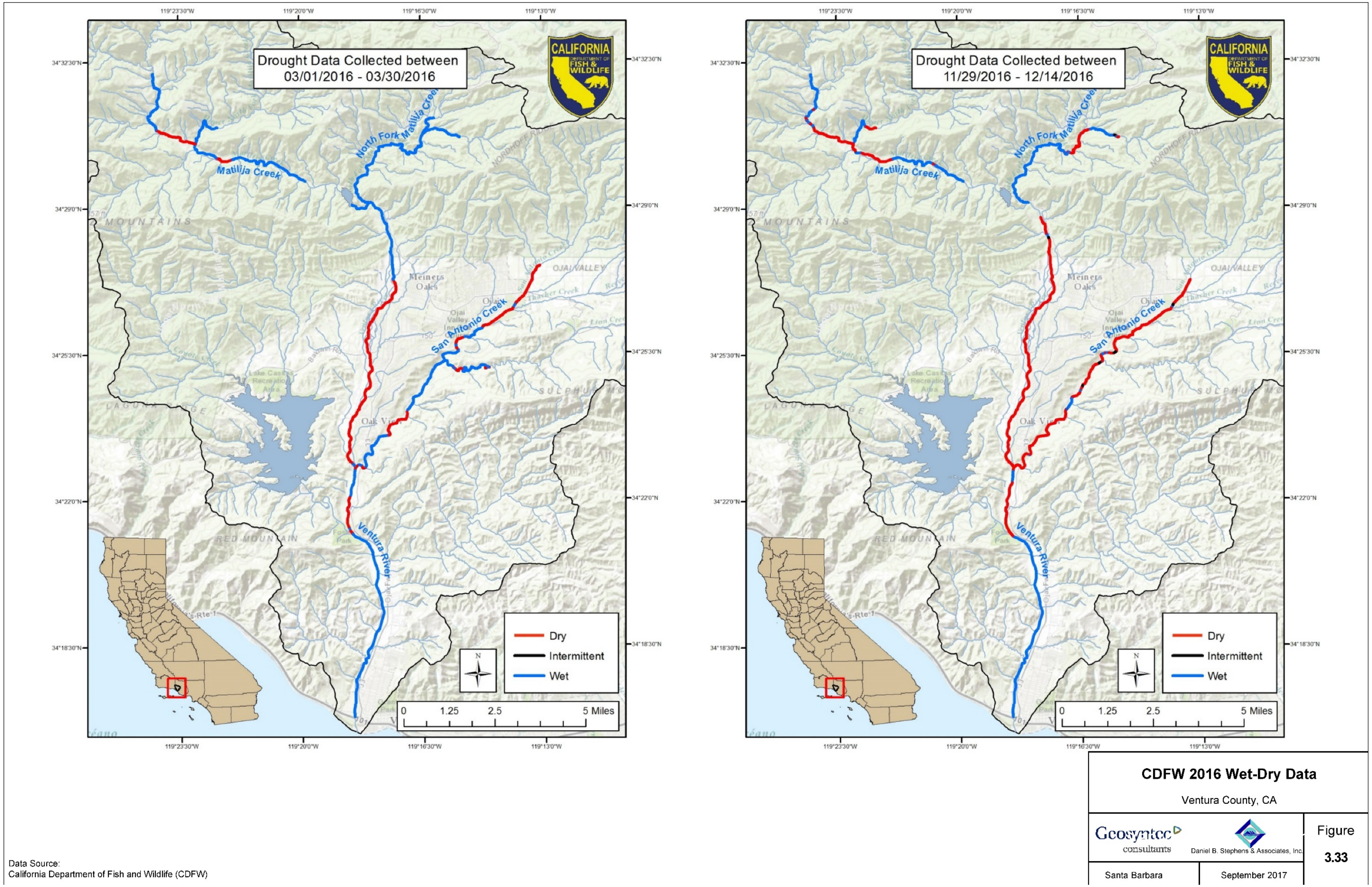

Figure 3.33 CDFW 2016 Wet-Dry Data

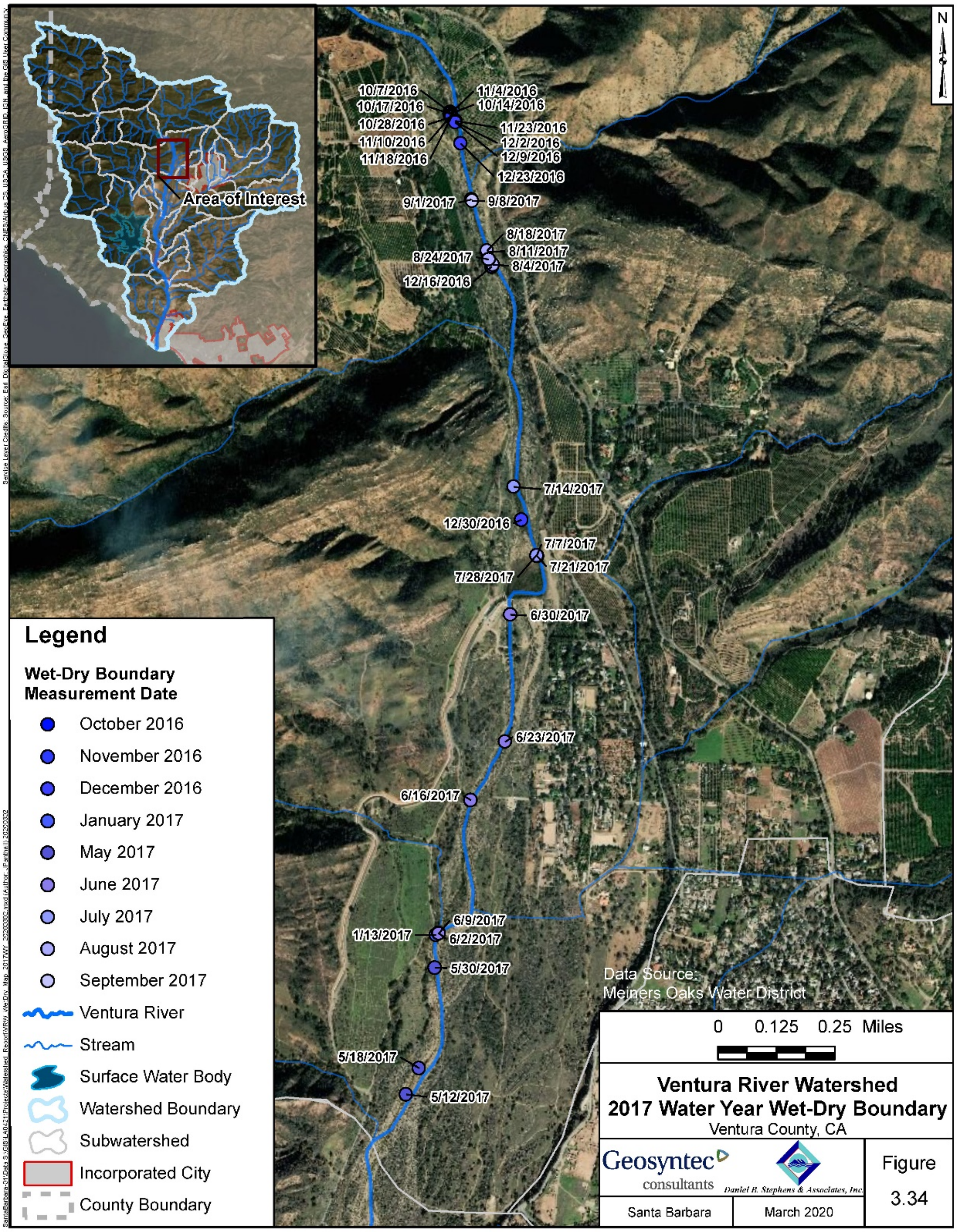

Figure 3.34 Ventura River Watershed 2017 Water Year Wet-Dry Boundary

4. DATA COMPILATION FOR NITROGEN TRANSPORT MODEL

This section describes watershed characteristics and data sources that are expected to be used during development of the nitrogen transport model. The nitrogen transport model will use a mass balance-based approach to estimate loading and transport of nitrogen from major sources in the watershed through groundwater. Additional detail on the modeling can be found in the project Final Study Plan (Geosyntec and DBS&A, 2019).

4.1 Sources

Source data for nitrogen loading to groundwater will be compiled[24] from multiple sources, including fertilizers from urban and agricultural areas, animal manure, and human waste sources, including OWTS and sanitary sewers. Table 4.1 shows data sources that are anticipated to be used for loading estimates in the nitrogen transport model. Table 4.2 shows data sources that are anticipated to be used in validation of the nitrogen transport model.

[24] Per the current project schedule the development of the nitrogen model will not commence until January 2020. Compilation of certain source data and information will be conducted at that time to enable most recent information to be used.

Table 4.1. Nitrogen Loading Data Expected to be Used in the Nitrogen Transport Model

Nitrogen Source	Data Expected to be Used
Nitrogen loading from urban areas	Literature values for residential and commercial fertilizer application
Nitrogen loading from agriculture fertilization	Literature values for nitrogen application rates by crop type in California and nitrogen fixation from leguminous crops if applicable
Nitrogen loading from animal manure	Published manure application by crop type and loading from horses and other livestock
Nitrogen loading from OWTS	OVSD nitrogen influent data, published nitrogen removal for OWTS, VCWPD data on OWTS type and counts
Nitrogen loading from sanitary sewer leaks	Published sewer exfiltration rates [25]
Nitrogen loading from background sources (natural soils and atmospheric deposition)	Published concentrations for groundwater and surface water in natural areas
Nitrogen uptake rates by plants and crops	Published literature values

OVSD = Ojai Valley Sanitary District

OWTS = Onsite Wastewater Treatment System

GAMA = Groundwater Ambient Monitoring and Assessment Program

VCWPD = Ventura County Watershed Protection District

[25] Published exfiltration rates vary considerably, but are generally low in well maintained systems. The reduction in overall effluent flow and seasonal variation after infiltration and inflow (I&I) work completed by OVSD (Figure 3.29) suggests exfiltration is minimal in this system, therefore this source may be determined to be negligible and not included in the nitrogen model.

Table 4.2. Nitrogen Calibration Data Expected to be Used in the Nitrogen Transport Model

Nitrogen Calibration Data	Data Expected to be Used
Surface water nitrogen concentration data in gaining reaches	CEDEN, CMWD, OVSD, SBCK, VCAILG, VCWPD
Groundwater nitrogen concentration data	VCWPD, State Water Board GAMA
Surface water and groundwater nitrogen concentration data, nitrate isotope ratios, and chemical sewage markers	VCEHD

CEDEN = California Environmental Data Exchange Network
CMWD = Casitas Municipal Water District
OVSD = Ojai Valley Sanitary District
SBCK = Santa Barbara Channel Keeper
GAMA = Groundwater Ambient Monitoring and Assessment Program
VCAILG = Ventura County Agricultural Irrigated Lands Group
VCEHD = Ventura County Environmental Health Division
VCWPD = Ventura County Watershed Protection District

Data for many of these nitrogen sources were also compiled during development of the 2012 Ventura River Watershed Algae TMDL (Los Angeles Regional Water Board, 2012a). While the Ventura River Watershed Algae TMDL source data were used to estimate loading to surface waters, groundwater was identified as a source of nutrients to surface water and therefore sources of nitrogen to groundwater (e.g., OWTS) were also considered. The source data and loading analysis, including the source assessment report (LWA, 2011), from the Ventura River Watershed Algae Algae TMDL will be used to inform loading to groundwater in the nitrogen model, with the inclusion of more recent data that have been compiled. The source assessment report also includes nitrogen mass loading information for surface waters that may be useful for validation of the nitrate transport model.

Data on application rates and types of fertilizers used for crops in the watershed will be compiled (if available). Where fertilizer data are not available, general application rates by crop type may be used. Loading from horses and other ranch or livestock animals in the watershed will be estimated based on the number of animals, the type of facility, and published literature values on manure generation and handling practices. Data from the Regional Board that were used in development of the Ventura River Watershed Algae TMDL and through implementation of their nonpoint source program may also be used.

Data are also available that reflect the assumed locations of parcels with OWTS (2016 data from Ventura County Environmental Health Division (VCEHD)), agricultural parcels (from Los Angeles Regional Water Board), and parcels with horses present (from Los Angeles Regional Water Board). These data will be used in determining spatial variations of loadings for the nitrogen model. These graphic information systems (GIS) datasets are continually being updated by the County and other agencies. The most recent GIS datasets will be requested prior to initiation of nitrogen transport modeling. Figure 4.1 shows the locations of OWTS parcels and agricultural parcels, two of the sources expected to be providing significant loading of nitrogen to groundwater in the watershed.

A study by the VCEHD investigating the impact of OWTS on impaired surface waters in the watershed found that OWTS are contributing nitrate to groundwater throughout the watershed and that surface waters are being impacted where high-density OWTS are near to surface waters (Geosyntec, 2018). Data from this study will be critical in estimating nitrogen loads from OWTS, and groundwater and surface water sample results will support model calibration.

Finally, any source of nitrogen to surface waters could also be a source to groundwater in losing reaches of the stream. Therefore, surface water data may be treated as a nitrogen source in areas identified as losing through the groundwater surface water interaction model. Effluent from the Ojai Valley Sanitary District (OVSD) treatment plant (see Section 3.11) to surface water in the Lower Ventura River will be included as a source if it is determined that there are losing reaches downstream of the outfall. Effluent data for nitrogen has been received from OVSD.

4.2 Surface Water Concentrations

Surface water concentrations of nitrogen (generally nitrate-nitrogen) are monitored by multiple agencies in the watershed (see Table 4.2). Data for surface water nitrogen concentrations throughout the groundwater flow and groundwater surface water interaction modeling period will be used to calibrate the nitrogen transport model. Because surface water could be a source of nitrogen to groundwater in losing stream reaches, the results of the groundwater surface water interaction model will be important in how surface water modeling results are used (i.e., surface water data may be used for calibration of groundwater concentrations in gaining reaches or as a source to groundwater in losing reaches).

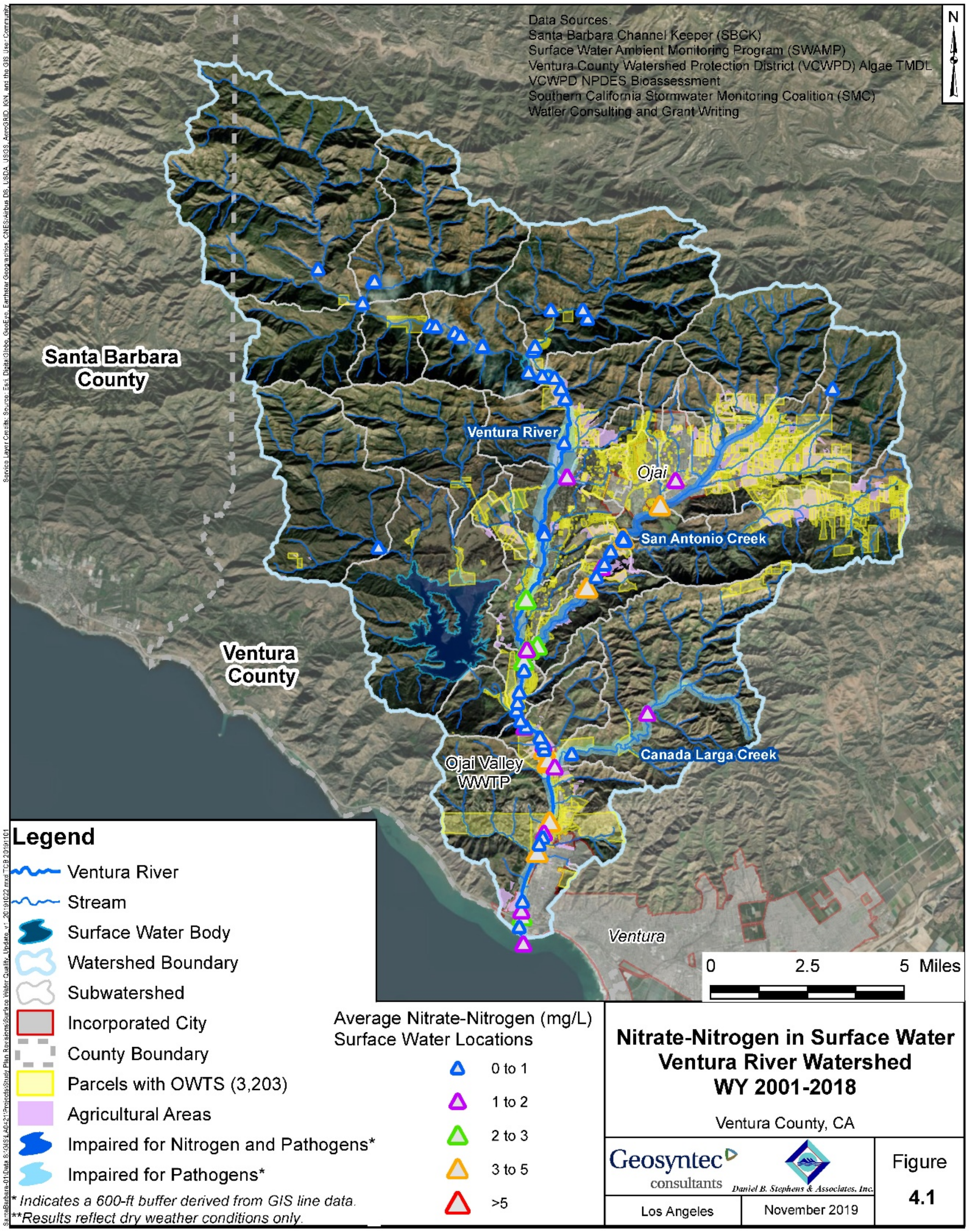

Figure 4.1 Nitrate-Nitrogen in Surface Water
Ventura River Watershed WY 2001 – 2018

Average nitrate-nitrogen surface water concentrations in dry weather from data sets compiled over a period from 2000 to 2018 are shown in Figure 4.1. The number of data points represented at each sampling location over this period varies from a single data point to monthly results over a period of years (e.g., Ventura River Watershed Algae TMDL monitoring data from VCWPD). Surface water data may have significant variation over time and from event to event at some locations, and this will be further analyzed prior to commencement of the nitrogen transport model development. Wet weather surface water quality data are also available at some locations and may be used to evaluate the loading of nitrogen from groundwater to surface water for wet weather compared to dry weather.

4.3 Groundwater Concentrations

Groundwater concentrations of nitrogen (generally nitrate-nitrogen) are monitored primarily by the VCWPD Groundwater Division (see). Data for groundwater nitrogen concentrations throughout the modeling period will be used to calibrate the nitrogen transport model. Average nitrate-nitrogen surface water concentrations from data compiled over a period from 1994 to 2018 are shown in Figure 4.2. The number of data points represented at each sampling location over this period varies from a single data point to more than 20 results for some wells. Groundwater data may also have significant variation over time and from event to event in some wells, and this will be further analyzed prior to the commencement of the nitrogen transport model development.

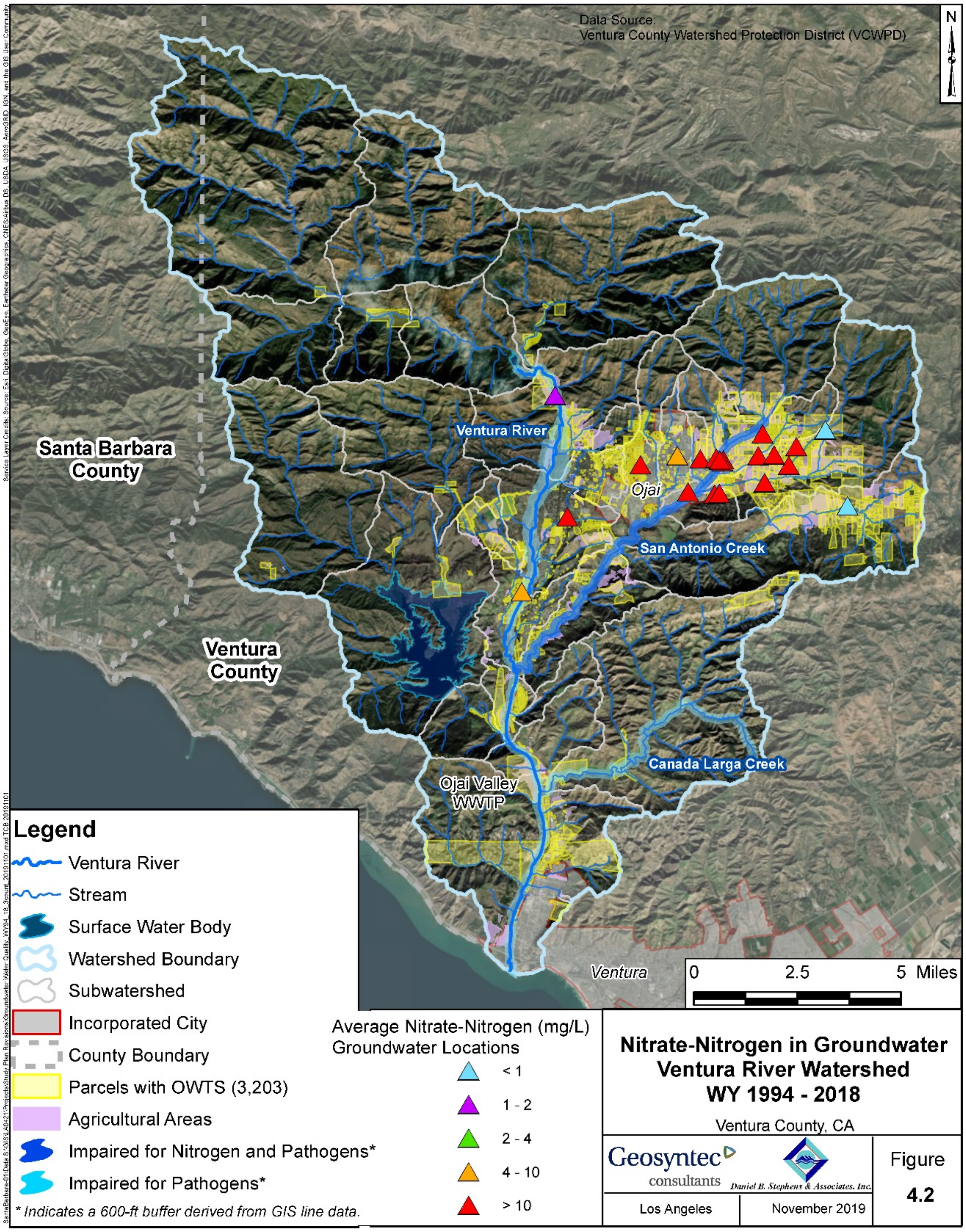

Figure 4.2 Nitrate-Nitrogen in Groundwater Ventura Watershed WY 1994 - 2018

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