NOTICE AND AGENDA OF SPECIAL MEETING

GROUNDWATER SUSTAINABILITY AGENCY
FOR THE WESTERN MANAGEMENT AREA
IN THE SANTA YNEZ RIVER GROUNDWATER BASIN

WILL BE HELD
AT **1:00 P.M.**, WEDNESDAY, OCTOBER 21, 2020

TELECONFERENCE MEETING ONLY – NO PHYSICAL MEETING LOCATION
PUBLIC PARTICIPATION DIAL-IN NUMBER: 1-267-866-0999
MEETING ID / PASSCODE: 5833 80 9639

Public participants can view presentation materials and live video on their device

Website: app.chime.aws (or download *Amazon Chime* app),
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You do NOT need to create an Amazon Chime account or login with email for meeting participation.

Public participant phones and microphones will be muted, and webcams disabled.
Live Chat Text (online users only) will be enabled for questions.

If your device does not have a microphone or speakers, you can also call Phone Number & log in with Meeting ID listed above to listen while viewing the live presentation online.

Teleconference Meeting During Coronavirus (COVID-19) Emergency: As a result of the COVID-19 emergency and Governor Newsom's Executive Orders to protect public health by issuing shelter-in-home standards, limiting public gatherings, and requiring social distancing, this meeting will occur solely via teleconference as authorized by and in furtherance of Executive Order Nos. N-29-20 and N-33-20.

Important Notice Regarding Public Participation in Teleconference Meeting: Those who wish to provide public comment on an Agenda Item, or who otherwise are making a presentation to the GSA Committee, may participate in the meeting using the dial-in number and passcode above. **Those wishing to submit written comments instead, please submit any and all comments and materials to the GSA via electronic mail at bbuelow@syrwcd.com.** All submittals of written comments must be received by the GSA no later than 5:00 p.m. on Tuesday, October 20, 2020, and should indicate **"October 21, 2020 GSA Meeting"** in the subject line. To the extent practicable, public comments and materials received in advance pursuant to this timeframe will be read into the public record during the meeting. Public comments and materials not read into the record will become part of the post-meeting materials available to the public and posted on the SGMA website.

In the interest of clear reception and efficient administration of the meeting, all persons participating in this teleconference are respectfully requested to mute their phones after dialing-in and at all times unless speaking.

AGENDA ON NEXT PAGE

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GROUNDWATER SUSTAINABILITY AGENCY
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WILL BE HELD
AT **1:00 P.M.**, WEDNESDAY, OCTOBER 21, 2020

I. Call to Order

II. Introductions and review of SGMA in the Santa Ynez River Valley Basin

III. Additions or Deletions to the Agenda

IV. Public Comment (Any member of the public may address the Committee relating to any non-agenda matter within the Committee's jurisdiction. The total time for all public participation shall not exceed fifteen minutes and the time allotted for each individual shall not exceed five minutes. No action will be taken by the Committee at this meeting on any public item.)

V. Receive and discuss received correspondence from the Santa Ynez Water Group

VI. Workshop on WMA Hydrogeologic Conceptual Model

VII. Next "Regular" WMA GSA Meeting: Wednesday, November 18, 2020, 10:00 AM. Notice will be sent prior to the meeting with instructions to attend conference call

VIII. WMA GSA Committee requests and comments

IX. Adjournment

[This agenda was posted 24 hours prior to the scheduled special meeting at 3669 Sagunto Street, Suite 101, Santa Ynez, California, and https://www.santaynezwater.org in accordance with Government Code Section 54954. In compliance with the Americans with Disabilities Act, if you need special assistance to review agenda materials or participate in this meeting, please contact the Santa Ynez River Water Conservation District at (805) 693-1156. Notification 72 hours prior to the meeting will enable the GSA to make reasonable arrangements to ensure accessibility to this meeting.]

Santa Ynez Water Group
c/o Doug Circle
Rancho Cañada de Los Pinos LLC
doug@circlevision.com

September 16, 2020

Board of Directors, Santa Ynez River Valley Basin **Eastern Management Area GSA**
Chair: Brett Marymee, SYRWCD (Cindy Allan, Alternate)
Brad Joos, SYRWCD Improvement District #1 (Paeter Garcia, Alternate)
Karen Waite, City of Solvang (Ryan Toussaint, Alternate)
Joan Hartman, County of Santa Barbara (Meighan Dietenhofer Alternate)

Board of Directors, Santa Ynez River Valley Basin **Central Management Area GSA**
Chair: Ed Andrisek, City of Buellton (John Sanchez, Alternate)
Art Hibbits, SYRWCD (Cindy Allan, Alternate)
Joan Hartman, County of Santa Barbara (Meighan Dietenhofer Alternate) (County has no vote, no financial responsibility)

Board of Directors, Santa Ynez River Valley Basin **Western Management Area GSA**
Chair: Chris Brooks, Vandenberg Village CSD (Katherine Stewart, Alternate)
Jim Mosby, City of Lompoc (Kristin Worthley, Alternate)
Bruce Nix, Mission Hills CSD (Myron Heavin, Alternate)
Steve Jordan, SYRWCD (Art Hibbits, Alternate)
Joan Hartman, County of Santa Barbara (Meighan Dietenhofer Alternate) (County has no vote, no financial responsibility)

c/o William (Bill) Buelow
Santa Ynez River Water Conservation District
3669 Sagunto Street, Suite 101
Santa Ynez, CA 93460

Transmitted via email attachment to bbuelow@syrwcd.com and via USPS

Re: GSP Development Process Comments and Requests

Dear Directors and Staff:

As you know the Santa Ynez Water Group (SYWG) was recently formed to engage on behalf of landowners with the GSAs concerning development of the Santa Ynez River Valley GSPs. SYWG includes, vineyards, vegetables, and other interests and currently represents 54 landowners and 7,853 acres in the Santa Ynez River Valley Basin. SYWG desires to work cooperatively and collaboratively with the GSAs on planning issues that will impact sustainable management of the groundwater basin and our business. To this end, we are sending this letter to offer comments and make requests that we believe will further our ability to effectively engage with the GSAs and increase transparency in the GSP development process:

1. Data Management Systems (DMS) Access: SYWG requests direct access, by website, FTP, or other means, to the data management systems being used to support GSP preparation. The data being used to develop the various technical memoranda should be made available to the public at the time the draft memoranda are released. This is a necessary step to provide transparency in the GSP development process for SYWG, other stakeholders, and the public. SYWG's consultant previously inquired with staff about data access and we were disappointed that this issue was not addressed with the GSA Boards during their August meetings.

2. Sustainable Management Criteria (SMC) and Projects and Management Actions (PMA): The SMC and PMA are the GSP components where the "rubber meets the road." The SMC and PMA will determine how much we as landowners can pump, how much we will pay to pump going forward, and impacts to our property values. Therefore, we cannot underemphasize the importance of ensuring the SMC and PMA development process is afforded as much time as possible to ensure stakeholder input is obtained and seriously considered and the most equitable and cost-effective PMAs can be developed. The current GSP development schedules allocate very little time and opportunities for this. Additionally, it is unclear how and when the SMC and PMA will be reconciled at the Basin level across the management areas, as that step is not explicitly show on the schedules presented during the August GSA meetings.

   We strongly encourage the GSAs to modify the GSP development schedules to allow more time for these critical items. We believe the SMC and PMA discussions should begin now, in parallel with completion of the technical tasks. We see no reason why the GSA Boards could not already be working on the sustainability goal and the initial steps of defining what constitutes undesirable results for the basin. Similarly, the discussion of potential PMAs that might need to be considered in the GSPs could also begin now. Completion of the technical work tasks is not a prerequisite to starting these discussions. Certainly the key sustainability issues should have already been identified in the work completed to date at a level sufficient to begin these discussions. The GSAs could also consider a shorter GSP comment period and instead spend more time obtaining and considering stakeholder input on the SMC and PMA. The time is better spent working more with the stakeholders upfront on the key issues as opposed to giving us more time to write comment letters.

   In addition to schedule, it is unclear what the process for developing the SMC and PMA will be. We recommend the GSAs develop and approve a clear and deliberate process for SMC and PMA development. The preferred process would have multiple entry points for stakeholder input and an iterative approach to arriving at achievable and acceptable SMC and PMA. An example process taken from another GSA is attached for your reference.

Please understand our landowner group supports the process. We are ready and willing to participate in a collaborative manner to enhance the overall outcome. Please reach out on how we can work together on this important effort.

Sincerely,

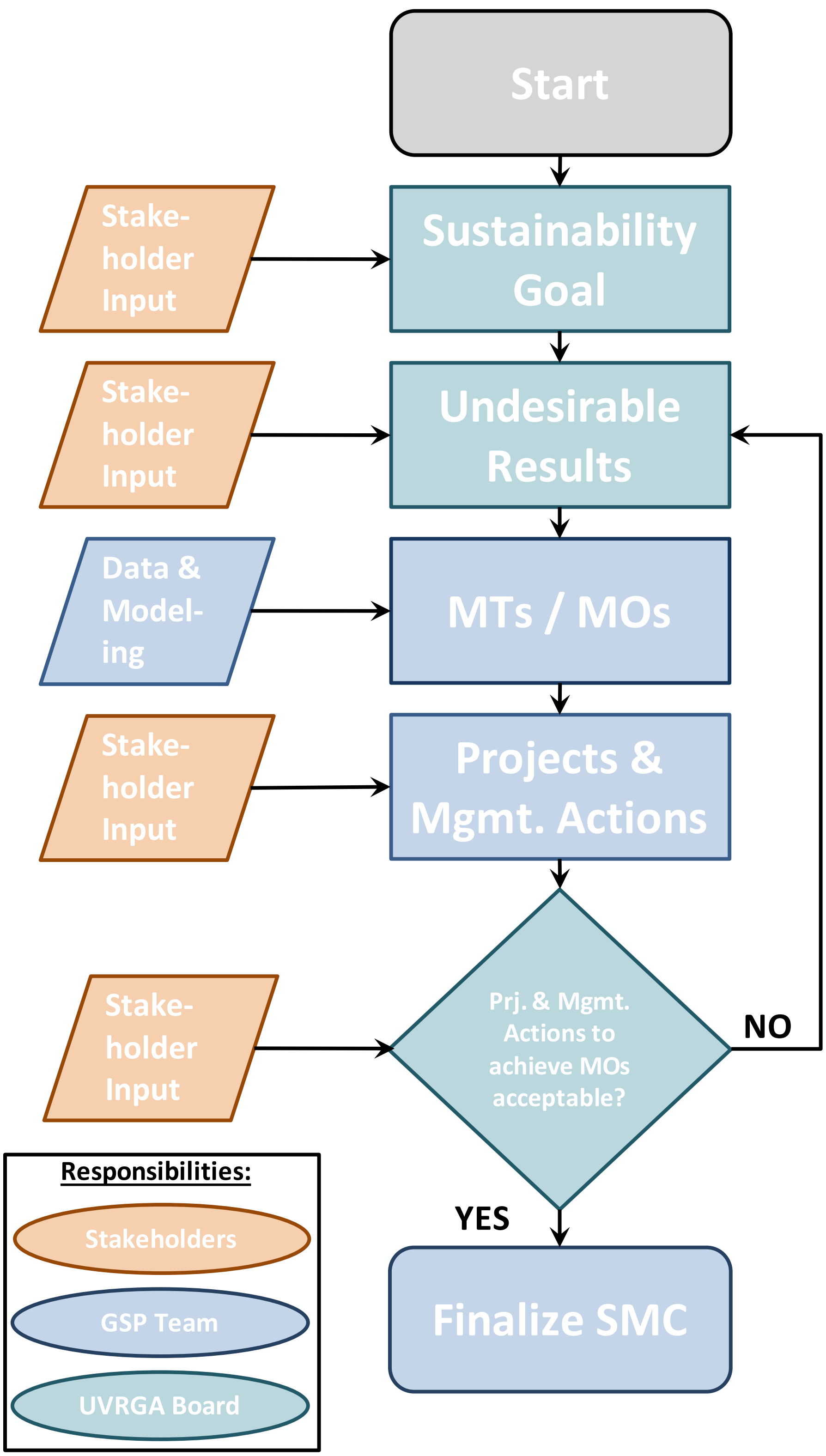
Doug Circle

Attachments: Example SMC and PMA Development Process

cc: SYWG Members
Bryan Bondy, Bondy Groundwater Consulting, Inc.

Figure 2

Proposed Sustainable Management Criteria Development Process



DRAFT TECHNICAL MEMORANDUM
2171 E. Francisco Blvd., Suite K • San Rafael, California • 94901
TEL: (415) 457-0701 FAX: (415) 457-1638 e-mail: sr@stetsonengineers.com

TO:	**WMA GSA**	DATE:	**October 2020**
FROM:	**Stetson Engineers**	JOB NO:	**2710-03**
RE:	DRAFT **Western Management Area Hydrogeologic Conceptual Model (HCM)**		

INTRODUCTION

The Sustainable Groundwater Management Act (SGMA) requires that the Groundwater Sustainability Plan (GSP) include a hydrogeologic conceptual model (HCM). This HCM is part of the Santa Ynez River Valley Groundwater Basin (referred to herein as the "Basin") setting and "characterizes the physical components and interaction of the surface water and groundwater systems in the basin."[1]

The Basin is located in Santa Barbara County in the central coast region of California (**Figure 1-1**). The Basin is divided into three management areas: Western Management Area (WMA), Central Management Area (CMA), and Eastern Management Area (EMA). This HCM memorandum is written for inclusion as a chapter in the WMA GSP in accordance with the SGMA.

The HCM provides a written description of the general physical characteristics of the Basin, specifically within the WMA, related to regional hydrology; land use; geology and geologic structures, including the lateral and vertical Basin (or aquifer) limits; introduction of groundwater quality; and definition of principle aquifers and aquitards. Description of these items in the HCM provides context for subsequent technical memoranda (or chapters of the GSP), such as water budgets, numerical groundwater models, and monitoring networks. Future plans and actions, including data collection and evaluation of projects and management actions, are based on the conceptual understanding described by this HCM.

This HCM contains the following sections:

- *Section 1, Western Management Area Extent and Subareas,* provides a general introduction to the Santa Ynez River Valley Groundwater Basin and adjacent basins, including a description of the WMA, subareas of the WMA and their key boundary characteristics, and notable water components.

[1] 23 CCR § 354.14 (a)

- *Section 2, WMA and Adjacent Geology,* provides an introduction and overview of the geology of the WMA. This includes a description of the regional geologic structural setting; relevant geologic units; and surface geologic map, including major structural features. A three-dimensional geologic model was developed for the Basin, and cross-sections developed from this model are provided.

- *Section 3, Principal Aquifers and Aquitards,* provides a discussion of geologic units corresponding to aquifers, including the three-dimensional Basin boundaries (lateral and basal boundaries). The physical characteristics of the aquifers in each subarea are summarized.

- *Section 4, Hydrologic Characteristics,* describes physical surface conditions that interact with the groundwater. This section includes topography, soil map, and watershed extent; a description of surface water components, including rivers, and ocean coast; and large anthropogenic alterations to the water environment, including imports, exports, and treated wastewater discharge.

- *Section 5, Uses and Users of Groundwater in the WMA,* discusses the primary use of groundwater in each of the WMA subareas, including a summary of where groundwater pumping occurs, agricultural lands, and groundwater-dependent ecosystems.

- *Section 6, Data Gaps and Uncertainty,* addresses the data gaps at the time that this memorandum was written and uncertainty with respect to certain components of the HCM.

A conceptual diagram showing the components of the surface water and groundwater systems in the Basin is shown in **Figure 1-2**. Sections 2 and 3 review the physical characteristics of the groundwater system shown in **Figure 1-2**. Sections 4 and 5 provides an overview of the water budget and how water moves through the WMA, as shown in **Figure 1-2**.

LIST OF ACRONYMS AND ABBREVIATIONS

3D	three-dimensional
AFY	acre-feet per year (rate of water flow)
Basin	Santa Ynez River Valley Groundwater Basin
CCWA	Central Coast Water Authority
CMA	Central Management Area
CSD	Community Services District
DWR	Department of Water Resources
EMA	Eastern Management Area
FY	Fiscal Year (July 1 through June 30)
GSP	Groundwater Sustainability Plan
HCM	Hydrogeologic Conceptual Model
SGMA	Sustainable Groundwater Management Act
SWRCB	State Water Resources Control Board
USGS	United States Geological Survey
USP	United States Penitentiary - Lompoc
VAFB	Vandenberg Air Force Base
WMA	Western Management Area

Geologic Units:

Qg	Geologic Unit, River Channel Deposits
Qal	Geologic Unit, Younger Alluvium
Qos	Geologic Unit, Older Dune Sands
Qoa	Geologic Unit, Terrace Deposits/Older Alluvium
Qo	Geologic Unit, Orcutt Sand
QTp	Geologic Unit, Paso Robles Formation
Tca	Geologic Unit, Careaga Sand
Tf	Geologic Unit, Foxen Formation
Tsq	Geologic Unit, Sisquoc Formation

TM	Geologic Unit, Monterey Formation

APPENDIX

APPENDIX A	Geosyntec (2020) "Draft Technical Memorandum on Regional Geology and 3D Geologic Model for the Santa Ynez River Valley Groundwater Basin"

1. WESTERN MANAGEMENT AREA BOUNDARIES AND SUBAREAS

1.1. Basin Boundaries and Management Areas

The Santa Ynez River Valley Groundwater Basin (Basin) in Santa Barbara County, California, is designated by the California Department of Water Resources (DWR) as Basin 3-15. The extent or boundaries of the Basin in DWR Bulletin 118 are based on regional geology studies and are shown in **Figure 1-1**. The Basin is a mapped "stacked series of aquifers with reasonably well-defined boundaries in a lateral direction, based on features that significantly impede groundwater flow, and a definable bottom."[2] The Basin extent is generally defined by the location of geologic units of "porous and permeable sediment or sedimentary rock that contains sufficient saturated material to yield significant quantities of groundwater to wells and springs."[3] DWR Basin 3-15 is bounded by the Purisima Hills to the north, the San Rafael Mountains to the northeast, the Santa Ynez Mountains to the south, and the Pacific Ocean to the west. DWR Basin 3-15 boundaries include areas of Vandenberg Air Force Base (VAFB) that have historically been excluded from regional groundwater studies due to a variety of factors, which are further discussed below.

The Basin is one of several within Santa Barbara County; **Figure 1-3** shows other groundwater basins adjacent to or near the Basin. North of and bordering the Basin is the San Antonio Creek Valley Groundwater Basin,[4] and the Santa Maria River Valley Groundwater Basin[5] is directly adjacent to the north of the San Antonio Creek Valley Groundwater Basin. To the southeast, along the south coast of Santa Barbara County, is the Goleta Groundwater Basin,[6] separated from the Basin by the Santa Ynez mountain range.

As previously discussed in the Outreach and Engagement Plan (chapter of the GSP) and in accordance with the SGMA, separate management areas have been implemented in the Basin, including the WMA, CMA, and EMA (**Figure 1-1**). The remainder of this HCM presents information for the WMA.

1.2. WMA Boundaries

The western boundary of the WMA is the Pacific Ocean from Cañada Honda Creek in the south to San Antonio Creek in the north. The northern boundary is at the Purisima Hills and the Purisima Anticline. The eastern boundary of the WMA corresponds to the watershed boundary of the "Santa Rosa Damsite" near Santa Rosa Park.[7] The northeastern boundary is composed of the Santa Rita Upland, around the Santa Rita Valley. The southern boundary of the WMA is

2 23 CCR § 341(g)(1)
3 23 CCR § 341(f)
4 DWR Basin 3-14
5 DWR Basin 3-12
6 DWR Basin 3-16
7 USGS Site 11131000. "SANTA YNEZ R AT SANTA ROSA DAMSITE NR BUELLTON CA"

complex, including the "narrows" of the Santa Ynez River, characterized by the exposed bedrock defining the river boundaries in this area, as well as the White Hills south of the City of Lompoc (**Figure 1-4**).

1.3. Western Management Area Subareas

The WMA encompasses 134 square miles of complexly folded, faulted, and eroded geologic units that create dynamic topography in the WMA and directly affect the hydrogeologic conditions of the WMA. In addition to natural features, human activity plays an active role in the movement of water into and out of the WMA. Due to the complexity of the various WMA features, it is divided into six subareas,[8] as shown in **Figure 1-4**. The six subareas are listed below, and the following subsections briefly describe key topographic characteristics and surface-ground water interactions that differentiate them.

- Santa Ynez River Alluvium
- Lompoc Plain
- Burton Mesa
- Lompoc Terrace
- Lompoc Upland and
- Santa Rita Upland

The remainder of this document presents details for each of these subareas and summarizes their effects or contributions to the HCM and water environment within the WMA.

1.3.1. Santa Ynez River Alluvium

The Santa Ynez River Alluvium contains the Santa Ynez River from the WMA/CMA boundary near Santa Rosa Park in the east and extends west to where the Santa Ynez River enters the Lompoc Plain, commonly referred to as the Lompoc Narrows at Robinson Bridge (**Figure 1-4**). Groundwater occurs in thin, unconsolidated sedimentary layers of younger alluvium directly over non-water-bearing, consolidated geologic units. Non-water-bearing consolidated geologic units also form the lateral boundaries as exposed bedrock in this area.

Groundwater recharge of the alluvium is primarily received from the surface and underflow of the Santa Ynez River, tributary creek flow, seepage, and irrigation return flows. The Santa Ynez

[8] Subareas are similar to and based on the Santa Ynez River Water Conservation District Annual Report subareas, also used for managing pumping in much of the WMA. Extents are adjusted to cover the entire Bulletin 118 basin boundary.

River is governed and regulated by the California State Water Resources Control Board as part of regional surface water rights. The water flowing through the alluvium, in a known and defined channel, is considered surface water by the California State Water Resources Control Board and is not subject to the SGMA.

1.3.2. Lompoc Plain

The Lompoc Plain subarea is composed of the Santa Ynez River floodplain that surrounds and includes the City of Lompoc (**Figure 1-4**). The Santa Ynez River enters the forebay of the Lompoc Plain from the Santa Ynez River Alluvium subarea at the Narrows at the east end of the Lompoc Plain, and terminates in the west where the river flows into the Pacific Ocean. Groundwater in the Lompoc Plain occurs in the unconsolidated units of the Lompoc Plain.

The Lompoc Plain subarea includes substantial agriculture for about 9,000 acres (Bright 1997), the City of Lompoc, the Lompoc Regional Wastewater Reclamation Plant, the Federal Bureau of Prisons facilities, and undeveloped coastline within the VAFB.

1.3.3. Burton Mesa

The Burton Mesa subarea is an upland located northwest of the Lompoc Plain and is bordered on the west by the Pacific Ocean (**Figure 1-4**). The Burton Mesa is characterized by generally thin layer of sediments that overlay the non-water-bearing Monterey Formation. Groundwater in this subarea occurs primarily in a perched condition, largely influenced by annual precipitation. During wet years, high rates of precipitation result in temporary runoff during storm events and perched conditions above non-water-bearing consolidated bedrock and/or above clays that separate the perched water from the regional aquifer system (Arcadis 2016).

The Burton Mesa subarea is almost entirely within the boundaries of VAFB. There is currently no known groundwater pumping for consumptive use in this subarea.

1.3.4. Lompoc Terrace

The Lompoc Terrace subarea is the upland area southwest of the Lompoc Plain and is bordered on the west by the Pacific Ocean. The Lompoc Terrace is similar to the Burton Mesa, with discontinuous, shallow perched groundwater conditions that overlay non-water-bearing, consolidated Monterey or Sisquoc Formations. A small northeastern portion of the Lompoc Terrace includes some Careaga Sand that extends beneath the Lompoc Plain, and is considered one of the principal aquifers within the WMA. The portion of Careaga Sand present in the Lompoc Terrace is a down-faulted wedge, overlain by younger Orcutt Sand deposits.

The Lompoc Terrace subarea is almost entirely within the extent of VAFB. It is relatively undeveloped, with no agriculture and no population centers, and has several buildings related to VAFB. The Lompoc Terrace contains the Space Launch Complexes, which currently get water from the Burton Mesa water supply system.

1.3.5. Lompoc Upland

The Lompoc Upland subarea is north and northeast of the Lompoc Plain (**Figure 1-4)**. The northern boundary of this subarea is, in part, a topographic boundary along the top of the Purisima Hills in the north. The Purisima Hills are a result of the Purisima Hill Anticline, a geologic anticline fold that resulted in uplifting and erosional thinning of the water-bearing principal aquifer units in this area.

The Lompoc Upland includes the consumptive water use population centers of Vandenberg Village Community Services District (CSD), Mission Hills CSD, and some agriculture. The Mission Hills Wastewater Treatment Plant contributes to groundwater recharge via return flows in the treatment plant's percolation ponds.

1.3.6. Santa Rita Upland

The Santa Rita Upland subarea is the portion of the Santa Rita Creek watershed that has unconsolidated water-bearing principal aquifer units (**Figure 1-4**). The northern boundary is bound by the Purisima Hills and the southern boundary is bound by the Santa Rita Hills. The water-bearing principal aquifer units are generally located within an east/west-trending geologic syncline fold (**Figure 2-1**).

The Santa Rita Upland subarea includes agriculture uses that comprise approximately 500 acres. Rural residential neighborhoods are served by shared well systems or Mutual Water Companies.

2. GEOLOGY OF THE WESTERN MANAGEMENT AREA

This section introduces and provides an overview of the regional geology and defining structures within the WMA that control the lateral and vertical extent of groundwater presence, groundwater storage, and groundwater flow. Much of this section provides text from the Draft Technical Memorandum on Regional Geology and 3D Geologic Model for the Santa Ynez River Valley Groundwater Basin, by Geosyntec (2020), which is included as **Appendix A** of this memorandum. **Appendix A** also describes the development of a three-dimensional geologic model based on data collected and analyzed as part of this GSP and references historical reports and studies.

The Basin is located on the Pacific Plate within the Transverse Range geomorphic province of California, which is characterized by east/west-striking, complexly folded and faulted bedrock formations. The Basin is an east/west-trending, linear, irregular structural depression between rugged mountain ranges and hills within the Transverse Range in Santa Barbara County, California. Primary structural features of the Basin include large anticlines and synclines. These large folds are evident in the rocks and deposits in the lowland between the folded and faulted Santa Ynez Mountains to the south, and the faulted San Rafael Mountains to the north (Upson and Thomasson 1951; for all citations provided herein, please see **Appendix A**).

2.1. MAPPED SURFACE GEOLOGY

The surface geology of the WMA and the near vicinity have younger geological formations that consist of the younger water-bearing units, and older non-water-bearing formations that constitute the WMA portion of the groundwater basin (**Figure 2-1**). The extent of the geologic units shown in **Figure 2-1** are exports from the three-dimensional model developed by Geosyntec (2020), provided in **Appendix A**. The Geosyntec report cites the extents of the surface geology that were originally mapped by Thomas Dibblee Jr.[9] Faults based on a Quaternary map compilation by the United States Geological Survey (USGS 2020) are also shown on **Figure 2-1**.

2.1.1. Geologic Units

Descriptions of the geologic units that are shown in **Figure 2-1**, in agreement with publicly available literature and as shown in the three-dimensional geological model (**Appendix A**), are provided in the following subsections. The geologic unit descriptions are provided from the surface units (youngest) to deeper underlying units (oldest), as shown in **Figure 2-1**. Detailed descriptions for the geologic units, as excerpted from **Appendix A** (Geosyntec 2020) are provided below:

[9] Dibblee conducted field mapping for the following USGS geologic quadrangles: Lompoc Hills and Point Conception Quadrangle, Point Arguello and Tranquillon Mountain Quadrangle, and Lompoc and Surf Quadrangle.

Younger Units

River Channel Deposits (Qg)

Qg occurs within the modern-day Santa Ynez River channel and consists of fine-to-coarse sand, gravels, and thin discontinuous lenses of clay and silt (Upson and Thomasson 1951; Wilson 1959; Miller 1976; Bright et al. 1992). The grain size typically decreases along the river's reach, fining towards the ocean (Upson and Thomasson 1951). The Qg unit thickness ranges from 30-feet (ft) to 40-ft, with observations of localized deposits up to 70-ft thickness 6 miles west of the City of Buellton along the Santa Ynez River, however, these deposits are largely indistinguishable from the underlying alluvium (Upson and Thomasson 1951). The Qg in the geologic model is interpreted using the Dibblee geologic map and from borehole data and is generally thought to be hydraulically connected to the Qal, described below.

Alluvium (Qal)

The geologic unit Quaternary Alluvium (Qal) is composed of a coarse sand upper member and a fine sand lower member which have been previously described by others (Dibblee 1950; Upson and Thomasson 1951; Wilson 1959; Miller 1976; Bright et al. 1992). Qal is composed of unconsolidated, normally graded gravel and medium-to-very coarse sand, which grades upwards into fine to coarse sand with rare gravels, then fines vertically upwards into fine sand, silt and clay (Upson and Thomasson 1951; Wilson 1959; Miller 1976; Bright et al. 1992; Fugro Consultants, Inc. 2007). The thickness of Qal varies from approximately 30 to 90-ft in the Buellton Subarea (Upson and Wilson 1951) to approximately 170-ft to 200-ft in the Lompoc Plain (Dibblee 1950; Upson and Thomasson 1951; Evenson and Miller 1963; Miller 1976; Bright et al. 1992). In sloped areas and drainages, the thickness of Qal varies from less than 10-ft to 50-ft (Fugro Consultants, Inc. 2007). Qal is the principal source of groundwater in the Lompoc Plain (Dibblee 1950; Upson and Thomasson 1951; Evenson and Miller 1963; Miller 1976; Berenbrock 1988; Bright et al. 1992).

Terrace Deposits / Older Alluvium (Qoa)

The geologic unit Quaternary Terrace Deposits and Older Alluvium (Qoa) typically consists of unconsolidated to poorly consolidated sands and gravels with common silt and clay zones (Dibblee 1950; Upson and Thomasson 1951; Miller 1976; Berenbrock 1988; Bright et al. 1992). Qoa thickness varies from 0-50-ft (Bright et al. 1992), up to 150-ft (Upson and Thomasson 1951; Miller 1976; Berenbrock 1988). Qoa underlies alluvium (Qal) in most of the southern Lompoc Plain and caps hilltops, benches and upland areas of the Santa Ynez River and major tributaries (Upson and Thomasson 1951; Miller 1976; Berenbrock 1988; Bright et al. 1992).

Orcutt Sand (Qo)

The geologic unit Quaternary Orcutt Sand (Qo) consists of unconsolidated, well sorted, coarse to medium sand and clayey sand with scattered pebbles and gravel stringers (Upson and Thomasson 1951; Bright et al. 1992). The top of the formation is locally indurated in Lompoc Valley and Burton Mesa by iron oxides, whereas the basal portion contains well-rounded pebbles of quartzite, igneous rocks, and Monterey chert and shale (Dibblee 1950). Qo thickness varies from 0-300-ft (Upson and Thomasson 1951; Evenson and Miller 1963; Bright et al. 1992).

Paso Robles Formation (QTp)

The Quaternary-Tertiary Paso Robles Formation (QTp) consists of poorly consolidated to unconsolidated, poorly sorted, gravels, sands, silts and clays (Dibblee 1950; Upson and Thomasson 1951; Wilson 1959; Miller 1976; Berenbrock 1988; Bright et al. 1992; Yates 2010). QTp varies in thickness from 2,800-ft in the Santa Ynez subarea (Upson and Thomasson 1951) 6.5 miles west of the San Lucas Bridge, to 700-ft in Santa Rita Valley (Dibblee 1950; Miller 1976) and thins westward where it pinches out in the eastern Lompoc plain (Dibblee 1950; Upson and Thomasson 1951; Miller 1976).

QTp yields water to wells throughout the study area (Upson and Thomasson 1951; Miller 1976; Berenbrock 1988; Bright et al. 1992) and is the principal water bearing unit in the basin near Lake Cachuma and in the Santa Ynez Upland (Yates 2010).

Careaga Sand (Tca)

The geologic unit Tertiary Careaga Sand (Tca) yields water and consists of massive, fine-to-coarse sand, with lenses of gravels and fossil shells (Dibblee 1950; Woodring and Bramlette 1950; Upson and Thomasson 1951; Wilson 1959; Evenson and Miller 1963; Miller 1976). Clay and silt beds are characteristically absent, and the uniformity in grain-size and presence of seashells distinguish it from the overlying QTp (Dibblee 1950; Upson and Thomasson 1951). Tca is often differentiated into the upper coarse sand Graciosa Member (Tcag) and the lower, fine sand Cebada Member (Tcac), which have been described in literature (Dibblee 1950; Woodring and Bramlette 1950; Upson and Thomasson 1951; Evenson and Miller 1963; Miller 1976; Berenbrock 1988; Bright et al. 1992). Tca thickness can vary from 450-ft to1000-ft (Upson and Thomasson 1951), but is typically observed between 500-ft to 800-ft thickness in the Lompoc area, surrounding Lompoc hills, and in the Buellton area (Dibblee 1950; Evenson and Miller 1963; Miller 1976). The Careaga Formation has been previously identified as an important aquifer within the Santa Ynez River Valley Groundwater Basin (Hoffman 2018).

Older Units

Tertiary-Mesozoic Rocks are consolidated non-water bearing units, all of marine origin. They consist of the near-shore marine Foxen (Tf), Sisquoc (Tsq), and Monterey (Tm) Formations. The Foxen Formation consists of light gray or tan massive claystone, siltstone, and/or mudstone (Dibblee 1950; Woodring and Bramlette 1950; Upson and Thomasson 1951). The Sisquoc Formation is massive to very thin bedded, white diatomite and diatomaceous mudstones, with basal massive fine sands (Dibblee 1950; Woodring and Bramlette 1950; Upson and Thomasson 1951). The Monterey Formation, primarily known for its vast oil reserves, consists of variably bedded siliceous shale, diatomaceous mudstone, porcelaneous shale, chert, phosphatic shale, silty shale, limestone, and a basal clay altered tuff (Dibblee 1950; Woodring and Bramlette 1950; Upson and Thomasson 1951).

2.2. Key Geologic Structures within the Western Management Area

Shown on the geologic map of the WMA and the immediate vicinity (**Figure 2-1**) are several geologic fault and fold structures. The existence and orientation of these geologic structures are related to regional movement, generally due to north/south compression. The locations and existence of these features are based on two sources: maps produced by Dibblee (**Appendix A**) and a Quaternary map compilation by the USGS (U.S. Geological Survey 2020).

2.2.1. Synclines and Anticlines

The Santa Rita Syncline is an east/west-trending fold from the CMA to the WMA. The eastern end of the syncline is in the Buellton Uplands portion of the CMA east of the WMA. The syncline extends westward to the WMA through the Santa Rita subarea to the Lompoc Upland subarea in the WMA (**Figure 2-1**). The unconsolidated sediments in the Santa Rita Syncline form much of the water-bearing principal aquifers in the Santa Rita and Lompoc Upland subareas. Younger Alluvium (Qal) and Orcutt Sand (Qo) overlie much of the Santa Rita Syncline (**Figure 2-1**).

The Purisima Anticline is an approximate east/west-trending fold present in the Purisima Hills forming the northern boundary of the central part of the Lompoc Uplands and Santa Rita Uplands in the WMA. In the east, the anticline is eroded, providing surface exposures of the Sisquoc Formation and the Foxen Formation.

2.2.2. Faults

Faults with potential to impede groundwater recharge, storage or flow are not currently identified in the WMA. Additional geophysical SkyTEM Aerial Electromagnetic (AEM) survey data collected within the WMA, in conjunction with potential input received from water users and the public may be used to update current understanding of faults that may affect the water environment within the WMA.

The location of the Santa Ynez River Fault is shown in **Figure 2-1**, consistent with the recent USGS Quaternary fault-and-fold map. The USGS mapped the fault with limited location accuracy (U.S. Geological Survey 2020). Other small fault features are found in the upper reaches of Purisima Canyon and Cebada Canyon in the Lompoc Upland subarea (**Figure 2-1**). These small northwest/southeast-tending thrust faults occur directly south of the western end of the Purisima Anticline (Dibblee 1950).

2.2.3 SUBSURFACE GEOLOGIC CONDITIONS

The subsurface geologic conditions within the Basin and WMA are the result of tectonic forces. A detailed subsurface three-dimensional model of the geologic units and structures for the entire WMA and immediate vicinity are provided in **Appendix A**. This effort included compiling new data, collecting recently drilled well completion reports, interpreting and assigning the driller logs to geologic units,[10] and locating them in three-dimensional space. Interpretations of the surface geology in terms of geologic maps, and interpretations of the subsurface from past reports were also pulled into the model. The resulting three-dimensional model is a synthesis of all of these sources and represents the best available three-dimensional understanding of the subsurface geologic units that make up the WMA aquifers.

2.2.4 Geologic Cross-Sections

The locations of five cross-sections through the WMA are shown in **Figure 2-2**. Details of the five cross-sectional views are shown in **Figure 2-3a** through **Figure 2-3c**. The locations of the cross-sections represent the structure and shape of the geologic units that underlie the WMA[11]. **Appendix A** includes detailed descriptions of the geology shown in each cross-section.

[10] The geologic units included in the geological model, map, cross-sections, and discussion are based on what could be generally recognized from the well drilling logs, which are mostly descriptions of the cuttings as the well is drilled with varying detail. The thinner aquifer units described in the aquifer unit section could not be unambiguously recognized from a majority of these logs.

[11] Cross section E-E’ lies near the border of the WMA and CMA and represents the geology at this boundary.

3 PRINCIPAL AQUIFERS AND AQUITARDS

Principal aquifers refer to aquifers or aquifer systems that store, transmit, and yield significant or economic quantities of groundwater to wells, springs, or surface water systems. The WMA is characterized by two Principal Aquifers: an Upper Aquifer and a Lower Aquifer. This section relates key geologic units to principal groundwater aquifers within the WMA. Definition of these geologic units and their principal aquifer properties is important in terms of groundwater occurrence, storage, and flow. These properties are also essential during development of the water budget, and evaluation of current groundwater characteristics and conditions, and for the numerical groundwater model employed to quantify groundwater flow in the Basin under historical, current, and projected future conditions. In agreement with the geologic model prepared for the Basin, the lateral and vertical extents of these aquifers, including the definable base of the Basin, are presented and discussed in this section.

3.1 WESTERN MANAGEMENT AREA BASIN EXTENT AND THICKNESS

The geologic units are categorized in terms of aquifer properties into two broad categories: (1) water-bearing units composed of "unconsolidated" sedimentary deposits and (2) non-water-bearing units composed of "consolidated" sedimentary deposits and crystalline rocks. The "unconsolidated" deposits allow water to infiltrate into them, be stored within them, and flow through them. The "consolidated" deposits impede groundwater infiltration, storage, and flow.

The unconsolidated, water-bearing sediments are those with sufficient permeability and storage potential to both store and convey groundwater. Less consolidated materials allow for greater permeability of water. In terms of the defined geologic units, the unconsolidated sediment applies to the Careaga Sand, Paso Robles, and younger formations.

Non-water-bearing units are consolidated sediments or rock that have low porosity, low hydraulic conductivity, or a combination of the two. Low porosity means there is relatively little space to contain groundwater, and low hydraulic conductivity means groundwater is transmitted relatively slowly. Consolidation such as cementation and compaction of sedimentary units reduces both porosity and hydraulic conductivity. Crystalline units in the area include igneous and metamorphic rocks, which are also significantly older and have no porosity, which is characteristic of their original extrusion. However, crystalline rock formations may have fractures resulting in localized instances of increased storage capability and hydraulic conductivity, which may be suitable for limited use such as domestic water supply, but as a general rule they are considered non-water-bearing. Within the defined geologic units of the WMA, these include the Foxen Formation, Sisquoc Formation, Monterey Formation, and the older formations.

3.1.1 Western Management Area Definable Bottom of the Basin

The boundary between the water-bearing and underlying non-water-bearing geologic units form the "definable bottom of the basin"[12] and "lateral basin boundaries," [13] as defined by the SGMA. Regarding the lateral basin boundaries, the current WMA Basin boundary by DWR is very close to the geologic contact between consolidated deposits (Foxen, Sisquoc, Monterey, and the older Formations) and unconsolidated deposits (formations younger than or equal to Careaga) shown in **Figure 2-1**. However, there are some minor differences with the geology mapped by Dibblee (**Figure 2-1**) and the current WMA boundary. For example, in the area north of Vandenberg Village, the Orcutt Sand is mapped by Dibblee to extend about 2,000 feet north of the current WMA Boundary. However, throughout most of the area, the current WMA boundary lies within a couple 100 feet of the surface geology mapped by Dibblee (**Figure 2-1).**

Based on the three-dimensional geological model (Geosyntec 2020), the *definable bottom of the Basin* was mapped using the contact between the consolidated deposits (Foxen, Sisquoc, Monterey, and the older Formations) and unconsolidated deposits (formations younger than or equal to Careaga) as the base elevation. The Basin bottom elevation has been contoured and is shown on **Figure 3-1**. The lateral Basin boundaries are also shown in **Figure 3-1** as approximated by the WMA Basin Boundary, where the basin bottom intersects the land surface and is analogous to the hard bottom and side that contains an aquifer.

The combined thickness of the Basin unconsolidated deposits is shown in **Figure 3-2**. This is the maximum depth of a groundwater well in an aquifer throughout the Basin. The variation of the thickness of the unconsolidated deposits across the WMA is shown in **Figure 3-2**. The saturated thickness of the aquifer at any particular time, or volume of water, is dependent on current groundwater elevations and other factors.

3.2 PRINCIPAL AQUIFERS AND DESCRIPTION FOR EACH WESTERN MANAGEMENT AREA SUBAREA

The aquifers present within the six subareas of the WMA (**Figure 1-4)** are divided into two Principal Aquifers: an upper and a lower unit. An aerial view of the location of two aquifer cross-sections is provided in **Figure 3-3**[14]. Cross-sections of the Upper Aquifer and Lower Aquifer in the Lompoc Plain and Lompoc Upland are provided in **Figure 3-4a** and **Figure 3-4b**. These aquifer cross-sections are from the Lompoc Groundwater Management Plan (West Yost 2013), based on extensive studies conducted by the USGS in the Lompoc area (Bright et al.

[12] 23 CCR § 354.14(b)(3)
[13] 23 CCR § 354.14(b)(2)
[14] The zones in Figure 3-3 correlate with management zones used by the Santa Ynez River Water Conservation District (Stetson, 2020), which correlate with five of the six subareas of the WMA. Zone A represents the Santa Ynez River Alluvium. Zone B represents the Lompoc Plain, Lompoc Upland, and Lompoc Terrace. Zone F represents the Santa Rita Upland.

1992; Bright et all. 1997). A description of the Upper and Lower Aquifers in each subarea is provided in the sections below.

3.2.1 Upper Aquifer

The Upper Aquifer consist of Santa Ynez River gravels, younger and older alluvial deposits, Orcutt Sand, and other younger alluvial geologic formations that are found throughout the WMA. Most of the extracted groundwater is from the alluvial areas of the Lompoc Plain and the Santa Ynez River Alluvium subarea. The Upper Aquifer is found in the Lompoc Plain, along the Santa Ynez River, and Lompoc Terrace. Additionally the Upper Aquifer is found in Orcutt Sand Deposits throughout the WMA.

Upper Aquifer in the Lompoc Plain

In the Lompoc Plain subarea, the Upper Aquifer corresponds to the Quaternary alluvium and terrace deposits of the Santa Ynez River. The Lompoc Plain Upper Aquifer is commonly divided into three water-bearing zones[15]: (1) the shallow zone; (2) the middle zone; and (3) the main zone, as described by the USGS (Bright et al. 1992) and adopted locally (West Yost 2013). The three zones in aquifer cross-section A-A' along the Santa Ynez River from east to west are shown in **Figure 3-4a**. This cross-section is from the Lompoc Groundwater Management Plan (West Yost 2013) and agrees with **Figure 2-3a**; geologic cross-section A-A' (Geosyntec 2020), although each focus on different details.

The shallow and middle zones of the Quaternary alluvium are also referred to as the upper member of the alluvium (Upson and Thomasson 1951; Berenbrock 1988). The shallow zone in **Figure 3-4a** includes river-channel deposits and predominately fine-grained sand, silt, and clay deposits of the alluvium that confine or partly confine the underlying deposits in the western, central, and northeastern portions of the subarea. The middle-zone deposits are similar to the shallow zone but contain interbedded lenses of coarse-grained sand and gravel deposits (HCI 1997; Bright et al. 1992). The medium to coarse sand and gravel areas in the upper member of the younger alluvium (shallow and middle zones) are described as follows (Upson and Thomasson 1951, p. 48):

> In tributary canyons along the south margin of the Lompoc plain and along the Santa Ynez River the upper member of the younger alluvium is predominantly sand and gravel and contains only thin, discontinuous beds of clay or silt. The coarsest deposits are those penetrated by wells along the river within a few thousand feet downstream from

[15] These layers of the younger alluvium are also referred to as the upper and lower members (Upson and Thomasson 1951; Berenbrock 1988) with the lower member correlating with the "Main Zone" in the City of Lompoc Groundwater Management Plan (West Yost, 2013). Note for the purposes of the WMA Groundwater Sustainability Plan, the younger alluvium (Qya) constitutes a Principal Aquifer, the Upper Aquifer, while these layers within the younger alluvium are considered part of this aquifer system.

Robinson Bridge, where very little silt or clay intervenes between the river channel deposits and the lower member of the younger alluvium.

These areas of coarser deposits in the upper part of the younger alluvium, particularly along the Santa Ynez River downstream of Robinson Bridge, are important areas of streamflow infiltration from the Santa Ynez River and tributaries.

The main zone includes the lower member of the alluvium. Medium to coarse sand and gravel comprise this zone. The main zone throughout most of the Lompoc Plain subarea is separated from the middle zone by lenses of silt and clay that result in confined or partially confined conditions in the main zone. However, in the eastern, southern, and northern portions of the Lompoc Plain subarea, the confining deposits are less continuous or absent, allowing movement of groundwater between the shallow, middle, and main zones.

Typical total thickness of the Upper Aquifer in the Lompoc Plain ranges from 160 feet to 200 feet, except in the far eastern portion of the Lompoc Plain east of the Santa Ynez River, where the total thickness ranges from 0 to 100 feet (**Figure 3-4a**). Based on a study by USGS (Bright et al. 1992), the main zone of the Upper Aquifer is absent in the southern portion of the Lompoc Plain (south of Central Avenue in the City of Lompoc) (**Figure 3-4b**).

The divisions of the Lompoc Plain Upper Aquifer are difficult to distinguish in well completion reports. In general, the texture of the three zones is such that the preponderance of coarse-grained textures increases with depth (HCI 1997). The main zone or lower member of the Upper Aquifer has historically been the primary source of water from the Lompoc Plain subarea.

The Upper Aquifer in the southern and eastern portions of the Lompoc Plain is underlain by Careaga Sand. In the western portion of the Lompoc Plain, which includes the estuary adjacent to the Pacific Ocean, the Upper Aquifer alluvium overlies the Sisquoc Formation or the Monterey Formation (**Figure 2-3a**; geologic cross-section A-A').

The intermediate-scale permeability of the younger alluvium ranges from 10 to 400 feet per day within the shallow zone (including the more permeable river channel deposits directly adjacent to the Santa Ynez River), 10 to 20 feet per day within the middle zone, and 300 to 400 feet per day within the main zone (West Yost 2013).

Upper Aquifer in the WMA Portions of the Santa Ynez River Alluvium

The Upper Aquifer in the WMA Santa Ynez River Alluvium subarea consists of alluvial deposits. As described in terms of geology, this includes relatively thin terrace deposits (Upson and Thomasson 1951) and recent and active river channel deposits overlie bedrock of primarily (Monterey Formation). Non-water-bearing consolidated geologic units also form the lateral boundaries as exposed bedrock in this area (**Figure 2-3c**; geologic cross-section E-E').

The occurrence of water in the WMA Santa Ynez River Alluvium is considered surface water because it flows through a known and defined channel. Surface water is governed by the California State Water Resources Control Board as part of regional surface water rights and is not subject to the SGMA.

The deposits of Santa Ynez River Alluvium consist of fine-to-coarse sand, gravels, and thin discontinuous lenses of clay and silt. Santa Ynez River alluvial deposits are relatively thin, with typical thicknesses of 60 to 80 feet, with local thicknesses of more than 100 feet. Wells completed within these deposits typically yield a few hundred to as high as 1,500 or more gallons per minute. These deposits underlie the floodplain and active river channel. The younger alluvium consists of clay, silt, sand, and gravel beneath the alluvium and floodplain along the Santa Ynez River (Wilson 1959). The permeability of these deposits ranges from 100 to 700 feet per day (Upson and Thomasson 1951).

Upper Aquifer WMA Orcutt Sand Deposits: Lompoc Upland, Santa Rita Upland, Burton Mesa, and Lompoc Terrace Upper Aquifer

Orcutt Sand, which is extant in the Lompoc and Santa Rita Uplands, Lompoc Terrace, and Burton Mesa (**Figure 2-1**), is composed of coarse sand, silt, and clay of mostly non-marine origin, with permeability of about 5 feet per day. In the upland and terrace locations, including the Lompoc Terrace, Burton Mesa, Lompoc Upland, and Santa Rita Upland, groundwater is sometimes locally present in “shallow” perched conditions. This occurrence is described as follows (Miller 1976, p. 24):

> Beneath the upland and terrace, the Orcutt Sand locally contains perched groundwater. Water levels in wells that tapped perched zones beneath the uplands in 1972 generally were more than 100 ft higher than levels in the underlying Paso Robles Formation and Careaga Sand.

Perched groundwater in the Orcutt Sand deposits on the Burton Mesa subarea is shown on a conceptualized hydrogeologic cross-section in **Figure 3-5** (Arcadis 2016). The shallow groundwater system in the Burton Mesa varies locally, existing either on top of the non-water-bearing shale that underlies the entire mesa, or on top of clay layers within multiple lenses throughout the subarea.

Currently, perched groundwater units, including the Orcutt Sand deposits on the Burton Mesa, have limited storage capacity and are not considered a primary water source in the WMA. The Orcutt Sand deposits of the VAFB are located above the deposits in the Lompoc Plain and separated by Monterey Shale as shown in **Figure 2-3a**, geologic cross-section B-B’. Orcutt Sand has not been included in historical investigations of groundwater in the WMA, most likely due to their perched condition and separation from the regional saturated flow of the Upper and Lower Aquifers in the Lompoc Plain and Upland (SBCWA 1999; Stetson 1992, 2020; Miller 1976;

Bright 1997; West Yost 2013). The thickness of the Orcutt Sand varies in the WMA from 0 to 300 feet (Bright et al. 1992).

Groundwater in Orcutt Sand exists in unsaturated conditions (Bright 1997) and contributes to the recharge of the Lower Aquifer, including the Paso Robles and Careaga Formations in the Lompoc Upland and Lompoc Terrace subareas. Where there is no Lower Aquifer and only older consolidated non-water-bearing formations, as is the case in the Burton Mesa and the southwestern portion of the Lompoc Terrace, water is most likely discharged to local tributaries or springs (Arcadis 2016). This discharge is seen as the interflow component of streamflow hydrographs.

Upper Aquifer in WMA Younger Alluvium, Lompoc Terrace Upper Aquifer

Additional small quantities of groundwater are found in the Younger Alluvium in the small coastal drainages that exist in the Lompoc Terrace subarea, including Bear Creek, which is outside of the Santa Ynez River watershed. This area is usually not included in the regional groundwater resources for the Lompoc area due to being outside of the Santa Ynez River watershed. Due to the small size of the drainage, alluvial deposits are estimated to be less than 30 feet thick with low groundwater storage capacity and has been scoured to bedrock in some locations (**Figure 2-1**). Groundwater in bedrock is not subject to SGMA.

3.2.2 Lower Aquifer

The Lower Aquifer consists primarily of the Paso Robles and Careaga Formations. These formations are found in the axis of the Santa Rita Syncline, which trends from the Santa Rita Upland through the Lompoc Upland, and continue under the Lompoc Plain and Lompoc Terrace. The Lower Aquifer is also the main aquifer in the Lompoc Terrace and Lompoc Upland (Bright et al. 1992). Groundwater conditions in the Lower Aquifer range from unconfined to confined in the Lompoc Upland and confined in the Lompoc Plain (Bright et al. 1997).

These Lower Aquifer units are older and more consolidated than younger alluvial formations that make up the Upper Aquifer. The Lower Aquifer units lie unconformably beneath the Upper Aquifer units. The Lower Aquifer locally outcrops on the Lompoc Terrace and along the south side of the Purisima Hills.

The Paso Robles Formation is composed of fine to coarse sand, silt, and clay of non-marine origin, with permeabilities that range from 10 to 100 feet per day. The lower part of the Paso Robles Formation is finer grained than the upper part. Except for parts of the Lompoc Upland and the eastern portion of the Lompoc Plain by the Santa Ynez River, the Paso Robles Formation is either completely unsaturated or not present in the Lompoc area (Bright et al. 1992). The younger Paso Robles Formation conformably overlies the Careaga Formation.

The Careaga Formation has two major components: the upper or Graciosa Member with medium to coarse sand, and the lower or Cebada Member with typically finer sand. The Graciosa Member of the Careaga Sand is the main producer of groundwater in the Lower Aquifer (Bright et al. 1992). Hydraulic conductivity of the Cebada Member ranges from 0.1 to 3 feet per day beneath the plain. Hydraulic conductivity of the Graciosa Member ranges from about 5 feet per day beneath the Lompoc Plain to 90 feet per day beneath the Lompoc Upland (Bright et al. 1992).

Lower Aquifer in the Lompoc Plain Subarea

The Lower Aquifer is located under the Upper Aquifer in the Lompoc Plain. The Lower Aquifer is absent in the western portion of the WMA near the Pacific Ocean, but approximately 5 miles inland, the Careaga Formation is present beneath the Upper Aquifer and throughout the rest of the Lompoc Plain, as shown in **Figure 3-4a** and **Figure 3-4b**. The Paso Robles formation is only located east of the Santa Ynez River in the Lompoc Plain. Most of the City of Lompoc has the Lower Aquifer underneath it. Groundwater in the Lower Aquifer beneath the Lompoc Plain is confined or partly confined by the stratified deposits that form this aquifer (Paso Robles Formation and Graciosa Member of the Careaga Sand), and by the overlying fine-grained deposits in the Upper Aquifer (Bright et al. 1992).

Lower Aquifer in the Lompoc Upland Subarea

As described above, the Lower Aquifer extends from the Lompoc Plain subarea to the north northeast into the Lompoc Upland). In the Lompoc Upland, the Paso Robles Formation forms part of the Lower Aquifer beneath the Lompoc Upland (**Figure 2-3a**, geologic cross-section B-B'); however, much of the Paso Robles Formation beneath the Lompoc Upland is unsaturated (Bright et al. 1992). The saturated portions of the Lower Aquifer in the Lompoc Upland is primarily the Careaga Formation. Prior to groundwater development, groundwater in the Lower Aquifer of the Lompoc Upland followed the surface topography and flowed into the Lower Aquifer of the Lompoc Plain. During very wet periods, recharge to the Lompoc Upland aquifer can occur from infiltration of the Santa Ynez River (Berenbrock 1988; pg. 15). Under developed conditions, groundwater levels beneath the Lompoc Upland declined, and the exchange of groundwater between the Lompoc Upland and Lompoc Plain is determined by the relative magnitudes of recharge and pumping in the two subareas (West Yost 2013).

Lower Aquifer in the Lompoc Terrace Subarea

The Lompoc Terrace subarea, the hilly area adjacent to the southwest part of the Lompoc Plain subarea, is a down-faulted wedge of Careaga Sand overlain by Orcutt Sand. The Lower Aquifer is in the buried syncline that becomes broader and widens to the northeast. Only the lower Cebada Member of the Careaga Sand is present or saturated in the Lompoc Terrace (Bright et al. 1992). The groundwater in the Lower Aquifer of the Lompoc Terrace follows the surface topography and flows either into the Lower Aquifer of the Lompoc Plain to the northeast or into the adjacent coastal drainage outside of the Santa Ynez River watershed (Bear Creek).

Lower Aquifer in the Santa Rita Upland Subarea

The Lower Aquifer extends into the Santa Rita Syncline from the Lompoc Upland subarea to the west and continues to the CMA Buellton Upland subarea to the east. The Lower Aquifer is found beneath younger Quaternary alluvial deposits like the Orcutt Sand and Quaternary Terrace deposits, as well as soils with high infiltration rates. Below an unconformity with the Orcutt Sand there is a syncline fold that includes the Paso Robles Formation and Careaga Sand underneath (**Figure 2-3c**, geologic cross-section D-D'). Consolidated rocks (Tsq and Tm) that out-crop out in the Santa Rita Hills to the south of the Santa Rita Valley Aquifer locally separate the Santa Ynez River riparian groundwater basins from the Santa Rita Upland (**Figure 2-3c**, geologic cross-section D-D'; Upson and Thomasson 1951). Groundwater in the Lower Aquifer of the Santa Rita Upland flows westward, partly into the Lower Aquifer of the Lompoc Upland. However, more water level data is needed in the Santa Rita Valley to confirm the direction and rate of movement of groundwater in the Lower Aquifer in this subarea.

Aquifer properties of the Lower Aquifer Formation appear consistent across the Santa Rita Syncline, including the Santa Rita Upland Lower Aquifer. Lower Aquifer deposits consist of fine to coarse sand, with permeabilities that range from 0.1 to 100 feet per day (Upson and Thomasson 1951; Wilson 1959; Bright et al. 1992, 1997).

3.3 SUMMARY OF UPPER AND LOWER AQUIFER PROPERTIES

In the Upper Aquifer in the WMA, the permeability, or hydraulic conductivity, of the alluvial deposits varies widely upon location and depth. The permeability of the river gravel deposits along the Santa Ynez River ranges from 100 to 700 feet per day (Upson and Thomasson 1951). The permeability of the younger alluvium within the shallow zone (including the more permeable river channel deposits directly adjacent to the Santa Ynez River) ranges from 10 to 400 feet per day, 10 to 20 feet per day within the middle zone, and 300 to 400 feet per day within the main zone (West Yost 2013). Similarly storage coefficients range widely in the Upper Aquifer depending upon location and depth. The specific yield of the river gravel deposits along the Santa Ynez River is estimated 30 percent (Bright et al. 1997). The specific yield of the shallow and middle zones of the Upper Aquifer in the Lompoc Plain range from 0.1 to 18 percent (Bright et al. 1997). In the main zone of the Lompoc Plain Upper Aquifer, the storage coefficient has been estimated to range from 0.02 to 0.2 percent.

In the Lower Aquifer in the WMA, the permeability and storage coefficients are generally less than the Upper Aquifer alluvial deposits. Hydraulic conductivity of the Graciosa Member of the Careaga Formation (upper Careaga) ranges from about 5 feet per day beneath the Lompoc Plain to 90 feet per day beneath the Lompoc Upland (Bright et al. 1992). Hydraulic conductivity of the Cebada Member of the Careaga Formation (lower Careaga) range from 0.1 to 3 feet per day beneath the Lompoc Plain. The Paso Robles Formation has a similar range of hydraulic conductivity as the Careaga. The storage coefficients for the Lower Aquifer has been estimated to range from 0.04 to 0.08 percent (Bright et al. 1997). The specific yield for unconfined portions of the Lower Aquifer have been estimated from 7.5 to 20 percent (HCI, 1997).

The wells in the WMA with available aquifer pump tests were analyzed. The data are from well completion reports from both DWR and the County of Santa Barbara Department of Environmental Health Services, as well as from local water agencies. Most of the data is from the County of Santa Barbara because the County requires a pump test for wells that are permitted as a single parcel and as multiple-parcel water systems, state small water systems, and Public Water Systems with less than 200 service connections. Most of the tests are of short duration and only include one observation of drawdown. Specific capacity data was analyzed for 74 pump tests in the Upper Aquifer with well depths of less 220 feet and for 69 pump tests in the Lower Aquifer with well depths greater than 220 feet.

Using the available pump-test data, the median yield, specific capacity, and hydraulic conductivity were calculated for each aquifer. The hydraulic conductivities were estimated using the methodology from Driscoll (Driscoll, 1986; Appendix 16D). The median yield of the pump tests were estimated to be 1000 and 500 gallons per minute (gpm) for the Upper and Lower Aquifers respectively. The median specific capacity of 25 and 6 gpm per foot of drawdown were estimated for the Upper and Lower Aquifers, respectively. The median hydraulic conductivities of 160 and 10 ft/day were calculated for the Upper and Lower Aquifers, respectively.

3.4 WATER QUALITY IN THE WESTERN MANAGEMENT AREA

Issues related to the degradation of water quality in the WMA most frequently pertain to excessive salinity and hardness (Regional Water Quality Control Board 2017).

In the Upper Aquifer in the WMA, the dissolved-solids concentration of groundwater in the central and western Lompoc Plain has increased from less than 1,000 milligrams per liter in the 1940s to greater than 2,000 milligrams per liter in the 1960s (Bright 1997). Groundwater quality was observed to deteriorate from east to west (Berenbrock 1988). Groundwater conditions in the Lompoc Plain are influenced by the quantity and quality of Santa Ynez streamflow and Cachuma Project operations, and more recent data from water supply wells indicate a decrease in dissolved-solids concentrations (West Yost 2013).

The Upper Aquifer in the WMA also has samples for some wells with water quality concentrations exceeding maximum or secondary contaminant levels for drinking water and impairment for irrigation, including the parameters of sodium, chloride, nitrate, hardness, alkalinity, and iron (Berenbrock 1988). In addition, the parameters of Arsenic and Manganese have exceeded contaminant levels in some well samples in the Lompoc Plain as provided in California's

Groundwater Ambient Monitoring Assessment (GAMA) program (Haas et al. 2019). Data and trends will be described in further detail in the documentation of the groundwater conditions technical memorandum.

In the Lower Aquifer in the WMA, the dissolved-solids concentration of groundwater are generally less than 1,000 milligrams per liter (Bright 1997). The main water quality issue with the lower aquifer is hardness (Allen 2020). In addition, the parameters of Arsenic, Iron, and Manganese have exceeded contaminant levels in some well samples in the Lompoc Upland and on Vandenberg Air Force Base (Haas et al. 2019). Some wells on the Vandenberg Air Force Base also show water quality impairments due to nitrate, sulfate, and hexavalent chromium (Haas et al. 2019).

4 HYDROLOGIC CHARACTERISTICS

Hydrologic characteristics of the WMA related to groundwater recharge, including aerial precipitation recharge, mountain-front recharge, and streamflow infiltration, are presented in this section, and a generalized representative graphic is included in **Figure 1-2**. Additional details for these topics will be included in the forthcoming water budget technical memorandum, which also will quantify the hydrologic inflows and outflows of the WMA.

4.1 TOPOGRAPHY

The topography of the WMA is a major factor on the movement of surface water and groundwater and magnitude of precipitation and groundwater recharge. Groundwater movement in the WMA follows the surface topography. The WMA boundary, topography, and various geographic features within or adjacent to the area are shown in **Figure 4-1**. Ground surface elevations in the WMA vary from sea level (0 feet) at the Santa Ynez River estuary to more than 1,000 feet above sea level in the surrounding hills. The City of Lompoc is about 80 to 100 feet above sea level, and the elevation of the Santa Rita Valley is about 400 to 500 feet above sea level. The terrain south of the Santa Ynez River rises steeply from the river to the Santa Ynez Mountain range. North of the Santa Ynez River the rise in elevation is gradual over upland terraces and toward the Purisima Hills. Burton Mesa and Lompoc Terrace are about 450 and 350 feet above sea level, respectively.

4.2 SOILS AND INFILTRATION

Precipitation and agricultural return flows can infiltrate to become groundwater, evaporate into the atmosphere, or run off to become surface water. Soil properties and slope are important controls on infiltration and runoff and indicate the potential for specific agricultural use. The soil characteristics of the WMA in terms of their potential infiltration rates are shown in **Figure 4-2**.

Soils are the combination of minerals, organic matter, living organisms, gas, and water that are located at land surface. Their total composition and elevation greatly affect their infiltration rate and contribution to groundwater recharge, in addition to the types of unconsolidated or consolidated sediments underlying them.

4.2.1 Natural Recharge Areas

The areas of soils with high infiltration rates (**Figure 4-2**) relate to the areas of existing recharge. Key areas for recharge to the lower aquifers include along the Purisima Hills in the Lompoc and Santa Rita Upland subareas, and to a lesser extent in the Lompoc Terrace and Burton Mesa. Additionally, the Lompoc Plain subarea receives most of its substantial recharge from the Santa

Ynez River[16] and much lesser quantities from percolation of runoff in the tributaries in the adjoining subareas. Percolation from the Santa Ynez River channel is therefore the most important source of recharge for the Lompoc Groundwater Basin, and controlled by the magnitude and timing of releases from Cachuma Reservoir (West Yost 2013). The Lompoc Terrace, Lompoc Upland and Santa Rita Upland subareas do not receive recharge from Santa Ynez River infiltration but contain large surface areas of soils with high infiltration rates (**Figure 4-2**).

4.2.2 Potential Groundwater Recharge Areas

In addition to natural recharge, DWR recommends[17] including in the GSP the Soil Agricultural Groundwater Banking Index map (**Figure 4-3**), which is a classification of the suitability of agricultural land for use in groundwater banking conducted by UC Davis. Groundwater banking means using artificial recharge to store water in the aquifer for later withdrawal through pumping.

The Soil Agricultural Groundwater Banking Index ratings are only available for agricultural land and are based on a combination score using the following five factors[18] to ensure that an artificial recharge project would be successful, including limited adverse impact on existing crops.

1. Deep percolation
2. Root zone residence time
3. Topography
4. Chemical limitations
5. Soil surface condition

Potential groundwater banking projects will be described in further detail when projects and management actions are developed for the WMA. Potential areas for artificial recharge have been identified along the Santa Ynez River and in the Santa Rita Upland, and are identified as "excellent" as shown on **Figure 4-3**.

[16] In the Lompoc Plain subarea, the green area shown on Figure 4-2 (soil types with high infiltration rates) overlies primarily the Santa Ynez River.

[17] DWR. 2016. *Best Management Practices for Sustainable Management of Groundwater*. Hydrogeologic Conceptual Model.

[18] A.T. O'Geen, Matthew, B.B. Saal, Helen E. Dahlke, David A. Doll, Rachel B. Elkins, Allan Fulton, Graham E. Fogg, Thomas Harter, Jan W. Hopmans, Chuck Ingles, Franz J. Niederholzer, Samuel Sandoval Solies, Paul S. Verdegaal, and Mike Walkinshaw. 2015. "Soil Suitability Index Identifies Potential Areas for Groundwater Banking on Agricultural Lands." *California Agriculture* 69(2):75–84. doi: 10.3733/ca.v069n02p75.

4.3 RUNOFF AND SURFACE FLOWS

The WMA aquifers are recharged by rainfall in the watershed and infiltration of surface flows in the Santa Ynez River and tributaries. Infiltration from the Santa Ynez River is the primary source of recharge to the aquifers that underlie the Lompoc Plain Subarea. These flows are supplemented by water-rights releases into the Santa Ynez River from Bradbury Dam at Lake Cachuma.

4.3.1 Santa Ynez River Watershed

The WMA is primarily composed of the Santa Ynez River watershed, as shown in **Figure 4-4**.[19] Marginal areas in the southwest and northwest of the WMA (**Figure 4-5**[20]) are outside the Santa Ynez River watershed, in the Burton Mesa and Lompoc Terrace subareas. The larger Santa Ynez River watershed is a catchment area for the Santa Ynez River upstream of the WMA, which is a major source of recharge to the WMA, especially within Santa Ynez River alluvium and the Lompoc Plain. Streamflow infiltration of the Santa Ynez River particularly occurs in the eastern Lompoc Plain, from the Lompoc Narrows at Robinson Bridge to V Street.

Precipitation, water imports, and other water sources in the Santa Ynez River watershed outside of the WMA interact with the WMA through a few routes:

- As runoff to surface water streams and rivers, which flows as surface water and subflow into the WMA. Examples are waters of the Santa Ynez River, Salsipuedes Creek, and San Miguelito Creek.
- As mountain front groundwater recharge, which is the subsurface inflow of groundwater to lowland aquifers from adjacent mountains. This likely occurs in upper elevations of the Santa Rita Upland subarea.
- As groundwater flow between management areas. Increasing groundwater pressure as a result of infiltration in the CMA may result in groundwater flowing into the WMA. This may occur along the eastern boundary of the Santa Rita Upland subarea and as subflow through the Santa Ynez River alluvium.

4.3.2 Santa Ynez River and Tributaries

The Santa Ynez River flows west over approximately 90 miles from its headwaters in the San Rafael and Santa Ynez Mountains, to the Pacific Ocean, draining approximately 900 square miles. The Santa Ynez River headwaters originate in the Santa Ynez and San Rafael Mountains

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19 Santa Ynez, Hydrologic Unit 18060010: 573,819 acres.

20 HUC in Figure 4-5 refers to the Hydrologic Unit Code. HUC 8 and 10 are watersheds and sub-watersheds delineated by USGS using a nationwide system.

at an elevation of about 4,000 feet near the eastern boundary of Santa Barbara County, with average annual precipitation of up to 49 inches per year.[21] The Santa Ynez River has three dammed reservoirs upstream of the WMA and the CMA: Jameson Reservoir is the farthest upstream, then Gibraltar Reservoir, and finally Lake Cachuma (**Figure 4-4**). Although reservoir releases do flow into the Santa Ynez River, the reservoirs are also managed to divert water out of the Santa Ynez River watershed via a system of tunnels through the Santa Ynez Mountains for use by the cities located on the Santa Barbara County south coast (i.e., Goleta and Santa Barbara).

Downstream of Bradbury Dam, the dam that forms Lake Cachuma, the Santa Ynez River continues flowing west, with the river subflow entering a bedrock-confined channel in the western portion of the CMA. After entering the WMA, the Santa Ynez River then flows through a series of meanders incised into confining bedrock units (Monterey Formation) until entering the forebay at the Lompoc Narrows. Thereafter, it flows northwest and west across the Lompoc Plain, discharging to the Santa Ynez River estuary and the Pacific Ocean. The flow of the Santa Ynez River is primarily intermittent throughout the Basin, carrying mainly flood flows from tributary watershed land downstream of Bradbury Dam and occasional spills and releases of water from Lake Cachuma. During summer months, water is released from Lake Cachuma to meet downstream water rights and releases for endangered steelhead as specified in the State Water Resources Control Board Order, the Cachuma Project Settlement Agreement, and the National Marine Fisheries Service Biological Opinion.

The two largest tributaries in the watershed join the Santa Ynez River in the WMA: Salsipuedes Creek and San Miguelito Creek (**Figure 4-4** and **Figure 4-5**). Salsipuedes Creek drains a 52-square-mile catchment area and joins the Santa Ynez River upstream of the Narrows. San Miguelito Creek drains an approximate 13-square-mile catchment area before encountering a debris basin at the WMA southern boundary and entering a concrete channel constructed through the western portion of the City of Lompoc before meeting the Santa Ynez River. San Miguelito Creek is the discharge point for tertiary treated water from the Lompoc Regional Wastewater Reclamation Plant, just upstream of the confluence with the Santa Ynez River. The Lompoc Wastewater Reclamation Plant has a design capacity of up to 5.5 million gallons per day[22] and collects effluent from the City of Lompoc, Vandenberg Village, and VAFB.

4.3.2.1 Downstream Water Rights Releases

The WMA is recharged by downstream water rights releases from Lake Cachuma as ordered by the Santa Ynez River Water Conservation District (SYRWCD). Water rights releases for users downstream of Lake Cachuma are set forth in the State Water Resources Control Board Order of 1973 (WR 73-37), as amended in 1989 (WR 89-18) and most recently in 2019 (2019-0148).

[21] PRISM Climate Group. 2014. *Average Annual Precipitation 1981–2010*.
[22] Dudek. 2019. *Santa Barbara County Integrated Regional Water Management Plan*. Update 2019.

These releases are based on the establishment of two accounts and accrual of credits (storing water) in Lake Cachuma for the above and below Narrows areas. Releases from the Above Narrows Account are made at Bradbury Dam for the benefit of downstream water users between the dam and the Lompoc Narrows. Releases from the Below Narrows Account are conveyed to the Narrows for the benefit of water users in the Lompoc Plain subarea. The SYRWCD designates the riparian flow subarea as Zone A, as shown in **Figure 3-3**. The figure shows the lower part the Above Narrows area, and SYRWCD designated Zone B (Lompoc Plain) in **Figure 3-3** indicates the Below Narrows area.

In addition, the Cachuma Project Settlement Agreement is an important component of downstream water rights releases. Pursuant to the Settlement Agreement between Cachuma Conservation Release Board, SYRWCD, SYRWCD Improvement District No. 1, and the City of Lompoc, relating to operation of the Cachuma Project entered into on December 17, 2002 (2002 Settlement Agreement), State Water Project (SWP)[23] supplies are commingled with water rights releases. The objective of such commingling operations is to maximize delivery of SWP supplies to lower the salinity in the Lower Santa Ynez River at the Narrows.

4.3.3 Water Imports

Water is primarily imported to the WMA and VAFB through the Central Coast Water Authority (CCWA) pipeline. Since 1997 this pipeline has delivered water from the State Water Project. Water is delivered at turnouts to specific water distribution systems, as well as to Lake Cachuma. Within the Basin, the receiving entities are VAFB, the City of Buellton, the City of Solvang, and the Santa Ynez River Water Conservation District Improvement District No. 1. CCWA water can also be mixed in with the water rights releases at Lake Cachuma based on the Cachuma Project Settlement Agreement. A map of the water import system in the WMA and upstream in the CMA and EMA are shown in **Figure 4-6**.

Within the WMA, the only importer of water is at VAFB, which imports all of the drinking water it uses. VAFB receives water from the CCWA pipeline at the turnout located in the Burton Mesa area, and additionally has active groundwater wells (the San Antonio Well Field) located in the San Antonio Creek Valley Groundwater Basin (DWR Basin 3-14). The VAFB relies primarily on the CCWA purchased water, which is supplemented by water pumped from the San Antonio Well Field, particularly when the CCWA water delivery system is undergoing maintenance. These imported waters, CCWA and San Antonio groundwater, enter the Santa Ynez River watershed via the domestic and municipal return flows from VAFB. Wastewater sourced from VAFB is collected from the Main Cantonment Area at VAFB and conveyed to the Lompoc Regional Wastewater Reclamation Plant[24] before discharge to San Miguelito Creek, near the confluence with the Santa Ynez River.

[23] The State Water Project is the source of water delivered by the Central Coast Water Authority (CCWA).
[24] Dudek. 2019. *Santa Barbara County Integrated Regional Water Management Plan*. Update 2019.

4.3.4 Treated Wastewater Sources

Wastewater treatment plants act as a point source of water flowing into the surface water system and/or where groundwater recharge is occurring.

Wastewater in the WMA is collected by the City of Lompoc, Federal Bureau of Prisons, Mission Hills Community Services District, Vandenberg Village CSD, and VAFB. Wastewater is conveyed to the following treatment facilities before it is discharged as treated effluent.[25] Locations of the WMA wastewater treatment plants and sewer collection areas are shown in **Figure 4-7**.

	Design Capacity (mgd)	Service Area/ Contributors	Current Disposal Method (Permit)	Level of Treatment	Recycled Water Uses
Lompoc Regional Wastewater Reclamation Plant	5.5	City of Lompoc; Vandenberg Village CSD; Vandenberg AFB.	Discharge to Miguelito Creek (tributary to Santa Ynez River) (NPDES)	Tertiary	On-site irrigation and dust control
Mission Hills CSD	0.57	Mission Hills CSD	Percolation ponds (WDR)	Primary	Groundwater recharge
US Penitentiary – Lompoc	—	US Penitentiary	Percolation Ponds WDR	—	Groundwater recharge

Source: CCWA 2011, page 48.
mgd = million gallons per day; WWTP = Wastewater Treatment Plant; NPDES = National Pollutant Discharge Elimination System; WDR = waste discharge requirement; CSD = Community Services District; AFB = Air Force Base

VAFB includes remote areas served by leach fields, septic tanks, and package treatment plants. In addition to VAFB, there are domestic users located outside of the sewer collection areas, also on septic systems.

[25] Dudek. 2019. *Santa Barbara County Integrated Regional Water Management Plan*. Update 2019.

5 USES AND USERS OF GROUNDWATER IN THE WESTERN MANAGEMENT AREA

This section discusses the primary uses of groundwater in the WMA, and presents a summary of locations where groundwater pumping occurs. In addition, this section describes water use on agricultural lands, and discusses water use by phreatophytes.

5.1 PRIMARY USE OF GROUNDWATER

Groundwater production within the WMA for both the Upper and Lower Aquifers is for agricultural, domestic, municipal, and industrial uses including mining operations (wells utilized by the Imery mining operation). Outside of the municipal users, including the City of Lompoc, Vandenberg Village CSD, Mission Hills CSD, VAFB, and the United States Penitentiary-Lompoc (USP or Penitentiary), most of the WMA is a mixture of rural areas with agriculture and some suburban development.

Groundwater production is reported by the Santa Ynez River Water Conservation District (SYRWCD) Annual Report (District Annual Report) [26] and includes the CMA and parts of the EMA. The Water Conservation District reports on average for the period 1982-2018 that the use of groundwater in the District was 71% "Agricultural Water,"[27] 3% "Special Irrigation Water,"[28] and 26% "Other Water."[29]

5.1.1 Water Use in the Lompoc Plain, Lompoc Upland, and Lompoc Terrace Subareas

The Lompoc Plain subarea, combined with the Lompoc Terrace subarea and Lompoc Upland subarea, forms the District Annual Report's Zone B. Prior to fiscal year (FY) 1993–1994, this also included the Santa Rita Upland subarea (Zone F). For this combined area, overall annual average water production has ranged from 13,632 acre-feet per year (AFY) in FY[30] 1979–1980 to 29,815 AFY in FY 2012–2013. For this zone, agricultural water has ranged from 7,233 AFY to 21,257 AFY. Special irrigation water has ranged up to 1,205 AFY, and other water has ranged from 5,778 to 9,407 AFY.

Water use in the Lompoc Plain subarea is primarily agriculture, but also includes domestic usage by the City of Lompoc and the Penitentiary (USP). The City of Lompoc, currently and for the planned future (through 2035), relies entirely on groundwater resources (Lompoc UWMP 2015)

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26 Stetson Engineers.2020. *Forty-Second Annual Engineering And Survey Report On Water Supply Conditions Of The Santa Ynez River Water Conservation District 2019–2020*.

27 Water first used on lands in the production of plant crops or livestock for market (CA WAT § 75508).

28 Water used for irrigation purposes at parks, golf courses, schools, cemeteries, and publicly owned historic sites.

29 Water used for purposes not including agriculture or irrigation at parks, golf courses, schools, cemeteries, and publicly owned historic sites. Generally, refers to municipal, industrial, or domestic uses of pumped or produced water.

30 Santa Ynez River Water Conservation District's fiscal year is July 1 through June 30.

and pumps from the Upper Aquifer. The USP relies on CCWA imported water for the municipal prison facilities, and, in addition, the USP uses water for a prison farm by using the VAFB's wells located in the Plain.

Water use in the Lompoc Upland subarea is primarily domestic and municipal use, including the population centers and urbanized areas of Vandenberg Village CSD and Mission Hills CSD. Both Vandenberg Village CSD and Mission Hills CSD pump from the Lower Aquifer.

The Lompoc Terrace subarea is relatively undeveloped with no agriculture and no population centers, but has several buildings related to VAFB. The Lompoc Terrace contains the Space Launch Complexes which has industrial and municipal water use (i.e. water for sound suppression and military buildings). The Lompoc Terrace currently gets water from the VAFB water supply system (imported water from CCWA and San Antonio well fields).

5.1.2 Santa Rita Upland Subarea

The Santa Rita Upland subarea forms the District Annual Report's Zone F. This zone was split off from Zone B in FY 1993–1994. Overall annual average water production has ranged from 722 AFY in FY[31] 1993–1994 to 2,423 AFY in FY 2015–2016. For this zone, agricultural water has ranged from 644 AFY to 2,313 AFY. There has been no special irrigation water, and other water has ranged from 50 to 160 AFY.

The Santa Rita Upland subarea has rural and agricultural groundwater uses. Rural residential communities are located in the Santa Rita Upland and are served by small, shared wells or mutual water companies, such as the Vista Hills Municipal Water Company (MWC), Santa Rita MWC and the Tularosa MWC.

5.1.3 Santa Ynez River Alluvium Subarea

Agriculture occurs in the Santa Ynez River Alluvium subarea, but there are no population centers in this subarea. There is some rural residential single and some shared wells, especially along Santa Rosa Road.

The WMA Santa Ynez River Alluvium subarea comprises a portion of the District Annual Report's Zone A, which extends through all of the Santa Ynez River Alluvium in the CMA and EMA.[32] For this larger Zone A area, overall annual average water production has ranged from 8,178 AFY in FY[33] 1979–1980 to 15,571 AFY in FY 2014–2015. In this zone, agricultural water has ranged from 6,363 to 12,677 AFY. Special irrigation water has ranged up to 1,059 AFY, and other water has ranged from 1,355 to 2,806 AFY. Major pumpers for Zone A include

[31] Santa Ynez River Water Conservation District's fiscal year is July 1 through June 30.

[32] Stetson Engineers. 2020. *Forty-Second Annual Engineering and Survey Report On Water Supply Conditions of the Santa Ynez River Water Conservation District 2019–2020*.

[33] Santa Ynez River Water Conservation District's fiscal year is July 1 through June 30.

Santa Ynez River Water Conservation District Improvement District No. 1, the City of Buellton, and the City of Solvang, all of which are located outside of the WMA.

5.1.4 Burton Mesa Subarea

The Burton Mesa subarea is almost entirely within the extents of VAFB and is the location of the base Cantonment Area which includes most of the facilities. However, the VAFB public water system, which supplies drinking water, does not produce water from the Burton Mesa subarea, and relies on imports, either from the CCWA or a well field in San Antonio Creek Valley Groundwater Basin.

Part of the Burton Mesa subarea is within the District Annual Report's Zone C but has no major groundwater pumping.

5.2 Agricultural Lands

In the WMA, a majority of agricultural lands are located in the Santa Ynez River Alluvium, the Lompoc Plain, and the Santa Rita Upland subareas. Some minor agriculture uses are present in the Lompoc Upland subarea. The distribution of crops within the WMA for a representative year, 2016, based on the California LandIQ database, is provided in **Figure 5-1**.

Planted crops in the area have changed over the years according to the United States Department of Agriculture.[34] Major crops include grapes, strawberries, raspberries, dry beans, walnuts, alfalfa, barley, herbs, peaches, cut-flowers, lettuce, and broccoli. Based on this United States Department of Agriculture source, dry beans were more common around 2010; since then, strawberries have become a common crop in the Lompoc Plain subarea, and grapes have become common in both the Santa Ynez River Alluvium and Santa Rita Upland subareas. The newest crop type in the WMA is cannabis.

Crop types affect the amount of water in demand and the timing of water use. Additionally, crops have varying tolerance for degraded water quality, and may require extra water to flush salts from soils. Finally, certain crops, such as leafy vegetables, are associated with fertilizer practices that result in high-nitrate return flows.

5.3 Water Exports

Water is exported from the Santa Ynez River watershed from three reservoirs on the Santa Ynez River upstream of the WMA, Jameson and Gibraltar Reservoirs and Lake Cachuma, through a series of tunnels to supply cities located on the Santa Barbara County south coast. No groundwater exports occur within the boundaries of the WMA.

[34] USDA (United States Department of Agriculture). "National Agricultural Statistics Service. CropScape - Cropland Data Layer." Accessed July 20, 2020. https://nassgeodata.gmu.edu/CropScape/.

5.4 Potential Groundwater Dependent Ecosystems

DWR recommends (DWR 2016) classification of potential groundwater-dependent ecosystems as (1) wetland features commonly associated with the surface expression of groundwater under natural, unmodified conditions, and (2) vegetation types commonly associated with the sub-surface presence of groundwater (phreatophytes) (**Figure 5-2**). The source of this dataset is a working group consisting of DWR, the California Department of Fish and Wildlife, and The Nature Conservancy.

Phreatophytes are plants that depend on, and obtain, groundwater that lies within reach of their roots. These include plants grown within the riparian zone of a river, and some agricultural crops, such as alfalfa. Historical estimates of phreatophytes water use indicate up to 6,000 AFY is used in the WMA (Bright 1997).

5.4.1 Discharge and Springs Areas

Groundwater discharges are described in terms of springs, seeps, and known areas of groundwater discharge. Active springs and seeps within and adjacent to the Basin are shown in **Figure 5-2**. Six active springs and seeps have been identified in the WMA including: four springs/seeps are located in the Lompoc Upland; one in the Burton Mesa, and one in the Lompoc Terrace subarea (**Figure 5-2**). The quantity of water discharging from these six springs located within the WMA is currently a data gap.

Groundwater in the WMA also discharges to the Santa Ynez River when the groundwater elevation is higher than the streamflow thalweg. Groundwater discharge to the Santa Ynez River will occur during wet winter and spring months, but during the summer and dry winter months, the streamflow loses water to the groundwater aquifers in the Lompoc Plain and Santa Ynez River Alluvium subareas. The Santa Ynez River is perennial downstream of the wastewater discharge from the Lompoc Regional Wastewater Treatment Plant to the Santa Ynez River estuary and Pacific Ocean.

Additionally, groundwater discharge to the Pacific Ocean is occurring as subflow. Approximately 150 to 400 AFY of underflow or discharge to the Pacific Ocean from groundwater was estimated by the USGS (Bright 1997).

6 DATA GAPS AND UNCERTAINTY

This HCM section describes data gaps and uncertainty in the conceptual understanding of the groundwater and the interaction with surface water. Overall, there are many existing ground water studies and data for the WMA, including two previous ground water models developed by the USGS (Bright 1997; Bright et all 1992) and the City of Lompoc (HCI 1997). However, the following data gaps below are currently identified for the WMA Hydrogeologic Conceptual Model:

6.1 INFLUENCE OF FAULTS ON GROUND WATER MOVEMENT

Faults with potential to impede groundwater recharge, storage or flow are not currently identified in the WMA. Additional geophysical SkyTEM AEM data collected within the WMA, in conjunction with potential input received from water users and the public may be used to update current understanding of faults that may affect the water environment within the WMA.

6.2 PERCHED GROUNDWATER CONDITIONS OF THE BURTON MESA AND LOMPOC TERRACE SUBAREAS

The Burton Mesa and Lompoc Terrace are almost entirely contained within the boundaries of Vandenberg Air Force Base. Only a few wells logs were reviewed in the Burton Mesa area for the three-dimensional understanding of the Basin (Geosyntec 2020). Additionally, geophysical and other data was not available to adequately evaluate perched groundwater conditions in the Burton Mesa and Lompoc Terrace. Based on available data and reports provided by VAFB (Arcadis 2016), perched groundwater in these areas is not connected to the saturated flow of the Santa Ynez River Basin. Therefore, it is unclear if additional data or study are necessary or needed.

6.3 SANTA RITA SUBAREA GROUND WATER MOVEMENT

Additional water-level data are needed to evaluate the hydraulic conditions between several subareas of the WMA including: 1) the Santa Rita subarea and the Lompoc Upland subarea; 2) the Santa Rita subarea and the Santa Ynez River Alluvium subarea; and 3) the Santa Rita subarea and the Buellton Uplands subarea of the CMA. Existing groundwater models in the WMA (Bright 1997 and HCI 1997) assume there is sub-flow between the Santa Rita and Lompoc Upland, but the exact quantity is not well known or quantified.

Additional data is needed to understand the role of perched aquifers that occur in the Santa Rita Upland. Current understanding for this area is constrained due to small areal extent.

6.4 Discharge Quantities of Identified Springs in the WMA

The quantity of water discharging from the six springs located within the WMA (**Figure 5-2**) is currently a data gap. Additional data is needed to understand how discharge from these springs changes over seasons and during wet and dry years.

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TO:	Stetson Engineers
SUBJECT:	DRAFT Technical Memorandum Regional Geology and 3D Geologic Model for the Santa Ynez River Valley Groundwater Basin
PREPARED BY:	Eryn Torres, Senior Professional Maygan Cline, Senior Geologist Mark Grivetti, Senior Principal Hydrogeologist
DATE:	May 12, 2020

1. INTRODUCTION

This technical memorandum is prepared as part of the hydrogeologic conceptual model (HCM) for the Western and Central Management Areas (WMA and CMA, respectively) Groundwater Sustainability Agencies[1] (GSAs) within the larger Santa Ynez River Valley Groundwater Basin (SYRVGB). This technical memorandum focuses on the geologic units within the SYRVGB, and the subsurface geologic model built to visualize those units. The aquifer characteristics of these units are then considered in a separate study which correlates principal aquifers within the basin. This technical memo describes the modeled geologic units and existing literature that identifies the water-bearing tendency of each unit but does not include an in-depth principal aquifer analysis or discussion.

The HCM is the conceptual understanding of the physical characteristics related to the regional hydrology, land use, geologic units and structures, groundwater quality, principal groundwater aquifers, and principle aquitards of the WMA and CMA portions of the SYRVGB (basin). Understanding the regional geologic setting and structural configuration is integral to conducting subsequent technical studies of the basin, including presence, absence and correlation of principal aquifers, identification of an appropriate monitoring network, numerical groundwater modeling, and identification of projects and management actions in accordance with the Sustainable Groundwater Management Act (SGMA).

A detailed subsurface three-dimensional model of the geologic units and structures (model) that comprise the basin was developed from publicly available published reports and data sources from the WMA and CMA GSAs. The model is intended for use as a visualization tool to communicate the regional geologic setting to the WMA and CMA GSAs, as well as the public, in accordance with SGMA. Additionally, the model will be used in concert with the Water Budget and the Data Management System to identify potential data gaps within the basin where additional data

[1] This technical memorandum does not include the Eastern Management Area (EMA) GSA within the SYRVGB. The EMA GSA is supported by a different consulting team.

collection may be warranted. Furthermore, model elements may be exported to support subsequent technical studies conducted in the basin for incorporation into a SGMA compliant Groundwater Sustainability Plan (GSP), due to the California Department of Water Resources (DWR) in January of 2022.

The remainder of this technical memorandum describes the geologic data and methodology used to build the model, including quality control methods implemented at the boundary of the CMA and EMA, for alignment with the model built by the EMA consultant team. Representative cross-sections and maps included as figures in this technical memorandum are derived from the model.

1.1 REGIONAL GEOLOGIC SETTING

The regional geology for the basin has been previously described in various publicly available reports. The previous reports contain comprehensive studies and descriptions of the geological formations in and surrounding the WMA and CMA, herein referred to as the basin, when describing the regional geology. The basin is located within the Transverse Range geomorphic province of California (Figure 1), which is characterized by east-west striking, complexly folded and faulted bedrock formations. The basin is an east-west trending, linear, irregular structural depression between rugged mountain ranges and hills within the Transverse Range in Santa Barbara County, CA. The basin is bounded by the Purisima Hills on the northwest, the San Rafael Mountains on the northeast, the Santa Ynez Mountains on the south, and the Pacific Ocean on the west. Primary structural features of the basin include large anticline-syncline pairs. These large folds are evident in the rocks and deposits in the lowland between the folded and faulted Santa Ynez Mountains on the south and the faulted San Rafael Mountains on the north (Upson and Thomasson, 1951). Regional geology is included in a plan view on Figure 2.

Geologic Formations Within the Basin

The geologic formations that comprise the water-bearing aquifers are defined as those with sufficient permeability, storage potential, and groundwater quality to store and convey groundwater. The geologic formations present in the basin are described below under "Geologic Formations." Further discussion of the water bearing characteristics of the aquifers is provided under "Aquifers." Stratigraphic representation of geologic formations included in the model are included in Figures 3 and 4.

Soils

Although not strictly a geologic formation, soils found in the study area are important in that they blanket most of the area, support vegetation, and provide varying degrees of infiltration depending on their characteristics. Soil typically vary with respect to the underlying geologic material. Soils underlain by consolidated deposits tend to be clayey loams, whereas soils underlain by unconsolidated deposits are typically sandy loams (Hydrologic Consultants, Inc., 1997 and references therein). Ultimately, both soils have formed from similar parent material, as the unconsolidated deposits are sourced from the erosion, transport and deposition of the underlying and surrounding consolidated deposits (i.e., shales and sandstones) that comprise the surrounding mountains and hills (Upson and Thomasson, 1951; Hydrologic Consultants, Inc., 1997).

River Channel Deposits (Qg)

Qg occurs within the modern-day Santa Ynez River channel and consists of fine-to-coarse sand, gravels, and thin discontinuous lenses of clay and silt (Upson and Thomasson, 1951; Wilson, 1959; Miller, 1976; Bright et al., 1992). The grain size typically decreases along the river's reach, fining towards the ocean (Upson and Thomasson, 1951). The Qg unit thickness ranges from 30-feet (ft) to 40-ft, with observations of localized deposits up to 70-ft thickness 6 miles west of the City of Buellton along the Santa Ynez River, however, these deposits are largely indistinguishable from the underlying alluvium (Upson and Thomasson, 1951). The Qg in the geologic model is interpreted using the Dibblee geologic map and from borehole data and is generally thought to be hydraulically connected to the Qa, described below.

Alluvium (fluvial-Qa)

Qa is composed of a coarse sand upper member and a fine sand lower member which have been previously described by others (Dibblee, 1950; Upson and Thomasson, 1951; Wilson, 1959; Miller, 1976; Bright et al., 1992). For the purposes of the geologic model described in Section 1.2 below, these units are not differentiated, and the alluvium was modeled as a single lithologic unit. Qa is composed of unconsolidated, normally graded gravel and medium-to-very coarse sand, which grades upwards into fine to coarse sand with rare gravels, then fines vertically upwards into fine sand, silt and clay (Upson and Thomasson, 1951; Wilson, 1959; Miller, 1976; Bright et al., 1992; Fugro Consultants, INC., 2014). The thickness of Qa varies from approximately 30 to 90-ft in the Buellton Subarea (Upson and Wilson, 1951) to approximately 170-ft to 200-ft in the Lompoc plain (Dibblee, 1950; Upson and Thomasson, 1951; Evenson and Miller, 1963; Miller, 1976; Bright et al., 1992). In sloped areas and drainages, the thickness of Qa varies from less than 10-ft to 50-ft (Fugro Consultants, INC., 2014). Qa is the principal source of groundwater in the Lompoc plain (Dibblee, 1950; Upson and Thomasson, 1951; Evenson and Miller, 1963; Miller, 1976; Berenbrock, 1988; Bright et al., 1992).

Terrace Deposits / Older Alluvium (fluvial-Qoa)

Qoa typically consists of unconsolidated to poorly consolidated sands and gravels with common silt and clay zones (Dibblee, 1950; Upson and Thomasson, 1951; Miller, 1976; Berenbrock, 1988; Bright et al., 1992). Qoa thickness varies from 0-50-ft (Bright et al., 1992), up to 150-ft (Upson and Thomasson, 1951; Miller, 1976; Berenbrock, 1988). Qoa underlies alluvium (Qa) in most of the southern Lompoc plain and caps hilltops, benches and upland areas of the Santa Ynez River and major tributaries (Upson and Thomasson, 1951; Miller, 1976; Berenbrock, 1988; Bright et al., 1992).

Orcutt Sand (eolian / nonmarine- Qo)

Qo consists of unconsolidated, well sorted, coarse to medium sand and clayey sand with scattered pebbles and gravel stringers (Upson and Thomasson, 1951; Bright et al., 1992). The top of the formation is locally indurated in Lompoc Valley and Burton Mesa by iron oxides, whereas the basal portion contains well-rounded pebbles of quartzite, igneous rocks, and Monterey chert and shale (Dibblee, 1950). Qo thickness varies from 0-300-ft (Upson and Thomasson, 1951; Evenson and Miller, 1963; Bright et al., 1992).

Paso Robles Formation (Alluvial fans- QTp)

QTp consists of poorly consolidated to unconsolidated, poorly sorted, gravels, sands, silts and clays (Dibblee, 1950; Upson and Thomasson, 1951; Wilson, 1959; Miller, 1976; Berenbrock, 1988; Bright et al., 1992; Yates, 2010). QTp varies in thickness from 2,800-ft in the Santa Ynez subarea (Upson and Thomasson, 1951) 6.5 miles west of the San Lucas Bridge, to 700-ft in Santa Rita Valley (Dibblee, 1950; Miller, 1976) and thins westward where it pinches out in the eastern Lompoc plain (Dibblee, 1950; Upson and Thomasson, 1951; Miller, 1976).

QTp yields water to wells throughout the study area (Upson and Thomasson, 1951; Miller, 1976; Berenbrock, 1988; Bright et al.,1992) and is the principal water bearing unit in the basin near lake Cachuma and in the Santa Ynez uplands (Yates 2010).

Careaga Sand (marine-Tca undifferentiated)

Tca yields water and consists of massive, fine-to-coarse sand, with lenses of gravels and fossil shells (Dibblee, 1950; Woodring and Bramlette, 1950; Upson and Thomasson, 1951; Wilson, 1959; Evenson and Miller, 1963; Miller, 1976). Clay and silt beds are characteristically absent, and the uniformity in grain-size and presence of seashells distinguish it from the overlying QTp (Dibblee, 1950; Upson and Thomasson, 1951). Tca is often differentiated into the upper coarse sand *Graciosa Member (*Tcag) and the lower, fine sand *Cebada Member* (Tcac), which have been described in literature (Dibblee, 1950; Woodring and Bramlette, 1950; Upson and Thomasson, 1951; Evenson and Miller, 1963; Miller, 1976; Berenbrock, 1988; Bright et al., 1992). Tca thickness can vary from 450-ft to1000-ft (Upson and Thomasson, 1951), but is typically observed between 500-ft to 800-ft thickness in the Lompoc area, surrounding Lompoc hills, and in the Buellton area (Dibblee, 1950; Evenson and Miller, 1963; Miller, 1976). The Careaga Formation has been previously identified as an important aquifer within the SYRVGB (Hoffman, 2018).

<u>Aquifers</u>

Comprehensive studies of the water-bearing aquifers in the basin have been developed and published in numerous reports that are listed in the Geologic Data Sources section of this memorandum. The aquifers are typically categorized into two categories: Santa Ynez River floodplain alluvium and upland deposits formations (referred to in the Lompoc Area as an Upper Aquifer and Lower Aquifer) and are described in detail below.

Santa Ynez River Floodplain Alluvium – Upper Aquifer
In the Lompoc Plain, the Santa Ynez River floodplain alluvium is referred to as the Upper Aquifer, which consists of Qg, and Qa. It has been divided into 3 parts (Bright *et al.*, 1997) identified as the shallow, middle and main zones, described below.

The Shallow Zone has an average thickness of 50-ft. It is composed of river channel deposits (30-ft to 40-ft thick) and shallow upper alluvium deposits.

The Middle Zone is composed of the lower portion of the upper alluvium (moderately permeable sand and gravel lenses interbedded with deposits of fine sand, silt, and clay). The interbedded fine sand, silt, and clay deposits confine or partly confine the sand and gravel lenses in the western, central, and northeastern plains. The thickness of sand and gravel lenses range from 5-ft to 40-ft.

The Main Zone is located within the lower member of alluvium and consists of medium to coarse sand and gravel, separated from the upper aquifer zones by lenses of silt and clay. The Main Zone overlays the unconsolidated deposits that form the Lower Aquifer in the Lompoc plain. In the eastern and northwestern regions of the Lompoc plain, the silt and clay layers are less continuous or absent. As a result, groundwater moves freely between the zones of the Upper Aquifer. In the southern plain, the sand and gravel deposits in the main zone are absent. The fine sand deposits of the shallow and middle zones are also less continuous or absent (Upson and Thomasson, 1951).

Upstream of the Lompoc Plain, the Santa Ynez River floodplain alluvium is often referred to just as the river alluvium (no zonation). The thickness of the river alluvium generally averages up to 70-ft (Upson and Thomasson, 1951). Because this unit overlies consolidated deposits that are non-water bearing (see Section 1.1.2), the subflow in this unit is considered a part of the Santa Ynez River flow and is regulated by the State Water Resources Control Board as part of surface water rights.

Upland Deposits Formations – Lower Aquifer
In the Lompoc area, the upland deposits formations are referred to collectively as the "Lower Aquifer" and consist of undifferentiated Terrace Deposits/Older Alluvium (Qoa), Orcutt Sand (Qo) and the Careaga Sand (Tca). These deposits are present beneath the Lompoc uplands, the Upper Aquifer through the eastern portion of the Lompoc plain, and Lompoc terrace.

The Paso Robles Formation (QTp) forms the Lower Aquifer beneath the Lompoc uplands and east river area of Lompoc plain. The Graciosa and Cebada Members of the Careaga Sand (Tca) are present beneath the Lompoc upland and most of the Lompoc plain. However, the Graciosa Member generally is absent or unsaturated. Where present, the Graciosa Member of the Careaga Sand (Tca) is the main producer of ground water in the Lower Aquifer.

These same formations (Qoa, Qo, QTp, and Tca) also make up the aquifers in the Santa Rita Upland and Buellton Upland.

Geologic Formations Surrounding the Basin

Additional Tertiary-Mesozoic age typically non-water-bearing bedrock units are present within and surrounding the basin. These units are important because they contribute to the geologic structure (Figure 5) of the basin and define the limits of the water-bearing aquifer units by limiting groundwater flow due to limited or non-permeability, reduced or no storage capacity, or poor groundwater quality. These constraining bedrock units within and surrounding the basin are included in the geologic model described in Section 1.2 and are described below.

Tertiary-Mesozoic Rocks

Tertiary-Mesozoic Rocks are consolidated non-water bearing units, all of marine origin. They consist of the near-shore marine *Foxen, Sisquoc,* and *Monterey Formations*. The Foxen Formation consists of light gray or tan massive claystone, siltstone, and/or mudstone (Dibblee, 1950; Woodring and Bramlette, 1950; Upson and Thomasson, 1951). The Sisquoc Formation is massive to very thin bedded, white diatomite and diatomaceous mudstones, with basal massive fine sands (Dibblee, 1950; Woodring and Bramlette, 1950; Upson and Thomasson, 1951). The Monterey Formation, primarily known for its vast oil reserves, consists of variably bedded siliceous shale, diatomaceous mudstone, porcelaneous shale, chert, phosphatic shale, silty shale, limestone, and a basal clay altered tuff (Dibblee, 1950; Woodring and Bramlette, 1950; Upson and Thomasson, 1951).

2. GEOLOGICAL MODEL

2.1 MODEL USE AND INTENT

The detailed subsurface three-dimensional model was developed as a visualization and communication tool to convey the regional geologic setting and confining features of the basin to WMA and CMA GSAs, and the public, in accordance with SGMA. Additionally, the model will be used in concert with the Water Budget and the DMS to identify potential data gaps within the basin where additional data collection may be warranted. Furthermore, model elements may be exported to support subsequent technical studies conducted in the basin for incorporation into a SGMA compliant Groundwater Sustainability Plan (GSP), due to the California Department of Water Resources (DWR) in January of 2022.

2.2 MODELING APPROACH

Modeling Software

The software used for the model is Seequent's Leapfrog Works (Leapfrog), an industry-standard geologic modeling software, designed to view and manage surface and subsurface data, build complex geologic models, visualize hydrogeological systems, understand the impact of water use, and provide jurisdictional authorities with tools to convey complex topics to the general public (Seequent, 2020).

Model Domain

The geologic model domain boundaries (model extent) were selected to encompass the entirety of the WMA and CMA, and slightly overlapping the EMA to the east. Ground surface elevations were defined using a combination of publicly available digital elevation models (DEM). Next, quantitative measurements for geologic units exposed at the ground surface were imported using existing literature and publicly available geologic maps. Contacts between those geologic units (surface between two different rock types) were defined as erosional or depositional, as the designation augments the model assumptions and subsurface interpolations. Once the contacts were defined, the volume between those contacts were filled according to the depositional environment, age of the geologic unit, and localized structure to form a complete geologic model. The data used to interpolate and interpret the geologic surfaces generated in 3D are described in detail in Section 1.2.3. Leapfrog's interpolation algorithm and manual manipulation according to professional judgement were used to adjust surfaces, as appropriate. Structural elements were also incorporated from existing literature and publicly available geologic maps. The generated result is a detailed subsurface geometric rendering of the geologic contacts presented in the attached cross-sections.

Data Quality

Data quality objectives include verification of alignment with existing literature and available geologic maps; and coordination with the EMA GSA and consultant team to review and confirm alignment between the modeled CMA/EMA boundary (boundary). To facilitate model alignment at the boundary, data review, modeling approach discussion and data sharing was conducted. The consultant teams for the CMA and EMA provided boundary data packages for review. Each consultant team reviewed the data received, organized and validated the data, then incorporated the data into their model to assess modeled boundary alignment. Geologic formations from locations were reviewed in both models, confirming assumptions across the boundary.

2.3 GEOLOGIC DATA SOURCES

Various publicly available data were sourced for compilation and assessment prior to incorporation into the model, described in detail below.

Borehole Data

Publicly available well bore and well completion information was obtained from the California Department of Water Resources (DWR) online inventory, the Santa Barbara County Public Health (CPH) historical paper well records, the Santa Ynez River Water Conservation District, and from the California Department of Oil and Gas and Geothermal Resources (CA DOGGR) open file report (USGS, 2010).

The DWR online database consists of redacted well completion reports of varying quality, and map locations of varying accuracy. Available well completion reports within the study area were obtained from the DWR online database using the DWR Well Completion Report Map Application and incorporated into a secure relational database for the purpose of building the model. Once the data were compiled, assessed and validated for their intended use, they were incorporated into the DMS prepared for the basin. The available well records are accompanied by a longitude and latitude provided by DWR; however, many records are simplified, and locations are centered in their respective township and range quadrant, within approximately one square miles of their actual location. Well locations were updated manually in GIS software using assessor parcel numbers (APN), hand-drawn maps, addresses, and other location information available in the well records.

Available historical County EHS well records were obtained in paper format, the files were digitized, and pertinent data was extracted. Well records were evaluated for useful information and incorporated as appropriate into the model.

Additional stratigraphic interpretations from 694 Oil and Gas wells were collected in digital format from the (USGS, 2010). The well information was sourced from the CA DOGGR records. These wells were originally interpreted to model the Santa Maria Basin and provide depositional trends and structural evolution of the basin.

In total, 916 well records were used from the study area there to build the model, including 349 DWR, 396 CPH, and 171 CA DOGGR well records. Of the total well records used, 518 well records are within the WMA and 221 are within the CMA. The geologic formations were transcribed from the DWR and CPH well logs for import to the geological model while interpretations from CA DOGGR were imported as interpreted.

Surface Topography

DEMs were used to provide a best estimate for ground surface elevation across the model domain. The primary DEM is based on USGS's recently released regional FEMA LiDAR surveys related to 2018 post-fire surveys. This DEM was collected at 1-meter accuracy and represents a bare earth surface with trees and features removed. USGS standard 1-meter DEMs are produced exclusively from high resolution light detection and ranging (LiDAR). In areas where a 1-meter accuracy DEM is not available a 1/3 arc-second equivalent (approximately 10-meter accuracy) used instead.

All DEMs were sourced from the National Map (TNM) via the USGS.

- *U.S. Geological Survey, 20190930, USGS NED one-meter x75y384 CA SoCal Wildfires B4 2018 IMG 2019: U.S. Geological Survey.*
- *U.S. Geological Survey, 20190924, USGS 13 arc-second n35w121 1 x 1 degree: U.S. Geological Survey. Sources for Descriptions of Geological Formations*

Surface Geology

i The model is composed of publicly available geologic data from the Unites States Geological Survey (USGS). Interpreted surface geology was publicly accessed via the

USGS Mapview database tool. Surface geology is comprised from the following USGS Quadrangles:

- *CMA: Solvang and Gaviota Quadrangle, Zaca Creek Quadrangle, Santa Rosa Hills and Sacate Quadrangle, and Los Alamos Quadrangle.*
- *WMA: Lompoc Hills and Point Conception Quadrangle, Point Arguello and Tranquillon Mountain Quadrangle, and Lompoc and Surf Quadrangle.*

Subsurface geology was partially interpolated using surface contacts of geologic units, as well as structural data (dip and dip azimuth) present in each quadrangle. Subsurface geology was extrapolated from a combination of surface contacts and structural data points from the geologic quadrangle using Leapfrog software.

The major formations shown in Figure 2 are described in Section 1.1 and included in the attached stratigraphic columns (Figures 3 and 4).

Descriptions of Geological Formations

There have been numerous investigations of geological formations of the basin by others in the past, some of which date back to the 1940s. Some of the more comprehensive reports for this area include the following:

- *Geology of Southwestern Santa Barbara County, California: Point Arguello, Lompoc, Point Conception, Los Olivos, and Gaviota Quadrangles* (Dibblee, 1950)
- *Geology and Ground-Water Features of Point Arguello Naval Missile Facility Santa Barbara County California* (Evenson and Miller, 1963)
- *Geology and Paleontology of The Santa Maria District California. USGS 222* (Woodring and Bramlette, 1950)
- *Evaluation of Ground-Water Flow and Solute Transport in the Lompoc Area, Santa Barbara County, California* (Bright *et al.,* 1997)
- *Preliminary Report on Water Storage Capacity of Unconsolidated Deposits Beneath Lompoc plain* (Upson, 1943)
- *Geology and Water Resources of the Santa Ynez River Basin, Santa Barbara County, California: Water-Supply Paper 1107* (Upson and Thomasson, 1951)
- *Ground-Water Hydrology and Quality in The Lompoc Area, Santa Barbara County, California, 1987-88: U.S. Geological Survey Water-Resources Investigations Report 91-4172* (Bright *et al*., 1992)
- *Ground-Water Appraisal of Santa Ynez River Basin, Santa Barbara County, California: U.S. Geological Survey Water-Supply Paper 1467* (Wilson, 1959)

- *Development of A System of Models for The Lompoc Ground-Water Basin and Santa Ynez River* (Hydrologic Consultants, Inc., 1997)
- *Ground-Water Resources in The Lompoc Area, Santa Barbara County, California* (Miller, 1976)
- *Phase I Services, Preliminary Geotechnical Engineering Study, East Cat Canyon Oil Field, Sisquoc Area, Santa Barbara County, California* (Fugro Consultants, Inc., 2014)
- *Assessment of Groundwater Availability on the Santa Ynez Chumash Reservation* (Yates, 2010)
- *Digital tabulation of stratigraphic data from oil and gas wells in the Santa Maria Basin and surrounding areas, central California coast: U.S. Geological Survey Open-File Report 2010–1129* (USGS, 2010)

<u>Cross Sections from Previous Reports</u>

An important and useful resource to build the model was the large number of existing geologic information and cross sections from previous studies and reports conducted in the basin. The selected reports include the following:

- *Geology of Southwestern Santa Barbara County, California: Point Arguello, Lompoc, Point Conception, Los Olivos, and Gaviota Quadrangles* (Dibblee, 1950)
- *Geology and Water Resources of the Santa Ynez River Basin, Santa Barbara County, California: Water-Supply Paper 1107* (Upson and Thomasson, 1951)
- *Ground-Water Appraisal of Santa Ynez River Basin, Santa Barbara County, California: U.S. Geological Survey Water-Supply Paper 1467* (Wilson, 1959)
- *Ground-Water Hydrology and Quality in The Lompoc Area, Santa Barbara County, California, 1987-88: U.S. Geological Survey Water-Resources Investigations Report 91-4172* (Bright *et al*., 1992)
- *Geologic Map of The Zaca Creek Quadrangle, Santa Barbara County, California* (Dibblee, 1993)
- *Geologic Map of The Los Alamos Quadrangle, Santa Barbara County, California* (Dibblee, 1993)
- *Evaluation of Ground-Water Flow and Solute Transport in the Lompoc Area, Santa Barbara County, California: Water-Resources Investigations Report 97-4056* (Bright *et al*., 1997)
- *Development of A System of Models for The Lompoc Ground-Water Basin and Santa Ynez River* (Hydrologic Consultants, Inc., 1997)

- *Geophysical and Geotechnical Study Sewer Force Main Crossing, Santa Ynez River, Solvang, California* (Fugro West, Inc., 2007)

A total of 58 cross-sections from previous reports were digitized and imported into the model for visualization. The locations for the 58 cross-sections are included on Figure 6. The imported cross-sections were assessed for their agreement with model elements and used to validate the modeled surfaces, thicknesses and presence within the basin.

3. MODEL VISUALIZATIONS

Views from the model are presented as **Figures 2, 5**, and **6**. An aerial view of the outcropping geologic units and basin boundaries is presented as **Figure 2**. Generalized stratigraphic columns are presented as **Figures 3** and **4**. Cross-section views of the basin are presented in **Figure 5**. **Figure 6** provides an aerial view of modeled data, including well locations, cross-sections and geologic formations.

Figure 1: Site Location Map. Identifies basin location and geomorphic province information.

Figure 2: Geological Map and GSA Boundaries. Figure 2 presents an aerial view of the outcropping geologic units and basin boundaries. Areas of interest include Lompoc Terrace, Lompoc Plain, and Lompoc Upland and are included for reference purposes. The cross sections A-A' through G-G' are also shown on the figure.

Figures 3 and 4: Stratigraphic Columns (Shallow and Deep). These figures provide schematic stratigraphic columns with depths and short descriptions of each geologic formation.

- The shallow stratigraphic columns provide detailed descriptions for shallow formations **in the** WMA and CMA areas to the depth of the Tca (approximately 1,300 ft below ground surface).
- The deep column presents formation approximations from the surface to the Tm (approximately 9,000 ft below ground surface).

Figures 5: Geologic Cross Sections.

- **Cross-section A-A'** extends from west-to-east along the Santa Ynez River through the Lompoc Plane and intersects with Cross sections B-B' and C-C'. In this area consolidated formations form a westward plunging syncline which propagates through the WMA.
- **B-B'** is located on the west side of the WMA with a south-to-north orientation similar to sections C-C' through G-G'. Consolidated formations form a repeated syncline/anticline fold system that extends to the north of the model.
- **C-C'** extends through the middle of the WMA through the Lompoc Plain and Lompoc Upland and continue the syncline/anticline fold structure observed in cross section B-B'.
- **D-D'** is located near the northern boundary between the WMA and CMA and displays a similar fold structure to cross section B-B' and cross section C-C'.

- **E-E’** extends across the Santa Ynez River at the southeast boundary between the WMA and CMA. The southern limb of the central syncline is observed at the northern end of cross section E-E’ along the north side of the Santa Ynez River. The middle and north portions of the section are mainly composed of consolidated rocks.
- **F-F’** transects through the CMA, south of Los Alamos. The central syncline continues through southeast of the model with the southern limb of the central syncline of consolidated rocks below the Santa Ynez River.
- **G-G’** is location on the east side of CMA which extends across the Santa Ynez River, through the City of Buellton and up through the Zaca Creek bed. Similar to cross section
- **F-F’**, the southern limb of the central syncline is located in the south below the Santa Ynez River and the northern anticline repeating in the north below Zaca Creek.

Figure 6: Available Data. Presents spatial distribution of available data resources incorporated into the model and potential data gaps, as described in additional detail below.

4. DATA GAPS

The model results will be used in concert with the Water Budget, the DMS and future additional technical studies conducted by others to identify potential data gaps within the basin and where additional data collection may be warranted. Data gaps may include lack of groundwater wells in portions of the basin, absence of ground surface elevation or groundwater measurement elevation for existing wells, inconsistent groundwater elevation measurements for a given well, long well screens that span multiple groundwater aquifers – providing insufficient or unreliable data, well screens that penetrate the river alluvium and do not represent principal aquifers, and other similar data gaps. Identification of data gaps within the model, paired with data gaps identified in other technical studies will be compiled and will inform recommendations for additional data gathering, as appropriate.

As presented on **Figure 6**, available data incorporated into the geologic model includes 58 cross sections from existing literature and previously published reports, and data from 1,439 unique well borehole locations. Cross-sections presented on **Figure 6** generally fit one of the three following categories:

- <u>Lompoc Plain:</u> the majority of available historical cross sections transect the Lompoc Plain along the Santa Ynez River (west-to-east) or crossing the river (south-to-north), within and the WMA.
- <u>Long cross-sections</u>: these transect the WMA (five) and CMA (two) from the Santa Ynez Mountains in the south, toward the San Antonio Creek Groundwater Basin in the north.
- <u>Short cross-sections</u>: transect the Santa Ynez River in the WMA (four) and CMA (three).

Although historical cross-sections are unavailable for the WMA/CMA boundary and are limited at the CMA/EMA boundary, well borehole data in those areas suggest that the model may sufficiently interpolate available borehole data, and data gaps in these two areas may not exist.

Well borehole data from the publicly available resources used in the model (i.e., well records from DWR, CPH, DOGGR, existing literature, and previously published reports) are distributed across most areas of the basin, with the following exceptions:

- An approximate 5.4 square mile (mi^2) area along the northern boundary of the CMA, northwest of the City of Buellton; and
- An approximate 26 mi^2 area within the Vandenberg Air Force Base, located in the northwest portion of the WMA, north of the Lompoc Upland and along the Pacific coastline.

Historical borehole data for these two areas was not obtained from the publicly available resources searched and therefore, the lack of well borehole data in these areas may be considered a data gap. However, subsequent technical studies may determine that these areas are not necessarily vital to understanding and managing the groundwater flow regime of the SYRVGB, and additional data collection (advancement of well boring, or installation or well(s)) may not be necessary or recommended in these areas.

Additional data collected by the DWR endorsed SkyTEM program will be useful in validating and refining the geological structure of the WMA and CMA in the model. SkyTEM uses the Aerial Electromagnetic method (AEM) to obtain large scale geophysical data, useful for interpreting geology and the presence/absence of groundwater. The collected SkyTEM geologic data may be useful to refine modeled extent of geologic units to a depth of approximately 1,000 to 1,400 feet below the ground surface within the SYRVGW. The existing well borehole and cross-section data incorporated into the model and presented in this technical memorandum will be used to verify and interpret the SkyTEM survey results. The SkyTEM data may also be used to enhance subsequent technical studies, including numerical groundwater modeling to estimate the SYRVGB system, particularly the areas with data gaps (**Figure 6**), groundwater flow along the boundaries of the management areas, and along the Santa Ynez River and tributaries.

* * * * * *

<u>Attachments</u>

Figure 1 Site Location Map

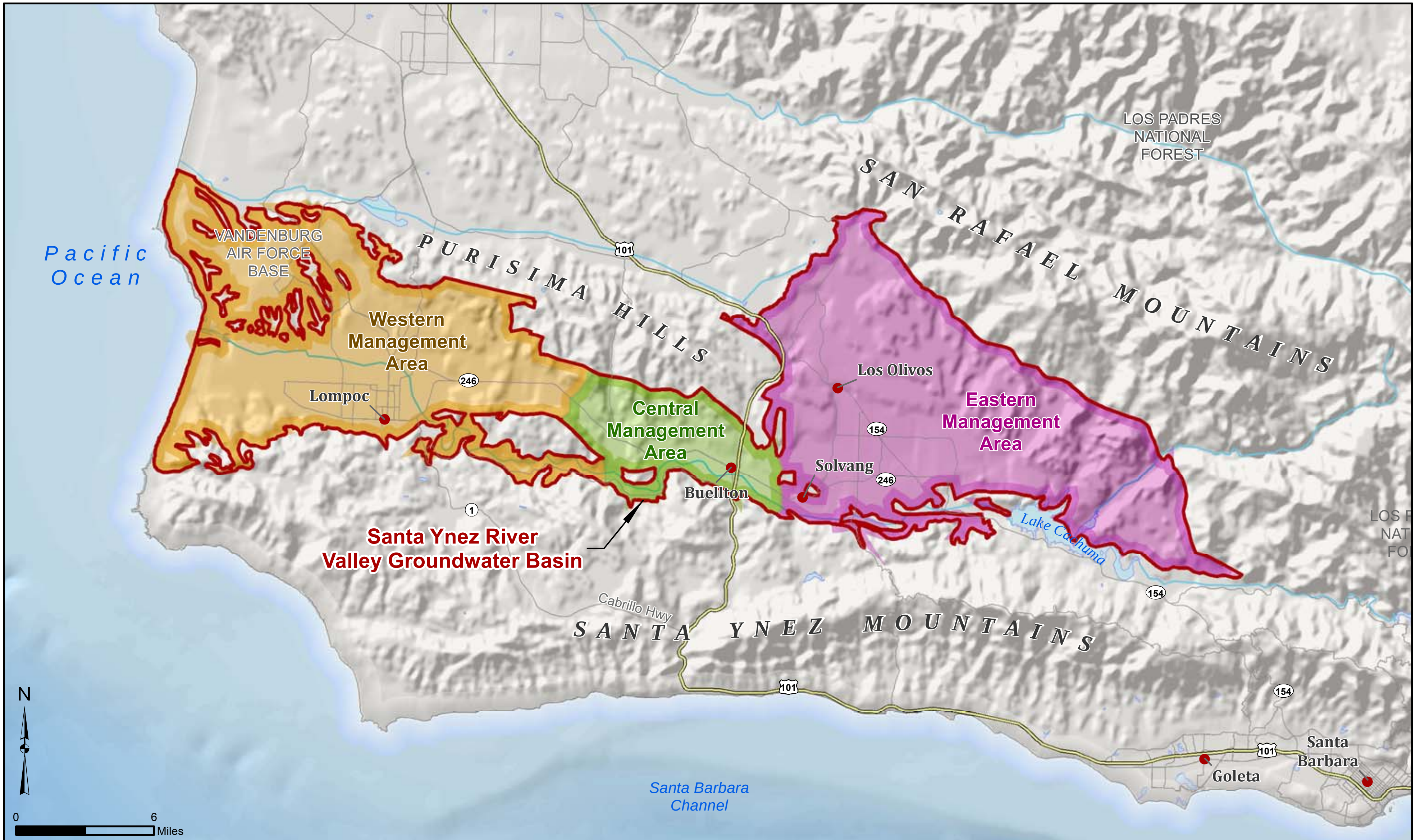
Figure 2 Geologic Map and GSA Boundaries

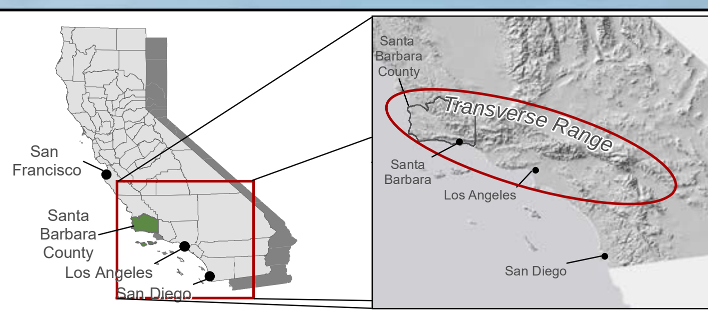
Figure 3 Shallow Stratigraphic Columns of Santa Ynez River Valley

Figure 4 Deep Stratigraphic Column of Santa Ynez River Valley

Figure 5 Geologic Cross Sections A-A’ through G-G’

Figure 6 Available Data Incorporated into Geologic Model





Explanation

- Santa Ynez River Valley Groundwater Basin
- Central Management Area
- Eastern Managment Area
- Western Management Area

Site Location Map

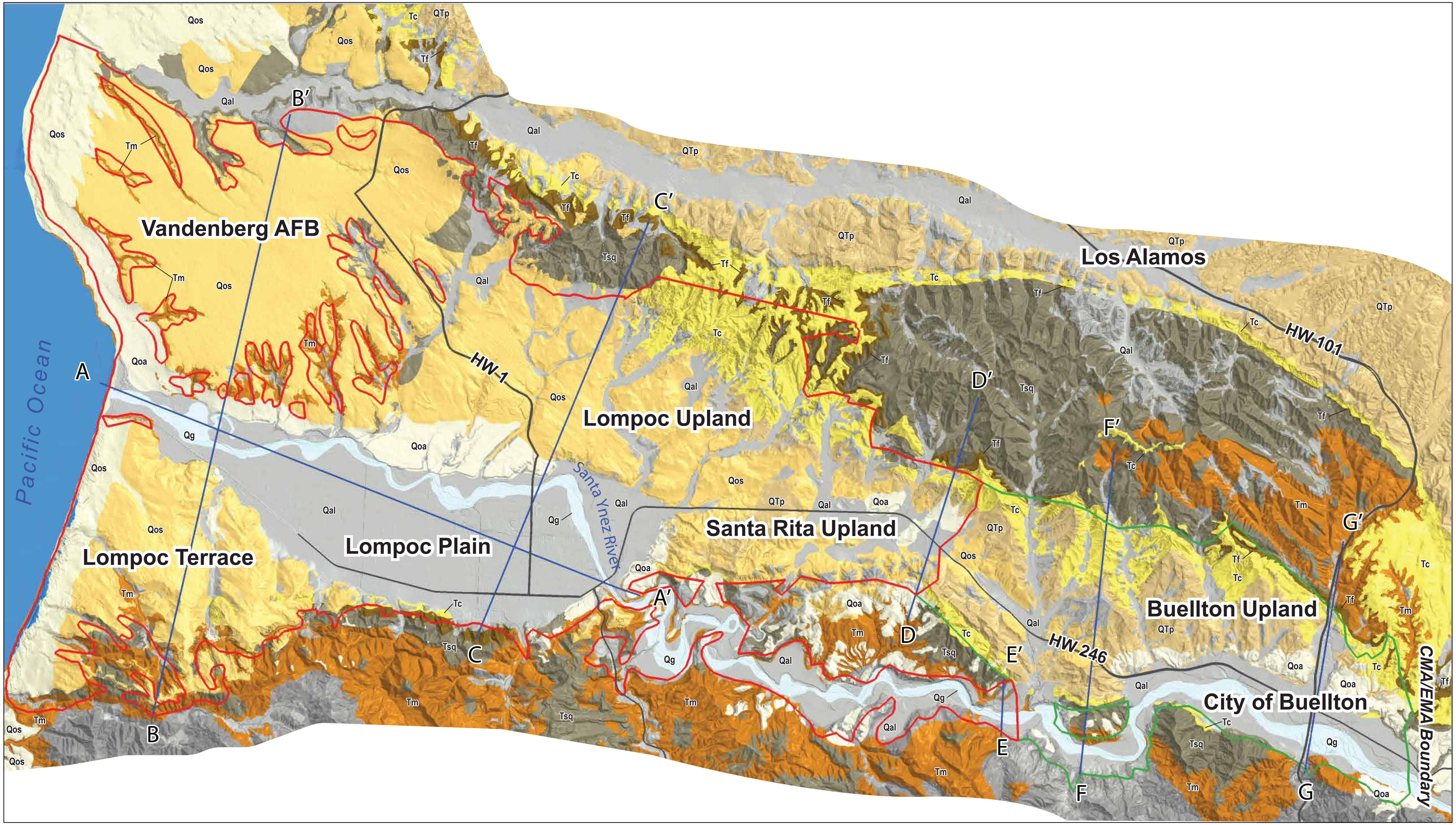
Santa Barbara County
California

Geosyntec consultants

Santa Barbara | April 2020

Figure 1

SantaBarbara-01\P:\GIS\Santa Ynez River Valley SGMA\Projects\2020 GW Model Tech Memo\Fig01_Basin_Wide_Map.mxd 4/29/2020 (Author: SMcKnight) 11:19:38 AM



Legend

- Cross Section Location
- Western Management Area
- Central Management Area

Model Geology

- River-Channel Deposits (Qg)
- Younger Alluvium (Qal)
- Older Dune Sands (Qos)
- Older Alluvium (Qoa)
- Orcutt Sand (Qo)
- Paso Robles Formation (QTp)
- Careaga Sandstone (Tca)
- Foxen Formation (Tf)
- Sisquoc Formation (Tsq)
- Monterey Formation (Tm)
- Tertiary - Older than Monterey

N

0 10,000 20,000 Feet

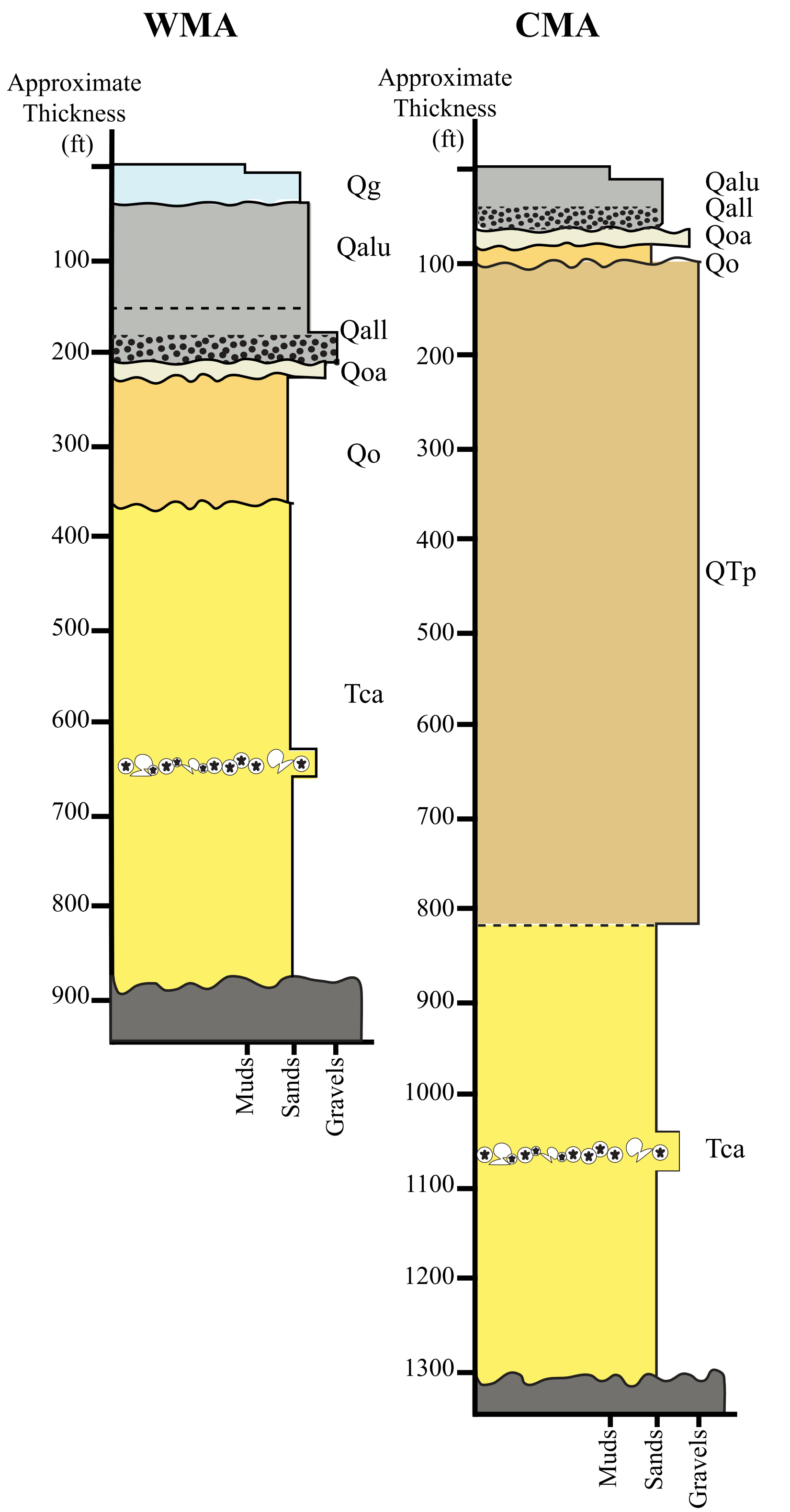
Geologic Map and Boundaries

Santa Ynez River Valley
Santa Barbara County, CA

Geosyntec consultants

Santa Barbara | April 2020

Figure 2



Formation Descriptions

River Gravels (Qg):
Coarse to fine sand, gravel and thin lenses of clay and silt; occurs in the modern channel of Santa Ynez River.

Young Alluvium (Qal):
Unconsolidated sands, gravels, silts and clays.
Upper Member (Qalu): Clay, silt and fine-grained sand and gravel stringers.
Lower Member (Qall): Cobbles, gravels, and medium to coarse grained sand. Cobbles/gravels concentrated at base.

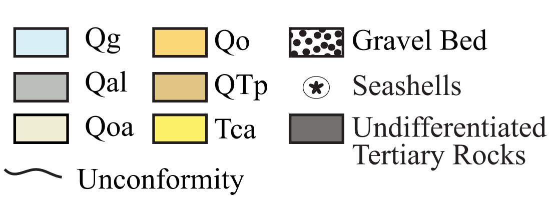
Older Alluvium (Qoa):
Unconsolidated gravels, sand, and silt.

Orcutt Sands (Qo):
Unconsolidated, well sorted coarse to medium-grained sand and clayey sand with scattered pebbles/gravel stringers.

Paso Robles Formation: (QTp):
Weakly consolidated lenticular beds of clay, fine to coarse-grained sand, and gravels.

Careaga Sandstone (Tca):
Weakly indurated, massive, fine to coarse-grained sand, with local lenses of pebbles and seashells.

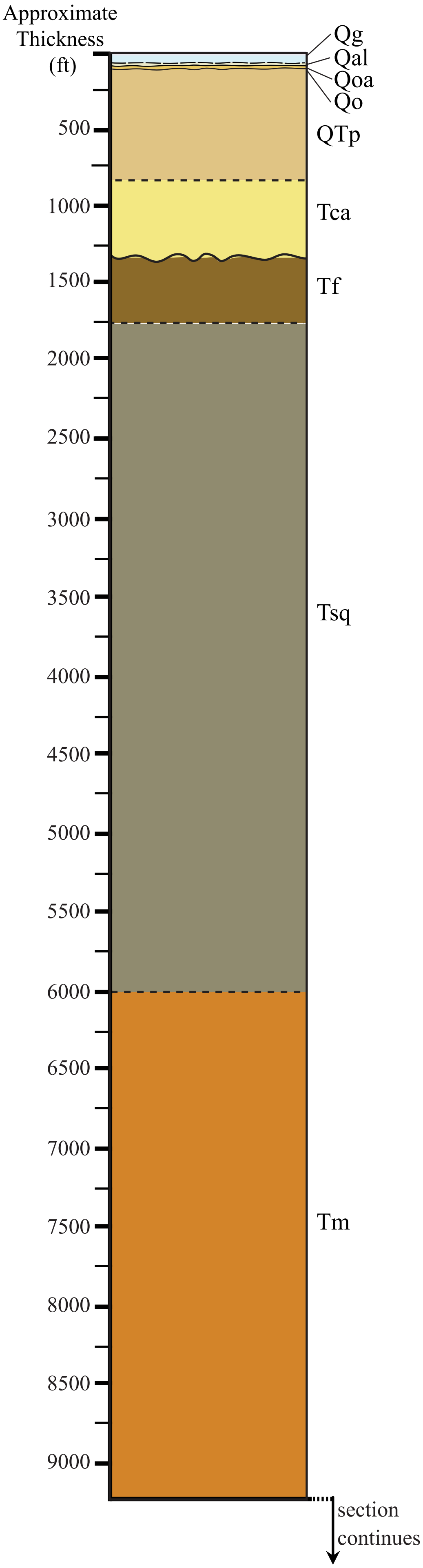
Legend



Geosyntec consultants

Shallow Stratigraphic Columns of Santa Ynez River Valley

Date:	April 2020	File No.:	
Project No.:	SB0959	Figure:	3



Formation Descriptions

River-Channel Deposits (Qg):
Coarse to fine sand, gravel and thin lenses of clay and silt; occurs in the modern channel of Santa Ynez River.

Younger Alluvium (Qal):
Unconsolidated sands, gravels, silts and clays.

Older Alluvium (Qoa):
Unconsolidated gravels, sand and silt.

Orcutt Sand (Qo):
Unconsolidated, well sorted, coarse to medium grained sand and clayey sand with scattered pebbles/gravel stringers.

Paso Robles Formation (QTp):
Weakly consolidated lenticular beds of clay, fine to coarse-grained sand, and gravels.

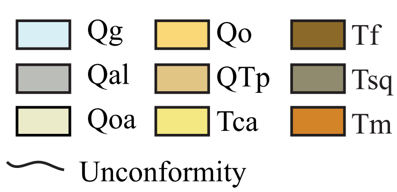
Careaga Sandstone (Tca):
Weakly indurated, massive, fine to coarse-grained sand, with local lenses of pebbles and seashells.

Foxen Formation (Tf):
Massive claystone/ siltstone/ mudstone.

Sisquoc Formation (Tsq):
Massive to very thin bedded, diatomaceous mudstone.

Monterey Formation (Tm):
Very well bedded siliceous shale, chert and diatomite.

Legend

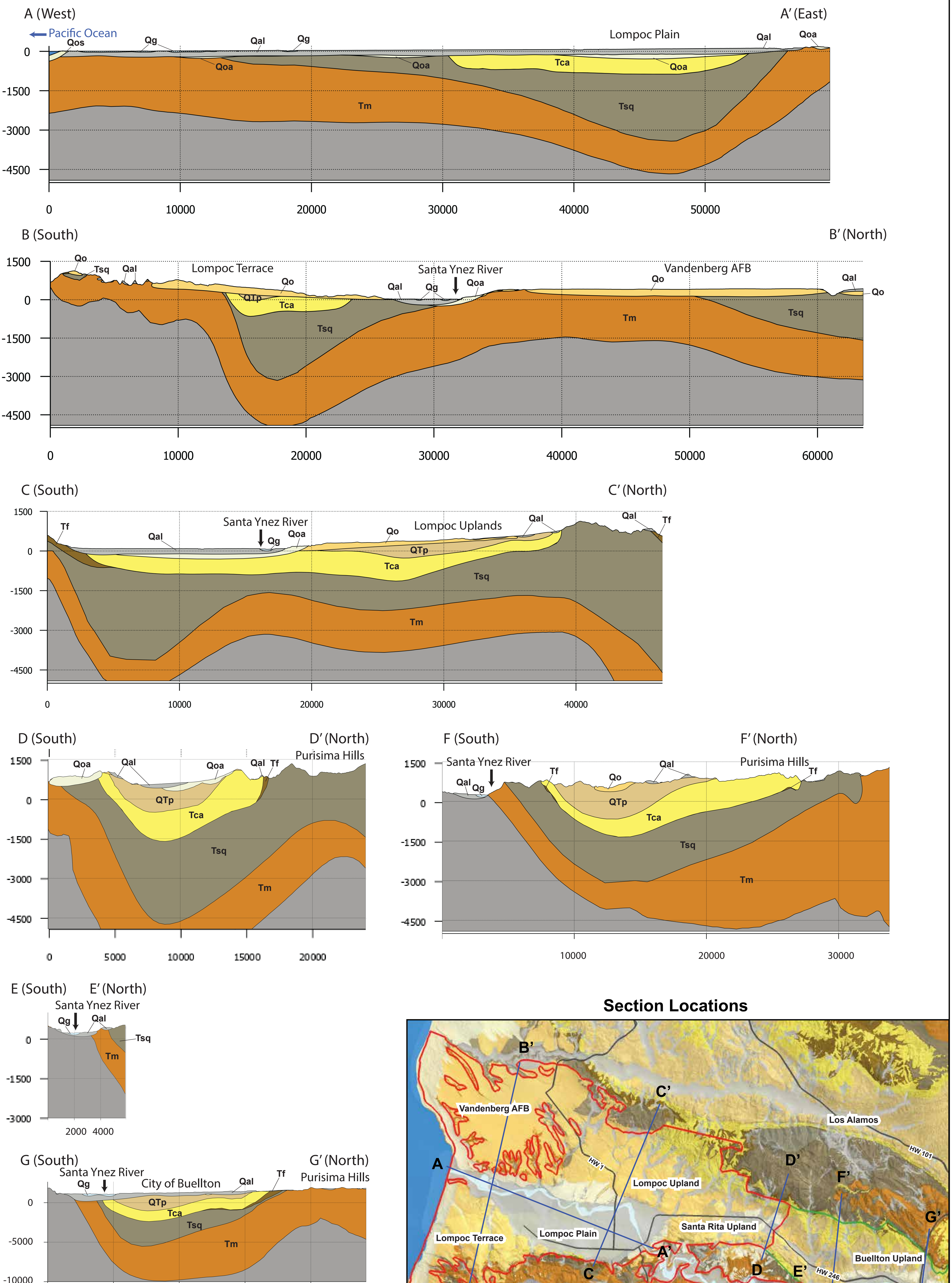


Geosyntec consultants

Deep Stratigraphic Column of Santa Ynez River Valley

Date:	April 2020	File No.:	
Project No.:	SB0959	Figure:	4

C:\Users\yzhang\Geosyntec\Eryn Torres - EVS\SYRV\20_Deliverables\figures



Geologic Model

River-Channel Deposits (Qg)	Orcutt Sand (Qo)	Sisquoc Formation (Tsq)
Younger Alluvium (Qal)	Paso Robles Formation (QTp)	Monterey Formation (Tm)
Older Dune Sands (Qos)	Careaga Sandstone (Tca)	Tertiary - Older than Monterey
Older Alluvium (Qoa)	Foxen Formation (Tf)	

Notes:
All images displayed at 2x vertical exaggeration
All units in Feet

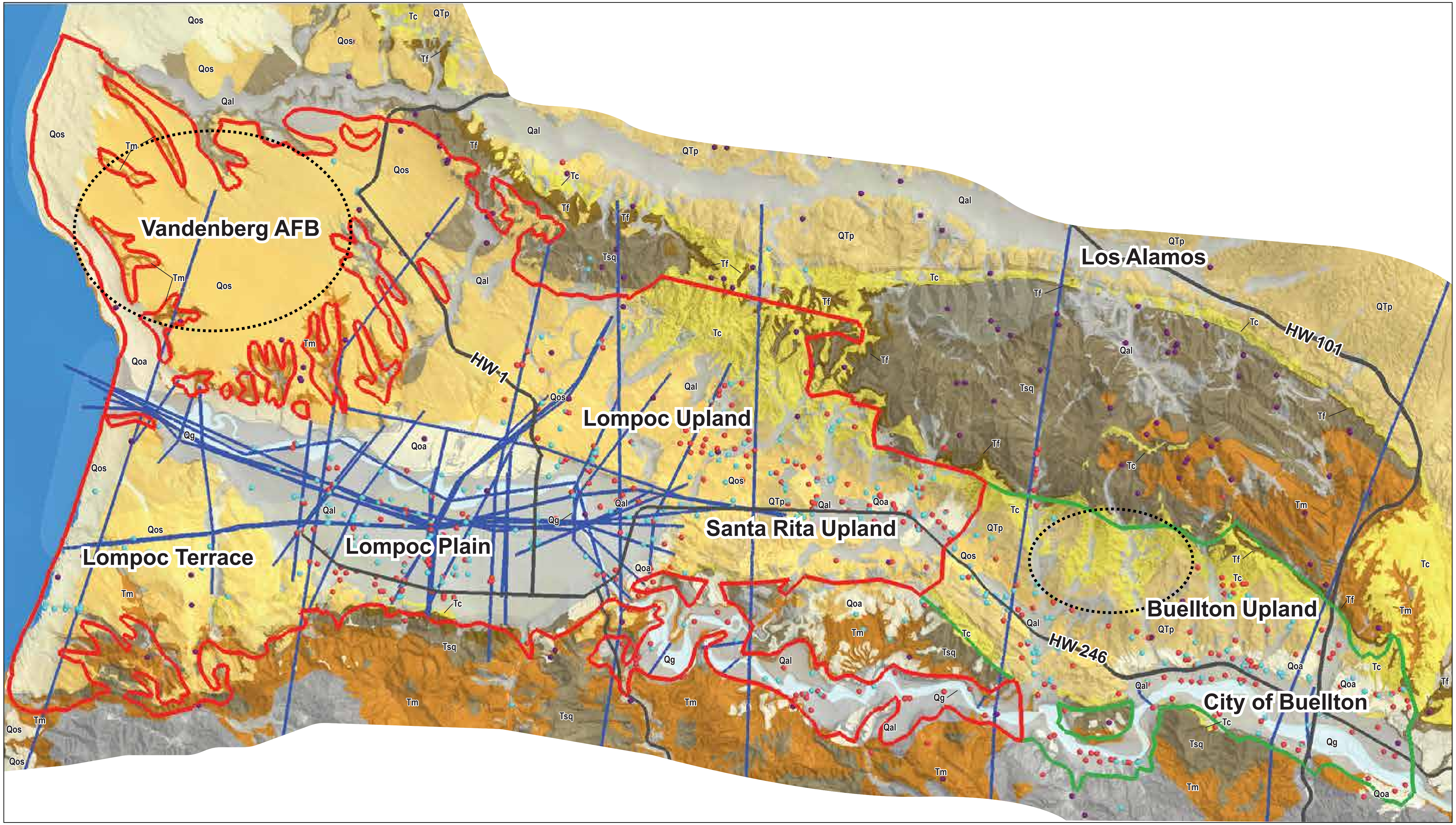
Geologic Cross Sections A-A' through G-G'

Santa Ynez River Valley
Santa Baraba County, CA

Geosyntec consultants

Figure 5

Santa Barbara | April 2020



Legend

- DWR Log Location
- CPH Log Location
- OFR Log Location
- Cross Section from Previous Report
- Major Roadway
- Western Management Area
- Central Management Area

Model Geology

- River-Channel Deposits (Qg)
- Younger Alluvium (Qal)
- Older Dune Sands (Qos)
- Older Alluvium (Qoa)
- Orcutt Sand (Qo)
- Paso Robles Formation (QTp)
- Careaga Sandstone (Tca)
- Foxen Formation (Tf)
- Sisquoc Formation (Tsq)
- Monterey Formation (Tm)
- Tertiary - Older than Monterey
- Data Gap Regions

N

0 10,000 20,000 Feet

Available Data Incorporated Into Geologic Model

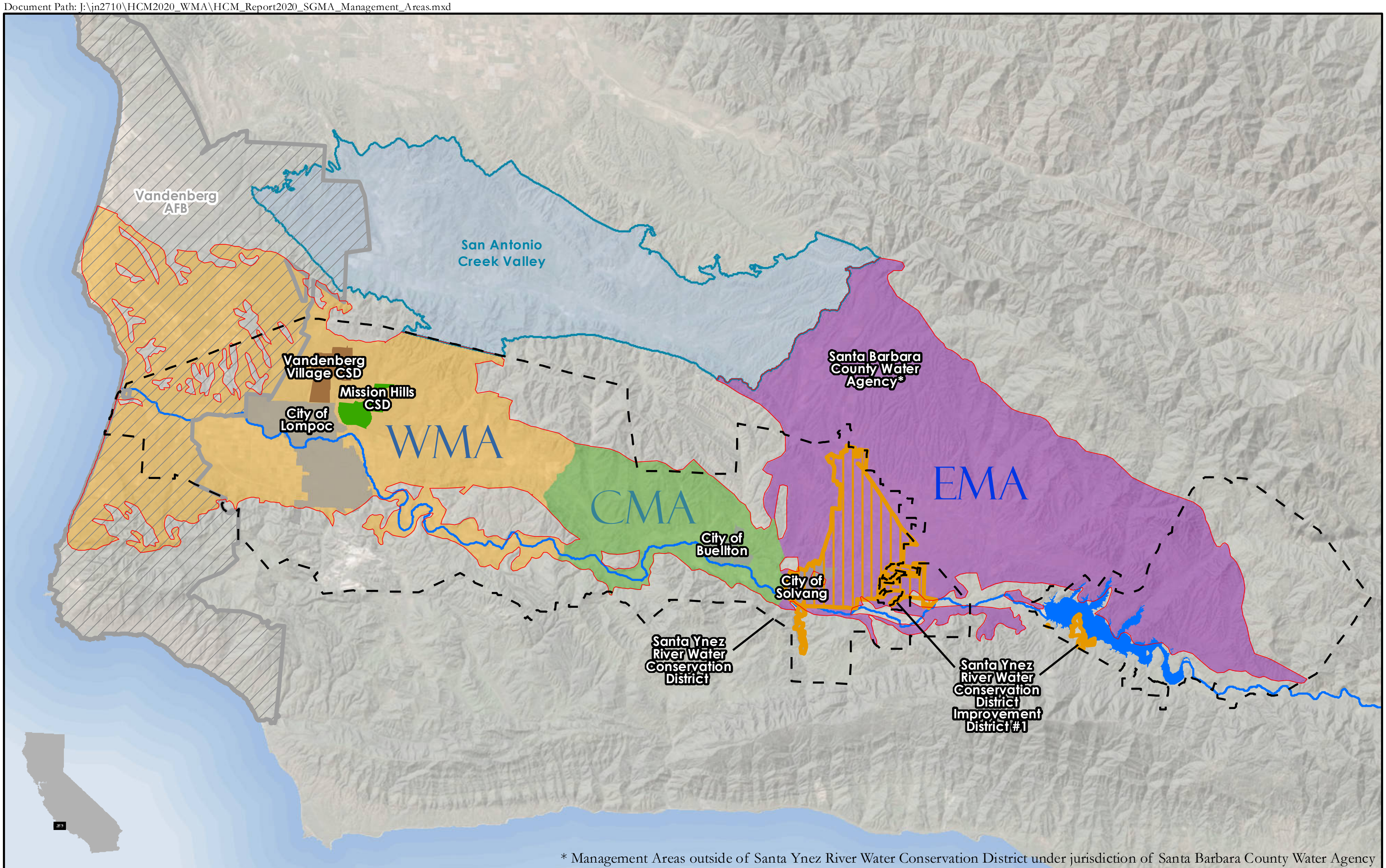
Santa Ynez River Valley
Santa Barbara County, CA

Geosyntec consultants

Figure 6

Santa Barbara | April 2020

Document Path: J:\jn2710\HCM2020_WMA\HCM_Report2020_SGMA_Management_Areas.mxd



* Management Areas outside of Santa Ynez River Water Conservation District under jurisdiction of Santa Barbara County Water Agency

STETSON ENGINEERS INC.

- Western Management Area (WMA)
- Central Management Area (CMA)
- Eastern Management Area (EMA)

SANTA YNEZ RIVER VALLEY GROUNDWATER BASIN
(DWR BULLETIN 118 BASIN NO. 3-105)
AND SGMA MANAGEMENT AREA BOUNDARIES

DRAFT

0 2 4 Miles

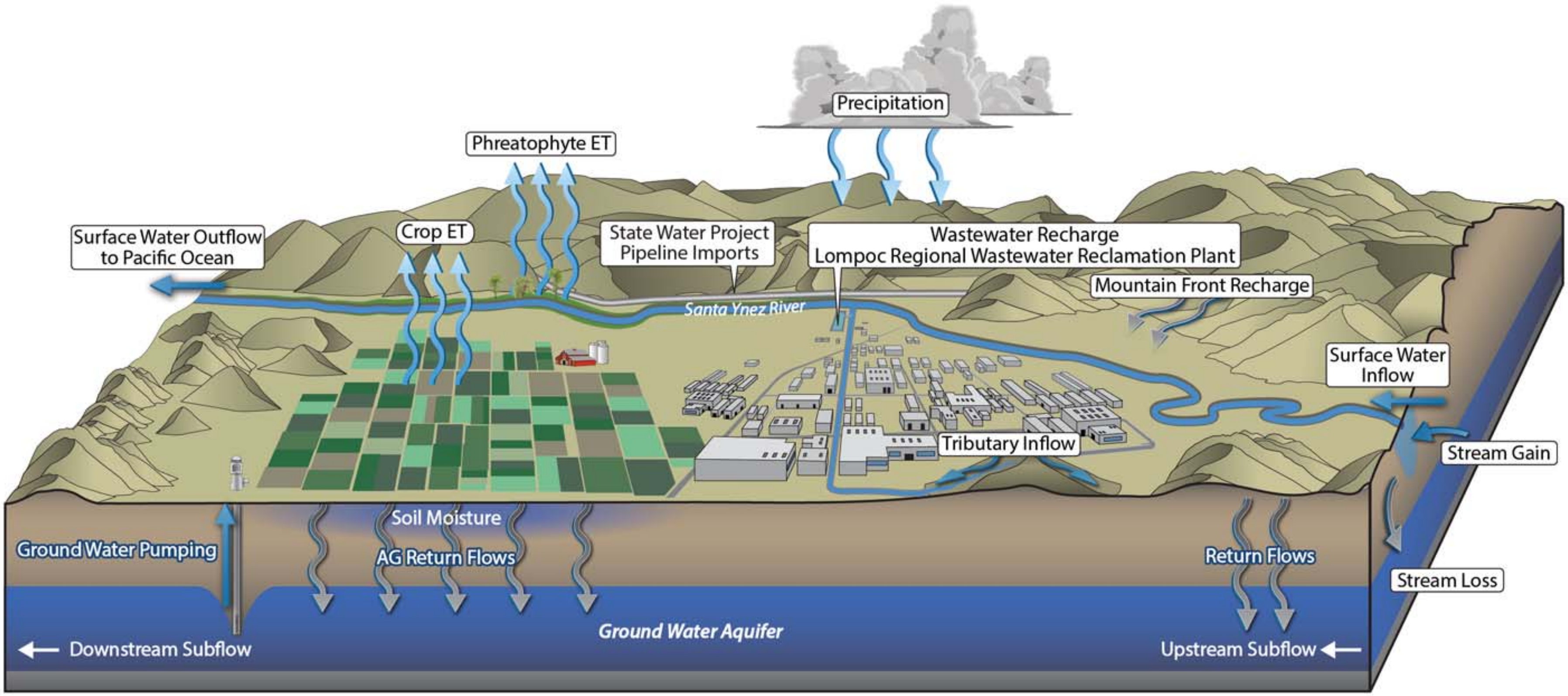
N

Sources:
NAIP (2018)
USGS National Elevation Dataset, 2002
Groundwater basin boundary from DWR Bulletin 118, 2018

FIGURE 1-1

DRAFT

WESTERN MANAGEMENT AREA OF THE SANTA YNEZ RIVER VALLEY GROUNDWATER BASIN



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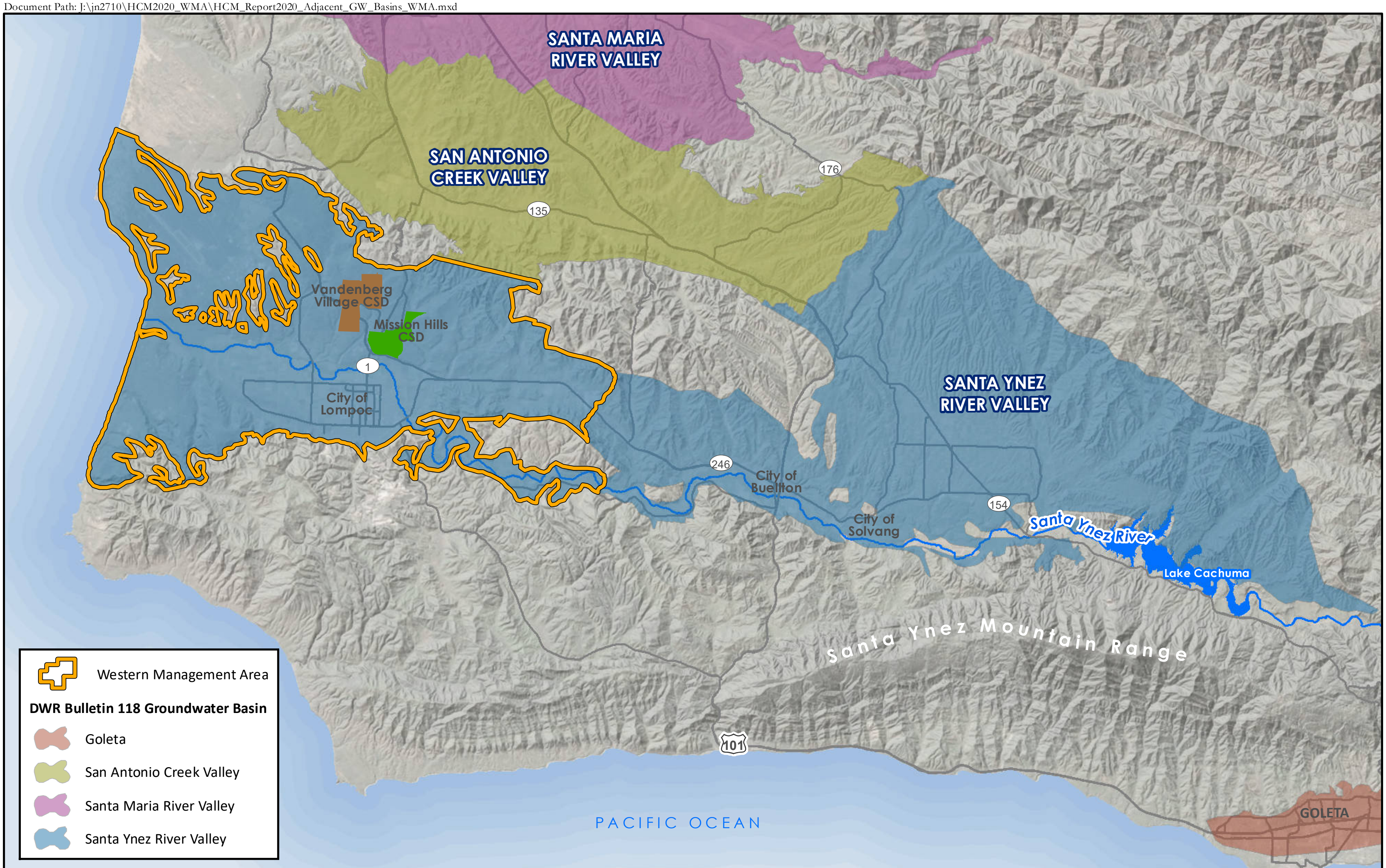
HYDROGEOLOGICAL CONCEPTUAL MODEL
WESTERN MANAGEMENT AREA
SANTA YNEZ RIVER VALLEY GROUNDWATER BASIN

FIGURE 1-2

Document Path: J:\jn2710\HCM2020_WMA\HCM_Report2020_Adjacent_GW_Basins_WMA.mxd



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WMA
Santa Ynez River Valley Groundwater Basin
Western Management Area
Groundwater Sustainability Agency

ADJACENT AND NEIGHBORING GROUNDWATER BASINS
WESTERN MANAGEMENT AREA

DRAFT

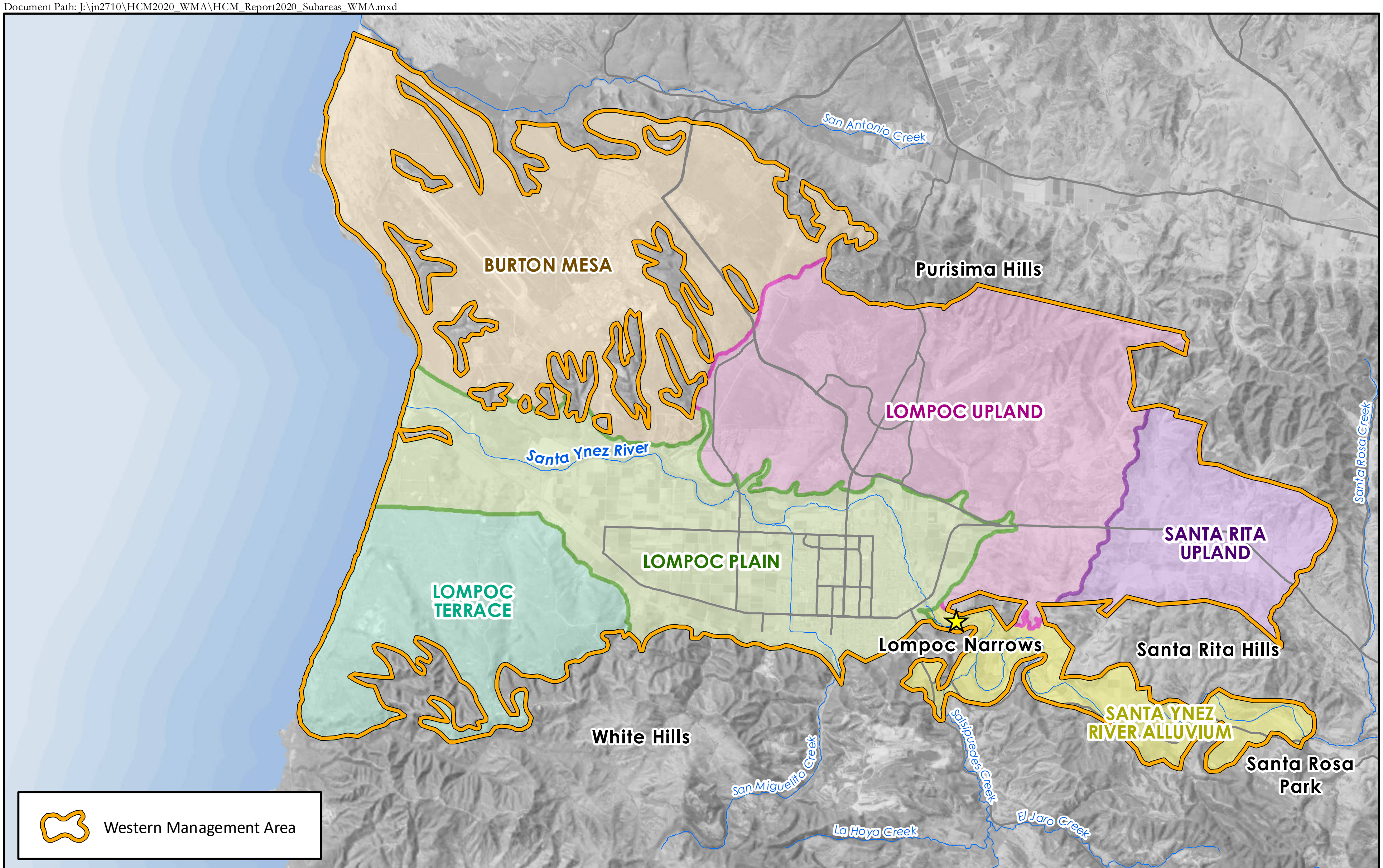
0 2 4 Miles

N

Sources:
ESRI World Imagery (2018 Maxar)
USGS National Elevation Dataset, 2002

FIGURE 1-3

Document Path: J:\jn2710\HCM2020_WMA\HCM_Report2020_Subareas_WMA.mxd



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WMA
Santa Ynez River Valley Groundwater Basin
Western Management Area
Groundwater Sustainability Agency

SUBAREAS
WESTERN MANAGEMENT AREA

DRAFT

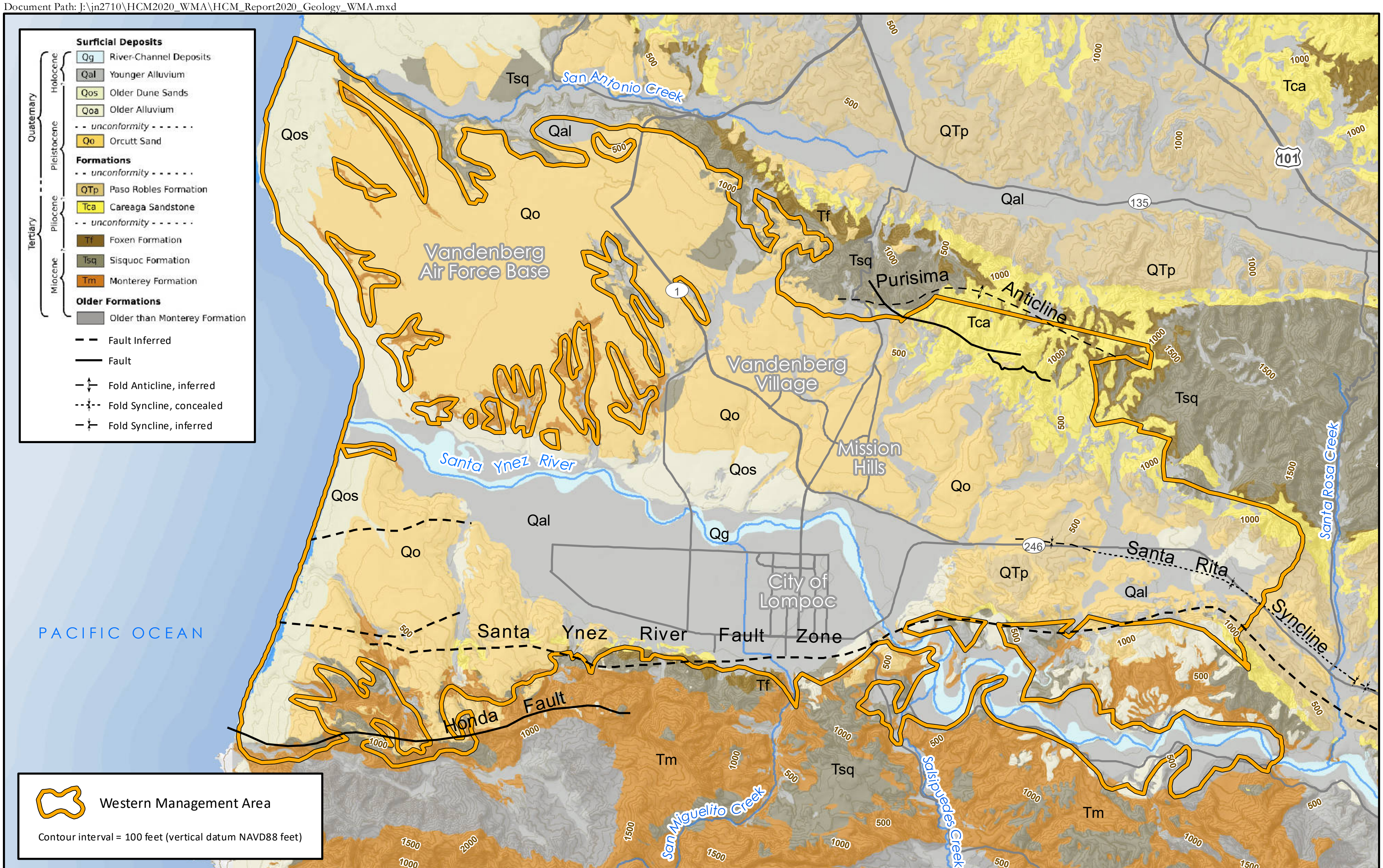
0 1 2 Miles

Sources:
USGS Nationa l Elevation Dataset, 2002
NAIP (2018)

N

FIGURE 1-4

Document Path: J:\jn2710\HCM2020_WMA\HCM_Report2020_Geology_WMA.mxd



DRAFT

0 1 2 Miles

N

Sources:
Geosyntec, 2020; Dibblee, 1993; USGS, 2020
USGS National Elevation Dataset, 2002

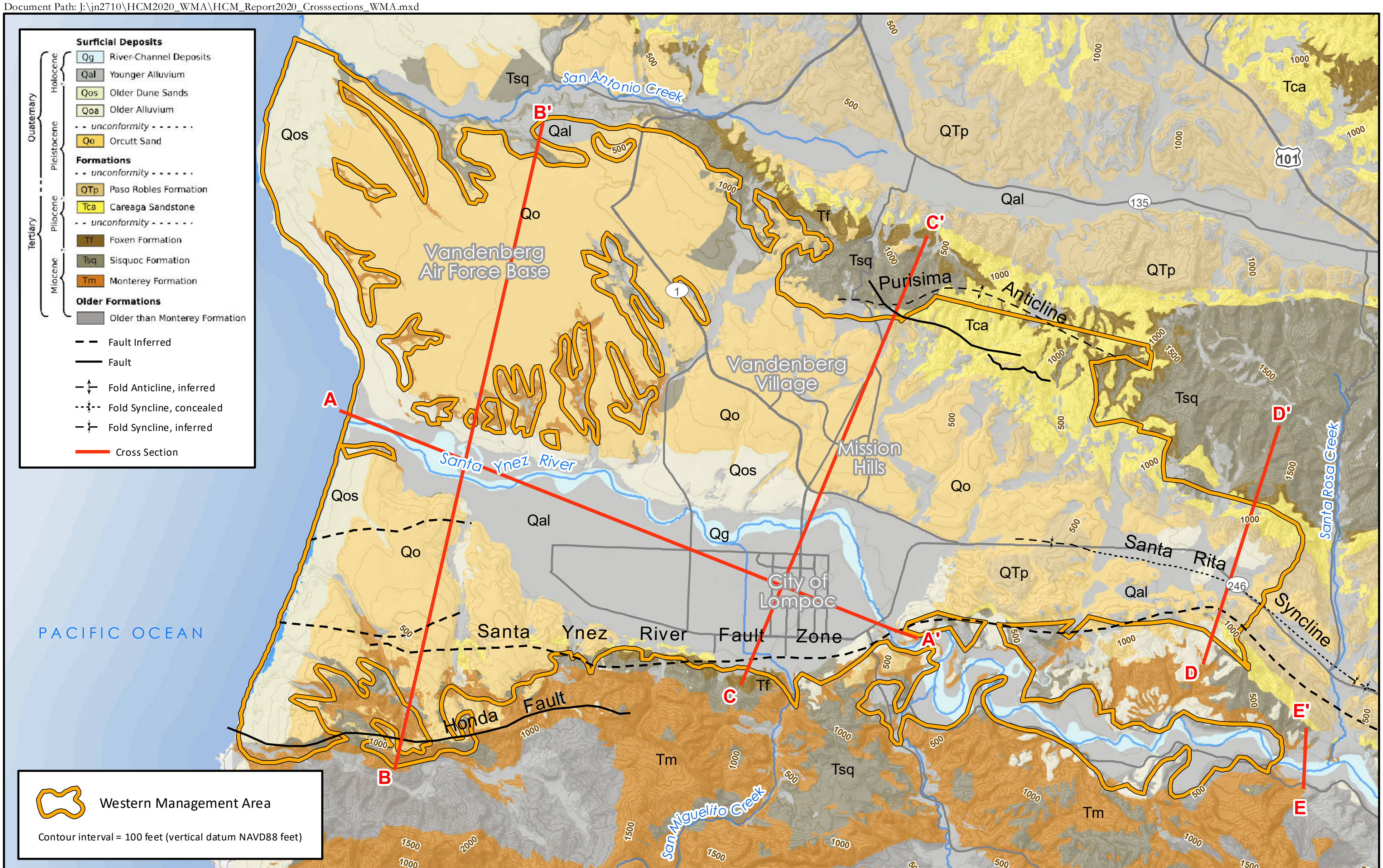
STETSON ENGINEERS INC.
Geosyntec consultants

WMA
Santa Ynez River Valley Groundwater Basin
Western Management Area
Groundwater Sustainability Agency

SURFACE GEOLOGY
WESTERN MANAGEMENT AREA

FIGURE 2-1

Document Path: J:\jn2710\HCM2020_WMA\HCM_Report2020_Crosssections_WMA.mxd



GEOLOGIC CROSS SECTIONS
WESTERN MANAGEMENT AREA

STETSON ENGINEERS INC.

Geosyntec consultants

WMA

Santa Ynez River Valley Groundwater Basin
Western Management Area
Groundwater Sustainability Agency

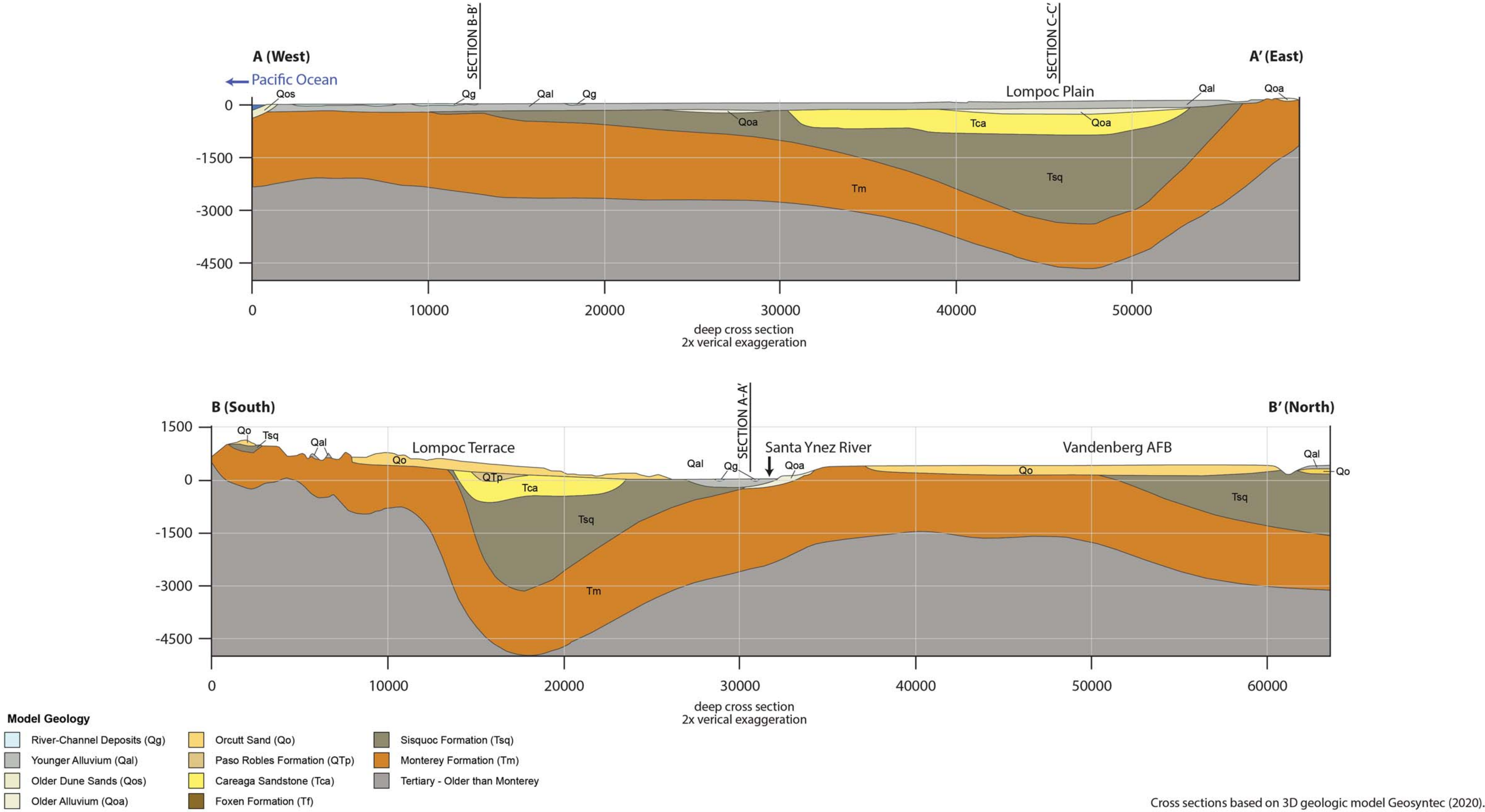
DRAFT

0 1 2 Miles

N

Sources:
Geosyntec, 2020; Dibblee, 1993; USGS, 2020
USGS National Elevation Dataset, 2002

FIGURE 2-2



Cross sections based on 3D geologic model Geosyntec (2020).

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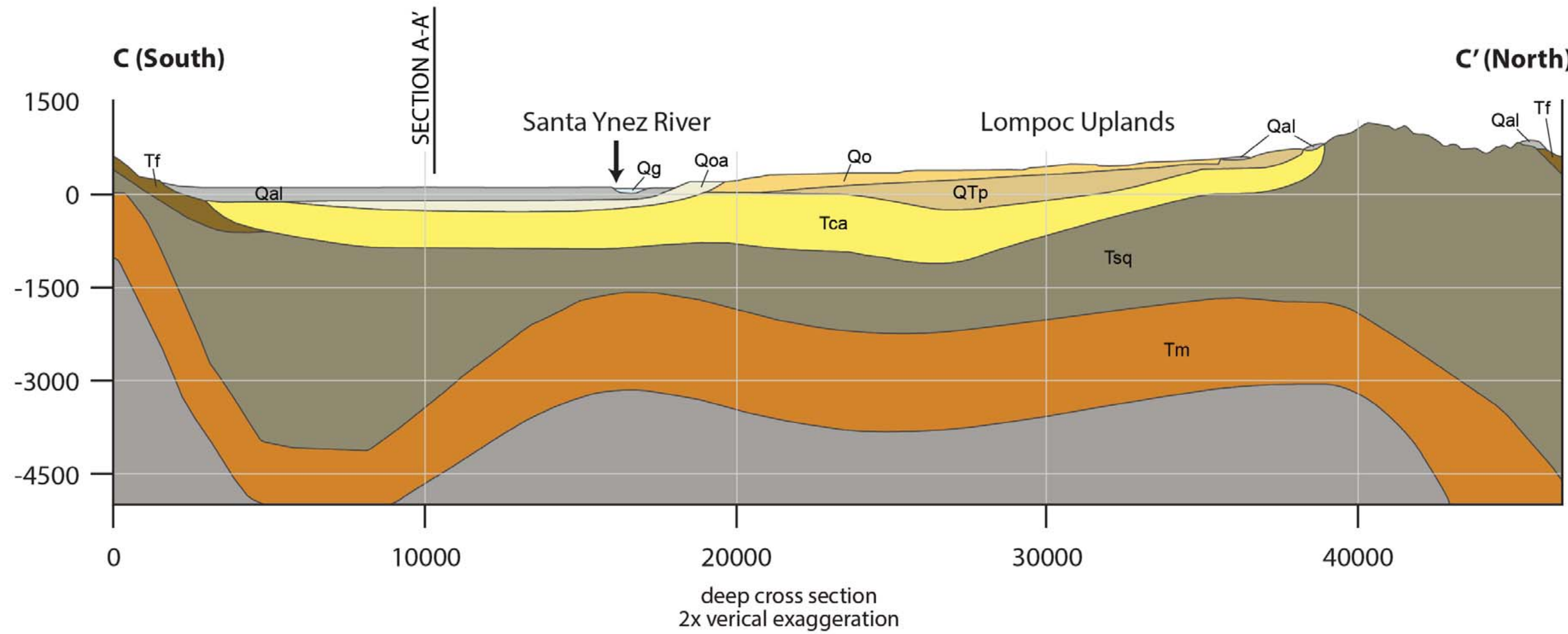
WMA
Santa Ynez River Valley Groundwater Basin
Western Management Area
Groundwater Sustainability Agency

Western Management Area Geologic Cross-sections A-A' and B-B'

Geosyntec consultants



Model Geology

River-Channel Deposits (Qg)	Orcutt Sand (Qo)	Sisquoc Formation (Tsq)
Younger Alluvium (Qal)	Paso Robles Formation (QTp)	Monterey Formation (Tm)
Older Dune Sands (Qos)	Careaga Sandstone (Tca)	Tertiary - Older than Monterey
Older Alluvium (Qoa)	Foxen Formation (Tf)	

Cross sections based on 3D geologic model Geosyntec (2020).

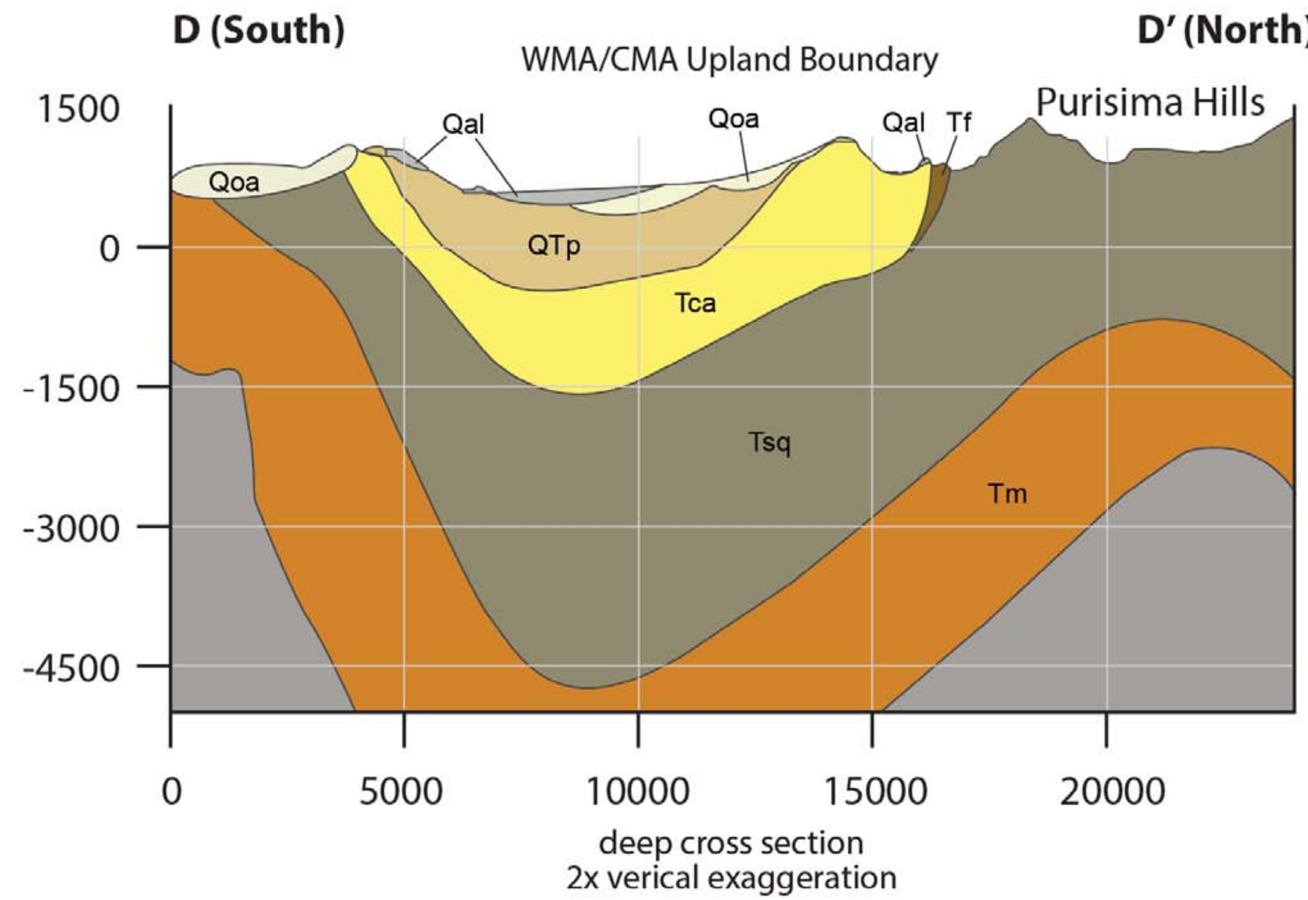
STETSON ENGINEERS INC.

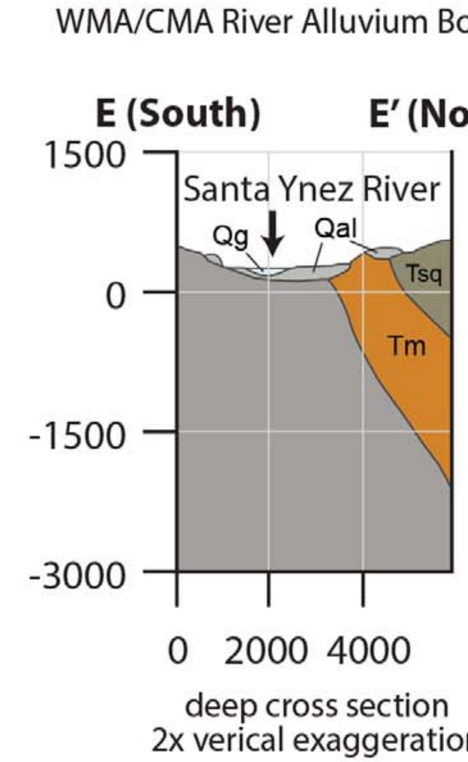
WMA
Santa Ynez River Valley Groundwater Basin
Western Management Area
Groundwater Sustainability Agency

Western Management Area Geologic Cross-section C-C'

Geosyntec consultants

FIGURE 2-3b





Model Geology

- River-Channel Deposits (Qg)
- Younger Alluvium (Qal)
- Older Dune Sands (Qos)
- Older Alluvium (Qoa)
- Orcutt Sand (Qo)
- Paso Robles Formation (QTp)
- Careaga Sandstone (Tca)
- Foxen Formation (Tf)
- Sisquoc Formation (Tsq)
- Monterey Formation (Tm)
- Tertiary - Older than Monterey

Cross sections based on 3D geologic model Geosyntec (2020).

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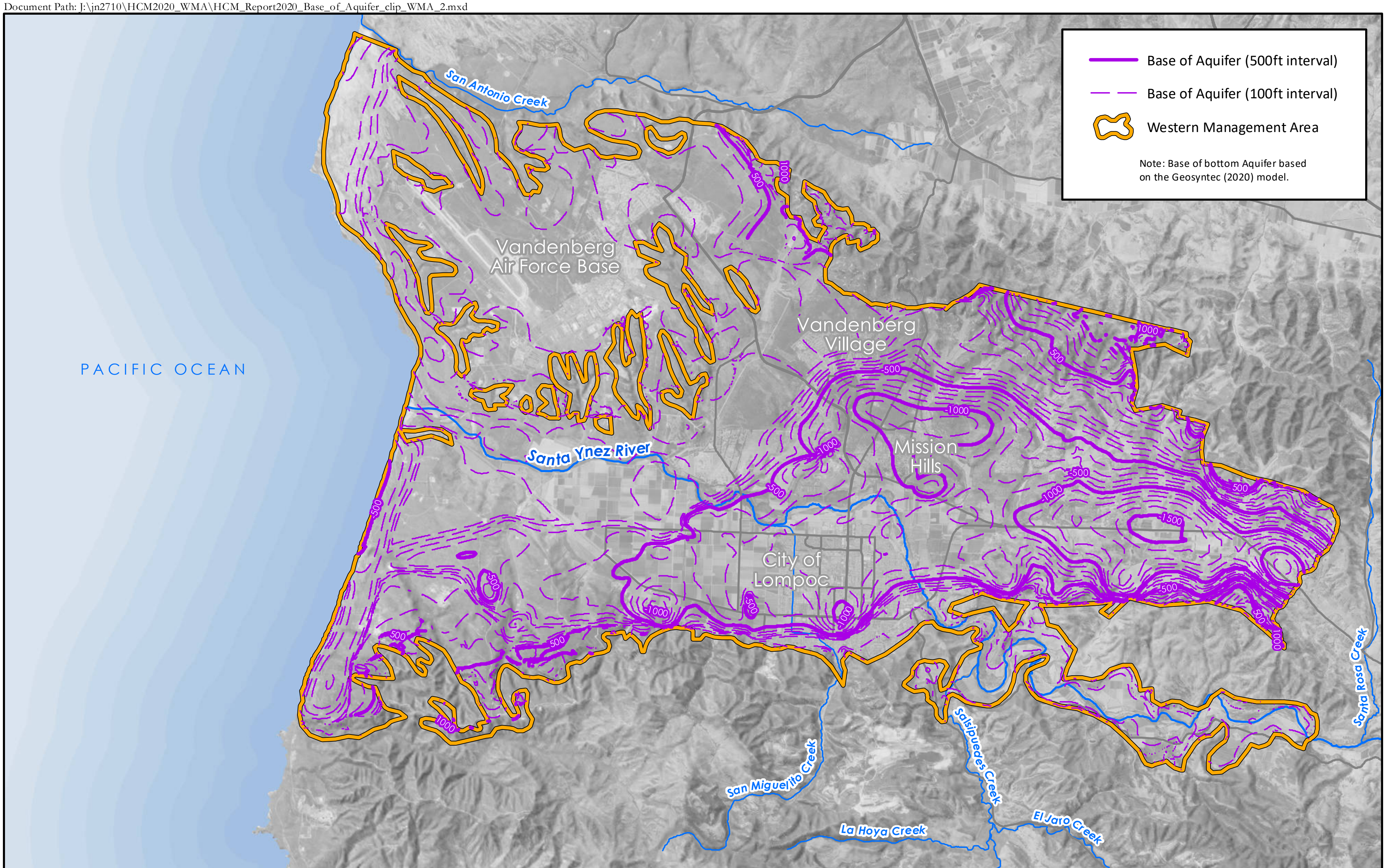
WMA
Santa Ynez River Valley Groundwater Basin
Western Management Area
Groundwater Sustainability Agency

Western Management Area Geologic Cross-sections D-D' and E-E'

Geosyntec consultants

FIGURE 2-3c

Document Path: J:\jn2710\HCM2020_WMA\HCM_Report2020_Base_of_Aquifer_clip_WMA_2.mxd



STETSON ENGINEERS INC.
Geosyntec consultants

WMA
Santa Ynez River Valley Groundwater Basin
Western Management Area
Groundwater Sustainability Agency

BOTTOM OF THE BASIN
SUBSURFACE ELEVATION CONTOUR
WITHIN WESTERN MANAGEMENT AREA

DRAFT

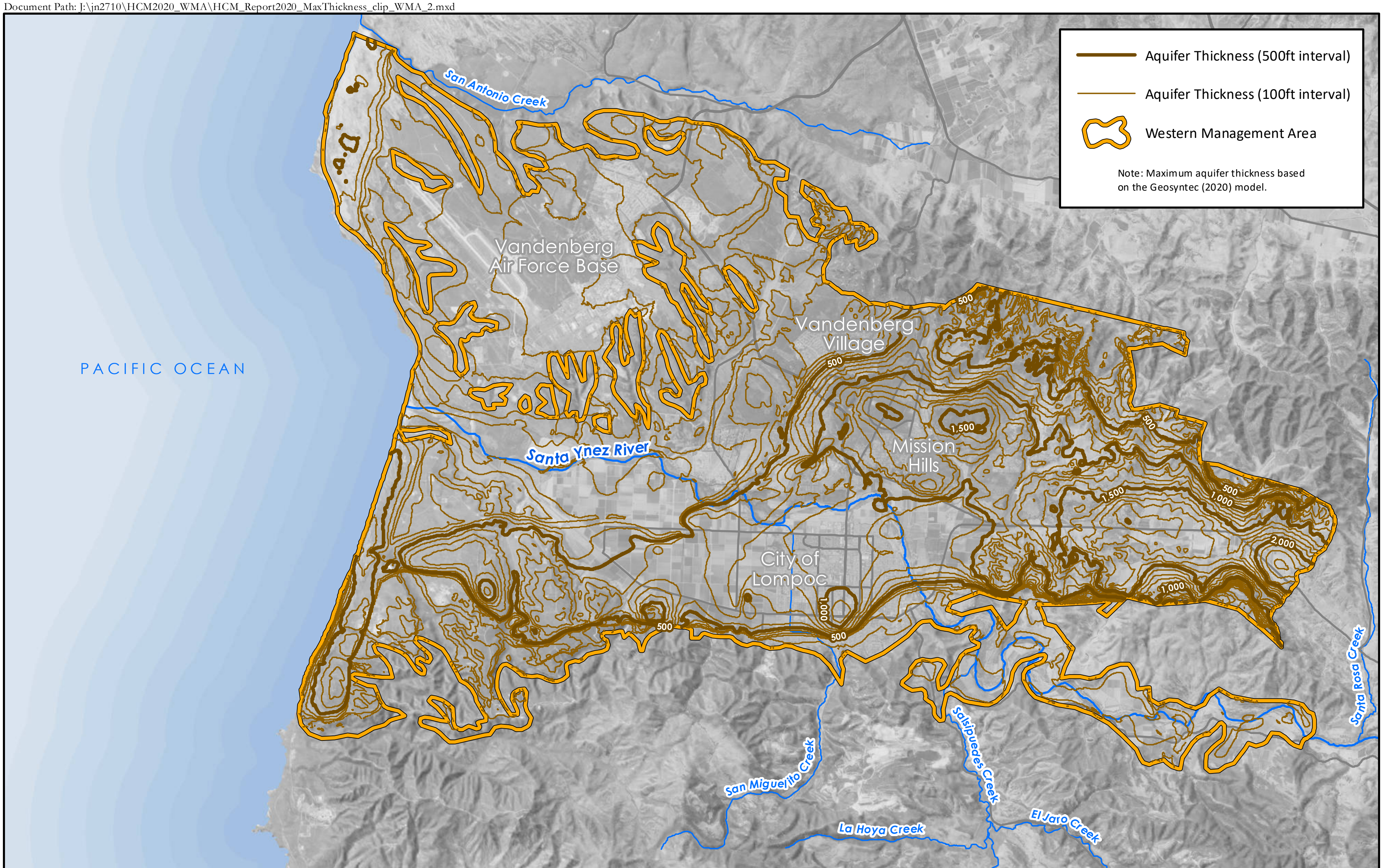
0 1 2 Miles

N

Sources:
USGS National Elevation Dataset, 2002
NAIP (2018)
Geosyntec (2020)

FIGURE 3-1

Document Path: J:\jn2710\HCM2020_WMA\HCM_Report2020_MaxThickness_clip_WMA_2.mxd



STETSON ENGINEERS INC.
Geosyntec consultants

WMA
Santa Ynez River Valley Groundwater Basin
Western Management Area
Groundwater Sustainability Agency

MAXIMUM THICKNESS OF THE BASIN
WITHIN WESTERN MANAGEMENT AREA

DRAFT

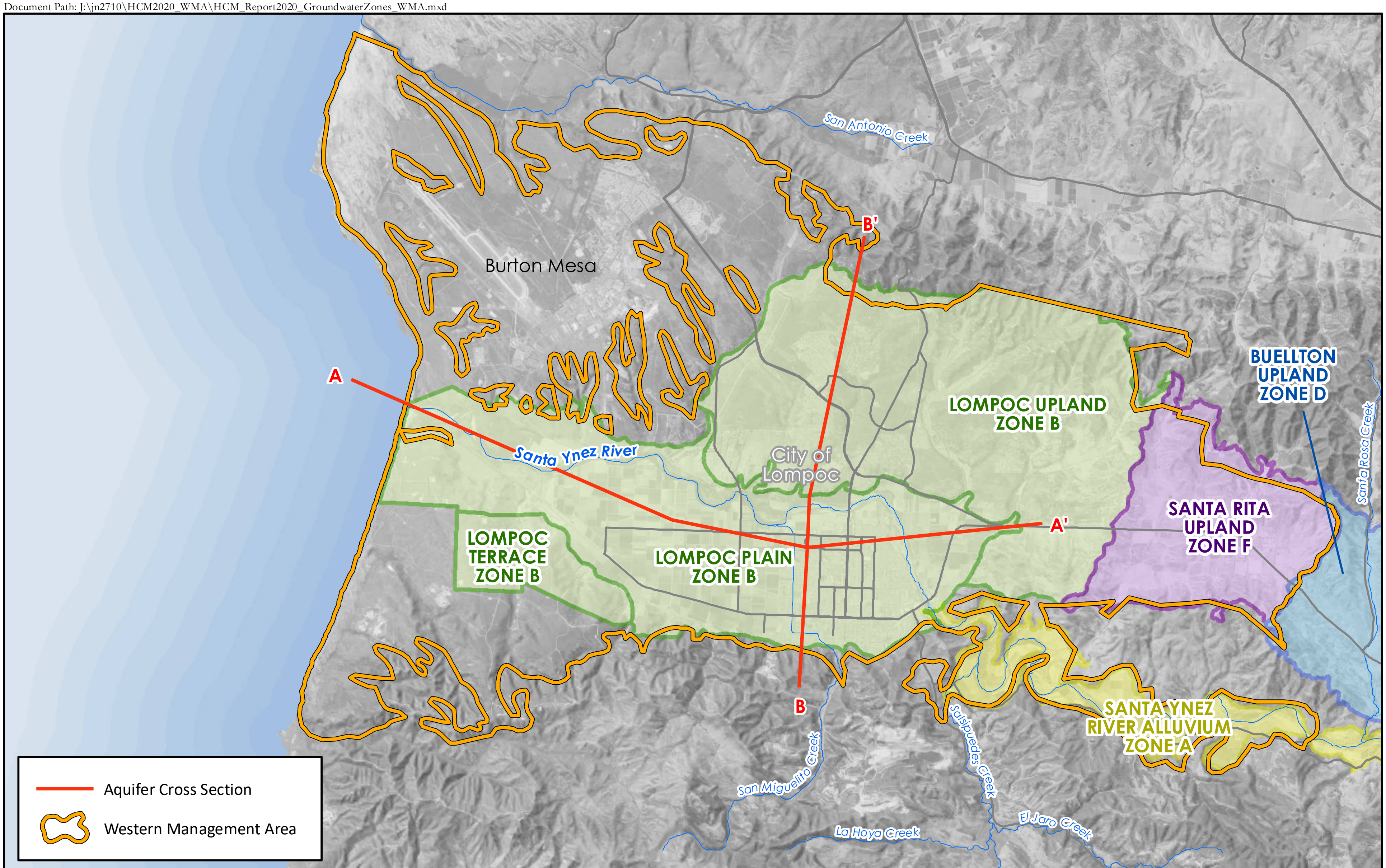
0 1 2 Miles

N

Sources:
USGS National Elevation Dataset, 2002
NAIP (2018)
Geosyntec (2020)

FIGURE 3-2

Document Path: J:\jn2710\HCM2020_WMA\HCM_Report2020_GroundwaterZones_WMA.mxd



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Santa Ynez River Valley Groundwater Basin
Western Management Area
Groundwater Sustainability Agency

SANTA YNEZ RIVER
WATER CONSERVATION DISTRICT
GROUNDWATER ZONES
AND THE WESTERN MANAGEMENT AREA

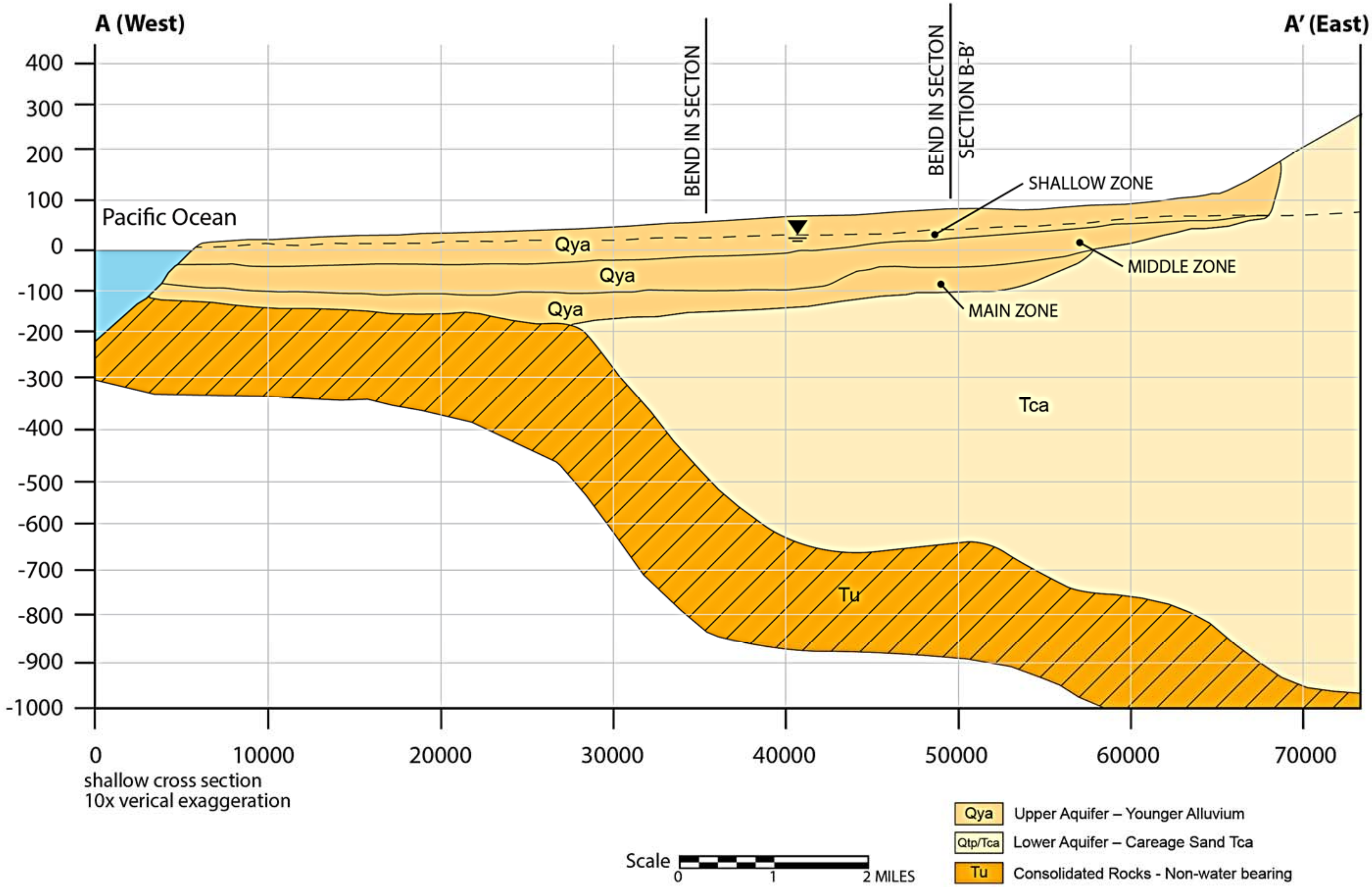
DRAFT

0 1 2 Miles

Sources:
West Yost and Associates (2012)
NAIP (2018)

N

FIGURE 3-3



Cross sections based on City of Lompoc Groundwater Management Plan (West Yost, 2013); Originally based on United States Geological Survey, Bright and Others, 1992 (Plate 1).

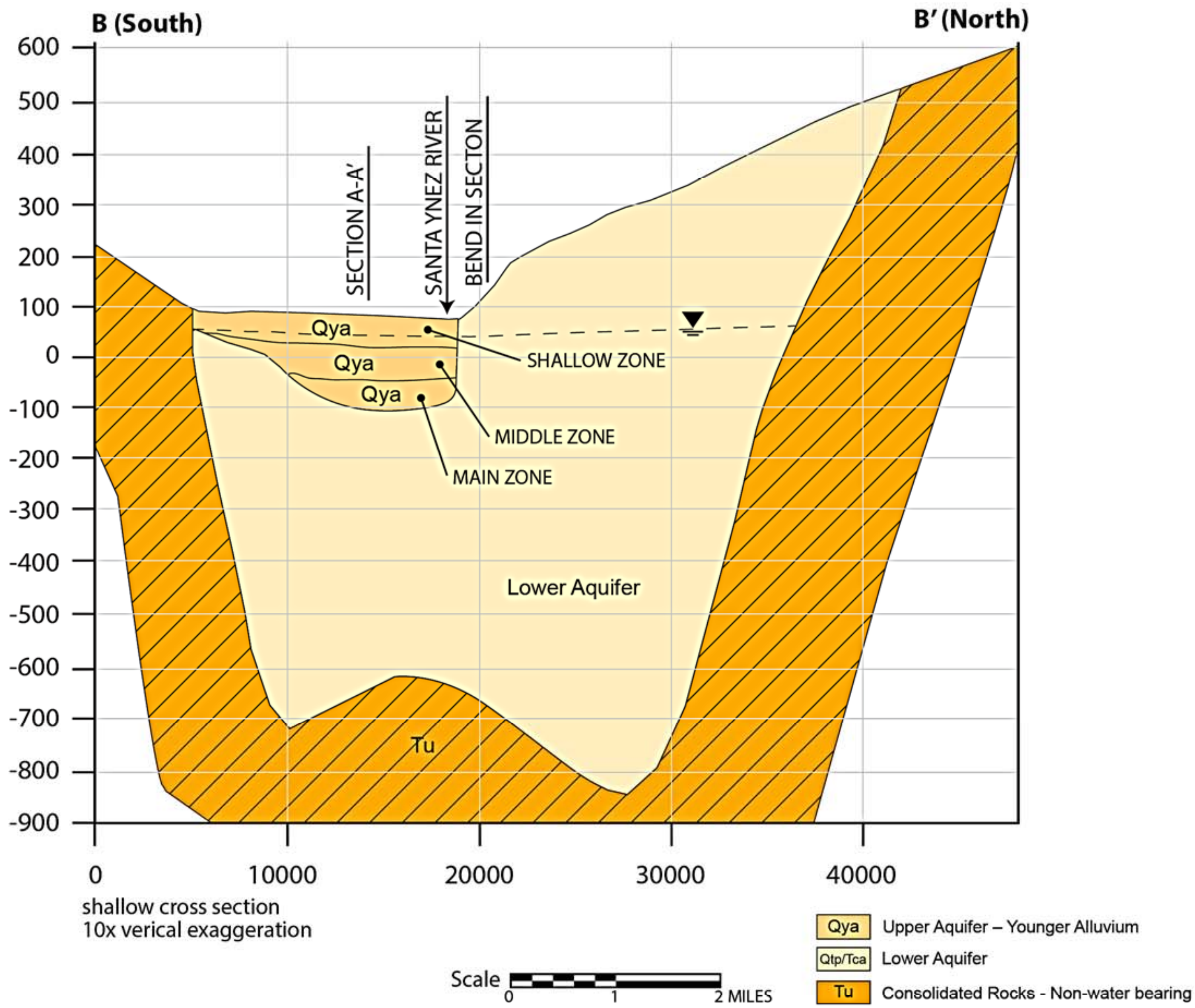
STETSON ENGINEERS INC.

WMA
Santa Ynez River Valley Groundwater Basin
Western Management Area
Groundwater Sustainability Agency

Western Management Area Aquifer Cross-section A-A'

WEST YOST ASSOCIATES
Consulting Engineers

FIGURE 3-4a



Cross sections based on City of Lompoc Groundwater Management Plan (West Yost, 2013); Originally based on United States Geological Survey, Bright and Others, 1992 (Plate 1).

STETSON ENGINEERS INC.

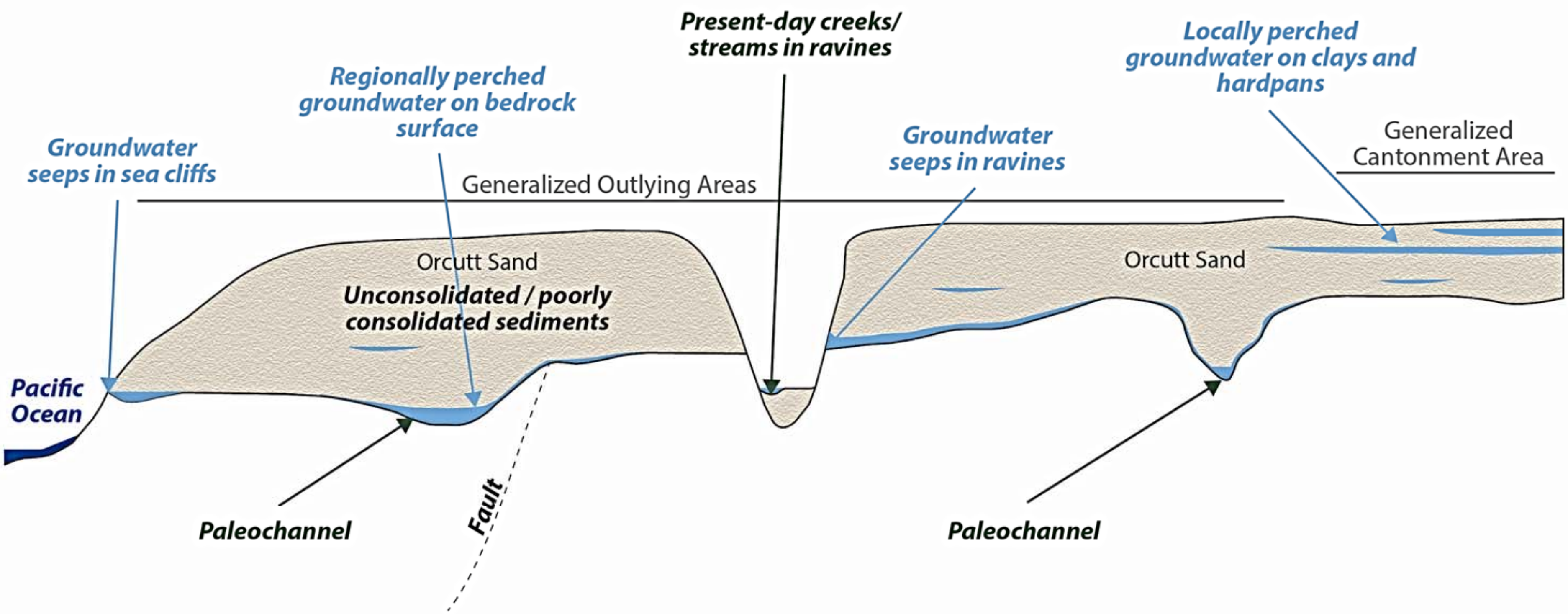
WMA

Santa Ynez River Valley Groundwater Basin
Western Management Area
Groundwater Sustainability Agency

Western Management Area Aquifer Cross-section B-B'

WEST YOST ASSOCIATES
Consulting Engineers

FIGURE 3-4b



NOT TO SCALE. This a generalized diagram with a high degree of vertical exaggeration to illustrate general concepts. It is not meant to illustrate any specific site at VAFB.

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Simplified Conceptual Geological / Hydrogeologic Cross Section

Source: Arcadis, 2016

FIGURE 3-5

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WMA
Santa Ynez River Valley Groundwater Basin
Western Management Area
Groundwater Sustainability Agency

TOPOGRAPHY
WESTERN MANAGEMENT AREA

DRAFT

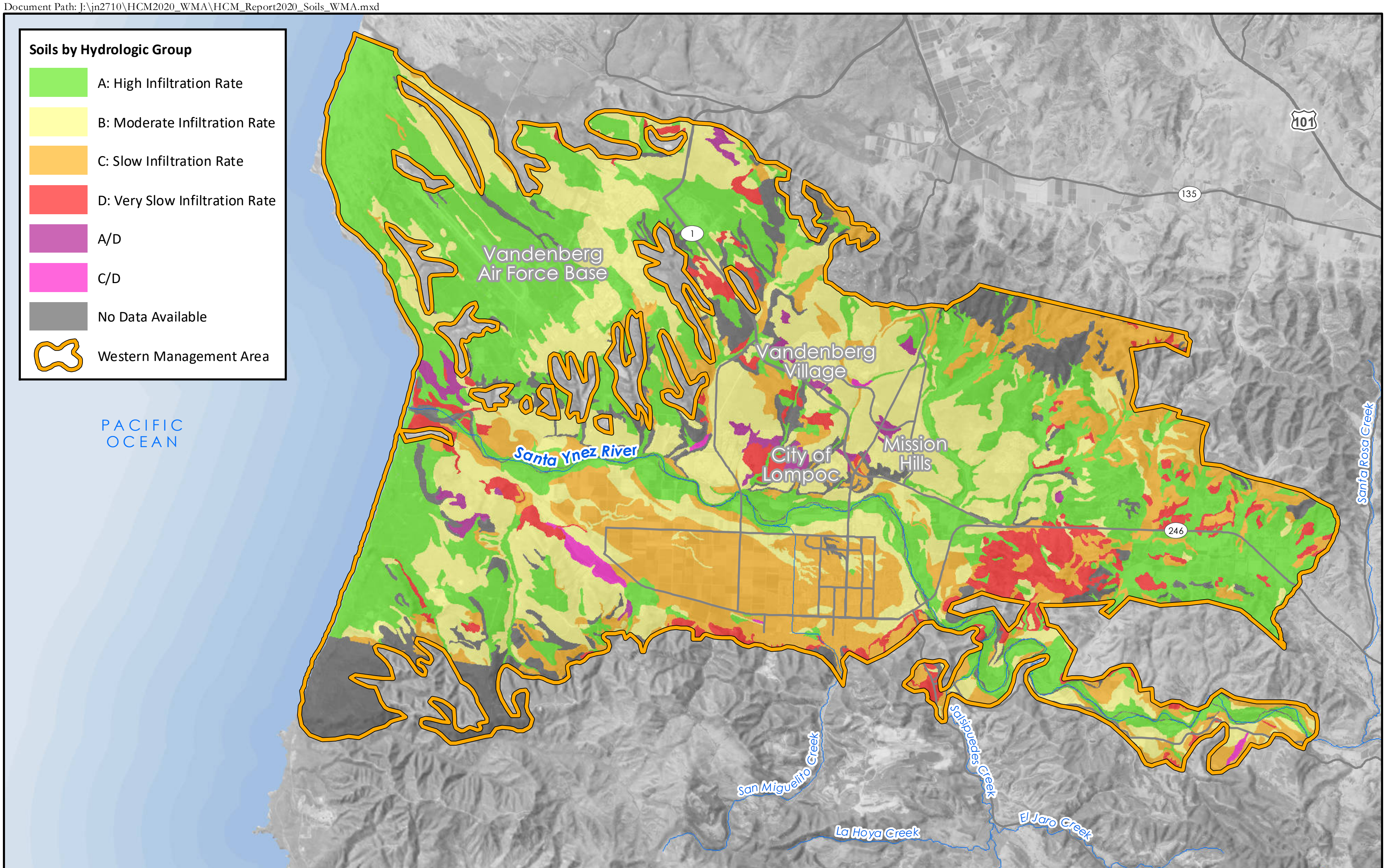
0 1 2 Miles

Sources:
USGS National Elevation Dataset, 2002
NAIP (2018)

N

FIGURE 4-1

Document Path: J:\jn2710\HCM2020_WMA\HCM_Report2020_Soils_WMA.mxd



STETSON ENGINEERS INC.

WMA
Santa Ynez River Valley Groundwater Basin
Western Management Area
Groundwater Sustainability Agency

SOIL CHARACTERISTICS
WESTERN MANAGEMENT AREA

DRAFT

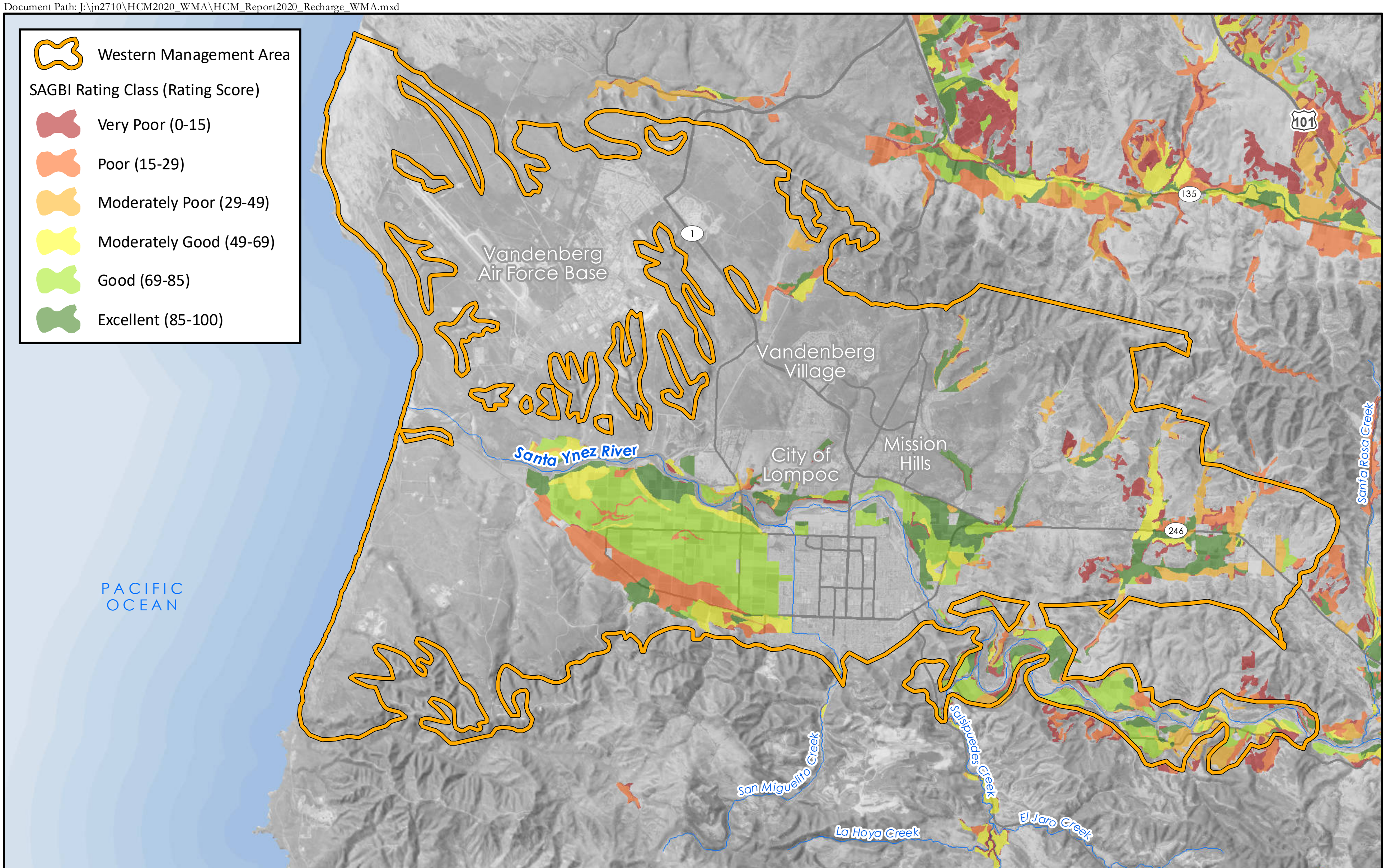
0 1 2 Miles

Source:
SSURGO Soil Survey Geographic Database,
National Resources Conservation Service.

N

FIGURE 4-2

Document Path: J:\jn2710\HCM2020_WMA\HCM_Report2020_Recharge_WMA.mxd



STETSON ENGINEERS INC.

WMA

Santa Ynez River Valley Groundwater Basin
Western Management Area
Groundwater Sustainability Agency

POTENTIAL GROUNDWATER RECHARGE AREAS
WESTERN MANAGEMENT AREA

DRAFT

0 1 2 Miles

N

Source:
Soil Agricultural Groundwater Banking Index (SAGBI) - UCDavis, 2020

FIGURE 4-3

Document Path: J:\jn2710\HCM2020_WMA\HCM_Report2020_SYRwatershed_WMA.mxd

STETSON ENGINEERS INC.

Western Management Area

Watershed Boundary

SANTA YNEZ RIVER WATERSHED AND SANTA YNEZ RIVER VALLEY GROUNDWATER BASIN

WESTERN MANAGEMENT AREA

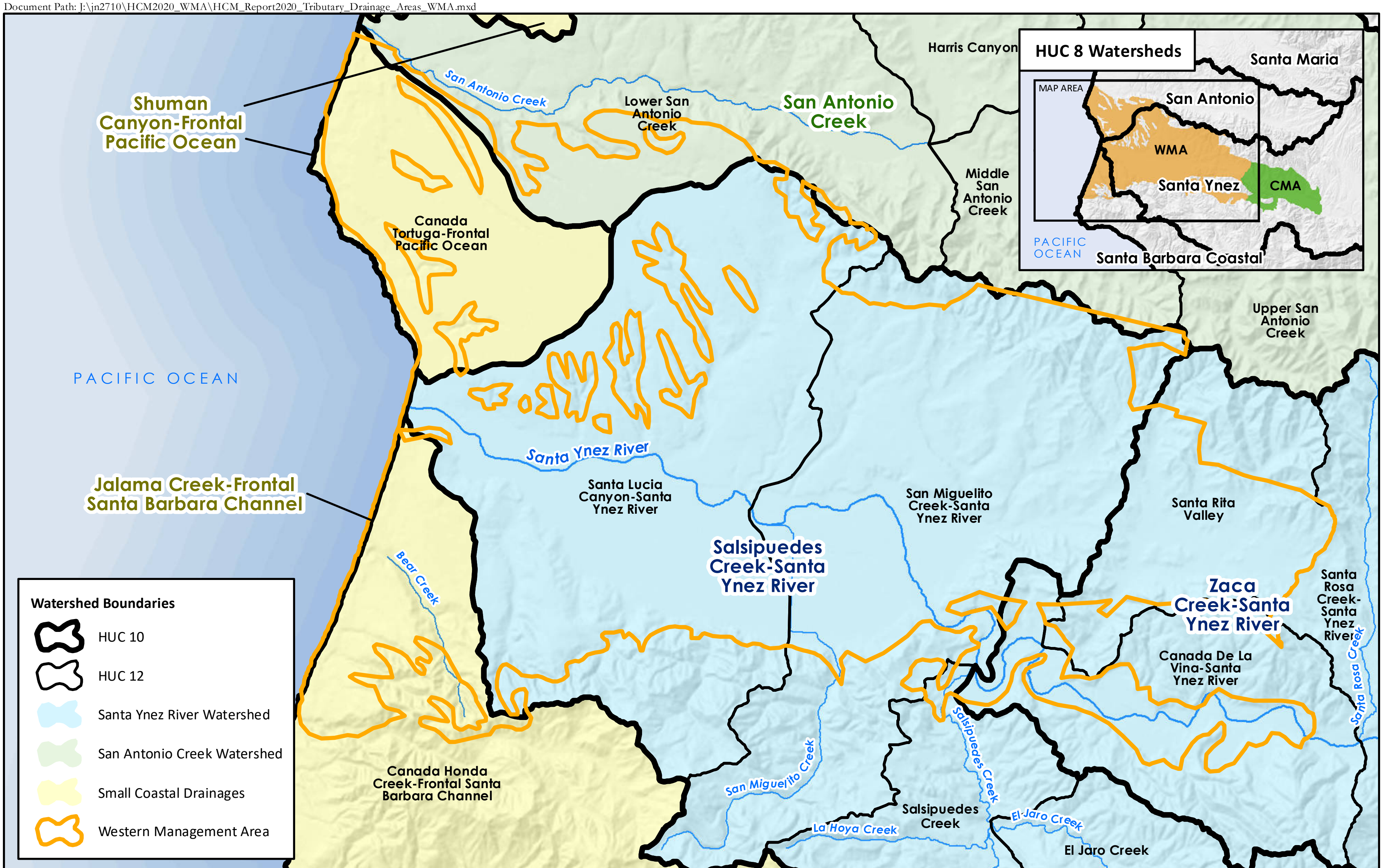
DRAFT

0 3.5 7 Miles

N

FIGURE 4-4

Document Path: J:\jn2710\HCM2020_WMA\HCM_Report2020_Tributary_Drainage_Areas_WMA.mxd



STETSON ENGINEERS INC.

WMA
Santa Ynez River Valley Groundwater Basin
Western Management Area
Groundwater Sustainability Agency

TRIBUTARY DRAINAGE AREAS
WESTERN MANAGEMENT AREA

DRAFT

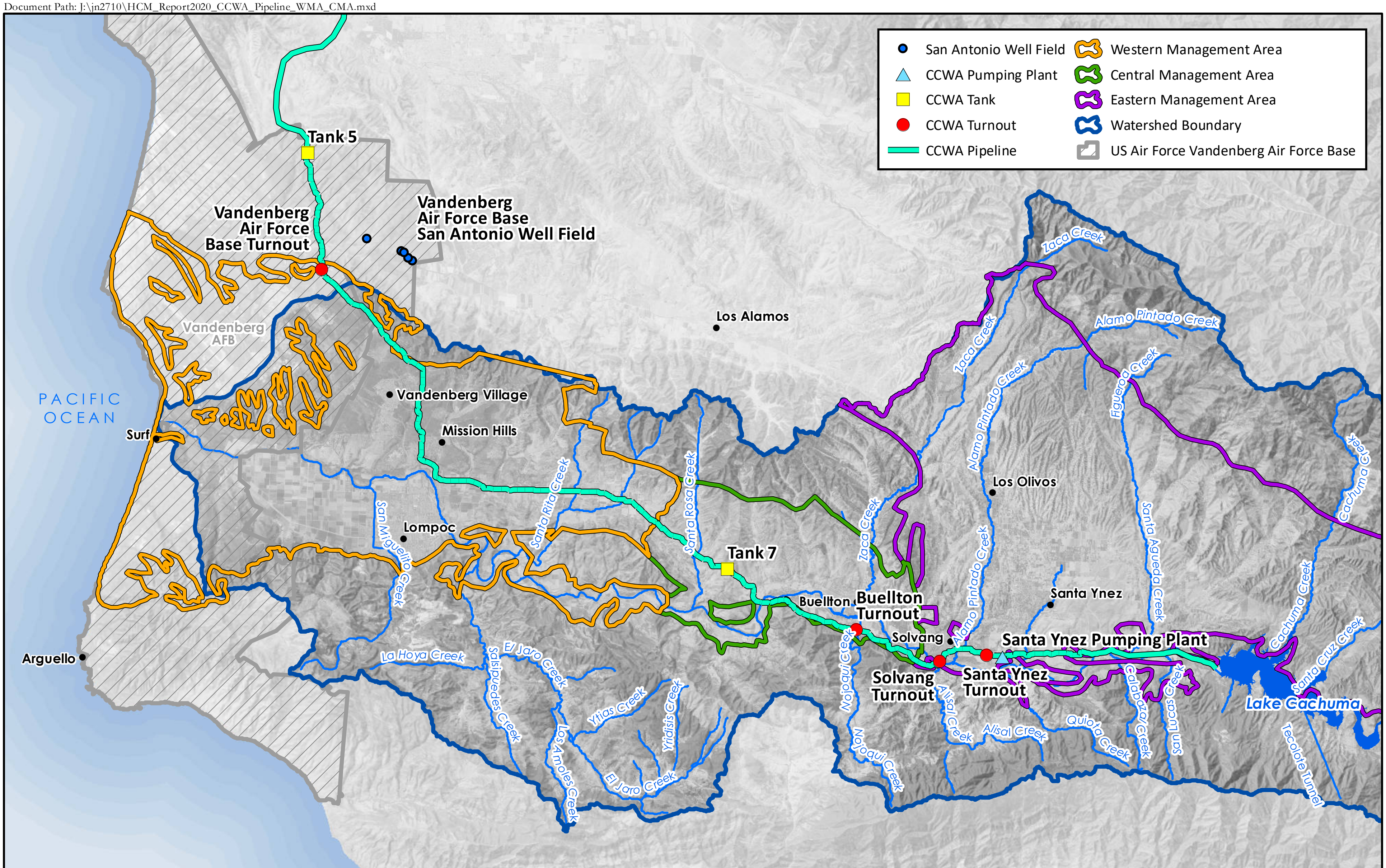
0 1 2 Miles

Sources:
USGS National Elevation Dataset, 2002
National Hydrography Dataset

N

FIGURE 4-5

Document Path: J:\jn2710\HCM_Report2020_CCWA_Pipeline_WMA_CMA.mxd



STETSON ENGINEERS INC.

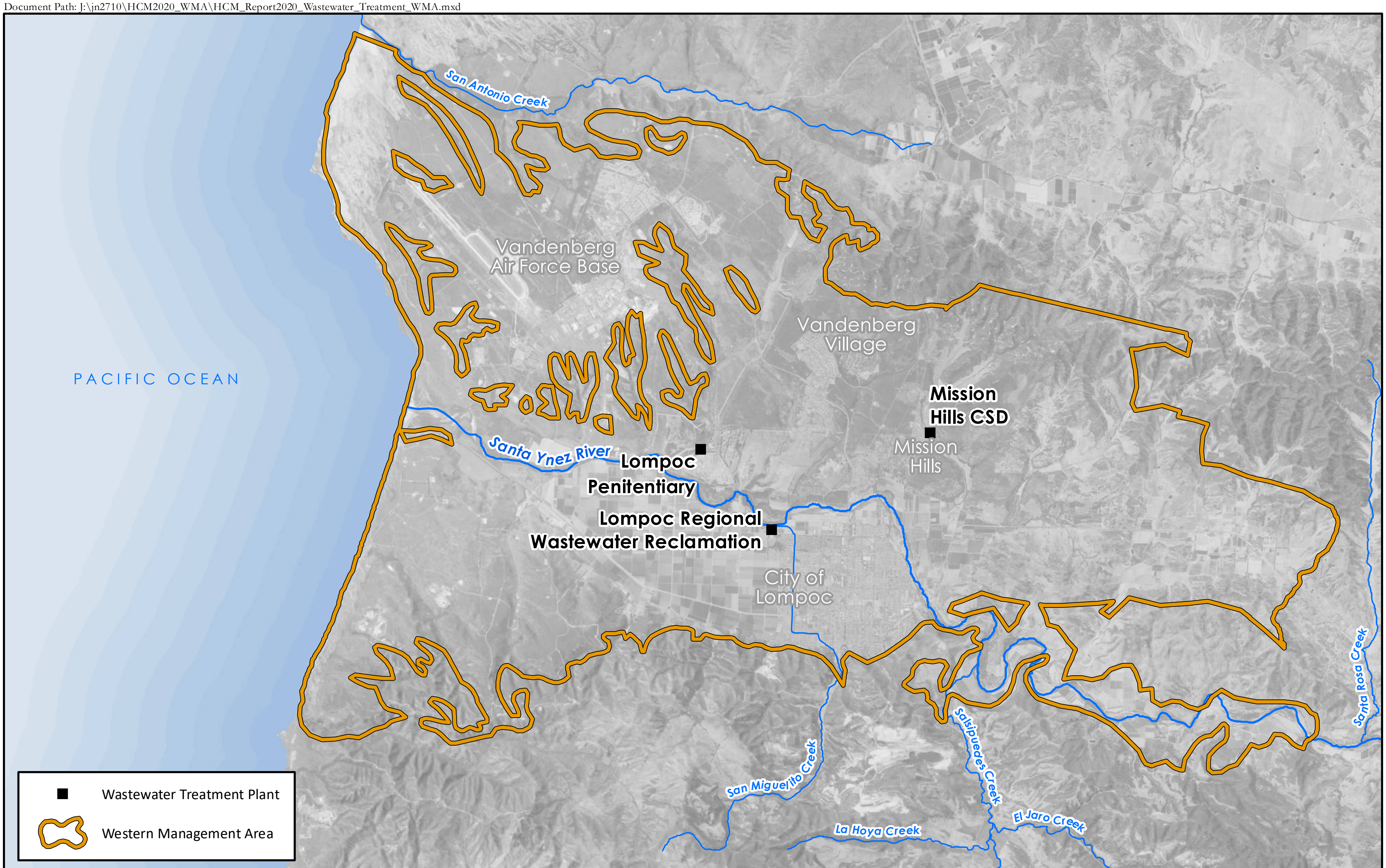
WATER IMPORTS
CCWA PIPELINE AND SAN ANTONIO WELLS
WESTERN AND CENTRAL MANAGEMENT AREAS

DRAFT

Source:
Central Coast Water Authority (CCWA)

FIGURE 4-6

Document Path: J:\jn2710\HCM2020_WMA\HCM_Report2020_Wastewater_Treatment_WMA.mxd



STETSON ENGINEERS INC.

WMA
Santa Ynez River Valley Groundwater Basin
Western Management Area
Groundwater Sustainability Agency

WASTEWATER TREATMENT PLANTS
WESTERN MANAGEMENT AREA

DRAFT

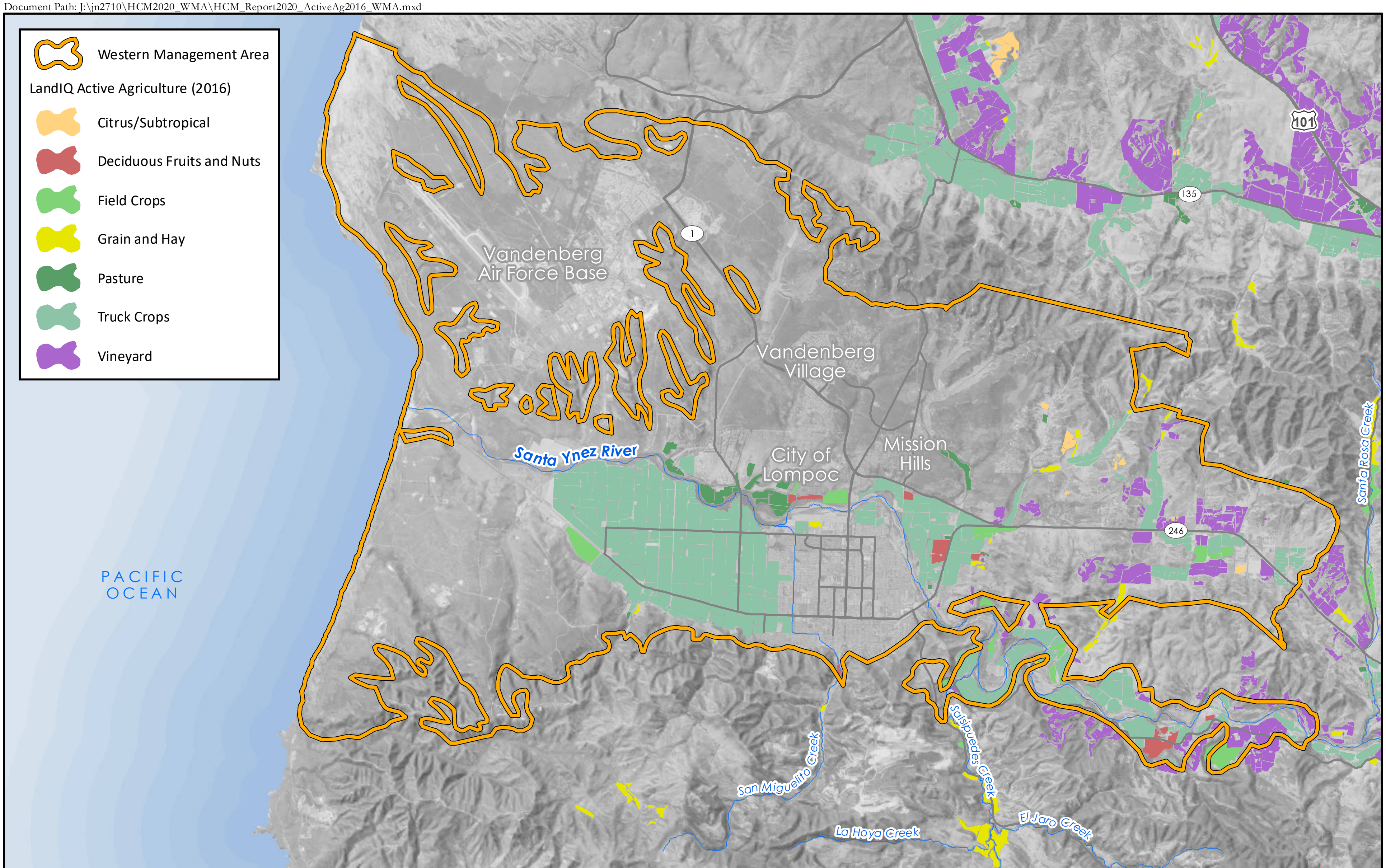
0 1 2 Miles

Sources:
USGS National Elevation Dataset, 2002

N

FIGURE 4-7

Document Path: J:\jn2710\HCM2020_WMA\HCM_Report2020_ActiveAg2016_WMA.mxd



STETSON ENGINEERS INC.

WMA
Santa Ynez River Valley Groundwater Basin
Western Management Area
Groundwater Sustainability Agency

ACTIVE AGRICULTURAL AREA 2016
WESTERN MANAGEMENT AREA

DRAFT

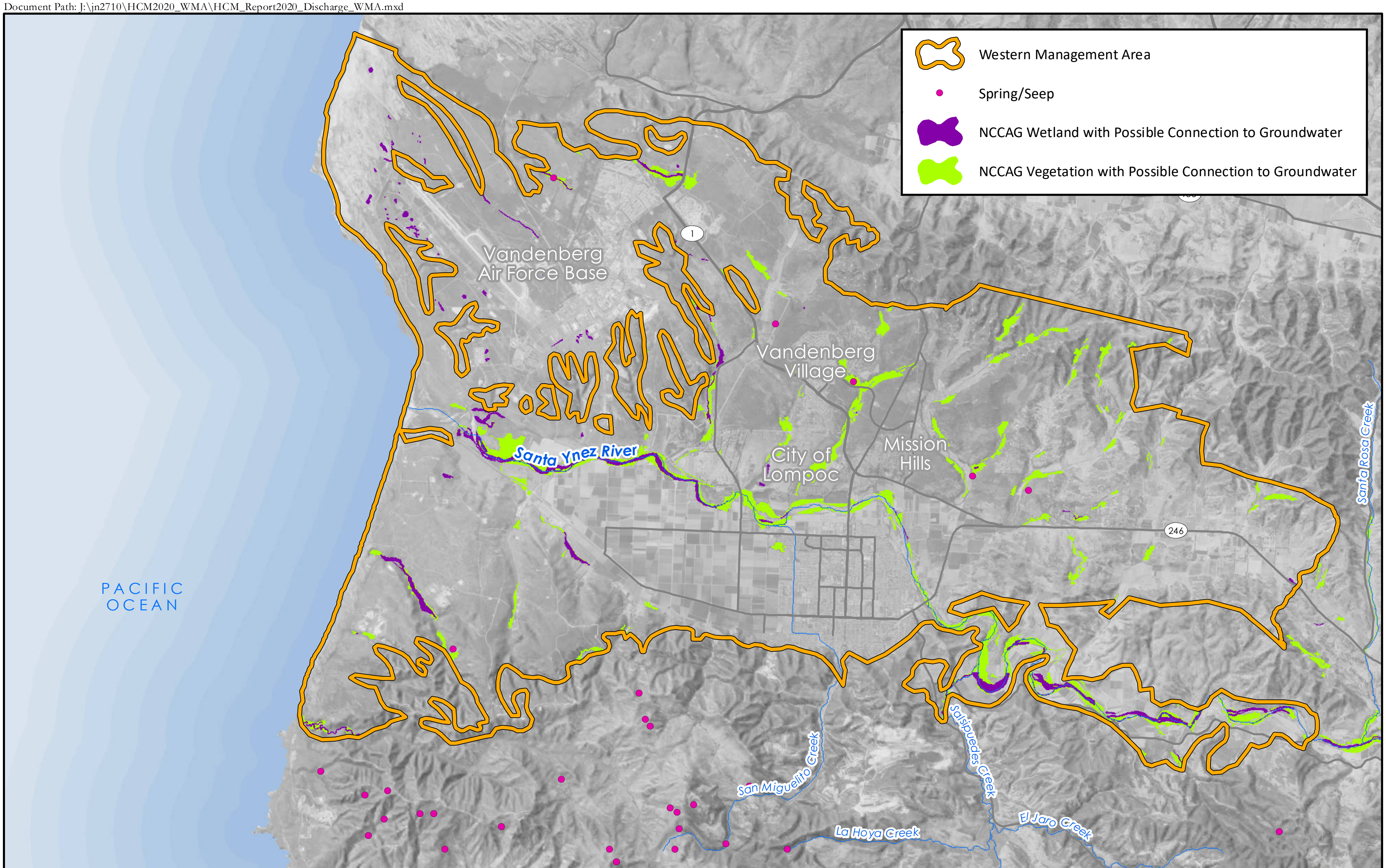
0 1 2 Miles

N

Source:
California Department of Water Resources, LandIQ 2016

FIGURE 5-1

Document Path: J:\jn2710\HCM2020_WMA\HCM_Report2020_Discharge_WMA.mxd



STETSON ENGINEERS INC.

WMA
Santa Ynez River Valley Groundwater Basin
Western Management Area
Groundwater Sustainability Agency

POTENTIAL GROUNDWATER DEPENDENT ECOSYSTEMS AND GROUNDWATER DISCHARGE AREAS

WESTERN MANAGEMENT AREA

DRAFT

0 1 2 Miles

N

Source:
The Natural Communities Commonly Associated with Groundwater (NCCAG) Wetland dataset.

FIGURE 5-2