Draft Atascadero Groundwater Sustainability Plan

Atascadero Groundwater Subbasin Section 4

DRAFT October 2019

Prepared for: Atascadero Subbasin Groundwater Sustainability Agency

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4. Basin Setting

This section describes the hydrogeologic conceptual model of the Atascadero Area Groundwater Sub-basin of the Salinas Valley Basin (Basin), including the Basin boundaries, geologic formations and structures, and principal aquifer units. The section also summarizes general Basin water quality, and generalized groundwater recharge and discharge areas. This section draws upon previously published studies, primarily hydrogeologic and geologic investigations prepared by Fugro for the San Luis Obispo County Flood Control and Water Conservation District (SLOCFCWCD) in 2002 and 2005 and the Atascadero Area Subbasin Basin Boundary Modification Application report (BBMR) (Fugro, 2016). All subsequent investigations, including the BBMR, adopted the geologic interpretations of the Fugro 2002 and 2005 reports. The Hydrogeologic Conceptual Model presented in this section is not intended to be exhaustive but is a summary of the relevant and important aspects of the Basin hydrogeology that influence groundwater sustainability. More detailed information can be found in the original reports (Fugro, 2002 and 2005). This section sets the framework for subsequent sections on groundwater conditions and water budgets.

4.1 Basin Topography and Boundaries

The Basin is a narrow structural northwest-trending trough that extends from the Santa Margarita area at its southern end to the City of Paso Robles in the north. The Basin is bounded by the Santa Lucia Range on the west. The ground surface elevation of the Basin ranges from approximately 1,300 feet above mean sea level (msl) in the highlands at the northern tip of the Basin to approximately 700 feet above msl where the Salinas River exits the Basin to the north. The southern tip of the Basin is approximately 1,000 feet msl. The middle part of the Basin forms an elongate narrow valley along the Salinas River, flanked by areas of variable topographic relief. The Basin encompasses an area of approximately 19,800 acres.

Figure 4-1 shows the topography of the Basin using 100-foot contour intervals. The Basin boundary is defined in California Department of Water Resources (DWR) Bulletin 118 (DWR, 2016). It is generally bounded by geologic units with low permeability, sediments with poor groundwater quality, rock, and structural faults. Along a portion of the northeast boundary, sediments of the Basin are continuous with the adjacent Paso Robles Area Groundwater Sub-basin of the Salinas Valley Basin (Paso Robles Basin). Specific Basin lateral boundaries include the following[1]:

- The northwestern, western, and southern boundaries of the Basin are defined by the contact of Basin sediments with older, relatively impermeable geologic units, including

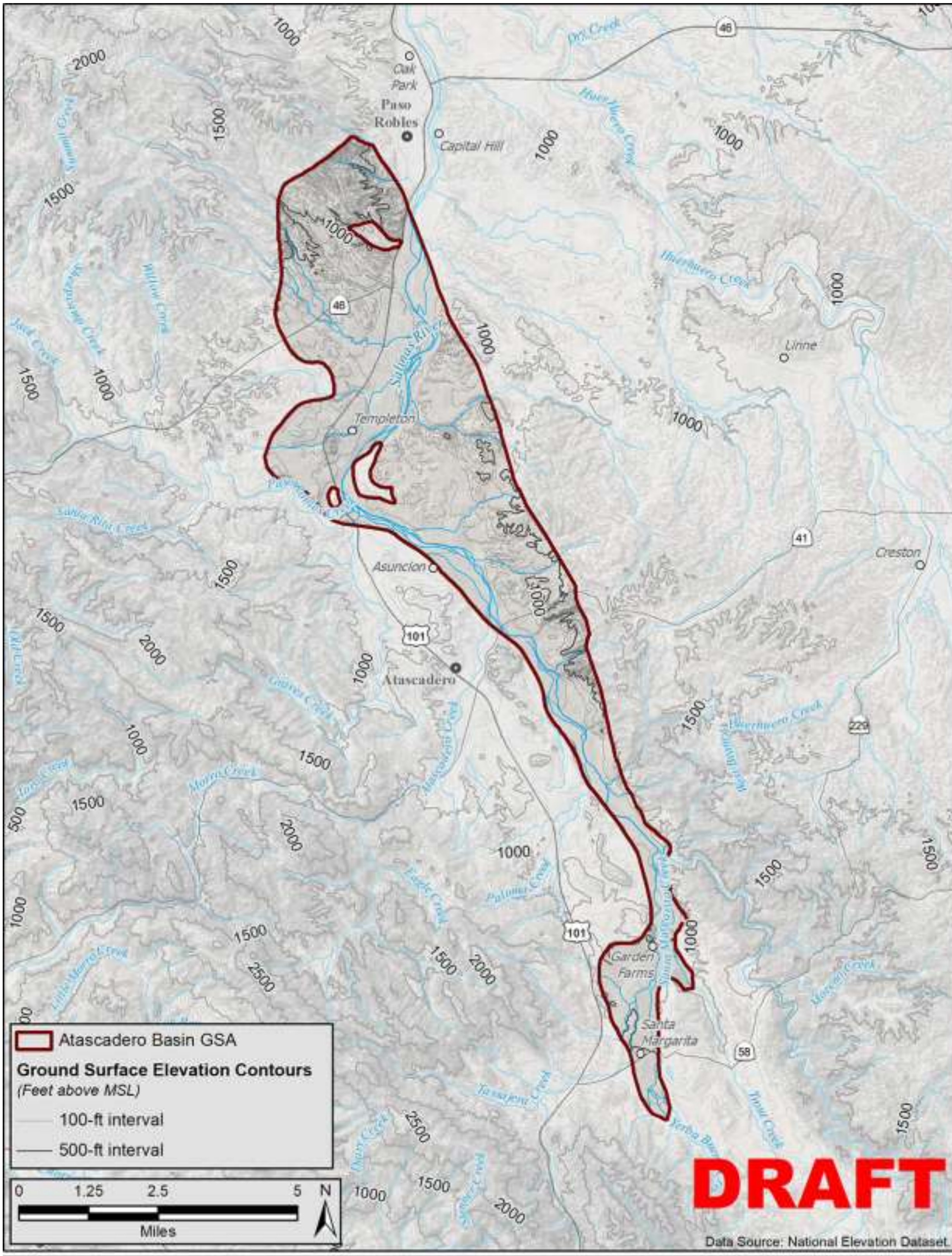
[1] Minor discrepancies between these boundary descriptions and the Bulletin 118 boundary are discussed in Section 4.3

Tertiary-age consolidated sedimentary beds, Cretaceous-age metamorphic rocks, and granitic rock.

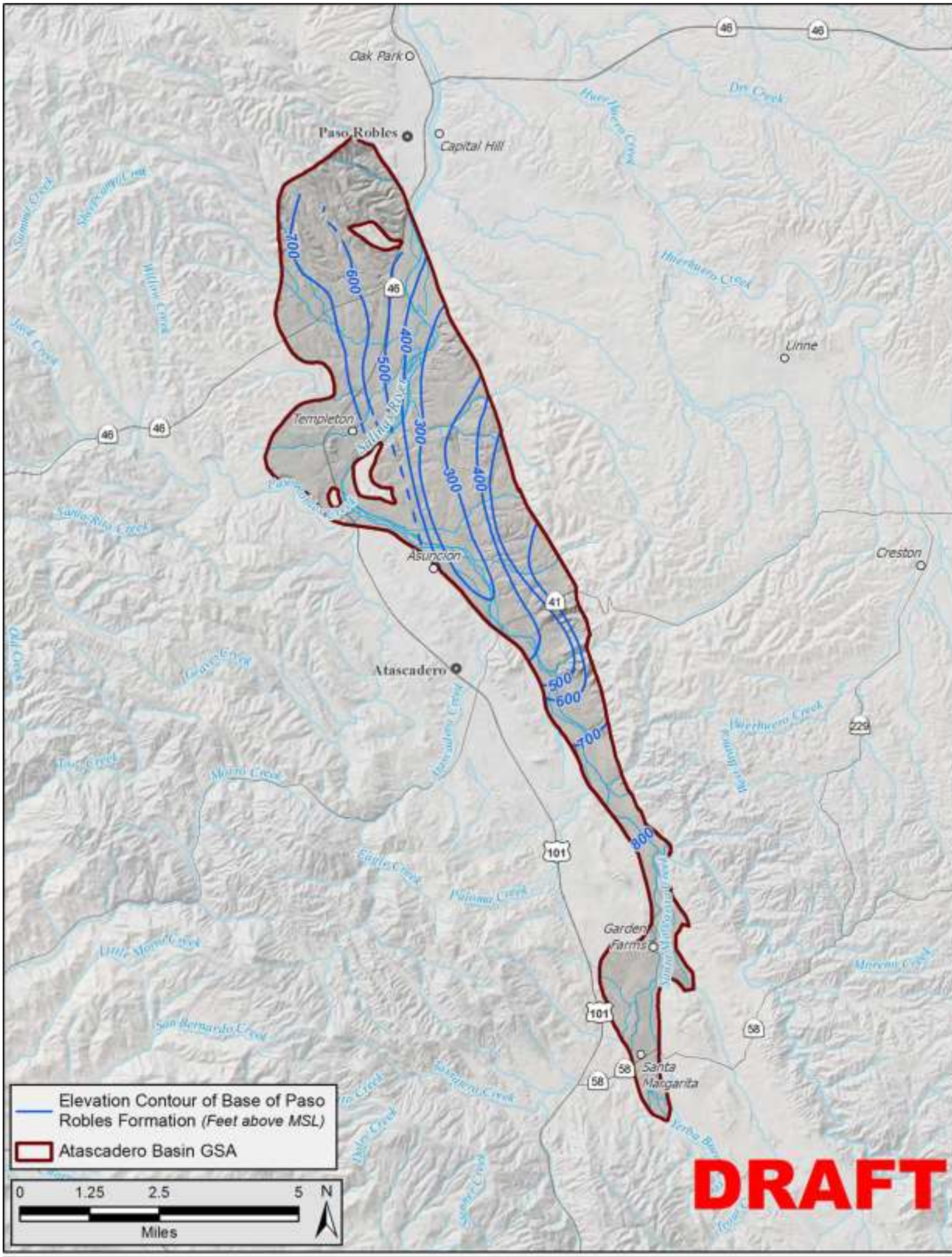
- Along the northern portion of the eastern boundary, north of Templeton, the Rinconada Fault defines the eastern boundary of the Basin and is assumed to form a leaky hydraulic barrier between the Paso Robles Basin and the Basin.

- Along the southern portion of the eastern boundary, south of Templeton, between Atascadero and Creston, the Rinconada Fault juxtaposes Monterey Formation rocks and other bedrock units with the Paso Robles Formation basin sediments.

The bottom of the Basin is generally defined as the base of the Paso Robles Formation, which is an irregular surface formed as the result of folding, faulting, and erosion (Fugro, 2002). The exception to this is the Santa Margarita area at the southern end of the Basin. In this area, the bottom of the Basin is defined as the base of the Alluvium. The Basin boundary and bottom are not considered absolute barriers to flow because some of the geologic units underlying the Paso Robles Formation produce sufficient quantities of water, but the water is generally of poor quality and it is therefore not considered part of the Basin. Figure 4-2 shows the lateral boundaries of the Basin and the approximate depth to the bottom of the Basin as defined by the base of the Paso Robles Formation.



Atascadero Basin Groundwater Sustainability Plan San Luis Obispo County, California	GEI Consultants / GSI Water Solutions, Inc.	Atascadero Basin Topography
Atascadero Basin GSA		OCTOBER 2019 FIGURE 4-1



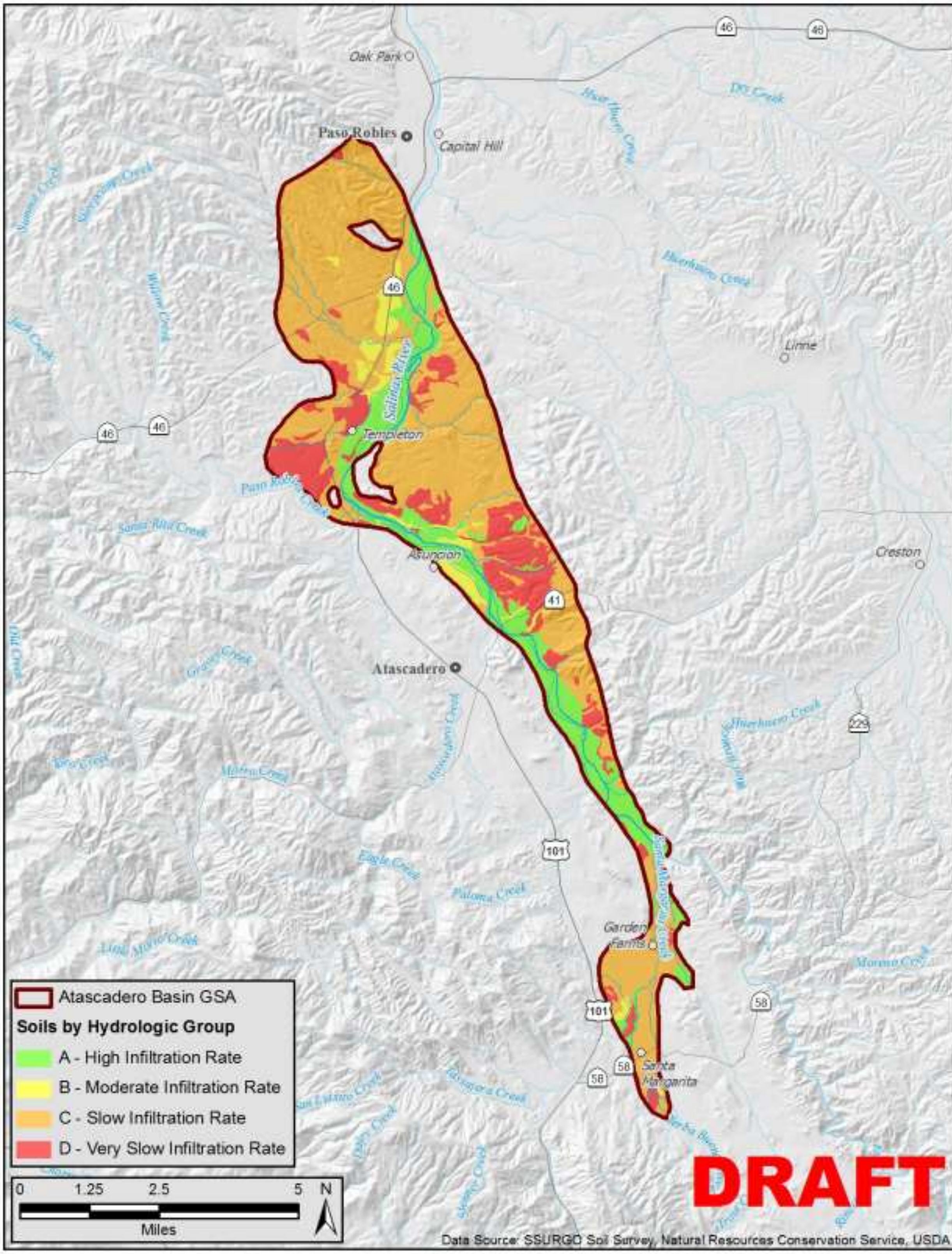
Atascadero Basin Groundwater Sustainability Plan San Luis Obispo County, California	GEI Consultants / GSI Water Solutions, Inc.	Base of the Basin as Defined by the Base of the Paso Robles Formation	
Atascadero Basin GSA		OCTOBER 2019	FIGURE 4-2

4.2 Soils Infiltration Potential

Saturated hydraulic conductivity of surficial soils is a good indicator of the soil's infiltration potential. Soil data from the U.S. Department of Agriculture (USDA) Natural Resources Conservation Service (NRCS) Soil Survey Geographic Database (SSURGO) (USDA NRCS, 2007) is shown by the four hydrologic groups on Figure 4-3. The soil hydrologic group is an assessment of soil infiltration rates that is determined by the water transmitting properties of the soil, which includes hydraulic conductivity and percentage of clays in the soil relative to sands and gravels. The groups are defined as:

- Group A – High Infiltration Rate: water is transmitted freely through the soil; soils typically less than 10 percent clay and more than 90 percent sand or gravel
- Group B – Moderate Infiltration Rate: water transmission through the soil is unimpeded; soils typically have between 10 and 20 percent clay and 50 to 90 percent sand
- Group C – Slow Infiltration Rate: water transmission through the soil is somewhat restricted; soils typically have between 20 and 40 percent clay and less than 50 percent sand
- Group D – Very Slow Infiltration Rate: water movement through the soil is restricted or very restricted; soils typically have greater than 40 percent clay, less than 50 percent sand

The hydrologic group of the soil generally correlates with the hydraulic conductivity of underlying geologic units, with lower soil hydraulic conductivity zones correlating to areas underlain by clayey portions of the Paso Robles Formation. The higher soil hydraulic conductivity zones generally correspond to areas underlain by Alluvium, unsaturated Older Alluvium, or areas of coarser sediments within the Paso Robles Formation.



Atascadero Basin Groundwater Sustainability Plan
San Luis Obispo County, California
Atascadero Basin GSA

GEI Consultants | GSI Water Solutions, Inc.

Atascadero Basin Soil Characteristics
OCTOBER 2019
FIGURE 4-3

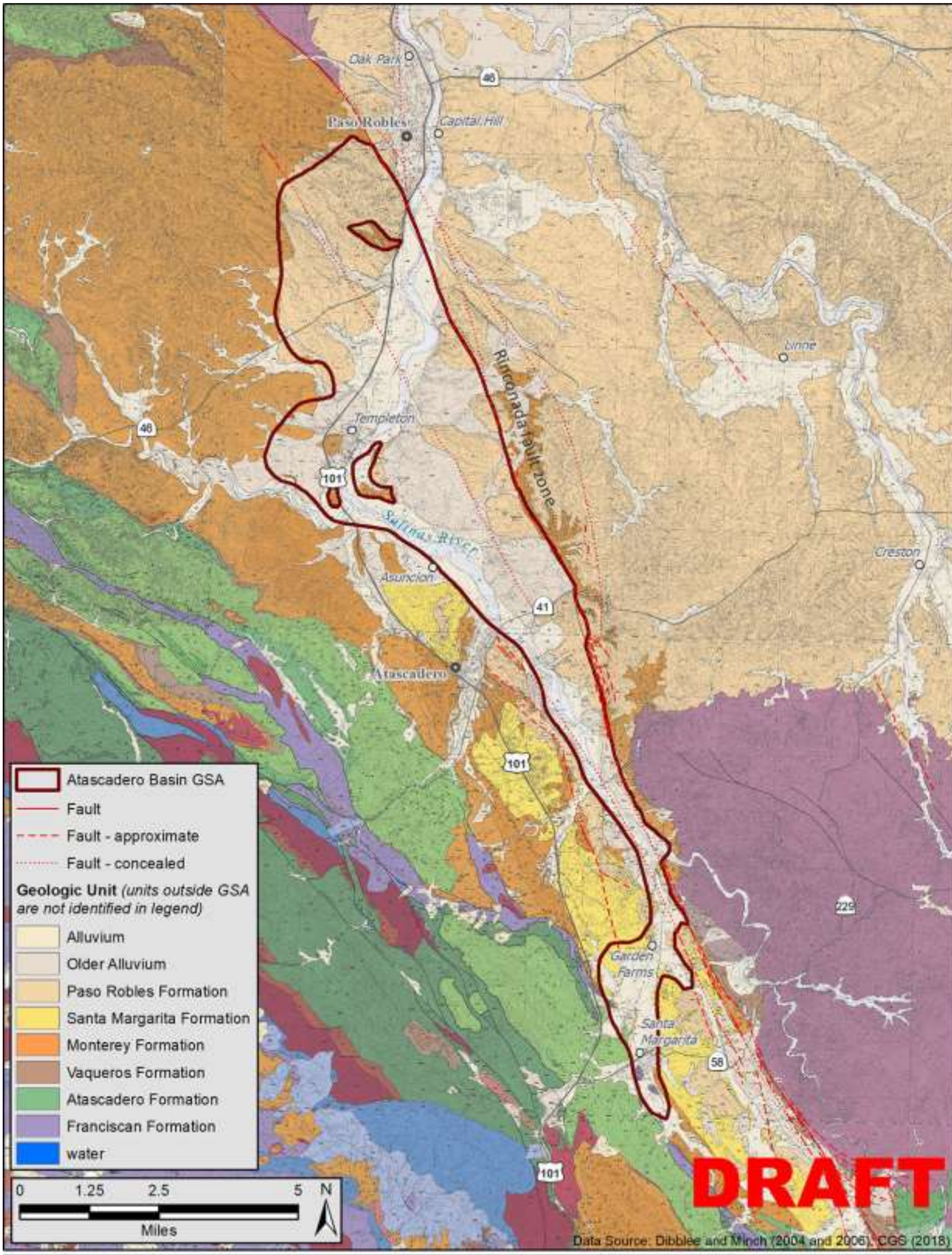
4.3 Regional Geology

This section provides a description of the geologic formations in the Basin. These descriptions are summarized from previously published reports by Fugro (2002 and 2005). Figure 4-4 shows the surficial geology and geologic structures of the Basin (Dibblee and Minch, 2004a,b,c,d,e,f,g,h and 2006a,b,c,d). Figure 4-5 provides the location of the geologic cross-sections shown on Figure 4-6 through Figure 4-10. The selected geologic cross-sections illustrate the relationship of the geologic formations that comprise the Basin and the geologic formations that underlie and bound the Basin. These cross sections shown on Figures 4-6 through 4-9 were directly adopted from the BBMR (Fugro, 2016). The cross section shown on Figure 4-10 includes a majority portion adopted from the BBMR (Fugro, 2016) with an extension of the southern end, completed for this GSP.

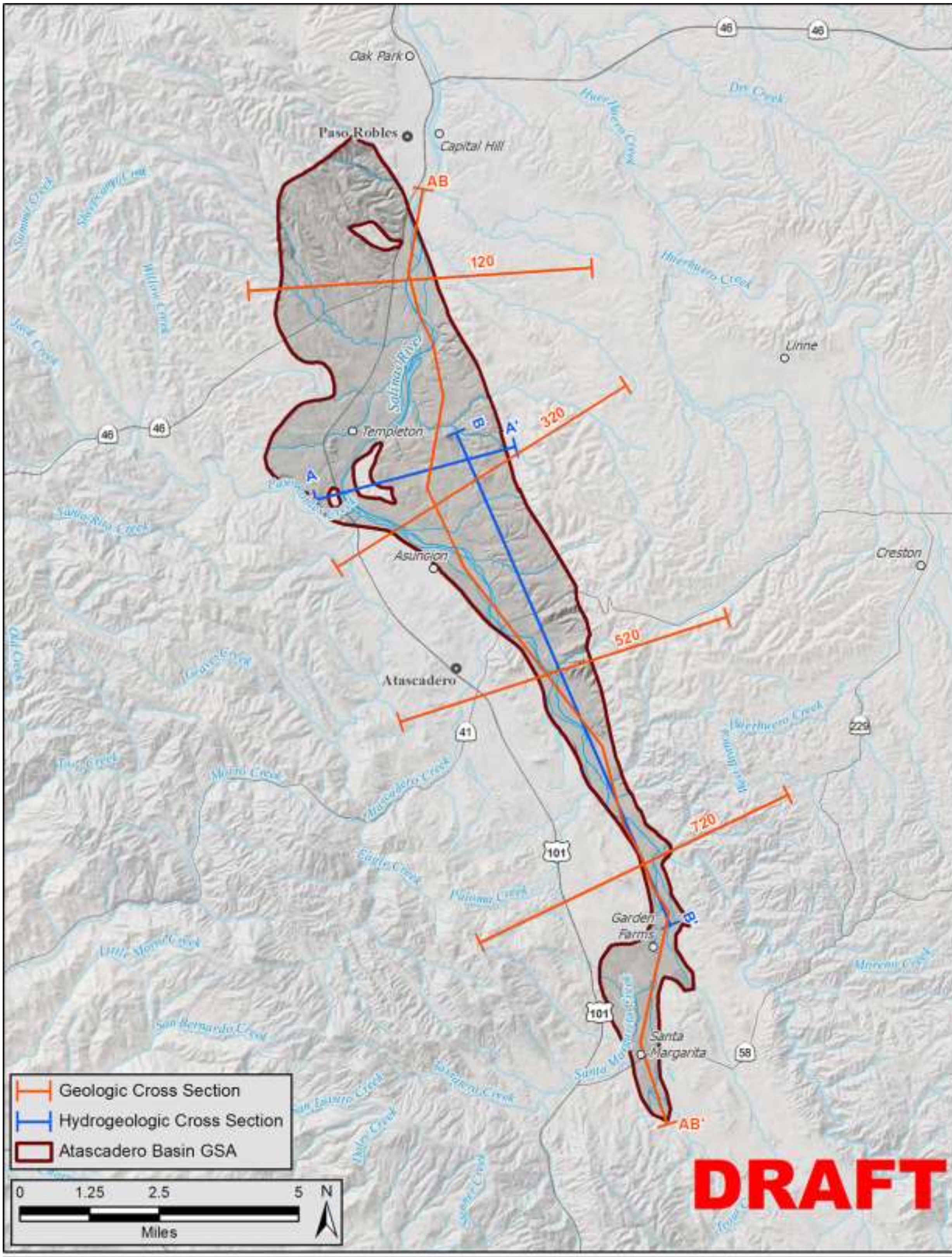
4.3.1 *Regional Geologic Structures*

The Basin is a narrow structural northwest-trending trough filled with sediments that have been folded and faulted by regional tectonics. The Basin is bounded on the west by the Santa Lucia Range. Water-bearing sedimentary deposits in the Basin are estimated to be up to approximately 700- to 800-feet thick. Based on inspection of well logs and the base of permeable sediments, the deepest part of the basin is the area between Templeton and the Rinconada Fault (Fugro, 2002) (Figures 4-2 and 4-10).

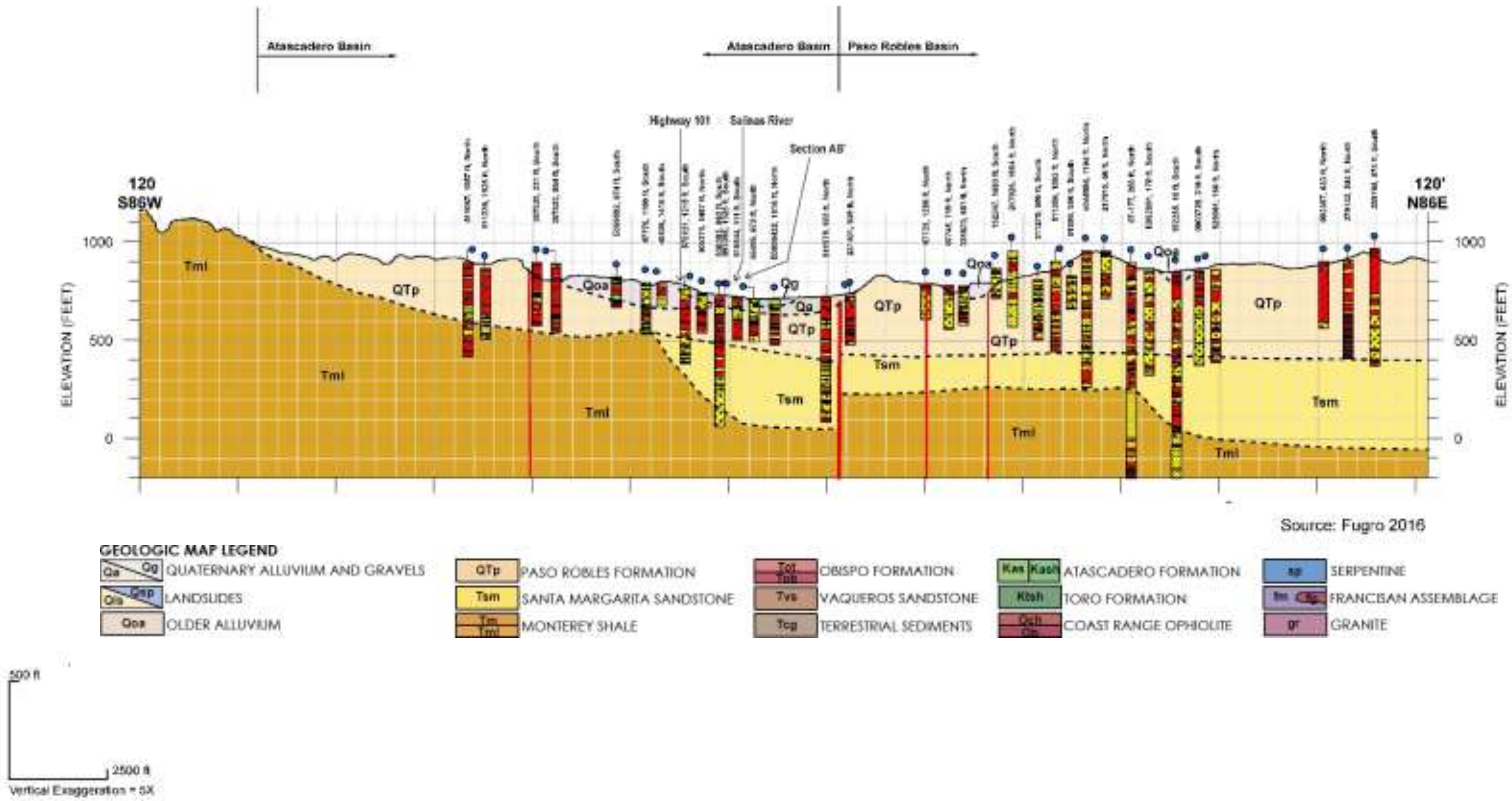
The northwestern, western, and southern boundaries of the Basin are defined by the contact of Paso Robles Formation sediments with older, relatively impermeable geologic units, including Tertiary-age consolidated sedimentary beds, Cretaceous-age metamorphic rocks, and granitic rock. The Rinconada Fault defines the eastern boundary of the Basin and, along the northern portion of the boundary between the Paso Robles Basin and the Basin, is assumed to form a leaky hydraulic barrier. Between Atascadero and Creston, the Rinconada Fault juxtaposes less permeable granitic and Monterey Formation rocks to the east with the Paso Robles Formation basin sediments west of the fault. Dibblee (1976) suggests that vertical displacement along the Rinconada Fault exists, but the data conflict depending on location. In the fault reach along the boundary of the Atascadero Basin, evidence exists to suggest relative uplift of the northeast block. Dibblee (1976) suggests that the earliest displacement since Miocene time was up on the northeast, then up on the southwest in the late Pleistocene. All evidence indicates that horizontal displacement on the fault is right lateral (Dibblee, 1976; Campion, et al, 1983). The Rinconada Fault is not considered active because it does not displace Holocene-age deposits, but it is considered potentially active because it displaces the Quaternary-age Paso Robles Formation.



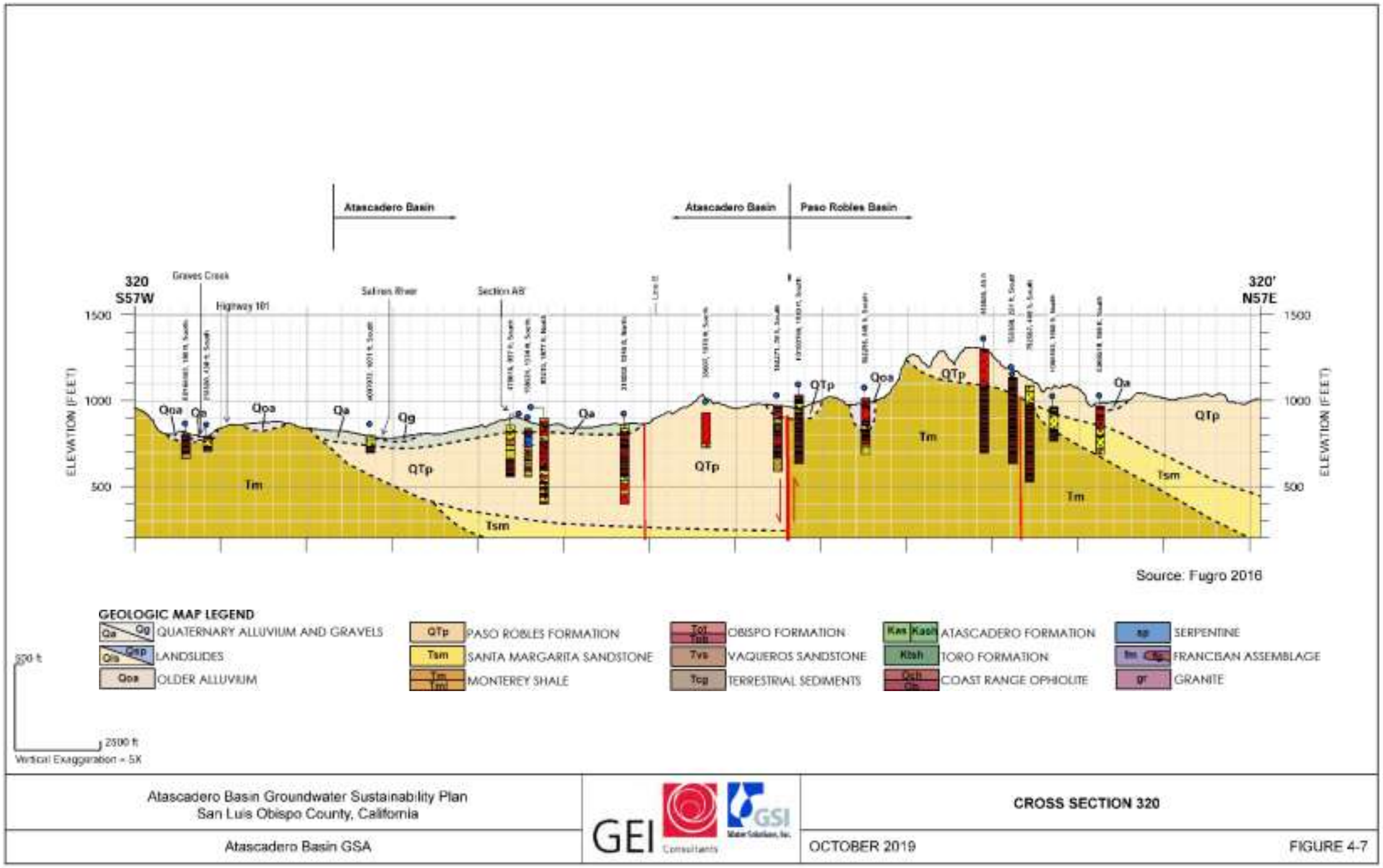
Atascadero Basin Groundwater Sustainability Plan San Luis Obispo County, California	GEI Consultants / GSI Water Solutions, Inc.	Surficial Geology and Geologic Structures	
Atascadero Basin GSA		OCTOBER 2019	FIGURE 4-4

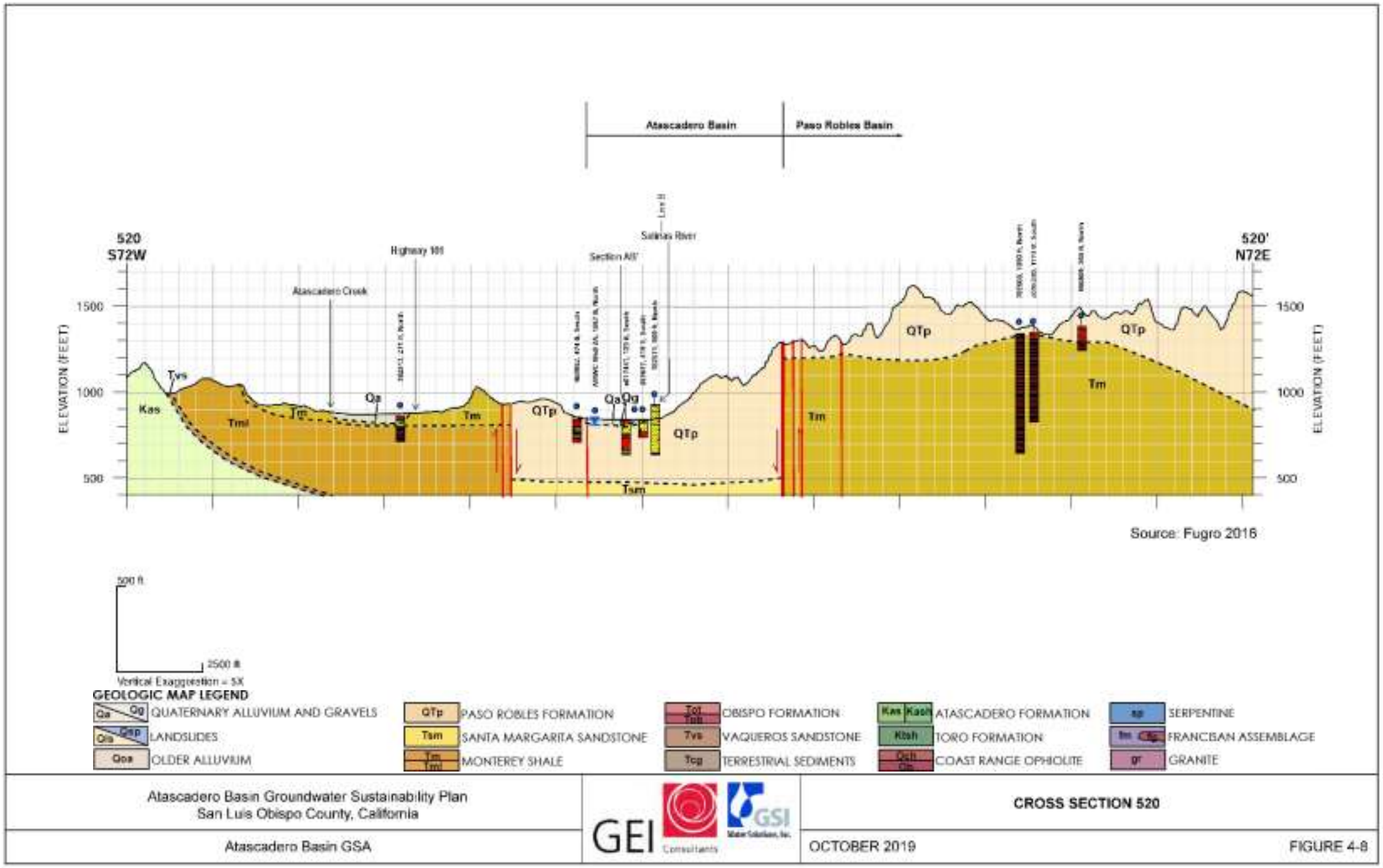


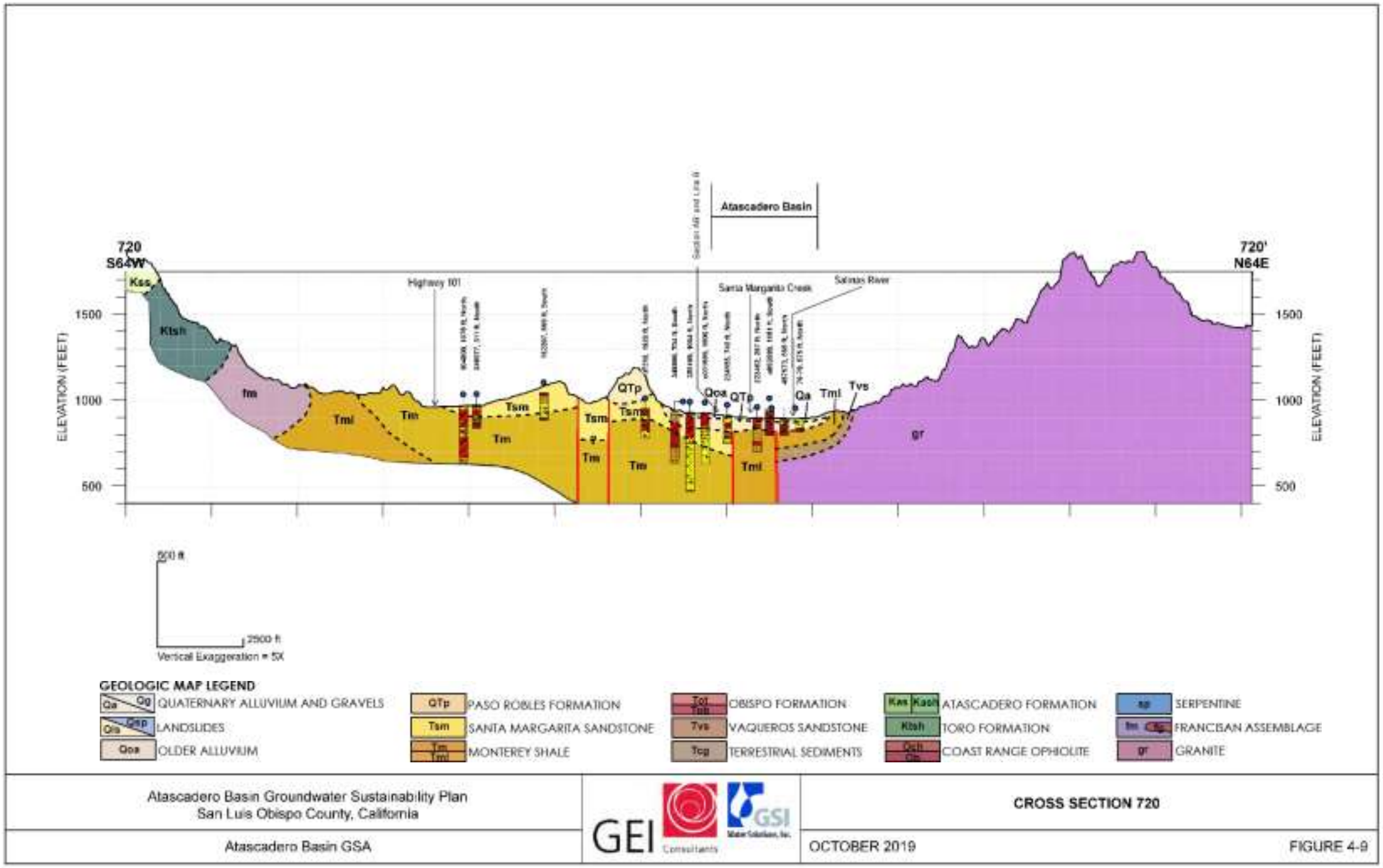
Atascadero Basin Groundwater Sustainability Plan San Luis Obispo County, California	GEI Consultants / GSI Water Solutions, Inc.	Cross Section Locations	
Atascadero Basin GSA		OCTOBER 2019	FIGURE 4-5

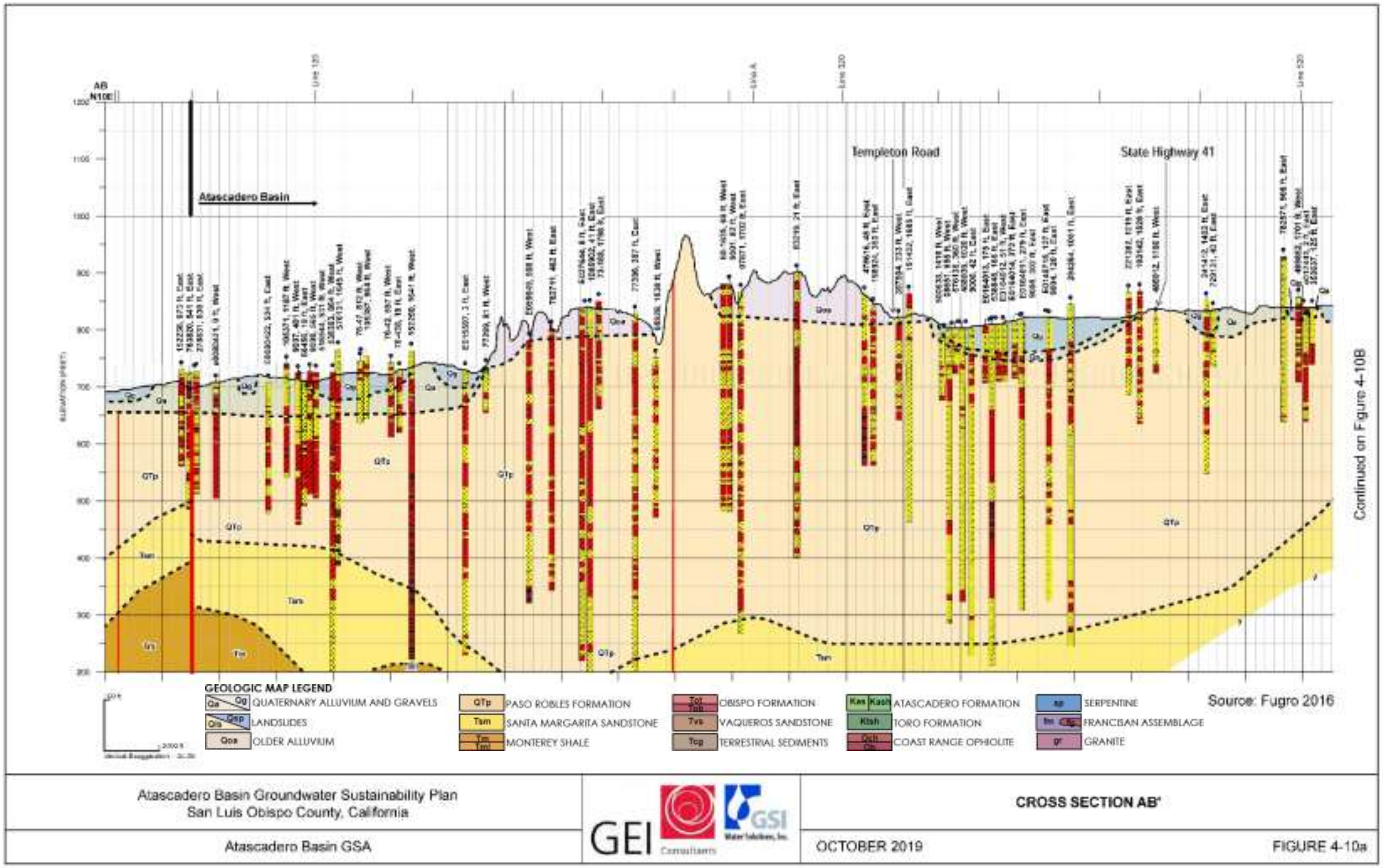


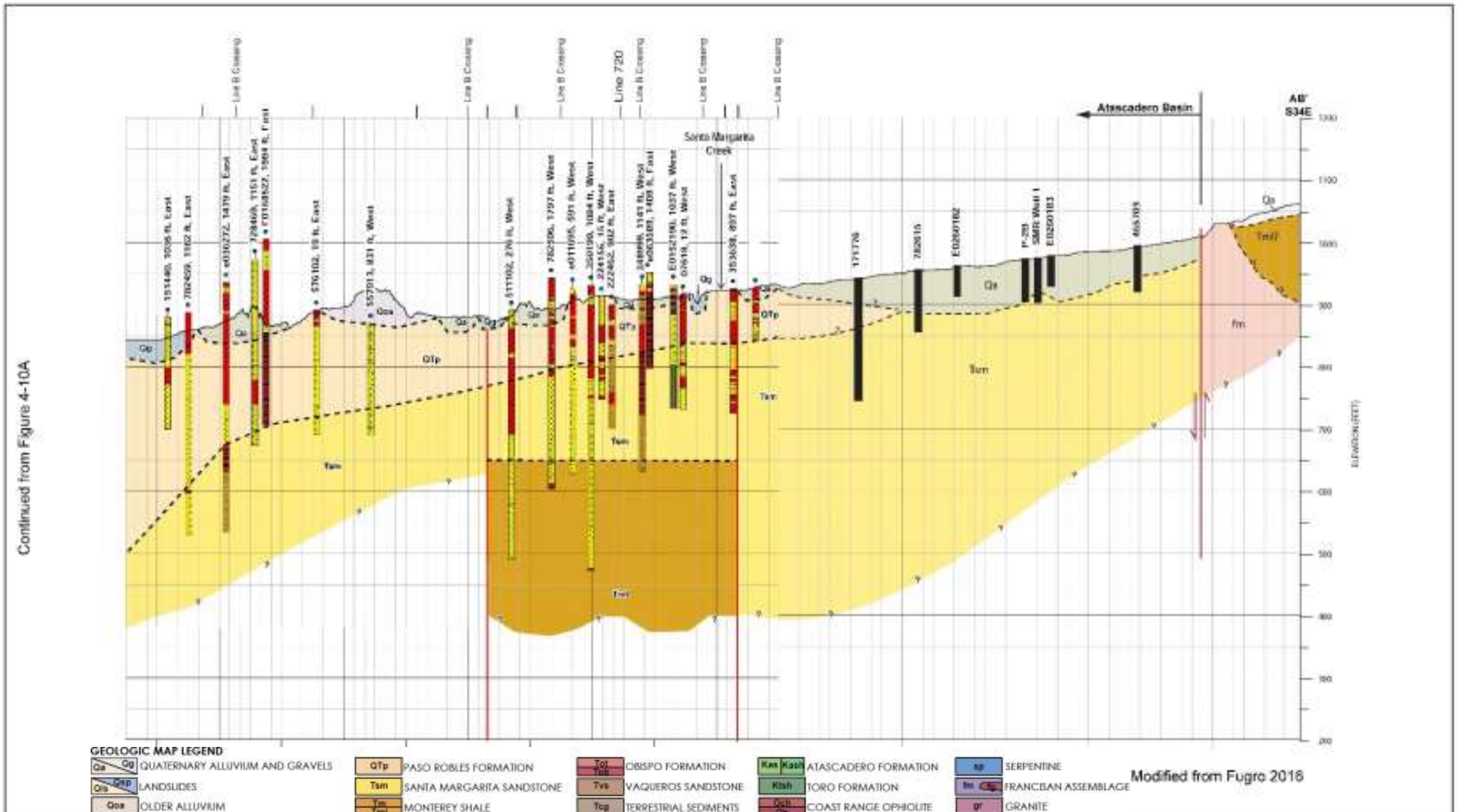
Atascadero Basin Groundwater Sustainability Plan San Luis Obispo County, California	GEI Consultants / GSI Water Solutions, Inc.	CROSS SECTION 120
Atascadero Basin GSA		OCTOBER 2019 FIGURE 4-6


Atascadero Basin
Atascadero Basin
Paso Robles Basin
320
S57W
320'
N57E
Graves Creek
Highway 101
Salinas River
Section AB'
ELEVATION (FEET)
1500
1000
500
Qoa
Qa
Qg
QTp
Tm
Tsm
Source: Fugro 2016
GEOLOGIC MAP LEGEND
QUATERNARY ALLUVIUM AND GRAVELS
LANDSLIDES
OLDER ALLUVIUM
PASO ROBLES FORMATION
SANTA MARGARITA SANDSTONE
MONTEREY SHALE
OBISPO FORMATION
VAQUEROS SANDSTONE
TERRESTRIAL SEDIMENTS
ATASCADERO FORMATION
TORO FORMATION
COAST RANGE OPHIOLITE
SERPENTINE
FRANCISAN ASSEMBLAGE
GRANITE
2500 ft
Vertical Exaggeration = 5X
Atascadero Basin Groundwater Sustainability Plan
San Luis Obispo County, California
Atascadero Basin GSA
CROSS SECTION 320
OCTOBER 2019
FIGURE 4-7


Atascadero Basin
Paso Robles Basin
520
S72W
520'
N72E
Highway 101
Atascadero Creek
Section A/A'
Salinas River
ELEVATION (FEET)
1500
1000
500
QTp
Tm
Tml
Kas
Tvs
Qa
Qg
Tsm
Source: Fugro 2016
500 ft
2500 ft
Vertical Exaggeration = 5X
GEOLOGIC MAP LEGEND
QUATERNARY ALLUVIUM AND GRAVELS
LANDSLIDES
OLDER ALLUVIUM
PASO ROBLES FORMATION
SANTA MARGARITA SANDSTONE
MONTEREY SHALE
OBISPO FORMATION
VAQUEROS SANDSTONE
TERRESTRIAL SEDIMENTS
ATASCADERO FORMATION
TORO FORMATION
COAST RANGE OPHIOLITE
SERPENTINE
FRANCISCAN ASSEMBLAGE
GRANITE
Atascadero Basin Groundwater Sustainability Plan
San Luis Obispo County, California
Atascadero Basin GSA
CROSS SECTION 520
OCTOBER 2019
FIGURE 4-8


Atascadero Basin
720
S64W
720'
N64E
Highway 101
Santa Margarita Creek
Salinas River
ELEVATION (FEET)
1500
1000
500
Kss
Ktsh
fm
Tml
Tm
Tsm
QTp
Qoa
Qa
Tvs
gr
500 ft
2500 ft
Vertical Exaggeration = 5X
GEOLOGIC MAP LEGEND
Qa Qg QUATERNARY ALLUVIUM AND GRAVELS
Qls Qsp LANDSLIDES
Qoa OLDER ALLUVIUM
QTp PASO ROBLES FORMATION
Tsm SANTA MARGARITA SANDSTONE
Tm Tml MONTEREY SHALE
Tor Tob OBISPO FORMATION
Tvs VAQUEROS SANDSTONE
Tcg TERRESTRIAL SEDIMENTS
Kas Kash ATASCADERO FORMATION
Ktsh TORO FORMATION
COAST RANGE OPHIOLITE
sp SERPENTINE
fm FRANCISCAN ASSEMBLAGE
gr GRANITE
Atascadero Basin Groundwater Sustainability Plan
San Luis Obispo County, California
Atascadero Basin GSA
GEI Consultants
GSI Water Solutions, Inc.
CROSS SECTION 720
OCTOBER 2019
FIGURE 4-9


Atascadero Basin
Templeton Road
State Highway 41
Continued on Figure 4-10B
GEOLOGIC MAP LEGEND
QUATERNARY ALLUVIUM AND GRAVELS
LANDSLIDES
OLDER ALLUVIUM
PASO ROBLES FORMATION
SANTA MARGARITA SANDSTONE
MONTEREY SHALE
OBISPO FORMATION
VAQUEROS SANDSTONE
TERRESTRIAL SEDIMENTS
ATASCADERO FORMATION
TORO FORMATION
COAST RANGE OPHIOLITE
SERPENTINE
FRANCISCAN ASSEMBLAGE
GRANITE
Source: Fugro 2016
Atascadero Basin Groundwater Sustainability Plan
San Luis Obispo County, California
Atascadero Basin GSA
CROSS SECTION AB'
OCTOBER 2019
FIGURE 4-10a



Atascadero Basin Groundwater Sustainability Plan San Luis Obispo County, California	GEI Consultants / GSI Water Solutions, Inc.	CROSS SECTION AB'
Atascadero Basin GSA		OCTOBER 2019 / FIGURE 4-10b

4.3.2 *Geologic Formations within the Basin*

The stratigraphy in the watershed of the Basin includes the water-bearing geologic units that form the basin aquifer, and the non-water bearing geologic units that underlie and are adjacent to the basin sediments. Figure 4-4 shows the extent of the geologic formations described in the following paragraphs[2]. Descriptions of the water bearing and some of the non-water bearing geologic formations are provided below, including hydrogeologic characterizations of each formation. In addition, the critical structural features within and bounding the basins are identified.

The main criteria for defining the water bearing geologic formations in the Basin are that they exhibit both sufficient permeability and storage potential for the movement and storage of groundwater such that wells can reliably produce more than 50 gallons per minute (gpm) on a long-term basis (Fugro, 2016). Another criterion is that the groundwater produced from the geologic formation must have generally acceptable quality. DWR (1979) used groundwater conductivity of 3,000 micromhos/centimeter as the maximum limit for basin groundwater quality. Application of these two criteria limits definition of the basin sediments to Quaternary-age alluvial deposits and the Plio-Pleistocene-age Paso Robles Formation.

4.3.2.1 Alluvium

The Alluvium (Qa) consists of alluvial (river or stream-related) deposits occurring beneath the flood plains of the rivers and streams within the Basin. These deposits reach a depth of about 100 feet or less below ground surface (bgs) and are typically comprised of coarse sand and gravel. The Alluvium is generally much coarser than the Paso Robles Formation sediments, with higher permeability that results in well production capability that often exceeds 1,000 gpm. One of the principal areas of groundwater recharge to the basin occur where the shallow alluvial sand and gravel beds are in direct contact with the Paso Robles Formation.

4.3.2.2 Older Alluvium

Numerous deposits of Older Alluvium are located throughout the Basin (Figure 4-4). These deposits are terraces of dissected older alluvial sands and gravels. They are unsaturated and therefore are not considered a principal aquifer unit within the Basin.

[2] Figure 4-4 includes the Basin boundary as defined by DWR Bulletin 118 (Bulletin 118 boundary) (DWR, 2016). As shown on Figure 4-4, the Bulletin 118 boundary does not everywhere include the full lateral extent of Basin sediments (described in Section 4.3.2) and the Bulletin 118 boundary also occasionally includes older, relatively impermeable non-Basin geologic units (described in Section 4.3.3). These discrepancies between the Bulletin 118 boundary and the surficial geology presented in Figure 4-4 are generally minor and may be corrected in a future BBMR.

4.3.2.3 Paso Robles Formation

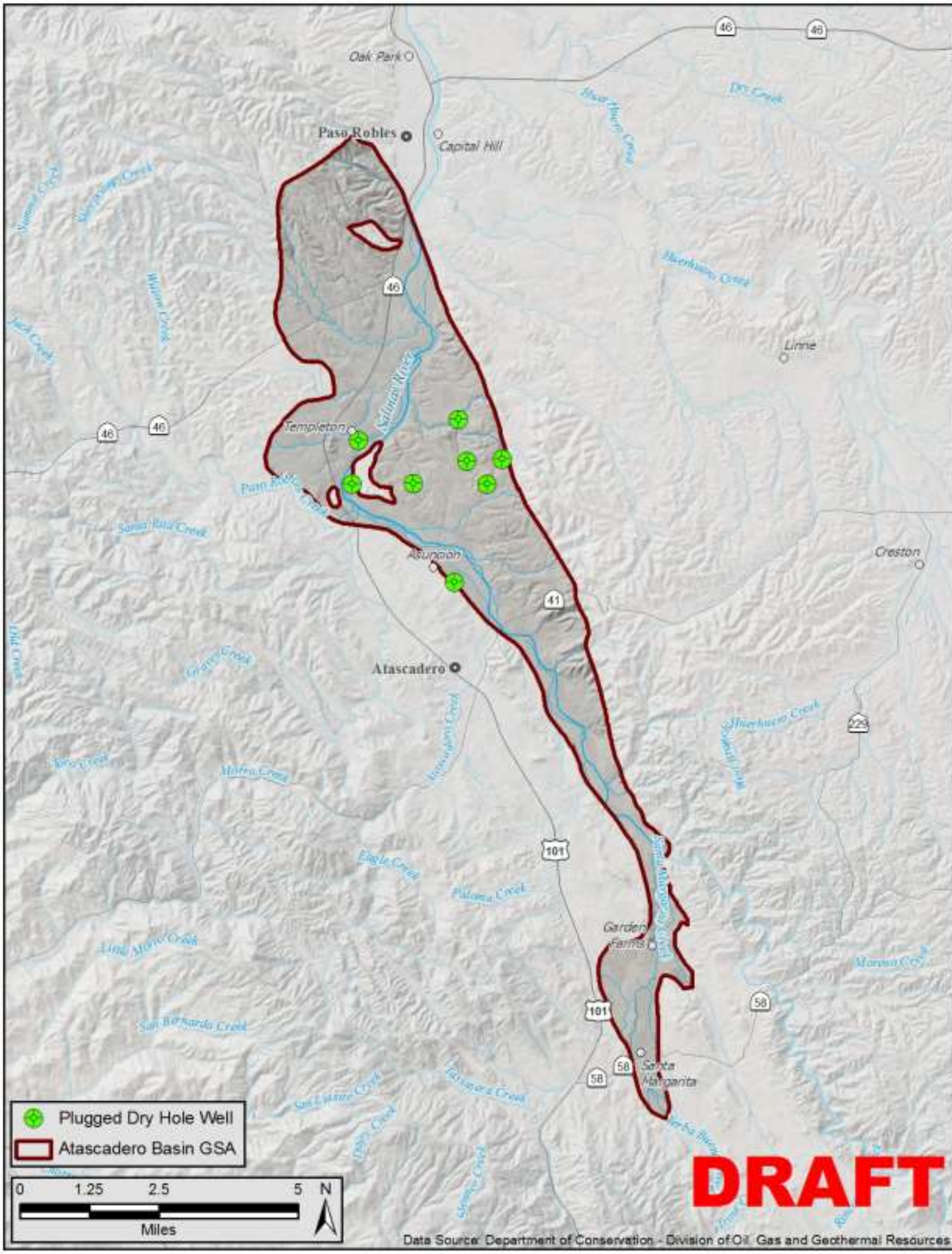
The Basin is comprised predominantly of Paso Robles Formation (QTp) sedimentary layers that extend from the ground surface, or the base of Alluvium, to approximately 700- to 800-feet thick in some areas of the Basin. The Paso Robles Formation is a Plio-Pleistocene, predominantly non-marine geologic unit comprised of relatively thin, often discontinuous sand and gravel layers interbedded with thicker layers of silt and clay. It was deposited in alluvial fan, flood plain, and lake depositional environments. Seashells are reported in some well logs near the base of the Paso Robles Formation, suggesting a near-shore marine depositional environment. The formation is unconsolidated and generally poorly sorted. It is not usually intensely deformed, except locally near fault zones. The sand and gravel beds within the unit have a high percentage of Monterey shale gravel fragments and generally have moderately lower permeability compared to the shallow, unconsolidated alluvial sand and gravel beds. The formation is typically sufficiently thick such that water wells generally produce several hundred gpm. In the area near Atascadero, the Paso Robles Formation has been folded, exposing the basal gravel beds. With the basal gravel exposed and in direct contact with the shallow alluvium, the Paso Robles Formation is recharged directly from the river alluvium (Fugro, 2016).

4.3.3 *Geologic Formations Surrounding the Basin*

Underlying the Basin sedimentary beds are older geologic formations that typically have lower permeability and/or porosity. In some cases, these older beds occasionally yield flow in excess of 50 gpm to wells, but wells drilled into these units are also often dry or produce groundwater less than 10 gpm. Generally, the water quality from the bedrock units is poor. In general, the geologic units underlying the basin include Tertiary-age consolidated sedimentary beds, Cretaceous-age metamorphic rocks, and granitic rock.

Figure 4-11 shows the location of oil and gas exploration wells drilled in the Basin. All of these oil and gas exploration wells were dry holes that were subsequently plugged. These oil and gas wells help identify the depth and extent of the geologic formations that surround and underlie the Basin.

The Tertiary-age older consolidated sedimentary formations include the Santa Margarita Formation, the Monterey Formation, and the Vaqueros Formation. These units crop out predominantly on the western edge of the Basin (Figure 4-4) and underlie the basin sediments.



Atascadero Basin Groundwater Sustainability Plan San Luis Obispo County, California	GEI Consultants / GSI Water Solutions, Inc.	Oil and Gas Wells in Atascadero Basin	
Atascadero Basin GSA		OCTOBER 2019	FIGURE 4-11

4.3.3.1 Santa Margarita Formation

The Santa Margarita Formation (Tsm) is an upper Miocene-age marine deposit, consisting of a white, fine-grained sandstone and siltstone with a thickness of up to 1,400 feet regionally. The unit is found beneath most of the basin. The Santa Margarita Formation crops out in the Santa Margarita area where many domestic water wells depend on its very limited flow capabilities. It is also a host to a number of springs. South of Templeton, water produced from the Santa Margarita Formation is often of acceptable water quality. However, north of Templeton in the area south of the City of Paso Robles, the unit becomes progressively more permeable and is the main reservoir for the historical presence of geothermal water. Groundwater in the geothermal areas is often under pressure and artesian flow is a common occurrence, with flow rates at times exceeding 400 gpm. The Santa Margarita Formation aquifer is not considered part of the Basin because the produced water quality is usually very poor and because it is relatively impermeable in many areas in the vicinity of the Basin. The geothermal waters contained in the Santa Margarita Formation in this area are often highly mineralized and characterized by elevated boron concentrations that restrict agricultural uses.

4.3.3.2 Monterey Formation

The Miocene-age Monterey Formation (Tm/Tml) consists of interbedded argillaceous and siliceous shale, sandstone, siltstone, and diatomite. The unit outcrops in the highlands surrounding the Basin and generally forms the adjacent bedrock unit, stratigraphically below the Paso Robles Formation, on the western edge of the Basin. Regionally, the unit thickness is as great as 2,000 feet, and the unit is often highly deformed. Water wells completed in the Monterey Formation are occasionally productive if a sufficient thickness of highly deformed and brittle siliceous shale is encountered. More often, however, the Monterey shale produces groundwater to wells in very low quantities. Springs issue from the Monterey Formation in the Atascadero area and on Cuesta Ridge south of the Basin. North of the Basin, the Monterey Formation can also be a source for oil in the area near Hames Valley, downstream of Lake San Antonio, and in upper Indian Valley. Groundwater produced from the Monterey Formation often has high concentrations of hydrogen sulfide, total organic carbon, and manganese. In the Paso Robles area, the Monterey Formation may be a host to geothermal water that has high sulfide concentrations in addition to high boron, iron, manganese, and total dissolved solids.

4.3.3.3 Vaqueros Formation

The marine Oligocene-age Vaqueros Formation (Tv) is a highly cemented fossiliferous sandstone that reaches a thickness up to 200 feet. Springs with flows up to 25 gpm are common in canyons where the Vaqueros Formation is exposed in the Santa Lucia Range. Most water wells tapping this formation produce less than 20 gpm. Generally, the quality of water in this unit is good, though hard due to the calcareous cement within the rock.

4.3.3.4 Metamorphic and Granitic Rocks

Portions of the southern and eastern edges of the Basin are bordered by Cretaceous-age metamorphic and granitic rock. The metamorphic rock units include the Franciscan, Toro, and Atascadero formations. The Franciscan Formation (fm) consists of discontinuous outcrops of shale, chert, metavolcanics, graywacke, and blue schist, with or without serpentinite. The Franciscan Formation has an undetermined thickness and has low permeability and porosity. Limited volumes of groundwater can be produced from this geologic unit, generally only where the metavolcanics rock has been highly fractured.

The Toro Formation (Ktsh) is a highly consolidated claystone and shale that does not typically yield significant water to wells. The Atascadero Formation (Kas) is highly consolidated but does have some sandstone beds that yield limited amounts of water to wells. Both the Toro and Atascadero formations are exposed in the Santa Lucia Range west of Santa Margarita, Atascadero, and Templeton.

The granitic rock (gr) lies east of the Rinconada Fault zone, east of the City of Atascadero. The Park Hill area south of Creston and east of Atascadero is well known for the difficulty of finding sufficient groundwater to serve single residences. Where water is found, it is typically low in salinity. The granitic rocks often have a decomposed regolith up to 80 feet in thickness in the valley floor areas that may contain limited amounts of groundwater despite low sediment permeability due to the breakdown of feldspar and iron and magnesium silicates into clays and fine-grained sediment. Springs are occasionally found where the rock is fractured.

4.4 Principal Aquifers and Aquitards

Water-bearing sand and gravel beds that may be laterally and vertically discontinuous are generally grouped together into zones that are referred to as aquifers. The aquifers can be vertically separated by fine-grained zones that can impede movement of groundwater between aquifers. Two aquifers exist in the Basin:

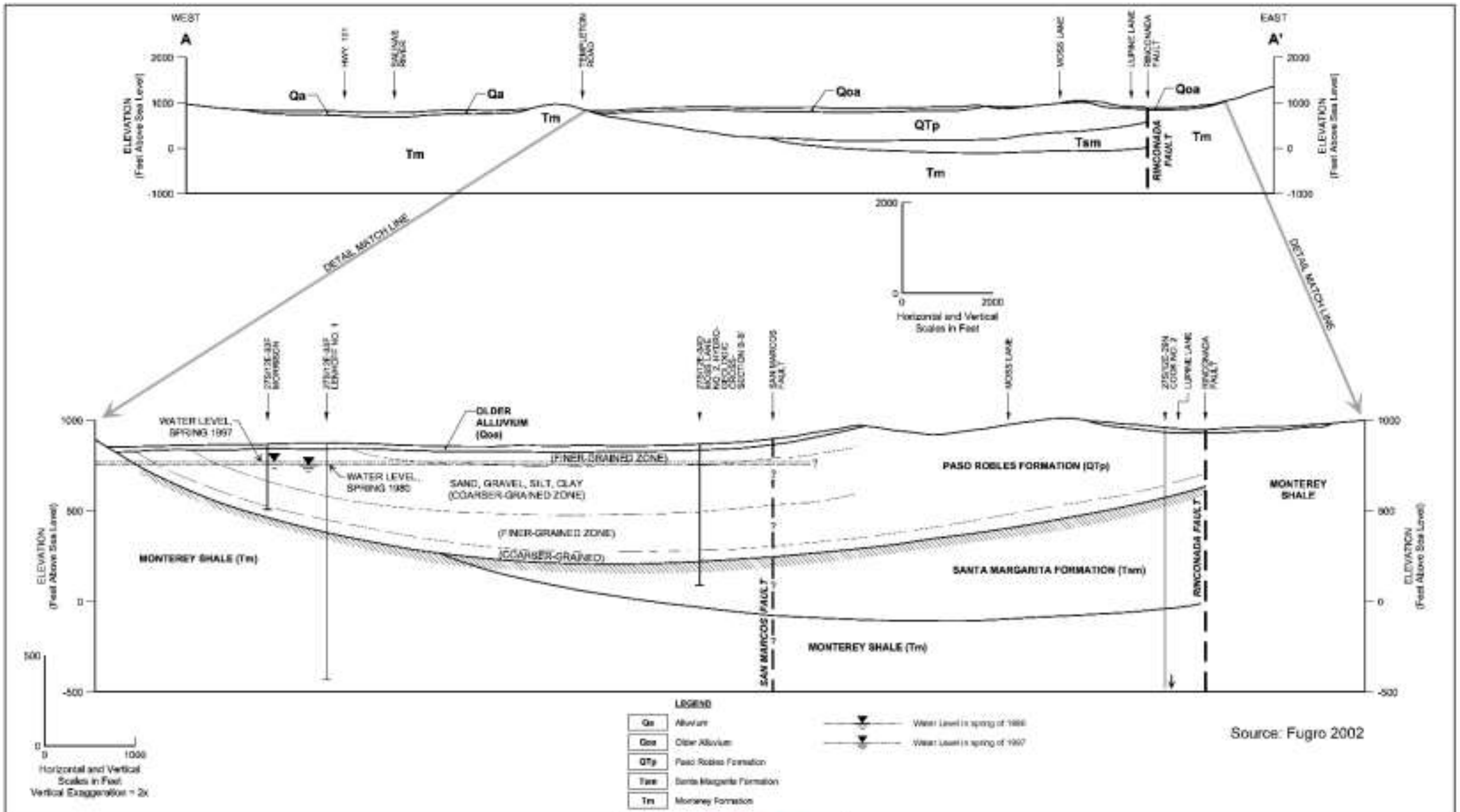
- **Alluvial Aquifer** – A relatively continuous aquifer comprising alluvial sediments that underlie the Salinas River and tributary streams;
- **Paso Robles Formation Aquifer** – An interbedded aquifer comprised of sand and gravel lenses in the Paso Robles Formation.

There are no formally defined or laterally continuous aquitards within the Basin. However, the upper portions of the Paso Robles Formation often contain thin, discontinuous clay layers interbedded with sand and “shale gravels” that can act as a leaky confining layer. These upper clay layers are generally pervasive throughout the Basin. In the Templeton area from Graves Creek to approximately Highway 46, the contact between the Alluvial Aquifer and the Paso Robles Formation Aquifer is characterized by a thick (60 feet) clay-rich aquitard that forms a hydraulic barrier to vertical groundwater flow, effectively separating the Alluvial Aquifer from the Paso Robles Formation Aquifer (Torres, 1979). Two areas where the Paso Robles Formation Aquifer is known to be in direct communication with the overlying Alluvial Aquifer, that is, there is little to no clay-rich confining layer, include:

1. The Atascadero area, along the Salinas River corridor from approximately the Highway 41 crossing downstream to the confluence with Paso Robles Creek ("Jack Creek"), and

2. The area north of Templeton, along the Salinas River corridor from approximately the junction of Highway 46 and US Highway 101 north to the Rinconada Fault.

Figure 4-5 shows the location of hydrogeologic sections that were used to depict the aquifers in the subsurface. Figure 4-12 and Figure 4-13 show the aquifers in profile, which are interpreted from the geologic logs, geophysical logs, groundwater levels, and water quality (Fugro, 2002 and 2005).



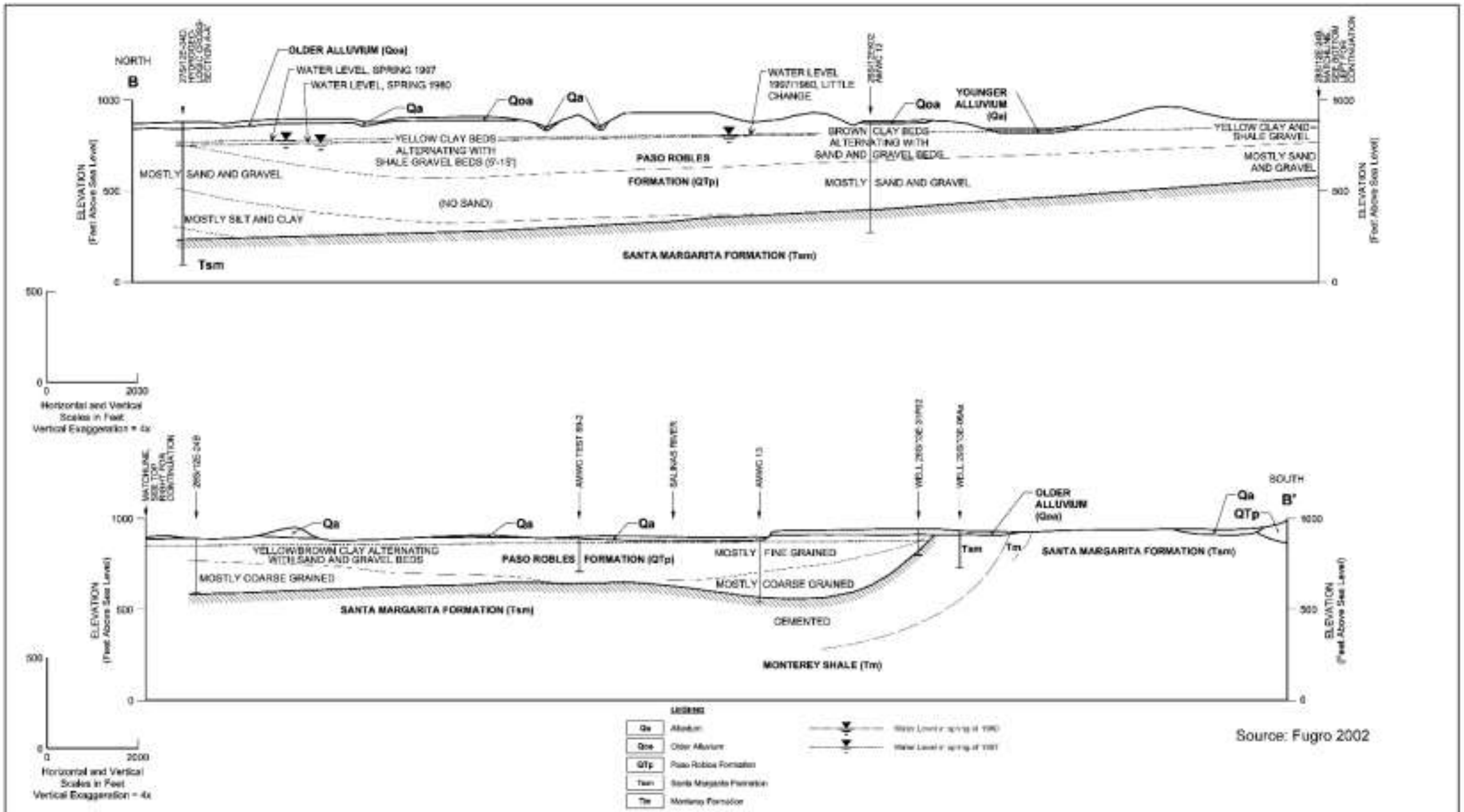
Atascadero Basin Groundwater Sustainability Plan
San Luis Obispo County, California

Atascadero Basin GSA

HYDROGEOLOGIC SECTION A

OCTOBER 2019

FIGURE 4-12



Atascadero Basin Groundwater Sustainability Plan San Luis Obispo County, California	GEI Consultants / GSI Water Solutions, Inc.	HYDROGEOLOGIC SECTION B
Atascadero Basin GSA		OCTOBER 2019 — FIGURE 4-13

4.4.1 *Aquifer Characteristics*

Fugro (2002) reviewed the results of several pumping tests performed on wells completed in the Alluvial Aquifer and the Paso Robles Formation Aquifer throughout the Basin. The aquifer characteristics of each unit are summarized below, and presented in Table 1.

4.4.1.1 Alluvial Aquifer

Water wells penetrating and extracting groundwater from the Alluvial Aquifer are located along the Salinas River and its tributaries, including within the Santa Margarita area. The unit, consisting almost entirely of sand and gravel, is everywhere unconfined with high to very high transmissivity values. The thickness of the Alluvium ranges widely, with an estimated maximum thickness of 75 to 90 feet. Specific capacity values for wells in the Alluvium range from 20 to 60 gallons per minute per foot (gpm/ft) at production rates as high as 1,000 gpm (Fugro, 2002) (Table 1). Overall, within the Basin, the geometric mean hydraulic conductivity of the Alluvial Aquifer is estimated at 481 ft/day (Fugro, 2002).

4.4.1.2 Paso Robles Formation Aquifer

In the Atascadero area and the area north of Templeton, the Paso Robles Formation Aquifer underlies and is in direct hydraulic contact with the Alluvial Aquifer along the Salinas River channel. Wells in the Paso Robles Formation Aquifer in hydraulic communication with the overlying Alluvium tend to have higher transmissivity values than wells that penetrate the portions of the Paso Robles Formation not in contact with the Alluvium. Constant discharge aquifer pumping tests for wells in Atascadero on the west side of the Salinas River showed production rates up to 1,300 gpm, with an average specific capacity of 15 gpm/ft (Fugro, 2002) (Table 1).

Elsewhere in the Basin the upper 300 feet or so of the Paso Robles Formation is characterized by thin (5 feet to 15 feet thick) interbedded brown or yellow clays with sand and "shale gravel", as described above. The beds tend to be thicker below 300 feet, with an increasing proportion of sand and gravel. The results of several controlled aquifer pumping tests were reviewed for wells in the Paso Robles Formation Aquifer, including wells in both the Templeton and Atascadero areas. None of these wells were in direct hydraulic communication with the Alluvial Aquifer. The specific capacity in these wells ranged from 0.9 to 5.7 gpm/ft at pumping rates of 110 to 810 gpm (Table 1). Overall, within the Basin, the geometric mean hydraulic conductivity of the Paso Robles Formation Aquifer is estimated at 8.6 ft/day and the storativity ranges from 0.04 to 0.0001 (Fugro 2002).

Table 4-1. Atascadero Basin Aquifer Properties

Well Location	Test (hours)	Flow (gpm)	Well Depth (ft)	Perf. Int. (ft)	Trans. (gpd/ft)	Q/s (gpm/ft)	Hyd. Cond. (ft/day)	Storativity	Aquifer of Completion
28S/12E-5	8	90	55	30	101,106	110	450.6		Qa
27S/12E-29	24	740	60	25	650,000	105	3475.9		Qa
27S/12E-31	20	220	60	20	24,200	27.2	161.8		Qa
27S/12E-31	24	15	25	10	15,840	7.1	211.8		Qa

Well Location	Test (hours)	Flow (gpm)	Well Depth (ft)	Perf. Int. (ft)	Trans. (gpd/ft)	Q/s (gpm/ft)	Hyd. Cond. (ft/day)	Storativity	Aquifer of Completion
28S/12E-03	72	1300	425	270	45,760	17.6	22.7		QTp
28S/12E-03	72	1300 (obs)	505	332	45,760	na (obs)	18.4	0.04	QTp
28S/13E-31a	12	1000	450	300	52,800	11.5	23.5		QTp
28S/13E-31b	12	950 (obs)	450	300	36,000	na (obs)	16	0.0002	QTp
28S/13E-31c	24	1000	330	120	22,000	14.5	24.5		QTp
28S/13E-31d	24	1000 (obs)	320	87	26,400	na (obs)	40.6	0.0001	QTp
28S/13E-31e	24	1000 (obs)	310	283	--	na (obs)	146.4	0.004	QTp
28S/12E-03	24	325	370	225	5,400	3	3.2		QTp
28S/12E-11	72	810	600	300	6,198	5.7	2.8		QTp
28S/12E-11	72	810(obs)	350	200	8,250	na (obs)	5.5	0.002	QTp
27S/12E-9	72	475	605	312	6,600	2.3	2.8		QTp
27S/12E-16	24	426	640	380	2,900	2.1	1		QTp
27S/12E-16	24	441	280	115	7,300	4.6	8.5		QTp
27S/12E-20	103	110	290	120	1,700	0.9	1.9		QTp
27S/12E-20	24	150	195	87	7,275	2.8	11.2		QTp
27S/12E-17	50	200	270	170	2,122	1.8	1.7		QTp
Summary:									
Qa (average/geomean)		266	50	21	70,846	62	481		
QTp (average/geomean)		567	399	225	10,583	6	8.6	0.009	

Notes:
Qa – Alluvial Aquifer
QTp – Paso Robles Formation Aquifer
gpm – Gallons per minute
Hyd. Cond. - Hydraulic conductivity
Trans. – Transmissivity
gpd/ft - Gallons per day per foot
Perf. Int. – Perforated interval
Q/s – Specific capacity
obs – Observation well data
na - Not applicable

4.4.2 *Confining Beds and Geologic Structures*

There are no formally defined or laterally continuous aquitards within the Basin. Along the northwestern, western, and southern boundaries of the Basin sediments of the Paso Robles Formation are in contact with older, relatively impermeable geologic units, including Tertiary-age consolidated sedimentary beds, Cretaceous-age metamorphic rocks, and granitic rock.

The Rinconada Fault defines the eastern boundary of the Basin and forms a hydraulic barrier between the Paso Robles Basin and the Basin. Between Atascadero and Creston, the Rinconada Fault juxtaposes less permeable granitic and Monterey Formation rocks with the Paso Robles Formation basin sediments. Farther north, the Rinconada Fault zone was exposed in trenches on the Santa Ysabel Ranch (GeoSolutions, 2000), where the investigation concluded that the fault was a barrier to groundwater flow in the Paso Robles Formation as evidenced by differences in water levels at the Santa Ysabel warm water spring and wells drilled at the edge of the terrace above the Salinas River flood plain. South of the City of Paso Robles, the Paso Robles Formation is found on both sides of the Rinconada Fault. Based on distinctly different trends observed in Paso Robles Formation water levels on either side of the Rinconada Fault[3], it is assumed that the fault zone forms a leaky barrier that restricts flow from the Basin to the main part of the Paso Robles Basin. Groundwater flow from the Basin west of the Rinconada Fault into the Paso

[3] Groundwater levels in the western portion of the Paso Robles Basin (east of the Rinconada Fault) have generally and dramatically declined since the mid to late 1990s; whereas groundwater levels in the Atascadero Basin have remained relatively stable (Fugro, 2016).

Robles Basin is limited to underflow in the alluvial Salinas River deposits and minor subsurface groundwater flux in the Paso Robles Formation (Fugro, 2016).

4.5 Primary Users of Groundwater

The primary groundwater users in the Basin include municipal, agricultural, rural residential, small community water systems, and small commercial entities. Municipal, domestic, and agricultural demands in the Basin currently rely almost entirely on groundwater. Both the municipal sector and the agriculture sector use groundwater from the Alluvial Aquifer and the Paso Robles Aquifer.

4.6 General Water Quality

In general, the groundwater quality of the basins is relatively good, with few areas of unacceptable quality and few significant trends of deteriorating water quality. The main source of recharge to the Basin is the percolation of streamflow from the Salinas River, which drains the Cretaceous-age granitic rocks and sedimentary beds of the northwestern La Panza Range. This recharge, typically a calcium and magnesium bicarbonate water, has the greatest influence on water quality in the basin. Increasing TDS and chlorides in shallow Paso Robles Formation deposits along the Salinas River in the central portion of the basin was identified as a trend of slight water quality deterioration (Fugro, 2002). Water quality in the Basin is discussed in further detail in Section 5.

4.7 Groundwater Recharge and Discharge Areas

Areas of significant areal recharge and discharge within the Basin are discussed below. Quantitative information about all natural and anthropogenic recharge and discharge is provided in Section 6: Water Budgets.

4.7.1 *Groundwater Recharge Areas*

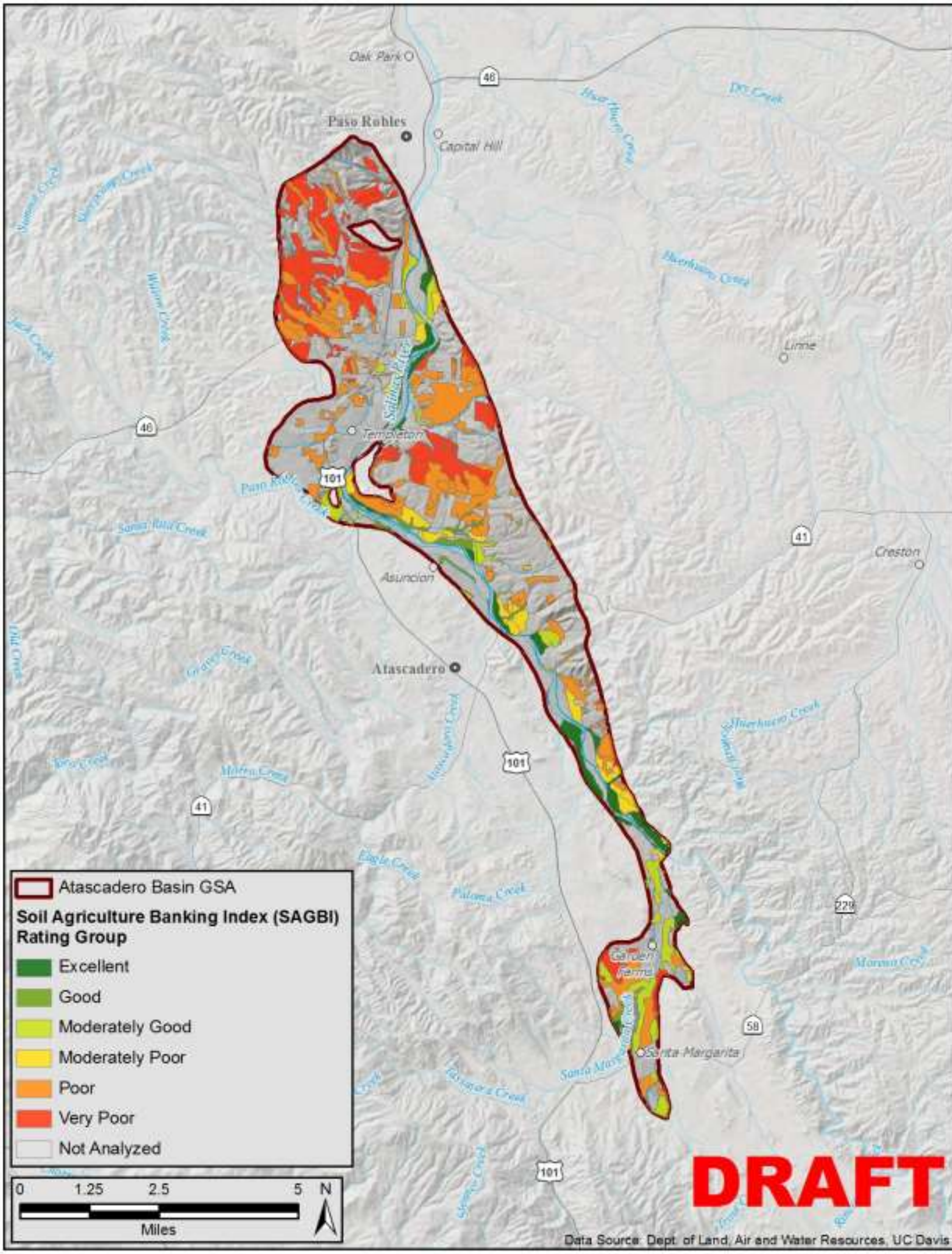
In general, natural areal recharge occurs via the following processes:

1. Distributed areal infiltration of precipitation,

2. Subsurface inflow from adjacent "non-water bearing bedrock", and

3. Infiltration of surface water from streams and creeks.

Figure 4-14 is a map that ranks soil suitability to accommodate groundwater recharge based on five major factors that affect recharge potential, including deep percolation, root zone residence time, topography, chemical limitations, and soil surface condition. The map was developed by the California Soil Resource Lab at UC Davis and the University of California Agricultural and



Atascadero Basin Groundwater Sustainability Plan San Luis Obispo County, California	GEI Consultants / GSI Water Solutions, Inc.	Potential Recharge Areas	
Atascadero Basin GSA		OCTOBER 2019	FIGURE 4-14

Natural Resources Department[4]. Areas with excellent recharge properties are shown in green. Areas with poor recharge properties are shown in red. Not all land is classified, but this map provides good guidance on where natural recharge likely occurs.

Subsurface inflow is the flow of groundwater from the surrounding "non-water bearing bedrock" into the basin sediments. Flow across the basin boundary is predominantly via highly conductive, but random and discontinuous, fractures. The rate of subsurface inflow to the Basin from the surrounding hill and mountain area varies considerably from year to year depending upon precipitation (intensity, frequency and duration, seasonal totals, etc.) and groundwater level gradients. There are no available published or unpublished inflow data for the hill and mountain areas surrounding the Basin. However, it is suspected that significant subsurface recharge comes into the Templeton area from the highland areas to the northwest.

In the area near Atascadero, the Paso Robles Formation has been folded, exposing the basal gravel beds. With the basal gravel exposed and in direct contact with the shallow alluvium, the Paso Robles Formation is recharged directly from the river alluvium (Fugro, 2002). Groundwater recharge from percolation of streamflow is known to occur near Atascadero and just south of the City of Paso Robles, with little to no recharge occurring in the Templeton area downstream of the confluence of the Salinas River with Graves and Paso Robles creeks (Fugro, 2016).

Significant anthropogenic recharge occurs via three processes, discussed further below:

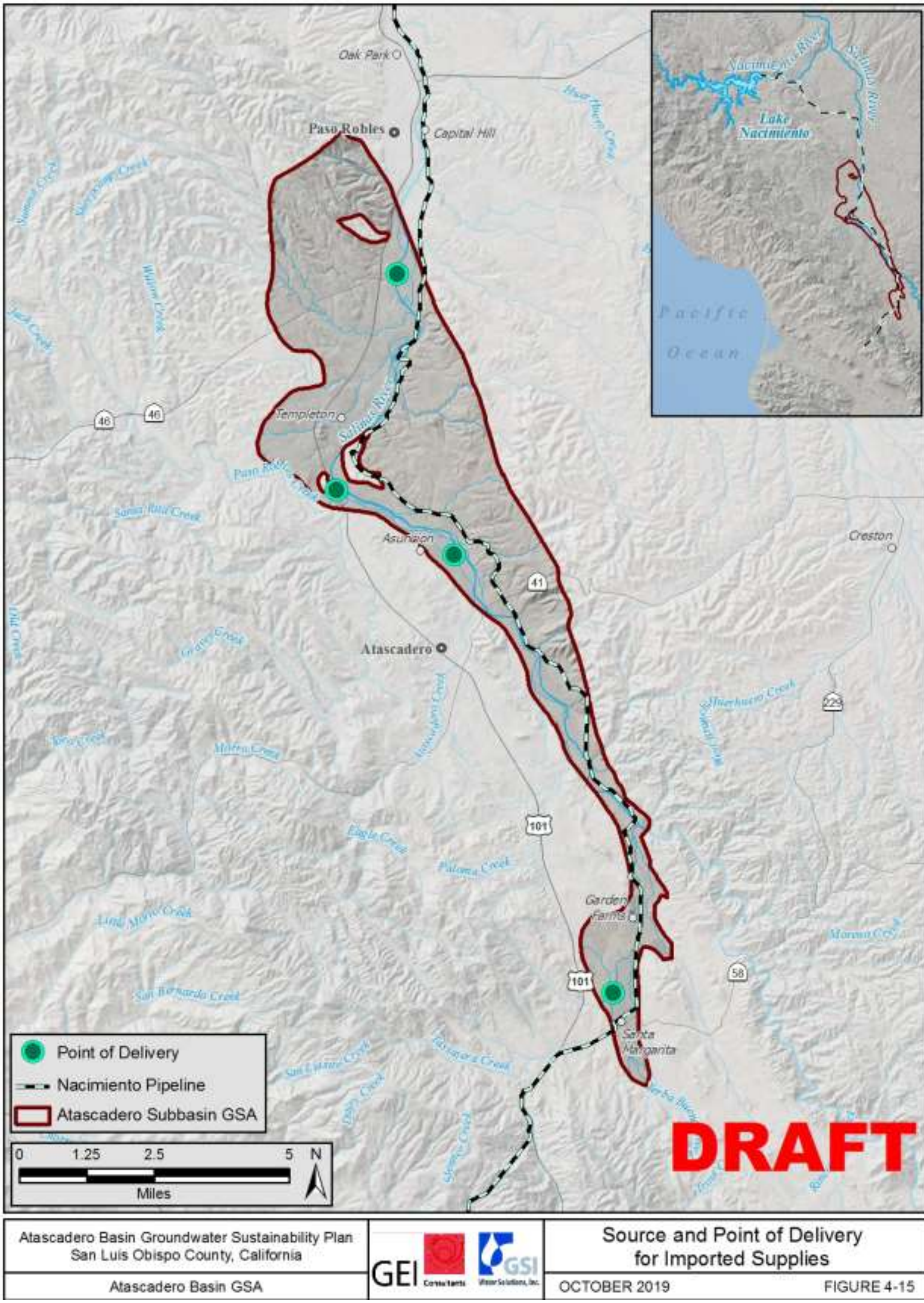
1. Percolation of wastewater treatment plant effluent,
2. Percolation of return flow from agricultural irrigation, and
3. Percolation of imported Lake Nacimiento water.

Wastewater treatment plants serving the communities of Atascadero and Templeton are operated within the Basin. Effluent from these plants is discharged to percolation ponds in the Alluvium adjacent to the Salinas River. Irrigated agriculture is prevalent in the Basin, especially in the northern portion. Return flows from irrigated agriculture occur when water is supplied to the irrigated crops in excess of the crop's water demand. This is done to avoid excess build-up of salts in the soil and is general standard practice. The percolation of the wastewater effluent and irrigation return flows are a significant anthropogenic source of recharge to the Basin.

The Nacimiento Water Project (NWP) regional raw water transmission facility delivers water from Lake Nacimiento to communities in San Luis Obispo County, including Atascadero, Templeton, the City of Paso Robles, and the Santa Margarita Ranch Mutual Water Company (SMRMWC). The NWP is designed to deliver 15,750 acre-feet of water per year (AFY). Atascadero Mutual Water Company (AMWC) has an allocation of 3,244 AFY and began taking

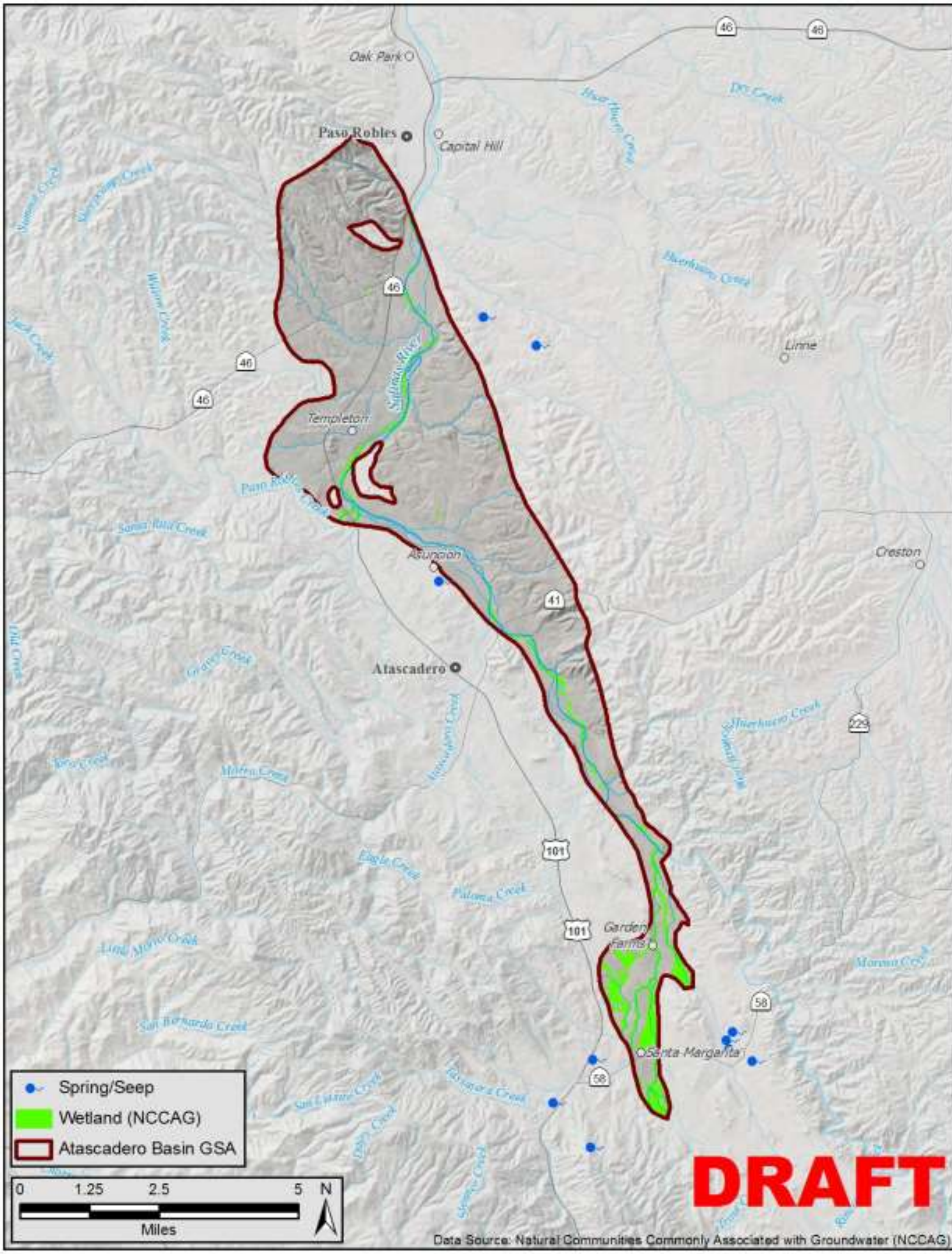
[4] Figure 4-14 shows the Soil Agricultural Groundwater Banking Index (SAGBI) map for the Paso Robles Subbasin. While the UC Davis database title SAGBI includes the term "banking", its use in this section is strictly as a dataset for evaluating recharge potential in the basin.

deliveries of water in the summer of 2012. Templeton Community Services District (TCSD) has an allocation of 406 AFY and began taking deliveries of water in 2012. The City of Paso Robles has an allocation of 6,488 AFY and the SMRMWC has an allocation of 80 AFY. Both AMWC and TCSD utilize their imported NWP water to recharge the Basin via percolation ponds located in the Alluvium adjacent to the Salinas River. The City of Paso Robles utilizes their NWP allocation in two ways: treatment in a package water treatment plant and applying directly to the ground surface on the alluvial gravels of the Salinas River floodplain in the north end of the Basin. SMRMWC has not yet begun receiving NWP water. The source and points of delivery for the imported NWP water with the Basin are shown on Figure 4-15.


Oak Park
Paso Robles
Capital Hill
Templeton
Salinas River
Paso Robles Creek
Asuncion
Creston
Atascadero
Garden Farms
Santa Margarita
Lake Nacimiento
Pacific Ocean
DRAFT
Point of Delivery
Nacimiento Pipeline
Atascadero Subbasin GSA
0 1.25 2.5 5
Miles
N
Atascadero Basin Groundwater Sustainability Plan
San Luis Obispo County, California
Atascadero Basin GSA
Source and Point of Delivery for Imported Supplies
OCTOBER 2019
FIGURE 4-15

4.7.2 *Groundwater Discharge Areas*

Natural groundwater discharge occurs as discharge to springs, seeps and wetlands, subsurface outflows, and evapotranspiration (ET) by phreatophytes. Figure 4-16 shows the locations of significant active springs, seeps, and wetlands within or adjacent to the Basin. There are no mapped springs or seeps located within the Basin. Groundwater discharge to streams and potential groundwater dependent ecosystems (GDEs) are discussed in Section 5. In contrast to mapped springs and seeps, which are derived from groundwater in the Paso Robles Formation, groundwater discharge to streams is derived from the Alluvium. Subsurface outflow and ET by phreatophytes are discussed in Section 6.



Atascadero Basin Groundwater Sustainability Plan
San Luis Obispo County, California

Atascadero Basin GSA

Springs/Seeps and Wetlands

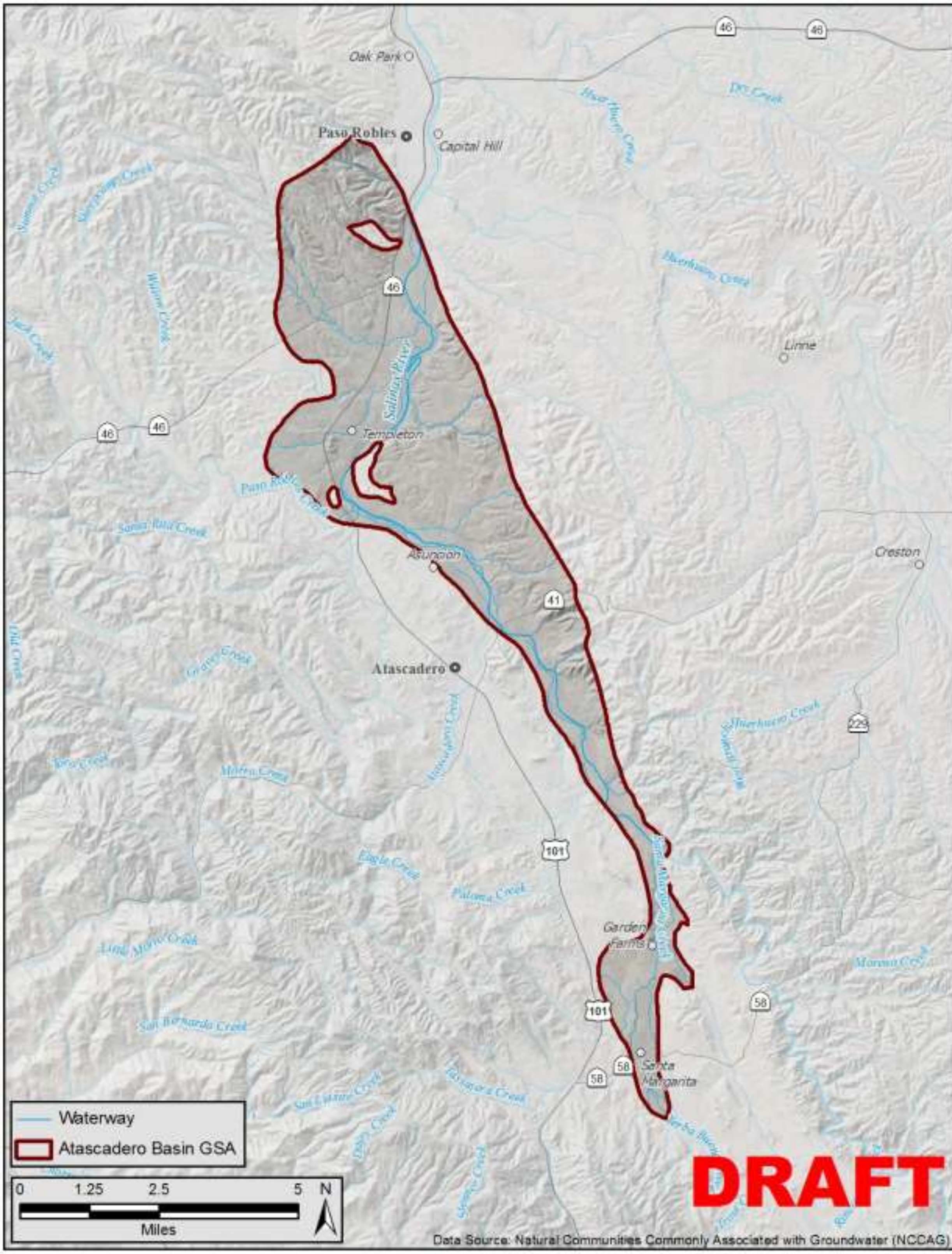
OCTOBER 2019

FIGURE 4-16

4.8 Surface Water Bodies

Figure 4-17 shows the Salinas River, which is considered significant to the management of groundwater in the Basin. The Salinas River is ephemeral, and during most of the year loses water to the shallow aquifer. A complete description and quantification of the stream/aquifer interaction is included in Sections 5 and 6. There are no natural lakes in the Basin.

There are no water supply reservoirs within the Basin; however, there is one reservoir in the watershed. The Salinas Dam south of the Basin on the Salinas River forms Santa Margarita Lake. The Salinas Dam was constructed in the early 1940s as an emergency measure to provide adequate water supplies for Camp San Luis Obispo. The military division of the United States Army Corps of Engineers (USACE) now has jurisdiction over the dam and reservoir facilities. The City of San Luis Obispo has an agreement with USACE to divert the entire yield of Santa Margarita Reservoir for water supply.



Atascadero Basin Groundwater Sustainability Plan San Luis Obispo County, California	GEI Consultants / GSI Water Solutions, Inc.	Surface Water Bodies
Atascadero Basin GSA		OCTOBER 2019 FIGURE 4-17

4.9 Data Gaps in the Hydrogeologic Conceptual Model

All hydrologic conceptual models contain a certain amount of uncertainty and can be improved with additional data and analysis. The hydrogeologic conceptual model of the Basin could be improved with certain additional data and analyses. Several data gaps are identified below.

4.9.1 *Groundwater Elevation Data*

Atascadero Basin has generally very good coverage in its existing groundwater monitoring network. However, the northwest end of the Basin, especially the area north of Highway 46, does not. A better understanding of water levels in the Paso Robles Formation in this area is important to the future management of the north end of the Basin. There are many existing private wells in the northwest area so there may be opportunities to bring one or more of them into the monitoring program through an outreach program.

4.9.2 *Fault Influence on Groundwater Flow*

The Rinconada Fault defines the eastern boundary of the Basin. In the area south of the City of Paso Robles, the Paso Robles Formation is found on both sides of the Rinconada Fault. Existing groundwater elevation data qualitatively show that the Rinconada Fault forms a leaky barrier to groundwater flow in this area, but no quantitative determination of the barrier's effectiveness has yet been made. A better understanding of the effectiveness of this barrier would aid in future management of the Basin. It may be possible to get a better understanding of the influence of the Rinconada Fault by performing aquifer tests across the trace of the fault.

4.9.3 *Vertical Groundwater Gradients*

There are no nested wells to demonstrate vertical hydraulic gradients. Demonstrating vertical gradients could be important to assess vertical flows between the Alluvium and the Paso Robles Aquifer as well as vertical flows within the Paso Robles Aquifer.

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