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Article 5.			Plan Contents for San Luis Obispo Valley Basin	GSP Document References				
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§ 354.			**Introduction to Plan Contents**					
			This Article describes the required contents of Plans submitted to the Department for evaluation, including administrative information, a description of the basin setting, sustainable management criteria, description of the monitoring network, and projects and management actions.					
			Note: Authority cited: Section 10733.2, Water Code.					
			Reference: Section 10733.2, Water Code.					
SubArticle 1.			**Administrative Information**					
§ 354.2.			**Introduction to Administrative Information**					
			This Subarticle describes information in the Plan relating to administrative and other general information about the Agency that has adopted the Plan and the area covered by the Plan.					
			Note: Authority cited: Section 10733.2, Water Code.					
			Reference: Section 10733.2, Water Code.					
§ 354.4.			**General Information**					
			Each Plan shall include the following general information:					
(a)			An executive summary written in plain language that provides an overview of the Plan and description of groundwater conditions in the basin.					Executive Summary is included in the GSP.
(b)			A list of references and technical studies relied upon by the Agency in developing the Plan. Each Agency shall provide to the Department electronic copies of reports and other documents and materials cited as references that are not generally available to the public.		11			Section 11 is a Reference List
			Note: Authority cited: Section 10733.2, Water Code.					
			Reference: Sections 10733.2 and 10733.4, Water Code.					
§ 354.6.			**Agency Information**					
			When submitting an adopted Plan to the Department, the Agency shall include a copy of the information provided pursuant to Water Code Section 10723.8, with any updates, if necessary, along with the following information:					
(a)			The name and mailing address of the Agency.		2.1			
(b)			The organization and management structure of the Agency, identifying persons with management authority for implementation of the Plan.		2.2	2-2		
(c)			The name and contact information, including the phone number, mailing address and electronic mail address, of the plan manager.		2.4			
(d)			The legal authority of the Agency, with specific reference to citations setting forth the duties, powers, and responsibilities of the Agency, demonstrating that the Agency has the legal authority to implement the Plan.		2.3			
(e)			An estimate of the cost of implementing the Plan and a general description of how the Agency plans to meet those costs.		10.1.3,10.2.2, 10,2,3		10-1	
			Note: Authority cited: Section 10733.2, Water Code.					
			Reference: Sections 10723.8, 10727.2, and 10733.2, Water Code.					
§ 354.8.			**Description of Plan Area**					

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			Each Plan shall include a description of the geographic areas covered, including the following information:					
(a)			One or more maps of the basin that depict the following, as applicable:					
	(1)		The area covered by the Plan, delineating areas managed by the Agency as an exclusive Agency and any areas for which the Agency is not an exclusive Agency, and the name and location of any adjacent basins.		3.1			
	(2)		Adjudicated areas, other Agencies within the basin, and areas covered by an Alternative.		3.2			
	(3)		Jurisdictional boundaries of federal or state land (including the identity of the agency with jurisdiction over that land), tribal land, cities, counties, agencies with water management responsibilities, and areas covered by relevant general plans.		3.3			
	(4)		Existing land use designations and the identification of water use sector and water source type.		3.4			
	(5)		The density of wells per square mile, by dasymetric or similar mapping techniques, showing the general distribution of agricultural, industrial, and domestic water supply wells in the basin, including de minimis extractors, and the location and extent of communities dependent upon groundwater, utilizing data provided by the Department, as specified in Section 353.2, or the best available information.		3.5			
(b)			A written description of the Plan area, including a summary of the jurisdictional areas and other features depicted on the map.		3.1	3-2		
(c)			Identification of existing water resource monitoring and management programs, and description of any such programs the Agency plans to incorporate in its monitoring network or in development of its Plan. The Agency may coordinate with existing water resource monitoring and management programs to incorporate and adopt that program as part of the Plan.		3.6			
(d)			A description of how existing water resource monitoring or management programs may limit operational flexibility in the basin, and how the Plan has been developed to adapt to those limits.	N/A				No water resource monitoring or management programs will limit the operation flexibility of SLO Basin.
(e)			A description of conjunctive use programs in the basin.		3.7			No active conjuctive use programs crurrently operating in SLO Basin.
(f)			A plain language description of the land use elements or topic categories of applicable general plans that includes the following:					
	(1)		A summary of general plans and other land use plans governing the basin.		3.8			
	(2)		A general description of how implementation of existing land use plans may change water demands within the basin or affect the ability of the Agency to achieve sustainable groundwater management over the planning and implementation horizon, and how the Plan addresses those potential effects					The exiisting land use plans will not affect the sustainable groundwater management in the SLO Basin.
	(3)		A general description of how implementation of the Plan may affect the water supply assumptions of relevant land use plans over the planning and implementation horizon.	NA				

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	(4)		A summary of the process for permitting new or replacement wells in the basin, including adopted standards in local well ordinances, zoning codes, and policies contained in adopted land use plans.		3.6.3.6, 3.6.3.7			
	(5)		To the extent known, the Agency may include information regarding the implementation of land use plans outside the basin that could affect the ability of the Agency to achieve sustainable groundwater management.	NA				Land Use Plans outside the SLO Basin won't affect the ability of the GSAs to achieve sustainable groundwater management.
(g)			A description of any of the additional Plan elements included in Water Code Section 10727.4 that the Agency determines to be appropriate.	NA				None
			Note: Authority cited: Section 10733.2, Water Code.					
			Reference: Sections 10720.3, 10727.2, 10727.4, 10733, and 10733.2, Water Code.					
§ 354.10.			**Notice and Communication**					
			Each Plan shall include a summary of information relating to notification and communication by the Agency with other agencies and interested parties including the following:					
(a)			A description of the beneficial uses and users of groundwater in the basin, including the land uses and property interests potentially affected by the use of groundwater in the basin, the types of parties representing those interests, and the nature of consultation with those parties.		App E			The Communication and Engagement Plan describes the beneficial uses and users in the basin.
(b)			A list of public meetings at which the Plan was discussed or considered by the Agency.				2-1	
(c)			Comments regarding the Plan received by the Agency and a summary of any responses by the Agency.		App K			
(d)			A communication section of the Plan that includes the following:					
	(1)		An explanation of the Agency's decision-making process.		App E			
	(2)		Identification of opportunities for public engagement and a discussion of how public input and response will be used.		App E			
	(3)		A description of how the Agency encourages the active involvement of diverse social, cultural, and economic elements of the population within the basin.		App E			
	(4)		The method the Agency shall follow to inform the public about progress implementing the Plan, including the status of projects and actions.		10.1.4			
			Note: Authority cited: Section 10733.2, Water Code.					
			Reference: Sections 10723.2, 10727.8, 10728.4, and 10733.2, Water Code					
SubArticle 2.			**Basin Setting**					
§ 354.12.			**Introduction to Basin Setting**					

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			This Subarticle describes the information about the physical setting and characteristics of the basin and current conditions of the basin that shall be part of each Plan, including the identification of data gaps and levels of uncertainty, which comprise the basin setting that serves as the basis for defining and assessing reasonable sustainable management criteria and projects and management actions. Information provided pursuant to this Subarticle shall be prepared by or under the direction of a professional geologist or professional engineer.					
			Note: Authority cited: Section 10733.2, Water Code.					
			Reference: Section 10733.2, Water Code.					
§ 354.14.			**Hydrogeologic Conceptual Model**					
(a)			Each Plan shall include a descriptive hydrogeologic conceptual model of the basin based on technical studies and qualified maps that characterizes the physical components and interaction of the surface water and groundwater systems in the basin.		4.1:4.8,5.7			
(b)			The hydrogeologic conceptual model shall be summarized in a written description that includes the following:					
	(1)		The regional geologic and structural setting of the basin including the immediate surrounding area, as necessary for geologic consistency.		4.5			
	(2)		Lateral basin boundaries, including major geologic features that significantly affect groundwater flow.		4.5.1			
	(3)		The definable bottom of the basin.			4-4		
	(4)		Principal aquifers and aquitards, including the following information:					
		(A)	Formation names, if defined.		4.5.2			
		(B)	Physical properties of aquifers and aquitards, including the vertical and lateral extent, hydraulic conductivity, and storativity, which may be based on existing technical studies or other best available information.		4.6			
		(C)	Structural properties of the basin that restrict groundwater flow within the principal aquifers, including information regarding stratigraphic changes, truncation of units, or other features.		4.5.1			
		(D)	General water quality of the principal aquifers, which may be based on information derived from existing technical studies or regulatory programs.		5.9			
		(E)	Identification of the primary use or uses of each aquifer, such as domestic, irrigation, or municipal water supply.		4.5.2			
	(5)		Identification of data gaps and uncertainty within the hydrogeologic conceptual model					The HCM for the SLO Basin is well defined.
(c)			The hydrogeologic conceptual model shall be represented graphically by at least two scaled cross-sections that display the information required by this section and are sufficient to depict major stratigraphic and structural features in the basin.		4.6.1	4-9:4-21		

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(d)			Physical characteristics of the basin shall be represented on one or more maps that depict the following:					
	(1)		Topographic information derived from the U.S. Geological Survey or another reliable source.		4.2	4-1		
	(2)		Surficial geology derived from a qualified map including the locations of cross-sections required by this Section.			4-8		
	(3)		Soil characteristics as described by the appropriate Natural Resources Conservation Service soil survey or other applicable studies.			4-6		
	(4)		Delineation of existing recharge areas that substantially contribute to the replenishment of the basin, potential recharge areas, and discharge areas, including significant active springs, seeps, and wetlands within or adjacent to the basin.		5.3	5-12:5-15		
	(5)		Surface water bodies that are significant to the management of the basin.		4.7			
	(6)		The source and point of delivery for imported water supplies.			3-3		
			Note: Authority cited: Section 10733.2, Water Code.					
			Reference: Sections 10727.2, 10733, and 10733.2, Water Code.					
§ 354.16.			**Groundwater Conditions**					
			Each Plan shall provide a description of current and historical groundwater conditions in the basin, including data from January 1, 2015, to current conditions, based on the best available information that includes the following:					
(a)			Groundwater elevation data demonstrating flow directions, lateral and vertical gradients, and regional pumping patterns, including:					
	(1)		Groundwater elevation contour maps depicting the groundwater table or potentiometric surface associated with the current seasonal high and seasonal low for each principal aquifer within the basin.			5-1:5-7		
	(2)		Hydrographs depicting long-term groundwater elevations, historical highs and lows, and hydraulic gradients between principal aquifers.			5-11		
(b)			A graph depicting estimates of the change in groundwater in storage, based on data, demonstrating the annual and cumulative change in the volume of groundwater in storage between seasonal high groundwater conditions, including the annual groundwater use and water year type.			5-9,5-10		
(c)			Seawater intrusion conditions in the basin, including maps and cross-sections of the seawater intrusion front for each principal aquifer.	NA				The SLO Basin is not adjacent to a coastline.
(d)			Groundwater quality issues that may affect the supply and beneficial uses of groundwater, including a description and map of the location of known groundwater contamination sites and plumes.		5.9	5-19	5-1	
(e)			The extent, cumulative total, and annual rate of land subsidence, including maps depicting total subsidence, utilizing data available from the Department, as specified in Section 353.2, or the best available information.		5.6			

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(f)			Identification of interconnected surface water systems within the basin and an estimate of the quantity and timing of depletions of those systems, utilizing data available from the Department, as specified in Section 353.2, or the best available information.		5.7			
(g)			Identification of groundwater dependent ecosystems within the basin, utilizing data available from the Department, as specified in Section 353.2, or the best available information.		5.8, App F, 7.3.6			
			Note: Authority cited: Section 10733.2, Water Code.					
			Reference: Sections 10723.2, 10727.2, 10727.4, and 10733.2, Water Code.					
§ 354.18.			**Water Budget**					
(a)			Each Plan shall include a water budget for the basin that provides an accounting and assessment of the total annual volume of groundwater and surface water entering and leaving the basin, including historical, current and projected water budget conditions, and the change in the volume of water stored. Water budget information shall be reported in tabular and graphical form.		6			Chapter 6 is the Water Budget Chapter.
(b)			The water budget shall quantify the following, either through direct measurements or estimates based on data:					
	(1)		Total surface water entering and leaving a basin by water source type.			6-4:6-6	6-1:6-3	
	(2)		Inflow to the groundwater system by water source type, including subsurface groundwater inflow and infiltration of precipitation, applied water, and surface water systems, such as lakes, streams, rivers, canals, springs and conveyance systems.			6-7:6-9	6-1:6-3	
	(3)		Outflows from the groundwater system by water use sector, including evapotranspiration, groundwater extraction, groundwater discharge to surface water sources, and subsurface groundwater outflow.			6-7:6-9	6-1:6-3	
	(4)		The change in the annual volume of groundwater in storage between seasonal high conditions.		6.4.7			
	(5)		If overdraft conditions occur, as defined in Bulletin 118, the water budget shall include a quantification of overdraft over a period of years during which water year and water supply conditions approximate average conditions.		6.4.9			
	(6)		The water year type associated with the annual supply, demand, and change in groundwater stored.				6-1:6-3	
	(7)		An estimate of sustainable yield for the basin.		6.4.8			
(c)			Each Plan shall quantify the current, historical, and projected water budget for the basin as follows:					
	(1)		Current water budget information shall quantify current inflows and outflows for the basin using the most recent hydrology, water supply, water demand, and land use information.		6.4	6-7:6-9	6-1:6-3	The historical and current water budget coponents are presented together.

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	(2)		Historical water budget information shall be used to evaluate availability or reliability of past surface water supply deliveries and aquifer response to water supply and demand trends relative to water year type. The historical water budget shall include the following:					
		(A)	A quantitative evaluation of the availability or reliability of historical surface water supply deliveries as a function of the historical planned versus actual annual surface water deliveries, by surface water source and water year type, and based on the most recent ten years of surface water supply information.		6.4.3	6-7:6-9	6-1:6-3	
		(B)	A quantitative assessment of the historical water budget, starting with the most recently available information and extending back a minimum of 10 years, or as is sufficient to calibrate and reduce the uncertainty of the tools and methods used to estimate and project future water budget information and future aquifer response to proposed sustainable groundwater management practices over the planning and implementation horizon.		6.4	6-7:6-9	6-1:6-3	
		(C)	A description of how historical conditions concerning hydrology, water demand, and surface water supply availability or reliability have impacted the ability of the Agency to operate the basin within sustainable yield. Basin hydrology may be characterized and evaluated using water year type.		6-2,	6-7:6-9	6-1:6-3	
	(3)		Projected water budgets shall be used to estimate future baseline conditions of supply, demand, and aquifer response to Plan implementation, and to identify the uncertainties of these projected water budget components. The projected water budget shall utilize the following methodologies and assumptions to estimate future baseline conditions concerning hydrology, water demand and surface water supply availability or reliability over the planning and implementation horizon:					
		(A)	Projected hydrology shall utilize 50 years of historical precipitation, evapotranspiration, and streamflow information as the baseline condition for estimating future hydrology. The projected hydrology information shall also be applied as the baseline condition used to evaluate future scenarios of hydrologic uncertainty associated with projections of climate change and sea level rise.		6.6			
		(B)	Projected water demand shall utilize the most recent land use, evapotranspiration, and crop coefficient information as the baseline condition for estimating future water demand. The projected water demand information shall also be applied as the baseline condition used to evaluate future scenarios of water demand uncertainty associated with projected changes in local land use planning, population growth, and climate.		6.6			

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		(C)	Projected surface water supply shall utilize the most recent water supply information as the baseline condition for estimating future surface water supply. The projected surface water supply shall also be applied as the baseline condition used to evaluate future scenarios of surface water supply availability and reliability as a function of the historical surface water supply identified in Section 354.18(c)(2)(A), and the projected changes in local land use planning, population growth, and climate.		6.6			
(d)			The Agency shall utilize the following information provided, as available, by the Department pursuant to Section 353.2, or other data of comparable quality, to develop the water budget:					
	(1)		Historical water budget information for mean annual temperature, mean annual precipitation, water year type, and land use.		6.4	6-10	6-1:6-3	
	(2)		Current water budget information for temperature, water year type, evapotranspiration, and land use.			6-10	6-1:6-3	
	(3)		Projected water budget information for population, population growth, climate change, and sea level rise.		6.6			
(e)			Each Plan shall rely on the best available information and best available science to quantify the water budget for the basin in order to provide an understanding of historical and projected hydrology, water demand, water supply, land use, population, climate change, sea level rise, groundwater and surface water interaction, and subsurface groundwater flow. If a numerical groundwater and surface water model is not used to quantify and evaluate the projected water budget conditions and the potential impacts to beneficial uses and users of groundwater, the Plan shall identify and describe an equally effective method, tool, or analytical model to evaluate projected water budget conditions.		6			Chapter 6 relies on the best available information and best available science to quantify the water budget. The model was being developed as part of the GSP and was not avaiable at the time the historical water budget was charachterzed. The inputs for the historical water budget informed the model and the model was used to develop the projected water budget.
(f)			The Department shall provide the California Central Valley Groundwater-Surface Water Simulation Model (C2VSIM) and the Integrated Water Flow Model (IWFM) for use by Agencies in developing the water budget. Each Agency may choose to use a different groundwater and surface water model, pursuant to Section 352.4.	NA				A GSFLOW model was deloped as part of this GSP and is documented in Appendix F.
			Note: Authority cited: Section 10733.2, Water Code.					
			Reference: Sections 10721, 10723.2, 10727.2, 10727.6, 10729, and 10733.2, Water Code.					
§ 354.20.			**Management Areas**					
(a)			Each Agency may define one or more management areas within a basin if the Agency has determined that creation of management areas will facilitate implementation of the Plan. Management areas may define different minimum thresholds and be operated to different measurable objectives than the basin at large, provided that undesirable results are defined consistently throughout the basin.	NA				The SLO Basin does not have management areas.
(b)			A basin that includes one or more management areas shall describe the following in the Plan:					

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	(1)		The reason for the creation of each management area.	NA				The SLO Basin does not have management areas.
	(2)		The minimum thresholds and measurable objectives established for each management area, and an explanation of the rationale for selecting those values, if different from the basin at large.	NA				The SLO Basin does not have management areas.
	(3)		The level of monitoring and analysis appropriate for each management area.	NA				The SLO Basin does not have management areas.
	(4)		An explanation of how the management area can operate under different minimum thresholds and measurable objectives without causing undesirable results outside the management area, if applicable.	NA				The SLO Basin does not have management areas.
(c)			If a Plan includes one or more management areas, the Plan shall include descriptions, maps, and other information required by this Subarticle sufficient to describe conditions in those areas.	NA				The SLO Basin does not have management areas.
			Note: Authority cited: Section 10733.2, Water Code.					
			Reference: Sections 10733.2 and 10733.4, Water Code.					
SubArticle 3.			**Sustainable Management Criteria**					
§ 354.22.			**Introduction to Sustainable Management Criteria**					
			This Subarticle describes criteria by which an Agency defines conditions in its Plan that constitute sustainable groundwater management for the basin, including the process by which the Agency shall characterize undesirable results, and establish minimum thresholds and measurable objectives for each applicable sustainability indicator.					
			Note: Authority cited: Section 10733.2, Water Code.					
			Reference: Section 10733.2, Water Code.					
§ 354.24.			**Sustainability Goal**					
			Each Agency shall establish in its Plan a sustainability goal for the basin that culminates in the absence of undesirable results within 20 years of the applicable statutory deadline. The Plan shall include a description of the sustainability goal, including information from the basin setting used to establish the sustainability goal, a discussion of the measures that will be implemented to ensure that the basin will be operated within its sustainable yield, and an explanation of how the sustainability goal is likely to be achieved within 20 years of Plan implementation and is likely to be maintained through the planning and implementation horizon.		8.3.1			
			Note: Authority cited: Section 10733.2, Water Code.					
			Reference: Sections 10721, 10727, 10727.2, 10733.2, and 10733.8, Water Code.					
§ 354.26.			**Undesirable Results**					

				GSP Document References				
				Page Numbers of Plan	Or Section Numbers	Or Figure Numbers	Or Table Numbers	Notes
(a)			Each Agency shall describe in its Plan the processes and criteria relied upon to define undesirable results applicable to the basin. Undesirable results occur when significant and unreasonable effects for any of the sustainability indicators are caused by groundwater conditions occurring throughout the basin.		8.5.1, 8.6.1, 8.8.1, 8.9.1, 8.10.1			
(b)			The description of undesirable results shall include the following:					
	(1)		The cause of groundwater conditions occurring throughout the basin that would lead to or has led to undesirable results based on information described in the basin setting, and other data or models as appropriate.		8.5.1.2, 8.6.1.2, 8.8.1.2, 8.9.1.2, 8.10.1.2			
	(2)		The criteria used to define when and where the effects of the groundwater conditions cause undesirable results for each applicable sustainability indicator. The criteria shall be based on a quantitative description of the combination of minimum threshold exceedances that cause significant and unreasonable effects in the basin.		8.5.1.1			
	(3)		Potential effects on the beneficial uses and users of groundwater, on land uses and property interests, and other potential effects that may occur or are occurring from undesirable results.		8.5.2.4, 8.6.2.4, 8.7.2.4, 8.9.2.4, 8.10.2.4			
(c)			The Agency may need to evaluate multiple minimum thresholds to determine whether an undesirable result is occurring in the basin. The determination that undesirable results are occurring may depend upon measurements from multiple monitoring sites, rather than a single monitoring site.		8.5.1			
(d)			An Agency that is able to demonstrate that undesirable results related to one or more sustainability indicators are not present and are not likely to occur in a basin shall not be required to establish criteria for undesirable results related to those sustainability indicators.		8.5.2.2			
			Note: Authority cited: Section 10733.2, Water Code.					
			Reference: Sections 10721, 10723.2, 10727.2, 10733.2, and 10733.8, Water Code.					
§ 354.28.			**Minimum Thresholds**					
(a)			Each Agency in its Plan shall establish minimum thresholds that quantify groundwater conditions for each applicable sustainability indicator at each monitoring site or representative monitoring site established pursuant to Section 354.36. The numeric value used to define minimum thresholds shall represent a point in the basin that, if exceeded, may cause undesirable results as described in Section 354.26.		8.5.2, 8.6.2, 8.8.2, 8.9.2, 8.10.2			
(b)			The description of minimum thresholds shall include the following:					

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	(1)		The information and criteria relied upon to establish and justify the minimum thresholds for each sustainability indicator. The justification for the minimum threshold shall be supported by information provided in the basin setting, and other data or models as appropriate, and qualified by uncertainty in the understanding of the basin setting.		8.4.2.1			
	(2)		The relationship between the minimum thresholds for each sustainability indicator, including an explanation of how the Agency has determined that basin conditions at each minimum threshold will avoid undesirable results for each of the sustainability indicators.		8.5.2.2, 8.6.2.2, 8.8.2.2, 8.9.2.2, 8.10.2.2			
	(3)		How minimum thresholds have been selected to avoid causing undesirable results in adjacent basins or affecting the ability of adjacent basins to achieve sustainability goals.		8.5.2.3, 8.6.2.3, 8.8.2.3, 8.9.2.3, 8.10.2.3			The SLO Basin is not connected to adjacent groundwater basins.
	(4)		How minimum thresholds may affect the interests of beneficial uses and users of groundwater or land uses and property interests.		8.5.2.4, 8.6.2.4, 8.8.2.4, 8.9.2.4, 8.10.2.4			
	(5)		How state, federal, or local standards relate to the relevant sustainability indicator. If the minimum threshold differs from other regulatory standards, the Agency shall explain the nature of and basis for the difference.		8.5.2.5, 8.6.2.5, 8.8.2.5, 8.9.2.5, 8.10.2.5			
	(6)		How each minimum threshold will be quantitatively measured, consistent with the monitoring network requirements described in Subarticle 4.		8.5.2.5, 8.6.2.5, 8.8.2.5, 8.9.2.5, 8.10.2.5			
(c)			Minimum thresholds for each sustainability indicator shall be defined as follows:					
	(1)		Chronic Lowering of Groundwater Levels. The minimum threshold for chronic lowering of groundwater levels shall be the groundwater elevation indicating a depletion of supply at a given location that may lead to undesirable results. Minimum thresholds for chronic lowering of groundwater levels shall be supported by the following:					
		(A)	The rate of groundwater elevation decline based on historical trends, water year type, and projected water use in the basin.		8.4.2.1			
		(B)	Potential effects on other sustainability indicators.		8.4.2.2			

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	(2)		Reduction of Groundwater Storage. The minimum threshold for reduction of groundwater storage shall be a total volume of groundwater that can be withdrawn from the basin without causing conditions that may lead to undesirable results. Minimum thresholds for reduction of groundwater storage shall be supported by the sustainable yield of the basin, calculated based on historical trends, water year type, and projected water use in the basin.		8.5.1			The Reduction of Groundwater Storage MT is evaluated with the same RMS and associated water level MTs and MOs as the chronic lowering of groundwater levels sustainability criteria.
	(3)		Seawater Intrusion. The minimum threshold for seawater intrusion shall be defined by a chloride concentration isocontour for each principal aquifer where seawater intrusion may lead to undesirable results. Minimum thresholds for seawater intrusion shall be supported by the following:					
		(A)	Maps and cross-sections of the chloride concentration isocontour that defines the minimum threshold and measurable objective for each principal aquifer.	NA				This Sustainability Indicator does not apply to the Basin since the Basin is not a coastal basin
		(B)	A description of how the seawater intrusion minimum threshold considers the effects of current and projected sea levels.	NA				This Sustainability Indicator does not apply to the Basin since the Basin is not a coastal basin
	(4)		Degraded Water Quality. The minimum threshold for degraded water quality shall be the degradation of water quality, including the migration of contaminant plumes that impair water supplies or other indicator of water quality as determined by the Agency that may lead to undesirable results. The minimum threshold shall be based on the number of supply wells, a volume of water, or a location of an isocontour that exceeds concentrations of constituents determined by the Agency to be of concern for the basin. In setting minimum thresholds for degraded water quality, the Agency shall consider local, state, and federal water quality standards applicable to the basin.	NA				This Sustainability Indicator does not apply to the Basin since the Basin is not a coastal basin
	(5)		Land Subsidence. The minimum threshold for land subsidence shall be the rate and extent of subsidence that substantially interferes with surface land uses and may lead to undesirable results. Minimum thresholds for land subsidence shall be supported by the following:					
		(A)	Identification of land uses and property interests that have been affected or are likely to be affected by land subsidence in the basin, including an explanation of how the Agency has determined and considered those uses and interests, and the Agency's rationale for establishing minimum thresholds in light of those effects.		8.8.2.4			
		(B)	Maps and graphs showing the extent and rate of land subsidence in the basin that defines the minimum threshold and measurable objectives.		4.8,5.6,	4-23		
	(6)		Depletions of Interconnected Surface Water. The minimum threshold for depletions of interconnected surface water shall be the rate or volume of surface water depletions caused by groundwater use that has adverse impacts on beneficial uses of the surface water and may lead to undesirable results. The minimum threshold established for depletions of interconnected surface water shall be supported by the following:					
		(A)	The location, quantity, and timing of depletions of interconnected surface water.		8.9			

				GSP Document References				
				Page Numbers of Plan	Or Section Numbers	Or Figure Numbers	Or Table Numbers	Notes
		(B)	A description of the groundwater and surface water model used to quantify surface water depletion. If a numerical groundwater and surface water model is not used to quantify surface water depletion, the Plan shall identify and describe an equally effective method, tool, or analytical model to accomplish the requirements of this Paragraph.		App G, 8.9			
(d)			An Agency may establish a representative minimum threshold for groundwater elevation to serve as the value for multiple sustainability indicators, where the Agency can demonstrate that the representative value is a reasonable proxy for multiple individual minimum thresholds as supported by adequate evidence.		8.9.2			
(e)			An Agency that has demonstrated that undesirable results related to one or more sustainability indicators are not present and are not likely to occur in a basin, as described in Section 354.26, shall not be required to establish minimum thresholds related to those sustainability indicators.		8.9.2.2			
			Note: Authority cited: Section 10733.2, Water Code.					
			Reference: Sections 10723.2, 10727.2, 10733, 10733.2, and 10733.8, Water Code.					
§ 354.30.			**Measurable Objectives**					
(a)			Each Agency shall establish measurable objectives, including interim milestones in increments of five years, to achieve the sustainability goal for the basin within 20 years of Plan implementation and to continue to sustainably manage the groundwater basin over the planning and implementation horizon.		8.5.3, 8.6.3, 8.8.3, 8.9.3, 8.10.3			
(b)			Measurable objectives shall be established for each sustainability indicator, based on quantitative values using the same metrics and monitoring sites as are used to define the minimum thresholds.		8.5.3, 8.6.3, 8.8.3, 8.9.3, 8.10.3			
(c)			Measurable objectives shall provide a reasonable margin of operational flexibility under adverse conditions which shall take into consideration components such as historical water budgets, seasonal and long-term trends, and periods of drought, and be commensurate with levels of uncertainty.		8.5.2.1			
(d)			An Agency may establish a representative measurable objective for groundwater elevation to serve as the value for multiple sustainability indicators where the Agency can demonstrate that the representative value is a reasonable proxy for multiple individual measurable objectives as supported by adequate evidence.		8.6, 8.8, 8.10	8-2 thru 8-11		
(e)			Each Plan shall describe a reasonable path to achieve the sustainability goal for the basin within 20 years of Plan implementation, including a description of interim milestones for each relevant sustainability indicator, using the same metric as the measurable objective, in increments of five years. The description shall explain how the Plan is likely to maintain sustainable groundwater management over the planning and implementation horizon.		Chapter 10			Chapter 10 is the Implementation Plan.

Article 5.			Plan Contents for San Luis Obispo Valley Basin	GSP Document References				
				Page Numbers of Plan	Or Section Numbers	Or Figure Numbers	Or Table Numbers	Notes
(f)			Each Plan may include measurable objectives and interim milestones for additional Plan elements described in Water Code Section 10727.4 where the Agency determines such measures are appropriate for sustainable groundwater management in the basin.		NA			
(g)			An Agency may establish measurable objectives that exceed the reasonable margin of operational flexibility for the purpose of improving overall conditions in the basin, but failure to achieve those objectives shall not be grounds for a finding of inadequacy of the Plan.		NA			
			Note: Authority cited: Section 10733.2, Water Code.					
			Reference: Sections 10727.2, 10727.4, and 10733.2, Water Code.					
SubArticle 4.			**Monitoring Networks**					
§ 354.32.			**Introduction to Monitoring Networks**					
			This Subarticle describes the monitoring network that shall be developed for each basin, including monitoring objectives, monitoring protocols, and data reporting requirements. The monitoring network shall promote the collection of data of sufficient quality, frequency, and distribution to characterize groundwater and related surface water conditions in the basin and evaluate changing conditions that occur through implementation of the Plan.					
			Note: Authority cited: Section 10733.2, Water Code.					
			Reference: Section 10733.2, Water Code.					
§ 354.34.			**Monitoring Network**					
(a)			Each Agency shall develop a monitoring network capable of collecting sufficient data to demonstrate short-term, seasonal, and long-term trends in groundwater and related surface conditions, and yield representative information about groundwater conditions as necessary to evaluate Plan implementation.		7			Chapter 7 is the Monitoring Netork.
(b)			Each Plan shall include a description of the monitoring network objectives for the basin, including an explanation of how the network will be developed and implemented to monitor groundwater and related surface conditions, and the interconnection of surface water and groundwater, with sufficient temporal frequency and spatial density to evaluate the affects and effectiveness of Plan implementation. The monitoring network objectives shall be implemented to accomplish the following:					
	(1)		Demonstrate progress toward achieving measurable objectives described in the Plan.		7.2			
	(2)		Monitor impacts to the beneficial uses or users of groundwater.		7.2			
	(3)		Monitor changes in groundwater conditions relative to measurable objectives and minimum thresholds.		7.2			
	(4)		Quantify annual changes in water budget components.		7.2			
(c)			Each monitoring network shall be designed to accomplish the following for each sustainability indicator:					

Article 5.			Plan Contents for San Luis Obispo Valley Basin	GSP Document References				
				Page Numbers of Plan	Or Section Numbers	Or Figure Numbers	Or Table Numbers	Notes
	(1)		Chronic Lowering of Groundwater Levels. Demonstrate groundwater occurrence, flow directions, and hydraulic gradients between principal aquifers and surface water features by the following methods:					
		(A)	A sufficient density of monitoring wells to collect representative measurements through depth-discrete perforated intervals to characterize the groundwater table or potentiometric surface for each principal aquifer.		7.3.1.1			
		(B)	Static groundwater elevation measurements shall be collected at least two times per year, to represent seasonal low and seasonal high groundwater conditions.		7.3.1			
	(2)		Reduction of Groundwater Storage. Provide an estimate of the change in annual groundwater in storage.		7.3.1,7.4.2			
	(3)		Seawater Intrusion. Monitor seawater intrusion using chloride concentrations, or other measurements convertible to chloride concentrations, so that the current and projected rate and extent of seawater intrusion for each applicable principal aquifer may be calculated.	NA				The Basin is not susceptible to seawater intrusion and will not be monitored for that indicator.
	(4)		Degraded Water Quality. Collect sufficient spatial and temporal data from each applicable principal aquifer to determine groundwater quality trends for water quality indicators, as determined by the Agency, to address known water quality issues.		7.4.4			
	(5)		Land Subsidence. Identify the rate and extent of land subsidence, which may be measured by extensometers, surveying, remote sensing technology, or other appropriate method.		7.4.5			
	(6)		Depletions of Interconnected Surface Water. Monitor surface water and groundwater, where interconnected surface water conditions exist, to characterize the spatial and temporal exchanges between surface water and groundwater, and to calibrate and apply the tools and methods necessary to calculate depletions of surface water caused by groundwater extractions. The monitoring network shall be able to characterize the following:					
		(A)	Flow conditions including surface water discharge, surface water head, and baseflow contribution.		7.4.6			
		(B)	Identifying the approximate date and location where ephemeral or intermittent flowing streams and rivers cease to flow, if applicable.		7.4.6, App F			
		(C)	Temporal change in conditions due to variations in stream discharge and regional groundwater extraction.		7.4.6, App F			
		(D)	Other factors that may be necessary to identify adverse impacts on beneficial uses of the surface water.		7.4.6, App F			
(d)			The monitoring network shall be designed to ensure adequate coverage of sustainability indicators. If management areas are established, the quantity and density of monitoring sites in those areas shall be sufficient to evaluate conditions of the basin setting and sustainable management criteria specific to that area.		7.4.6			

Article 5.			Plan Contents for San Luis Obispo Valley Basin	GSP Document References				
				Page Numbers of Plan	Or Section Numbers	Or Figure Numbers	Or Table Numbers	Notes
(e)			A Plan may utilize site information and monitoring data from existing sources as part of the monitoring network.		7.2.4			
(f)			The Agency shall determine the density of monitoring sites and frequency of measurements required to demonstrate short-term, seasonal, and long-term trends based upon the following factors:					
	(1)		Amount of current and projected groundwater use.		7.2			
	(2)		Aquifer characteristics, including confined or unconfined aquifer conditions, or other physical characteristics that affect groundwater flow.		7.2			Discussed throughout Chapter 7 and Chapter 8.
	(3)		Impacts to beneficial uses and users of groundwater and land uses and property interests affected by groundwater production, and adjacent basins that could affect the ability of that basin to meet the sustainability goal.		7.2			Discussed throughout Chapter 7 and Chapter 8.
	(4)		Whether the Agency has adequate long-term existing monitoring results or other technical information to demonstrate an understanding of aquifer response.		7.2			Discussed throughout Chapter 7 and Chapter 8. Specifically in the Interconnected GW/SW components of the plan.
(g)			Each Plan shall describe the following information about the monitoring network:					
	(1)		Scientific rationale for the monitoring site selection process.		7.2.3			
	(2)		Consistency with data and reporting standards described in Section 352.4. If a site is not consistent with those standards, the Plan shall explain the necessity of the site to the monitoring network, and how any variation from the standards will not affect the usefulness of the results obtained.		7.5			
	(3)		For each sustainability indicator, the quantitative values for the minimum threshold, measurable objective, and interim milestones that will be measured at each monitoring site or representative monitoring sites established pursuant to Section 354.36.		7.4			
(h)			The location and type of each monitoring site within the basin displayed on a map, and reported in tabular format, including information regarding the monitoring site type, frequency of measurement, and the purposes for which the monitoring site is being used.			7-1, 7-2, 7-3	7-1:7-5	
(i)			The monitoring protocols developed by each Agency shall include a description of technical standards, data collection methods, and other procedures or protocols pursuant to Water Code Section 10727.2(f) for monitoring sites or other data collection facilities to ensure that the monitoring network utilizes comparable data and methodologies.		App H			
(j)			An Agency that has demonstrated that undesirable results related to one or more sustainability indicators are not present and are not likely to occur in a basin, as described in Section 354.26, shall not be required to establish a monitoring network related to those sustainability indicators.		7.4.3			
			Note: Authority cited: Section 10733.2, Water Code.					
			Reference: Sections 10723.2, 10727.2, 10727.4, 10728, 10733, 10733.2, and 10733.8, Water Code					

				GSP Document References				
				Page Numbers of Plan	Or Section Numbers	Or Figure Numbers	Or Table Numbers	Notes
§ 354.36.			**Representative Monitoring**					
			Each Agency may designate a subset of monitoring sites as representative of conditions in the basin or an area of the basin, as follows:					
(a)			Representative monitoring sites may be designated by the Agency as the point at which sustainability indicators are monitored, and for which quantitative values for minimum thresholds, measurable objectives, and interim milestones are defined.		7.2.2			
(b)			(b) Groundwater elevations may be used as a proxy for monitoring other sustainability indicators if the Agency demonstrates the following:					
	(1)		Significant correlation exists between groundwater elevations and the sustainability indicators for which groundwater elevation measurements serve as a proxy.		7.3.1			
	(2)		Measurable objectives established for groundwater elevation shall include a reasonable margin of operational flexibility taking into consideration the basin setting to avoid undesirable results for the sustainability indicators for which groundwater elevation measurements serve as a proxy.		8.4,8.6,8.10			
(c)			The designation of a representative monitoring site shall be supported by adequate evidence demonstrating that the site reflects general conditions in the area.		8.4			
			Note: Authority cited: Section 10733.2, Water Code.					
			Reference: Sections 10727.2 and 10733.2, Water Code					
§ 354.38.			**Assessment and Improvement of Monitoring Network**					
(a)			Each Agency shall review the monitoring network and include an evaluation in the Plan and each five-year assessment, including a determination of uncertainty and whether there are data gaps that could affect the ability of the Plan to achieve the sustainability goal for the basin.		7.7,7.8			
(b)			Each Agency shall identify data gaps wherever the basin does not contain a sufficient number of monitoring sites, does not monitor sites at a sufficient frequency, or utilizes monitoring sites that are unreliable, including those that do not satisfy minimum standards of the monitoring network adopted by the Agency.		7.3.1.1,7.3.2.1,7.4.2.1			
(c)			If the monitoring network contains data gaps, the Plan shall include a description of the following:					
	(1)		The location and reason for data gaps in the monitoring network.		7.3.1.1,7.3.2.1,7.4.2.1			
	(2)		Local issues and circumstances that limit or prevent monitoring.	NA				
(d)			Each Agency shall describe steps that will be taken to fill data gaps before the next five-year assessment, including the location and purpose of newly added or installed monitoring sites.		7.3.1.1,7.3.2.1,7.4.2.1			

Article 5.			Plan Contents for San Luis Obispo Valley Basin	GSP Document References				
				Page Numbers of Plan	Or Section Numbers	Or Figure Numbers	Or Table Numbers	Notes
(e)			Each Agency shall adjust the monitoring frequency and density of monitoring sites to provide an adequate level of detail about site-specific surface water and groundwater conditions and to assess the effectiveness of management actions under circumstances that include the following:					
	(1)		Minimum threshold exceedances.		7.5.4			
	(2)		Highly variable spatial or temporal conditions.		7.5.4			
	(3)		Adverse impacts to beneficial uses and users of groundwater.		7.5.4			
	(4)		The potential to adversely affect the ability of an adjacent basin to implement its Plan or impede achievement of sustainability goals in an adjacent basin.		7.5.4			
			Note: Authority cited: Section 10733.2, Water Code.					
			Reference: Sections 10723.2, 10727.2, 10728.2, 10733, 10733.2, and 10733.8, Water Code					
§ 354.40.			**Reporting Monitoring Data to the Department**					
			Monitoring data shall be stored in the data management system developed pursuant to Section 352.6. A copy of the monitoring data shall be included in the Annual Report and submitted electronically on forms provided by the Department.					
			Note: Authority cited: Section 10733.2, Water Code.					
			Reference: Sections 10728, 10728.2, 10733.2, and 10733.8, Water Code.					
SubArticle 5.			**Projects and Management Actions**					
§ 354.42.			**Introduction to Projects and Management Actions**					
			This Subarticle describes the criteria for projects and management actions to be included in a Plan to meet the sustainability goal for the basin in a manner that can be maintained over the planning and implementation horizon.					
			Note: Authority cited: Section 10733.2, Water Code.					
			Reference: Section 10733.2, Water Code.					
§ 354.44.			**Projects and Management Actions**					
(a)			Each Plan shall include a description of the projects and management actions the Agency has determined will achieve the sustainability goal for the basin, including projects and management actions to respond to changing conditions in the basin.		9			
(b)			Each Plan shall include a description of the projects and management actions that include the following:					
	(1)		A list of projects and management actions proposed in the Plan with a description of the measurable objective that is expected to benefit from the project or management action. The list shall include projects and management actions that may be utilized to meet interim milestones, the exceedance of minimum thresholds, or where undesirable results have occurred or are imminent. The Plan shall include the following:					

Article 5.			Plan Contents for San Luis Obispo Valley Basin	GSP Document References				
				Page Numbers of Plan	Or Section Numbers	Or Figure Numbers	Or Table Numbers	Notes
		(A)	A description of the circumstances under which projects or management actions shall be implemented, the criteria that would trigger implementation and termination of projects or management actions, and the process by which the Agency shall determine that conditions requiring the implementation of particular projects or management actions have occurred.		9.6			A
		(B)	The process by which the Agency shall provide notice to the public and other agencies that the implementation of projects or management actions is being considered or has been implemented, including a description of the actions to be taken.		9.4.1.8			
	(2)		If overdraft conditions are identified through the analysis required by Section 354.18, the Plan shall describe projects or management actions, including a quantification of demand reduction or other methods, for the mitigation of overdraft.		9.2.3			
	(3)		A summary of the permitting and regulatory process required for each project and management action.		9.4.1.7			
	(4)		The status of each project and management action, including a time-table for expected initiation and completion, and the accrual of expected benefits.		9.4.1			
	(5)		An explanation of the benefits that are expected to be realized from the project or management action, and how those benefits will be evaluated.		9.4.1.1			
	(6)		An explanation of how the project or management action will be accomplished. If the projects or management actions rely on water from outside the jurisdiction of the Agency, an explanation of the source and reliability of that water shall be included.		9.4.1.2			
	(7)		A description of the legal authority required for each project and management action, and the basis for that authority within the Agency.		9.4.1.6			
	(8)		A description of the estimated cost for each project and management action and a description of how the Agency plans to meet those costs.		9.4.1.3,10.1.3			
	(9)		A description of the management of groundwater extractions and recharge to ensure that chronic lowering of groundwater levels or depletion of supply during periods of drought is offset by increases in groundwater levels or storage during other periods.		9.4.8			
(c)			Projects and management actions shall be supported by best available information and best available science.		9.4.1			
(d)			An Agency shall take into account the level of uncertainty associated with the basin setting when developing projects or management actions.		9.4.1.5			
			Note: Authority cited: Section 10733.2, Water Code.					
			Reference: Sections 10727.2, 10727.4, and 10733.2, Water Code.					

B

City of San Luis Obispo Resolution to Form GSA

RESOLUTION NO. 10796 (2017 SERIES)

A RESOLUTION OF THE CITY COUNCIL OF THE CITY OF SAN LUIS OBISPO, CALIFORNIA, AUTHORIZING THE CITY TO BECOME A GROUNDWATER SUSTAINABILITY AGENCY FOR THE SAN LUIS OBISPO VALLEY GROUNDWATER BASIN FOR THE AREA THAT LIES BENEATH AND WITHIN THE JURISDICTIONAL BOUNDARIES OF THE CITY OF SAN LUIS OBISPO

WHEREAS, in 2014 the California Legislature and the Governor passed into law the Sustainable Groundwater Management Act (SGMA) for local management of groundwater resources in California through the formation of Groundwater Sustainability Agencies (GSAs) and through preparation and implementation of Groundwater Sustainability Plans (GSPs); and

WHEREAS, the City overlies a portion of the San Luis Obispo Valley Groundwater Basin (SLOVGB), which is subject to SGMA, and thus one or more GSAs must be formed for the SLOVGB by June 30, 2017, or the SLOVGB may be subject to regulation by the State Water Resources Control Board; and

WHEREAS, the City is a "local agency" as that term is defined by SGMA, and as such is authorized to form a GSA to manage groundwater resources in the SLOVGB and within the City's jurisdictional boundaries in accordance with SGMA and other applicable laws and authorities; and

WHEREAS, the City desires to form a GSA to manage groundwater resources in the SLOVGB beneath and within the City's jurisdictional boundaries; and

WHEREAS, the City intends that its GSA will work cooperatively with the other GSAs that have formed or will be formed in the SLOVGB to prepare one or more GSPs by January 31, 2022, so that groundwater resources in the SLOVGB will be properly managed and sustainable in accordance with the provisions of SGMA; and

WHEREAS, it is essential that the City form this GSA because SGMA grants GSAs substantial additional powers and authorities to ensure sustainable groundwater management. Acting as the GSA within the City's jurisdictional boundaries will, among other things, confirm the City's role as the local groundwater management agency, ensure access to SGMA authorities, and preserve access to grant funding and other opportunities that may be available to GSAs; and

WHEREAS, pursuant to the requirements of SGMA, the City held a public hearing on this date after publication of notice pursuant to California Government Code section 6066 to consider adoption of this Resolution.

NOW, THEREFORE, BE IT RESOLVED by the Council of the City of San Luis Obispo as follows:

SECTION 1. All of the above recitals are true and correct and incorporated herein by reference.

SECTION 2. The City of San Luis Obispo hereby elects to become the Groundwater Sustainability Agency in accordance with the Sustainable Groundwater Management Act over the portion of the San Luis Obispo Valley Groundwater Basin which lies under and within the jurisdictional boundaries of the City of San Luis Obispo.

SECTION 3. The City Manager is authorized and directed to submit a notice of this Resolution along with all other required information to the California Department of Water Resources in accordance with the Sustainable Groundwater Management Act.

SECTION 4. The City Groundwater Sustainability Agency shall consider the interests of all beneficial uses and users of the groundwater within the jurisdictional boundaries of the City and will develop an outreach program for all such stakeholders. The City Groundwater Sustainability Agency will continue to coordinate with other local agencies and stakeholders that overlie the San Luis Obispo Valley Groundwater Basin in order to manage groundwater resources.

SECTION 5. The City Groundwater Sustainability Agency shall establish and maintain a list of persons interested in receiving notices regarding the City's involvement in the preparation of one or more Groundwater Sustainability Plans in the San Luis Obispo Valley Groundwater Basin, where any person may request in writing to be placed on the City's list of interested persons.

SECTION 6. Resolution Number 10777 (2017 Series) is hereby repealed.

Upon motion of Council Member Pease, seconded by Council Member Christianson, and on the following roll call vote:

AYES:	Council Members Christianson, Gomez, and Pease Vice Mayor Rivoire and Mayor Harmon
NOES:	None
ABSENT:	None

The foregoing resolution was adopted this 16th day of May, 2017.

Heidi Harmon
Mayor Heidi Harmon

ATTEST:

Carrie Gallagher
Carrie Gallagher
City Clerk

APPROVED AS TO FORM:

J. Christine Dietrick
City Attorney

IN WITNESS WHEREOF, I have hereunto set my hand and affixed the official seal of the City of San Luis Obispo, California, this 24th day of May, 2017.

Carrie Gallagher
Carrie Gallagher
City Clerk

C

County of San Luis Obispo Resolution to Form GSA

IN THE BOARD OF SUPERVISORS

County of San Luis Obispo, State of California

Tuesday, May 23, 2017

PRESENT: Supervisors Bruce S. Gibson, Adam Hill, Lynn Compton, Debbie Arnold, and Chairperson John Peschong

ABSENT: None

RESOLUTION NO. 2017-146

RESOLUTION FORMING THE SAN LUIS OBISPO VALLEY BASIN – COUNTY OF SAN LUIS OBISPO GROUNDWATER SUSTAINABILITY AGENCY AND FINDING THAT THE PROJECT IS EXEMPT FROM SECTION 21000 ET SEQ. OF THE CALIFORNIA PUBLIC RESOURCES CODE (CEQA)

The following Resolution is hereby offered and read:

WHEREAS, in 2014, the California Legislature adopted, and the Governor signed into law, three bills (SB 1168, AB 1739, and SB 1319) collectively referred to as the Sustainable Groundwater Management Act (SGMA) (Water Code §§ 10720 *et seq.*), that became effective on January 1, 2015, and that have been subsequently amended; and

WHEREAS, the intent of SGMA, as set forth in Water Code Section 10720.1, is to provide for the sustainable management of groundwater basins at a local level by providing local groundwater agencies with the authority, and technical and financial assistance necessary, to sustainably manage groundwater; and

WHEREAS, SGMA requires the formation of Groundwater Sustainability Agencies (GSAs) for the purpose of achieving groundwater sustainability through the adoption and implementation of Groundwater Sustainability Plans (GSPs) for all medium and high priority basins as designated by the California Department of Water Resources (DWR); and

WHEREAS, SGMA requires that a local agency or collection of agencies decide to become a GSA for all medium and high priority basins on or before June 30, 2017 and that the GSA or GSAs for basins DWR has not designated as "subject to critical conditions of overdraft" develop a GSP or coordinated GSPs on or before January 31, 2022; and

WHEREAS, the San Luis Obispo Valley Groundwater Basin (Basin) has been designated by DWR as a medium priority basin, but not subject to critical conditions of overdraft; and

WHEREAS, the County of San Luis Obispo and the City of San Luis Obispo are each a "local agency" within the Basin as defined in Water Code Section 10721(n) and thus are eligible to form GSAs; and

WHEREAS, it is anticipated that the City of San Luis Obispo will form a GSA for the portion of the Basin within the City boundary; and

WHEREAS, the County of San Luis Obispo intends to form a GSA to cover all other portions of the Basin; and

WHEREAS, SGMA authorizes certain entities, specifically water corporations regulated by the Public Utilities Commission and mutual water companies, to participate in a GSA through a memorandum of agreement or other legal agreement; and

WHEREAS, a number of such entities overlie the Basin, including the Edna Valley Growers Mutual Water Company, the Edna Ranch Mutual Water Company, the Varian Ranch Mutual Water Company and the Golden State Water Company, and it is anticipated that such entities will desire to enter into a memorandum of agreement with the County and City of San Luis Obispo establishing a process by which such entities will participate in the preparation of the GSP for the Basin; and

WHEREAS, the County of San Luis Obispo published a notice of public hearing consistent with the requirements contained within Water Code Section 10723(b); and

WHEREAS, the Board of Supervisors conducted such a public hearing on May 23, 2017; and

WHEREAS, the County of San Luis Obispo is committed to the sustainable management of groundwater within the Basin and intends to consider the interests of all beneficial users and uses of groundwater within the Basin through, among other things, coordination with the City of San Luis Obispo and the entities eligible to participate in SGMA as described above.

NOW, THEREFORE, BE IT RESOLVED AND ORDERED by the Board of Supervisors of the County of San Luis Obispo, State of California, that:

Section 1: The foregoing recitals are true and correct and are incorporated herein by reference.

Section 2: The County of San Luis Obispo hereby decides to become the GSA for, and undertake sustainable groundwater management within, the Basin, with the exception of the portions of the Basin located within the City of San Luis Obispo ("GSA Boundary"). The GSA shall be known as the San Luis Obispo Valley Basin – County of San Luis Obispo Groundwater Sustainability Agency, and a map of the GSA Boundary is attached hereto as Exhibit A and incorporated herein.

Section 3: The Director of Public Works of the County of San Luis Obispo, or designee, is hereby authorized and directed to submit notice of adoption of this Resolution in addition to all other information required by SGMA, including but not limited to, all information required by Water Code Section 10723.8, to DWR, and to develop and maintain an interested persons list as described in Water Code Section 10723.4 and a list of interested parties as described in Water Code Section 10723.8(a)(4).

Section 4: The Director of Public Works of the County of San Luis Obispo, or designee, is hereby authorized and directed to take such other and further actions as may be necessary or appropriate to implement the intent and purposes of this Resolution.

Section 5: The Board of Supervisors finds that the adoption of this Resolution is exempt from the requirements of the California Environmental Quality Act (Public Resources Code §§ 21000 et seq.) (CEQA) pursuant to Section 15061(b)(3) of the CEQA Guidelines.

Section 6: The Environmental Coordinator of the County of San Luis Obispo is hereby directed to file a Notice of Exemption in accordance with the provisions of CEQA.

Upon motion of Supervisor Hill, seconded by Supervisor Gibson, and on the following roll call vote, to wit:

AYES: Supervisors Hill, Gibson, Compton, Arnold and Chairperson Peschong

NOES: None

ABSENT: None

ABSTAINING: None

the foregoing resolution is hereby adopted on the 23rd day of May, 2017.

John Peschong
Chairperson of the Board of Supervisors

ATTEST:

TOMMY GONG
Clerk of the Board of Supervisors

By: Annette Ramirez
Deputy Clerk
[SEAL]

APPROVED AS TO FORM AND LEGAL EFFECT:

RITA L. NEAL
County Counsel

By: /s/ Erica Stuckey
Deputy County Counsel

Dated: May 1, 2017

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STATE OF CALIFORNIA,)
) **ss.**
COUNTY OF SAN LUIS OBISPO)

I, Tommy Gong, County Clerk and ex-officio Clerk of the Board of Supervisors, in and for the County of San Luis Obispo, State of California, do hereby certify the foregoing to be a full, true and correct copy of an order made by the Board of Supervisors, as the same appears spread upon their minute book.

WITNESS my hand and the seal of said Board of Supervisors, affixed this 23rd day of May, 2017.

Tommy Gong
County Clerk and Ex-Officio Clerk
of the Board of Supervisors

(SEAL)

By: [signature]
Deputy Clerk

D

Memorandum of Agreement – Preparation of GSP

DICK 1.

MEMORANDUM OF AGREEMENT REGARDING PREPARATION OF A GROUNDWATER SUSTAINABILITY PLAN FOR THE SAN LUIS OBISPO VALLEY GROUNDWATER BASIN

This Memorandum of Agreement ("MOA") is entered into by and between the City of San Luis Obispo ("City"), the County of San Luis Obispo ("County"), the Edna Valley Growers Mutual Water Company ("EVGMWC"), the Varian Ranch Mutual Water Company ("VRMWC"), the Edna Ranch Mutual Water Company ("ERMWC") and the Golden State Water Company ("GSWC") (each referred to individually as a "Party" and collectively as the "Parties") for purposes of coordinating preparation of a single groundwater sustainability plan for the San Luis Obispo Valley Groundwater Basin.

Recitals

WHEREAS, on September 16, 2014, Governor Jerry Brown signed into law Senate Bills 1168 and 1319 and Assembly Bill 1739, known collectively as the Sustainable Groundwater Management Act ("SGMA"), which became effective on January 1, 2015 and which have been and may continue to be amended from time to time; and

WHEREAS, SGMA requires the establishment of a groundwater sustainability agency ("GSA") or agencies for all basins designated as medium- or high-priority by the Department of Water Resources ("DWR") on or before June 30, 2017; and

WHEREAS, SGMA further requires the adoption of a groundwater sustainability plan ("GSP") or coordinated GSPs for all basins designated by DWR as medium- or high-priority and not subject to critical conditions of overdraft on or before January 31, 2022; and

WHEREAS, DWR has designated the San Luis Obispo Valley Groundwater Basin (Basin No. 3-9) ("Basin") as a medium-priority basin not subject to critical conditions of overdraft; and

WHEREAS, the County and the City have each decided to become the GSA within their respective service areas overlying the Basin and have informed DWR of their decision and intent to undertake sustainable groundwater management therein; and

WHEREAS, the County and the City desire to collectively develop a single GSP to sustainably manage the Basin; and

WHEREAS, the County and the City further desire to include the other Parties to this MOA who each constitute entities eligible to participate in a GSA (sometimes referred to individually as a "Participating Party" or collectively as the "Participating Parties") in the development of the GSP through the creation of the Groundwater Sustainability Commission.

NOW, THEREFORE, it is mutually understood and agreed as follows:

Section 1
Purpose

This MOA is entered into by the Parties for the purpose of establishing the manner in which the City and the County, with input from the Participating Parties, will coordinate in the development of a single GSP for the Basin that will be considered for adoption by the City Council and the County Board of Supervisors and subsequently submitted to DWR for approval. This MOA may also serve as the basis for continued cooperation among the City and the County in the management of the Basin during the period between adoption of the GSP by the City Council and the County Board of Supervisors and approval of the GSP by DWR. As more specifically set forth in Section 10.3 below, this MOA shall automatically terminate upon DWR's approval of the GSP for the Basin.

Section 2
Term

This MOA shall become effective on the date that the last of the six (6) Parties signs ("Effective Date") and shall remain in effect until terminated in accordance with Section 9.2 or Section 10.3 below.

Section 3
City and County Roles and Responsibilities

3.1 The City and the County shall work jointly to meet the objectives of this MOA.

3.2 The City and the County shall retain the services of a consultant(s) to meet the objectives of this MOA, including, but not limited to, preparation of a GSP for the Basin in accordance with the provisions set forth in Section 7 below.

3.3 The City and the County shall each designate a staff person(s) to participate in the development of the GSP and related technical studies through, without limitation, the provision of guidance and available data, in coordination with the consultant(s), and to administer the Groundwater Sustainability Commission (e.g. to, among other things, timely publish all agendas and take minutes).

3.4 The City and the County shall each be responsible for adopting the GSP and implementing the GSP within their respective service areas. Notwithstanding the foregoing, nothing contained in this MOA shall be construed as obligating either the City Council or the County Board of Supervisors to adopt the GSP developed pursuant to this MOA or as preventing either the City Council or the County Board of Supervisors from adopting the GSP developed under this MOA in the event that the other elects not to adopt it or in the event that the Groundwater Sustainability Commission fails to recommend approval.

3.5 The City and the County may lead certain Basin-wide public outreach and stakeholder involvement to improve development of the GSP.

3.6 The City shall be responsible for taking all legally required actions associated with its appointment of the member and alternate member to the Groundwater Sustainability Commission representing the City as set forth in Section 4.5, including, without limitation, all applicable requirements under the Maddy Act (Government Code §§ 54970 et seq.) and the County shall be responsible for taking all such actions associated with its appointment of the member and alternate member to the Groundwater Sustainability Commission representing the County and its confirmation of the members and alternate members to the Groundwater Sustainability Commission representing the Participating Parties as set forth in Section 4.4 and Section 4.3, respectively.

Section 4
Establishment of the Groundwater Sustainability Commission

4.1 The City and the County hereby establish the Groundwater Sustainability Commission to serve as an advisory committee to the City Council and the County Board of Supervisors in connection with preparation of the GSP and interim Basin management actions subject to each Participating Party making its required contributions under Section 6(B).

4.2 The Groundwater Sustainability Commission shall be composed of five (5) members: one (1) member representing the City, one (1) member representing the County, one (1) member representing EVGMWC, one (1) member collectively representing VRMWC and ERMWC and one (1) member representing GSWC.

4.3 Each of the Participating Parties shall nominate a member and an alternate member to represent it on the Groundwater Sustainability Commission subject to confirmation by the County Board of Supervisors with the exception that VRMWC and ERMWC shall jointly nominate a member and an alternate member to represent them subject to confirmation by the County Board of Supervisors. Said members shall serve at the pleasure of the County Board of Supervisors and may be removed at any time provided that the County Board of Supervisors shall have no authority to replace a removed member with an individual who has not been nominated by the relevant Participating Party or collection of Participating Parties.

4.4 The County Board of Supervisors shall appoint the member and alternate member representing the County and said members shall serve at the pleasure of the County Board of Supervisors.

4.5 The City Council shall appoint the member and alternate member representing the City and said members shall serve at the pleasure of the City Council.

4.6 All meetings of the Groundwater Sustainability Commission shall be conducted in accordance with the Ralph M. Brown Act (Government Code §§ 54950 et seq.).

4.7 A majority of the members of the Groundwater Sustainability Commission shall constitute a quorum for purposes of transacting business, except that less than a quorum may vote to adjourn the meeting.

4.8 Each member of the Groundwater Sustainability Commission shall be entitled to one (1) vote on any matter under consideration by the Groundwater Sustainability Commission.

4.9 All advisory opinions submitted by the Groundwater Sustainability Commission to the City Council and the County Board of Supervisors shall be supported by a majority of the members, except for the recommendation to adopt the GSP or any amendments thereto which shall be supported by at least four (4) of the members.

4.10 The County Board of Supervisors and the City Council may approve or reject any advisory opinion submitted by the Groundwater Sustainability Commission provided that in every case that the County Board of Supervisors or City Council rejects an advisory opinion of the Groundwater Sustainability Commission related to the contents or adoption of the GSP it shall do so only after holding a public hearing, at which time the members of the Groundwater Sustainability Commission shall have the right to appear and address the City Council and the County Board of Supervisors.

4.11 None of the members or alternate members shall be entitled to any compensation from the County or the City for their service on the Groundwater Sustainability Commission.

Section 5
Establishment of Additional Advisory Committees

The City Council and the County Board of Supervisors may from time to time jointly establish one or more additional advisory committees or establish standing or ad hoc committees to assist in carrying out the purposes and objectives of this MOA. Without limiting the foregoing, it is anticipated that the City Council and the County Board of Supervisors will establish a stakeholder advisory committee to the Groundwater Sustainability Commission to consider the interests of beneficial uses and users not already represented on the Groundwater Sustainability Commission consistent with Water Code Section 10723.2.

Section 6
Funding

The City and the County agree to jointly fund the costs associated with implementation of this MOA in accordance with and subject to the following:

A. Within sixty (60) days of the Effective Date and prior to each anniversary of the Effective Date, City and County staff shall prepare an annual budget for the GSAs to implement this MOA for approval by the City Council and the County Board of Supervisors.

B. Each of the Participating Parties shall be responsible for contributing the following funds to help defray the costs of the Groundwater Sustainability Commission and in consideration for their participation thereon within thirty (30) days of the Effective Date and within thirty (30) days of each anniversary of the Effective Date:

EVGMWC	$28,200
VRMWC	$4,550
ERMWC	$4,550
GSWC	$12,700

C. Subject to City Council and County Board of Supervisor approval of the annual budget, the City and County agree to fund the annual budget (less the contributions set forth in Section 6(B)) in accordance with the percentage allocations set forth below. Notwithstanding the foregoing and Section 10.1, the City Council and the County Board of Supervisors may amend said percentage allocations without the agreement of the Participating Parties.

County	70%
City	30%

D. It is anticipated that the vast majority of budgeted costs to be paid by the City and the County will involve costs for consultant services. Consequently, most City and County contributions will be paid in the manner described in Section 7 below.

Section 7
Retention of Consultants

7.1 The County agrees to act as the contracting agent to retain the services of a consultant(s) as described in Section 3.2 above.

7.2 Notwithstanding the foregoing, the County agrees that the City and one (1) member of the Groundwater Sustainability Commission not representing the City or the County designated by the Groundwater Sustainability Commission shall be included in the selection of any consultant retained by the County pursuant to this MOA. More specifically, a staff representative from the City and the designated member of the Groundwater Sustainability Commission shall be given an opportunity to review and approve all requests for proposals prior to their release and to participate in the various stages of the selection process, including, but not limited to, review of proposals and participation on interview panels.

7.3 All consultant contracts entered into by the County pursuant to this MOA shall include the following: (1) a provision requiring that the consultant name the City as an additional insured, (2) an expected spend plan estimating the amount of the not to exceed contract amount that the consultant expects to invoice each month, and (3) a provision requiring that the consultant calculate both the County and City's share of each invoice consistent with Section 6(C) and send monthly invoices to both the County and the City showing the foregoing calculation.

7.4 Both the City and the County shall be responsible for remitting payment of their share of each monthly invoice directly to the consultant within thirty (30) days of receipt or within the time frame otherwise set forth in the consultant contract.

Section 8
Notice

8.1 To provide for consistent and effective communication among the Parties, each Party shall designate a representative as its central point of contact on matters relating to this MOA.

8.2 All notices, statements, or payments related to this MOA shall be deemed to have been duly given if in writing and delivered electronically, personally or mailed by first-class, registered or certified mail to the Parties at the addresses set forth in Exhibit A. The Parties may update Exhibit A from time to time without formal amendment to this MOA.

Section 9
Withdrawal and Termination

9.1 Any Participating Party may unilaterally withdrawal from this MOA without causing or requiring termination of this MOA. Withdrawal shall become effective upon thirty (30) days written notice to the remaining Parties' designated addresses as listed in Exhibit A. A Participating Party that has withdrawn from this MOA shall remain obligated to pay its allocation of the current annual budget. If a Participating Party withdraws, the Groundwater Sustainability Commission shall automatically be reconstituted to no longer include a member or alternate member representing the withdrawing Participating Party. In addition, the withdrawing Participating Party's annual contribution as set forth in Section 6(B) for all subsequent years shall be allocated among the remaining Participating Parties on a pro rata basis.

9.2 This MOA may be terminated by either the City or the County upon thirty (30) days written notice to all Parties' designated addresses as listed in Exhibit A. Upon termination, any unused portion of the cost contributions described in Section 6(B) and Section 6(C) as of the effective date of termination shall be returned to each Party on a pro rata basis. If the City terminates this MOA, it shall remain obligated to pay its cost share obligation under any existing consultant contract entered into by the County pursuant to this MOA.

Section 10
Miscellaneous

10.1 Subject to the exception set forth in Section 6(C), this MOA may be amended only by unanimous written consent of all current Parties.

10.2 This MOA may be executed in counterparts.

10.3 This MOA shall automatically terminate upon DWR's approval of the adopted GSP. Depending on the content of the GSP, the Parties may decide to enter into a new agreement to coordinate GSP implementation.

10.4 This MOA is made in the State of California, under the Constitution and laws of said State and is to be so construed.

10.5 If any provision of this MOA is determined to be invalid or unenforceable, the remaining provisions shall remain in full force and unaffected to the fullest extent permitted by law and regulation.

10.6 This MOA constitutes the sole, entire, integrated and exclusive agreement between the Parties regarding the contents herein. Any other contracts, agreements, terms, understandings, promises or representations not expressly set forth or referenced in this writing are null and void and of no force and effect.

10.7 The Parties agree and acknowledge that this MOA has been developed through negotiation, and that each Party has had a full and fair opportunity to revise the terms of this MOA. Consequently, the normal rule of construction that any ambiguities are to be resolved against the drafting party shall not apply in construing or interpreting this MOA.

[signatures to follow on next page]

IN WITNESS WHEREOF, the Parties have executed this MOA by authorized officials thereof on the dates indicated below.

CITY OF SAN LUIS OBISPO

By: ____________________

Its: ____________________

Date: ____________________

APPROVED AS TO FORM AND LEGAL EFFECT:

By: ____________________

Its: ____________________

Date: ____________________

COUNTY OF SAN LUIS OBISPO

B

Its

Date

APPROVED AS TO FORM AND LEGAL EFFECT:

By: [signature]

Its: Deputy County Counsel

Date: Nov. 6, 2017

EDNA VALLEY GROWERS MUTUAL WATER COMPANY

By: ____________________

Its: ____________________

Date: ____________________

VARIAN RANCH MUTUAL WATER COMPANY

By: ____________________

Its: ____________________

Date: ____________________

EDNA RANCH MUTUAL WATER COMPANY

By: ____________________

Its: ____________________

Date: ____________________

GOLDEN STATE WATER COMPANY

By: ____________________

Its: ____________________

Date: ____________________

IN WITNESS WHEREOF, the Parties have executed this MOA by authorized officials thereof on the dates indicated below.

CITY OF SAN LUIS OBISPO

By: ____________________

Its: ____________________

Date: ____________________

APPROVED AS TO FORM AND LEGAL EFFECT:

By: ____________________

Its: ____________________

Date: ____________________

COUNTY OF SAN LUIS OBISPO

By: JOHN PESCHONG

Its: Chairperson, Board of Supervisors, County of San Luis Obispo, State of California

Date: January 9, 2018

APPROVED AS TO FORM AND LEGAL EFFECT:

By: ____________________

Its: ____________________

Date: ____________________

ATTEST:

Tommy Gong, County Clerk-Recorder and Ex-Officio Clerk of the Board of Supervisors

By, SANDY CURRENS
Deputy Clerk

EDNA VALLEY GROWERS MUTUAL WATER COMPANY

By: [signature]

Its: President

Date: 11/2/17

EDNA RANCH MUTUAL WATER COMPANY

By: ____________________

Its: ____________________

Date: ____________________

VARIAN RANCH MUTUAL WATER COMPANY

By: ____________________

Its: ____________________

Date: ____________________

GOLDEN STATE WATER COMPANY

By: ____________________

Its: ____________________

Date: ____________________

IN WITNESS WHEREOF, the Parties have executed this MOA by authorized officials thereof on the dates indicated below.

CITY OF SAN LUIS OBISPO

By: ____________________

Its: Mayor

Date: 1/26/18

APPROVED AS TO FORM AND LEGAL EFFECT:

By: ____________________

Its: Asst. City Attorney

Date: 1/25/18

COUNTY OF SAN LUIS OBISPO

By: ____________________

Its: ____________________

Date: ____________________

APPROVED AS TO FORM AND LEGAL EFFECT:

By: ____________________

Its: Deputy County Counsel

Date: Nov. 6, 2017

EDNA VALLEY GROWERS MUTUAL WATER COMPANY

By: ____________________

Its: ____________________

Date: ____________________

VARIAN RANCH MUTUAL WATER COMPANY

By: ____________________

Its: ____________________

Date: ____________________

EDNA RANCH MUTUAL WATER COMPANY

By: ____________________

Its: ____________________

Date: ____________________

GOLDEN STATE WATER COMPANY

By: ____________________

Its: ____________________

Date: ____________________

EXHIBIT A
PARTY ADDRESS LIST

County of San Luis Obispo
County Government Center, Room 206
San Luis Obispo, CA 93408
Attention: Wade Horton, Public Works Director

City of San Luis Obispo
Utilities Department
879 Morro Street
San Luis Obispo, CA 93401-2710
Attention: Carrie Mattingly, Utilities Director

Edna Valley Growers Mutual Water Company
4910 Edna Road
San Luis Obispo, CA 93401
Attention: Bob Schiebelhut, President

Varian Ranch Mutual Water Company
2060 Varian Circle
Arroyo Grande, CA 93420
Attention: James Lokey

Edna Ranch Mutual Water Company
5665 Edna Ranch Circle
San Luis Obispo, CA 93401
Attention: Andy Mangano

Golden State Water Company
2330 A Street, Suite A
Santa Maria, CA 93455
Attention: General Manager, Coastal District

EXHIBIT A
PARTY ADDRESS LIST

County of San Luis Obispo
County Government Center, Room 206
San Luis Obispo, CA 93408
Attention: Wade Horton, Public Works Director

City of San Luis Obispo
Utilities Department
879 Morro Street
San Luis Obispo, CA 93401-2710
Attention: Carrie Mattingly, Utilities Director

Edna Valley Growers Mutual Water Company
4910 Edna Road
San Luis Obispo, CA 93401
Attention: Bob Schiebelhut, President

Varian Ranch Mutual Water Company
2060 Varian Circle
Arroyo Grande, CA 93420
Attention: James Lokey

Edna Ranch Mutual Water Company
5665 Edna Ranch Circle
San Luis Obispo, CA 93401
Attention: Andy Mangano

Golden State Water Company
2330 A Street, Suite A
Santa Maria, CA 93455
Attention: General Manager, Coastal District

IN WITNESS WHEREOF, the Parties have executed this MOA by authorized officials thereof on the dates indicated below.

CITY OF SAN LUIS OBISPO

By: ____________________

Its: ____________________

Date: ____________________

APPROVED AS TO FORM AND LEGAL EFFECT:

By: ____________________

Its: ____________________

Date: ____________________

COUNTY OF SAN LUIS OBISPO

By: ____________________

Its: ____________________

Date: ____________________

APPROVED AS TO FORM AND LEGAL EFFECT:

By: ____________________

Its: ____________________

Date: ____________________

EDNA VALLEY GROWERS MUTUAL WATER COMPANY

By: ____________________

Its: ____________________

Date: ____________________

EDNA RANCH MUTUAL WATER COMPANY

By: ____________________

Its: ____________________

Date: ____________________

VARIAN RANCH MUTUAL WATER COMPANY

By: [illegible signature]

Its: President

Date: 10/31/2017

GOLDEN STATE WATER COMPANY

By: ____________________

Its: ____________________

Date: ____________________

IN WITNESS WHEREOF, the Parties have executed this MOA by authorized officials thereof on the dates indicated below.

CITY OF SAN LUIS OBISPO

By: ____________________

Its: ____________________

Date: ____________________

APPROVED AS TO FORM AND LEGAL EFFECT:

By: ____________________

Its: ____________________

Date: ____________________

COUNTY OF SAN LUIS OBISPO

By: ____________________

Its: ____________________

Date: ____________________

APPROVED AS TO FORM AND LEGAL EFFECT:

By: ____________________

Its: ____________________

Date: ____________________

EDNA VALLEY GROWERS MUTUAL WATER COMPANY

By: ____________________

Its: ____________________

Date: ____________________

EDNA RANCH MUTUAL WATER COMPANY

By: [signature]

Its: PRESIDENT

Date: 11/14/17

VARIAN RANCH MUTUAL WATER COMPANY

By: ____________________

Its: ____________________

Date: ____________________

GOLDEN STATE WATER COMPANY

By: ____________________

Its: ____________________

Date: ____________________

IN WITNESS WHEREOF, the Parties have executed this MOA by authorized officials thereof on the dates indicated below.

CITY OF SAN LUIS OBISPO

By: ____________________

Its: ____________________

Date: ____________________

APPROVED AS TO FORM AND LEGAL EFFECT:

By: ____________________

Its: ____________________

Date: ____________________

COUNTY OF SAN LUIS OBISPO

By: ____________________

Its: ____________________

Date: ____________________

APPROVED AS TO FORM AND LEGAL EFFECT:

By: ____________________

Its: ____________________

Date: ____________________

EDNA VALLEY GROWERS MUTUAL WATER COMPANY

By: ____________________

Its: ____________________

Date: ____________________

VARIAN RANCH MUTUAL WATER COMPANY

By: ____________________

Its: ____________________

Date: ____________________

EDNA RANCH MUTUAL WATER COMPANY

By: ____________________

Its: ____________________

Date: ____________________

GOLDEN STATE WATER COMPANY

By: Denise Kruger

Its: Sr. Vice President

Date: November 3, 2017

E

Notice and Communication

Communication and Engagement Plan

C&E Plan Implementation Workplan

DRAFT

Communication and Engagement Plan

for Groundwater Sustainability Plan Development in the San Luis Obispo Valley Groundwater Basin

Prepared for San Luis Obispo County

June 5, 2019

Table of Contents

The Sustainable Groundwater Management Act (SGMA) requires local governments and water agencies in California's high- and medium-priority groundwater basins, as defined by the California Department of Water Resources (DWR), to form Groundwater Sustainability Agencies (GSAs) and operate under a Groundwater Sustainability Plan (GSP) by the year 2022. Basins subject to critical conditions of overdraft must begin to manage groundwater under a GSP sooner – by January 31, 2020.

This Communication and Engagement Plan (C&E Plan) describes the planned activities for engaging interested parties in SGMA implementation efforts in the San Luis Obispo Valley Basin. It is designed to meet the stakeholder engagement requirements of SGMA and the GSP Regulations. The ultimate purpose of the document is to facilitate effective communication and engagement with the multiple and varied stakeholders in the San Luis Obispo Valley Basin.

Structure of this C&E Plan

DWR defines the purpose of its Stakeholder *Communication and Engagement Guidance Document* (C&E Guidance Document) to:

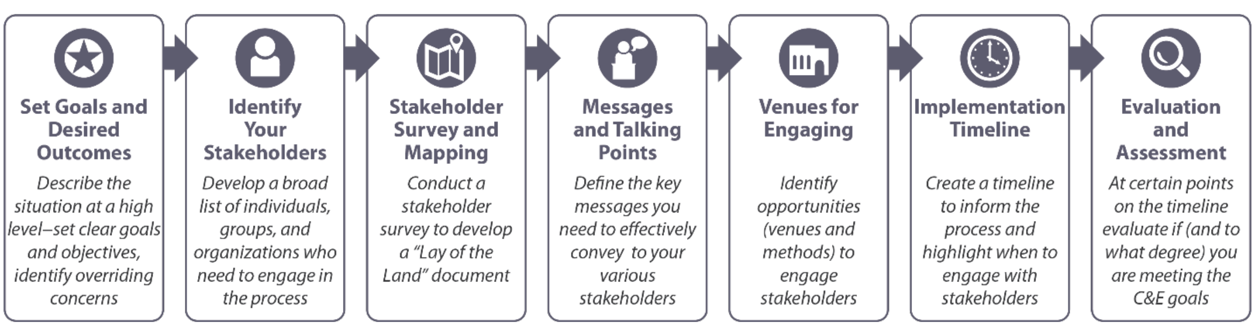
- Demonstrate how a GSA can effectively communicate and engage with multiple and varied stakeholders
- Identify the methods and tools to support communication and engagement
- Identify how a GSA can conduct meaningful engagement to develop a GSP

The C&E Guidance Document describes DWR's seven-step process for communication and engagement:

1. ***Set Goals and Desired Outcomes***
2. ***Identify Your Stakeholders***
3. ***Stakeholder Survey and Mapping***
4. ***Messages and Talking Points***
5. ***Venues for Engaging***
6. ***Implementation Timeline***
7. ***Evaluation and Assessment***

This C&E Plan is organized to follow the steps suggested above and shown in **Figure 1**.

***Figure 1**. Engagement Steps from DWR GSP Stakeholder and Engagement Guidance Document*



1. Introduction to the San Luis Obispo Valley Basin

The San Luis Obispo Valley Basin (Groundwater Basin 3-009[1]) is situated in the San Luis and Edna Valleys in central to southwest San Luis Obispo County. The basin overlies an area of approximately 12,700 acres and is part of the Central Coast Watershed. It is bound on the northeast by the Santa Lucia Range, on the southwest by the San Luis Range, and on all other sides by contact with impermeable Miocene and Franciscan Group rocks. A rise in bedrock south of the San Luis Obispo Airport has created two separate subsurface drainage systems known as the San Luis Valley subbasin and the Edna Valley subbasin. The Edna Valley subbasin covers approximately 4,700 acres and is entirely within the unincorporated San Luis Obispo County (County). The San Luis Valley subbasin spans approximately 8,000 acres and includes both the unincorporated county and city of San Luis Obispo (City).

- **City of San Luis Obispo.** The City of San Luis Obispo is located near the intersection of Highway 101 and Hwy 1. A portion of the City is located within the basin. The City's land uses consist primarily of commercial and residential areas.
- **San Luis Obispo County.** San Luis Obispo County is located in the southern region of California between approximately San Miguel and Santa Maria. The entire basin is located within the County. The County's land uses consist of commercial, agricultural, residential, and undeveloped lands.

The primary sources of water supply for uses in the basin include groundwater from the San Luis Obispo Valley Basin and surface water from the Whale Rock Reservoir, Salinas Reservoir, the Nacimiento Water Project, and recycled water through the City's Water Recycling Program.[2]

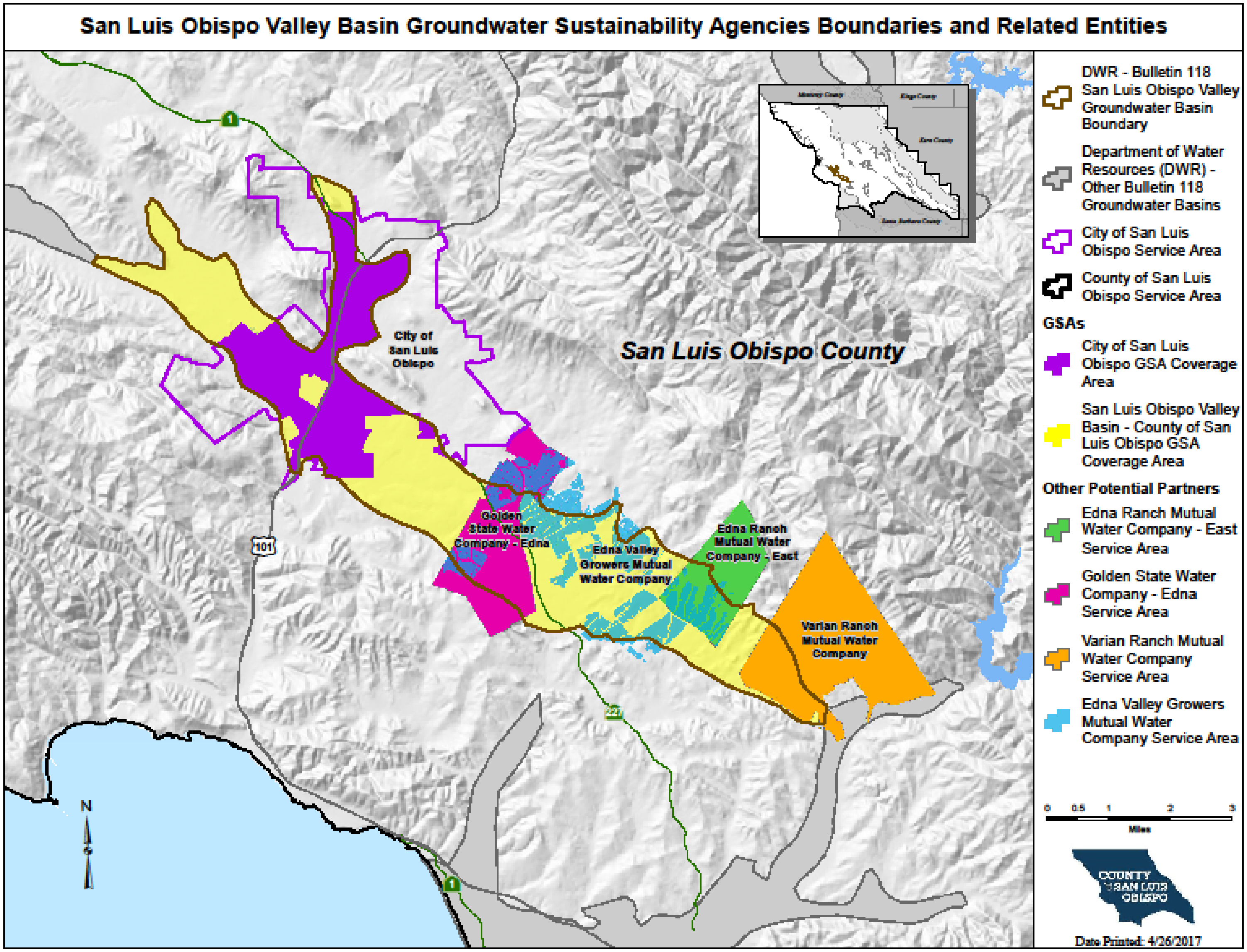
Water users in the basin include municipalities, communities, rural domestic residences, and industrial, environmental, and agricultural users. The major water purveyors are the Edna Valley Growers Mutual Water Company, Varian Ranch Mutual Water Company, Edna Ranch Mutual Water Company, and Golden State Water Company.

Figure 2 shows the location of the San Luis Obispo Valley Basin and the GSA boundaries.

[1] As identified and delineated in California Department of Water Resources Bulletin 118 https://water.ca.gov/Programs/Groundwater-Management/Bulletin-118

[2] https://www.slocity.org/government/department-directory/utilities-department/water/water-sources/recycled-water

***Figure 2**. San Luis Obispo Valley Basin Groundwater Sustainability Agency Boundary*



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2. Goals and Desired Outcomes

The goal of this C&E Plan is to describe the planned activities for engaging interested parties in SGMA implementation efforts in the San Luis Obispo Valley Basin and to provide opportunities for interested parties to participate in GSP development. This plan serves as a roadmap to support achieving the desired outcomes identified below.

- **Educate the public about the importance of the GSP and the value of their input.** Stakeholder input is a critical part of the GSP development process. Basin stakeholders define the values of the local community and priorities for groundwater management. This valuable input identifies the unique concerns of the stakeholders and guides decision-making and development of projects and management actions. The C&E Plan is designed to encourage stakeholder participation and to disseminate information about GSP development.
- **Engage a diverse group of stakeholders.** The C&E Plan is developed with thoughtful consideration about how to engage the diverse array of stakeholders in the basin. One size does not fit all when it comes to stakeholder engagement. The C&E Plan outlines multiple venues for communication with varied audiences.
- **Make stakeholder participation easy and accessible.** One way to increase engagement is to make participation easy for the stakeholders. The opportunities for stakeholders to engage in GSP development should be clear and easily accessible. The C&E Plan provides methods to make engagement easy for stakeholders.
- **Allow interested parties the opportunity to provide meaningful input.** Aligning the engagement schedule with the GSP development schedule allows stakeholders to engage at key decision points in the GSP development process. Public meetings will inform interested parties about what decisions need to be made, provide relevant technical information, and request feedback.
- **Provide a roadmap for GSA leadership.** The C&E Plan provides a clear roadmap and schedule for GSA leaders to follow, keeping engagement efforts consistent among stakeholders and on track throughout the duration of the project.

The goal and desired outcomes listed above are the drivers for this planning document. They inform and shape the remainder of this C&E Plan.

3. GSP Participants and the Decision-Making Process

Everyone in the basin has a role to play in GSP development. Generally, participants fall into one of the following groups.

- GSA Leadership
- Technical Experts
- Interested Parties

Each of these groups provide a unique contribution to the GSP.

GSA Leadership

To comply with SGMA, two GSAs were formed to manage the groundwater resources of the San Luis Obispo Valley Basin in a sustainable manner as directed under a GSP that must be prepared by 2022 and implemented for the next 40 years

- City of San Luis Obispo Groundwater Sustainability Agency
- San Luis Obispo Valley Basin - County of San Luis Obispo Groundwater Sustainability Agency

In January 2018, the City and the County entered into a Memorandum of Agreement (MOA) with the Edna Valley Growers Mutual Water Company, Varian Ranch Mutual Water Company, Edna Ranch Mutual Water Company, and Golden State Water Company to prepare a single GSP for the San Luis Obispo Valley Basin, establishing the Groundwater Sustainability Commission (GSC or Commission). The GSC serves as an advisory committee to the San Luis Obispo City Council and County of San Luis Obispo Board of Supervisors.

The GSC has five members as shown in **Table 1**.

Table 1. Commission Membership

San Luis Obispo Valley Groundwater Sustainability Commission Members
• One member representing the City • One member representing the County • One member representing Edna Valley Growers Mutual Water Company • One member collectively representing Varian Ranch Mutual Water Company and Edna Ranch Mutual Water Company • One member representing Golden State Water Company

All meetings of the Commission are open to the public and interested parties are encouraged to attend. The Commission will make recommendations to the City Council and County Board of Supervisors regarding GSP development (e.g., recommendation to adopt). A public Notice of Intent to adopt the GSP and a public hearing will be held prior to adoption of the GSP. The final decision-making power to adopt the GSP will be executed separately by the City Council and County Board of Supervisors.

Technical Experts

Technical experts are there to provide subject matter expertise on highly complex issues about the basin and surrounding basins and to inform the Commission and interested parties about the benefits and consequences of potential projects and management actions identified in GSP development. Technical experts may include outside consultants or staff of agencies that are signatories to the MOA. Section 3.2 of the MOA outlines how the City and County will retain consultant services.

Interested Parties

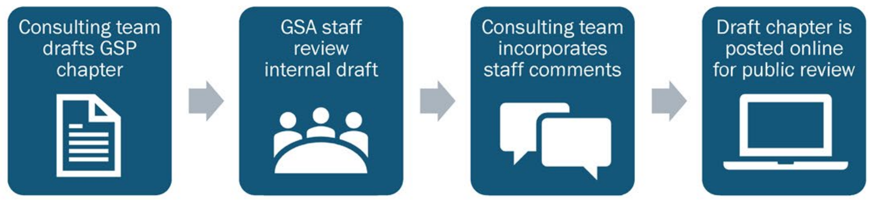
Interested parties consist of beneficial users of groundwater, stakeholders, and anyone affected/impacted by groundwater in and around basin. The interested parties may represent environmental interests, Native American tribes, agricultural interests, urban groundwater users, etc. *GSA Leadership* and *Technical Experts* provide information to interested parties through the engagement venues and tools described in this plan. The interested parties provide input regarding the priorities and values of the community and the likelihood of the success of proposed project concepts and the hurdles that must be overcome to achieve groundwater sustainability. Interested parties may also include agencies, such as the U.S. Department of Fish and Wildlife, with an interest in sustainable groundwater management in the basin. Interested parties can participate in the GSP development process by attending public meetings, commenting on draft documents, and participating in workshops. More information on interested parties is included in **Section 4. Stakeholder Groups**.

GSP Chapter Review Process

The San Luis Obispo Valley Basin GSAs formulated a process for reviewing draft GSP chapters, as illustrated in ***Figure 3***. GSA leadership, technical experts, and interested parties have an opportunity to provide feedback on each chapter of the GSP at varying stages of the review process.

The individual chapters will be prepared by the consulting team with input from GSA staff. After the draft chapters have been approved by the Commission they will be posted on the Portal to begin a minimum 30-day comment period. Specific dates will be provided for each draft document to allow for adequate review. Public comments will be submitted through the Portal and all comments received will be available for review. The comments will be reviewed by the technical experts and be considered for inclusion in the draft GSP.

Figure 3. *GSP Chapter Review Process*



	Consulting team drafts GSP chapter	GSA staff review internal draft	Consulting team incorporates staff comments	Draft chapter is posted online for public review
Technical Specialist				
Consultant	X		X	
GSA Staff		X		
GSA Leadership				
GSC (the Commission)				X
Interest Parties				X
GSA				

GSP Review Process

Comments collected during public review of draft chapters will be considered when revising the chapters for the Draft GSP. After the draft GSP has been approved by the Commission it will be posted on the Portal to begin an additional minimum 30-day comment period. The roles of the GSP participants in preparation of the Final Draft GSP will follow the steps shown in Figure 4.

Figure 4. *GSP Review Process*

	Consulting team drafts GSP	GSA staff review internal draft GSP	Consulting team incorporates staff comments	Draft GSP is posted online for public review
Technical Specialist				
Consultant	X		X	
GSA Staff		X		
GSA Leadership				
GSC (the Commission)				X
Interest Parties				X
GSA				

GSP Adoption Process

Once the GSP has been finalized, the Commission will make a recommendation to the GSAs to adopt the GSP. The City of San Luis Obispo City Council and San Luis Obispo County Board of Supervisors will then consider adoption of the GSP. The GSP participants with responsibilities in this phase are shown in Figure 5.

Figure 5. *GSP Adoption Process*

	Final GSP posted	GSAs adopt GSP
Technical Specialist		
Consultant		
GSA Staff		
GSA Leadership		
GSC (the Commission)	X	
Interest Parties		
GSA		X

4. Stakeholder Groups

Pursuant to California Water Code sections 10723.8 and 10723.2, the San Luis Obispo Valley Basin GSAs will consider throughout the project the interests of all beneficial uses and users of groundwater, as well as those that are responsible for implementing the actions developed within the basin's GSP. The San Luis Obispo Valley Basin GSAs are committed to an open public review and feedback process, including active and open discussions with all interested parties during the GSP development process. ***Appendix A*** includes the initial list of interested parties submitted to the California Department of Water Resources at the time of the GSA's formation. The list includes parties grouped by the categories below.

- Agencies
- Water corporations regulated by PUC or a Mutual Water Company
- Agricultural users
- Domestic well owners
- Municipal well operators
- Public water systems
- Local land use planning agencies
- Environmental users of groundwater
- Surface water users
- Federal government
- California Native American tribes
- Disadvantaged Communities

Stakeholder Group Identification

The stakeholder list provided in ***Appendix A*** was used to form the Basin's initial interested parties list. The interested parties list was expanded by adding information collected via the SGMA interest e-mail list hosted on the County's website.[3] The SGMA interest e-mail list has been online for more than one year and over 280 parties have indicated interest in being added to the Basin's mailing list.

Once signed up for the interest list, parties are contacted via email when events related to GSP development are scheduled for the San Luis Obispo Valley Basin. The interested parties list will continue to expand as people answer the stakeholder survey (**Section 5**) and are encouraged to sign up for communications via the Groundwater Communication Portal described below.

Groundwater Communication Portal

A web-based outreach tool called the San Luis Obispo Valley Basin Groundwater Communication Portal (Portal) electronically notifies interested parties when the GSAs host events regarding groundwater management. The Portal is used to grow and maintain the interested parties list described above. Interested parties can add themselves to the interest list and access draft chapters for review at any time by registering for portal access at [to be added once domain name has been purchased].

[3] https://www.slocounty.ca.gov/Departments/Public-Works/Committees-Programs/Sustainable-Groundwater-Management-Act-(SGMA)/San-Luis-Obispo-Valley-Groundwater-Basin.aspx

The Portal will track outreach engagements such as Commission meetings and communications with individuals or groups of stakeholders involved in the development of the GSP and store the information in a database for GSA retrieval. The database will include meeting dates, locations, times, and documents such as meeting agendas. A description of the Portal and its functions is provided in ***Appendix B*.**

5. Stakeholder Survey

DWR created a stakeholder survey template hosted at the Communication and Engagement Digital Toolkit[4] webpage. The survey is designed to learn about stakeholder interests, issues, and challenges. The survey may include the following questions:

- Are you familiar with SGMA regulations?
- Are you currently engaged in activity or discussions regarding groundwater management in this region?
- Do you own or manage land in this region?
- Do you manage water resources? If yes, what is your role?
- What is your primary interest in land or water resources management?
- Do you have concerns about groundwater management? If so, what are they?
- Do you have recommendations regarding groundwater management? If so, what are they?
- What else do you want us to know?
- Who else should we listen to?

The survey has been customized for San Luis Obispo Valley Basin GSP development and is included as ***Appendix C***. The survey is scheduled to be distributed to interested parties in Summer 2019. The results of the survey will be used to inform this plan and will be included in the Final C&E Plan submitted with the Final GSP.

[4] https://water.ca.gov/Programs/Groundwater-Management/Assistance-and-Engagement

6. Venues and Tools: Opportunities for Engagement

The San Luis Obispo Valley GSAs aim to encourage stakeholders with diverse social, cultural, and economic backgrounds to be actively involved in the GSP development. To achieve this goal, *focused engagement* and thoughtfully selected *venues and tools* should be employed.

Focused Engagement

The initial list of interested parties that was imported into the Portal from the County's SGMA email interest list included 290 entries. To support the diversity of elements and ensure we engage with potentially underrepresented communities on the list, the groups below will be given focused attention when choosing venues and tools for engagement.

- **Disadvantaged Communities.** The City is recognized as a Disadvantaged Community (DAC).[5] Meetings will be held in proximity to this area to allow easy access for interested parties. Information about GSP development and meeting dates/times will be posted in areas that the City has found to be successful in reaching underrepresented populations in previous outreach efforts. These areas include public events such as the Farmer's Market, City kiosks at City facilities such as the finance office where utility bills are paid, the parks and recreation department where after-school programs are coordinated, and other City facilities such as the Senior Citizens Center.
- **Bilingual Residents.** The GSAs will gather information regarding the languages spoken in the communities within the basin and provide translation services for the languages as appropriate per the Dymally-Alatorre Bilingual Service Act.
- **Tribal Governments.** Per SGMA §10720.3(c), any federally recognized Indian tribe may voluntarily agree to participate in the planning, financing, and management of groundwater basins. There are no federally recognized Native American tribes within the geographic boundaries of the San Luis Obispo Valley Basin. However, the Northern Chumash Tribal Council community encompasses the County area. Therefore, the San Luis Obispo Valley GSAs will refer to DWR's Engagement with Tribal Governments Guidance Document and will contact the tribal representative to invite participation in GSP development.

Stakeholder Workshops

Stakeholder workshops are designed to create opportunities for stakeholders and other interested parties to provide meaningful input during GSP chapter development. The workshop schedule is aligned with the GSP development schedule (***Appendix D***) for this purpose. The workshops will be led by technical experts such as consultants or GSA staff. Workshop dates will vary based on when input is deemed most useful. Suggestions for optimizing the benefit of the workshops are listed below.

- Choose workshop venues, dates, and times to maximize stakeholder participation.
- Use the Portal to inform interested parties about workshops during GSP development.

[5] Per DWR Disadvantaged Communities Mapping Tool at https://gis.water.ca.gov/app/dacs/; accessed May 28, 2019

- Announce the Portal at stakeholder workshops and encourage attendees to sign up.

Groundwater Sustainability Commission Meetings

Regular meetings of the Groundwater Sustainability Commission provide an opportunity for City and County staff, participating parties, and their consultants to present updates on the status of GSP development. Meetings are scheduled every three months (quarterly). See the GSP development schedule (***Appendix D***) for planned dates. An interested party may sign up on the emailing list using the Portal to receive updates on meeting dates and times. Meetings of the Groundwater Sustainability Commission are subject to the Brown Act and are open to the public.

Public Notices and Hearings

Meeting notices will be sent in advance of stakeholder workshops and Commission meetings. SGMA requires a publicly noticed hearing at three distinct points in GSP development:

- At GSA formation §10723(b) – this process is complete
- When a GSP is adopted or amended (§10728.4)
- Before imposing or increasing fees

Public Draft GSP Documents

When draft GSP component documents (e.g., chapters) are released by the Commission, they will also be posted to the Portal and will be open for public comment. A comment form will be available on the Portal to submit comments on draft documents by chapter and section. These comments will be considered when revising the public draft documents and finalizing the Final Draft GSP chapters.

Tools for Communication

Initially, the GSAs anticipate producing the informational materials listed below.

GSA Website

The County has a webpage dedicated to SGMA implementation in the San Luis Obispo Valley Basin. Both the City and County websites point to this page[6] to share information on GSP development. The site will be supplemented by the Portal as discussed below.

Groundwater Communication Portal (Portal)

The GSAs will use the San Luis Obispo Valley Basin Portal as a tool to communicate with interested parties. The Portal will store interested party information and distribute e-mail invitations for events posted to the calendar, these events may include GSC meetings, workshops, and other outreach events. There are additional tools within the Portal that will be used to enhance communication. These tools include the following:

- **E-Blast.** E-mails will be sent to interested parties for those who sign up for email notifications on the Portal using the e-blast tool. E-blasts will be effective for sending reminders of upcoming deadlines, such as the close of a survey or comment period.
- **Public Comment Form.** During public comment periods, a form will be available on the Portal for interested parties to submit comments on draft GSP documents. The form allows comments

[6] https://www.slocounty.ca.gov/Departments/Public-Works/Committees-Programs/Sustainable-Groundwater-Management-Act-(SGMA)/San-Luis-Obispo-Valley-Groundwater-Basin.aspx

by chapter and automatically stores the information for GSA review, reducing the risk of misplaced comments.

Direct Mailing

Communications about GSP development will be sent only in digital format. For those who don't have access online or prefer to receive direct postal mailings, the agenda and agenda packet will be mailed to those who request it. There may be times when a direct postal mailing is appropriate. The County sent a mailer in May 2019 to provide information about the next two Commission meetings. The mailer also includes a request form for the recipient to fill out and return to the County if he/she desires to receive notification of future events via postal mail. A copy of the mailer is provided as ***Appendix E***.

Outreach Materials

Given previous outreach efforts within City limits, the City does not believe a direct mail piece would be effective in reaching community members or the DAC population. To reach these community members, the City plans to direct outreach efforts for SGMA meetings to online resources, public events such as a Farmer's Market, and with outreach at several City kiosks at City facilities including the finance office where utility bills are paid, the parks and recreation department where after-school programs are coordinated, and at other City facilities such as the Senior Citizens Center.

FAQ

A frequently asked questions (FAQ) document will be created and updated periodically throughout the GSP development. The FAQ will address questions about SGMA, San Luis Obispo Valley Basin GSAs, and the development of the GSP. Updates to the FAQ will be posted on the Portal and on the County and City websites.

7. Evaluation and Assessment

The activities identified in this C&E Plan are designed to meet the goals and objectives identified in **Section 2**. Below, **Table 3** lists tasks compiled from the contents of this C&E Plan. This is a working list that will be modified and updated as needed throughout GSP development.

Table 3. Outreach Tasks

C&E Plan Section	Task	Description
4	Launch Groundwater Communication Portal (GCP)	Link to Portal from existing website, announce URL at Commission meeting, post future meetings to calendar, send invitations
5	Conduct Stakeholder Survey	Modify DWR's stakeholder survey for this basin, collect stakeholder feedback via custom survey (***Appendix C***)
6	Assess need for translation services	Document the GSA determination of what constitutes a substantial number of non-English speaking people per the Dymally-Alatorre Bilingual Service Act and the level to which translation services will be provided
6	Public Postings	Post information about GSP development and meetings in public spaces within the City limits such as Farmer's Market and City facilities
6	Conduct Stakeholder Workshops	Conduct stakeholder workshops per the GSP Development Schedule (***Appendix D***)
6	Public Notices	Send meeting notices in advance of stakeholder meetings, including Commission meetings
6	Direct Mailing	Send direct mail to land owners in unincorporated areas of the basin to announce GSP development and Commission meetings. Stakeholders who request it may have the agenda and agenda packet sent to them
6	Hold a public hearing for GSP adoption	Per SGMA § 10728.4, give 60-day notice and hold a public hearing to adopt the final GSP before submitting to DWR
6	Include GCP URL on printed materials	Educate public about where they can find information and updates related to groundwater management in the basin
6	Announce GCP at public meetings	Educate public about where they can find information and updates related to groundwater management in the basin (GCP)

Like the list above, this C&E Plan is a living document to be updated as needed throughout GSP development. Successful use and implementation of the task list and C&E Plan will indicate success.

8. Appendices

Appendix A. **Stakeholder lists submitted at time of GSA formations**
Appendix B. **Groundwater Communication Portal (GCP)**
Appendix C. **San Luis Obispo Valley Basin Stakeholder Survey**
Appendix D. **GSP Development Schedule**
Appendix E. **Postal Mailer: Groundwater Sustainability Plan Update**
Appendix F. **References**

Appendix A.

Stakeholder lists submitted at time of GSA formations

GSA Formation **Exhibit D: List of Beneficial Users**

Initial List of Interested Parties within the San Luis Obispo Valley Basin

Pursuant to the California Water Code Section 10723.2, the San Luis Obispo Valley Basin – County of San Luis Obispo Groundwater Sustainability Agency, in coordination with other GSAs within the San Luis Obispo Valley Groundwater Basin (Basin), will consider the interest of all beneficial uses and users, as well as those responsible for implementing a Groundwater Sustainability Plan (GSP). The County of San Luis Obispo has developed a list of interested parties and will revise the list as needed throughout the development of the GSP. An initial list of stakeholders and interested parties within the proposed San Luis Obispo Valley Basin – County of San Luis Obispo GSA service area, as defined in the water code, follows.

Agency:
County of San Luis Obispo
San Luis Obispo County Flood Control & Water Conservation District
City of San Luis Obispo
Coastal San Luis Resource Conservation District

Water Corporations Regulated by PUC or a Mutual Water Company:
Edna Ranch Mutual Water Company - East
Golden State Water Company - Edna
Varian Ranch Mutual Water Company
Edna Valley Growers Mutual Water Company
Maxwellton Mutual Water

Agricultural users:
Individual agricultural landowners
Farm Bureau
Coastal San Luis Obispo Resource Conservation District
UC Cooperative Extension
USDA Conservation Service
USDA Farm Service Agency
Grower-Shipper Association
SLO Wine Country Association

Domestic well owners:
Individual rural residential/suburban landowners
Tiffany Ranch
O'Conner Way

Municipal well operators:
Covered in other categories

Public water systems:
(per EHS records)
141 Suburban Road Water Supply
200 Suburban Road Water Supply
Bear Valley Water Company

GSA Formation **Exhibit D: List of Beneficial Users**

Initial List of Interested Parties within the San Luis Obispo Valley Basin

Buttonwood Industrial Park- Inactive
CB&I Constructors Inc
Chevron - Tank Farm
Congregation Beth David
Copeland S Investments
East Airport Fiero Lane Water Company
Edna Valley Vineyard
Elks Lodge #322
Ernie Ball Inc
Fiero Lane Water Company
Hidden Hills Mobilodge
Higuera Apartments
Holdgrafter & Associates
Horizon Lane Water Supply
Irish Hills
J M Sims Water Supply
Jespersen Ranch
Laureate Water Company
Madonna Inn Water Company
Noll Properties Industrial Park
Paragon Triangle Water Supply
Poly Ranch
R. Howard Strabaugh Inc
San Luis Business Park
San Luis Sourdough - Inactive
San Luis Water & Power
SLO County Farm Bureau
SLO Partners
Sunset Drive-In Snack Bar
Tank Farm Business Park
Tank Farm Industrial Plaza
Tiger Water Supply
Toyota San Luis Obispo
Vachell Water System
Wallace Water Systems
Whitson Industrial Park
Williams Water Company
Edna Ranch West (not in basin)

Local land use planning agencies:
City of San Luis Obispo
County of San Luis Obispo
San Luis Obispo Council of Government (SLO COG)

GSA Formation **Exhibit D: List of Beneficial Users**

Initial List of Interested Parties within the San Luis Obispo Valley Basin

Environmental users of groundwater:
Central Coast Salmon Enhancement
The Nature Conservancy

Surface water users:
Individual agricultural landowners
City of San Luis Obispo
Central Coast Salmon Enhancement

Federal government:
U.S. Fish & Wildlife

California Native American tribes:
Chumash – no specific water uses in area

Disadvantaged communities:
Covered under other categories

Appendix B.

Groundwater Communication Portal (Portal)

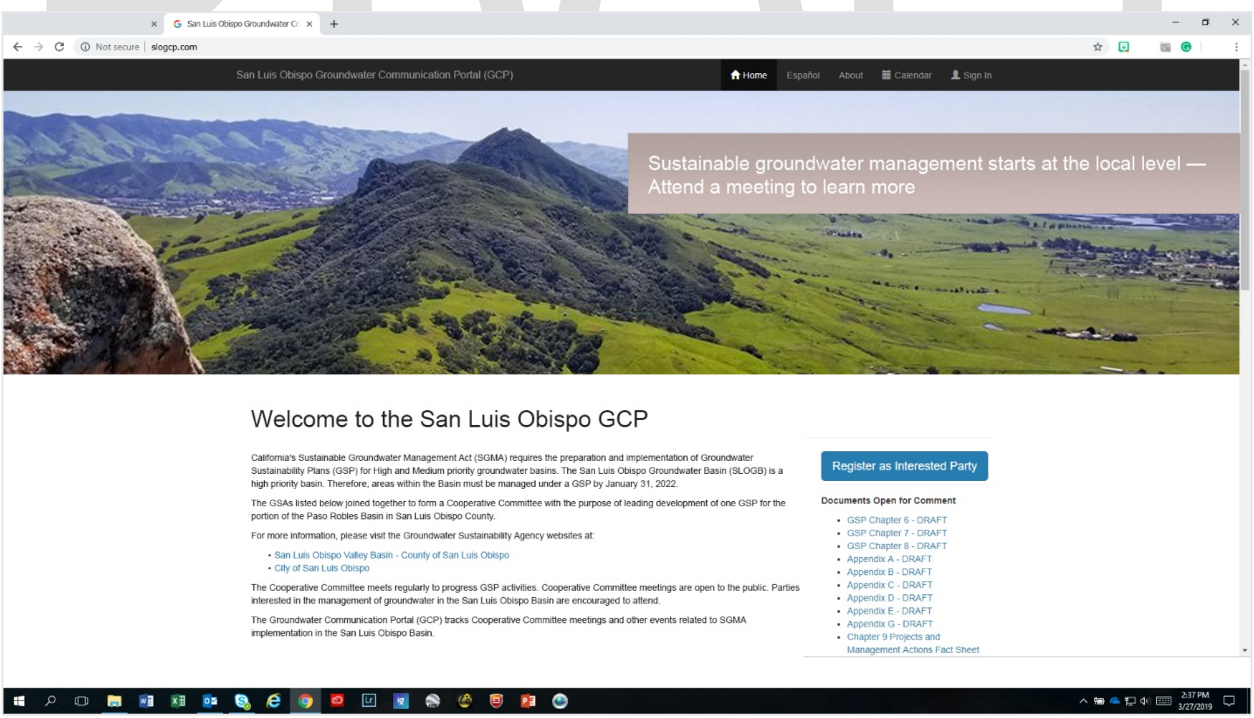
San Luis Obispo Valley Basin Groundwater Communication Portal (Portal)

GEI Consultants developed a tool to help our clients with their SGMA outreach efforts. The tool, referred to as the Groundwater Communication Portal (Portal), can be customized for any groundwater basin to track engagement efforts. The GCP is a web-based tool where you can post events and automatically inform interested parties with the click of a button. Interested parties can register with the GCP to stay informed about events related to GSP development and register for individual events to receive updates.

The GCP serves as a repository for all information about GSA meetings and interested parties. Storing all stakeholder engagement information in one place will be beneficial both for creating the communications section of the GSP and for continued tracking of outreach efforts moving forward to GSP 5-year updates and implementation. The Portal's administrative functions include report generation, so you can easily generate your list of interested parties or details about events (e.g., who was notified). Administrators may also add attachments to the events, including items such as meeting agendas, minutes, and sign-in sheets.

Portal Features

- Maintain the GSAs' list of interested parties
- Allow interested parties to self-register
- Post meeting details and documents
- Automatically notify interested parties with the click of a button
- Track who was notified and who replied to your invitation
- View a calendar of events
- Send e-mail blasts
- Track outreach efforts with a communication log
- Upload project documents and collect public comments



Draft design for the San Luis Obispo Valley GCP

Appendix C.

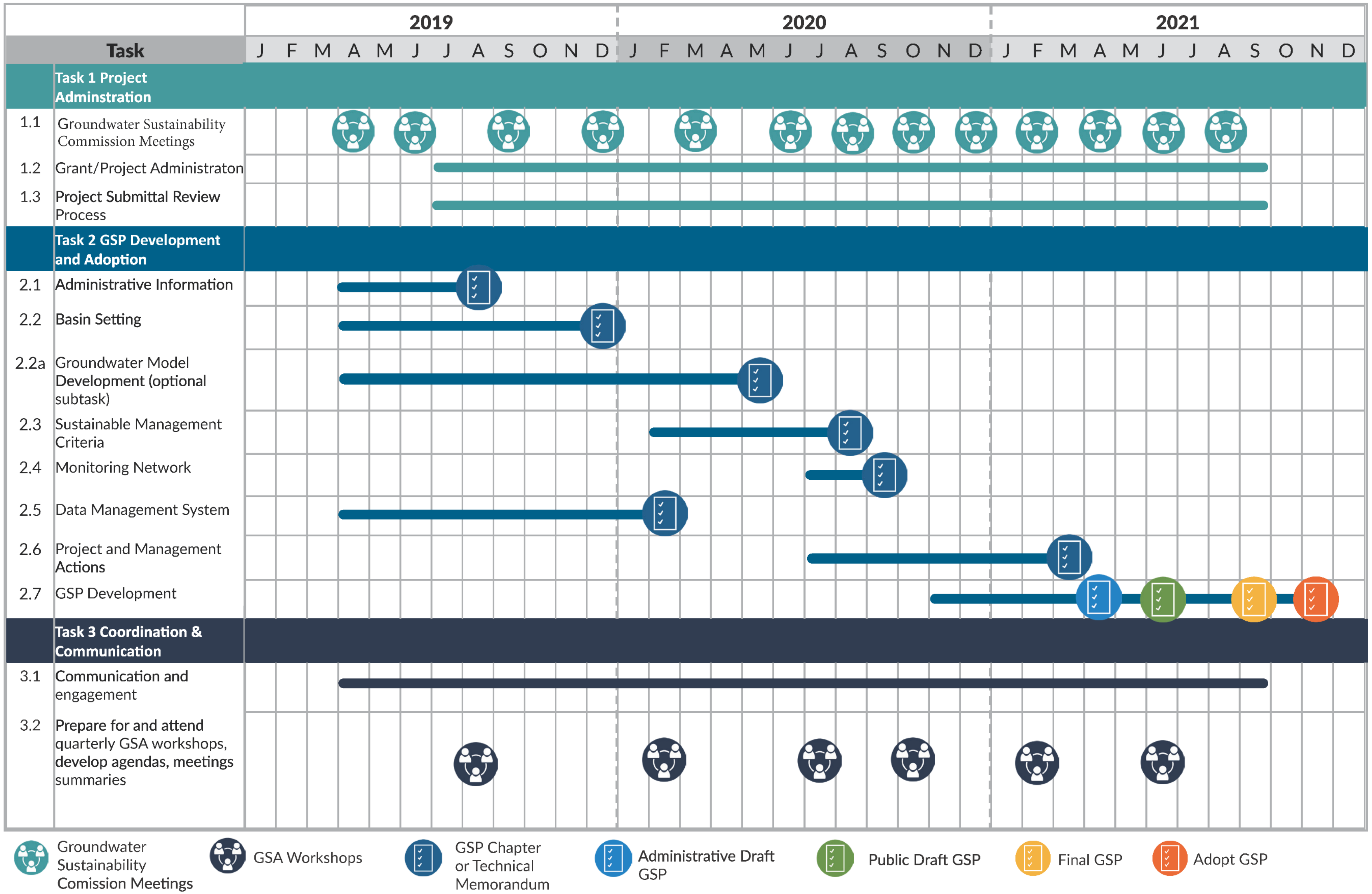
San Luis Obispo Valley Basin Stakeholder Survey

(not included in this draft)

Appendix D.

GSP Development Schedule

PROJECT SCHEDULE



WSC Water Systems Consulting, Inc.

Appendix E.

Postal Mailer: Groundwater Sustainability Plan Update

SLO Basin Groundwater Sustainability Plan Update

The Groundwater Sustainability Commission (GSC) for the San Luis Obispo Valley Groundwater Basin (SLO Basin) is preparing a Groundwater Sustainability Plan (GSP). The purpose of the GSP is to sustainably manage our groundwater resources and meet the requirements of the Sustainable Groundwater Management Act (SGMA). All interested stakeholders and members of the public are encouraged to participate to help guide the GSP development process.

The GSC held a meeting on April 4, 2019 to initiate and provide an overview of the GSP process. The SLO Basin's pathway to sustainability through the development of a GSP is described below.

PHASE 1
FACT REPORTING AND EDUCATION
- GSP Kickoff
- Communications and Engagement Plan
- Plan Area and Basin Setting: Hydrogeologic Conceptual Model, Current Historical Groundwater Conditions, and Water Budget
- Groundwater Model Development
- Data Management System

MARCH 2019 – AUGUST 2020

PHASE 2
SUSTAINABLE GOAL SETTING
- Sustainable Management Criteria: Management Areas
- Sustainability Goal, Measurable Objectives, Minimum Threshold, and Undesired Results

JANUARY 2020 – JULY 2020

PHASE 3
PLAN TO SUSTAINABILITY
- Projects and Management Actions to Achieve Sustainability
- Plan Implementation: Estimate Costs and Schedule

JUNE 2020 – FEBRUARY 2021

PHASE 4
GSP DOCUMENTATION
- Administrative Draft GSP
- Final GSP

OCTOBER 2020 – AUGUST 2021

SGMA-COMPLIANT PLAN

Upcoming Meetings

JUNE 2019

» **Wednesday, June 12 || 3:30pm**
Groundwater Sustainability Commission Meeting
- *Draft Communication and Engagement Plan*
- *Groundwater Communications Portal Debut*
- *Integrated Groundwater-Surface Water Model*

AUGUST 2019

» **Date and Time: TBD**
Groundwater Sustainability Agency Workshop

June 12 meeting located at:

SLO City/County Library
995 Palm Street
San Luis Obispo, CA 93401

If you would like to receive email notification, please sign up for the SGMA Email List at: **www.slocounty.ca.gov/slobasin**

At this website you can also find out information about progress to-date and all posted agendas and meeting materials.

Postal Mailing List Request Form *San Luis Obispo Valley Basin - County of San Luis Obispo Groundwater Sustainability Agency*

If you wish to receive meeting notification and printed meeting materials by postal mail, please provide your contact information below: (please check one)

☐ Agenda

☐ Agenda Packet (a fee may be applied)
(includes the agenda)

Name ______________________________

Company ______________________________

Address ______________________________

City, State, Zip ______________________________

Please tear along the dotted line and return this Postal Mailing List Request Form to:

Dick Tzou
San Luis Obispo County Public Works Department
County Government Center, Room 206
San Luis Obispo, CA 93408

Email: dtzou@co.slo.ca.us | Phone: (805) 781-4473

COUNTY OF SAN LUIS OBISPO

Appendix F.

References

Stakeholder Communication and Engagement Guidance Document for Groundwater Sustainability Plan, Department of Water Resources, January 2018

Engagement with Tribal Governments Guidance Document for Sustainable Management of Groundwater, Department of Water Resources, June 2017

COMMUNICATIONS & ENGAGEMENT IMPLEMENTATION WORKPLAN

for SLO Basin Groundwater Sustainability Plan (GSP) Development

LAST UPDATED: AUGUST 2019

PREPARED BY WATER SYSTEMS CONSULTING

HOW TO USE THIS WORKPLAN

The enclosed workplan is intended to supplement the San Luis Obispo Groundwater Sustainability Communications and Engagement Plan (C&E Plan) and serve as the primary, day-to-day tool for managing its effective implementation.

This workplan was developed by Water Systems Consulting. Monthly updates will be provided to the full GSA team, namely with updated detail on the "Implementation Priorities" slide, on page 8.

CONTENTS

01

TARGET STAKEHOLDER AUDIENCES

TARGET STAKEHOLDER CATEGORIES, detail

GENERAL PUBLIC. Citizen groups, community leaders

LAND USE. GSC Agencies (City of San Luis Obispo Mayor and City Council; County of San Luis Obispo Dept. of Planning and Building staff); **US Forest Service; Land Use Commission**

PRIVATE / RURAL GROUNDWATER USERS. Private pumpers, domestic users (townhome and mobile home communities, campgrounds, private homeowners)

AGRICULTURAL WATER USERS.
All GSC Agencies; water agencies + irrigation districts (Golden State Water Company, Mutual Water Company; **Farm bureaus** (San Luis Obispo County Farm Bureau; individual agriculture land owners; Cal Poly; A Lab)

URBAN / INDUSTRIAL USERS. Commercial and industrial users (Airvol Block)

INTEGRATED WATER MANAGEMENT.
SLO County Flood and Water Conservation District, IRWMG Group; Water Resource Advisory Committee; Zone 9 Flood Control District; DWR

ENVIRONMENTAL AND CONSERVATION ORGS.
Federal and state agencies (US Fish and Wildlife); **Environmental groups** (Central Coast Salmon Enhancement / Creek Lands; The Nature Conservancy; Sierra Club; NOAA; National Marine Fisheries); **Conservation groups** (Save Our Water; Water Use It Wisely; San Luis Obispo Master Gardeners; SLO County Land Conservancy; CA Conservation Corp); **Resource conservation districts** (San Luis Obispo County Flood and Water Conservation District; Coastal San Luis Resource Conservation District; Central Coast Water Conservation; Regional Water Quality Control Board, State Division of Drinking Water).

ECONOMIC DEVELOPMENT. SLO Economic Development Corp; Hourglass Project; wine association; **Elected officials** (San Luis Obispo County Board of Supervisors; Senators Bill Monning, Dianne Feinstein, Kamala Harris; Congressman Salud Carbajal; Assemblyman Jordan Cunningham).

HUMAN RIGHT TO WATER. Disadvantaged communities; Rural Community Assistance Corp

TRIBES. The Chumash people

PRIORITY STAKEHOLDERS CATEGORIES,

July-December 2019

While outreach to all stakeholders audiences will take place continuously, priority attention will be given to the groups below over the next few months. This is based an analysis of these group's proximity to the need for a sustainable groundwater plan—namely in either their ability to influence this outcome and/or how the plan will impact then; as well as their level of interest in participating in plan development.

LAND USE. **GSC Agencies** (City of San Luis Obispo Mayor and City Council; County of San Luis Obispo Dept. of Planning and Building staff); **US Forest Service; Land Use Commission**

AGRICULTURAL WATER USERS.
All GSC Agencies; water agencies + irrigation districts (Golden State Water Company, Mutual Water Company; **Farm bureaus** (San Luis Obispo County Farm Bureau; individual agriculture land owners; Cal Poly; A Lab)

ENVIRONMENTAL AND CONSERVATION ORGS.
Federal and state agencies (US Fish and Wildlife); **Environmental groups** (Central Coast Salmon Enhancement / Creek Lands; The Nature Conservancy; Sierra Club; NOAA; National Marine Fisheries); **Conservation groups** (Save Our Water; Water Use It Wisely; San Luis Obispo Master Gardeners; SLO County Land Conservancy; CA Conservation Corp); **Resource conservation districts** (San Luis Obispo County Flood and Water Conservation District; Coastal San Luis Resource Conservation District; Central Coast Water Conservation; Regional Water Quality Control Board, State Division of Drinking Water).

02

GOALS AND EVALUATION METRICS

OUTREACH GOALS

- Create an inclusive, transparent participation experience that builds public trust in the Groundwater Model and GSP and optimizes participation among all those impacted.
- Employ outreach methods that facilitate shared understanding of the importance of sustainable groundwater and its impact on stakeholders.
- Communicate "early and often," and actively identify and eliminate barriers to participation.
- Develop a cost-effective, stakeholder-informed GSP supported by best-in-class technical data.

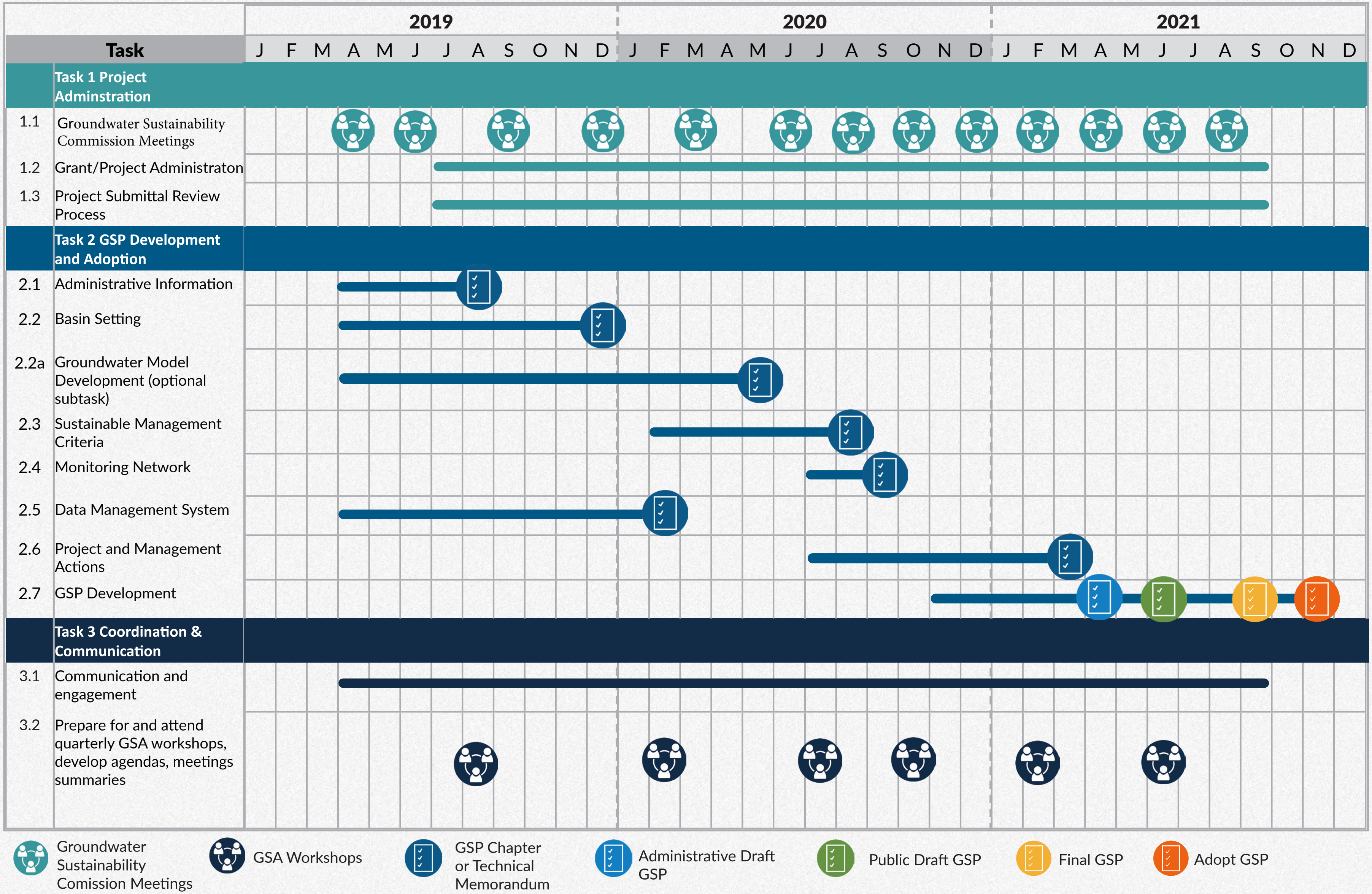
EVALUATION METRICS

- Rate and representative diversity of Portal subscribes / unsubscribes relevant to our target stakeholder categories
- Rate and representative diversity of public comment at key project milestones, compared to our target stakeholder categories
- Representative diversity of GSC Meeting attendance over time, compared to our target stakeholder categories
- Representative diversity of Stakeholder Workshop attendance over time, compared to our target stakeholder categories

03

WORKPLAN AND TIMELINE

PROJECT SCHEDULE



COMMUNICATION PRIORITIES, Jul-Nov 2019

	JUL	AUG	SEP	OCT	NOV
GSP DEVELOPMENT	• Develop Intro and Admin Info Chapter • Develop Basin Setting Chapter • Develop Groundwater Model • Develop Data Management System	• **Develop Intro and Admin Info Chapter—COMPLETE** • Develop Basin Setting Chapter • Develop Groundwater Model • Develop Data Management System	• Develop Basin Setting Chapter • Develop Groundwater Model • Develop Data Management System	• Develop Basin Setting Chapter • Develop Groundwater Model • Develop Data Management System	• Develop Basin Setting Chapter • Develop Groundwater Model • Develop Data Management System
C&E PLAN DEVELOPMENT	• C&E Plan, respond to public comment • Add outreach materials to portal • Finalize, distribute survey; synthesize results	------	------	------	------
GSC QUARTERLY MEETINGS	------	• Plan Sep meeting agenda/ content • Create presentation deck	• Finalize presentation deck/graphics • **Facilitate meeting—SEP 11**	------	• Plan Dec meeting agenda/content • Create presentation deck
STAKEHOLDER WORKSHOPS	• Workshop #1 planning • Develop presentation and workshop materials	**FACILITATE WORKSHOP #1**	------	------	• Set workshop #2 date/time/ location
STAKEHOLDER OUTREACH	• Monthly workplan to team • Develop master messaging • Develop FAQs • Develop trifold brochure, table tents, posters, mini presentation deck, flyer • RECRUIT: Send outreach materials to stakeholder orgs to distribute • ENGAGE/INVITE: **Send eblast and snail mail Workshop #1 invite Print all materials** • INFORM: **JUL 15—Send quarterly ebulletin and snail mail bulletin** • INFORM: Post news/content to Communications Portal	• Monthly workplan to team • Adapt messaging, outreach materials, and approach as needed following Workshop #1 • RECRUIT: Send outreach materials to stakeholder orgs to distribute • RECRUIT: Present intro deck at target stakeholder orgs; distribute materials • INVITE: **2 weeks prior to workshop, send eblast Workshop #1 invite reminder.** • INFORM: Post news/content to Communications Portal	• Monthly workplan to team • Adapt messaging, outreach materials, and approach as needed following Workshop #1 • RECRUIT: Recruit stakeholders to subscribe to portal, emphasize priority segments, ACTION TBD • INFORM: Draft quarterly bulletin content • INFORM: Post news/content to Communications Portal	• Monthly workplan to team • RECRUIT: Recruit stakeholders to subscribe to portal, emphasize priority segments, ACTION TBD • INFORM: **OCT 15—Send quarterly ebulletin and snail mail bulletin** • INFORM: Post news/content to Communications Portal	• Monthly workplan to team • RECRUIT: Recruit stakeholders to subscribe to portal, emphasize priority segments, ACTION TBD • INFORM: Post news/content to Communications Portal

04

OUTREACH TOOLS AND MATERIALS

WEBSITES

The following materials will be used in regular cadence to keep the public informed of project progress, including invitations to four quarterly workshops and to make public comment in line with project milestones and drafting of plan chapters.

A. WEBSITE AND COMMUNICATIONS PORTAL—The central hub for project information, engagement, and public comment. FAQs will be housed here; the stakeholder list is managed here; and email communications are distributed from here to subscribed stakeholders.

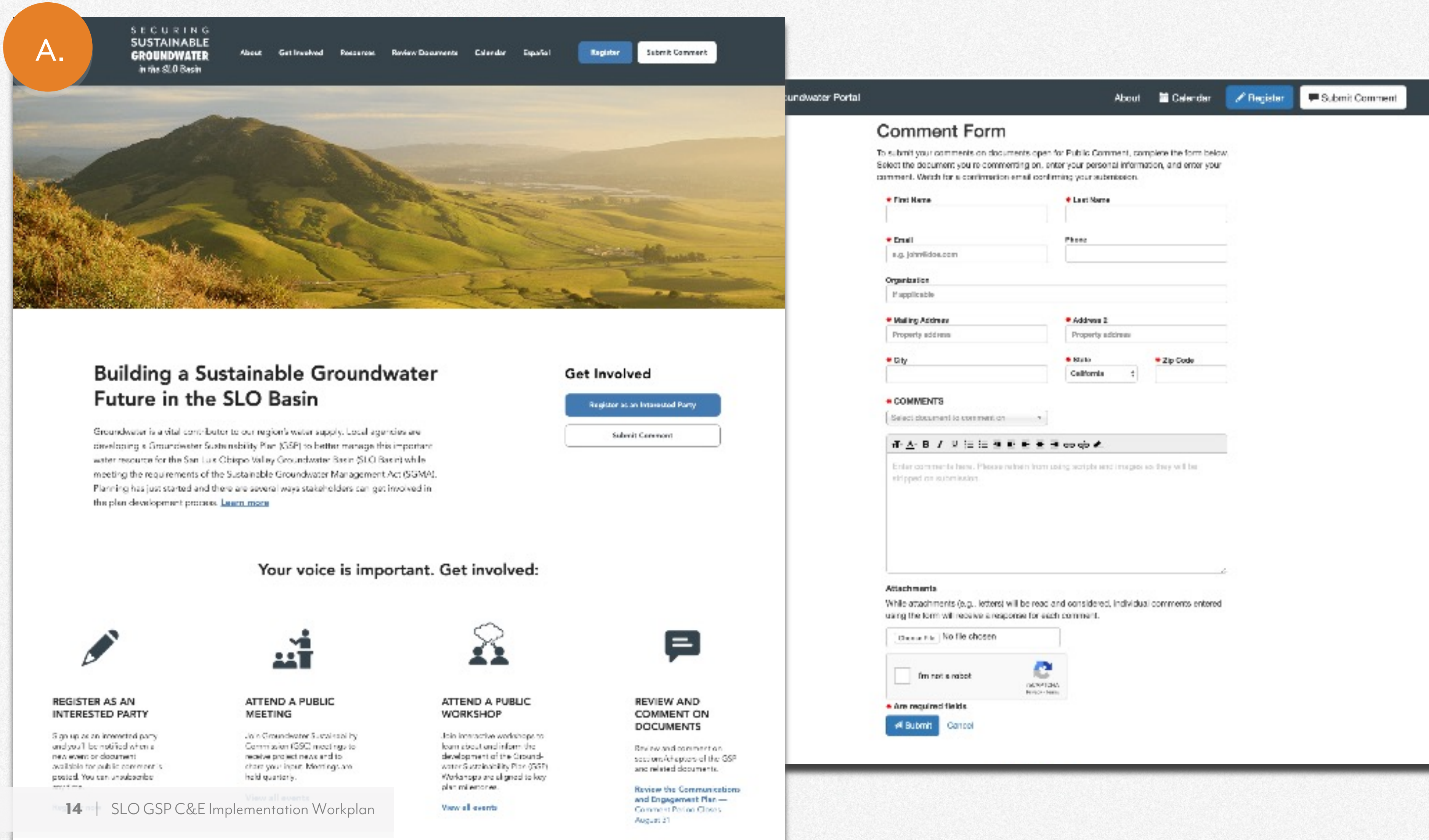
SLOWaterBasin.com

B. CITY OF SAN LUIS OBISPO WEB PAGE WITH FAQS, LINK TO PORTAL, ETC. —Stakeholders can access the full basin characterization report here, as well as an interactive map of the SLO Basin.

WEBSITES

A. GROUNDWATER COMMUNICATIONS PORTAL

B. CITY OF SAN LUIS OBISPO WEB PAGE



WEBSITES

A. GROUNDWATER COMMUNICATIONS PORTAL

B. CITY OF SAN LUIS OBISPO WEB PAGE

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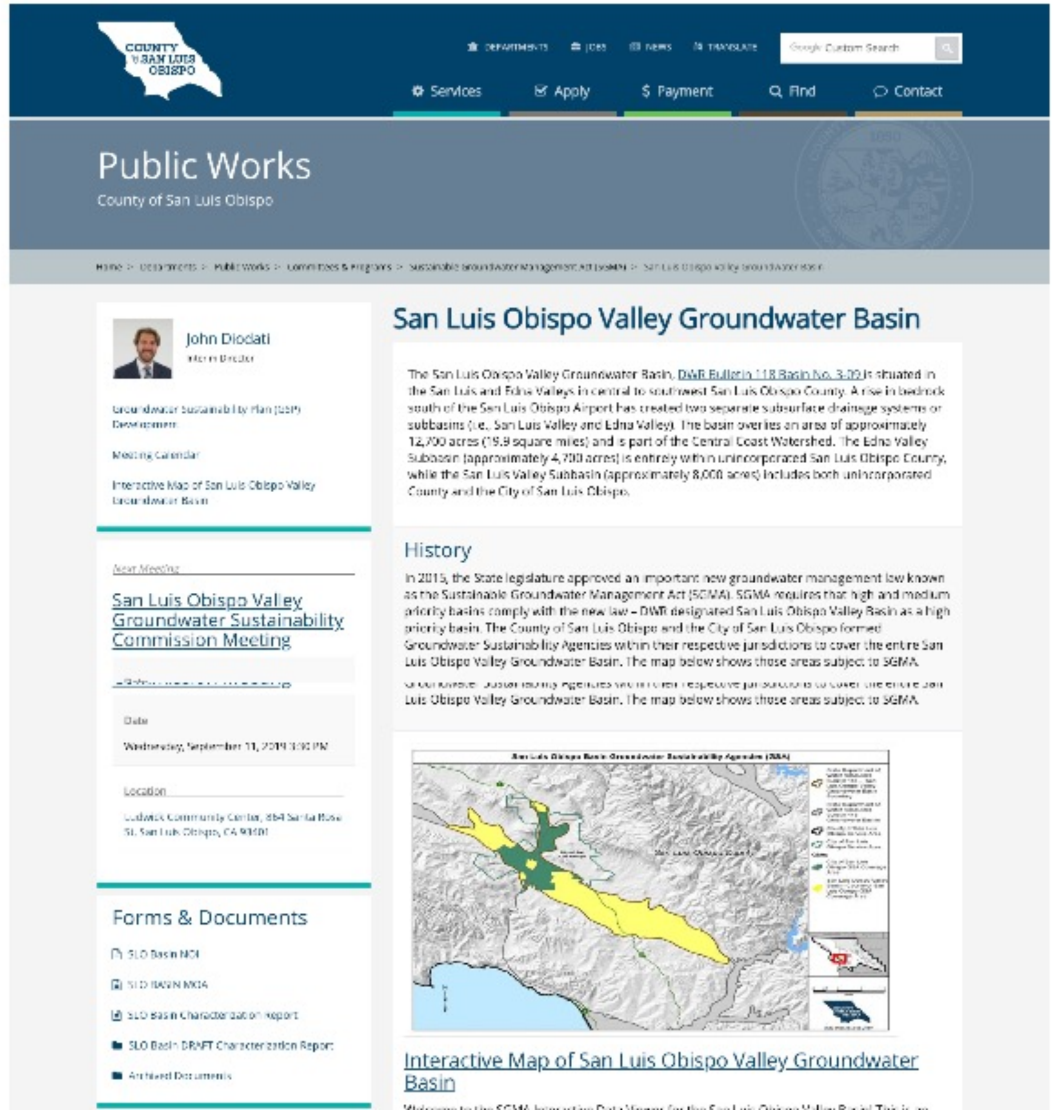


STAKEHOLDER RECRUITMENT MATERIALS

Inclusive and diverse representation of affected stakeholders in the GSP process is critical to creating an effective GSP. These materials will be used to continually recruit participation among target stakeholder audiences, including focused recruitment for audiences that are continually underrepresented in GSC meetings and workshops.

A. PHYSICAL MAILER

B. RACK CARD

C. TABLE TENTS

D. FLYER

STAKEHOLDER RECRUITMENT MATERIALS

PHYSICAL MAILER

SLO Basin Groundwater Sustainability Plan Update

The Groundwater Sustainability Commission (GSC) for the San Luis Obispo Valley Groundwater Basin (SLO Basin) is preparing a Groundwater Sustainability Plan (GSP). The purpose of the GSP is to sustainably manage our groundwater resources and meet the requirements of the Sustainable Groundwater Management Act (SGMA). All interested stakeholders and members of the public are encouraged to participate to help guide the GSP development process.

The GSC held a meeting on April 4, 2019 to initiate and provide an overview of the GSP process. The SLO Basin's pathway to sustainability through the development of a GSP is described below.

PHASE 1
FACT REPORTING AND EDUCATION
- GSP Kickoff
- Communications and Engagement Plan
- Plan Area and Basin Setting: Hydrogeologic Conceptual Model, Current Historical Groundwater Conditions, and Water Budget
- Groundwater Model Development
- Data Management System

MARCH 2019 – AUGUST 2020

PHASE 2
SUSTAINABLE GOAL SETTING
- Sustainable Management Criteria: Management Areas
- Sustainability Goal, Measurable Objectives, Minimum Threshold, and Undesired Results

JANUARY 2020 – JULY 2020

PHASE 3
PLAN TO SUSTAINABILITY
- Projects and Management Actions to Achieve Sustainability
- Plan Implementation: Estimate Costs and Schedule

JUNE 2020 – FEBRUARY 2021

PHASE 4
GSP DOCUMENTATION
- Administrative Draft GSP
- Final GSP

OCTOBER 2020 – AUGUST 2021

SGMA-COMPLIANT PLAN

Upcoming Meetings

JUNE 2019

» **Wednesday, June 12 || 3:30pm**
Groundwater Sustainability Commission Meeting
- *Draft Communication and Engagement Plan*
- *Groundwater Communications Portal Debut*
- *Integrated Groundwater-Surface Water Model*

AUGUST 2019

» **Date and Time: TBD**
Groundwater Sustainability Agency Workshop

June 12 meeting located at:

SLO City/County Library
995 Palm Street
San Luis Obispo, CA 93401

If you would like to receive email notification, please sign up for the SGMA Email List at: **www.slocounty.ca.gov/slobasin**

At this website you can also find out information about progress to-date and all posted agendas and meeting materials.

Postal Mailing List Request Form

San Luis Obispo Valley Basin - County of San Luis Obispo Groundwater Sustainability Agency

If you do not have access to email and wish to receive meeting notification and printed meeting materials by postal mail, please provide your contact information below: (please check one)

☐ Agenda

☐ Agenda Packet (a fee may be applied)
(includes the agenda)

Name ______________________________

Company ______________________________

Address ______________________________

City, State, Zip ______________________________

Please tear along the dotted line and return this Postal Mailing List Request Form to:

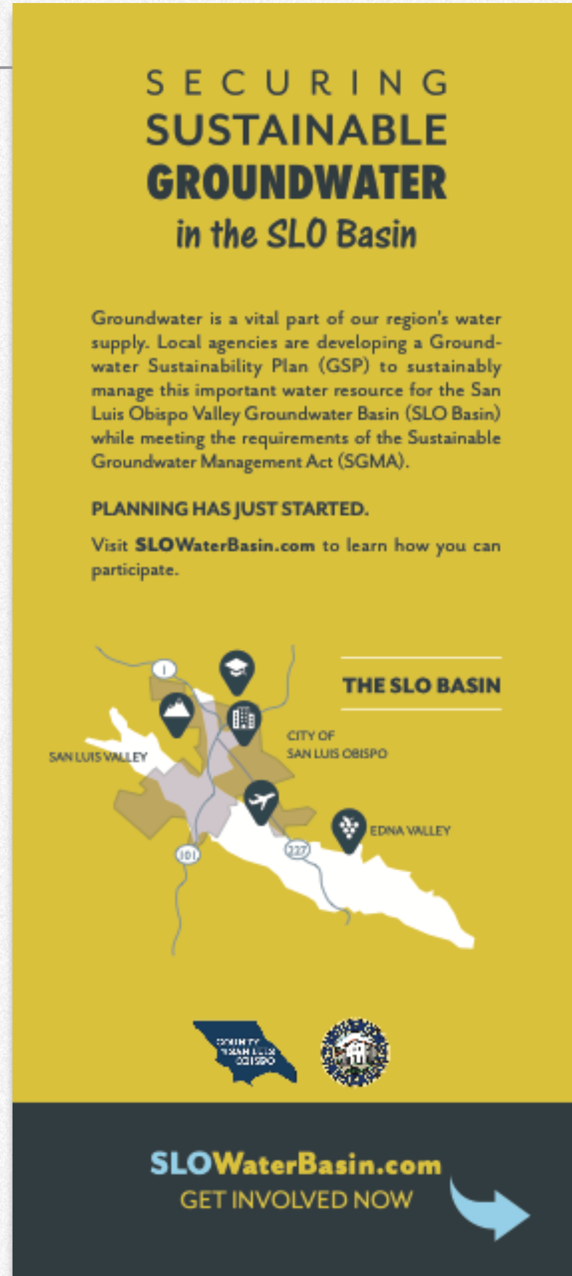
Dick Tzou
San Luis Obispo County Public Works Department
County Government Center, Room 206
San Luis Obispo, CA 93408

Email: dtzou@co.slo.ca.us | Phone: (805) 781-4473

COUNTY OF SAN LUIS OBISPO

STAKEHOLDER RECRUITMENT MATERIALS

RACK CARD



STAKEHOLDER RECRUITMENT MATERIALS

FLYER

Groundwater is a vital part of our region's water supply. Local agencies are developing a Groundwater Sustainability Plan (GSP) to sustainably manage this important water resource for the San Luis Obispo Valley Groundwater Basin (SLO Basin) while meeting the requirements of the Sustainable Groundwater Management Act (SGMA).

PLANNING HAS JUST STARTED. Visit **SLOWaterBasin.com** to learn how you can participate.

ESPAÑOL?

Si necesita solicitar alojamiento para asistir a un evento, incluidos los servicios de traducción al español, comuníquese con Dick Tzou a dtzou@co.slo.ca.us o al 805-781-4473.

THE SLO BASIN

Your voice is important. Here's how to get involved:

MEETINGS.
Join Groundwater Sustainability Commission (GSC) meetings to receive project news and to share your input. MEETINGS ARE HELD QUARTERLY.

WORKSHOPS.
Join interactive workshops to learn about and inform the development of the GSP. WORKSHOPS ARE ALIGNED WITH PLAN MILESTONES.

REVIEW AND COMMENT.
Review and comment on sections/chapters of the GSP. FIND DOCUMENTS OPEN FOR COMMENT ON THE WEBSITE.

SLOWaterBasin.com — GET INVOLVED NOW

STAKEHOLDER RECRUITMENT MATERIALS

TABLE TENT

STAKEHOLDER COMMUNICATION MATERIALS

These materials will be used in regular cadence to keep subscribed stakeholders and the visitors to the Portal informed of project progress, including participation to four quarterly workshops and to make public comment.

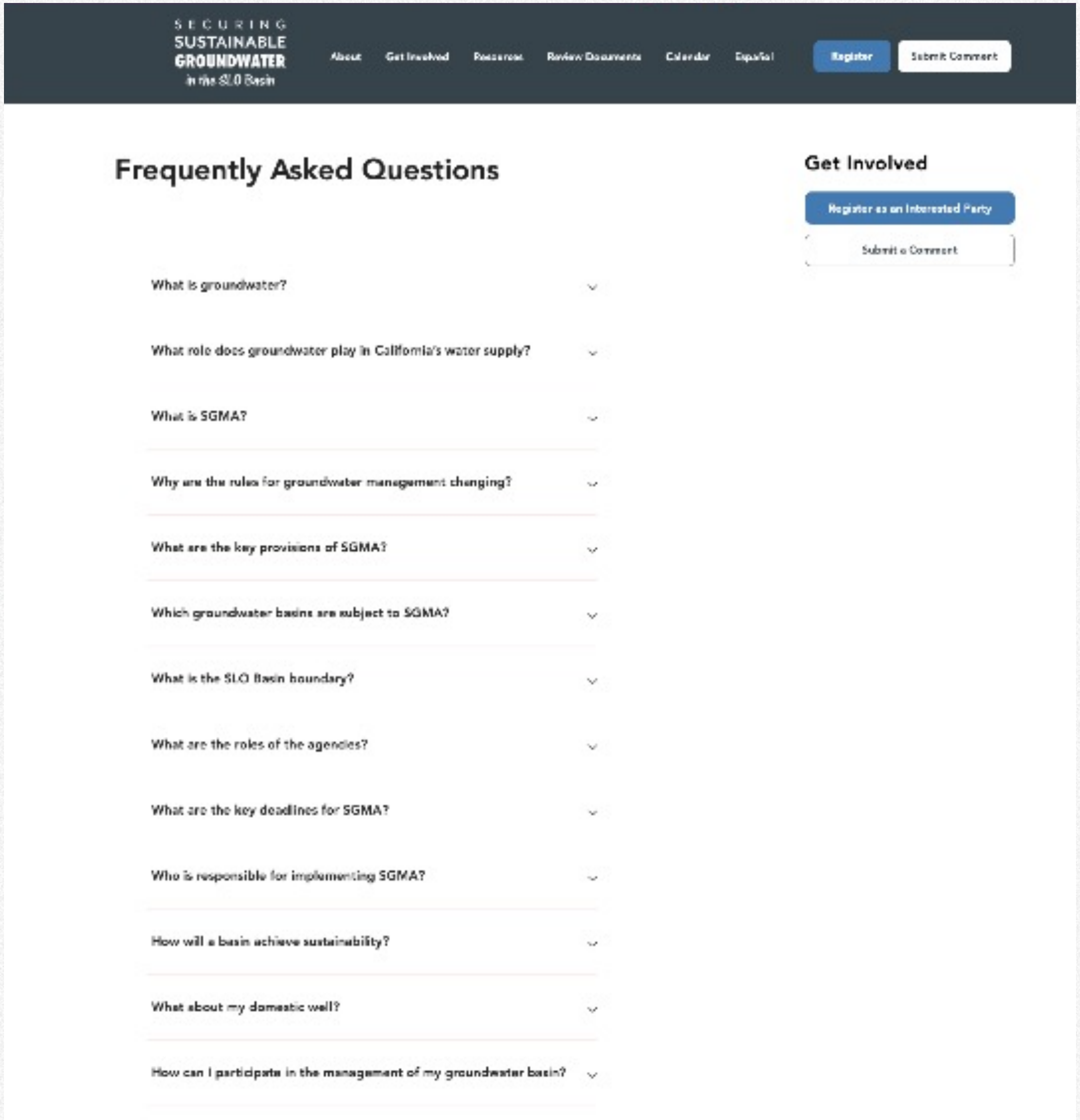
A. FAQS — Housed at SLOWaterBasin.com

B. QUARTERLY NEWSLETTER — Sent to to subscribed stakeholders (email and snail mail); includes notices/news of opportunities to participate, upcoming meetings and workshops, and a summary of the quarterly GSC meetings and past workshops.

C. GSP PORTAL SUBSCRIBER EBLASTS

STAKEHOLDER COMMUNICATION MATERIALS

FAQS



STAKEHOLDER COMMUNICATION MATERIALS

NEWSLETTER

A QUARTERLY UPDATE OF THE SLO BASIN GROUNDWATER SUSTAINABILITY PLAN DEVELOPMENT
VOLUME 1 | JULY 2019

In this issue

Building a Sustainable Groundwater Future in the SLO Basin

During a normal year, nearly 40 percent of California's agricultural and urban water demand is met by the use of groundwater, which has resulted in declining groundwater levels in some groundwater basins throughout California. In an effort to ensure the sustainable use of California's groundwater and a water-secure future for the State, the Sustainable Groundwater Management Act (SGMA) was signed into law in 2014. The California Department of Water Resources (DWR) prioritized 515 groundwater basins in California into one of four categories; high, medium, low or very low priority based on a set of criteria.

SGMA is a State law that requires local governments and water agencies that overlie high and medium priority basins to form Groundwater Sustainability Agencies (GSAs) for the purpose of sustainably managing the groundwater basins. Locally, the San Luis Obispo Valley Groundwater Basin (SLO Basin) has been identified as a high priority basin by the State. Therefore, to meet SGMA requirements, the County of San Luis Obispo (County) and the City of San Luis Obispo (City) each formed a GSA. These two GSAs are the governmental entities tasked with developing and implementing the SLO Basin's Groundwater Sustainability Plan (GSP).

Although the GSAs were formed by the two local public agencies, representatives of the Golden State Water Company, Edna Ranch Mutual Water Company, Varian Ranch Mutual Water Company, and Edna Valley Growers Mutual Water Company were engaged in developing a governance structure. In addition to the formation of the two GSAs, a Groundwater Sustainability Commission (GSC) — an advisory body to the GSAs — was established through a Memorandum of Agreement (MOA) between the GSAs and the above participating parties, and the terms under which the City GSA and County GSA will jointly develop a single GSP in coordination with the GSC.

GSP development recently began and will continue through January 2022. All interested stakeholders and members of the public are encouraged to participate to help guide the GSP development process. Visit SLOWaterBasin.com for details on how you can participate in this important process.

Why am I receiving this?

- You live or work in the SLO Basin
- You may be affected by the SLO Basin's groundwater use
- You subscribed to receive updates about SGMA or GSP development

Through the duration of the SLO Basin GSP development, this newsletter will be distributed quarterly to all subscribers of the SLOWaterBasin.com Portal and made available at GSC meetings and stakeholder workshops. To stop receiving these newsletters, go to SLOWaterBasin.com, scroll to the bottom of the page and click "unsubscribe."

SLOWaterBasin.com – GET INVOLVED NOW

STAKEHOLDER COMMUNICATION MATERIALS

EBLASTS

Quarterly Update: SLO Groundwater Sustainability Plan (July 2019)

SV **SLO Valley Groundwater Communication Portal (GCP) <no-reply-slogcp@geiconsult...**
Tiffany Meyer
Tuesday, August 20, 2019 at 11:31 AM
Show Details

WHY AM I RECEIVING THIS EMAIL? You are receiving this email because you subscribed to receive updates about SGMA or GSP development. To unsubscribe, visit http://SLOWaterBasin.com, scroll to the bottom, and click "unsubscribe." The Groundwater Sustainability Agencies for the San Luis Obispo Valley Groundwater Basin (SLO Basin) are currently developing a new Groundwater Communication Portal (Portal) at http://SLOWaterBasin.com. The Portal will be the online communication hub for public participation in the GSP development process, including reviewing and submitting public comments on GSP chapters/sections.

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Building a Sustainable Groundwater Future in the SLO Basin

A quarterly update of the SLO Basin Groundwater Sustainability Plan development

Volume 1 | July 2019

DOWNLOAD THE FULL ISSUE HERE: http://slowaterbasin.com/service/document/download/40

ISSUE SUMMARY:

SGMA and Groundwater Sustainability Plan Overview— During a normal year, nearly 40 percent of California's agricultural and urban water demand is met by the use of groundwater, which has resulted in declining groundwater levels in some groundwater basins throughout California. In an effort to ensure the sustainable use of California's groundwater and a water-secure future for the State, the Sustainable Groundwater Management Act (SGMA) was signed into law in 2014 …

April 10, 2019 GSC Meeting Summary — On April 9, 2019 the County Board of Supervisors approved a contract with Water System Consulting (WSC) to develop a GSP for the SLO Basin. Following this selection, the GSC held a kick-off meeting on April 10, 2019 to initiate the development of a Groundwater Sustainability Plan (GSP) …

June 12, 2019 GSC Meeting Summary —The Groundwater Communications Portal (Portal) at SLOWaterBasin.com was previewed by the consulting team. The Portal will be the online communication hub for public participation in the GSP development process, including reviewing and submitting public comments on GSP chapters/sections. The best way to stay apprised of project news and opportunities to participate and engage is to register on the Portal as an "interested party" …

Project Milestones and Opportunities to Participate —The Groundwater Sustainability Plan (GSP) will be developed in phases through the end of 2021 to meet the required completion deadline of January 31, 2022. There will be ample opportunity for the public to participate in the plan development process, including participation in quarterly public GSC meetings, interactive workshops, and review and comment for each GSP chapter … NEXT WORKSHOP on SGMA and Groundwater 101: August 14, 2019.

Future GSC Chapter/Section Review Opportunities — Download the full PDF for details on all future opportunities to participate in the GSP development …

F

Groundwater Dependent Ecosystems in the San Luis Obispo Valley Groundwater Basin

Stillwater Sciences

895 Napa Ave., Suite B-4, Morro Bay, CA 93442
phone 805-570-7499

TECHNICAL MEMORANDUM

DATE:	October 19, 2020
TO:	WSC and Cleath-Harris Geologists
FROM:	Aleksandra Wydzga and Ethan Bell (Stillwater Sciences)
SUBJECT:	Groundwater-Dependent Ecosystems in the San Luis Obispo Valley Groundwater Basin

The purpose of this memo is to summarize known information about surface water hydrology relevant to Groundwater Dependent Ecosystems (GDEs) in the San Luis Obispo (SLO) Valley Groundwater Basin (Section 1), identify GDEs overlying and dependent upon the SLO Valley Groundwater Basin (Section 2), identify sustainable GDE indicators (Section 3) for the SLO Valley Groundwater Basin, and propose a hydrologic monitoring network to track these indicators over time (Section 4). GDEs are defined in California's Sustainable Groundwater Management Act (SGMA) as "ecological communities of species that depend on groundwater emerging from aquifers or on groundwater occurring near the ground surface" (23 CCR § 351(m)).

1 EXISTING SURFACE WATER HYDROLOGY

1.1 Overview of GDE Relevant Surface and Groundwater Hydrology

The Basin is overlain by two watersheds: San Luis Obispo (SLO) and Pismo (Figure 1). Flows in SLO and Pismo Creeks can be divided into wet season flows, typically occurring from January to April, and dry season flows, typically from June to October. Short transitional periods occur between the wet and dry seasons. Wet season instream flows originate from a range of sources including precipitation-driven surface runoff events, water draining from surface depressions or wetlands, shallow subsurface flows (e.g., soil), and groundwater. Dry season instream flows, however, if present, are fed primarily by groundwater. As groundwater levels fall over the dry season, so do the corresponding instream flows. If groundwater elevations remain above instream water elevations, groundwater discharges into the stream and surface flows continue through the entire dry season (creating perennial conditions). If groundwater elevations fall below the streambed elevation, the stream can go dry. Streams that typically flow in the wet season and dry up in the dry season are termed intermittent. Due to climactic changes or groundwater pumping, over time streams can transition from historically perennial to intermittent conditions (Barlow and Leake 2012). Dry season flows supported by groundwater in the SLO and Pismo Creeks are critical for the survival of various special-status species, including but not limited to the federally threatened California red-legged frog (CRLF) *(Rana draytonii)* and Steelhead (*Oncorhynchus mykiss)*.

SLO Creek and Pismo Creek are underlain by numerous aquifers. These aquifers are connected to one another, and to surface waters, but the degree of connection varies spatially. Aquifers can include confined aquifers, unconfined aquifers, and perched aquifers (see Chapter 4 of the Draft

Groundwater Sustainability Plan). Aquifers may be hydrologically linked with ponds, lakes, wetlands, and creeks. In the SLO Valley Groundwater Basin, few data exist to characterize the connection between surface water and groundwater.

The SLO Valley Groundwater Basin is divided into two sub-basins: the SLO Valley sub-basin and the Edna Valley sub-basin. While the groundwater in these basins is hydraulically connected, a shallow subsurface bedrock divide between the two sub-basins partially isolates the deeper portions of the two aquifers (Appendix A). Groundwater in the Edna sub-basin flows both towards the SLO Valley sub-basin in the northwest portion of the basin and towards Price Canyon in the southwest portion of the basin. Groundwater flowing towards Price Canyon rises to the surface as it approaches the bedrock constriction of Price Canyon and the Edna fault system. A 1954 DWR map (Appendix B) best illustrates the groundwater flow from the Edna Valley sub-basin both towards SLO and into Price Canyon. As groundwater from the Edna sub-basin flows towards Price Canyon and rises to the surface, it creates a perennial reach of Pismo Creek that flows through Price Canyon and supports year-round critical habitat for threatened steelhead.

1.2 Losing and Gaining Reaches

Streams are often subdivided into losing and gaining reaches to describe their connection to groundwater. In a losing reach water flows from the stream to the groundwater while in a gaining reach water flows from the groundwater into the stream. The connection between losing reaches to the regional aquifer may be unclear as water can be trapped in perched aquifers above the regional water table. Figure 1 shows the likely extent of known gaining and losing reaches in SLO and Pismo Creeks during typical late spring and dry season conditions. This map is compiled from various data sources, including a field survey of wet and dry reaches of SLO Creek (Bennett 2015), field surveys and flow measurements of Pismo Creek (Balance Hydrologics 2008), an instream flow study of Pismo Creek (Stillwater Sciences 2012), a regional instream flow assessment that included SLO and Pismo Creeks (Stillwater Sciences 2014), spring and summer low flow measurements in SLO and Pismo Creeks (2015–2018) (Creek Lands Conservation 2019), and consideration of the effects of local geologic features such as bedrock outcrops and faults, both of which can force deeper groundwater to the surface. The effect of faults and bedrock outcrops can be localized or extend for some distance downstream. Portions of the SLO and Pismo Creeks and their tributaries for which no data exist are left unhighlighted in Figure 1. In general, the extent of losing or gaining reaches can vary by water year type or pumping conditions. For example, East Corral de Piedra and West Corral de Piedra on the north-east side of the basin can be dry in the spring and summer during drier years but be flowing in wetter years (Creek Lands Conservation 2019). In contrast, gaining reaches shown on SLO Creek appear fairly consistent across water year types (Bennett 2015, Creek Lands Conservation 2019). Figure 1 is based on limited data sources and improved mapping of losing and gaining reaches is recommended (Section 4).

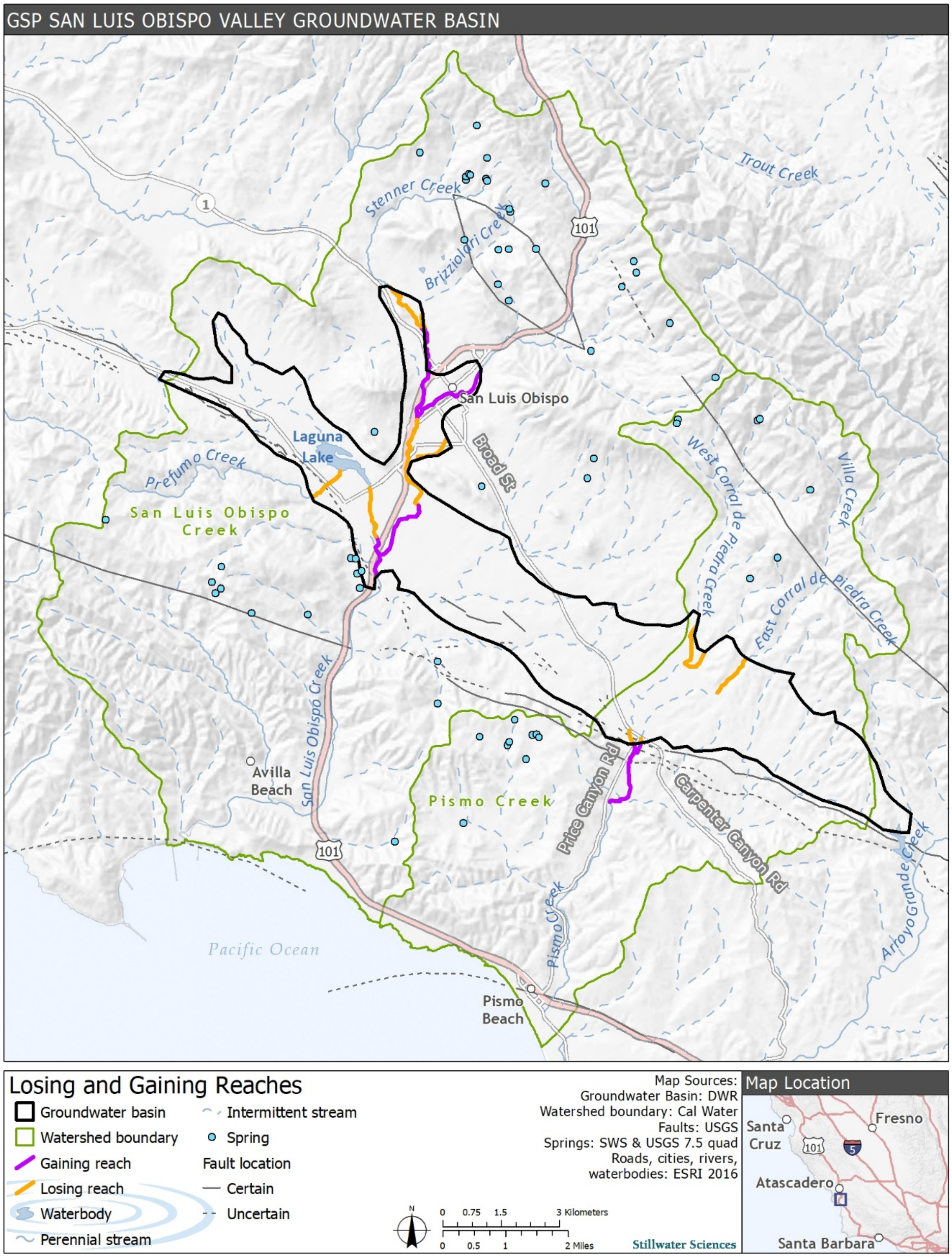

Figure 1. Typical late spring and dry season losing and gaining reaches in the basin. Portions of the SLO and Pismo Creeks and their tributaries for which no data exist are left unhighlighted.

1.3 Relevance to GDEs

Depending on location and time of year, GDEs that overly the SLO Valley Groundwater Basin can be supported by a range of water sources including direct precipitation, surface runoff, shallow subsurface flow, and groundwater. Shallow subsurface flow can vary from short-term precipitation driven flow (e.g. macro-pores filled during a precipitation event that drain on the order of days to weeks) to flow that is directly connected to groundwater (e.g. groundwater discharge into streams during the dry season). In the wet season, GDEs overlying the SLO Groundwater Basin are supported by a wider range of surface and groundwater hydrological sources than in the dry season. In the dry season, the primary water source supporting the GDEs is groundwater, although in some reaches irrigation return flow may be present. Irrigation return flow can have surface water sources from outside the basin (e.g. City of SLO parcels) or local groundwater (e.g. Edna Valley). Groundwater supporting GDEs overlying the SLO Valley Groundwater Basin can originate outside of the groundwater basin or within the groundwater basin. Both our proposed our strategy to identify sustainable GDE indicators (Section 3) and our proposed monitoring network (Section 4) take advantage of and integrate these hydrologic realities to focus on the assessment and monitoring of GDEs in locations and during seasons that are reliant on groundwater originating in the SLO Groundwater Basin.

2 POTENTIAL GROUNDWATER DEPENDENT ECOSYSTEMS (GDES) AND ASSOCIATED FLORA AND FAUNA

2.1 Distribution of Potential GDEs Based on Best Available Vegetation and Wetland Data

Groundwater dependent ecosystems (GDEs) are defined in California's Sustainable Groundwater Management Act (SGMA) as "ecological communities of species that depend on groundwater emerging from aquifers or on groundwater occurring near the ground surface" (23 CCR § 351(m)). As described in The Nature Conservancy's guidance for GDE analysis (Rohde et al. 2018), a GDE's dependence on groundwater refers to reliance of GDE species and/or communities on groundwater for all or a portion of their water needs. The Department of Water Resources (DWR) compiled a statewide Natural Communities Commonly Associated with Groundwater database (DWR 2019). This database identifies potentially groundwater dependent ecosystems based on the best available vegetation and wetland data (Klausmeyer et al. 2018). DWR (2019) identifies potentially groundwater dependent wetland areas using National Wetland Inventory (NWI) wetland data (USFWS 2018). These data were evaluated and assessed to accurately capture wetland and riverine features. In the SLO Valley Groundwater Basin, the best available vegetation mapping dataset (FVEG) was from the California Fire and Resource Assessment Program Vegetation (California Department of Forestry and Fire Protection 2015). FVEG is a remotely sensed dataset that classifies vegetation to coarse types (i.e., the California Wildlife Habitat Relationship System). Given the limitations of this dataset to accurately capture and identify vegetation using a precise classification system, it was deemed inappropriate for use in determining potential GDEs in the SLO Groundwater Basin. Instead, a manual assessment of vegetation with potential groundwater dependence was conducted using National Agricultural Imagery Program 2018 color aerial imagery (NAIP 2018). Vegetation communities identified as potentially groundwater dependent included riparian trees and shrubs, and oak woodlands. Oak woodlands were considered potentially groundwater dependent, particularly coast live oak riparian woodlands, because coast live oak (*Quercus agrifolia*) is known to make use of groundwater at depths of up to 36 ft (see Steinberg 2002 and references cited therein). Some other species of California oak, particularly blue oak (*Q. douglasii*) are known to develop deeper roots that can access deeper groundwater in fractured bedrock on hillslopes (up to 70 feet [Lewis and Burgy 1964]), however such landscape positions are substantially different from what would be expected for GDEs occurring within a recognized groundwater basin on valley bottom or floodplain alluvial deposits. Therefore, we rely on the species-specific rooting and groundwater depth data for coast live oak cited by Steinberg (2002).

Potential vegetation and wetland GDEs were retained if the underlying depth to water in 2019 was inferred to be 30 feet or shallower based on the existing well network (Figure 2). Depth to groundwater was interpolated from seventeen wells for which groundwater level data was available in the spring of 2019 (WSC in progress). The depth to groundwater shown in Figure 2 is assumed to represent regional groundwater levels; however, the screening depth is known for only 6 of the 17 of the wells. Wells where the screened depth is unknown may be measuring groundwater levels for deeper aquifers that are unconnected to the shallow groundwater system, and thus groundwater deeper than 30 ft for a given well may not reflect the absence of shallow groundwater, but instead reflects the absence of data. To determine the hydraulic connectivity between potential perched aquifers to the regional aquifer, additional monitoring with nested piezometers could be utilized.

For the purposes of differentiating between potential and unlikely GDEs, different assumptions were made for the SLO versus Edna Valley sub-basins in areas of no groundwater data. In the SLO sub-basin (underlying SLO Creek), it was assumed that the depth to regional groundwater was less than 30 feet because the limited available data indicate that groundwater in this sub-basin is generally relatively shallow. In the Edna Valley (underlying Pismo Creek), it was assumed that the depth to regional groundwater was more than 30 feet because the limited available data indicate that the groundwater in this sub-basin is generally deeper. One exception to this assumption was made on upper East Corral de Piedra where the conditions were assumed to be similar to those on upper West Corral de Piedra where early dry season wet conditions have been observed by Stillwater Sciences and Balance Hydrologics (2008). The 30-foot depth criterion is consistent with guidance provided by The Nature Conservancy (Rohde et al. 2019) for identifying GDEs.

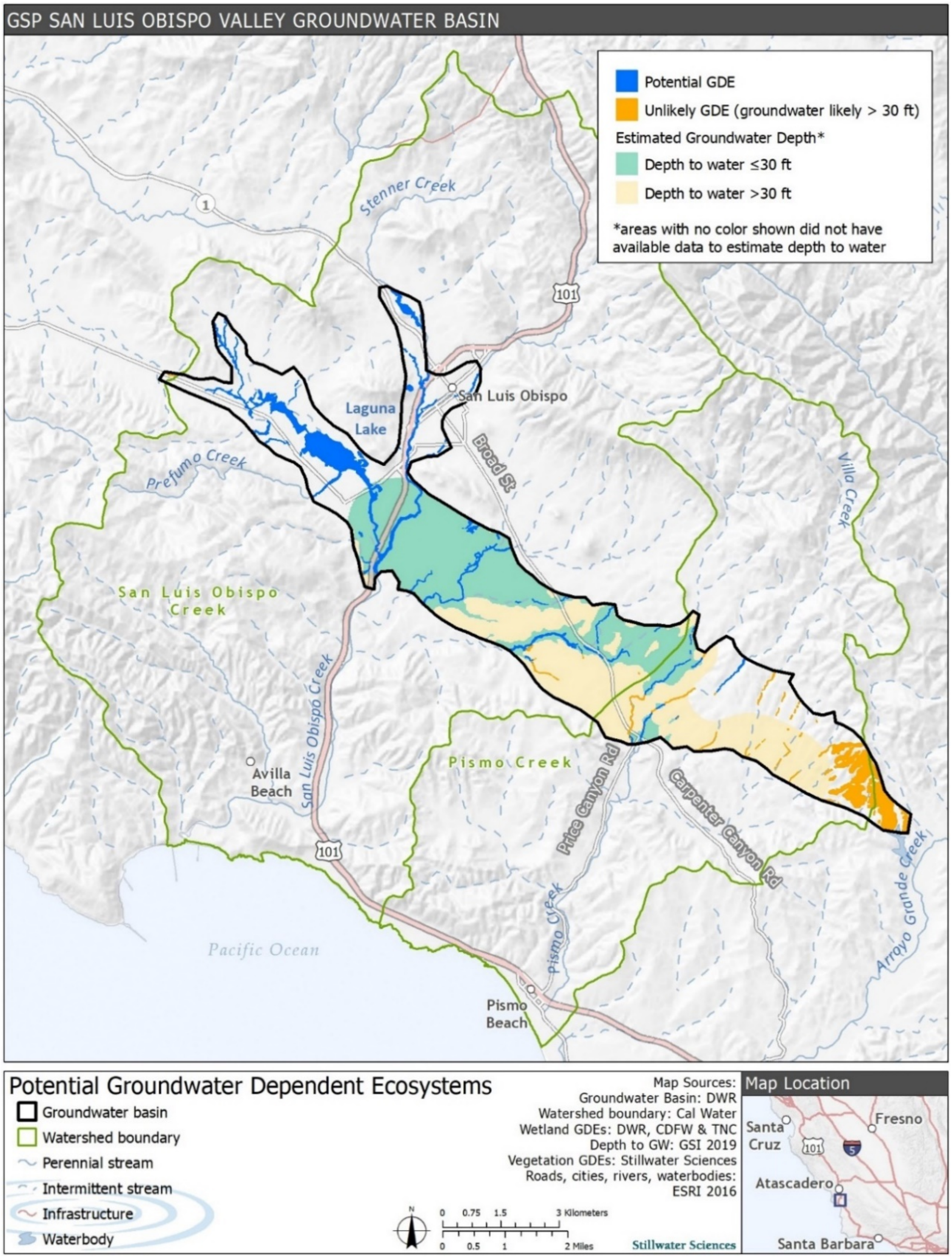

Figure 2. Potential Groundwater Dependent Ecosystems.

2.2 Special-Status Species and Sensitive Natural Communities Associated with GDEs

For the purposes of this memorandum, special-status species are defined as those:

- listed, proposed, or under review as endangered or threatened under the federal Endangered Species Act (ESA) or the California Endangered Species Act (CESA);
- designated by California Department of Fish and Wildlife (CDFW) as a Species of Special Concern;
- designated by CDFW as Fully Protected under the California Fish and Game Code (Sections 3511, 4700, 5050, and 5515);
- designated as rare under the California Native Plant Protection Act (CNPPA); and/or
- included on CDFW's most recent *Special Vascular Plants, Bryophytes, and Lichens List* (CDFW 2020) with a California Rare Plant Rank (CRPR) of 1, 2, 3, or 4.

In addition, sensitive natural communities are defined as:

- vegetation communities identified as critically imperiled (S1), imperiled (S2), or vulnerable (S3) on the most recent California Sensitive Natural Communities List (CDFW 2020).

To determine the terrestrial and aquatic special-status species that may utilize potential GDE units overlying the SLO Valley Groundwater Basin, Stillwater ecologists queried existing databases on regional and local occurrences and distributions of special-status species. Databases accessed include the California Natural Diversity Database (CNDDB) (CDFW 2019b), eBird (2019), and TNC freshwater species list (TNC 2019). Spatial database queries were centered on the potential GDEs plus a 1-mile buffer. Stillwater's ecologists reviewed the database query results and identified special-status species and sensitive natural communities with the potential to occur within and to be associated with the vegetation and aquatic communities in or immediately adjacent to the potential GDEs. Table 1 summarizes these special-status species and sensitive natural communities, describes their habitat preferences and potential dependence on GDEs, and identifies known nearby occurrences (Table 1). Wildlife species were evaluated for potential groundwater dependence using the Critical Species Lookbook (Rohde et al. 2019).

The SLO Valley Groundwater Basin supports steelhead belonging to the South-Central California Coast Distinct Population Segment (DPS) which is federally listed as threatened. Within this DPS, the population of steelhead within the SLO Creek, and Pismo Creek portions of the groundwater basin have both been identified as Core 1 populations which means they have the highest priority for recovery actions, have a known ability or potential to support viable populations, and have the capacity to respond to recovery actions (NMFS 2013). One critical recovery action listed by the National Marine Fisheries Service (NMFS) includes the implementation of operating criteria to ensure instream flows allow for essential steelhead habitat functions (NMFS 2013).

The SLO Valley Groundwater Basin was determined to have **high ecological value** because: (1) the known occurrence and presence of suitable habitat for several special-status species including the Core 1 population status of South-Central California Coast Steelhead DPS and several special-status plants and animals that are directly or indirectly dependent on groundwater (Table 1); and (2) the vulnerability of these species and their habitat to changes in groundwater levels (Rohde et al. 2018).

Table 1. Special-status species and sensitive natural communities documented in the vicinity of the San Luis Obispo (SLO) Valley Groundwater Basin with a potential GDE association.

Common name *Scientific name*	**Status[1] Federal/ State/CRPR**	**Potential to occur**	**Query source**	**GDE association[2]**	**Habitat association and occurrence**
Birds					
Bank swallow *Riparia*	–/ST/–	Some potential	eBird	Indirect	Nests in vertical bluffs or banks, usually adjacent to water (i.e., rivers, streams, ocean coasts, and reservoirs), where the soil consists of sand or sandy loam. This species relies on surface water that may be supported by groundwater (Rohde et al 2019). eBird occurrences in SLO Valley including Laguna Lake.
Least bittern *Ixobrychus exilis*	–/SSC/–	Some potential	eBird	Direct	Freshwater and brackish marshes with dense aquatic or semiaquatic vegetation interspersed with clumps of woody vegetation and open water. eBird occurrences in SLO Valley including Laguna Lake.
Loggerhead shrike *Lanius ludovicianus*	–/SSC/–	Likely	CNDDB, eBird	Indirect	Open shrubland or woodlands with short vegetation and and/or bare ground for hunting; some tall shrubs, trees, fences, or power lines for perching; typically nest in isolated trees or large shrubs. CNDDB occurrences in SLO Valley.
Northern harrier *Circus hudsonius*	–/SSC/–	Some potential	eBird	Indirect	Nests, forages, and roosts in wetlands or along rivers or lakes, but also in grasslands, meadows, or grain fields. eBird occurrences in SLO Valley including Laguna Lake.
Peregrine falcon *Falco peregrinus*	–/SFP/–	Some potential	eBird	Indirect	Wetlands, woodlands, cities, agricultural lands, and coastal area with cliffs (and rarely broken-top, predominant trees) for nesting; often forages near water. eBird occurrences in SLO Valley including Laguna Lake.
Redhead *Aythya americana*	–/SSC/–	Some potential	eBird	Direct	Freshwater emergent wetlands with dense stands of cattails (*Typha* spp.) and bulrush (*Schoenoplectus* spp.) interspersed with areas of deep, open water; forage and rest on large, deep bodies of water. Summer resident in southern California. eBird occurrences in SLO Valley including Laguna Lake along SLO Creek.

Common name ***Scientific name***	**Status[1] Federal/ State/CRPR**	**Potential to occur**	**Query source**	**GDE association[2]**	**Habitat association and occurrence**
Tricolored blackbird *Agelaius tricolor*	–/ST/–	Likely	CNDDB, eBird	Direct	Feeds in grasslands and agriculture fields; nesting habitat components include open accessible water with dense tall emergent vegetation, a protected nesting substrate (including flooded or thorny vegetation), and a suitable nearby foraging space with adequate insect prey. Relies on groundwater dependent ecosystems for breeding and roosting (Rohde et al 2019). CNDDB occurrence in Edna Valley and eBird occurrence in SLO Valley including Laguna Lake, Pismo Creek, and Stenner Creek.
White-tailed kite *Elanus leucurus*	–/SFP/–	Likely	CNDDB, eBird	Indirect	Lowland grasslands and wetlands with open areas; nests in trees near open foraging area. CNDDB and eBird occurrences in SLO Valley including Laguna Lake.
Mammals					
Pallid bat *Antrozous pallidas*	–/SSC/–	Likely	CNDDB	Potential Indirect	Roosts in rock crevices, tree hollows, mines, caves, and a variety of vacant and occupied buildings; feeds in a variety of open woodland habitats. CNDDB occurrence in SLO Valley.
Amphibians and reptiles					
California red-legged frog *Rana draytonii*	FT/SSC/–	Likely	CNDDB	Direct	Breeds in still or slow-moving water with emergent and overhanging vegetation, including wetlands, wet meadows, ponds, lakes, and low-gradient, slow moving stream reaches with permanent pools; uses adjacent uplands for dispersal and summer retreat. Relies on surface water that may be supported by groundwater (Rohde et al. 2019). Critical habitat is within the SLO watershed. CNDDB occurrences include SLO Creek and tributaries.
Coast Range newt *Taricha torosa*	–/SSC/–	Likely	CNDDB	Direct	Chaparral, oak woodland, and grasslands. Relies on surface water that may be supported by groundwater for breeding. CNDDB occurrences are in SLO Creek and Brizziolari Creek.
Foothill yellow-legged frog *Rana boylii*	–/SE/–	Unlikely	CNDDB	Direct	Shallow tributaries and mainstems of perennial streams and rivers, typically associated with cobble or boulder substrate; occasionally found in isolated pools, vegetated backwaters, and deep, shaded, spring-fed pools. All CNDDB occurrences are historical (1958) in Arroyo Grande Creek and population is possibly extirpated.

Common name ***Scientific name***	**Status[1] Federal/ State/CRPR**	**Potential to occur**	**Query source**	**GDE association[2]**	**Habitat association and occurrence**
Northern California legless lizard *Anniella pulchra*	–/SSC/–	Likely	CNDDB	Indirect	Chaparral, pine-oak woodlands, desert scrub, sandy washes, and stream terraces with sycamores, cottonwoods, or oaks. Occurs in moist warm loose soil with plant cover. CNDDB occurrences in Edna Valley.
Western pond turtle *Emys marmorata*	–/SSC/–	Likely	CNDDB	Direct	Ponds, lakes, rivers, streams, creeks, marshes, and irrigation ditches with basking sites. Relies on surface water that may be supported by groundwater. CNDDB occurrences include SLO and Edna Valley, as well as, Pismo Creek, Miossi Creek, Prefumo Creek, and Mainstem and East Fork of SLO Creek
Fish					
Steelhead, South Central California DPS *Oncorhynchus mykiss*	FT/–/–	Likely	CNDDB	Direct	Rivers and streams with cold water, clean gravel of appropriate size for spawning, and suitable rearing habitat; typically rear in fresh water for one or more years before migrating to the ocean. Suitable habitat present (migration, rearing); species known to occur in SLO and Pismo Creek and their tributaries (i.e., West Corral de Piedra Creek).
Plants and Sensitive Natural Communities					
San Luis Obispo sedge *Carex obispoensis*	–/–/1B.2	Likely	CNDDB	Direct	Seeps, often with serpentine and sometimes gabbro soils or clay soils in closed-cone coniferous forest, chaparral, coastal prairie, coastal scrub, and valley and foothill grassland (CNPS 2020); all CNDDB observations are along Prefumo Creek and Froom Creek outside of the groundwater basin
Congdon's tarplant *Centromadia parryi* subsp. *congdonii*	–/–/1B.1	Likely	CNDDB	Direct	Valley and foothill grassland (CNPS 2020); all CNDDB observations are within the SLO Creek watershed including around Laguna Lake and East Fork of SLO Creek
Chorro Creek bog thistle *Cirsium fontinale* var. *obispoense*	FE/SE/1B.2	Likely	CNDDB	Direct	Serpentine seeps and drainages in chaparral, cismontane woodlands, coastal scrub, and valley and foothill grassland (CNPS 2020); CNDDB observations are limited to the SLO Creek watershed and are associated with seeps and springs,
Adobe sanicle *Sanicula maritima*	–/CR/1B.1	Likely	CNDDB	Direct	Clay and serpentine soils in chaparral, coastal prairie, meadows and seeps, and valley and foothill grassland (CNPS 2020); multiple CNDDB occurrences in open grassy area of Laguna Lake Park, along Laguna Creek, and South Hills

Common name ***Scientific name***	**Status[1] Federal/ State/CRPR**	**Potential to occur**	**Query source**	**GDE association[2]**	**Habitat association and occurrence**
Saline clover *Trifolium hydrophilum*	–/–/1B.2	Likely	CNDDB	Direct	Marshes and swamps, mesic and alkaline soils in valley and foothill grassland, and vernal pools (CNPS 2020); one CNDDB occurrence, located in Laguna Lake Park
Coastal and Valley Freshwater Marsh	–/S2.1/–	Likely	CNDDB	Direct	Dominated by perennial, emergent monocots including tules (*Schoenoplectus* spp.) and cattails (*Typha* spp.). May form completely closed canopies (Holland 1986). CNDDB observations around Laguna Lake.

[1] **Status codes:**

Federal

FE = Federally listed endangered

FT= Listed as threatened under the federal Endangered Species Act

– No federal status

State Rank

SE = Listed as Endangered under the California Endangered Species Act

ST = Listed as Threatened under the California Endangered Species Act

SFP = CDFW Fully Protected species

SSC = CDFW species of special concern

CR = California State listed as rare

S2.1 = CDFW imperiled and threatened species

– No state status

California Rare Plant Rank (CRPR)

1B = Plants rare, threatened, or endangered in California and elsewhere

CRPR Threat Ranks

0.1 Seriously threatened in California (high degree/immediacy of threat)

0.2 Fairly threatened in California (moderate degree/immediacy of threat)

– No CRPR status

[2] **Groundwater Association**

Direct: Species directly dependent on groundwater for some or all of its water needs (e.g., cottonwood with roots in groundwater, juvenile steelhead in dry season)

Indirect: Species dependent upon other species that rely on groundwater for some or all of their water needs (e.g., riparian birds)

3 GDE EVALUATION AND SUSTAINABLE INDICATORS

In Section 2 we identified potential GDEs distributed throughout the SLO Valley Groundwater Basin. In Section 3 we identify specific GDE types that are likely or have potential to occur in the SLO Valley Groundwater Basin. Each GDE type has a different requirement to sustainably function. For each GDE type we then identify sustainable GDE indicators and target values. Sustainable GDE indictors are metrics that can be monitored to determine if undesirable impacts are occurring. The target values are set based on the best available data for each GDE type. These values are determined by the needs of special-status species, sensitive natural communities, or keystone species associated with each GDE type. As more data becomes available, the indicator type or target value may be refined. Furthermore, sustainable GDE indicator target values may not be met due to management activities (e.g., pumping) or due to climate (e.g., extended drought conditions). Thus if sustainable indicator target values are not met, additional studies or assessments to determine the cause may be required.

3.1 GDE Types

Eight distinct likely or uncertain types of GDEs have been identified in the SLO Valley Groundwater Basin. Likely GDE types include riverine (fast moving), riverine (slow moving), riparian, lacustrine, and wetland/marsh. Three uncertain GDE types include seasonal wetlands/wet meadows, springs and seeps, and oak woodlands. Seasonal wetlands are uncertain because their dependence of surface water versus groundwater is unknown and may be site specific. Spring and seeps are uncertain because they may be dependent on recharge from fractured bedrock in the surrounding hills rather than SLO Valley Groundwater Basin water. Oak woodlands are uncertain because groundwater elevation data from areas they are present (e.g. the eastern Edna Valley) are unavailable. Additional studies for these GDE types are recommended in Section 3.2.

The diversity of GDEs overlying the SLO Valley Groundwater Basin is due to the unique hydrogeomorphology of the basin, whereas the groundwater basin is oriented perpendicular to the general direction of surface water flow (Figure 2). A description of each GDE type along with associated special-status species, natural sensitive communities, and/or keystone species are listed in Table 2. Keystone species are defined as species that serve as indicators of GDEs sustainability. If the sustainable indicator target value is met for a GDE type with a keystone species, all habitats and species associated with that GDE type are assumed to be protected.

While a complete list of special-status species with known occurrence or presence of suitable habitat in potential GDE units overlying or within 1 mile of the SLO Valley Groundwater Basin are listed in Table 1, only those species that have a direct association with GDEs are included in Table 2. Examples of species omitted from Table 2 include species that are believed to have be extirpated from this area (e.g., foothill yellow-legged frog) or have an indirect association with GDEs (e.g., loggerhead shrike). Species that have an indirect association are assumed to be protected if the GDE indicators listed above are met. For example, the loggerhead shrike is known to occur within the SLO Valley Groundwater Basin. It lives in shrublands or woodlands with short vegetation and/or bare ground for hunting, uses tall shrubs and trees for perching, and typically nests in isolated trees. Some trees or shrubs used for perching or nesting may be part of a GDE; which is assumed to be protected if GDE indicators that are developed for each GDE type (Table 2) are met.

Table 2. Summary of Groundwater Dependent Ecosystem (GDE) types known to occur in the San Luis Obispo (SLO) Valley Groundwater Basin.

GDE type	GDE habitat description	Associated special-status species[A], sensitive natural communities[B], or keystone species[C]	Key life stages primarily dependent on groundwater	Sustainable GDE indicator	Monitoring period[D]	Location and target value
Riverine (Fast moving)	Fast moving, flowing water	Steelhead, South Central California DPS[C] *Oncorhynchus mykiss*	Juvenile steelhead	Flow rate (cfs)	Late spring (May-June) and dry season (July–Oct)	1) Stenner Creek at Nipomo St = 0.85 cfs (late spring); 0.33 cfs (dry season) (SWS 2014) 2) SLO Creek at Marsh St = 1.20 cfs (late spring); 0.90 cfs (late summer) (SWS 2014)
					Late spring (May–June) and dry season (July–Oct)	Pismo Creek at Railroad crossing = 1.50 cfs (late spring)/; 0.50 cfs (dry season) (Stillwater 2016)
Riverine (Slow moving)	Slow moving or still water; interspersed or interconnected with wetlands, marshes, or grasslands	California red-legged frog[C] *Rana draytonii*	Larval development and metamorphosis	Water depth (ft)	Late spring (May–June) and dry season (July–Oct)	East Fork of SLO Creek at Jespersen Road = 2.3 ft
		Coast Range newt *Taricha torosa*	Larval development and metamorphosis			
		Western pond turtle *Emys marmorata*	Foraging adults and juveniles			
Lacustrine/ Lacustrine Connected	Open water. Interspersed or interconnected with wetlands, marshes, tributaries, or grasslands	Least bittern *Ixobrychus exilis*	All life stages	TBD[E]	TBD	Laguna Lake Target values TBD
		Redhead *Aythya americana*	Adults; potential for limited resident breeding			
		Tricolored blackbird *Agelaius tricolor*	All life stages			

GDE type	GDE habitat description	Associated special-status species[A], sensitive natural communities[B], or keystone species[C]	Key life stages primarily dependent on groundwater	Sustainable GDE indicator	Monitoring period[D]	Location and target value
Wetland/ Marsh	Dominated by perennial, emergent monocots including tules (*Schoenoplectus* spp.) and cattails (*Typha* spp.). May form completely closed canopies (Holland 1986)	Coastal and Valley Freshwater Marsh	Adult plants	TBD	TBD	Tank Farm wetlands Target value TBD
Riparian	Dominated by mature woody vegetation including cottonwoods, sycamores, and willows	California Sycamore Woodland; Fremont Cottonwood Forest and Woodland and/or Black Cottonwood Forest and Woodland	Adult trees	Depth to groundwater (ft) and/or rate of groundwater elevation change[F]	TBD	See Figure 3 and Table 3 for all proposed locations Target values TBD
Seasonal wetland/wet meadow	An area that is inundated by water seasonally (i.e., present during the growing season but absent by the end of the growing season in most years) (FGDC 2013)	Adobe sanicle *Sanicula maritima* Congdon's tarplant *Centromadia parryi* ssp. *congdonii,* Saline clover *Trifolium hydrophilum*	Adult plants	TBD	TBD	TBD
Springs and seeps	A location where water from the ground rises to the surface, commonly with saturated soil, standing, or flowing water year-round.	Chorro Creek bog thistle *Cirsium fontinale* var. *obispoense* SLO sedge *Carex obispoensis*	Adult plants	TBD	TBD	TBD

GDE type	GDE habitat description	Associated special-status species[A], sensitive natural communities[B], or keystone species[C]	Key life stages primarily dependent on groundwater	Sustainable GDE indicator	Monitoring period[D]	Location and target value
Oak woodlands	Coast live oak riparian woodlands	Coast live oak[C] *Quercus agrifolia*; Pallid bat *Antrozous pallidas*[G]	Adult trees	Depth to groundwater (ft) and/or rate of groundwater elevation change	TBD	TBD

[A] A list of special-status species with known occurrence or presence of suitable habitat in potential GDE units overlying the or within 1 mile of the SLO Valley Groundwater Basin are listed in Table 1. Of those species, only those species that are likely or have some potential to occur and that have a direct association with potential GDEs are listed in Table 2.
[B] Sensitive natural communities as defined as vegetation communities that are critically imperiled, imperiled, or vulnerable on the most recent California Sensitive Natural Communities List (CDFW 2020) or by CNPS 2020.
[C] Keystone species.
[D] Monitoring is proposed only for those time periods for which each GDE type is anticipated to be primarily dependent upon groundwater originating in the SLO Valley groundwater Basin (see Section 4 for discussion).
[E] TBD = To be determined
[F] Depth to groundwater or the rate of groundwater elevation change in the dry season is anticipated to be the sustainable indicator for mature woody riparian vegetation and oak woodland based on research by Amlin, N. M., and S. B. Rood. 2002; Mahoney, J. M., and S. B. Rood. 1998; Rood, S. B., and J. M. Mahoney. 1990; Segelquist, C. A., M. L. Scott, and G. T. Auble. 1993; Shafroth, P. B., J. C. Stromberg, and D. T. Patten. 2002; and Vaghti, M. G., and S. E. Greco. 2007.
[G] Pallid bats utilize oak savannahs, black oaks, oak grasslands, and open oak woodlands (Pierson and Rainey 2002). Oak savannahs are usually characterized by valley oak, blue oak, interior live oak, or coast live oak, with the specific composition dependent on latitude and elevation. Pallid bats typically roost in caves, crevices, bridges, buildings and occasionally tree hollows.

3.2 Evaluation of Potential GDEs and GDE Types

The potential GDEs and GDE types identified herein were based on the best available but limited groundwater data, wetland data and low-resolution vegetation data. These potential GDEs and GDE types require ground-truthing to determine the dominant vegetation types and quality, habitat types and quality, existing hydrologic conditions and their spatial extent to improve our understanding of their distribution and groundwater dependence. Ground-truthing should include reconnaissance level field-survey of a sub-set of accessible areas mapped as potential GDEs. At each site, field biologists could assess the following: (1) vegetation data (e.g., dominant vegetation types and plant species, indications of the proportion of live vs. senescent canopy, and vegetation density); (2) qualitative observations of hydrologic conditions (e.g. flowing or standing water); and, (3) habitat conditions for special-status or keystone species by comparing each species' habitat preferences (e.g., large trees, open water or herbaceous cover, etc.) to conditions present at the site. Based on this field data, GDE distribution, GDE type, and habitat for associated special-status species could be refined. Habitat assessments should be focused on federally or state threatened or endangered flora or fauna with direct groundwater association including the state threatened species Tricolored blackbird *(Agelaius tricolor),* the federally threatened California red-legged frog (*R. draytonii*), the federally threatened Steelhead trout (*O. mykiss*), and the federally endangered Chorro Creek bog thistle (*Cirsium fontinale* var. *Obispoense)*.

Furthermore, seven of the eight GDE types (Table 2) may require additional assessment/analysis to either determine the extent to which the GDE type is groundwater dependent, the timing of groundwater dependence, and/or to refine the sustainable GDE indicator or target values. To this extent the following are proposed for consideration:

1. **Riverine (fast moving).** Conduct an instream flow study of mainstem SLO and Stenner Creeks to identify flows required by juvenile steelhead in the late spring and summer/early fall dry season, as well as, an assessment of the quality of steelhead habitat in the East Fork of SLO Creek and Davenport Creek.
2. **Lacustrine.** Conduct a study of Laguna Lake to determine the magnitude, timing and duration of the dependence of the Lake on groundwater originating from the SLO Valley Groundwater Basin (e.g. a surface-groundwater assessment/model). Based on the results of the study and associated special-status species habitat assessments, develop sustainable GDE indicator(s), timing of groundwater dependence, and indicator target values.
3. **Wetland/Marsh.** Conduct an assessment of wetlands and marshes found within the SLO Valley Groundwater Basin that support special-status species or sensitive natural communities; determine the magnitude, timing and duration of their dependence on groundwater originating from the SLO Valley Groundwater Basin; and develop sustainable GDE indicator(s) and associated information.

Oak tree along East Corral de Piedra Creek

4. **Riparian.** Install groundwater monitoring wells at proposed locations (Table 3), collect and analyze data. Refine GDE indicator(s) and develop site specific target values for the depth to groundwater below the surface (ft) that will sustain the GDE at each location.
5. **Seasonal wetlands.** Conduct an assessment of seasonal wetlands and wet meadows found within the SLO Valley Groundwater Basin, especially those that support groundwater dependent special-status species including Adobe sanicle, Congdon's tarplant, and Saline clover. While these plants need soil saturation or inundation for seed germination, establishment and growth, the dependence on groundwater versus surface water is unknown and may be site specific. If seasonal wetlands primarily dependent on groundwater originating in the SLO Groundwater Basin are indentified, develop sustainable GDE indicator(s) and associated information.
6. **Springs and seeps.** Conduct an assessment of springs and seeps within the SLO Valley Groundwater Basin to identify their locations and to determine their dependence on groundwater originating from the SLO Valley Groundwater Basin. The study could include measurements of the magnitude and timing of flow rates and/or an isotopic analysis to identify water sources. It is anticipated that many springs and seeps will be dependent on recharge from fractured bedrock in the surrounding hills rather than SLO Valley Groundwater Basin water. Springs and seeps within the basin that are known to occur include but are not limited to the base of the South Hills, Irish Hills, and hills surrounding Laguna Lake. If appropriate, develop a sustainable groundwater indicator and associated information.
7. **Oak woodlands.** Conduct an assessment of oak woodlands within the SLO Valley Groundwater Basin to determine the oak species composition and distribution, with a particular focus on coast live oak riparian woodlands. Utilize existing wells or install new monitoring wells to monitor depth to groundwater. Utilizing the assessment and monitoring data determine if oak woodlands (e.g. Eastern Edna Valley) (Figure 2) are groundwater dependent. For example, coast live oak may have several deep main roots that tap groundwater if present within approximately 36 feet of the soil surface (Canadell et al 1996; Cooper 1922; Plumb 1980). If the oak woodlands are determined to be groundwater dependent, conduct an assessment of Pallid bat habitat distribution within oak woodlands and develop sustainable GDE indicators and associated data.

3.3 Identification of Sustainable GDE Indicators

Each type of GDE (Table 2) has a different suite of fauna and flora associated with it. For some GDE types, we also identified associated sensitive natural communities (as identified by CDFW 2020 or CNPS 2020) or keystone species. Keystone species are defined as species that serve as indicators of GDEs sustainability. To develop indicators for each GDE type the requirements of sensitive or keystone species were considered. To this extent the life histories and habitat requirements of key faunal species are discussed in the following section, along with an explanation of the development of GDE indicators dependent on faunal species.

3.4 Life Histories and Habitat Requirements of Key Faunal Species

3.4.1 Key aquatic species

Steelhead

Steelhead have one of the most complex life histories of any salmonid species, exhibiting both anadromous and freshwater resident life histories. Freshwater residents are typically referred to as rainbow trout, and those exhibiting an anadromous life history are called steelhead (NMFS 1998).

Steelhead exhibit highly variable life history patterns throughout their range but are broadly categorized into winter and summer reproductive ecotypes. Winter steelhead, the most widespread reproductive ecotype and the only type currently present in Central California Coast streams, become sexually mature in the ocean, enter spawning streams in summer, fall or winter, and spawn a few months later in winter or late spring (Meehan and Bjornn 1991; Behnke 1992).The timing of upstream migration is correlated with higher flow events, such as freshets or sand bar breaches, and seasonal decline of associated lower water temperatures in winter (NMFS 2006)

Spawning occurs primarily from January through March but may begin as early as late December and may extend through April (Hallock 1987). Individual steelhead may spawn more than once, returning to the ocean between each spawning migration. Steelhead may spawn more than one season before dying (iteroparity), in contrast to other species of the *Oncorhynchus* genus. Upon emerging from the gravel, fry rear in edgewater habitats and move gradually into pools and riffles as they grow larger. Cover is an important habitat component for juvenile steelhead, both as velocity refuge and as a means of avoiding predation (Shirvell 1990, Meehan and Bjornn 1991). Steelhead, however, tend to use riffles and other habitats not strongly associated with cover during summer rearing more than other salmonids. In winter, they become inactive and hide in any available cover, including gravel, cobbles, or woody debris. Juvenile steelhead rear a minimum of one and typically two or more years in fresh water before migrating to the ocean during smoltification (the process of physiological change that allows ocean survival). Juvenile migration to the ocean generally occurs from December through August.

Although various steelhead life stages occur in aquatic habitats that overly the SLO Groundwater Basin, these aquatic habitats are supported by a range of surface and groundwater sources (see Section 1 for discussion). However, during the late spring and dry season, the primary source supporting steelhead in GDEs overlying the SLO Valley Groundwater Basin is groundwater. Thus the dependence of steelhead on groundwater is greatest during the late spring and the summer-fall dry season and it is for these times of the year that target values for sustainable GDE indicators are proposed (Table 2). Target values are based on the best available data.

In 2014 Stillwater Sciences completed a county-wide instream flow study for steelhead trout during their two most flow sensitive periods for minimum instream flows: late spring (May and June) and late summer (August and September) (Stillwater 2014). All available hydrologic and physical terrain data and instream flow assessments were reviewed and analyzed to explore appropriate watershed stratification and to assess the ability to extrapolate existing instream flow analyses throughout all watersheds of the County. A predictive model, based on watershed area, was developed to estimate minimum instream flows during these time periods. The purpose of the Stillwater (2014) study analysis was to provide a preliminary estimate of the magnitude and timing of instream flows that would support steelhead in creeks of SLO County and was not intended to provide sufficient precision or detail from which to establish regulatory limits. However, due to an absence of a detailed instream flow study in SLO Creek, this study is utilized to set preliminary target flow values herein. Two sites were selected for monitoring: Stenner Creek at the Nipomo Street Bridge and Mainstem SLO Creek at the Marsh Street Bridge (Table 2, Figure 3). These locations were selected because in the dry season these are in hydrologically gaining reaches, indicating that at the proposed locations the instream flows are primarily supported by SLO Valley Groundwater Basin groundwater. In Stenner Creek at Nipomo Street the sustainable flow target is set at 0.85 cfs for the late spring (May-June) and 0.33 cfs for the dry season (July-Oct) (SWS 2014) and at SLO Creek at the Marsh Street bridge the target is set at 1.20 cfs (late spring) and 0.90 cfs (dry season) (SWS 2014). To evaluate the approximate streamflow values proposed herein, a detailed instream flow study for SLO Creek for SLO and Stenner Creeks is recommended.

In 2016 Stillwater Sciences completed an instream flow study on Pismo Creek (Stillwater 2016). Based on this study, the streamflow target values recommended for mainstem Pismo Creek at the railroad crossing are set at 2.50 cfs in May, 1.50 cfs in June, and 0.50 cfs from July through the end of October. Similar to the approach used for SLO Creek, this location was selected for monitoring because it is located in a hydrologically a gaining reach and is likely supported by groundwater originating in the SLO Valley Groundwater Basin during the dry season.

California Red-legged Frog (CRLF)

CRLF is a federally listed as threatened and is a CDFW species of special concern. The species' range occurs from south of Elk Creek in Mendocino County to Baja California, with isolated remnant populations occurring in the Sierra foothills, from sea level to approximately 8,000 ft (Stebbins 1985, Shaffer et al. 2004). Most California red-legged frog populations are currently largely restricted to coastal drainages on the central coast of California.

CRLF habitat includes wetlands, wet meadows, ponds, lakes, and low-gradient, slow-moving stream reaches. Breeding habitats are generally characterized by still or slow-moving water with deep pools (usually at least 2.3 ft deep, although frogs have been known to breed in shallower pools) with emergent and overhanging vegetation (Jennings and Hayes 1994). Breeding sites can be ephemeral or permanent; if ephemeral, inundation is usually necessary into the summer months (through July or August) for successful metamorphosis. Although some adults may remain resident year-round at favorable breeding sites, others may disperse overland up to a mile or more (Fellers and Kleeman 2007). Movements may be along riparian corridors, but many individuals move directly from one site to another without apparent regard for topography or watershed corridors (Bulger et al. 2003). CRLFs sometimes enter a dormant state during summer or in dry weather (aestivation), finding cover in small mammal burrows, moist leaf litter, root wads, or cracks in the soil. However, CRLFs in coastal areas are typically active year-round because temperatures are generally moderate (USFWS 2002, Bulger et al. 2003).

The breeding (i.e., mating and egg-laying) season begins as early as late November and lasts though as late as April (Jennings and Hayes 1994). Females lay egg masses containing approximately 2,000–6,000 eggs (USFWS 2002). Eggs hatch within 6–14 days and tadpoles require approximately 11–20 weeks to metamorphose, generally from May to September (USFWS 2002), although overwintering by CRLFs has been documented at non-forested breeding sites (Fellers et al. 2001). CRLFs become reproductively mature frogs at 2 to 4 years, with females taking longer to develop (Jennings and Hayes 1994).

Pools with water depths greater than 2.3 feet deep are optimal, though not required, to support a majority of the breeding and larval development periods. This water depth is used to set the sustainable GDE target value. Although CRLF begin to breed as early as late November, and tadpole growth and development continues through as late as September, the aquatic habitats utilized by CRLF are supported by a range of surface and groundwater sources throughout the year. However, during the late spring and dry season, the primary source supporting CRLF in GDEs overlying the SLO Valley Groundwater Basin is groundwater. For the slow moving riverine GDE type, the target values for sustainable GDE indicators are proposed based on CRLF requirements for the late spring and summer (Table 2). We propose that CRLF is a keystone species for the slow moving riverine GDE type, and if the proposed sustainable indicator criterion is met for the late spring and summer, it assumed that sufficient groundwater will be available year-round for all habitats and species associated with this GDE type, including newts and western pond turtles.

Coast Range Newt

Coast Range newts occur commonly in the Coast Ranges from central Mendocino County south to northern San Diego County. Populations south of the Salinas River in Monterey County are considered by CDFW as a Species of Special Concern. Coast Range newts breed in ponds, reservoirs, and streams. Habitats are often in or near streams in valley-foothill hardwood and hardwood-conifer areas (Morey 1988); in southern California, suitable habitats include a generally drier zone of chaparral, oak woodland, or grassland. Stream-breeding newts in southern California commonly lay eggs in deep, slow pools, occasionally in runs, and almost never in riffles (Gamradt and Kats 1997, as cited in AmphibiaWeb 2020). Egg masses may be attached to aquatic vegetation, branches, and the outer surfaces of rocks; in southern California, egg masses are usually laid under rocks in quiet stream pools (AmphibiaWeb 2020) After metamorphosis, California newts disperse from aquatic habitats to terrestrial uplands. Deep leaf litter and animal burrows may be used as summer aestivation sites. During or after winter/spring rains, Coast Range newts return to their breeding site to mate, often migrating large distances and in large numbers. During a study by Trenham (1988), newts were recaptured up to 3,200 m (nearly two miles) away from the breeding pond where they were originally captured and marked.

Migration from aestivation sites to breeding sites generally begins anywhere from late December to February, depending on the amount of rainfall, though populations that breed in stream pools migrate later, typically in March and April after stream flooding has subsided (Nafis 2020). Egg incubation to hatching times may vary at different locations, ranging from two weeks to two and a half months depending on water temperature, and the larval period lasts several months (Nafis 2020, AmphibiaWeb 2020). Larvae transform and begin to live on land at the end of the summer or in early fall, until as late as October (Nafis 2020). In summary stream-breeding Coast Range newts require quiet stream pools from March through October.

Western Pond Turtle

Western pond turtle is a CDFW species of special concern. Western pond turtles inhabit fresh or brackish water characterized by areas of deep water, low flow velocities, moderate amounts of riparian vegetation, warm water and/or ample basking sites, and underwater cover elements, such as large woody debris and rocks (Jennings and Hayes 1994). Along major rivers, western pond turtles are often concentrated in side-channel and backwater areas. Turtles may move to off-channel habitats, such as oxbows, during periods of high instream flows (Holland 1994). Although adults are habitat generalists, hatchlings and juveniles require specialized habitat for survival through their first few years. Hatchlings spend much of their time feeding in shallow water with dense submerged or short emergent vegetation (Jennings and Hayes 1994). Although an aquatic reptile, western pond turtles require upland habitats for basking, overwintering, and nesting, typically within 0.6 mi from aquatic habitats (Holland 1994). Reese and Welsh (1998) recorded frequent and prolonged year-round use of terrestrial habitat up to 0.3 mi (500 m) from the Trinity River for both nesting and overwintering activities.

Western pond turtle eggs are typically laid in June and July, though they may be laid throughout the year (Holland 1994, Reese 1996); local climatic and water level variations can alter the timing of nesting in this species (Crump 2001). Egg-laying sites vary from sandy shorelines to various forest soil types, although they are generally located in grassy meadows, away from trees and shrubs (Holland 1994), with canopy cover commonly less than about 10% (Reese 1996). Incubating eggs are extremely sensitive to increased soil moisture, which can cause high mortality (Bettelheim 2005, Shaffer 2005, Ashton et al. 1997). Young hatch in late fall and emerge either immediately or overwinter in the nest and emerge in early spring. Low fecundity, low hatchling and juvenile survivorships, high adult survivorship, and potentially long lifespans are characteristic of this species (Jennings et al. 1992). Western pond turtles have temperature-dependent sex determination, where the temperature of the egg during incubation determines the sex (Spinks et al. 2003). In summary, while pond turtles nest sites occur only in upland habitats, aquatic habitat is used year-round by foraging adults and juveniles, particularly deep pools with low flow.

3.4.2 Key birds

Least Bittern

Least bittern is a CDFW species of special concern. The smallest of the ardeids, they are cryptic marsh associates that are seldom seen. Because of their secretive nature, there are significant knowledge gaps regarding breeding behavior and interannual movement patterns.

Breeding populations exist in small patches throughout the state but are concentrated in the Central Valley and along the Southern Coast (Sterling 2008; Poole et al. 2020), with some documented breeding populations in the eastern Sierra (Kirk 1995) and Klamath basin (Poole et al. 2020). SLO County is within the known breeding range (Sterling 2008).
Least bittern are known to breed in both freshwater and brackish marshes (Sterling 2008, Poole et al. 2020), where they build nests atop platforms secured to the stalks of emergent vegetation (usually *Typha* or *Scirpus* spp., but occasionally *Phragmites* spp.) (Weller 1961, Poole et al. 2020). Nests are built up to 75 centimeters above the water surface where water depth is between eight centimeters and one meter. Least bittern show a preference for habitat that includes dense stands of emergent vegetation with adjacent pockets of open water. (Weller 1961, Poole et al. 2020). Breeding usually begins in late April and lasts through August (Kirk 1995, Sterling 2008, Poole et al. 2020). Population abundances decrease outside of the breeding season, which suggests seasonal migration, though some birds are likely winter residents. While foraging, least bittern stalk prey beneath the water surface by perching on the stalks of emergent vegetation (Weller 1961). Important food resources include small fish, terrestrial and aquatic invertebrates, amphibians, and occasionally small mammals (Weller 1961, Poole et al. 2020).

Flooded stands of emergent vegetation are a critical requirement for successful breeding (minimum depth of 8 cm) and foraging. Maintaining stable water levels in Laguna Lake such that emergent vegetation on the lake margins remains inundated throughout the nest selection and breeding season (April–August) is the most important consideration for least bittern in the SLO watershed. However, the role of groundwater in maintaining these water elevations is unclear.

Redhead

A CDFW species of special concern, redheads are medium-bodied freshwater diving ducks (pochards) that occur throughout the United States. Pacific flyway redheads breed predominantly in Alaska, Canada, and the midwestern United States (Bellrose 1980, Beedy and Deuel 2008, Baldassarre 2014, Woodin and Michot 2020), however, resident populations occur year-round in California and breed in limited numbers from April through August (Gibbs et al. 1992 as cited in Beedy and Deuel 2008). 2019 CDFW breeding waterfowl surveys estimated 5,051 breeding individuals in the state, with a long-term average of 3,958 breeding individuals (Skalos and Weaver 2019). Seasonal migrants winter throughout California between September and April (Beedy and Deuel 2008, Baldassarre 2014). Resident breeding populations occur mostly in the Central Valley and the northeastern region of the state (in Siskiyou and Modoc County, and the Klamath Basin) (Bellrose 1980, Beedy and Deuel 2008). However, breeding occurrences have been documented outside of the "typical" range in Alameda, Monterey, and Ventura counties

(Beedy and Deuel 2008), so breeding could occur within the SLO watershed if habitat requirements for successful nesting are met.

Redheads tend to build nests in dense stands of emergent vegetation (typically *Typha* and *Scirpus* spp.) over shallow water, though they have been recorded building ground nests in dense cover (Bellrose 1980, Baldassarre 2014, Beedy and Deuel 2008). Proximity to open water is a key requirement for successful breeding, as hens lead broods to water approximately one day after hatching (Bellrose 1980, Yerkes 2000, Baldassarre 2014). Redheads exhibit flexibility in foraging behavior, diving for submerged aquatic vegetation in water up to one meter deep, and tipping up or dabbling in shallower water (Bellrose 1980, Baldassarre 2014, Woodin and Michot 2020). Wigeon grass (*Rupia* spp.), duckweed (*Lemna* spp.), pond weed (*Potamogeton* and *Stuckenia* spp.), and both terrestrial and aquatic invertebrates are important food resources (Bellrose 1980, Baldassarre 2014, Woodin and Michot 2020). Most breeding pairs documented in California occupied permanent or semipermanent wetlands containing ponds with water deeper than one meter (CDFG and USFWS unpubl. data as cited in Beedy and Deuel 2008). Research in other geographic areas has tied reproductive success to water permanence, depth of water beneath nest sites, and overland distance from nest locations to foraging water (Bellrose 1980, Yerkes 2000). Other than maintaining a hydrologic regime conducive to the growth of critical forage plants and nesting substrate, the maintenance of permanent open water approximately one meter deep is the most important consideration for this species in the SLO watershed.

For redheads, maintaining a depth of one meter in open water would be a good target for the breeding season for reproduction and year-round for wintering birds. However, the role of groundwater in maintaining open water is unclear.

Tricolored blackbird

Tricolored blackbird is listed as threatened by the state of California. Tricolored blackbirds are the most prodigious colonially nesting bird in North America (Cook and Toft 2005, Beedy et al. 2020). Endemic to California, their breeding range includes most of the Central Valley and parts of the Central and Southern California Coast (Beedy 2008, Beedy et al. 2020). SLO County is within the known breeding range (Beedy 2008), however in 2017 only three birds were observed breeding in the County during annual surveys (Meese 2017).

Nest initiation begins in late March with breeding lasting through August (Beedy 2008, Wilson et al. 2016, Beedy et al. 2020). Historically, tricolored blackbird colonies nested in flooded stands of vegetation (particularly *Typha* spp. and *Schoenoplectus* spp.) (Cook and Toft 2005, Wilson et al. 2016, Beedy et al. 2020). However, since the arrival of Europeans in California, there has been an observable shift in behavior, with tricolored blackbirds often utilizing protective stands of non-native upland vegetation such as Himalayan blackberry (*Rubus armeniacus*). It is thought that this switch has resulted from the widespread degradation or outright disappearance of historic Central Valley wetlands. Colonies occupying non-native upland habitat exhibit increased reproductive success when compared to colonies that nest in native flooded vegetation (Cook and Toft 2005).

Successful reproduction for tricolored blackbirds requires a combination of access to open water, appropriate nesting substrate, and proximity to high-quality foraging habitat (Beedy and Hamilton 1997). This species primarily feeds on terrestrial arthropods, including Coleoptera, Orthoptera, Diptera, Hemiptera, Arachnids, and Lepidoptera (Beedy and Hamilton 1997, Crase and DeHaven 1977). Colonies are usually located within a few kilometers of productive grassland, shrubland, forest, or agricultural land (Beedy and Hamilton 1997, Wilson et al. 2016).

Maintaining open water in proximity to suitable nesting habitat (whether emergent vegetation or substantial stands of armored upland vegetation) during the nesting season would be a good target for this species. However, the role of groundwater in maintaining open water in proximity to nesting habitat is unclear.

4 PROPOSED SURFACE WATER MONITORING NETWORK

Depending on location and time of year, GDEs that overly the SLO Valley Groundwater Basin can be supported by a range of water sources including direct precipitation, surface runoff, shallow subsurface flow, and groundwater. Shallow subsurface flow can vary from short-term precipitation driven flow (e.g. macro-pores filled during a precipitation event that drain on the order of days to weeks) to flow that is directly connected to groundwater (e.g. groundwater discharge into streams during the dry season). Because GDEs overlying the SLO Groundwater Basin are supported by a wider range of surface and groundwater hydrological processes in the wet season, we propose to focus monitoring of GDEs in the late spring baseflow period and summer/early fall dry season. During the late spring and summer/early fall dry season, the primary sources supporting these GDEs are likely groundwater, although in some reaches irrigation return flow may also be a factor. Irrigation return flow could have surface water sources from outside the basin (e.g. City of SLO parcels) or be dependent on local groundwater (e.g. Edna Valley). Base flows and groundwater levels during the late spring and summer/early fall dry seasons are also critical to ensure sustainable ecological conditions for many groundwater dependent species. Groundwater supporting GDEs overlying the SLO Valley Groundwater Basin can originate outside of the groundwater basin or within the groundwater basin. Our proposed monitoring network accounts for these two sources of groundwater by selecting locations that are likely primarily dependent of groundwater originating in the SLO Groundwater Basin. For example, proposed monitoring locations for instream flows (Table 3, Figure 4) are located in reaches that are likely hydrologically gaining in the late spring and dry season (Figure 1). Herein we assume that if the GDE indicators are met in the late spring and dry season, then sufficient groundwater would also be available in the wet season to sustain GDEs. However, we recommend that as more data becomes available, this assumption be revisited.

Mainstem SLO Creek several hundred feet upstream of the Marsh St Bridge, September 2020

4.1 Proposed Monitoring Network

There are six existing County stage gages within or adjacent to the SLO Valley Groundwater Basin (Figure 3, Table 3). An additional three stage gages are proposed. These proposed stream gage locations may be modified as future work is completed in the basin. Rating curves, which correlate stage with stream flows, should be developed for all nine sites. In addition, we propose that groundwater be monitored at all of these nine sites plus five additional sites (Figure 3, Table 3) for riparian and wetland/marsh GDE types.

In addition to the above stage, stream flow, and groundwater monitoring, we recommend that streamflow is spatially mapped across a range of seasons and water year types to identify losing and gaining reaches with the SLO Groundwater Basin. Identifying losing and gaining reaches is fundamental to understanding surface-groundwater connectivity. This type of data collection is conducted by measuring instream flow in multiple locations along a reach of creek in a short period of time and examining the loss or gain of stream flow rates along the length of the stream channel. An example of this type of data collection on Stenner Creek is provided in Appendix C.

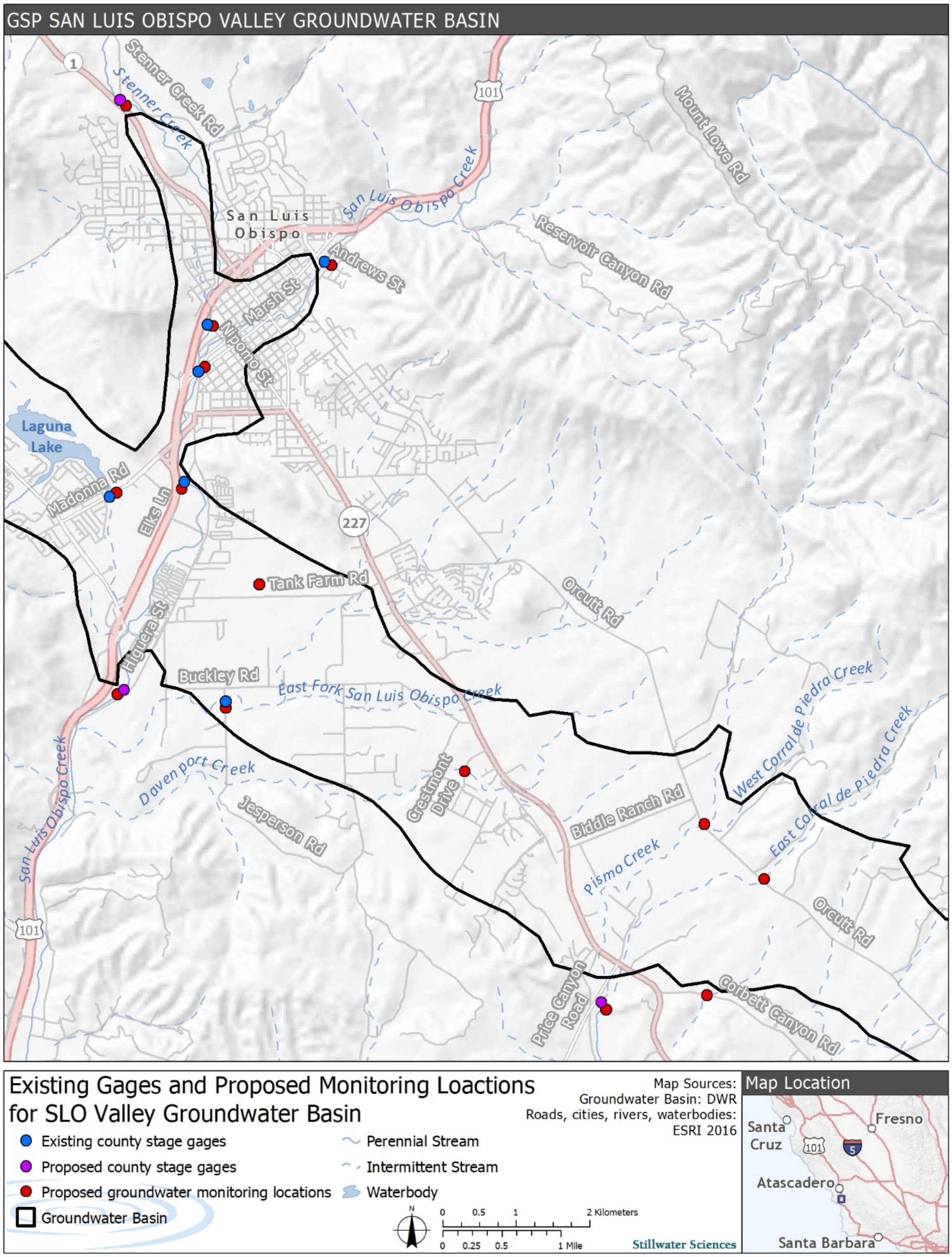

Figure 3. Existing and proposed monitoring locations for Groundwater Dependent Ecosystems.

Table 3. Summary of proposed hydrologic monitoring for the SLO Valley Groundwater Basin.

Water Body	Location	Proposed monitoring parameters	Purpose	Sustainable GDE indicators	Sustainable GDE indicator target values
Existing county stage gage and proposed groundwater monitoring locations					
1) Stenner Creek	Nipomo Street	1) Stage (ft) 2) Flow rate (ft/sec) 3) Groundwater elevation (ft)	1) Water budget 2) Surface-groundwater connectivity 3) Sustainable GDE indicators	Flow rate (cfs)	0.85 cfs (late spring); 0.33 cfs (dry season)[A]
				Depth to groundwater below ground surface (ft)	TBD
2) Mainstem SLO Creek	Andrews Street	1) Stage (ft) 2) Flow rate (ft/sec)	1) Flow into the basin for water budget 2) Surface-groundwater connectivity 3) Sustainable GDE indicator	Depth to groundwater below ground surface (ft)	TBD
3) Mainstem SLO Creek	Marsh Street	1) Stage (ft) 2) Flow rate (ft/sec) 3) Groundwater elevation (ft)	1) Water budget 2) Surface-groundwater connectivity 3) Sustainable GDE indicators	Flow rate (cfs)	1.20 cfs (late spring); 0.90 cfs (dry season)[A]
				Depth to groundwater below ground surface (ft)	TBD
T4) Mainstem SLO Creek	Elks Lane	1) Stage (ft) 2) Flow rate (ft/sec) 3) Groundwater elevation (ft)	1) Water budget 2) Surface-groundwater connectivity 3) Sustainable GDE indicator	Depth to groundwater below ground surface (ft)	TBD
5) East Fork SLO Creek	Jespersen Road	1) Stage (ft) 2) Flow rate (ft/sec) 3) Groundwater elevation (ft)	1) Water budget 2) Surface-groundwater connectivity 3) Sustainable GDE Indicators	Water depth (ft)	2.3 feet[B] (late spring and dry season)
				Depth to groundwater below ground surface (ft)	TBD
6) Prefumo Creek	Madonna Road	1) Stage (ft) 2) Flow rate (ft/sec) 3) Groundwater elevation (ft)	1) Water budget 2) Surface-groundwater connectivity 3) Laguna Lake study 4) Sustainable GDE indicator	Depth to groundwater below ground surface (ft)	TBD

Water Body	Location	Proposed monitoring parameters	Purpose	Sustainable GDE indicators	Sustainable GDE indicator target values
New proposed stage gage and groundwater monitoring locations					
7) Stenner Creek	Stenner Creek Road	1) Stage (ft) 2) Flow rate (ft/sec) 3) Groundwater elevation (ft)	1) Flow into the basin for water budget 2) Surface-groundwater connectivity 3) Sustainable GDE indicator	Depth to groundwater below ground surface (ft)	TBD
8) Mainstem SLO Creek	Old bridge, near Higuera Street	1) Stage (ft) 2) Flow rate (ft/sec) 3) Groundwater elevation (ft)	1) Flow out of the basin for water budget 2) Surface-groundwater connectivity 3) Sustainable GDE indicator	Depth to groundwater below ground surface (ft)	TBD
9) Pismo Creek	Railroad Crossing	1) Stage (ft) 2) Flow rate (ft/sec) 3) Groundwater elevation (ft)	1) Water budget 2) Surface-groundwater connectivity 3) Sustainable GDE indicators	Flow rate (cfs)	1.50 cfs (late spring)/; 0.50 cfs (dry season) (Stillwater 2016)
				Depth to groundwater below ground surface (ft)	TBD
New proposed groundwater monitoring locations					
10) Tank Farm Wetlands	Near Tank Farm Rd	Groundwater elevation (ft)	GDE indicator	Groundwater depth below surface (ft)	TBD
11) Davenport Creek	Crestmont Road	Groundwater elevation (ft)	GDE indicator	Groundwater depth below surface (ft)	TBD
12) East Corral de Piedra	Orcutt Road	Groundwater elevation (ft)	GDE indicator	Groundwater depth below surface (ft)	TBD
13) West Corral de Piedra	Orcutt Road	Groundwater elevation (ft)	GDE indicator	Groundwater depth below surface (ft)	TBD
14) Canada de Verde	Corbett Canyon Rd	Groundwater elevation (ft)	GDE indicator	Groundwater depth below surface (ft)	TBD

[A] In 2014 Stillwater Sciences completed a county-wide instream flow study for steelhead trout during their two most flow sensitive periods for minimum instream flows (late spring and later summer). A predictive model, based on watershed area, was developed to estimate minimum instream flows during these time periods. Values reported here are based on this model assuming that Stenner Creek at the Nipomo Street bridge has a watershed area of 11.0 square miles and SLO Creek at the Marsh Street Bridge has a 24.5 square mile watershed area
[B] Jennings and Hayes 1994
[C] Stillwater Sciences 2016

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Appendices

Appendix A

Basin Sediment Thickness Map
(GSI 2017)

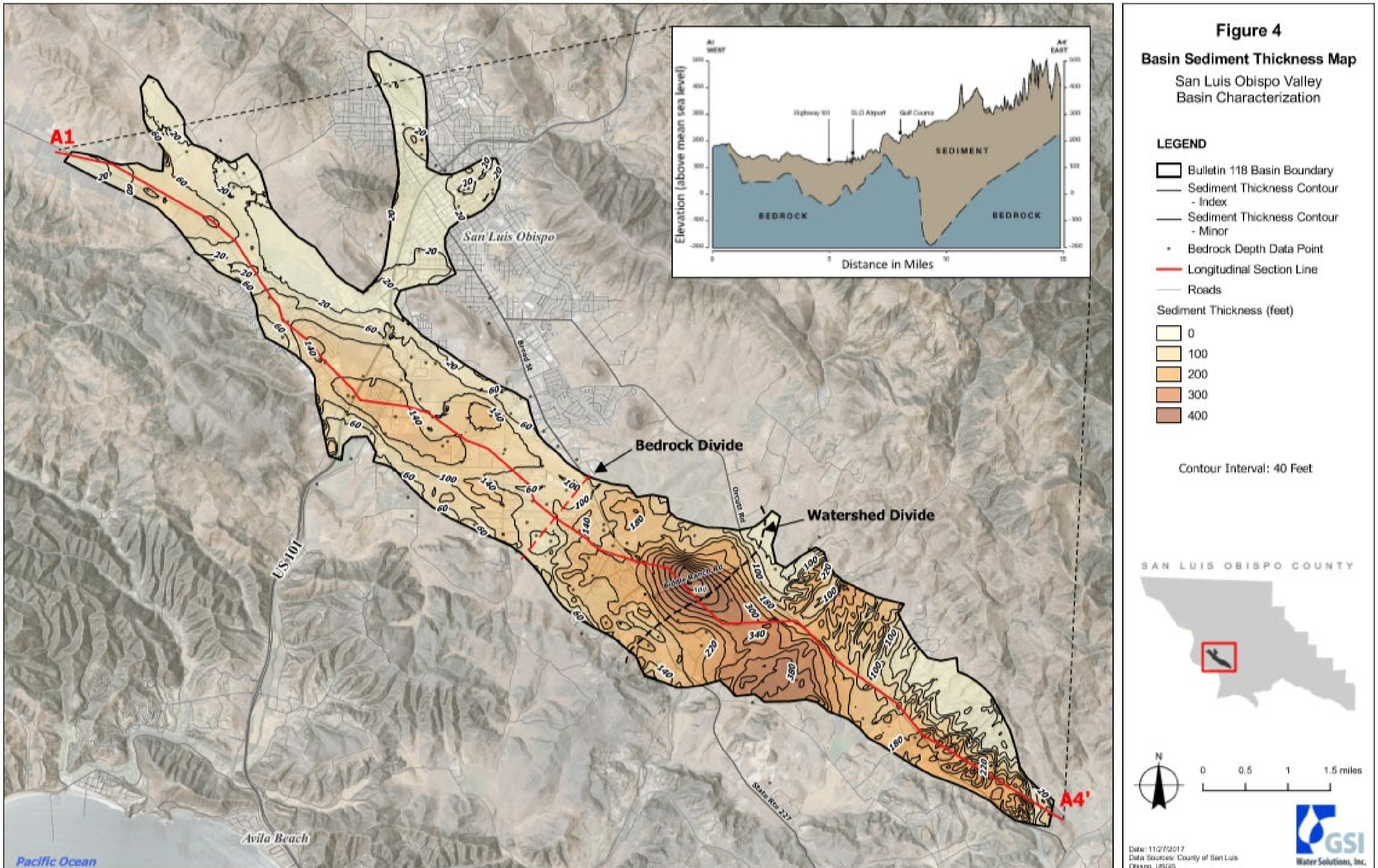

Figure A-1. SLO Groundwater Valley Basin Sediment Thickness Map (GSI 2017).

Appendix B

Fall 1954 Water Level Map (GSI 2017)

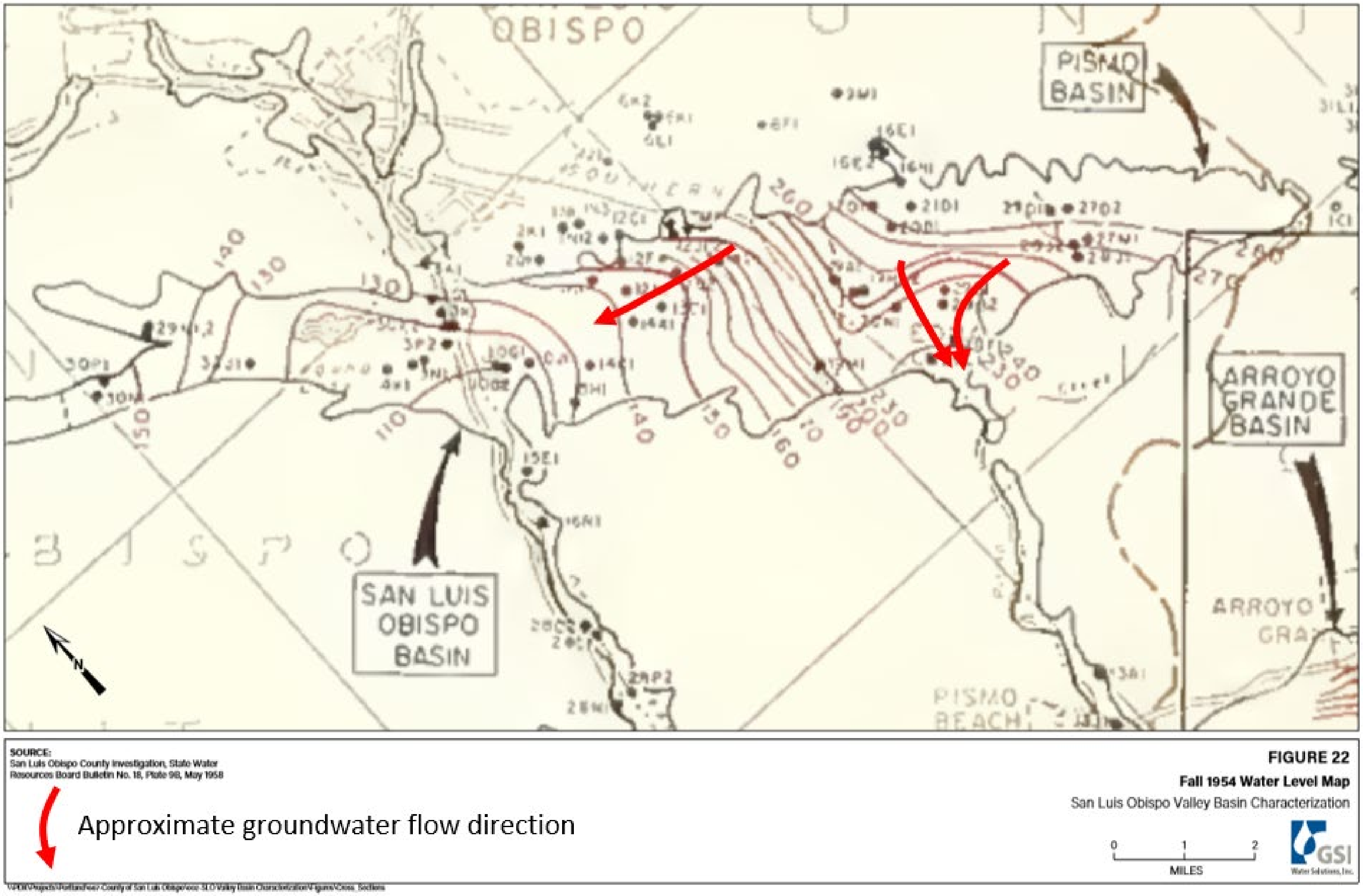

Figure B-1. SLO Groundwater Valley Basin 1954 Water Level Map (Data from DWR, Figure from GSI 2017; direction of groundwater flow (red arrows) added by Stillwater Sciences)

Appendix C

Map of Gaining and Losing Instream Flow Conditions, Stenner Creek, September 2020 (Creek Lands Conservation, unpublished data)

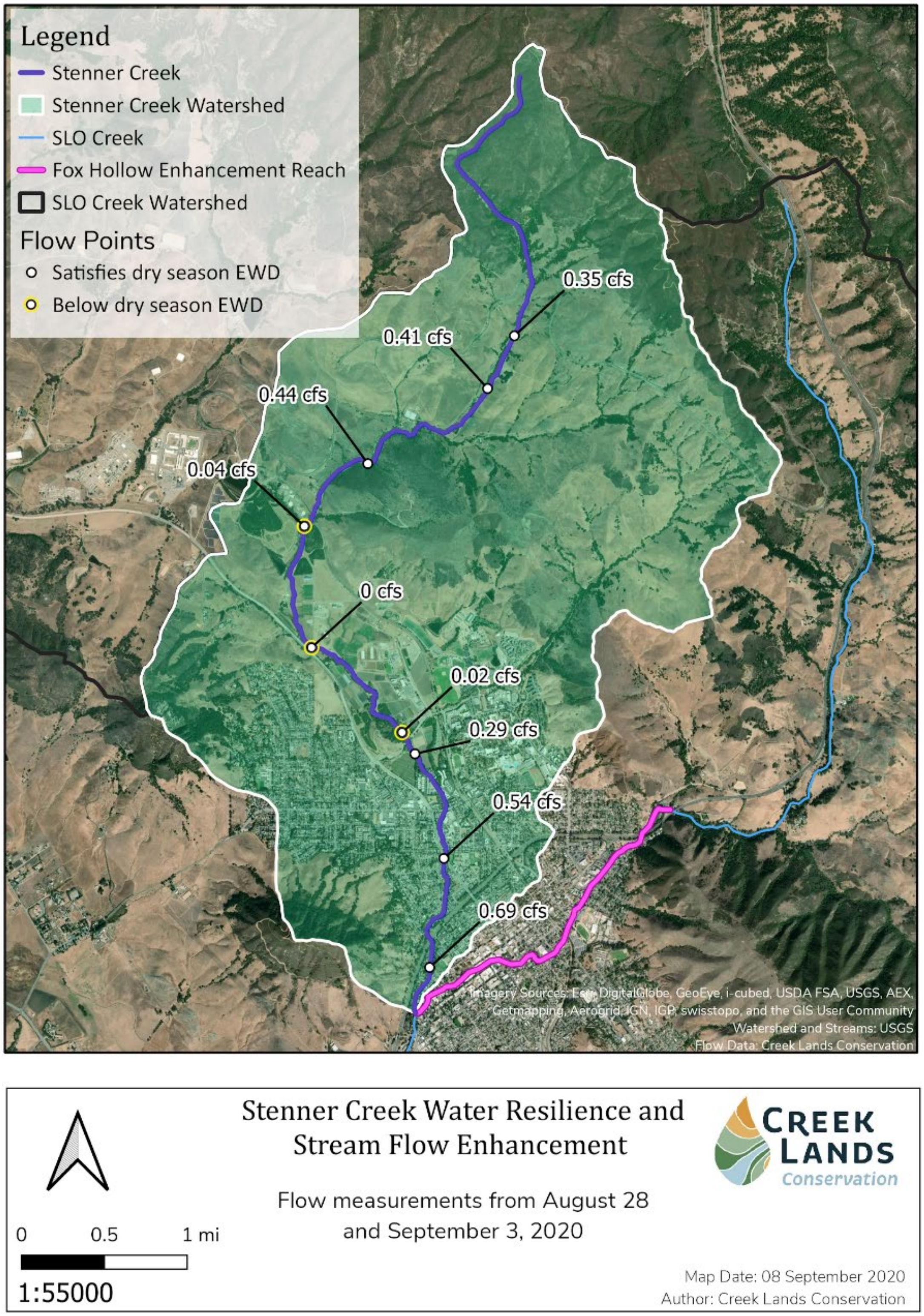

Figure C-1. Stenner Creek flow rate (cfs) as measured by Creek Lands Conservation (CLC) in late August/early September 2020 showing losing and gaining hydrologic conditions. Flow is also compared to environmental water demand (EWD) as defined by Stillwater Sciences (2014). (Figure by CLC)

Surface Water / Groundwater Modeling Documentation

Selection of appropriate modeling software for development of SLO Basin integrated SW/GW model

Surface Water/Groundwater Modeling Approach Technical Memorandum (Modeling TM No.1)

Surface Water/Groundwater Modeling Calibration Technical Memorandum (Modeling TM No.2

DRAFT Technical Memorandum

To: Michael Cruikshank
Water Systems Consulting, Inc.

and

Dick Tzou, San Luis Obispo County Project Manager.
Mychal Boerman, City of San Luis Obispo Project Manager

From: Dave O'Rourke (GSI)

Date: May 31, 2019

Re: Selection of appropriate modeling software for development of SLO Basin integrated SW/GW model

---

1.0 Introduction

This Technical Memo (TM) was developed by the consultant team supporting the San Luis Obispo Valley Groundwater Basin (SLOVGB, or SLO Basin) Groundwater Sustainability Commission (GSC). The GSC consists of representatives of two distinct Groundwater Sustainability Agencies (GSAs), representing the City and County of San Luis Obispo. The SLOVGB has been identified as a high priority basin according to the DWR basin prioritization. Under the terms of the Sustainable Groundwater Management Act (SGMA), high-priority basins must complete a Groundwater Sustainability Plan (GSP) by January 31, 2022, and must achieve sustainability by 2042. A numerical model is recommended for support the GSP development.

1.1 Background

Previous hydrogeologic investigations (DWR 1958, Boyle 1992, DWR 1997) have concluded that infiltration from streams in the basin represent a significant portion of the water budget. Because of this factor, the GSC has opted for development of an integrated groundwater surface water model to support the development of the GSP. Several modeling alternatives are available. This document discusses the approach that will be taken to develop an integrated groundwater-surface water model that will be used to assist the GSC during their development of a Groundwater Sustainability Plan (GSP).

1.2 Objective

The objective of this TM is to discuss the differences in the available modeling platform alternatives, and document the supporting information that led to the selection of the most appropriate modeling platform.

1.3 Model Selection Criteria

The consulting team performing the technical work for the SLO Basin GSP has been tasked with the development of an integrated groundwater/surface water flow model for use in supporting the GSP development. The model will be used to estimate future groundwater levels in the basin, and to demonstrate the effect that various proposed management actions will have on the goal of achieving sustainability by 2042.

Available modeling methods have been researched and evaluated for their ability to meet project needs. It is important that the modeling approach meet DWR Sustainable Groundwater Management Act (SGMA) public domain requirements, so any models not meeting this requirement were not considered.

There are several alternatives available for consideration of the model selection, which will be discussed in Section 2 of this memo. Model alternatives will be evaluated based on the following criteria.

- Capability to realistically model essential groundwater – surface water interactions, including rainfall-runoff relationships, streamflow accumulation, surface-water hydrology, variable groundwater elevations, perennial and seasonal groundwater interaction between surface water and groundwater, and irrigation-related return flows to the aquifer
- Perceived credibility, as demonstrated by citation in the peer-reviewed literature
- Meets DWR SGMA public domain requirements
- Ability to model recharge from irrigation and septic systems
- Ability to meet project requirements within the defined scope and budget
- Longevity of model, availability of support/updates
- Transparency
- Degree of leveraging information developed during development of previous models and investigations.
- Proven use for similar applications

2.0 Overview of Alternative Model Options

The following alternative modeling approaches and software packages were considered and documented in this technical memo:

- MODFLOW + HSPF (Coupled Model)
- GSFLOW
- MODFLOW-OWHM
- DWR Integrated flow model (IWFM)

2.1 Overview of MODFLOW + HSPF (Coupled model)

One approach that has been used successfully over the past 20+ years is the construction of separate models for groundwater and surface water, and tailored development of computer code to allow the two models to communicate data at points of intersection (for example, at the location where a stream from the surrounding watershed enters the basin). Because hydrologic response in the groundwater environment is much slower than that of the surface water environment, groundwater models generally utilize much longer stress periods (typically monthly, seasonal, or annual) than surface water models (typically daily or hourly). MODFLOW models are "distributed" or spatially discretized into small cells (typically from 100 ft^2 to 1 mi^2), whereas surface water models usually are discretized into irregular shaped sub-watershed scales on the order of tens to hundreds of square miles, with the advantage of much shorter surface water model computational time on the order of minutes. The only distributed surface water model with gridded cells is PRMS, which is used in GSFLOW. This section will present independent summaries of MODFLOW and HSPF, followed by a brief discussion of the requirements to couple the two models.

2.1.1 MODFLOW

With the exception of IWFM (which will be discussed separately), the groundwater modeling alternatives discussed in this memo all utilize some version of MODFLOW. MODFLOW is a publicly available groundwater modeling code developed by the USGS. It is the most commonly used groundwater modeling code in the world, and is considered an industry standard. In essence, MODFLOW discretizes the active model area into a grid of rectangles, assigns hydrogeologic parameters and initial conditions to each cell, and solves the groundwater flow equation for each cell in the model area. The USGS is continually updating MODFLOW and releasing new versions. In 2011, they released MODFLOW-NWT, a version of MODFLOW that significantly improved the capability of MODFLOW to solve for conditions in unconfined aquifers subject to drying and re-wetting during seasonal climatic fluctuations. In 2013, MODFLOW-USG (Un-Structured Grid) was released, a version that overcame previous constraints on geometric representation of girds, and thus significantly improved the ability of the model to represent complex geologic settings, as well as providing a much more efficient solver for numerical computations. MODFLOW-USG cannot be used with GSFLOW or MODFLOW-OWHM. In 2019, a new object-oriented program and underlying framework called MODFLOW 6 was developed to provide a platform for supporting multiple models and multiple types of models within the same simulation. Each version of MODFLOW has its own individual constraints and advantages when considered in coupling with a surface water model; these will be discussed in more detail later in this TM. Within the MODFLOW 6 framework, a regional-scale groundwater model may be coupled with multiple local-scale groundwater models. Or, a surface-water flow model could be coupled to multiple groundwater flow models. MODFLOW 6 is not compatible with GSFLOW or MODFLOW-OWHM.

2.1.2 HSPF

HSPF is a continuous simulation hydrologic model that grew out of a number of EPA models, including the NPS model, ARM, and the Stanford Watershed Model. A continuous simulation model simulates the inter-storm periods are modeled through a series of soil-moisture routines. Once the model has simulated the hydrologic cycle on the land surface, water (and pollutants) can be routed through a drainage network of many sub-watersheds within the HSPF model.

HSPF has routines to model rainfall and the water budget of land surface processes, including interception, evaporation, transpiration, surface runoff, interflow, groundwater baseflow, surface and subsurface detention storages, the root-zone soil moisture balance, and overland and river routing of storm water runoff. The pathway of water from precipitation to the watershed outlet is through canopy interception, infiltration or runoff, where infiltrated water moves through a series of underground storages (including root-zone storage) and surface runoff is routed down the river network.

Water that does not infiltrate becomes surface runoff which either flows into surface storage or becomes storm flow, which is routed by a modified Chezy-Manning equation over the land surface and to the river network. The Chezy-Manning equation accounts for the runoff delayed response of the watershed due to friction and watershed shape. The infiltrated water, however, follows a more complicated path.

There are basically three possible fates in the subsurface: interflow, baseflow, or root-zone storage. The infiltrated water is first partitioned between interflow and active ground-water recharge in a similar way to how surface water is partitioned between surface runoff and infiltration. Interflow storage is subsequently routed to the stream through a simple linear reservoir. Active groundwater recharge is partitioned between baseflow storage and root-zone storage and is a function of the soil moisture in the model. Root-zone storage terminates in evapotranspiration; baseflow storage is routed either to the stream through another simple linear reservoir with a longer residence time than for interflow, or ultimately to deep percolation to recharge the underlying aquifer.

2.1.3 Coupled Model

In a coupled model, custom computer code needs to be developed at points of intersection between the HSPF model and the MODFLOW model. Both HSPF and MODFLOW are written using the computer language Fortran. To appropriately couple the groundwater and surface models, detailed tracking of the calibrated HSPF model output is necessary. HSPF output such as streamflow must be stored in a separate file, routed to the input files for the MODFLOW simulations. HSPF calculated deep percolation of surface water is tracked in HSPF model for each sub watershed and must be distributed over the MODFLOW cells that lie within each sub-watershed. The distribution of HSPF calculated deep percolation over MODFLOW grid cells, as input to the MODFLOW recharge input files, is done externally to both HSPF and MODFLOW models using a Geographical Information System (GIS).

As discussed previously, HSPF frequently operates with stress periods of days (or shorter), while MODFLOW typically is applied using monthly, seasonal, or annual stress periods. Therefore, any output from HSPF will likely require additional processing to generate average values consistent with the stress period setup of the MODFLOW model.

In summary, because MODFLOW and HSPF are designed to simulate the groundwater and surface water environments independently, they are well-suited to model the watershed and aquifer processes of SLO Basin. The end results should be a calibrated HSPF surface water model and a calibrated MODFLOW groundwater model. A potential disadvantage is that models are independent and a few iterations may be required when the calibrated HSPF calculated deep percolation does not provide the recharge needed to calibrate the groundwater model. The advantage of this method is that both the most versatile and industry standard surface water and groundwater models are used and allows the modeler to use familiar and well-supported graphical user interfaces and software packages for pre- and post-processing. Also, each model can be independently updated and used for when smaller surface water or groundwater projects that have no great impact on surface water groundwater interaction need to be assessed without having to deal with a more complicated fully integrated model.

2.2 Overview of GSFLOW

GSFLOW is a fully integrated watershed-groundwater model (Markstrom et al., 2008) that has been widely used throughout the United States by the USGS and other hydrologic professionals to model surface water and groundwater conditions in various geologic settings. GSFLOW is a coupled groundwater and watershed flow model based on integration of the USGS Precipitation-Runoff Modeling System (PRMS) and MODFLOW. The PRMS and MODFLOW models are compiled, calibrated, and run separately before calibrating and running the combined model (GSFLOW) to complete the model development process. Normally coupled model simulations have run times that are much longer than uncoupled groundwater or surface-water models and in many cases, forward model run times can become limiting for practical calibration. However, GSFLOW simulates these processes in a computationally efficient manner such that GSFLOW can be applied to watershed-scale problems ranging from a few square kilometers to several thousand kilometers and for time periods that range from months to several decades using a daily timestep (Markstrom et al., 2008).

GSFLOW was developed to simulate coupled groundwater – surface water flow in one or more watersheds by simultaneously simulating flow across the land surface, within subsurface saturated and unsaturated materials, and within streams and lakes (Markstrom et al., 2008; Regan et al., 2016). GSFLOW can be conceptualized as three regions with exchanges of flow between them. GSFLOW uses physically based processes and empirical methods with user inputs of air temperature and precipitation (snow/rain) to simulate the distribution of precipitation into runoff, evapotranspiration, infiltration, groundwater flow, and surface-water flow.

GSFLOW also provides other advantages over other models that may be used. Watershed scale data is available online through several public data providers that contain data for many watersheds throughout the country. These data are standardized and GSFLOW was designed to readily incorporate the data available online by using semi-automated tools that are available for use and are relatively simple to use. Gardner et al. (2018) introduces the use of these tools that rely on ArcGIS using ArcPy. ArcPy allows control of ArcGIS using Python, a widely used and well documented programming language, to perform GIS related tasks in a semi-automated way. These tools take all the required data needed for PRMS and GSFLOW models and can generate the input files required to run each model, respectively. At this time, these tools do not generate input files for the MODFLOW model so this part of the development of the model is still required to be done manually.

GSFLOW does not have a common or well-supported GUI to assist with pre- and post-processing of well files and output. EarthFX, a Canadian company, has recently released a software package designed to assist with GSFLOW modeling, but company representatives communicated that the product is not a comprehensive pre- and post- processor.

2.3 Overview of MODFLOW-OWHM

MODFLOW-OWHM (OWHM) includes the Farm Process package for MODFLOW for simulating the use and movement of water across irrigated and other landscapes. OWHM also incorporates several additional MODFLOW capabilities from various independent versions of MODFLOW such as the subsidence and seawater-intrusion packages and local-grid refinement capability that are not currently available in GSFLOW. The core concept of the Farm Process is to internally calculate crop irrigation requirements (crop demands) and to then allocate surface-water and groundwater irrigation supplies to meet those demands that cannot be met by precipitation or root uptake from groundwater.

Through the Farm Process, OWHM provides several specialized capabilities to represent and manage the surface-water and groundwater deliveries to farms that extend beyond the core water-withdrawal and irrigation-application capabilities of MODFLOW, MODFLOW-NWT, and GSFLOW. OWHM also provides options for simulating the effects of land subsidence on coupled groundwater and surface-water systems with irrigated agriculture. However, if these capabilities are not needed, the Water Mission Area of the USGS recommends use of GSFLOW for most projects requiring hydrologic simulation and analysis of coupled groundwater/surface-water/watershed systems.

OWHM: OWHM was first released in 2014 (Hanson and others, 2014a). OWHM includes the Farm Process for MODFLOW-2005 for simulating the use and movement of water across irrigated and other landscapes. OWHM also incorporates and enhances many capabilities from various independent versions of MODFLOW. These include MODFLOW's Local Grid Refinement capability (MODFLOW-LGR; Mehl and Hill, 2007, 2013), MODFLOW-NWT (Niswonger and others, 2011), Surface-Water Routing Process (SWR; Hughes and others, 2012), and the Riparian Evapotranspiration Package (Maddock and others, 2012).

The core concept of the Farm Process is based on a farm irrigation water budget (Schmid and Hanson, 2007; Hanson and others, 2010). The Farm Process estimates farm crop demands and irrigation requirements within user specified water-balance subregions and then determines available water supplies from precipitation, surface-water and groundwater deliveries, and root uptake from groundwater to meet those demands. A key feature of the Farm Process is the internal calculation of this residual irrigation demand, and automatic activation of user specified wells to meet that demand. Water from precipitation and irrigation in excess of consumptive use is either directed as overland runoff (return flow) to the stream network or to the underlying saturated or unsaturated zones as deep percolation. The Farm Process provides several options that allow the user to constrain surface-water and groundwater supplies and to conjunctively manage surface-water and groundwater allocations. OWHM also uses the time-step and stress-period concepts of MODFLOW, and can be run with or without the Farm Process active.

2.4 Overview of IWFM

The DWR- developed Integrated Water Flow Model (IWFM) is a computer program developed and maintained by DWR, and used for water resources management and planning within a basin. It is capable of calculating groundwater flows, soil moisture movement in the topsoil, stream flows, land surface flows and flow exchange between the groundwater, streams and land surface as generated by rainfall, agricultural irrigation, and municipal and industrial water use. In addition, IWFM can calculate agricultural water demands based on crop type and acreage, soil types, irrigation methods, and rainfall rates, so it can be used to evaluate management actions associated with changes in agriculture. Municipal and industrial water demands can be estimated based on population and per-capita water use rates, so these may be varied to simulate management actions in these water use sectors. IWFM is a tool that can help understand the movement of the surface and subsurface water flows within a basin, and to plan the use of groundwater and surface water to meet future agricultural, municipal and industrial water demands.

DWR maintains IWFM, and has made IWFM available to Groundwater Sustainable Agencies (GSAs) to develop their Groundwater Sustainability Plans (GSPs) as a tool that can be used for sustainable groundwater management. There is at present no GUI for this model, although one is in development.

3.0 Comparisons of Significant Features of Modeling Alternatives

There are many technical differences in the details of the various presented modeling alternatives, too many for a comprehensive discussion of all of them. This section will present brief comparisons on the most significant differences between the alternatives presented as they impact the decision of which modeling alternative to select for support of the GSP.

All four modeling alternatives presented will provide simulation both of watershed processes outside of the Basin and groundwater processes within the Basin. The factors that differentiate between alternatives and dictate the selection will likely be the teams judgement of some of the technical details.

The coupled model approach using MODFLOW + HSPF allows the modeler to utilize MODFLOW-USG, which has advantages with respect to layer geometry and solver capabilities. GSFLOW and OWHM do not support MODFLOW-USG. Independent development of separate MODFLOW and HSPF models allows the modeler access to well supported GUI software, which can be a time saver during model development and post-processing. However, the project requirements associated with the necessity for custom coding required to link two independent models may be a significant portion of the work effort. In addition, this would not result in a single integrated model, but in two independent models that communicate. The necessity for custom coding introduces a “black box” element that may not be easily understood by the stakeholders, and the custom coding may complicate legacy uses of the models by future users. Although MODFLOW and HSPF are industry standard models, the coupling of the two models is a significant feature, and the lack of established standard methods may be problematic for the public process aspects of SGMA. California Water Code 23 CCR §352.4(f)(3) states that “Groundwater and surface water models developed in support of a Plan after the effective date of these regulations shall consist of public domain open-source software”. The original source code required for coupling of two models could be interpreted to violate this requirement.

GSFLOW has a comparable modeling approach to the coupled model approach, but it is contained within a single modeling package supported by the USGS. As such, the documentation of the linkage between the surface water and groundwater processes is more robust than would be the case in the coupled model approach. GSFLOW is better than OWHM for headwaters to basin simulations and consideration of generation of overland runoff, soil zone processes, and streamflow generation. As such it is appropriate for application to environmental flows, streamflow water budget analysis, and watershed issues.

MODFLOW-OWHM is more appropriate for consideration of areas with intense irrigation, like the Central Valley. Its internal functions that calculate crop demand make changes in water demands under different crop types easier to implement. OWHM has the Local Grid Refinement capability, not available in GSFLOW. Allocation of crop demand between surface water and groundwater sources is more explicitly considered, and ability to simulate transient land uses is easier to effect. Calculation of runoff from headwater watershed areas is not performed. The primary purpose of OWHM is to evaluate conjunctive use of groundwater and surface water supplies in agricultural areas. OWHM provides specialized capabilities to represent the SW and GW deliveries to farms that extend beyond the typical water withdrawal and irrigation application capabilities of MODFLOW and GSFLOW. OWHM supports the subsidence and sea water intrusion packages. However, we do not anticipate using these packages.

Both codes use the time-step and stress-period concepts of MODFLOW, but GSFLOW uses daily time steps and internal daily stress periods for certain budget items; OWHM uses longer time steps of several days to weeks within each stress period. This has implications for file size and run times. A traditional

MODFLOW groundwater model might typically be run with annual, seasonal, or monthly stress periods, with several variable length time-steps per stress period. In this instance, long-term calibration runs of 50-75 years are feasible. With daily stress periods, the run time and file size of such long runs can become problematic.

IWFM has some aspects of both GSFLOW and OWHM. It can generate runoff estimates at the basin boundary, but is more focused on agriculture-related simulations and management actions. It has no software package to assist with pre- and post-processing. Because it was developed by a California state agency, it's applications have been largely limited to California, and so does not have the degree of public use and documentation as the USGS models, which are applied nationwide.

4.0 Recommendation

All four options would meet the technical requirements of an integrated groundwater surface water model to support the GSP development in the Basin. However:

- The coupled model approach could potentially be problematic with respect to the requirement that models "…shall consist of open domain public source software…", due to the necessity for custom code implementation to link the two independent models;
- The OWHM model does not develop estimates for watershed runoff in headlands areas upstream of the basin;
- IWFM has no dedicated pre- and post- processors available for input development of output data presentation, and is less widely applied than the USGS-developed models.
- GSFLOW offers the representation of the Basin watershed from the headlands to the outflow from the Basin, development of streamflow estimates for ungaged streams, and an appropriate level of detail to simulate different management actions.

For these and other reasons discussed in the body of this TM, the team recommends that the GSC endorse the use of GSFLOW for use in the development of an integrated groundwater/surface water model for use in support the GSP development.

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Date:	2/27/2020	
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CC:	Mladen Bandov, PE	
Prepared by:	Adam Rianda, PE; Erik Cadaret, GIT; Dave O'Rourke, PG, CHG, PE	
Reviewed by:	Michael Cruikshank, PG, CHG	
Project:	SLO Basin Groundwater Sustainability Plan	
Subject:	**Draft** Surface Water/Groundwater Modeling Approach Technical Memorandum (Modeling TM No.1)	

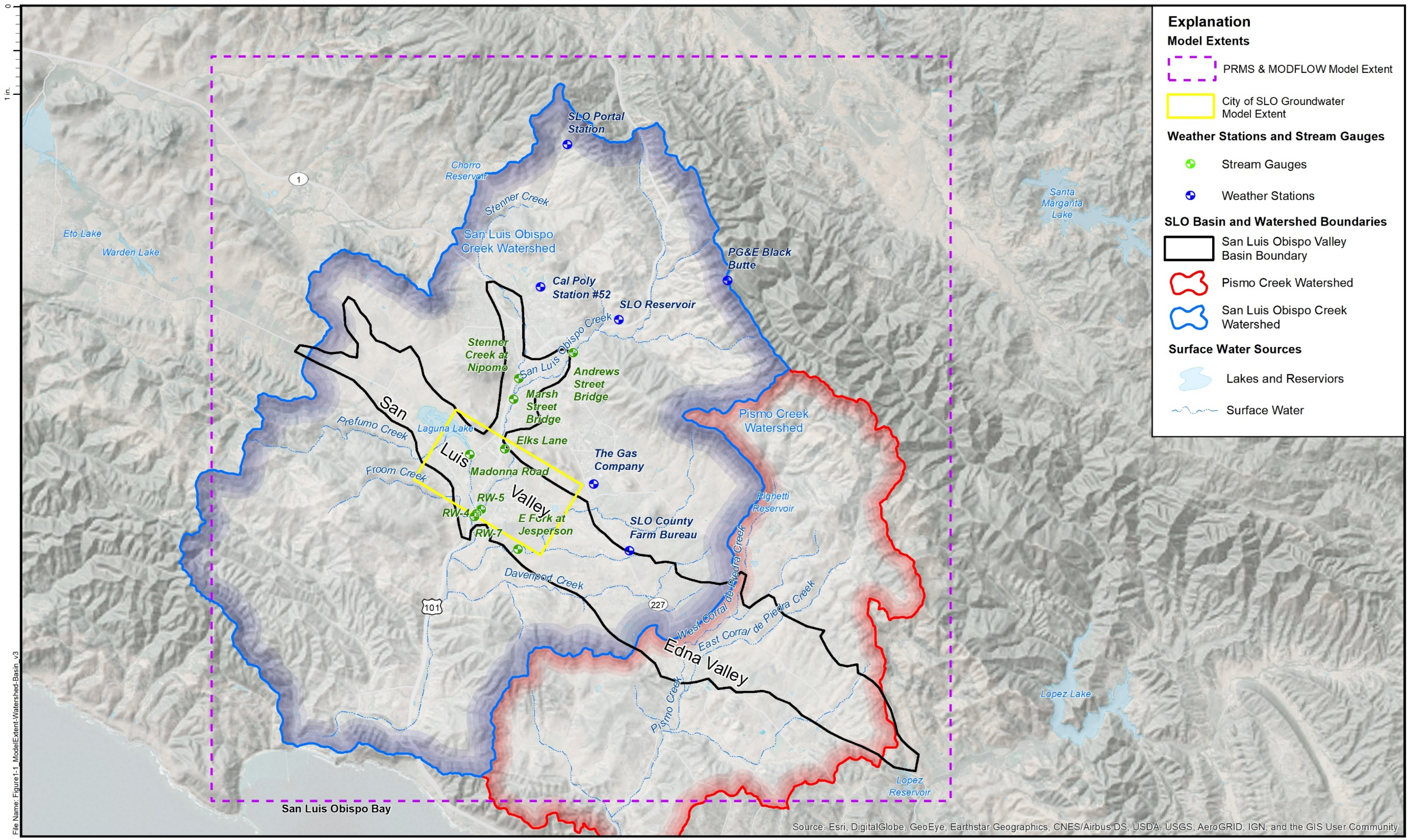
Section 1. Introduction

This draft Technical Memo (TM No.1) is prepared by Water Systems Consulting, Inc. (WSC) and GSI Water Solutions, Inc. (GSI), for the San Luis Obispo (SLO) County Groundwater Sustainability Agency (GSA) and the City of SLO GSA. As part of the Groundwater Sustainability Plan (GSP) for the SLO Valley Groundwater Basin (Basin), the consultant team is developing an integrated surface water-groundwater numerical model for the objective of evaluating the potential impacts of proposed projects and management actions associated with the GSP. The objective of this TM is to document the modeling approach and hydrogeologic conceptual model (HCM) associated with the construction of the integrated numerical model of the SLO Basin.

The Basin covers approximately 20 square miles in central San Luis Obispo County (County). The Basin extents are defined as the contact of water-bearing sediments with the non-water-bearing formations of the Santa Lucia Range to the northeast, and the San Luis Range and the Edna Fault Zone to the southwest. Annual average precipitation in the Basin is approximately 18 to 22 inches (GSI Water Solutions, Inc., 2018). The Basin is commonly divided into two sub-areas: the San Luis Valley and the Edna Valley. The San Luis Valley occupies approximately the northwestern half of the Basin; it includes the City of San Luis Obispo (City), and the primary land uses are municipal and industrial. Most water supply in the San Luis Valley is from both in-basin groundwater sources and imported surface water sources (Whale Rock Reservoir, Salinas Reservoir, and Nacimiento Reservoir). The Edna Valley occupies the southeastern half of the Basin. The primary land use is agriculture, with wine grapes as the dominant crop type. Groundwater is the major source of water supply in the Edna Valley.

To date, a watershed scale groundwater or integrated surface water-groundwater model has not been published for the entire Basin. In 1997, the California Department of Water Resources (DWR) performed initial work on a basin groundwater model, but the model was never published. A groundwater model was developed within a portion of the Basin that encompasses the San Luis Valley (the City of SLO model)(Cleath-Harris Geologists, 2018) and a surface water hydraulic model has been developed for the San Luis Obispo Creek watershed (Questa Engineering Corp., 2007). Figure 1-1 shows the watershed and Basin boundaries, and the proposed model extent for both PRMS and MODFLOW.

GSI developed a TM to evaluate multiple integrated surface water-groundwater modeling systems and identified the best modeling system to achieve compliance and project objectives for the SLO GSP (GSI Water Solutions, Inc., 2019). GSFLOW, a fully integrated hydrologic model (IHM) developed by the United States Geological Survey (USGS) (Markstrom, Niswonger, Regan, Prudic, & Barlow, 2008), was recommended to the GSP Groundwater Sustainability Commission (GSC) to be selected as the model system to be used for the GSP. IHM models like GSFLOW can provide important information about water resources and are often used as decision support tools for resource management (Laniak, et al., 2013). GSFLOW integrates the Precipitation-Runoff Modeling System (PRMS) watershed model code with the MODFLOW groundwater model code.



Prepared for:

SAN LUIS OBISPO VALLEY BASIN GSP

Author: EC
Date: 2/18/2020

N

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0 0.75 1.5 3 Km

References:
1. Coordinate System: NAD 1983 StatePlane California V FIPS 0405 Feet
Projection: Lambert Conformal Conic
Datum: North American 1983
2.
3.

Notes:
1.
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3.

Model Extents, Watershed, and Basin Overview

Figure 1-1

Section 2. Hydrogeologic Conceptual Model

This section of the TM summarizes the HCM for the San Luis Obispo Valley Groundwater Basin (Basin) (DWR Basin 3-09), including summary discussion of both geologic formations and hydrogeologic conditions significant to the development of the numerical model. These subjects are evaluated in greater detail in the Basin Characterization Report (GSI Water Solutions, Inc., 2018), and the reader is directed to that report for a more comprehensive discussion of relevant topics.

2.1. Geologic Formations and Water Bearing Properties

For the purpose of the GSP, the rocks in the Basin vicinity may be considered as two basic groups; the water-bearing sediments of the SLO Basin, and the consolidated bedrock of the surrounding hills and watershed. Compared to the saturated sediments that comprise the Basin aquifers, the consolidated bedrock formations are not considered to be water-bearing. Although bedding plane and/or structural fractures in these rocks may yield small amounts of water to wells, they do not represent a significant portion of the pumping in the area. In fact, the DWR Bulletin 118 delineation of the Basin boundaries is defined both laterally and vertically by the contacts of the Basin sediments with the surrounding and underlying consolidated bedrock formations.

Figure 2-1 displays a stratigraphic column of the significant local geologic units. Figure 2-2 presents a geologic map of the Basin vicinity (assembled from a mosaic of the Dibblee maps from the San Luis Obispo, Pismo Beach, Lopez Mountain, and Arroyo Grande NE quadrangles) showing where the various formations crop out at the surface.

Figure 2-2 also displays the Basin boundaries defined in DWR Bulletin 118. Inspection of Figure 2-2 indicates that the existing DWR GIS shapefiles for the Basin boundary do not match up precisely with the mapped extent of the water-bearing formations. This is likely an artifact of previous mapping being performed at a larger statewide scale.

The water-bearing sedimentary formations and the non-water-bearing bedrock formations are briefly described below, from the youngest to the oldest.

2.1.1. Basin Sedimentary Formations

Recent Alluvium

The Recent and Older Alluvium is the mapped geologic unit composed of unconsolidated sediments of gravel, sand, silt, and clay, deposited by fluvial processes along the courses of San Luis Obispo Creek, Davenport Creek, East and West Corral de Piedras Creeks, and their tributaries. Lenses of sand and gravel are the productive strata within the Alluvium. There is no significant difference in hydrogeologic properties between Recent and Older Alluvium. These strata have no significant lateral continuity across large areas of subsurface within the Basin. Thickness of Alluvium may range from just a few feet to greater than 50 feet.

Paso Robles Formation

The Paso Robles Formation underlies the Recent Alluvium throughout most of the Basin and overlies the Pismo Formation where present. It is composed of poorly sorted, unconsolidated to mildly consolidated sandstone, siltstone, and claystone, with thin beds of volcanic tuff in some areas. The Paso Robles Formation is exposed at the surface through much of the Edna Valley, except in areas where existing streams have deposited Recent Alluvium on top of it. Wells that screen both the Recent Alluvium and Paso Robles Formation have reported yields from less than 100 to over 500 gallons per minute (gpm). There is no laterally extensive fine-grained confining unit separating the Paso Robles formation from the Recent Alluvium in the Basin.

Pismo Formation

The oldest geologic water-bearing unit with significance to the hydrogeology of the Basin is the Pismo Formation. The Pismo Formation is a Pliocene-aged sequence of unconsolidated to loosely consolidated marine deposited sedimentary units composed of claystone, siltstone, sandstone, and conglomerate. There are five recognized members of the Pismo Formation (Figure 2-1). While all are part of the Pismo Formation, the distinct members reflect different depositional environments, and the variations in geology may affect the hydrogeologic characteristics of the strata. From the bottom (oldest) up, these are:

- The Edna Member, which lies unconformably atop the Monterey Formation, and is locally bituminous (hydrocarbon-bearing)
- The Miguelito Member, primarily composed of thinly bedded grey or brown siltstones and claystones
- The Gragg Member, usually described as a medium-grained sandstone
- The Bellview Member, composed of interbedded fine-grained sandstones and claystones
- The Squire Member, generally described as a medium- to coarse-grained fossiliferous sandstone of white to grey sands.

Previous reports have identified the significant thicknesses of sand at depth beneath the Paso Robles Formation in the Edna Valley as the Squire Member of the Pismo Formation. However, ambiguities exist in the identification of the individual Pismo Formation members, so for the purposes of this report, these sediments will be referred to more generally as the Pismo Formation. The Pismo Formation is extensive below the Paso Robles Formation in the Edna Valley. There is no laterally extensive fine-grained confining layer separating the Pismo Formation from the Paso Robles Formation in the Basin. Thicknesses of Pismo Formation up to 400 feet are reported or observed in well completion reports.

Wells that are completed in both the Paso Robles and Pismo Formations are reported to yield from less than 100 gpm to approximately 700 gpm.

2.1.2. Bedrock Formations

Monterey Formation

The Monterey Formation is a thinly bedded siliceous shale, with layers of chert in some locations. In other areas of the County outside of the Basin, the Monterey Formation is the source of significant oil production. While fractures in consolidated rock may yield small quantities of water to wells, the Monterey Formation is not considered to be a Basin aquifer for the purposes of this Study. Some wells in the Basin screen both Basin sediments and the upper portion of the Monterey Formation. Of the bedrock formations discussed here, the Monterey Formation is the one most often used for water supply in the Basin. There are no paired wells that provide specific data comparing water levels in wells screening the Monterey Formation and the Basin sediments. However, the Monterey Formation is assumed to receive rainfall recharge in the mountains at higher elevations than the Basin. For this reason it is assumed that an upward vertical flow gradient exists between the Monterey Formation and the overlying Basin sediments. Because the Monterey formation is significantly less productive than the Basin sediments, the rate of this flux is not expected to be significant.

Obispo Formation

The Obispo Formation and associated Tertiary volcanics are composed of materials associated with volcanic activity along tectonic plate margins approximately 20 to 25 million years ago. Although fractures in consolidated volcanic rock may yield small quantities of water to wells, the Obispo Formation is not considered to be an aquifer for the purposes of this Study.

Franciscan Assemblage

The Franciscan Assemblage contains the oldest rocks in the Basin area, ranging in age from late Jurassic through Cretaceous (150 to 66 million years ago). The rocks include a heterogeneous collection of basalts, which have been altered through high-pressure metamorphosis associated with subduction of the oceanic crust beneath the North American Plate before the creation of the San Andreas Fault. Although fractures may yield small quantities of water to wells, the Franciscan Assemblage is not considered to be an aquifer for the purposes of this Study.

2.2. Geologic Structure

The primary geologic structures of significance to the hydrogeology of the Basin are the Edna Fault Zone and the adjacent Los Osos Fault Zone, which together form the southwestern boundary of the Basin through the uplift of the Franciscan and Monterey strata southwest of the faults. The Edna Fault is identified as a normal fault, extending from southeast of the Edna Valley to the vicinity of the town of Edna (Figure 2-2). There are some disconnected and unnamed fault splays mapped in the area south of the San Luis Obispo County Regional Airport. The Los Osos Fault Zone is mapped along the southwest edge of the Los Osos Valley. Movement along the Edna and Los Osos Valley Fault Zones has brought the water-bearing sediments of the Basin into contact with the bedrock formations of the San Luis Range. No available water level or other data indicate that the faults have any significant effect on the movement or quality of groundwater in the Basin.

2.3. Lithologic Data

All readily available lithologic data were obtained for the preparation of the Characterization Report (GSI Water Solutions, Inc., 2018) and updated for this TM. Sources of data included Well Completion Reports on file with the County and DWR, boring logs documented in published government reports or private consultant reports, geophysical boring logs, and various other sources. In all, 405 data points with lithologic information were collected for use in the GSP. (The reader is referred to the Characterization Report to evaluate the details of twelve cross sections generated in the Basin, which will not be duplicated herein.) Lithologic data were assigned spatial coordinates based on available mapping, and descriptions of geologic materials were recorded in a database for reference in future Sustainable Groundwater Management Act management activities. Lithologic data point locations are presented in Figure 2-3.

Available lithologic data, cross sections, and land surface elevation data were evaluated to identify probable contacts between geologic formations. Based on these data, GSI developed a map of total thickness of combined Basin sediments (Alluvium, Paso Robles Formation, and Pismo Formation), presented in Figure 2-4. This figure indicates that the Basin sediments are significantly thicker in the Edna Valley than in the San Luis Valley. Lithologic data were reviewed to identify contacts between the Recent Alluvium, Paso Robles Formation, and Pismo Formation. Based on these contacts, twelve cross sections were developed and presented in the Characterization Report (GSI Water Solutions, Inc., 2018); the reader is directed to that report to review details of the cross sections. Based on this data, a 3-D lithologic model of the SLO Basin sediments was developed using the software package Leapfrog©. Leapfrog 3D is a geologic modeling platform that incorporates and processes data from multiple sources including boreholes, GIS, grids, mesh/surface information, and historical cross section data. The Leapfrog model can be used as a basis to develop a numerical groundwater model grid and/or for 3D visualization and presentation purposes (Figure 2-5).

2.4. Hydrogeologic Setting

This section of the TM presents a summary discussion of hydrogeologic conditions in the SLO Basin as they pertain to the integrated model development. These subjects are evaluated in greater detail in the Basin Characterization Report (GSI Water Solutions, Inc., 2018), and the reader is directed to that report for a more comprehensive discussion of relevant topics. This TM will present an overview of the hydrogeology but will not duplicate the level of detail provided in the Characterization Report.

2.4.1. Hydrogeologic Units

Although there are significant intervals of clay evident in boring logs throughout the Basin, the clay lenses are not consistent across large areas. There is no evidence of laterally extensive impermeable strata that vertically isolates the geologic formations from one another. As a result, it appears that in the San Luis Valley, the Recent Alluvium and the Paso Robles Formation function as a single hydrogeologic unit. Work performed for the City indicates that alluvial deposits have a significantly higher hydraulic conductivity than the Paso Robles Formation and the Pismo Formation (Cleath, 2019). It does not appear that wells in the San Luis Valley are screened exclusively in either the Recent Alluvium or the Paso Robles Formation. Similarly, in the Edna Valley, there is no laterally extensive impermeable strata separating the Paso Robles and Pismo Formations. Frequently, the sand of one formation is in contact with the sands of the other formation. Therefore, it appears that in the Edna Valley, the Paso Robles Formation and the Pismo Formation function as a single hydrogeologic unit. Therefore, the modeling approach will be to represent each of the geologic units separately in the model, but no discrete barriers to vertical flow between the units will be simulated.

2.4.2. Recharge

The primary mechanisms for recharge in the Basin occur via infiltration of rainfall, percolation of seasonal streamflow from the alluvial sediments to underlying formations, deep percolation of applied irrigation water, and mountain front recharge. Mountain front recharge has not been specifically discussed or quantified in previous studies.

DWR (Department of Water Resources, 1958) estimated that average recharge to the Basin was 2,250 acre-feet per year (AFY). Working with data from a longer period of record, Boyle (Boyle Engineering Corp., 1991) estimated total recharge to the Basin from 1978-1990 was 3,650 AFY (1,510 acre-feet from irrigation percolation, 1,450 acre-feet from rainfall, 430 acre-feet from stream seepage losses, 300 acre-feet from reclaimed wastewater). In its draft report, DWR (Department of Water Resources , 1997), using a groundwater model approach, estimated combined recharge from precipitation, agriculture return flows, and incidental urban recharge, to average 4,560 AFY and range from 2,300 AFY in a drought year to 9,590 AFY in a wet year (As discussed previously, the groundwater model was never published). It should be noted that DWR (Department of Water Resources , 1997) estimates aquifer recharge from stream seepage only during dry years; in wet years, DWR estimated that the aquifer discharges to streams.

Cleath-Harris Geologists (CHG), a member of the consultant team developing the SLO Basin GSP, is preparing estimates of a historical water budget simultaneously with the development of the Basin numerical model. Estimates for each of the components of recharge discussed herein will be utilized during the calibration of the model.

2.4.3. Groundwater Pumping

Patterns and quantities of groundwater use in the Basin have varied depending on the period of record. The City of San Luis Obispo did not begin using groundwater until the late 1980s. In the 1990s, the City relied on significant groundwater use, particularly during the drought of the early 1990s. Today, by contrast, the City's potable water wells are used only for emergency standby due to groundwater contamination. The City does have plans to utilize groundwater as a drinking water supply in the future.

Agricultural groundwater use in the Edna Valley has changed in recent decades in response to market drivers, with the total irrigated acreage expanding significantly, and the crop types changing. Currently, wine grapes are the dominant crop type. No continuous estimates of groundwater pumpage in the Basin are available. Agricultural wells have not been metered in the past, and methods to estimate agricultural pumpage indirectly may vary. However, various published estimates have been presented in past reports and are briefly discussed below.

DWR (Department of Water Resources, 1958) estimates that 1,900 acre-feet of groundwater was pumped at that time. No details on this estimate are evident in the report text.

Boyle (Boyle Engineering Corp., 1991) reports an estimate of agricultural groundwater pumpage of 5,200 AFY, based on evaluation of irrigated acreage of various crop types, unit water use for each crop type, and irrigation efficiency. It is noteworthy that there is no reported irrigated vineyard acreage reported for their study period (1978-1990). Municipal and industrial pumpage is estimated to average 600 to 800 AFY during that period but was reported to be as high as 2,600 AFY during the drought year of 1990. Resultant total groundwater pumpage estimates for the Basin range from 5,690 to 7,810 AFY.

In its draft report, DWR (Department of Water Resources , 1997) presents some estimates for groundwater pumpage in the Basin. For years ranging from 1970 to 1995, groundwater pumpage estimates for all water user groups from the San Luis Valley range from 1,900 to 3,300 AFY, with the maximum estimate in the drought year of 1990. Pumpage estimates from the Edna Valley range from 2,330 to 4,340 AFY. Resultant total groundwater pumpage estimates for the Basin range from 4,380 to 7,640 AFY.

CHG is developing estimates of historical pumping as part of the water budget analysis. The results of that analysis will be incorporated into the historical calibration of the groundwater model.

2.4.4. Evapotranspiration

Evapotranspiration refers to the process by which water is transferred from the land to the atmosphere by evaporation from the soil and other surfaces and by transpiration from plants. This mechanism for outflow from the Basin may be significant in areas where the water table is near the land surface, such as along the stream corridors in the Basin. Transpiration of applied irrigation water to agricultural crops is also a significant process in the hydrology of the Basin. The details of the evapotranspiration processes will be represented in the integrated model.

2.4.5. Surface Water/Groundwater Interaction

Surface water/groundwater interactions represent a significant portion of the water budget of SLO Basin. In the Basin, these interactions occur primarily at streams and lakes.

Laguna Lake is the only lake in the Basin. The downstream outlet of the lake is dammed to artificially impound water to maintain water elevation in the lake to preserve and enhance the wildlife habitat and recreational purposes. The water in the lake is partially supplied by seasonal flow in Prefumo Creek, which flows into Laguna Lake. During dry periods, the lake may remain at least partially full, although it may dry up during extended drought. This appears to indicate that in addition to surface water inflow, the water in the lake is at least partially supplied by subsurface groundwater inflow.

Groundwater interaction with streams in the Basin is not well quantified, but it is recognized as an important component of recharge in the water budget. During the dry season when many streams have no flow, the groundwater elevation is below the streambed. Therefore, it is generally understood that San Luis Obispo Creek discharges to the underlying aquifer, at least in the first part of the wet-weather flow season. If there is constant seasonal surface water flow, it is possible that groundwater elevations may rise to the point that they are higher than the stream elevation, and the creek may become a seasonally gaining stream, but there are no data to corroborate this. It may remain a losing stream throughout most or all years.

The amount of flow in surface water/groundwater interaction is difficult to quantify. Boyle (Boyle Engineering Corp., 1991) assumed that 10 percent of the measured surface water flow coming into the Basin in San Luis Obispo Creek and Stenner Creek was recharged to the aquifer and at an average rate of 430 AFY. In its draft report, DWR (Department of Water Resources , 1997) reports model-generated estimates ranging from streams gaining 2,700 AFY from the aquifer, to streams losing 680 AFY to the aquifer.

The County, through its Water Resources Division coordination with Zone 9 and the City, maintains a network of five stream gages in the San Luis Valley of the Basin to record heights of flow throughout the year for flood warning purposes. The gages were constructed in November 2001 and have periods of record from 2005 to the present. Continuous monitoring of the height of flow at the gages is recorded, but equivalent discharge (e.g. cubic feet per second) is not recorded. Partial rating curves have recently been developed for some of the gages based on field measurements of discharge for observed flows. Additionally, estimated theoretical rating curves for each gage based on hydraulic modeling using HEC-RAS have been developed (Questa Engineering Corp., 2007).

2.4.6. Groundwater Flow Patterns

Groundwater flow in the Basin is predominantly from the Edna Valley toward the San Luis Obispo Creek alluvium, at which point the flow direction leaves the Basin through the alluvium. Groundwater in the northwestern areas of the Basin near the City boundary and Los Osos Valley Road flows southeastward toward the San Luis Obispo Creek alluvium. In the Edna Valley, there are also local areas of flow leaving the Basin along the Corral de Piedras Creek and alluvium of other smaller tributaries, in the southeastern portion of the Basin.

DWR (Department of Water Resources, 1958) published a series of maps depicting groundwater elevation maps for the various parts of its study area, including groundwater elevations in the Basin for Fall 1954. This map displays dominant groundwater flow direction from higher elevations in the Edna Valley (over 280 feet relative to mean sea level [msl]) to lower elevations (less than 110 feet msl) where San Luis Obispo Creek exits the Basin (GSI Water Solutions, Inc., 2018).

Boyle (Boyle Engineering Corp., 1991) presents water level elevation contour maps for the spring of 1986 and 1990. Contours for spring of 1990 display a pattern of groundwater flow in the Basin very similar to that exhibited in the DWR map. Contours for the spring of 1986 are not presented in this report, but 1986 represents wetter conditions than the 1990 map, and it is noted in Boyle (Boyle Engineering Corp., 1991) that there is a difference of approximately 10 feet of elevation between the two maps, representing the variation in water levels that may be observed between wet and dry weather cycles (GSI Water Solutions, Inc., 2018).

In its draft report, DWR (Department of Water Resources , 1997) used a computer groundwater model developed for its study to generate a series of modeled water level maps representing wet, dry, and average conditions. The model results are not re-presented in this Study, but the maps display the same general flow patterns as the DWR (Department of Water Resources, 1958) and Boyle (Boyle Engineering Corp., 1991) maps based on field data. Water level elevations in what DWR defines as the San Luis sub-basin in wet years were approximately 10 to 20 feet higher than in dry years. In what DWR defines as the Edna sub-basin, the difference in groundwater elevations between wet and dry years was approximately 20 to 30 feet.

Recent groundwater level data collected as a part of the District's voluntary monitoring network were obtained and used to generate a water table map to evaluate more recent conditions. Figure 2-6 presents the contours generated from the data for the October 2019 monitoring event. Because there are no significant or extensive aquitards separating the Alluvium, Paso Robles Formation, and Pismo Formation, the water level maps assume that all three formations function as a single hydrogeologic unit. This map confirms the previously estimated primary direction of groundwater flow from the Edna Valley to the San Luis Valley, but several new features are apparent. First, a pronounced mound is evident at the location where Corral de Piedras Creek enters the Basin in Edna Valley, near the corner of Biddle Ranch Road and Orcutt Road. This indicates that this is a groundwater recharge area, and that the recent rains of 2016-2017 have elevated water levels in this area. Secondly, a depression in the water table surface is evident in the area near Edna Road and Biddle Ranch Road, likely due to agricultural pumping in the area in recent years. The southeast and northwest extents of the Basin had no wells monitored during this event to calculate water levels in these areas.

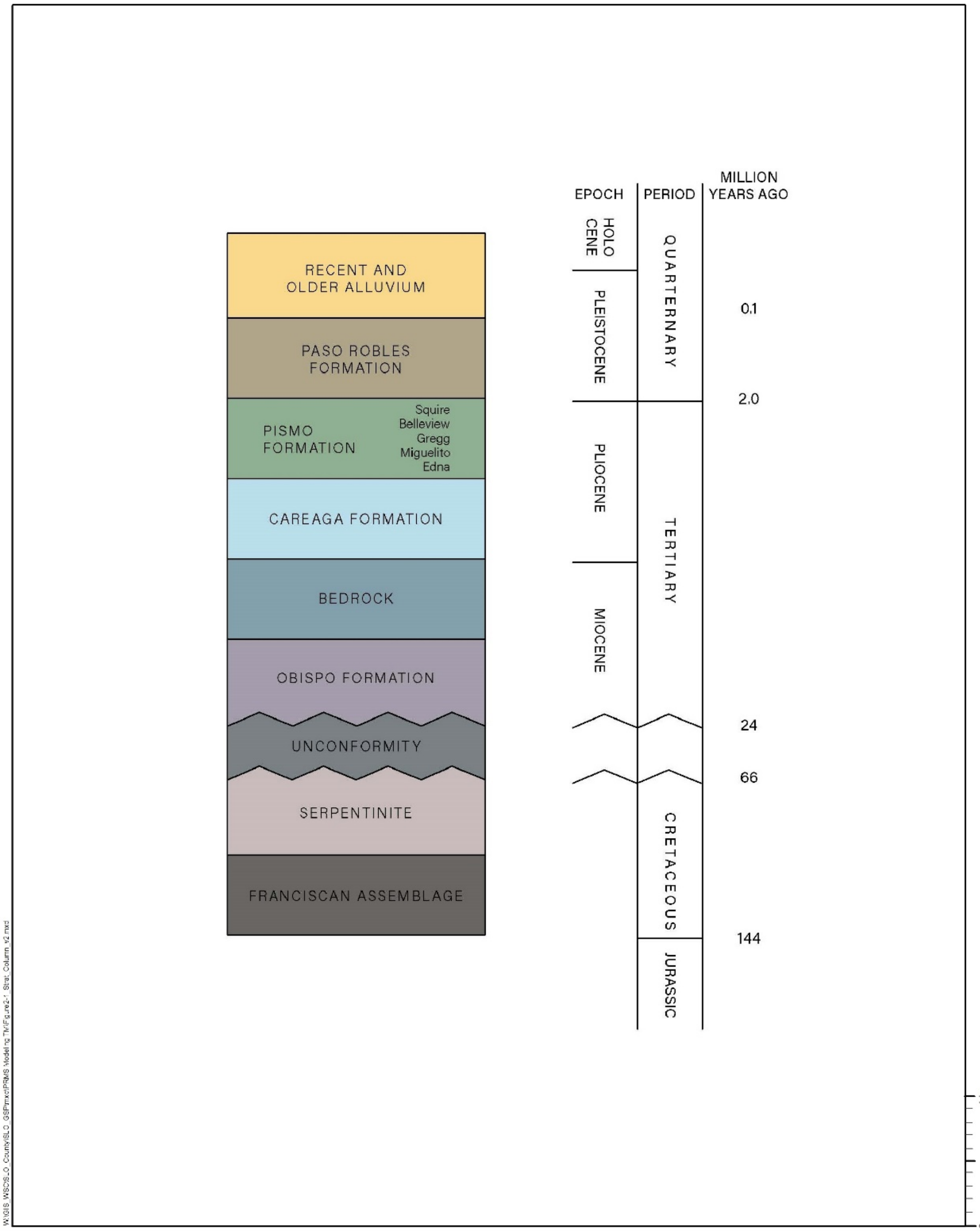
The San Luis Valley and the Edna Valley are characterized by different patterns of groundwater use. In the San Luis Valley, groundwater use has been dominated by municipal and industrial use. In the Edna Valley, groundwater use is dominated by agricultural use. During the past 20 to 25 years, vineyards have supplanted other crop types as the dominant agricultural use. Available water level data were reviewed, and data from wells with the longest period of record are presented here.

Figure 2-7 presents long-term groundwater elevation hydrographs for ten wells throughout the Basin. Three main patterns of water level change are evident in these hydrographs. The hydrographs for the wells in the San Luis Valley indicate that water levels in these wells, although somewhat variable in response to seasonal weather and water use fluctuations and longer-term drought cycles, are essentially stable. There are no long-term trends indicating steadily declining water levels in this area. By contrast, several wells in the Edna Valley display steadily declining water levels during the past 20 to 25 years.

Two wells in close proximity to the groundwater recharge area in Edna Valley where Corral de Piedras Creek enters the Basin display much greater volatility in response to drought cycle fluctuations than the wells in San Luis Valley but appear to rebound to pre-drought levels when the drought cycle ends; water levels in these wells do not display a long-term decline of water levels.

2.4.7. Hydraulic Properties

During the preparation of the Basin Characterization Report (GSI, 2018), all available data on constant rate aquifer tests and specific capacity tests in the Basin were collected, reviewed, and presented in the report. Seventy-seven well locations in the Basin were identified that had an estimate of aquifer hydraulic parameters, indicating reasonable data density in the Basin. Wells screened in the Alluvium and Paso Robles Formation have reported transmissivities ranging from about 5,000 to 158,000 gallons per day per foot (gpd/ft), and averaging over 42,000 gpd/ft. Wells screened in Paso Robles and Pismo Formations have transmissivities ranging from less than 1,000 to about 40,000 gpd/ft, and average about 10,000 gpd/ft. These data are presented in a summary table in Chapter 4 of the GSP.



Prepared for:

Author: EC
Date: 1/13/2020

SAN LUIS OBISPO VALLEY BASIN GSP

Notes:
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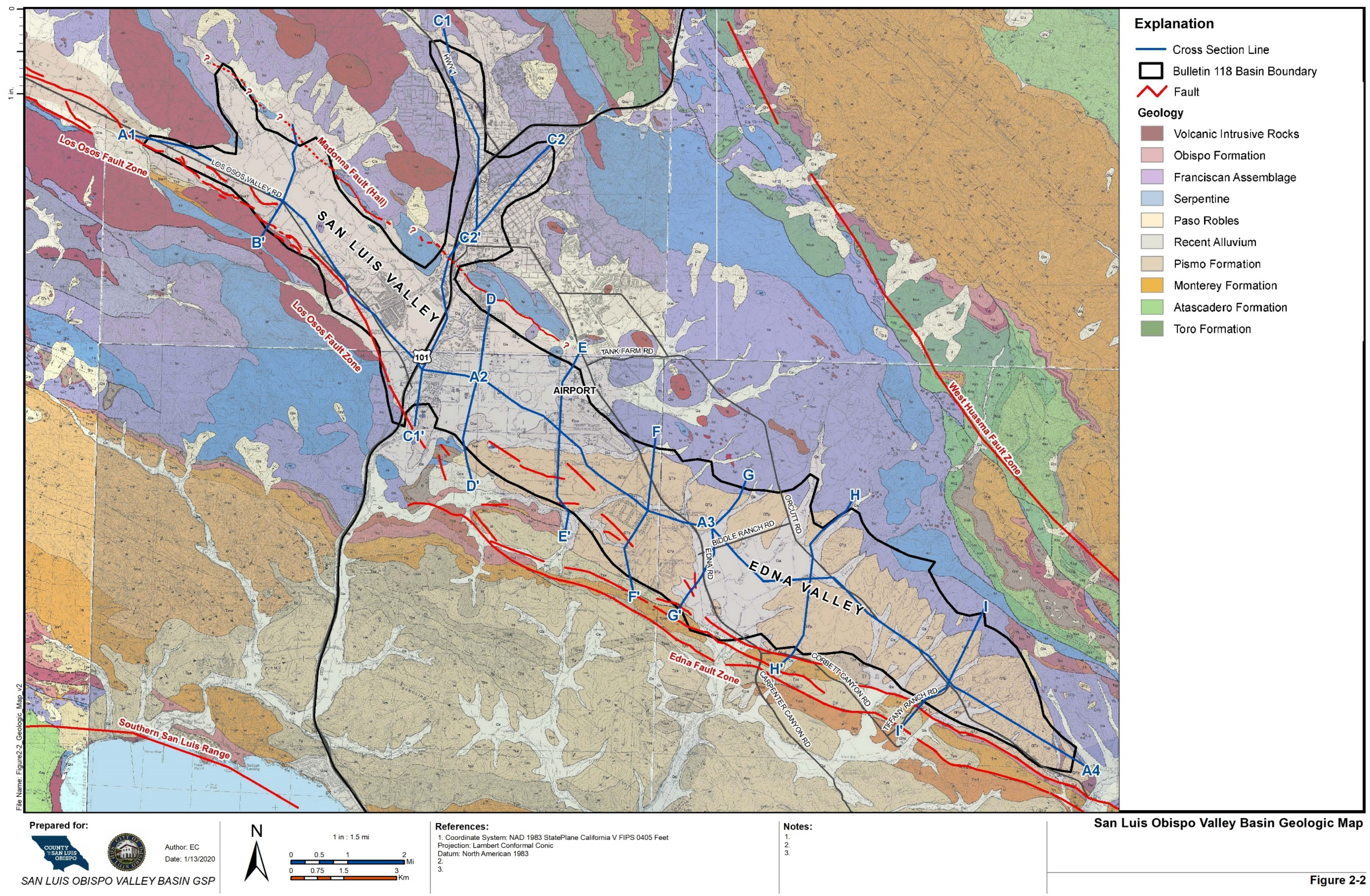
3.

Local Geologic Stratigraphic Column

Figure 2-1


Explanation
Cross Section Line
Bulletin 118 Basin Boundary
Fault
Geology
Volcanic Intrusive Rocks
Obispo Formation
Franciscan Assemblage
Serpentine
Paso Robles
Recent Alluvium
Pismo Formation
Monterey Formation
Atascadero Formation
Toro Formation
SAN LUIS VALLEY
EDNA VALLEY
AIRPORT
Los Osos Fault Zone
Madonna Fault (Hall)
West Huasna Fault Zone
Edna Fault Zone
Southern San Luis Range
LOS OSOS VALLEY RD
TANK FARM RD
BIDDLE RANCH RD
EDNA RD
ORCUTT RD
CORBETT CANYON RD
CARPENTER CANYON RD
TIFFANY RANCH RD
A1
A2
A3
A4
B'
C1
C1'
C2
C2'
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File Name: Figure2-2_Geologic_Map_v2
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SAN LUIS OBISPO VALLEY BASIN GSP
Author: EC
Date: 1/13/2020
1 in : 1.5 mi
References:
1. Coordinate System: NAD 1983 StatePlane California V FIPS 0405 Feet
Projection: Lambert Conformal Conic
Datum: North American 1983
2.
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Notes:
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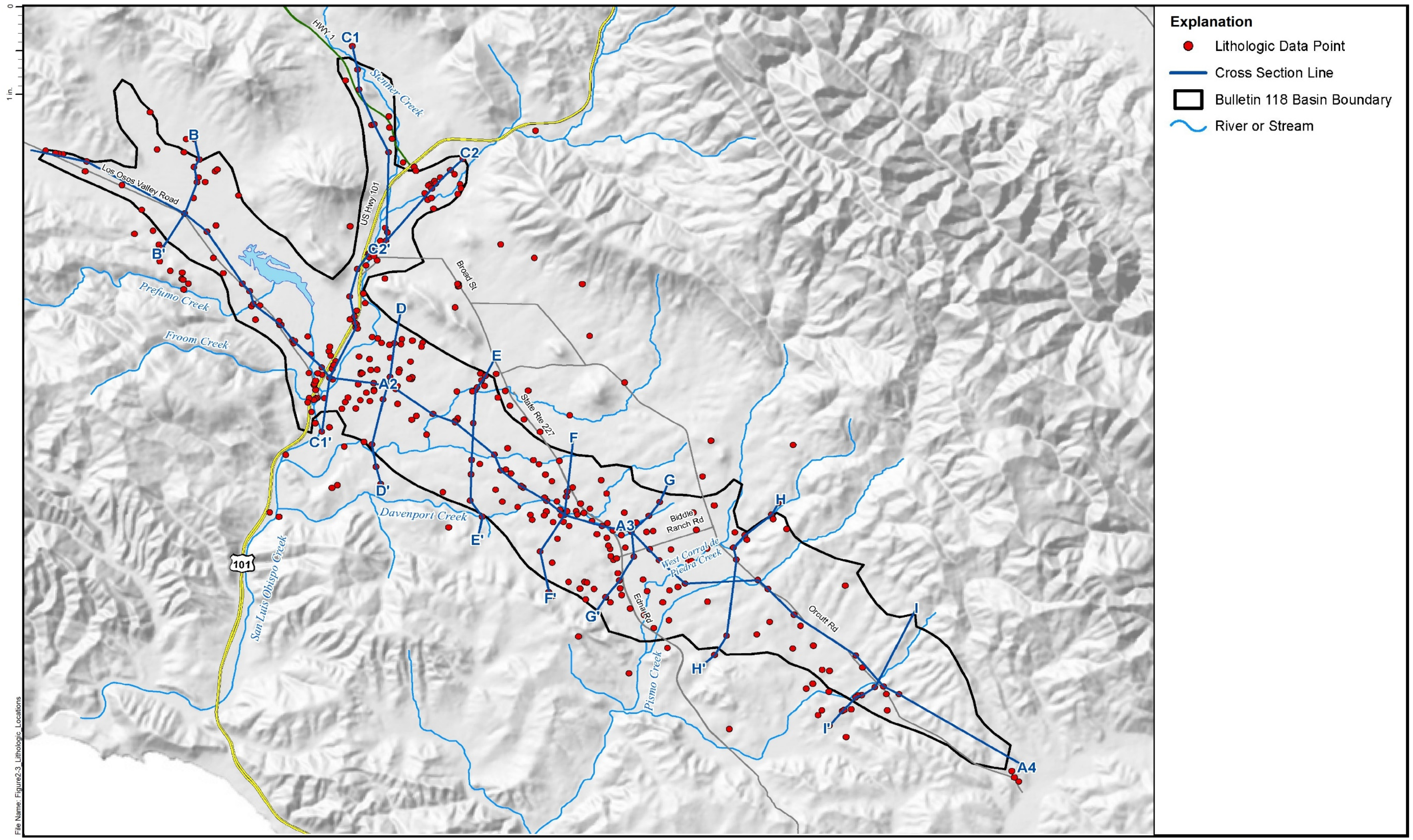
San Luis Obispo Valley Basin Geologic Map
Figure 2-2



Prepared for:

COUNTY OF SAN LUIS OBISPO

Author: EC
Date: 10/15/2019

SAN LUIS OBISPO VALLEY BASIN GSP

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References:
1. Coordinate System: NAD 1983 StatePlane California V FIPS 0405 Feet
Projection: Lambert Conformal Conic
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Notes:
1.
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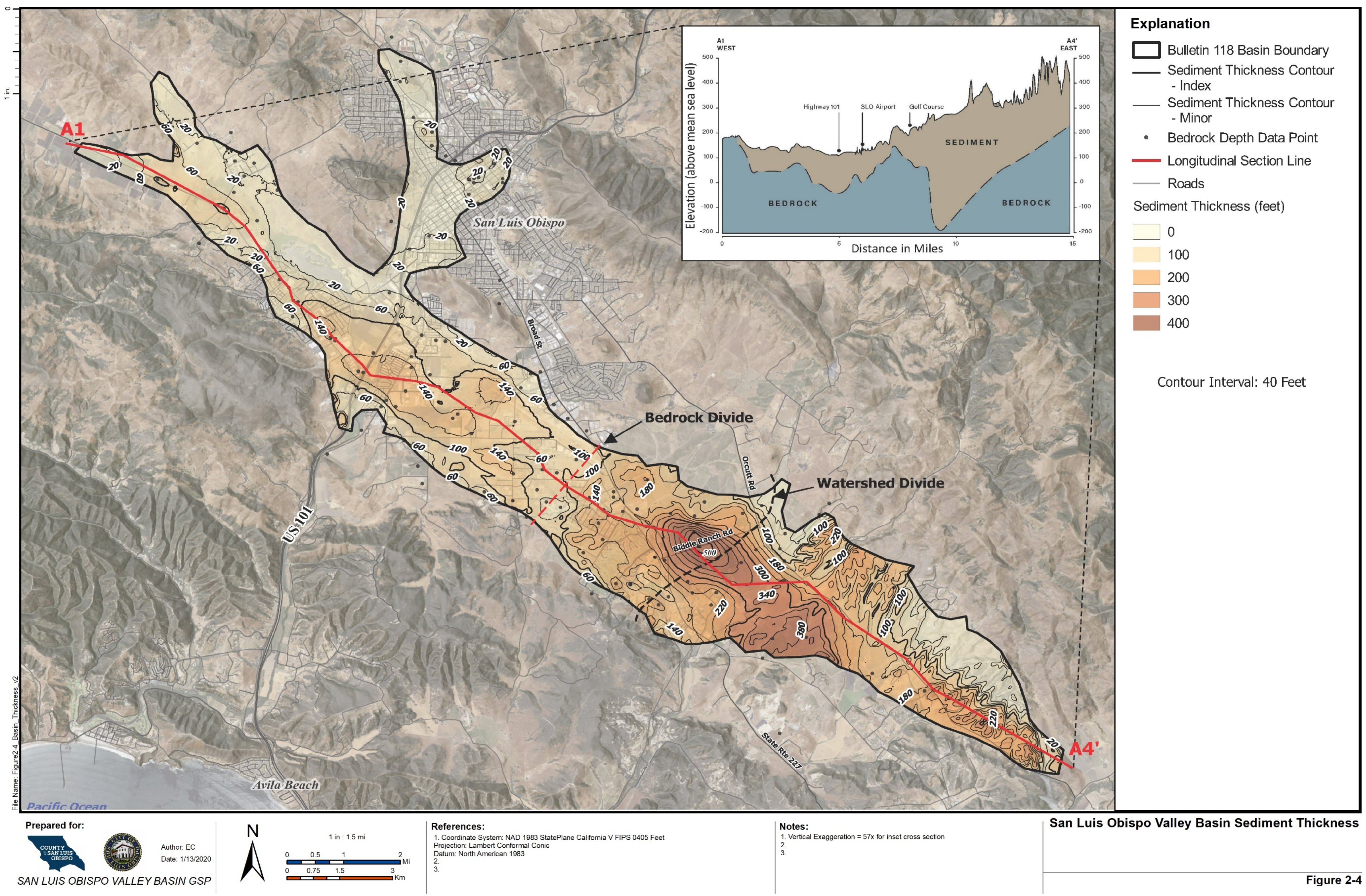
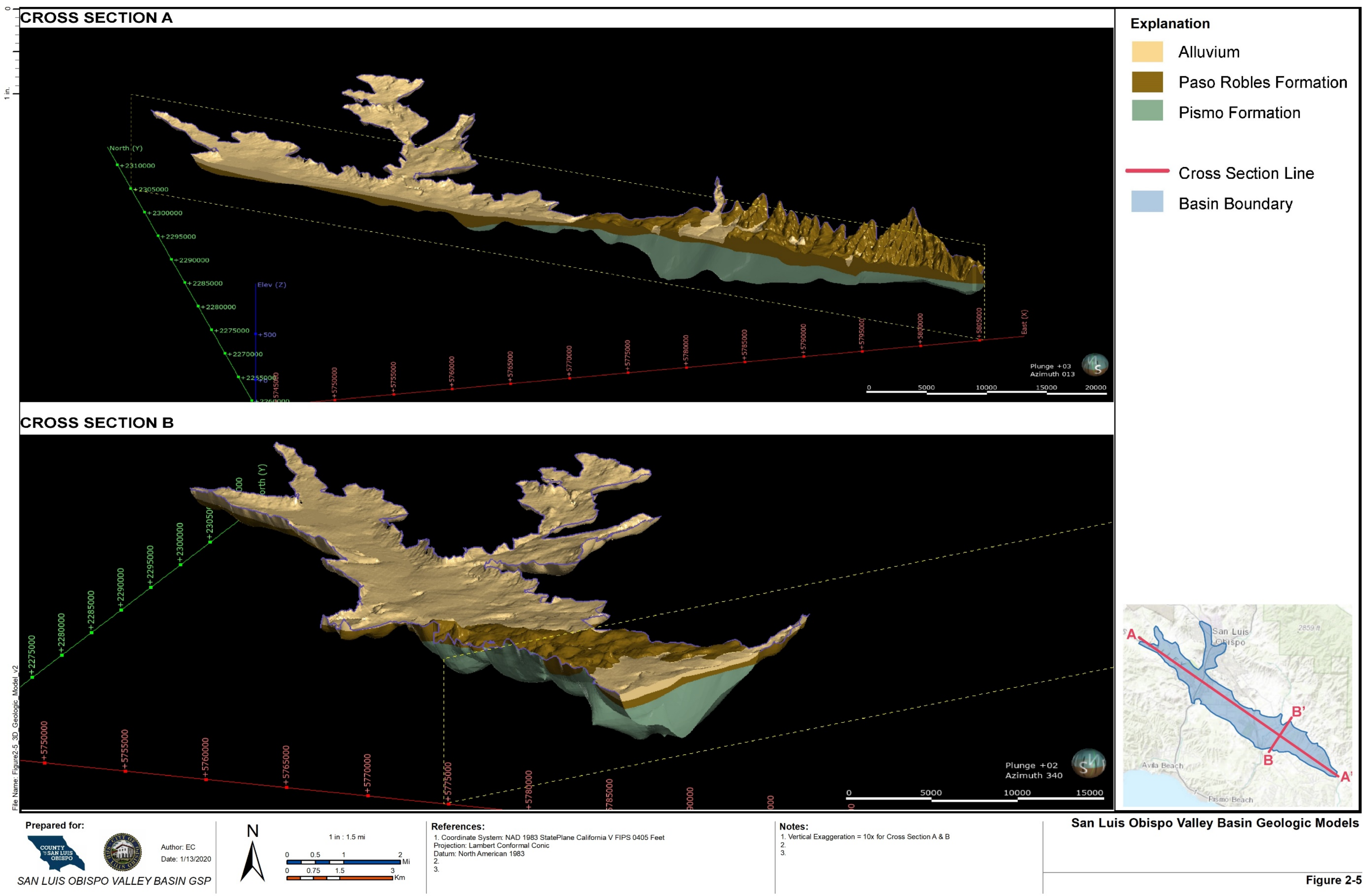
San Luis Obispo Valley Basin Cross Section Lines and Lithologic Data Points

Figure 2-3



San Luis Obispo Valley Basin Sediment Thickness

Figure 2-4


CROSS SECTION A
CROSS SECTION B
Explanation
Alluvium
Paso Robles Formation
Pismo Formation
Cross Section Line
Basin Boundary
Plunge +03
Azimuth 013
Plunge +02
Azimuth 340
A
A'
B
B'
San Luis Obispo
Avila Beach
Pismo Beach
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SAN LUIS OBISPO VALLEY BASIN GSP
Author: EC
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1. Coordinate System: NAD 1983 StatePlane California V FIPS 0405 Feet
Projection: Lambert Conformal Conic
Datum: North American 1983
2.
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Notes:
1. Vertical Exaggeration = 10x for Cross Section A & B
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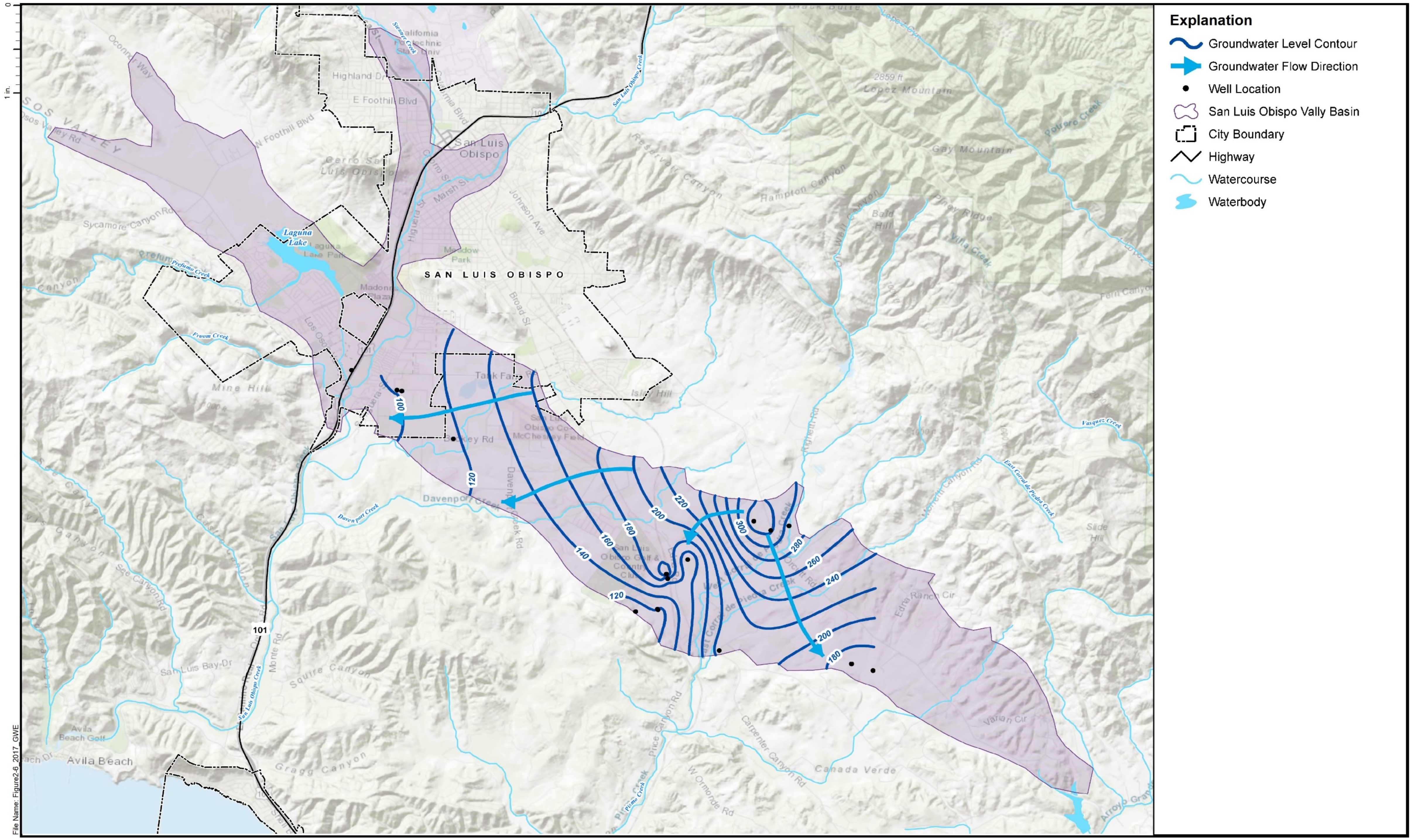
3.
San Luis Obispo Valley Basin Geologic Models
Figure 2-5



Prepared for:

SAN LUIS OBISPO VALLEY BASIN GSP

Author: EC
Date: 10/14/2019

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References:
1. Coordinate System: NAD 1983 StatePlane California V FIPS 0405 Feet
Projection: Lambert Conformal Conic
Datum: North American 1983
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Notes:
1.
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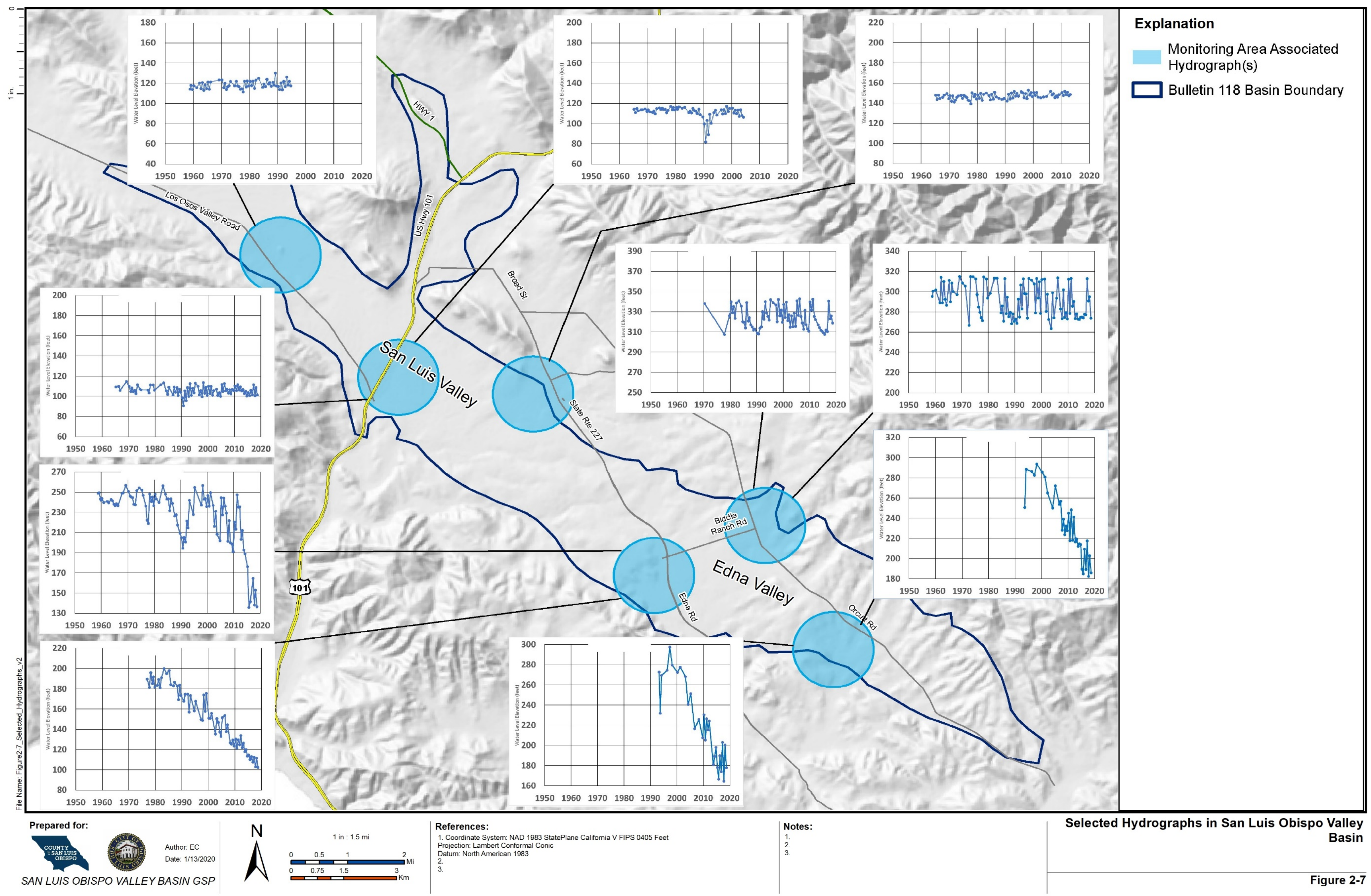
October 2017 Groundwater Elevations

Figure 2-6



Selected Hydrographs in San Luis Obispo Valley Basin

Figure 2-7

Section 3. Modeling Approach

The GSA expressed a preference for an integrated surface water-groundwater model to be used to support the GSP, rather than a traditional groundwater model limited to the extents of the Basin. An integrated model simulates surface water processes in the contributing watershed as well as groundwater flow within the basin and incorporates results of the surface water simulation as input into the groundwater flow model. There are numerous approaches and available modeling codes capable of achieving this objective. GSI and WSC evaluated four options for development of an integrated numerical model and documented the results in a TM prepared for GSA staff (GSI Water Solutions, Inc., 2019), and presented the results to the GSC in a public meeting. The four options considered were:

- MODFLOW + HSPF (coupled model)
- MODFLOW-One Water (OWHM)
- IWFM – DWR Integrated Flow Model
- GSFLOW

For reasons documented in the supporting TM (GSI Water Solutions, Inc., 2019), the decision was made to use GSFLOW as a platform for the integrated model.

GSFLOW is a fully integrated watershed-groundwater model (Markstrom et al., 2008) that has been used throughout the United States by the USGS and other hydrologic professionals to model surface water and groundwater conditions in various geologic settings. GSFLOW is a coupled groundwater and watershed flow model based on integration of the USGS watershed model PRMS and groundwater model MODFLOW. The PRMS and MODFLOW models can be developed separately, with initial parameter estimation performed in the two models separately, before integrating the two component models. Then the integrated model is calibrated and run using GSFLOW to complete the model development process.

GSFLOW was developed to simulate coupled groundwater – surface water flow in one or more watersheds by simultaneously simulating flow across the land surface, within subsurface saturated and unsaturated materials, and within streams and lakes (Markstrom et al., 2008). GSFLOW uses physically based processes and empirical methods with user inputs of air temperature and precipitation (i.e., snow/rain) to simulate the distribution of precipitation into runoff, evapotranspiration, infiltration, groundwater flow, and surface-water flow.

Details of the modeling approach for PRMS and MODFLOW are presented in the following sections.

Section 4. PRMS: Surface Water-Component Model

The modeling software that will be used to simulate the watershed-scale surface water component of the integrated model is PRMS version 5.0.0. PRMS is a deterministic, distributed-parameter, physical-process hydrologic model used to simulate and evaluate the watershed response of various combinations of climate and land use (Markstrom, et al., PRMS-IV, the Precipitation-Runoff Modeling System, Version 4, 2015).

In the PRMS model, climate data, including precipitation and temperature, are applied to simulate hydrologic water budgets based on spatially defined watershed-component model parameters such as plant canopy and soil zone properties. Surface and subsurface flow is calculated through the cascading of rain-generated runoff. When run in PRMS-only simulations, runoff that infiltrates into the soil zone is distributed to the subsurface reservoir and groundwater reservoir where it can interflow to streams or lakes. When run in a coupled GSFLOW simulation, groundwater flow routing is simulated in MODFLOW rather than PRMS. Initial parameter estimation of the PRMS model will be performed in PRMS-only mode prior to integration into GSFLOW and final calibration of the integrated model.

4.1. Model Discretization

Model discretization is performed using Gsflow-Arcpy (Gardner, Morton, Huntington, Niswonger, & Henson, 2018), a toolkit of ArcGIS Python codes. Gsflow-Arcpy consists of a series of python scripts that, when run in succession, produce model-ready PRMS parameter files and a parameter shapefile for visual representation of all inputs.

Prior to performing the model discretization, the watershed boundary, or model domain, for PRMS and GSLFOW was delineated. The model domain was defined by all land area that drains surface runoff into the San Luis Obispo Valley Groundwater Basin. The two primary watersheds that make up this area are the San Luis Obispo Creek and Pismo Creek watersheds. The two pre-delineated watersheds were trimmed at the south-west boundary of the Basin. A topographic analysis was then performed along the south-west boundary to capture all sub-watersheds that drain to the Basin, including the Prefumo Creek and Froom Creek sub-watersheds. Figure 4-1 presents the PRMS model domain.

4.1.1. Hydrologic Response Unit Discretization

The first step in preparation of the PRMS model is the spatial discretization of the watershed into individual hydrologic response units (HRU). This is performed to allow for spatial variability in model inputs (elevation, slope, vegetation type, etc.) and reporting of the simulation results, as a water balance and energy balance are computed at each timestep at each HRU. A grid-based approach, which entails the delineation of the watershed into square grid-cell HRUs, was selected for both the PRMS and MODFLOW models. Various grid cell sizes were evaluated, ranging from 250-foot (ft) to 1,000-ft. Sample grids at differing cell sizes were overlaid onto aerials and base maps to evaluate grid cell density. GSI and WSC performed a brief literature review to assess what grid cell size has been used in comparison to the entire modeled area for other GSFLOW modeling studies documented in the state. The ratios of cell size to watershed size were assessed in comparison to other GSFLOW models, including the Santa Rosa Plain Model (Woolfenden & Nishikawa, 2014) and the Santa Cruz Mid-County Basin Model prepared by HydroMetrics Water Resources, Inc. (Huntington, King, & Tana, 2016). This comparison indicated that 500-foot grid cells for the model yielded a grid cell to model area ratio within the bounds of those from other documented GSFLOW modeling studies. Therefore, a uniform grid cell size of 500 ft x 500 ft, totaling 21,462 cells, was adopted for the initial model development.

The delineation of the watershed into HRUs for the PRMS model was performed using the Gsflow-Arcpy toolkit. Limitations of the ArcInfo grid format is that it will only perform raster-based calculations on vertical-horizontal oriented grid cells (Environmental Systems Research Institute (ESRI), 2013). Additionally, GSFLOW requires that the grid cells in PRMS output files match those in the MODFLOW files or if the PRMS and MODFLOW grid cells orientation and total model extents differ, HRU's assigned in PRMS and their associated gravity reservoirs are reassigned proportionally to each MODFLOW grid cell. To resolve this limitation, the vertical oriented PRMS grid and its populated input data fields will be used for PRMS calibration. Once PRMS and MODFLOW have been initially run separately, PRMS HRU's and their associated gravity reservoirs will be reassigned to the MODFLOW grid. This combined grid will create the final grid to be used for GSFLOW calibration and multiple model runs assessing various scenarios. This approach will maintain the integrity of the developed PRMS input files and allows for simplified integration between PRMS and MODFLOW into GSFLOW that does not require custom code integration and use of additional data files.

Once the HRU grid cells are generated, the next step in the discretization is the designation of cells as one of four types: land, lake, swale, or inactive. Two water bodies within the watershed, Laguna Lake and the Righetti Reservoir, were designated in the model input. Swales, which represent a sink without an outlet, were not identified within the watershed and therefore were excluded from the designation in the model input. Inactive cells represent those outside the watershed boundary that are not included in the model simulation.

The last step to the HRU discretization is the designation of sub-basins. Sub-basins were delineated based on the locations of the various stream gages (see Section 4.2.2), the outlet of Righetti Reservoir, and the model outlet points. Figure 4-1 presents the results of HRU discretization and Figure 4-2 presents the locations of model sub-basin points and model outlet points.

4.1.2. Stream Segments

Another spatial unit that is defined as part of the model discretization is the delineation of stream segments throughout the watershed. In PRMS, lateral flows, inflow and outflow are calculated at each stream segment. Delineation of the stream segments began with first assigning mean surface elevations to each HRU grid cell within the watershed using a 10-meter resolution digital elevation model (DEM) from the National Elevation Dataset (National Elevation Dataset, 2019). The mean elevations are then used by the Gsflow-Arcpy script to designate the stream segments locations by creating continuously down-sloping HRUs. Generated stream segments were viewed in comparison to USGS National Hydrography Dataset (NHD) streams in ArcMap (National Hydrography Dataset, 2002 - 2016) and recent satellite imagery from Google Earth to evaluate the accuracy of the stream delineation. Stream segment alignments were iteratively adjusted by manually altering the mean elevation of HRUs and rerunning the Gsflow-Arcpy script. The level of detail with regards to stream order was optimized to be representative of the main branches and the primary tributaries. Figure 4-3 presents the stream segments generated for the PRMS model.

4.2. Model Inputs and Calibration Data

Like the model discretization, Gsflow-Arcpy (Gardner, Morton, Huntington, Niswonger, & Henson, 2018) was used to assign input parameters to the HRUs such that they are formatted and structured for direct use by the PRMS model software.

4.2.1. Climate Input

PRMS requires a variety of climatic data for use throughout the various stages of modeling, including pre-processing of input data (mean monthly precipitation, maximum temperature, and minimum temperature), simulation runs (daily precipitation, maximum temperature, and minimum temperature), and calibration (solar radiation and evapotranspiration). Climatic data, dating back to 1870, was obtained from the Cal Poly Weather Station through the help of the Irrigation Training & Research Center (ITRC). The Cal Poly Weather Station houses not only the ITRC owned gages but also the California Irrigation Management Information System (CIMIS) and National Oceanic and Atmospheric Administration (NOAA) weather stations. While there are other County and privately-owned climate stations throughout the watershed, the Cal Poly Weather Station is the only station that has extensive records spanning the duration of the anticipated calibration period. Furthermore, the ITRC has performed thorough quality control reviews on the data collected from the Cal Poly Weather Station.

As part of the pre-processing and generation of input data, mean monthly precipitation was spatially distributed to each HRU within the model domain using 30-year normal baseline datasets, spanning from 1981 to 2010, from the Parameter-Regression on Independent Slopes Model (PRISM) (NACSE, 2019). Monthly precipitation scaling factors, that act as multipliers to account for changes in elevation, were then calculated for each HRU based on a ratio between the PRISM data and 1870-2018 mean monthly observed precipitation data from the Cal Poly Weather Station. Figure 4-4 and Figure 4-5 show the mean annual precipitation PRISM dataset and mean annual precipitation scaling factors derived from the PRISM and the Cal Poly Weather Station datasets. During PRMS simulations, the HRU precipitation scaling factors will be multiplied by the daily precipitation measurements from the Cal Poly Weather Station to calculate daily precipitation at each HRU. This will be performed using the precip_1sta module, as discussed further in Section 4.3. The accuracy of the precipitation scaling factors will be assessed by comparing the measured precipitation at the three County rain gages (SLO Portal, SLO Reservoir, and The Gas Company) to the modeled rainfall at each respective HRU.

Mean monthly minimum and maximum temperature values were assigned to each HRU using the 30-year normal PRISM dataset, as done with precipitation. Daily minimum and maximum temperature will be calculated at each HRU during PRMS simulations using daily observed maximum and minimum temperature data from the Cal Poly Weather Station and monthly PRISM data assigned to each HRU. PRMS simulations will use the temp_sta module to perform temperature calculations, as discussed further in Section 4.3. The accuracy of the modeled temperature will be assessed by comparing the modeled minimum and maximum temperatures to the measured values at the two nearby weather stations (PG&E Black Butte and SLO County Farm Bureau) with data available on Weather Element (Weather Element, 2014).

4.2.2. Streamflow Data

The County of San Luis Obispo owns and operates five real-time data monitoring stream gages along San Luis Obispo Creek, within the model domain. Each gage station records creek stage (depth) on fifteen-minute intervals. Available stage data at each station dates to 2005. Of the five County stream gages, three have stage-discharge relationships, or rating curves, that were approximated by Central Coast Salmon Enhancement (CCSE) based on recorded stage data and measured flows between 2017 and 2019. These stream gages include the Andrews Street Bridge, Stenner Creek at Nipomo, and Elks Lane (Figure 1-1). The rating curves generated for these gauge stations are considered the best available information for use in converting stage data to flow rate, and therefore are anticipated to be the primary datasets for use in calibrating the PRMS model. As previously mentioned, Questa Engineering Corps also estimated theoretical rating curves for each of the five County gages using a HEC-RAS model (Questa Engineering Corp., 2007). However, preliminary application of these rating curves to the stream gage data resulted in abnormal daily mean hydrographs in comparison to the hydrographs generated using the CCSE rating curves. The Questa rating curves may be used as a secondary dataset for comparison of modeled to observed flows at the Jesperesen and Madonna Road gage stations, where no CCSE rating curves exist.

In addition to the County owned gages, the City of San Luis Obispo collects weekly measurements of stage and flow within San Luis Obispo Creek at the outfall of the Water Resources Recovery Facility (WRRF) during the months of April to September as part of the National Pollutant Discharge Elimination System (NPDES) permitting program. It is not anticipated that this data will be used for calibration purposes given the apparent daily and monthly data gaps.

Lastly, monthly diversion data, dating back to 2010, is available for the 500-acre-foot Righetti Reservoir located along West Corral De Piedra Creek. A sub-basin, or sub-watershed, was designated at this reservoir in the model so that simulated flows can potentially be calibrated to observed monthly data. The efficacy of calibration at this location will be dependent on the capabilities of the PRMS routing modules and the limited information available on the day-to-day operations of the reservoir. At the very least, the Righetti Reservoir diversion data may be used to incorporate future diversion flows into modeling scenarios.

4.2.3. Additional Parameters

Vegetation, soil, and impervious land cover surfaces play important roles in routing and distributing runoff throughout PRMS. Vegetation is used by relating vegetation type to root depth and evapotranspiration to model water balances within the soil zone, and vegetation's various roles in runoff processes. Vegetation data was retrieved from the LANDFIRE datasets available through the United States Department of Agriculture, Forest Service (LANDFIRE, 2019). The vegetation parameters are calculated and populated before the soil parameters in order to establish root depths for each vegetation type. Soil data from SSURGO and STATSGO (Soil Survey Staff, 2019) are used to extract available water content (AWC), saturated hydraulic conductivity (Ksat), soil type, and percentages of sand, silt, and clay values throughout the watershed. These values are then assigned to various soil parameters used in PRMS to model flux's between vegetation and the soil-root zone. Impervious land cover surfaces are used to model surface runoff in areas that have no infiltration or in areas with different infiltration rates then can be expected from certain vegetated areas or soil types. The National Land Cover Database (Homer, Fry, & Barnes, 2012) data is used to derive these areas within each HRU grid cell represented as percentages. Figure 4-6 shows the National Land Cover Database data showing land cover types in the Basin derived from the impervious Arcpy script.

4.3. PRMS Modules

PRMS simulates the hydrologic cycle through various processes, each with one or more modules available for use. Table 4-1 presents the modules that have been selected for use in this model.

Table 4-1. PRMS Modules to Be Used

Module Name	Process	Description[1]
basin	Basin Definition	Defines shared watershed wide and HRU physical parameters and variables.
cascade	Cascading Flow	Determines computational order of the HRUs and groundwater reservoirs for routing flow downslope.
soltab	Solar Table	Computes potential solar radiation and sunlight hours for each HRU for each day of the year.
obs	Time Series Data	Reads and stores observed data from all specified measurement stations.
temp_sta	Temperature Distribution	Distributes maximum and minimum temperatures to each HRU by using temperature data measured at one station.
precip_1sta	Precipitation Distribution	Determines the form of precipitation and distributes it from one or more station to each HRU by using monthly correction factors to account for differences in altitude, spatial variation, topography, topography, and measurement gage efficiency.
ddsolrad	Solar Radiation Distribution	Distributes solar radiation to each HRU and estimates missing solar radiation data using a maximum temperature per degree-day relation.
transp_tindex	Transpiration Period	Determines whether the current time step is in a period of active transpiration by the temperature index method.
potent_jh	Potential Evapotranspiration	Computes the potential evapotranspiration by using the Jensen-Haise formulation (Jensen & Haise, 1963)
intcp	Canopy Interception	Computes volume of intercepted precipitation, evaporation from intercepted precipitation, and throughfall that reaches the soil.
srunoff_smidx	Surface Runoff	Computes surface runoff and infiltration for each HRU by using a nonlinear variable-source-area method allowing for cascading flow.
soilzone	Soil-Zone	Computes inflows to and outflows from soil zone of each HRU and includes inflows from infiltration, groundwater, and upslope HRUs, and outflows to gravity drainage, interflow, and surface runoff to down-slope HRUs.
gwflow	Groundwater	Sums inflow to and outflow from PRMS groundwater reservoirs. Used in the PRMS-only model, not the integrated GSFLOW model.
strmflow	Streamflow	Computes flow in the stream network using the Muskingum routing method and flow and storage in on-channel lake using several methods. Used in the PRMS-only model, not the integrated GSFLOW model.

[1] (Markstrom, et al., PRMS-IV, the Precipitation -Runoff Modeling System, Version 4: Updated Tables from Version 4.0.3 to Version 5.0.0, 2019; Markstrom, Niswonger, Regan, Prudic, & Barlow, 2008)

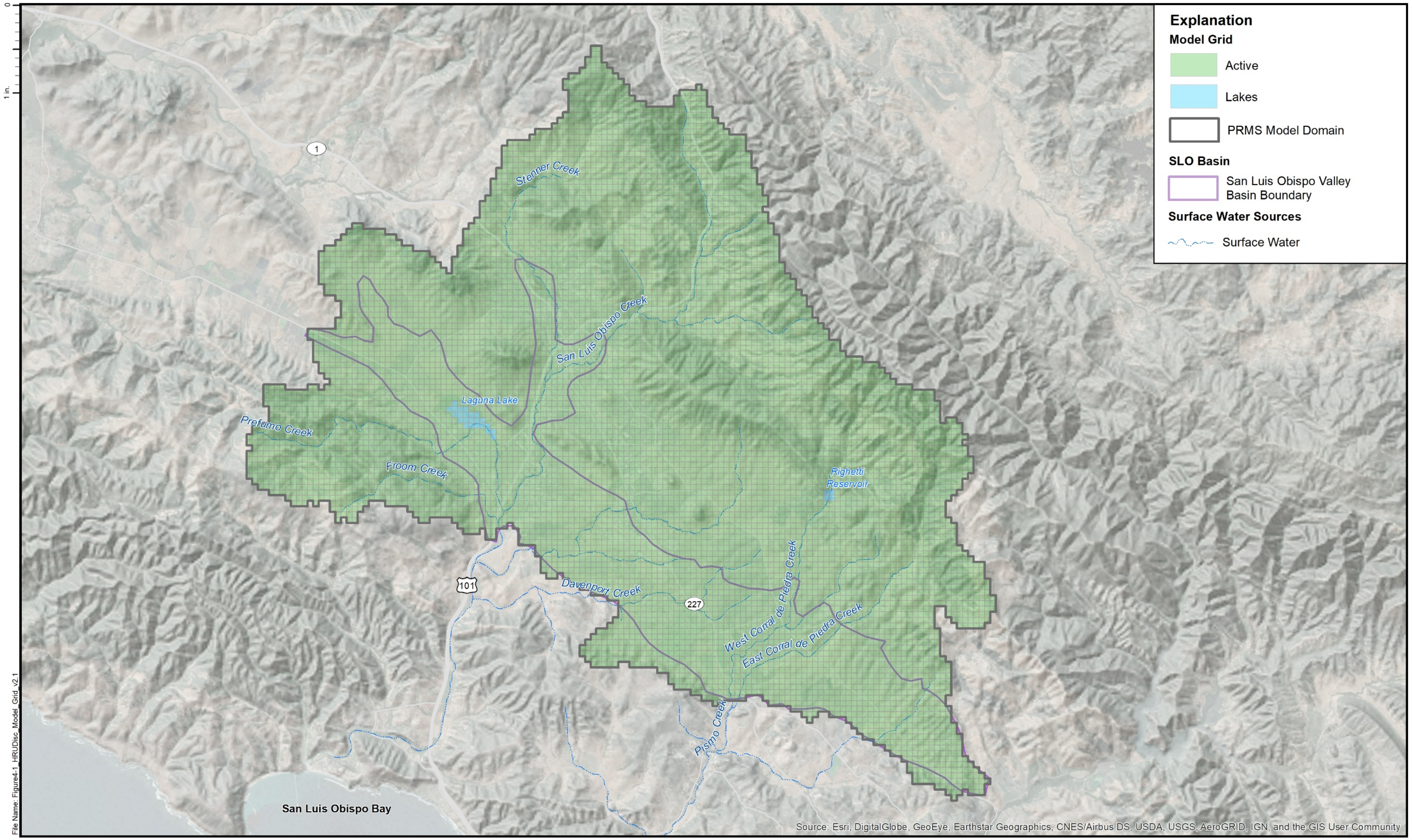
4.4. Calibration Approach

The PRMS model will be calibrated using the USGS Luca software (Hay & Umemoto, 2007) and a step-wise approach that includes the optimization of the following data sets: mean monthly solar radiation, mean monthly potential evapotranspiration, streamflow volume (annual mean, mean monthly, and monthly mean), and streamflow timing (daily and monthly mean). Simulated values and model outputs will be compared to calibration data sets generated from measured data. Data sets for solar radiation and potential evapotranspiration will be derived from measurements recorded at the Cal Poly CIMIS Weather Station 52. Calibration data sets for streamflow volume and timing will be derived from the CCSE and Questa Engineering Corps rating curves and measured stage data at the five County stream gages, as discussed in Section 4.2.2. The Madonna Road stream gage will be used for calibration of the integrated GSFLOW model but not for initial calibration of the PRMS model, as it is located downstream of Laguna Lake which will be modeled in MODFLOW using the Lake Package. The PRMS calibration simulation period will be based on the available stream gage data, which spans from July 2006 to August 2019.

Modeled and measured streamflow will be evaluated in the integrated model via comparison of daily and mean monthly hydrographs as well as using goodness-of-fit statistics. Goodness-of-fit statistics that will be considered for use include the percent-average-estimation-error (PAEE), the absolute-average-estimation-error (AAEE), and the Nash-Sutcliffe model efficiency (NSME). Table 4-2 presents the range of goodness-of-fit criteria as outlined for the Santa Rosa Plain Model (Woolfenden & Nishikawa, 2014). The optimal goal is to achieve calibration results within the "Very Good" or "Excellent" range, however, this may not be feasible at each stream gage location due to limitations associated with the accuracy of the rating curves and stream gage stage data.

Table 4-2. Goodness-of-fit Statistics

Goodness-of-fit Category	PAEE (%)	AAEE (%)	NSME
Excellent	-5 to 5	≤0.5	≥0.95
Very Good	-10 to -5 or 5 to 10	0.5 to 1.0	0.85 to 0.94
Good	-10 to -5 or 5 to 10	10 to 15	0.75 to 0.84
Fair	-10 to -5 or 5 to 10	15 to 25	0.6 to 0.74



Prepared for:

Author: EC
Date: 12/18/2019

SAN LUIS OBISPO VALLEY BASIN GSP

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References:
1. Coordinate System: NAD 1983 StatePlane California V FIPS 0405 Feet
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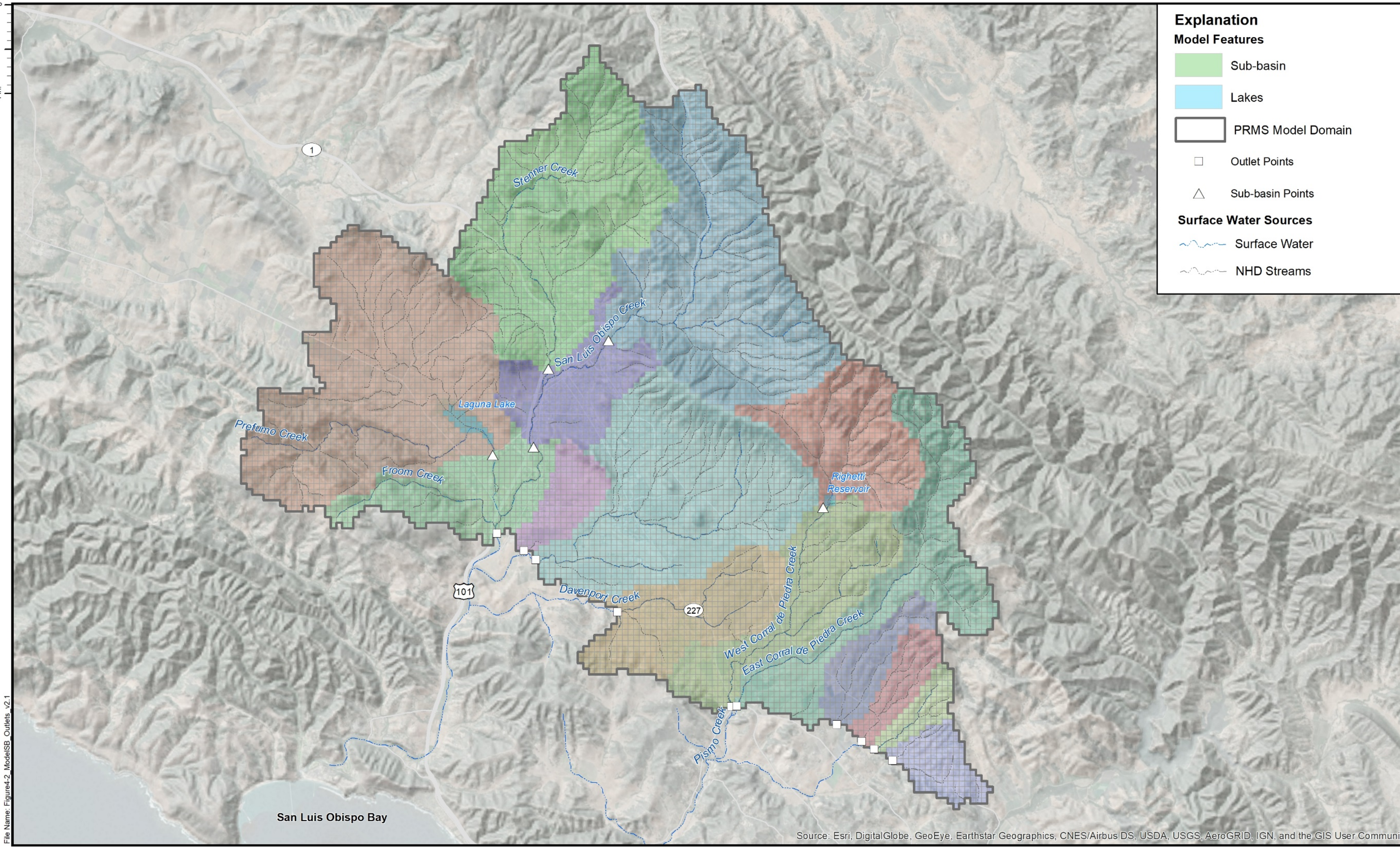
HRU Discretization of Model Grid

Figure 4-1



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Author: EC
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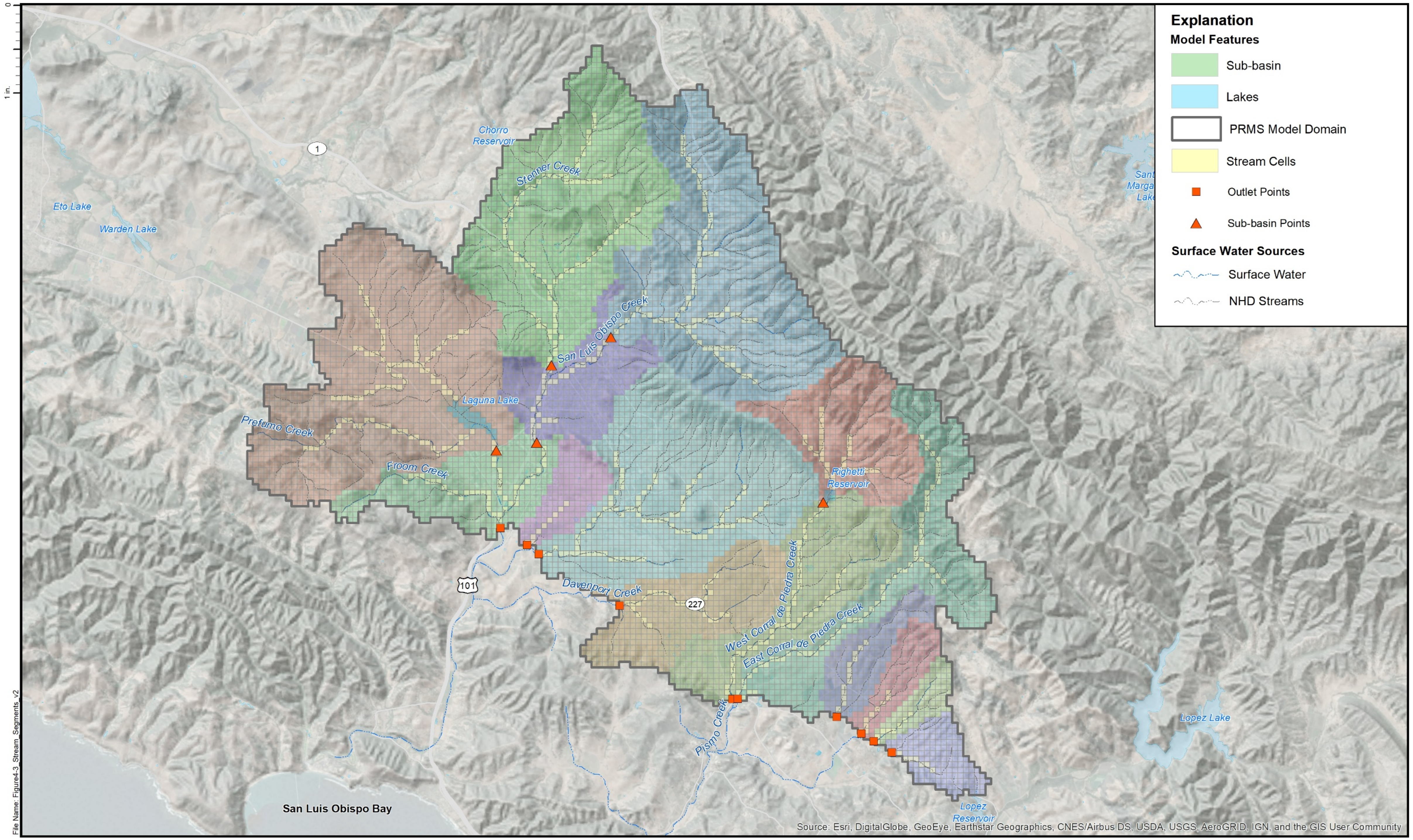
Model Sub-basins and Outlets

Figure 4-2



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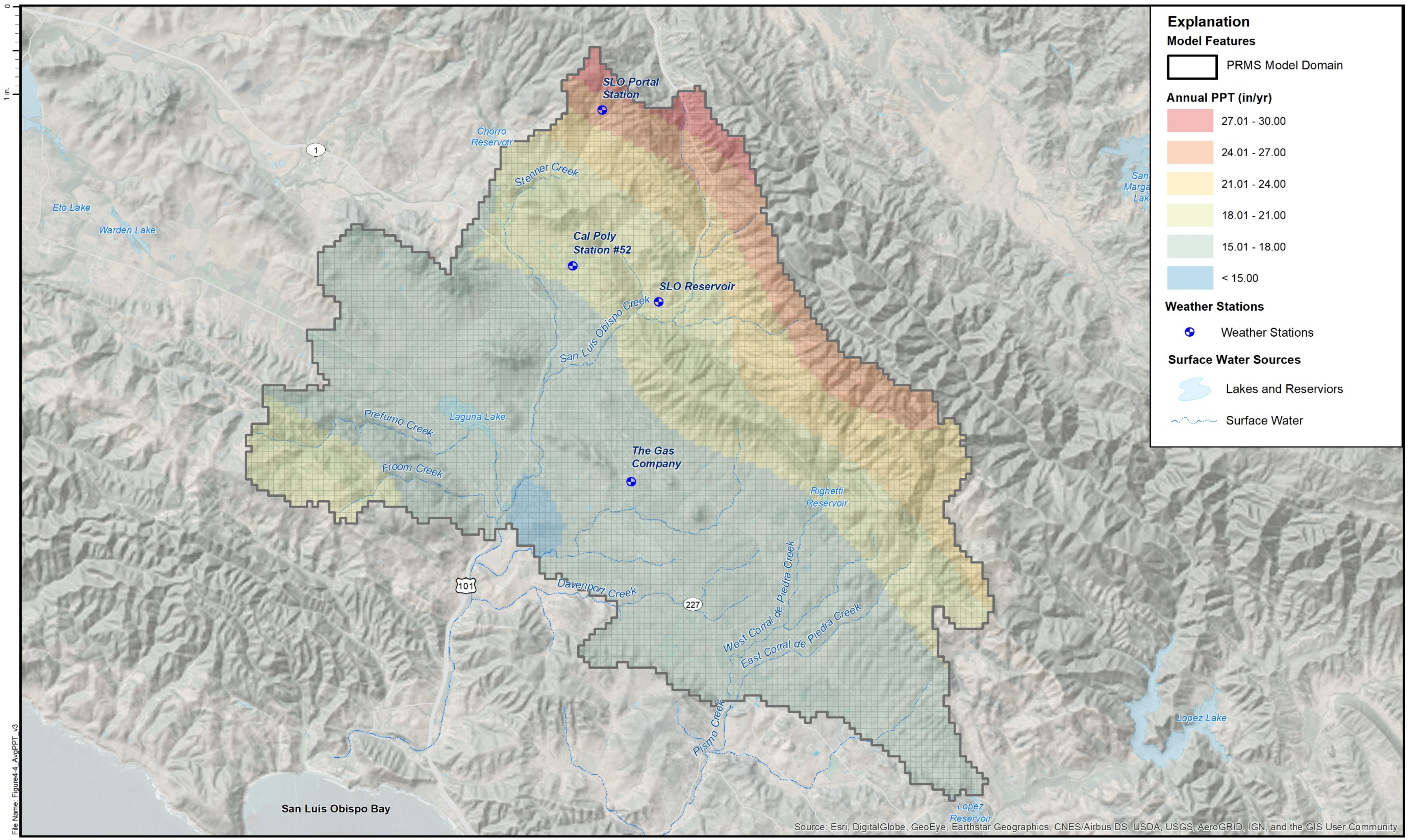
Model Stream Segments and Sub-basins

Figure 4-3



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COUNTY OF SAN LUIS OBISPO

Author: EC
Date: 12/18/2019

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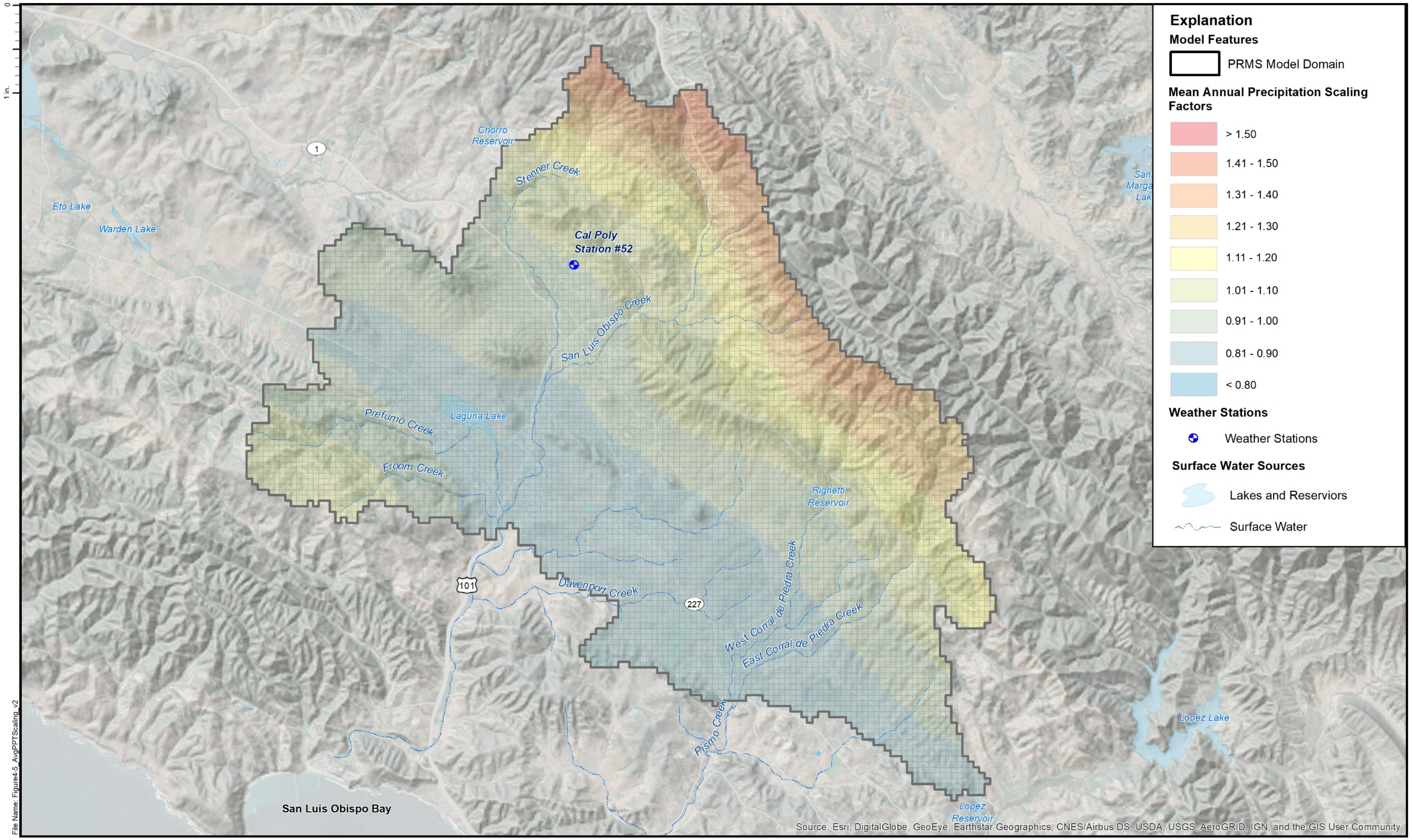
Mean Annual (1980 - 2010) PRISM Precipitation

Figure 4-4



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Author: EC
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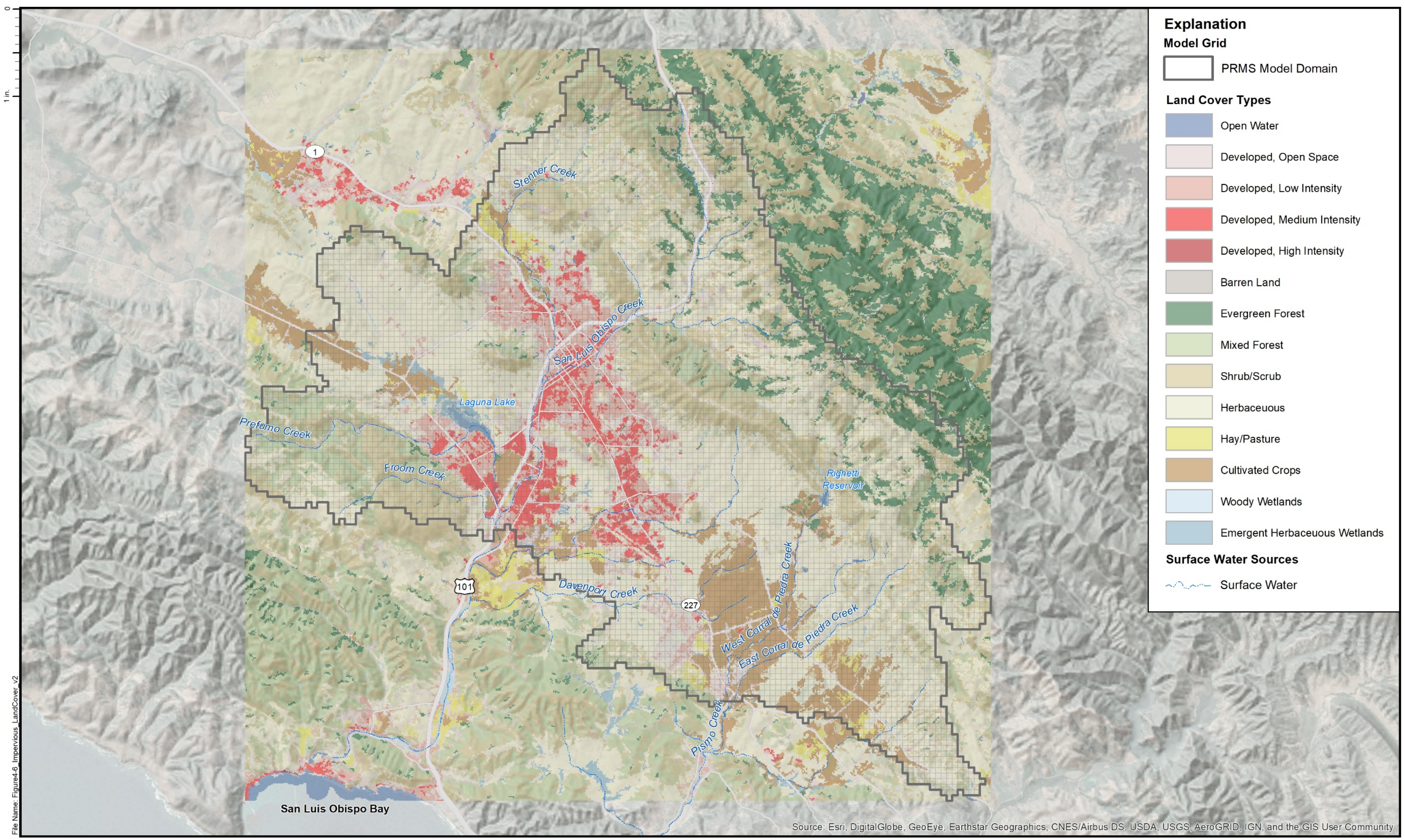
Mean Annual Precipitation Scaling Factors

Figure 4-5



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Author: EC
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Land Cover Types

Figure 4-6

Section 5. MODFLOW: Groundwater Flow Model

MODFLOW is a publicly available groundwater modeling code developed by the USGS. It is the most used groundwater modeling code in the world and is considered an industry standard. MODFLOW-NWT is the most recent version of MODFLOW that is compatible with GSFLOW; this is the version of MODFLOW that is being implemented. This section of the TM summarizes the modeling approach for the MODFLOW portion of the GSFLOW model.

5.1. Model Discretization

Model grid discretization for the areas represented by both PRMS and MODFLOW were discussed in the previous discussion of PRMS model approach. A uniform grid cell size of 500 feet by 500 feet was adopted for model development.

Vertical discretization of the model (i.e., model layering) will be implemented based on the dominant geologic formations in the Basin (Figure 5-1). One layer each will be assigned to the Recent Alluvium, Paso Robles Formation, and Pismo Formation. In addition, because there are wells identified within the Basin that draw from both the Basin sediments and the underlying Monterey Formation bedrock, a fourth model layer will be added to represent undifferentiated bedrock (i.e., both Franciscan and Monterey Formation represented with a single layer) beneath the Basin, and extending up to the watershed boundaries.

5.1.1. Lateral Boundaries

Groundwater elevations at the northwest extent of the Basin where it bounds with the Los Osos Valley Basin, and at the southeast extent of the Basin where it bounds with the Arroyo Grande sub-basin, are assumed to be coincident with divides in the groundwater surface between the adjacent basins. These lateral boundaries of the Basin will be represented with Constant Head Boundaries (CHBs) with elevations assigned using the most accurate estimate of groundwater elevations in these areas that can be developed from available data.

5.1.2. Mountain Front Recharge

Groundwater elevations in the bedrock formations of the mountains surrounding the Basin are higher than the groundwater elevations within the Basin. Since groundwater flows from areas of higher head to areas with lower head, it is assumed that some amount of inflow to the Basin sediments occurs through the mechanism of mountain front recharge. Subsurface inflow to the Basin through mountain front recharge will be estimated as part of CHG's water budget analysis. It is not expected that this will comprise a significant portion of the Basin water budget. The estimates that will be generated for this component of inflow to the Basin will be represented using General Head Boundaries (GHBs) along the lateral boundaries of the Basin.

5.1.3. Recharge

In a traditional MODFLOW model, various components of recharge to the aquifer such as infiltration of precipitation, irrigation and municipal return flow, etc., are estimated and implemented into the model via the MODFLOW Recharge Package. With the integrated modeling approach provided by GSFLOW, these components of recharge are explicitly simulated using the physically-based processes simulated in PRMS, and the results are transmitted for use by MODFLOW in the groundwater flow simulations. Initial estimates of these recharge components will be made based on water budget analysis and calibration of the MODFLOW model to observed historical water levels. Refinement and revision of these estimates will occur during the combined calibration process using both PRMS and MODFLOW.

5.1.4. Infiltration of Streamflow

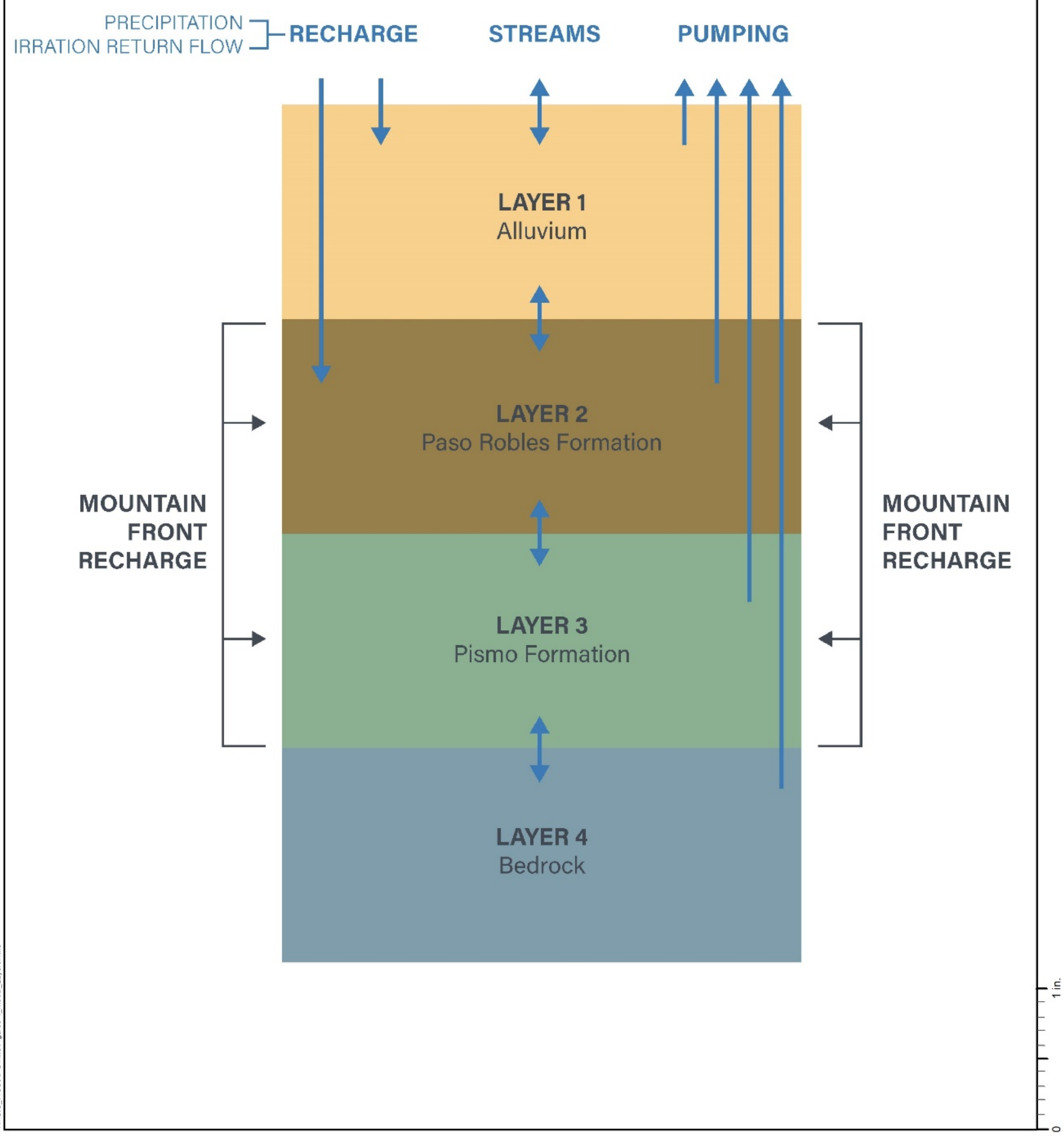
As discussed previously, seasonal infiltration of streamflow to the underlying aquifers is a significant component of the Basin water budget. Streamflow processes within the Basin will be represented using the Streamflow Routing packages available in MODFLOW (SFR and SFR2). Estimates of streamflow infiltration into the underlying aquifers in the Basin provided by the CHG water budget analysis and by previous studies will be used as general guides during historical calibration. Parameters of the SFR package will be adjusted until the quantities of flux between the streams and the aquifers are consistent with the available data.

5.1.5. Well Pumpage

CHG estimates of historical well pumpage developed for the water budget analysis will be incorporated into the historical calibration of the groundwater model. Municipal pumpage by the City will be represented in the specific wells owned and operated by the City. For representation of agricultural pumpage in MODFLOW, there is often not adequate information on well location or pumpage amounts to attempt to explicitly represent pumpage from individual wells. A common approach is to spread estimated agricultural pumping amounts over the entire area of irrigated fields. GSI anticipates that given the amount of data available on well locations in the irrigated areas of the Basin and estimates of historical agricultural pumpage generated by CHG's water budget analysis, it may be feasible to apply irrigation pumpage to specific wells located within the irrigated field areas. Pumpage from de minimis well owners will be estimated based on County data and spread across the areas where the wells are located; no effort to identify specific de minimis wells will be made.

5.2. Calibration Approach

As discussed previously, PRMS and MODFLOW may be run separately during the early stages of model development. It is anticipated that GSI will conduct initial parameter estimation using a long-term historical simulation in MODFLOW-only mode, prior to and separate from the PRMS initial calibration. Because PRMS must be run using daily time steps, it is not necessarily the most efficient tool to perform a long-term simulation to generate initial parameter estimates. Evaluation of the hydrographs in Figure 2-7 indicate that water levels were in approximate equilibrium prior to 1980. The drought of the late 1980s and early 1990s is clear in the hydrographs of some of these wells. In addition, water level declines in Edna Valley wells beginning in the 1990s is evident. In order to capture these significant trends in water levels over the years, the initial parameter estimation of the MODFLOW model will be performed to simulate the 40-year period from 1980 to 2019 using quarterly or monthly stress periods, before the MODFLOW and PRMS models are combined for the integrated model. Annual values provided by the CHG water budget analysis will be used to guide model inputs for such model parameters as pumping and recharge. Aquifer hydraulic properties such as transmissivity and storativity will be varied within ranges indicated by available data (GSI 2018). After the initial parameter estimates of the groundwater flow model are complete, the MODFLOW model will be combined with the PRMS model to perform a joint calibration in which the points of contact between the surface water model and the groundwater flow model are adjusted over the calibration period. All the hydrographs displayed in Figure 2-7 will be used as calibration targets for the MODFLOW model. A commonly referenced metric for groundwater model calibration is to achieve a scaled root mean square error less than 10% for water level calibration targets. GSI and WSC will attempt to meet this calibration standard for modeled groundwater elevations.



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Date: 10/15/2019

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Model Layering and Hydrologic Conceptual Model

Figure 5-1

Section 6. Summary and Next Steps

This TM has presented the data summary, HCM, and anticipated modeling approach for the development of an integrated surface water-groundwater model of the SLO Basin and its contributing watersheds. After approval by the GSA staff, the next step is to perform calibration of the model, discussed in Section 5.2. After separate initial runs of PRMS and MODFLOW are completed, the two models will be joined in GSFLOW, and a combined calibration will be implemented in which parameters of both models will be adjusted to achieve a good fit between observed and modeled water levels, stream flow, and other water budget components.

After calibration of the integrated model is completed, a sensitivity analysis will be performed. The purpose of a sensitivity analysis to identify parameters or boundary conditions to which model forecasts are particularly sensitive. Sensitivity analysis provides a measure of the influence of parameter uncertainty on model predictions. During the sensitivity analysis, key model input parameters and boundaries (such as pumping, recharge, transmissivity, etc.) are systematically varied on the calibrated model simulation, and the resulting impact on the modeled heads are quantified. Calibration and sensitivity analyses will be documented in a separate Technical Memo.

After the completion of the sensitivity analysis, if the model is judged to be adequate for the purposes of the GSP, it will be used to run predictive scenarios simulating projects and management actions to be specified by the GSAs. When the predictive scenarios are complete, an uncertainty analysis will be performed. The purpose of the uncertainty analysis is to identify the impact of parameter uncertainty on the use of the model's ability to effectively support management decisions. This can inform the interpretation of the model results to identify high priority locations for recharge projects, expansion of monitoring networks, and other management actions. The uncertainty analysis is like the sensitivity analysis in that key model parameters are systematically varied and resultant impacts on modeled heads are quantified. However, the uncertainty analysis is performed on the predictive scenario runs rather than the calibration simulation.

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Date:	7/19/2021	
To:	Dick Tzou, PE Water Resources Engineer County of San Luis Obispo Mychal Boerman Deputy Director of Utilities Department City of San Luis Obispo	**Phone:** (805) 781-4473
CC:	Mladen Bandov, PE	
Prepared by:	Erik Cadaret, PG; Dave O'Rourke, PG, CHG, PE; Ailco Wolf, PG, CHG	
Reviewed by:	Michael Cruikshank, PG, CHG	
Project:	SLO Basin Groundwater Sustainability Plan	
Subject:	**Draft** Surface Water/Groundwater Modeling Calibration Technical Memorandum (Modeling TM No.2)	

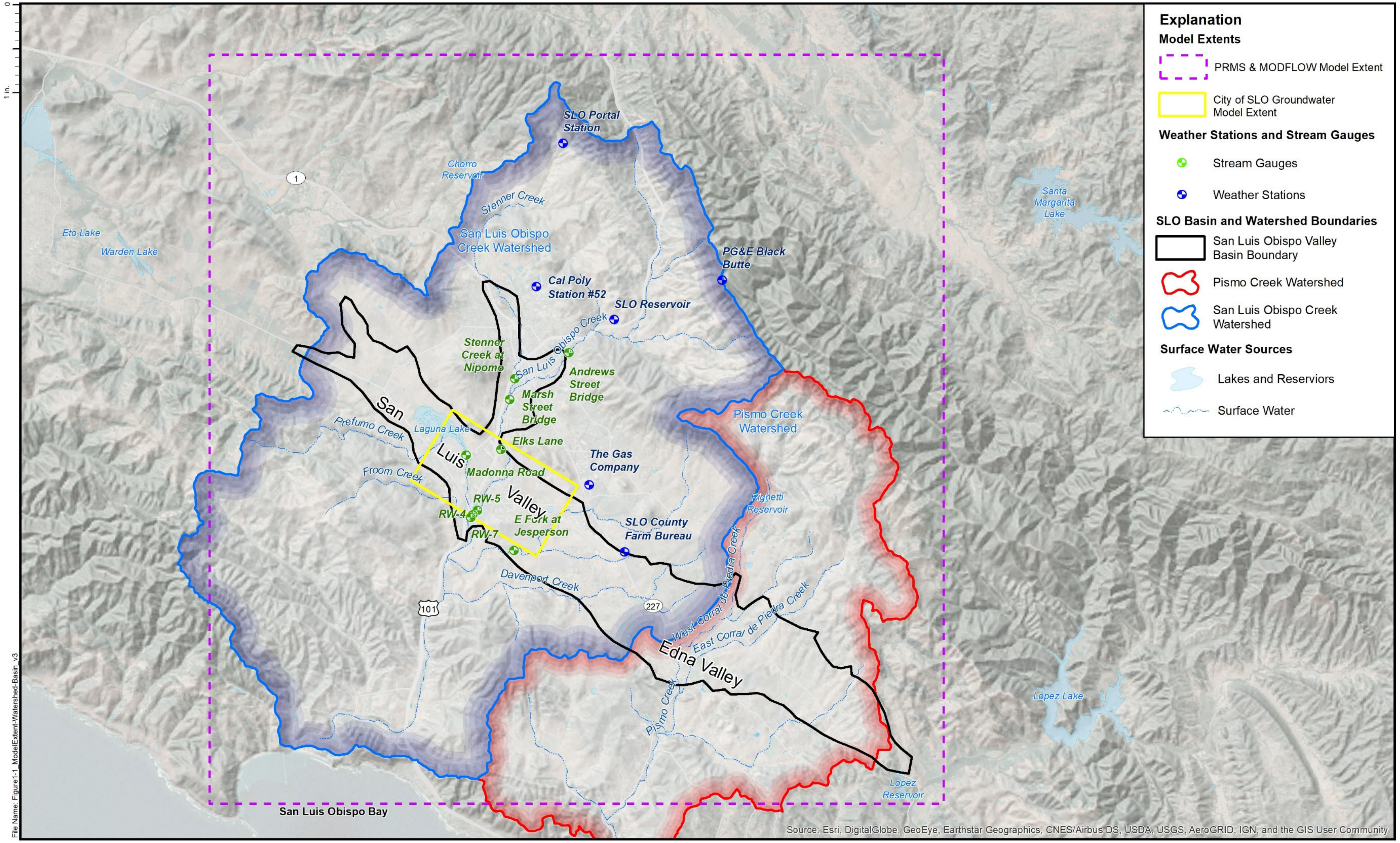
Section 1. Introduction

This draft Technical Memo (TM No.2) is prepared by Water Systems Consulting, Inc. (WSC) and GSI Water Solutions, Inc. (GSI), for the San Luis Obispo (SLO) County Groundwater Sustainability Agency (GSA) and the City of SLO GSA. As part of the Groundwater Sustainability Plan (GSP) for the SLO Valley Groundwater Basin (Basin), the consultant team is developing an integrated surface water-groundwater numerical model for the objective of evaluating the potential impacts of proposed projects and management actions associated with the GSP. The objective of this TM is to document the modeling calibration associated with the construction of the integrated numerical model of the Basin.

The Basin covers approximately 20 square miles in central San Luis Obispo County (County). The Basin extents are defined as the contact of water-bearing sediments with the non-water-bearing Formations of the Santa Lucia Range to the northeast, and the San Luis Range and the Edna Fault Zone to the southwest. Annual average precipitation in the Basin is approximately 18 to 22 inches (GSI Water Solutions, Inc., 2018). The Basin is commonly divided into two sub-areas: the San Luis Valley and the Edna Valley. The San Luis Valley occupies approximately the northwestern half of the Basin; it includes the City of San Luis Obispo (City), and the primary land uses are municipal and industrial. Most water supply in the San Luis Valley is from both in-basin groundwater sources and imported surface water sources (Whale Rock Reservoir, Salinas Reservoir, and Nacimiento Reservoir). The Edna Valley occupies the southeastern half of the Basin. The primary land use is agriculture, with wine grapes as the dominant crop type. Groundwater is the major source of water supply in the Edna Valley.

To date, a watershed scale groundwater or integrated surface water-groundwater model has not been published for the entire Basin. In 1997, the California Department of Water Resources (DWR) performed initial work on a basin groundwater model, but the model was never published. A groundwater model was developed within a portion of the Basin that encompasses the San Luis Valley (the City of SLO model) (Cleath-Harris Geologists, 2018) and a surface water hydraulic model has been developed for the San Luis Obispo Creek watershed (Questa Engineering Corp., 2007). Figure 1-1 shows the watershed and Basin boundaries, and the integrated model grid.

GSI developed a TM to evaluate multiple integrated surface water-groundwater modeling systems and identified the best modeling system to achieve compliance and project objectives for the SLO GSP (GSI Water Solutions, Inc., 2019). GSFLOW, a fully integrated hydrologic model (IHM) developed by the United States Geological Survey (USGS) (Markstrom, Niswonger, Regan, Prudic, & Barlow, 2008), was recommended to the GSP Groundwater Sustainability Commission (GSC) to be selected as the model system to be used for the GSP. In this TM, we will present the calibration process and results for the surface water model (PRMS) and groundwater model component (MODFLOW) that were completed separately before being coupled in the GSFLOW integrated model. Preliminary calibration and results from the GSFLOW calibration are also discussed. This TM will conclude with next steps to be completed that includes GSFLOW sensitivity analysis describing the most sensitive parameters that influence results of the GSFLOW model and if any data is needed to be improved upon and model validation runs will be completed at the end of 2025 as part of the 5-year GSP update.



Prepared for:

SAN LUIS OBISPO VALLEY BASIN GSP

Author: EC
Date: 2/18/2020

N

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References:
1. Coordinate System: NAD 1983 StatePlane California V FIPS 0405 Feet
Projection: Lambert Conformal Conic
Datum: North American 1983
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Notes:
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Model Extents, Watershed, and Basin Overview

Figure 1-1

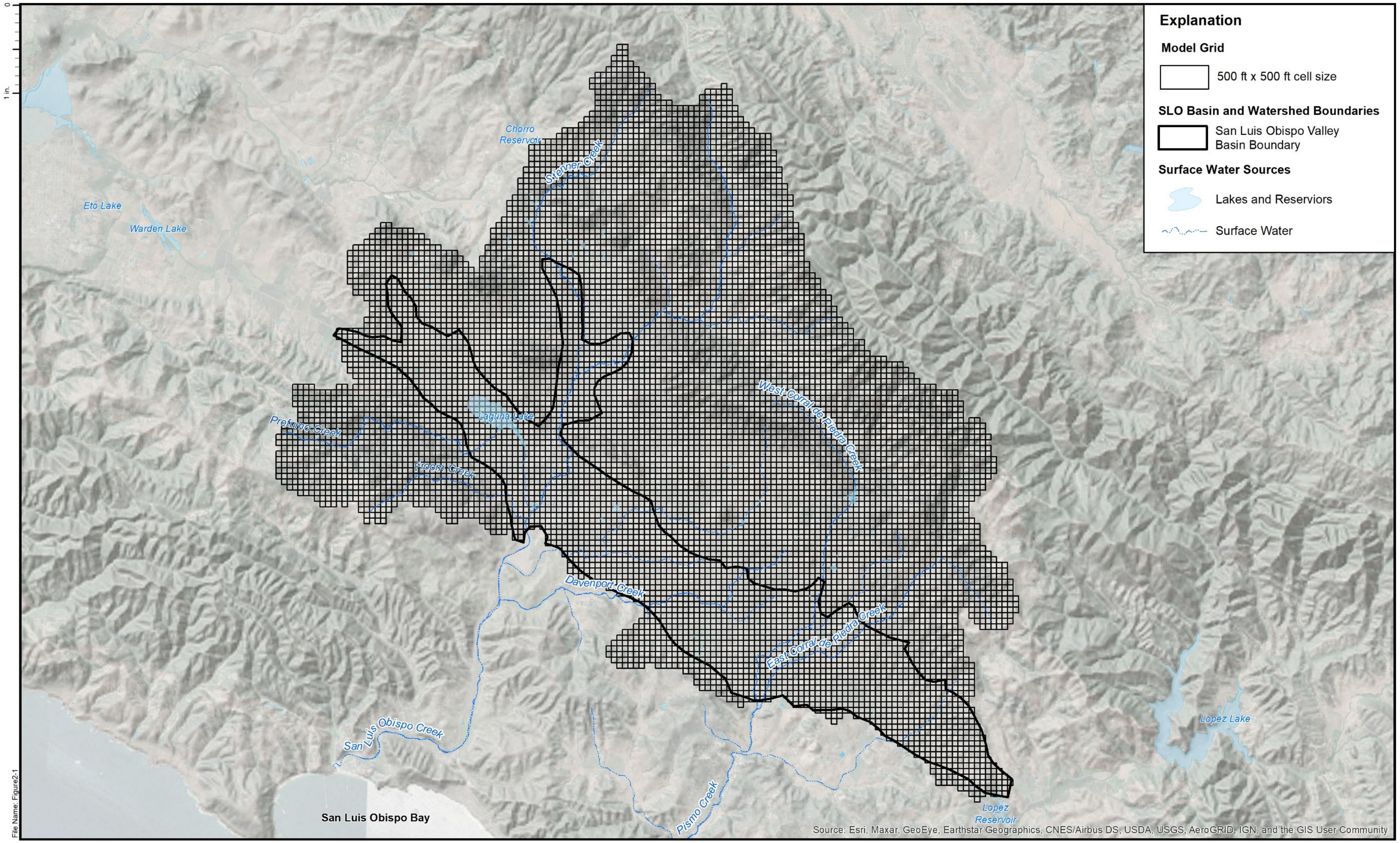
Section 2. Surface Water Model Development

The Basin surface water model was developed using the Precipitation-Runoff Modeling System (PRMS) version 5.0.0 which simulates the watershed-scale surface water component of the GSFLOW integrated model. PRMS is a deterministic, distributed-parameter, physical-process hydrologic model used to simulate and evaluate the watershed response of various combinations of climate and land use (Markstrom, et al., PRMS-IV, the Precipitation-Runoff Modeling System, Version 4, 2015).

In the PRMS model, climate data, including precipitation, temperature, and solar radiation, are applied to simulate hydrologic water budgets based on spatially defined watershed-component model parameters such as plant canopy and soil zone properties. Surface and subsurface flow is calculated through the cascading of rain-generated runoff. When run in PRMS-only mode, runoff that infiltrates into the soil zone is distributed to the subsurface reservoir and groundwater reservoir where it can interflow to streams or lakes. When run in a coupled GSFLOW simulation, groundwater flow routing is simulated in MODFLOW rather than PRMS. Initial parameter estimation of the PRMS model was performed in PRMS-only mode prior to integration into GSFLOW and final calibration of the integrated model for water year (WY) 1985 - 2019. The calibration period for the surface water model was WY 2006 – 2019 based on the available surface water data sets.

2.1. Model Grid

The surface water model was developed to cover the entire Basin watershed. The model grid cell was determined by evaluating various grid cell sizes ranging from 250-ft to 1,000-ft. The ratios of cell size to watershed size were assessed in comparison to other GSFLOW models, including the Santa Rosa Plain Model (Woolfenden & Nishikawa, 2014) and the Santa Cruz Mid-County Basin Model prepared by HydroMetrics Water Resources, Inc. (Huntington, King, & Tana, 2016). It was determined that 500-ft by 500-ft model grid would be an appropriate grid cell size to discretize the model over the watershed area (Figure 2-1).



Prepared for:

SAN LUIS OBISPO VALLEY BASIN GSP

Author: EC
Date: 1/5/2021

References:
1. Coordinate System: NAD 1983 StatePlane California V FIPS 0405 Feet
Projection: Lambert Conformal Conic
Datum: North American 1983
2.
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San Luis Obispo Valley Basin Model Grid

Figure 2-1

2.2. Datasets and Sources

The data used in the surface water model to develop and calibrate PRMS are described in the following sections.

2.2.1. Climate Data

The climate data sources within the Basin include two weather stations, Cal Poly #52 and SLO Reservoir[1](shown in Figure 1-1) and Parameter-Regression on Independent Slopes Model (PRISM) data (Table 2-1) were used in the surface water model calibration.

Table 2-1: Climate data used for surface water model.

Climate Data Source	Date Range	Precipitation (in)[A]	Date Range	Temperature (F)[B]	Date Range	Evapotranspiration (in)[C]	Date Range	Solar Radiation (Ly/day)[C]
Cal Poly #52*	1870 - 2019	YES	1906 - 2019	YES	1986 - 2019	YES	1986 - 2019	YES
SLO Reservoir	2005 - 2019	YES	-	-	-	-	-	-
PRISM	1981 - 2010	YES	1981 – 2010	YES	-	-	-	-

* - Weather station contains sensors from ITRC, CIMIS, and NOAA

A - Daily precipitation record starts 2/1/1893
B - Daily temperature record starts 4/1/1906
C - Daily evaporation and solar radiation record starts 4/2/1986

PRISM data spatially distributes precipitation and temperature to account for orographic effects due to elevation change. The 800m mean monthly precipitation and minimum and maximum temperature values from 1981 to 2010 from the Parameter-Regression on Independent Slopes Model (PRISM) (NACSE, 2019) were used in the surface water model. Monthly precipitation scaling factors and daily minimum and maximum temperature were calculated at each HRU using GSFLOW-ArcPy scripts developed by Gardner

[1] The Irrigation Training & Research Center (ITRC) noted in a technical memorandum dated April 22nd, 2014 that the data recorded between 2006 – 2010 was not correct due to maintenance issues and corrections are recommended using the SLO Reservoir weather station precipitation values. Precipitation and temperature data records were corrected by the consultant using their professional judgement according to this recommendation by the ITRC to produce a consistent measures climate dataset for use in the surface water model.

et al., 2018. The precip_1sta and temp_sta modules were used to perform precipitation and temperature calculations as described above.

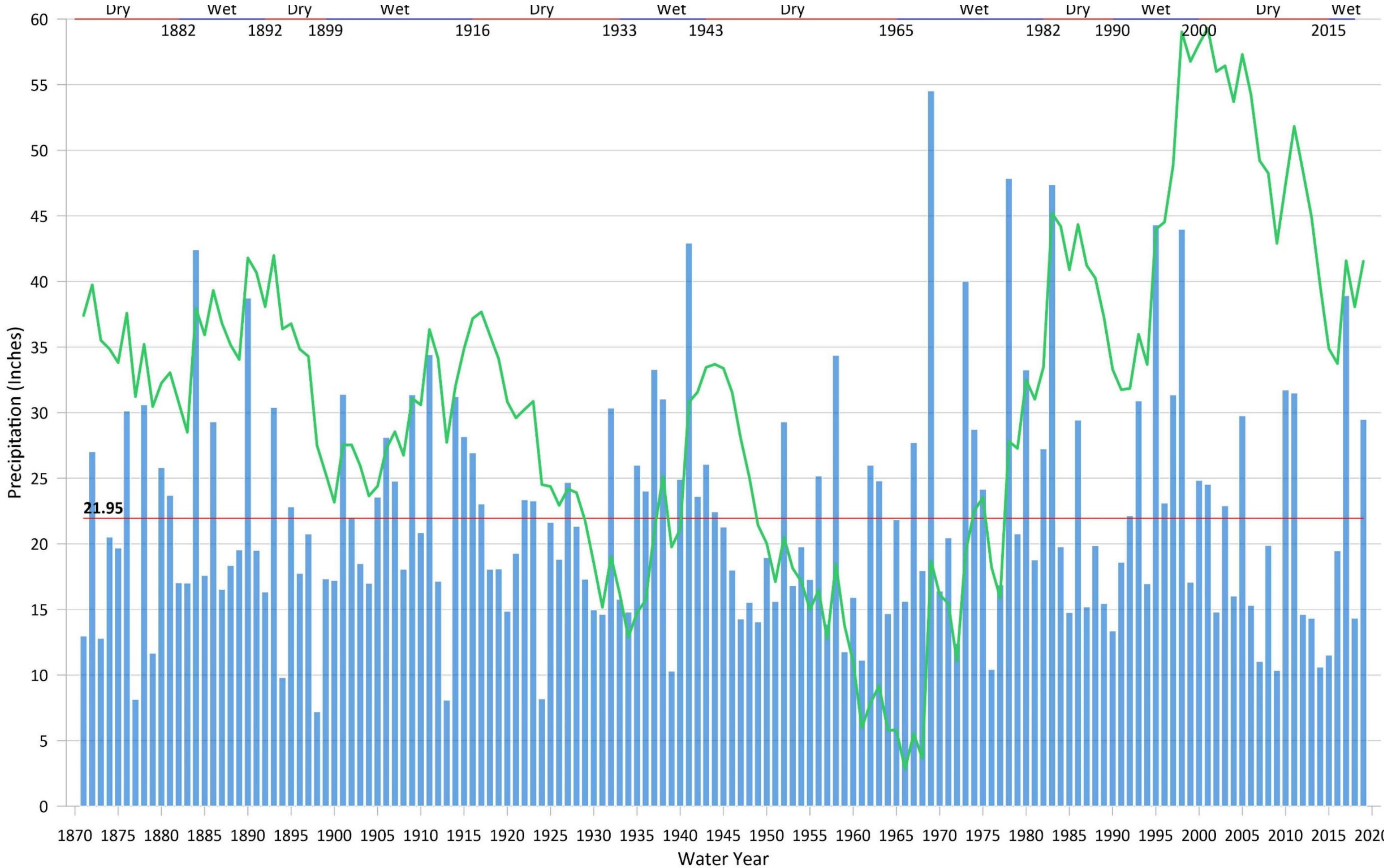
Figure 2-2 shows the measured Cal Poly #52 precipitation data from1870 to 2018 as well the approximated wet-dry years as interpreted from the calculated cumulative departure from the mean (CDFM) line.

2.2.2. Potential Evapotranspiration Data

Potential evapotranspiration (PET) for natural vegetation and irrigated crops was computed by the PRMS model based on air temperature, solar radiation, and two Jensen-Haise formula coefficients using the Jensen-Haise method (Jensen and Haise, 1963). Annual PET data for reference crops are available from CIMIS and specific evapotranspiration data for different crop types within the Basin are available from DWR. The actual evapotranspiration was calculated in the model from the PET data while also considering land use, vegetation type, soil type, and available soil moisture.

2.2.3. Topography

A 10-m USGS digital elevation model (DEM) was used to determine the slopes, connectivity, and elevations within the watershed area. The DEM was processed using the GSFLOW-ArcPy scripts (Gardner et al., 2018) that utilize the USGS Cascade Routing Tool (Henson et al., 2013) to define the cascading surfaces and subsurface flow paths for the grid-based domain. As part of the CRT calculation, unintentional swales (low-lying areas) are smoothed to provide continuous down-sloping HRUs. After these calculations have been completed, we found not all unintentional swales were adequately smoothed and, in these areas, manual modifications were made to provide continuous down-sloping HRUs. Figure 2-3 presents the 10-m DEM used for the surface water model.



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Author: EC

01/18/2021

SAN LUIS OBISPO VALLEY BASIN GSP

Legend

Precipitation (Annual)

CDFM

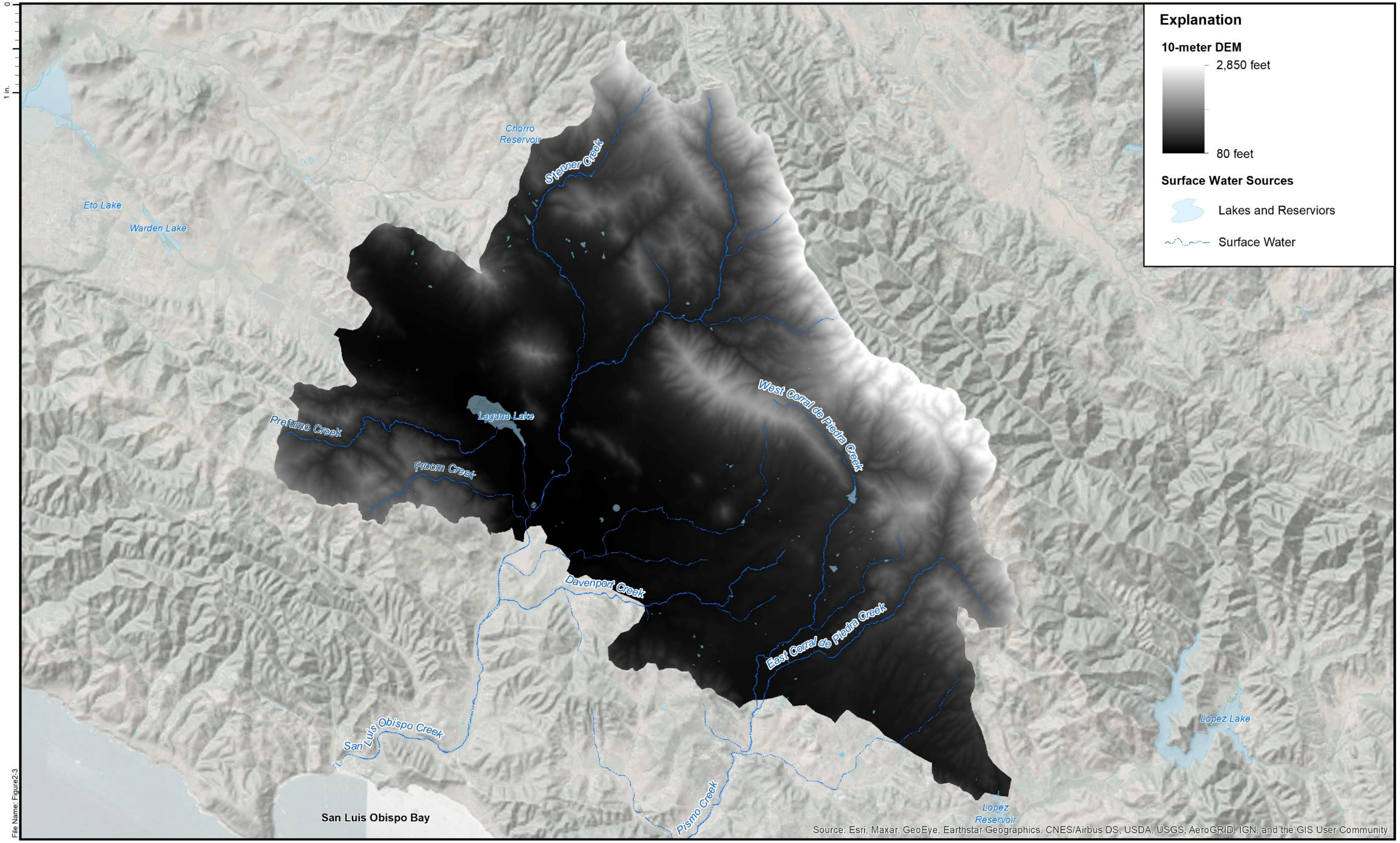
Historical Average Precipitation

Notes:

1. Data Source: Cal Poly State University, Cal Poly/NOAA Station

San Luis Obispo Historical Annual Precipitation and CDFM

Figure 2-2



Prepared for:

Author: EC
Date: 1/18/2021

SAN LUIS OBISPO VALLEY BASIN GSP

1 in : 1.5 mi
0 0.5 1 2 Mi
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References:
1. Coordinate System: NAD 1983 StatePlane California V FIPS 0405 Feet
Projection: Lambert Conformal Conic
Datum: North American 1983
2.
3.

Notes:
1. 10-meter DEM obtained from USGS Seamless Dataset
2.
3.

San Luis Obispo Valley Basin Watershed 10-meter Digital Elevation Model (DEM)

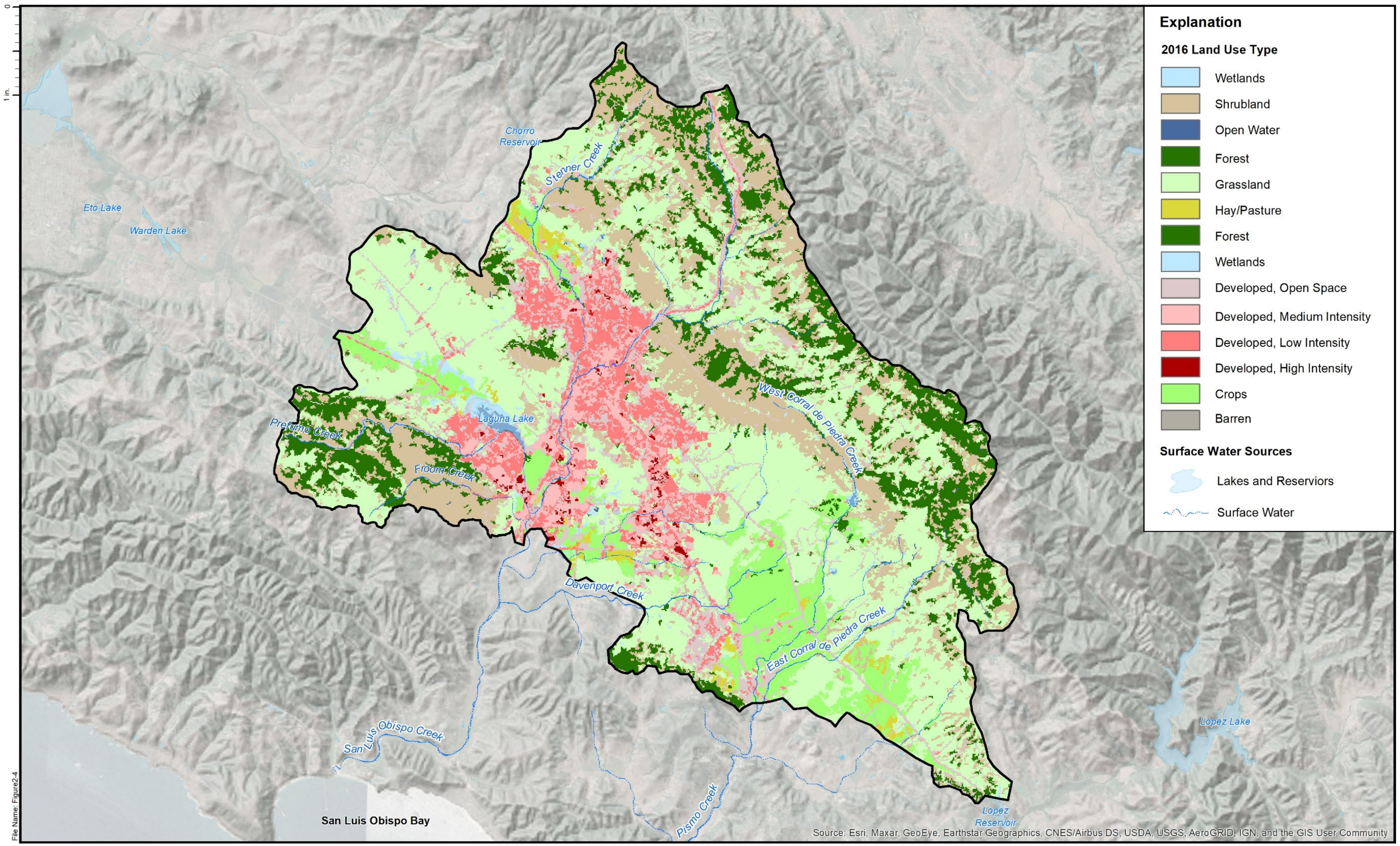
Figure 2-3

2.2.4. Land Use

Soil attributes based on the National Resources Conservation Service (NRCS) soil survey data (SSURGO and STATSGO) are assigned to HRUs and are used by various soil parameters in PRMS to model flux's between vegetation and the soil-root zone. SSURGO data didn't fully extend across the entire watershed and STATSGO data was used in the northeast portion of the watershed in the Santa Lucia Mountains to provide full soil data coverage.

Land use was fixed in the PRMS baseline model to provide a starting point for comparison for future model scenarios. The National Land Cover Dataset (Homer, Fry, & Barnes, 2012) is a grid-based representation of land uses in the watershed and was used as a base land use layer. DWR spatial crop data from 2014 and U.S. Forest Service (USFS) Landfire dataset were used in conjunction with the NLCD dataset to provide a more detailed characterization of land cover and use. The land cover percentages are assigned to each HRU and is used to model flux's between vegetation and the soil root-zone and in the case of impervious land cover areas, no infiltration that would lead to surface runoff. Figure 2-4 through 2-7 presents the NLCD land use, DWR crop, and Landfire vegetation datasets used for the surface water model.

Imperviousness of each grid was determined from the NLCD 2016 dataset (Figure 2-8). Visual comparisons between NLCD 2001 and NLCD 2016 data indicate minimal changes in the watershed. The average imperviousness of the watershed in 2001 was 31.6% and shifted slightly to 34% in 2016. Imperviousness as a percentage of the total watershed area in 2001 was 16.4% and shifted slightly to 17.1% in 2016. As such, use of the 2016 data was determined to be representative of the modeling period.



Prepared for:

SAN LUIS OBISPO VALLEY BASIN GSP

Author: EC
Date: 1/18/2021

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References:
1. Coordinate System: NAD 1983 StatePlane California V FIPS 0405 Feet
Projection: Lambert Conformal Conic
Datum: North American 1983
2.
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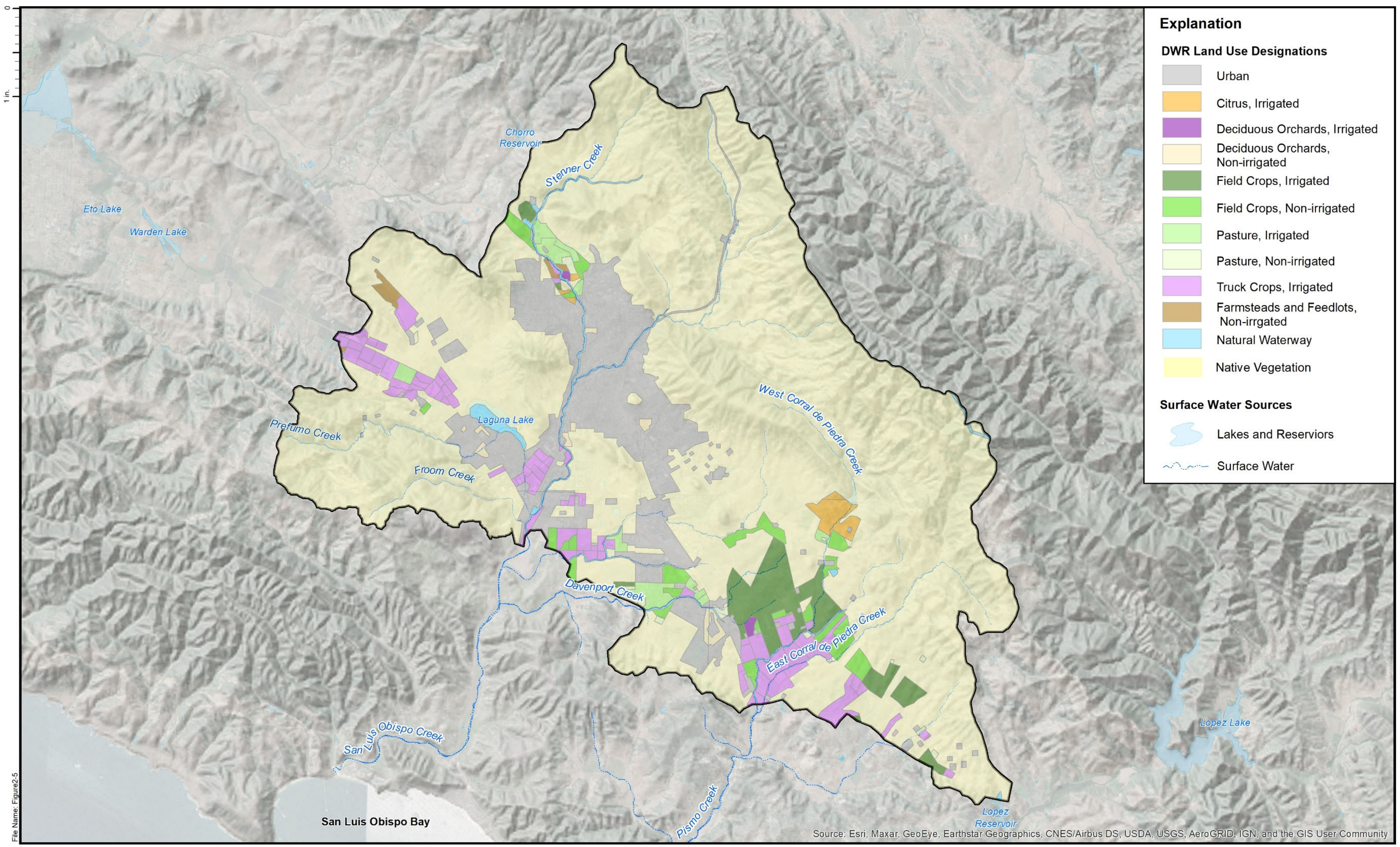
Notes:
1. Land use data obtained from USGS NLCD
2.
3.

San Luis Obispo Valley Basin Watershed National Land Cover Dataset 2016 Land Use

Figure 2-4



Prepared for:

Author: EC
Date: 1/18/2021

SAN LUIS OBISPO VALLEY BASIN GSP

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References:
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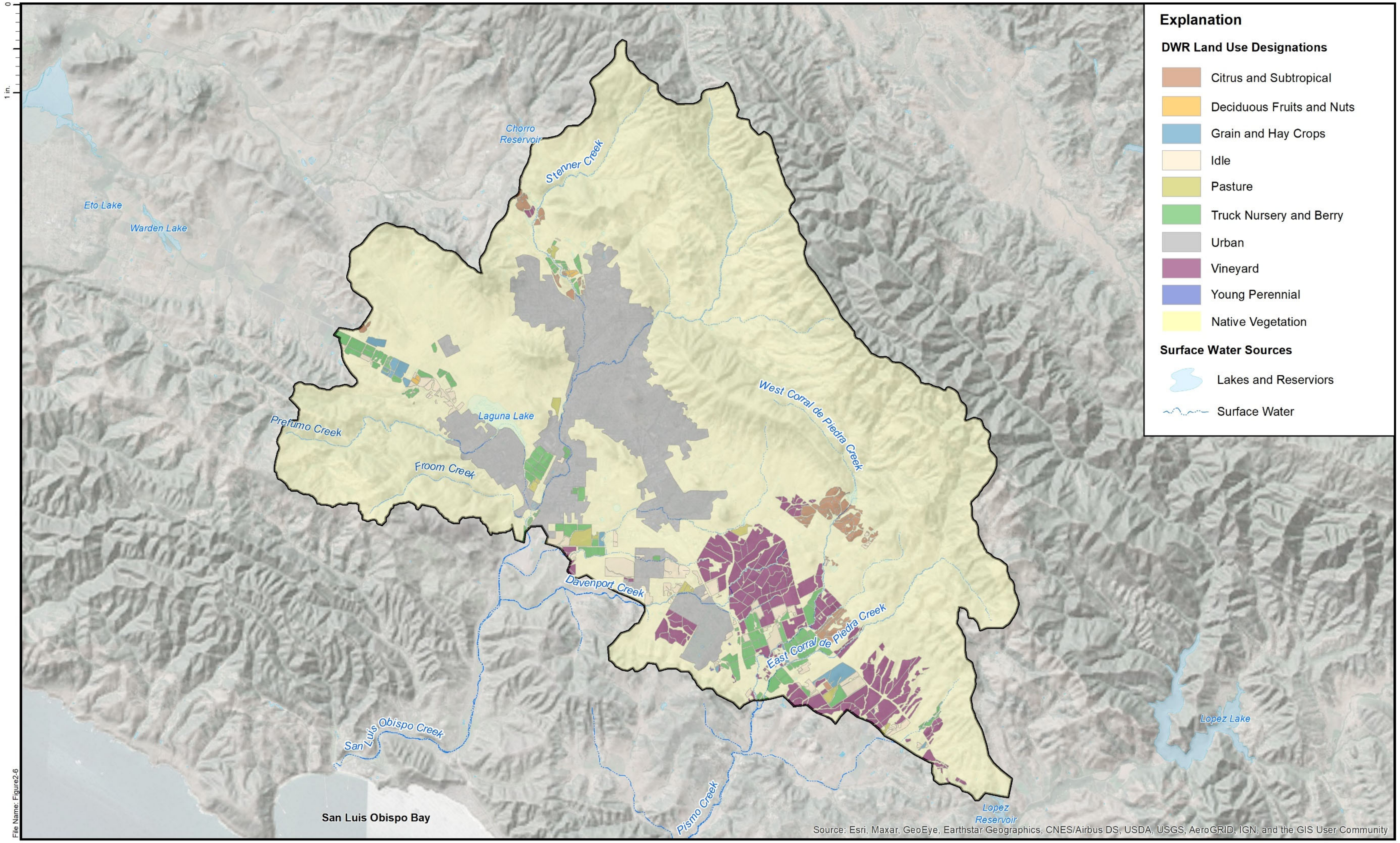
Projection: Lambert Conformal Conic
Datum: North American 1983
2.
3.

Notes:
1. Land use data obtained from California DWR Land Use Viewer
2.
3.

San Luis Obispo Valley Basin Watershed
Deparment of Water Resources Land Use 1996

Figure 2-5



Prepared for:

Author: EC
Date: 1/18/2021

SAN LUIS OBISPO VALLEY BASIN GSP

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References:
1. Coordinate System: NAD 1983 StatePlane California V FIPS 0405 Feet
Projection: Lambert Conformal Conic
Datum: North American 1983
2.
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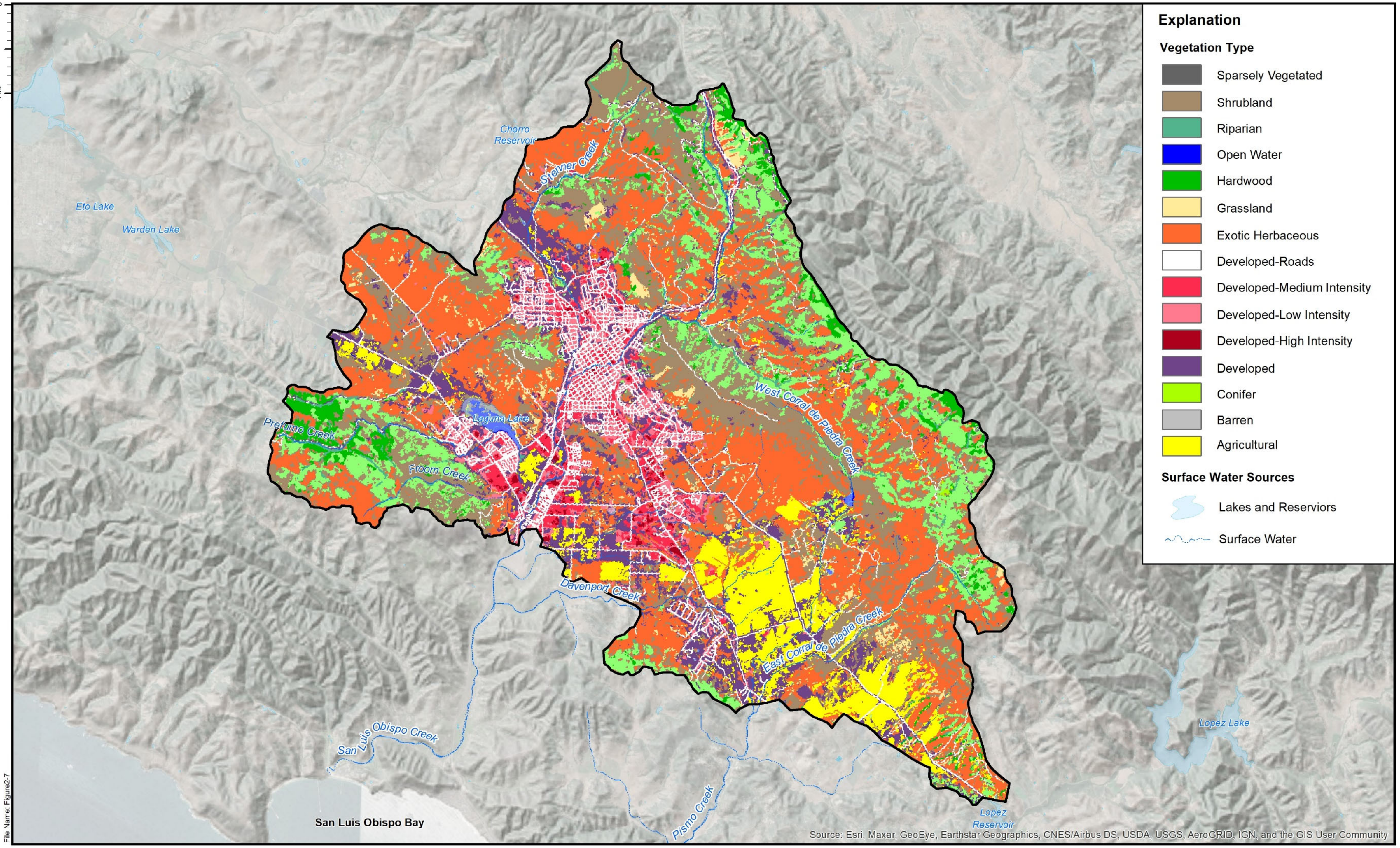
Notes:
1. Land use data obtained from California DWR Land Use Viewer
2.
3.

San Luis Obispo Valley Basin Watershed
Deparment of Water Resources Crop Survey 2014

Figure 2-6



Prepared for:

Author: EC
Date: 1/18/2021

SAN LUIS OBISPO VALLEY BASIN GSP

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0 0.75 1.5 3 Km

References:

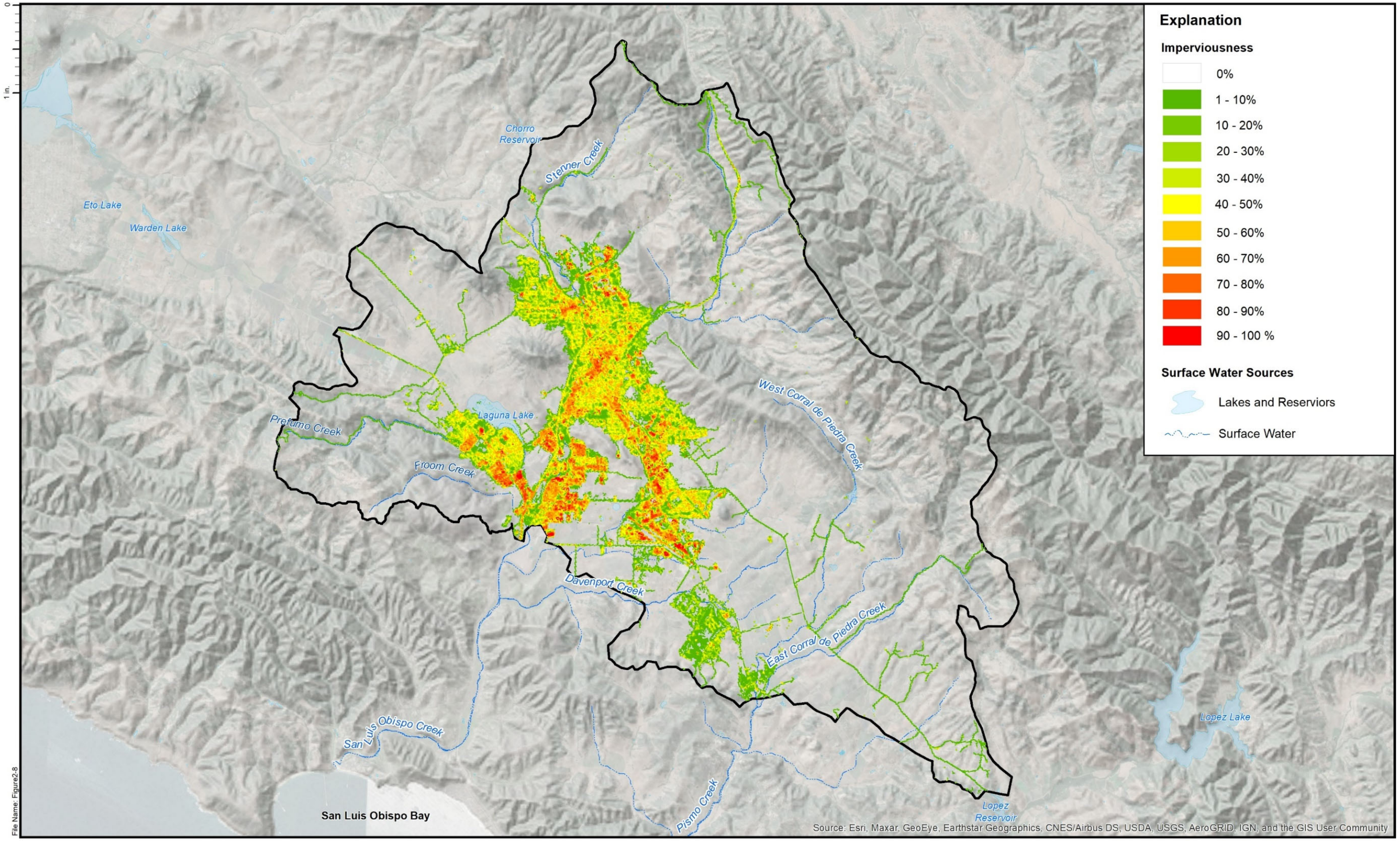
1. Coordinate System: NAD 1983 StatePlane California V FIPS 0405 Feet
Projection: Lambert Conformal Conic
Datum: North American 1983
2.
3.

Notes:

1. Vegetation type data retrieved from 2016 USFS LANDFIRE dataset
2.
3.

San Luis Obispo Valley Basin U.S. Forest Service 2016 LANDFIRE

Figure 2-7



Prepared for:

SAN LUIS OBISPO VALLEY BASIN GSP

Author: EC
Date: 1/18/2021

1 in : 1.5 mi

References:
1. Coordinate System: NAD 1983 StatePlane California V FIPS 0405 Feet
Projection: Lambert Conformal Conic
Datum: North American 1983
2.
3.

Notes:
1. Imperviousness data obtained from USGS NLCD
2.
3.

San Luis Obispo Valley Basin National Land Cover Dataset 2016 Imperviousness

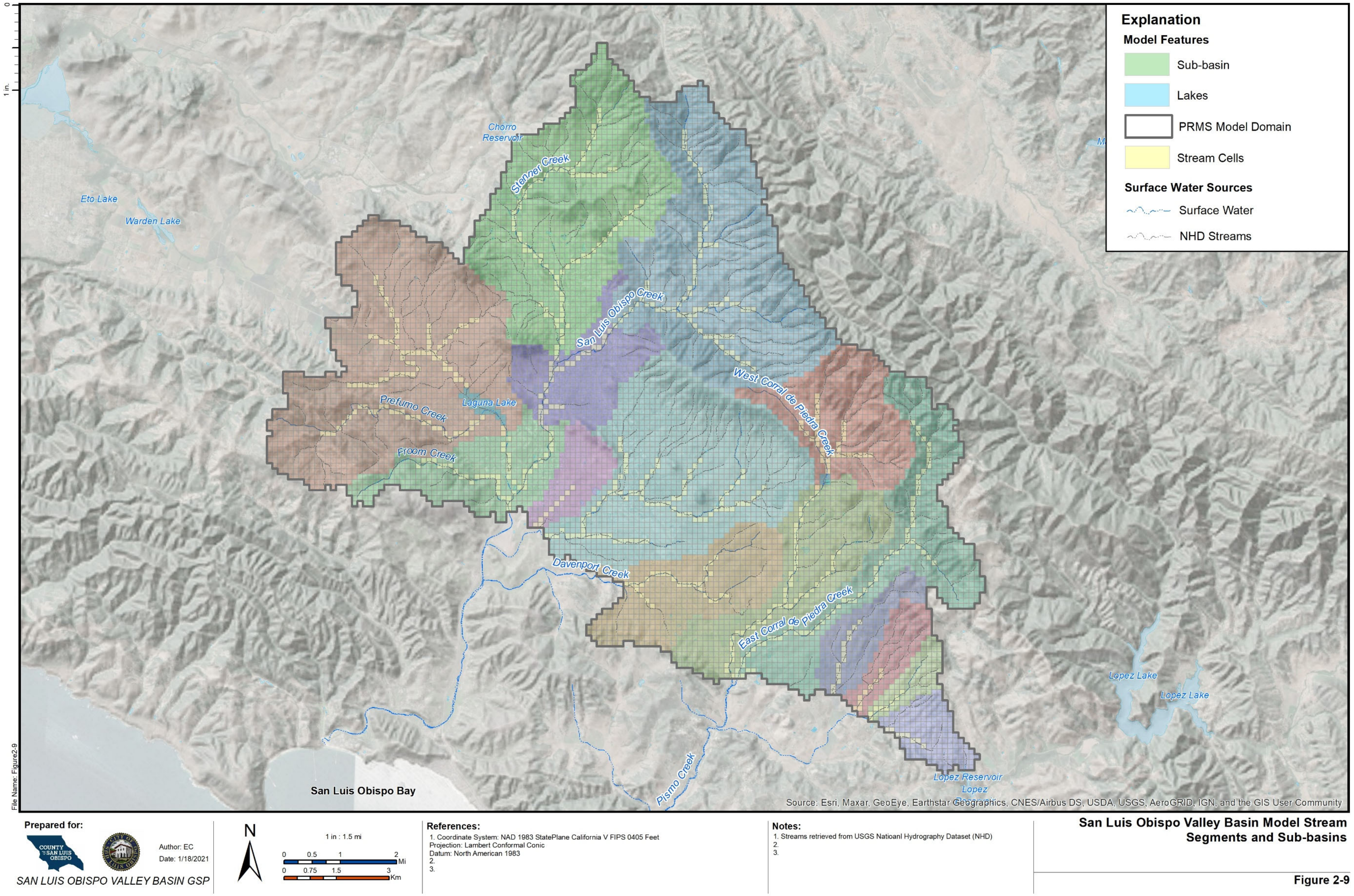
Figure 2-8

2.2.5. Irrigation

Irrigation within the Basin wasn't directly incorporated into the PRMS model. Changes in irrigation will be evaluated and incorporated in the GSFLOW model as part of the calibration process to provide the water budget fluxes necessary for modeled scenario evaluations.

2.2.6. Stream Network

Streamflow and routing are handled in MODFLOW using the SFR package once PRMS is coupled in MODFLOW. Before integrating in GSFLOW, PRMS requires streamflow routing to be completed. The PRMS stream network is delineated by assigning mean surface elevations to each HRU grid cell within the watershed using the watershed 10-m DEM as described in *Topography* from the National Elevation Dataset (National Elevation Dataset, 2019).The mean elevations are then used by the GSFLOW-ArcPy scripts to designate the stream segments locations by creating continuously down-sloping HRUs. Generated stream segments were viewed in comparison to USGS National Hydrography Dataset (NHD) streams in ArcMap (National Hydrography Dataset, 2002 - 2016) and recent satellite imagery from Google Earth to evaluate the accuracy of the stream delineation. Stream segment alignments were iteratively adjusted by manually altering the mean elevation of HRUs and rerunning the GSFLOW-ArcPy scripts. The level of detail with regards to stream order was optimized to be representative of the main branches and the primary tributaries. Figure 2-9 presents the stream segments generated for the PRMS model.



References:
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Projection: Lambert Conformal Conic
Datum: North American 1983
2.
3.

Notes:
1. Streams retrieved from USGS Natioanl Hydrography Dataset (NHD)
2.
3.

San Luis Obispo Valley Basin Model Stream Segments and Sub-basins

Figure 2-9

2.2.7. *Streamflow Gages*

The County of San Luis Obispo owns and operates five real-time data monitoring stream gages along San Luis Obispo Creek and its tributaries, within the model domain (Figure 2-10). Table 2-2 provides a summary of the streamflow data available for each stream gage. Each gage station records creek stage (depth or elevation) on fifteen-minute intervals. Available stage data at each station dates to back to 2005 apart from the Andrews Street Bridge gage. Of the five County stream gages, three have stage-discharge relationships, or rating curves, that were approximated by Central Coast Salmon Enhancement (CCSE) based on recorded stage data and measured flows between 2017 and 2019 (CCSE, 2019). These stream gages include the Andrews Street Bridge, Stenner Creek at Nipomo, and Elks Lane. Rating curves generated for these gauge stations (Figures 2-11 through 2-13) are considered the best available information for use in converting stage data to flow rate, and therefore were the primary data for used in calibrating the PRMS model.

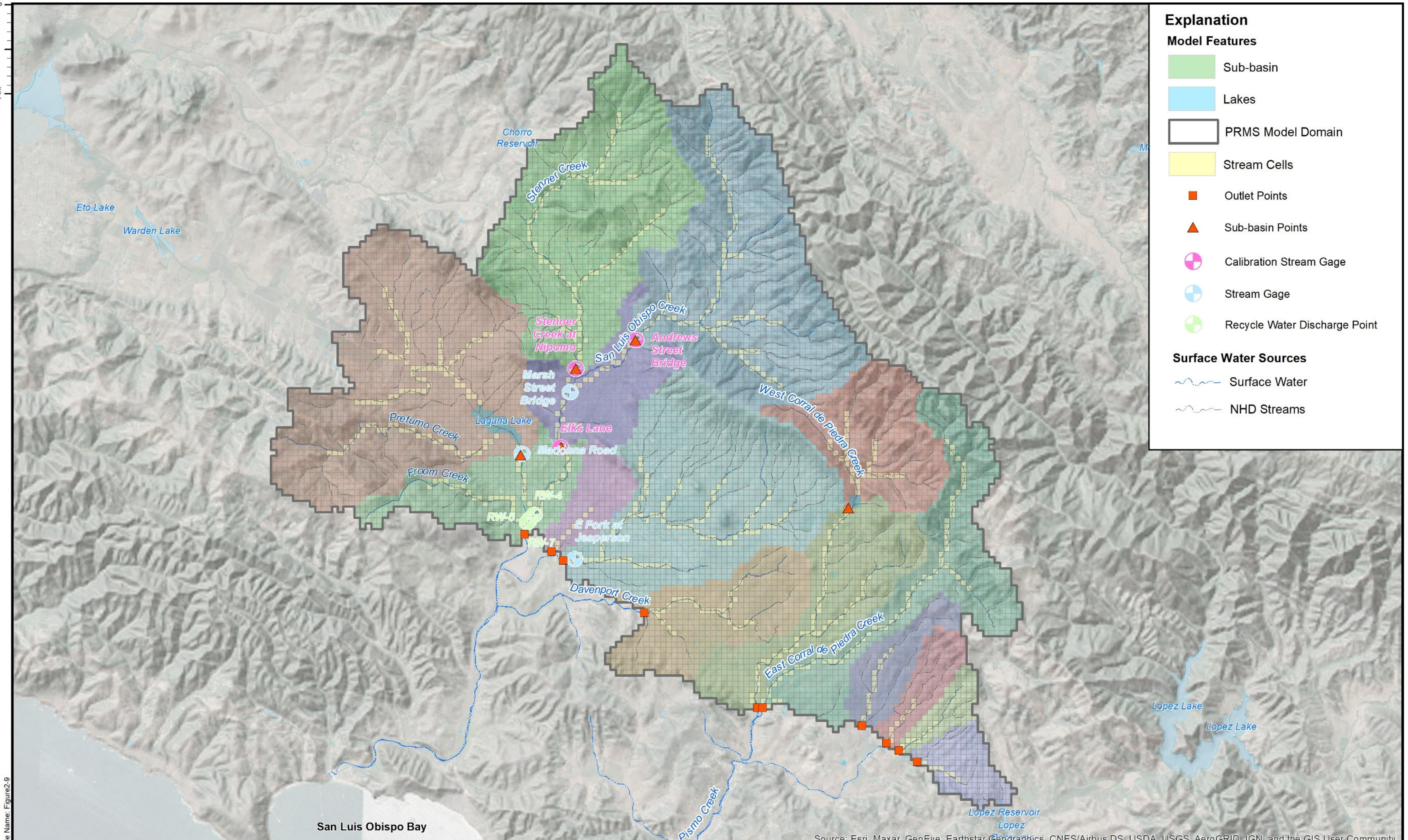
Questa Engineering Corps also estimated theoretical rating curves for each of the five County gages using a HEC-RAS model (Questa Engineering Corp., 2007). However, preliminary application of these rating curves to the stream gage data resulted in abnormal daily mean hydrographs in comparison to the hydrographs generated using the CCSE rating curves. The Questa rating curves was used as a secondary dataset for comparison of modeled to observed flows at the Jespersen and Madonna Road gage stations, where no CCSE rating curves exist (Figures 2-14 & 2-15).

In addition to the County owned gages, the City of San Luis Obispo collects weekly measurements of stage and flow within San Luis Obispo Creek at the outfall of the Water Resources Recovery Facility (WRRF) during the months of April to September as part of the National Pollutant Discharge Elimination System (NPDES) permitting program. This data was not included in PRMS and instead will be included in the SFR package of MODFLOW and will be evaluated in GSFLOW.

Table 2-2: Stream gage data for the Basin.

Stream Gage	Source/Station No.	Data Recorded	Data Interval	Data Range	Datum[1]
Andrews St Bridge	SLO County (745)	Stage	15 Minutes	8/26/2006 - 8/31/2019	NAVD 88
Stenner Creek at Nipomo	SLO County (781)	Stage	15 Minutes	5/23/2005 - 8/31/2019	NAVD 88
Elks Ln	SLO County (740)	Stage	15 Minutes	5/20/2005 - 8/31/2019	NAVD 88
Madonna Rd	SLO County (778)	Stage	15 Minutes	5/20/2005 - 8/31/2019	NAVD 88
E. Fork at Jespersen Rd	SLO County (783)	Stage	15 Minutes	5/20/2005 - 8/31/2019	NAVD 88
RW-4	City of SLO	Depth, Flow	Weekly	2005 - 2019	-
RW-5	City of SLO	Depth, Flow	Weekly	2005 - 2019	-
RW-7	City of SLO	Depth, Flow	Weekly	2005 - 2019	-

[1]Prior to 5/23/2017 County data was recorded on NGVD 29 datum. Conversion is 2.86 feet.



Prepared for:

SAN LUIS OBISPO VALLEY BASIN GSP

Author: EC
Date: 1/18/2021

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1 in : 1.5 mi
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References:
1. Coordinate System: NAD 1983 StatePlane California V FIPS 0405 Feet
Projection: Lambert Conformal Conic
Datum: North American 1983
2.
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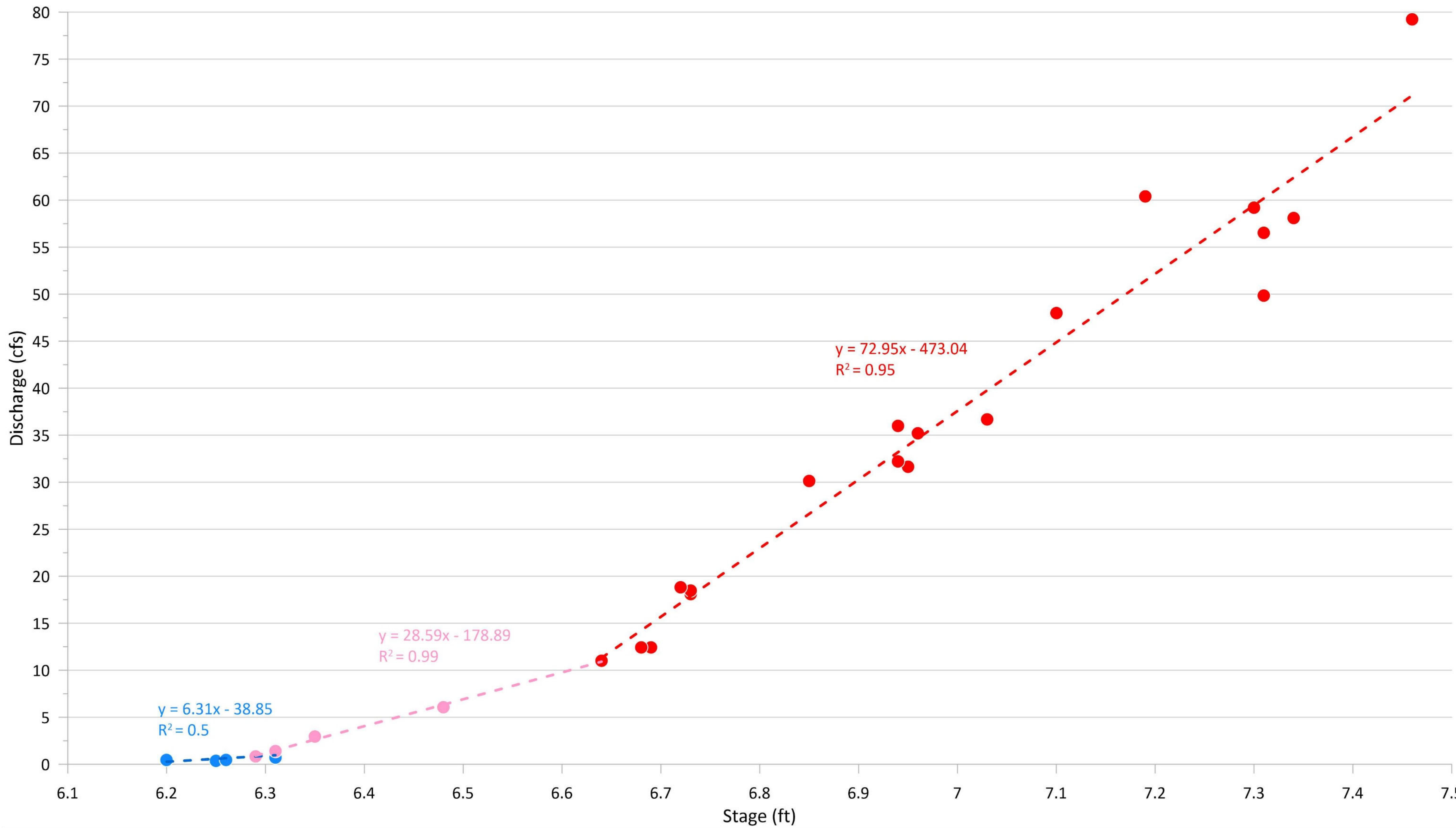
Notes:
1. Streams retrieved from USGS Natioanl Hydrography Dataset (NHD)
2.
3.

San Luis Obispo Valley Basin Model Stream Gages

Figure 2-10

File Name: Figure2-9



Prepared for:

Author: EC
01/13/2021

SAN LUIS OBISPO VALLEY BASIN GSP

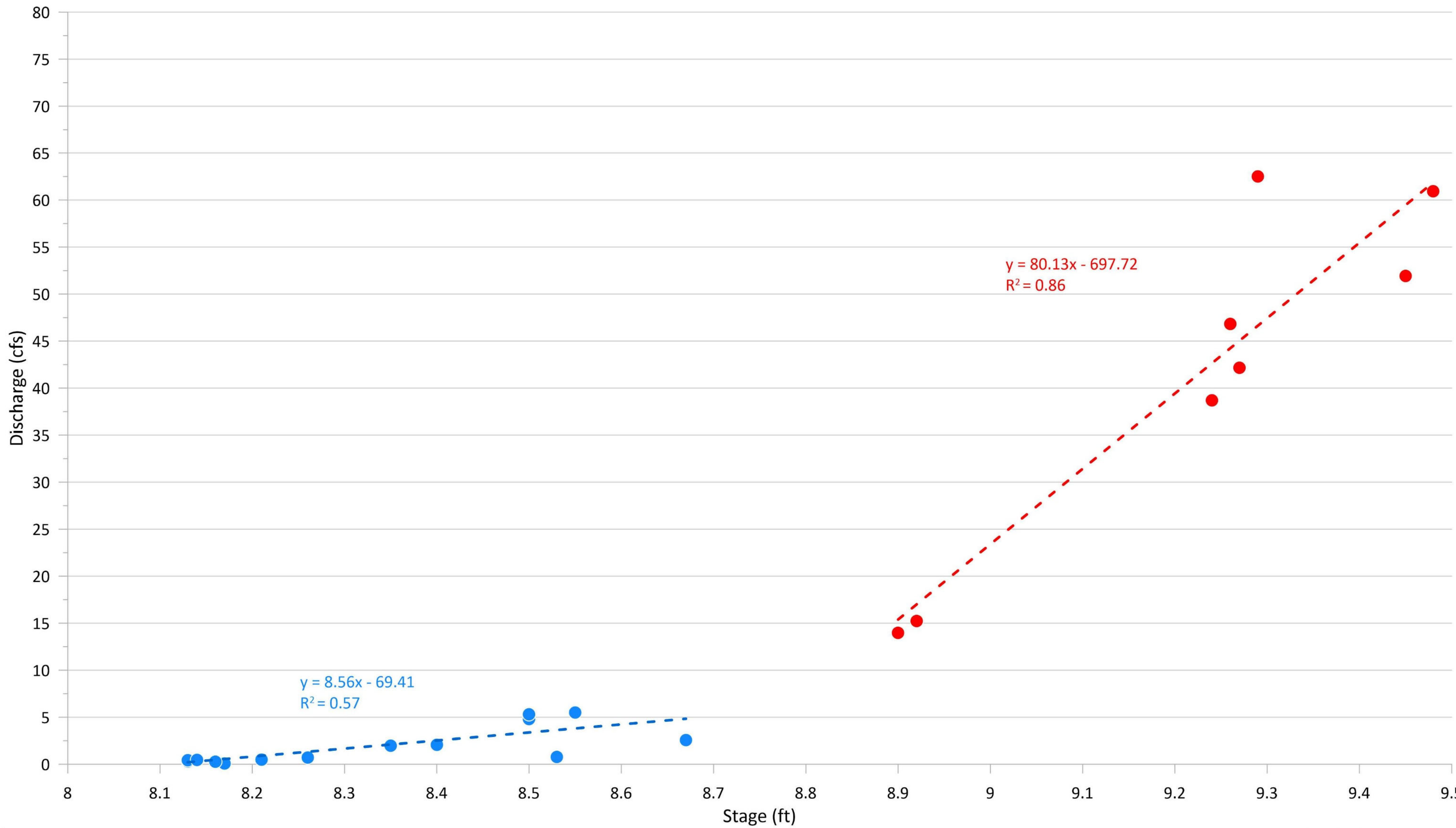
Legend

Low Flow
Medium Flow
High Flow

Notes:
1. Data Source: Central Coast Salmon Enhancement (CCSE)

CCSE Rating Curve for Andrews St Bridge

Figure 2-11



Prepared for:

Author: EC

01/13/2021

SAN LUIS OBISPO VALLEY BASIN GSP

Legend

Low Flow

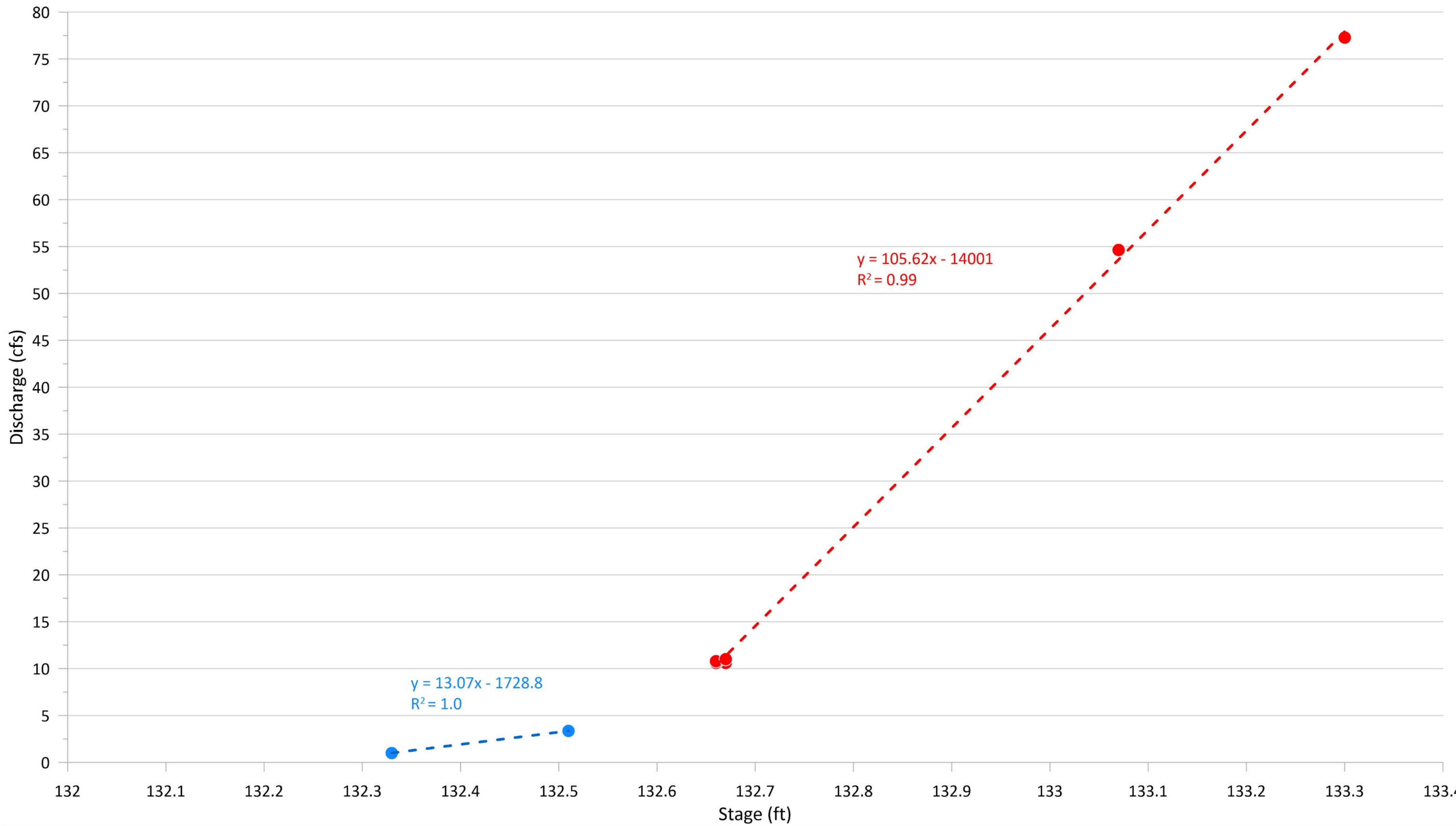
High Flow

Notes:

1. Data Source: Central Coast Salmon Enhancement (CCSE)

CCSE Rating Curve for Stenner

Figure 2-12



Prepared for:

Author: EC

01/13/2021

SAN LUIS OBISPO VALLEY BASIN GSP

Legend

Low Flow

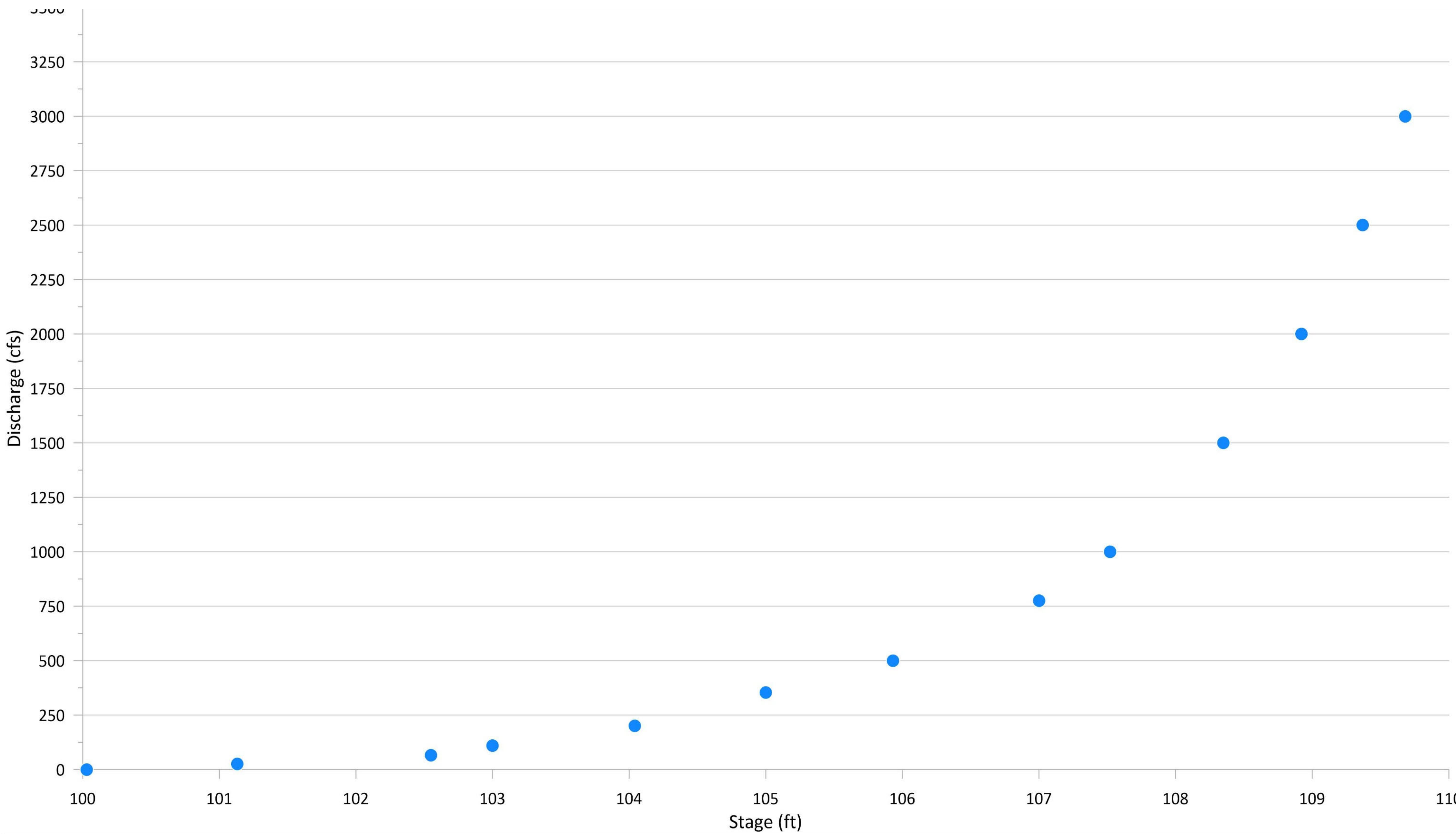
High Flow

Notes:

1. Data Source: Central Coast Salmon Enhancement (CCSE)

CCSE Rating Curve for Elks Ln

Figure 2-13



Prepared for:

SAN LUIS OBISPO VALLEY BASIN GSP

Author: EC

01/13/2021

Legend

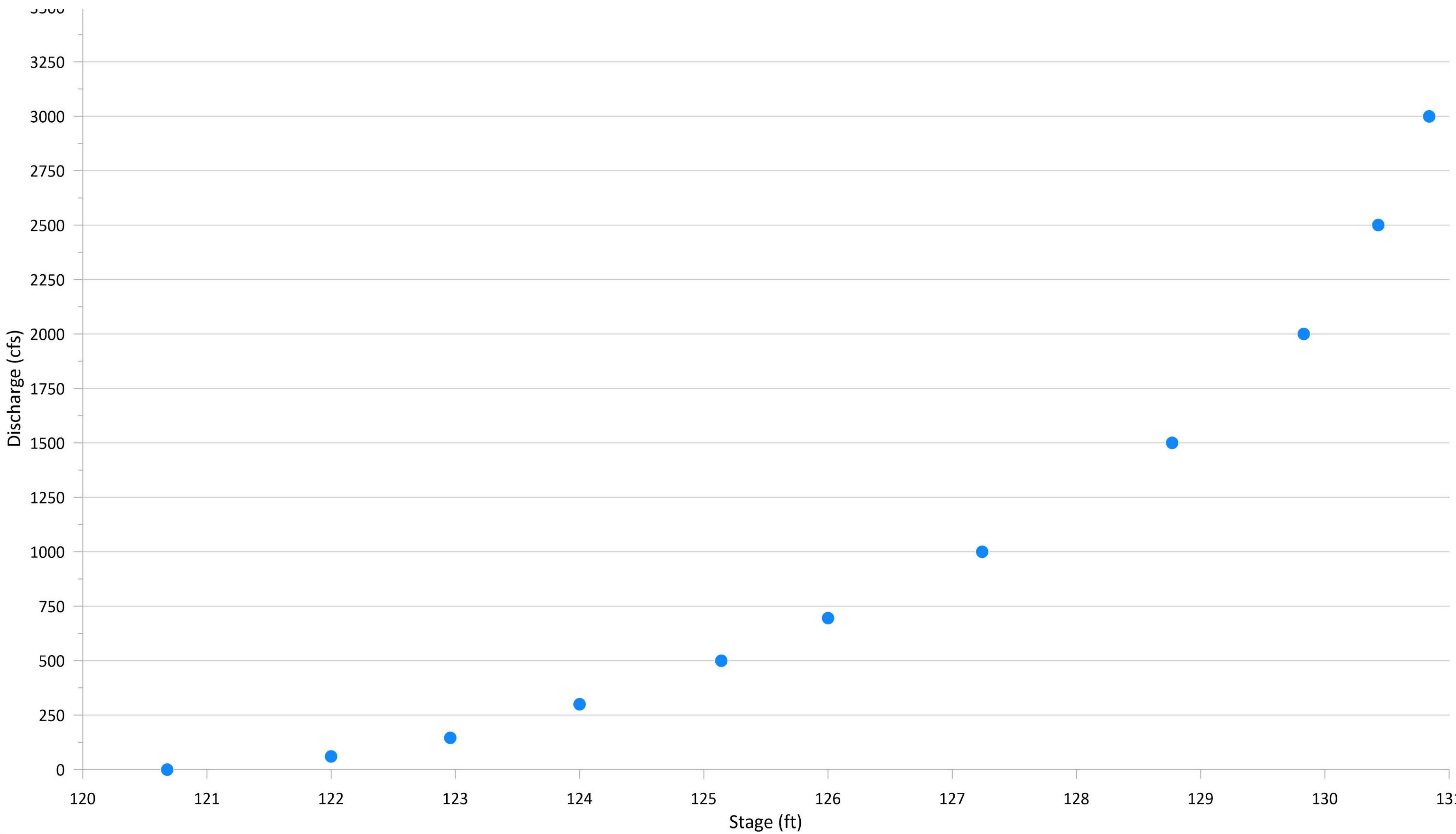
Flow

Notes:

1. Data Source: Questa Engineering Corporation

Questa Rating Curve for Jespersen

Figure 2-14



Prepared for:

Author: EC

01/13/2021

SAN LUIS OBISPO VALLEY BASIN GSP

Legend

Flow

Notes:

1. Data Source: Questa Engineering Corporation

Questa Rating Curve for Madonna

Figure 2-15

2.3. PRMS Modules Used

PRMS simulates the hydrologic cycle through various processes, each with one or more modules available for use. Table 2-3 presents the modules that were selected for use in the surface water model.

Table 2-3: Selected modules used in PRMS model.

Module Name	Process	Description[1]
basin	Basin Definition	Defines shared watershed wide and HRU physical parameters and variables.
cascade	Cascading Flow	Determines computational order of the HRUs and groundwater reservoirs for routing flow downslope.
soltab	Solar Table	Computes potential solar radiation and sunlight hours for each HRU for each day of the year.
obs	Time Series Data	Reads and stores observed data from all specified measurement stations.
temp_sta	Temperature Distribution	Distributes maximum and minimum temperatures to each HRU by using temperature data measured at one station.
precip_1sta	Precipitation Distribution	Determines the form of precipitation and distributes it from one or more station to each HRU by using monthly correction factors to account for differences in altitude, spatial variation, topography, topography, and measurement gage efficiency.
ddsolrad	Solar Radiation Distribution	Distributes solar radiation to each HRU and estimates missing solar radiation data using a maximum temperature per degree-day relation.
transp_tindex	Transpiration Period	Determines whether the current time step is in a period of active transpiration by the temperature index method.
potent_jh	Potential Evapotranspiration	Computes the potential evapotranspiration by using the Jensen-Haise formulation (Jensen & Haise, 1963)
intcp	Canopy Interception	Computes volume of intercepted precipitation, evaporation from intercepted precipitation, and throughfall that reaches the soil.
srunoff_smidx	Surface Runoff	Computes surface runoff and infiltration for each HRU by using a nonlinear variable-source-area method allowing for cascading flow.
soilzone	Soil-Zone	Computes inflows to and outflows from soil zone of each HRU and includes inflows from infiltration, groundwater, and upslope HRUs, and outflows to gravity drainage, interflow, and surface runoff to down-slope HRUs.
gwflow	Groundwater	Sums inflow to and outflow from PRMS groundwater reservoirs. Used in the PRMS-only model, not the integrated GSFLOW model.
strmflow	Streamflow	Computes flow in the stream network using the Muskingum routing method and flow and storage in on-channel lake using several methods. Used in the PRMS-only model, not the integrated GSFLOW model.

[1] (Markstrom, et al., PRMS-IV, the Precipitation -Runoff Modeling System, Version 4: Updated Tables from Version 4.0.3 to Version 5.0.0, 2019; Markstrom, Niswonger, Regan, Prudic, & Barlow, 2008)

2.4. PRMS Calibration Approach and Parameters

The PRMS model was calibrated using the USGS Luca software (Hay & Umemoto, 2007) in a step-wise approach that includes the optimization of solar radiation, PET, and streamflow. The PRMS calibration period was based on available stream gage data, which spans from July 2006 to August 2019. Simulated values and model outputs were compared to calibration data sets generated from measured data. Data sets for solar radiation and potential evapotranspiration were derived from measurements recorded at the Cal Poly #52 weather station. Calibration data sets for streamflow were derived from the CCSE rating curves and measured stage data at Andrews Street Bridge, Stenner Creek at Nipomo, and Elks Lane. The Questa Engineering rating curves at these streamflow gages were not used for comparison due to their documented issues and possible over estimation of streamflow (Questa Engineering Corp., 2007).

2.4.1. Potential Evapotranspiration and Solar Radiation

PRMS solar radiation (SR) and PET parameters were first calibrated to measured SR and calculated PET at the Cal Poly weather station. PRMS calculates solar radiation using the ddsolrad module where the parameters are slope and intercept of the maximum temperature per degree day linear relationship. Monthly parameters (dday_intcp and dday_slope) are calibrated (Table 2-4) to monthly averages of solar radiation (Figure 2-16). Based on calibrated air temperature and solar radiation, monthly coefficients (jh_coef) for the Jensen-Haise equation are adjusted to calibrate simulated potential evapotranspiration to average potential evapotranspiration at the stations (Table 2-4). The Jensen-Haise equation requires air temperature and solar radiation so average monthly air temperature and solar radiation from the Cal Poly weather station was used.

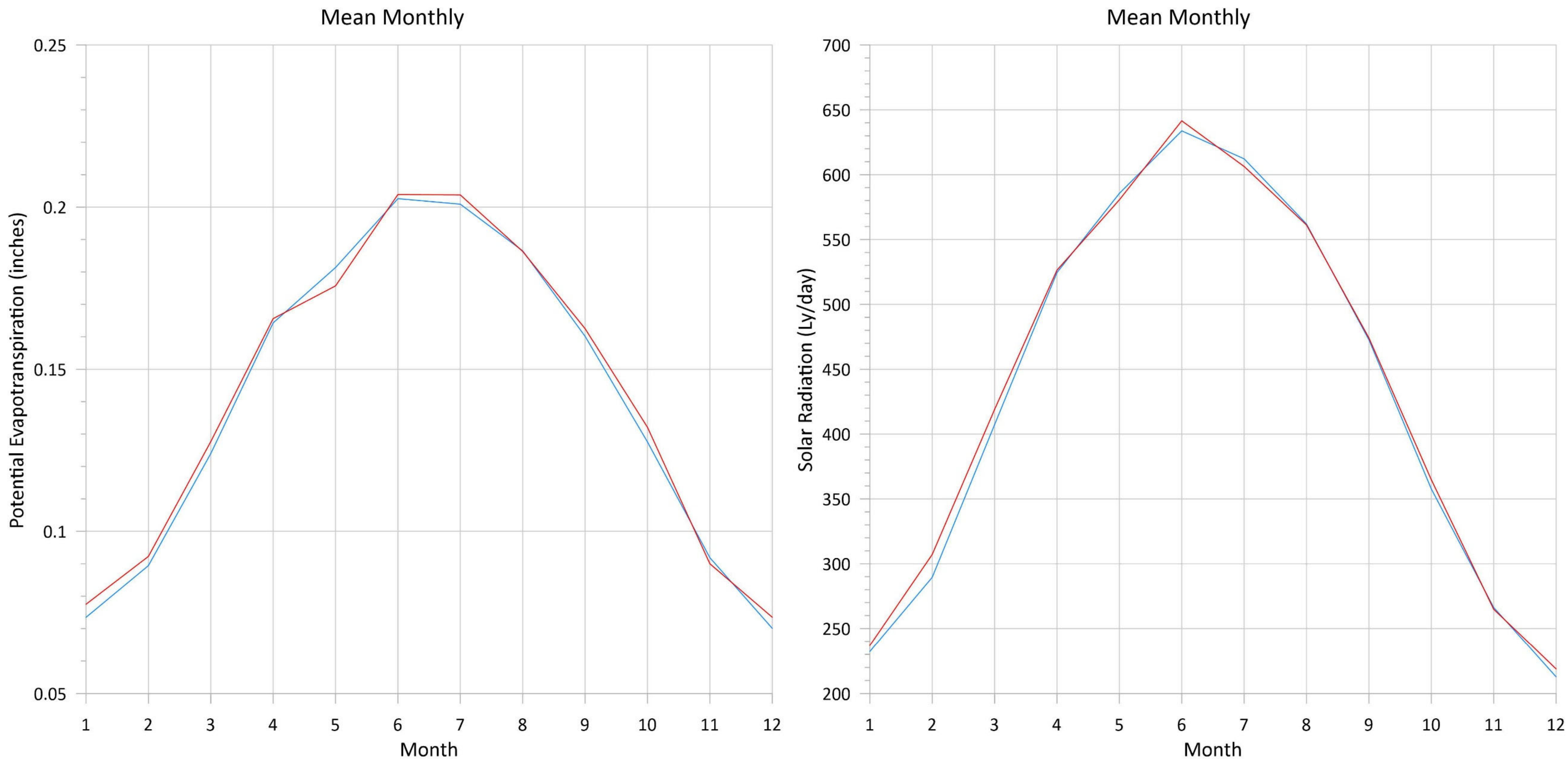
Table 2-4: Solar radiation and potential evapotranspiration monthly calibration parameters.

Parameter	dday_inctp[A]	dday_slope[B]	jh_coef[C]
January	-9	0.19	0.013951
February	-9	0.21	0.013001
March	-9	0.208	0.012301
April	-7.8	0.2	0.012401
May	-10	0.225	0.011559
June	-22	0.39	0.011049
July	-38	0.57	0.010966
August	-36	0.54	0.010735
September	-15	0.255	0.01105
October	-15	0.26	0.012034
November	-15	0.265	0.012719
December	-10	0.21	0.01492

A - intercept in temperature degree-day relation

B - slope in temperature degree-day relation

C - monthly adjustment factor using in Jensen-Haise PET calculations



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Author: EC
01/14/2021

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Legend

Weather Station
PRMS Output

Notes:
1. Data Source: Cal Poly Weather Station 52

ET and Solar Radiation Calibration

Figure 2-16

2.4.2. Surface Water Parameters

Calibration of the surface water component consisted of adjusting various watershed parameters for the entire Basin for Andrews Street Bridge, Stenner Creek, and Elks Lane stream gages. Each of these gages are in the SLO Valley portion of the Basin. Some parameters represent the soil zone reservoir volumes and other parameters represent coefficients for empirical equations describing flows to and from soil zone reservoirs. Table 2-5 shows the watershed parameters and provides their calculated values.

The capillary zone capacities soil_moist_max and soil_rechr_max have spatial variation within each HRU based on calculations using the SSURGO/STATSGO soils datasets. In general, parameters representing flows from the soil zone are on the low end of the expected range while parameters representing soil moisture capacities (sat_threshold, soil_moist_max, and soil_rechr_max_frac) are relatively high. Soil moisture capacity variables were the most sensitive in influencing surface water flow outputs in the model.

Table 2-5: Surface water model watershed parameters.

Parameter Name	Parameter Description	Associated flow	Min	Max	Average
Carea_max	Maximum possible area contributing to surface runoff as proportion of HRU	Hortonian Surface Flow	0	0.0083	0.0003
fastcoef_lin	Linear coefficient to route preferential-flow storage down slope	Fast interflow	0.63	0.63	0.63
fastcoaf_sq	Non-linear coefficient to route preferential flow down slope	Fast interflow	0.899	0.899	0.899
gwflow_coef	Groundwater routing coefficient	Groundwater flow	0.0023	0.0023	0.0023
gwsink_coef	Groundwater sink coefficient	Groundwater flow	0	0	0
imperv_stor_max	Maximum impervious area retention storage for each HRU	Hortonian Surface Flow	0.05	0.05	0.05
pref_flow_den	Preferential-flow pore density	Preferential flow	0.2	0.2	0.2
sat_treshold	Soil saturation threshold, above field-capacity threshold	gravity and preferential flow	4.6	13.6	6.2
slowcoef_lin	Linear coefficient to route gravity-flow storage down slope	Slow interflow	0.0266	0.0276	0.0266
slowcoef_sq	Non-linear coefficient to route gravity-flow storage down slope	Slow interflow	0.0107	0.0582	0.0108
smidx_coef	Coefficient in non-linear contributing area algorithm for each HRU	Hortonian Surface Flow	0.36	0.36	0.36
smidx_exp	Exponent in non-linear contributing area algorithm for each HRU	Hortonian Surface Flow	0.21	0.21	0.21
soil_moist_max	Maximum available water holding capacity of soil profile. Soil profile is surface to bottom of rooting zone.	NA	1.007	16.392	4.236
soil_rechr_max_frac	Fraction of capillary reservoir capillary reservoir water-holding capacity where losses occur as evaporation and transpiration	NA	0	1	0.3479
soil2gw_max	Maximum amount of capillary reservoir excess that is routed directly to the groundwater reservoir	Direct recharge	0	0	0
ssr2gw_rate	Coefficient in equation used to route water from subsurface reservoirs to the groundwater reservoirs	Gravity drainage	0.0084	35.64	0.032
ssr2gw_exp	Coefficient in equation used to route water from the subsurface reservoirs to the groundwater reservoirs	Gravity drainage	1.2	1.2	1.2

2.4.3. Surface Water Calibration Results

The surface water evaluation of the PRMS model consists of a ‘weight of the evidence’ approach (Donigian, 2002) where both qualitative graphical comparisons and quantitative statistical comparisons are made. Graphical comparisons generally include visual evaluation of timeseries plots comparing the measured and simulated flow rates at calibrated stream gages, while quantitative comparisons may include calculating a range of standard statistical measures.

For our purposes, the model was evaluated to verify the model accuracy does not exceed the accuracy or uncertainty associated with the data used to develop and calibrate the model. Since the surface water data measured at Andrews Street Bridge, Stenner Creek at Nipomo, and Elks Lane using the CSSE dataset has known inherent data uncertainty due to inconsistent stage measurements and rating curves for each gage, it’s expected that the calibration may not achieve the best desirable relative calibration goals and we shouldn’t expect to achieve exceptional calibration goals at each gage.

Relative calibration goals are proposed based on guidance from USGS (Woolfenden and Nishikawa, 2014 and Helsel et al., 2020) specific to PRMS and GSFLOW application. Simulated and measured streamflow was evaluated in the integrated model via comparison of daily mean, mean monthly, monthly mean, and annual mean hydrographs as well as using goodness-of-fit statistics. Goodness-of-fit statistics that were used include the reduced major axis regression (RMA) R^2, percent-average-estimation-error (PAEE), the absolute-average-estimation-error (AAEE), and the Nash-Sutcliffe model efficiency (NSME).

Reduced major axis (RMA; type II) linear regression analysis was chosen to calculate the R^2 for measured monthly mean streamflow versus simulated monthly mean streamflow to investigate the linear relationship between measured and simulated streamflow used in the calibrated model. RMA regression was used since there was relatively significant unexplained error in our predictor variable (measured monthly mean streamflow) that ordinary least squares (OLS) regression cannot adjust for (OLS assumes no error in predictor variable) resulting in a biased regression model which in our case, would provide erroneous results. RMA regression makes no assumptions about dependence (Friedman et al., 2013) and minimizes the sum of triangular areas between data points and the best fit line (Carr, 2012).

The RMA R^2 measures the linear goodness-of-fit and assumes estimation error in both simulated and measured data. The PAEE and AAEE measure the model bias, or systematic error, but cannot provide a definitive measure of goodness of fit alone. The NSME provides a measure of the mean square error, similar to the normalized root-mean-square error (RMSE) and can be a good indicator of the goodness of fit, but can still have substantial estimation bias. Therefore, the combination of these statistics is used to represent goodness of fit. A model that exactly matches observed results would have RMA R^2 value of 1.0, PAEE and AAEE values of 0, and an NSME value of 1.0 (Woolfenden and Nishikawa, 2014; Helsel et al., 2020).

Table 2-6 presents the range of goodness-of-fit criteria as outlined for the Santa Rosa Plain Model (Woolfenden & Nishikawa, 2014) and includes the RMA R^2 categories to further evaluate model fit. The optimal goal is to achieve calibration results within the “Very Good” or “Excellent” range, however, this may not be feasible at each stream gage location due to the following limitations:

- Accuracy of the stage data and rating curves from CSSE and Questa Engineering datasets.
- Limited model calibration period (WY 2006 – 2019) in relation to the full model run period (WY 1985 – 2019).
- Stream gages used for calibration are not spatially distributed throughout the model domain (i.e. no stream gages exist within Edna Valley to be used for calibration purposes).
- Precipitation data from 2006 – 2010 was corrected from documented measurement error at the primary rain gage used for calibration.

Table 2-6: Surface water model goodness-of-fit statistics calibration goals.

Goodness-of-fit Category	RMA R^2	PAEE (%)	AAEE (%)	NSME
Excellent	0.9	-5 to 5	≤0.5	≥0.95
Very Good	0.8	-10 to -5 or 5 to 10	0.5 to 1.0	0.85 to 0.94
Good	0.7	-15 to -10 or 10 to 15	10 to 15	0.75 to 0.84
Fair	0.6	-25 to -15 or 15 to 25	15 to 25	0.6 to 0.74

It's also well documented that in practice a wide range of goodness-of-fit categories may be achieved at stream gages that were used in the model calibration and it's rare to obtain "Excellent" or "Very good" classifications for more than one stream gage (Hunt et al., 2013, Woolfenden & Nishikawa, 2014).

Daily mean, mean monthly, annual mean, and monthly mean hydrographs of modeled and measured streamflow were evaluated at the Andrews Street Bridge, Stenner Creek at Nipomo, and Elks Lane stream gages (i.e. calibration gages) to determine if measured streamflow's were reasonably simulated at the stream gages.

As seen in Figures 2-17 – 2-19 showing the daily mean streamflow for each stream gage, there is one notable rainfall event that produced greatly outsized simulated flow versus measured flow. This rainfall event took place on October 13, 2009 and according to NOAA, it was a very wet and windy storm front that resulted in up to 15-inches of rain in the Santa Lucia Mountains along California's central coast (NOAA, 2020). The measured rainfall at the Cal Poly Station used in the model on this day was 6.22 inches which is the wettest day in the calibration period and almost two times greater than the next wettest day in the calibration period. Table 2-7 presents the flow at each stream gage for the top five wettest days and precipitation in the calibration period which take place in seasonally wetter months between October and March. Considering the substantially higher rainfall on October 13, 2009 compared to the other four wettest days in the calibration period, it would be expected for the measured data to reflect substantially higher flows for such a substantial rainfall event, but that is not the case. Before the development of this model, it was known that there may be varying degrees of measurement error in the stream gage stage data and how relevant the rating curves developed by Questa and CCSE (CCSE 2019, Questa Engineering Corp., 2007) will prove to be and the data may have a strong influence on the quality of model results. The discrepancy between the measured flow and simulated flow during this rainfall event relative to the other wettest days of the calibration period showcases the limitations of the available streamflow data in the Basin and may introduce increased model error into the model beyond natural variation inherently present in surface water processes. With improved data collection and recalibration of the model in the future, the model results may be improved.

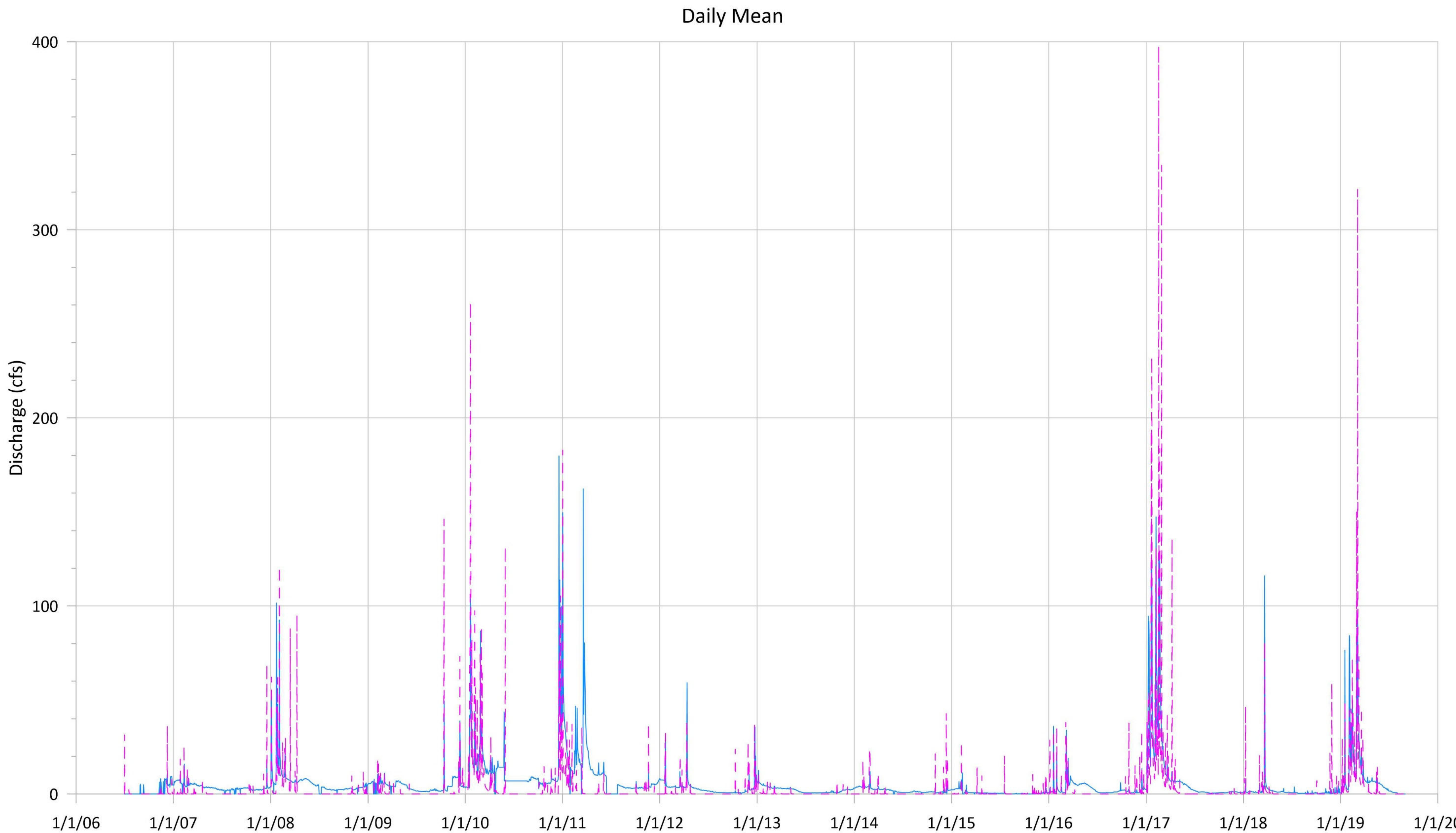
Table 2-7: Measured flow at each rain gage and precipitation for the five wettest days in the calibration period.

Date	Elks Ln - CCSE	Stenner - CCSE	Andrew - CCSE	Elks Ln - PRMS Output	Stenner - PRMS Output	Andrew - PRMS Output	Precipitation (in)
10/13/2009	109.576	65.187	12.455	500.698	208.717	161.02	6.220
12/18/2007	112.930	40.110	17.297	227.893	98.621	72.429	3.465
3/22/2018	309.108	176.052	116.027	298.599	131.353	81.099	3.250
1/4/2008	158.501	79.552	51.835	233.301	100.386	68.252	3.189
12/19/2010	442.437	222.541	179.727	402.626	161.086	133.622	3.071

Despite the limitations of the streamflow data available in the Basin that was used in the model, the calibration resulted in a reasonable fit of the calculated mean monthly, annual mean, and monthly mean data as shown in Figures 2-20 – 2-22. In addition, the model produced anticipated goodness-of-fit statistics for the RMA R^2, NSME, PAEE, and AAEE as shown in Figures 2-23 – 2-25. The RMA R^2 for monthly mean streamflow values for all three gages were above 0.75 indicating a strong, positive relationship between measured and simulated streamflow which was expected. Stenner Creek had one-year in the beginning of the calibration period with a NSME values below 0 and a strongly negative PAEE value indicating the model provided insignificant predictive value at Stenner Creek at the beginning of the calibration period. Andrews Street Bridge had consistently high NSME values for most of the calibration period, but was positively biased indicating simulated streamflow at Andrews Street Bridge were on average higher than observed values. For Elks Lane and Stenner Creek, the PAEE and AAEE were within a similar range, however, Andrews Street Bridge had a very high PAEE and AAEE. Simulated flows at Elks Lane provided the most predictive value and is the southmost stream gage in the model domain. Table 2-8 summarizes the goodness-of-fit statistics for each calibration gage and the assigned goodness-of-fit determination. Overall, the model fit the mean of the measured data and generally estimates high and low streamflow events reasonably well and the calibrated input parameters for PRMS should be adequate for use in evaluating model scenarios based on daily, monthly, and annual changes when fully coupled into GSFLOW.

Table 2-8: Streamflow calibration goodness-of-fit statistics for monthly mean data.

Calibrated Stream Gage	RMA R^2	PAEE (%)	AAEE (%)	NSME	Goodness-of-fit Determination
Andrews Street Bridge	0.76	50.36%	50.36%	0.68	Poor
Stenner Creek	0.81	1.37%	1.37%	0.33	Good
Elks Lane	0.85	9.02%	9.02%	0.75	Very Good



Prepared for:

Author: EC

07/26/2021

SAN LUIS OBISPO VALLEY BASIN GSP

Legend

CCSE Discharge

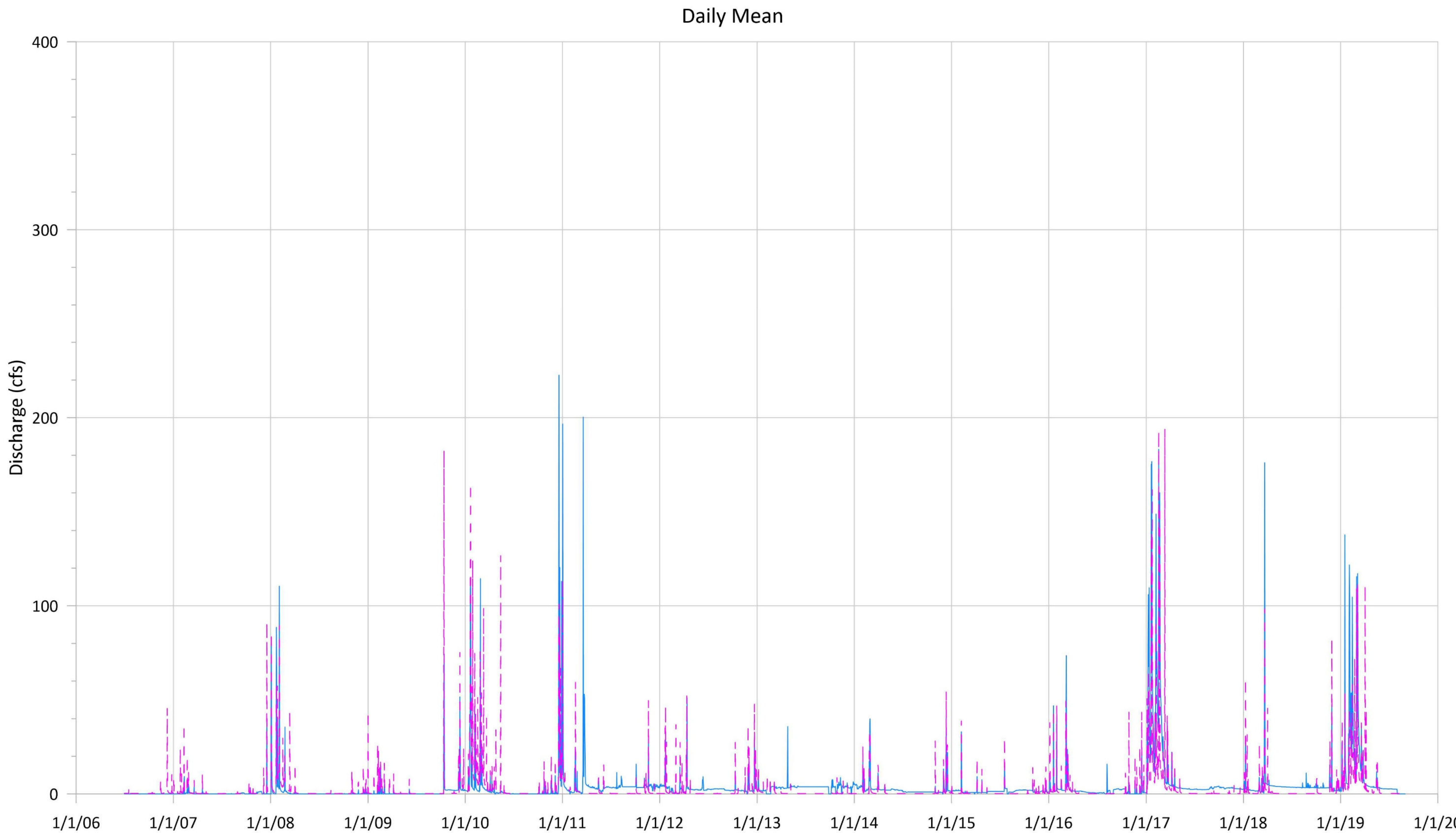
PRMS Dicharge

Notes:

1. Data Source: Central Coast Salmon Enhancement (CCSE)

Andrews Street Bridge Stream Gage Hydrograph

Figure 2-17



Prepared for:

Author: EC

07/26/2021

SAN LUIS OBISPO VALLEY BASIN GSP

Legend

CCSE Discharge

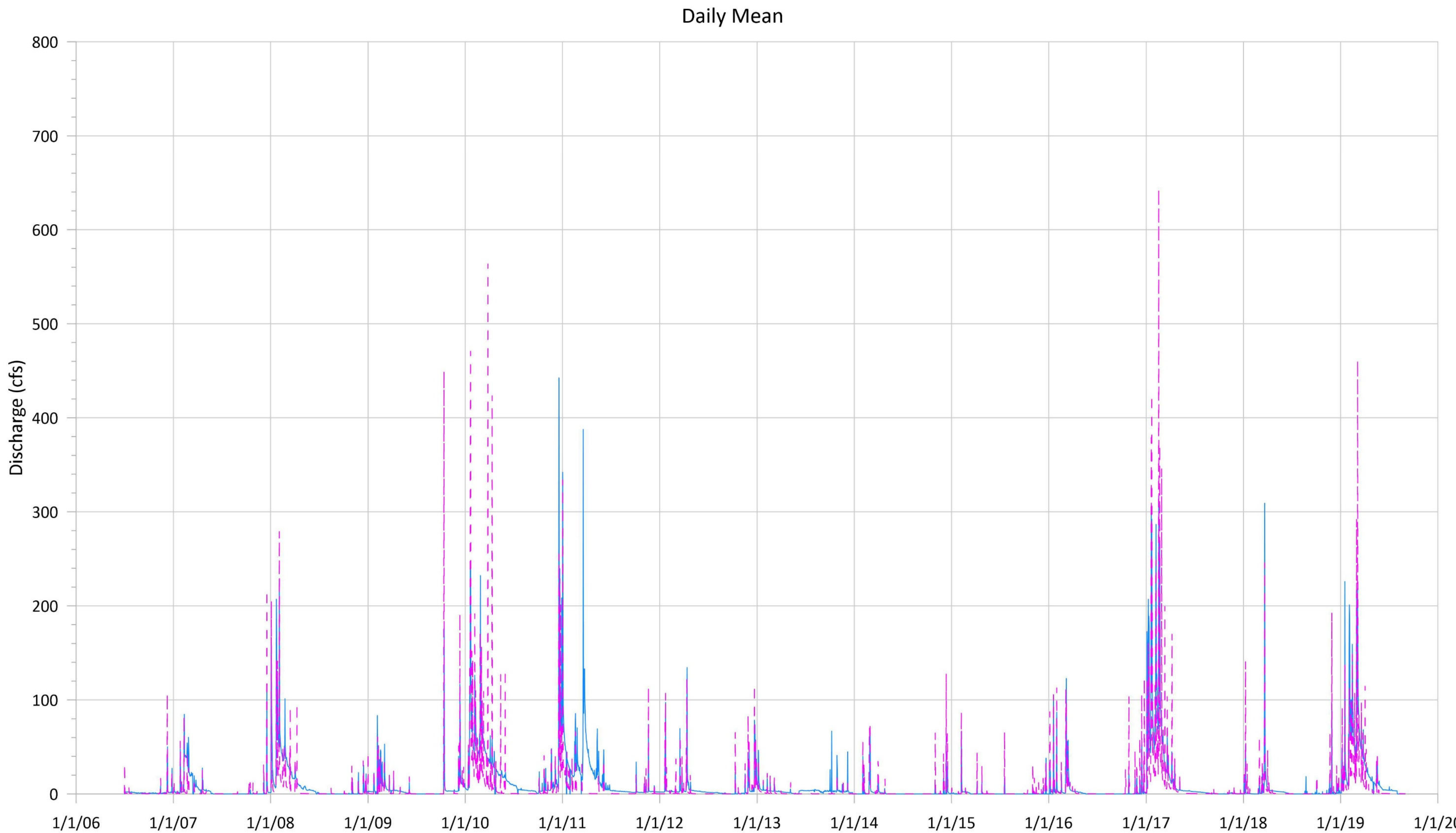
PRMS Dicharge

Notes:

1. Data Source: Central Coast Salmon Enhancement (CCSE)

Stenner Creek Stream Gage Hydrograph

Figure 2-18



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Author: EC

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Legend

CCSE Discharge

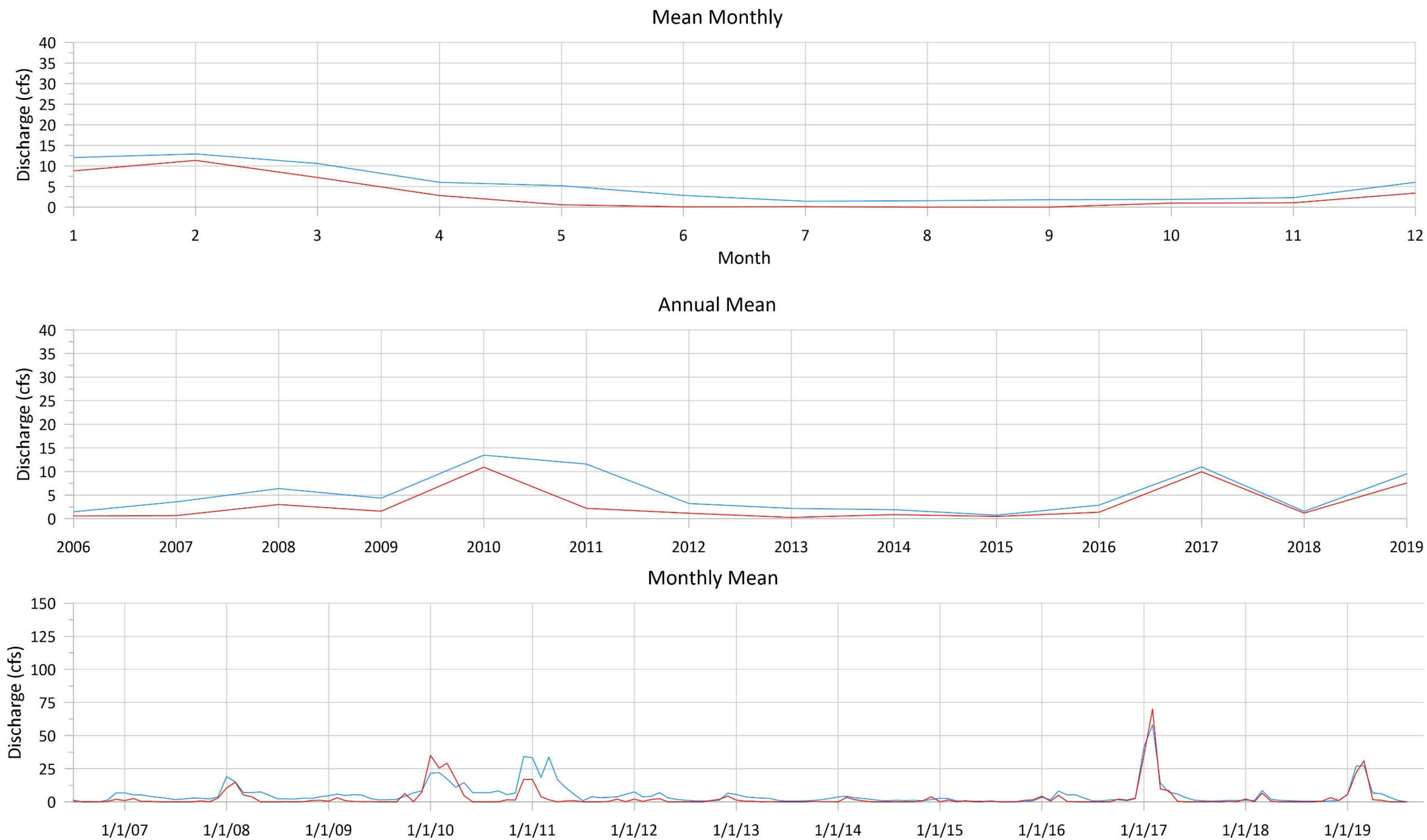
PRMS Dicharge

Notes:

1. Data Source: Central Coast Salmon Enhancement (CCSE)

Elks Lane Stream Gage Hydrograph

Figure 2-19



Prepared for:

Author: EC

07/27/2021

SAN LUIS OBISPO VALLEY BASIN GSP

Legend

CCSE Discharge

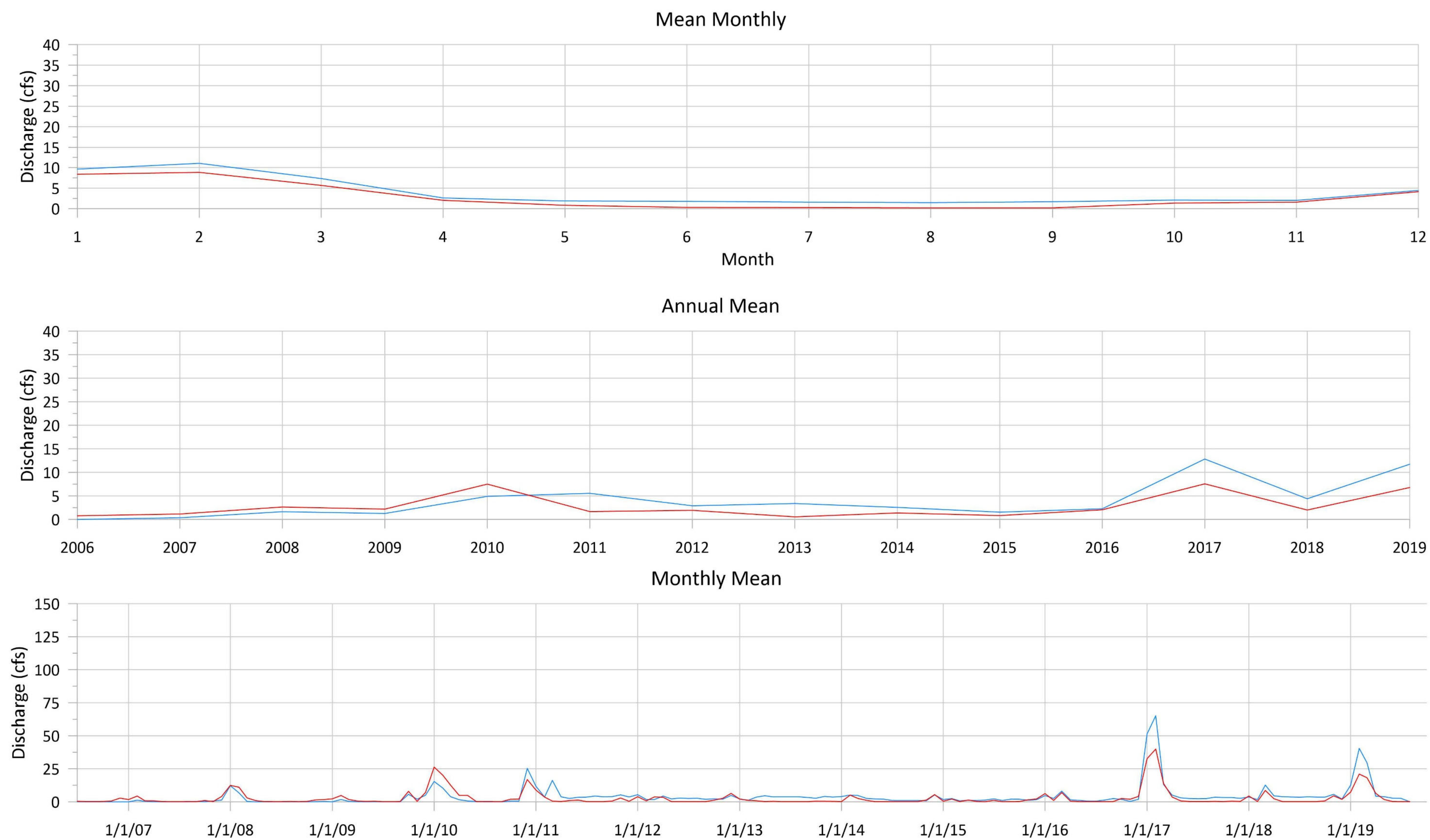
PRMS Discharge

Notes:

1. Data Source: Central Coast Salmon Enhancement (CCSE)

Andrews Street Bridge Stream Gage Calibration

Figure 2-20



Prepared for:

Author: EC

07/27/2021

SAN LUIS OBISPO VALLEY BASIN GSP

Legend

CCSE Discharge

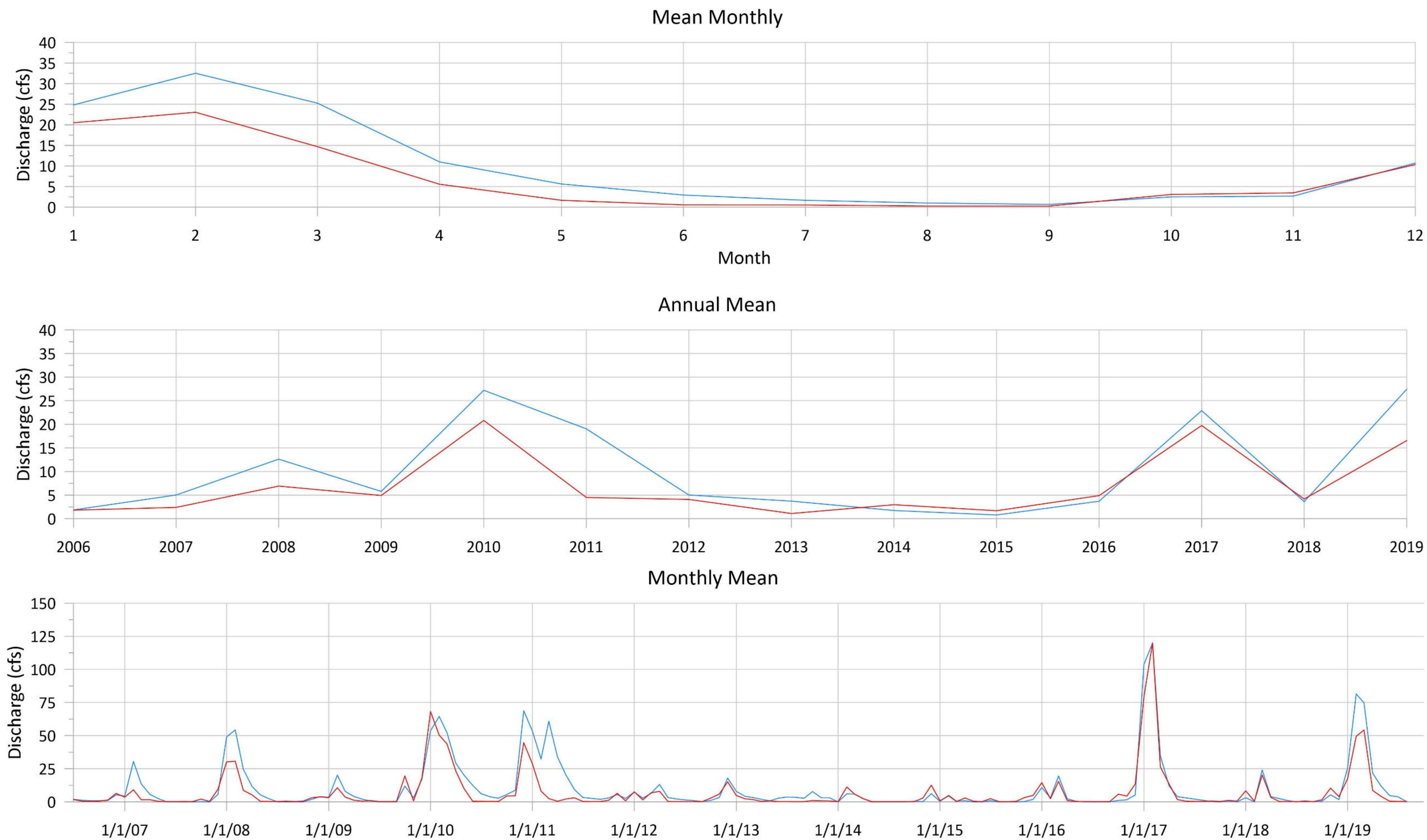
PRMS Discharge

Notes:

1. Data Source: Central Coast Salmon Enhancement (CCSE)

Stenner Creek Stream Gage Calibration

Figure 2-21



Prepared for:

Author: EC

07/27/2021

SAN LUIS OBISPO VALLEY BASIN GSP

Legend

CCSE Discharge

PRMS Discharge

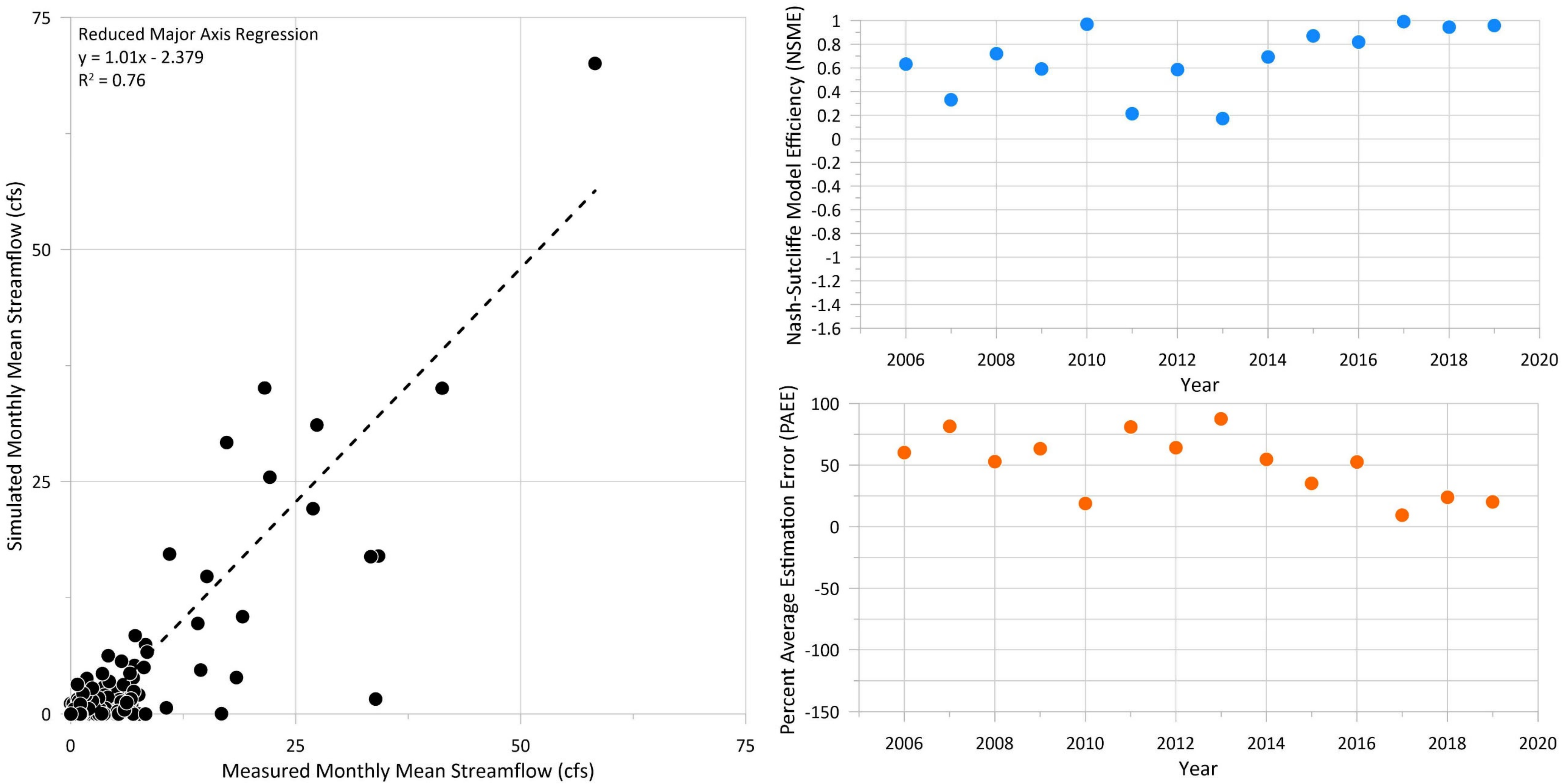
Notes:

1. Data Source: Central Coast Salmon Enhancement (CCSE)

Elks Lane Stream Gage Calibration

Figure 2-22

Goodness-of-fit Statistics



Prepared for:

Author: EC

07/27/2021

SAN LUIS OBISPO VALLEY BASIN GSP

Legend

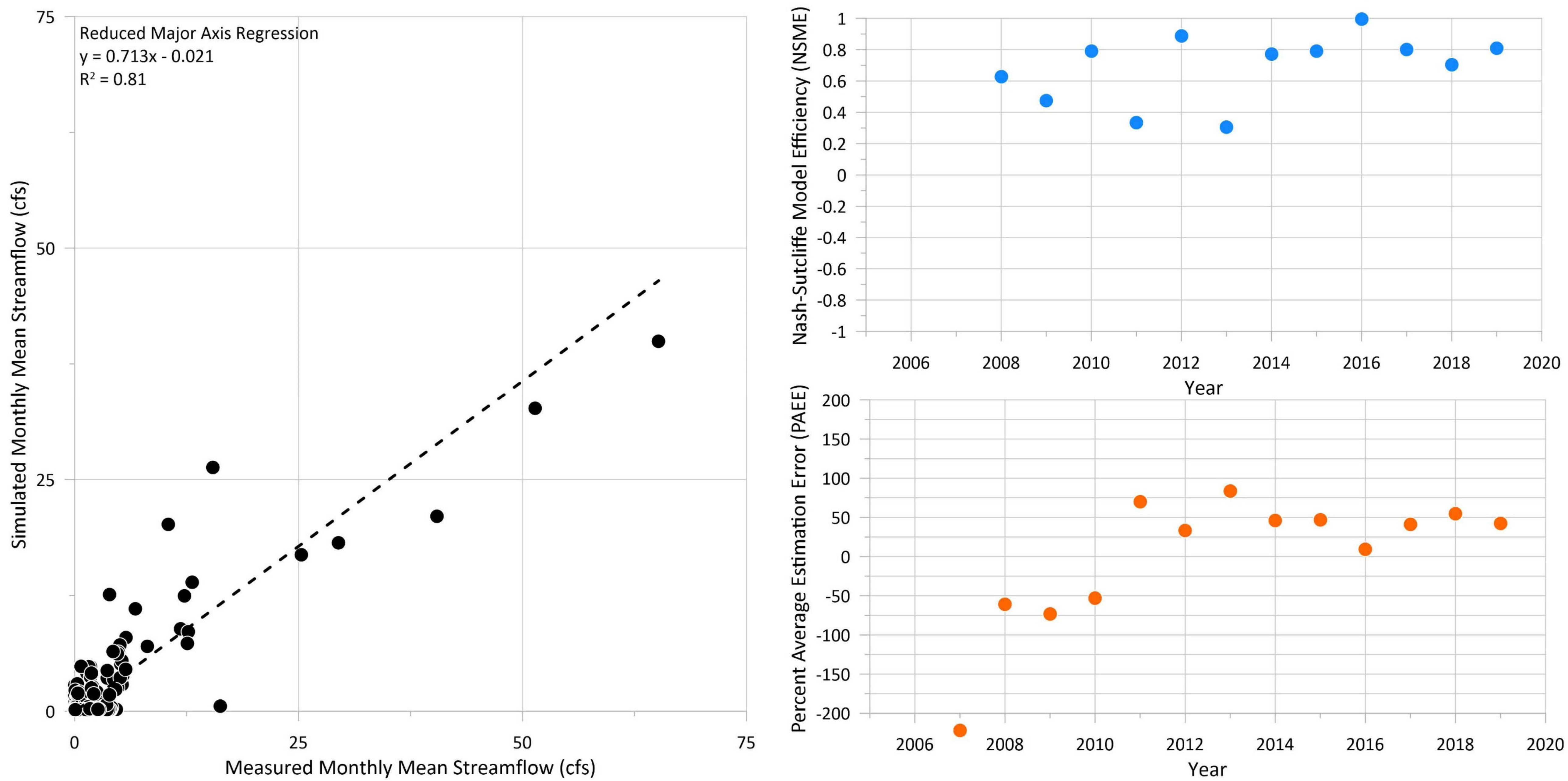
● Streamflow Data
● NSME
● PAEE

Notes:
1. Data Source: Central Coast Salmon Enhancement (CCSE)

Andrews Street Bridge
Model Calibration Statistics

Figure 2-23

Goodness-of-fit Statistics



Prepared for:

Author: EC

07/27/2021

SAN LUIS OBISPO VALLEY BASIN GSP

Legend

- Streamflow Data
- NSME
- PAEE

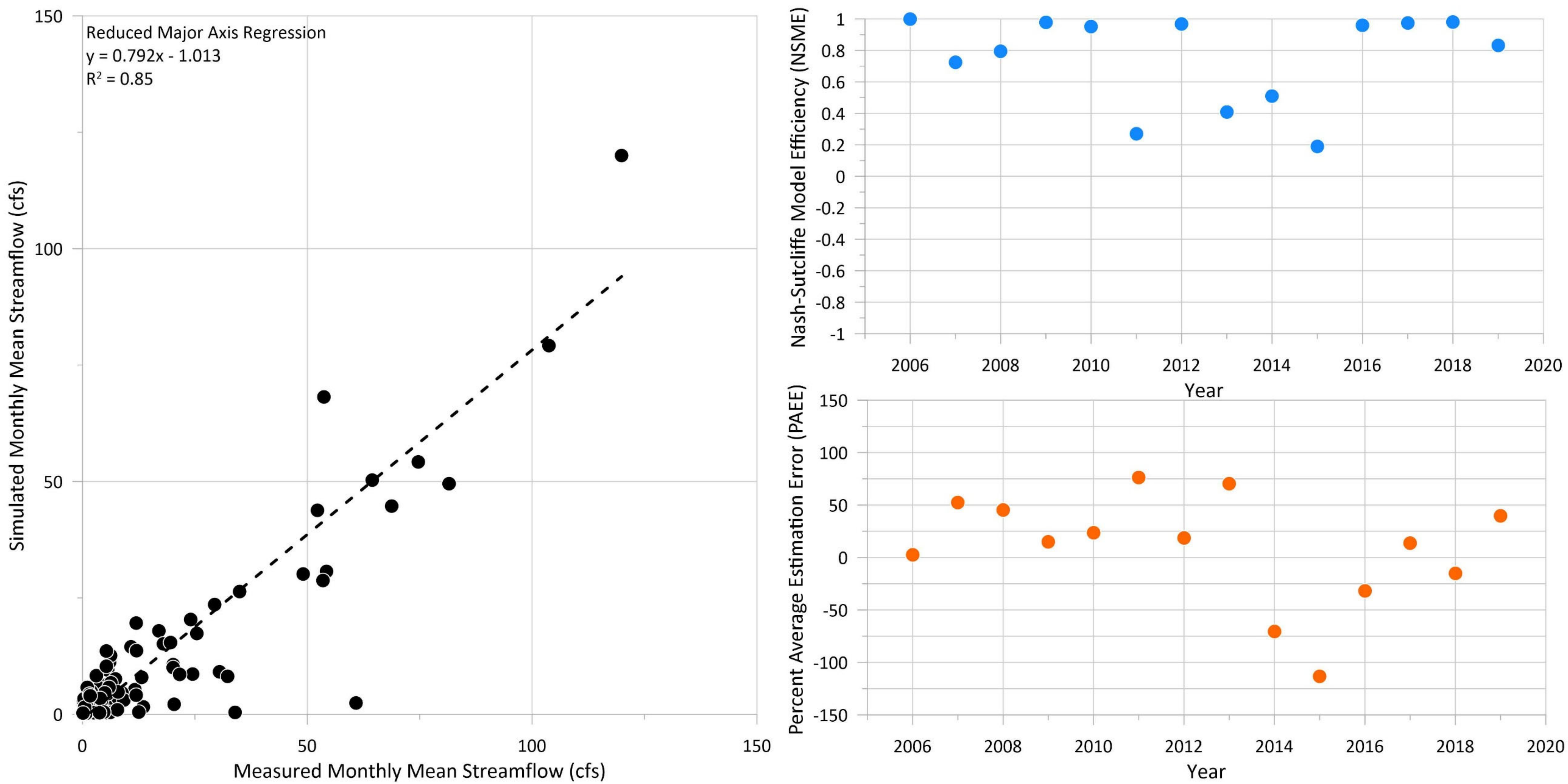
Notes:

1. Data Source: Central Coast Salmon Enhancement (CCSE)
2. 2006 NSME and PAEE
3. 2007 NSME and PAEE -3.97 and -222.27, respectively, and are not displayed on chart due to scale

Stenner Creek Model Calibration Statistics

Figure 2-24

Goodness-of-fit Statistics



Prepared for:

Author: EC
07/27/2021
SAN LUIS OBISPO VALLEY BASIN GSP

Legend
- Streamflow Data
- NSME
- PAEE

Notes:
1. Data Source: Central Coast Salmon Enhancement (CCSE)

Elks Lane Model
Calibration Statistics

Figure 2-25

Section 3. Groundwater Model Development

Groundwater model development was performed using MODFLOW, a public domain groundwater modeling code developed and maintained by the U.S. Geological Survey, and Groundwater Vistas, a proprietary software package used for pre-processing and post-processing of groundwater model data developed and maintained by James Rumbaugh of Environmental Systems International.

Although it was originally considered for the PRMS model and the MODFLOW model to have different grids, additional research with the authors of GSFLOW Groundwater vistas determined that there would likely be no significant advantage, and numerous disadvantages, in setting up the groundwater model this way. Ultimately, it was agreed that the most efficient approach would be for the PRMS model and the MODFLOW model to have coincident model grids. Thus, the MODFLOW model maintains the same 500-foot square grid size with a north-south orientation as that previously described for the PRMS model (Figure 2-1).

The original hydrogeologic conceptual model (HCM) developed for the model was to have four layers. From the top down, Layer 1 will represent the Recent Alluvium. Layer 2 is to represent the Paso Robles Formation, which underlies the Alluvium. Layer 3 represents the Pismo Formation, which underlies the Paso Robles Formation in the Edna Valley, but does not occur over significant areas in SLO Valley. Layer 4 represents the undifferentiated bedrock which underlies the Basin, and crops out in the contributing watershed areas north and south of the Basin. Layer 4 represents the Franciscan Assemblage, the Monterey Formation, and in some areas the Obispo Formation. This HCM was maintained until the final calibration of the integrated model in GSFLOW, as will be discussed in Section 4.

3.1. Datasets and Sources

The layering of the model is complex due to variable depositional environments in different parts of the model domain. In the area of SLO Valley near downtown San Luis Obispo north of the main body of the Basin (colloquially referred to as the “Antlers” due to its shape), the Alluvium directly overlies bedrock; no Paso Robles Formation or Pismo Formation is present. In the main body of the Basin in the SLO Valley where Alluvium and Paso Robles Formation overlie bedrock; there is no significant Pismo Formation present. In the northwestern portion of the Edna Valley, no Alluvium is present, and the Paso Robles Formation crops out at the surface, underlain by the Pismo Formation. There is a pod of Alluvium that crops out at the surface associated with East and West Corral de Piedras Creeks. In the southeast extent of the Basin, the Paso Robles Formation crops out at the surface, underlain by the Pismo Formation. In the contributing watershed area, none of the sedimentary layers of the Basin exist and none of the three Formations that comprise the Basin sediments occurs over the entire model area.

The variable depositional environments made for challenging grid geometry, since MODFLOW-2005 requires all layers to extend throughout the entire model domain. To address this issue, in areas where a particular layer does not exist, the model used “dummy” grid cells of 1-foot thickness to maintain layer continuity, and assigned hydraulic characteristics appropriate to either the layer above or below the dummy cell.

To evaluate the extent and thickness of each Formation in the Basin, and the associated thickness and extent of the model layers, GSI reviewed all Well Completion Reports (WCRs) available from the County Department of Environmental Health, the County Agency that oversees well permit applications in the County. For each available WCR, the lithologic descriptions were reviewed, and geologic contacts between the Formations comprising the Basin sediments were assigned. Geologic cross sections were generated based on evaluation of this data. Cross sections are presented in Chapter 4 of the Groundwater Sustainability Plan, and in the Basin Characterization report previously published (GSI, 2017). These data were then processed using the software Leapfrog, to generate a 3-dimensional geologic model representing the Basin. The Leapfrog stratigraphic model was then imported into Groundwater Vistas to create the 3-dimensional groundwater in MODFLOW using Groundwater Vistas.

During the preparation of the Basin characterization Report (GSI, 2017), a comprehensive summary of available data of hydraulic characteristics of the Basin Formations (hydraulic conductivity, transmissivity, specific capacity, storativity) were documented and compiled. These data were referenced to assign initial parameter estimates for aquifer hydraulic properties to the model, which were then adjusted during the calibration process.

Water level data were obtained from the county's water level monitoring program. Additional water level data was obtained from various other reports compiled as part of this project. A review of Well Completion Reports for wells in the Basin indicates that because most wells are screened to the bottom of permeable sediments, very few wells are screened in only one of the geologic Formations. In the San Luis Obispo Valley, wells are commonly screened across both Alluvium and Paso Robles Formation. In the Edna Valley, wells are commonly screened across both the Paso Robles Formation and the Pismo Formation. Because of this, wells used for calibration targets were generally assigned to the deepest model layer at the target location, unless specific data indicated otherwise. (For example, some wells are clearly indicated as alluvial wells).

3.2. MODFLOW Modules Used

The following MODFLOW modules were used in the development of the groundwater model:

- Basic package – Used to define time discretization and identify active flow areas and no flow cells.
- Solver package - Used to define numerical parameters associated with selected numerical solution alternative.
- Well package - Used to represent pumping from Basin.
- General Head Boundary package - Used during MODFLOW-only initial runs to represent mountain front recharge.
- Recharge package - Used during MODFLOW-only initial runs to represent aerially distributed precipitation-sourced aquifer recharge.
- Evapotranspiration Package - Used during MODFLOW-only initial runs to represent evapotranspiration from shallow aquifer.

- Horizontal Flow Boundary package - Used represent the Edna fault system along the southern boundary of the Basin.
- Constant head package - Used during MODFLOW-only initial runs to represent heads along the boundaries of adjacent basin, Los Osos Basin to the northwest, and Arroyo Grande sub-basin to the southeast.
- Layer Property Flow package- Used to define layer thickness and aquifer hydraulic properties in the model.
- Discretization package - Used to define grid size and transient time steps.
- Lake Package - Used to represent Laguna Lake and Righetti Reservoir.
- Streamflow Routing Package - Used to simulate streamflow and surface water/groundwater interaction.
- Unsaturated Zone Flow package - Used in GSFLOW combined model to simulate temporary storage in the vadose zone.

3.3. MODFLOW Calibration Approach and Parameters

The following general approach was used during the calibration of the MODFLOW groundwater model.

3.3.1. Steady-State Model

Once the Basin water budget was delivered as Chapter 6 of the GSP, the annual estimates of pumping were available for direct application in transient model tuns. Some of the primary water budget components described in the water budget, such as precipitation-based recharge and stream flow into and out of the aquifer, were available for use as estimates for initial inputs into the model. A steady-state version of the model (I.e., a single stress period, with no time variation of aquifer inflows and outflows) representing pre-development conditions (I.e., no groundwater pumping) was developed in which long term average values for these values were input into the model. A series of runs were then commenced in which key parameters from each layer (horizontal and vertical hydraulic conductivity, GHB head assignments, streamflow conductance, evapotranspiration parameters) were varied. Mass balance output from each layer of the model were exported and evaluated to assess the direction and quantity of vertical flow between the model layers. The goal of this portion of the calibration process was to reach a steady state version of the model in which water levels were reasonable, and direction and quantity of vertical flow between the model layers was consistent with the hydrogeologic conceptual model (HCM) presented in the modeling approach Technical Memo. In addition, vertical flow between the layers prior to the commencement of pumping in the Basin would be upward from layer 4 to layer 1 in the main body of the Basin. Estimates of aquifer discharge to streams or inflow from streams was targeted at values in the vicinity of the estimates developed during the water budget and presented in Chapter 6 of the GSP. After each run, mass balance information for each model layer was exported individually, and imported into a visual representation of the model layers to assess direction of vertical flow and the amounts in acre-feet per year. The primary parameters that were varied during this effort were horizontal and vertical hydraulic conductivity, assigned to appropriate zones in each layer, and streambed conductance in the SFR package (The water budget information did not assess the flow between layers). Additionally, dry cells in the groundwater model were a persistent problem, and model parameters were adjusted to attempt to minimize or eliminate dry cells in the model domain.

Repeated model runs were simulated and analyzed manually to achieve an acceptable steady-state version of the model. Once it was judged that the steady-state model yielded reasonable water levels and mass balance output, and dry cells were reduced to a manageable amount, the model was converted to perform transient simulations.

3.3.2. Transient Model – Annual Stress Periods

When the steady-state version of the model had reached a level of acceptability in which the vertical flow between model layers was judged to conform to the HCM, and water levels appeared to replicate the flow patterns and groundwater elevations exhibited in the earliest available water level maps (1954, presented in Chapter 5), and dry cells were at a minimum, then a transient version of the model was prepared in which 35 annual stress periods representing water years 1985 through 2019 were simulated. This version of the model does not have the required time step discretization to integrate with PRMS under GSFLOW; therefore, this version of the model was considered an interim step to the ultimately calibrated GSFLOW model.

Municipal pumping was applied at the documented locations of the municipal pumping wells, with annual pumping volumes included as compiled by Cleath-Harris Geologists (CHG) during the preparation of the Basin water budget. Agricultural pumping was distributed equally to well locations assigned by GSI throughout the areas identified as having agricultural land use, with total agricultural pumping volumes as determined by CHG.

Annually variable water budget volumes for precipitation-based recharge, were distributed equally to all cells in the model.

Streamflow into the Basin was taken from the CHG water budget, distributed among the streams which flow into the SLO Valley and the Edna Valley from the contributing bedrock watershed area, and input into the model as stream inflow in the SFR package average to stream cells that enter the Basin.

Evapotranspiration parameters were left unchanged from the steady-state version of the model.

A similar exercise as previously described was employed for the transient model. Layer-specific mass balance results from the model run were exported and assessed. Transient water level data from all well data judged to be with the agricultural pumping in Edna Valley placed in layer 3 (Pismo Formation). It was observed that vertical flow from layer 3 to the upper layers reversed direction, from upward to downward in response to declining water levels inlayer 3, and streamflow into the Basin.

3.3.3. PEST Application

After the version of the model with 35 annual stress periods was running smoothly and within expected parameters, GSI utilized the software package PEST to refine hydraulic parameter estimation in the model to achieve a better calibration. PEST refers to a software package and associated suite of utility programs which support it. PEST employs mathematical optimization routines to adjust model parameters within constraints defined by the modeler. PEST sets up routines wherein the model is run many times (hundreds to thousands of times), while parameters chosen by the modeler are varied within constraints defined by the modeler. Calibration statistics such as the sum squared of residuals are tracked after each run, and parameter estimates are varied from one run to the next in a manner intended to drive the calibrations statistics downward with successive simulations.

Because PEST may run the MODFLOW model hundreds to thousands of times during the optimization, the run time for the MODFLOW model cannot be too long. When the MODFLOW model is ultimately run in conjunction with PRMS under GSFLOW, the MODFLOW model must have daily time steps (though not necessarily daily stress periods), to match the time steps employed by PRMS. The version of the model with 35 annual time steps took approximately 3 to 4 minutes to run. This run time is quick enough that PEST appeared to be feasible to use. If we had set up a version of the model with monthly stress periods and daily time steps, it was estimated that the MODFLOW model would take multiple hours to run, thus making the time involved with a PEST analysis infeasible.

The model parameters selected to vary during the successive PEST runs of the MODFLOW model were horizontal and vertical hydraulic conductivity. Inflows and outflows to the groundwater model such as recharge, streamflow, and pumping have been defined in the water budget. Therefore, it was judged that the hydraulic parameters of the aquifer were the most appropriate model variables to adjust during the PEST runs.

A table of compiled aquifer hydraulic parameter estimates (transmissivity, hydraulic conductivity, specific capacity, and storativity) generated in the Basin over the years was previously compiled by GSI during the preparation of the Basin Characterization Report (included as Appendix A to this TM). These values were used to define the minimum and maximum values of horizontal hydraulic conductivity used in the MODFLOW model during the PEST simulations. Vertical hydraulic conductivity is very rarely measured in the field, so there are no direct measurements for this parameter. However, it is commonly acknowledged that the vertical hydraulic conductivity of an aquifer is lower than the horizontal hydraulic conductivity. Therefore, the PEST constraints for vertical hydraulic conductivity were defined such that they were allowed to vary between 0.1 ft/day and 0.00001 ft/day. This range of variability is considered reasonable because vertical hydraulic conductivity of clays is very low, and significant amounts of clay in an area can significantly impede vertical movement of groundwater.

Separate zones of hydraulic conductivity were defined for each model layer within the Basin, and separate layers within each layer were defined for the areas of Edna Valley and San Luis Obispo Valley (within SLO Valley, separate zones were defined for the main part of the Basin and the "Antlers" area.

3.3.4. PEST Run Summary

The calibration statistics from the optimal PEST run are provided in Table 3-1. A residual (also referred to as error) is defined as the difference between the modeled head and the observed head at a particular calibration target location. Most modelers promulgate a calibration standard that considers both the numerical value of the residual, as well as the range of heads across the model domain. For example if the range of water levels across a model is 10 feet, an average residual of 10 feet is not adequate. But if the range of water levels across a model domain is 250 feet, then an average residual of 10 feet will likely be more than adequate. Several sources propose a standard that the Scaled Root Mean Square Error (that is, the root mean square of all residuals in the model divided by the range of heads observed in the calibration data), referred to hereafter as the Relative Error, be maintained at a level lower than 10% (ESI, 1999; Spitz and Moreno, 1996; ASTM, 2020). The results of this PEST run of the model using annual time steps meet the ASTM standards for groundwater model calibration. Because this model employed annual stress periods, the results did not capture the seasonal variability of water levels inherent in the calibration target data. Wells in the county water level program are monitored twice a year, in spring and summer, and so have to different measurements for each year. This version of the model only generates one water level per year.

Table 3-1: PEST-Generated Calibration Statistics for 35 Annual Stress Period Model

Residual Mean	3.35
Absolute Residual Mean	15.02
Residual Std. Deviation	20.26
RMS Error	20.54
Min. Residual	-122.31
Max. Residual	56.31
Number of Observations	1781
Range in Observations	235.25
Scaled Residual Std. Deviation	8.6%
Scaled Absolute Residual Mean	6.4%
Scaled RMS Error	8.7%
Scaled Residual Mean	0.014

The transient model with annual time steps just described was considered an interim version of the model whose primary purpose was to define an appropriate initial distribution of aquifer hydraulic conductivity for the Basin. Final calibration in the combined GSFLOW model was expected to change significantly, because many of the primary inflows such as recharge, streamflow, and mountain front recharge, which were directly defined in the MODFLOW-only model, would necessarily be generated by PRMS in the GSFLOW simulations and transmitted to MODFLOW for use in the simulations. This is a significant difference. Basic water budget terms needed to be re-assessed in terms of the PRMS-MODFLOW interface in GSFLOW. In addition, the daily time step/monthly stress period time discretization utilized in MODLFOW for the purposes of the integrated GSFLOW simulations creates significantly more detail and variability than the MODFLOW-only simulations.

Section 4. GSFLOW Model Development, Calibration, and Validation

The GSFLOW model is developed by integrating the PRMS and MODFLOW models described in Sections 2 and 3, respectively. The GSFLOW platform is designed to integrate PRMS and MODFLOW models and includes scripts for facilitating this integration. The GSFLOW model grid maintains the same 500-foot grid cells developed for PRMS and MODFLOW.

Model calibration of a groundwater model generally consists of matching simulated groundwater levels to historic water level measurements from wells in the Basin and of matching simulated surface water flows to historic streamflow gage data. This section describes the calibration process, including the modeling period, calibration approach and parameters, and specific calibration goals. In addition to the calibration goals listed below, the model output was evaluated to achieve a model mass-balance error that is within acceptable limits, defined as less than 1 percent based on USGS guidance (Reilly and Harbaugh, 2004).

4.1. Modeling Period

The GSFLOW modeling period will comprise a total of 35 years from Water Years 1985 through 2019. The first two years are considered a "windup" period wherein the model equilibrates prior to the formal calibration period beginning in Water Year 1987, which corresponds to the analytical water budget period. This period enables leveraging of the existing climate data and groundwater data that is available in the Basin. The model was run on daily time steps for the PRMS and GSFLOW and monthly groundwater modeling stress periods with daily time steps in MODFLOW.

4.2. Calibration Approach and Parameters

Calibration of the integrated GSFLOW model will consist of adjustment of specific parameters that govern the surface water and groundwater portions of the model domain. The model calibration approach and parameters that will be adjusted for the surface water and groundwater portions of the model are summarized in the following sections. While the individual calibration of the surface water and groundwater models are discussed in previous separate sections, the individual model calibrations will be confirmed in the coupled GSFLOW model and if further calibration adjustments were needed then parameters in PRMS, MODFLOW were altered

4.2.1. Surface Water

The surface water portion of the GSFLOW model was initially run in PRMS-only mode and then calibrated by comparing model-predicted flows to historic wet season streamflow gage data (Section 4.3.7). Calibrating the model for wet-weather flows in advance of integrating the models will aid the calibration of the groundwater portion of the model in GSFLOW by providing a well-defined spatial representation of groundwater recharge from rain events (Allander et al., 2014). The dry-weather surface water flows will be calibrated within the integrated GSFLOW model (i.e., in conjunction with the groundwater calibration described in Section 6.2.2), due to the inherent dependence of the low flows on the groundwater model. The calibration of dry-weather flows will be based upon comparison to historic streamflow gages, manual streamflow measurements, and wet-dry maps across different seasons and years (Section 4.3.8).

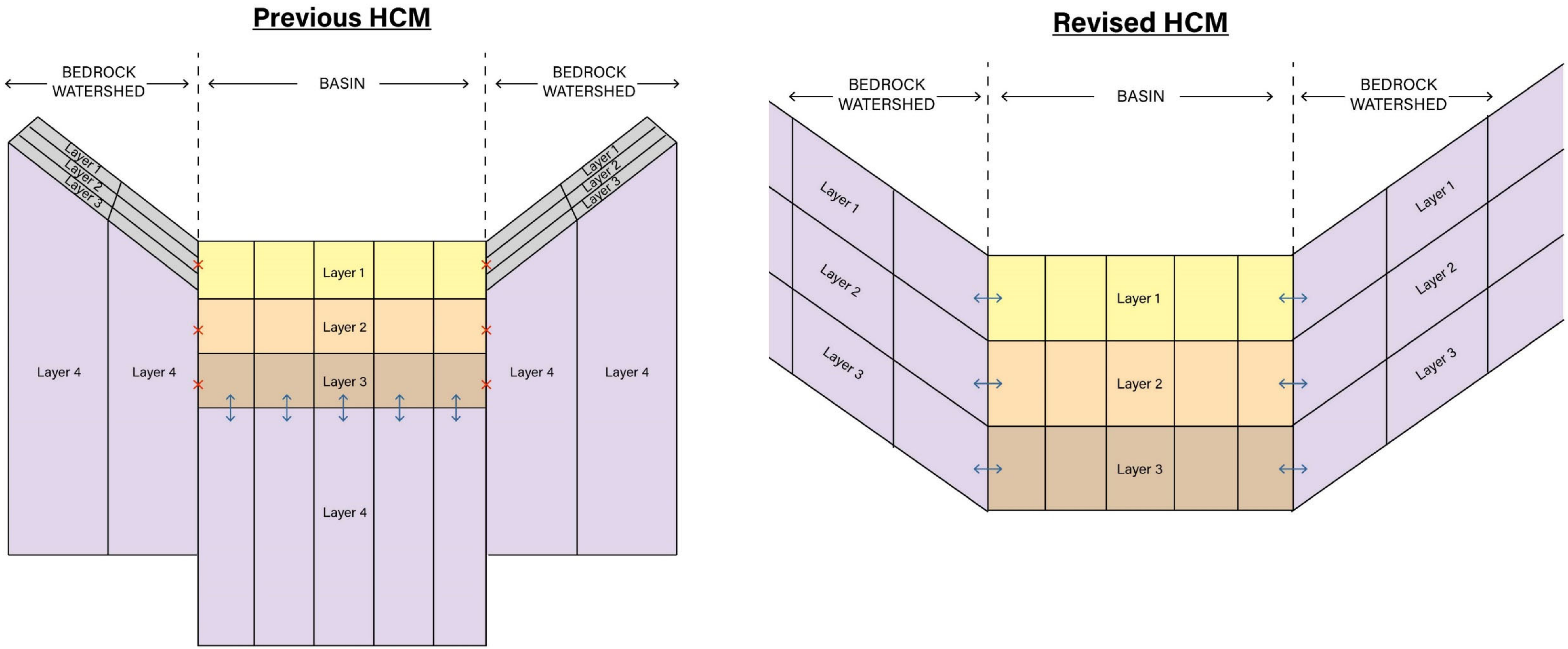
4.2.2. Groundwater

When the combined PRMS-MODFLOW integrated model was initially run in GSFLOW, the transient MODFLOW model was re-discretized temporally to simulate monthly stress periods with daily time step, as required in order to be consistent with the PRMS model. In addition, the Unsaturated Zone Flow Package was added to the MODFLOW model, which is a requirement of GSFLOW and provides the connection between surface and groundwater water from direct precipitation on land surface. After this, the integrated model was run in GSFLOW, and the results were evaluated to ascertain what changes were necessary to achieve a groundwater model calibration that meets the ASTM standards discussed previously.

Modeling problems were encountered with the integrated model that stemmed from the representation of Layer 4 (combined bedrock layer) that crops out in the contributing watershed area and underlies the Basin. These geologic formations are not part of the groundwater basin, and are not really aquifers in the usual sense of the word; they do not readily yield groundwater usable in economic quantities. However, because of the requirements of GSFLOW, it is necessary to include these formations in the groundwater model because the watershed area is an important part of the surface water model.

The primary function of the contributing bedrock watershed area to the groundwater model is to receive output from PRMS, to generate and deliver streamflow to the SFR cells and ultimately to the main area of the basin, some recharge to the fractured bedrock, and flux between the bedrock and the basin sediments. In the original conceptual model developed for this project, the combined bedrock of Franciscan Assemblage, Monterey Formation, and Obispo Formation was to be represented as a single layer, with appropriate parameter estimates assigned for hydraulic characteristics such as hydraulic conductivity, transmissivity, and storativity. Problems arose due to the relatively large area of the bedrock layer as a single layer, with unreasonable quantities of storage needed to be accepted into the layer, and transmitting unreasonable quantities of flux through the bottom of Layer 3 to achieve model calibration. In addition, there was no flux between the bedrock layer and the margins of the Basin, since Layers 1, 2, and 3 pinch out at the margins. Thus, the water budget component of mountain front recharge, as conceptualized in the HCM, was not properly being simulated in the model runs with the original single Layer 4 to represent the bedrock.

Ultimately, it was decided to revise the HCM in order to more realistically represent hydrologic processes in the bedrock layer. Instead of a single monolithic model layer representing the bedrock in the contributing watersheds, the model was changed so that the bedrock was represented by 3 layers. These layers would be analogous to, and in direct contact with Layers 1, 2, and 3 in the Basin, and would not extend beneath the Basin sediments in the main part of the Basin. This conceptualization, displayed in Figure 4-1, allows the model to more readily transmit hydrologic fluxes across the Basin margins and achieve calibration with water derived from the watershed areas without having to resort to an unrealistic upward flux from the original Layer 4. Because the adjusted HCM can now transmit water as mountain block recharge directly to Layer 1, 2 and 3 the original HCM Layer 4 is not needed and was removed to reduce the model run time. Additionally, the streamflow model cells that used to be in Layer 4 were move to Layer 1 with extended thickness below and near the streamflow cell to represent some streamflow infiltration into the fractured bedrock system.



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Author: EC

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SAN LUIS OBISPO VALLEY BASIN GSP

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Groundwater Hydrogeologic Conceptual Model

Figure 4-1

4.3. Calibration Goals

The model calibration goals for the surface water and groundwater portions of the model are presented in the following sections. While the surface water and groundwater calibration goals are discussed in separate sections, the final calibrations were performed in the coupled GSFLOW model.

4.3.1. Surface Water

The surface water evaluation of the GSFLOW model consists of a 'weight of the evidence' approach (Donigian, 2002) where both qualitative graphical comparisons and quantitative statistical comparisons are made. Graphical comparisons generally include visual evaluation of timeseries plots comparing the measured and simulated flow rates at calibrated stream gages, while quantitative comparisons may include calculating a range of standard statistical measures. This approach is nearly identical to the approach taken to evaluate the surface water model calibrated in PRMS-only mode as described in 2.4.3.

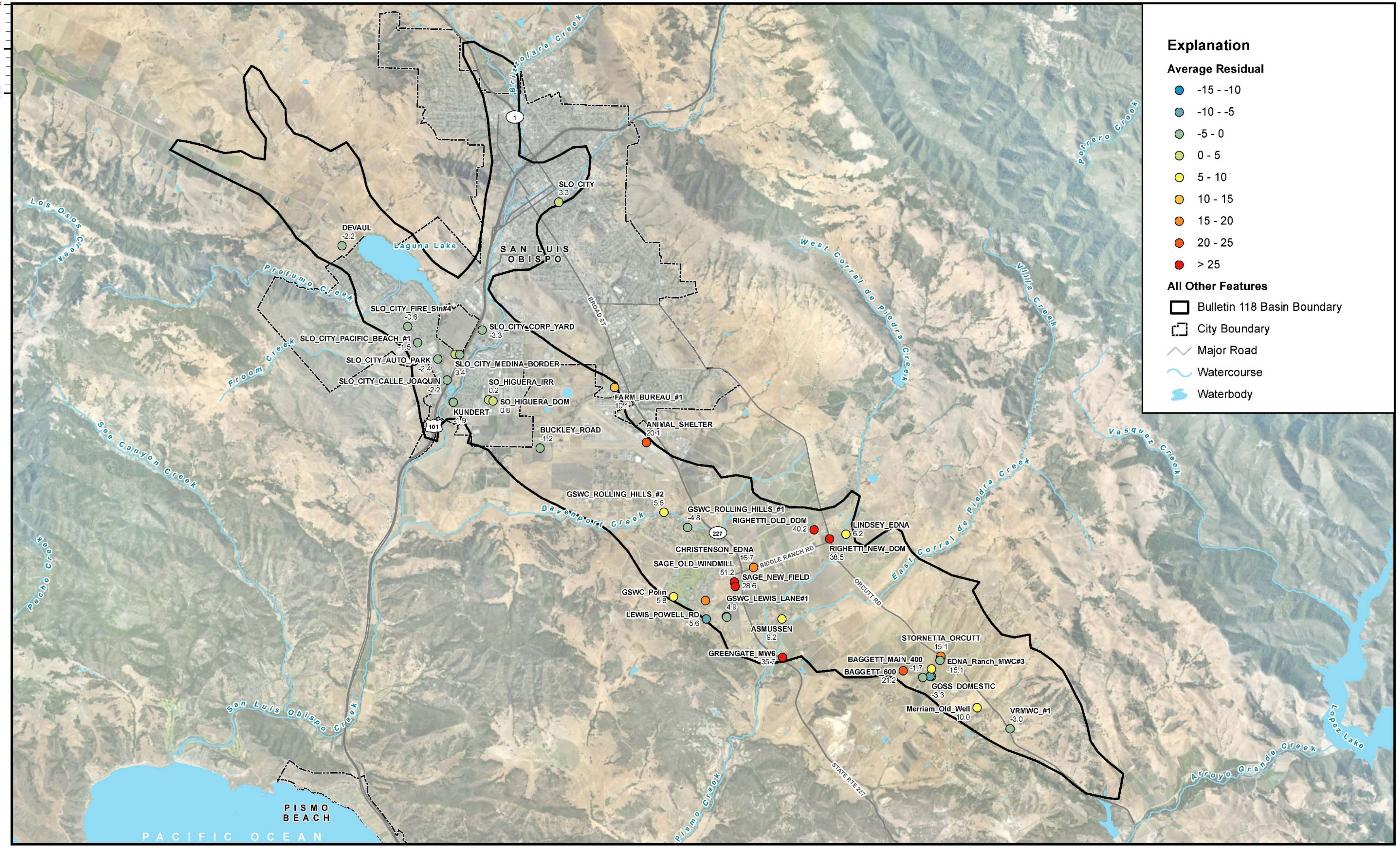
Table 4-1- presents the range of goodness-of-fit criteria as outlined for the Santa Rosa Plain Model (Woolfenden & Nishikawa, 2014) and includes the RMA R^2 categories to further evaluate model fit. The optimal goal is to achieve calibration results within the "Very Good" or "Excellent" range, however, as described in 2.4.3 this may not be feasible.

Table 4-1: Surface water model goodness-of-fit statistics calibration goals.

Goodness-of-fit Category	RMA R^2	PAEE (%)	AAEE (%)	NSME
Excellent	0.9	-5 to 5	≤0.5	≥0.95
Very Good	0.8	-10 to -5 or 5 to 10	0.5 to 1.0	0.85 to 0.94
Good	0.7	-15 to -10 or 10 to 15	10 to 15	0.75 to 0.84
Fair	0.6	-25 to -15 or 15 to 25	15 to 25	0.6 to 0.74

4.3.2. Groundwater

The groundwater model is evaluated primarily on the statistical evaluation of residuals in modeled head (groundwater surface elevation) across the model domain. As previously discussed, the primary goal is to achieve a relative error of less than 10% (ESI, Spitz and Moreno, ASTM). Additional analysis includes scatter plots of observed versus modeled residuals to identify any particular areas that are problematic in the model, and graphs of residuals versus time is presented to identify any model-wide change in residual with time, and to identify if the model has a bias toward positive or negative residuals. Groundwater elevation hydrographs for calibration targets are considered in this statistical evaluation, and are presented in Appendix B. A map displaying the locations of groundwater calibration targets, and the average residual for each target location, is presented as Figure 4-2.



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Author: AB
Date: 7/16/2021

SAN LUIS OBISPO VALLEY BASIN GSP

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0 0.425 0.85 1.7 Kilometers

References:
1. Coordinate System: NAD 1983 StatePlane California V FIPS 0405 Feet
Projection: Lambert Conformal Conic
Datum: North American 1983
2. San Luis Obispo County aerial photo, 2018.
3. USGS

SLO Groundwater Model Calibration Target Locations and Average Residuals

Figure 4-2

After the model-wide calibration goals were achieved, iterative additional simulations continued to be run to attempt to achieve a better fit between modeled and observed data at the specific wells identified as representative wells. In particular, the representation of surface water/groundwater interaction along Corral de Piedras Creeks in the Edna Valley, as expressed in transient groundwater elevations in alluvial wells along the stream course, will continue to be evaluated and a better fit for these alluvial wells will be attempted. The final output of calibration statistics for the GSFLOW model is presented in Table 4-2.

Table 4-2: Integrated GSFLOW Groundwater Model Statistics

Residual Mean	5.6
Absolute Residual Mean	12.8
Residual Std. Deviation	17.4
RMS Error	18.3
Min. Residual	-66.7
Max. Residual	79.5
Number of Observations	2563
Range in Observations	239
Scaled Residual Std. Deviation	7.3%
Scaled RMS Error (Relative Error)	7.6%
Scaled Absolute Mean	5.3%

Summaries of calibration statistics for the Representative Wells identified in Chapters 7 and 8 of the GSP in San Luis Valley, Edna Valley area, and for the combined basin area are presented are presented in Table 4-3. The calibration statistics for the Representative Wells are better than for the model overall.

Calibration figures are presented in Appendix B. Scatter plots of observed versus modeled residuals for the entire model area are presented in Figure B-1. This plot corresponds to the calibration statistics is presented in Table 4-2. Distribution of residuals with time for the entire model area are presented in Figure B-2; these results do not indicate any temporal bias in residuals in the model. Scatter plots and graphs of residuals with time for the SLO Valley representative wells and Edna Valley representative wells are presented in Figures B-3 through B-6.

Final calibrated hydrographs for 42 wells used as calibration targets are included in Appendix B. Hydrographs for wells in San Luis Valley are included as figures B-7 through B-21. Hydrographs for wells located in Edna Valley are presented in Figures B-22 through B-48. Inspection of all 42 hydrographs indicates that the model results approximate observed water levels adequately for the model to be used to assess projects and management actions in this GSP.

Table 4-3 GSFLOW Groundwater Calibration Statistics for Subsets of Model Domain

Calibration Target Subset	Mean Residual (ft)	Residual Standard Deviation (ft)	Relative Error	Well Count
San Luis Valley Representative Wells	2.2	10.8	6.1%	5
Edna Valley Representative Wells	0.4	14.3	6.1%	5
All Representative Wells	0.9	13.6	5.8%	10

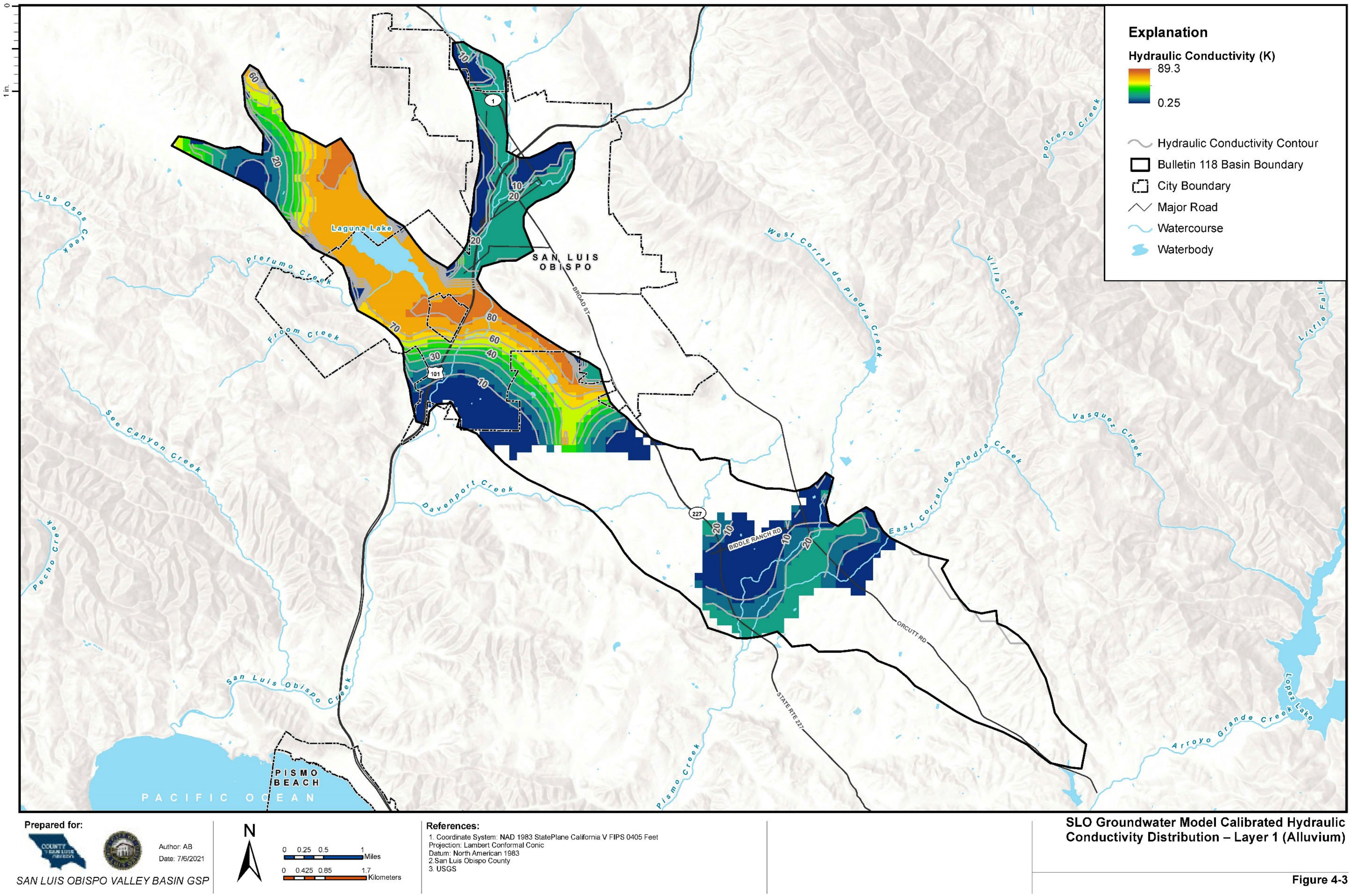
The response of the basin aquifer to various stresses observed in the period of record are accurately captured in the model results. Long-term trends of declining water levels in Edna Valley, and the response to pumping and drought conditions in the San Luis Valley in the early 1990s, are reflected in the model results. It is acknowledged that some wells do not display modeled groundwater levels that accurately capture the seasonal fluctuation observed in the field data. This is an area for improvement that will be discussed further at the end of this TM.

The primary model parameters that affect modeled groundwater elevations are hydraulic conductivity and storativity. Figures 4-3 through 4-5 display the calibrated hydraulic conductivity fields for model Layers 1 (Alluvium), 2 (Paso Robles Formation), and 3 (Pismo Formation). Table 4-3 presents the range and average hydraulic conductivity values for each model layer.

Figures 4-6 through 4-8 present the final calibrated model distribution of specific storage for the model. (Specific storage is multiplied by aquifer thickness to calculate aquifer storativity; specific storage is the parameter required by MODFLOW to define storage in the model.) Table 4-4 presents the range and average values of specific storage for each of the model layers.

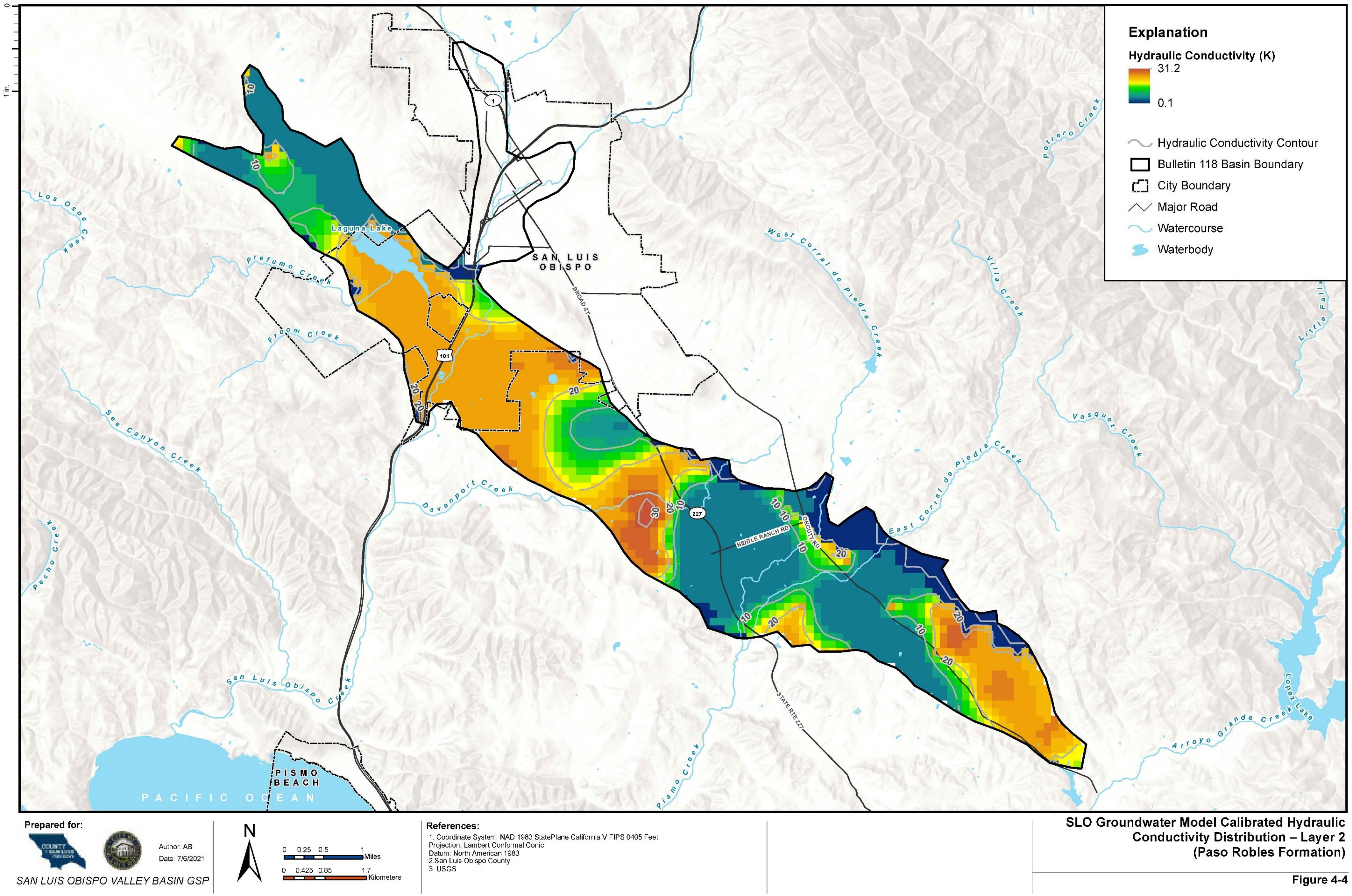
Table 4-4 Calibrated GSFLOW Groundwater Model Parameters

Model Layer	Hydraulic Conductivity (ft/day)			Specific Storage (1) (unitless)			Streambed Conductance (ft2/day)		
	Average	Max	Min	Average	Max	Min	Average	Max	Min
1	34.2	89.3	0.25	4.2E-4	9.8E-3	1E-6	1.4	10	0.1
2	14.2	31.2	0.1	9.3E-5	1.5E-3	1E-6	na (2)	na	na
3	8.9	50.0	0.1	1.0E-4	1.5E-3	1E-6	na	na	na
Notes: 1. Specific Yield was set at 0.05 for all layers. 2. na = not applicable. (Streams only represented in Layer 1).									



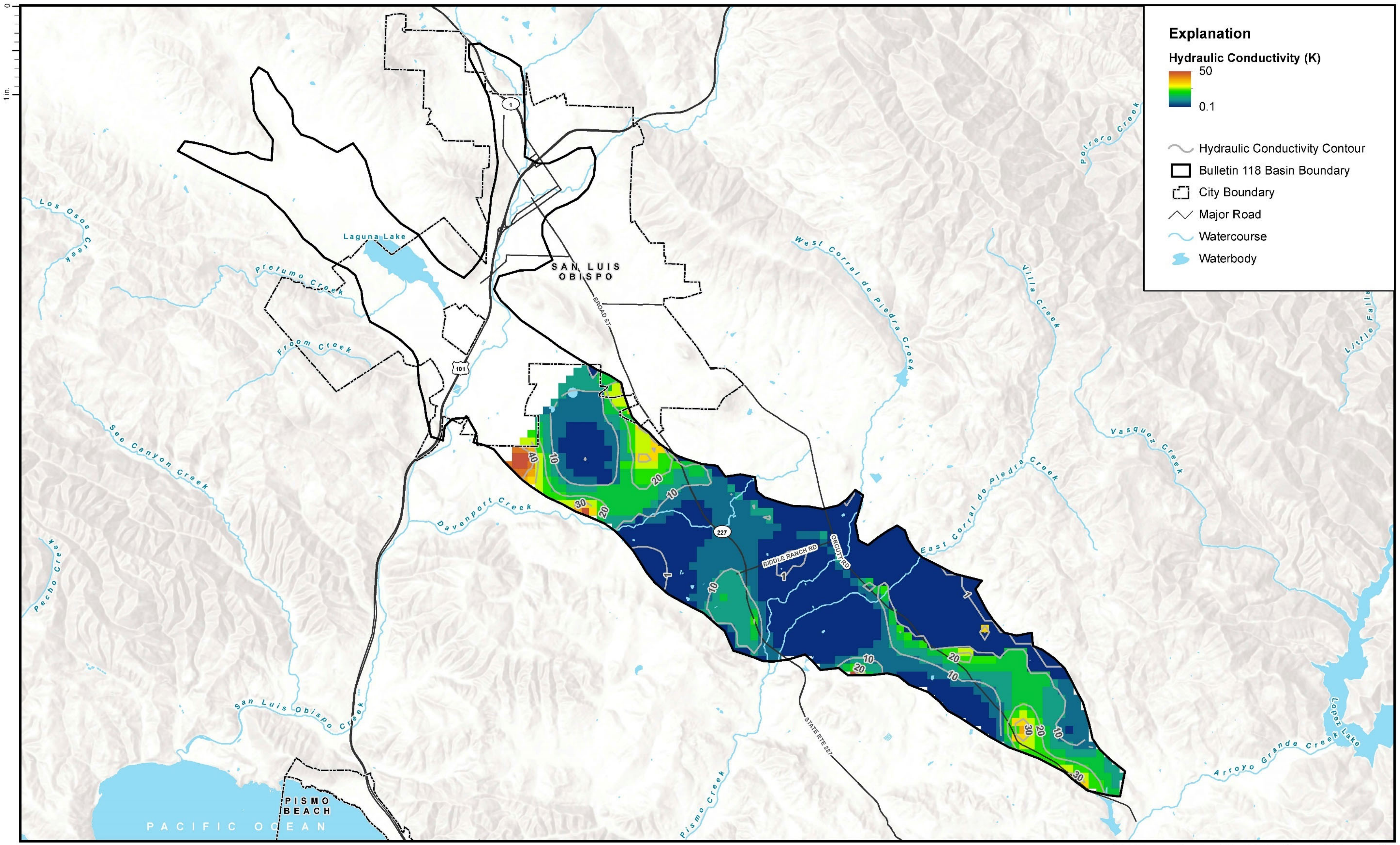
SLO Groundwater Model Calibrated Hydraulic Conductivity Distribution – Layer 1 (Alluvium)

Figure 4-3



SLO Groundwater Model Calibrated Hydraulic Conductivity Distribution – Layer 2 (Paso Robles Formation)

Figure 4-4



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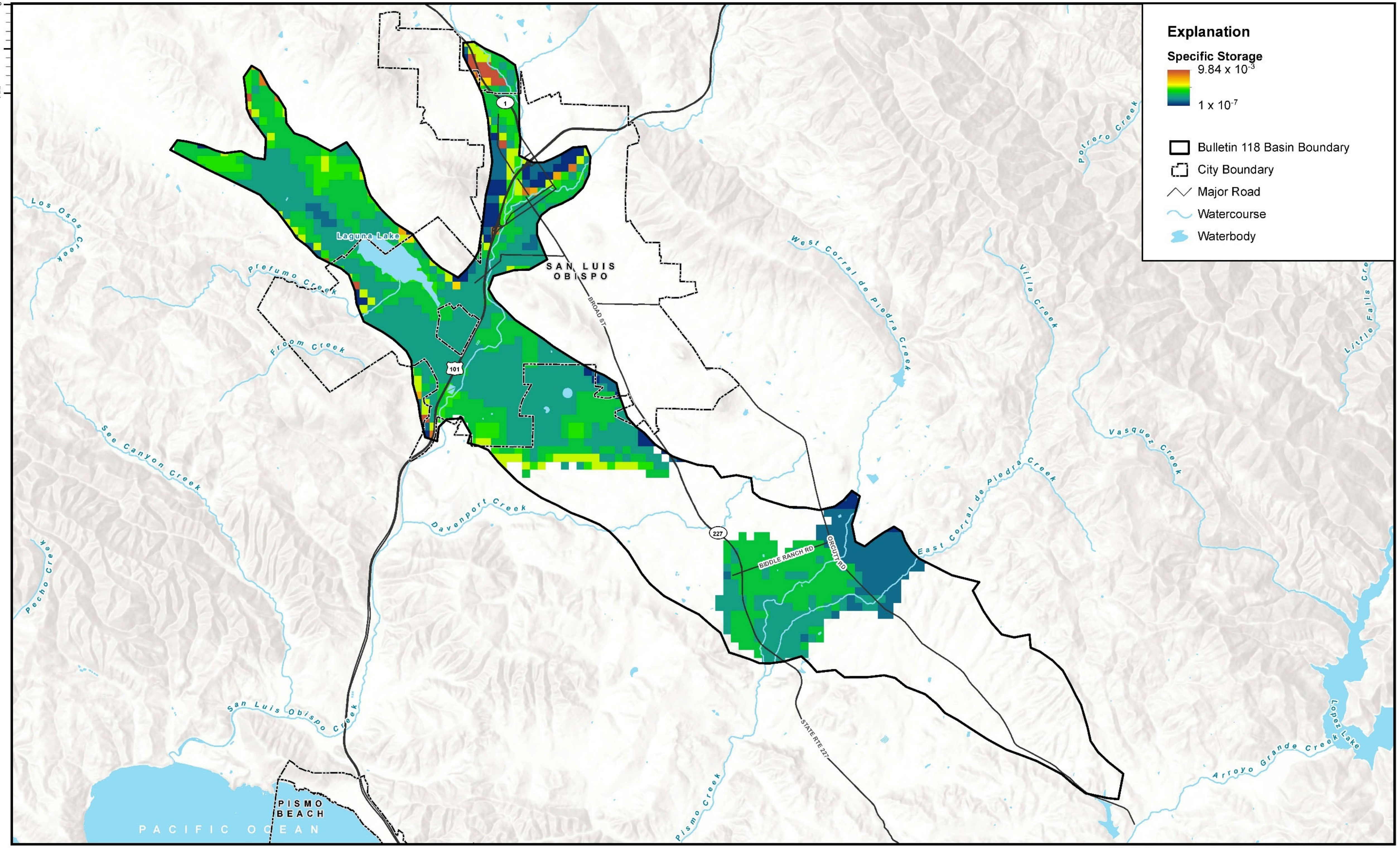
References:
1. Coordinate System: NAD 1983 StatePlane California V FIPS 0405 Feet
Projection: Lambert Conformal Conic
Datum: North American 1983
2. San Luis Obispo County
3. USGS

SLO Groundwater Model Calibrated Hydraulic Conductivity Distribution – Layer 3 (Pismo Formation)

Figure 4-5



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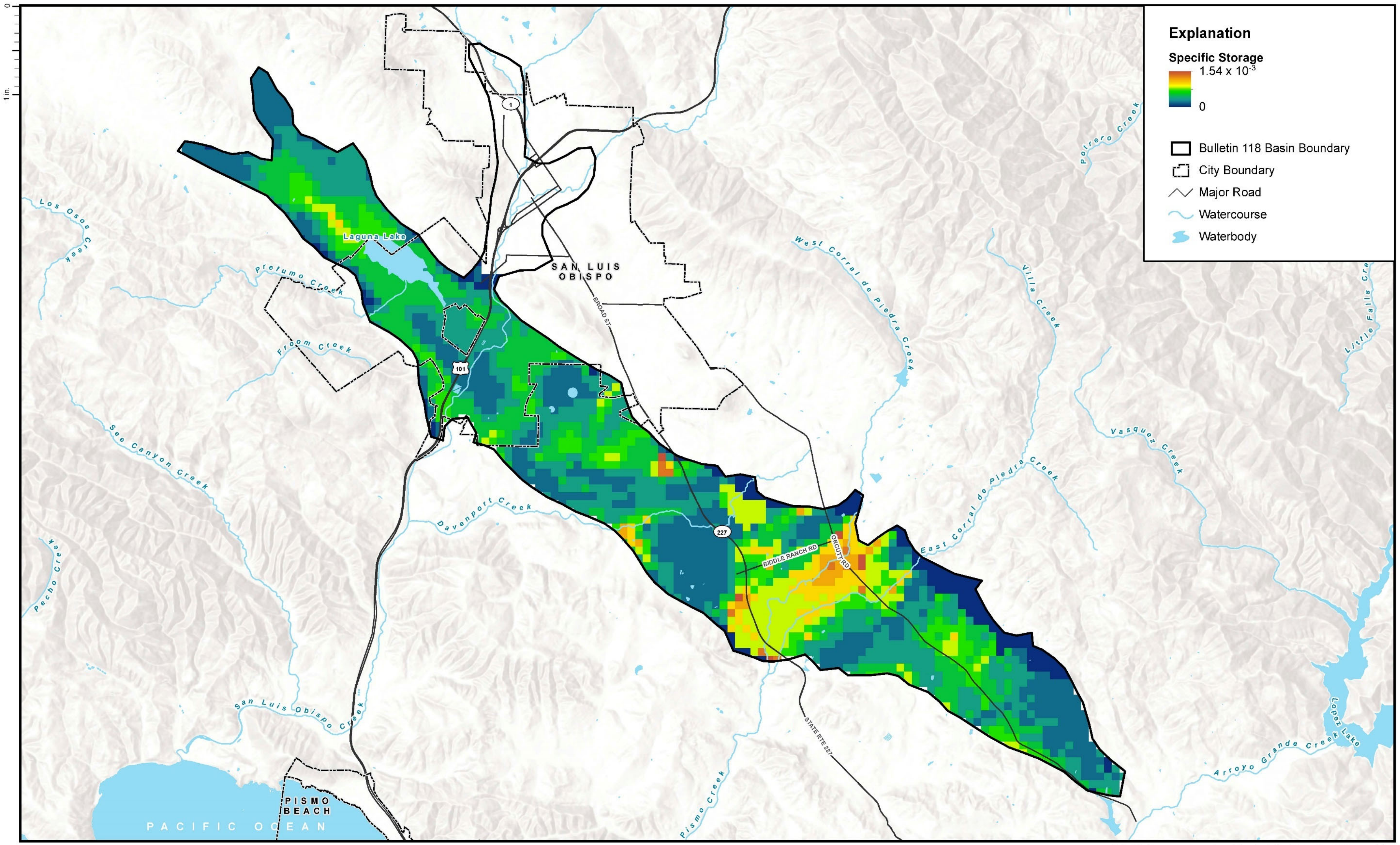
3. USGS

SLO Groundwater Model Calibrated Specific Storage Distribution – Layer 1 (Alluvium)

Figure 4-6



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Author: AB
Date: 7/6/2021

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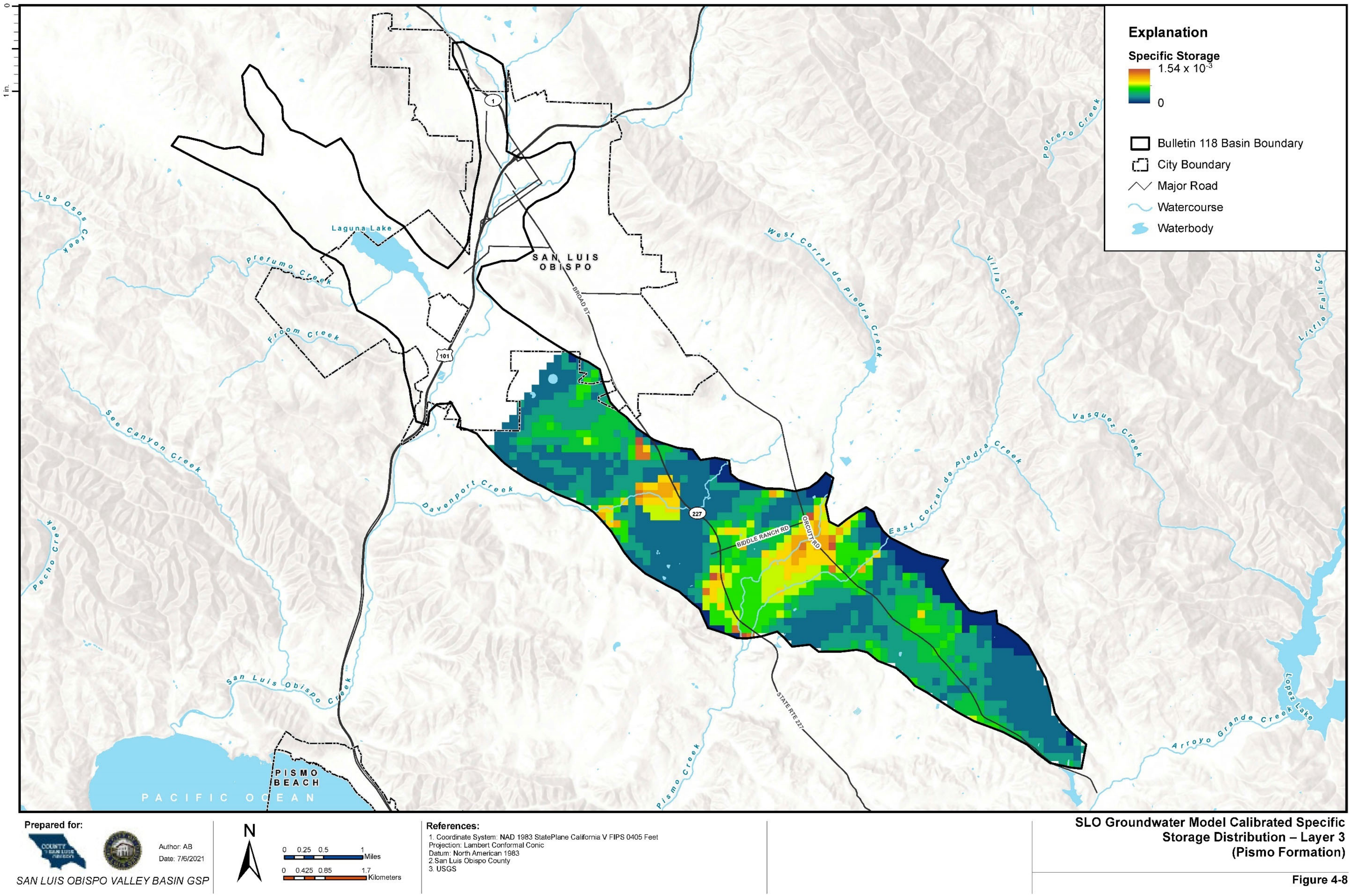
Projection: Lambert Conformal Conic
Datum: North American 1983
2.San Luis Obispo County
3. USGS

SLO Groundwater Model Calibrated Specific Storage Distribution – Layer 2 (Paso Robles Formation)

Figure 4-7



SLO Groundwater Model Calibrated Specific Storage Distribution – Layer 3 (Pismo Formation)

Figure 4-8

Section 5. Sensitivity Analysis

Sensitivity analysis is the process of identifying the model parameters that have the most effect on calibrated model results. The general approach to complete a sensitivity analysis is to systematically vary selected model parameters or boundary conditions, and measure their effect on model results. Model results may be assessed using modeled water levels or calibration statistics.

For the purpose of evaluating the integrated model, the following parameters were selected for sensitivity analysis. These parameters were selected based on previous modeling experience with identification of sensitive and significant model parameters, and consideration of the local hydrogeologic setting. The summary of calibrated values for these parameters are presented in Table 4-4. (The values for pumping used in the model were obtained from the analytical water budget analysis.)

- Horizontal hydraulic conductivity.
- Storage (specific storage and specific yield)
- Streambed Conductance
- Pumping

Each of these parameters was varied by plus and minus 20% of the final calibrated value. The effect of this variation in parameter values on the calibrated model is measured by the effect on the sum of residuals squared (RSS), a common calibration statistic. Results are presented in Figure 5-1, and discussed below.

The most sensitive parameter among the four parameters evaluated is pumping. The change in the RSS from the calibrated model ranged from -8.7% to 8.2% of the baseline RSS value. Municipal and agricultural pumping was estimated during the water budget based on available information regarding agricultural practices and residential development, and these estimates were incorporated into the model. Pumping locations were assigned based on GIS well data provided by the county. It was observed during calibration that the distribution of agricultural pumping locations had a significant impact on calibration of representative wells in the Edna Valley. One of the management actions proposed in the Implementation Plan (Chapter 10 of the GSP) is a well metering and reporting program to gather information on non-de minimis wells in the Basin. This plan will provide better data on pumping amounts and locations within the Basin, and will inform future revisions to the model.

The second most sensitive parameter among the four parameters evaluated is aquifer storage. The change in the RSS from the calibrated model ranged from 5.3% to -3.8% of the baseline RSS value. Data on storativity in the Basin is sparse. It is necessary to measure water levels in an observation well during a constant rate aquifer test in order to calculate storativity, and this is rarely done for municipal or agricultural wells. Values typical of confined aquifers were used as initial estimates, and some distribution of storativity values was generated using PEST. Storativity can have a significant impact on seasonal fluctuations of water levels in an aquifer. This parameter should be evaluated further in future model revisions.

The third most sensitive parameter among the four parameters evaluated is streambed conductance. The change in the RSS from the calibrated model ranged from 1% to -0.9% of the baseline RSS value. Streambed conductance is a lumped parameter conceptually incorporating hydraulic conductivity of alluvium, model cell size, and thickness of alluvial sediments. It is not directly measurable. Streambed conductance may have a more significant effect on modeled water levels in the Edna Valley than the San Luis Valley due to the seasonal recharge from East and West Corral de Piedras Creeks, and observed water level fluctuations that mimic surface water flow patterns.

The least sensitive parameter among the four parameters evaluated is horizontal hydraulic conductivity. The change in the RSS from the calibrated model ranged from 1% to 0.1% of the baseline RSS value. This is the only parameter among those evaluated that had higher RSS values than the baseline calibrated value for both the increase and decrease of parameter value variations. This indicates that the calibrated horizontal hydraulic conductivity field may be close to optimal, and significant changes in the distributed parameter field don not have correspondingly large effects on calibration.

Uncertainty analysis is an option for model evaluation that is mentioned in the DWR Groundwater Modeling BMP document. In uncertainty analysis, the methodology is essentially identical to that of sensitivity analysis, in that model parameters are varied and the effect on model output is evaluated. However, in uncertainty analysis, variation of model parameters is performed on the predictive model (instead of the calibrated historical model), and results are measured as changes in water level from the calibrated predictive model runs (instead of changes on calibration statistics). The modeling team judged that given the admitted uncertainty regarding pumping volumes and locations, streambed parameters, and storage parameters, that a formal uncertainty analysis is likely premature. The results would likely be quite similar to the sensitivity analysis just presented. It will be considered during any future revisions to improve the model.

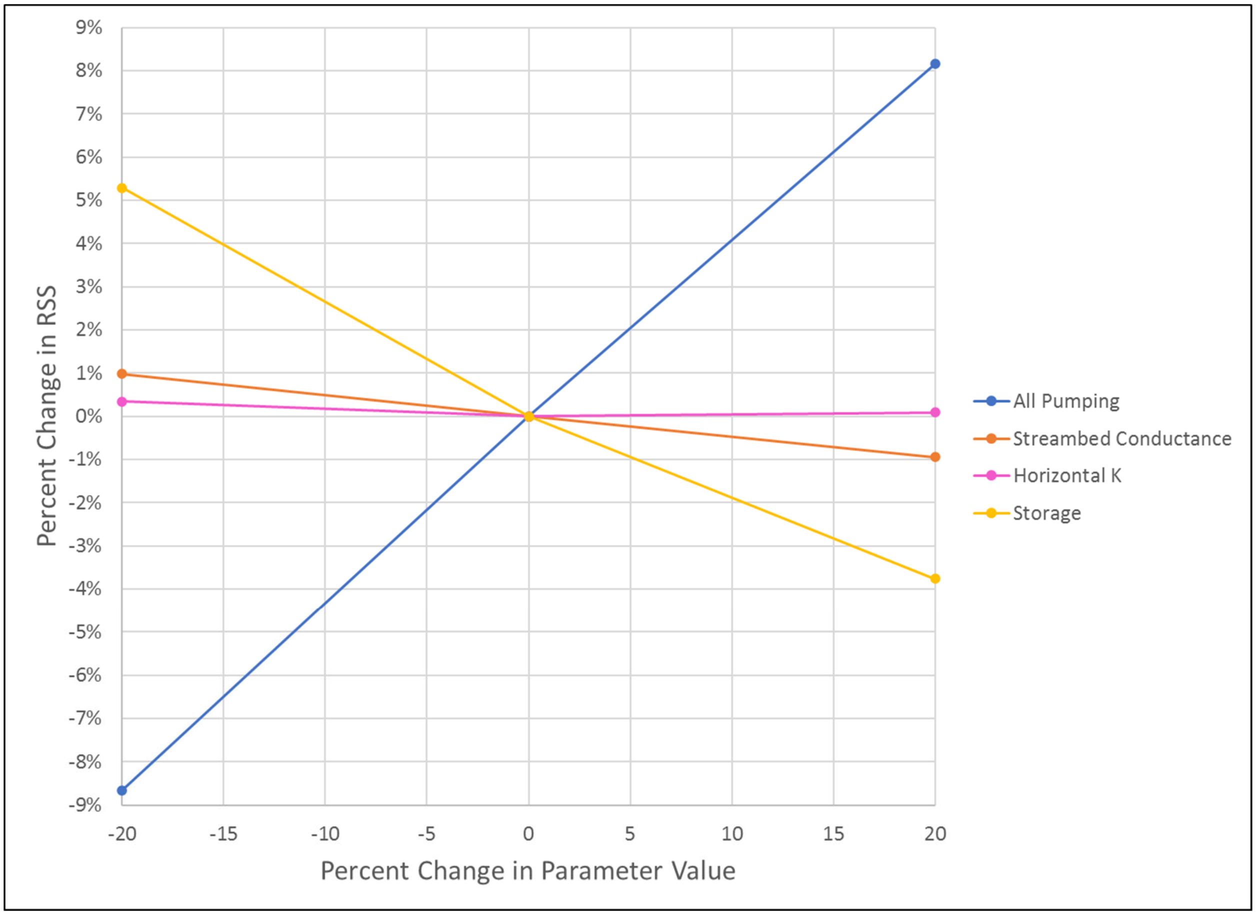


Figure 5-1. Model Sensitivty Analysis Results

Section 6. Summary, Areas for Model Improvement, and Next Steps

This TM has presented the data summary, revised HCM, final model calibration results, and sensitivity analysis for the GSFLOW model of the San Luis Obispo Valley Groundwater Basin and its contributing watersheds. The model calibration results are within industry standards, and the model is judged by the modeling team to be adequate for the objective of assessing projects and management actions identified in the GSP.

Projects and management actions identified by the GSAs as potential actions to assess using the model include reduction of agricultural pumping, reduction of mutual water company pumping, installation of a recharge basin, and relocation of the Sentinel Peak Pismo Creek discharge point from its present location to a location within the Basin. These simulations were performed. Changes in water levels from baseline conditions at representative wells are documented in Chapter 9 of the GSP.

The GSP process mandated by SGMA requires updates to the GSP every 5 years. During these updates, models may be revised considering new data and information collected during the intervening period between the last version of the GSP and the new one. As such, it is expected that this GSFLOW model will be updated to incorporate new data generated by an improved monitoring network, updated water level data from existing calibration targets, potential revisions to the HCM, and other factors. During the development of the model, numerous areas were identified as areas for potential improvement when the GSP is updated in 5 years. Some of these are discussed below.

Potential areas for model revision and improvement include:

1. Representation of the groundwater/surface water interaction in Edna Valley is a significant area to focus on in the future. Although long-term trends in water level declines were captured, many of the modeled results for wells in the vicinity of West Corral de Piedras Creek do not accurately capture the amplitude of seasonal or drought cycle fluctuations in water levels. Because of their proximity to the creek, it is speculated that there may be a stronger influence of seasonal surface water flow on water levels in this area than the model is capturing. Improvements to the surface water monitoring network as proposed in Chapter 7 of the GSP will provide important additional data describing the surface water flow regime that could help with this important component of the Basin aquifer system.
2. A revision to the HCM to include a fourth model layer representing bedrock beneath the Basin may be appropriate. If this change is implemented it may more accurately represent some wells that are screened in both the alluvial sediments and the underlying Monterey Formation, and simulate the expected vertical flow from underlying bedrock into the lowest of the aquifer strata throughout the Basin. In addition, it may not be necessary to have all four layers active in the upper watershed. It may improve run times if only the top layer is active in the upper part of the bedrock contributing watershed, and incorporate bedrock layers two through four closer the Basin boundary.
3. A more detailed evaluation of vertical hydraulic conductivity (Kv) for all three model layers in the Edna Valley may help the representation of seasonal and drought cycle water level fluctuations for wells in this area. Kv was initially determined during the PEST runs of the annual

stress period version of the model, allowing Kv to be estimated independent of horizontal K. Much of the PEST-generated distribution was manually revised during final calibration. A closer inspection of Kv in areas where seasonal amplitude of water level changes is not captured may be appropriate.

4. Assess and improve precipitation input distribution and increase volume, especially from 1995-1998, because water levels in Edna do not exhibit the rise that they get in the comparable wet water year 2005. Because of the water year 2005 water level response, the model response to wet years appears adequate, so it is inferred that the spatial distribution of precipitation input can possibly be improved.
5. Modeled change in storage calculation for period of record for both SLO Valley and Edna Valley are less than the analytic estimates presented in Chapter 6 of the GSP (water budget), especially in Edna Valley. Again, the change in storage is level during wet period from WY 95 thru 98 which is counter intuitive; the model needs more water during this period.
6. Outflow from the entire SLO basin is modeled as an average of 10,500 AFY whereas the analytic estimate presented in Chapter 6 is 16,000 AFY. If the water budget estimate is closer to reality, (which is uncertain since there is no reliable stream gage data measuring flow out of the basin), then this indicates the model could use more precipitation volume input. Improvements in the Surface Water monitoring network proposed in Chapter 7 of the GSP will help with this evaluation.
7. Based on items 4 through 6, it appears that model may be running on the dry side which leads to more numerical convergence issues and mass balance discrepancies, and to counter this the GW model "borrows" water from the basin outflow. The model fails to reach convergence during 29 daily time steps out of the 12,783 daily GSFLOW iterations. The groundwater model has zero mass balance errors for all the 12,783 time steps. The surface water component of GSFLOW model has significant mass balance errors for 12 of the 12,783 days, which occur during very wet days. Eleven of the 12 occurrences and a mass of approximately 50 to 100 acre-ft per month or 10% of the total flow of that month. On the wettest day on 1-3-2006 a mass balance error of 3,000 acre-ft per month occurs or 10% of the total flow for that month.
8. Based on item 7 the model could be numerically improved for those 12 days. However, without reliable stream gage data we will not know if this error actually makes the model better or worse. Nor do we know if Chapter 6 water budget estimates (16,000 AFY) are better or worse than the modeled outflow results (10,500 AFY). It is therefore important to install stream gages that measure the outflow of the basin at key locations so we can more reliably estimate the correct volume of surface water leaving the basin. With this improved surface water outflow estimates, it would makes sense to address and improve on the issues mention in Bullet 4 thru 7 for the 5-year model update.
9. Groundwater evapotranspiration was not explicitly modeled because the UZF Package removed water above ground surface during the simulation that effectively conceptualized as ET. This was primarily due to long model run time issues during calibration process. Now that the model is calibrated and has a comparatively shorter run time (4-5 hours) it may make sense to explicitly model groundwater ET during future revisions to provide a little bit more spatial control of how much and where it happens. Groundwater ET is minimal in the Edna Basin and predominantly occurs SLO Basin, but the since the model calibration is excellent in the area of known groundwater ET statistically we do not expect great improvement with respect to water levels.

10. Water level calibration has the largest residuals either close to the mountain front (northern Basin boundary) or in the main SLO/Edna border pumping depression. Improvements near the mountain front could be effected through structural changes in local layer elevations, storage, pumping, return flow and/or K, but local refinement of these parameters were not very sensitive.
11. Similarly, the water levels in Greengate and Christensen Representative Wells were also not very sensitive. It may be advisable to revisit PEST for a more focused assessment of K and S in these area; however, it is not practically feasible to use PEST for a model that takes 4 to 5 hours to run. In addition for these two key wells pumping distribution was varied to greater success. For the key wells a more detailed evaluation of agricultural pumping in their vicinity will be collected through the proposed metering and reporting program.
12. Implementation of the metering and reporting program for non-de minimis wells in Edna Valley will provide important information with respect to the volume and distribution of pumping in Edna Valley. It was determined during calibration and during sensitivity analysis that model results are quite sensitive to pumping data. More accurate data on well locations and reported pumping will be a significant improvement over the estimated values used to date.

Next steps that will provide improvement to any model updates as outlined in Chapter 10 of the GSP (Implementation Plan) include implementation of an expanded groundwater level monitoring network, installation of multiple stream gages in the Basin (and development of reliable rating curves for existing gages on San Luis Creek), implementation of a metering and reporting plan for non-de minimis wells.

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Appendix A –Groundwater Hydraulic Parameters

Appendix A Table of Contents

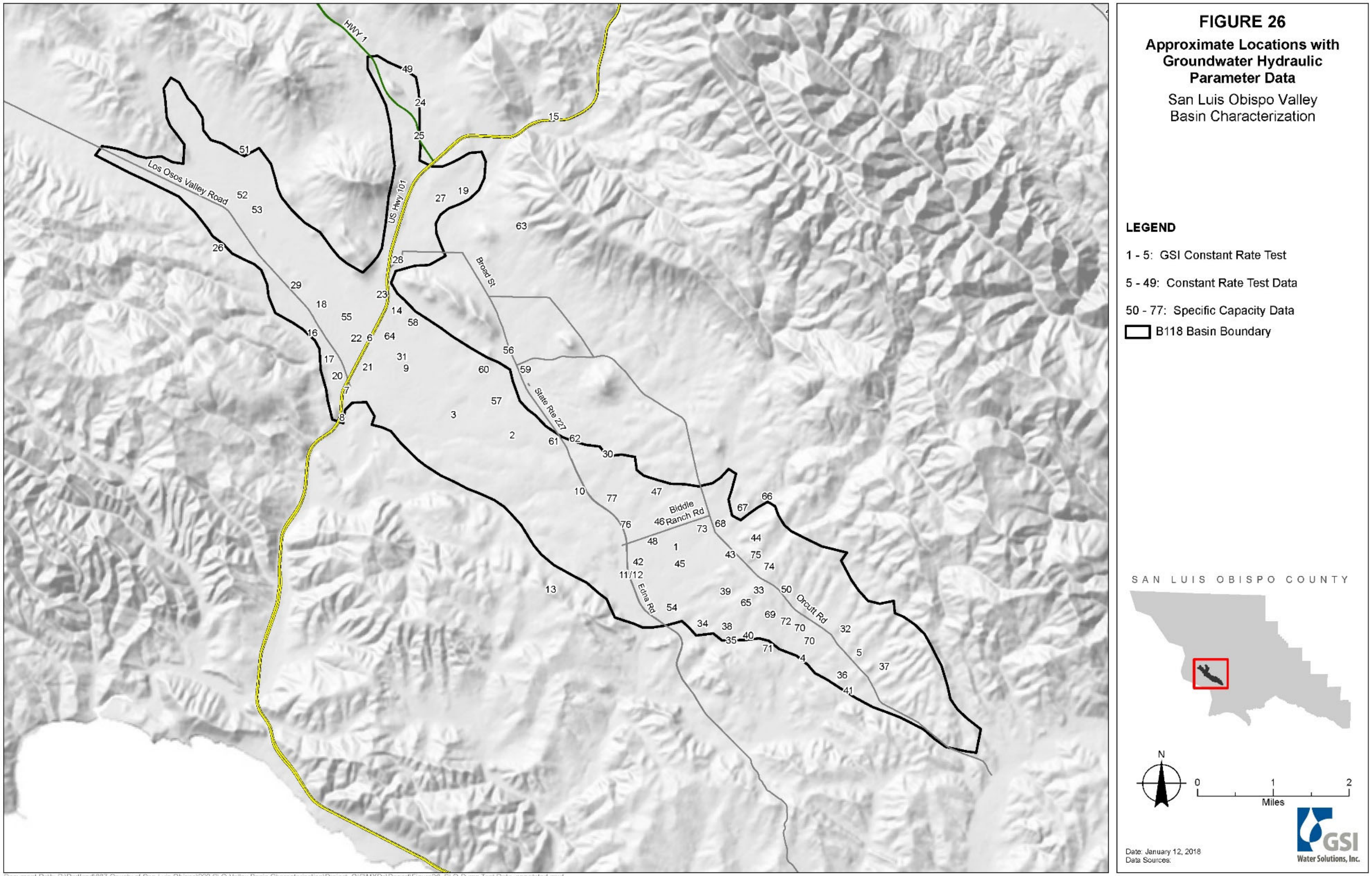


FIGURE 26
Approximate Locations with Groundwater Hydraulic Parameter Data
San Luis Obispo Valley Basin Characterization

San Luis Obispo Valley Basin water well pump test data summary

Label No.	Date Drilled	Pump Test Date	Pumping Rate (GPM)	Static Water Level (feet bgs)	Pumping Water Level (feet bgs)	Drawdown (feet)	Specific Capacity (gpm/foot)	Est. Transmissivity (gpd/foot)	Screen Length (feet)	Hydraulic Conductivity (ft/day)	Total Depth (feet)	Perforations	Formation Screened
1		7/31/2017	60	74.3	133	58.7	1.02	2,880 - 4,525	280	1.37 - 2.15	440	180-200; 240-380; 320-440	Pismo
2		8/8/2017	27	21	27.5	6.5	4.2	3,605 - 4,620			98		Paso Robles
3		8/24/2017	55	15.58	78	62.42	0.9	3,227 - 4,840					Paso Robles
4		11/21/2017	265	67.6	155.2	87.6	3.03	1,600	300	2.82 - 3.11	500	200-500	Pismo
5	12/4/2017	12/9/2017	37	132	144.9	12.9	2.87	5,692 - 9,678	200	3.8 - 6.5	300	90-290	Paso Robles/Pismo
6	2/7/2003	2/18-21/2003	350	7.5	39.6	32.1	11	23,100	60	51.3	145	45-85; 115-135	Alluvium/Paso Robles
7	1/31/2003	2/6/2003	400-450	8.92	28.67	19.75	33.3	66,600	45	197.3	80	25-70	Alluvium/Paso Robles
8	2/10/2003	2/19/2003	250	5.5	28.92	23.42	9.3	18,600	30	82.7	70	30-60	Alluvium/Paso Robles
9	4/18/1996	4/19-21/1996	3.7	11.86	23.36	11.5	0.32	187	15	1.7	70	52-67	Alluvium
10	1/23/2013	2/5-9/2013	135	46.78	114.41	67.63	2	3,992	60	8.9		80-100; 140-180	Paso Robles/Pismo
11	8/18/1992	5/31/1992	656	52.4	122.3	69.90	9.38	5,773	200	3.8	440	130-190; 290-430	Pismo/Bedrock
12	4/4/2001	5/9/2001	500	70	85	15	33.33	66,667	180	49.4	520	160-200; 370-510	Pismo/Bedrock
13		5/12-16/2014	149	258.25	295.1	36.85	4.35	8,700	190	6.1	550	280-420; 490-540	Pismo/Obispo or Bedrock
14	6/15/1988	6/30/1988	135	20.5	25.9	5.4	25	50,000	20	333.3	80	50-70	Alluvium/Paso Robles
15	7/12/1988	7/15/1988	80	24	42	18	4.44	8,889	30	39.5	57	27-57	Alluvium
16	7/22/1988	7/26/1988	300	11.5				Incomplete Data			140	40-130	Alluvium/Paso Robles
17	4/20/1989	5/16/1989	250	11.5	53.3	41.8	5.98	15,000	70	28.6	140	60-130	Alluvium/Paso Robles
18	7/27/1988	9/2/1988	95	22	59	37.0	2.57	5,135	70	9.8	180	55-125	Alluvium/Paso Robles
19	7/25/1988	8/4/1988	70	24	27.3	3.3	21.21	42,424	20	282.8	48	28-48	Alluvium
20	10/6/1989	10/24/1989	375	10.42	33.58	23.16	16.19	21,300	95	29.9	175	60-120; 140-175	Paso Robles/Pismo
21	6/28/1989	7/6/1989	200	10.4	38.5	28.1	7.12	21,120	60	46.9	175	50-90; 150-170	Alluvium/Paso Robles
22	4/26/1989	5/10/1989	900	11	39.3	28.3	31.80	63,604	80	106.0	140	42-122	Alluvium/Paso Robles
23		6/14/1989	500	20	47	27	18.52	37,037			60	?	Alluvium
24	12/22/1989	12/27/1989	50	11	31.2	20.2	2.48	4,950	15	44.0	53	33-48	Bedrock
25	4/18/1989	4/20/1989	100	14	26	12	8.33	16,667	10	222.2	44	34-44	Alluvium
26		7/18/1986	60	55	280	225	0.27	533	80	0.9	296	220-300	Bedrock
27		5/15/1989	80	9.92	31	21.08	3.80	26,400	20	176	49	29-49	Alluvium
28		4/22/1993	165	19.63	33.4	13.77	11.98	87,120	30	387.2	65	30-60	Alluvium
29		10/10/1990	25	39.5	78.5	39	0.64	400	80	0.67	145	60-140	Paso Robles
30		7/20/2011	20	46.5	272	225.5	0.09	177	140	0.169	300	160-300	Bedrock
31		6/26/1991	100	20	58	38	2.63	24,000	40	80	140	90-130	Paso Robles
32		4/12/1994	90	53.46	120	66.54	1.35	2,640	85	4.141	170	85-170	Pismo
33		6/26/1989	596	51.2	147.5	96.3	6.19	3,311	280	1.577	400	60-120; 160-360; 380-400	Paso Robles/Squire
34		6/15/2007	350	65.5	138	72.5	4.83	10,266				200-?	
35		6/15/2007	300	37.5	134	96.5	3.11	7,401				170-?	
36		6/9/1985	295	36.25	98.45	62.2	4.74	33,807			240		Paso Robles/Pismo
37		2/10/1997	300	110.2(?)	131.3	21.2	14.15	39,600	220	24	490	190-290; 350-410; 430-490	Pismo
38		8/6/2014	150	166	215	49	3.06	3,046			300		
39		8/7/2014	158	171	219	48	3.29	3,627			310		
40		12/12/2008	170	116	186	70	2.43	5,081					
41		12/22/2005	350	39.6	82	42.4	8.25	18,480	230	10.71	430?	200-430	
42		6/29/2016	150	131.8	226.1	94.3	1.59	10,850	100	14.47	290	180-280	Pismo
43		6/30/1993	100	39.66	78.83	39.17	2.55	1,508	60	3.35	110	50-110	Paso Robles
44		7/21/1993	70	10.5	21.5	11	6.36	2,174	40	7.25	100	20-40; 80-100	Paso Robles/Bedrock
45		3/25/2008	200	76.7	219.3	142.6	1.40	3,105	200	2.07	400	130-170; 220-380	Pismo
46		4/3/2007	300	34.6	112.3	77.7	3.86	9,542	260	4.89	480	220-480	Bedrock
47		4/9/2007	400	28.3	78	49.7	8.05	26,400	240	14.67	420	180-420	Pismo
48		12/17/2015	150	114	266	152	0.99	851 - 1,414	?		299	?	Pismo
49		10/28/2010	600	26.5	32.3	5.8	103.45	158,400					Alluvium/Paso Robles

San Luis Obispo Valley Basin groundwater basin water well specific capacity data summary

Label No.	Date Drilled	Specific Capacity Test Date	Pumping Rate (GPM)	Static Water Level (feet bgs)	Pumping Water Level (feet bgs)	Drawdown (feet)	Specific Capacity (gpm/foot)	Duration (hours)	Est. Transmissivity (gpd/foot)	Screen Length (feet)	Estimated Hydraulic Conductivity (ft/day)	Total Depth (feet)	Perforations	Formation Screened
48			435				6-10		10,000-20,000			250?		Paso Robles/Pismo
49		May 1999	12	10	24	14	0.86	4	1,714	?		30		Alluvium
50	1995	2002	18	19	63	44	0.41	12	818			86		Alluvium/Paso Robles
51	2003	2003	3.5	16	42	26	0.13	72	269			80		Alluvium/Paso Robles
52		7/18/1966	130			60	2.17	20	4,333	30	19.3	90	60-90	Paso Robles
53		4/15/1987	200			30	6.67	12	13,333	30	59.3	110	80-110	Paso Robles
54		12/22/1972	60			30	2	8	4,000	25	21.3	75	50-75	Alluvium
55		1980	24			110	0.22	8	436	80	0.7	160	80-160	Bedrock
56		9/11/1991	15			13	1.15	8	2,308	40	7.7	90	50-90	Alluvium
57		9/12/1959	1.25			8	0.16	4	313	10	4.2	28	18-28	Alluvium
58		3/4/1957	45			18	2.5	12	5,000	17	39.2	37	20-37	Alluvium
59		3/15/1961	12			6	2	5	4,000	5	106.7	85	40-43; 75-77	Alluvium/Paso Robles
60		3/30/1956	8			4	2	2	4,000	15	35.6	32	17-32	Paso Robles
61		9/18/1989	5			20	0.25	1	500	10	6.7	50	40-50	Bedrock
62		8/29/1990	4			14	0.29	4	571	30	2.5	50	20-50	Alluvium
64		8/7/2014	47	206	257	51	0.92	1.5	1,843			340		Unknown
65		7/21/1993	75	22	33	11	6.82	4	13,636	50	36.36	100	50-100	Bedrock
66		7/23/1993	69	11	16.25	5.25	13.14	4.5	26,286	55	63.72	100	25-65; 85-100	Paso Robles/Bedrock
67		July 1993?	32	40	95?			4				120	60-120	Paso Robles
68		7/19/2012 5/19/2014 4/24/2017	83 104 109	45 82 178	87 123 212	42 41 34	2.0 2.5 3.2							Paso Robles/Pismo
69		5/9/2014 4/24/2017	94 124	182 85	196 117	14 32	6.7 3.9							Paso Robles/Pismo
70		4/24/2017	206	100	123	23	9.0							Paso Robles/Pismo
71		7/19/2012 5/19/14 4/24/17	320 367 483	98 133 104	101 183 141	3 50 37	106.7 7.3 13.1							Paso Robles/Pismo
72		12/5/12 5/19/14 4/24/17	93 55 81	86 140 50	101 65 152	15 12 15	6.2 4.6 5.4							Paso Robles/Pismo
73		12/11/12 4/24/17	23 30	55 25	57 26	2 1	15.5 30.0							Paso Robles/Pismo
74		12/11/2012	17	62	66	4	4.7							Paso Robles/Pismo
75		12/5/2012 5/19/14 4/24/17	133 104 127	73 96 89	98 152 126	25 56 37	5.3 1.9 3.4							Paso Robles/Pismo
76		12/5/2012 5/19/14 4/24/17	96 91 91	71 94 85	98 123 99	27 29 14	3.6 3.1 6.5							Paso Robles/Pismo
33		7/19/2012 5/19/14 4/24/17	183 169 259	107 86 75	135 132 135	28 46 60	6.5 3.7 4.3							Paso Robles/Pismo
32		4/24/2017	311	116	176	60	5.2							Paso Robles/Pismo
1		4/24/2017	65	29	49	20	3.3							Paso Robles/Pismo

Appendix B –GSFLOW Groundwater Calibration Figures

Appendix B List of Figures

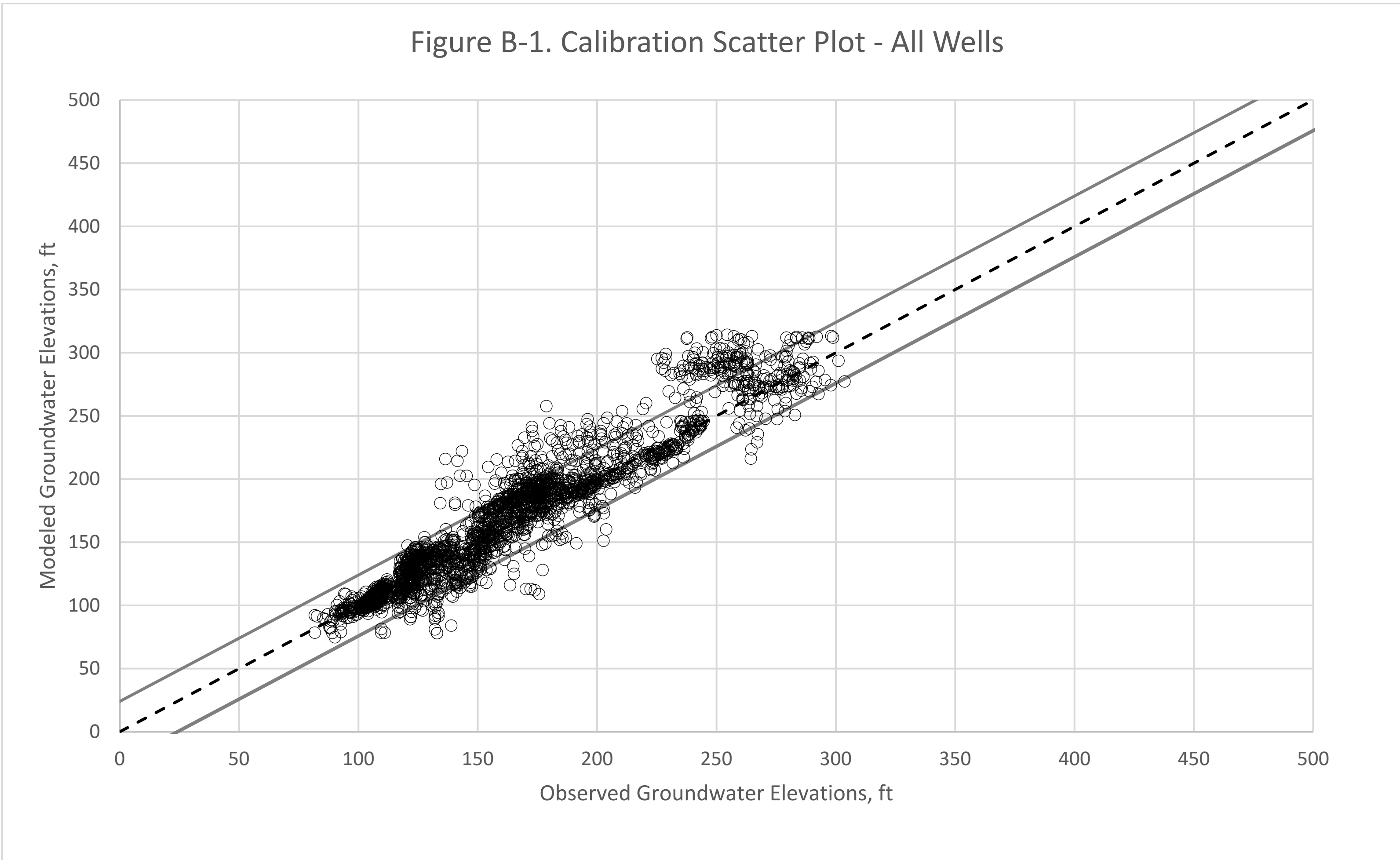


Figure B-1. Calibration Scatter Plot - All Wells
Modeled Groundwater Elevations, ft
Observed Groundwater Elevations, ft
0
50
100
150
200
250
300
350
400
450
500

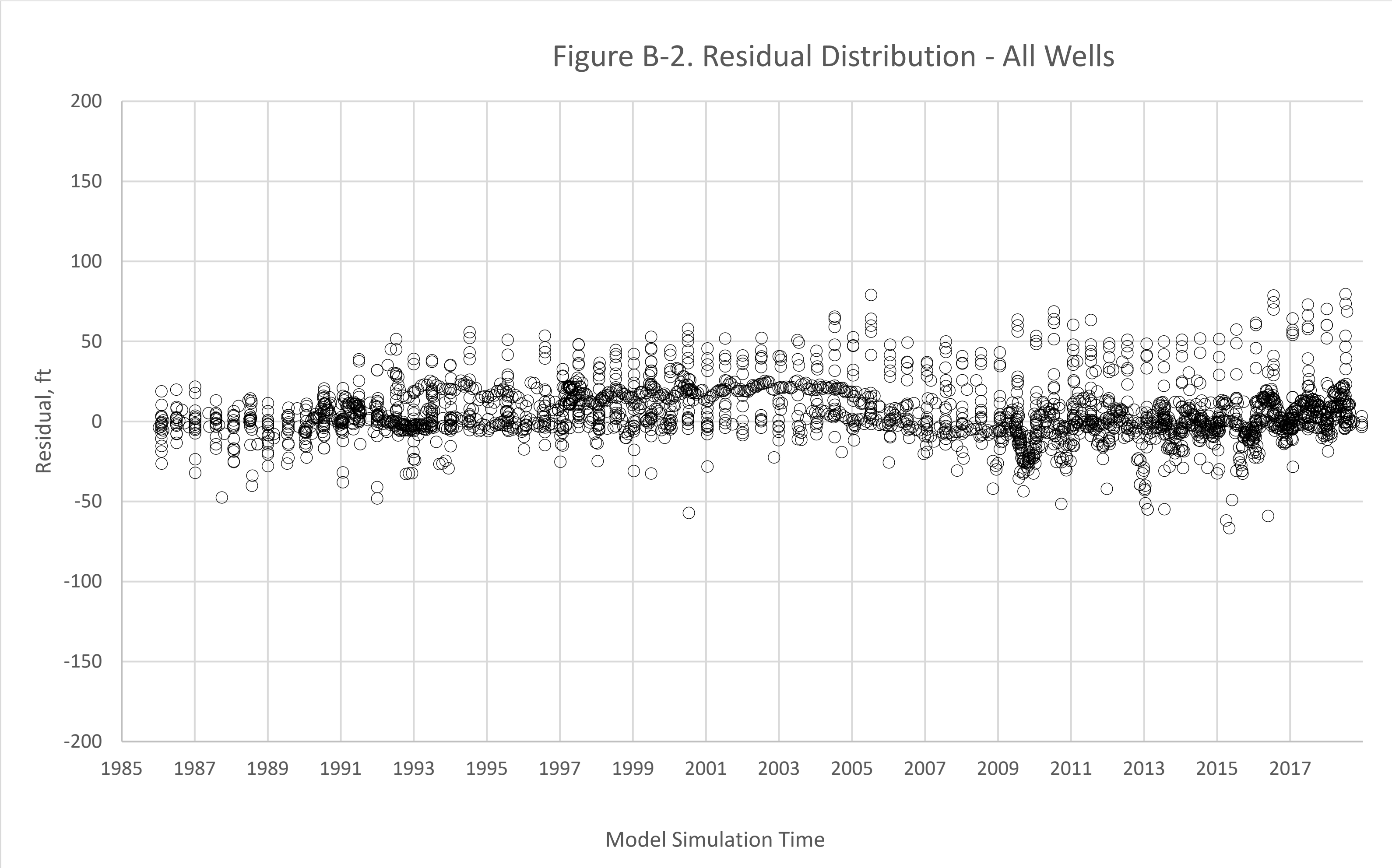
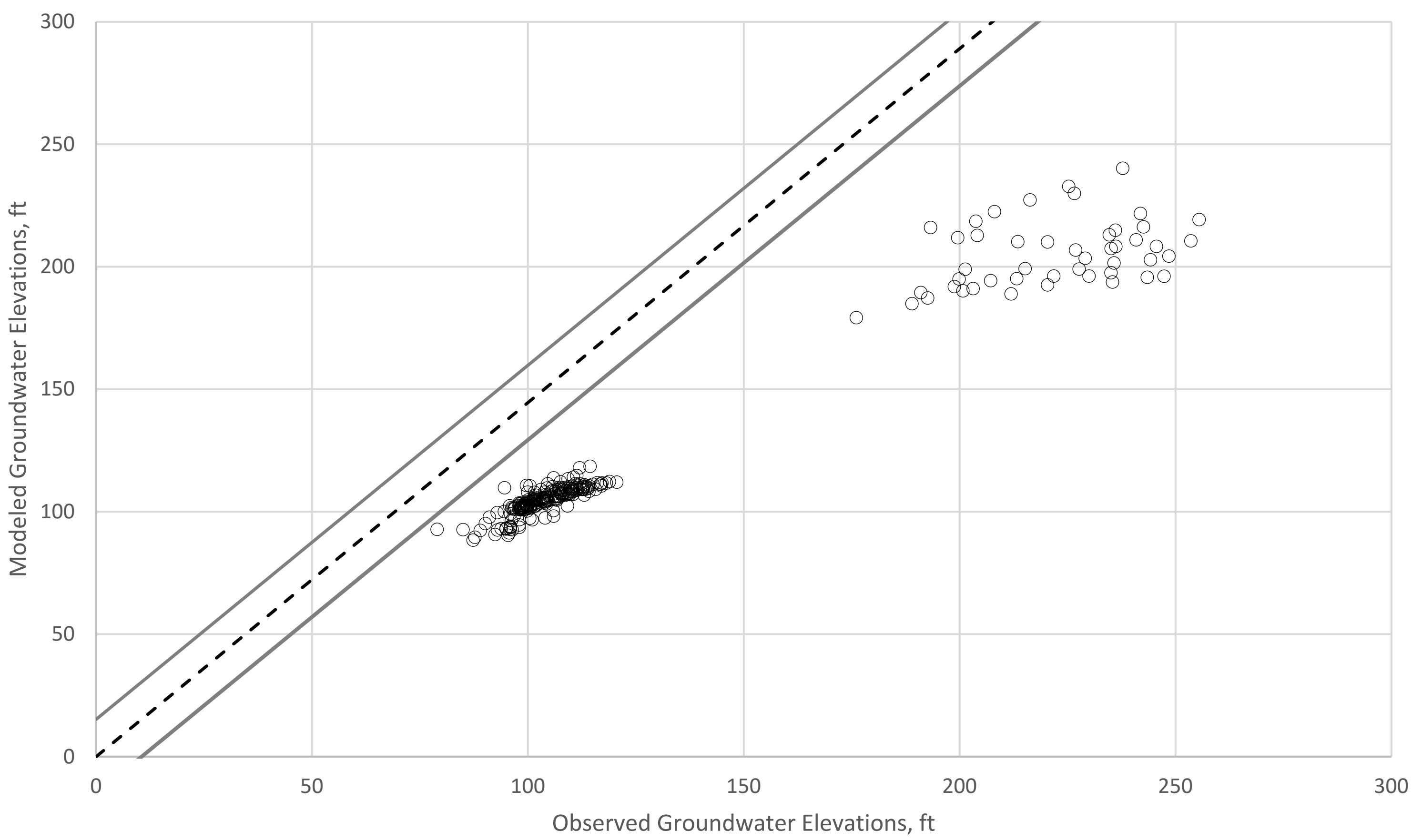


Figure B-2. Residual Distribution - All Wells
Residual, ft
200
150
100
50
0
-50
-100
-150
-200
1985
1987
1989
1991
1993
1995
1997
1999
2001
2003
2005
2007
2009
2011
2013
2015
2017
Model Simulation Time

Figure B-3. Calibration Scatter Plot - SLO Key Wells



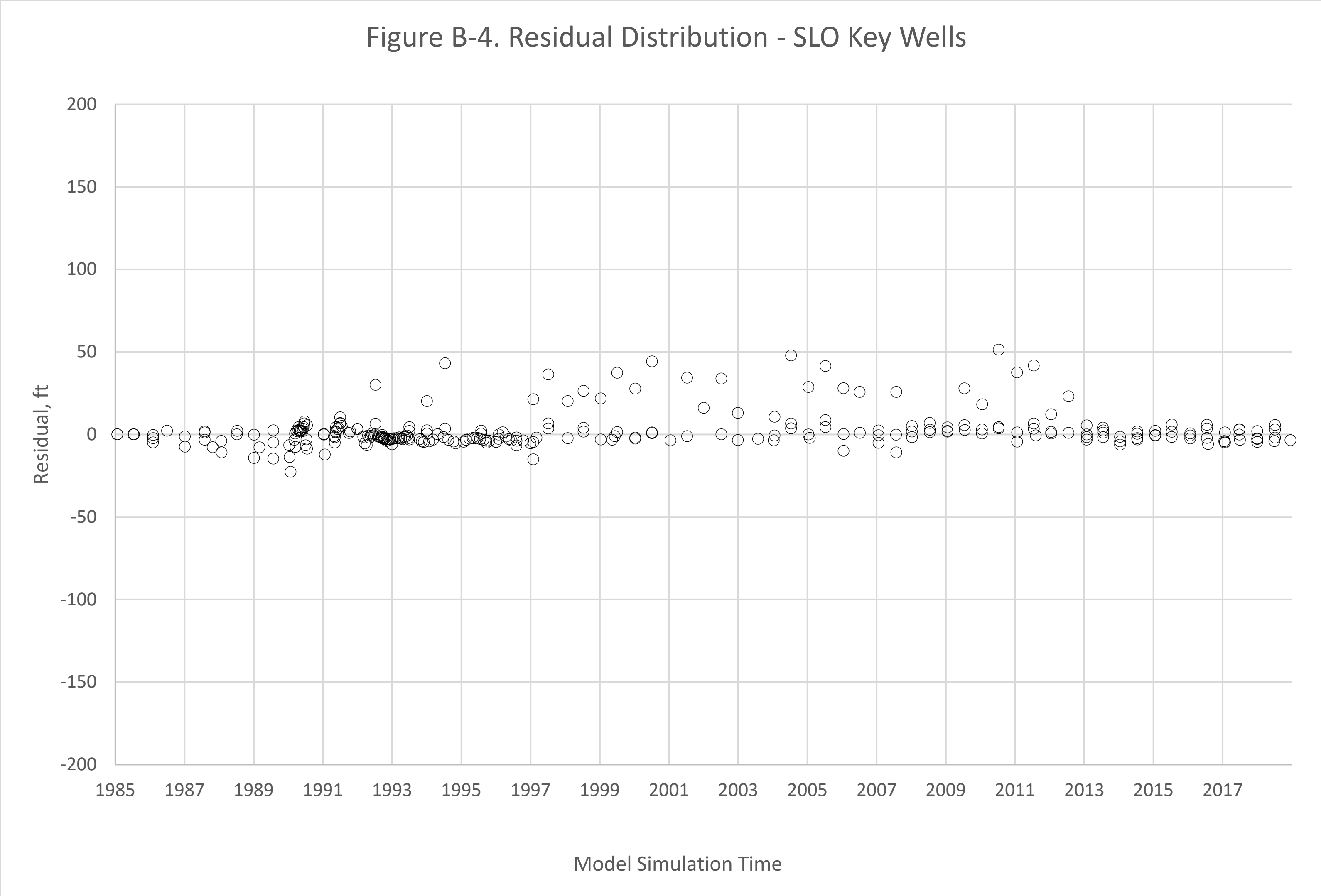


Figure B-4. Residual Distribution - SLO Key Wells
200
150
100
50
0
-50
-100
-150
-200
Residual, ft
1985
1987
1989
1991
1993
1995
1997
1999
2001
2003
2005
2007
2009
2011
2013
2015
2017
Model Simulation Time

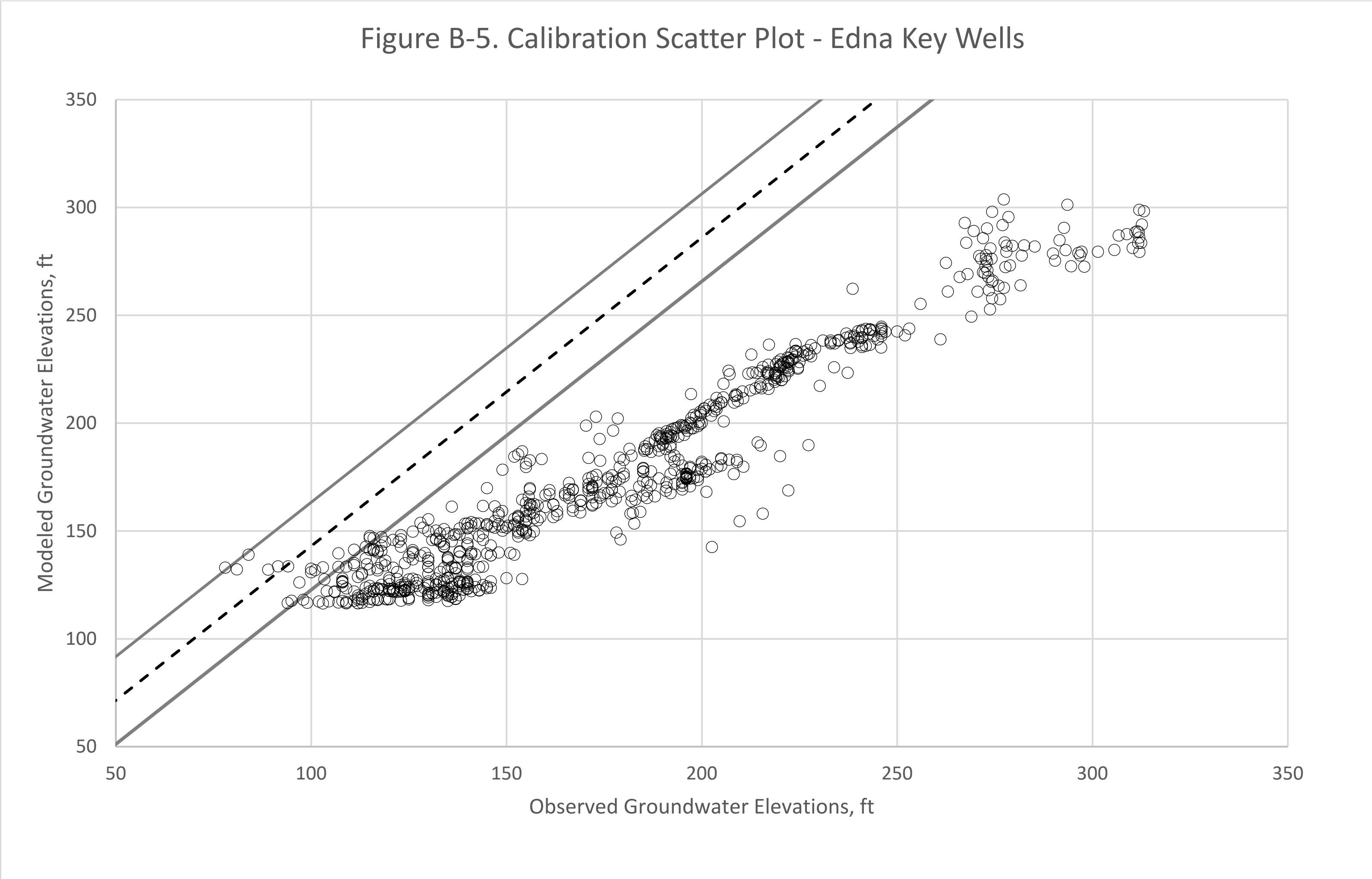


Figure B-5. Calibration Scatter Plot - Edna Key Wells
Modeled Groundwater Elevations, ft
Observed Groundwater Elevations, ft
50
100
150
200
250
300
350

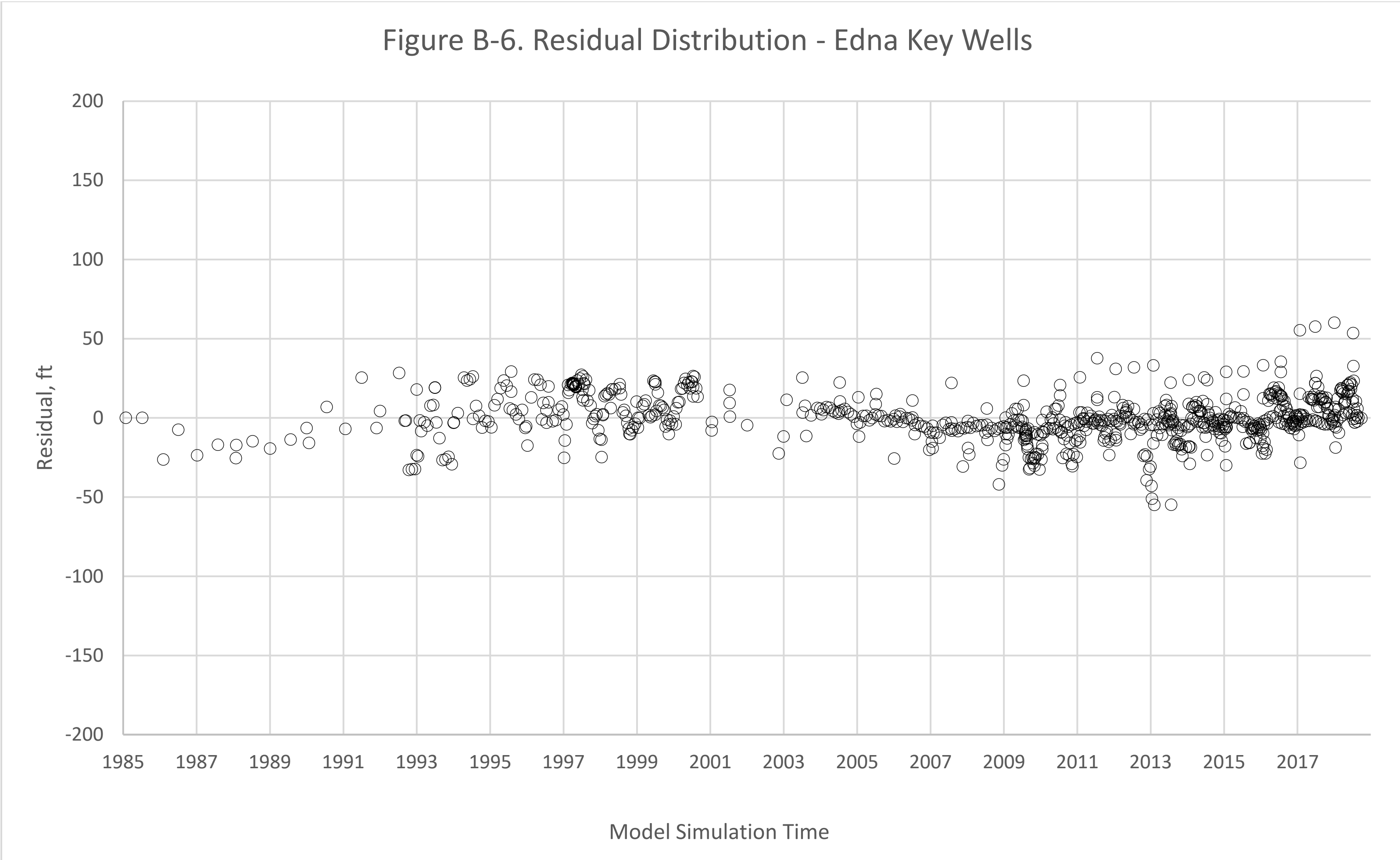


Figure B-6. Residual Distribution - Edna Key Wells
200
150
100
50
0
-50
-100
-150
-200
Residual, ft
1985
1987
1989
1991
1993
1995
1997
1999
2001
2003
2005
2007
2009
2011
2013
2015
2017
Model Simulation Time

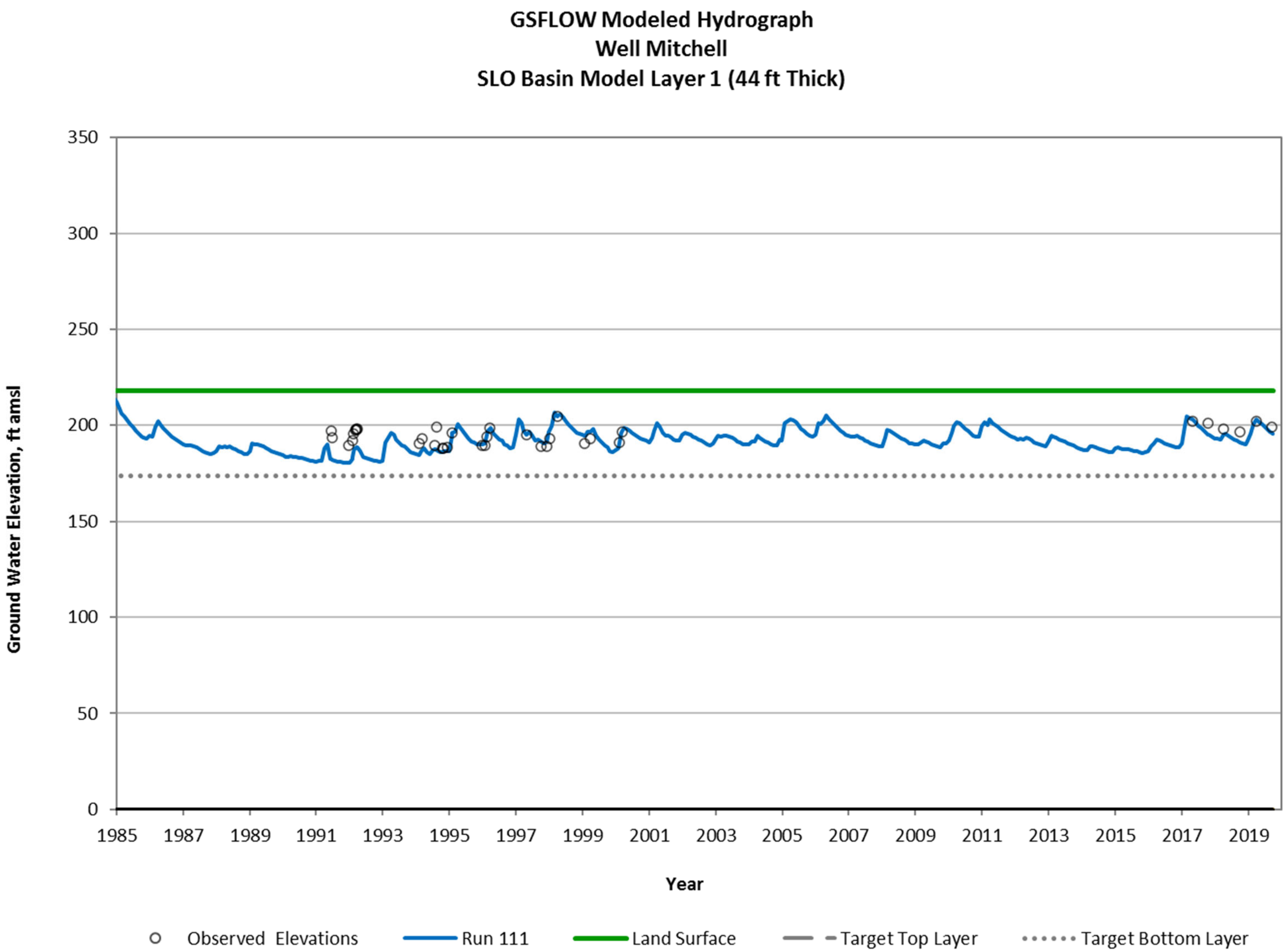

GSFLOW Modeled Hydrograph
Well Mitchell
SLO Basin Model Layer 1 (44 ft Thick)
350
300
250
200
150
100
50
0
Ground Water Elevation, ft amsl
1985
1987
1989
1991
1993
1995
1997
1999
2001
2003
2005
2007
2009
2011
2013
2015
2017
2019
Year
Observed Elevations
Run 111
Land Surface
Target Top Layer
Target Bottom Layer

Figure B-7

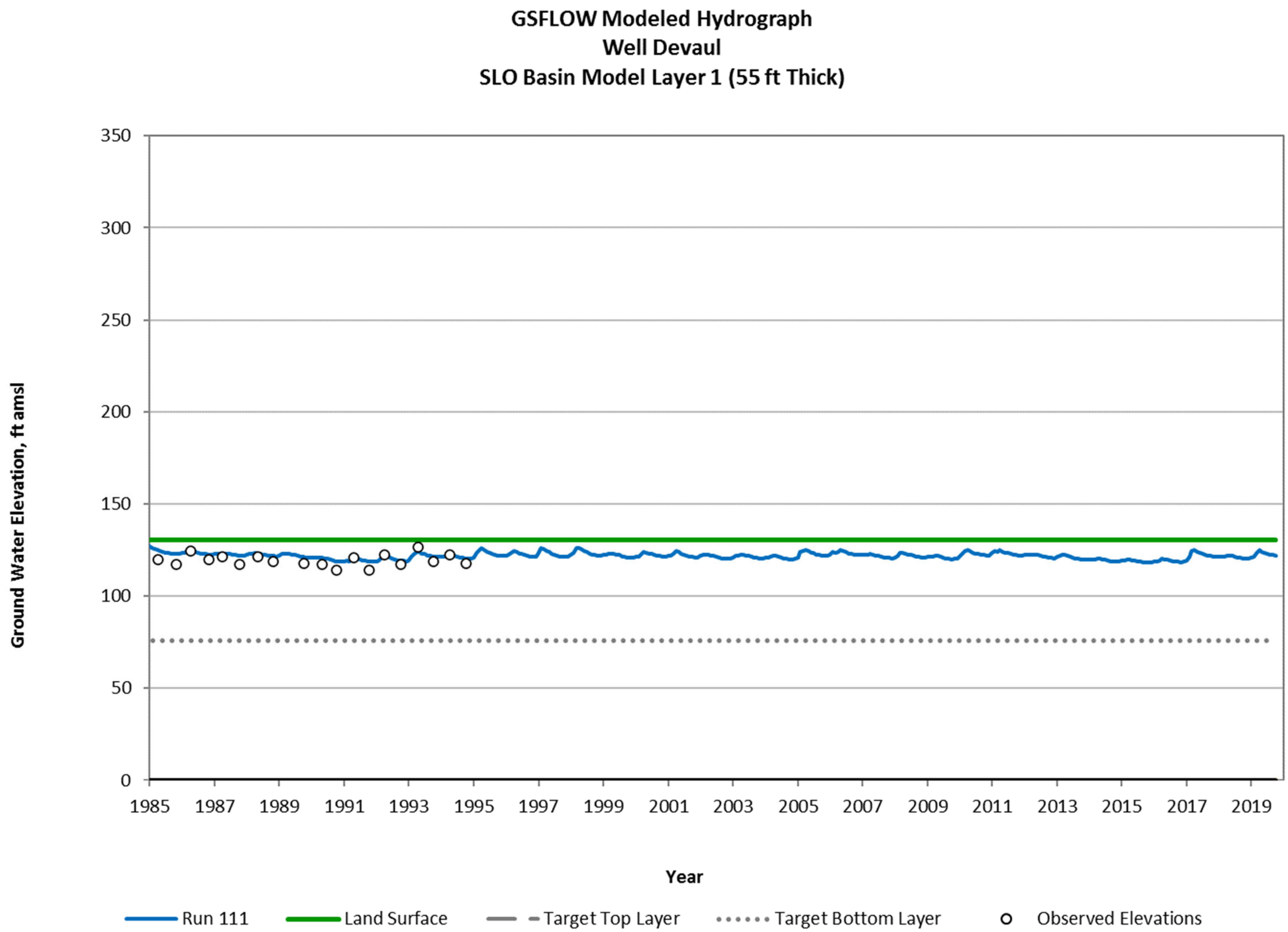

GSFLOW Modeled Hydrograph
Well Devaul
SLO Basin Model Layer 1 (55 ft Thick)
Ground Water Elevation, ft amsl
350
300
250
200
150
100
50
0
1985
1987
1989
1991
1993
1995
1997
1999
2001
2003
2005
2007
2009
2011
2013
2015
2017
2019
Year
Run 111
Land Surface
Target Top Layer
Target Bottom Layer
Observed Elevations

Figure B-8

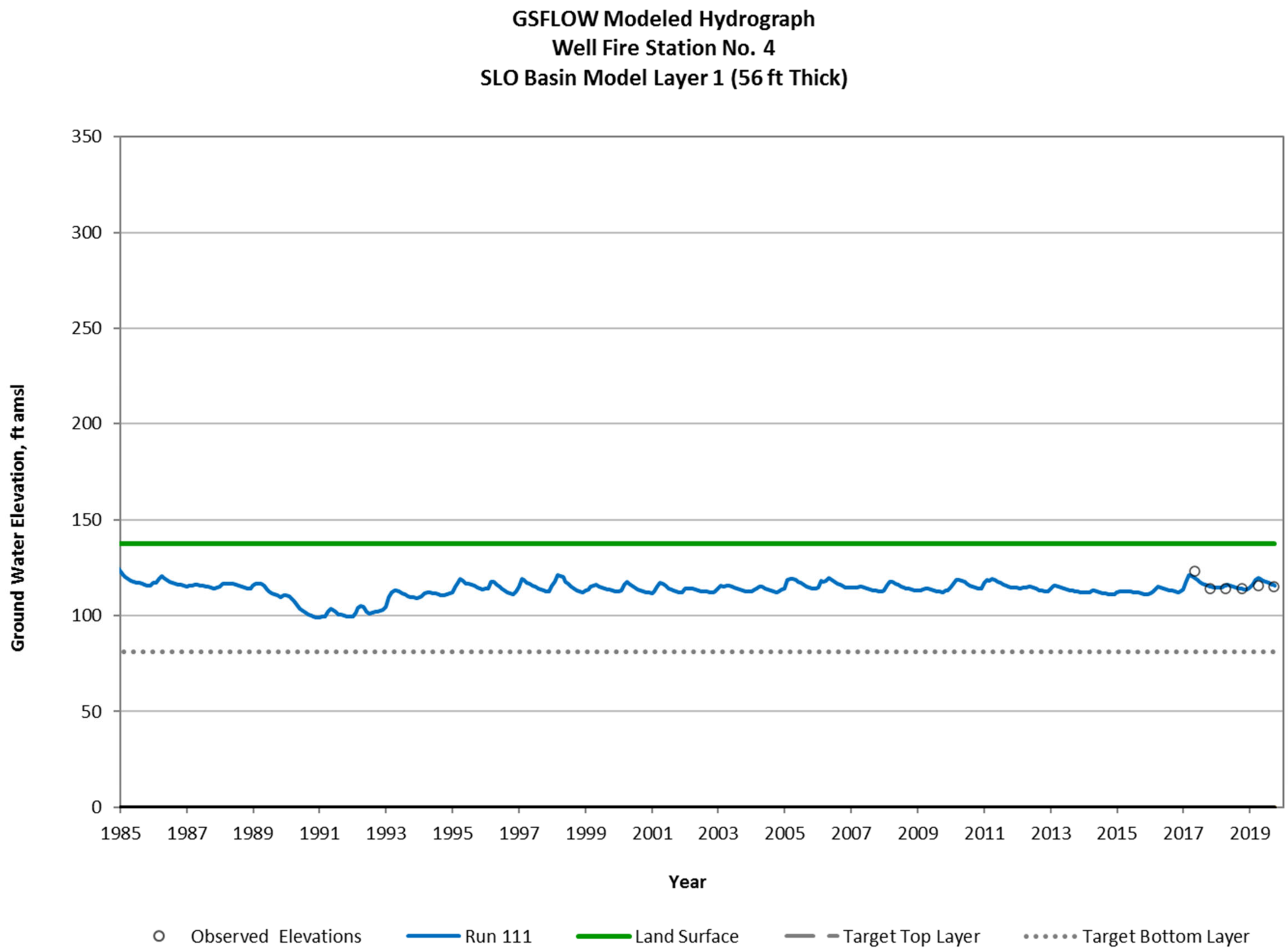

GSFLOW Modeled Hydrograph
Well Fire Station No. 4
SLO Basin Model Layer 1 (56 ft Thick)
Ground Water Elevation, ft amsl
350
300
250
200
150
100
50
0
1985
1987
1989
1991
1993
1995
1997
1999
2001
2003
2005
2007
2009
2011
2013
2015
2017
2019
Year
Observed Elevations
Run 111
Land Surface
Target Top Layer
Target Bottom Layer

Figure B-9

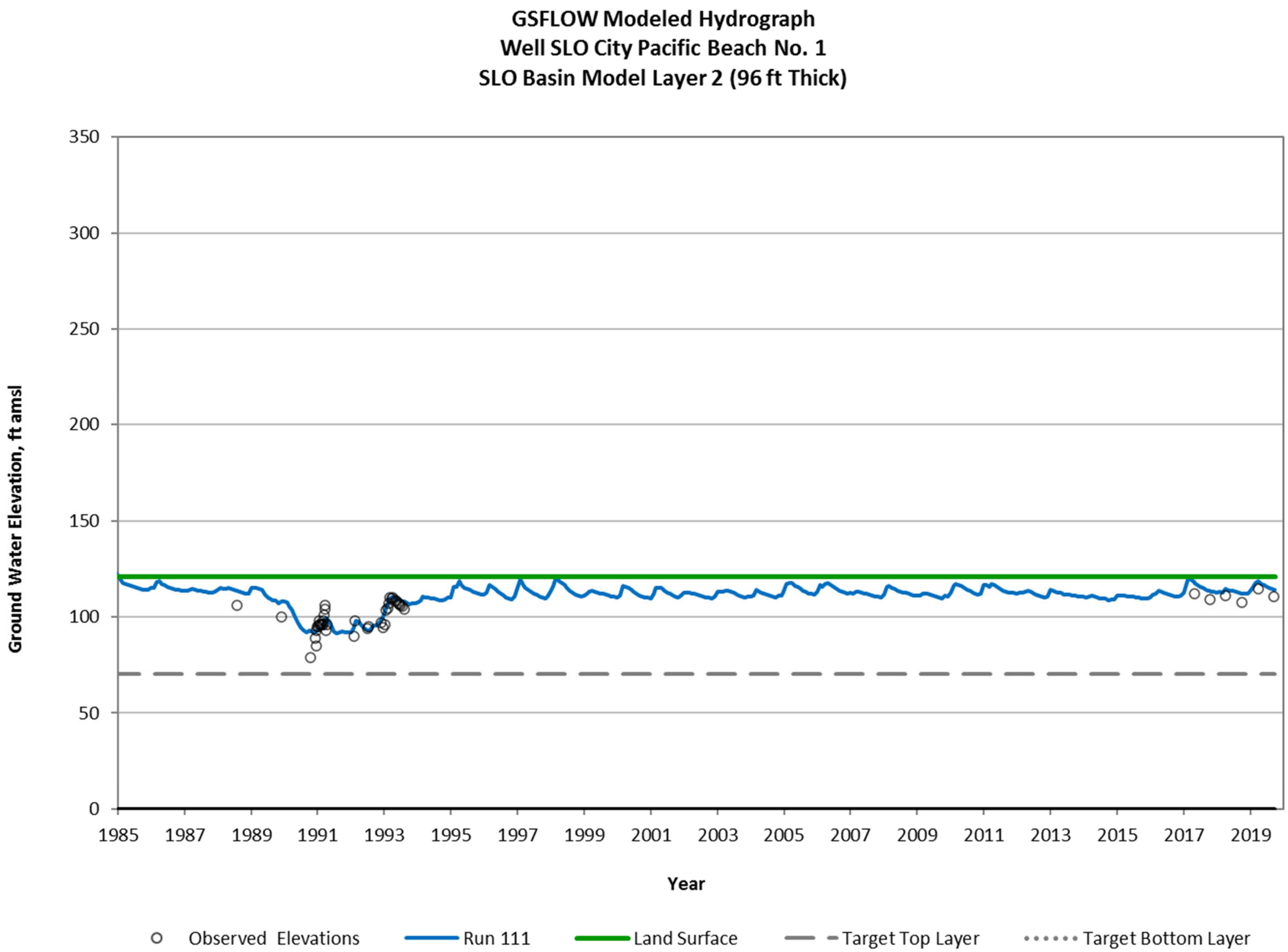

GSFLOW Modeled Hydrograph
Well SLO City Pacific Beach No. 1
SLO Basin Model Layer 2 (96 ft Thick)
Ground Water Elevation, ft amsl
350
300
250
200
150
100
50
0
1985
1987
1989
1991
1993
1995
1997
1999
2001
2003
2005
2007
2009
2011
2013
2015
2017
2019
Year
Observed Elevations
Run 111
Land Surface
Target Top Layer
Target Bottom Layer

Figure B-10

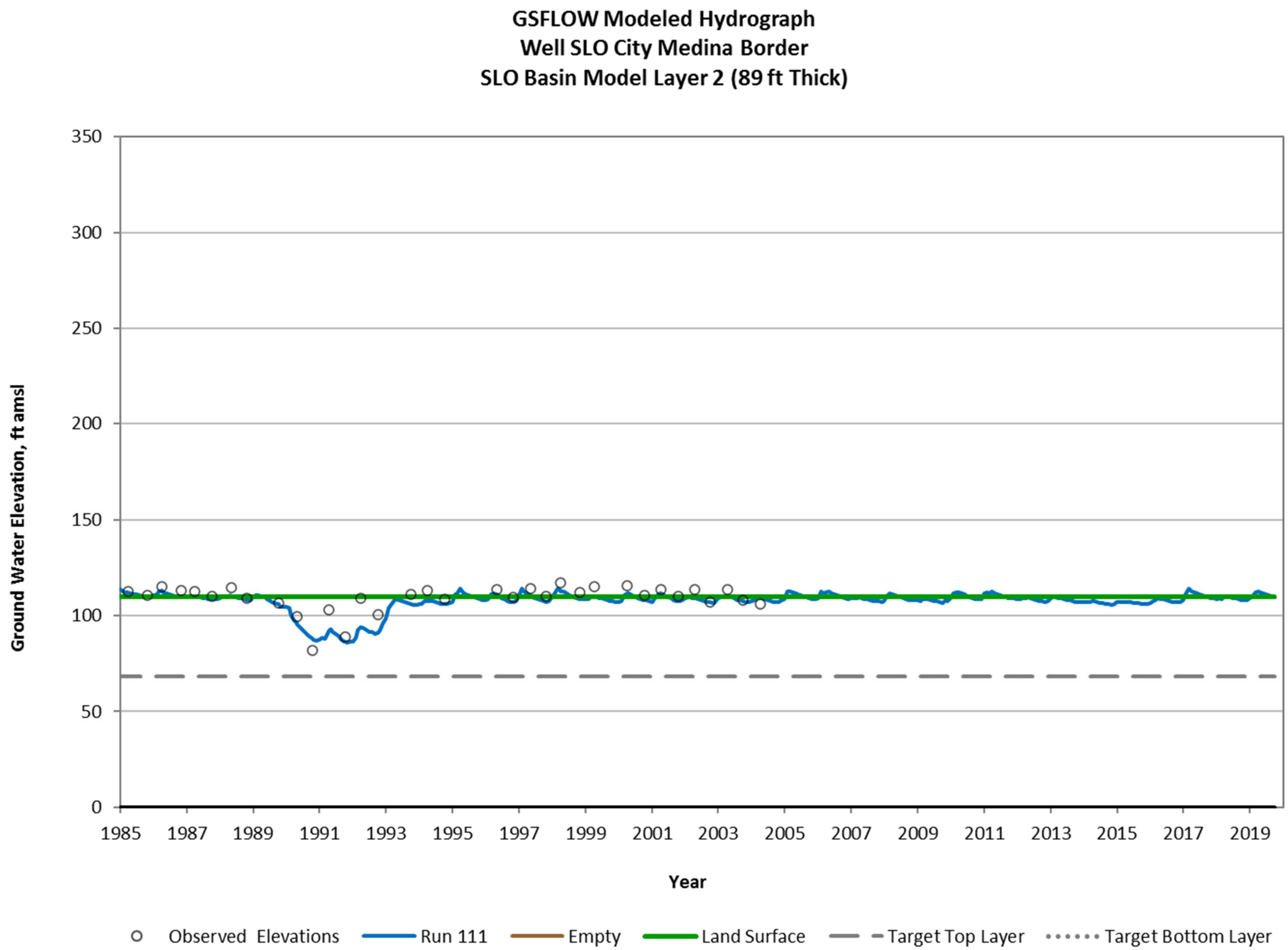

GSFLOW Modeled Hydrograph
Well SLO City Medina Border
SLO Basin Model Layer 2 (89 ft Thick)
Ground Water Elevation, ft amsl
350
300
250
200
150
100
50
0
1985
1987
1989
1991
1993
1995
1997
1999
2001
2003
2005
2007
2009
2011
2013
2015
2017
2019
Year
Observed Elevations
Run 111
Empty
Land Surface
Target Top Layer
Target Bottom Layer

Figure B-11

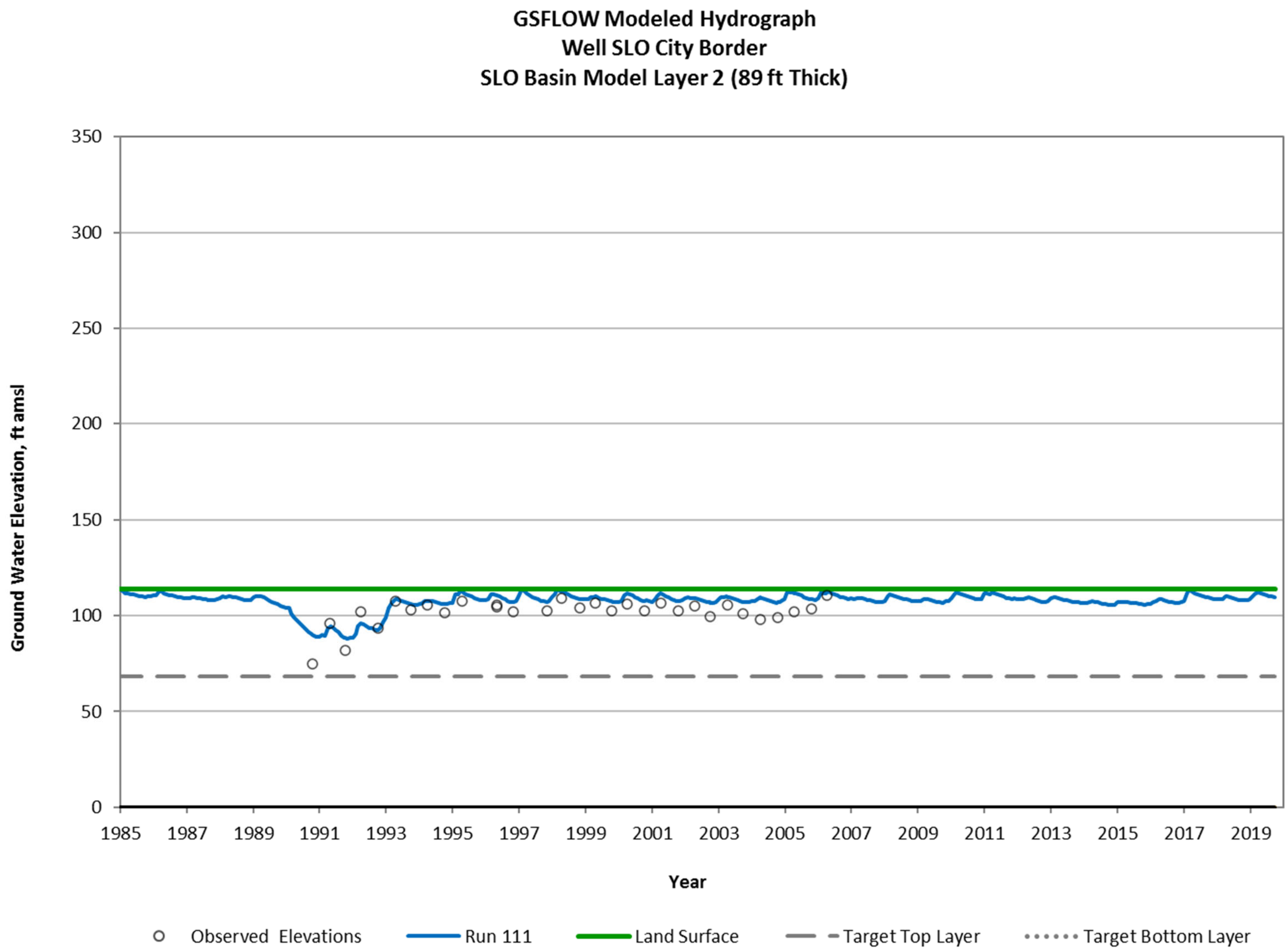

GSFLOW Modeled Hydrograph
Well SLO City Border
SLO Basin Model Layer 2 (89 ft Thick)
Ground Water Elevation, ft amsl
350
300
250
200
150
100
50
0
1985
1987
1989
1991
1993
1995
1997
1999
2001
2003
2005
2007
2009
2011
2013
2015
2017
2019
Year
Observed Elevations
Run 111
Land Surface
Target Top Layer
Target Bottom Layer

Figure B-12

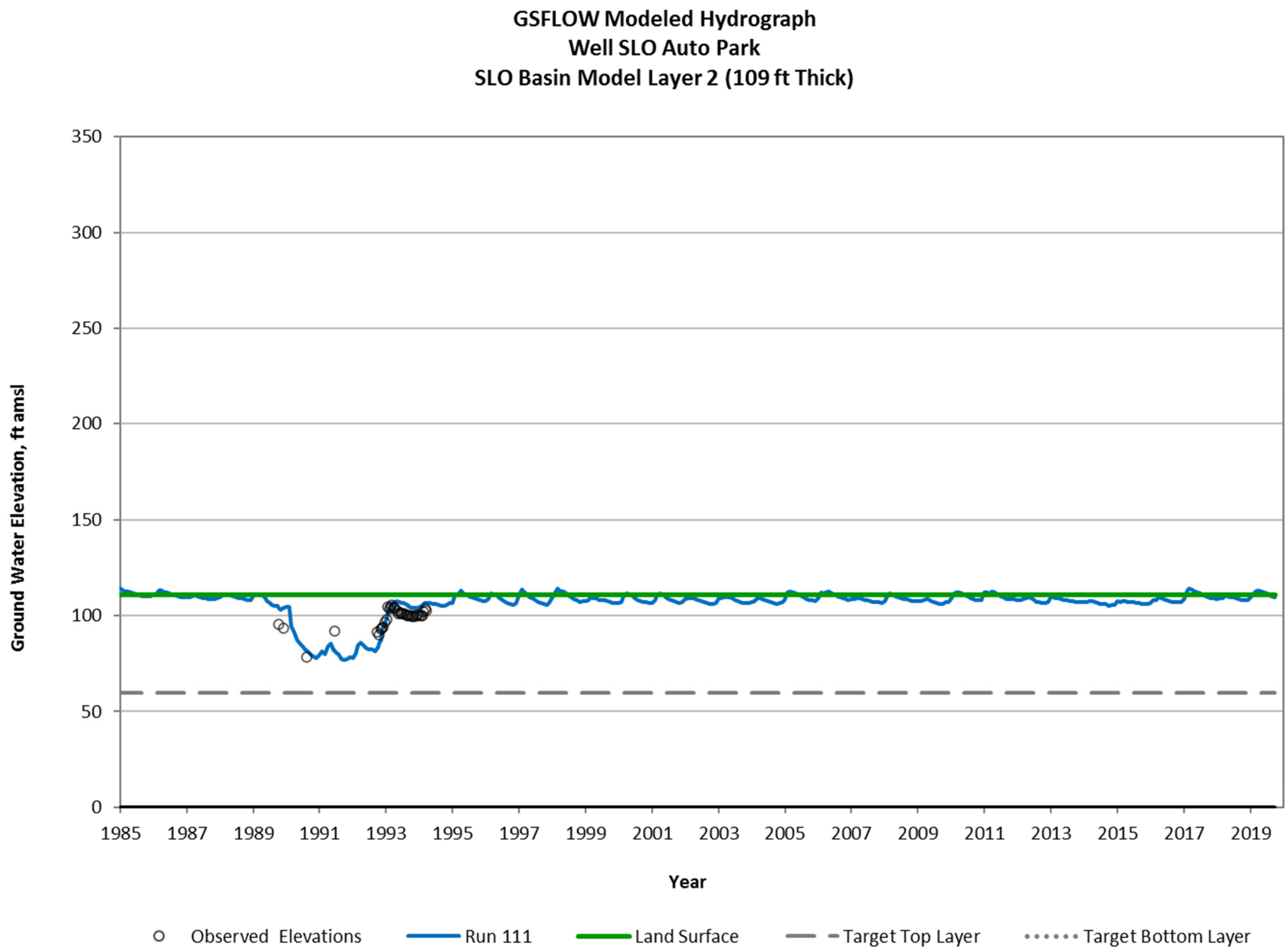

GSFLOW Modeled Hydrograph
Well SLO Auto Park
SLO Basin Model Layer 2 (109 ft Thick)
Ground Water Elevation, ft amsl
350
300
250
200
150
100
50
0
1985
1987
1989
1991
1993
1995
1997
1999
2001
2003
2005
2007
2009
2011
2013
2015
2017
2019
Year
Observed Elevations
Run 111
Land Surface
Target Top Layer
Target Bottom Layer

Figure B-13

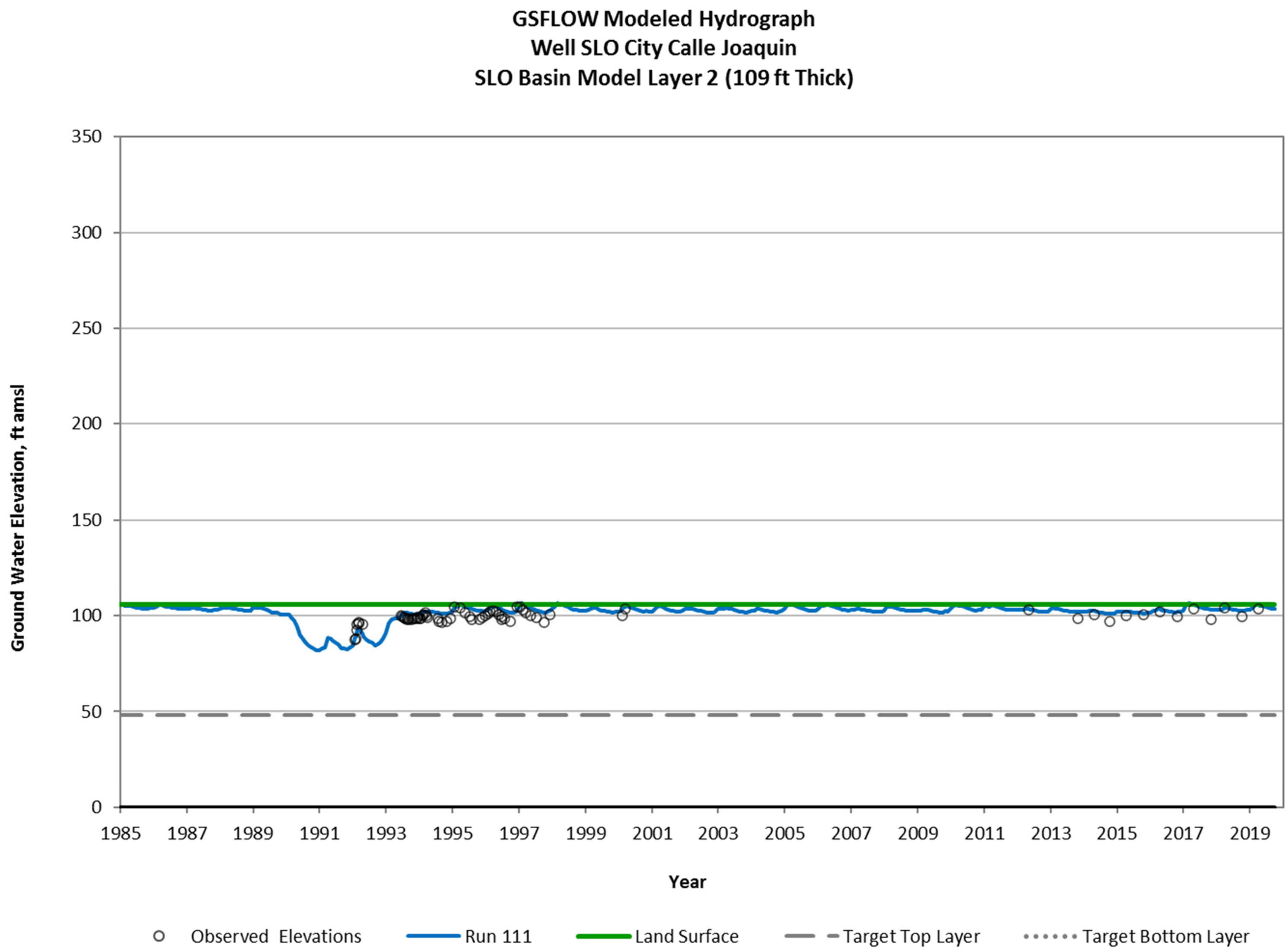

GSFLOW Modeled Hydrograph
Well SLO City Calle Joaquin
SLO Basin Model Layer 2 (109 ft Thick)
Ground Water Elevation, ft amsl
350
300
250
200
150
100
50
0
1985
1987
1989
1991
1993
1995
1997
1999
2001
2003
2005
2007
2009
2011
2013
2015
2017
2019
Year
Observed Elevations
Run 111
Land Surface
Target Top Layer
Target Bottom Layer

Figure B-14

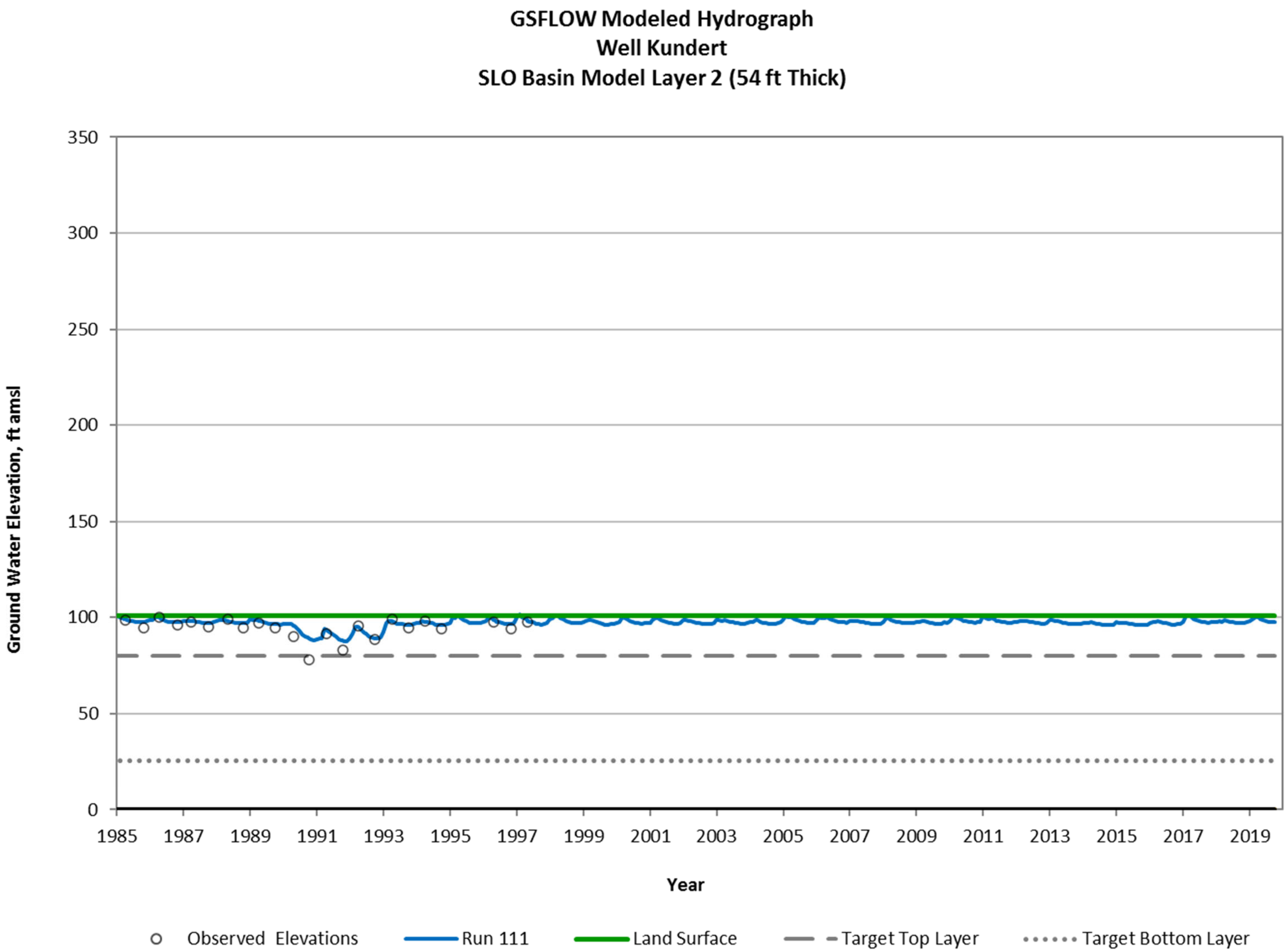

GSFLOW Modeled Hydrograph
Well Kundert
SLO Basin Model Layer 2 (54 ft Thick)
Ground Water Elevation, ft amsl
350
300
250
200
150
100
50
0
1985
1987
1989
1991
1993
1995
1997
1999
2001
2003
2005
2007
2009
2011
2013
2015
2017
2019
Year
Observed Elevations
Run 111
Land Surface
Target Top Layer
Target Bottom Layer

Figure B-15

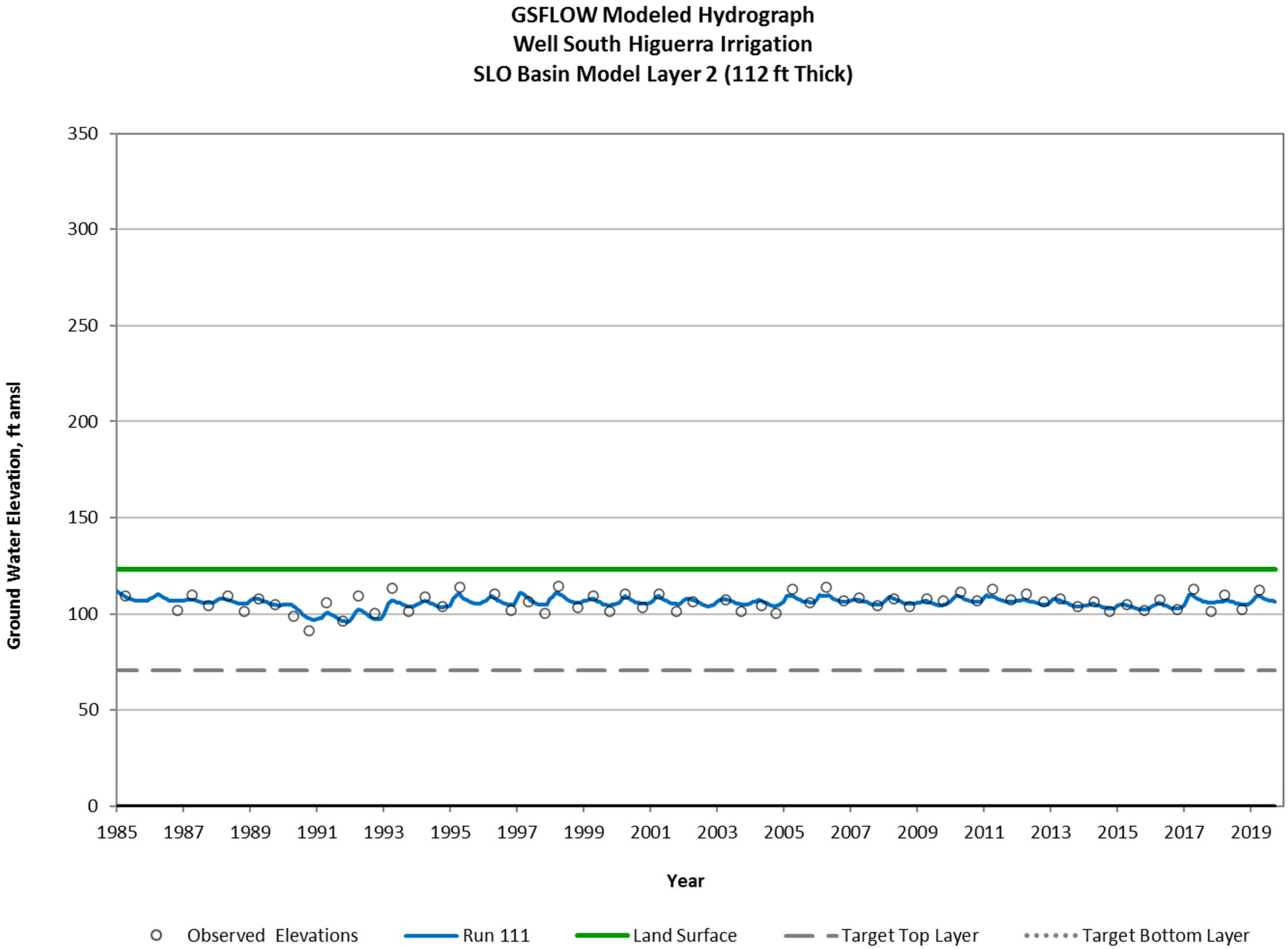

GSFLOW Modeled Hydrograph
Well South Higuerra Irrigation
SLO Basin Model Layer 2 (112 ft Thick)
350
300
250
200
150
100
50
0
Ground Water Elevation, ft amsl
1985
1987
1989
1991
1993
1995
1997
1999
2001
2003
2005
2007
2009
2011
2013
2015
2017
2019
Year
Observed Elevations
Run 111
Land Surface
Target Top Layer
Target Bottom Layer

Figure B-16

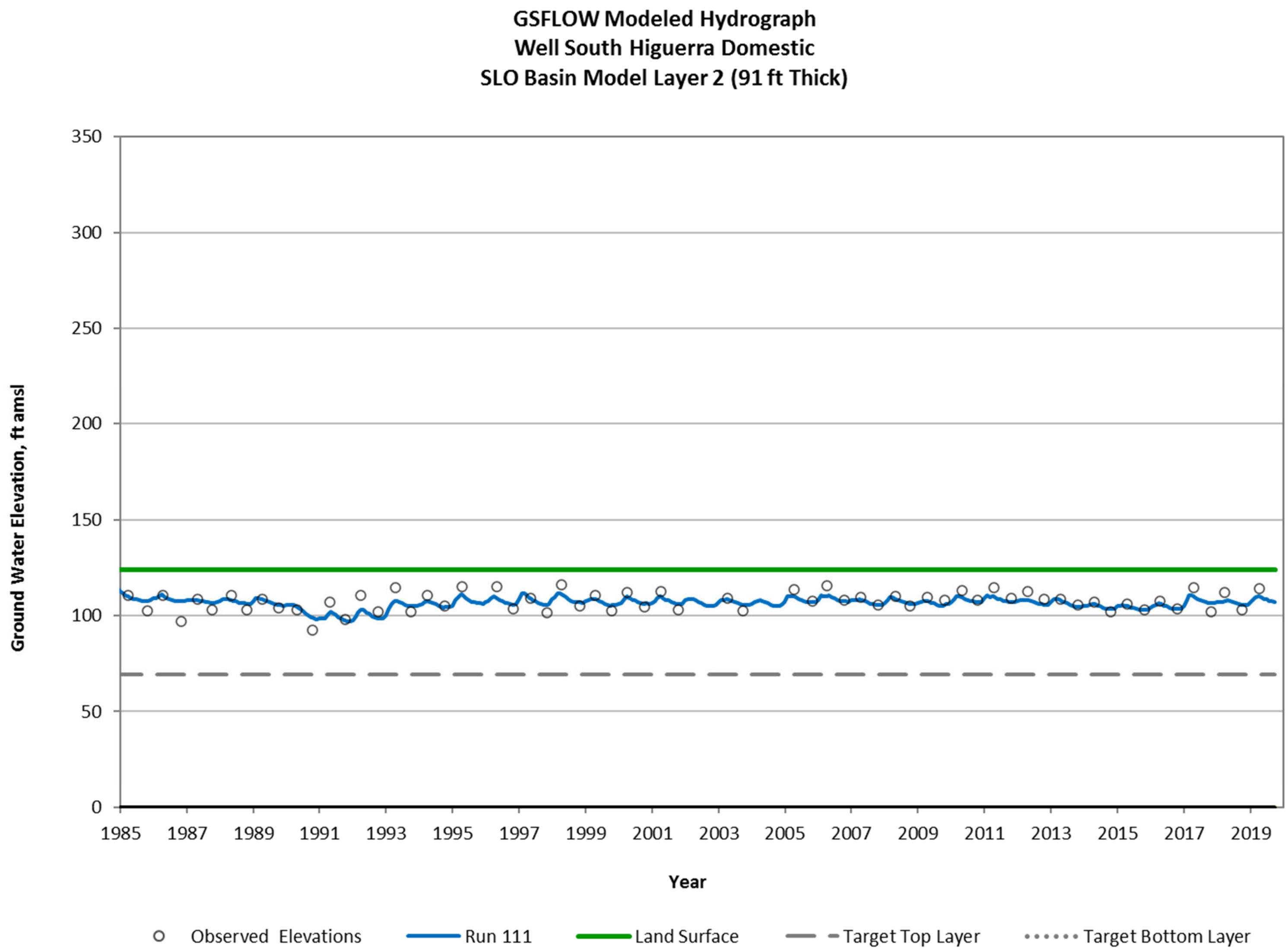

GSFLOW Modeled Hydrograph
Well South Higuerra Domestic
SLO Basin Model Layer 2 (91 ft Thick)
Ground Water Elevation, ft amsl
350
300
250
200
150
100
50
0
1985
1987
1989
1991
1993
1995
1997
1999
2001
2003
2005
2007
2009
2011
2013
2015
2017
2019
Year
Observed Elevations
Run 111
Land Surface
Target Top Layer
Target Bottom Layer

Figure B-17

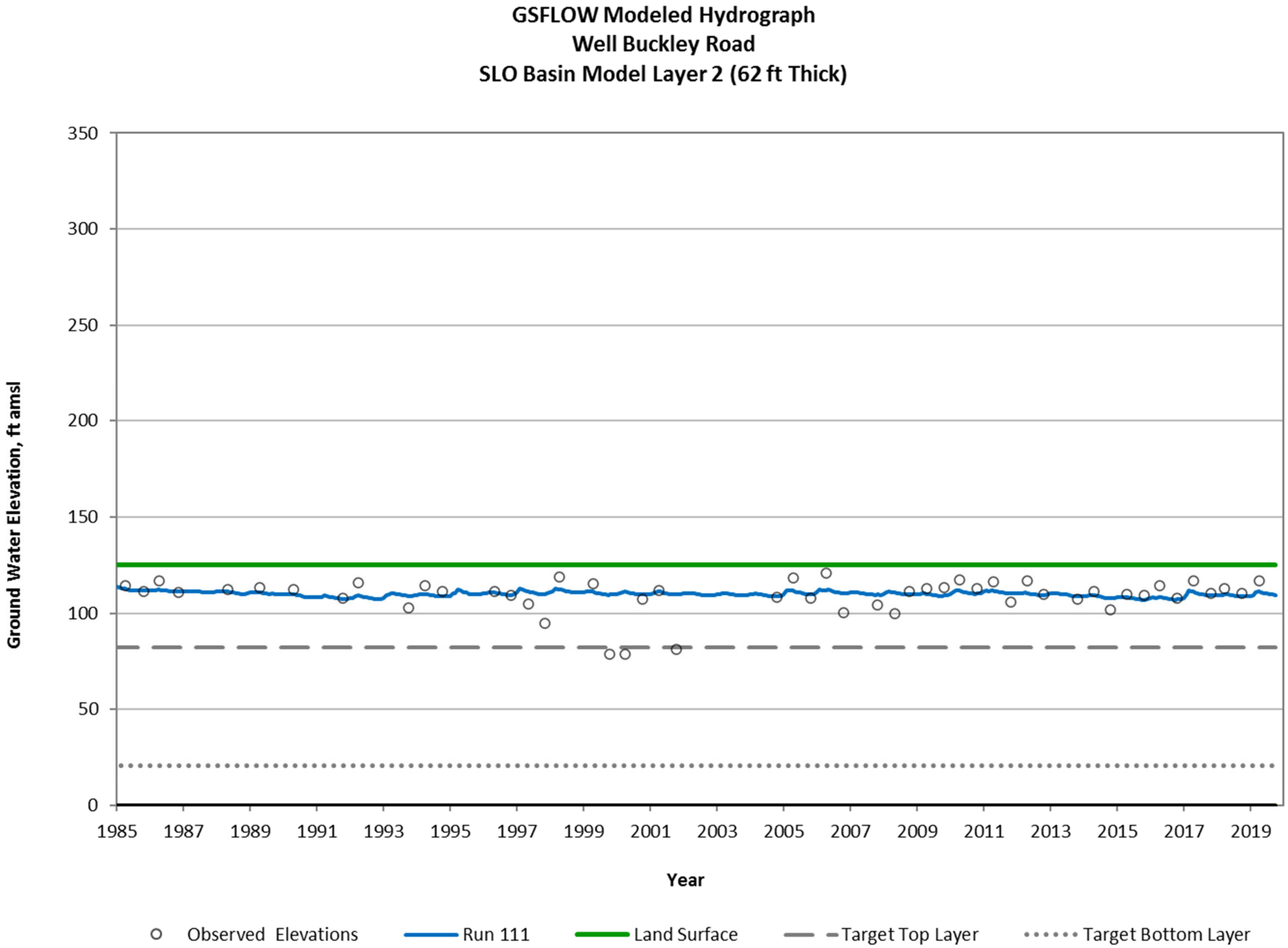

GSFLOW Modeled Hydrograph
Well Buckley Road
SLO Basin Model Layer 2 (62 ft Thick)
Ground Water Elevation, ft amsl
350
300
250
200
150
100
50
0
1985
1987
1989
1991
1993
1995
1997
1999
2001
2003
2005
2007
2009
2011
2013
2015
2017
2019
Year
Observed Elevations
Run 111
Land Surface
Target Top Layer
Target Bottom Layer

Figure B-18

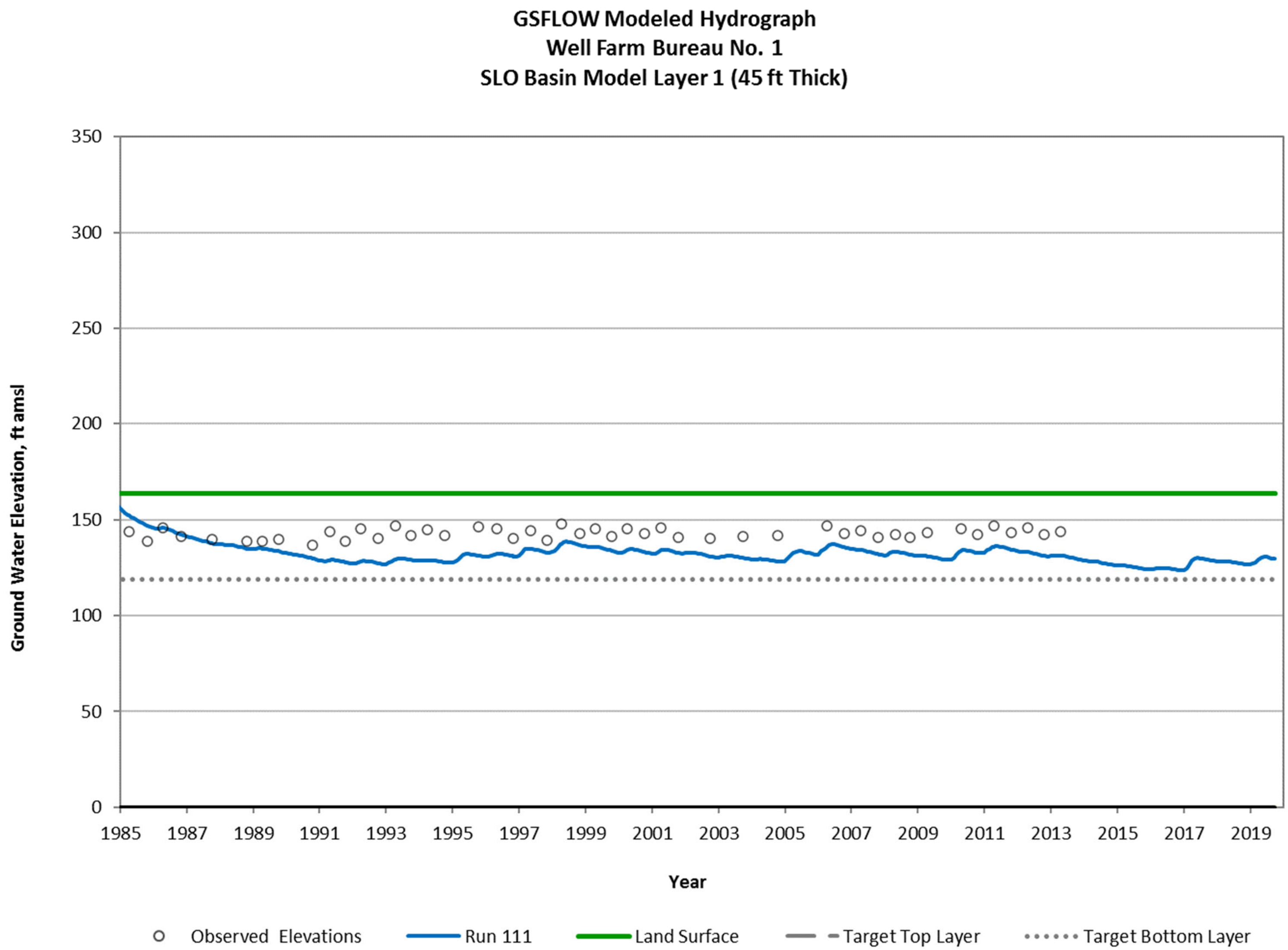

GSFLOW Modeled Hydrograph
Well Farm Bureau No. 1
SLO Basin Model Layer 1 (45 ft Thick)
Ground Water Elevation, ft amsl
350
300
250
200
150
100
50
0
1985
1987
1989
1991
1993
1995
1997
1999
2001
2003
2005
2007
2009
2011
2013
2015
2017
2019
Year
Observed Elevations
Run 111
Land Surface
Target Top Layer
Target Bottom Layer

Figure B-19

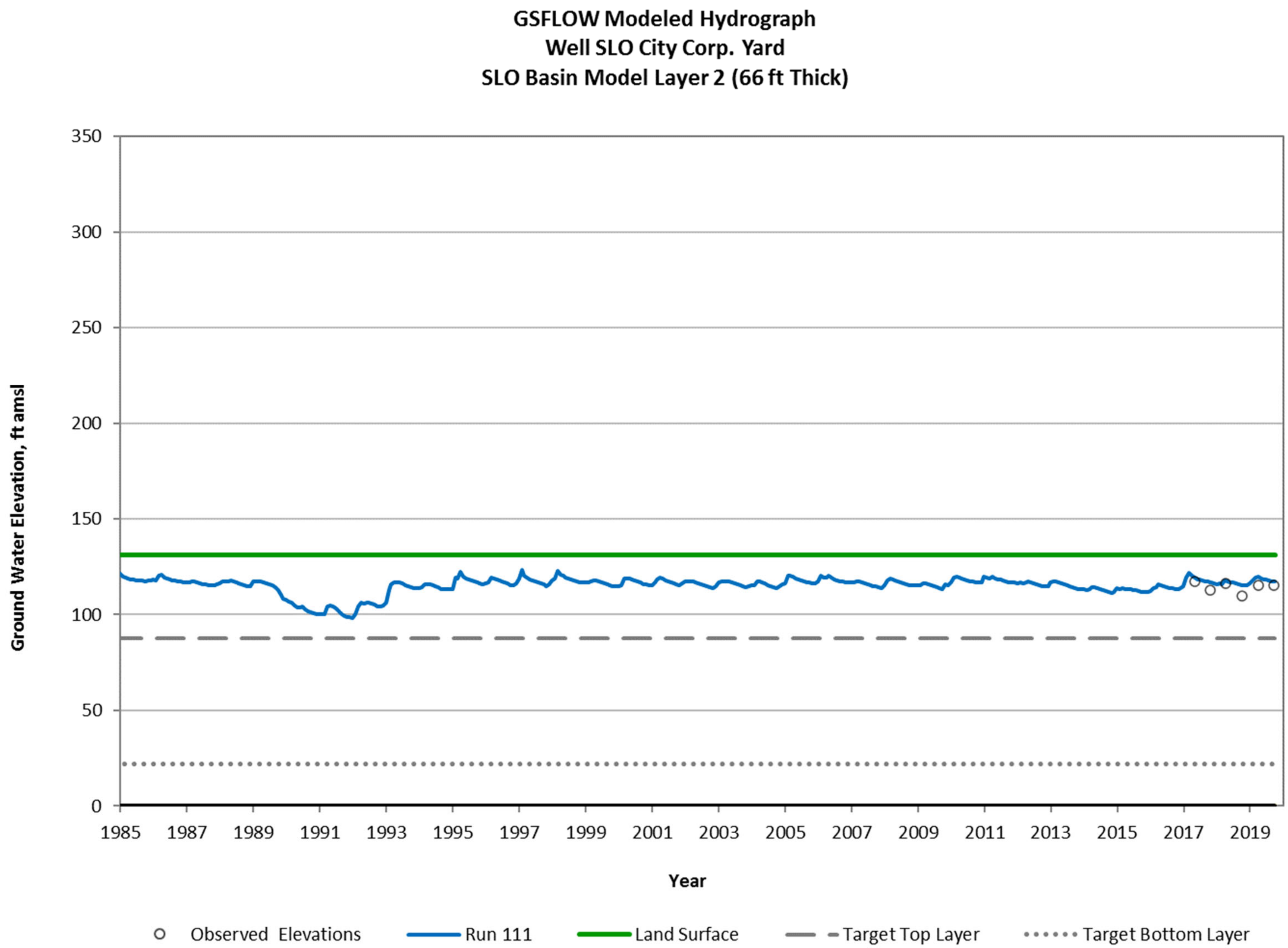

GSFLOW Modeled Hydrograph
Well SLO City Corp. Yard
SLO Basin Model Layer 2 (66 ft Thick)
Ground Water Elevation, ft amsl
350
300
250
200
150
100
50
0
1985
1987
1989
1991
1993
1995
1997
1999
2001
2003
2005
2007
2009
2011
2013
2015
2017
2019
Year
Observed Elevations
Run 111
Land Surface
Target Top Layer
Target Bottom Layer

Figure B-20

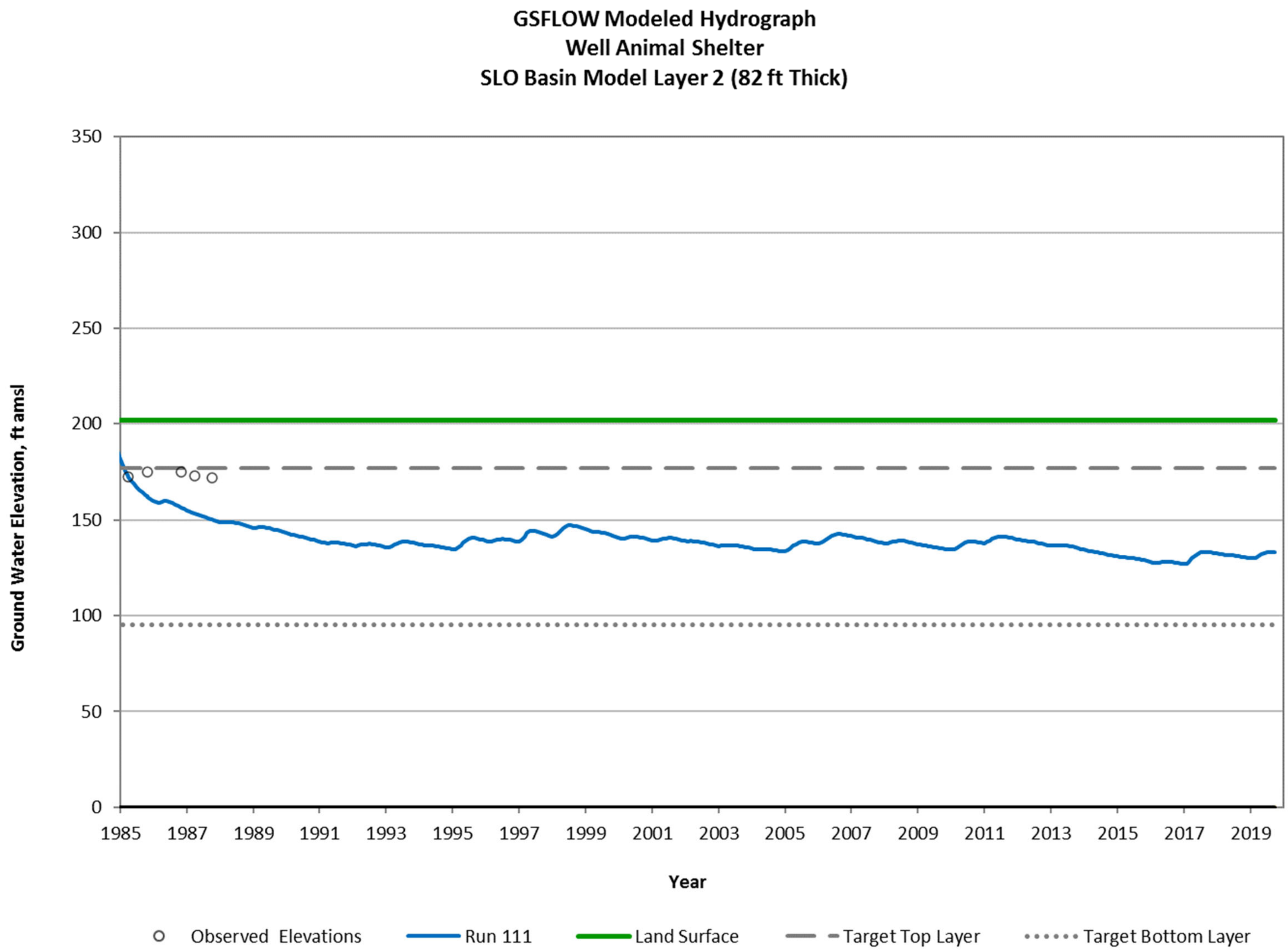

GSFLOW Modeled Hydrograph
Well Animal Shelter
SLO Basin Model Layer 2 (82 ft Thick)
Ground Water Elevation, ft amsl
350
300
250
200
150
100
50
0
1985
1987
1989
1991
1993
1995
1997
1999
2001
2003
2005
2007
2009
2011
2013
2015
2017
2019
Year
Observed Elevations
Run 111
Land Surface
Target Top Layer
Target Bottom Layer

Figure B-21

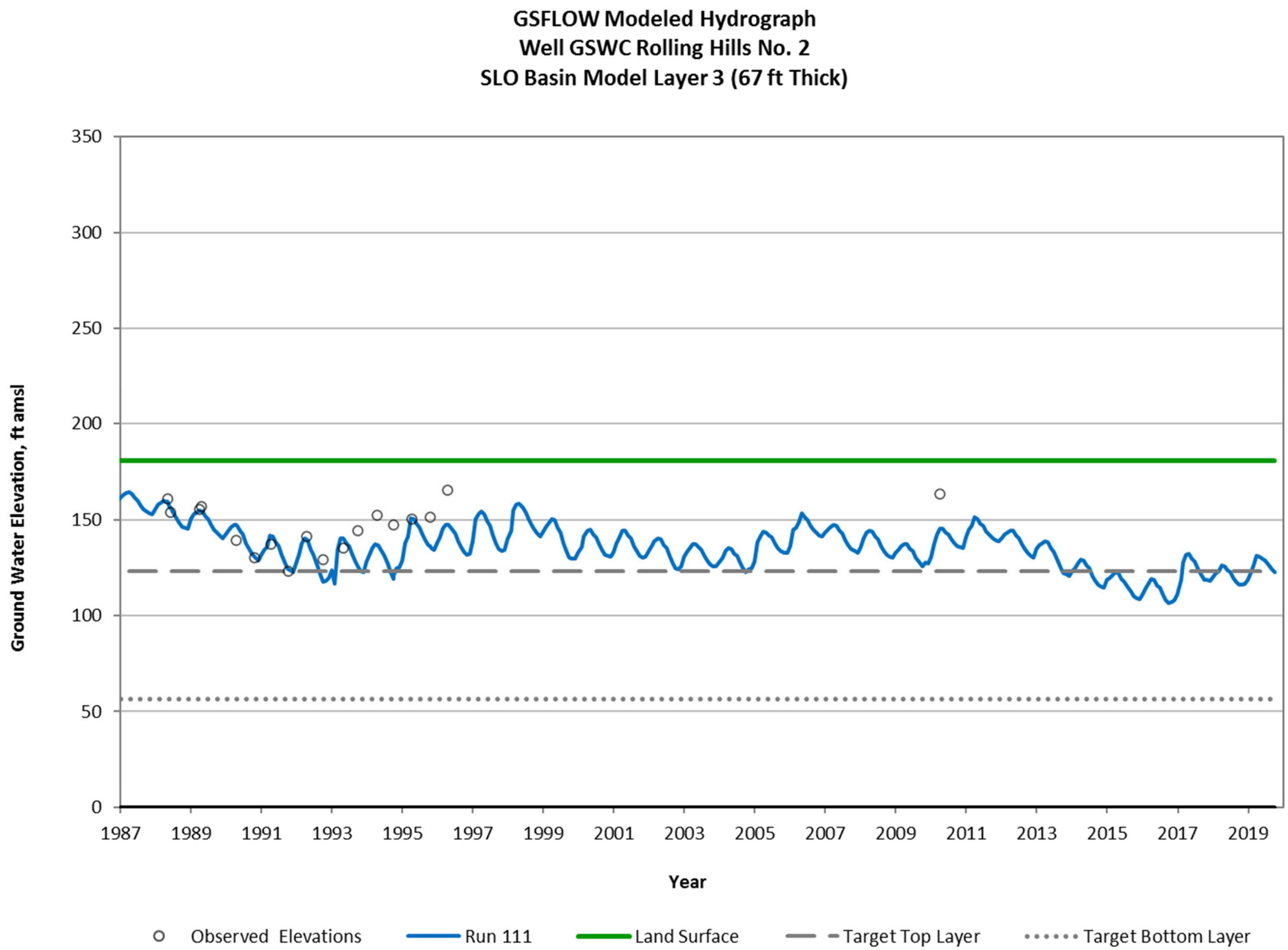

GSFLOW Modeled Hydrograph
Well GSWC Rolling Hills No. 2
SLO Basin Model Layer 3 (67 ft Thick)
Ground Water Elevation, ft amsl
350
300
250
200
150
100
50
0
1987
1989
1991
1993
1995
1997
1999
2001
2003
2005
2007
2009
2011
2013
2015
2017
2019
Year
Observed Elevations
Run 111
Land Surface
Target Top Layer
Target Bottom Layer

Figure B-22

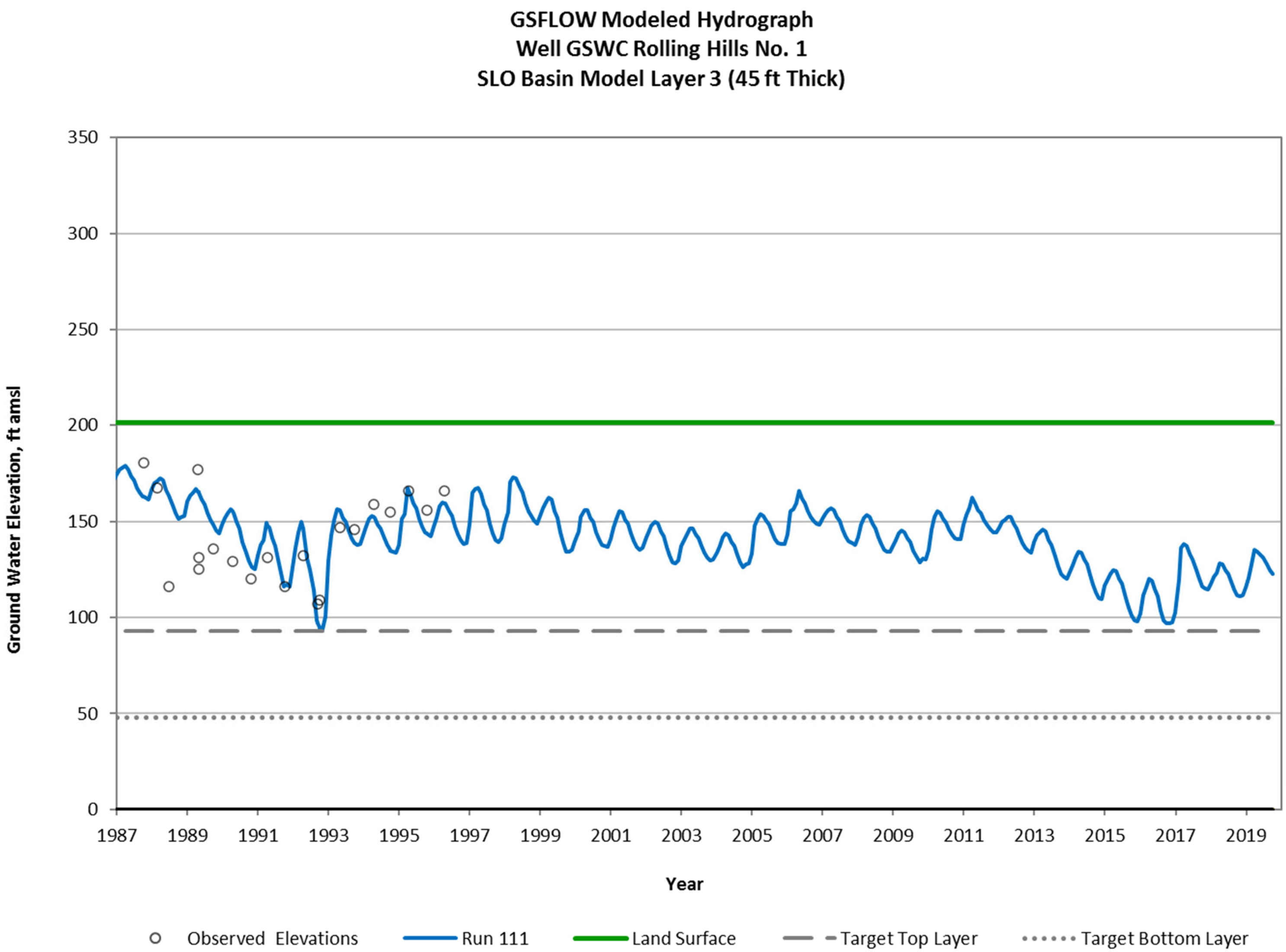

GSFLOW Modeled Hydrograph
Well GSWC Rolling Hills No. 1
SLO Basin Model Layer 3 (45 ft Thick)
Ground Water Elevation, ft amsl
350
300
250
200
150
100
50
0
1987
1989
1991
1993
1995
1997
1999
2001
2003
2005
2007
2009
2011
2013
2015
2017
2019
Year
Observed Elevations
Run 111
Land Surface
Target Top Layer
Target Bottom Layer

Figure B-23

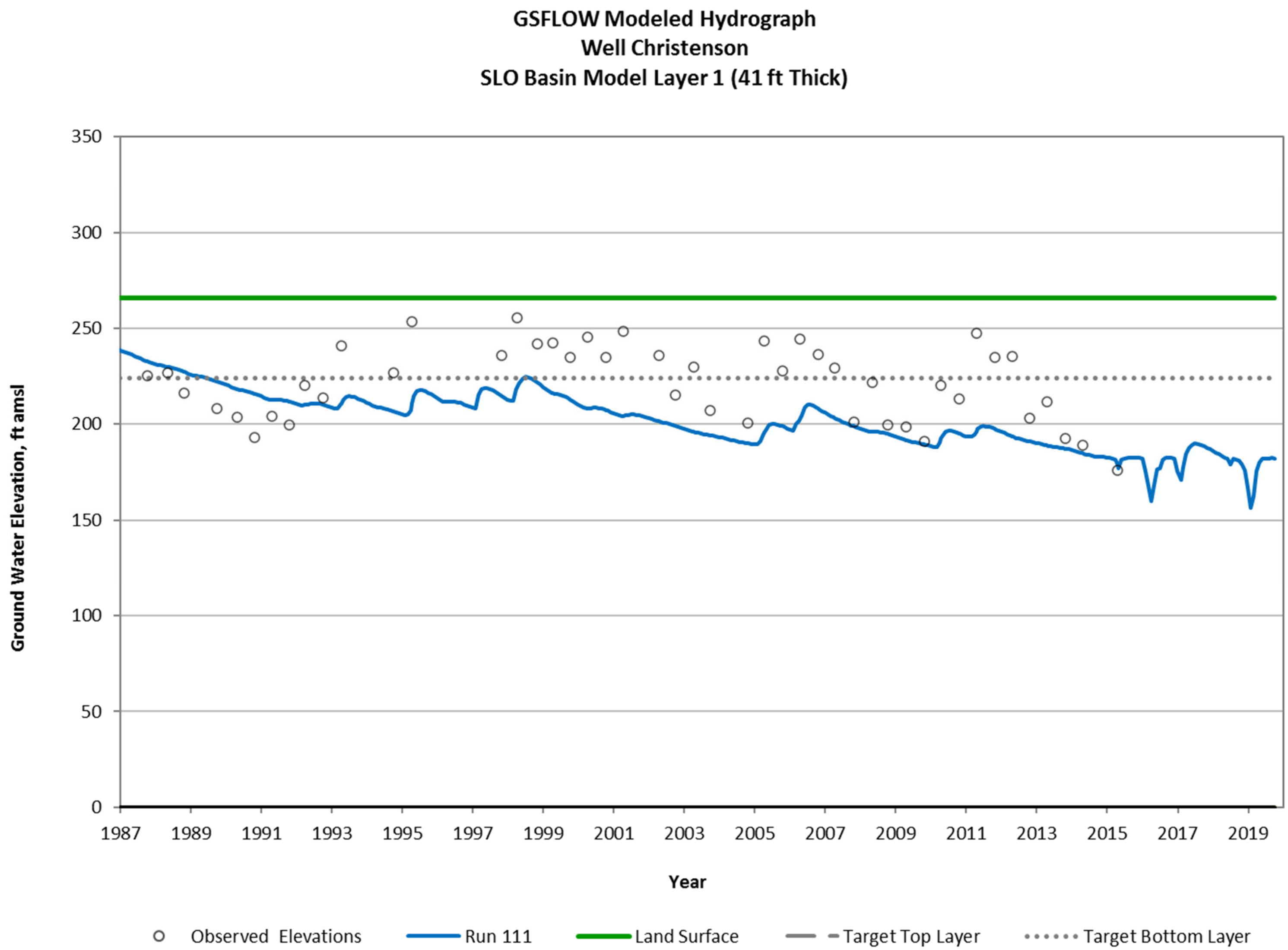

GSFLOW Modeled Hydrograph
Well Christenson
SLO Basin Model Layer 1 (41 ft Thick)
Ground Water Elevation, ft amsl
350
300
250
200
150
100
50
0
1987
1989
1991
1993
1995
1997
1999
2001
2003
2005
2007
2009
2011
2013
2015
2017
2019
Year
Observed Elevations
Run 111
Land Surface
Target Top Layer
Target Bottom Layer

Figure B-24

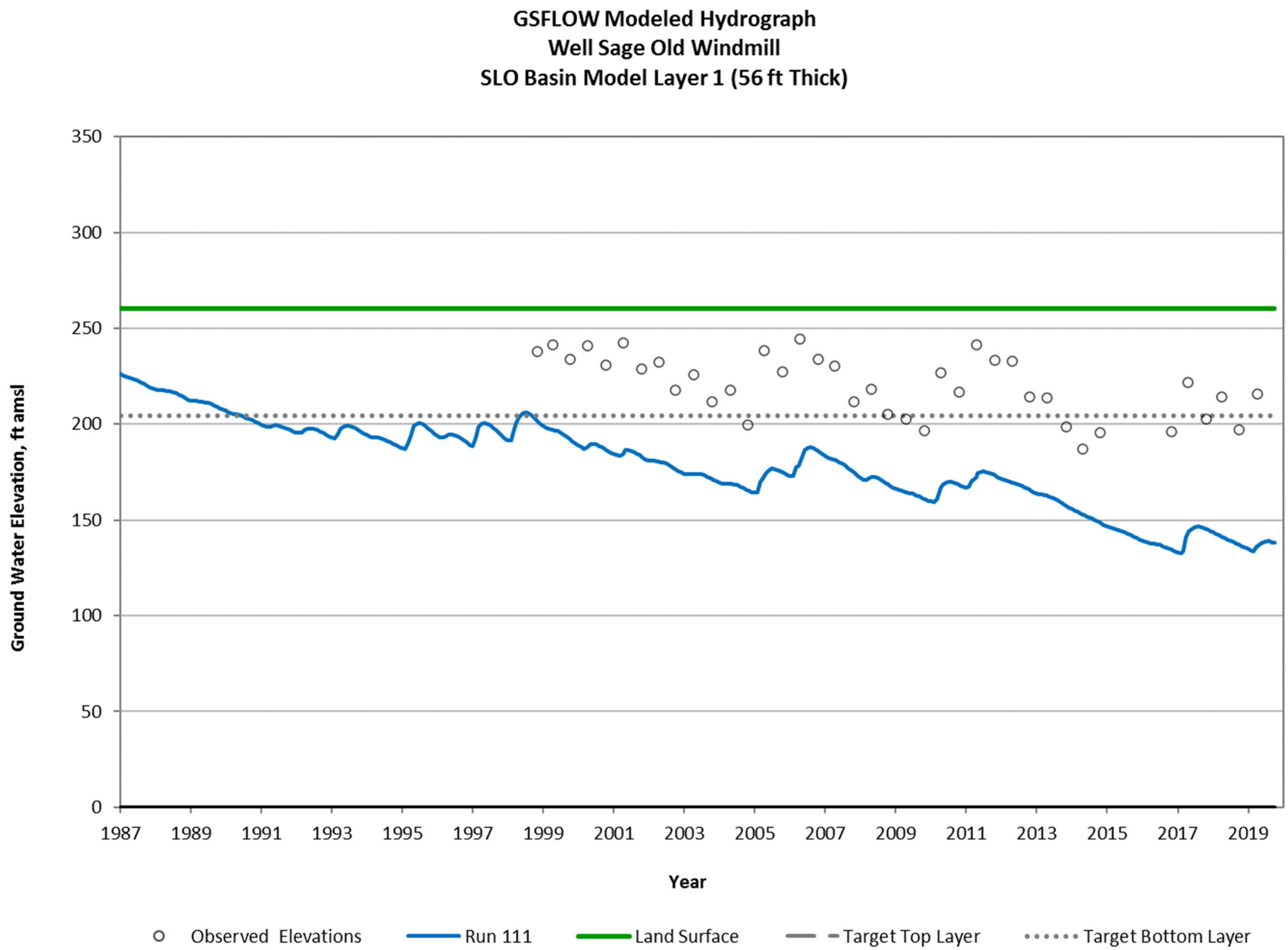

GSFLOW Modeled Hydrograph
Well Sage Old Windmill
SLO Basin Model Layer 1 (56 ft Thick)
Ground Water Elevation, ft amsl
350
300
250
200
150
100
50
0
1987
1989
1991
1993
1995
1997
1999
2001
2003
2005
2007
2009
2011
2013
2015
2017
2019
Year
Observed Elevations
Run 111
Land Surface
Target Top Layer
Target Bottom Layer

Figure B-25

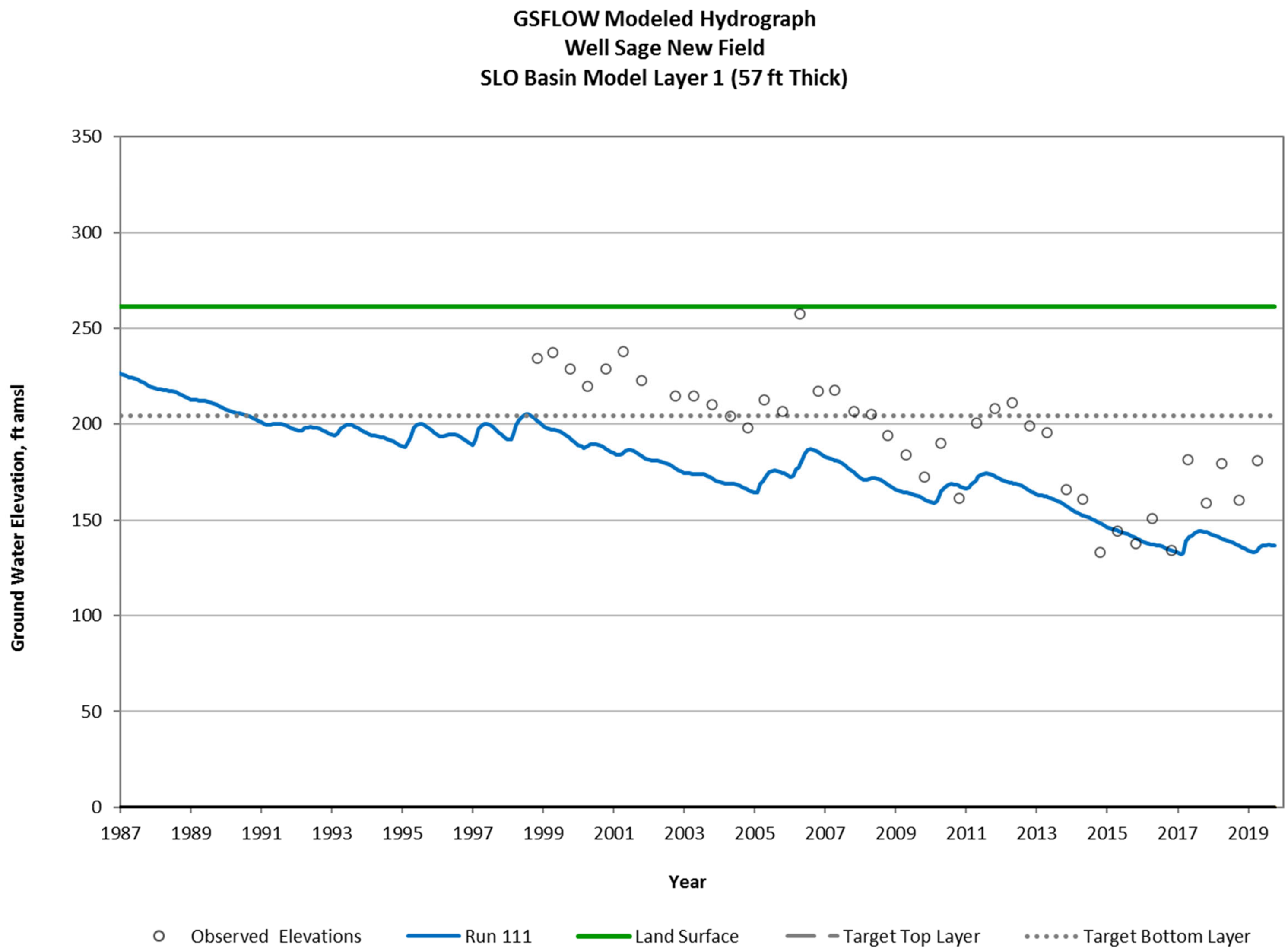

GSFLOW Modeled Hydrograph
Well Sage New Field
SLO Basin Model Layer 1 (57 ft Thick)
350
300
250
200
150
100
50
0
Ground Water Elevation, ft amsl
1987
1989
1991
1993
1995
1997
1999
2001
2003
2005
2007
2009
2011
2013
2015
2017
2019
Year
Observed Elevations
Run 111
Land Surface
Target Top Layer
Target Bottom Layer

Figure B-26

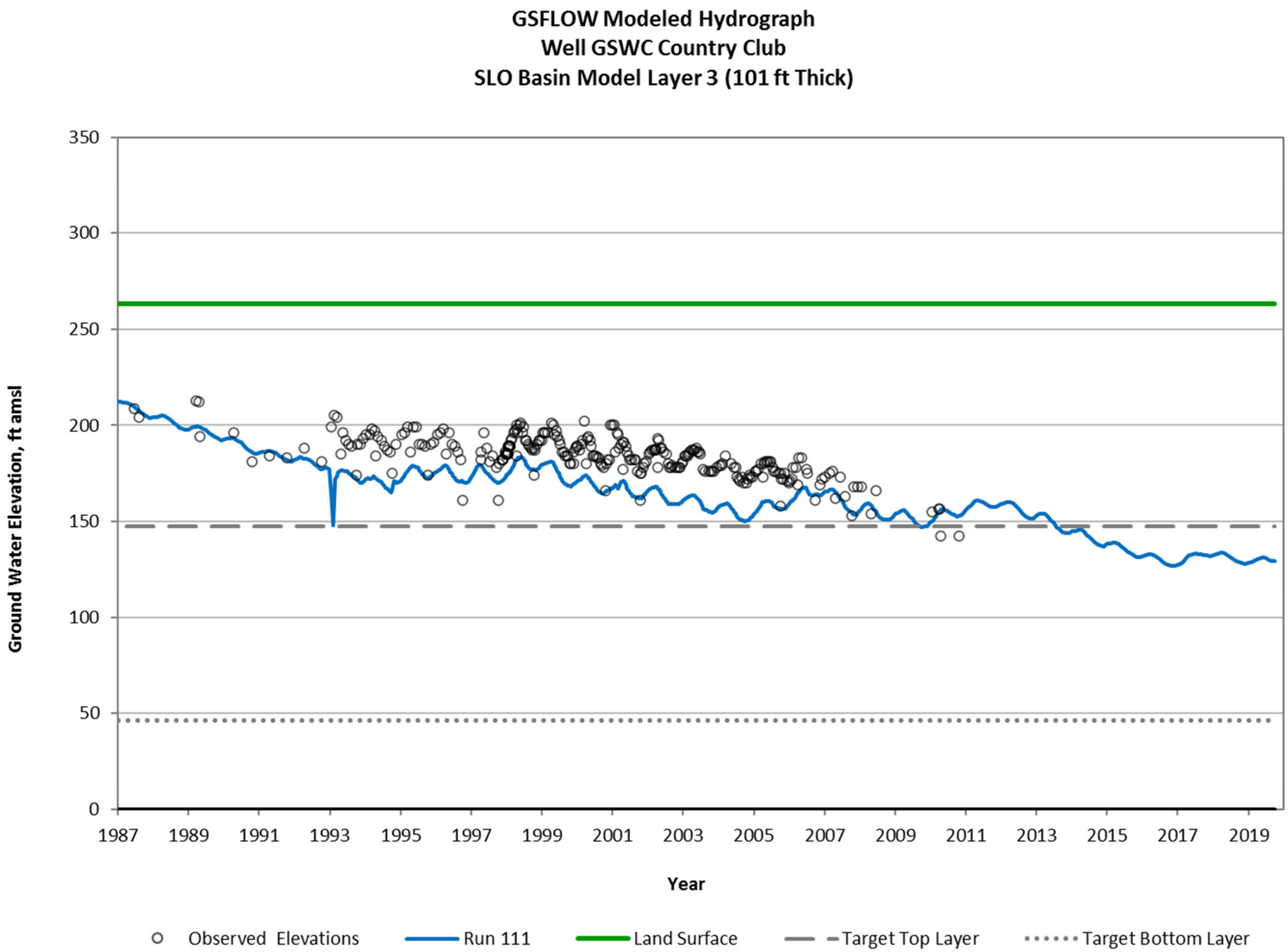

GSFLOW Modeled Hydrograph
Well GSWC Country Club
SLO Basin Model Layer 3 (101 ft Thick)
Ground Water Elevation, ft amsl
350
300
250
200
150
100
50
0
1987
1989
1991
1993
1995
1997
1999
2001
2003
2005
2007
2009
2011
2013
2015
2017
2019
Year
Observed Elevations
Run 111
Land Surface
Target Top Layer
Target Bottom Layer

Figure B-27

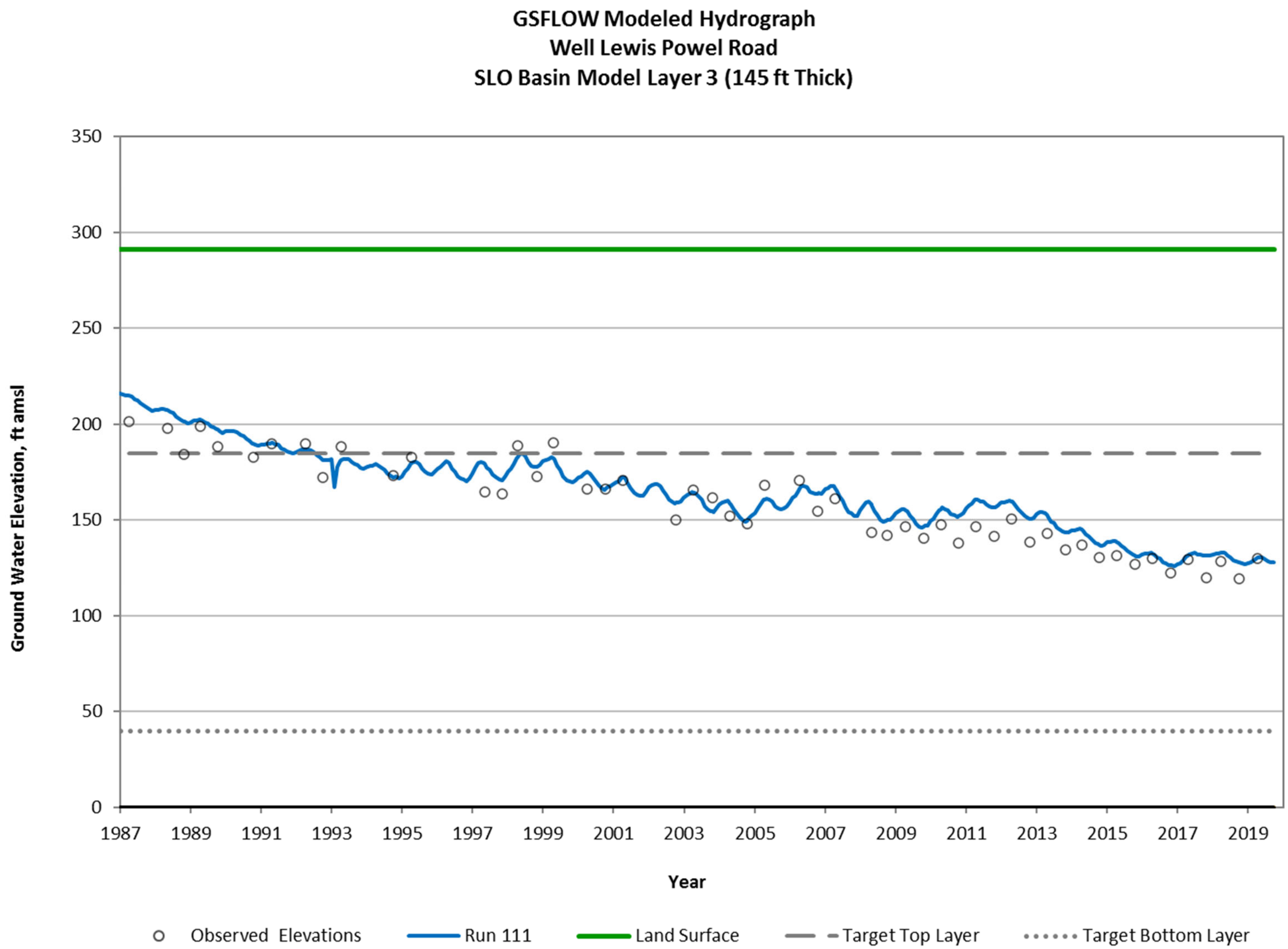

GSFLOW Modeled Hydrograph
Well Lewis Powel Road
SLO Basin Model Layer 3 (145 ft Thick)
Ground Water Elevation, ft amsl
350
300
250
200
150
100
50
0
1987
1989
1991
1993
1995
1997
1999
2001
2003
2005
2007
2009
2011
2013
2015
2017
2019
Year
Observed Elevations
Run 111
Land Surface
Target Top Layer
Target Bottom Layer

Figure B-28

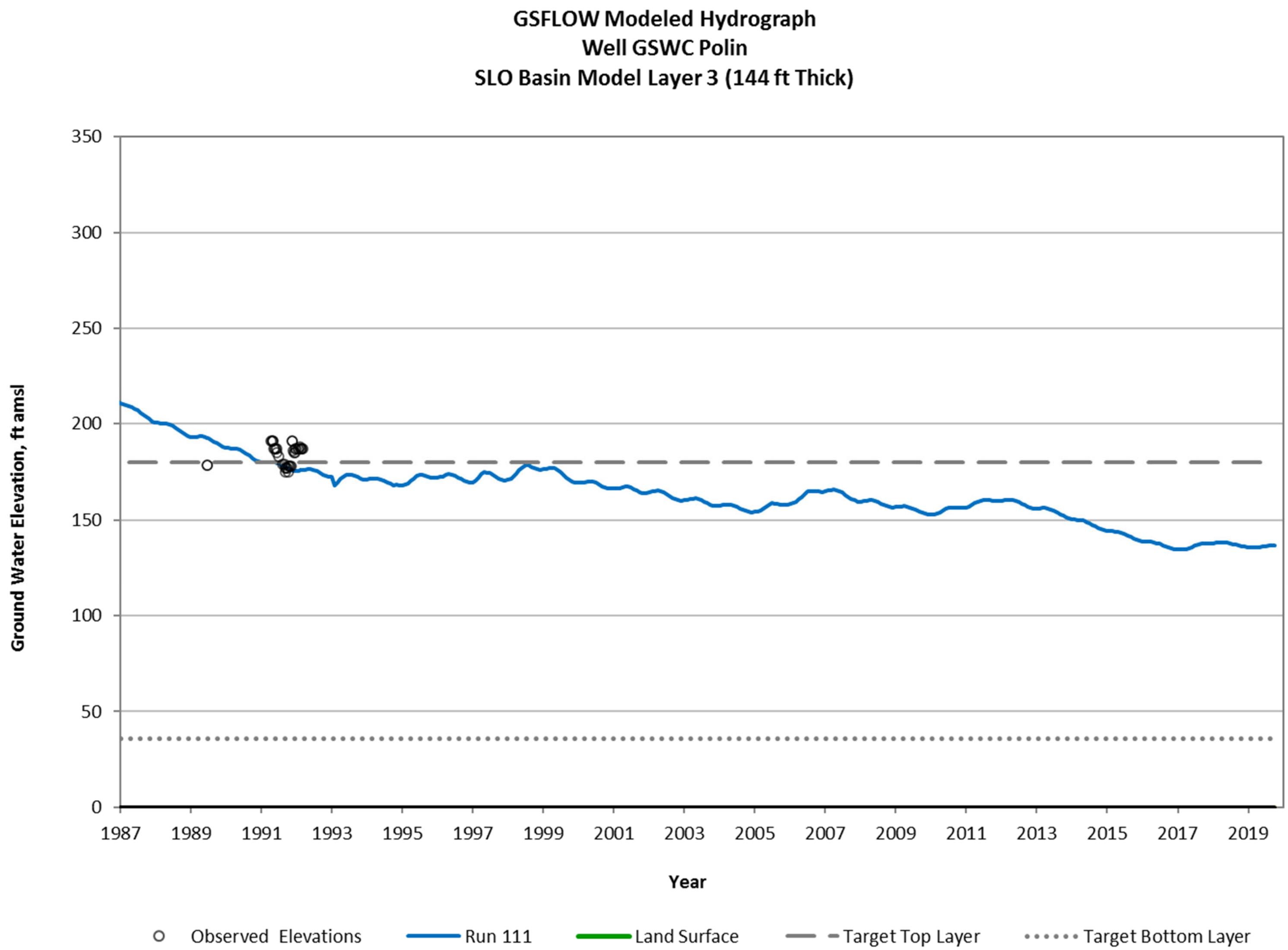

GSFLOW Modeled Hydrograph
Well GSWC Polin
SLO Basin Model Layer 3 (144 ft Thick)
Ground Water Elevation, ft amsl
350
300
250
200
150
100
50
0
1987
1989
1991
1993
1995
1997
1999
2001
2003
2005
2007
2009
2011
2013
2015
2017
2019
Year
Observed Elevations
Run 111
Land Surface
Target Top Layer
Target Bottom Layer

Figure B-29

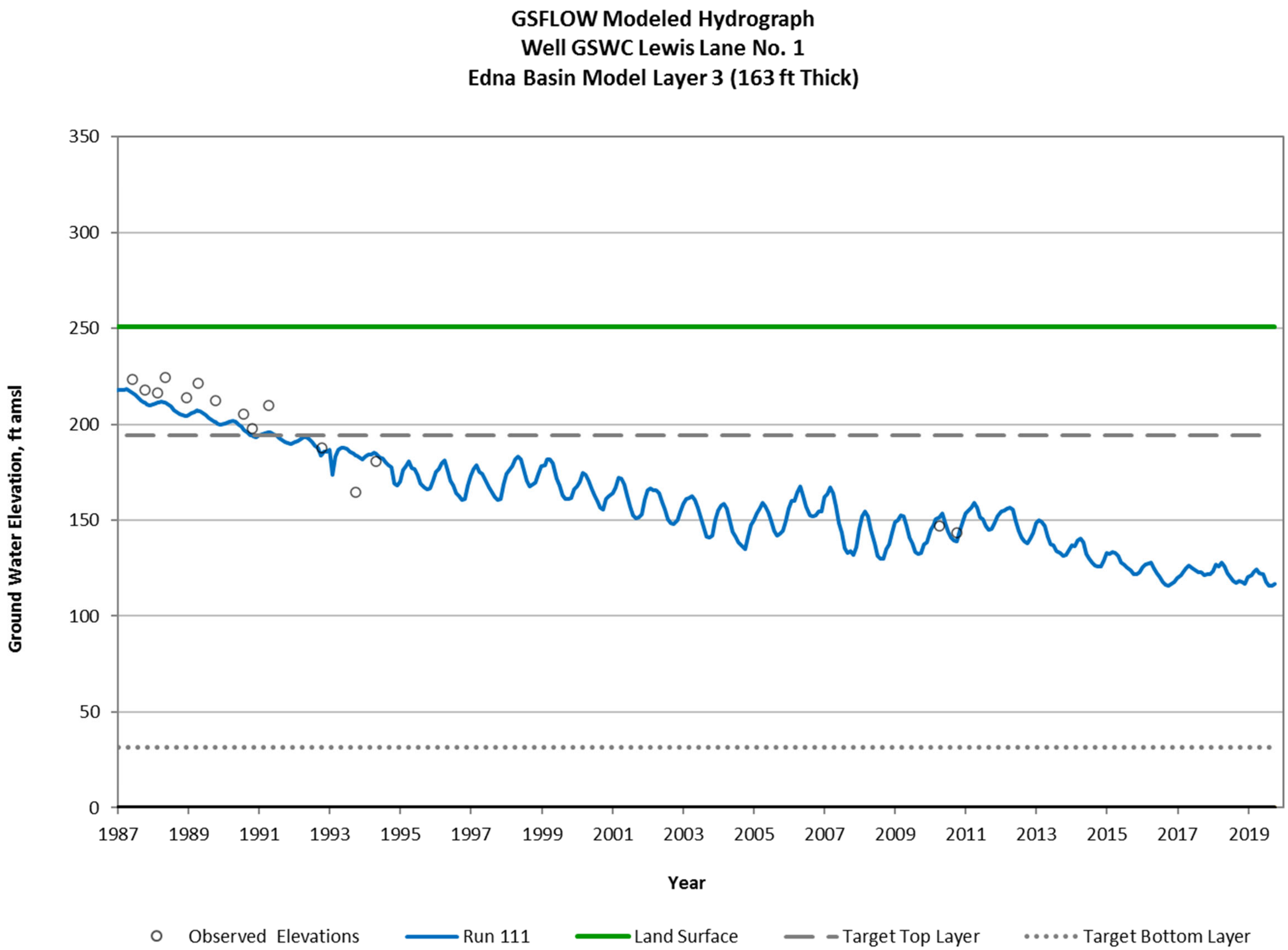

GSFLOW Modeled Hydrograph
Well GSWC Lewis Lane No. 1
Edna Basin Model Layer 3 (163 ft Thick)
Ground Water Elevation, ft amsl
350
300
250
200
150
100
50
0
1987
1989
1991
1993
1995
1997
1999
2001
2003
2005
2007
2009
2011
2013
2015
2017
2019
Year
Observed Elevations
Run 111
Land Surface
Target Top Layer
Target Bottom Layer

Figure B-30

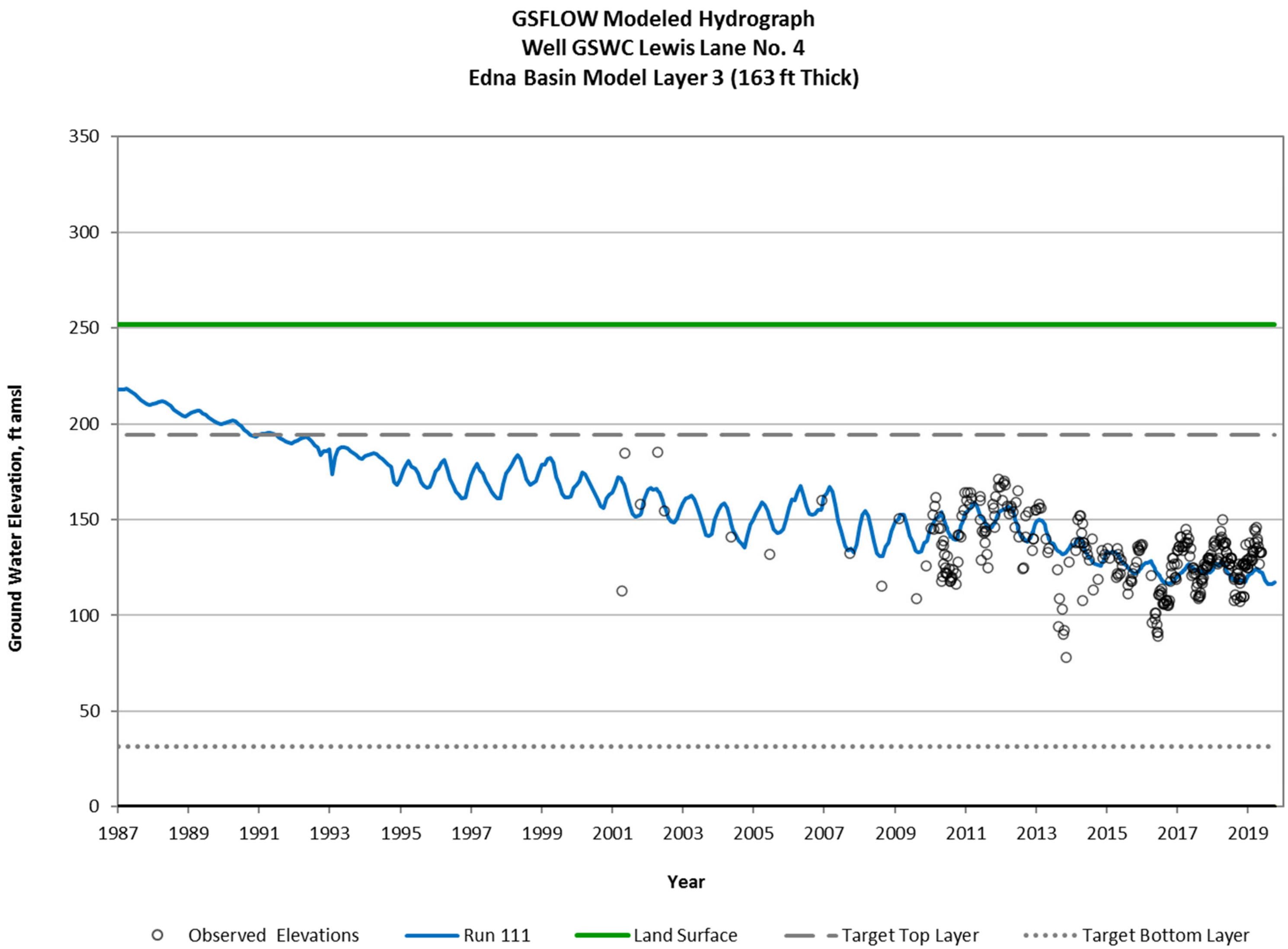

GSFLOW Modeled Hydrograph
Well GSWC Lewis Lane No. 4
Edna Basin Model Layer 3 (163 ft Thick)
Ground Water Elevation, ft amsl
350
300
250
200
150
100
50
0
1987
1989
1991
1993
1995
1997
1999
2001
2003
2005
2007
2009
2011
2013
2015
2017
2019
Year
Observed Elevations
Run 111
Land Surface
Target Top Layer
Target Bottom Layer

Figure B-31

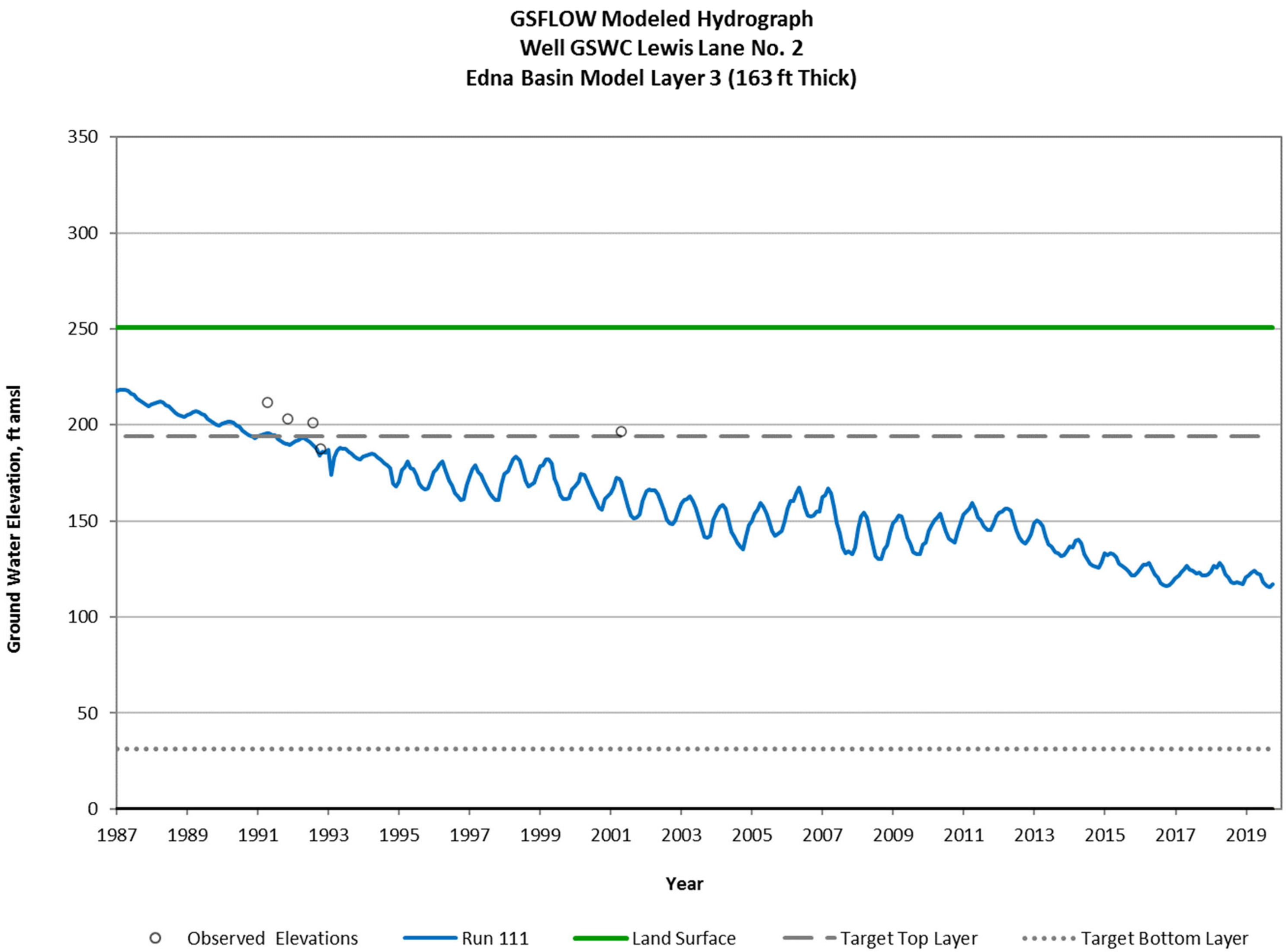

GSFLOW Modeled Hydrograph
Well GSWC Lewis Lane No. 2
Edna Basin Model Layer 3 (163 ft Thick)
Ground Water Elevation, ft amsl
350
300
250
200
150
100
50
0
1987
1989
1991
1993
1995
1997
1999
2001
2003
2005
2007
2009
2011
2013
2015
2017
2019
Year
Observed Elevations
Run 111
Land Surface
Target Top Layer
Target Bottom Layer

Figure B-32

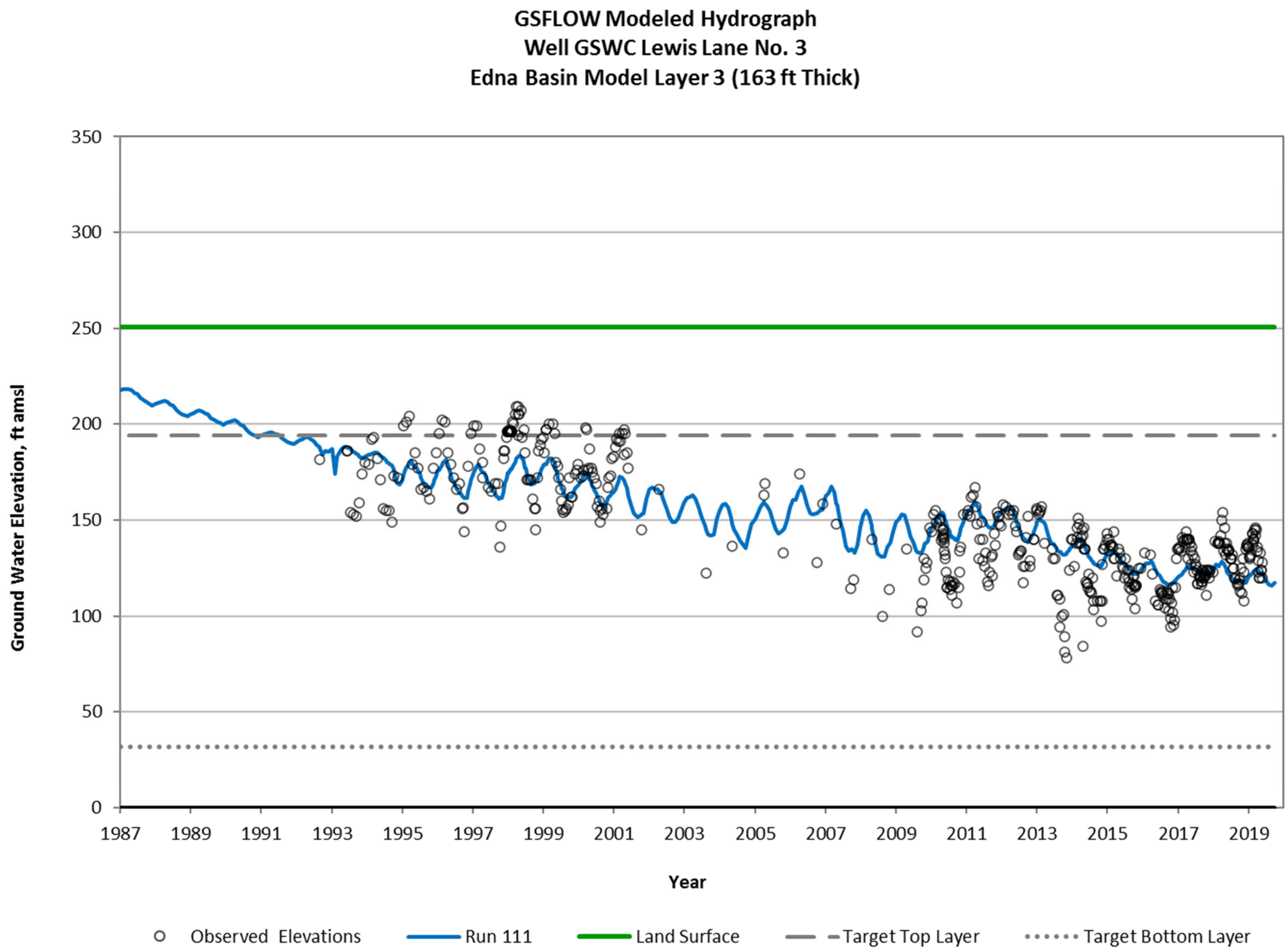
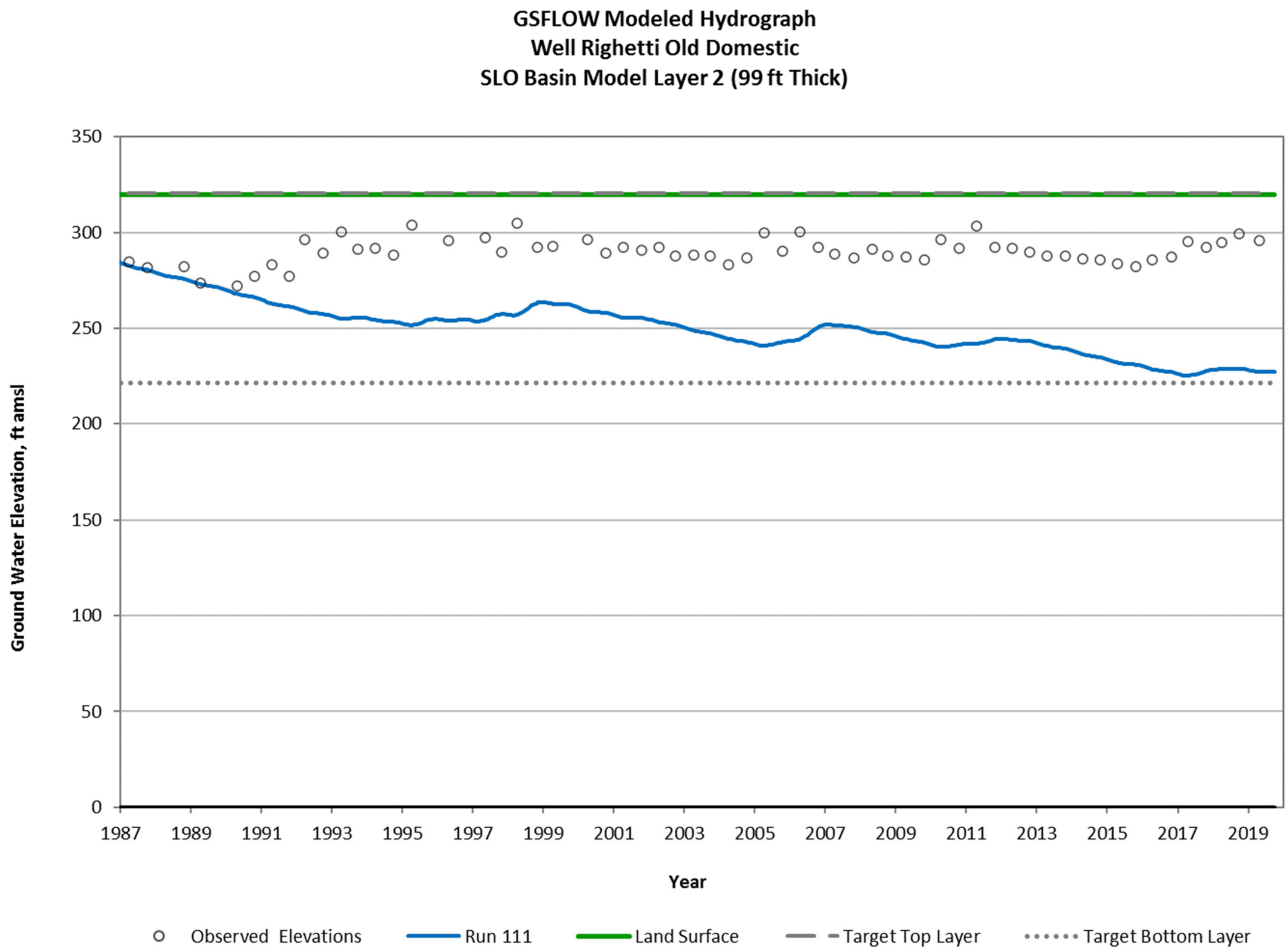

GSFLOW Modeled Hydrograph
Well GSWC Lewis Lane No. 3
Edna Basin Model Layer 3 (163 ft Thick)
Ground Water Elevation, ft amsl
350
300
250
200
150
100
50
0
1987
1989
1991
1993
1995
1997
1999
2001
2003
2005
2007
2009
2011
2013
2015
2017
2019
Year
Observed Elevations
Run 111
Land Surface
Target Top Layer
Target Bottom Layer

Figure B-33


GSFLOW Modeled Hydrograph
Well Righetti Old Domestic
SLO Basin Model Layer 2 (99 ft Thick)
Ground Water Elevation, ft amsl
0
50
100
150
200
250
300
350
1987
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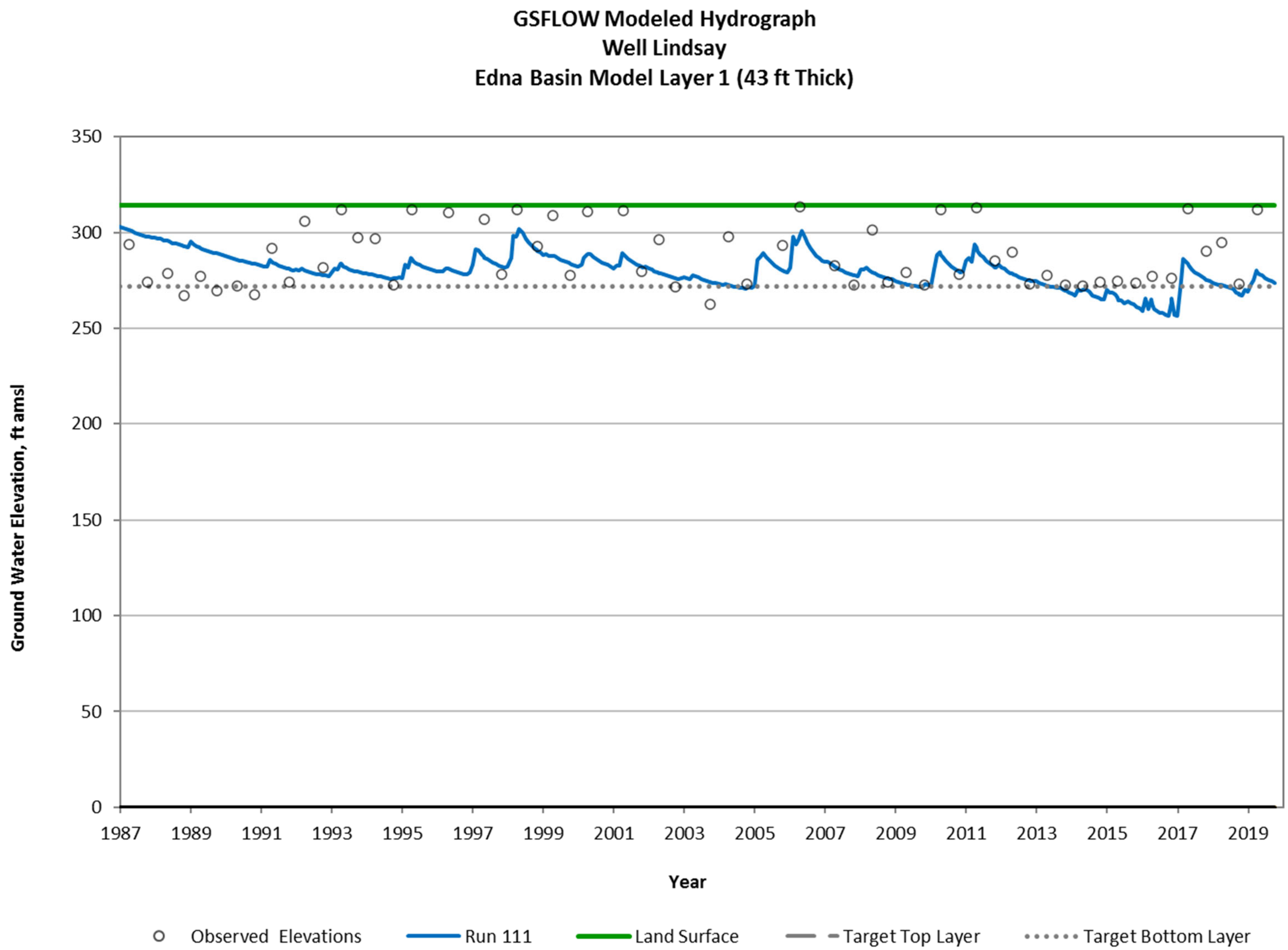
2015
2017
2019
Year
Observed Elevations
Run 111
Land Surface
Target Top Layer
Target Bottom Layer

Figure B-34


GSFLOW Modeled Hydrograph
Well Lindsay
Edna Basin Model Layer 1 (43 ft Thick)
Ground Water Elevation, ft amsl
350
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250
200
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50
0
1987
1989
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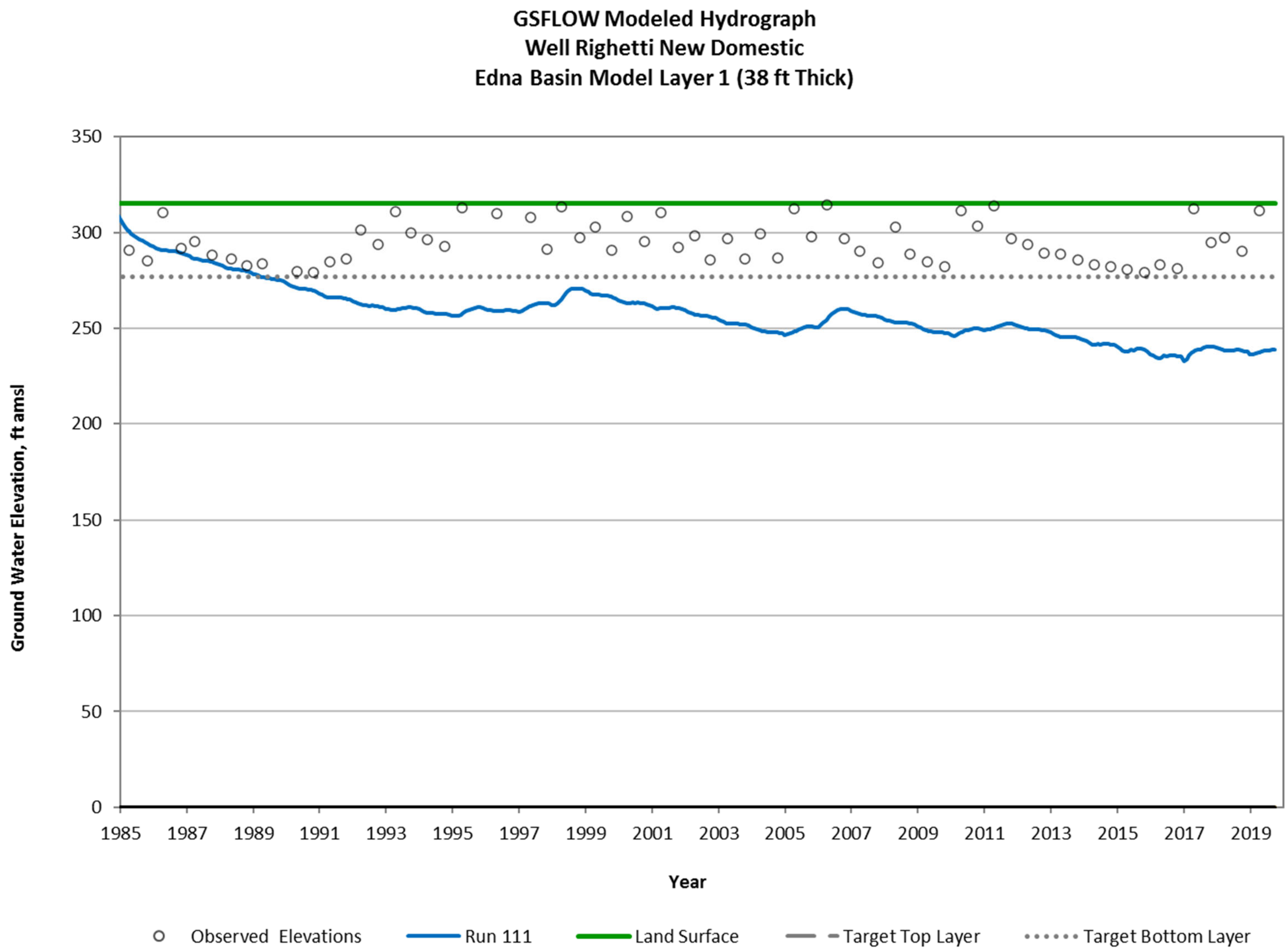
2019
Year
Observed Elevations
Run 111
Land Surface
Target Top Layer
Target Bottom Layer

Figure B-35


GSFLOW Modeled Hydrograph
Well Righetti New Domestic
Edna Basin Model Layer 1 (38 ft Thick)
Ground Water Elevation, ft amsl
350
300
250
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100
50
0
1985
1987
1989
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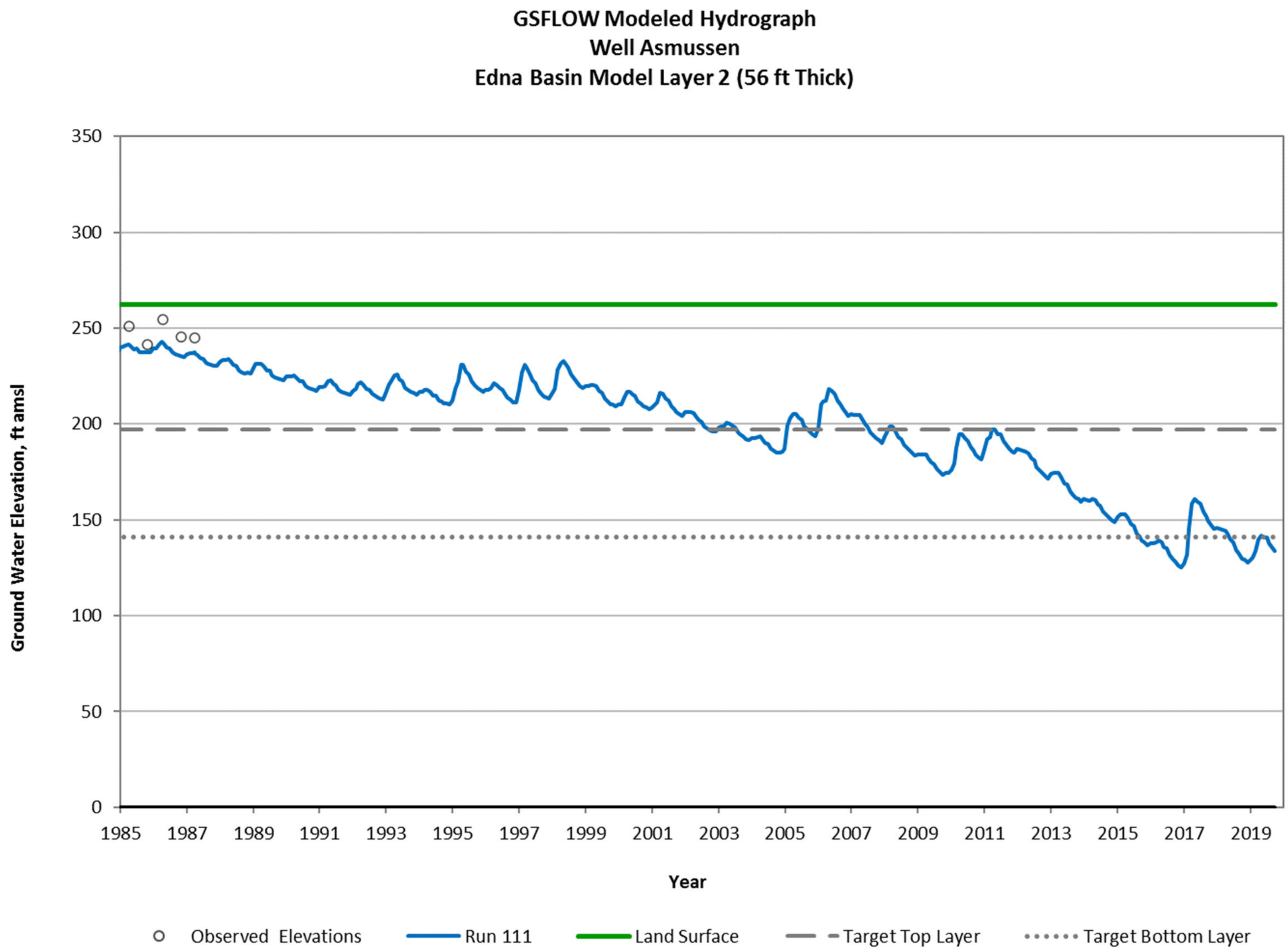
Year
Observed Elevations
Run 111
Land Surface
Target Top Layer
Target Bottom Layer

Figure B-36


GSFLOW Modeled Hydrograph
Well Asmussen
Edna Basin Model Layer 2 (56 ft Thick)
Ground Water Elevation, ft amsl
350
300
250
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100
50
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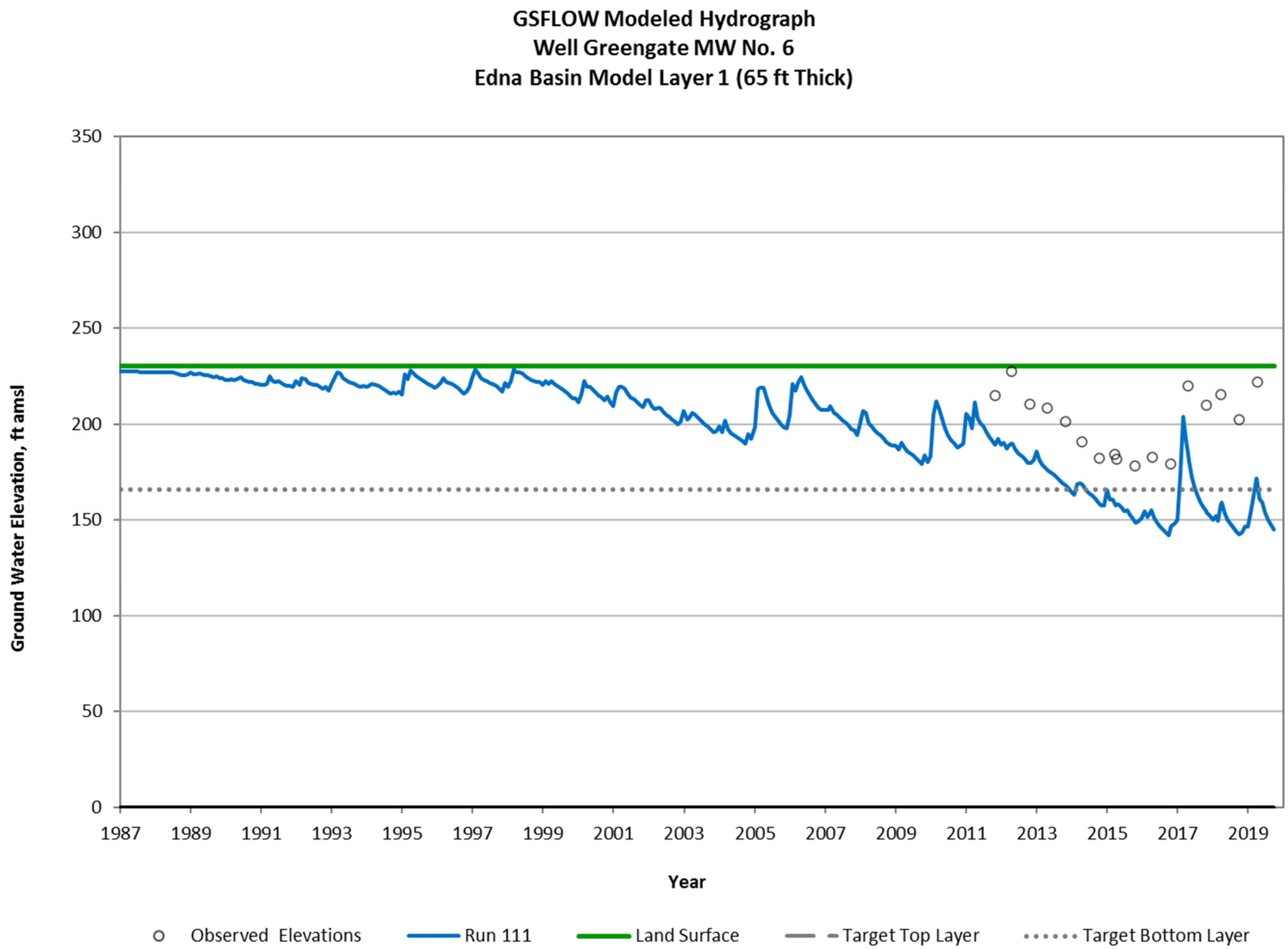
Year
Observed Elevations
Run 111
Land Surface
Target Top Layer
Target Bottom Layer

Figure B-37


GSFLOW Modeled Hydrograph
Well Greengate MW No. 6
Edna Basin Model Layer 1 (65 ft Thick)
Ground Water Elevation, ft amsl
350
300
250
200
150
100
50
0
1987
1989
1991
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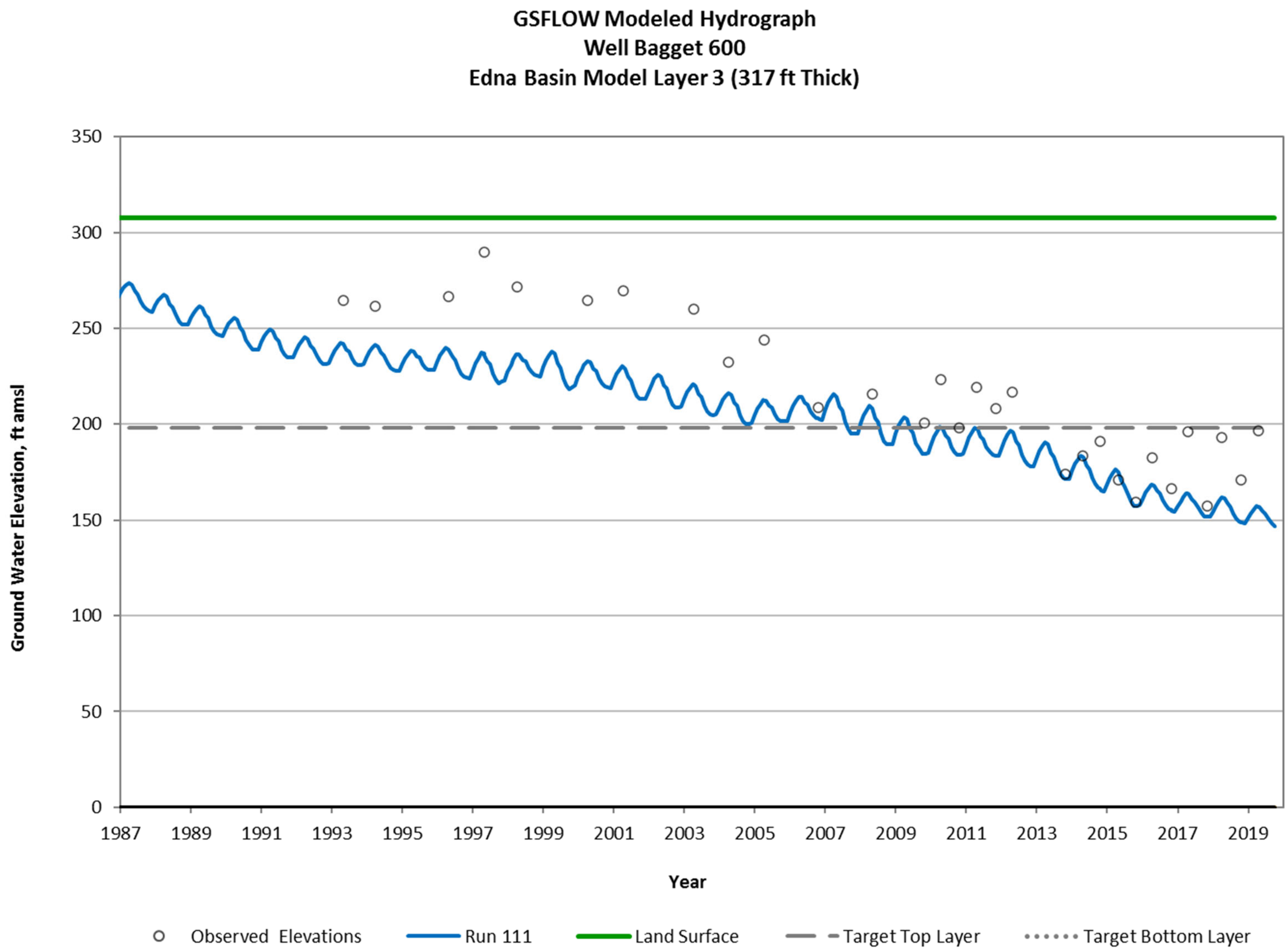
Year
Observed Elevations
Run 111
Land Surface
Target Top Layer
Target Bottom Layer

Figure B-38


GSFLOW Modeled Hydrograph
Well Bagget 600
Edna Basin Model Layer 3 (317 ft Thick)
Ground Water Elevation, ft amsl
350
300
250
200
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100
50
0
1987
1989
1991
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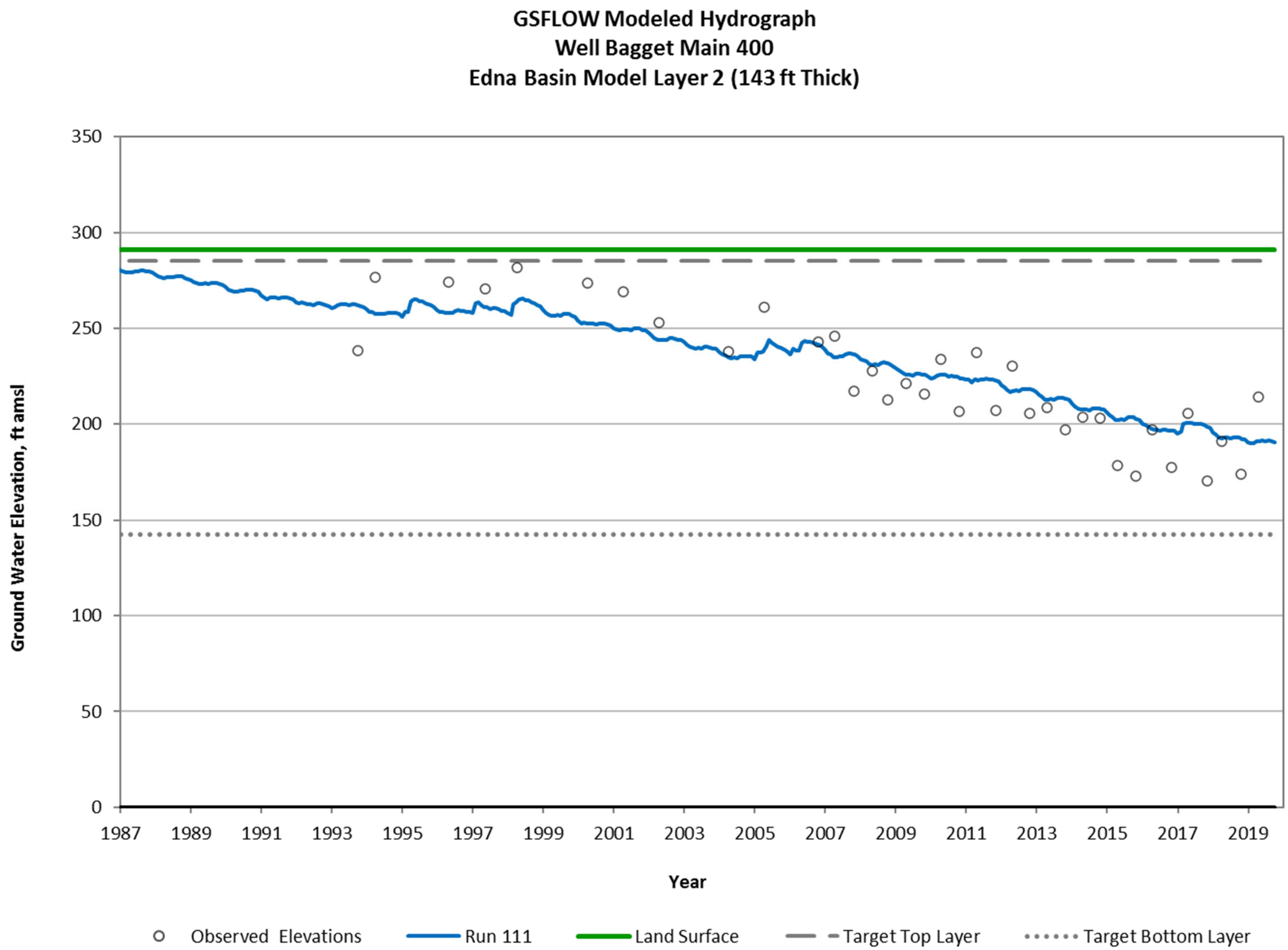
2019
Year
Observed Elevations
Run 111
Land Surface
Target Top Layer
Target Bottom Layer

Figure B-39


GSFLOW Modeled Hydrograph
Well Bagget Main 400
Edna Basin Model Layer 2 (143 ft Thick)
Ground Water Elevation, ft amsl
350
300
250
200
150
100
50
0
1987
1989
1991
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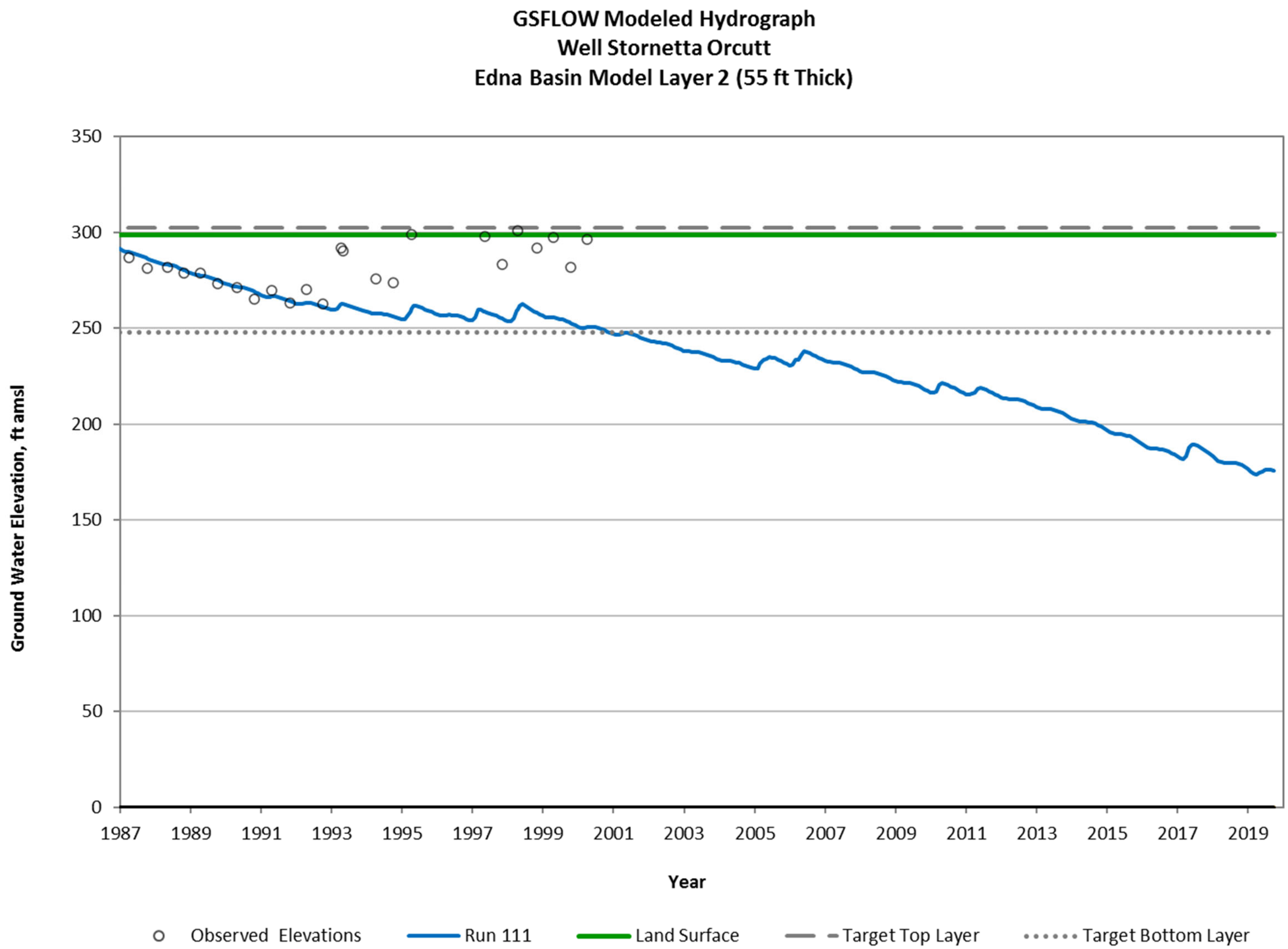
2019
Year
Observed Elevations
Run 111
Land Surface
Target Top Layer
Target Bottom Layer

Figure B-40


GSFLOW Modeled Hydrograph
Well Stornetta Orcutt
Edna Basin Model Layer 2 (55 ft Thick)
Ground Water Elevation, ft amsl
350
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100
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1987
1989
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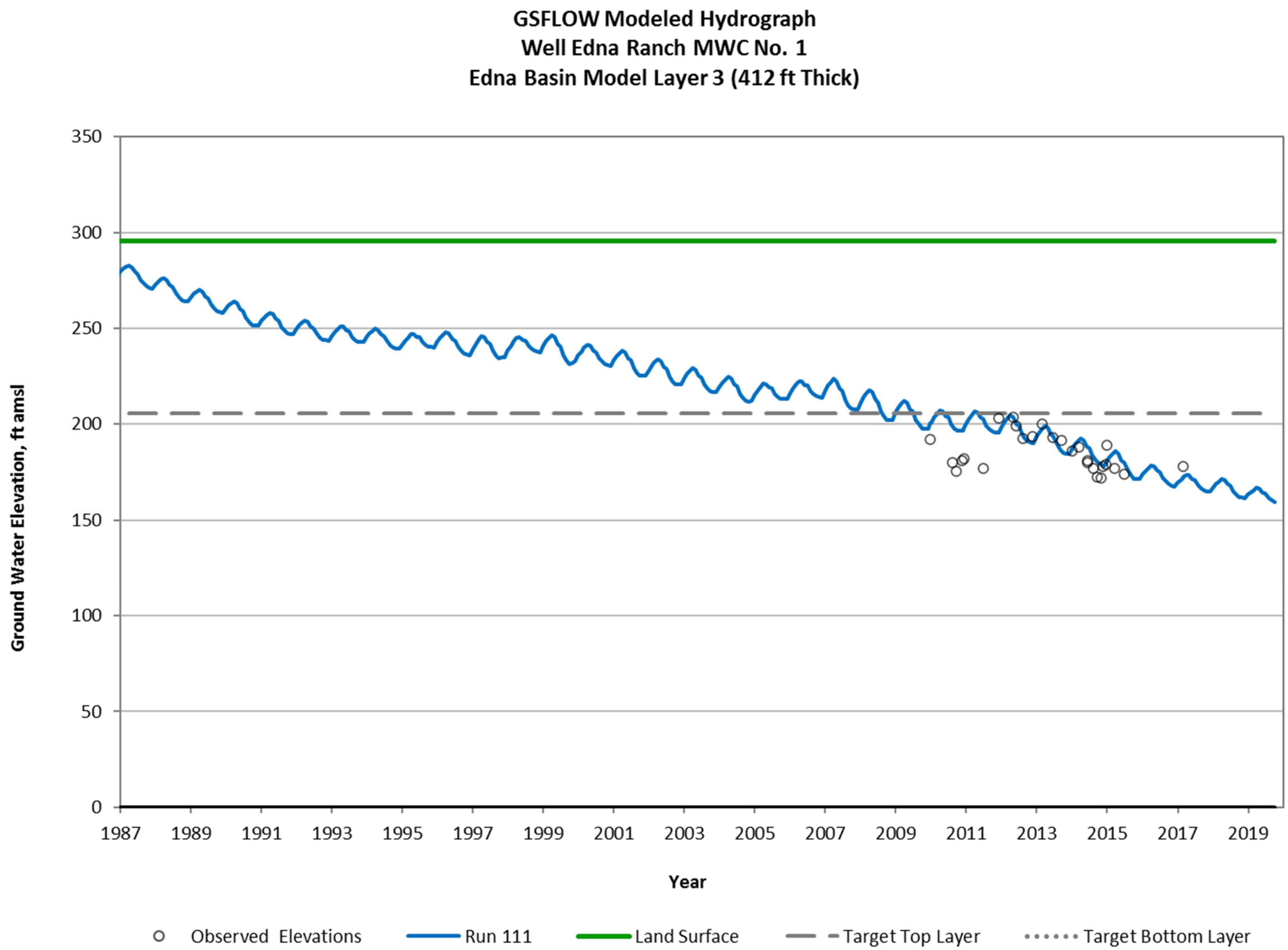
Year
Observed Elevations
Run 111
Land Surface
Target Top Layer
Target Bottom Layer

Figure B-41


GSFLOW Modeled Hydrograph
Well Edna Ranch MWC No. 1
Edna Basin Model Layer 3 (412 ft Thick)
Ground Water Elevation, ft amsl
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150
100
50
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1987
1989
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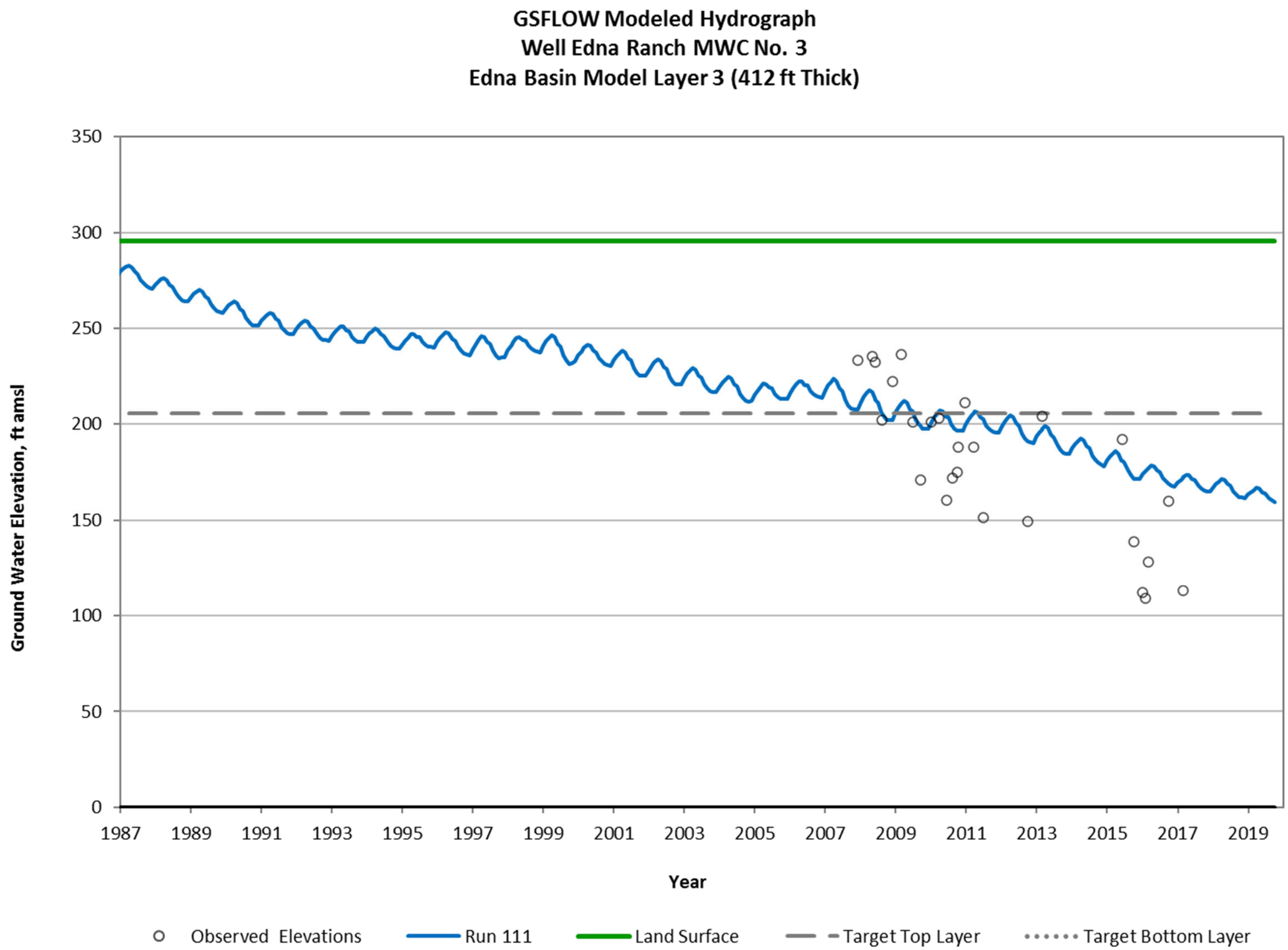
Year
Observed Elevations
Run 111
Land Surface
Target Top Layer
Target Bottom Layer

Figure B-42


GSFLOW Modeled Hydrograph
Well Edna Ranch MWC No. 3
Edna Basin Model Layer 3 (412 ft Thick)
Ground Water Elevation, ft amsl
350
300
250
200
150
100
50
0
1987
1989
1991
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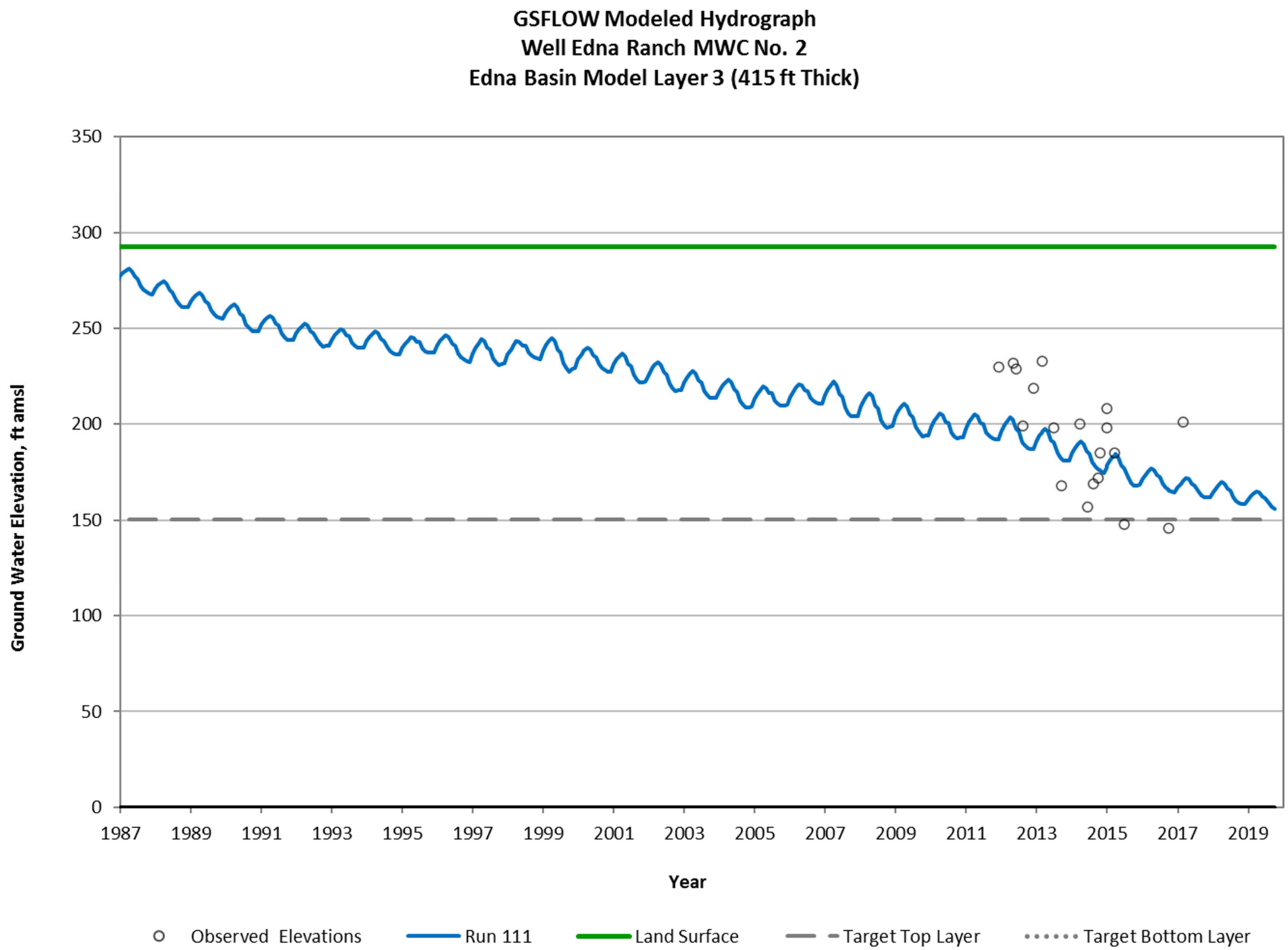
Year
Observed Elevations
Run 111
Land Surface
Target Top Layer
Target Bottom Layer

Figure B-43


GSFLOW Modeled Hydrograph
Well Edna Ranch MWC No. 2
Edna Basin Model Layer 3 (415 ft Thick)
Ground Water Elevation, ft amsl
350
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250
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150
100
50
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1987
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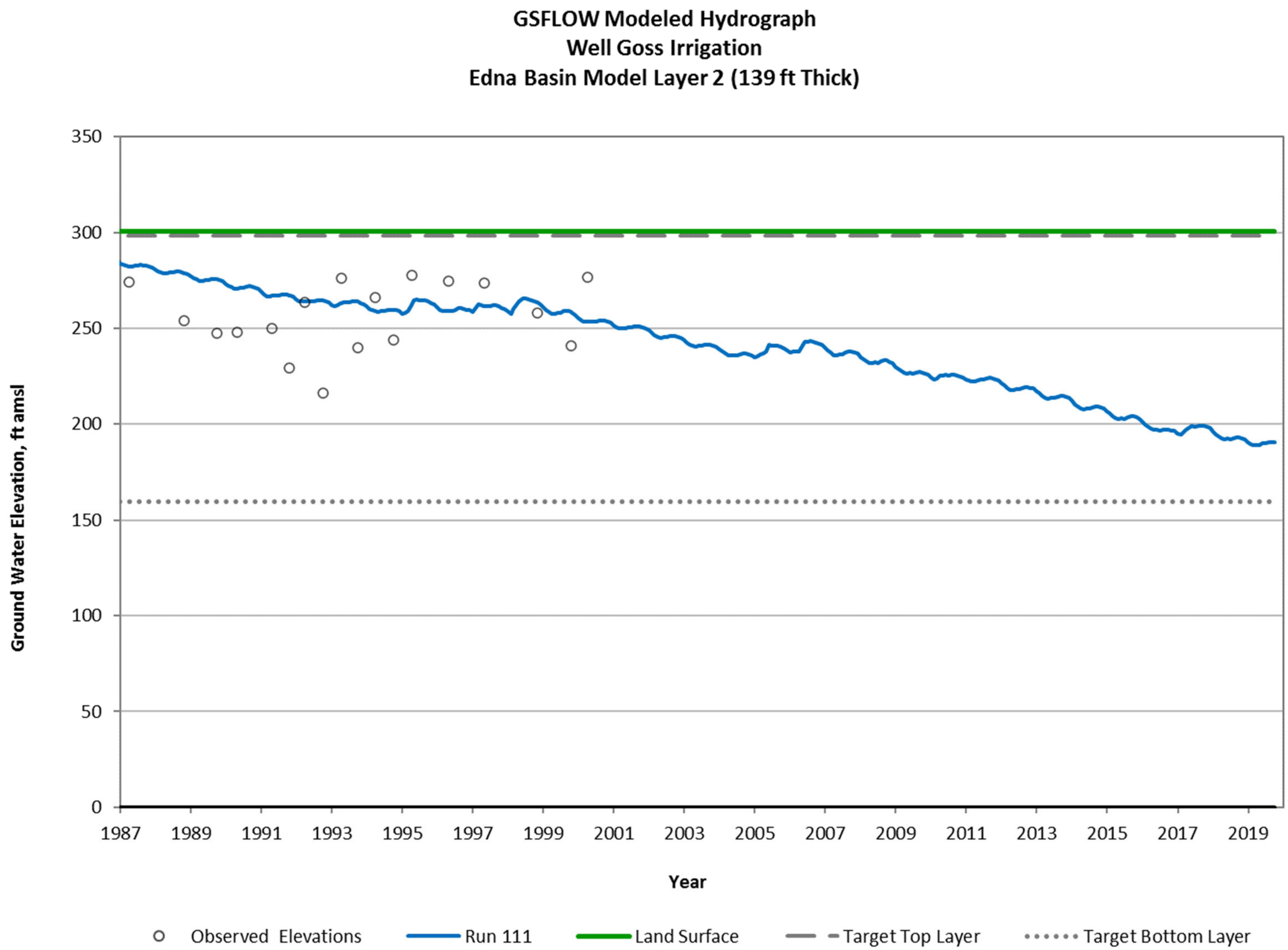
Observed Elevations
Run 111
Land Surface
Target Top Layer
Target Bottom Layer

Figure B-44


GSFLOW Modeled Hydrograph
Well Goss Irrigation
Edna Basin Model Layer 2 (139 ft Thick)
Ground Water Elevation, ft amsl
350
300
250
200
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100
50
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1987
1989
1991
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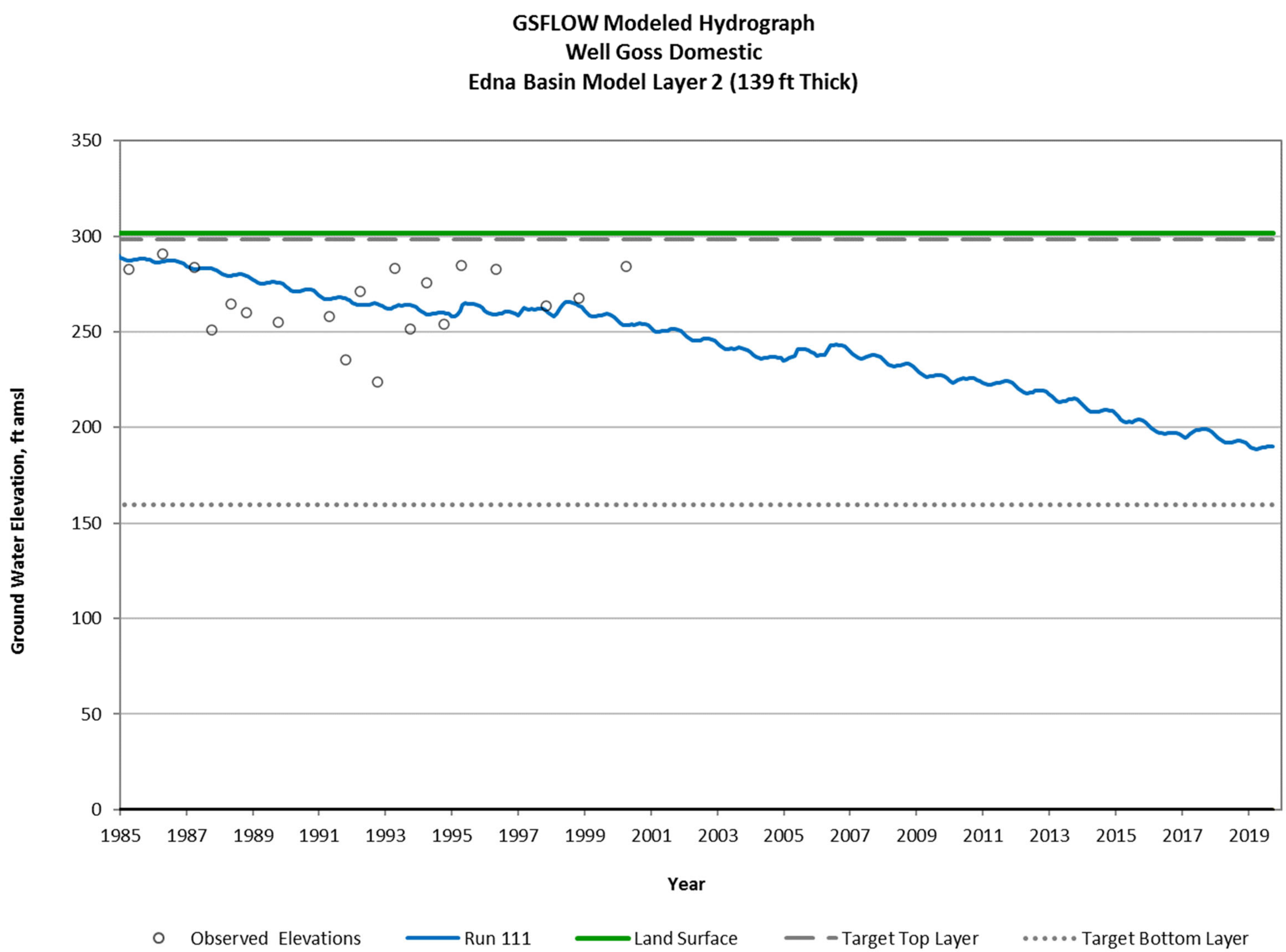
Observed Elevations
Run 111
Land Surface
Target Top Layer
Target Bottom Layer

Figure B-45


GSFLOW Modeled Hydrograph
Well Goss Domestic
Edna Basin Model Layer 2 (139 ft Thick)
Ground Water Elevation, ft amsl
350
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1985
1987
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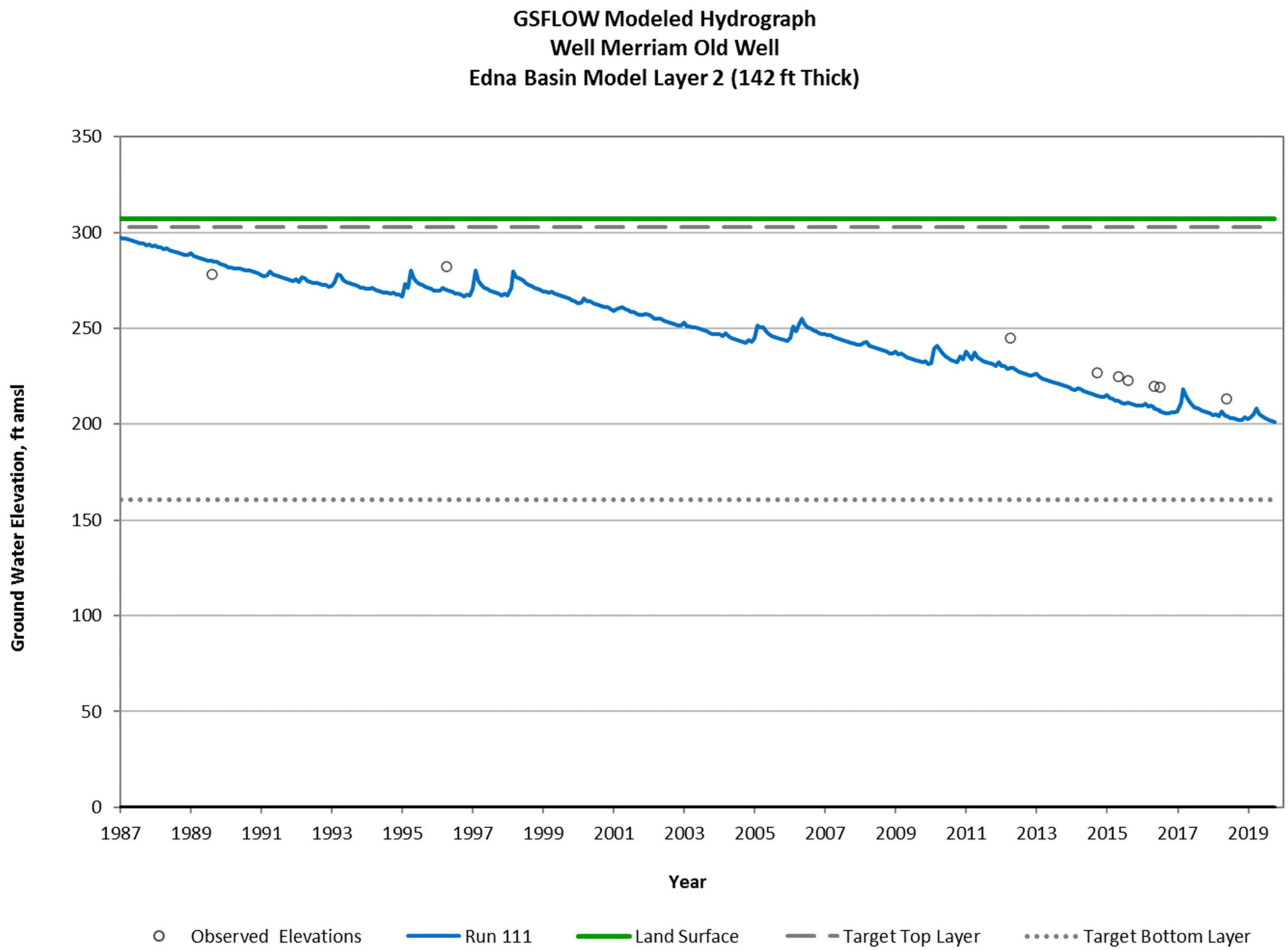
Year
Observed Elevations
Run 111
Land Surface
Target Top Layer
Target Bottom Layer

Figure B-46


GSFLOW Modeled Hydrograph
Well Merriam Old Well
Edna Basin Model Layer 2 (142 ft Thick)
Ground Water Elevation, ft amsl
350
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100
50
0
1987
1989
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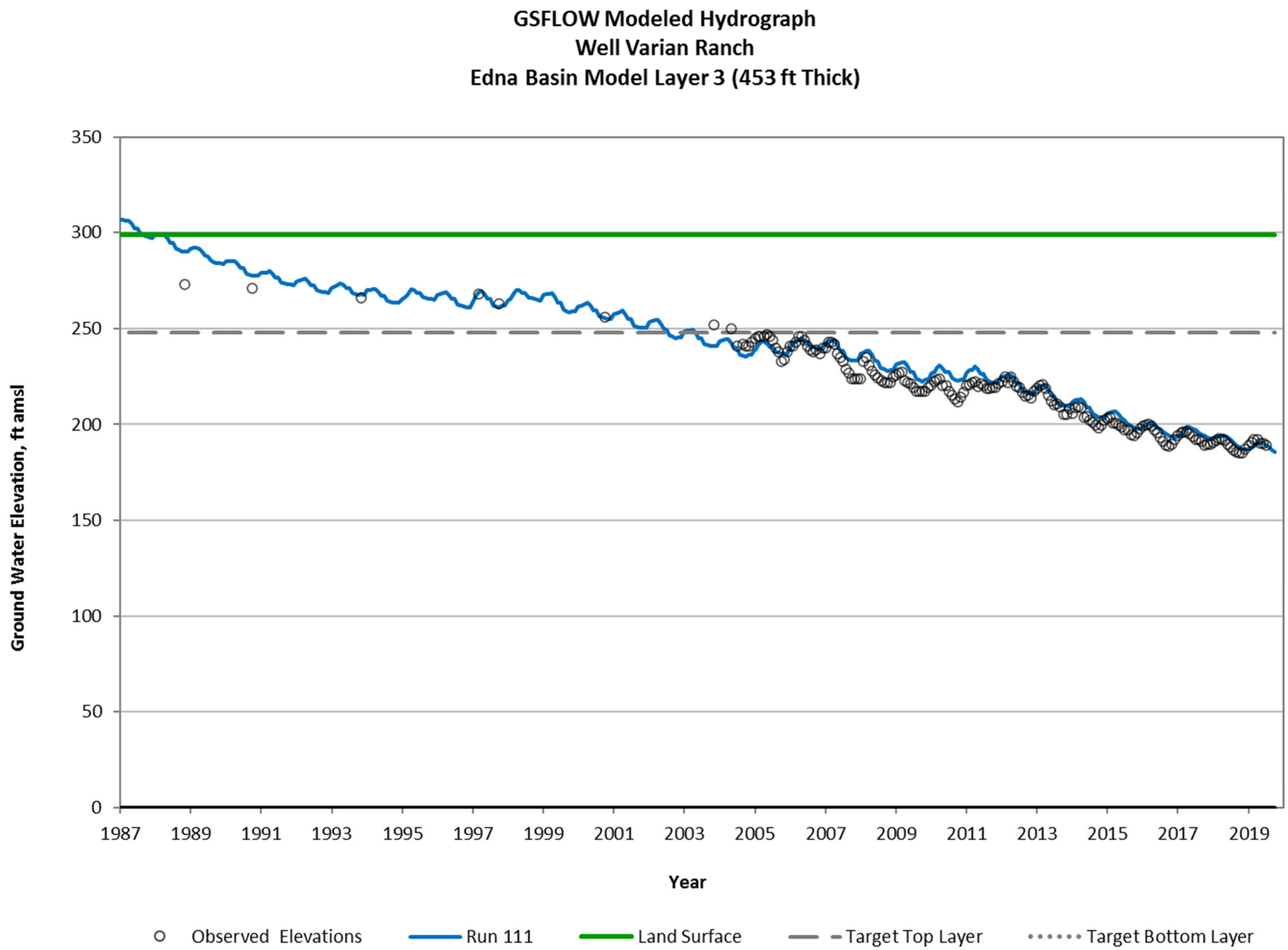
Year
Observed Elevations
Run 111
Land Surface
Target Top Layer
Target Bottom Layer

Figure B-47


GSFLOW Modeled Hydrograph
Well Varian Ranch
Edna Basin Model Layer 3 (453 ft Thick)
Ground Water Elevation, ft amsl
350
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50
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1987
1989
1991
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1995
1997
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2001
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Year
Observed Elevations
Run 111
Land Surface
Target Top Layer
Target Bottom Layer

Figure B-48

DRAFT

Cleath-Harris Geologists, Inc.
75 Zaca Lane, Suite 110
San Luis Obispo, CA 93401
(805) 543-1413

TECHNICAL MEMORANDUM

Date: November 21, 2019

To: Dick Tzou, PE
Water Resources Engineer
County of San Luis Obispo

From: Neil D. Currie, PG
Project Geologist
Cleath-Harris Geologists

Subject: Optional Task 2.4B Geophysical Survey

As part of the development of the Groundwater Sustainability Plan for the San Luis Obispo groundwater basin, Cleath-Harris Geologists (CHG) has completed Task 2.4B, the passive seismic geophysical survey of a bedrock divide identified in the 2018 Characterization Report. [1] The results of this effort are reported herein.

CONDUCT OF WORK

To complete the investigation of the bedrock divide between the San Luis Obispo and Edna Valley portions of the groundwater basin, CHG reviewed and interpreted existing well completion reports, reviewed existing surface geology maps, and performed a geophysical survey of the area of interest. The passive seismic data collected during the survey was post-processed, calibrated and modeled to estimate the depth to bedrock across the area of interest. Data sets from well completion reports, surface maps, and the geophysical survey were then used to generate contours of the depth of permeable sediments and a saturated thickness map across the area of interest. These contours were also used to develop cross-sections for comparison with prior work.

AREA OF INVESTIGATION

A bedrock divide was identified south of San Luis Obispo County Airport in the 2018 Characterization Report. CHG established an area of investigation which was bounded by Davenport Creek Road in the west, Buckley Road and Highway 227 to the north, Greystone Place to the east and the hill fronts to the south. This area is outlined in Figure 1.

1 GSI Water Solutions, 2018, San Luis Obispo Valley Basin Characterization and Monitoring Well Installation, prepared for San Luis Obispo County Flood Control and Water Conservation District, January 18, 2018.

REVIEW OF WELL COMPLETION REPORTS

Within the area of investigation, the Characterization Report had utilized 22 wells to contour the base of permeable sediments. As part of the effort to identify well logs suitable for calibrating passive seismic data, CHG reviewed Well Completion Reports (WCRs) in the area. This resulted in the identification of an additional 38 wells which intersected the base of permeable sediments within the area of interest. Data from these wells was combined with the geophysical results to contour the base of permeable sediments. These wells are illustrated in Figure 1.

PASSIVE SEISMIC GEOPHYSICAL METHOD (HVSR) BACKGROUND

The horizontal to vertical spectral ratio (HVSR) passive seismic geophysical method relies on the observation that all materials in nature have a natural resonance frequency. When energy-induced vibrations interact with a material, the amplitude of vibrations increase at the specific resonance frequency of the material. In complex earth systems, this amplitude increase will occur at multiple frequencies, with each corresponding to a compositional layer. When the spectral ratio of horizontal to vertical frequencies are plotted, the highest (peak) amplitude generally corresponds to the interface between overlying unconsolidated sediments and underlying consolidated bedrock. By analyzing the amplitude and frequencies of vibrations at ground surface, the depths and general composition of layers can be modeled to provide insight into subsurface conditions.

To collect data, a high precision accelerometer is utilized. As the instrument records, it detects natural background noise transmitted into the ground from varied sources including ocean waves, traffic, wind movement through trees, and distant machinery. Both the frequency and amplitudes of this sound is recorded along three orthogonal axes. This data is used to approximate subsurface conditions with a model.

The simplest of the HVSR models is a two layer system in which the top layer is lower velocity unconsolidated sediments and the bottom layer is higher velocity bedrock. Under these conditions, the relationship between the peak resonance frequency and sediment thickness overlying bedrock can be express using the following equation.[2]

$$f = \frac{v}{4h}$$

For the above equation, f is resonance frequency in hertz, v is the shear wave velocity of the upper layer in meters per second, and h is the thickness of the upper layer in meters. With this method, a recording is taken adjacent to a well where h is known, and the data processed to identify f, the peak resonating frequency. The equation is then used to determine the velocity v

2 Ibs-von Seht, M., and Wohlenberg, J., 1999, Microtremor measurements used to map thickness of soft sediments, Bulletin of the Seismological Society of America, v. 89, p.250-259.

of pressure waves through the sediment. This velocity may then be held constant to determine thickness (h) at nearby locations where no well is present, but measured resonance frequencies are available.

The physical definition of the basin boundary as presented in the 2018 Characterization Report and used herein is the occurrence of unconsolidated or loosely consolidated sediments down to the contact with the basement rock of Miocene-aged formations and Franciscan Assemblage. This definition fits with the passive seismic methodology described above, where the highest amplitudes of the horizontal to vertical spectral ratio generally correspond to the interface between overlying unconsolidated sediments and underlying consolidated bedrock. In practice, both amplitude and pattern recognition are useful in interpreting the pseudo-depth profiles generated by HVSR.

GEOPHYSICAL DATA COLLECTION

After identifying existing wells, seven survey lines were laid out to provide coverage in the area of interest. A total of 64 stations were surveyed in completing these lines. Locations of each survey point are included in Figure 2. At each station, a Tromino 3G+ digital accelerometer was utilized to collect passive seismic data, with each recording being one hour duration. Following collection, data was first post-processed using the Grilla software package included with the instrument, then forward-modeled using OpenHVSR[3] software. Figure 3 shows an example of two traces collected during the survey. This figure illustrates both the typical peak shape observed in the area that demarks the base of permeable sediments, and the downward shift in frequency associated with greater soft-sediment thickness.

RESULTS OF SURVEY

Combining geophysical points with well data brought the total number of contoured points to 123 from the original 22 used for the Characterization Report in the study area. This data set, along with mapped surface geology was used to contour the base permeable sediments within the area of interest (Figure 4). Additionally, this data was used to generate elevations showing the base of permeable sediments which are overlain on cross-sections previously developed for the Characterization Report (Figures 5, 6, and 7). These contours are generally in agreement with those previously developed, with some notable differences.

Portions of three Characterization Report cross-sections pass through the area of investigation: A-A’, E-E’, and F-F’. Line A-A’, which trends roughly northwest to southeast, is in agreement with the geophysical survey (Figure 7). The red line plotted on cross section shows the

3 Bignardi, S., Yezzi, A.J., Fiusello, S., and Comelli, A., 2018, OpenHVSR - Processing toolkit; Enhanced HVSR processing of distributed microtremor measurements and spatial variation of their informative content, Computers & Geosciences, v. 20, p. 10-20.

interpretation of the base of permeable sediments based on geophysics and additional well data. The dashed orange line on the cross-section highlights the original base of permeable sediments. Along this line, the refined base of permeable sediments corresponds well with the original.

Two significant revisions occur in the assessment of the base of permeable sediments along Line E-E' (Figure 5). The first occurs at Well #17182 and is attributable to differences in the assigned well elevation. The second major revision occurs at Well #529099 where a soft brown shale logged at 140 feet below ground surface (bgs) is interpreted as the base of permeable sediments, rather than a blue clay which is logged at 115 feet bgs (Figure 5).

For the latter revision, CHG's selection of the soft shale was based on the geophysical survey, wherein the change in velocity between the shale and the overlying unconsolidated sediments provides a sharper signal peak than the shift between unconsolidated sand and unconsolidated clay. This sharper peak (Figure 3 at Base of Permeable Sediments) was subsequently used to calibrate velocities for the unconsolidated sediments and the deeper consolidated sediments.

Increased point density along Line F-F' highlights several structural features that lie between the contoured (logged) wells utilized in the Characterization Report (Figure 6). These include two synclinal structures and an anticline. The first syncline occurs just south of Well #E0161526 (Figure 4). The deepest portion of this syncline lies under the eastern half of the Crestmont subdivision. In this area, the base of permeable sediments is approximately 30 feet above msl. This is 150 feet deeper than at the nearby bedrock divide locality.

South of this syncline is a northwest/southeast trending anticlinal structure that underlines the boundary between the Crestmont subdivision and the vineyard to the south (Figure 4 and 6). This structural high was not previously mapped. Based on well and geophysical data, bedrock rises to an elevation of 184 feet above sea level within the eastern portion of the anticline, and may restrict flow between adjacent synclines (Figure 4).

Geophysical and well data also highlighted the second synclinal structure which underlies the vineyard at the south end of the area of investigation (Figure 4 and Figure 6). This syncline is deeper than the one which lies to the north, reaching -60 feet below sea level at its lowest point. Examination of well completion reports for wells located on the golf course suggests this structure continues to east. Basin sediments south of the syncline are truncated by the Edna Fault zone. The location of this fault boundary has been moved farther south on Line F-F' (Figure 6), based on the Characterization Report geology map and well data.

Geophysical work and interpreted contours confirm the presence of a bedrock divide between the San Luis Obispo and Edna Valley portions of the groundwater basin. This divide is composed of rocks from the Franciscan, Monterey, and Obispo Formations and is largely impermeable. The divide is generally higher in elevation to the south (near Davenport Creek) and lower elevation to the north in the Hidden Springs Road area. Based on preliminary Spring 2019 groundwater contours of the area, saturated thickness across the divide was up to fifty feet (Figure 8).

A saturated thickness map of groundwater basin sediments is shown in Figure 9, based on the difference in elevation between water level contours for Spring 2019 and the base of permeable sediments. The greatest saturation and associated groundwater storage capacity is present along the two synclinal axes, as expected. Groundwater along the southern syncline is mostly stored within the Pismo Formation, while groundwater along the northern syncline is mostly within the Paso Robles Formation. Between these synclines is an anticline where basin saturation is less than 50 feet thick, becoming unsaturated both at the bedrock divide and at the eastern limits of the study area.

SUMMARY AND CONCLUSIONS

The geophysical survey conducted by CHG has confirmed the presence of a bedrock divide between the Edna Valley and San Luis Obispo portions of the groundwater basin. This divide ranges in elevation from approximately 100 feet above mean sea level to 180 feet above mean sea level. Saturated thickness across this interval ranged from none to an estimated 50 feet. Additionally, the geophysical survey identified two synclines and an anticline which underlie the area. These structures, along with the bedrock divide, affect groundwater flow within this portion of the basin.

FIGURES

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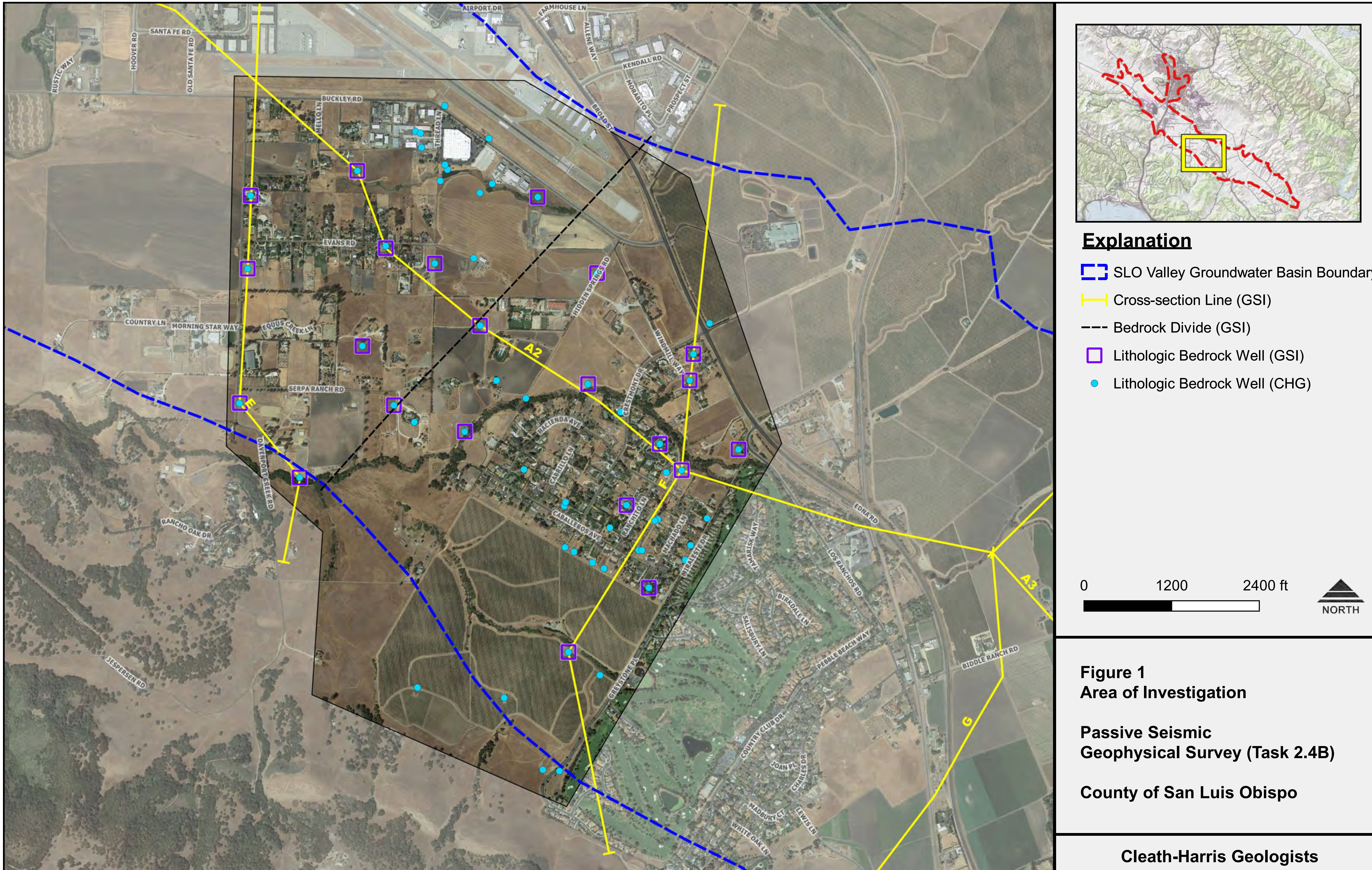


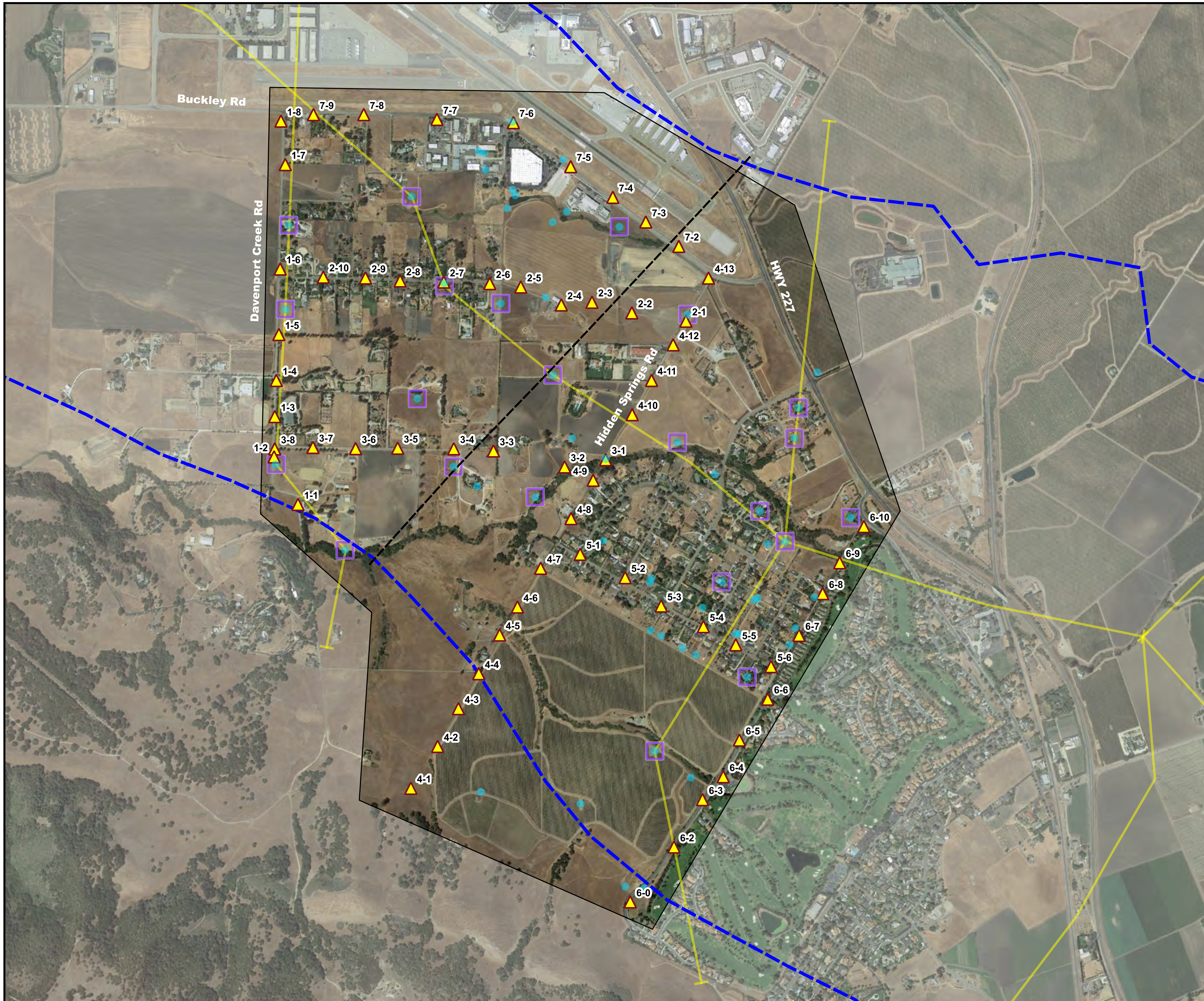
Figure 1
Area of Investigation

Passive Seismic Geophysical Survey (Task 2.4B)

County of San Luis Obispo

Cleath-Harris Geologists

DRAFT



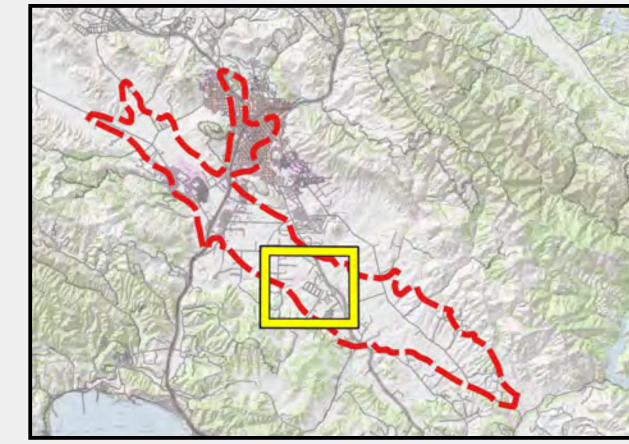


Figure 2
Geophysical Survey Locations

Passive Seismic
Geophysical Survey (Task 2.4B)

County of San Luis Obispo

Cleath-Harris Geologists

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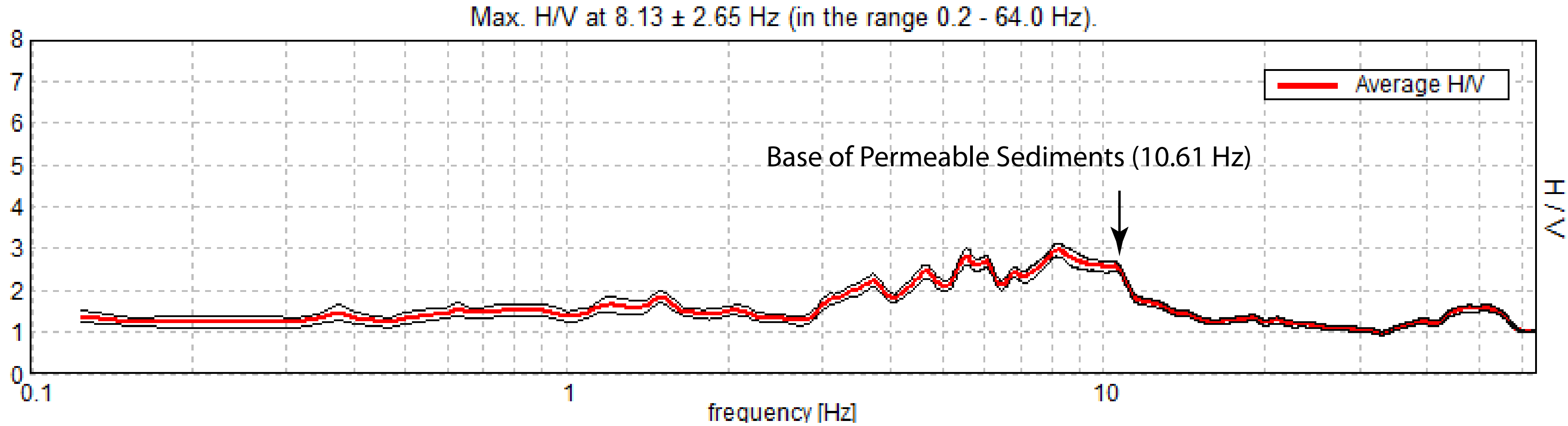
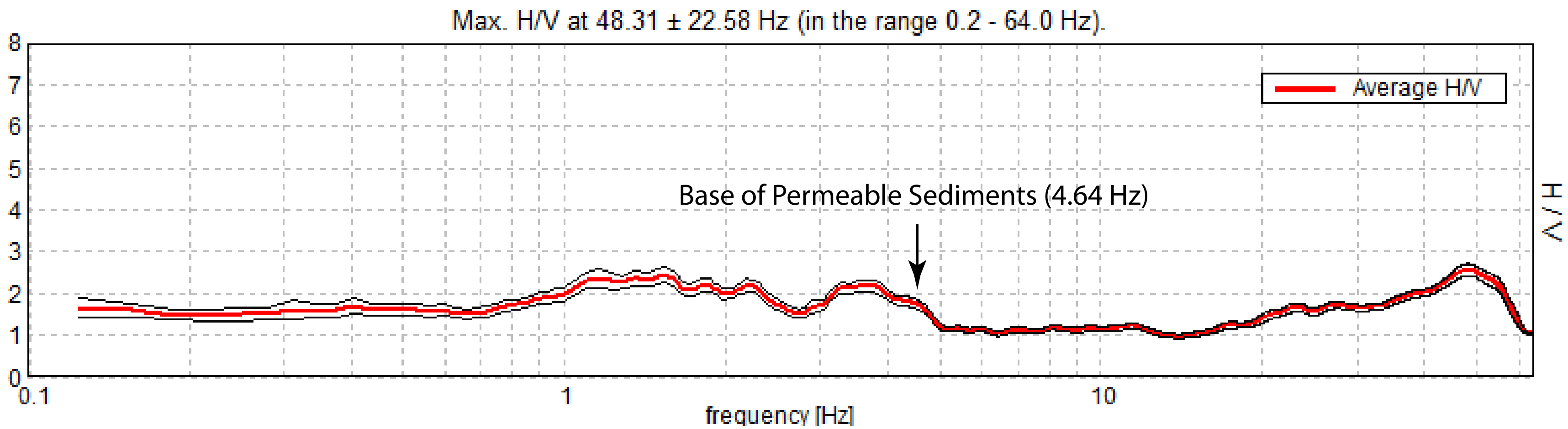


Station 3-4 (nearest bedrock high)- Modeled depth of 25 feet below ground surface. Location is illustrated in FIgure 2.



Station 1-2 (near Well #529099)- Modeled depth of 136 feet below ground surface. Location is illustrated in Figure 2.

Figure 3
Example Tromino Traces
Passive Seismic Geophysical Survey- (Task 2.4B)
County of San Luis Obispo

Cleath-Harris Geologists

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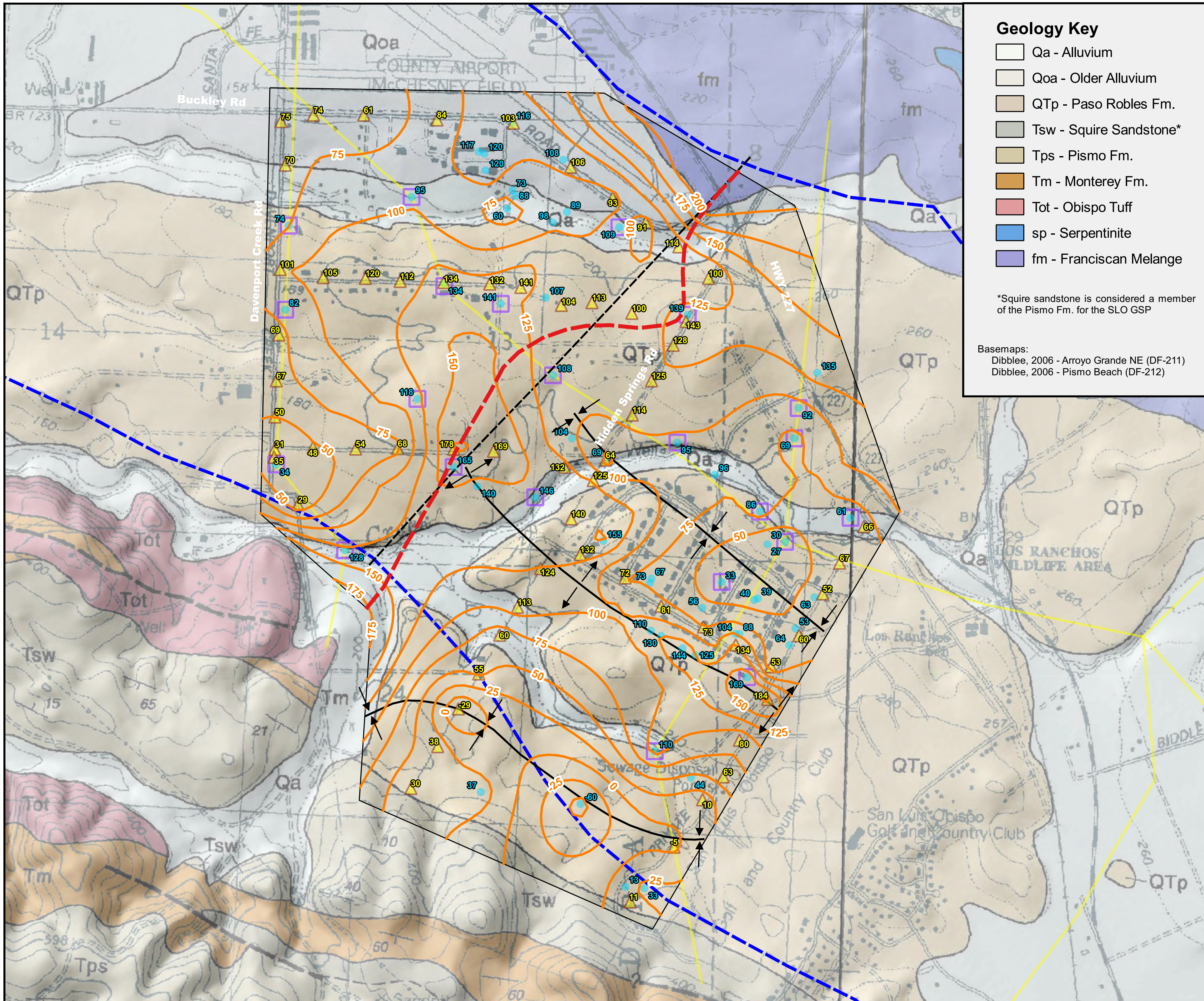
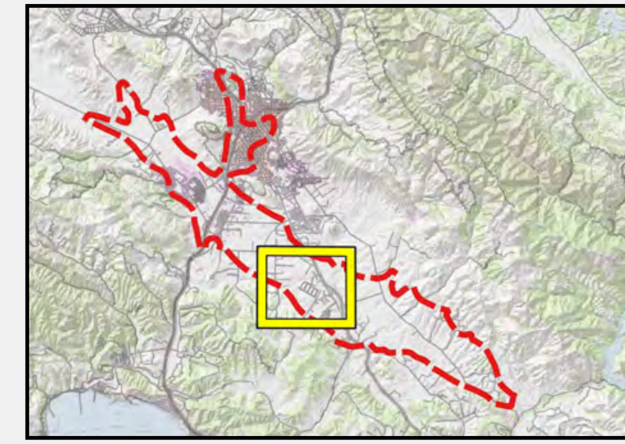


Geology Key

- Qa - Alluvium
- Qoa - Older Alluvium
- QTp - Paso Robles Fm.
- Tsw - Squire Sandstone*
- Tps - Pismo Fm.
- Tm - Monterey Fm.
- Tot - Obispo Tuff
- sp - Serpentinite
- fm - Franciscan Melange

*Squire sandstone is considered a member of the Pismo Fm. for the SLO GSP

Basemaps:
Dibblee, 2006 - Arroyo Grande NE (DF-211)
Dibblee, 2006 - Pismo Beach (DF-212)



Explanation

- SLO Valley Groundwater Basin Boundary
- Cross-section Line (GSI)
- Bedrock Divide (GSI)
- Lithologic Bedrock Well (GSI) *
- 104 Lithologic Bedrock Well (CHG) *
- 60 Geophysical Survey Point *
- Contour - Bedrock Surface Elevation *
- Bedrock Divide (CHG interpreted)

Geologic Structure

Anticline Syncline Fault

* All elevations shown are in feet above mean sea level

0 1200 2400 ft

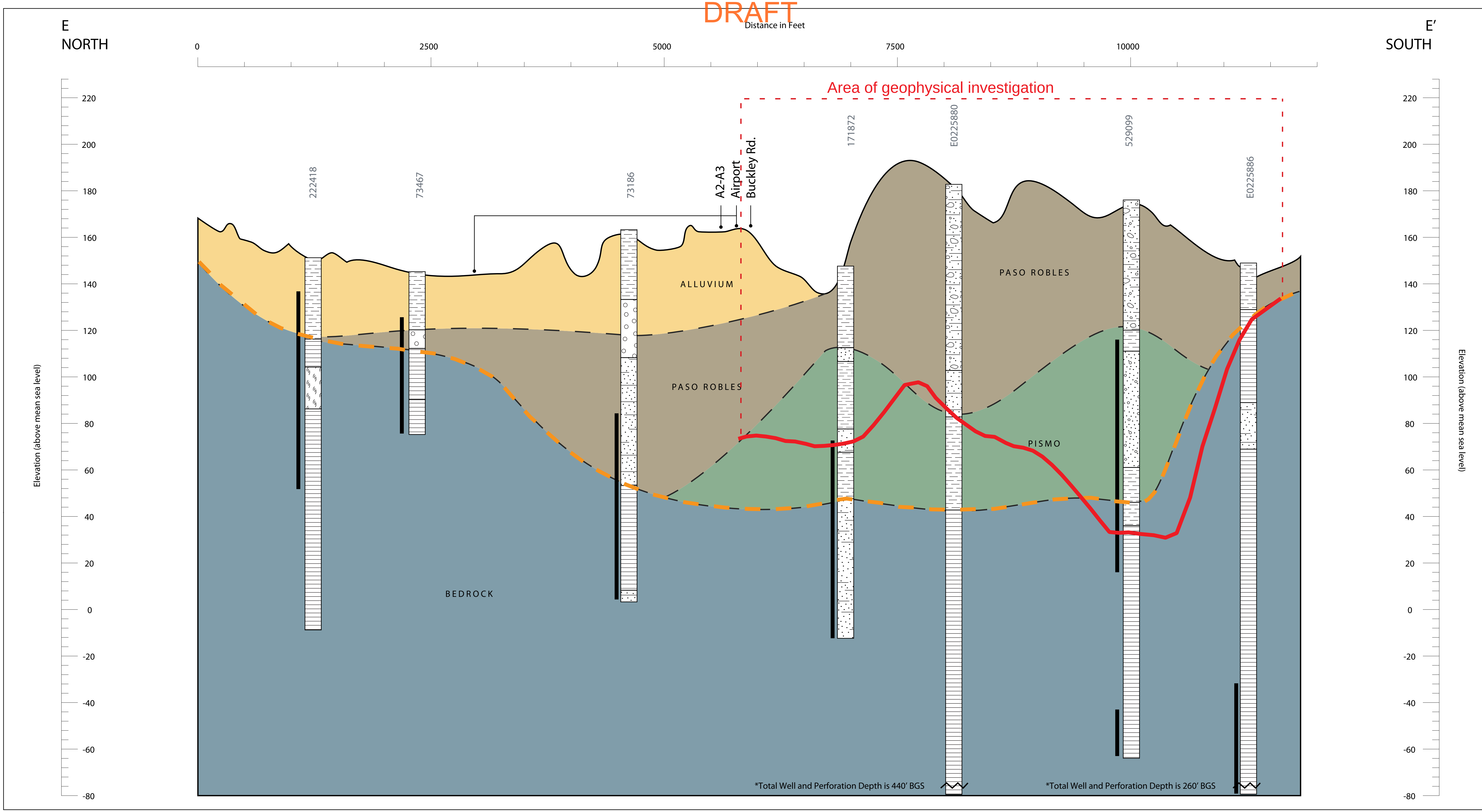
NORTH

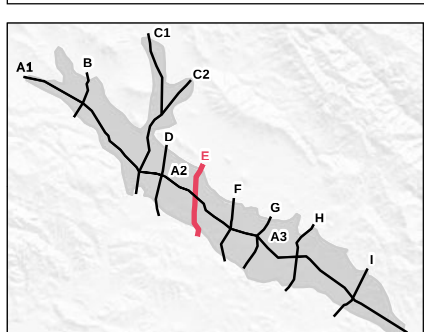
Figure 4
Contoured Bedrock Surface

Passive Seismic Geophysical Survey (Task 2.4B)

County of San Luis Obispo

Cleath-Harris Geologists





LEGEND

Alluvium	Clay	Rock	Silty Sand
Paso Robles	Fill	Sandstone	Sand
Pismo	Clayey Gravel	Clayey Sand	Sand and Gravel
Bedrock	Gravel	Serpentine	With Shell Fragments
Perforated	Silt	Shale	

VERTICAL EXAGGERATION:
25X

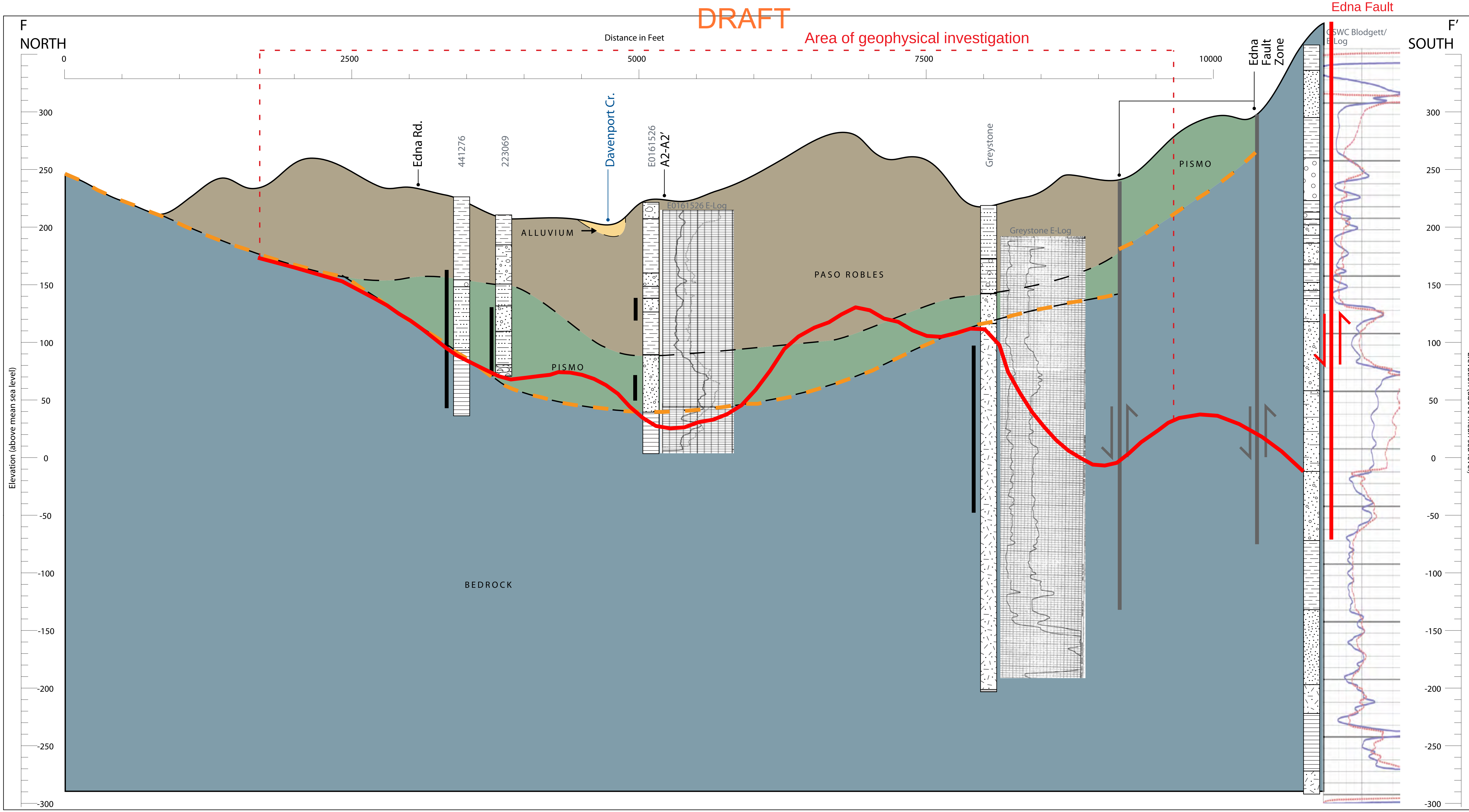
Figure 5
Cross-section E (CHG Modified)

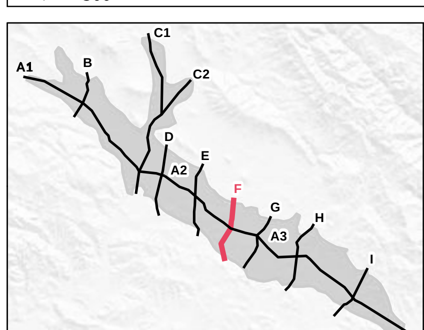
CHG modified bedrock surface
GSI original bedrock surface

Cross Section E-E′
San Luis Obispo Valley Basin Characterization

GSI
Water Solutions, Inc.

\\PDX\Projects\Portland\667-County of San Luis Obispo\002-SLO Valley Basin Characterization\Figures\Cross_Sections





LEGEND

Alluvium	Clay	Rock	Silty Sand
Paso Robles	Fill	Sandstone	Sand
Pismo	Clayey Gravel	Clayey Sand	Sand and Gravel
Bedrock	Gravel	Serpentine	With Shell Fragments
Perforated	Silt	Shale	

VERTICAL EXAGGERATION:
10X

Figure 6
Cross-section F (CHG Modified)

CHG modified bedrock surface — CHG modified fault
GSI original bedrock surface — GSI original faults

Cross Section F-F'
San Luis Obispo Valley Basin Characterization

GSI Water Solutions, Inc.

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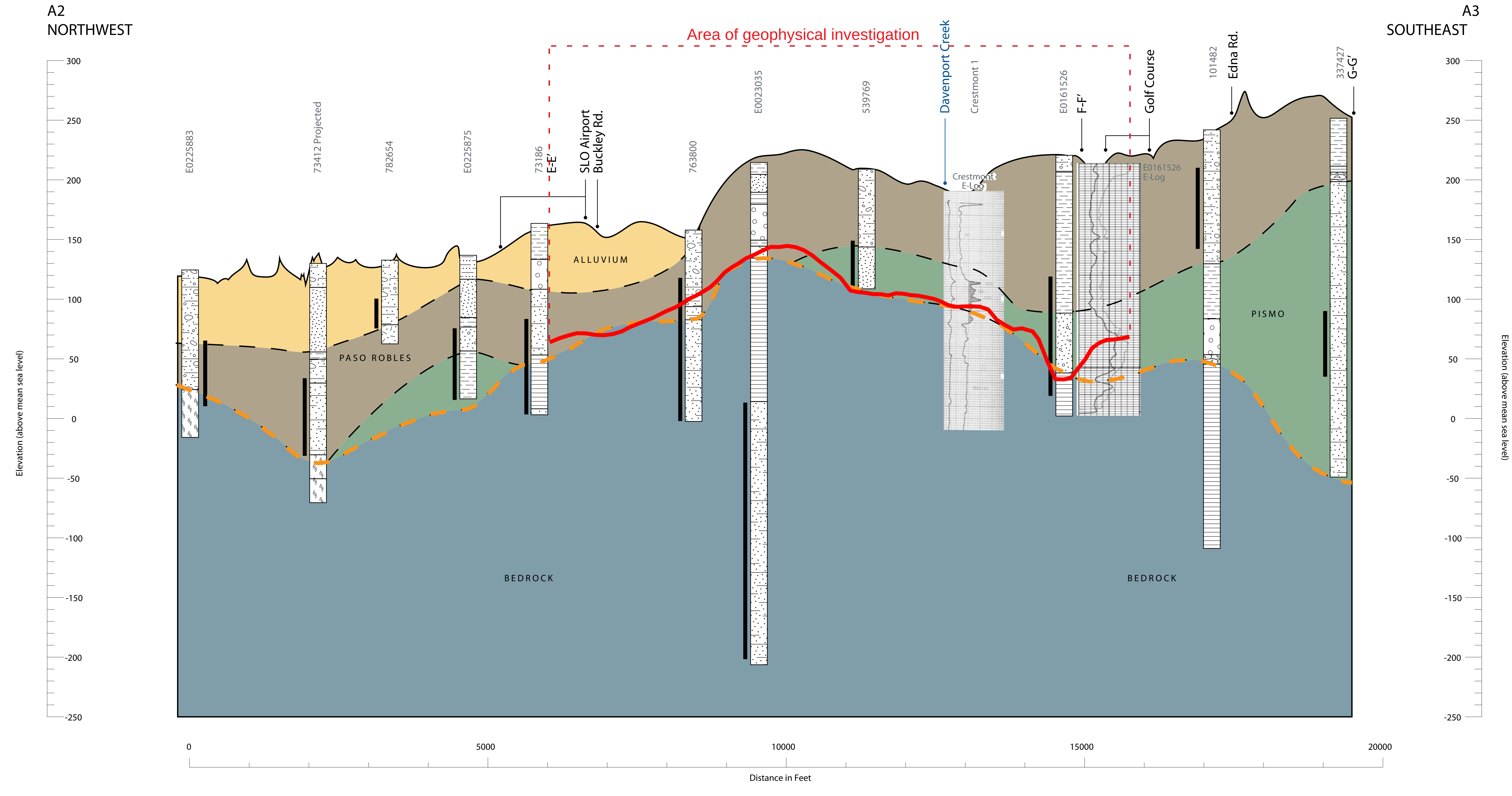
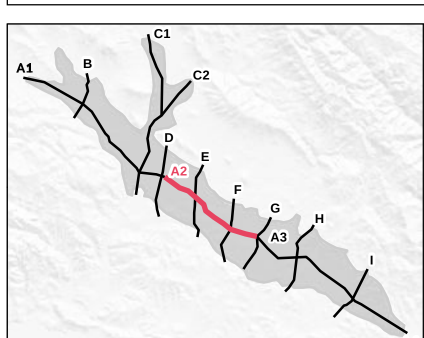




LEGEND

Alluvium	Clay	Rock	Silty Sand
Paso Robles	Fill	Sandstone	Sand
Pismo	Clayey Gravel	Clayey Sand	Sand and Gravel
Bedrock	Gravel	Serpentine	With Shell Fragments
Perforated	Silt	Shale	

VERTICAL EXAGGERATION:
20X

Figure 7
Cross-section A2-A3 (CHG Modified)

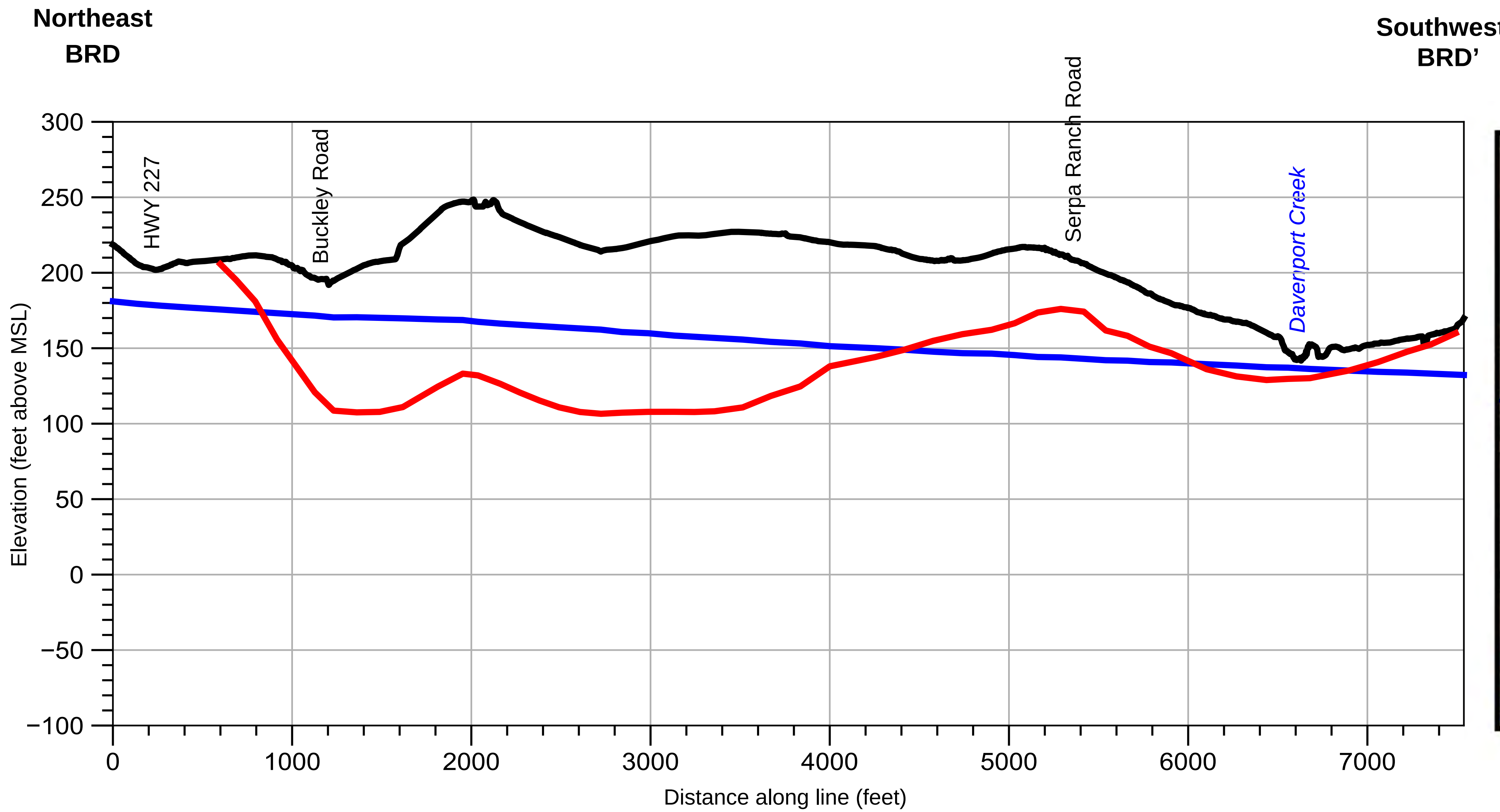
CHG modified bedrock surface
GSI original bedrock surface

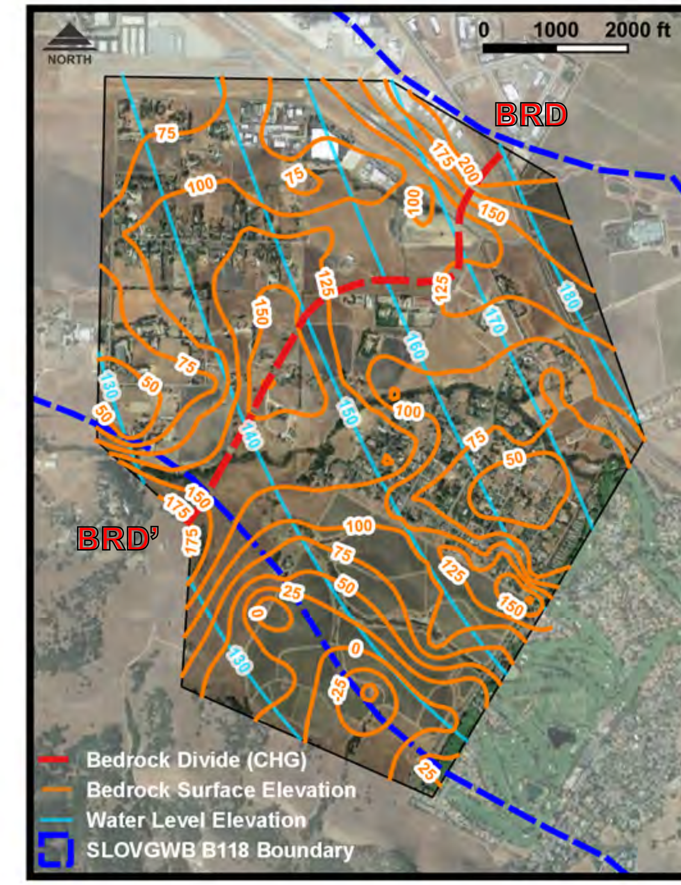
Cross Section A2-A3
San Luis Obispo Valley Basin Characterization

GSI Water Solutions, Inc.

\\PDX\Projects\Portland\667-County of San Luis Obispo\002-SLO Valley Basin Characterization\Figures\Cross_Sections

DRAFT





Explanation

Ground surface

Bedrock surface (interpreted by CHG from geophysical survey data)

Groundwater surface - Spring 2019 (data compiled by CHG from various sources)

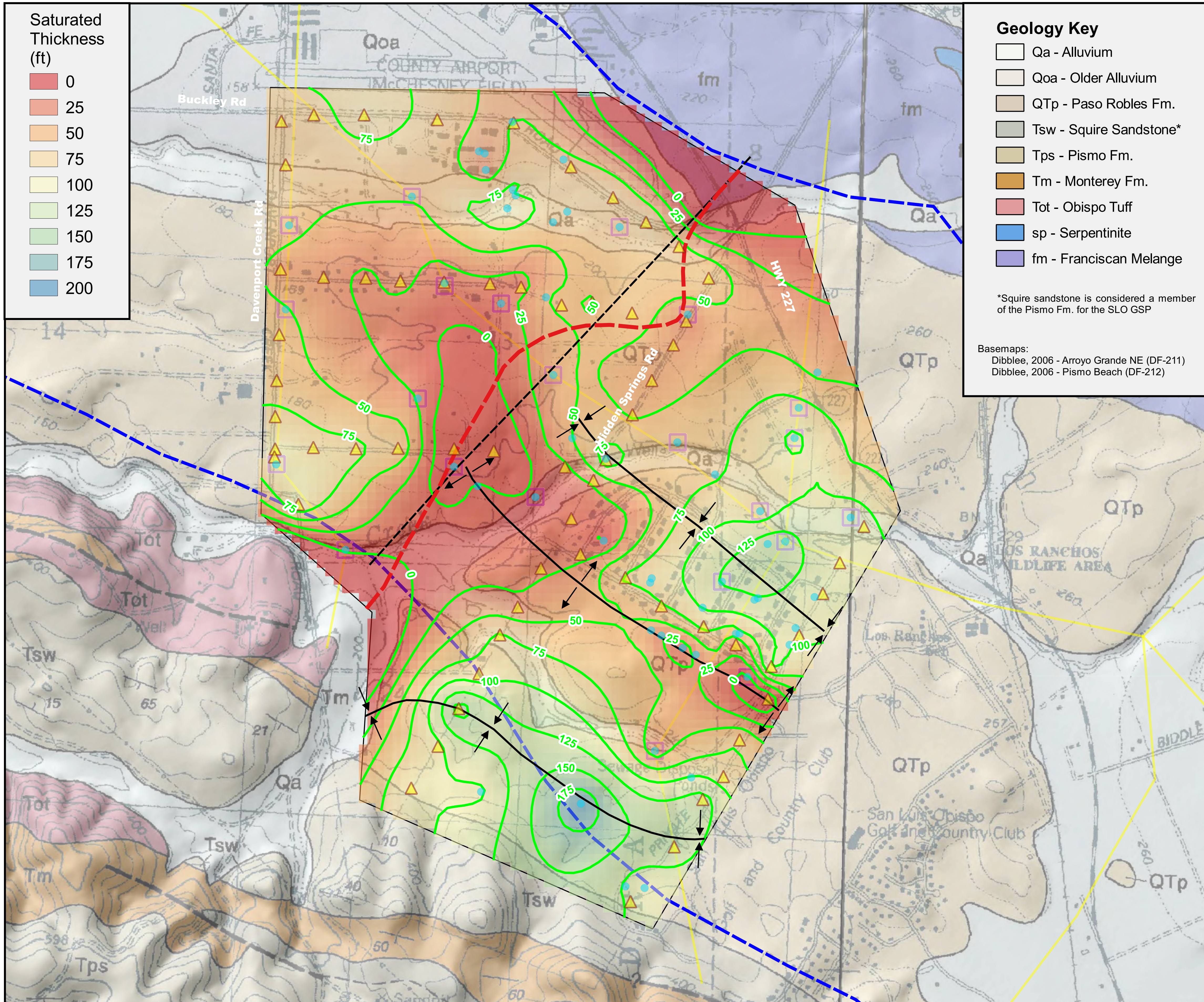
Figure 8
Cross-section BRD - BRD’
Along Bedrock Divide Line

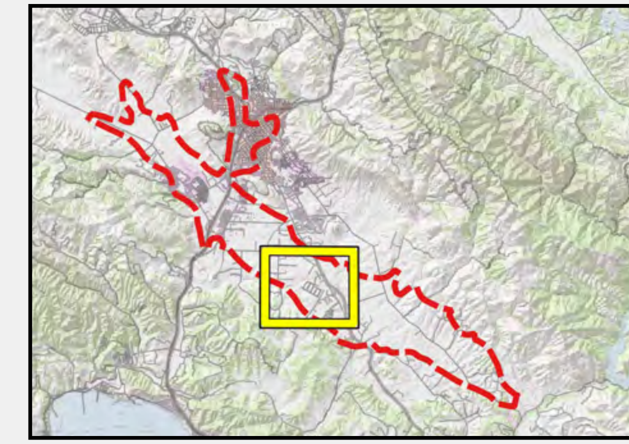
Passive Seismic Geophysical Survey
(Task 2.4B)

County of San Luis Obispo

CLEATH-HARRIS GEOLOGISTS

DRAFT





Explanation

- SLO Valley Groundwater Basin Boundary
- Cross-section Line (GSI)
- Bedrock Divide (GSI)
- Lithologic Bedrock Well (GSI)
- Lithologic Bedrock Well (CHG)
- Geophysical Survey Point
- Contour - Saturated Thickness
- Bedrock Divide (CHG interpreted)

Geologic Structure

Anticline · Syncline · Fault

0 · 1200 · 2400 ft

NORTH

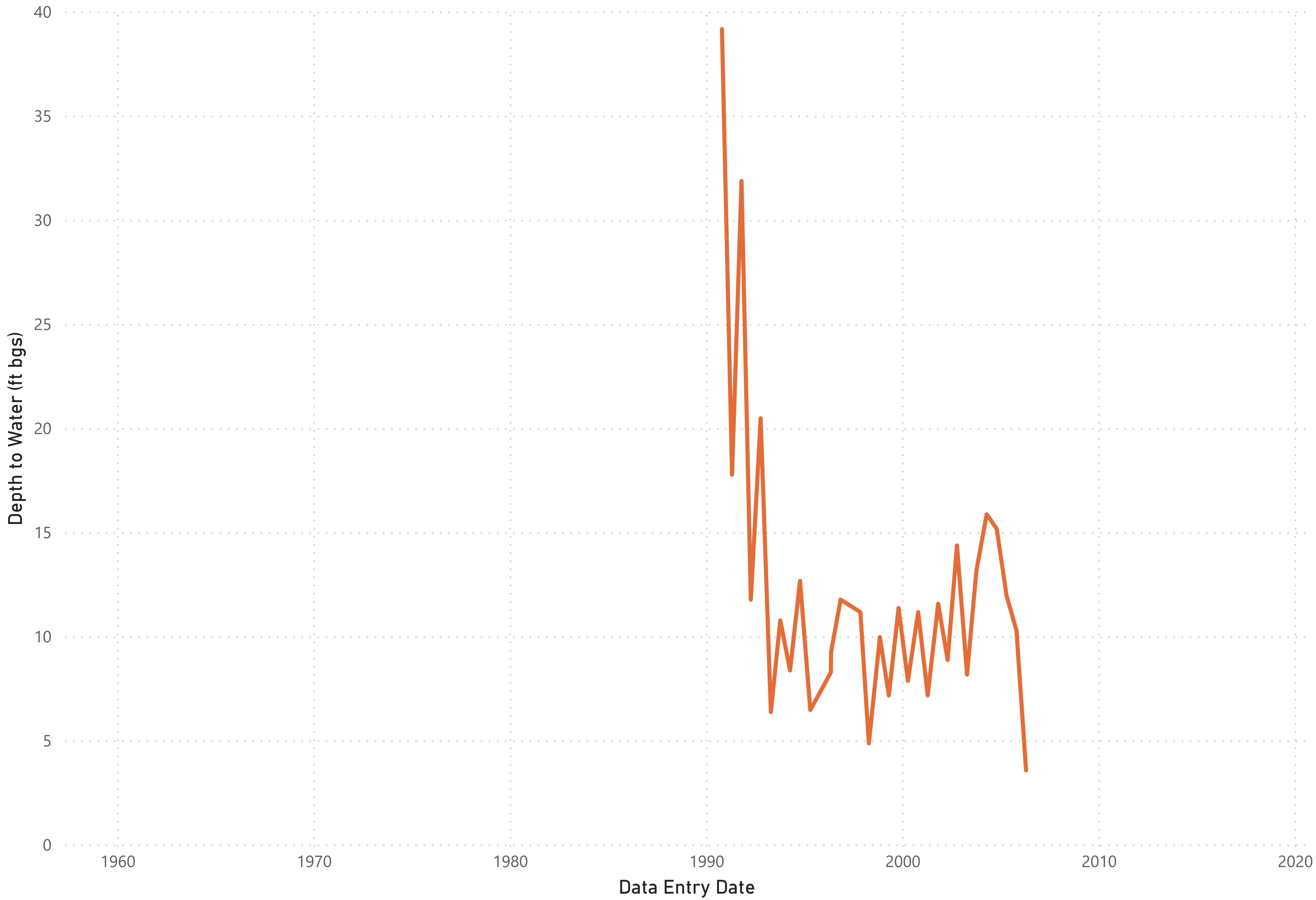
Figure 9
Saturated Thickness

Passive Seismic Geophysical Survey (Task 2.4B)

County of San Luis Obispo

Cleath-Harris Geologists

Depth to Water



Well Location (larger = more samples)...

Well Number	Earliest Data Entry Date	Latest Data Entry Date
30S/12E-29Q01	10/22/1962	11/20/1970
30S/12E-32J01	11/18/1958	10/04/1994
31S/12E-03P01	10/12/1990	04/11/2006
31S/12E-03P02	04/05/1965	04/08/2004
31S/12E-10D03	05/09/2012	10/09/2019
31S/12E-10F03	04/05/1965	05/05/1997
31S/12E-10G02	04/05/1965	10/03/2019
31S/12E-10H03	04/12/1984	10/03/2019
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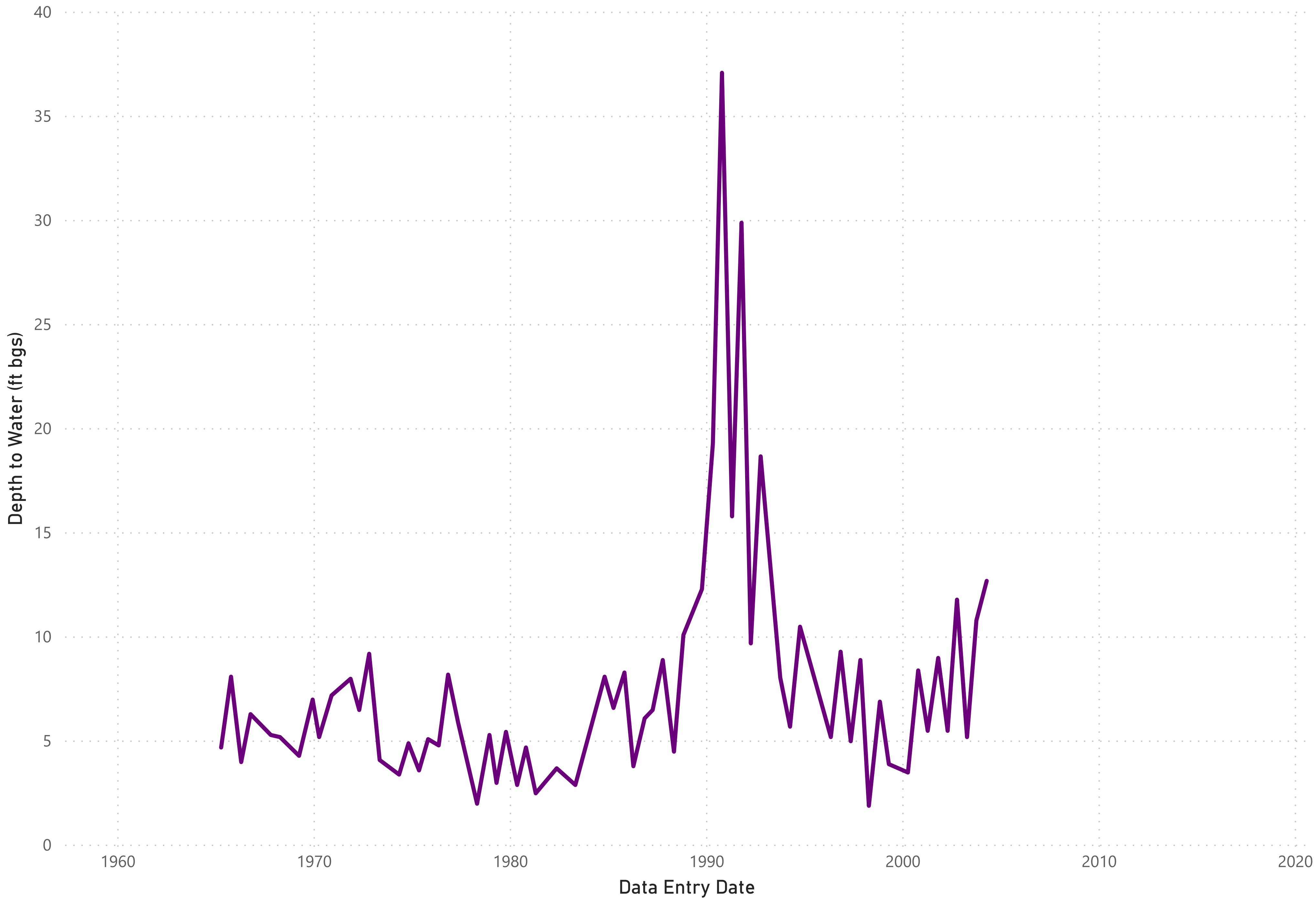
31S/12E-12N01	10/22/1962	11/20/1970
31S/12E-12Q03	04/06/1965	10/06/1987
31S/12E-13J01	10/11/1970	04/15/1996
31S/12E-14C01	11/19/1958	10/03/2019
Total	**11/01/1953**	**10/09/2019**

Depth to Water



Well Location (larger = more samples)...

Well Number	Earliest Data Entry Date	Latest Data Entry Date
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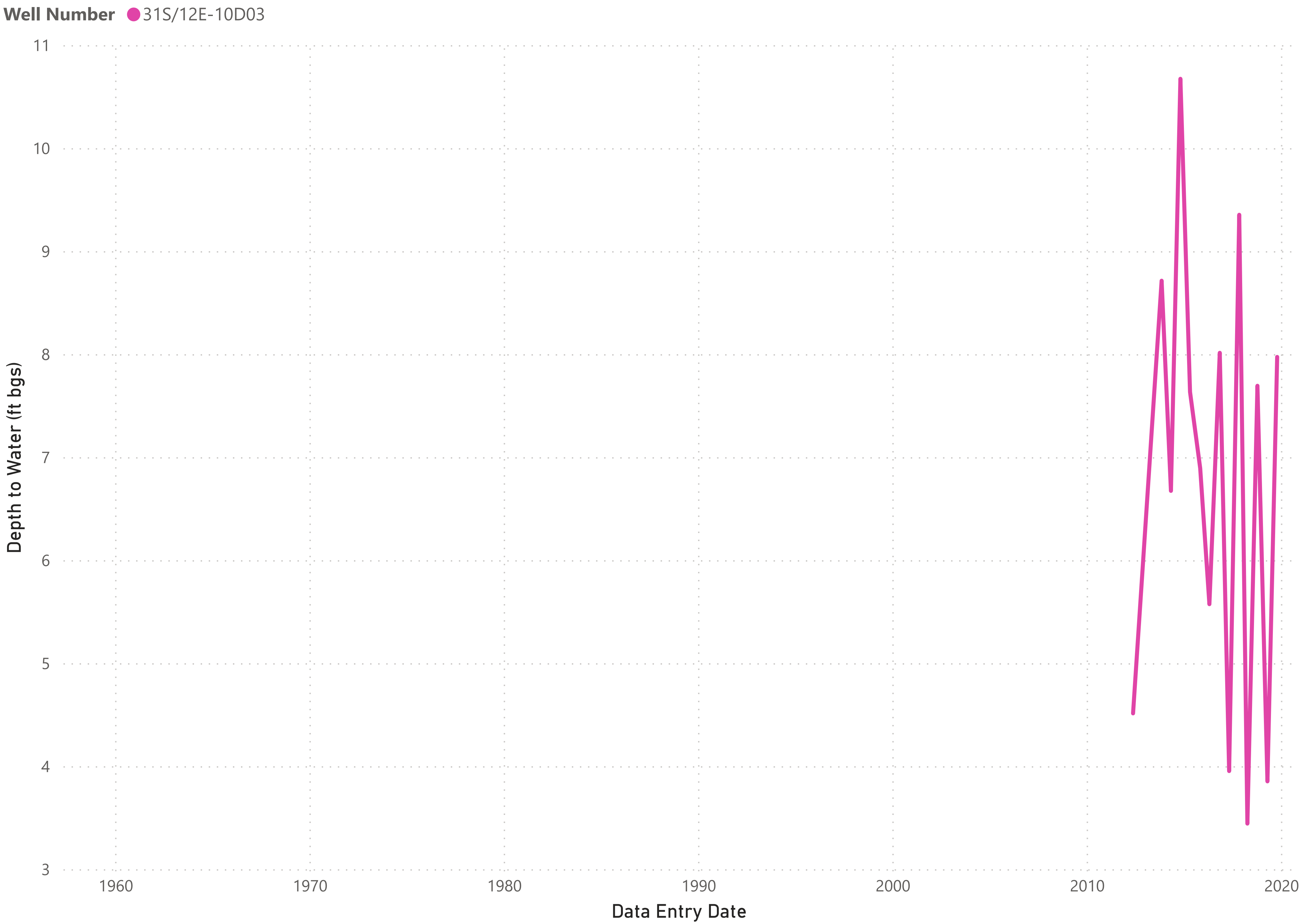
31S/12E-03P02	04/05/1965	04/08/2004
31S/12E-10D03	05/09/2012	10/09/2019
31S/12E-10F03	04/05/1965	05/05/1997
31S/12E-10G02	04/05/1965	10/03/2019
31S/12E-10H03	04/12/1984	10/03/2019
31S/12E-12E03	04/05/1965	04/19/2013
31S/12E-12N01	10/22/1962	11/20/1970
31S/12E-12Q03	04/06/1965	10/06/1987
31S/12E-13J01	10/11/1970	04/15/1996
31S/12E-14C01	11/19/1958	10/03/2019
Total	**11/01/1953**	**10/09/2019**

Depth to Water



Well Location (larger = more samples)...

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31S/12E-03P02	04/05/1965	04/08/2004
31S/12E-10D03	05/09/2012	10/09/2019
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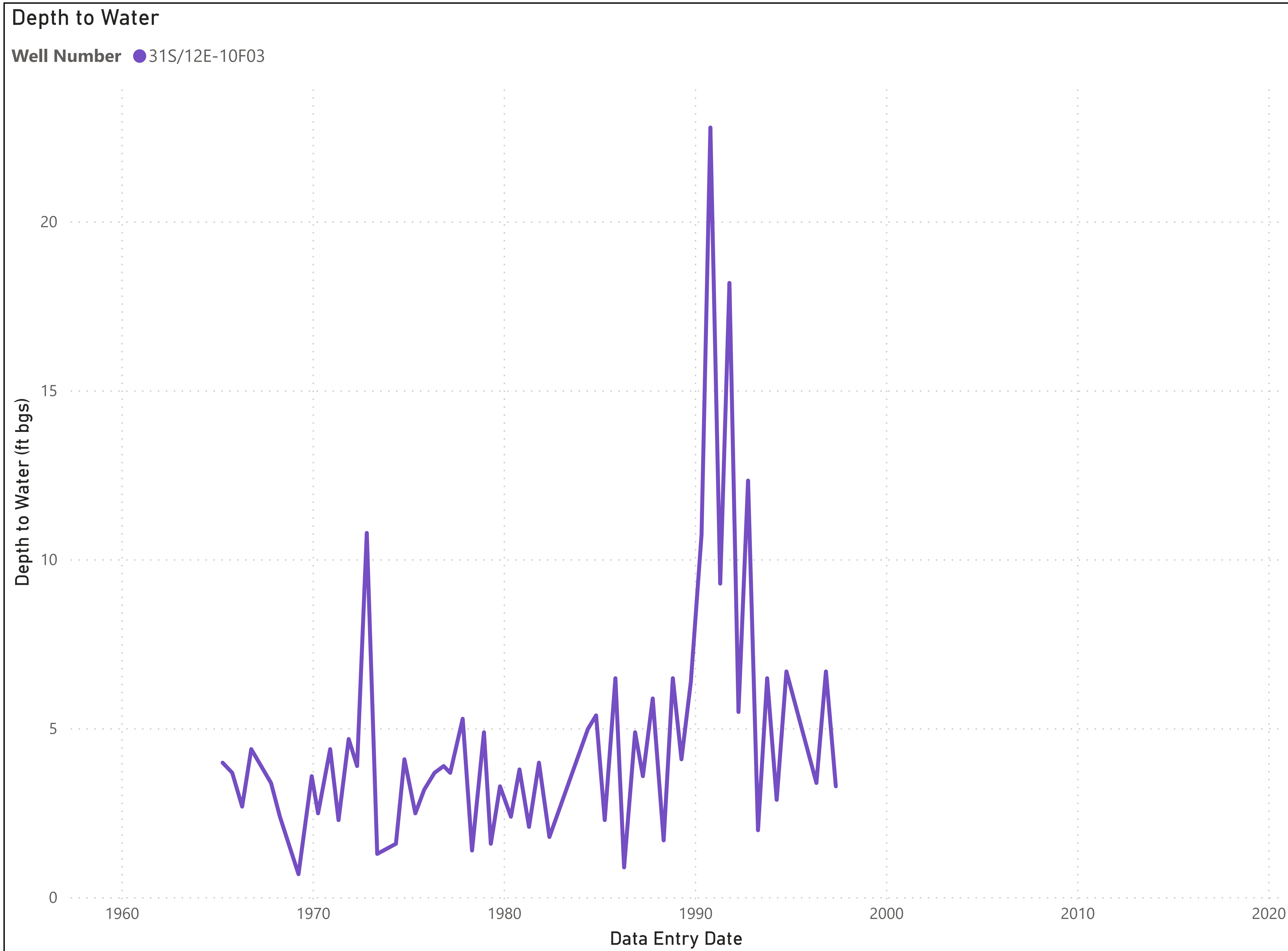

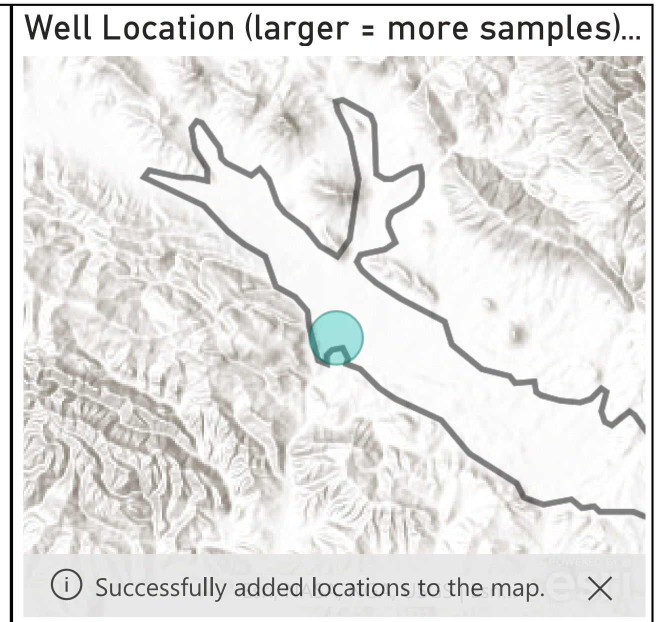

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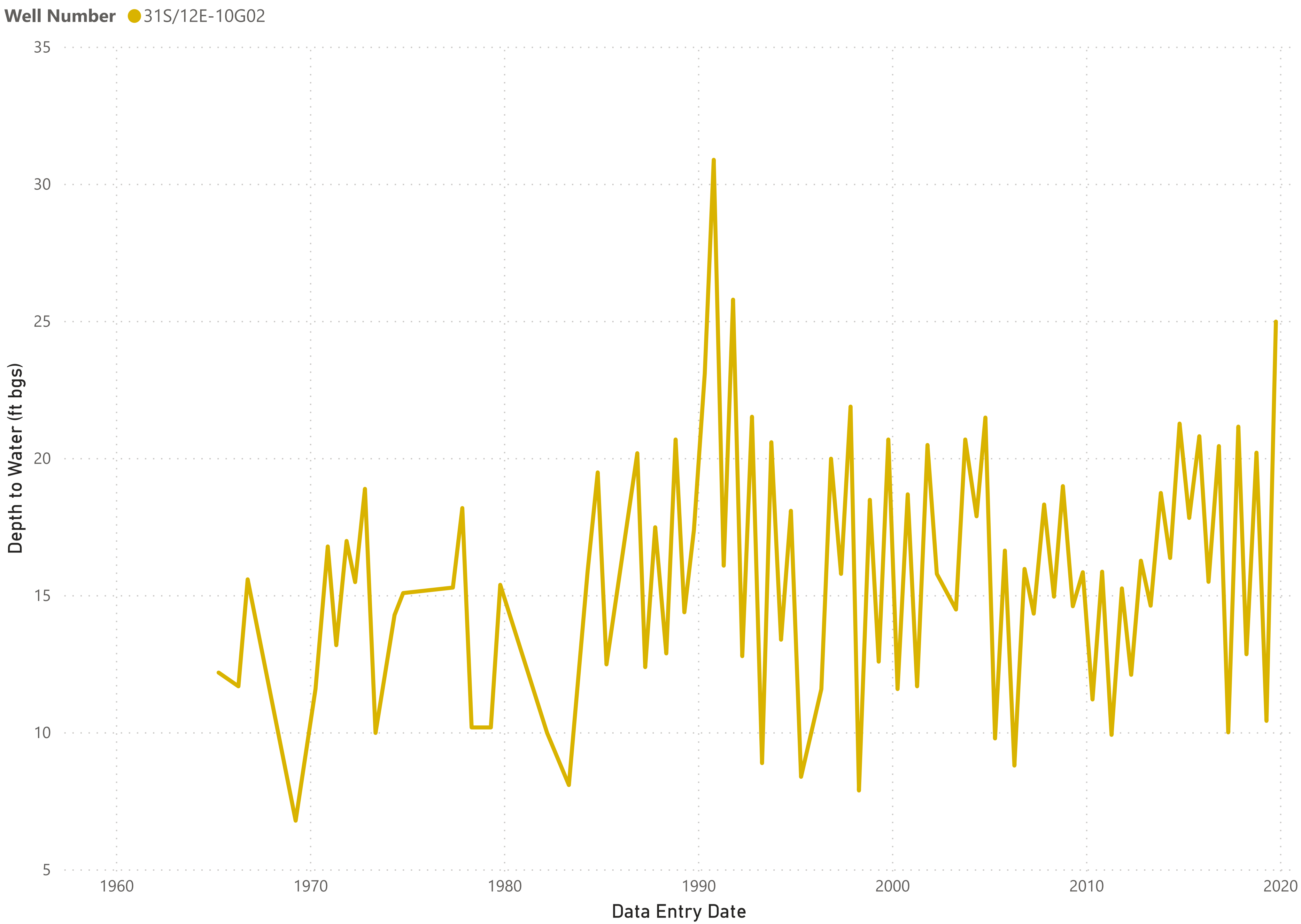
31S/12E-14C01	11/19/1958	10/03/2019
Total	**11/01/1953**	**10/09/2019**

Depth to Water



Well Location (larger = more samples)...

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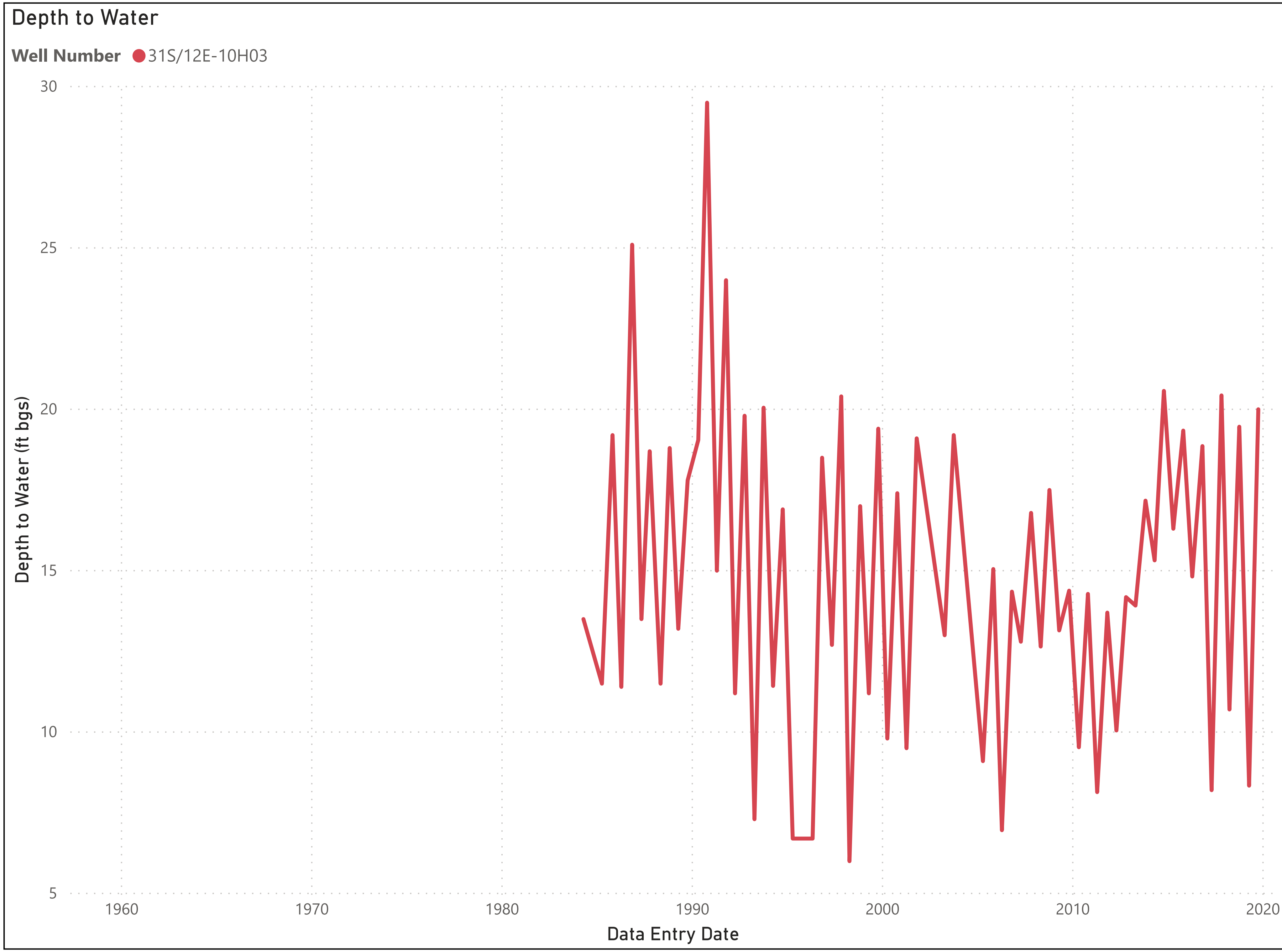

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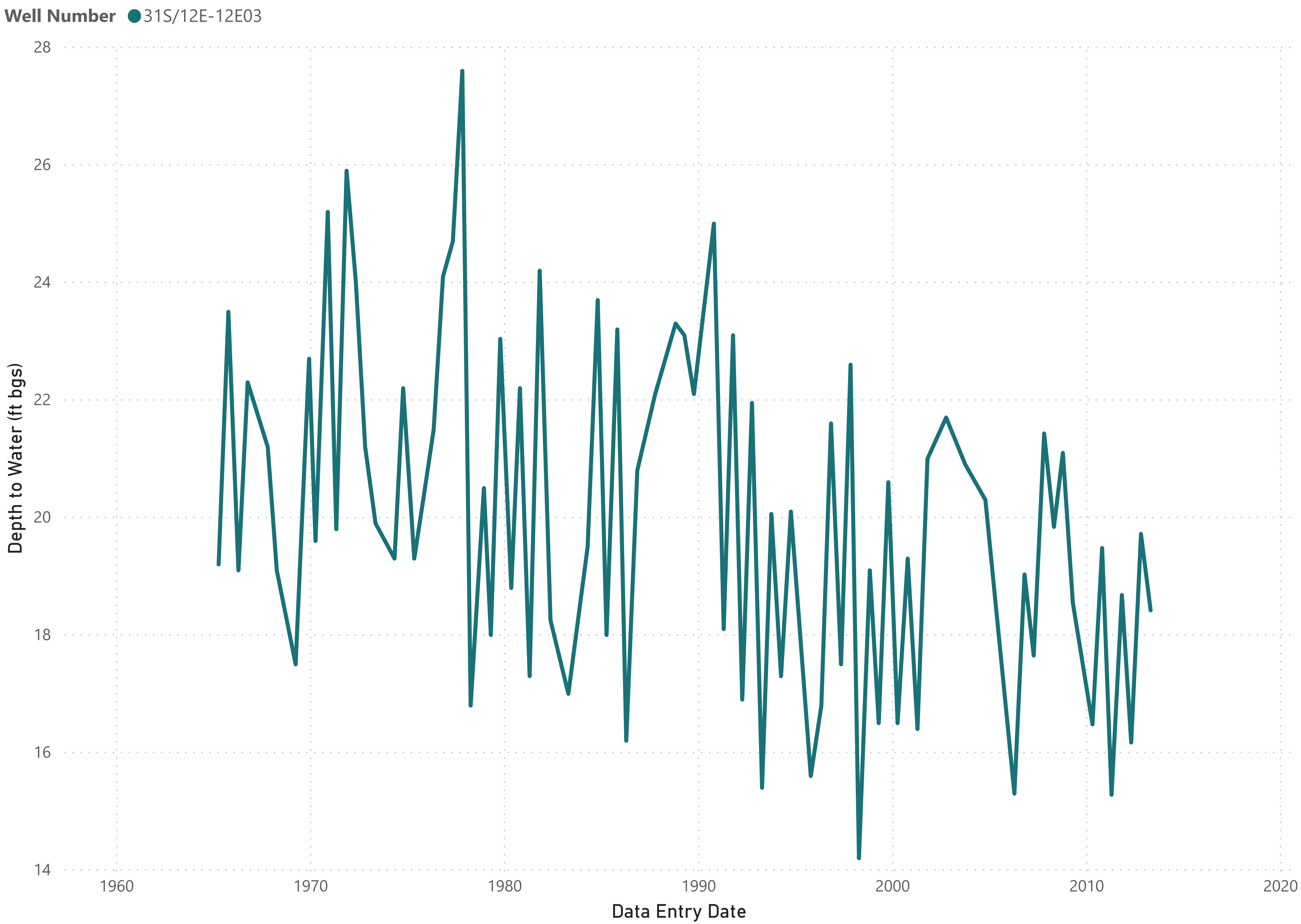

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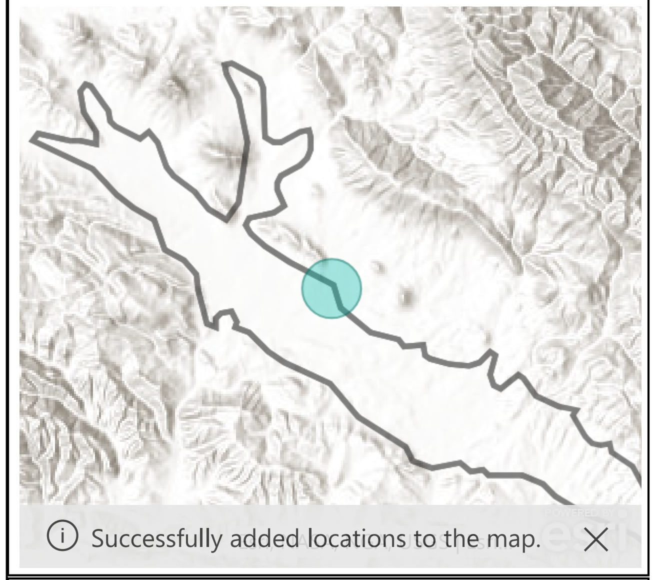

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31S/12E-12N01	10/22/1962	11/20/1970
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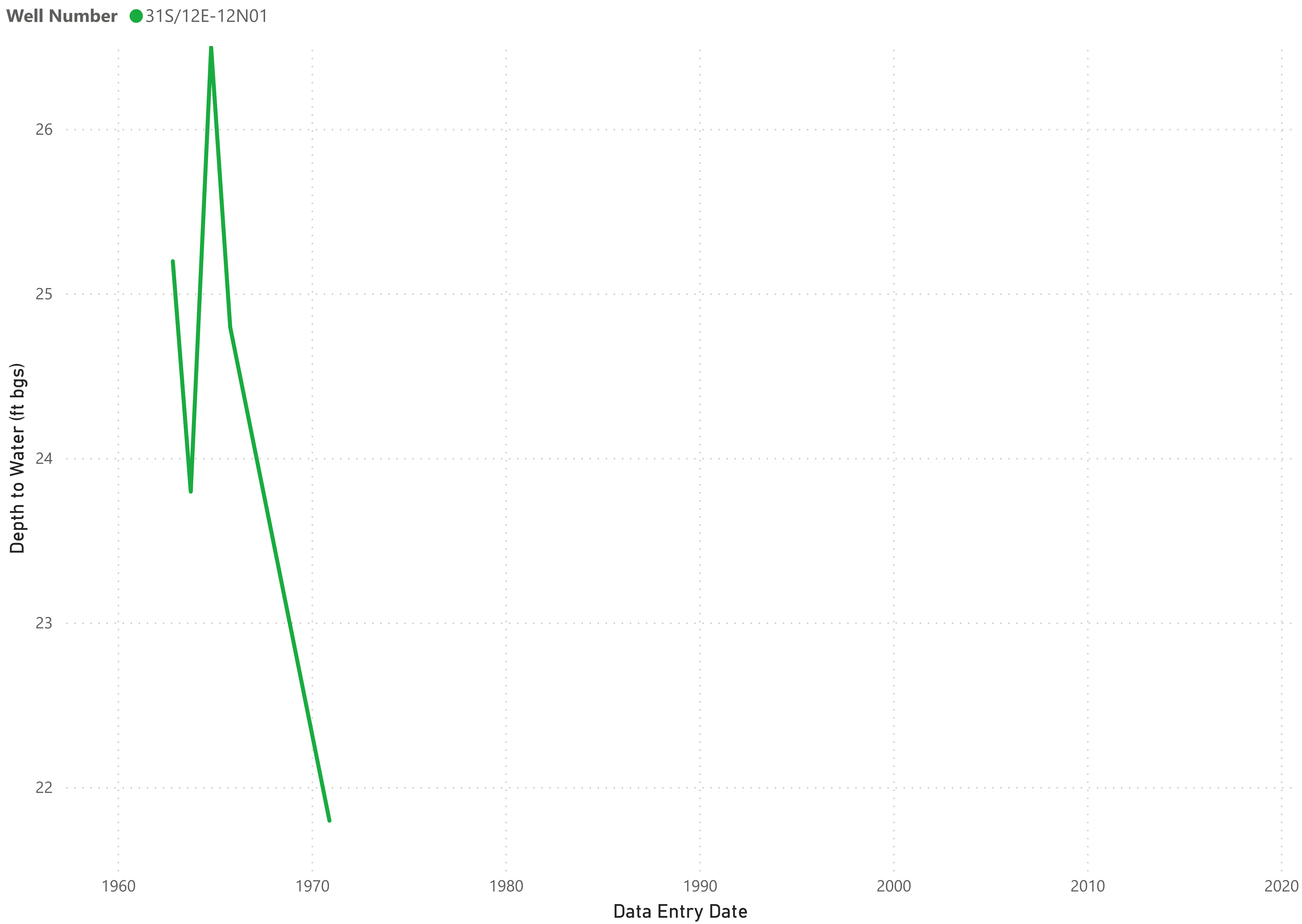

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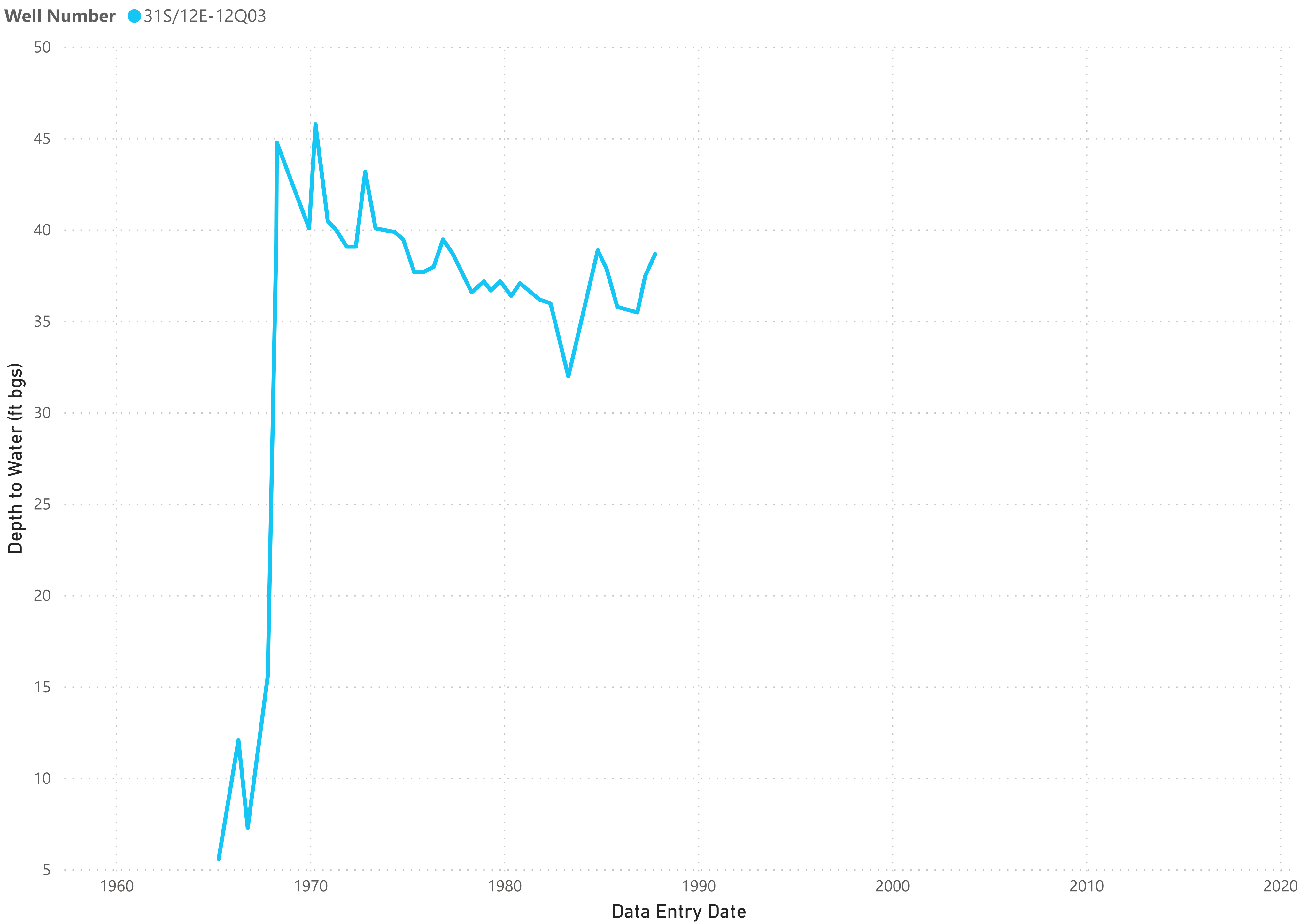

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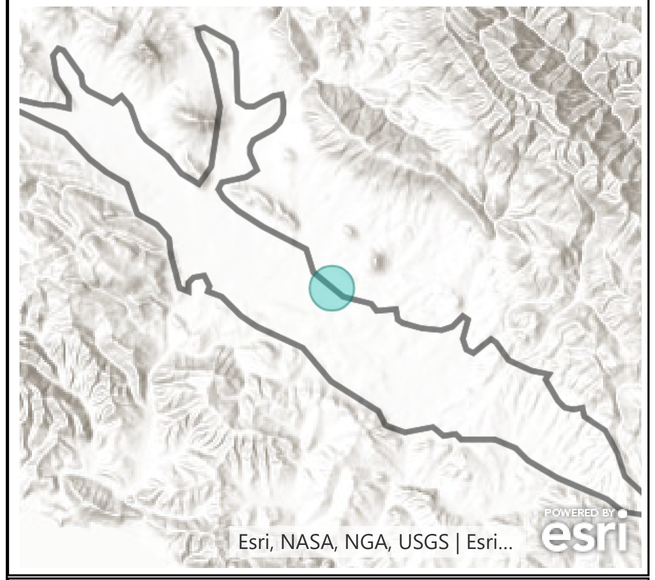

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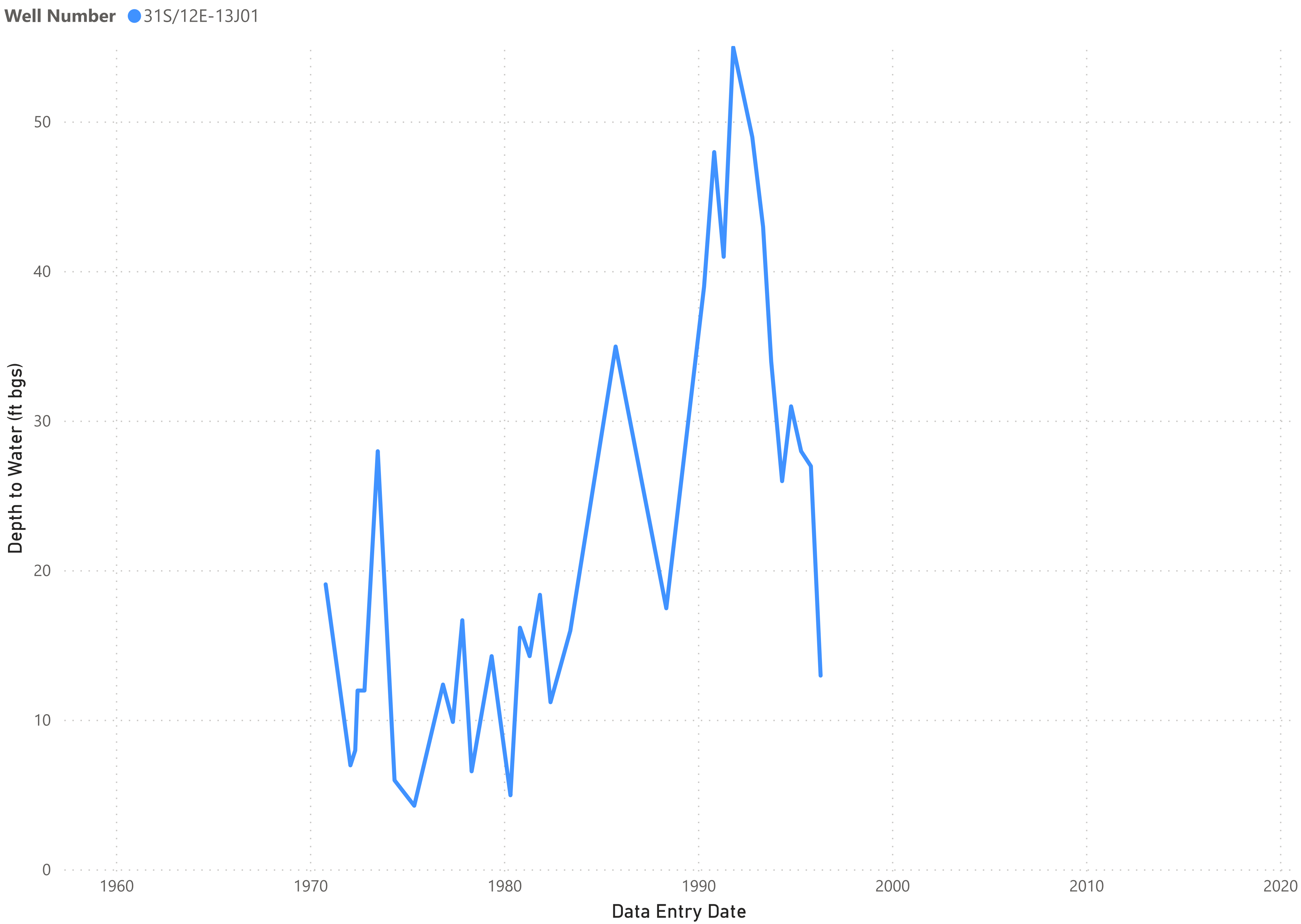
Depth to Water



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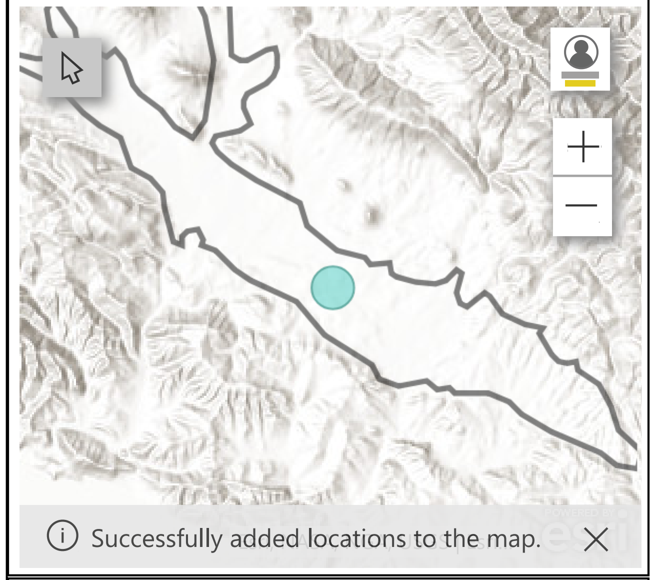

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31S/12E-03P02	04/05/1965	04/08/2004
31S/12E-10D03	05/09/2012	10/09/2019
31S/12E-10F03	04/05/1965	05/05/1997
31S/12E-10G02	04/05/1965	10/03/2019
31S/12E-10H03	04/12/1984	10/03/2019
31S/12E-12E03	04/05/1965	04/19/2013
31S/12E-12N01	10/22/1962	11/20/1970
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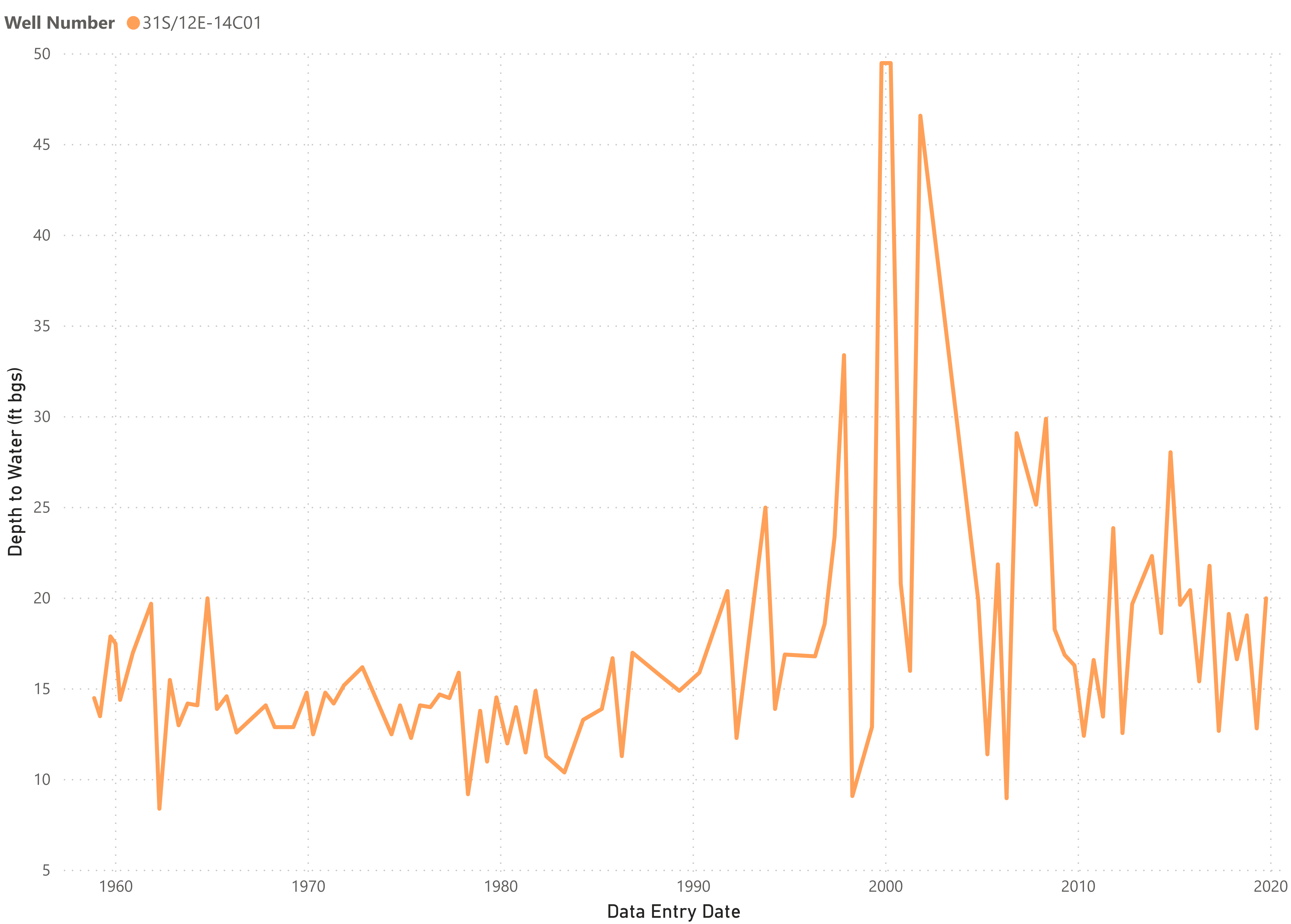
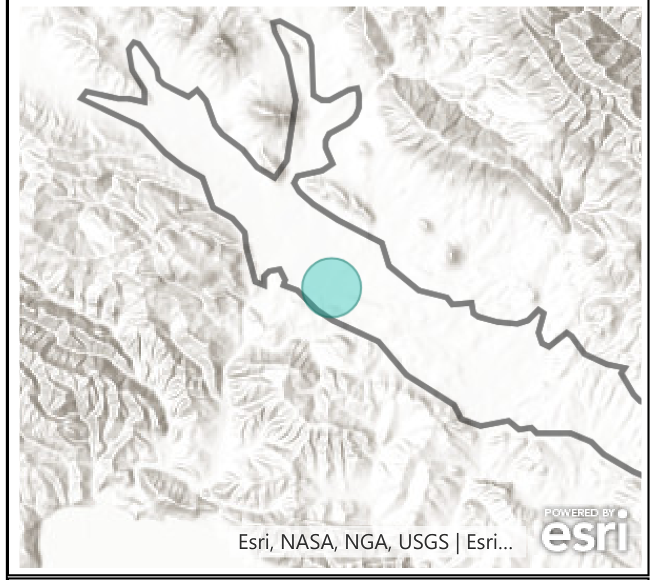
31S/12E-14C01	11/19/1958	10/03/2019
Total	**11/01/1953**	**10/09/2019**

Depth to Water



Well Location (larger = more samples)...



Well Number	Earliest Data Entry Date	Latest Data Entry Date
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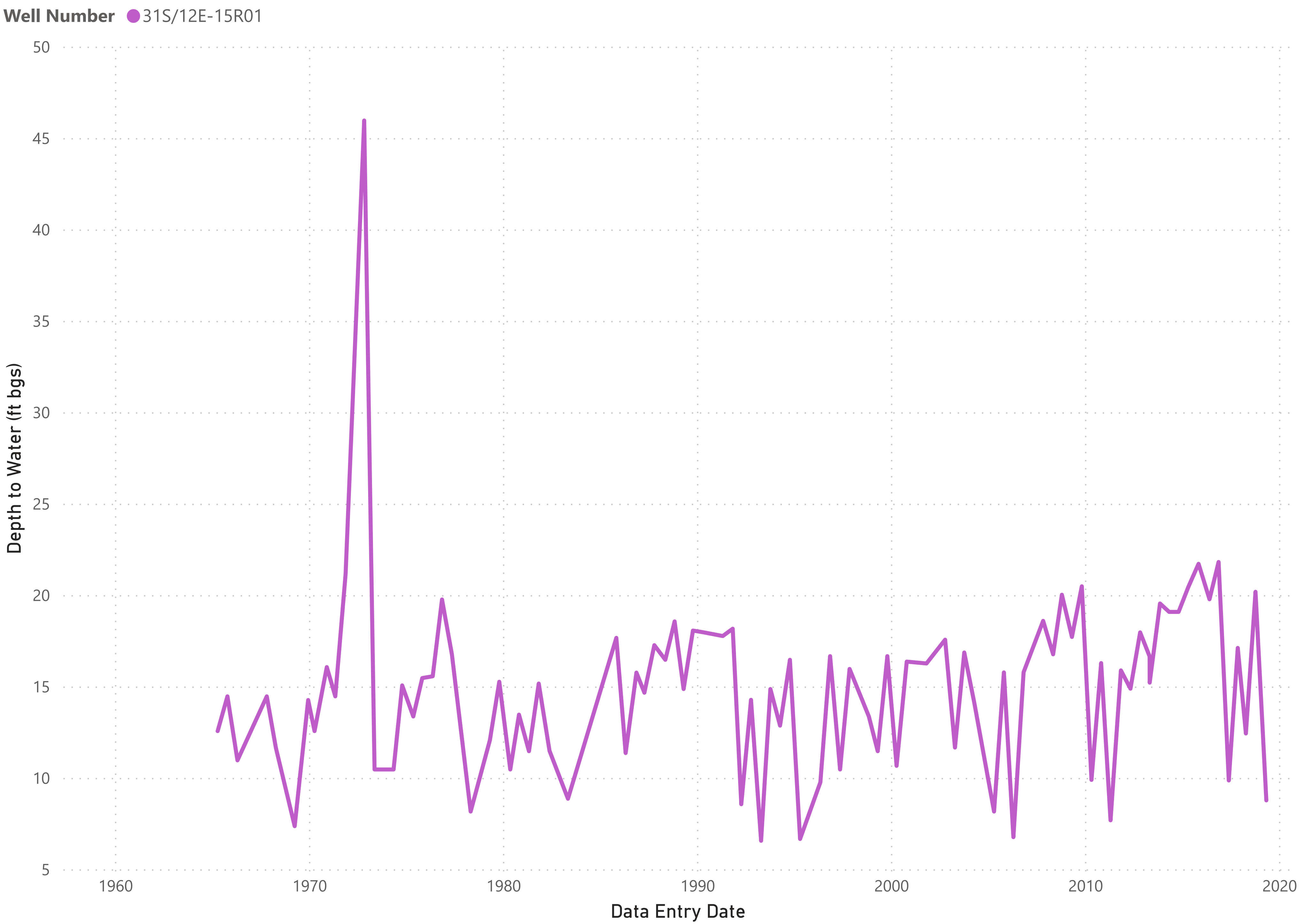
Total	**11/01/1953**	**10/09/2019**

Depth to Water



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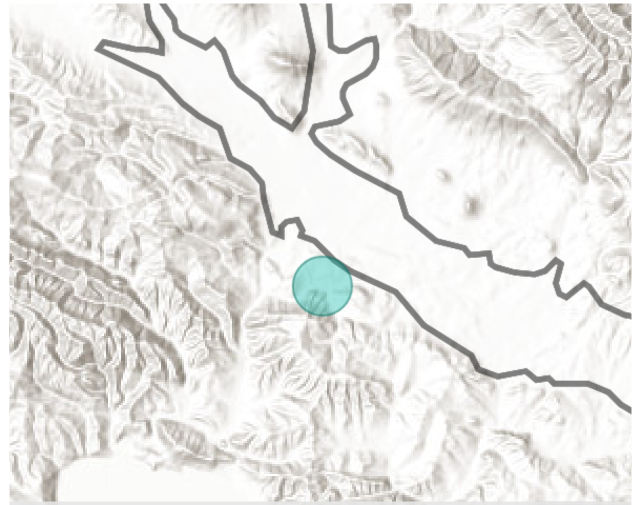

Successfully added locations to the map.

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31S/12E-15R01	04/05/1965	04/25/2019
31S/12E-28C01	04/20/1965	05/02/1979
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31S/12E-32C01	12/03/1959	10/16/1980
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31S/12E-33E02	04/07/1964	10/11/1979
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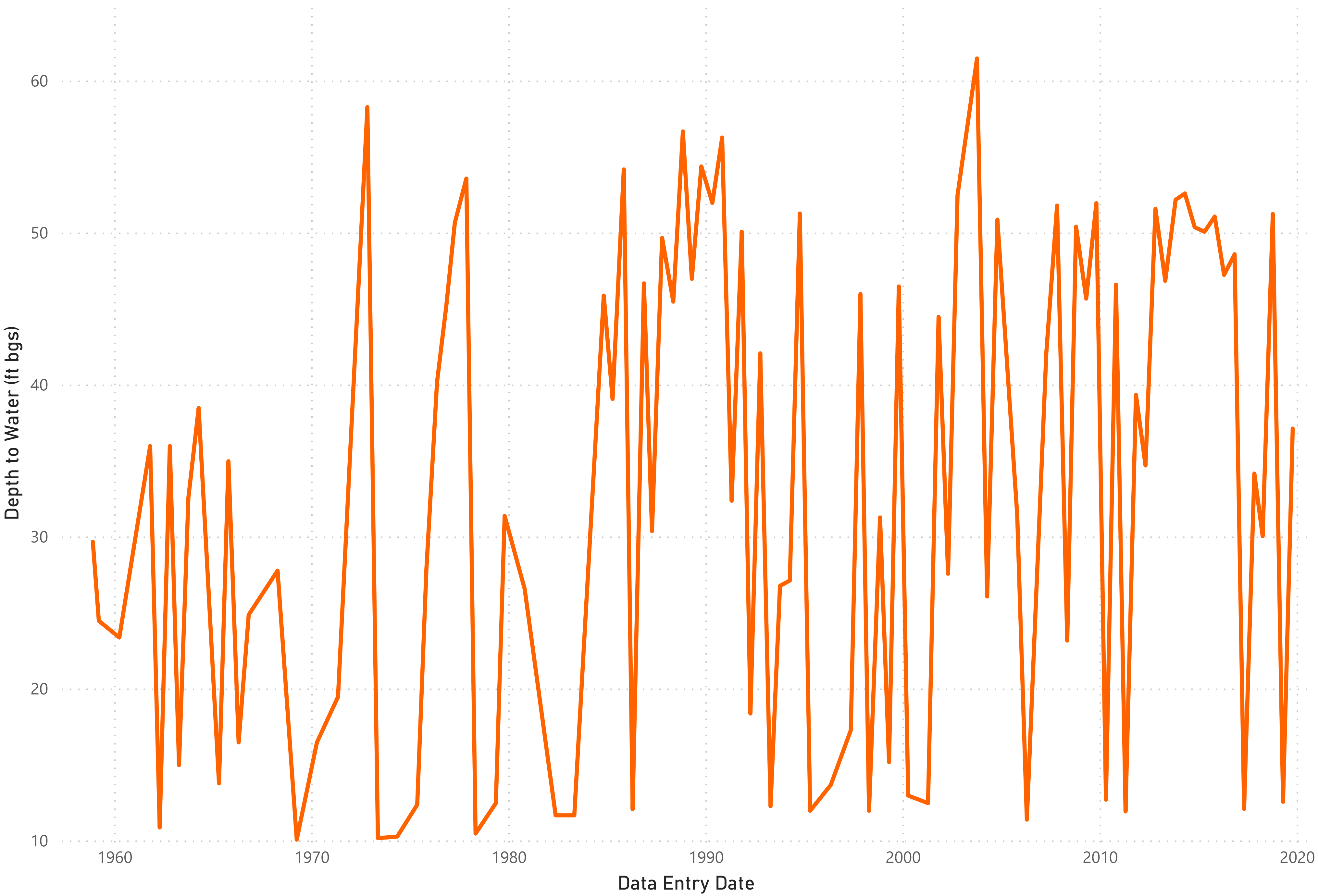
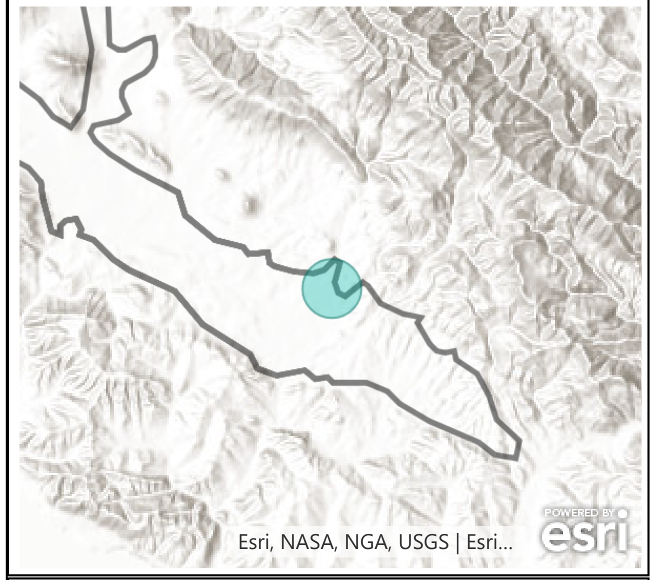
31S/13E-16N01	11/19/1958	10/07/2019
31S/13E-17B01	12/11/1974	10/23/1975
31S/13E-17Q04	12/11/1974	10/07/2019
31S/13E-17R01	05/02/1970	10/03/2019
Total	**11/01/1953**	**10/09/2019**

Depth to Water

Well Number ● 31S/13E-16N01



Well Location (larger = more samples)...



Well Number	Earliest Data Entry Date	Latest Data Entry Date
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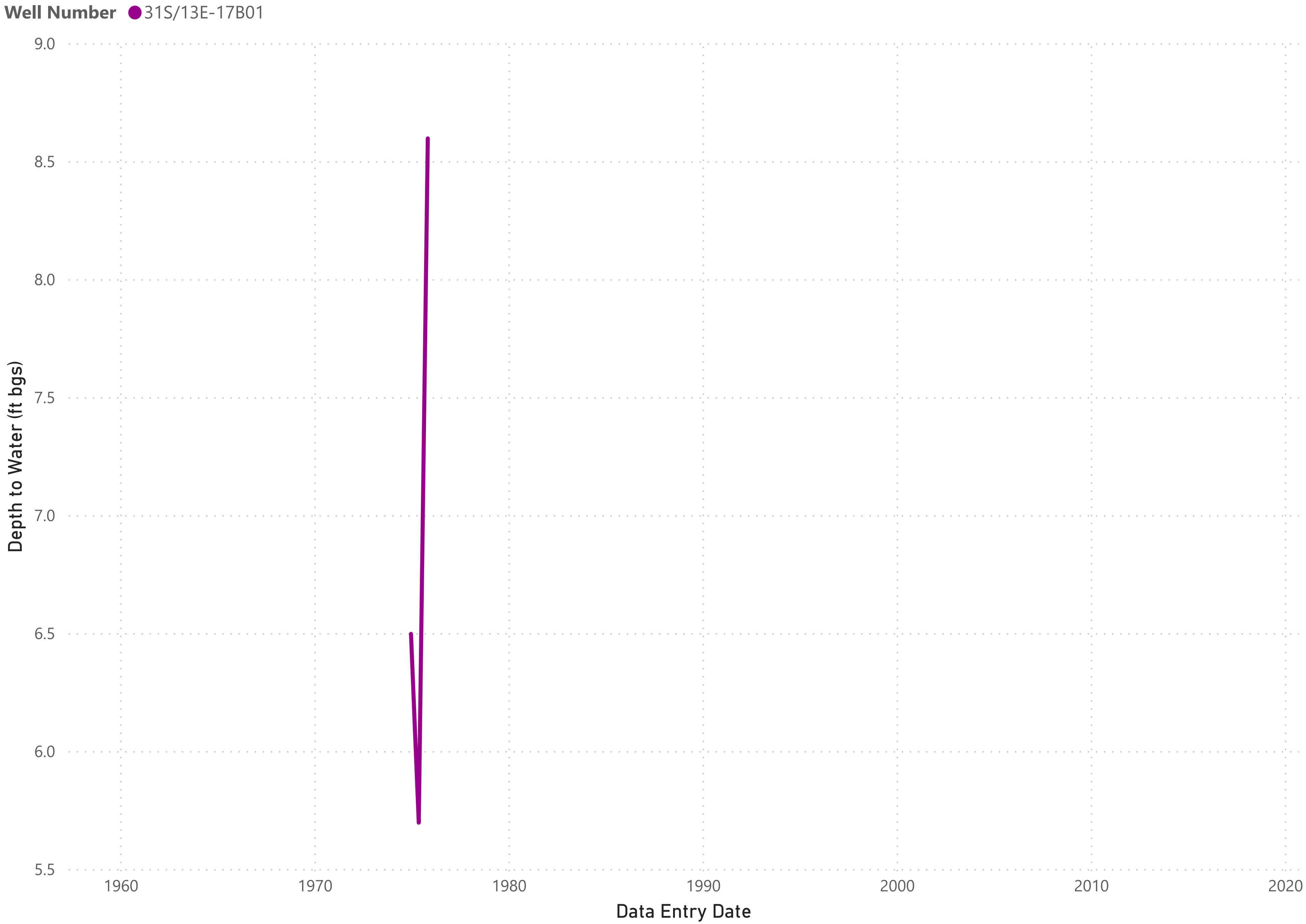
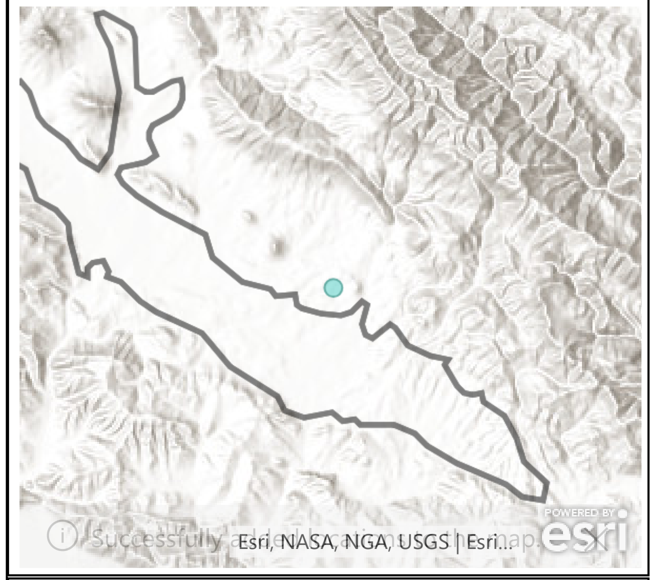
31S/12E-32D02	12/30/1959	05/08/1975
31S/12E-33E02	04/07/1964	10/11/1979
31S/12E-34N01	10/08/1965	05/02/1977
31S/13E-16N01	11/19/1958	10/07/2019
31S/13E-17B01	12/11/1974	10/23/1975
31S/13E-17Q04	12/11/1974	10/07/2019
31S/13E-17R01	05/02/1970	10/03/2019
31S/13E-18J01	12/10/1974	05/02/1979
31S/13E-18J02	12/10/1974	05/04/1987
31S/13E-18J03	10/23/1975	04/01/1987
Total	**11/01/1953**	**10/09/2019**

Depth to Water

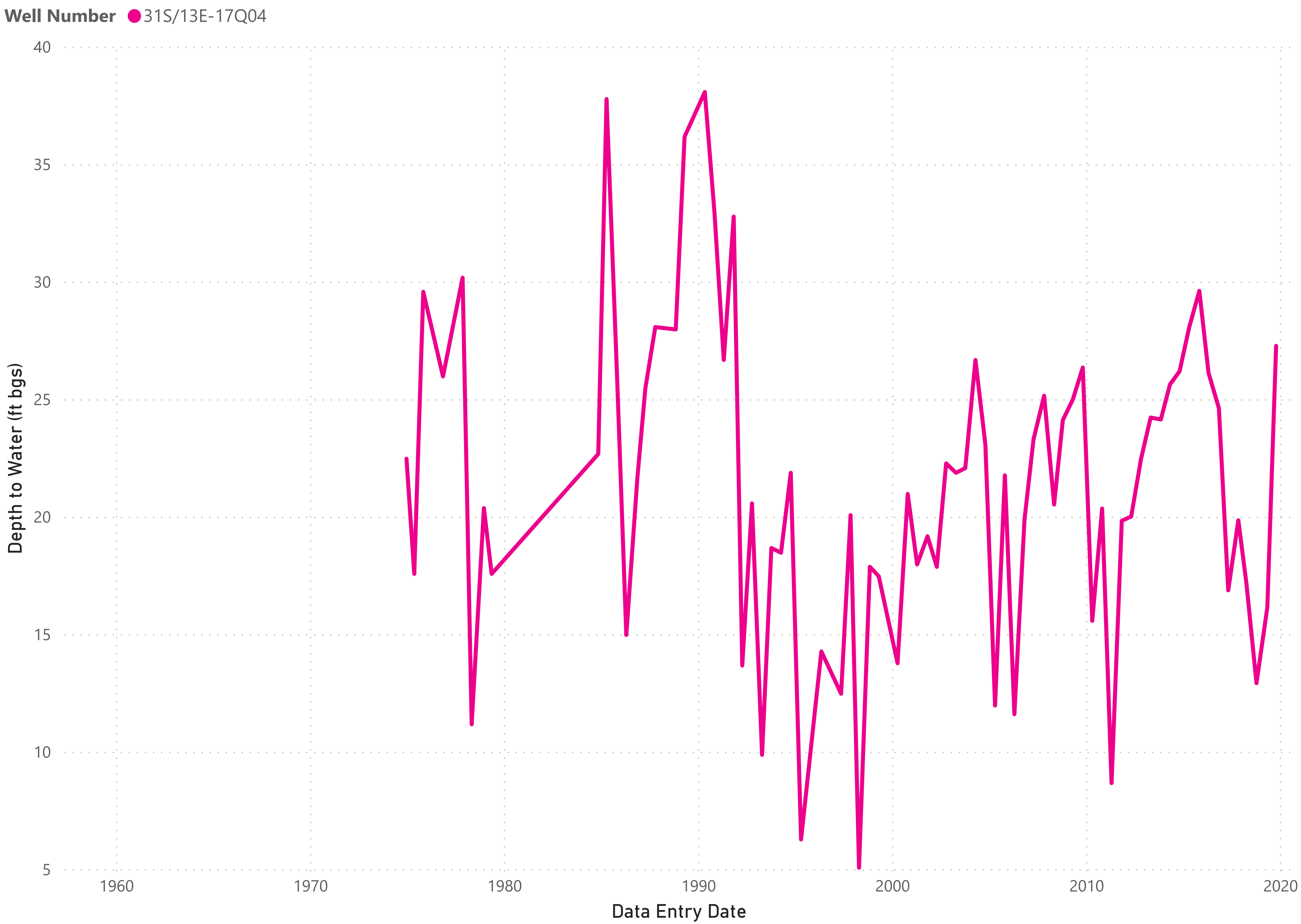


Well Location (larger = more samples)...



Well Number	Earliest Data Entry Date	Latest Data Entry Date
31S/12E-28N01	11/19/1958	04/09/1963
31S/12E-32C01	12/03/1959	10/16/1980
31S/12E-32D01	12/30/1959	05/08/1975
31S/12E-32D02	12/30/1959	05/08/1975
31S/12E-33E02	04/07/1964	10/11/1979
31S/12E-34N01	10/08/1965	05/02/1977
31S/13E-16N01	11/19/1958	10/07/2019
31S/13E-17B01	12/11/1974	10/23/1975
31S/13E-17Q04	12/11/1974	10/07/2019
31S/13E-17R01	05/02/1970	10/03/2019
31S/13E-18J01	12/10/1974	05/02/1979
31S/13E-18J02	12/10/1974	05/04/1987
31S/13E-18J03	10/23/1975	04/01/1987
Total	**11/01/1953**	**10/09/2019**

Depth to Water



Well Location (larger = more samples)...

Well Number	Earliest Data Entry Date	Latest Data Entry Date
31S/12E-33E02	04/07/1964	10/11/1979
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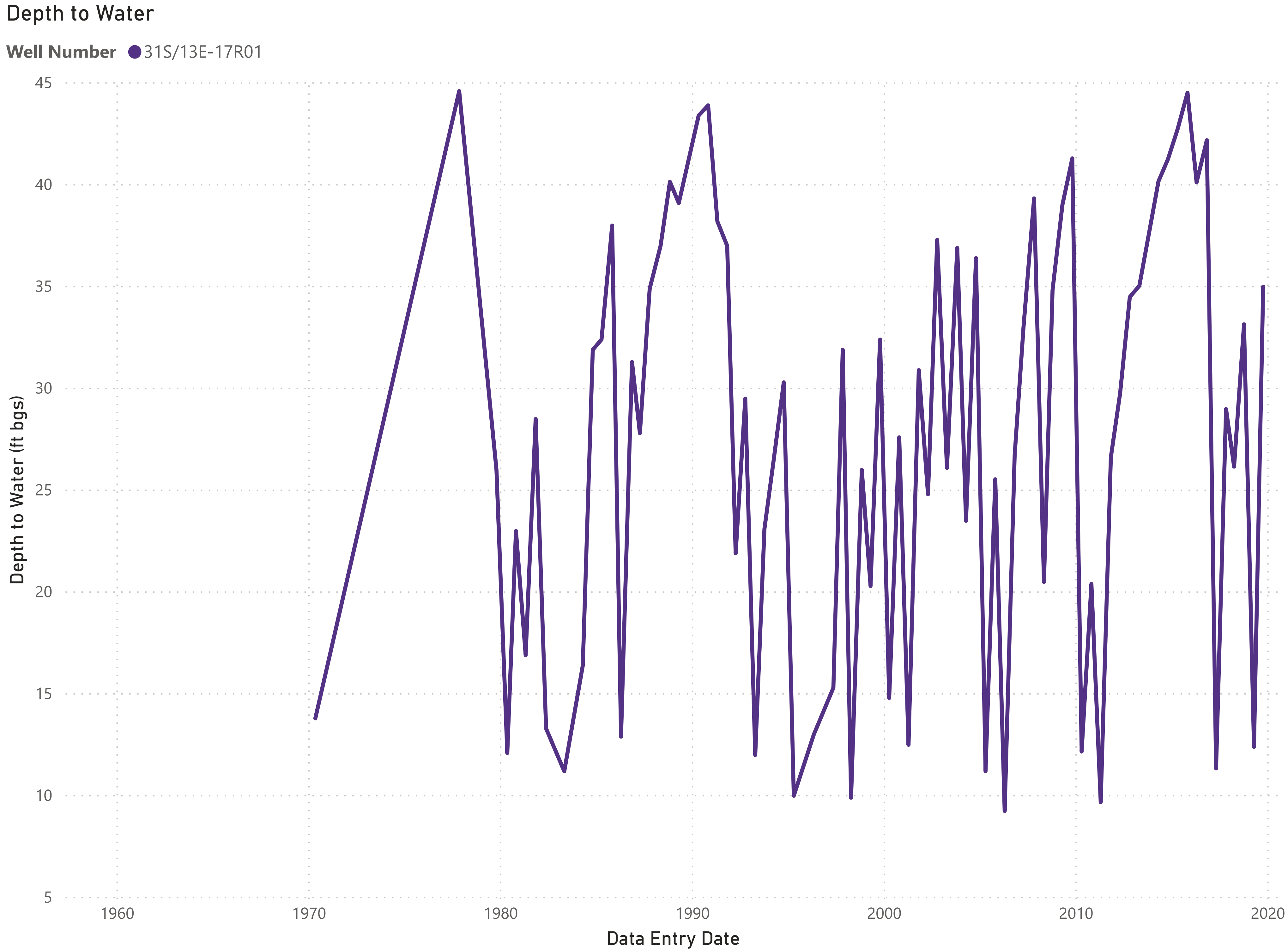
31S/13E-16N01	11/19/1958	10/07/2019
31S/13E-17B01	12/11/1974	10/23/1975
31S/13E-17Q04	12/11/1974	10/07/2019
31S/13E-17R01	05/02/1970	10/03/2019
31S/13E-18J01	12/10/1974	05/02/1979
31S/13E-18J02	12/10/1974	05/04/1987
31S/13E-18J03	10/23/1975	04/01/1987
31S/13E-18N01	04/05/1965	04/15/1996
31S/13E-18R01	12/10/1974	05/04/1987
31S/13E-18R02	12/10/1974	05/06/1976
31S/13E-19A03	12/10/1974	04/04/1987
Total	**11/01/1953**	**10/09/2019**



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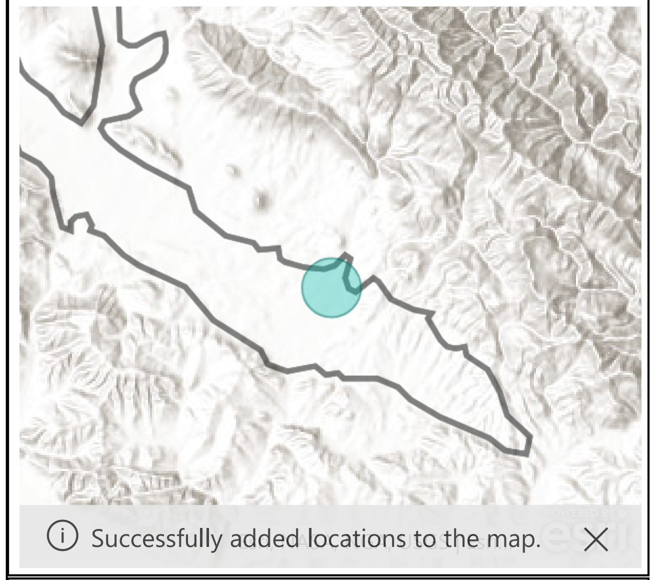
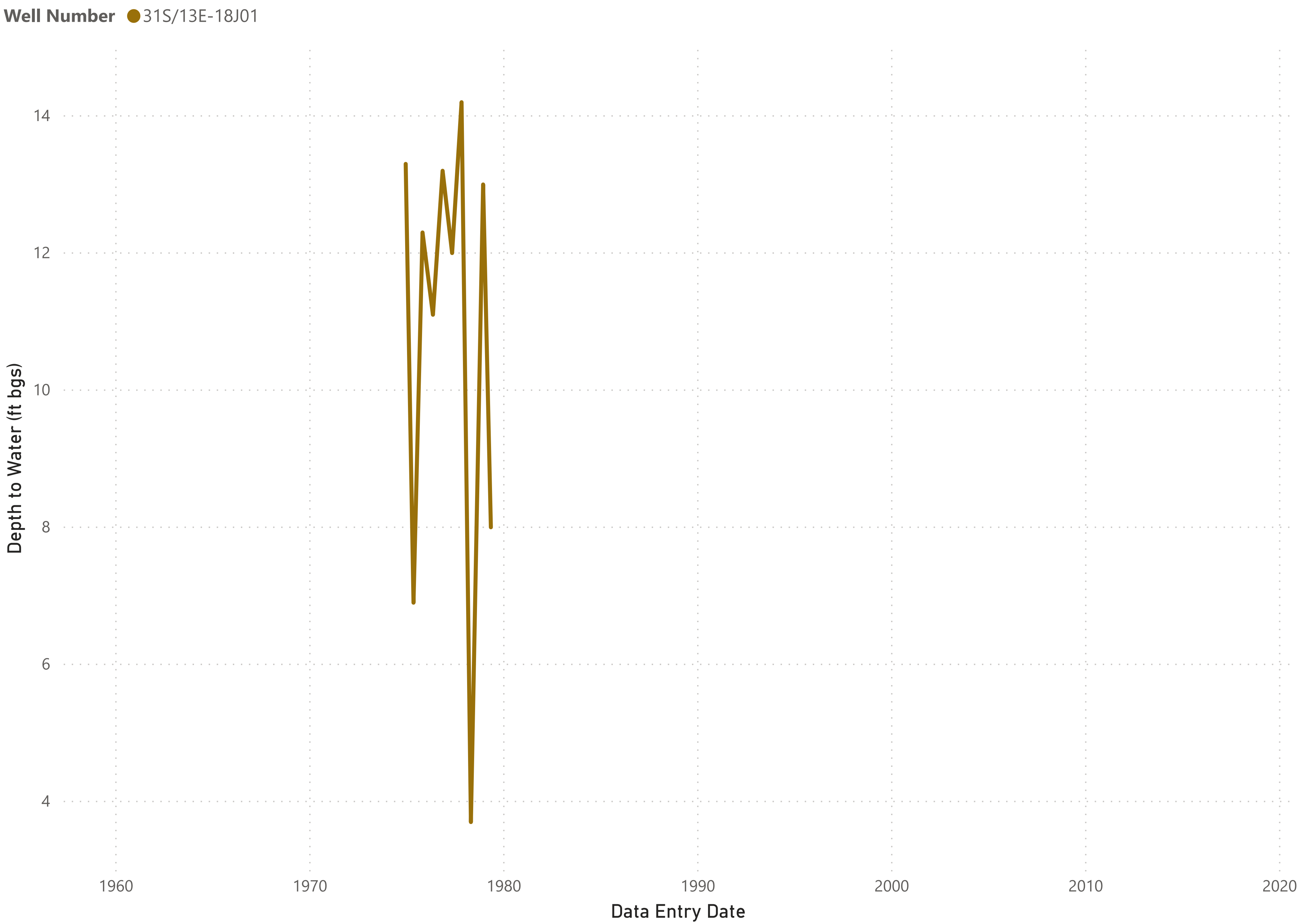
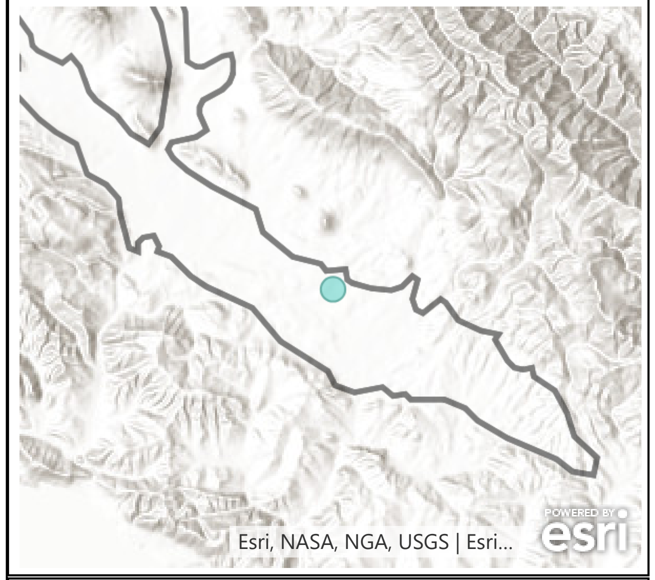


Well Number	Earliest Data Entry Date	Latest Data Entry Date
31S/12E-28N01	11/19/1958	04/09/1963
31S/12E-32C01	12/03/1959	10/16/1980
31S/12E-32D01	12/30/1959	05/08/1975
31S/12E-32D02	12/30/1959	05/08/1975
31S/12E-33E02	04/07/1964	10/11/1979
31S/12E-34N01	10/08/1965	05/02/1977
31S/13E-16N01	11/19/1958	10/07/2019
31S/13E-17B01	12/11/1974	10/23/1975
31S/13E-17Q04	12/11/1974	10/07/2019
31S/13E-17R01	05/02/1970	10/03/2019
31S/13E-18J01	12/10/1974	05/02/1979
31S/13E-18J02	12/10/1974	05/04/1987
31S/13E-18J03	10/23/1975	04/01/1987
Total	**11/01/1953**	**10/09/2019**

Depth to Water

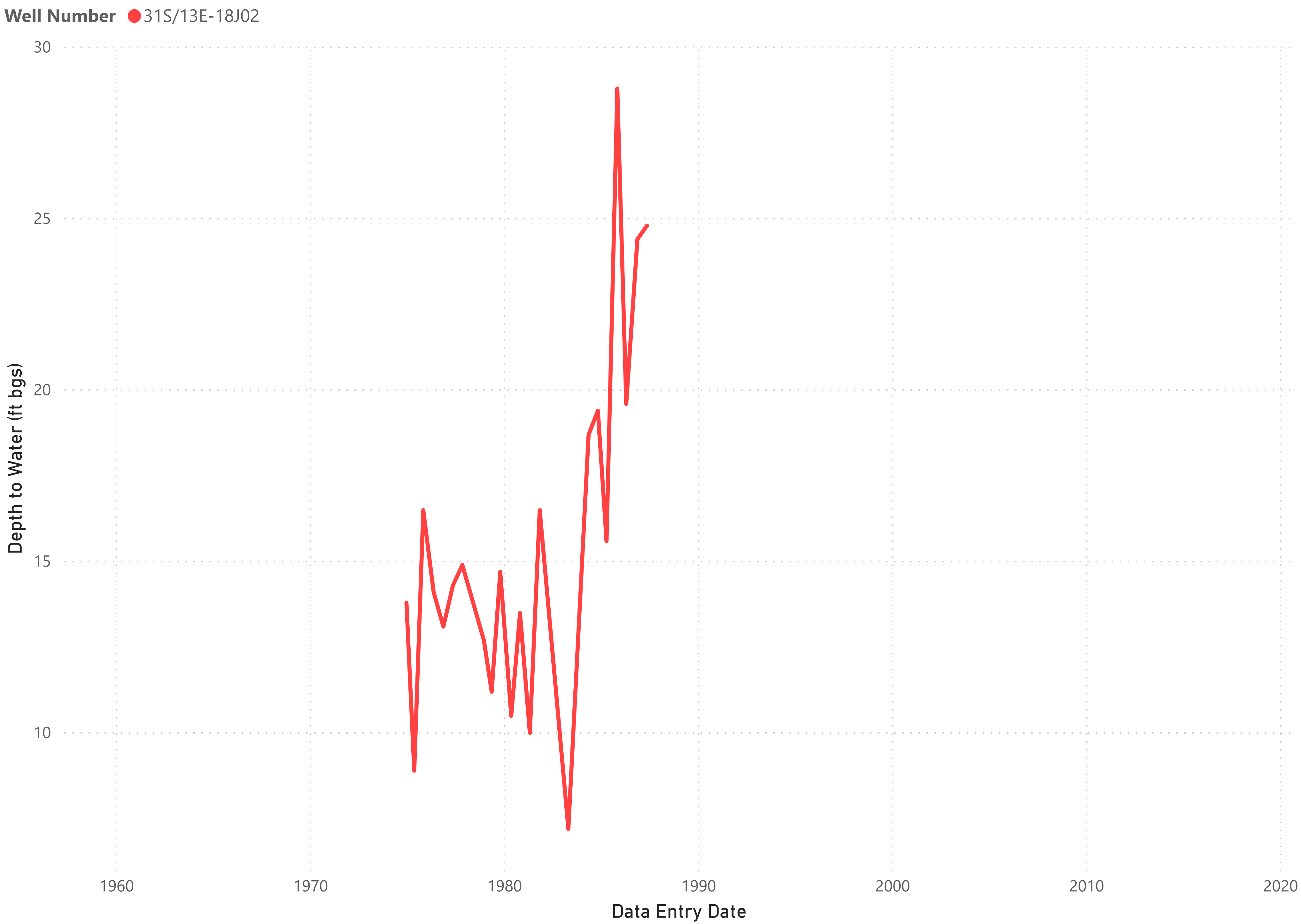


Well Location (larger = more samples)...



Well Number	Earliest Data Entry Date	Latest Data Entry Date
31S/12E-28N01	11/19/1958	04/09/1963
31S/12E-32C01	12/03/1959	10/16/1980
31S/12E-32D01	12/30/1959	05/08/1975
31S/12E-32D02	12/30/1959	05/08/1975
31S/12E-33E02	04/07/1964	10/11/1979
31S/12E-34N01	10/08/1965	05/02/1977
31S/13E-16N01	11/19/1958	10/07/2019
31S/13E-17B01	12/11/1974	10/23/1975
31S/13E-17Q04	12/11/1974	10/07/2019
31S/13E-17R01	05/02/1970	10/03/2019
31S/13E-18J01	12/10/1974	05/02/1979
31S/13E-18J02	12/10/1974	05/04/1987
31S/13E-18J03	10/23/1975	04/01/1987
Total	**11/01/1953**	**10/09/2019**

Depth to Water



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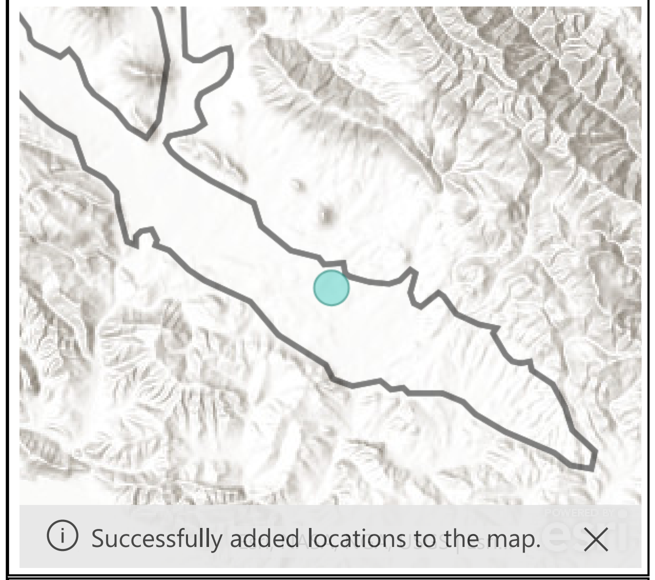
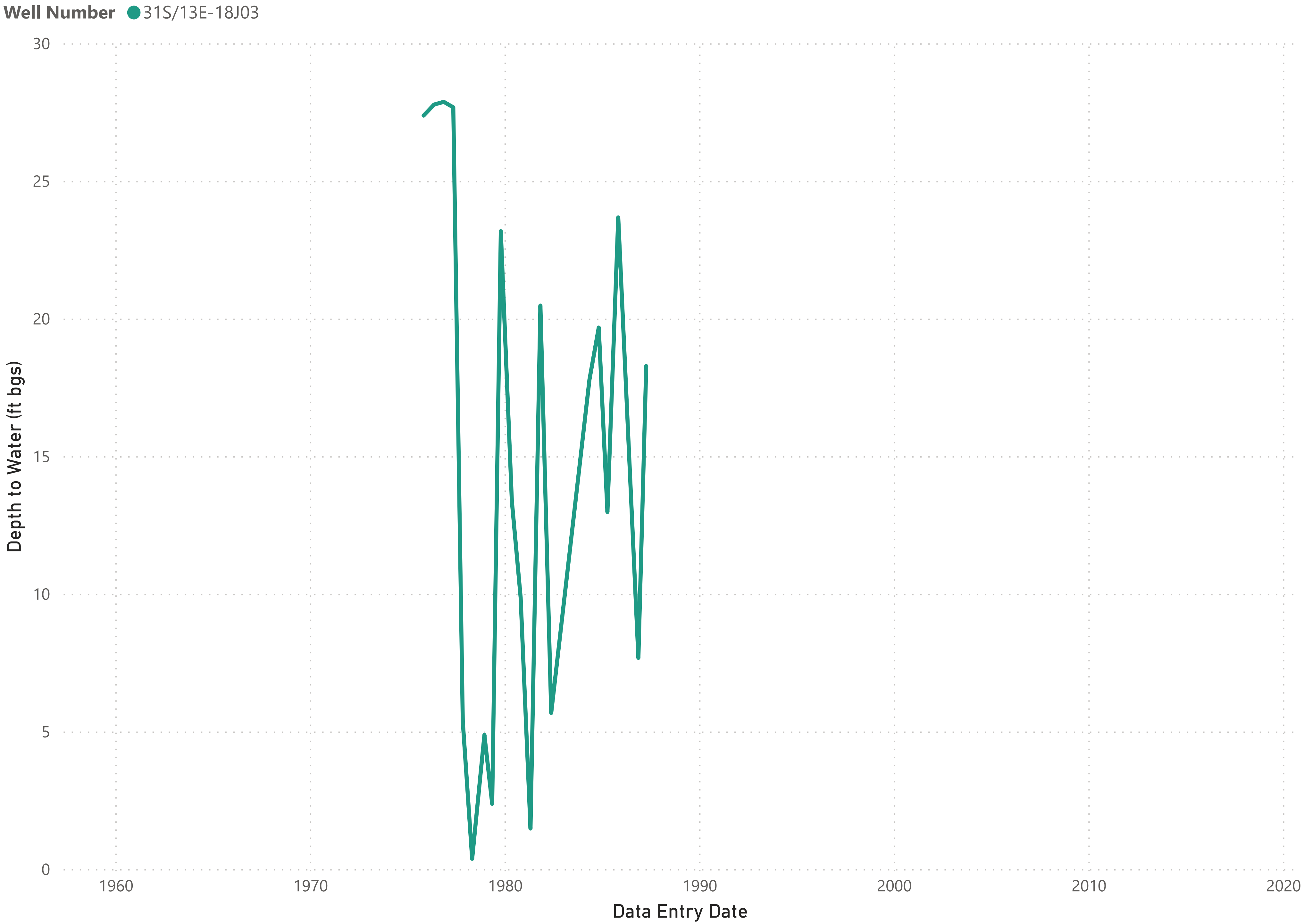


Well Number	Earliest Data Entry Date	Latest Data Entry Date
31S/12E-33E02	04/07/1964	10/11/1979
31S/12E-34N01	10/08/1965	05/02/1977
31S/13E-16N01	11/19/1958	10/07/2019
31S/13E-17B01	12/11/1974	10/23/1975
31S/13E-17Q04	12/11/1974	10/07/2019
31S/13E-17R01	05/02/1970	10/03/2019
31S/13E-18J01	12/10/1974	05/02/1979
31S/13E-18J02	12/10/1974	05/04/1987
31S/13E-18J03	10/23/1975	04/01/1987
31S/13E-18N01	04/05/1965	04/15/1996
31S/13E-18R01	12/10/1974	05/04/1987
31S/13E-18R02	12/10/1974	05/06/1976
31S/13E-19A03	12/10/1974	04/04/1987
Total	**11/01/1953**	**10/09/2019**

Depth to Water



Well Location (larger = more samples)...

Well Number	Earliest Data Entry Date	Latest Data Entry Date
31S/12E-33E02	04/07/1964	10/11/1979
31S/12E-34N01	10/08/1965	05/02/1977
31S/13E-16N01	11/19/1958	10/07/2019
31S/13E-17B01	12/11/1974	10/23/1975
31S/13E-17Q04	12/11/1974	10/07/2019
31S/13E-17R01	05/02/1970	10/03/2019
31S/13E-18J01	12/10/1974	05/02/1979
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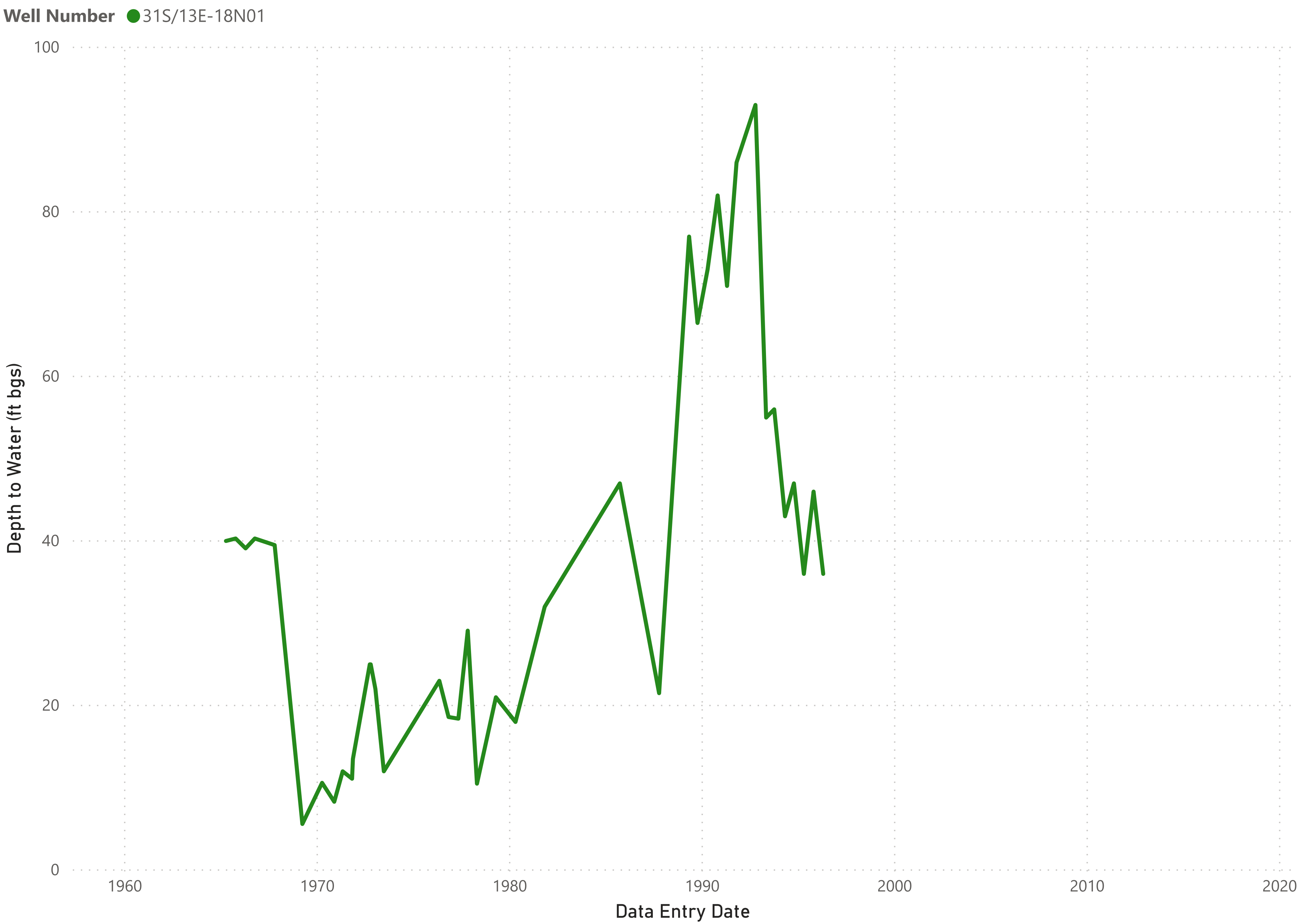
31S/13E-18J03	10/23/1975	04/01/1987
31S/13E-18N01	04/05/1965	04/15/1996
31S/13E-18R01	12/10/1974	05/04/1987
31S/13E-18R02	12/10/1974	05/06/1976
31S/13E-19A03	12/10/1974	04/04/1987
Total	**11/01/1953**	**10/09/2019**

Depth to Water



Well Location (larger = more samples)...

Well Number	Earliest Data Entry Date	Latest Data Entry Date
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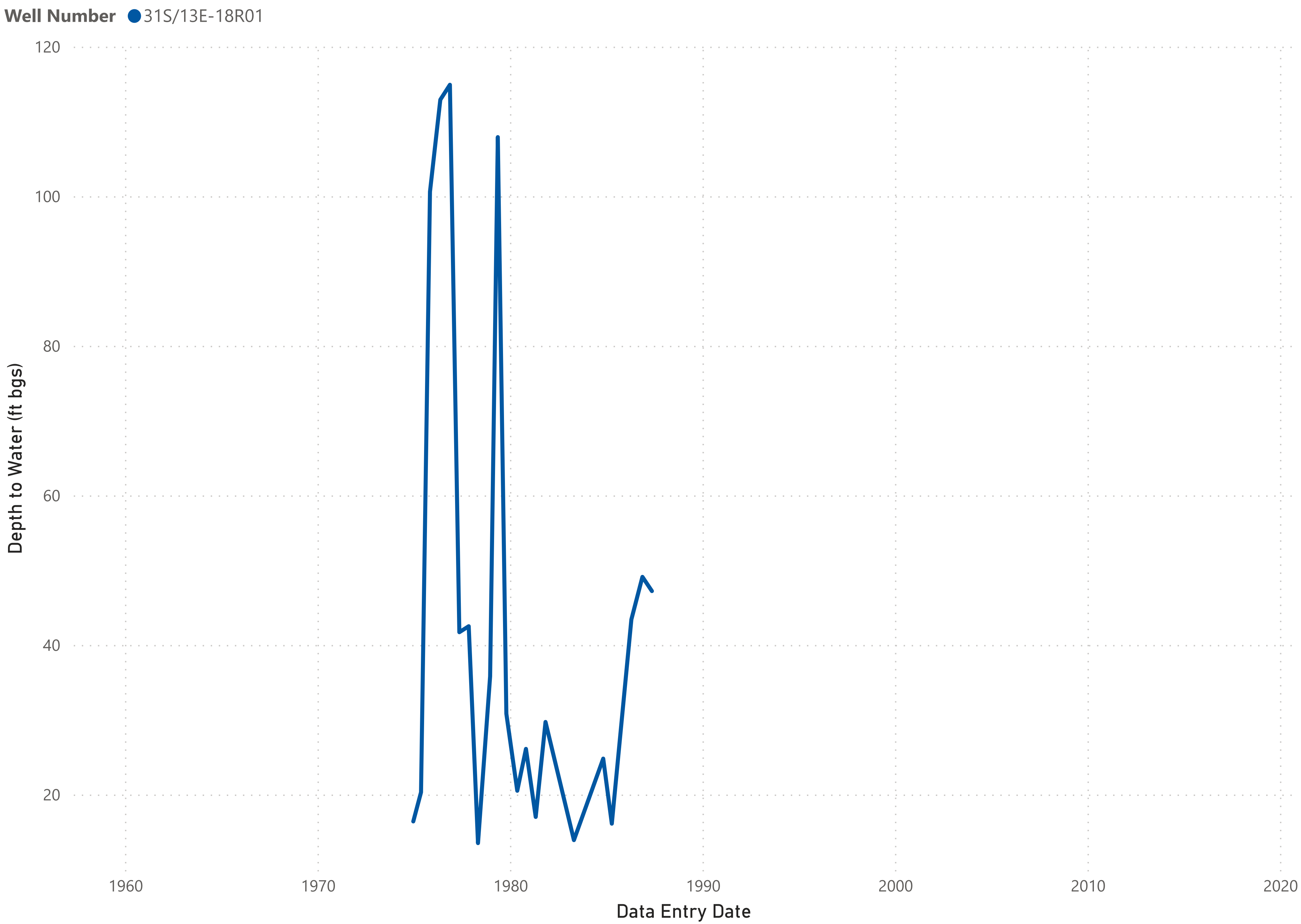
31S/12E-34N01	10/08/1965	05/02/1977
31S/13E-16N01	11/19/1958	10/07/2019
31S/13E-17B01	12/11/1974	10/23/1975
31S/13E-17Q04	12/11/1974	10/07/2019
31S/13E-17R01	05/02/1970	10/03/2019
31S/13E-18J01	12/10/1974	05/02/1979
31S/13E-18J02	12/10/1974	05/04/1987
31S/13E-18J03	10/23/1975	04/01/1987
31S/13E-18N01	04/05/1965	04/15/1996
31S/13E-18R01	12/10/1974	05/04/1987
31S/13E-18R02	12/10/1974	05/06/1976
31S/13E-19A03	12/10/1974	04/04/1987
Total	**11/01/1953**	**10/09/2019**

Depth to Water



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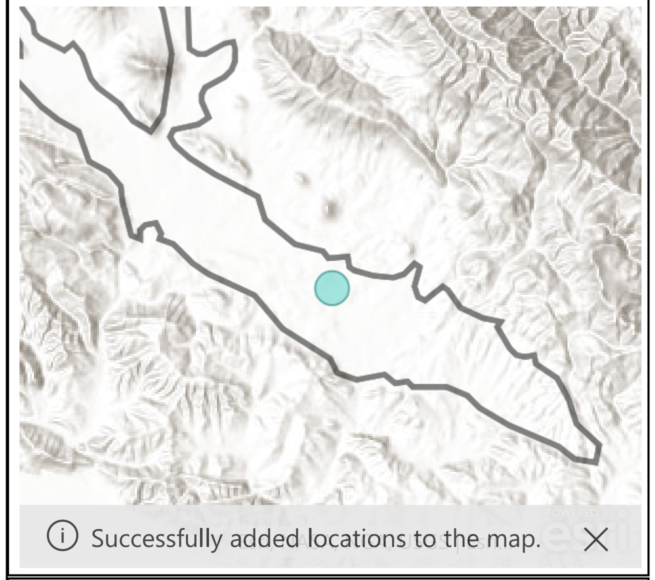

Well Number	Earliest Data Entry Date	Latest Data Entry Date
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31S/12E-34N01	10/08/1965	05/02/1977
31S/13E-16N01	11/19/1958	10/07/2019
31S/13E-17B01	12/11/1974	10/23/1975
31S/13E-17Q04	12/11/1974	10/07/2019
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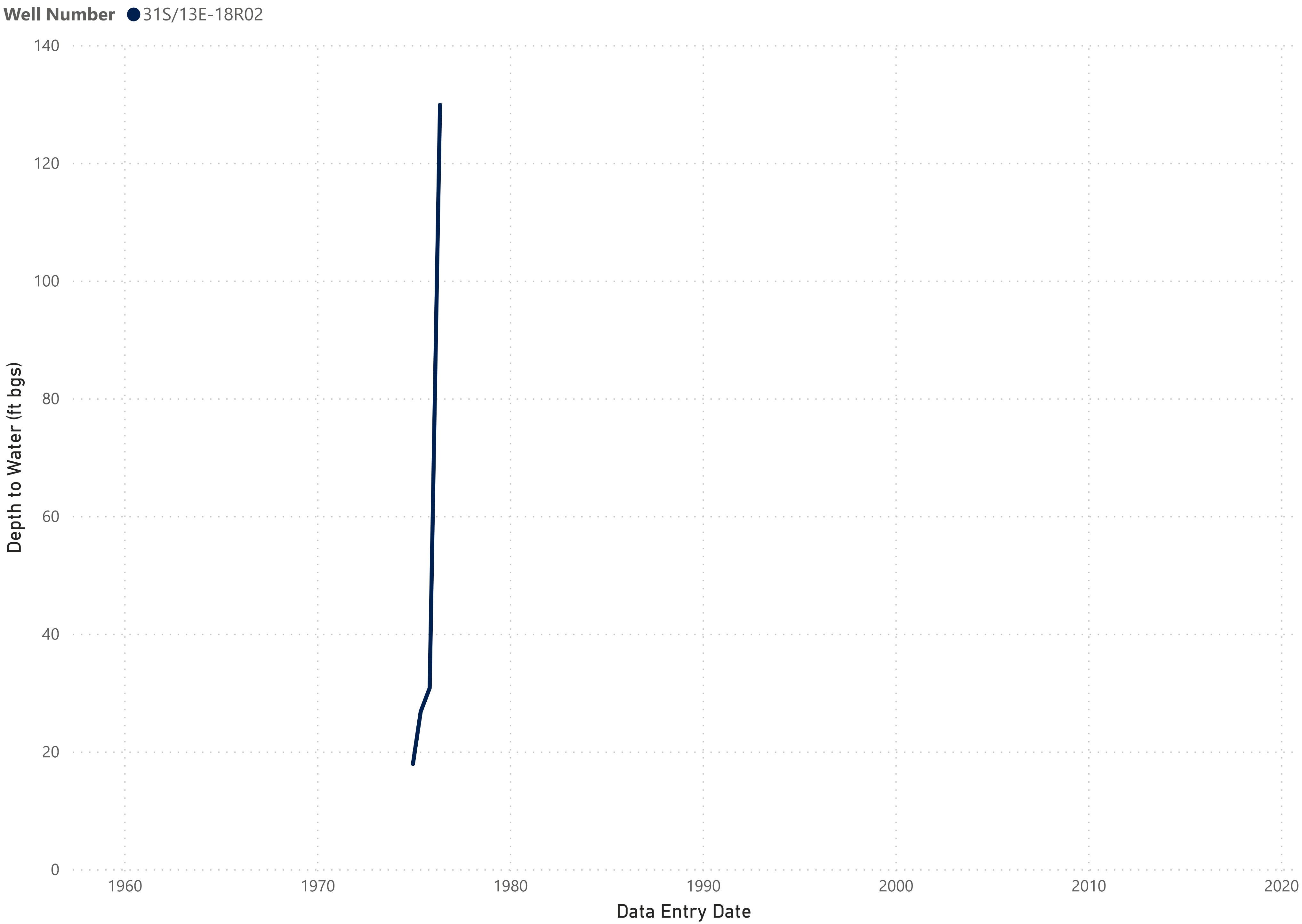
31S/13E-18N01	04/05/1965	04/15/1996
31S/13E-18R01	12/10/1974	05/04/1987
31S/13E-18R02	12/10/1974	05/06/1976
31S/13E-19A03	12/10/1974	04/04/1987
Total	**11/01/1953**	**10/09/2019**

Depth to Water



Well Location (larger = more samples)...

Well Number	Earliest Data Entry Date	Latest Data Entry Date
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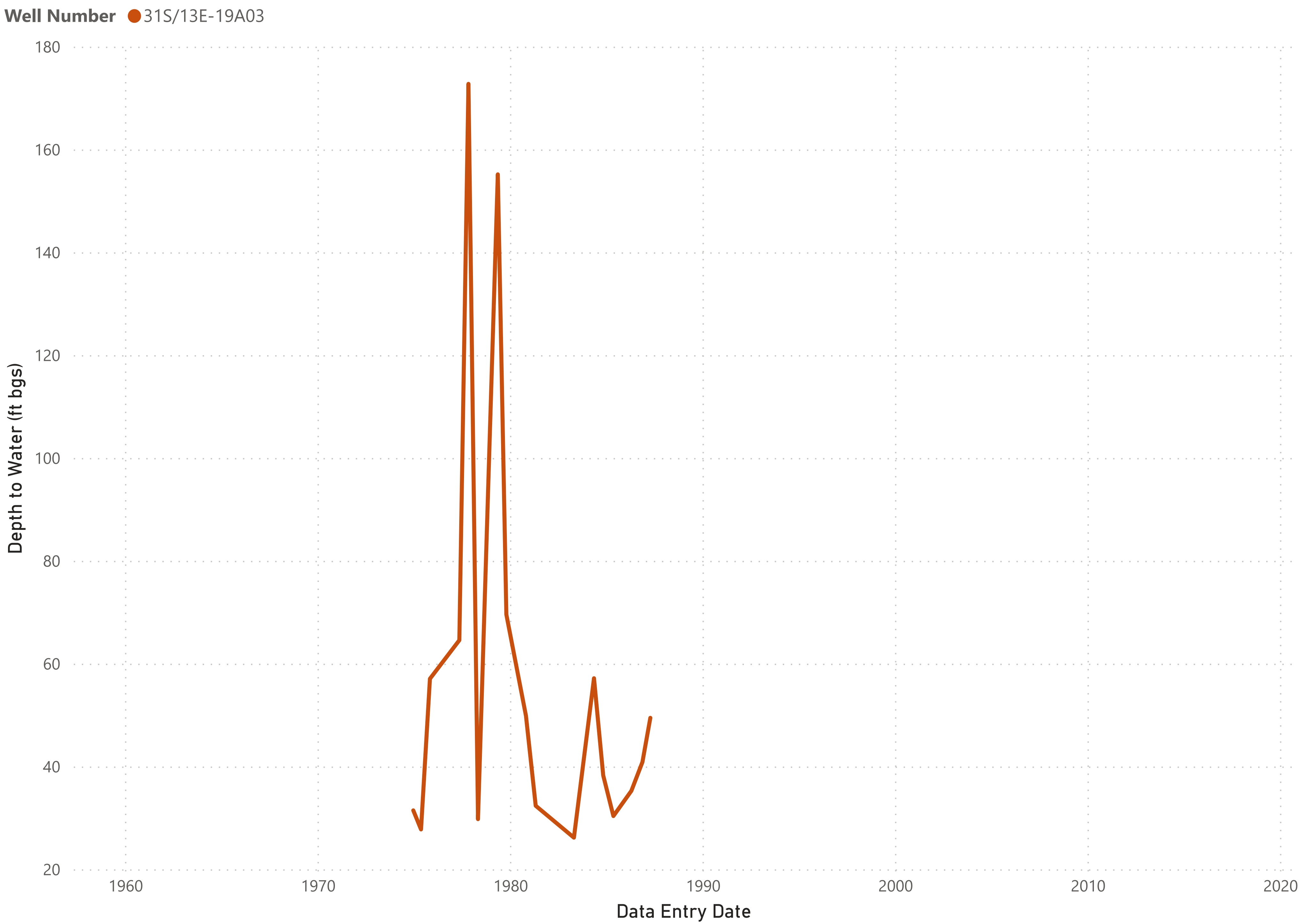
31S/12E-34N01	10/08/1965	05/02/1977
31S/13E-16N01	11/19/1958	10/07/2019
31S/13E-17B01	12/11/1974	10/23/1975
31S/13E-17Q04	12/11/1974	10/07/2019
31S/13E-17R01	05/02/1970	10/03/2019
31S/13E-18J01	12/10/1974	05/02/1979
31S/13E-18J02	12/10/1974	05/04/1987
31S/13E-18J03	10/23/1975	04/01/1987
31S/13E-18N01	04/05/1965	04/15/1996
31S/13E-18R01	12/10/1974	05/04/1987
31S/13E-18R02	12/10/1974	05/06/1976
31S/13E-19A03	12/10/1974	04/04/1987
Total	**11/01/1953**	**10/09/2019**

Depth to Water



Well Location (larger = more samples)...

Well Number	Earliest Data Entry Date	Latest Data Entry Date
31S/13E-17Q04	12/11/1974	10/07/2019
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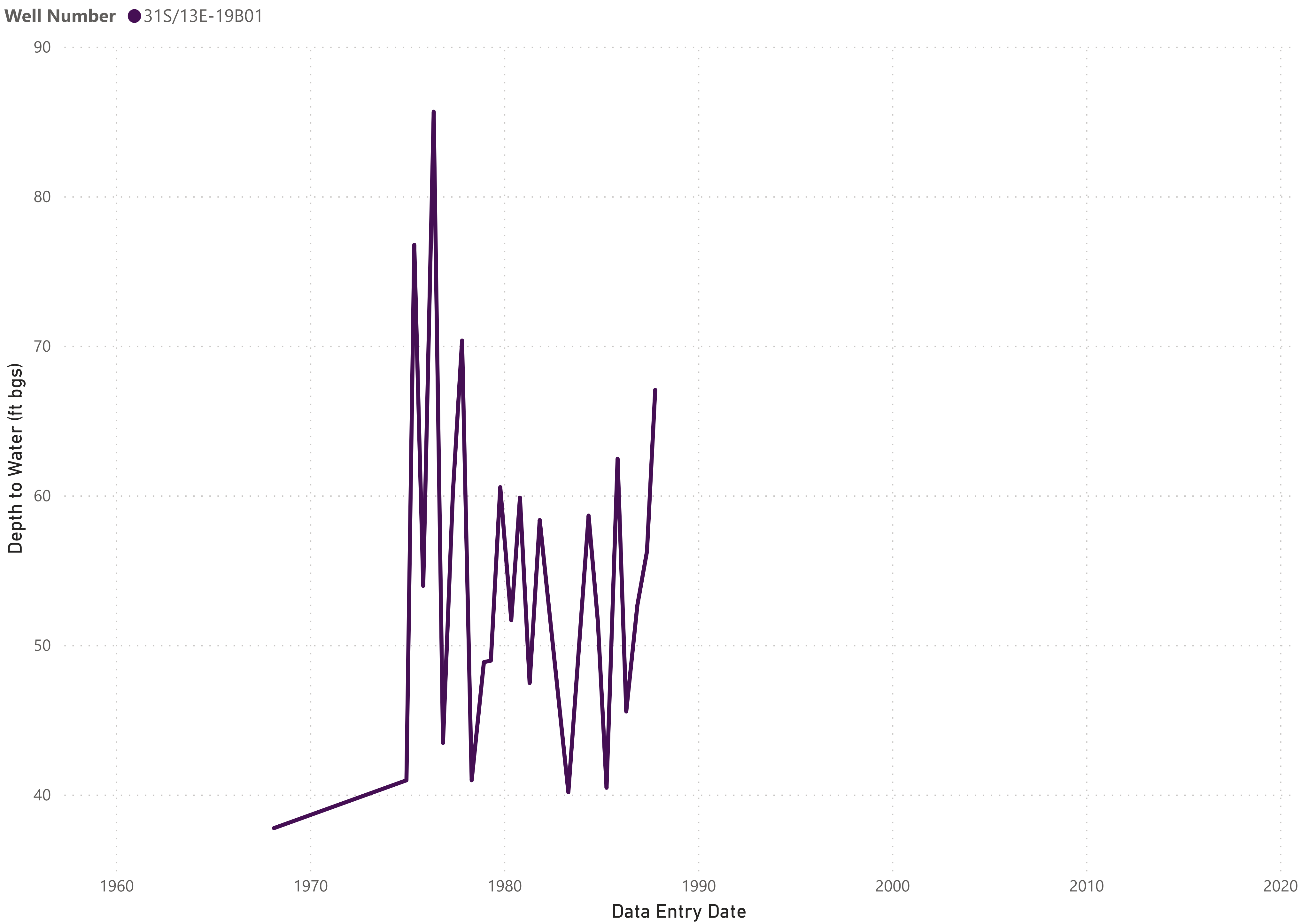
31S/13E-18J01	12/10/1974	05/02/1979
31S/13E-18J02	12/10/1974	05/04/1987
31S/13E-18J03	10/23/1975	04/01/1987
31S/13E-18N01	04/05/1965	04/15/1996
31S/13E-18R01	12/10/1974	05/04/1987
31S/13E-18R02	12/10/1974	05/06/1976
31S/13E-19A03	12/10/1974	04/04/1987
31S/13E-19B01	02/10/1968	10/06/1987
31S/13E-19H01	11/19/1958	10/03/2019
31S/13E-19H04	10/27/1977	04/04/1987
31S/13E-19L01	04/05/1965	10/19/2010
Total	**11/01/1953**	**10/09/2019**

Depth to Water



Well Location (larger = more samples)...

Well Number	Earliest Data Entry Date	Latest Data Entry Date
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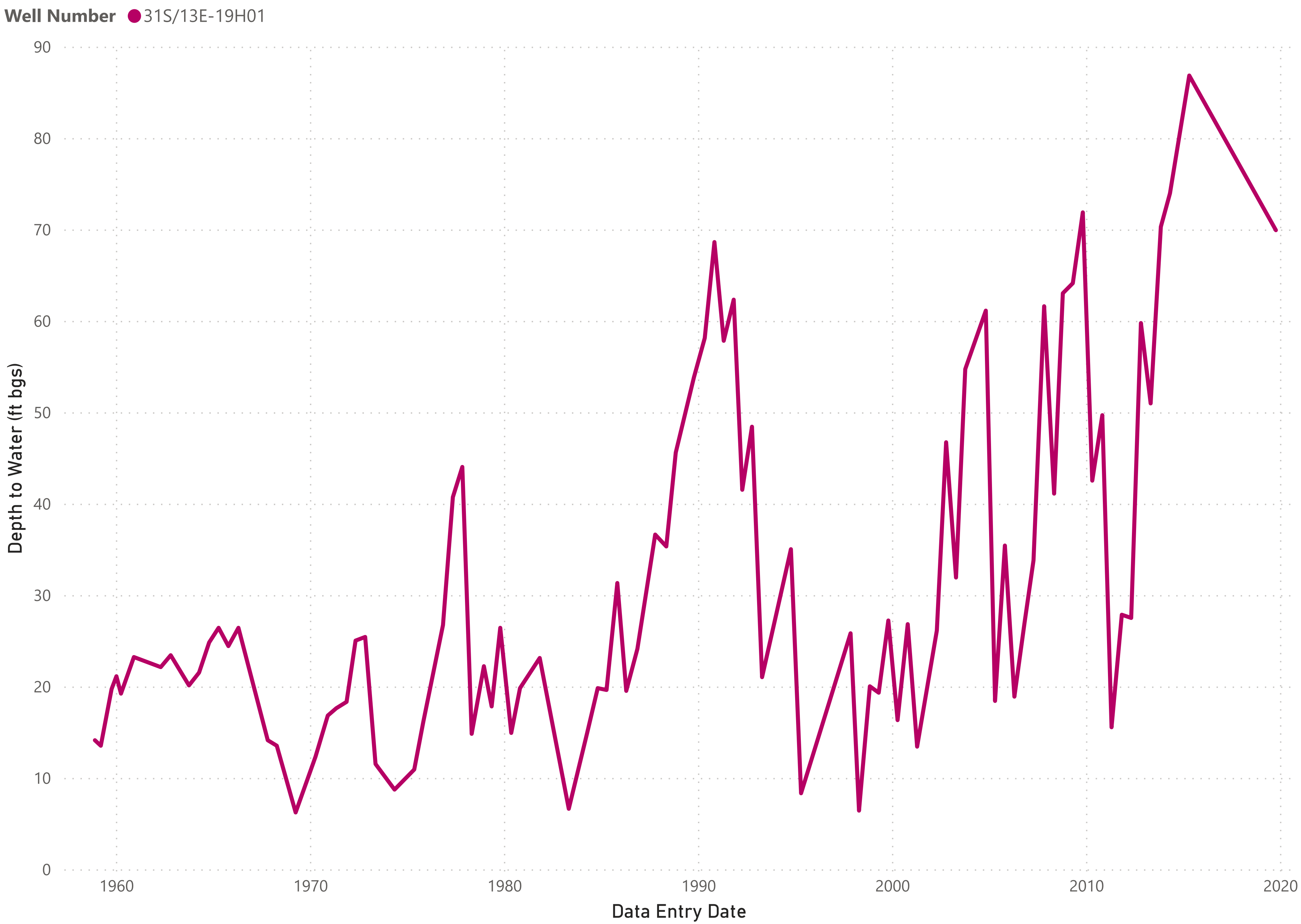
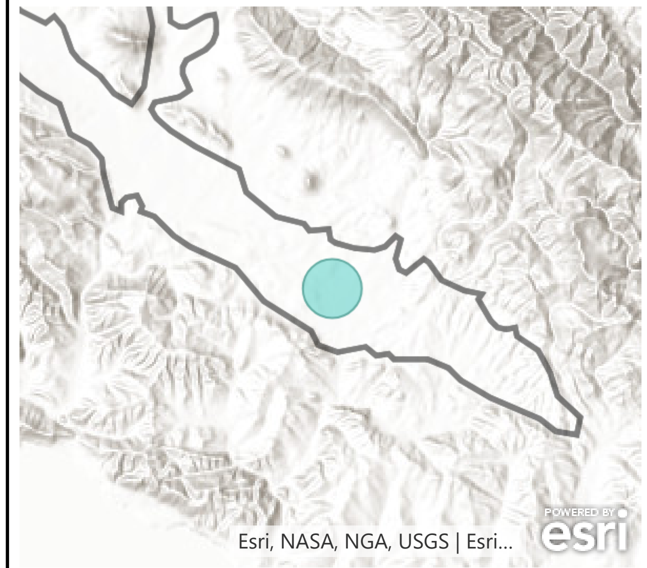
31S/13E-17R01	05/02/1970	10/03/2019
31S/13E-18J01	12/10/1974	05/02/1979
31S/13E-18J02	12/10/1974	05/04/1987
31S/13E-18J03	10/23/1975	04/01/1987
31S/13E-18N01	04/05/1965	04/15/1996
31S/13E-18R01	12/10/1974	05/04/1987
31S/13E-18R02	12/10/1974	05/06/1976
31S/13E-19A03	12/10/1974	04/04/1987
31S/13E-19B01	02/10/1968	10/06/1987
31S/13E-19H01	11/19/1958	10/03/2019
31S/13E-19H04	10/27/1977	04/04/1987
31S/13E-19L01	04/05/1965	10/19/2010
Total	**11/01/1953**	**10/09/2019**

Depth to Water

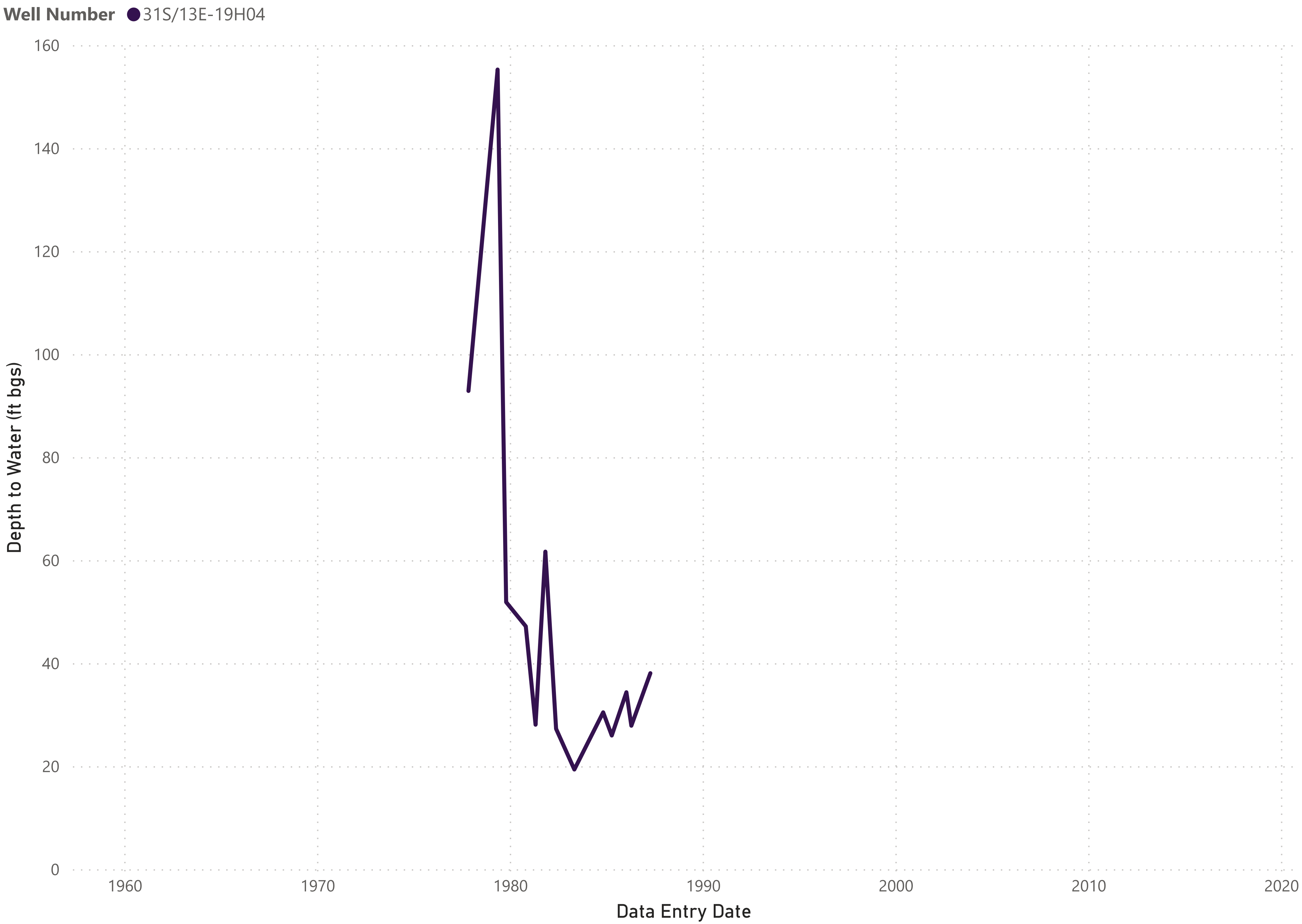


Well Location (larger = more samples)...



Well Number	Earliest Data Entry Date	Latest Data Entry Date
31S/13E-18J03	10/23/1975	04/01/1987
31S/13E-18N01	04/05/1965	04/15/1996
31S/13E-18R01	12/10/1974	05/04/1987
31S/13E-18R02	12/10/1974	05/06/1976
31S/13E-19A03	12/10/1974	04/04/1987
31S/13E-19B01	02/10/1968	10/06/1987
31S/13E-19H01	11/19/1958	10/03/2019
31S/13E-19H04	10/27/1977	04/04/1987
31S/13E-19L01	04/05/1965	10/19/2010
31S/13E-19Q01	12/16/1976	10/07/2019
31S/13E-19R01	11/01/1977	10/19/2012
31S/13E-19R02	10/14/1992	10/14/2001
31S/13E-19R03	10/07/1994	04/04/2019
Total	**11/01/1953**	**10/09/2019**

Depth to Water



Well Location (larger = more samples)...

Well Number	Earliest Data Entry Date	Latest Data Entry Date
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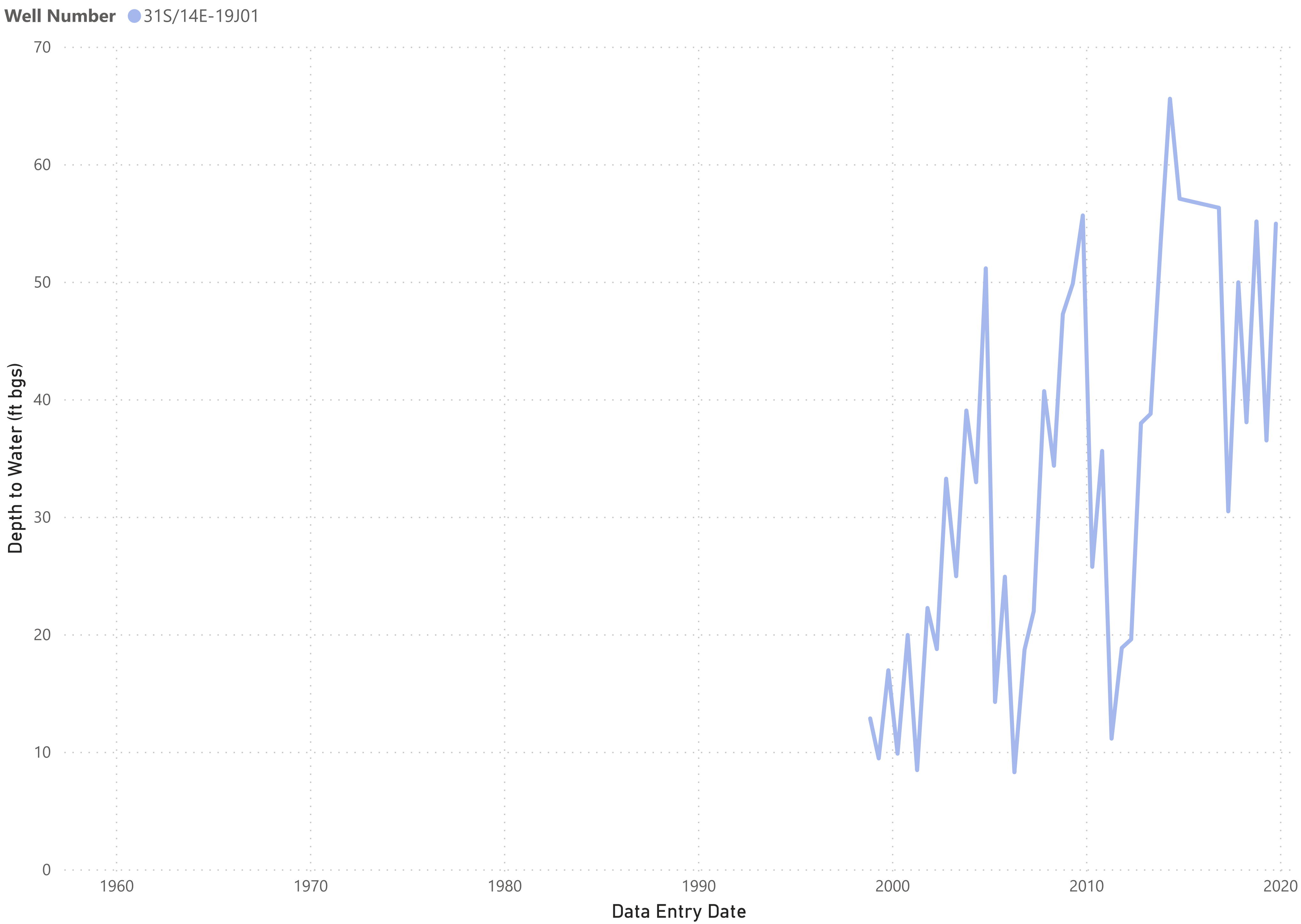
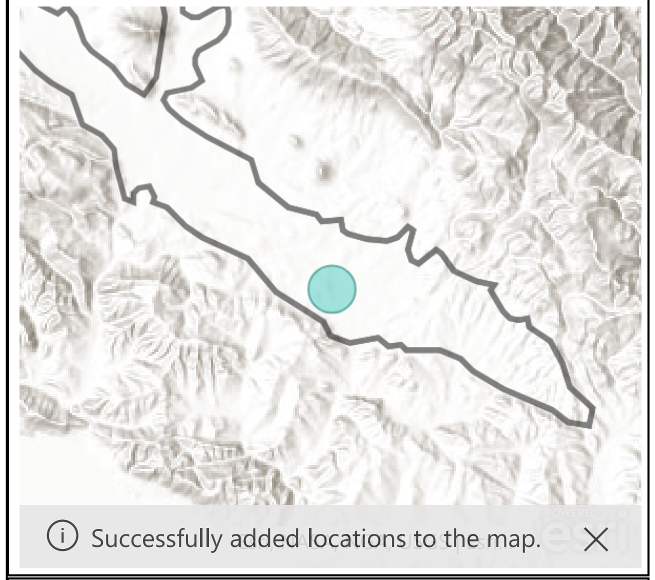
31S/13E-18R01	12/10/1974	05/04/1987
31S/13E-18R02	12/10/1974	05/06/1976
31S/13E-19A03	12/10/1974	04/04/1987
31S/13E-19B01	02/10/1968	10/06/1987
31S/13E-19H01	11/19/1958	10/03/2019
31S/13E-19H04	10/27/1977	04/04/1987
31S/13E-19L01	04/05/1965	10/19/2010
31S/13E-19Q01	12/16/1976	10/07/2019
31S/13E-19R01	11/01/1977	10/19/2012
31S/13E-19R02	10/14/1992	10/14/2001
31S/13E-19R03	10/07/1994	04/04/2019
Total	**11/01/1953**	**10/09/2019**

Depth to Water

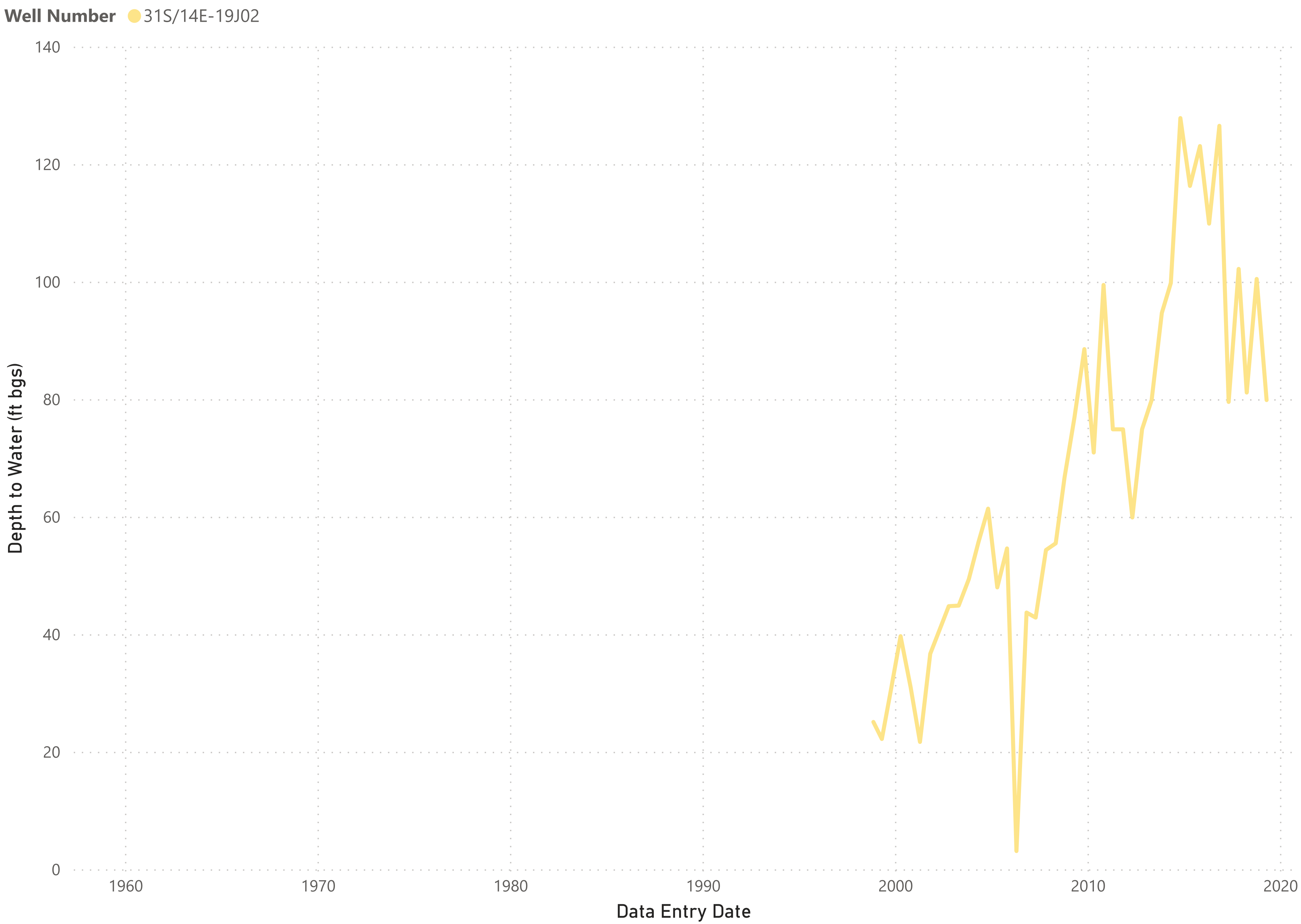


Well Location (larger = more samples)...



Well Number	Earliest Data Entry Date	Latest Data Entry Date
31S/13E-27D03	04/05/1965	04/03/2000
31S/13E-27M01	11/01/1953	04/03/2000
31S/13E-27M02	12/11/1974	04/03/2000
31S/13E-27M03	10/01/1993	10/07/2019
31S/13E-28J03	04/30/1993	10/07/2019
31S/13E-29B03	05/06/1975	10/23/1975
31S/13E-29C01	04/05/1965	04/04/1987
31S/13E-29F05	10/09/1964	11/20/1970
31S/13E-29F06	10/28/2011	10/03/2019
31S/13E-34L01	11/01/1977	10/02/1979
31S/13E-34P01	12/11/1974	05/02/1979
31S/14E-19J01	11/04/1998	10/03/2019
31S/14E-19J02	11/04/1998	04/09/2019
Total	**11/01/1953**	**10/09/2019**

Depth to Water



Well Location (larger = more samples)...

Well Number	Earliest Data Entry Date	Latest Data Entry Date
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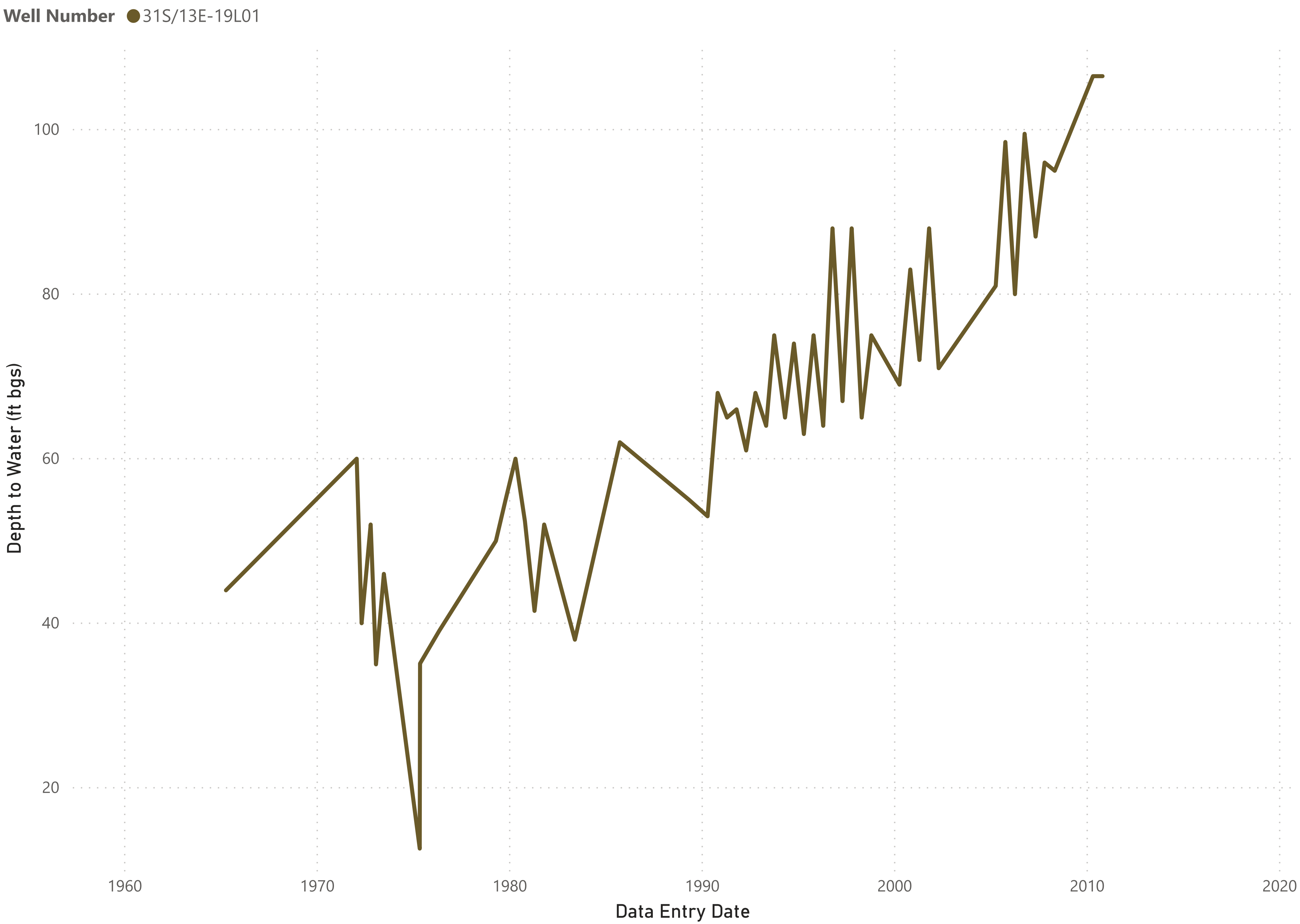
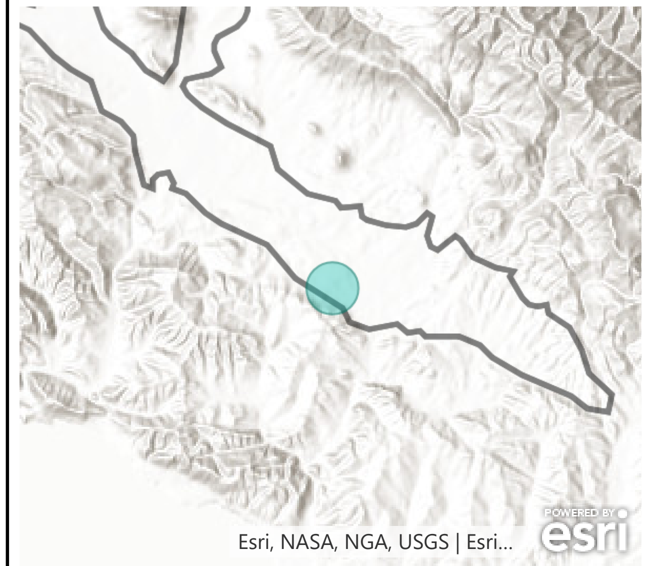
31S/13E-27M01	11/01/1953	04/03/2000
31S/13E-27M02	12/11/1974	04/03/2000
31S/13E-27M03	10/01/1993	10/07/2019
31S/13E-28J03	04/30/1993	10/07/2019
31S/13E-29B03	05/06/1975	10/23/1975
31S/13E-29C01	04/05/1965	04/04/1987
31S/13E-29F05	10/09/1964	11/20/1970
31S/13E-29F06	10/28/2011	10/03/2019
31S/13E-34L01	11/01/1977	10/02/1979
31S/13E-34P01	12/11/1974	05/02/1979
31S/14E-19J01	11/04/1998	10/03/2019
31S/14E-19J02	11/04/1998	04/09/2019
Total	**11/01/1953**	**10/09/2019**

Depth to Water



Well Location (larger = more samples)...



Well Number	Earliest Data Entry Date	Latest Data Entry Date
31S/13E-19A03	12/10/1974	04/04/1987
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31S/13E-19H01	11/19/1958	10/03/2019
31S/13E-19H04	10/27/1977	04/04/1987
31S/13E-19L01	04/05/1965	10/19/2010
31S/13E-19Q01	12/16/1976	10/07/2019
31S/13E-19R01	11/01/1977	10/19/2012
31S/13E-19R02	10/14/1992	10/14/2001
31S/13E-19R03	10/07/1994	04/04/2019
31S/13E-19R04	04/15/2001	04/10/2019
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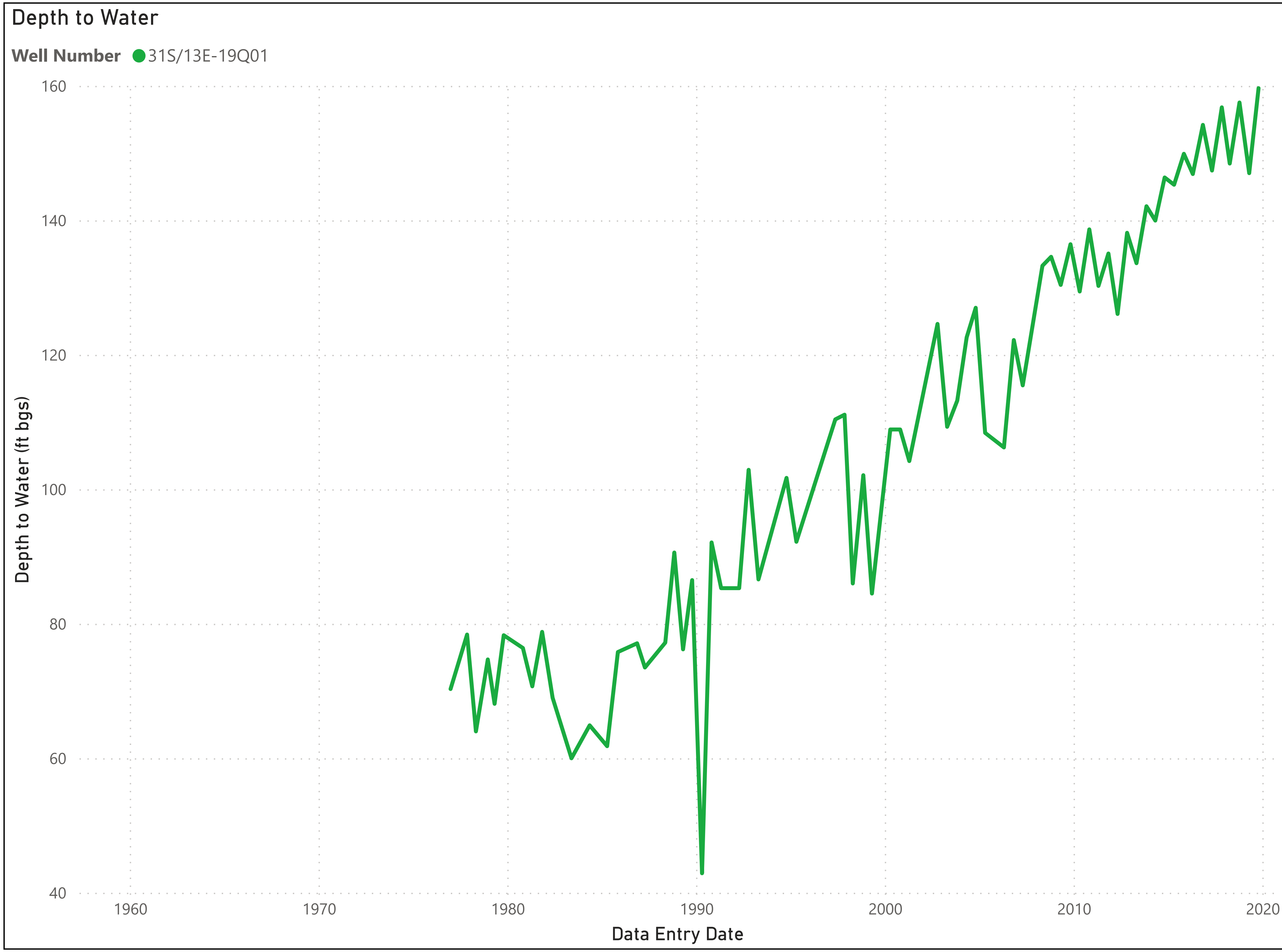
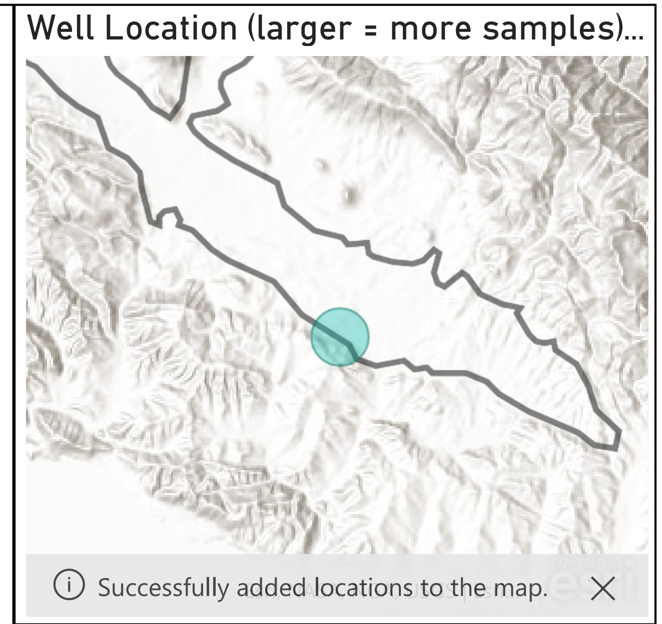
31S/13E-20K01	12/10/1974	05/04/1987
31S/13E-27D03	04/05/1965	04/03/2000
Total	**11/01/1953**	**10/09/2019**





Well Number	Earliest Data Entry Date	Latest Data Entry Date
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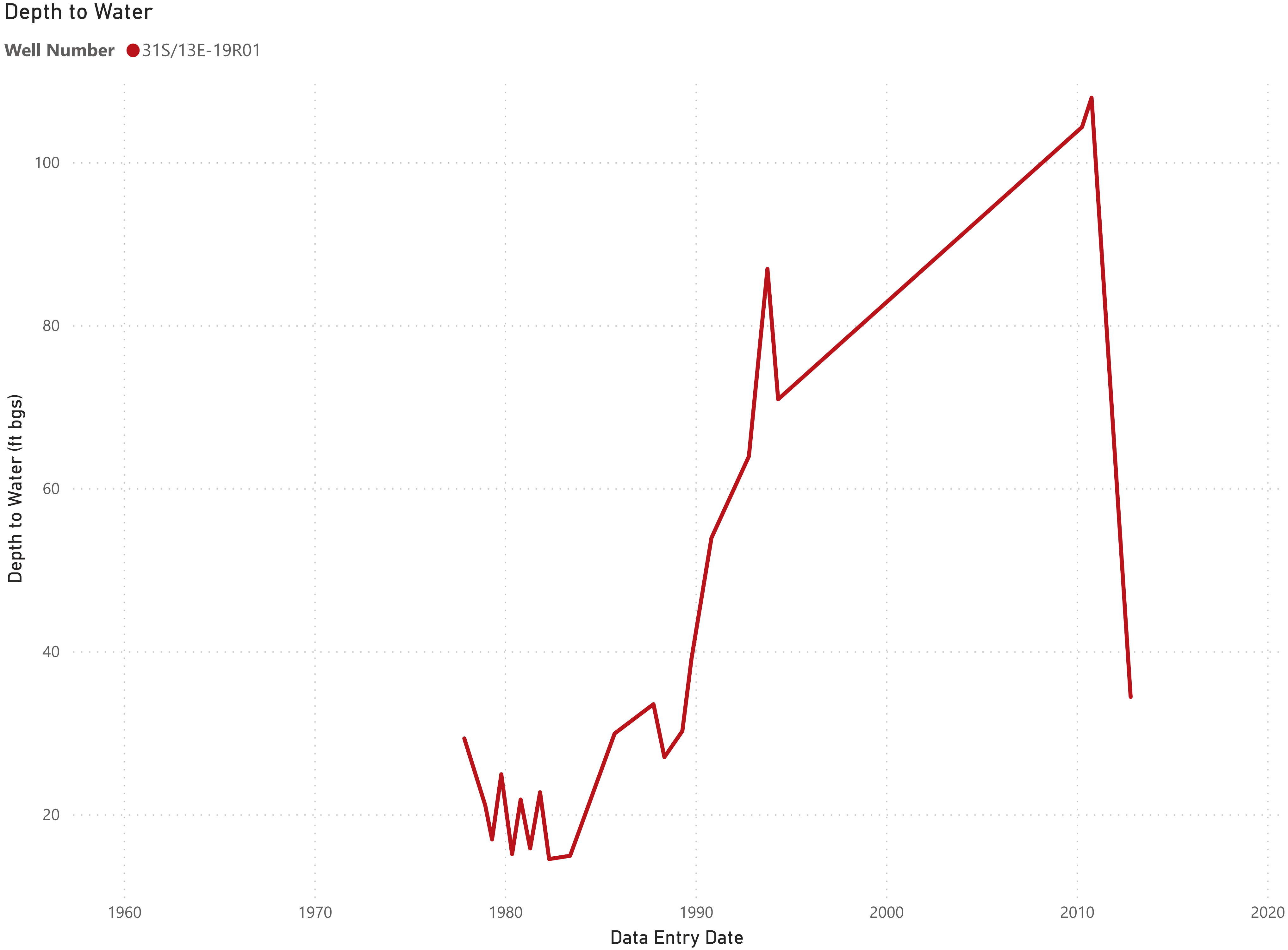
31S/13E-19B01	02/10/1968	10/06/1987
31S/13E-19H01	11/19/1958	10/03/2019
31S/13E-19H04	10/27/1977	04/04/1987
31S/13E-19L01	04/05/1965	10/19/2010
31S/13E-19Q01	12/16/1976	10/07/2019
31S/13E-19R01	11/01/1977	10/19/2012
31S/13E-19R02	10/14/1992	10/14/2001
31S/13E-19R03	10/07/1994	04/04/2019
31S/13E-19R04	04/15/2001	04/10/2019
31S/13E-20G01	12/10/1974	05/04/1987
31S/13E-20K01	12/10/1974	05/04/1987
31S/13E-27D03	04/05/1965	04/03/2000
Total	**11/01/1953**	**10/09/2019**



Well Location (larger = more samples)...

Well Number	Earliest Data Entry Date	Latest Data Entry Date
31S/13E-19A03	12/10/1974	04/04/1987
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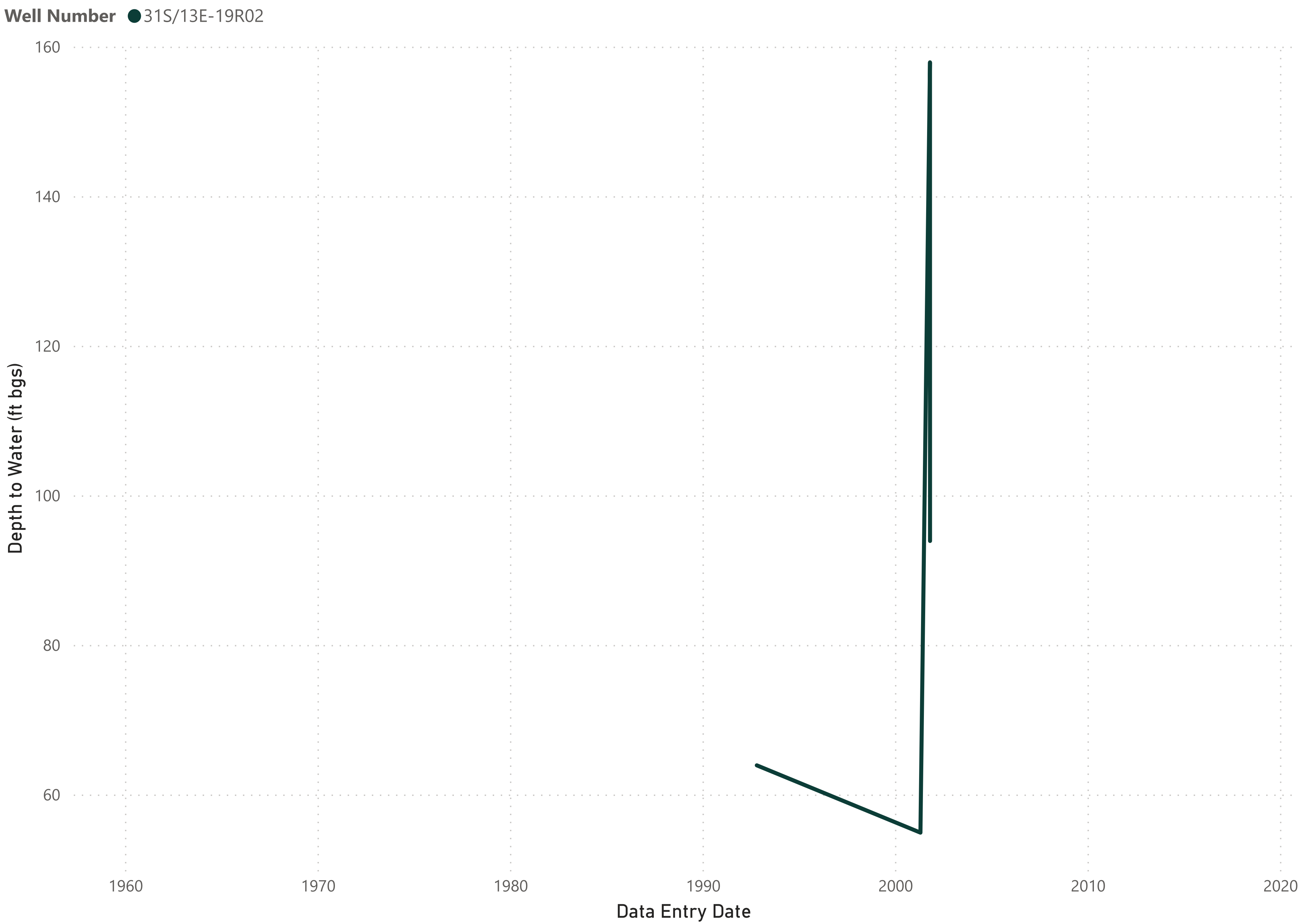
31S/13E-19H01	11/19/1958	10/03/2019
31S/13E-19H04	10/27/1977	04/04/1987
31S/13E-19L01	04/05/1965	10/19/2010
31S/13E-19Q01	12/16/1976	10/07/2019
31S/13E-19R01	11/01/1977	10/19/2012
31S/13E-19R02	10/14/1992	10/14/2001
31S/13E-19R03	10/07/1994	04/04/2019
31S/13E-19R04	04/15/2001	04/10/2019
31S/13E-20G01	12/10/1974	05/04/1987
31S/13E-20K01	12/10/1974	05/04/1987
31S/13E-27D03	04/05/1965	04/03/2000
Total	**11/01/1953**	**10/09/2019**

Depth to Water



Well Location (larger = more samples)...

Well Number	Earliest Data Entry Date	Latest Data Entry Date
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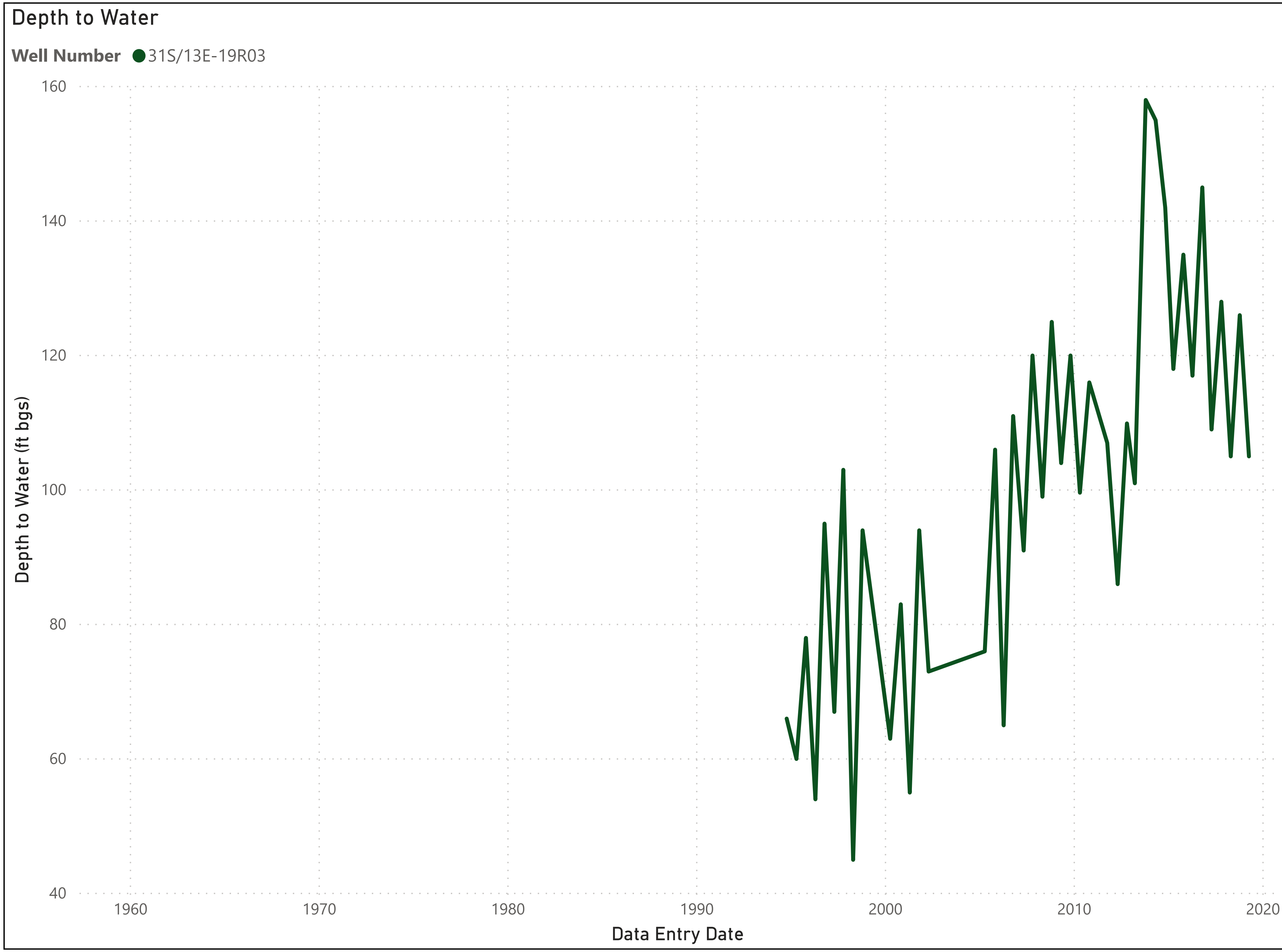
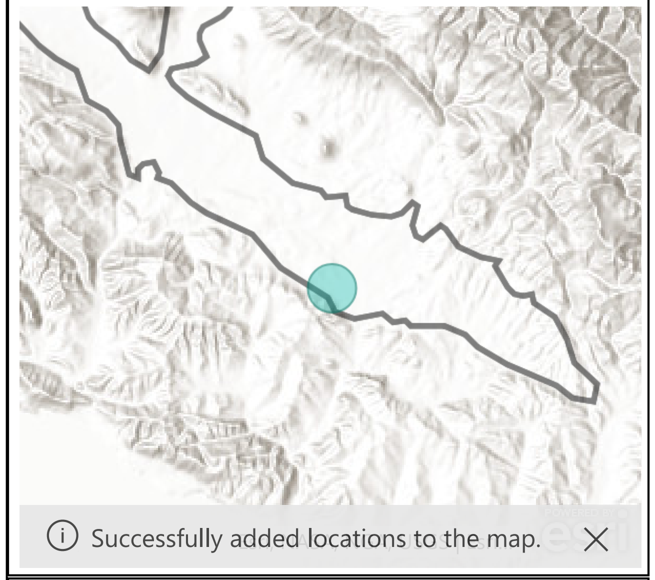
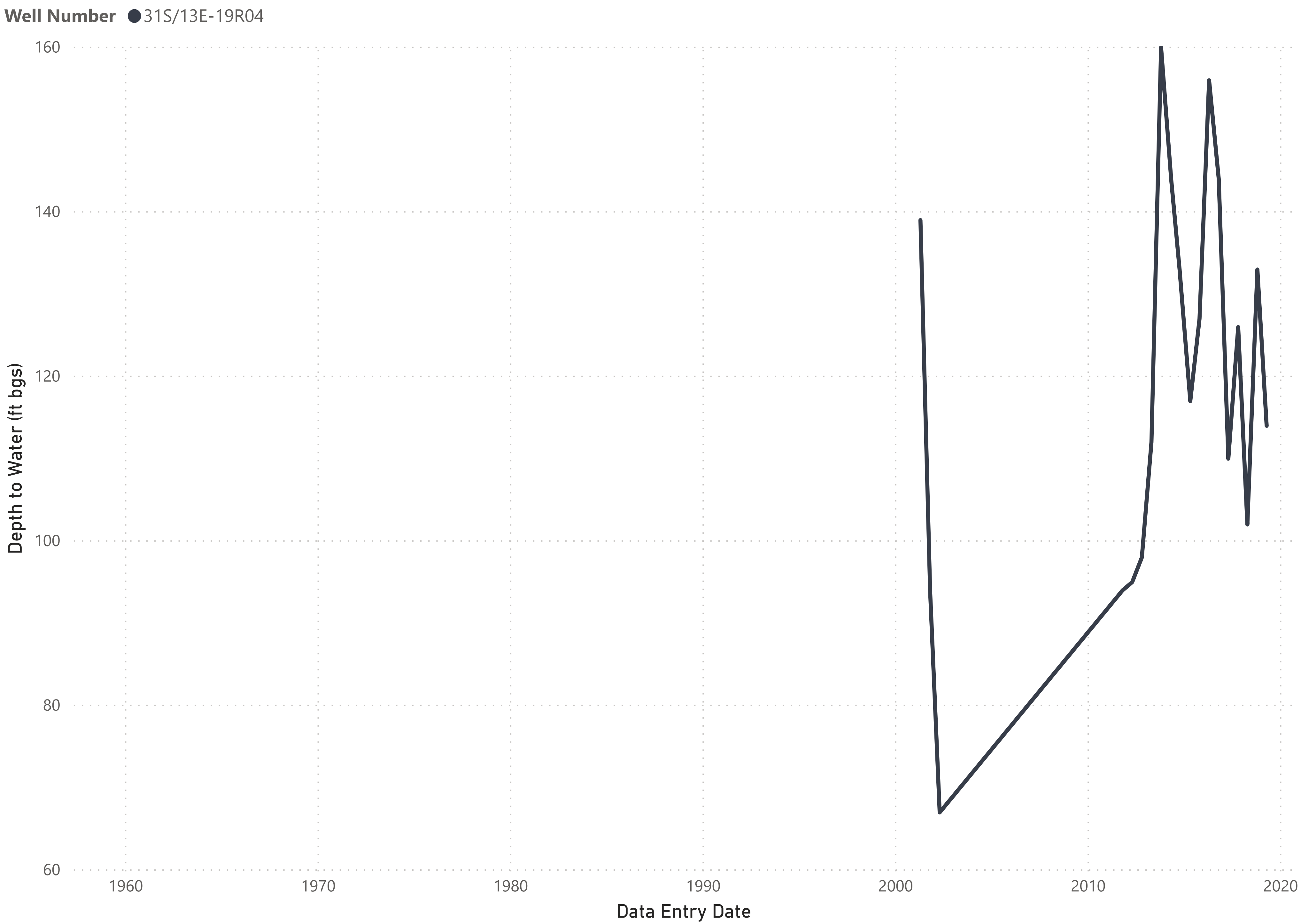
31S/13E-19H01	11/19/1958	10/03/2019
31S/13E-19H04	10/27/1977	04/04/1987
31S/13E-19L01	04/05/1965	10/19/2010
31S/13E-19Q01	12/16/1976	10/07/2019
31S/13E-19R01	11/01/1977	10/19/2012
31S/13E-19R02	10/14/1992	10/14/2001
31S/13E-19R03	10/07/1994	04/04/2019
31S/13E-19R04	04/15/2001	04/10/2019
31S/13E-20G01	12/10/1974	05/04/1987
31S/13E-20K01	12/10/1974	05/04/1987
31S/13E-27D03	04/05/1965	04/03/2000
Total	**11/01/1953**	**10/09/2019**



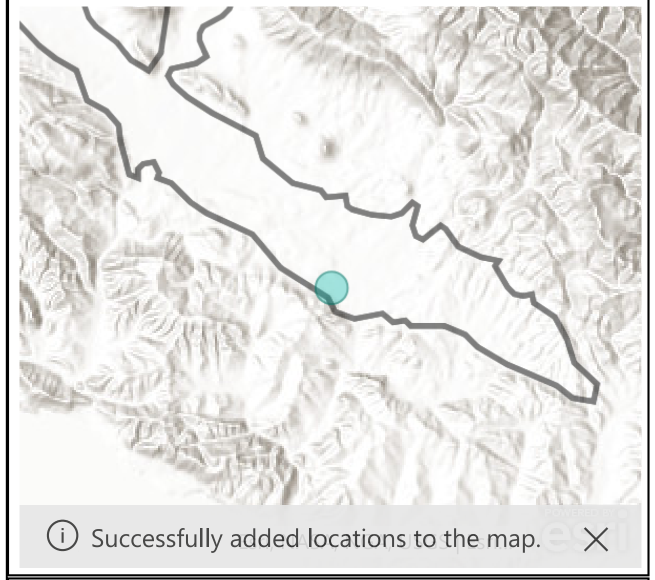


Well Number	Earliest Data Entry Date	Latest Data Entry Date
31S/13E-19A03	12/10/1974	04/04/1987
31S/13E-19B01	02/10/1968	10/06/1987
31S/13E-19H01	11/19/1958	10/03/2019
31S/13E-19H04	10/27/1977	04/04/1987
31S/13E-19L01	04/05/1965	10/19/2010
31S/13E-19Q01	12/16/1976	10/07/2019
31S/13E-19R01	11/01/1977	10/19/2012
31S/13E-19R02	10/14/1992	10/14/2001
31S/13E-19R03	10/07/1994	04/04/2019
31S/13E-19R04	04/15/2001	04/10/2019
31S/13E-20G01	12/10/1974	05/04/1987
31S/13E-20K01	12/10/1974	05/04/1987
31S/13E-27D03	04/05/1965	04/03/2000
Total	**11/01/1953**	**10/09/2019**

Depth to Water



Well Location (larger = more samples)...



Well Number	Earliest Data Entry Date	Latest Data Entry Date
31S/13E-19L01	04/05/1965	10/19/2010
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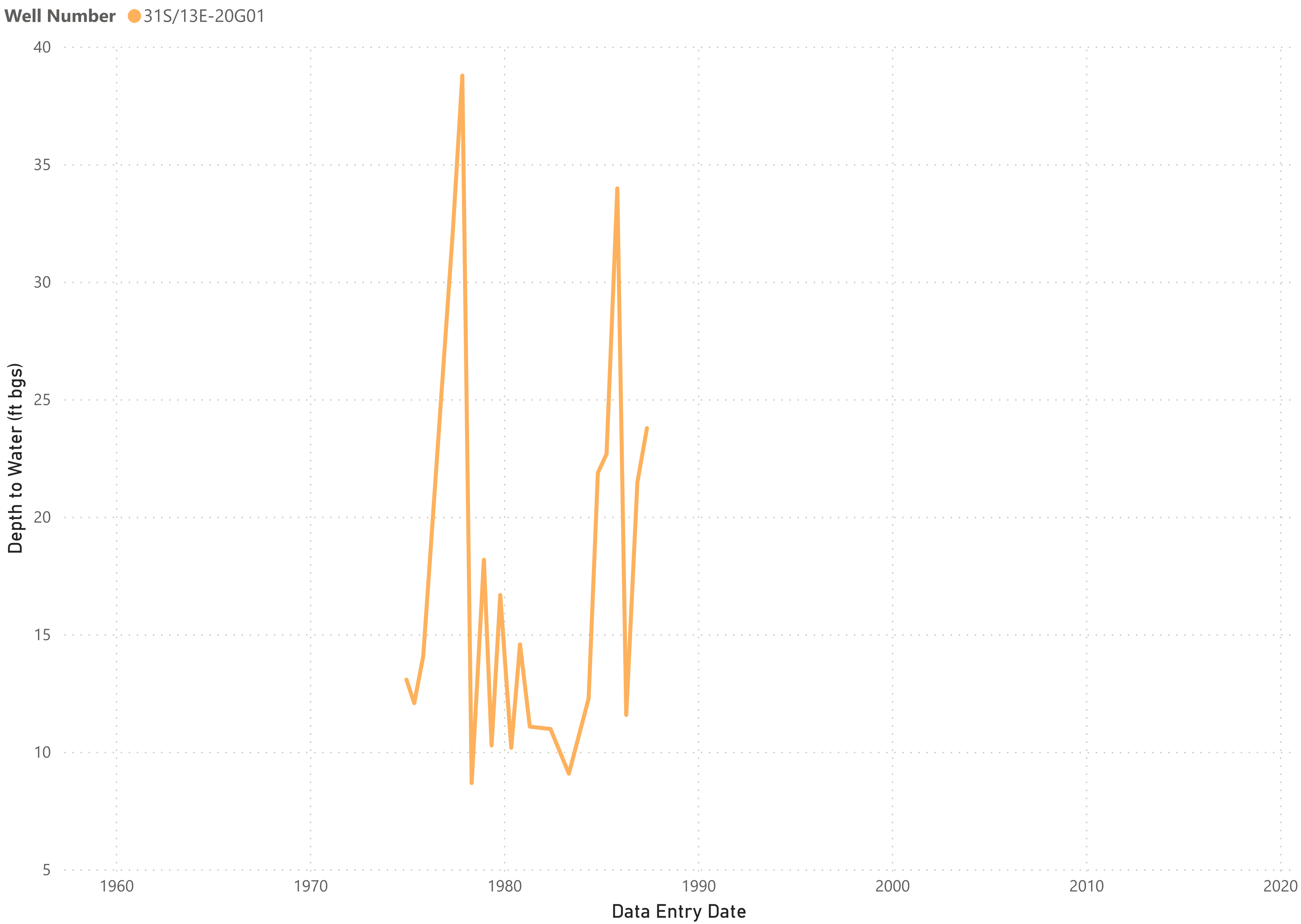
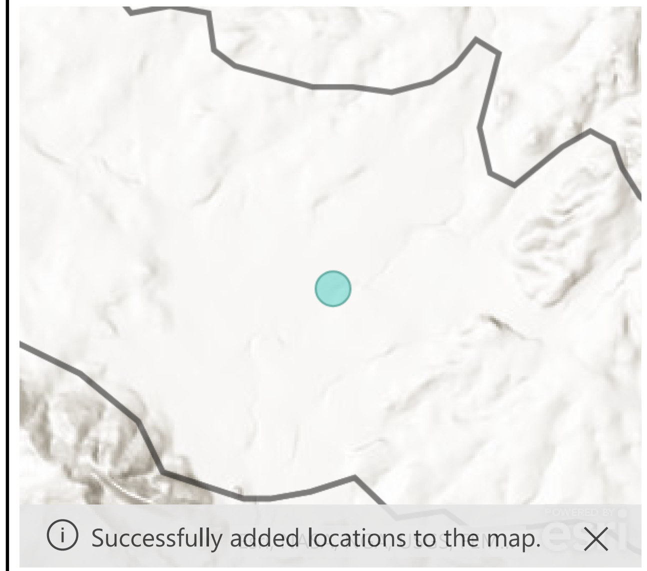
31S/13E-19R01	11/01/1977	10/19/2012
31S/13E-19R02	10/14/1992	10/14/2001
31S/13E-19R03	10/07/1994	04/04/2019
31S/13E-19R04	04/15/2001	04/10/2019
31S/13E-20G01	12/10/1974	05/04/1987
31S/13E-20K01	12/10/1974	05/04/1987
31S/13E-27D03	04/05/1965	04/03/2000
31S/13E-27M01	11/01/1953	04/03/2000
31S/13E-27M02	12/11/1974	04/03/2000
31S/13E-27M03	10/01/1993	10/07/2019
31S/13E-28J03	04/30/1993	10/07/2019
Total	**11/01/1953**	**10/09/2019**

Depth to Water



Well Location (larger = more samples)...



Well Number	Earliest Data Entry Date	Latest Data Entry Date
31S/13E-19L01	04/05/1965	10/19/2010
31S/13E-19Q01	12/16/1976	10/07/2019
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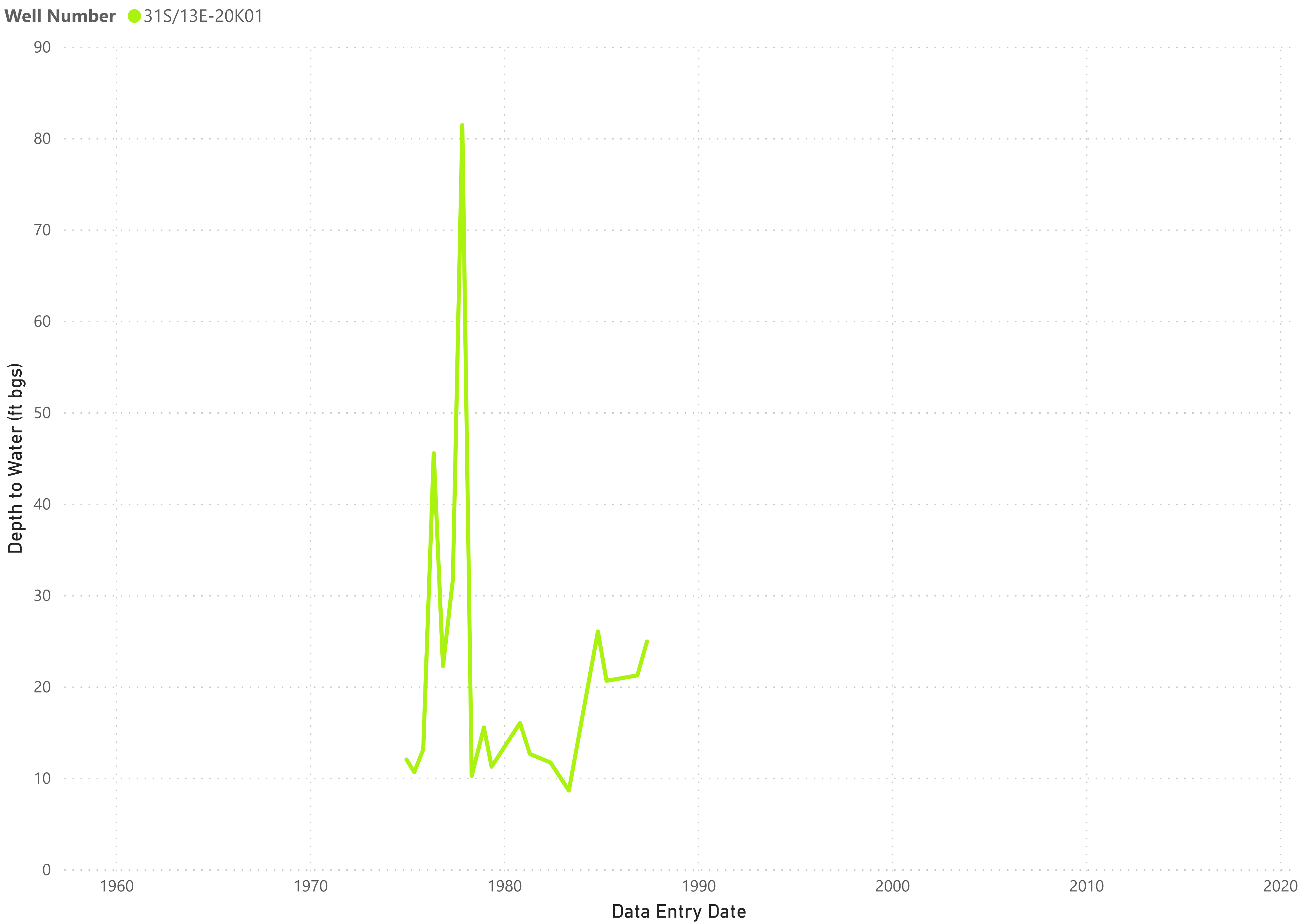
31S/13E-19R02	10/14/1992	10/14/2001
31S/13E-19R03	10/07/1994	04/04/2019
31S/13E-19R04	04/15/2001	04/10/2019
31S/13E-20G01	12/10/1974	05/04/1987
31S/13E-20K01	12/10/1974	05/04/1987
31S/13E-27D03	04/05/1965	04/03/2000
31S/13E-27M01	11/01/1953	04/03/2000
31S/13E-27M02	12/11/1974	04/03/2000
31S/13E-27M03	10/01/1993	10/07/2019
31S/13E-28J03	04/30/1993	10/07/2019
Total	**11/01/1953**	**10/09/2019**

Depth to Water



Well Location (larger = more samples)...

Well Number	Earliest Data Entry Date	Latest Data Entry Date
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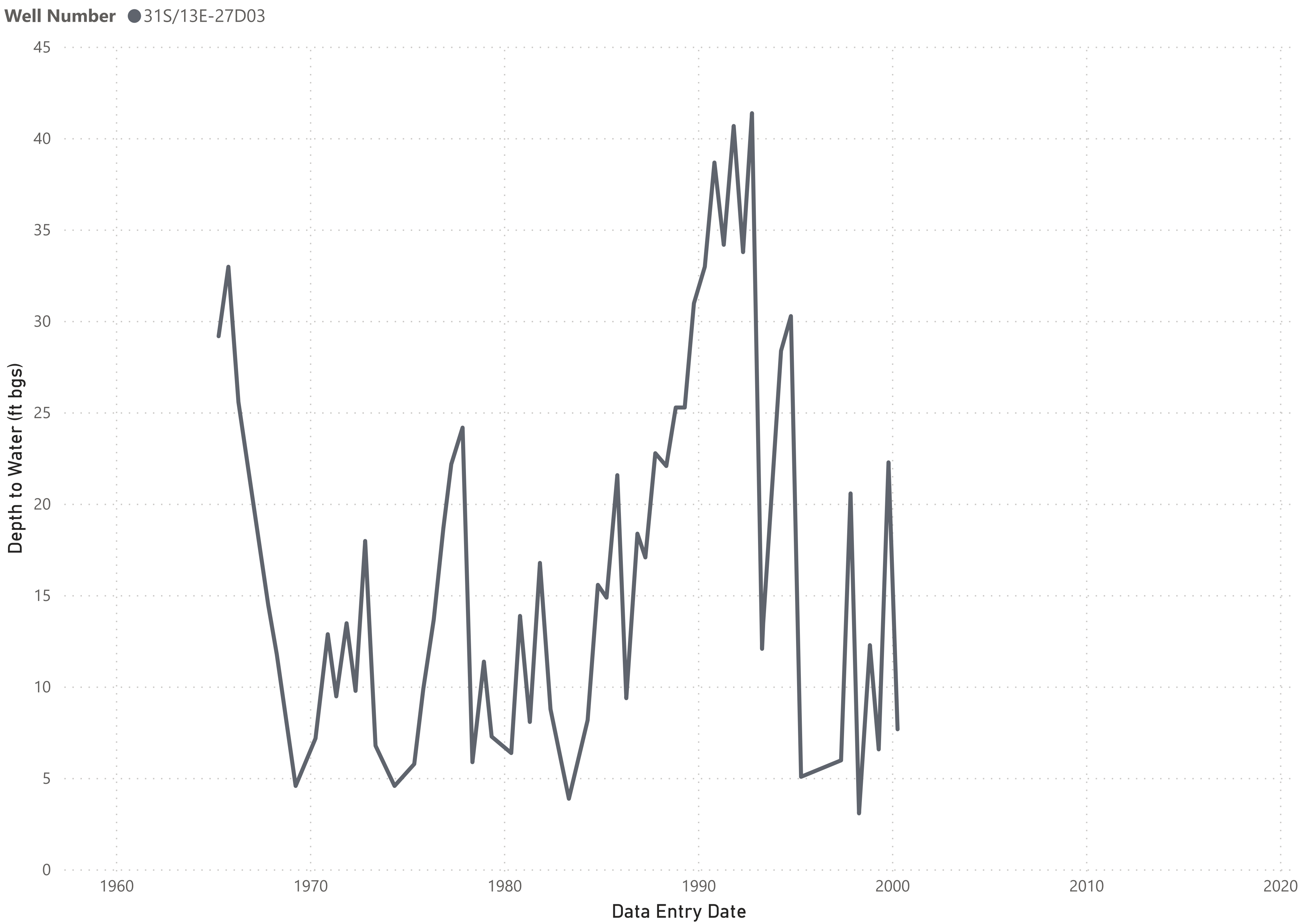
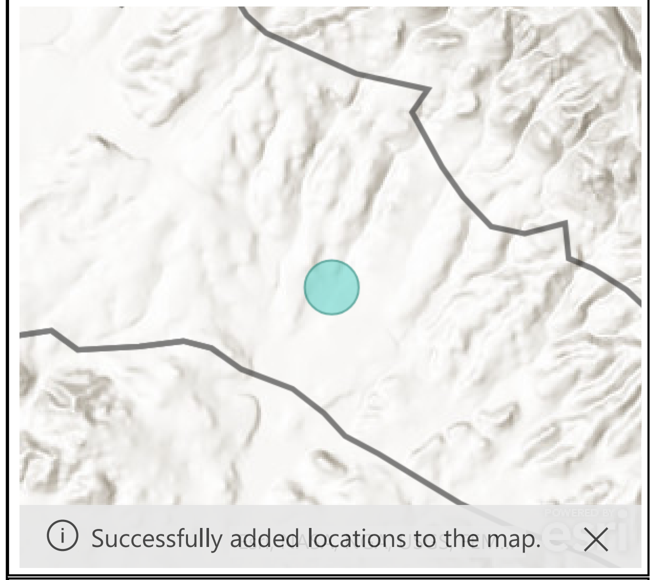
31S/13E-19R03	10/07/1994	04/04/2019
31S/13E-19R04	04/15/2001	04/10/2019
31S/13E-20G01	12/10/1974	05/04/1987
31S/13E-20K01	12/10/1974	05/04/1987
31S/13E-27D03	04/05/1965	04/03/2000
31S/13E-27M01	11/01/1953	04/03/2000
31S/13E-27M02	12/11/1974	04/03/2000
31S/13E-27M03	10/01/1993	10/07/2019
31S/13E-28J03	04/30/1993	10/07/2019
31S/13E-29B03	05/06/1975	10/23/1975
31S/13E-29C01	04/05/1965	04/04/1987
31S/13E-29F05	10/09/1964	11/20/1970
31S/13E-29F06	10/28/2011	10/03/2019
Total	**11/01/1953**	**10/09/2019**

Depth to Water



Well Location (larger = more samples)...



Well Number	Earliest Data Entry Date	Latest Data Entry Date
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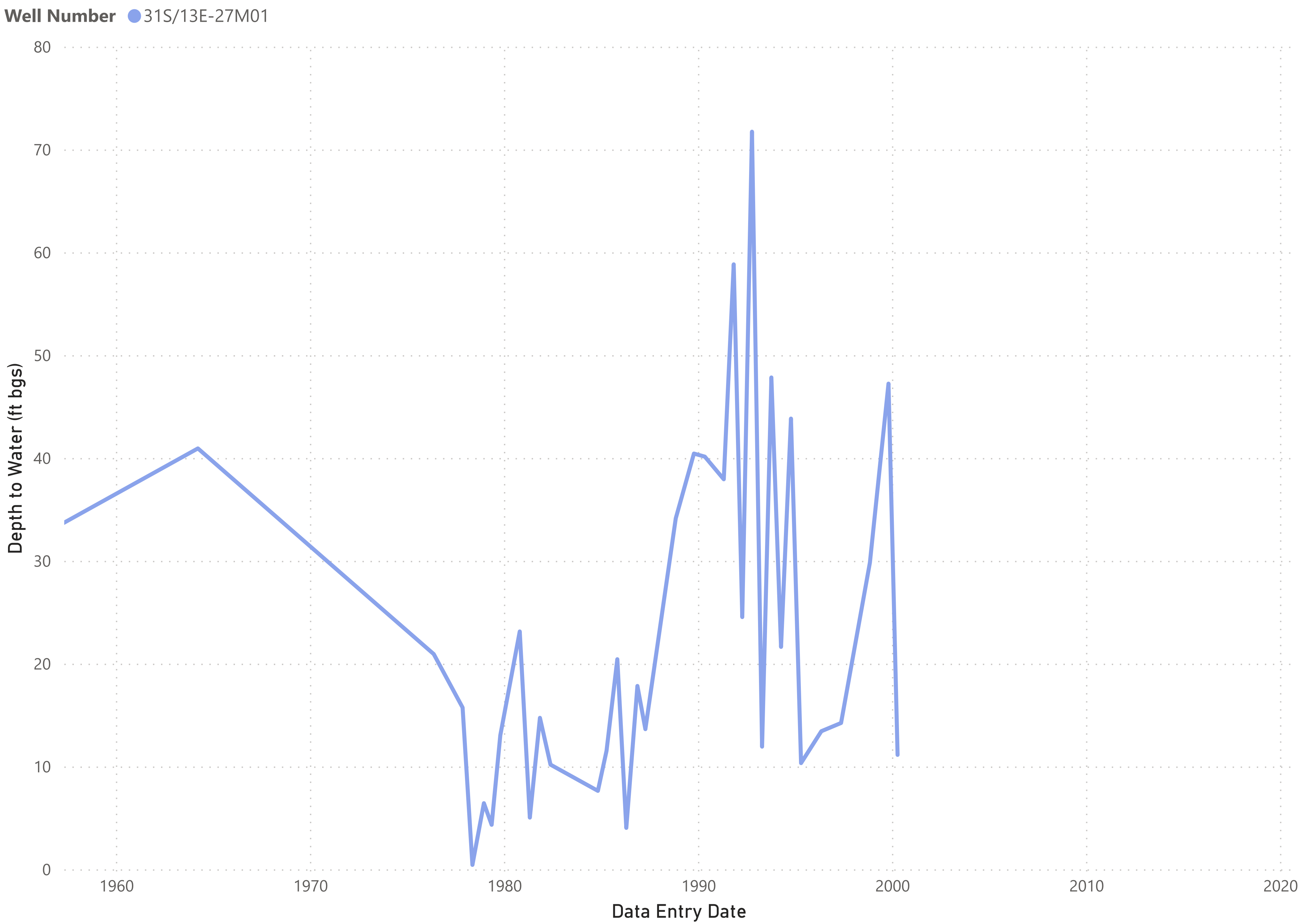
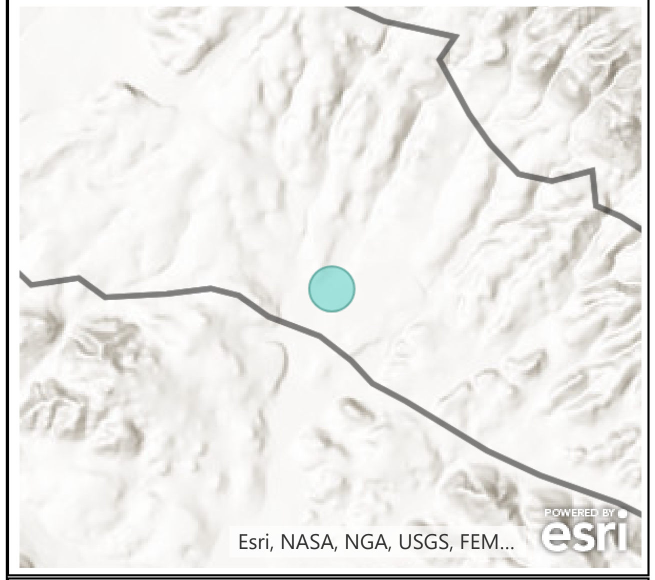
31S/13E-19Q01	12/16/1976	10/07/2019
31S/13E-19R01	11/01/1977	10/19/2012
31S/13E-19R02	10/14/1992	10/14/2001
31S/13E-19R03	10/07/1994	04/04/2019
31S/13E-19R04	04/15/2001	04/10/2019
31S/13E-20G01	12/10/1974	05/04/1987
31S/13E-20K01	12/10/1974	05/04/1987
31S/13E-27D03	04/05/1965	04/03/2000
31S/13E-27M01	11/01/1953	04/03/2000
31S/13E-27M02	12/11/1974	04/03/2000
31S/13E-27M03	10/01/1993	10/07/2019
31S/13E-28J03	04/30/1993	10/07/2019
Total	**11/01/1953**	**10/09/2019**

Depth to Water



Well Location (larger = more samples)...



Well Number	Earliest Data Entry Date	Latest Data Entry Date
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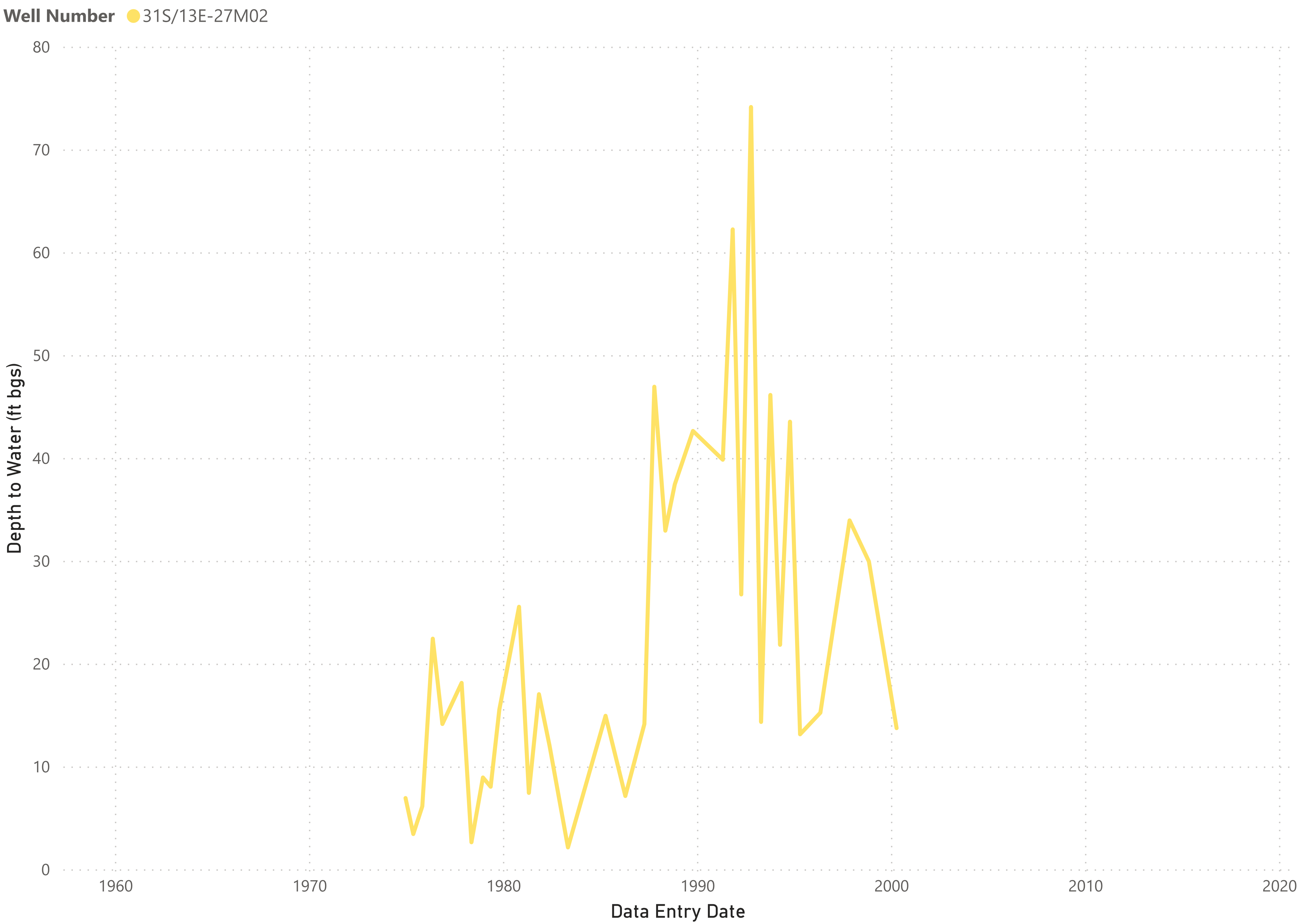
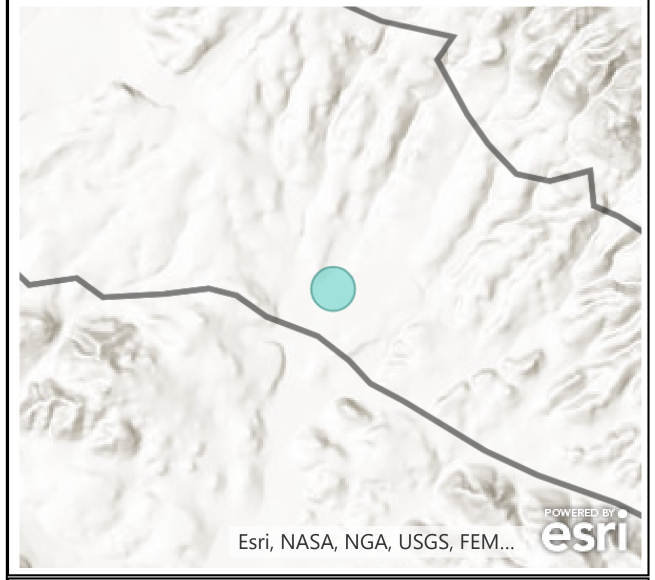
31S/13E-20K01	12/10/1974	05/04/1987
31S/13E-27D03	04/05/1965	04/03/2000
31S/13E-27M01	11/01/1953	04/03/2000
31S/13E-27M02	12/11/1974	04/03/2000
31S/13E-27M03	10/01/1993	10/07/2019
31S/13E-28J03	04/30/1993	10/07/2019
31S/13E-29B03	05/06/1975	10/23/1975
31S/13E-29C01	04/05/1965	04/04/1987
31S/13E-29F05	10/09/1964	11/20/1970
31S/13E-29F06	10/28/2011	10/03/2019
Total	**11/01/1953**	**10/09/2019**

Depth to Water

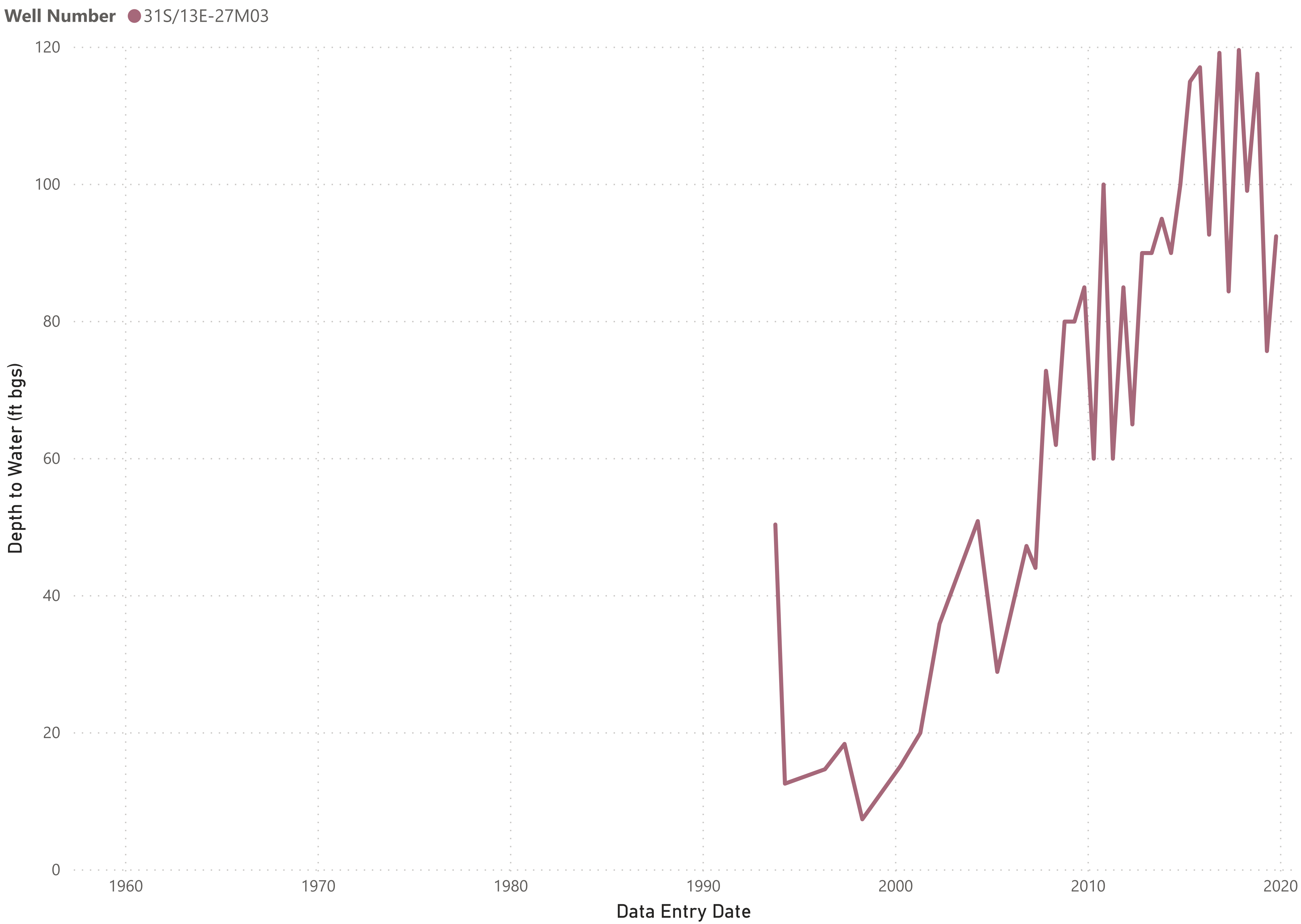


Well Location (larger = more samples)...



Well Number	Earliest Data Entry Date	Latest Data Entry Date
31S/13E-27D03	04/05/1965	04/03/2000
31S/13E-27M01	11/01/1953	04/03/2000
31S/13E-27M02	12/11/1974	04/03/2000
31S/13E-27M03	10/01/1993	10/07/2019
31S/13E-28J03	04/30/1993	10/07/2019
31S/13E-29B03	05/06/1975	10/23/1975
31S/13E-29C01	04/05/1965	04/04/1987
31S/13E-29F05	10/09/1964	11/20/1970
31S/13E-29F06	10/28/2011	10/03/2019
31S/13E-34L01	11/01/1977	10/02/1979
31S/13E-34P01	12/11/1974	05/02/1979
31S/14E-19J01	11/04/1998	10/03/2019
31S/14E-19J02	11/04/1998	04/09/2019
Total	**11/01/1953**	**10/09/2019**

Depth to Water



Well Location (larger = more samples)...

Well Number	Earliest Data Entry Date	Latest Data Entry Date
31S/13E-27D03	04/05/1965	04/03/2000
31S/13E-27M01	11/01/1953	04/03/2000
31S/13E-27M02	12/11/1974	04/03/2000
31S/13E-27M03	10/01/1993	10/07/2019
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31S/13E-29C01	04/05/1965	04/04/1987
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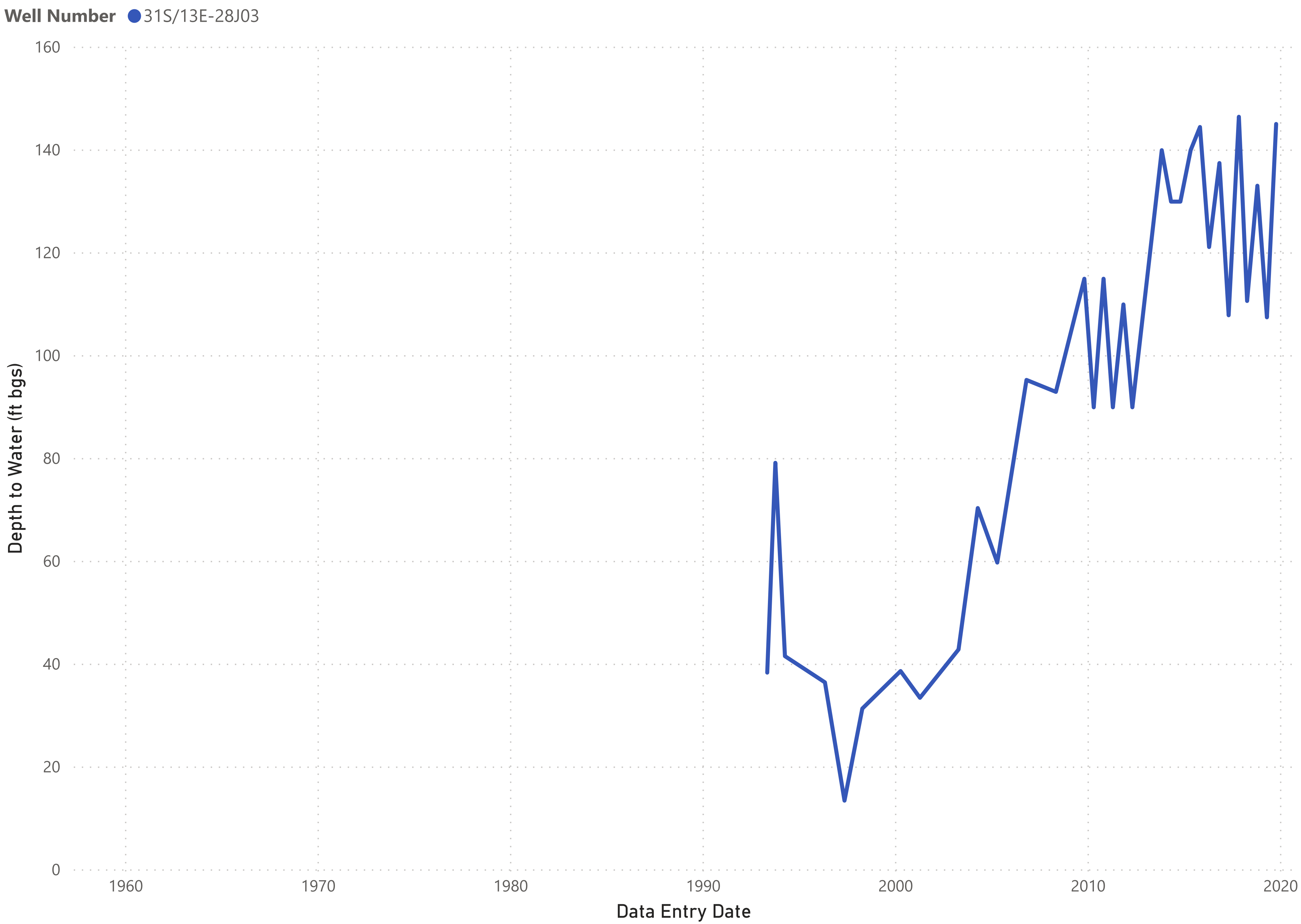
31S/13E-29F06	10/28/2011	10/03/2019
31S/13E-34L01	11/01/1977	10/02/1979
31S/13E-34P01	12/11/1974	05/02/1979
31S/14E-19J01	11/04/1998	10/03/2019
31S/14E-19J02	11/04/1998	04/09/2019
Total	**11/01/1953**	**10/09/2019**

Depth to Water



Well Location (larger = more samples)...

Well Number	Earliest Data Entry Date	Latest Data Entry Date
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31S/13E-27M01	11/01/1953	04/03/2000
31S/13E-27M02	12/11/1974	04/03/2000
31S/13E-27M03	10/01/1993	10/07/2019
31S/13E-28J03	04/30/1993	10/07/2019
31S/13E-29B03	05/06/1975	10/23/1975
31S/13E-29C01	04/05/1965	04/04/1987
31S/13E-29F05	10/09/1964	11/20/1970
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31S/14E-19J01	11/04/1998	10/03/2019
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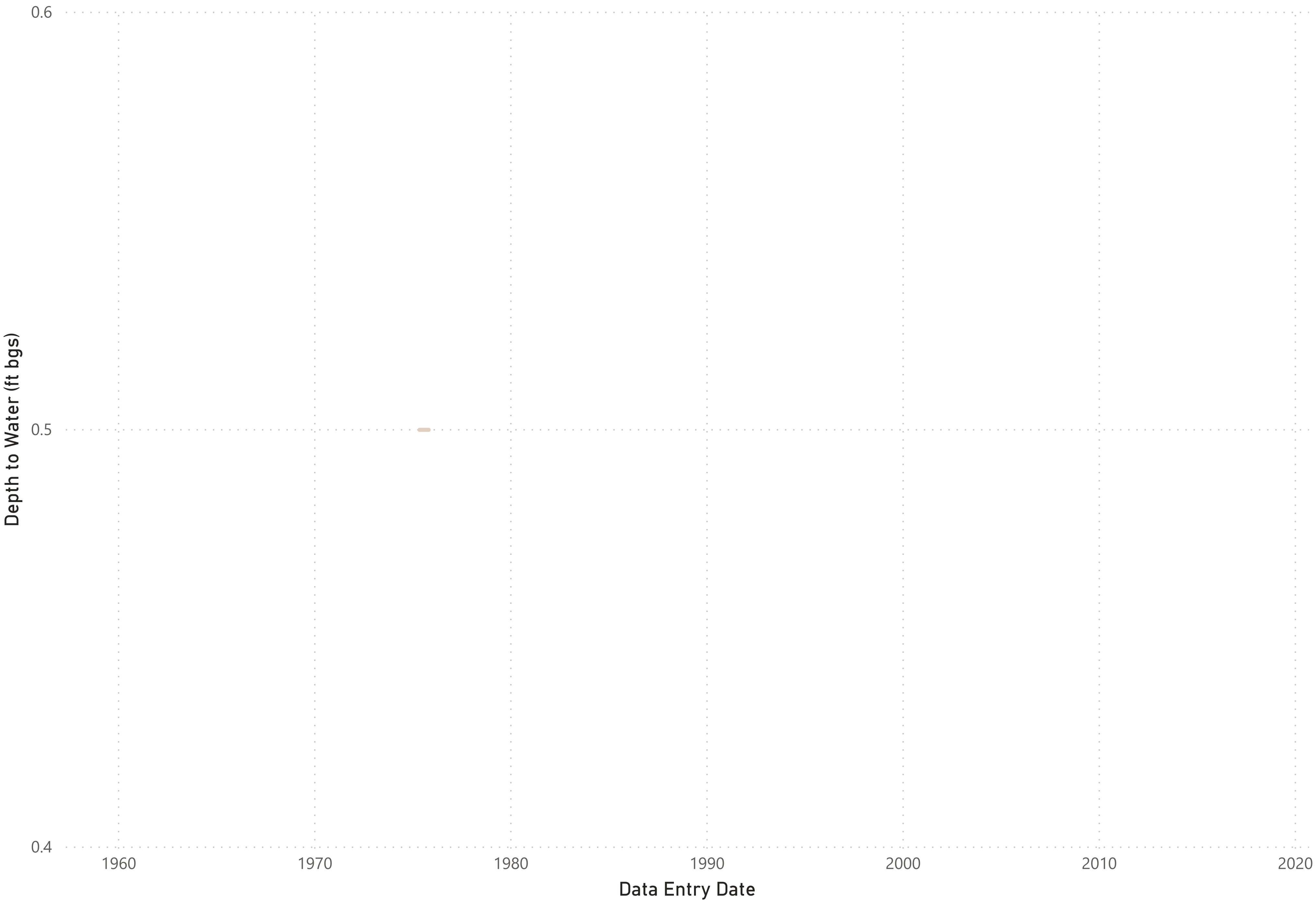
Total	**11/01/1953**	**10/09/2019**

Depth to Water



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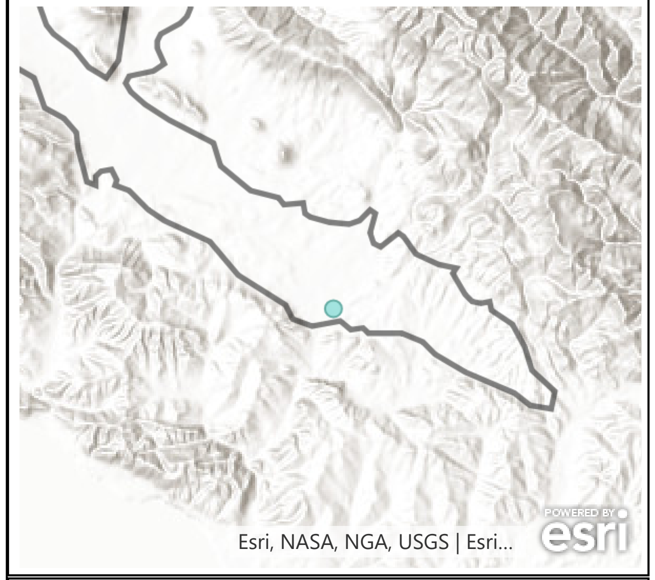

Well Number	Earliest Data Entry Date	Latest Data Entry Date
31S/13E-27D03	04/05/1965	04/03/2000
31S/13E-27M01	11/01/1953	04/03/2000
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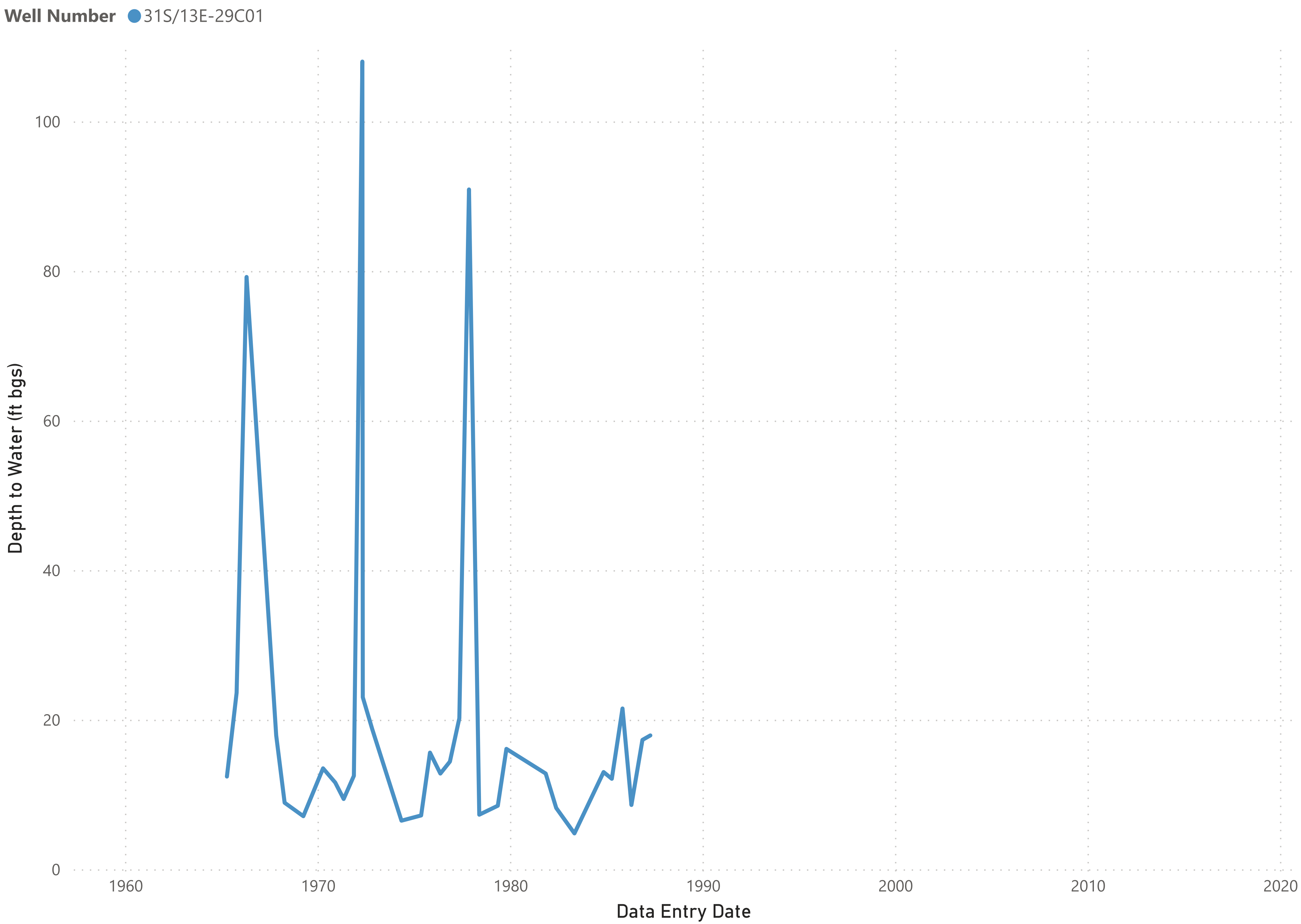
31S/13E-29C01	04/05/1965	04/04/1987
31S/13E-29F05	10/09/1964	11/20/1970
31S/13E-29F06	10/28/2011	10/03/2019
31S/13E-34L01	11/01/1977	10/02/1979
31S/13E-34P01	12/11/1974	05/02/1979
31S/14E-19J01	11/04/1998	10/03/2019
31S/14E-19J02	11/04/1998	04/09/2019
Total	**11/01/1953**	**10/09/2019**

Depth to Water



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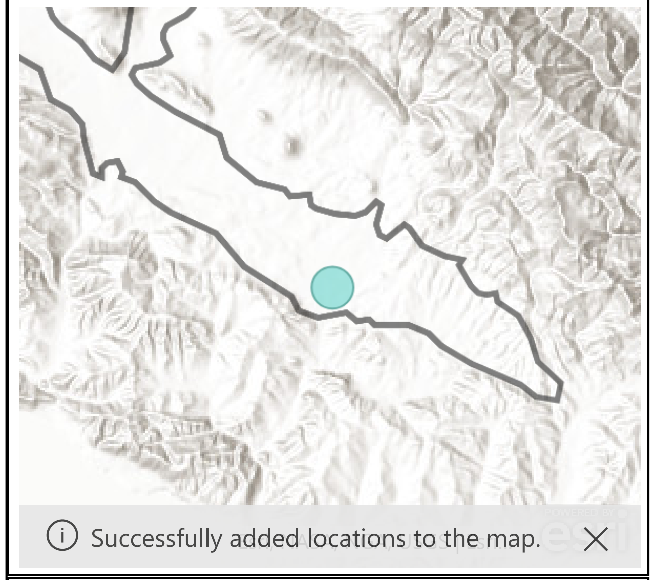

Well Number	Earliest Data Entry Date	Latest Data Entry Date
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31S/13E-27M01	11/01/1953	04/03/2000
31S/13E-27M02	12/11/1974	04/03/2000
31S/13E-27M03	10/01/1993	10/07/2019
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31S/13E-29C01	04/05/1965	04/04/1987
31S/13E-29F05	10/09/1964	11/20/1970
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31S/13E-34L01	11/01/1977	10/02/1979
31S/13E-34P01	12/11/1974	05/02/1979
31S/14E-19J01	11/04/1998	10/03/2019
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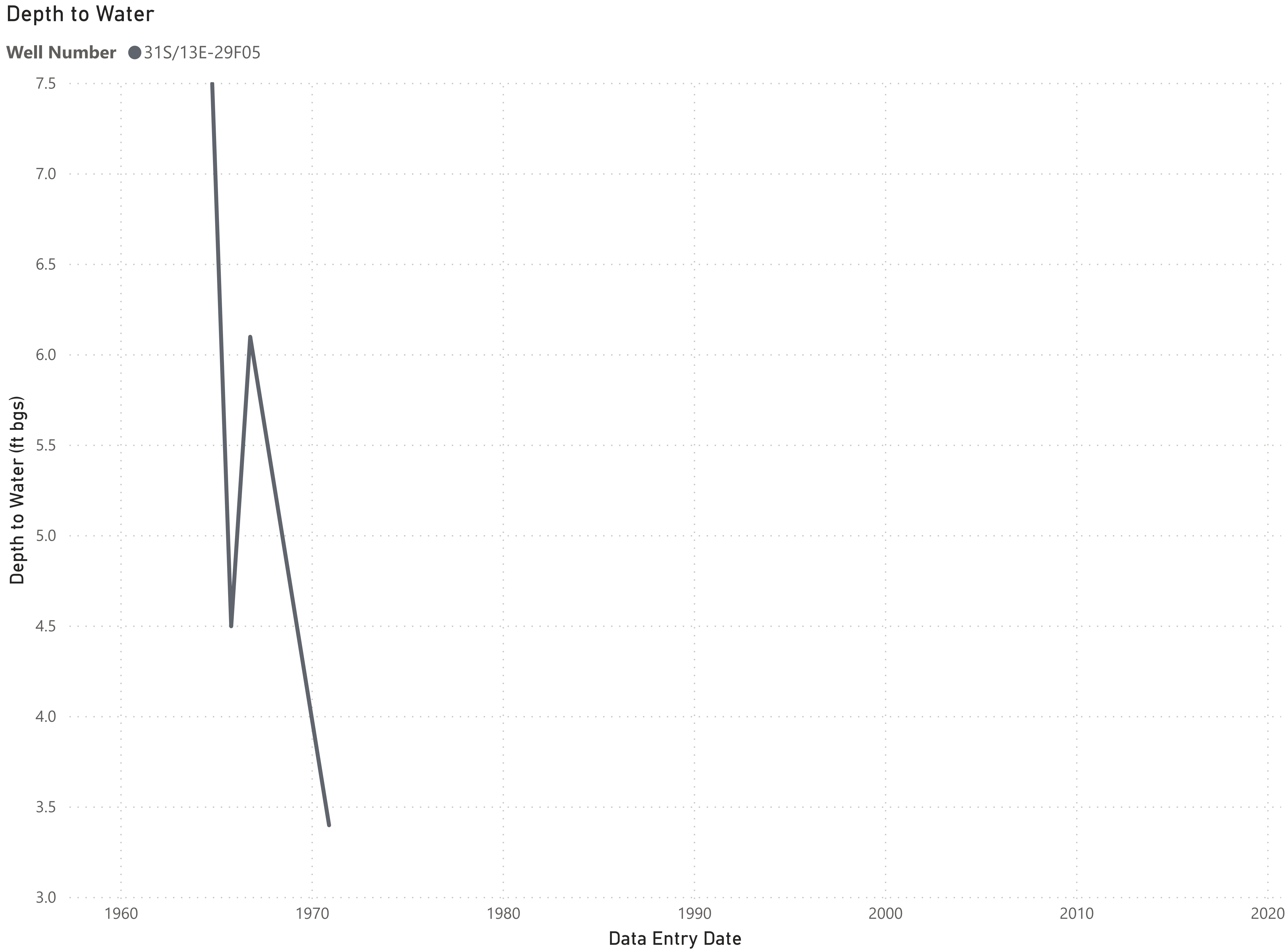
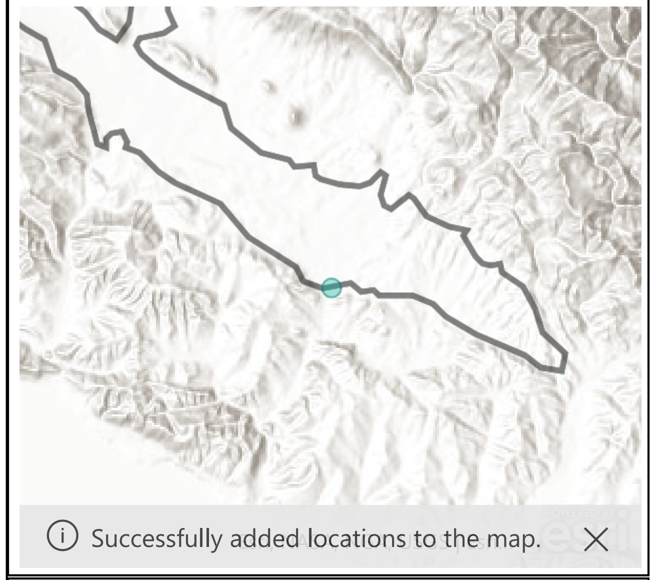
Total	**11/01/1953**	**10/09/2019**





Well Number	Earliest Data Entry Date	Latest Data Entry Date
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31S/13E-27M03	10/01/1993	10/07/2019
31S/13E-28J03	04/30/1993	10/07/2019
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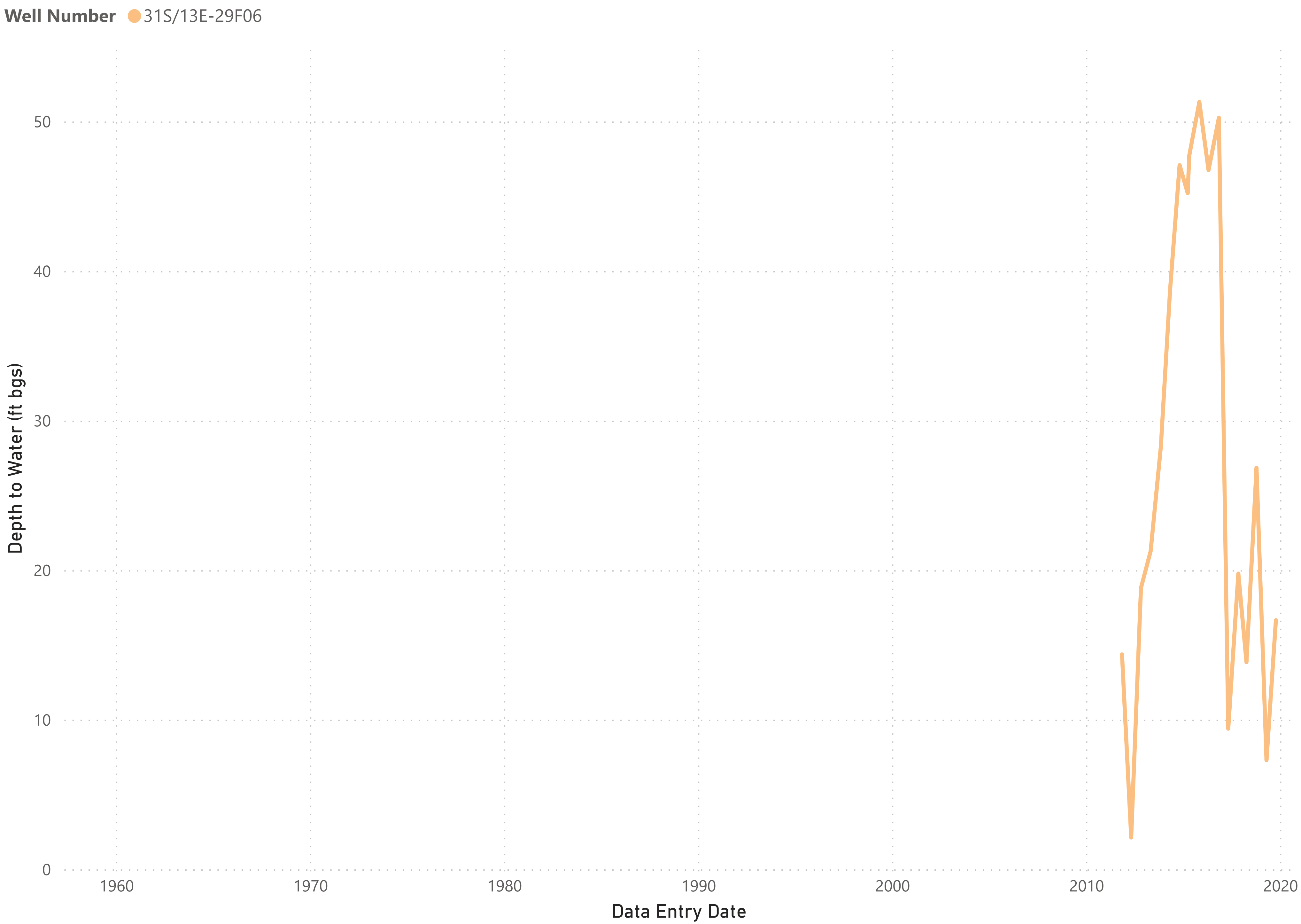
31S/13E-29C01	04/05/1965	04/04/1987
31S/13E-29F05	10/09/1964	11/20/1970
31S/13E-29F06	10/28/2011	10/03/2019
31S/13E-34L01	11/01/1977	10/02/1979
31S/13E-34P01	12/11/1974	05/02/1979
31S/14E-19J01	11/04/1998	10/03/2019
31S/14E-19J02	11/04/1998	04/09/2019
Total	**11/01/1953**	**10/09/2019**

Depth to Water



Well Location (larger = more samples)...

Well Number	Earliest Data Entry Date	Latest Data Entry Date
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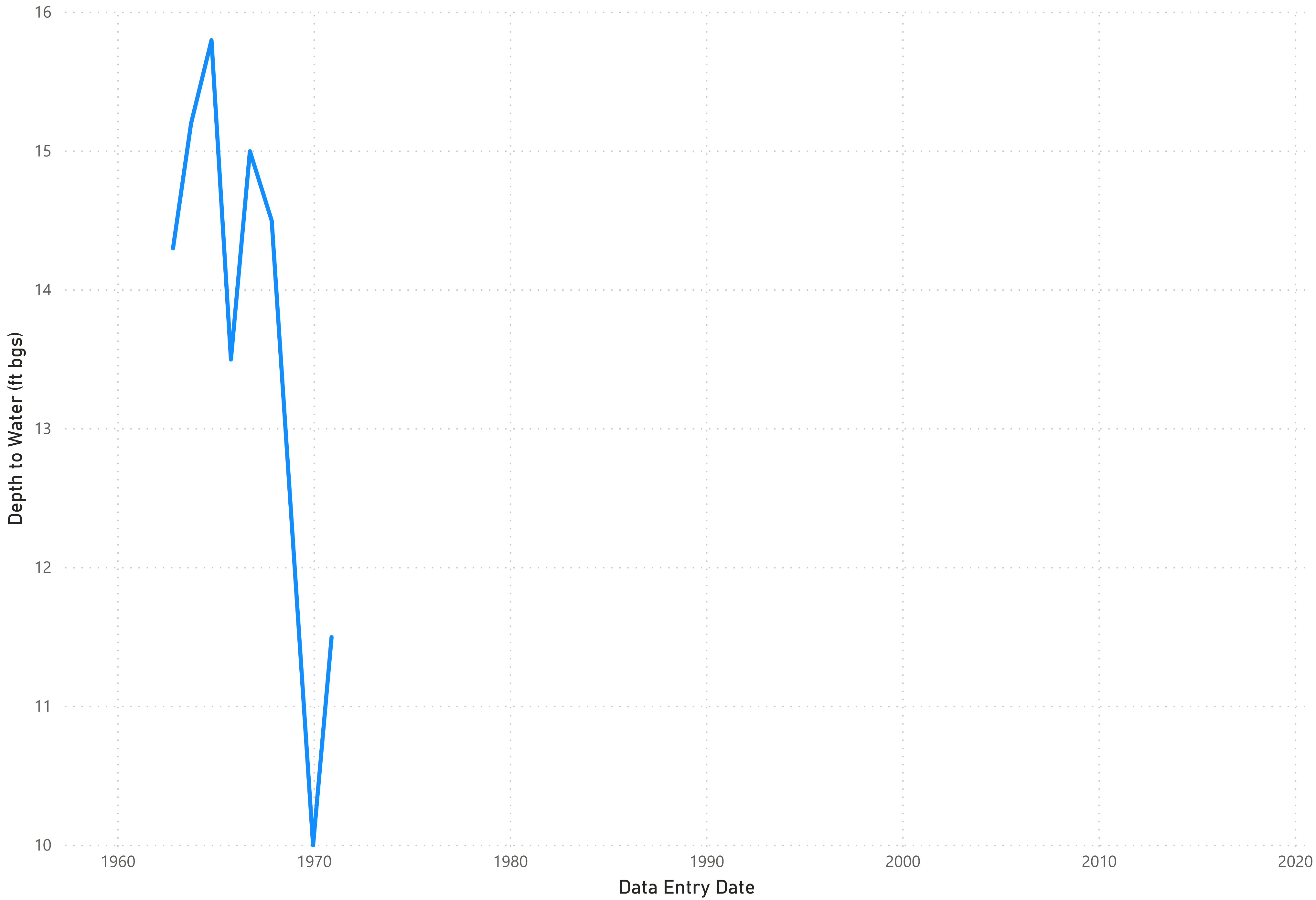
31S/13E-27M02	12/11/1974	04/03/2000
31S/13E-27M03	10/01/1993	10/07/2019
31S/13E-28J03	04/30/1993	10/07/2019
31S/13E-29B03	05/06/1975	10/23/1975
31S/13E-29C01	04/05/1965	04/04/1987
31S/13E-29F05	10/09/1964	11/20/1970
31S/13E-29F06	10/28/2011	10/03/2019
31S/13E-34L01	11/01/1977	10/02/1979
31S/13E-34P01	12/11/1974	05/02/1979
31S/14E-19J01	11/04/1998	10/03/2019
31S/14E-19J02	11/04/1998	04/09/2019
Total	**11/01/1953**	**10/09/2019**

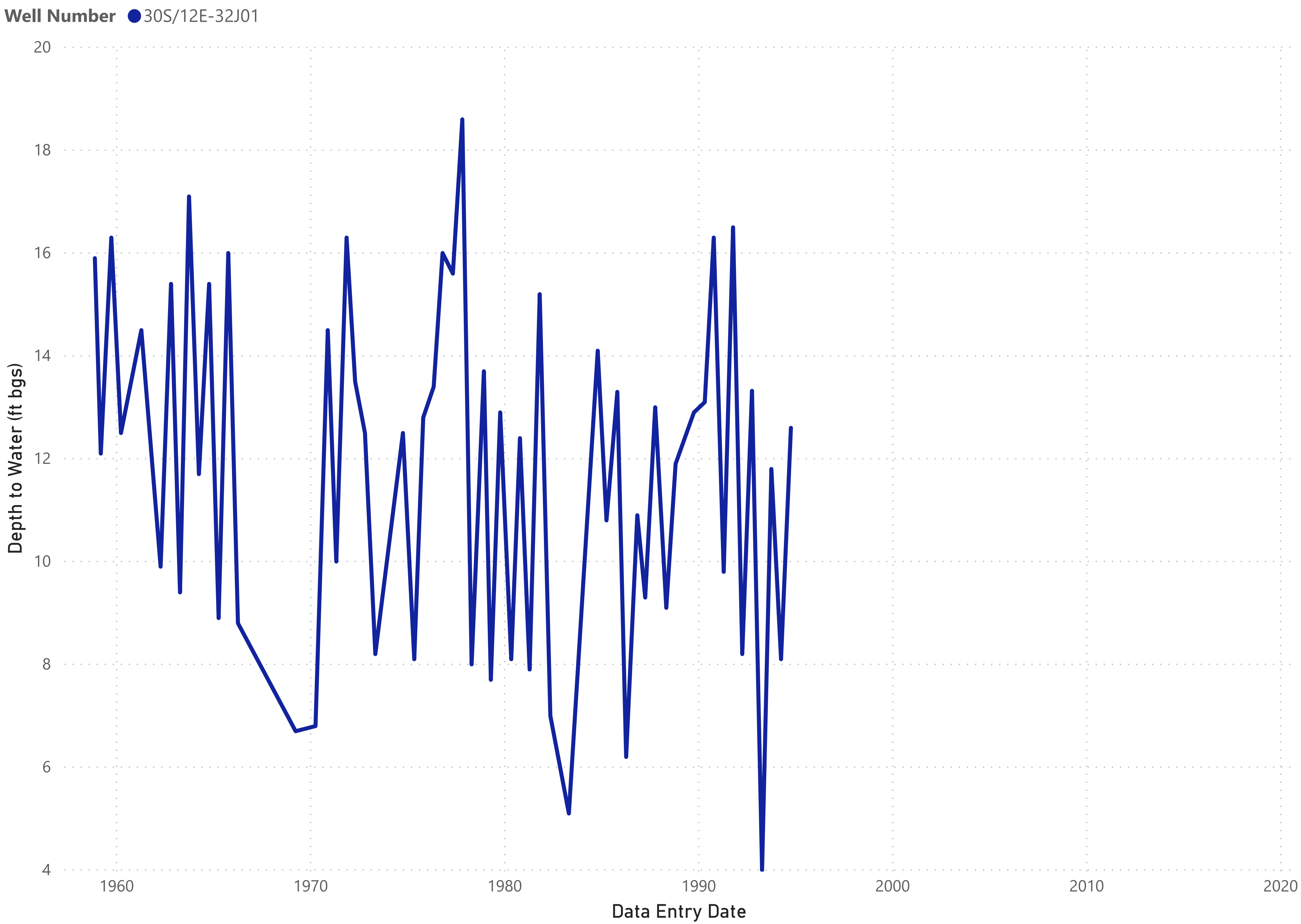
Depth to Water



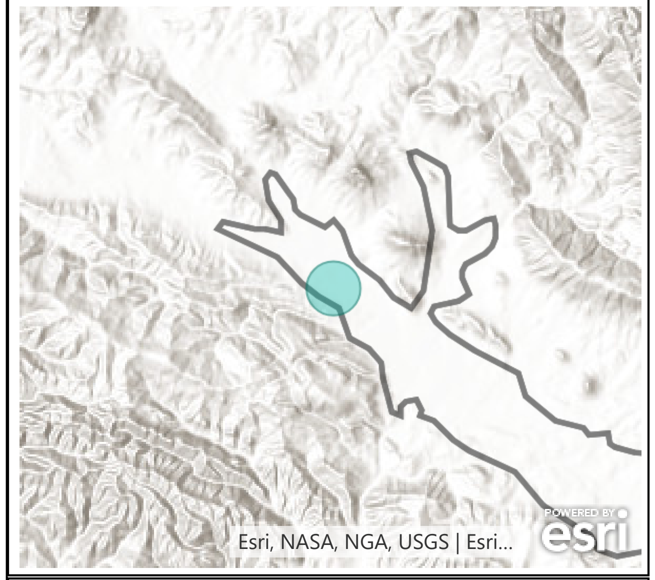
Well Location (larger = more samples)...

Well Number	Earliest Data Entry Date	Latest Data Entry Date
30S/12E-29Q01	10/22/1962	11/20/1970
30S/12E-32J01	11/18/1958	10/04/1994
31S/12E-03P01	10/12/1990	04/11/2006
31S/12E-03P02	04/05/1965	04/08/2004
31S/12E-10D03	05/09/2012	10/09/2019
31S/12E-10F03	04/05/1965	05/05/1997
31S/12E-10G02	04/05/1965	10/03/2019
31S/12E-10H03	04/12/1984	10/03/2019
31S/12E-12E03	04/05/1965	04/19/2013
31S/12E-12N01	10/22/1962	11/20/1970
31S/12E-12Q03	04/06/1965	10/06/1987
31S/12E-13J01	10/11/1970	04/15/1996
31S/12E-14C01	11/19/1958	10/03/2019
Total	**11/01/1953**	**10/09/2019**

Depth to Water

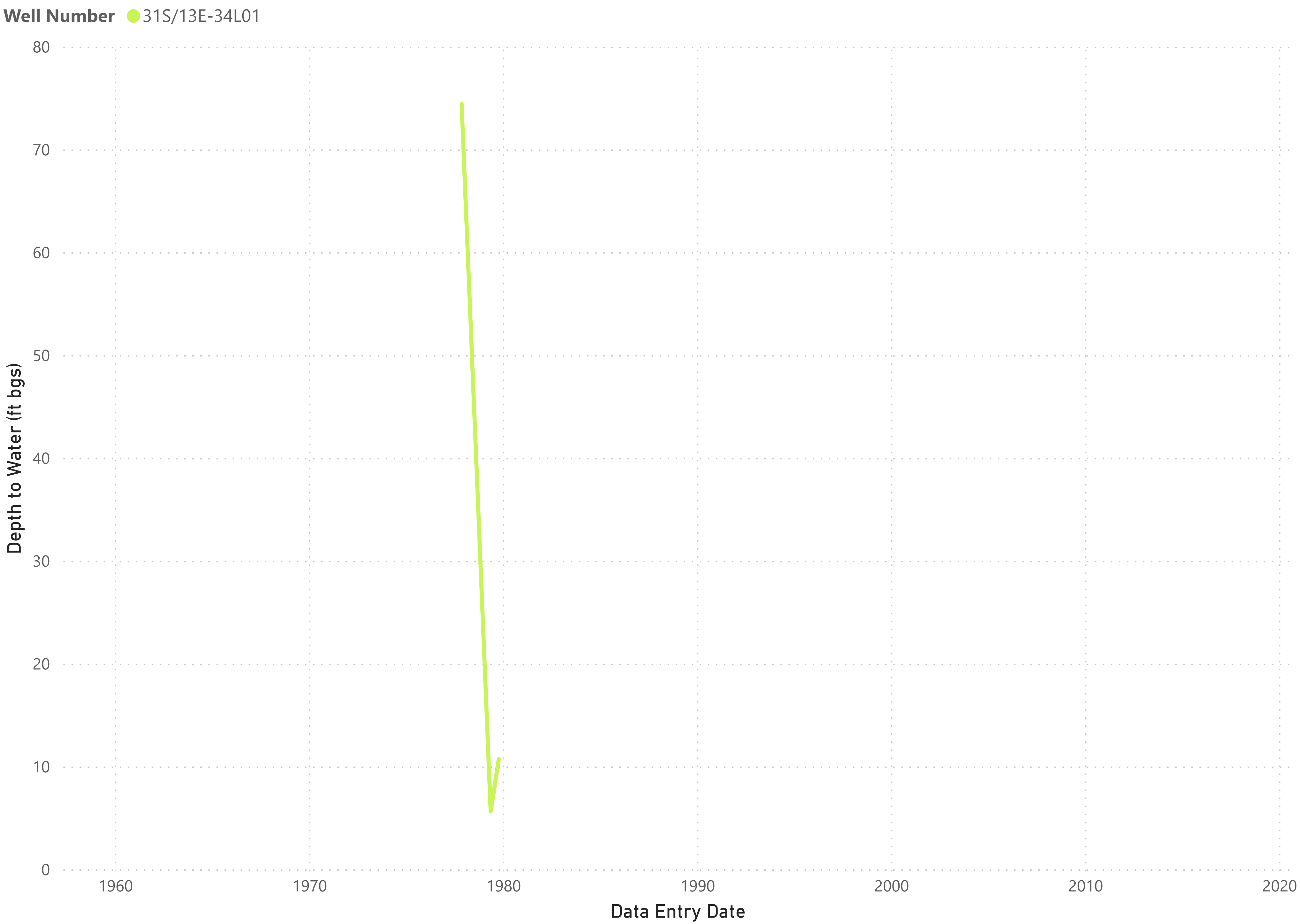


Well Location (larger = more samples)...



Well Number	Earliest Data Entry Date	Latest Data Entry Date
30S/12E-29Q01	10/22/1962	11/20/1970
30S/12E-32J01	11/18/1958	10/04/1994
31S/12E-03P01	10/12/1990	04/11/2006
31S/12E-03P02	04/05/1965	04/08/2004
31S/12E-10D03	05/09/2012	10/09/2019
31S/12E-10F03	04/05/1965	05/05/1997
31S/12E-10G02	04/05/1965	10/03/2019
31S/12E-10H03	04/12/1984	10/03/2019
31S/12E-12E03	04/05/1965	04/19/2013
31S/12E-12N01	10/22/1962	11/20/1970
31S/12E-12Q03	04/06/1965	10/06/1987
31S/12E-13J01	10/11/1970	04/15/1996
31S/12E-14C01	11/19/1958	10/03/2019
Total	**11/01/1953**	**10/09/2019**

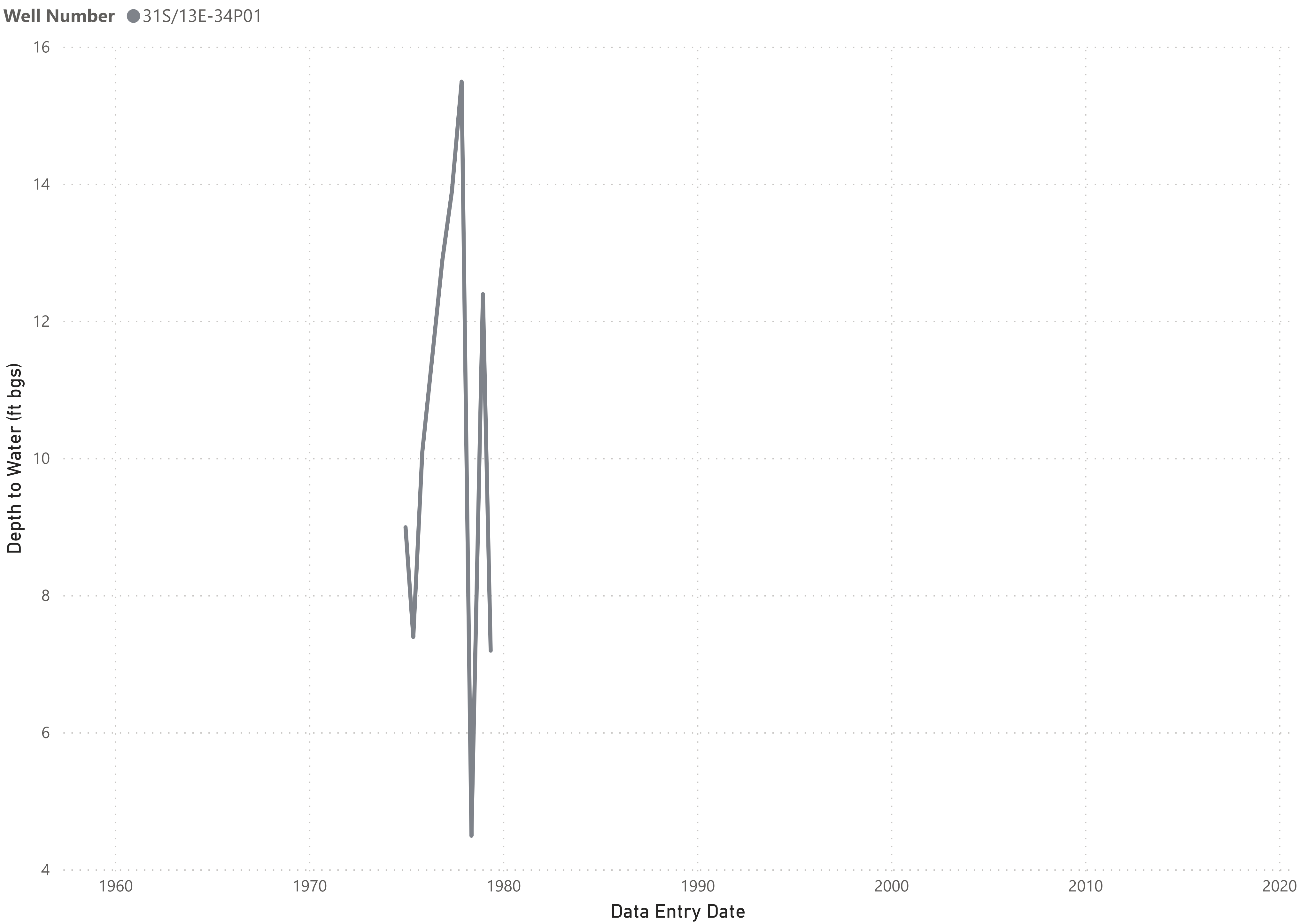
Depth to Water



Well Location (larger = more samples)...

Well Number	Earliest Data Entry Date	Latest Data Entry Date
31S/13E-27D03	04/05/1965	04/03/2000
31S/13E-27M01	11/01/1953	04/03/2000
31S/13E-27M02	12/11/1974	04/03/2000
31S/13E-27M03	10/01/1993	10/07/2019
31S/13E-28J03	04/30/1993	10/07/2019
31S/13E-29B03	05/06/1975	10/23/1975
31S/13E-29C01	04/05/1965	04/04/1987
31S/13E-29F05	10/09/1964	11/20/1970
31S/13E-29F06	10/28/2011	10/03/2019
31S/13E-34L01	11/01/1977	10/02/1979
31S/13E-34P01	12/11/1974	05/02/1979
31S/14E-19J01	11/04/1998	10/03/2019
31S/14E-19J02	11/04/1998	04/09/2019
Total	**11/01/1953**	**10/09/2019**

Depth to Water



Well Location (larger = more samples)...

Successfully added locations to the map.

Well Number	Earliest Data Entry Date	Latest Data Entry Date
31S/13E-27D03	04/05/1965	04/03/2000
31S/13E-27M01	11/01/1953	04/03/2000
31S/13E-27M02	12/11/1974	04/03/2000
31S/13E-27M03	10/01/1993	10/07/2019
31S/13E-28J03	04/30/1993	10/07/2019
31S/13E-29B03	05/06/1975	10/23/1975
31S/13E-29C01	04/05/1965	04/04/1987
31S/13E-29F05	10/09/1964	11/20/1970
31S/13E-29F06	10/28/2011	10/03/2019
31S/13E-34L01	11/01/1977	10/02/1979
31S/13E-34P01	12/11/1974	05/02/1979
31S/14E-19J01	11/04/1998	10/03/2019
31S/14E-19J02	11/04/1998	04/09/2019
Total	**11/01/1953**	**10/09/2019**

H

Data Management

Groundwater Level Measurement Procedures for the San Luis Obispo Valley Groundwater Basin GSP

Streamflow Measurement in Natural Channels

Data Management Plan

Groundwater Level Measurement Procedures for the San Luis Obispo Valley Groundwater Basin GSP

Introduction

This document establishes procedures for measuring and recording groundwater levels for the SLO Basin Groundwater Monitoring Program, and describes various methods used for collecting meaningful groundwater data.

Static groundwater levels obtained for the groundwater monitoring program are determined by measuring the distance to water in a non-pumping well from a reference point that has been referenced to sea level. Subtracting the distance to water from the elevation of the reference point determines groundwater surface elevations above or below sea level. This is represented by the following equation:

$$E_{GW} = E_{RP} - D$$

Where:

E_{GW}	=	Elevation of groundwater above mean sea level (feet)
E_{RP}	=	Elevation above sea level at reference point (feet)
D	=	Depth to water (feet)

References

Procedures for obtaining and reporting water level data for the SLO Basin Groundwater Monitoring Program are based on a review of the following documents.

- State of California, Department of Water Resources, 2016, *Best Management Practices for the Sustainable Management of Groundwater: Monitoring Protocols, Standards, and Sites*, December 2016.
- State of California, Department of Water Resources, 2014, *Addendum to December 2010 Groundwater Elevation Monitoring Guidelines for the Department of Water Resources' California Statewide Groundwater Elevation Monitoring (CASGEM) Program,* October 2, 2014.
- State of California, Department of Water Resources, 2010, *Groundwater Elevation Monitoring Guidelines*, prepared for use in the California Statewide Groundwater Elevation Monitoring (CASGEM) program, December 2010.
- U.S. Geological Survey, 2011, *Groundwater Technical Procedures of the U.S. Geological Survey*, Techniques and Methods 1-A1, compiled by William L. Cunningham and Charles W. Schalk.
- U.S. Geological Survey, 1977, *National Handbook of Recommended Methods for Water-Data Acquisition*, a Unites States contribution to the International Hydrological Program.

Well Information

Table 1 below lists important well information to be maintained in a well file or in a field notebook. Additional information that should be available to the person collecting water level data include a description of access to the property and the well, the presence and depth of cascading water, or downhole obstructions that could interfere with a sounding cable.

Table 1
Well File Information

Well Completion Report	Hydrologic Information	Additional Information to be Recorded
Well name	Map showing basin boundaries and wells	Township, Range, Section and ¼-¼ Section
Well Owner	Name of groundwater basin	Latitude and Longitude (Decimal degrees)
Drilling Company	Description of aquifer	Assessor's Parcel Number
Location map or sketch	Confined, unconfined, or mixed aquifers	Description of well head and sounding access
Total depth	Pumping test data	Reference point elevations
Perforation interval	Hydrographs	Well use and pumping schedule if known
Casing diameter	Water quality data	Date monitoring began
Date of well completion	Property access instructions/codes	Land use

Reference Points and Reference Marks

Reference point (RP) elevations are the basis for determining groundwater elevations relative to sea level. The RP is generally a point on the well head that is the most convenient place to measure the water level in a well. In selecting an RP, an additional consideration is the ease of surveying either by Global Positioning System (GPS) or by leveling.

The RP must be clearly defined, well marked, and easily located. A description, sketch, and photograph of the point should be included in the well file. Additional Reference Marks (RMs) may be established near the wellhead on a permanent object. These additional RMs can serve as a benchmark by which the wellhead RP can be checked or re-surveyed if necessary. All RMs should be marked, sketched, photographed, and described in the well file.

All RPs for Groundwater Monitoring Program wells should be reported based on the same horizontal and vertical datum by a California licensed surveyor to the nearest tenth of one foot vertically, and the nearest one foot horizontally. The surveyor’s report should be maintained in the project file.

In addition to the RP survey, the elevation of the ground surface adjacent to the well should also be measured and recorded in the well file. Because the ground surface adjacent to a well is rarely uniform, the average surface level should be estimated. This average ground surface elevation is referred to in the USGS Procedural Document (GWPD-1) and DWR guidelines as the Land Surface Datum.

Water Level Data Collection

Prior to beginning the field work, the field technician should review each well file to determine which well owners require notification of the upcoming site visit, or which well pumps need to be turned off to allow for sufficient water level recovery. Because groundwater elevations are used to construct groundwater contour maps and to determine hydraulic gradients, the field technician should coordinate water level measurements to be collected within as short a period of time as practical. Any significant changes in groundwater conditions during monitoring events should be noted in the Annual Monitoring Report. For an individual well, the same measuring method and the same equipment should be used during each sampling event where practical.

A static water level should represent stable, non-pumping conditions at the well. When there is doubt about whether water levels in a well are continuing to recover following a pumping cycle, repeated measurements should be made. If an electric sounder is being used, it is possible to hold the sounder level at one point slightly above the known water level and wait for a signal that would indicate rising water. If applicable, the general schedule of pump operation should be determined and noted for active wells. If the well is capped but not vented, remove the cap and wait several minutes before measurement to allow water levels to equilibrate to atmospheric pressure.

When lowering a graduated steel tape (chalked tape) or electric tape in a well without a sounding tube in an equipped well, the tape should be played out slowly by hand to minimize the chance of the tape end becoming caught in a downhole obstruction. The tape should be held in such a way that any change in tension will be felt. When withdrawing a sounding tape, it should also be brought up slowly so that if an obstruction is encountered, tension can be relaxed so that the tape can be lowered again before attempting to withdraw it around the obstruction.

Despite all precautions, there is a small risk of measuring tapes becoming stuck in equipped wells without dedicated sounding tubes. If a tape becomes stuck, the equipment should be left on-site and re-checked after the well has gone through a few cycles of pumping, which can free the tape due to movement/vibration of the pump column. If the tape remains stuck, a pumping contractor will be needed to retrieve the equipment. A dedicated sounding tube may be installed by the pumping contractor at that time.

All water level measurements should be made to an accuracy of 0.01 feet. The field technician should make at least two measurements. If measurements of static levels do not agree to within 0.02 feet of each other, the technician should continue measurements until the reason for the disparity is determined, or the measurements are within 0.02 feet.

Record Keeping in the Field

The information recorded in the field is typically the only available reference for the conditions at the time of the monitoring event. During each monitoring event it is important to record any conditions at a well site and its vicinity that may affect groundwater levels, or the field technician’s ability to obtain groundwater levels. Table 2 lists important information to record, however, additional information should be included when appropriate.

Table 2
Information Recorded at Each Well Site

Well name	Changes in land use	Presence of pump lubricating oil in well
Name and organization of field technician	Changes in RP	Cascading water
Date & time	Nearby wells in use	Equipment problems
Measurement method used	Weather conditions	Physical changes in wellhead
Sounder used	Recent pumping info	Comments
Reference Point Description	Measurement correction(s)	Well status

An example of a field log sheet from DWR is attached.

Measurement Techniques

Four standard methods of obtaining water levels are discussed below. The chosen method depends on site and downhole conditions, and the equipment limitations. In all monitoring situations, the procedures and equipment used should be documented in the field notes and in final reporting. Additional detail on methods of water level measurement is included in the reference documents.

Graduated Steel Tape

This method uses a graduated steel tape with a brass or stainless steel weight attached to its end. The tape is graduated in feet. The approximate depth to water should be known prior to measurement.

- Estimate the anticipated static water level in the well from field conditions and historical information;
- Chalk the lower few feet of the tape by applying blue carpenter's chalk.
- Lower the tape to just below the estimated depth to water so that a few feet of the chalked portion of the tape is submerged. Be careful not to lower the tape beyond its chalked length.
- Hold the tape at the RP and record the tape position (this is the "hold" position and should be at an even foot);
- Withdraw the tape rapidly to the surface;
- Record the length of the wetted chalk mark on the graduated tape;
- Subtract the wetted chalk number from the "hold" position number and record this number in the "Depth to Water below RP" column;
- Perform a check by repeating the measurement using a different RP hold value;
- All data should be recorded to the nearest 0.01 foot;
- Disinfect the tape by wiping down the submerged portion of the tape with single-use, unscented disinfectant wipe, or let stand for one minute in a dilute chlorine bleach solution and dry with clean cloth.

The graduated steel tape is generally considered to be the most accurate method for measuring static water levels. Measuring water levels in wells with cascading water or with condensing water on the well casing causes potential errors, or can be impossible with a steel tape.

Electric Tape

An electric tape operates on the principle that an electric circuit is completed when two electrodes are submerged in water. Most electric tapes are mounted on a hand-cranked reel equipped with batteries and an ammeter, buzzer or light to indicate when the circuit is completed. Tapes are graduated in either one-foot intervals or in hundredths of feet depending on the manufacturer. Like graduated steel tapes, electric tapes are affixed with brass or stainless steel weights.

- Check the circuitry of the tape before lowering the probe into the well by dipping the probe into water and observe if the ammeter needle or buzzer/light signals that the circuit is completed;
- Lower the probe slowly and carefully into the well until the signal indicates that the water surface has been reached;
- Place a finger or thumb on the tape at the RP when the water surface is reached;
- If the tape is graduated in one-foot intervals, partially withdraw the tape and measure the distance from the RP mark to the nearest one-foot mark to obtain the depth to water below the RP. If the tape is graduated in hundredths of a foot, simply record the depth at the RP mark as the depth to water below the RP;
- Make all readings using the same needle deflection point on the ammeter scale (if equipped) so that water levels will be consistent between measurements;

- Make check measurements until agreement shows the results to be reliable;
- All data should be recorded to the nearest 0.01 foot;
- Disinfect the tape by wiping down the submerged portion of the tape with single-use, unscented disinfectant wipe, or let stand for one minute in a dilute chlorine bleach solution and dry with clean cloth;
- Periodically check the tape for breaks in the insulation. Breaks can allow water to enter into the insulation creating electrical shorts that could result in false depth readings.

The electric tape may give slightly less accurate results than the graduated steel tape. Errors can result from signal "noise" in cascading water, breaks in the tape insulation, tape stretch, or missing tape at the location of a splice. All electric tapes should be calibrated annually against a steel tape that is maintained in the office and used only for calibration.

Air Line

The air line method is usually used only in wells equipped with pumps. This method typically uses a 1/8 or 1/4-inch diameter, seamless copper tubing, brass tubing, stainless steel tubing, or galvanized pipe with a suitable pipe tee for connecting an altitude or pressure gage. Plastic (i.e. polyethylene) tubing may also be used, but is considered less desirable because it can develop leaks as it degrades. An air line must extend far enough below the water level that the lower end remains submerged during pumping of the well. The air line is connected to an altitude gage that reads directly in feet of water, or to a pressure gage that reads pressure in pounds per square inch (psi). The gage reading indicates the length of the submerged air line.

The formula for determining the depth to water below the RP is: **d = k – h** where d = depth to water; k = constant; and h = height of the water displaced from the air line. In wells where a pressure gage is used, h is equal to 2.31 ft/psi multiplied by the gage reading. The constant value for k is approximately equivalent to the length of the air line.

- Calibrate the air line by measuring an initial depth to water (d) below the RP with a graduated steel tape. Use a tire pump, air tank, or air compressor to pump compressed air into the air line until all the water is expelled from the line. When all the water is displaced from the line, record the stabilized gage reading (h). Add d to h to determine the constant value for k.
- To measure subsequent depths to water with the air line, expel all the water from the air line, subtract the gage reading (h) from the constant k, and record the result as depth to water (d) below the RP.

The air line method is not as accurate as a graduated steel tape or electric and is typically accurate to the nearest one foot at best. Errors can occur from leaky air lines, or when tubing becomes clogged with mineral deposits or bacterial growth. The air line method is not desirable for use in the Groundwater Monitoring Program.

Pressure Transducer

Electrical pressure transducers make it possible to collect frequent and long-term water level or pressure data from wells. These pressure-sensing devices, installed at a fixed depth in a well, sense the change in pressure against a membrane. The pressure changes occur in response to changes in the height of the water column in the well above the transducer membrane. To compensate for atmospheric changes, transducers may have vented cables or they can be used in conjunction with a barometric transducer that is installed in the same well or a nearby observation well above the water level.

Transducers are selected on the basis of expected water level fluctuation. The smallest range in water levels provides the greatest measurement resolution. Accuracy is generally 0.01 to 0.1 percent of the full scale range.

Retrieving data in the field is typically accomplished by downloading data through a USB connection to a portable computer or data logger. A site visit to retrieve data should involve several steps designed to safeguard the stored data and the continued useful operation of the transducer:

- Inspect the wellhead and check that the transducer cable has not moved or slipped (the cable can be marked with a reference point that can be used to identify movement);
- Ensure that the instrument is operating properly;
- Measure and record the depth to water with a graduated steel or electric tape;
- Document the site visit, including all measurements and any problems;
- Retrieve the data and document the process;
- Review the retrieved data by viewing the file or plotting the original data;
- Recheck the operation of the transducer prior to disconnecting from the computer.

A field notebook with a checklist of steps and measurements should be used to record all field observations and the current data from the transducer. It provides a historical record of field activities. In the office, maintain a binder with field information similar to that recorded in the field notebook so that a general historical record is available and can be referred to before and after a field trip.

<u>Quality Control</u>

The field technician should compare water level measurements collected at each well with the available historical information to identify and resolve anomalous and potentially erroneous measurements prior to moving to the next well location. Pertinent information, such as insufficient recovery of a pumping well, proximity to a pumping well, falling water in the casing, and changes in the measurement method, sounding equipment, reference point, or groundwater conditions should be noted. Office review of field notes and measurements should also be performed by a second staff member.

All field tapes (both steel and electric) used for the monitoring program should be calibrated annually against another acceptable steel tape. An acceptable steel tape is one that is maintained in the office for use only in calibrating the field tapes. Adjustments for tape calibration should be applied and noted.

STATE OF CALIFORNA
THE RESOURCES AGENCY
DEPARTMENT OF WATER RESOURCES

WELL DATA

STATE WELL NUMBER	COUNTY	REFERENCE POINT ELEV.	MEASURING AGENCY
			DWR

NO MEASUREMENT	QUESTIONABLE MEASUREMENT
0. Measurement discontinued	0. Caved or deepened
1. Pumping	1. Pumping
2. Pump house locked	2. Nearby pump operating
3. Tape hung up	3. Casing leaky or wet
4. Can't get tape in casing	4. Pumped recently
5. Unable to locate well	5. Air or pressure gauge measurement
6. Well has been destroyed	6. Other
7. Special	7. Recharge operation at or nearby well
8. Casing leaky or wet	8. Oil in casing
9. Temporarily inaccessible	

DATE	N M	Q M	TAPE AT RP	TAPE AT WS	RP to WS	OBSR VR	COMMENTS

DWR 1213

Figure 4 – Example of Water Level Well Data Field Collection Form

Streamflow Measurement in Natural Channels

The most practical method for measuring streamflow in natural channels is the velocity-area method, which has the following computation[1]:

$$Q = \sum_{i=1}^{n}(a_i v_i)$$

where:

Q = total discharge (reported in cubic feet per second).

a_i = cross-sectional area of flow for the *i*th segment of the *n* segments into which the cross section is divided (square feet), and

v_i = the corresponding mean velocity of flow normal to the *i*th segment (feet per second).

The conceptual model for the velocity area-method is shown below. A stream is divided into segments, each with an individual area and velocity, which are then multiplied and summed using the above equation.

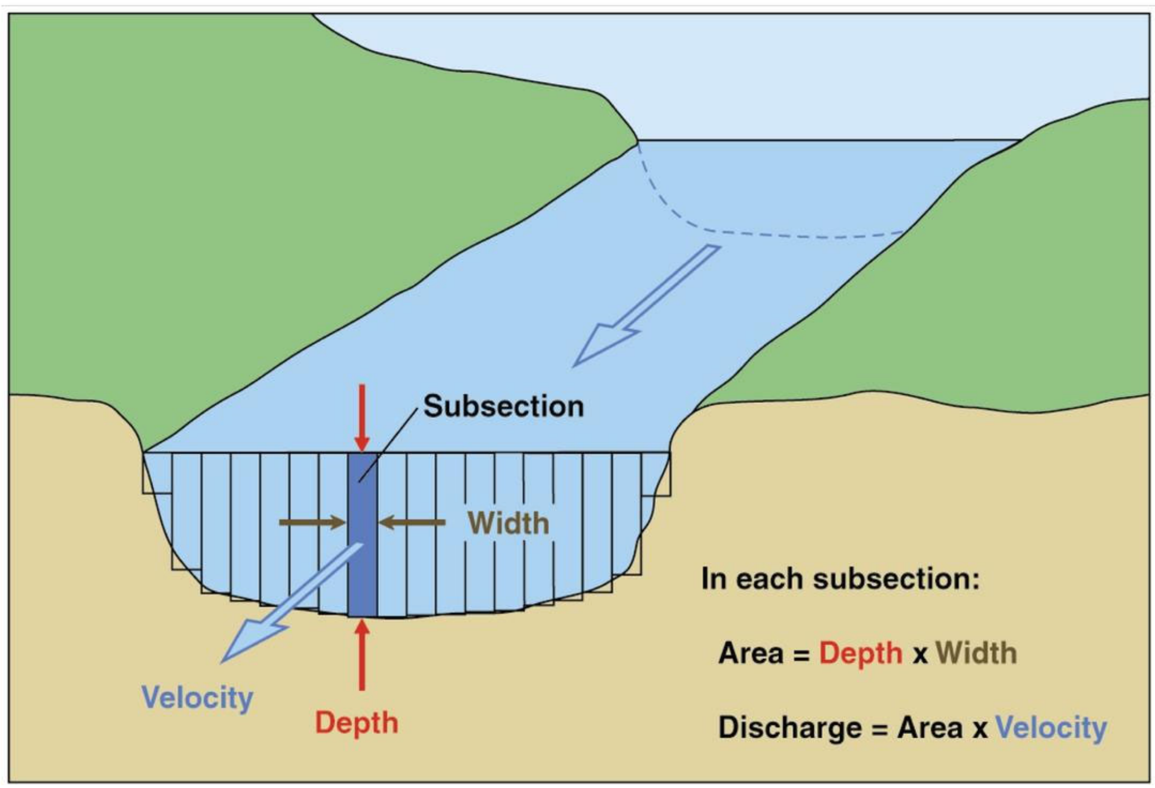


Diagram of Channel cross-section with segments for discharge computation (USGS)

In natural channels, stream gages are used to record stage (feet), which is the height of water in the stream above an arbitrary point, usually at or below the stream bed. The stage is then converted to streamflow through the use of a rating curve, or stage-discharge relation. A rating curve incorporates information collected that is specific to each site, including the cross-sectional area of

[1] Turnipseed, D.P. and Sauer, V.B., 2010. Discharge Measurements at Gaging Stations, USGS Techniques and Methods 3-A8.

the channel and the average velocity for a given flow stage. These rating curves are developed using depth profiles and average flow velocity measurements during storm-runoff events. Rating curves may need to be revised periodically as they can shift due to changes in channel geometry. Measuring average flow velocity across a channel at different stream stages is the most challenging part of developing a rating curve.

DRAFT

San Luis Obispo Valley Basin Data Management Plan

Data Management System to Support Implementation of the Sustainable Groundwater Management Act

Prepared for:

County of San Luis Obispo GSA
City of San Luis Obispo GSA

Prepared by:

GEI Consultants
2868 Prospect Park Drive, Suite 400
Sacramento, CA 95670

August 31, 2020

Table of Contents

Figures

Tables

1. Introduction

The purpose of this Data Management Plan (DMP) is to describe the planned Data Management System (DMS) and the process for collection, review, and upload of data used to develop a Groundwater Sustainability Plan (GSP) for the San Luis Obispo Valley Groundwater Basin (SLO Basin). This document does not provide final specifications for a complete DMS. Rather, it describes the data needed to comply with SGMA, the method to be used for data collection, and the plan for DMS development.

1.1 SGMA DMS Requirements

The Sustainable Groundwater Management Act (SGMA) requires development of a DMS. The DMS stores data relevant to development of a groundwater basin's GSP as defined by the GSP Regulations (California Code of Regulations, Title 23, Division 2, Chapter 1.5, Subchapter 2).

The GSP Regulations give general guidelines for a DMS:

> ***§ 352.6. Data Management System***
>
> *Each Agency shall develop and maintain a data management system that is capable of storing and reporting information relevant to the development or implementation of the [Groundwater Sustainability] Plan and monitoring of the basin.*
>
> *Note: Authority cited: Section 10733.2, Water Code.*
> *Reference: Sections 10727.2, 10728, 10728.2, and 10733.2, Water Code.*
>
> ***§ 352.4. Data and Reporting Standards***
>
> *(c) The following standards apply to wells:*
>
> *(3) Well information used to develop the basin setting shall be maintained in the Agency's data management system*
>
> *Note: Authority cited: Section 10733.2, Water Code.*
> *Reference: Sections 10727.2, 10727.6, and 10733.2, Water Code.*
>
> ***§ 354.40. Reporting Monitoring Data to the Department***
>
> *Monitoring data shall be stored in the data management system developed pursuant to Section 352.6. A copy of the monitoring data shall be included in the Annual Report and submitted electronically on forms provided by the Department.*
>
> *Note: Authority cited: Section 10733.2, Water Code.*
> *Reference: Sections 10728, 10728.2, 10733.2, and 10733.8, Water Code.*

To comply with SGMA, the SLO Basin DMS will store data that is relevant to development and implementation of the GSP as well as for monitoring and reporting purposes.

2. Data Needs for SGMA

The SLO Basin is in San Luis Obispo County, California. The county spans multiple groundwater basins – 6 of which are engaged in SGMA activity. Each basin complying with SGMA is required to store data in a DMS. Rather than host several systems, a county-wide DMS will be implemented to support county data initiatives for SGMA and other non-SGMA data initiatives.

Figure 1. Groundwater Basins in San Luis Obispo County[1]

SGMA defines sustainable groundwater management as "the management and use of groundwater in a manner that can be maintained during the planning and implementation horizon without causing undesirable results."[2] Furthermore, SGMA outlines six undesirable results as follows:[3]

> *One or more of the following effects caused by groundwater conditions occurring throughout the basin:*
>
> *(1) Chronic lowering of groundwater levels indicating a significant and unreasonable depletion of supply if continued over the planning and implementation horizon. Overdraft during a period of drought is not sufficient to*

---

[1] Source: California Department of Water Resources, SGMA Data Viewer, accessed August 14, 2020.
[2] §10721(v)
[3] §10721(x)

establish a chronic lowering of groundwater levels if extractions and groundwater recharge are managed as necessary to ensure that reductions in groundwater levels or storage during a period of drought are offset by increases in groundwater levels or storage during other periods.

(2) Significant and unreasonable reduction of groundwater storage.

(3) Significant and unreasonable seawater intrusion.

(4) Significant and unreasonable degraded water quality, including the migration of contaminant plumes that impair water supplies.

(5) Significant and unreasonable land subsidence that substantially interferes with surface land uses.

(6) Depletions of interconnected surface water that have significant and unreasonable adverse impacts on beneficial uses of the surface water.

The presence or absence of the six undesirable results in a groundwater basin is determined by monitoring and reviewing data for six sustainability indicators (one for each undesirable result). A set of associated measurable objective and minimum threshold will be assigned for each indicator and will be included in the DMS.

There are multiple metrics by which the sustainability indicators may be observed. The sustainability indicators and their respective metrics, as defined in the GSP Regulations and described by the California Department of Water Resources (DWR) in the Sustainable Management Criteria Best Management Practice (BMP) document,[4] are shown in **Figure 2**.

Figure 2. DWR's Sustainability Indicators and Metrics

Sustainability Indicators	Lowering GW Levels	Reduction of Storage	Seawater Intrusion	Degraded Quality	Land Subsidence	Surface Water Depletion
Metric(s) Defined in GSP Regulations	• Groundwater Elevation	• Total Volume	• Chloride concentration isocontour	• Migration of Plumes • Number of supply wells • Volume • Location of isocontour	• Rate and Extent of Land Subsidence	• Volume or rate of surface water depletion

[4] https://water.ca.gov/LegacyFiles/groundwater/sgm/pdfs/BMP_Sustainable_Management_Criteria_2017-11-06.pdf.

Table 1 describes the types of data that may possibly be monitored for each sustainability indicator. Sustainability indicators do not need to be tracked by every available monitoring type.

Table 1. Monitoring data for the SGMA sustainability indicators

Sustainability Indicator	Monitoring Data Types							
					Water Quality			
	Water Level	Extensometer	GPS	InSAR	Chloride	±10 constituents	Stream stages	Well and/or Site Data
Lowering groundwater levels	✓							✓
Reduction of storage	✓							✓
Seawater intrusion	✓				✓			✓
Degraded quality	✓				✓	✓		✓
Land subsidence	✓	✓	✓	✓				✓
Surface water depletion	✓						✓	✓

The DMS will accommodate data relevant to each sustainability indicator. The monitoring data types listed in **Table 1** represent the various data sets required to populate the DMS for tracking sustainability indicators. However, there is additional data that is readily available and may be included in the DMS to assist with preparation of GSPs and to support annual reporting.

3. Data Sources

Table 2 illustrates the data sources that will be used to populate the DMS to support GSP development, sustainability indicator monitoring, and annual reporting. The data categories listed below inform the design of the DMS and support the data needs presented previously in **Table 1**.

Table 2. Data Sources to Populate the DMS

Data Category	State and Federal Data Sources						Local Data Sources	
	California Statewide Groundwater Elevation Monitoring (CASGEM)	Well Logs	California Data Exchange Center (CDEC)	Geotracker Groundwater Ambient Monitoring and Assessment (GAMA)	United States Geological Survey (USGS)	Irrigated Lands Program	Participating Agencies	Other Groundwater Users*
Well and Site Info	✓	✓		✓	✓		✓	✓
Lithology	✓	✓		✓	✓		✓	
Water Level	✓				✓		✓	✓
Water Quality				✓	✓	✓	✓	
Subsidence					✓		✓	
Precipitation			✓				✓	
Land Use							✓	
Surface Water (Diversions, Stream Gages)			✓				✓	
Pumping							✓	✓

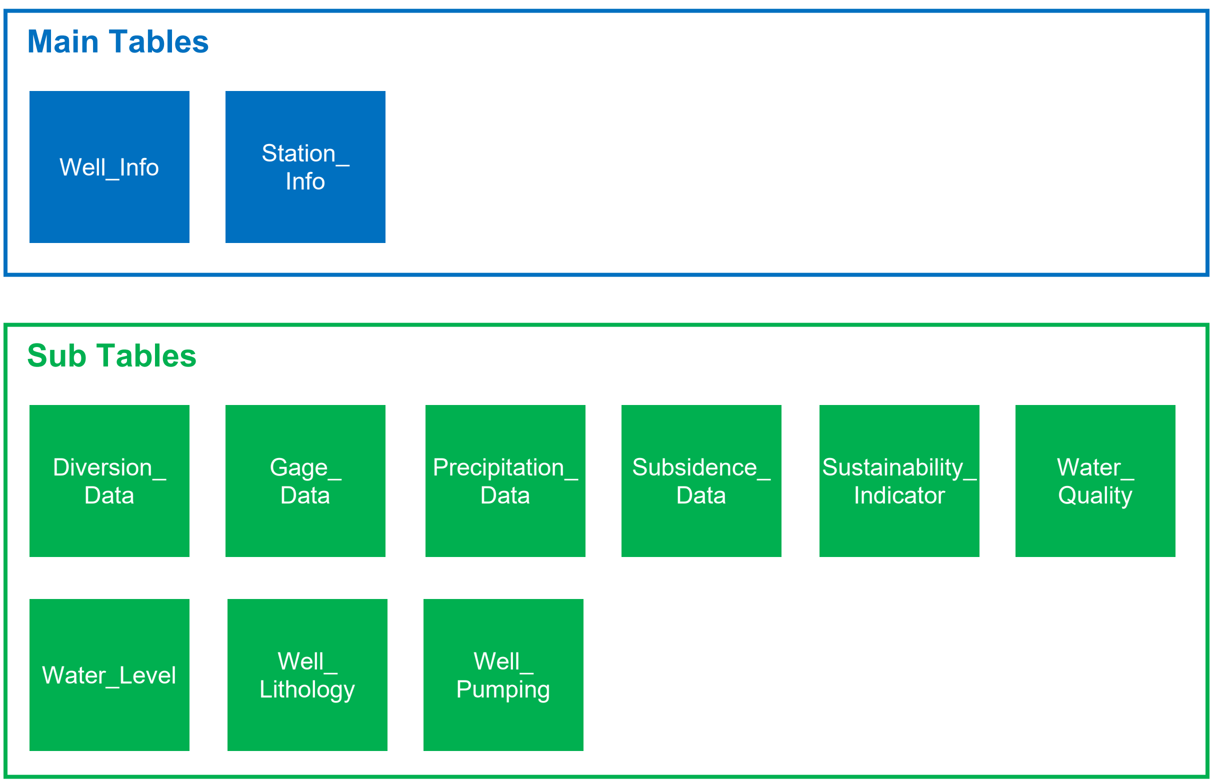
*Private parties and mutual water companies

4. Data Structure

The DMS will be comprised of a database plus an online web viewer. Data stored in the DMS will be separated by categories into tables. The tables shall contain columns and rows of data. Each field will hold a specific type of data, such as a number, text, or date. The planned DMS data tables are shown as **Figure 3**. The figure is color-coordinated to show the relationship between tables:

- **Main tables (Blue)** – Each dataset will be associated with EITHER a well or a station (e.g., extensometer). These are the main tables and include point data with unique identification and locations.
- **Sub tables (Green)** – Sub tables are related to the main tables and hold additional details about a well or site (e.g., correlation of a well with a water level measurement).

Figure 3. DMS Tables



A brief description of the main and sub tables is provided as **Table 3**.

Table 3. DMS Table Descriptions

Table	Description
Main Tables	
Station_Info	Information about type of station (recharge site, diversion, gage, extensometer, GSP) and location information
Well_Info	General information about well, including well construction and screen information
Sub Tables	
Diversion_Data	Diversion volume measurements for a diversion site or managed recharge
Gage_Data	Measurements collected at river or stream gages
Precipitation_Data	Volumetric measurements collected at precipitation monitoring stations
Subsidence_Data	Measurements collected at subsidence monitoring stations (e.g., extensometer)
Sustainability_Indicator	Minimum Thresholds and Measurable Objectives set for monitoring network sites tracking Sustainable Management Criteria for SGMA compliance
Water_Quality	Contains water quality data for wells or any other type of site
Water_Level	Water level measurements for wells
Well_Lithology	Lithologic information at a well site (each well may have many lithologies at different depths)
Well_Pumping	Pumping or recharge measurements for wells

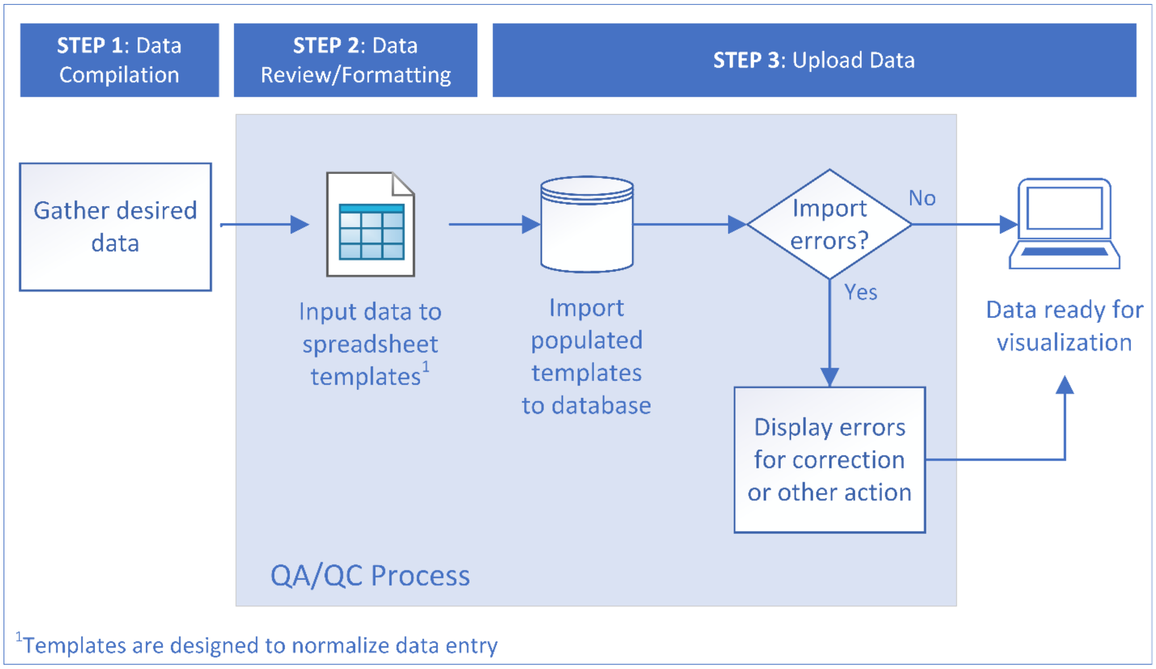
5. Data Import

Importing data to the DMS consists of three steps, as shown on **Figure 4** and listed below:

1. Data compilation
2. Data review and formatting
3. Upload data

The DMS shall be designed to use this process to import data for all basins in San Luis Obispo County. The DMS development team will upload data to support the SLO Basin GSP. Data for other basins will be loaded by other teams' GSP efforts.

Figure 4. Template Import Process for Local Data



5.1 Data Compilation (STEP 1)

Historical data must be gathered to populate the DMS. Select state and federal data (as provided earlier in **Table 2**) for the SLO Basin will be compiled by the GSAs and their consultant(s). Participating agencies and other stakeholders will compile local data and data for other basins in the County.

5.2 Data Formatting and Review (STEP 2)

After the data is compiled, it shall be normalized by use of Microsoft Excel templates designed exclusively for the DMS. Each of the main and sub tables, described previously in **Section 4**, will have a template.

The tables below list and describe the templates planned for the DMS. There are three types of data templates:

- Groundwater well data templates: for data associated with a well.
- Station data templates: for data associated with a station. A station is defined as any site, that isn't a groundwater well, tracking DMS data (e.g., extensometer).
- Independent data templates: for data that is not associated with a single well or station.

Table 4. Well Data Templates

Template	Description
WELL_INFO	Well site information including construction and location
WELL_SCREEN	Screened intervals associated with a well site
WELL_AQUIFER	Aquifers associated with a well site
WELL_LITHOLOGY	Lithologic information at a well site (each well may have many lithologies at different depths)
WELL_WATER_LEVEL	Water level measurements taken at wells
WELL_PUMPING	Pumping or recharge measurements for wells
WELL_WATER_QUALITY	Water quality data collected at well sites
WELL_SUST_INDICATOR	Minimum Thresholds, Measurable Objectives, and Interim Milestones set for wells (not stations)

Table 5. Station Data Templates

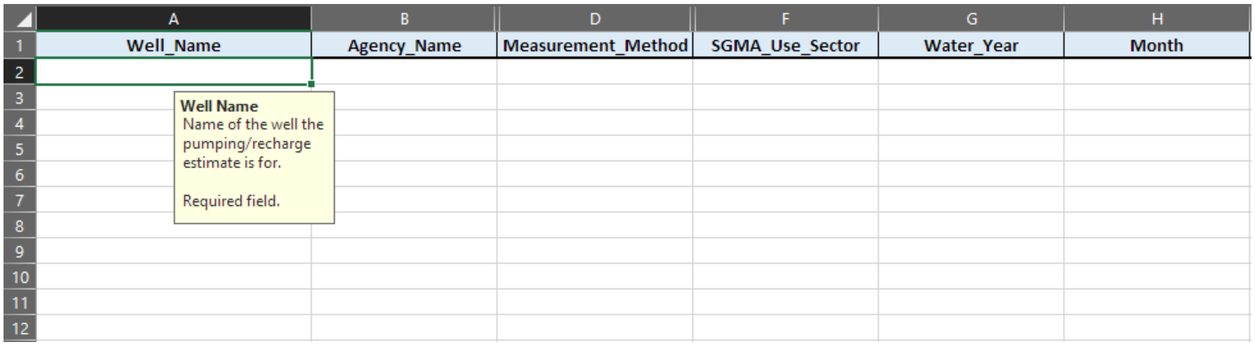
Template	Description
STATION_INFO	Information about a non-well station (e.g., recharge site) and location information
STATION_PRECIPITATION_DATA	Volumetric measurements collected at stations such as precipitation monitoring sites
STATION_SUBSIDENCE_DATA	Measurements from subsidence stations
STATION_GAGE_DATA	Measurements collected at river and stream gages
STATION_WATER_QUALITY	Water quality data collected at non-well stations
STATION_DIVERSION_DATA	Diversion volume measurements for a diversion site or managed recharge
STATION_SUST_INDICATOR	Minimum Thresholds, Measurable Objectives, and Interim Milestones set for stations (not wells)

Table 6. Independent Data Templates

Template	Description
AGENCY	Addresses and other identifying information about the source agencies for data in the system
WATER_YEAR	Water year type (e.g., dry)
DOCUMENT	Document information including file type, name, and file path

The data templates will include rules restricting formatting and alphanumeric properties to provide quality assurance/quality control (QA/QC) and to prevent errors and duplication when importing. The templates include pop-up windows to describe the type of data that should be entered in each column. If a specific filter must be applied, then only values that meet the criteria will appear in a drop-down list. **Figure** 5 provides a screenshot of an example Excel template.

Figure 5. Example Template (Well Pumping)



When data is compiled it must also be reviewed for accuracy. The template restrictions described above provide one level of QA/QC. As a second level of QA/QC, the initial set of compiled historical data will be reviewed by the consulting team before it is migrated into the database. This review will be focused and limited in scope. It will include the following manual checks:

- Identifying outliers that may have been introduced during the original data entry process
- Identifying potential duplication of data
- Removing or flagging questionable data
- Visualizing data in various software platforms outside the DMS to further assess the quality of the data

After the historical data is populated, future data will be reviewed by the County before it is fully imported to the DMS.

5.3 Data Upload (STEP 3)

Once the data is formatted and reviewed it will be uploaded to the DMS and displayed with a visualization tool (described in the next section). When loading the data, an automated check will be run by the DMS to capture errors or duplicates, if any, and a response will be generated to indicate errors so they may be corrected.

The upload templates will be available for download in the DMS interface to load future data.

6. SGMA Data Viewer

The DMS will include a user-friendly web viewer to display the SGMA data including the SGMA-specific sustainable management criteria (SMC) information such as representative monitoring sites, minimum thresholds, measurable objectives, and interim milestones.

The DMS SGMA data will display both with a map view and a detail view. Clicking on a point on the map will reveal details of the selected well or feature. The viewer will generate a hydrograph for points with water level data, and time-series graphs for water quality and subsidence data. The visual design of the Data Viewer (with test data) is shown in **Figure 6.**

Figure 6. Design for Data Viewer

The types of data to be visualized on the map and available via the map's navigation menu are listed in **Table 7**.

Table 7. Map Viewer Navigation

Menu Navigation	Description
Groundwater Levels	Water level data and associated wells with well completion reports.
Groundwater Storage	GSA groundwater storage monitoring network sites.
Water Quality	Water quality well and station data for greater than 100 constituents.
Land Subsidence	Subsidence data from extensometers and other stations plus InSAR data.
Interconnected Surface Water	Data related to the interconnected surface water sustainability indicator such as proximity wells, river and stream gages, precipitation stations, and more.
Seawater Intrusion	Sites tracking the SGMA seawater intrusion sustainability indicator.

Hydrogeologic Conceptual Model (HCM)	Data useful for development of a hydrogeoglogic conceptual model of the basin including suitability of soil for recharge, geologic maps, and fault maps.
Boundaries	GSA and other relevant boundaries.

There are two categories of data displayed on the map viewer: data stored in the DMS and reference data drawn directly from outside sources that is useful for groundwater management. All the data discussed in the previous sections, **3. Data Sources** and **4. Data Structure**, referred to data to be stored in the DMS database. **Table 8** below displays a list of reference data that is available for display in the map viewer but is tied directly to an external source (such as CDEC), not to the data stored in the DMS.

Table 8. Reference Data Not Stored in the DMS Database

Menu Navigation	Data Title	Source
Groundwater Levels	DWR Periodic Groundwater Measurements	• California Natural Resources Agency Open Data Platform https://data.cnra.ca.gov/dataset/periodic-groundwater-level-measurements • Water Data Library http://wdl.water.ca.gov/waterdatalibrary
	DWR Continuous Groundwater Measurements	• https://data.cnra.ca.gov/dataset/continuous-groundwater-level-measurements • http://wdl.water.ca.gov/waterdatalibrary
	USGS Periodic Groundwater Measurements	• https://nwis.waterdata.usgs.gov/usa/nwis/gwlevels
	Seasonal Groundwater Level Reports	DWR Enterprise Water Management database (EWM), which includes water level data previously stored in the DWR Water Data Library and CASGEM databases.
	Well Completion Reports	• https://data.cnra.ca.gov/dataset/well-completion-reports • https://gis.water.ca.gov/arcgis/rest/services/Environment/i07_WellCompletionReports/FeatureServer • https://gis.water.ca.gov/arcgis/rest/services/Environment/i07_WellCompletionReports/MapServer
Water Quality	Water Quality Portal (WQP)	• https://www.waterqualitydata.us/
Land Subsidence	DWR Extensometers	• https://data.cnra.ca.gov/dataset/wdl-ground-surface-displacement
	USGS Extensometers	• https://waterservices.usgs.gov/rest/Site-Test-Tool.html
	TRE ALTAMIRA InSAR Dataset	• Image Server: https://gis.water.ca.gov/arcgisimg/rest/services/SAR • Download @OpenData: https://data.cnra.ca.gov/dataset/tre-altamira-insar-subsidence
	NASA JPL InSAR Dataset	• Image Server: https://gis.water.ca.gov/arcgisimg/rest/services/SAR • Download @OpenData: https://data.cnra.ca.gov/dataset/nasa-jpl-insar-subsidence
Interconnected Surface Water	CDEC Stations	• http://cdec.water.ca.gov/

Menu Navigation	Data Title	Source
Water Budget	Statewide Crop Mapping 2014	• Feature Server: https://gis.water.ca.gov/arcgis/rest/services/Planning/CropMapping2014/FeatureServer • Map Server: https://gis.water.ca.gov/arcgis/rest/services/Planning/CropMapping2014/FeatureServer • Download and API @OpenData: https://data.cnra.ca.gov/dataset/crop-mapping-2014
Hydrogeologic Conceptual Model	UC Davis SAGBI	• California Soil Resource Lab at UC Davis and UC-ANR.
	Soil Survey Geographic Database	• https://services.arcgis.com/P3ePLMYs2RVChkJx/ArcGIS/rest/services/DownloaderBasinsv2/FeatureServer/0 • http://www.arcgis.com/home/item.html?id=c2b408ba5c0a4fe1a79377906935c1a4
	CGS Geologic Map - 750k Generalized	• Metadata: https://maps.conservation.ca.gov/cgs/metadata/GDM_002_GMC_750k_v2_metadata.html • Webmap: https://maps.conservation.ca.gov/cgs/gmc/ • Service: http://spatialservices.conservation.ca.gov/arcgis/rest/services/CGS/GeologicMapCA/MapServer/21
	Quaternary Surficial Deposits	• Project Website: http://www.conservation.ca.gov/cgs/fwgp/Pages/sr217.aspx • Metadata: https://maps.conservation.ca.gov/cgs/metadata/QSD_metadata.html • Webmap: https://maps.conservation.ca.gov/cgs/qsd/ • Service: https://spatialservices.conservation.ca.gov/arcgis/rest/services/CGS/GeologicMapCA/MapServer
	Fault Activity Map of California	• Metadata: https://maps.conservation.ca.gov/cgs/metadata/GDM_006_FAM_750k_v2_metadata.html • Webmap: https://maps.conservation.ca.gov/cgs/fam/ • Service: https://spatialservices.conservation.ca.gov/arcgis/rest/services/CGS/FaultActivityMapCA/MapServer
Boundaries	GSA Boundaries	• DWR Bulletin-118 basin boundaries or as provided by client
	County Boundaries	• https://data.cnra.ca.gov/dataset/california-counties
	Canals and Aqueducts	• https://data.cnra.ca.gov/dataset/canals-and-aqueducts-local
	Disadvantaged Communities Blocks	• https://data.cnra.ca.gov/dataset/census-block-group-2010
	Disadvantaged Communities Places	• https://data.cnra.ca.gov/dataset/census-place-2016
	Disadvantaged Communities Tracts	• https://data.cnra.ca.gov/dataset/census-tract-2010
	Water Agencies	• https://data.cnra.ca.gov/dataset/water-districts
	CASGEM Groundwater Basins Prioritization – 2019 -	• https://data.cnra.ca.gov/dataset/ca-bulletin-118-groundwater-basins

7. DMS User Types

All data stored in the DMS will be accessible by administrative users, based on user permissions. Some sensitive data, such as private well data, may require a higher level of permission to retrieve. These permissions will be determined by the client.

Monitoring sites and their associated datasets are added to the DMS by managing entity administrators. In addition to user permissions, access to the monitoring datasets is controlled through assigning one of three options to the data type as follows:

- **Private data** – Private data are monitoring datasets only available for viewing, depending on user type, by the entity's associated users in the DMS.
- **Shared data** – Shared data are monitoring datasets available for viewing by all users in the DMS, except for public users.
- **Public data** – Public data are monitoring datasets that are available publicly that can be viewed by all user types in the DMS; public datasets may also be published to other websites or DMSs as needed.

Managing entity administrators can set and maintain data access options for each data type associated with their entity.

8. Data Retrieval

Data may be retrieved in several ways: via the map viewer, by table, or by report type.

- **Map Viewer**: The map viewer will be used to retrieve small amounts of data currently displayed on screen.
- **By Table**: The Exports page will allow for export of entire DMS tables as comma-separated values (CSV) files. **Figure 7** illustrates the design for the Exports page.
- **By Report Type**: Reporting templates will be created to extract the specific group of data required for annual reporting to DWR.

Figure 7. SLO County Exports Page Design

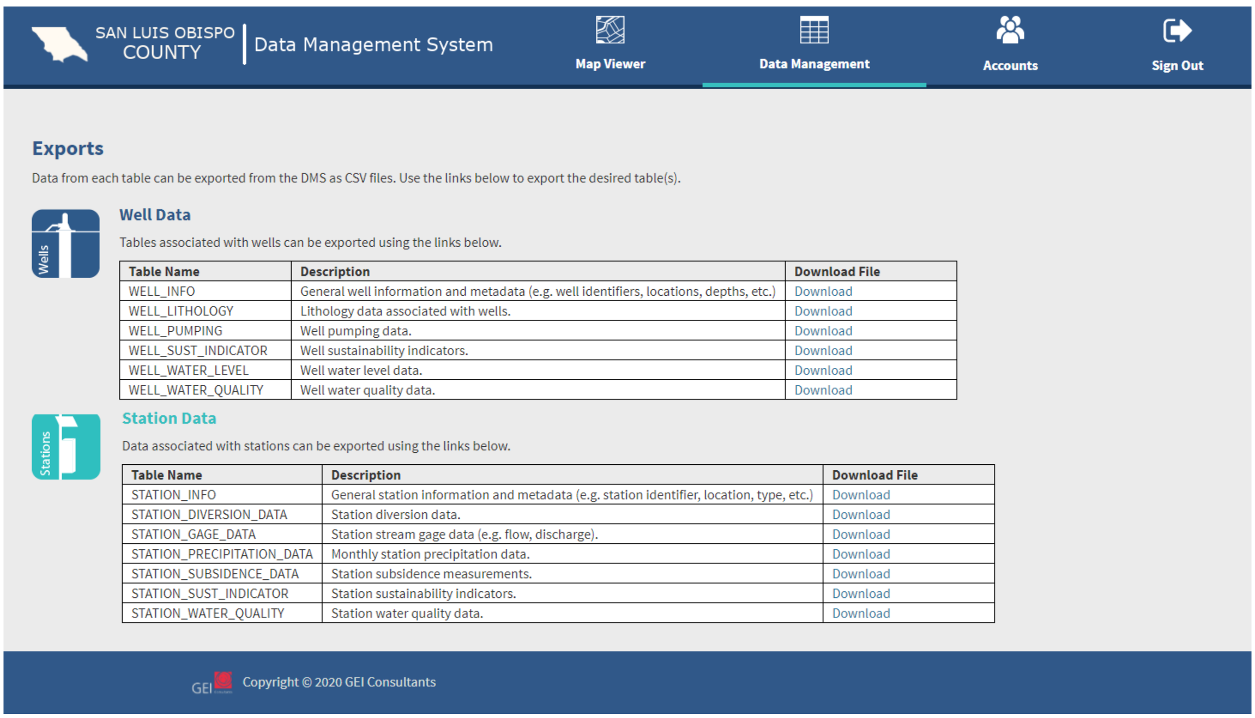


Table Name	Description	Download File
WELL_INFO	General well information and metadata (e.g. well identifiers, locations, depths, etc.)	Download
WELL_LITHOLOGY	Lithology data associated with wells.	Download
WELL_PUMPING	Well pumping data.	Download
WELL_SUST_INDICATOR	Well sustainability indicators.	Download
WELL_WATER_LEVEL	Well water level data.	Download
WELL_WATER_QUALITY	Well water quality data.	Download

Table Name	Description	Download File
STATION_INFO	General station information and metadata (e.g. station identifier, location, type, etc.)	Download
STATION_DIVERSION_DATA	Station diversion data.	Download
STATION_GAGE_DATA	Station stream gage data (e.g. flow, discharge).	Download
STATION_PRECIPITATION_DATA	Monthly station precipitation data.	Download
STATION_SUBSIDENCE_DATA	Station subsidence measurements.	Download
STATION_SUST_INDICATOR	Station sustainability indicators.	Download
STATION_WATER_QUALITY	Station water quality data.	Download

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Response to Public Comments

SLO Valley Basin Groundwater Sustainability (GSP) Public Comments

Last Updated: 8/11/21

ID	Name	Comment Subject	Comment	Date/Time	Response
1	James Waldsmith	GSP Chapters 1 & 2 - DRAFT	Could you send me a copy of the presentations presented on 9-11-19 in PDF format? In reviewing the available download of chapters 1 and 2 I do not find any of the Hydrology data presented. Please confirm receipt of this communication.	9/14/2019 13:24	Yes.
2	Toby Moore	GSP Chapters 1 & 2 - DRAFT - Agency Information	Golden State Water Company is of the opinion that an advisory body, similar or with the same structure of the current Groundwater Sustainability Commission (GSC), may be beneficial and perhaps necessary for GSP implementation. The MOU establishing the GSC contemplates this and does have language stating the following, "Depending on the content of the GSP the Parties may decide to enter into a new agreement to coordinate implementation." Inclusion of this language in Section 2.3.2 is recommended. Please consider the addition of the following text before the last sentence in Section 2.3.2. "The Parties may decide to enter into a new agreement to coordinate GSP implementation."	10/31/2019 9:17	The text is updated accordingly.
3	George Donati	SLO Basin GSP Chapters 3 & 4 - DRAFT	3.1 SLO Bain Introduction - We need to include the history of the Edna Valley Basin. In the 1950's - 1960's the East branch of the Corral de Piedra creek was dammed to install a 500 acre foot reservoir. In the 1970's, this dam was raised for a 1000 acre foot reservoir. This dam removed all flow of water into the Edna Valley Basin as the water was used for crop irrigation outside of the Edna Valley Basin. The flow downstream of the dam is not properly managed by the owner of the dam and the state water board. This has greatly reduced the re-charge of the Edna Valley Basin for the past 50 years. 3.4.1 Water Source Types - This states " Excluding the Edna Valley Golf Course, all water demand in the SLO Basin are met with groundwater" - This needs to be clarified. The Golf course uses ground water to irrigate the course, and the golf course sells groundwater water to Golden State Water Company for residential use. 3.4.2 Water Use Sectors - Industrial - The ground water wells that supply water to the Price Canyon Oil Field are just outside of the basin boundary. Why are these wells not considered to use groundwater from the Edna Valley Basin since a natural flow from the creek passes adjacent to these wells? 3.6.1.3 We are monitoring the flow of San Luis Obispo Creek as surface water leaves the San Luis Basin. Why not	1/30/2020 8:10	3.1 The text is amended to include mention of the construction of the reservoir on West Corral de Piedras Creek. Self-reported outflows from the Righetti Reservoir are discussed in further detail in Chapter 6- Water Budget. 3.4.1 Comment noted. The text is updated to make the clarification. 3.4.2 The Price Canyon Oil Field wells are outside of the SLO Basin and not under the jurisdiction of the GSP. Additionally, they are screened in bedrock formations which are not part of the Basin sediments. 3.6.1.3 Comment noted.

ID	Name	Comment Subject	Comment	Date/Time	Response
			monitor the flow of the other major creeks, east and west Corral de Piedra at the edge of the Edna Valley Basin to determine the flow that is leaving the Basin? Or better yet, the flow that could be coming into the basin below the Dam on the East side of the valley.		Chapter 7 Monitoring Network identifies the lack of a stream gage on East and West Corral de Piedras as a data gap and recommends additional gages be installed and monitored as part of the Implementation Plan.
4	Toby Moore	Communication and Engagement Plan	Appendix B of the plan describes the Groundwater Communication Portal's functionality which includes a repository of comments provided by stakeholders. However, it does not indicate whether the comments submitted will be visible or available via other means for stakeholders to review. Currently there appears to not be such functionality. As a member of the Groundwater Sustainability Commission, I feel this functionality is helpful and would encourage its implementation.	8/29/2019 9:20	Noted. The comments will be posted to SLOwaterbasin.org at the conclusion of the public comment period associated with the Chapter or technical memorandum. In addition, all public comments and responses are to be included as an appendix to the final GSP.
5	Sally Kruger	General Comments	Hi there, saw you on the GSP call yesterday and don't know if you know that we used to live on Righetti Road just down from the Righetti dam and had a creek (WCDPC) running through our property that used to have lots of steelhead in it. Unfortunately, between climate change, droughts and the dam, the steelhead have pretty much disappeared. I found yesterday's meeting to have a very interesting figure in it. The one that estimates a sustainable basin for the SLO Valley is estimated to be 5600 AF. The Righetti dam has State water right permits to hold back 991 AF. (The largest private reservoir in the State) Of course, their property and the dam are not within the boundaries of the watershed for which the plan is being developed. But I couldn't help but be astonished that the permits allow them almost 20% of the water needed to maintain the whole slo water basin and all the vineyards and ag as well as residents contained in it. I've spent a great deal of my time and energy working with Creeklands conservation, CDFW and SWRCB over the last 15 years to try to restore the water and the fish. I'm sure you would know as many of the city's projects have very long time lines. We now live in town, but I continue to work on "my" creek. Just some interesting info for you. Again, thanks, Sally	6/29/2020 12:53	Comment noted. Thank you for the information. One point that needs clarification is that total storage capacity of the reservoir is not equivalent to the annual allowable diversion; Self-reported outflows from the reservoir in recent years average 350 AFY.The terms of the surface water diversion permit associated with Righetti Reservoir are under the purview of the State Water Board. To the extent that any review of the permit conditions results in any additional water being released to West Corral de Piedras Creek, it will be beneficial to the basin.

ID	Name	Comment Subject	Comment	Date/Time	Response
6	Mark Capeli	SLO GSP Chapter 5 -- DRAFT - 5.8 Potential Groundwater Dependent Ecosystems See letter dated May 29, 2020 appended to the Response to Comments.	Enclosed with this letter are NOAA's National Marine Fisheries Service (NMFS) comments on Chapter 5: Groundwater Conditions of the San Luis Obispo Valley Groundwater Basin (SLO Valley Basin) Groundwater Sustainability Plan (GSP).	5/29/2020 14:59	1. Graphs #1, #3, and #4 do not include data for recent years. However, data from other wells in the vicinity and knowledge of groundwater use patterns in the SLO Creek Valley support our statement that no trends of declining groundwater storage is evident. The data gaps are recognized. Ground surface elevation will be included on the graphs when finalized. 2. Page 24 Chapter 5 references areas identified by Stillwater Percolation Zone Study with "naturally high percolation potential that through management actions ...could enhance local groundwater supplies...". The management actions referenced here would be recharge basins. The source of the recharge water is not indicated, and any diversions from the natural creek would be evaluated in light of potential effects on steelhead habitat. 3. Comments were made regarding identification of GDEs based on a 30-foot depth to water. This is a desktop evaluation threshold based on TNC guidelines to identify potential GDEs. Additional GDE field characterization is recommended in the monitoring plan for streams and creeks in the Basin. The TNC threshold is not specific to oaks, so that comment is removed. 4. If groundwater elevations

ID	Name	Comment Subject	Comment	Date/Time	Response
					have not declined below historical levels in the vicinity of a stream, as is the case along SLO Creek, this is an indicator that anthropogenic activities have not resulted in lowered water levels. If water levels are consistent over htepast 30 years, it is implied as per Darcy's Law that stream conditions have not been impacted in this area due to groundwater usage. Additional stream corridor characterization and monitoring is recommended in Chapter 7, Monitoring Networks. Few wells have complete periods of record, but comparisons with nearby wells that span the gaps in the period of record, and knowledge of groundwater use patterns in the area, can illuminate the conditions along a stream corridor.
7	Steph Wald	General Comments	Ch 5 comments Thank you for the opportunity to comment on Chapter 5 Groundwater Conditions of the SLO Basin Groundwater Sustainability Plan. We previously provided comments dated January 7, 2018, in the earlier phases of the development of the SLO Valley Basin. Those comments provided direction on a framework for addressing Groundwater Dependent Ecosystems (GDE) under SGMA by The Nature Conservancy. Thank you for utilizing the framework and careful consideration of GDE's in Chapter 5.Regarding the integration of technical datasets on GDE's, Figure 5-15 identifies potential GDEs and that those identified are not yet verified. While a monitoring network for future planning efforts may verify GDEs through subsequent field reconnaissance, I would suggest that project development could be informed by having GDE verification sooner rather than later. If this is not possible, and there isn't enough data to label them unlikely GDE different language to label them might be appropriate such as less likely GDEs. Page 25, second paragraph, second sentence, add The Stillwater study	6/1/2020 14:24	Comment noted. Chapter 7 includes a recommendation for the GDE's to be further evaluated in the Implementation Phase of the GSP.

ID	Name	Comment Subject	Comment	Date/Time	Response
			identifies much of the drainage area of East and West Corral de Piedras Creeks, as well as area of alluvium of smaller streams to the southeast, as having high recharge potential. Thank you.		
8	Toby Moore	DRAFT_SLOGSP_Modeling_TM No.1.pdf - Section 5. MODFLOW: Groundwater Flow Model	In section 5.1.5 "Well Pumpage", the memo identifies that the model will estimate well extractions for all wells except those owned and used for "municipal pumpage by the City will be represented in the specific wells owned and operated by the City". Golden State Water Company (GSWC) also owns and operates a public water system (GSWC - Edna System) and their municipal well extractions are metered and should be inputs into the model as opposed to estimates. Suggested text: "CHG estimates of historical well pumpage developed for the water budget analysis will be incorporated into the historical calibration of the groundwater model. Municipal pumpage by the City and Golden State Water Company (GSWC) will be represented in the specific wells owned and operated by the City and GSWC, respectively."	6/15/2020 16:41	Metered pumpage for Golden State MWC, Edna Ranch MWC, and Varian Ranch MWC are included in the model. Text is changed to reference all municipal supplies.

ID	Name	Comment Subject	Comment	Date/Time	Response
9	Jean-Pierre Wolff	General Comments	Dave, Sometime ago I mentioned to you that within the Edna Valley watershed there are several permitted reservoirs diverting surface water flow from the creeks flowing into the basin. As such these diversions impact the ecosystem and groundwater recharge through percolation. The largest of these privately owned reservoirs is the Righetti reservoir which in 1990 was granted a 4th SWRCB permit which nearly doubled the allowable capacity from 552 AF to 951 AF. The four permits are 20496, 15444, 14086 and 12887 West Corral de Piedra Creek. These permits are regularly reviewed by the SWRCB when expiring and part of the permit extension/renewal process includes an evaluation of potential impact on the downstream hydrology and ecosystem, in this case the threaded steelhead trout habitat is mentioned in previous studies and reports. Additionally, since the SLO Basin and Edna Valley is now a DWR designated high priority basin this additional information needs to be part of the record. When comparing and contrasting the annual basin recharge deficit versus upstream surface water diversion, the impact of a 951 AF reservoir and to a smaller extent the cumulative effect of other smaller reservoirs should not be ignored in the sustainability plan. As an example, the groundwater basin study being currently performed for the Arroyo Grande Basin does include the impact of Lopez Lake discharge flow rates for basin recharge and its ecosystem. I respectfully suggest that this consideration and evaluation be made part of the Sustainability Plan. Feel free to circulate my input to your colleagues collaborating on the work product. Regards, Jean-Pierre Jean-Pierre Wolff Ph.D. Grower and Vintner	6/29/2020 12:56	Our understanding of the permit is that a total storage capacity of 951 AFY is allowed as storage. Details of required outflow releases through the dam are specific to the permit conditions., The current permit relies on self-reporting of downstream flow releases by the dam operator. This is what is simulated in the model and the water budget, in the absence of more specific data. Chapter 6 (Water Budget) indicates that recent self-reported releases average about 350 AFY. The terms of the surface water diversion permit associated with Righetti Reservoir are under the purview of the State Water Board. To the extent thatany permit review results in any additional water being released to West Corral de Piedras Creek, it will be beneficial to the basin.
10	Howard Carroll	Draft_SLO_GSP_Chapter_6.pdf	Groundwater Sustainability Plan SLO Basin have reviewed the exhibits and participated in your video presentations, but as a small farmer in the Edna Valley (25 acres) I do not possess the technical information nor the practical insight of my neighboring agricultural operations. Mr. George Donati, General Manager of Pacific Coast Farming, has farmed over two decades in the Edna Valley and during that period managed over 2,000 acres of irrigated crops. I value the science and broad overview of farming operations he brings to the group. Recently, I reviewed his comments to Chapter 6 and support his recommendations for investigation, analysis of points of conflict, clarification and study he has brought to your attention. With both the diversified population overlying the SLO Basin and the long-term impacts of the GSP, it becomes essential to devote time and resources to respond to questions and	9/30/2020 12:40	Comment noted. We also appreciate Mr. Donati's experience and contributions to help us try to clarify this difficult chapter.

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			suggestions. Howard Carroll2175 Biddle Ranch Road San Luis Obispo, CA 93401		
11	Brent Burchett	Draft_SLO_GSP_Chapter_6.pdf — Part 1	Certainly the preparation of this Chapter 6: Groundwater Budget is a complex task, and we remain willing to partner with staff and stakeholders in the SLO Basin to improve the current draft that is presented for comment. San Luis Obispo County Farm Bureau respectfully submits several suggestions and questions here for further discussion. We caution there is still insufficient data to paint a fully accurate picture of what is occurring in the Basin and what policies will actually achieve our mutual goal of achieving groundwater sustainability. Absent critical data that we all might wish existed, we should use a more robust monitoring network going forward to learn from actual outcomes of different management decisions across the Basin. Our groundwater challenges were not created overnight, and we have to be realistic about what we know is occurring, and what is simply our best guess today in 2020. This Groundwater Sustainability Plan will require long-term cooperation and open communication among the agriculture community, and the more realistic and forthright we can be about our current data strengths and weaknesses, the better we can find a path forward that works for everyone. The conclusion that the Edna Valley Subbasin is in 1,100 AFY overdraft is not fully supported by this document. We are disappointed that there appears to be a general presumption that over-pumping in Edna Valley is occurring and a partial narrative is presented here to support that presumption. For example, it is unclear why the Boyle analysis from 1991 is relied on for some areas but not in others. Look at Page 9, Table 6-2: Historical Water Budget -Edna Valley Subarea. This table is significant and will likely be a key reference point for the development of regulations for the Basin. Unfortunately, Table 6-2 currently suffers from a lack of data. We are concerned about the figures for	9/30/2020 18:35	1. The 1100 AFY deficit value is supported by pumping estimates and water level trends. We relied on the Boyle Report for some historical data. 2. Table 6-2 Diversion of inflow to reservoir and basin runoff are the contributing factors. 3. Because all streams have increased watershed area in the downstream direction, it is not unreasonable to observe outflows exceeding inflows for wet years. In wet years the runoff from the basin contributes significantly to stream outflow. Outflow on SLO Creek may be greater due to WWTP effluent.

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			precipitation versus stream inflows for 2010-2019. In 2011, 2016, 2017 and 2019, inflows are reported as less than outflows. This seems counter intuitive. It appears that there is only one stream for actual data for this period. It appears that a third of the years show stream outflows greater than inflows (1993, 1997, 2000, 2001, 2003, 2005, 2006, 2011, 2016 and 2019). All of these years except 2016 are wet or above-normal precipitation years. What factors might cause this difference between outflows and inflows, is it infiltration? Please explain how the of Precipitation figures were derived for Table 6-2.		
12	Brent Burchett	Draft_SLO_GSP_Chapter_6.pdf — Part 2	On Page 31, the use of Department of Water Resources assumptions on precipitation infiltration for the Arroyo Grande-Nipomo Mesa area of the Santa Maria groundwater Basin and reference to the Paso Robles groundwater Basin are troubling. Heavy clay soils (soils consisting of more than 50 percent clay) are the predominant soil type in the Edna Valley Subbasin. To use Arroyo Grande or Paso Robles average soil types (that are generally sandy or calcareous, respectively) to presume 11-13 inches of precipitation are required before percolation occurs into the Edna Valley is inaccurate. Another example of insufficient data is on the discussion of surface water diversions on Page 30. Reported annual surface water diversions ranged from 14 acre-feet to 900 acre-feet, with average annual diversion over the base period estimated at 350 acre-feet per year (AFY). What specific data points were used to derive this 350 AFY average? Was this data self-reported by the reservoir owner? This diversion is significant as it affects the largest stream coming into Edna Valley. The description on Page 22, Section 6.3.1 Historical Time Period, does not make sense. What was the basis for selecting certain years for	9/30/2020 18:35	1. These values are based on field studies by Blaney in Ventura County and the Lompoc Valley (less sandy conditions than the Nipomo Mesa), which were considered applicable by DWR and Fugro to central coast basins. We are making the same assumption. 2. Yes, the self-reported diversions from 2010-2018 were correlated with precipitation. Reservoir evaporation was also factored in. 3. The years selected for estimating storage using the specific yield method were to determine storage at the beginning and ending of the

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			groundwater storage calculations? The interval between those years is not consistent and excludes 2016. By excluding 2016, it suggests that the 2014 low point will not be the low point going forward, while an equally valid point could be made that the 2016-2019 trend indicates an upward trend in storage. If storage is increasing, is the Basin really in overdraft? On Page 49, Table 6-14, the exclusion of 2016 paints an inaccurate picture. If 2016 was included, the significant increase from 2016-2019 would be apparent, an increase that was likely due to greater rain coupled with conservation efforts. Since the SLO Subarea was stable from 2014-2016, the 5,970 acre-feet increase is in the Edna Subarea, probably rising from 10,000 acre-feet in 2016 to 105,630 in 2019. The absence of 2016 is problematic. On Page 26, Table 6-6: Land Cover Acreages, why are the totals for Irrigated Agriculture different than those presented in Table-5: Irrigated Agriculture Acreages? We look forward to continued dialogue with all of the stakeholders and appreciate consideration of our comments.		base period and to illustrate storage trends. This is mentioned on page 22. The specific years selected do not change the overall decline in storage over the base period or the estimated overdraft. Yes, 2016-2019 shows an upward trend in storage in the water budget, but this was also a wet period that followed a severe drought. Overdraft takes into account both wet and dry periods. Most of the annual diversion amount is from Righetti reservoir, which is self-reported. 4. Including 2016 will not change the overall loss in storage over the base period, which is the main factor in overdraft. The water budget does show an increase in storage from 2016 to 2019. 5. Table 6-6 and Table 5 Irrigated Agriculture Acreages are not different for years that appear in both tables. In much of Edna Valley, Fall 2015 was the low point in groundwater elevations. Water budget calculations and storage calculations were made for years which had the most robust data, and interpolated in between these years consistent with other observed trends, Yes, there has been some recovery in the 2016-2019 period, but the evaluation is over the long term starting in 1987. Consistent declining water

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					levels indicate Edna Valley is in overdraft.
13	Howard Carroll	Workshop #3 Sustainable Goal Setting	Sustainable Goal Setting Comments: I have reviewed the options for both the Minimum Thresholds (MT), the Measurable Objectives (MO) and the respective diagrams and charts. It appears some off the options are a step backwards in the management of our water. I endorse goals that will allow agricultural operations to continue in a sustainable envelop rather than force a reduction of agricultural operations when we are above the water levels in last year of the 2015 drought. Therefore, I support MT alternative #3 and MO alternative #4.I believe the long-term solution to the MT and MO of the Edna basin is by enhancing the water resources that are available. Importing recycled water from the City of San Luis Obispo, move the release point of reverse osmosis treated water from Sentinel Oil upstream and look carefully at the storage and releases of the Righetti Dam. Private and governmental cooperation could make these options a reality and really provide sustainability for our water basis.	10/27/2020 16:00	Your endorsements for the SMCs are noted. Two of the projects you mention (City recycled water and Sentinel Peak discharge as supplemental sources) are included in the Projects and Management Actions chapter. The terms of the surface water diversion permit associated with Righetti Reservoir are under the purview of the State Water Board. To the extent that any review process of this permit results in any additional water being released to West Corral de Piedras Creek, it will be beneficial to the basin.
14	Fintan du Fresne	Workshop #3 Sustainable Goal Setting	Firstly, I greatly support efforts to collectively manage this very important resource. My background is in geology and I have been involved in grape growing the Edna Valley for 15 years now. As a geologist I have a deep concern with establishing thresholds and objectives on such a limited data set. Both the number of wells used and the limited length of most well data do not allow a scientifically rigorous record of the basin to be established. With this in mind, if MT and MO must be set to comply with SGMA, we should at this stage use those that allow the greatest flexibility: MT 3 and MO 4.	10/30/2020 9:00	Your comments on the proposed SMCs are noted. The period of record of available data is used in establishing SMCs, and this data will improve in the future with an expanded monitoring well network.

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15	Nathan Carlson	Workshop #3 Sustainable Goal Setting	As the manager of an agricultural business within the Edna Valley, the sustainability and livelihoods of many of my employees, vendors, and business partners rest upon our ability to continue to operate and farm securely into the future. We operate several water wells to support our business, and have put in place best practices to preserve and conserve our water resources. Our farming operations have been certified under an audited Sustainability program since 2014, and our production process and facility have just this year attained a Sustainability certification as well only the fourth winery to achieve this level of certification. What I have learned from our process of continuous improvement is that in order to make good decisions, it is necessary to measure consistently and accurately over a long period of time, in order to understand trends and priorities. In the process of seeing the water budgets in development, I have concerns that not enough data has been collected to lock the basin into restrictions based on estimates and questionable data. For this reason, I would urge adoption of the Minimum Threshold alternative #3, and the Measurable Objective Alternative #3 for the time being. Together with collection of data over the first five years, we will have a stronger basis to enact future guidelines for the basin. What does make sense today is for our basin to seek supplemental water sources that have been identified, such as recovered water from the city of San Luis Obispo, and to pursue mandated releases from reservoirs that trap and deprive the basin of its natural recharge. Meanwhile, we and other users will continue to pursue strategies of water use reduction, reclamation and storage, and reduction of landscape and crop demands as replanting decisions are made.	10/30/2020 11:18	Water budget calculations and storage calculations were made for years which had the most robust data, and interpolated in between these years consistent with other observed trends.

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16	Jeanne Blackwell	General Comments	Can you really have a discussion about groundwater protection without recognizing the constant threat of over a million gallons a day of toxic, radioactive waste, man made chemicals, hydrogen sulfide to mention just a few that is deposited each day at the Arroyo Grande Oil Field that sits on 3 active fault lines? This water could potentially reach any ground water in the county and contaminate it. Once the groundwater is contaminated and with the construct of the fault lines no water anywhere in the county is safe. And the reason for that is none of the wells at the Arroyo Grande Oil Field have been certified safe by the EPA Class I Underground Injection Control program mandated under CFR 144.11. So, the biggest threat to our water is the elephant in the room and I would like to know if you are going to address this issue. Every community and municipality's ground water in SLO County is threatened with irreversible and irreparable water damage because of the unlicensed, un permitted, illegal and unlawful dumping of toxic waste in the unincorporated areas of SLO county. The Board of Supervisors is the lead agency and responsible for allowing the Oil to operate without permit or license. It seems to be it would behoove every municipality that depends on clean, unencumbered groundwater would demand the Board of Supervisors get the proper and necessary certification and official verification that the Arroyo Grande Oil Field is safe to dispose of radioactive toxic and other hazardous waste without fear or threat of contamination for 10,000 years or until the toxic waste becomes inert, whichever comes first. I would like to know what you intend to do about the illegal dumping in our backyard. Thank you.	6/29/2020 14:15	The Arroyo Grande oil field is outside of and downgradient from the San Luis Obispo Valley Groundwater Basin, and is not regulated under SGMA. Additionally those wells are completed in bedrock formations which are not part of the Basin sediments. Under appropriate operations and permitted conditions, oil field extractions operations are not anticipated to endanger water supply or quality in SLO Basin. Effluent from the Sentinel Peak water treatment plant has undergone tertiary treatment, and is being considered as a possible supplemental water source for the Edna Valley agricultural stakeholders under the Projects and Managements Actions evaluations.
17	George Donati	Draft_SLO_GSP_Chapter_6.pdf - 6.3.5 Total Groundwater in Storage	To: Dick Tzou and all Consultants — My biggest question for the Edna Valley Basin, how can these consultants come up with a Sustainable Yield of less than 3500 AFY in a basin, when the Basin contains Groundwater Storage Estimates of an average of 120,000 AF? This Sustainable yield is only 3% of the storage. If you read the paragraphs below table 6-14, they explain why they increased the groundwater storage to a much higher number in the Edna Basin than previous consultants. It used to be 34,000 AF of storage. However even with this 3.5X increase in storage, the sustainable yield did not increase at all. In fact it decreased. These numbers do not make sense at all to me.	9/28/2020 13:53	Safe yield is determined by stopping storage and water level declines; it is not a function of total groundwater in storage. The sustainable yield estimate is the level of pumping that would not result in continued decline in water levels or groundwater in storage. Safe yield is not a function of total Basin groundwater in storage. For example, Paso

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					basin has about 30million AF storage but only 60,000 AFY safe yield (0.2%). Consistent declining water levels indicate Edna Valley is in overdraft.
18	Chris Darway	General Comments	The graph for pumping does not have an accurate trajectory for two reasons: (1) the trajectory for 2007 to 2019 should be down and not up; and (2) the trajectory being down since 2015 is dramatic. Conservation measures after drought.	9/29/2020 16:48	Assuming we are talking about Figure 6-8, the trajectory for groundwater extraction is shown as decreasing pumping from 2007-2019. The visual trajectory appears “up” only because the bars are below the zero line, so a decreasing trajectory is toward the top of the page.
19	Chris Darway	General Comments	Why is 2016 data being excluded? I keep rereading the Water Budget material and came across the reasoning for those years at p 22: "These years include the beginning and ending years in the base period, along with sufficient intervening years to characterize change in storage trends through the base period". This is highly discretionary. Look at the intervals between the years chosen: 4,5,3,7,6,3 and 5 years. More important, by excluding 2016, they allow the argument that the 2014 low point will not be the low point going forward, when an equally valid point is that the 2016-19 trend indicates an upward trend in storage. If increasing storage, where is the overdraft?	9/29/2020 16:49	Hydrologic base periods are selected according to several criteria, including length of record, inclusion of at least one extended wet period and dry period, beginning and ending at a similar point in the cumulative precipitation curve, etc. However, 2016 data is not excluded. Tables 6-1, 6-2, and 6-3 present estimates for all water budget components for every year from 1987-2019.
20	Chris Darway	General Comments	On page 44 why did you choose the years shown in table 6-14? There were 21 representative wells (note some of our wells weren't developed until the early 1990s and then select the years for water levels without any explanation as to why those years?	9/29/2020 16:50	The years presented in Table 6-14 are years for which water level maps were generated, which were then used to estimate changes in storage based on the water levels between those years. Often it is not easily discernible in a basin scale water level map to see water

ID	Name	Comment Subject	Comment	Date/Time	Response
					level changes between successive years
21	Earl Darway	General Comments	How can consultants come up with a Sustainable Yield of less than 4000 AFY in a basin, when the Basin contains Groundwater Storage Estimates of an average of 120,000 AF? This Sustainable yield is only 3% of the storage.	9/29/2020 16:51	Safe yield is not dependent on the total amount of groundwater in storage. The sustainable yield estimate is the level of pumping that would not result in continued decline in water levels or other undesirable effects. Safe yield is determined by stopping storage and water level declines; it is not a function of total groundwater in storage. For example, Paso basin has about 30million AF storage but only 60,000 AFY safe yield (0.2%).

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22	George Donati	Draft_SLO_GSP_Chapter_6.pdf - 6.3.4 Historical Groundwater Budget — Part 1	To Dick Tzou and all Consultants, Again in the Groundwater Budget, I find estimated and incorrect Data. Or, I do not understand the Data. My questions are below: Groundwater: 1. I do not see where streambed infiltration is counted here? Why not if over 5000 AFY flows through our streams? 2. Explain all these inflow and outflow numbers? Are they estimates? • Page 5. This map may need to be updated. This map shows irrigated acres inside and outside the basin. How is this going to be managed by SGMA? Wells outside of the basin DO affect the basin. How are these wells going to be managed by SGMA? • Page 26. Table 6.6. Land Cover. Why is Irrigated AG in the Edna Valley, 2001 2016, a different total in this table than the subtotal of irrigated AF in Table 6.5? 237 acres of Developed Urban. Is this homes and businesses? • Page 27. Stream inflow to Basin. No mention here of the Dam preventing stream inflow to the Edna Basin. • Page 30. Stream inflow was adjusted due to the Dam. However you used 2010 to 2018 as an average for the entire 33 years. Maximum diversion of 900 AFY does not make sense in the big rain years with over 5000 AFY flowing out of the creeks. And this includes ET? According to your water budget ET of precipitation amounts to a 58% - 90% loss. Please check these numbers. • Page 31. ET of Precipitation. You are using Arroyo Grande/Nipomo Mesa (Sandy Soils) and Paso Robles to estimate how much rain we need to have before infiltration starts. Edna is mainly heavy clay soils and is no comparison to sandy/ calcareous soils. Using 11-13 rain before percolation is not correct. • Page 36. Table 6-8. This data does not make logical sense. Lots of Assumptions here. We need real Data! • Page 40. Urban groundwater extractions. Are the individual homeowner wells being counted here? Does the septic leach field counter the extraction? How much ground water does the golf course use? • Page 41. Agricultural Groundwater Extractions. These are all Estimated! Why not get real data and then use real data to determine groundwater extractions. • Page 43. Table 6-11. Consumptive Water use. Are you using the low, med or High to estimate water use?	9/30/2020 11:50	1. Streambed infiltration is counted under groundwater/surface water interaction (Section 6.3.3; page 30). On the main tables (6-1 to 6-3), is it shown as an outflow item from surface water budget and inflow item for groundwater budget. 2. Explanation of all the inflow and outflow numbers are presented in Chapter 6. Inflow and outflow items are estimates derived from hard data such rainfall, water levels, temperature, irrigated acreage, aerial imagery, municipal pumping, surface water deliveries, and WWTP discharges. 3. Acreages shown outside the basin are irrigated by wells located in the basin. These may be updated as new information comes forward. Management of wells outside the basin are not under the purview of SGMA. 4. The acreage totals for the overlapping years in these two tables (2011, 2013, and 2016) are not different, they are the same. Yes, 237 acres are homes and businesses. 5. Reservoir impacts to streamflow is presented in the very next paragraph, although because of the need to insert two figures, the chapter text resumes on page 30. 6. The dataset was from 2010 to 2018, so not just those two years. Rather than an average, the dataset

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					was used to correlate reported diversions with rainfall. 7. Maximum diversion is self-reported by reservoir operator and based on limit of reservoir size, not amount of rainfall. 8. These values are based on field studies by Blaney in Ventura County and the Lompoc Valley (less sandy conditions than the Nipomo Mesa), which were considered applicable by DWR and Fugro to central coast basins. We are making the same assumption. 9. The data indicates lower thresholds for irrigated land, which makes logical sense. Local field studies for infiltration thresholds were not part of scope of work for this planning document. They could be done in the future. 10. Yes, individual homeowners are counted and septic return flows partially counter the extraction. The golf courses are irrigated in part with recycled water and in part with groundwater, which are accounted for separately in the water budget. Golf course groundwater use is included in groundwater extractions (Urban). Recycled water use on golf courses is accounted for through the ET of applied water (urban) and infiltration of applied water (urban). 11. Yes, metering agricultural wells for

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					groundwater use would be useful. 12. Each year has a specific value based on the daily soil moisture budget (Figure 6-17). The low, medium and high values are shown in the table for perspective.

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23	George Donati	Draft_SLO_GSP_Chapter_6.pdf - 6.3.4 Historical Groundwater Budget — Part 2	• Page 49. Table 6-14. Groundwater storage. This is our reservoir to use when in drought years and this can be replenished in large rainfall years. If this is truly groundwater storage, then we can re-fill this reservoir in the wet years, and use it in the drought years. Correct? How did 3300 AF sustainable yield get calculated from a 120,000 AF reservoir? • Page 50. Change in Storage 1987-2019. The Edna Valley shows a 27,000 AF decline over these 33 years, which is less than 100 AF/year. They state this is reasonable. However they again omit the fact that the 1000AF dam does not let water into our basin. If they calculate this loss, the Edna Valley actually has gained storage over the past 33 years. • Page 53. Table 6-17. Estimated Overdraft. These numbers are not real data. They cannot use the Boyle study for some of their data, and then not use the Boyle study for the conclusion of available water at 4,000 AF/year. • Page 56. Current Water Budget. 1. Current years (2016-2019), Rain increased by 1500 AFY. 2. Stream flow INTO our basin decreased by 140 AFY. How can this be? 3. Groundwater extractions. Where do they get these numbers. They are not reasonable to go higher in wet years of 2016-2019 when Ag Irrigation is much less. 4. Streamflow OUT of the Basin. In the 33 year total of 3580 is only 50 AFY less than the inflow into the Basin. This would mean that there is only 50 AFY of infiltration into the basin???? However the Groundwater Budget shows 1890 AFY infiltration.??? Thank you, George Donati	9/30/2020 11:50	1. If the replenishment in wet years does not balance the storage loss in dry years, no amount of storage will be sustainable. They are not directly related. The 3,300 AFY yield is based on being able to balance the elements of inflow and outflow over long-term climatic conditions (wet and dry). 2. A decline of 27,440 acre-feet over 33 years is 830 AFY loss in storage, not less than 100. The reservoir is estimated to withhold an average of 350 AFY of surface inflow to the basin, so removing the reservoir would only partially offset the loss in storage. Sustainable yield is calculated on a pumping amount under which continued declines will not occur. 3. The Boyle report was used to fill some of the historical surface water (imported water) data which came from City records. The conclusions of the Boyle report are provided as a comparison to the current water budget. 4. The reservoir on West Corral de Piedra Creek diverted enough streamflow to cause inflow to go down while rainfall increased. 5. Average Ag irrigation from 2016-2019 was greater than during the base period (Table 6-19), so extractions going up makes sense. 6. There is an estimated 510 AFY of average stream infiltration in the basin (Table

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					6-19). The difference between stream inflow and stream outflow is only 50 AFY because there is significant surface water runoff within the basin, especially during high rainfall years. Additional declines which may be feasible for deep agricultural wells may not be feasible for shallower domestic wells.

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24	Keith Watkins	Draft_SLO_GSP_Chapter_6.pdf - Part 1	Draft SLO GSP Chapter 6 Comments: • Page 7, first paragraph SLO Basin fills quicker and basin becomes full, preventing further recharge. When this occurs does some water flow back into the Edna basin if it is still not full? This would provide additional credits in wet years to the Edna basin. • Page 17, 6.1.1 Is the Base Period truly representative of the basins? Prior to 1987 was a very wet period, followed by a very dry period (1987 through 1991). The period chosen contains two extended droughts with individual wet years between. Wouldn't it make sense to have a wet period to balance the two extended droughts? • Page 19, 6.1.1 Rainfall totals are based on Cal Poly records with an attempt to balance with data from the gas company. This information slights the Edna basin where growers have historical data showing an average of 20% more rainfall than the numbers being used. Shouldn't we balance these number with additional data from south of the Edna basin? Possibly Arroyo Grande or Lopez Lake? • Page 31, Evapotranspiration of Precipitation Assumption that no water infiltrates when precipitation is below 11 inches. This does not account for heavy rain events early in the season that do penetrate below the crop root zone. Nor does it account for the fact that the crop is potentially already saturated from an irrigation allowing precipitation to penetrate much quicker. Basing this data from the Nipomo Mesa, which has much more wind than the Edna basin, also lowers the reliability of the numbers. • Page 33, Stream Outflow from Basin - Outflow on Pismo Creek is all based on data from two years at the end of a drought period (91). These years are not representative due to the lower water levels in the basin after a drought. So much of stream outflow is dependent on the intensity of the rain event. Actual data needs to be collected to determine when flows happen and at what volume in correlation with storm events. • Page 34, Infiltration These infiltration numbers do not take into account cultural practices that enhance infiltration and minimize runoff, such at soil chiseling, ground cover between rows, contouring of rows to catch water flow, and drains to catch flows and recycle to reservoir storage. Also, assumptions that no water infiltrates after 30of rainfall does not consider the timing and intensity of rain events • Page 37, Subsurface inflow. Water flows down gradient from the south end of the Edna basin, through the basin and out either Pismo Creek or into the SLO Basin. The model has flows out of Edna basin even during drought periods when the gradient should be reduced. Does the	9/29/2020 10:52	1. No, there is not enough pressure for groundwater in SLO Valley to flow upgradient into Edna Valley. 2. Figure 6-10 shows base period covers three dry periods, three wet periods, and one average period. It is balanced. 3. The spatially balanced average annual precipitation data in Figure 4-3 (Chapter 4) does not show the Edna Valley as having more rainfall than Cal Poly (actually less). The Figure supports using the Gas Company location for estimation of rainfall in the Basin. 4. The 11 inches is for agricultural fields and accounts for irrigation – otherwise the number is 18 inches (Table 6-8). Heavy rains in the early season are more likely to create runoff than infiltration – the soil moisture deficit needs to be met before infiltration can occur. 5. Outflow is not all based on two years of data, but only those two years can be used to check the numbers. Yes, we need stream flow data. 6. Agreed. The methodology does not account for individual grower practices or specific rain fall patterns. 7. Yes, that is considered, and the flow from Edna to SLO is an annual average based on high and low values (Page 39). Water does not flow from SLO Valley to Edna Valley; the hydraulic gradient is to

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			model consider this fact and reduce outflows to compensate for lower groundwater levels in the Edna basin?		the northwest. The Cal Poly data is the most robust dataset available in the basin. Average isohyetal contours based on long term records, and data from the Gas Company rain gage are used to estimate rainfall in other parts of the Basin. Base period selected based on several criteria, and must include at least one wet period and dry period, start and end on similar climatic conditions, etc. Additional stream flow data will be recommended to be collected as part of the implementation plan. The annual time step of the water budget requires some simplifying assumptions. The hydraulic gradient remains northward from Edna Valley to SLO Valley even in times of drought (see water level maps in Chapter 5).

ID	Name	Comment Subject	Comment	Date/Time	Response
25	Keith Watkins	Draft_SLO_GSP_Chapter_6.pdf - Part 2	• Page 49, Table 6-14 Groundwater Storage. From 1986 to 2005 (19 years) the average annual change was -349 ac-ft per year. Are we putting too much of an emphasis on the lowering of levels during the drought with this current evaluation? With Edna basin storage of over 105,000 ac-ft, setting target water levels lower than current pumping levels seems prudent to allow for sustainable agricultural operations and protection of the basins. • Page 53, 6.3.8 Utilizing Et to establish groundwater usage is not accurate when many growers utilize various methods to determine crop water demand. Many permanent crop growers utilize deficit irrigation to improve crop set, improve fruit quality, or meet winery demands. • Page 56, Table 6-19 - The current model assumes higher ag extractions, even with more acreage coming out of production? Stream inflows decrease even with an increase in precipitation. Stream outflows increasing, even with decreasing inflows. For the last four years, the model still shows a reduction in groundwater, even though we are showing a rise in the water levels (Table 6-14)? With so much contrary information, we need to build good data base to build our program on. We should take the next five years to build good information and use it to make the correct decisions on whether the basin is truly in a deficit position. Using data developed to substantiate the hypothesis does not create good policy.	9/29/2020 10:52	1. This will be evaluated in Chapter 8 - Sustainable Management Criteria. 2. The methodology used is the industry standard for estimating crop demand and is supported by DWR BMPs. It may not address specific grower practices but, short of water meters, is the most efficient way to evaluate demand on the basin scale. 3. There was still more average acreage from 2016-2019 than for the 1987-2019 base period (Table 6-5). 4. Stream inflow was less because of the upstream reservoir diverting flows after the drought. Stream outflow was more because the precipitation was greater and created more runoff. Without the reservoir, both the inflows and outflow would have been greater in 2016-2019, compared to the base period. 5. The rise in water levels mentioned is based on comparing 2014 storage to 2019 storage in Table 6-14 which is from the specific yield method. The reduction in groundwater over the last four years (2016-2019) is from the water balance. These are two different time periods and two different methods. The information is complex and may appear contrary. The status of the basin and magnitude of the deficit is based on accepted methodologies in

ID	Name	Comment Subject	Comment	Date/Time	Response
					accordance with DWR BMPs. Yes, we need to build good data to make the correct decisions. It would not be unreasonable to take the next five years to build on the available information and use it to make informed decisions on whether the basin is truly in a deficit position, provided that the actions taken do not result in avoidable, undesirable consequences.

ID	Name	Comment Subject	Comment	Date/Time	Response
26	George Christensen	General Comments	Comments on Chapter 6 of SLO Valley Basin GSP1) • Table 6-4: Historical Base Period Rainfall. This table causes me to challenge the credibility of the entire GSP. What kind of farmer, engineer, doctor, banker or venture capitalist is going to make critical decisions when more than 25% of the foundational data supporting the proposal is manufactured? Furthermore, to apply a simple constant value of 90% to all categories of the data seems like a bit of a "short cut" and a tad irresponsible. If we must follow this example of "creating datum", then I suggest doing an extrapolation for each of the year categories, e.g., dry, wet, Above Normal, Below Normal. I did a simple regression between Cal Poly and the Gas Co and sure enough it was close to a 90% relationship in the "wet" years. However, other years had lesser values with "dry" years having the lowest relationship of only 83%. Another oddity is all of the years are categorized into one of four categories: wet, dry, above normal or below normal. This states that a "normal" year does not exist where the measured rainfall fell within an expected range. Lack of a "normal" group will skew the data such that EVERY datum is abnormal and normalcy can never be observed or measured. Lack of a normal range immediately causes bias in the analysis of the data. To summarize, this table causes me to be skeptical of other data and conclusions set forth in this chapter. 2) For the Edna Valley subarea, several streams that provide critical recharge via percolation are impacted by private reservoirs totaling more than 900AF. While I believe that these reservoirs are permitted and well-maintained by the owners, data is not presented regarding the outflow from those reservoirs/dams which could impact the recharge of the Edna Valley subarea. I would like to see "credible data" be included into this model reflecting the effect these private water storage facilities are or are not having on the Edna Valley subarea. 3) While "the estimated average specific yield value for the Edna Valley subarea is also close to 30 percent greater for GSP storage calculations." (Section 6.3.5), where is the updated/revised sustainable yield for this newly sized subarea? Respectfully, George Christensen Vegetable grower	9/29/2020 17:11	1. The correlation between rainfall at Cal Poly and the Gas Company is robust (R2=0.9625) and used appropriately for adjusting annual rainfall to better represent the basin. The DWR classification for assigning the “type year” don’t include normal years. 2. The self-reported groundwater diversions from the reservoir were used in the water budget and summarized on page 30. 3. The updated/revised sustainable yield for the Edna Valley is 3,300 AFY (section 6.3.7.) Note that storage and sustainable yield are not directly related.

ID	Name	Comment Subject	Comment	Date/Time	Response
27	Thomas Murrell	Workshop #3 Sustainable Goal Setting	We need to have accurate data before making decisions. Are there plans to install monitoring wells? if so, how much time is needed to get accurate information from those wells? Seems like we are using a lot of guesswork to create a very impactful policy. I don't think it is wise or fair to make policies that end up being too drastic. Proposed Monitoring Level No. 2 (Higher than drought levels) is too drastic. The goal should be to adopt reasonable polices and resource management so that the Edna Valley reaches a level of sustainability for all stakeholders. Agriculture is precious to the Edna Valley and San Luis Obispo. Let's help sustain it, not destroy it.	10/29/2020 10:28	Comments on alternative SMC proposals are noted, and were discussed and considered during public GSC meetings We are improving the dataset with about 40 wells in the GSP monitoring network.
28	George Donati	Workshop #3 Sustainable Goal Setting	1. Since 2008 the Edna Valley Growers have been asking the City of SLO to sell to us some of their tertiary treated water since we had heard that they are dumping it down the SLO creek to the ocean. We have gone through 1 long period of drought recently and we could have used that water during the drought rather than lowering our water table. The City continues to put up road blocks to sell us water. If we had this water available, we would not be in an overdraft of our basin . 2. The Righetti Dam releases into the creek need to be enforced. This is over 600 acre feet of water that should be flowing into the creek and into the basin. 3. Golden State Water needs to look into purchasing water from the State Water Pipeline so that they are not using water from the Edna Valley Basin. Golden State currently has a Selenium issue with their water. This could alleviate this Selenium issue to all other Domestic water users in the Basin. 4. We need to Augment Water storage in the basin with Sentinel Peak Resources R.O. water. This RO water is currently dumped into the Pismo Creek and flows to the ocean due to little to no percolation in this area. We propose to move the discharge point of this RO water further up the Corral de Piedra Creek so that this helps to maintain a live stream for fish and at the same time recharge the basin.	10/30/2020 9:21	Each of the projects listed is evaluated as part of the Projects and Management Actions Chapter (Chapter 9).

ID	Name	Comment Subject	Comment	Date/Time	Response
29	Brian Talley	Workshop #3 Sustainable Goal Setting	As we consider setting key goals and targets for management of the SLO Basin, goals that will likely have huge impacts on our future sustainability, I think two key issues are not receiving enough consideration. First, much of the data that forms the basis for decision making is incomplete, erroneous or contradictory. Second, not enough consideration is given potential supply enhancements that could materially affect the safe yield of the basin. Because of this, I favor a moderate approach to goal setting in the near term to learn more about how our basin responds to adaptive management practices over the longer term. For instance, much of Chapter 6 of the draft GSP is composed of estimated values. More significantly, it appears that the saturated thickness for well 31S/13E-27MO3 is dramatically understated at 60 feet when in fact it is 280 feet. This data is then interpolated to conclude that the saturated thickness for all wells in the Edna Valley is much less than it is. This in turn leads to a recommendation of drastic reduction in pumping in the Edna Valley, potentially to the MT2 level, which could be insufficient to support existing agricultural operations. Representative monitoring wells need to be selected and accurate drilling logs need to be reviewed so that we have a more accurate data and can base management decisions on that data. Meanwhile, there are a number of opportunities to enhance water supply in the basin that haven't received enough consideration. A group of Edna Valley growers has tried to purchase tertiary treated water from the City of San Luis Obispo since 2008. This could add 600-1000 AF to the basin supply. The same Edna Valley growers are in discussions with Sentinel Power to move their discharge point for RO treated water, a byproduct of their petroleum operations, further up the Corral de Piedra creek and adding as much as 1000 AF to the basin. The Righetti dam has operated inconsistently with the permit issued by Department of Water Resources. Ensuring that their releases comply with the permit would add 600 AF to the basin and enhance the Corral de Piedra creek fish habitat. Golden State Water is struggling with elevated Selenium in their wells: they should purchase the State Water they are entitled to, which would both alleviate their Selenium issue and enhance the supply of the basin. Farmers have adopted conservation measures including pressure compensating drip irrigation and the use of highly efficient micro sprinklers. Let's make sure that domestic users are as focused on conservation as farmers. True sustainability is a long game, with a horizon of 20 years as opposed to 5. We shouldn't make critical decisions now	10/30/2020 9:40	We are improving the dataset with about 40 wells in the GSP monitoring network and proposed stream gages in Edna Valley. Construction Data for Well 27M03 has been corrected. The Projects and Management actions involving supplemental water sources that you mention are being considered in Chapter 9.

ID	Name	Comment Subject	Comment	Date/Time	Response
			based on incomplete or erroneous data. At the same time, we need to explore every viable opportunity to enhance the water supply of the basin. Making bad decisions now could have devastating impacts on agriculture in the Edna Valley, one of our county's critical industries, as well as the foundation of San Luis Obispo's green belt, which is a defining characteristic of the city.		

ID	Name	Comment Subject	Comment	Date/Time	Response
30	Jim McGarry	Draft_SLO_GSP_Chapter_6.pdf - 6.3 HISTORICAL WATER BUDGET	I do not see where streambed infiltration is counted here? Why not if over 5000 AFY flows through our streams? In aerial images for this small valley. Irrigated Ag acres. This page needs to be checked for accuracy. We do not want to rely on aerial images for this small valley. Urban groundwater extractions. Are the individual wells factored here? Does the septic leach field counter the extraction? How much ground water does the golf course use?	9/28/2020 14:08	Streambed infiltration is labelled as GW/SW interaction in Tables 6-1, 6-2, 6-3. Aerial images are reasonably accurate for this purpose. Yes, they are. Yes, total esitmated pumpage from the water budget was distributed equally to all well locations provided in county well GIS data. . Golf Course use is included as part of Urban Demand per DWR Water Budget BMP and not reported separately.
31	Chris Darway	Draft_SLO_GSP_Chapter_6.pdf	Why is 2016 data being excluded? I keep rereading the Water Budget material and came across the reasoning for those years at p 22: "These years include the beginning and ending years in the base period, along with sufficient intervening years to characterize change in storage trends through the base period". This is highly discretionary. Look at the intervals between the years chosen: 4,5,3,7,6,3 and 5 years.	9/29/2020 16:47	2016 data is not excluded from the water budget. Tables 6-1, 6-2, and 6-3 present estimates for all water budget components for water years 1987-2019.Groundwater storage is estimated by the water budget for all years using all the available data over the base period. The years selected for estimating storage using the specific yield method were to calibrate the beginning and end of the base period and to illustrate storage trends. They do not change the overall decline in storage over the base period or the estimated overdraft.

ID	Name	Comment Subject	Comment	Date/Time	Response
32	James McGarry	General Comments	1. Since 2008 the Edna Valley Growers have been asking the City of SLO (using Rob Miller with the Wallace Group) to sell to us some of their tertiary treated water since we had heard that they are dumping it down the SLO creek to the ocean. We have gone through 1 long period of drought recently and we could have used that water during the drought rather than lowering our water table. The City continues to put up road blocks to sell us water. If we had this water available, we would not be in an overdraft of our basin (if we are at all). 2. The Righetti Dam releases into the creek need to be enforced. This is over 600 acre feet of water that should be flowing into the creek and into the basin.3.Golden State Water needs to start purchasing water from the State Water Pipeline so that they are not using water from the Edna Valley Basin. Golden State currently has a Selenium issue with their water as brought up by Toby Moore in the Workshop. This could alleviate this Selenium issue to all other Domestic water users in the Basin. 4. We need to Augment Water storage with Sentinel Peak Resources R.O. water by discharging the water that is currently going out to the ocean, further up the Corral de Piedra Creek. 7. Corral de Piedra creek needs to be brought back to life to save the fish. If this were done using surface water, then our basin would be in a plus balance. 8. During the last drought, very few domestic wells went dry (these were old wells that were not drilled to a sustainable level). Those unsustainable wells have been replaced. We can get through the next drought with MT's below the last drought levels.	10/30/2020 11:47	The projects listed are evaluated as part of the Projects and Management Actions Chapter 9.

ID	Name	Comment Subject	Comment	Date/Time	Response
33	Andy Mangano	Workshop #3 Sustainable Goal Setting - Part 1	Edna Ranch Mutual Water company (East) / Public Comment SLO Basin GSP — Stakeholders Workshop #3 — 10/01/2020 Edna Ranch Mutual Water Company (East) appreciates the opportunity to provide the following comments. We recognize the Basin faces challenges and we encourage a collaborative process whereby SGMA employs science and up to date accurate information to best determine a sustainable plan for all users. Observations: 1) in our initial review, there appears to be incomplete data which requires the consultant to base their conclusions on estimates, For example: A) There is a lack of data for stream inflows and outflows B) A lack of well drilling logs C) A lack of monitoring wells to accurately measure water levels D) The representative well most relevant to our MWC is 315/13E-27M03, which is depicted on page 26 of the workshop #3 materials. We understand the actual drilling logs show saturated thickness of 280 feet rather then 60 feet mentioned Suggestions: 2) Robust stream gauges, procurement of all well drilling logs for all representative wells, robust well metering locations and strategically located monitoring wells. 3) In the first 5 years, we should fully develop all revenant scientific data and at the same time, proceed cautiously given the lack of data, and the necessary reliance or guesses and estimates, that could be considered unreliable.4) In reviewing the Paso Robles GSP, we note there is a 5 year period of improved monitoring and fact gathering before any policies are implemented. We encourage Edna Valley adopt the same approach during the first 5 year period. We also recommend during this period to fully explore all augmentation opportunities and conservation measures.	10/31/2020 9:45	As part of the monitoring network the GSP will recommend additional stream gages. We are improving the dataset with 40 wells in the GSP monitoring network and will collect a robust dataset in the 5 years following the development of the GSP. Well construction data for 27M03 has been corrected.

ID	Name	Comment Subject	Comment	Date/Time	Response
34	Andy Mangano	Workshop #3 Sustainable Goal Setting - Part 2	5) SGMA requires a minimum of 10 years for the historical analysis. If the 10 year period had been adopted, the trend for groundwater pumping would be decreasing rather than increasing when using the 33 year model as depicted on Page 29 of 127 in Chapter 6 of the water budget. 6) Actual City of SLO greenbelt extends out to Edna Ranch. The City in 2014 adopted a policy in support of providing recycled water use within the City's Greenbelt. What is the status of this policy implementation? 7) The last page of the Workshop #3 materials projects an augmentation of 500 AFY that would raise the water levels by 33 feet. If the City could provide up to 1000 AFY of recycled water, it appears the water levels would increase for our representative (MO3) to 1995-99 levels as depicted in the graph on page 26. 8) Chapter 6 of the water budget, page 25 (70 of 127) shows there are 453 acres of row crops. Page 43 (88 of 127) indicates row crops (overhead sprinklers) use a median of 1.6 AFY and vineyards (drip irrigation) use 0.6 AFY. Does this mean that if row crops converted to drip irrigation there would be a corresponding reduction of 453 AFY? If row crops converted from overhead sprinklers to drip, would this not achieve a savings of 453 AFY? It appears a lot of water could be saved by converting overhead sprinklers to drip irrigation. Respectively Submitted By Edna Ranch Mutual Water Company (east) Board Of Directors	10/31/2020 9:45	The management actions listed here will be considered in chapter 9/Projects and Management Actions. It will consider irrigation efficiency as a management action. However, it should be noted that increased irrigation efficiency also results in reduced irrigation return flows, so the net impact on the aquifer may not be significant.
35	Earl Darway	General Comments	There are two lines of numbers that are curious. 1/3 of the years show stream outflow exceeds inflow: 1993, 1997, 2000, 2001, 2003, 2005, 2006, 2011, 2016, and 2019. All these years are Wet of Above Normal, except 2016 Below Normal. Is this due to infiltration and / or GW/SW intersection? Does this make sense to you? Similar question regarding ET evaporation: In 8 Dry years, the evaporation essentially equaled the precipitation: Precip ET Evaporation1987 6780 66101990 5960 58602007 3810 38002009 5170 51002013 4640 46002014 4590 45502015 5230 51602018 6130 6020 The numbers above don't make sense.	9/30/2020 19:01	1. All streams increase in watershed area in the downstream direction. In wet years the runoff from the basin contributes significantly to stream outflow. 2. 2016 followed a severe drought, and diversion of inflow to the upstream reservoir was a contributing factor. 3. Since there is a need to overcome the soil moisture deficit before infiltration can occur, there is a minimum rainfall threshold the must be met every year. In dry years, this minimum can take of most or all of the available

ID	Name	Comment Subject	Comment	Date/Time	Response
					precipitation. That's why there's often little recharge in dry years.
36	Earl Darway	General Comments	Page 29 shows a gain of 5970 AFT for years 2016 -2019. The graph shows an upward trajectory for Edna. Table 6-14 should show the amount of storage for 2016. By not doing so, we miss the great increase from 2016-2019--most likely due to greater rain plus conservation efforts. Since the SLO subarea was stable during 2014-2016, the 5970 increase is in Edna--probably rising from about 100,000 AFT in 2016 to 105, 630 in 2019. Impressive and not apparent because 2016 numbers are not shown.	9/30/2020 19:01	Not finding referenced gain on page 29, but storage increase between 2016-2019 is estimated by water budget in Tables 6-1, 6-2, 6-3. Focusing on a partial rebound following severe drought doesn't resolve big picture declines. We must evaluate a long-term time period.
37	Robert Schiebelhut	Workshop #3 Sustainable Goal Setting	Revision Needed For Representative Well 31S/13E-27MO3: Page 22 of the materials presented at Workshop #3 depicts a graph of the Baggett Main Well--31S/13E-27MO3--a well at Edna Ranch. I believe the well log for this well was made available several years ago but in any event, I have recently forwarded the drilling log to David O' Rourke. In fact, the drilling log shows an actual depth of 400 feet with sands all the way to 400 feet. Bedrock was not encountered. Please revise the graph to show the well depth at 400 feet and al least 280 feet of Saturated Thickness--- instead of 60 feet. Thank you	10/26/2020 13:48	Comment noted, model and hydrograph have been corrected to reflect this.
38	Brian Bertelsen	Workshop #3 Sustainable Goal Setting	As a property owner in the Edna Valley, I fully support MT-3 and MO-4. Additionally, I am in favor of a 5 year period of collecting good, reliable data of the water basin and exploring all options to utilize recycled SLO water for farm irrigation purposes which helps this basin as well as allows the city of SLO to sustainably discharge its treated water.	10/30/2020 10:44	Comment on preferred SMCs is noted, and was discussed in public GSC meetings. Improved data collection will be a high priority in the implementation plan.

ID	Name	Comment Subject	Comment	Date/Time	Response
39	Brian Talley	Draft_SLO_GSP_Chapter_6.pdf	My family has farmed wine grapes and vegetables in the Edna Valley for more than 30 years. During this time, we've made numerous changes to reduce our water consumption and preserve this most precious resource. As I've reviewed the various documents in the Water Budget Chapter of the Groundwater Sustainability Plan for the SLO Basin, I'm struck by the complex and often contradictory nature of the data that underpins many of the findings and likely future decisions. My concern is that significant changes are contemplated based on erroneous or missing data, and this could have potentially devastating impacts on agriculture in our region. I encourage you to slow down and adopt a more adaptive approach that relies on better data to guide decision making. This should start with a robust and accurate monitoring system where stakeholders can monitor progress and agree on best practices to achieve mutually agreed upon objectives. The consequences of getting this wrong could not only destroy the livelihood of those of us farming in the Edna Valley, but have lasting negative impacts on land use in the valley. Just as my family has relied on an adaptive and evolving approach to manage our resources, so should we all as a group going forward.	9/29/2020 15:23	The monitoring well network has been expanded from 12 wells to 40 wells, and will provide better data during the first 5-year implementation period. The importance of agriculture to the local economy is understood by the GSAs. The SGMA legislation mandates a specific timeline. A plan with recommended SMCs must be filed by January 2022. Adaptive management through the 20-year planning period based on additional data is planned.
40	George Donati	Draft_SLO_GSP_Chapter_6.pdf - 6.3.3 Historical Surface Water Budget	To: Dick Tzou and all Consultants George Donati comments: I have reviewed the data in the Water Budget (Chapter 6). I find that much of the date is estimated, inaccurate, contradictory, and possibly manufactured. Many of my findings are outlined below. I have farmed in this valley since 1996 using ground water on permanent crops. We need to slow down our Sustainability Plan process so that we can gather accurate data to be able to make the correct long-lasting decisions. We need to have time to gather accurate data as the basis for our Sustainable plan. This will protect all homeowners, landowners, Farmers and residents while we accurately sustain the Edna Valley Basin. Again, below are my findings of data that I am questioning. Page 6. SLO subarea surface inflow watershed is 28,823 acres. Edna subarea inflow watershed is 10,145 acres. Edna is only 35% as big as SLO. Page 9. Figure 6-2. Surface Water: 1. Is the stream inflow above the Righetti dam or below? If below, then this cuts a lot of our watershed out of the equation. 2. What is ET of Precipitation? Why is this number almost always about 90% of total precipitation? This means that 90% of rainwater is evaporated during cloudy and rainy weather? Please explain.	9/30/2020 12:09	Your comments on slowing down timeline for GSP submittal is duly noted. However, the SGMA legislation mandates a specific timeline. A GSP must be filed by January 2022, which will also include an adaptive management approach in implementing the plan in the next 20-years. The Edna Valley contributing watershed is smaller than the SLO Valley contributing watershed area, so the inflows into Edna Valley are smaller. 1. The stream inflow is below the Righetti Reservoir. 2. The estimated ET of precipitation is based on the minimum infiltration thresholds (ET of rainfall prior to deep percolation or

ID	Name	Comment Subject	Comment	Date/Time	Response
			3. Where is the stream inflow measured? Stream Inflow of 5480 AFY (2019) calculates into 3400 gallons per minute of water flowing into our basin below the dam in the creek for 365 days, 24 hours per day??? Or is this above the Dam? Can this be correct when we see no water flowing in these creeks? 4. Stream Outflow is higher than stream inflow? Where is this additional water coming from? 5. Riparian ET. How can this be the same number every year when we had long years of drought and no streamflow for many years? Thank You, George Donati		runoff). On average, 74% of rainfall is estimated to evaporate (not 90%), while only 67% evaporates during a wet period (Table 6-20). These are reasonable values. 3. Stream flow on west corral de Piedra is estimated below the dam. The inflow is for all drainages, not just below the dam. Stream flow is intermittent within a wide range, from dry to peak flows of over 1,000 cubic feet per second (cfs)and mean daily flows of over 700 cfs (over 300,000 gallons per minute) recorded on Pismo Creek. During the high flows, much of the water passes through the basin. It would only take about 35 days with high flows (say 80 cfs average) to deliver 5,480 acre-feet of water. Yes, the creeks are dry most of the year. 4. The additional water is from Runoff from within the Basin. 5. It's a small enough number compared to the surface water budget to use as average over most years. During severe drought years it was reduced (Table 6-2).

ID	Name	Comment Subject	Comment	Date/Time	Response
41	Rick Rogers	Workshop #3 Sustainable Goal Setting - Part 1	NOAA's National Marine Fisheries Service respectfully submits the following comments regarding the "Draft Options for Basin Sustainability Goals Workshop Presentation Slides" presented to the public via webinar on October 1, 2020. We previously relayed these concerns via public comment during the September 9, 2020, SLO Groundwater Sustainability Meeting. Specifically, we are concerned that the SLO GSA continues to promote sustainable management criteria for streamflow depletion impacts that may be insufficiently protective of South-Central California Coast steelhead, listed as threatened under the federal Endangered Species Act. Per SGMA regulations, the required metric for the undesirable result of interconnected surface water (ISW) depletion is the rate or volume of surface water depletions caused by groundwater use that has adverse impacts on beneficial uses of the surface water and may lead to undesirable results (California water code 23 CCR 354.28(c)(6)). SGMA requires that if a proxy metric is used, then significant correlation must be established between the two metrics (CCR 354.36(b). Unfortunately, the October 1 Workshop Presentation ("Draft Options for Basin Sustainability Goals") continues to propose utilizing groundwater elevations experienced during our recent historical drought as a proxy for ISW depletion, despite there being no identified correlation between those groundwater elevation and "adverse impacts on beneficial uses of the surface water". Identified beneficial uses of San Luis Creek, Pismo Creek, and many other streams traversing the basin are designated by the Central Coast Regional Water Quality Control Board (CCRWQCB) 2017 Basin Plan, and include preserving cold water habitat (COLD), steelhead migration (MIGR), steelhead spawning and rearing (SPAWN), and protecting threatened and endangered species (RARE).The proposed sustainable management criteria neither analyzes nor establishes any ecologically-meaningful relationship between groundwater levels and impacts to these beneficial uses of surface water.	10/28/2020 11:02	The GSP monitoring network identifies stream gages on SLO Creek and East and West Corral de Piedras and will be considered for MO's and MT's once data has been collected. Water level data in alluvial wells in SLO Valley indicate there has been no historical declines in water levels that would impact SLO Creek. Water level data in alluvial wells in Edna Valley and anecdotal information from residents indicates that Corral de Piedras Creeks go dry every summer, and are seasonally disconnected from the underlying aquifer.

ID	Name	Comment Subject	Comment	Date/Time	Response
42	Rick Rogers	Workshop #3 Sustainable Goal Setting - Part 2	ISW depletion impacts instream aquatic habitat primarily by reducing groundwater accretion to a gaining stream, or accelerating ISW depletion from a losing stream. The impacts can be both physical (e.g., pool volume shrinks as water surface elevation declines) and chemical (e.g., water quality can suffer as pools and riffles lose connectivity). Thus, the appropriate method to determine whether pumping is having significant and unreasonable adverse impacts on beneficial uses of surface water and setting protective management criteria is to understand the level of impact (i.e., volume of ISW depletion) and how habitat quality and functionality change because of that impact, all evaluated on an ecologically pertinent time-scale. Further analysis is required throughout the SLO groundwater basin to establish localized relationships between ISW depletion and the instream habitat characteristics that result. Addressing these impacts will require data and analytical tools that the SLO GSA may not possess at this time. Thus, NMFS recommends the developing Groundwater Sustainability Plan elaborate sufficiently as to when, where, and how data informing streamflow depletion impacts will be collected during the first few years of GSP implementation, and clearly commit to developing a detailed analysis plan with interested stakeholders at a later date. The sustainable yield presented at the workshop is fatally flawed. Per SGMA regulations and guidance, sustainable yield can only be achieved if the basin is sustainable (i.e., avoiding all undesirable results, including depletion of ISW). As explained above, the proposed sustainable management criteria for ISW depletion (i.e., groundwater elevations consistent with extreme drought conditions) likely will not avoid adverse impacts on beneficial uses of surface water; thus, the presented sustained yield estimates are likely invalid and inconsistent with SGMA regulations. Finally, excluding streams as "disconnected from groundwater" based upon a one-time 30-foot depth to groundwater measurement is a concept developed for discerning impacts to riparian vegetation (rooting depth for oak trees), and is not appropriate for analyzing threats to ESA-listed steelhead and their habitat.	10/28/2020 11:02	The GSP monitoring network identifies stream gages on SLO Creek and East and West Corral de Piedras and will be considered for MO's and MT's once data has been collected.

ID	Name	Comment Subject	Comment	Date/Time	Response
43	James Lokey	Workshop #3 Sustainable Goal Setting	These comments are in regard to the October 1st Stakeholder Workshop #3 presentation slides on Minimum Thresholds (MTs) and Measurable Objectives (MOs):We note on Slides 22 through 27 that the MT(1) for most of the representative wells is set at or near the lowest recorded water level for each well. However, on slide 27 for VRMWC Well #1 your team has recognized that this well has historically shown no ability to recover (other than seasonal partial recovery) over the long term. The MT for this well on slide 27 is set at 160 feet. Thus, in theory, we assume this setting would provide time for the GSA to take actions per the GSP that would reverse the long-term declining trend at this end of the aquifer. At our current rate of long-term decline, a Minimum Threshold of 160 feet for VRMWC Well #1 provides approximately 5 years of continued decline before reaching this MT. While we would prefer to halt this negative trend much sooner than 5 years from now, we understand the reality of the situation and it will take time to implement actions and fund projects to turn this around. We therefore concur with 160 fee as an acceptable MT for VRMWC Well #1, as long as the GSP sets a Measurable Objective that is at least 20 feet above the MT for this well. The MO2 for this well, to incorporate some recovery over the drought years, appears to be in an appropriate range to help provide a sustainable source of water for the long term at this far end of the basin. As shown in the attached chart of our Well #1 water table, as recorded at the lowest level each year since 1988, our water table was declining at an average annual rate of 1.4 feet per year. But since 2003, and over the last 17 years, that decline increased to over 4.24 feet per year on average, which is a 300% increase. The Varian Ranch Mutual Water Company and the residents of the Varian Ranch Development undertook a conscientious water conservation effort over those years which has resulted in the average water use per connection at Varian Ranch declining by over 40% compared to the years prior to 2003.Therefore, we would also ask the GSA to study if the steady decline in the water table at this well may be the result of heavier water use over the last 17 years with the increased number of vineyards and citrus groves that have been developed in the Edna Valley. While we recognize the economic vitality of the agricultural industry to our community and we certainly wish to work with our Agricultural neighbors in maintaining their operations, the water use of the 48 homes at the Varian Ranch development is deminimis when compared to all other uses in the basin and this fact needs to be addressed as the GSP is developed to bring the	10/30/2020 17:57	Comments on proposed SMCs are noted and were discussed at GSC public meetings. Projects and Management Actions will discuss proposed augmentation possibilities to address the groundwater declines. It is recognized that Varian MWC pumping is a small amount when compared to agricultural pumping amounts.

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			entire valley into a sustainable condition. We also encourage the GSA to fully explore all augmentation opportunities that may be available from within and outside the basin.		
44	Peter Orradre	Workshop #3 Sustainable Goal Setting	I am a property owner in Edna Valley and have a serious interest in how our water will be handled in the future. Please see my comments below. I am in support of the MT #3 which addresses the lower water levels than recent low droughts and MO #4 which addresses the Edna Valley wells the best. It is in everyone's best interest to adopt a water conservation program for all domestic and ag wells within the first 5 years of the GSP. This would be equitable for all users to use the most efficient practices. The most sensible approach to coming up with a successful long term plan starts with collecting accurate data versus using estimates or skewed models. I appreciate all your energy throughout this most important task. Sincerely, Peter Orradre	11/1/2020 14:19	Comment received, SMC priorities are noted, and were discussed in public GSC meetings.

ID	Name	Comment Subject	Comment	Date/Time	Response
45	Barbara Baggett	Workshop #3 Sustainable Goal Setting	Thank you the opportunity to comment. I have lived in the Edna Valley for 40 years. I appreciate the hard work of the consultants and staffs to develop the data on which we are to make decisions. But they had a disadvantage due to lack of data. For example, no real stream gauges or monitoring wells. Just production wells; and for those, incomplete drilling logs.. Incomplete rain records for this Valley. Not their fault but we need more information. As with the Paso Basin we need to use the first 5 years to develop full and complete data, especially reliable water level data. I have offered one of my inactive wells for monitoring. I join my neighbors in advocating for MT-3 and MO-4 for the first 5 years. I also applaud the efforts of those actively working on bringing in new water, especially recycled water from the City of San Luis Obispo, This will benefit all of us. I also support identifying and implementing all feasible conservations measures. Working together we can reach sustainability. Barbara Baggett	11/1/2020 11:02	Data will be collected in the first 5 years with a monitoring well network increased from 12 to 40 wells, as well as proposed stream gages. Comments on proposed SMCs are noted and were discussed at public meetings. New water sources are evaluated in Chapter 9, Projects and Management Actions.
46	Sarah Hinrichs	Workshop #3 Sustainable Goal Setting	As the CFO for an agricultural business, I oversee several Commercial, Industrial, Agricultural and Residential properties which depend upon water security for their ability to operate and as a large portion of their real estate value. We are careful and aware users of our water resources, and have put into place many conservation measures such as conversion to low-water use landscaping, calibration of our crop irrigation systems, and improving water storage and distribution systems to maximize efficiency. As the Edna Valley Basin begins to build a structure to regulate and manage our shared resources, I think is important to proceed with caution and seek robust data over the next several years. In considering the options laid out, I support the adoption of the Minimum Threshold alternative #3, and the Measurable Objective Alternative #4, in order to allow users security in their operations as this information is collected. Additionally, it makes sense to identify and pursue outside supplemental water sources, many of which have been identified already, to improve the water security of our basin. Together with conservation, storage, and distribution improvements, we can work together to preserve our property values and agricultural traditions into the future.	10/30/2020 14:32	Comments on proposed SMCs are noted and were discussed at public meetings. Supplemental water sources are evaluated in Chapter 9, Projects and Management Actions.

ID	Name	Comment Subject	Comment	Date/Time	Response
47	Bruce Falkenhagen	Workshop #3 Sustainable Goal Setting	Gentlemen: I have been following this issue for a while and very pleased that this seems to be moving ahead. I am a resident of the Edna Valley for 20 years with a 40 acre parcel just outside of the SLO Greenbelt. The property has little water beneath it down 500' to well below sea level, because it is all Monterey formation and holds water only in the limited fractures. I have three comments on the work to date: 1) I believe that the City of SLO needs to be much more active in giving it's reclaimed sewage water to help the Edna Valley basin. After all, it has declared almost the entire length of the Valley as IT'S greenbelt. So it would follow that the city should help keep it green and in agricultural crops. It doesn't, directionally it will push or even force landowners to convert their flat land to a higher and better use, like higher home density or industrial projects. And despite SLO making objections at that time that it is part of "their" greenbelt and that use should not be allowed suddenly has little basis or foundation. The argument by the developer would be very simple. SLO kept the water and would not allow it to be used to keep the Valley green and in agriculture, so SLO not only has lost the right to object, but by its actions or lack thereof, have in fact endorsed the project. They, the City, has done nothing to help hold the Greenbelt as a green belt. 2) We know the story of the Righetti dam. The owners/controllers must require and enforce the requirement for it to release the water that it is required to release which was part of it's building/development permit. I can not understand that the regulators have not enforced this permit requirement or whatever the document was that made the release requirement. 3) The backup data being relied upon to justify these actions and projections are filled with assumptions. Since so much is at stake here, and if the assumptions are wrong, the underpinnings of the program are gone and much money has been wasted. I agree with the concept that everything should be held in abeyance for 5 years, to see how accurate those projections were, and then discard the ideas found to be based on events/situations that did not occur, and focus on those that predicted properly and accurately. Thank you very much for your time, and thank everyone involved for donating so much of their time to move this forward.	11/1/2020 16:35	The City of SLO recycled water program is considered as a potential supplemental supply in Chapter 9. The terms of the surface water diversion permit associated with Righetti Reservoir are under the purview of the State Water Board. To the extent that any review process of this permit results in any additional water being released to West Corral de Piedras Creek, it will be beneficial to the basin. Additional data will be collected from a much-improved monitoring well network and stream gages in the first 5 years.

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48	George Christensen	Workshop #3 Sustainable Goal Setting	There are four main points which I would like to make. 1) Credibility of data. Today's models are not based on observed or collected data. A significant portion of the data has been generated and interpolated from "similar" sites. I strongly urge the team to prioritize the collection of credible data from the monitoring wells for the next 5-7 years. After that date is analyzed and added into the models, we will need to re-evaluate. 2) Aggressive, regular replenishment of the Edna Valley aquifer. Over the next 5-7 years, I would like to see the team focus on these 3 initiatives that could significantly recharge the Edna Valley aquifer: (a) reach an agreement with the City of SLO for the discharge from the waste water treatment plant; (b) engage with Sentinel and land owners to move the Sentinel discharge location to a more advantageous location; (c) work with the Righetti ranch to release sufficient water to have a year-round steady flow in the Corral de Piedra Creek. 3) Agricultural Conservation. Provide seminars and information about new/modern water conservation equipment and process for the growers in the Edna Valley. 4) Based upon the points I have outlined above, I strongly support MT-3 and MO-4 for the next 5-7 years when we can re-evaluate AFTER we have gathered actual data. Respectfully, George Christensen Vegetable Grower	11/2/2020 11:56	The integrated groundwater/surface water model used is based on observed collected data from the basin including rainfall, water levels, municipal pumping volumes, irrigated acreage, and other data specific to the basin. The data management plan will increase monitoring wells to over 40 and fills in data gaps over the next 5 years. City recycled water and Sentinel Peak water are considered as potential supplemental supplies in Chapter 9. The terms of the surface water diversion permit associated with Righetti Reservoir are under the purview of the State Water Board. To the extent that this process results in any additional water being released to West Corral de Piedras Creek, it will be beneficial to the basin. Improvement of irrigation efficiency is considered as a management action in Chapter 9. However, it should be noted that improvements in this areas result in decreased amounts of irrigation return flow, so the net impact to the aquifer may be less than anticipated. Comments on proposed SMCs are noted.

ID	Name	Comment Subject	Comment	Date/Time	Response
49	June McIvor	Workshop #3 Sustainable Goal Setting	Dear SLO Water Basin GSC: Phase 2 Cellars, LLC dba Tolosa Winery appreciates the opportunity to provide input on the SLO Basin Groundwater Sustainability Plan. As we acutely feel the encroachment of commercial development right up against our surrounding vineyards, it is more important than ever to take steps which allow agriculture in Edna Valley to thrive as well as to protect the city's™s defining green belt. Setting the key goals and targets for management of the SLO Basin is the essential foundation of sustainability of the basin and of our critical agriculture industry. It must not be done on incomplete or erroneous data, and time should be taken to make sure data is accurate upon which to base management decisions. We are in favor of taking the first 5 years to gather good data, including improved monitoring that includes: stream gauges, strategically located monitoring wells, review of the drilling logs of each monitoring well, and ideally, robust monitoring of water levels in all wells every month of the year. While this data is collected and analyzed, we need to proceed cautiously with no required reduction in pumping; MT-3 is the most appropriate threshold. We also believe there is more that can be done to augment our basin. Opportunities include: Obtaining tertiary treated water from the City of SLO, rather than that valuable water being dumped to the ocean; Adoption of water conservation measures by all users in the Basin, not just by agriculture; Releases from the Righetti Dam into the West Corral de Piedra Creek, as required; Golden State Water purchasing water from the State Water Pipeline instead of using water from the Edna Valley Basin; Sentinel Peak Resources could discharge their R.O. water further up Corral de Piedra Creek, rather than the current discharge that goes out to the ocean. With all of these opportunities for augmenting the basin, we believe that MO-4 is the logical objective. Thank you for your consideration. June R. McIvor President & CEO Phase 2 Cellars, LLC dba Tolosa Winery	11/2/2020 12:05	Additional data will be collected in the first 5 years through improved monitoring well and stream gage networks. The projects that you mention are considered as potential sources for supplemental water. Comments on proposed SMCs are noted.

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50	Brent Burchett	Workshop #3 Sustainable Goal Setting	These comments are submitted on behalf of the San Luis Obispo County Farm Bureau to provide additional stakeholder input on the Draft Options for Basin Sustainability Goals Stakeholder Workshop #3 (October 1, 2020) Presentation Slides. Based on feedback from farmers in the SLO Valley Basin, we recommend Minimum Threshold 3 and Measurable Objective 4. We share the goal of all basin stakeholders to achieve sustainability for all users, whether residential, municipal, or agricultural. As we detailed in comments submitted on September 30, 2020 regarding Chapter 6-Groundwater Budget, there are currently too many significant data deficiencies to proceed down a path of immediate cuts to farmers in the Basin. The current reliance on production wells as a data source creates inaccurate information for GSA decision-makers, and should be replaced over the next five years with monitoring wells. Our initial priority needs to be building a monitoring network to guide our actions in the decade to come. As we have not exhausted opportunities to supplement our existing water resources with sources like tertiary treated water from the City of San Luis Obispo, State Water, or water being released into the ocean, it would be reckless to balance the Basin solely on the backs of our farmers. Adopting Minimum Threshold 2 (Higher Water Levels than Recent Low Drought Water Levels) for any or all wells may be politically expedient, but such an approach could fail to actually achieve sustainability if assumptions about groundwater impact from specific farms or areas in the Basin are miscalculated. We do not want additional data monitoring for the sake of delaying negative impacts to agriculture. Rather, our Farm Bureau wants farming in the Edna Valley to remain viable for the next generation, and our City and County leaders have an obligation to sustain Edna Valley agriculture's essential contributions to our City and County's economy and quality of life. We know farmers will have to participate in a more robust well monitoring network, and we may have to make changes that affect agriculture, but let's equip our GSA to do so armed with better information than we have today.	11/2/2020 12:10	Comments on proposed SMCs are noted. The well monitoring network has been improved from 12 wells to 40 wells. potential projects mentioned for supplemental water are being considered in Chapter 9. The significance of agriculture to the local economy is recognized by the GSAs.

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51	Robert Schiebelhut	Workshop #3 Sustainable Goal Setting	Some Additional Water Augmentation Suggestions: The ag community has been and continues to be committed to pursuing various feasible water augmentation projects. In addition to those that are under discussion, I would like the consultants and staff to consider the area under the Edna sub basin--the bedrock--as a potential source of water for our sub basin. Our sub basin does have active faults and may have water flows in the bedrock with enhanced recharge--or even a large captured pool of water. Can we initiate surface reconnaissance employing geophysics--e.g. seismic, magnetic, ground penetrating radar etc? Favorable indicators would justify deep drilling in the hope of locating important additional water sources. Also, the written materials presented to date show a good number of wells that extend into the bedrock, and in some cases, quite deep. Can we evaluate the drilling logs and production records of these wells to develop information to supplement our reconnaissance efforts? Additionally, would it make sense to explore potential important water sources not yet tapped up in our watersheds? I would appreciate our consultants and staff views on this as well. Thank you for you consideration. Bob Schiebelhut	11/2/2020 16:29	Additional water from bedrock wells is possible. The applicability of surface geophysical method to identify fracture patterns would need an independent evaluation. It should be noted that groundwater from deeper bedrock wells is often of relatively poorer quality than shallow wells, due to increased mineralization of the groundwater that occurs during prolonged exposure to the surrounding bedrock. Comment Noted.
52	Jena Wilson	Workshop #3 Sustainable Goal Setting	The Righetti Dam releases into the creek need to be enforced. This is over 600 acre feet of water that should be flowing into the creek and into the basin. Golden State Water needs to start purchasing water from the State Water Pipeline so that they are not using water from the Edna Valley Basin. Golden State currently has a Selenium issue with their water as brought up by Toby Moore in the Workshop. This could alleviate this Selenium issue to all other Domestic water users in the Basin. We need to Augment Water storage with Sentinel Peak Resources R.O. water by discharging the water that is currently going out to the ocean, further up the Corral de Piedra Creek. Corral de Piedra creek needs to be brought back to life to save the fish. If this were done using surface water, then our basin would be in a plus balance.	11/2/2020 17:42	The terms of the surface water diversion permit associated with Righetti Reservoir are under the purview of the State Water Board. To the extent that any review of the permit conditions results in any additional water being released to West Corral de Piedras Creek, it will be beneficial to the basin. The State Water and Sentinel Peak projects are evaluated in Chapter 9.

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53	Jean-Pierre Wolff	Workshop #3 Sustainable Goal Setting	I would like to take this opportunity to express my appreciation for the significant effort put forward by the County of San Luis Obispo, the City of San Luis Obispo, the representatives of the Edna Valley, the consultants and the numerous volunteers who have contributed to this GSP thus far. When addressing water, the history of California has shown that it is at times challenging to decouple emotions and personal interest from science. In addition, the accurate projections of drought impact to hydrological models requires allowances for margin of error due to unknowns. Based on the various scenarios presented at the GSP workshop of October 1, 2020 I suggest that the Minimum Threshold alternative should be MT-1 based on the most recent significant drought. The Measurable Objective alternative should be based on M-4 allowing time to address and implement water conservation measures, water augmentation alternatives and applied innovation in water technology. During this ongoing GSP development, I suggest that a refresher evaluation be made in the Edna Valley agricultural land use and its associated ground water extraction to validate the various models assumptions. The successful implementation of the GSP will require three distinct efforts and course of action. Firstly, water conservation will need to become an integral part of the solution in order to meet the MO and MT. The agriculturists of the Edna Valley have already demonstrated some of these initiatives with ongoing implementations. Secondly, water augmentation must be addressed sooner than later. This year, our Governor has made a priority for California to reduce the impact of droughts and climate change through water portfolio diversification. The San Luis Obispo and Edna Valley Basin is in a unique position to address this issue. A good example are the opportunities for recycled water from the City of San Luis Obispo recently upgraded water treatment plant with its emphasis on recycled water and the nearby Price Canyon oil fields high quality recycled water production through reversed osmosis technology. Another opportunity of water augmentation is improved management of the upstream reservoir permittee to leverage conjunctive benefits of West Coral de Piedra Creek such as the downstream public trust surface water aquatic environmental benefits and ground water recharge through percolation. Lastly, technology innovation will need to become part of	11/2/2020 17:49	Comments on proposed SMCs are noted. Water conservation is nearly always the cheapest alternative to reduce groundwater pumping, and water augmentation will be integral to future management of the Basin. Management of Righetti Reservoir could improve the conjunctive use of SW and GW resources in the Basin and contributing watershed.

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			the long-term solutions such as precision farming utilizing soil moisture sensors, local weather stations, accurate well monitoring to name a few.		

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54	Chris Darway	General Comments	1. Page 29 shows a gain of 5970 AFT for years 2016 - 2019. The graph shows an upward trajectory for Edna. Table 6-14 should show the amount of storage for 2016. By not doing so, we miss the great increase from 2016-2019--most likely due to greater rain plus conservation efforts. Since the SLO subarea was stable during 2014-2016, the 5970 increase is in Edna--probably rising from about 100,000 AFT in 2016 to 105, 630 in 2019. Impressive and not apparent because 2016 numbers are not shown. 2. There are two lines of numbers that are curious. 1/3 of the years show stream outflow exceeds inflow: 1993, 1997, 2000,2001,2003 , 2005, 2006, 2011, 2016, and 2019. All these years are Wet of Above Normal, except 2016 Below Normal. Is this due to infiltration and / or GW/SW intersection? Does this make sense to you? Similar question regarding ET evaporation: In 8 Dry years, the evaporation essentially equaled the precipitation: Precip ET Evaporation 1987 6780 6610 1990 5960 5860 2007 3810 3800 2009 5170 5100 2013 4640 4600 2014 4590 4550 2015 5230 5160 2018 6130 6020 The numbers above don't make sense.	11/3/2020 13:39	Tables 6-1, 6-2, 6-3 present annual water budgets for all water years from 1987 to 2019. Table 6-14 only indicates years for which water level maps were generated to estimate changes in storage between those years. It is often not possible to see significant changes in water levels in a basin scale map from year to year. Stream outflow could exceed inflow because there a greater area of contributing watershed; so that fact that wet years show greater SW outflow is not problematic. In dry years, ET can be approximately equal to precipitation, indicating most water is being used or evaporated, and little runs off.
55	Chris Darway	General Comments	How can consultants come up with a Sustainable Yield of less than 4000 AFY in a basin, when the Basin contains Groundwater Storage Estimates of an average of 120,000 AF? This Sustainable yield is only 3% of the storage.	11/3/2020 13:40	Safe yield is not a function of groundwater in storage. For example, Paso basin has about 30million AF storage but only 60,000 AFY safe yield (0.2%). Safe yield is determined by stopping storage and water level declines; it is not a function of total groundwater in storage. Sustainable yield and storage are not directly correlated.

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56	Earl Darway	General Comments	Why is 2016 data being excluded? I keep rereading the Water Budget material and came across the reasoning for those years at p 22: "These years include the beginning and ending years in the base period, along with sufficient intervening years to characterize change in storage trends through the base period". This is highly discretionary. Look at the intervals between the years chosen: 4,5,3,7,6,3 and 5 years. More important, by excluding 2016, they allow the argument that the 2014 low point will not be the low point going forward, when an equally valid point is that the 2016-19 trend indicates an upward trend in storage. If increasing storage, where is the overdraft?	11/3/2020 13:40	2016 data is not excluded from the water budget. Groundwater storage is estimated by the water budget for all years using all the available data over the base period in Tables 6-1, 6-2, 6-3. The years selected for estimating storage using the specific yield method were to calibrate the beginning and end of the base period and to illustrate storage trends. They do not change the overall decline in storage over the base period or the estimated overdraft. Yes, 2016-2019 shows an upward trend in storage in the water budget, but this was also a wet period that followed a severe drought. Overdraft takes into account both wet and dry periods.
57	Earl Darway	General Comments	The graph for pumping does not have an accurate trajectory for two reasons: (1) the trajectory for 2007 to 2019 should be down and not up; and (2) the trajectory being down since 2015 is dramatic. Conservation measures after the drought.	11/3/2020 13:41	Assuming we are talking about Figure 6-8, the trajectory for groundwater extraction is shown as decreasing pumping from 2007-2019. The visual trajectory appears "up" only because the bars are below the zero line, so a decreasing trajectory is toward the top of the page.
58	Earl Darway	General Comments	On page 44 why did you choose the years shown in table 6-14? There were 21 representative wells (note some of our wells weren't developed until the early 1990's) and then select the years for water levels without any explanation as to why those years?	11/3/2020 13:43	The years selected for estimating storage using the specific yield method were to determine storage at the beginning and ending of the base period and to illustrate storage trends. This is mentioned on page 22. The specific years selected do not change the overall decline in storage over the

ID	Name	Comment Subject	Comment	Date/Time	Response
					base period or the estimated overdraft.
59	Chris Darway	General Comments	Additional comment: Page 29 shows a gain of 5970 AFT for years 2016 -2019. The graph shows an upward trajectory for Edna. Table 6-14 should show the amount of storage for 2016. By not doing so, we miss the great increase from 2016-2019--most likely due to greater rain plus conservation efforts. Since the SLO subarea was stable during 2014-2016, the 5970 increase is in Edna--probably rising from about 100,000 AFT in 2016 to 105, 630 in 2019. Impressive and not apparent because 2016 numbers are not shown.	11/3/2020 13:43	Not finding referenced gain on page 29, but storage increase between 2016-2019 is estimated by water budget. Yes, 2016-2019 shows an upward trend in storage in the water budget, but this was also a wet period that followed a severe drought. Overdraft takes into account both wet and dry periods. e.
60	Karen Merriam	General comments	I am directly affected by the sustainable groundwater planning underway for the Edna Valley. I purchased 10 acres on Tiffany Ranch Road at the south end of the Edna Valley in 1996. There was no vegetation or structures on the land. There was a well that was drilled in 1989 to 115 ft. This well yielded fresh, abundant water from 60+ ft. below the surface when I began pumping in 1997 when I built my home on the property. In 2016 my well ran dry. It cannot be recharged and no further drilling is possible in that location. When I bought my property in ‘96, most of the land was dry land farming and cattle ranching. As documented, there has been exponential growth of irrigated agriculture on most of the land now surrounding my 10 acres and throughout Edna Valley. (I should note that I know of at least two neighboring wells that have also gone dry.) In 2016, after consultation with Tim Cleath, I was fortunate to find potable water after drilling to 300 ft in the corner of my property farthest from the original well. My understanding is that this is the only area on my property where a productive well can be placed. The cost of drilling, laying new water and electric pipes, etc. exceeded $30,000 four years ago. I am concerned that if present levels of demand for drawing on the Edna Valley water continue to expand, even my new well will not be sustainable. If the new well should fail, then my property will lose all value and will not be habitable. The excellent and thorough hydrogeologic mapping of the Edna Valley clearly shows that in the south end of the valley where my property is located, there is poor recharge available compared to other areas such as Coral de	11/17/2020	Comments on proposed SMCs are noted and were discussed at length during public GSC meetings. It is documented that smaller wells or wells on the margin of the basin have gone dry due or been removed from production due to declining water levels.

ID	Name	Comment Subject	Comment	Date/Time	Response
			Piedra. Therefore, I strongly urge those who represent individual property owners such as me to support sustainability goals based on the data provided, and on consideration of drought resilience and equitable distribution of risk and cost. Minimum Water Levels should go no lower than levels observed at the 2015 drought culmination. According to all projections from climate scientists, the extremes of heat and drought we are now experiencing will likely only increase. It would be foolish to ignore this data. For this reason, I believe that we should plan for minimum higher water levels than recent recorded low drought water levels: Minimum Threshold Alternative #2. Thank you for your consideration of these comments.		

ID	Name	Comment Subject	Comment	Date/Time	Response
61	George Christensen	DRAFT Chapter 7 - Monitoring Networks	January 22, 2021Comments on Chapter 7 - Monitory Networks for the SLO Basin GSP George Christensen Vegetable grower and resident - Edna Valley. A successful groundwater sustainability plan needs to include ALL consumers of the SLO basin. It has been brought to my attention that the currently proposed SGMA regulations only apply to MOST consumers of water in the SLO water basin, not ALL consumers. I believe that there are several hundred residential/domestic consumers who are not included in the scope of the SGMA. This is unreasonable as those unregulated consumers can and will certainly impact the basin's performance. If the SGMA is to be equitable, it must encompass all consumers including domestic/residential, commercial, industrial and agricultural in the SLO basin. Not representing all members from each group is unfair to both the regulated and unregulated groups. All consumers, regardless of size/capacity must be considered and included in the GSP. The challenge of shallow domestic wellsite has been said many times that one of the major goals of the GSP is to protect/prevent residential wells from going dry in drought conditions. While this is important, it cannot be the primary overriding goal of the GSP. Shallow residential wells have always been a concern during drought conditions in the Edna Valley. Homeowners with shallow wells are victims of poor decisions usually due to lack of information. 'Right sizing a residential well is the responsibility of the homeowner similar to ensuring the main electrical panel is sized large enough to support normal household operation. Just like upgrading the electrical panel on older homes is sometimes required to support changes in the home/lifestyle, so is upgrading the well to ensure an adequate water supply. The onus to remove the risk of residential wells going dry is solely on the homeowner, not on the homeowner's neighbors. It would be unfair to penalize the homeowner's neighbors simply because they failed to'right size their well. I suggest that official guidelines/recommendations be generated for both new and existing homeowners in the Edna Valley to help them right size their residential well.he Righetti reservoir: Edna Valley basin's single biggest influencer. The Righetti reservoir has been around for 50+ years and in that time it has had a significant impact on the Edna Valley basin. The challenge is to understand what kind of impact, the size of the impact and mechanics of the impact. There are many theories and postulations, but none that I have found based upon actual hard facts. I believe that the reservoir has a significant impact on the Edna Valley basin	1/22/2021 14:50	All well users are included in estimates of Basin pumping. However, domestic users who pumps less than 2 AFY (de minimums extractors) cannot be required to be metered by SGMA. Improved data on location of these wells would be useful. It is up to the GSAs to decide how deminimis extractors will be incorporated in the management of the basin via the GSP or with other regulation. Most shallow wells were right-sized for conditions at the time of installation and provided adequate production for domestic use at the time. Stream gages have been proposed for Streams in Edna Valley. The terms of the surface water permit for Righetti Reservoir are under the purview of the State Water Board. To the extent that process results in increased releases to Corral de Piedras Creek, it will be beneficial to the Basin. It is anticipated that a program will be implemented to improve data on the construction of the monitor wells. However, the primary data gathered from these wells in the future is water level data, which will be dependable and useful in basin management.

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			but I lack data to substantiate that belief. I strongly encourage the GSP to include streamflow meters both in the watershed area above the reservoir and in the West Corral de Piedra creek immediately below the reservoir to improve our understanding of the impact of the Richetti Reservoir. Only then can we include the reservoir in the GSP. Good Data enables Good decisions And of course the corollary to the above statement is that poor or incomplete data will drive bad decisions. This is evidenced in several places in Chapter 7, but I will specifically focus upon Table 7-1.There are 18 wells listed for the Edna Valley. 9 of the 18 wells (50%!!) are missing either well depth, screen intervals or both. How can we expect good decisions when 50% of the critical data is missing? There isn't any way a credible prediction of wells going dry can be made with these critical pieces of data missing. EV-10 is indicated to have a State Well Completion Report. If that is true, then why isn't First Data Year, Last Data Year, Data period and Data count included? Is this just a simple oversight or a sign of a less than thorough inspection of data presented to the public? The summary is simple: We do not have enough high fidelity, accurate data today to drive major decisions.		

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62	Keith Watkins	General Comments	Developing an adequate monitoring plan is crucial to developing operational plans for maintaining our basin. To develop good information, we need to invest in several new monitoring wells and track them for multiple years to be able to really know what our groundwater levels are doing. Chapter 7.1.2--The list of criteria is in many respects too vague. What does "proximity and frequency of nearby pumping wells" mean? Specifically, what is the minimum distance from other wells? How much "frequency" of nearby wells mean is allowed? What does "spatial distribution relative to the applicable sustainability indicators" mean? Same questions for "Groundwater use" and "impacts on beneficial uses and Basin users." In other words, how are we to know how to apply these criteria to evaluate the selection of the Representative Wells?	1/26/2021 8:43	Most of this text comes from the DWR BMP documents. We wouldn't want a monitoring well immediately adjacent to an active pumping well, but there is no set numerical distance criteria. Spatial distribution simply means not clustering too many wells in one area. Most of these are considerations to be considered holistically in concert with one another while developing the monitoring network. We believe the new monitoring network of 40 wells adequately addresses these criteria.
63	Chris Darway	General Comments	Chapter 7.1.2--The list of criteria is in many respects too vague. What does "proximity and frequency of nearby pumping wells" mean? Specifically, what is the minimum distance from other wells? How much "frequency" of nearby wells mean is allowed? What does " spatial distribution relative to the applicable sustainability indicators" mean? Same questions for "Groundwater use" and "impacts on beneficial uses and Basin users." In other words, how are we to know how to apply these criteria to evaluate the selection of the Representative Wells?	1/27/2021 13:03	Most of this text comes from the DWR BMP documents. It would not be desirable to have a monitoring well immediately adjacent to an active pumping well, but there is no set numerical distance criteria. Spatial distribution simply means not clustering too many wells in one area. Most of these are considerations to be considered holistically in concert with one another while developing the monitoring network. We believe the new monitoring network of 40 wells adequately addresses these criteria.
64	Chris Darway	General Comments	Table 7.1 -- Why monitor a well outside the Basin in Arroyo Grande water basin -- EV-18? 52 years of records and no depth of monitoring info.	1/27/2021 13:06	The primary reason for keeping this well is to document the presence of the groundwater divide between the SLO Basin and the Arroyo Grande Sub-basin.

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65	Earl Darway	General Comments	7.2.1 Groundwater monitoring. This states there are a total of 40 monitoring wells in both basins. This states that there are 18 monitoring wells in the Edna basin, however, when I look at the detailed information in table 7-1, of the 18 "monitoring wells", only 6 of these wells are deep enough to be used to monitor our groundwater, 4 of these 6 wells are being used of Ag irrigation, and 1 is a public supply well for GSW. This leaves only 1 well that is an official monitoring well as described in 7.1.2. and this well does not meet the criteria outlined to be an official monitoring well. We need to establish official monitoring wells that meet the criteria before we move forward.	1/27/2021 13:11	Ultimately the goal is to have a dedicated monitoring well network. However, we must begin with what we have access to. There is no reason active wells cannot be used as monitoring wells as long as care is taken to ensure that wells are not pumping at the time of monitoring. This has been part of the data collection protocols for existing County groundwater level data. If a well is deep enough to intersect the water table, it is deep enough to monitor. Staff do not agree that the one dedicated monitoring well outlined by the commenter does not meet the criteria to be an official monitoring well. This well has no pump, known construction details, and a dependable boring log.
66	George Donati	DRAFT Chapter 7 - Monitoring Networks	I have 3 comments and 1 question:1.Chapter 7.1.3. Scientific rational -SGMA regulations require that the GSP identify sites that do not meet BMPs. Also, if wells lack construction info, the GSP shall include a schedule to acquire monitoring wells with all the necessary information. As Table 7-1 shows, there are many wells that do not have BMP's and lack construction information. We need this data on the individual wells please.2.Table 7-1. San Luis valley has 11 monitoring wells that are not being used for other purposes. All of these wells are less than 100 ft deep. Not sure if this is deep enough to qualify the criteria. Edna Valley area has only 2 monitoring wells that are not being used for other purposes. One of these wells is very shallow at only 150 ft deep. EV 14 is a monitoring well and is the only well that meets the criteria in the entire Edna basin. Many wells outlined in table 7-1 are missing information which is required, or they are being pumped for Ag or Domestic purposes and will not give accurate data for monitoring the Edna basin. Should we have more proper monitoring wells so that we can monitor our ground water properly? Can we use the first 5 years to set this	1/27/2021 13:53	An ideal monitoring well is a well that meets all criteria, and a goal would be to move toward a complete network of dedicated monitoring wells. However, this should be considered a goal, not a requirement. We must move forward with what is available. There is nothing wrong with using active wells as monitoring wells as long as the wells cease pumping prior to the monitoring event. This has been part of the data collection protocols for existing County groundwater level data. Shallow wells (150 feet or less) are adequate for monitoring as long as they intersect the

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			up?3.Table 7-2. They are asking for a monitoring well east of Crestmont road. John Silva's property, just east of the intersection of Crestmont and Hwy 227 has 4 wells and one of these could work. Please contact me if you are interested in one of these wells. Question - Just below this comment box on your web site there is a statement -While attachments (e.g., letters) will be read and considered, individual comments entered using the form will receive a response for each comment.I have never received a written response to any of my previous comments. Is there a plan to do this? Thank you, George Donati		water table. We were unaware of the Silva well, that could be useful, we will contact you regarding that well. Yes, we are posting all initial responses to comments online for viewing. We will also incorporate the responses or any changes into the chapters as appropriate when they get finalized as a compiled document.
67	Robert Schiebelhut	DRAFT Chapter 7 - Monitoring Networks	Many in the Edna Valley believe that the SGMA process should include consideration of the actual impact of the Righetti reservoir on the Edna sub basin. There has never been a hydrology connecting the two. The State recognizes the nexus between the two. On February 21, 1991, the State Water Resources Control Board expressly reserved jurisdiction to modify the terms of the Righetti permits based on "the findings of the hydrology study now in progress of the Pismo Ground Water Basin and the Edna Valley. The study will include a safe yield estimate of the basin" (State Water Resources Control Board Order WR 91-02, page 8). The referenced study was never completed even though 30 years has passed. SGMA requires an appropriate study of the relevant factors to determine safe yield, and therefore our process should include a complete review of the impact of the Righetti reservoir on the Edna sub basin. In Chapter 7, page 119, the chart states that the Righetti Reservoir (one of the largest privately owned in California) is a beneficiary of about 21% of the Pismo watershed. The important watershed for determining the actual impact of the Reservoir is the West Corral de Piedra watershed. The State Water Resources Board's Decision 1672 (dated November 27, 1990 found that the Righetti Reservoir captures the stream flow of approximately 3000 acres of the 5300 acre West Corral de Piedra watershed--57%, not just 21%. This higher percentage reflects the	1/28/2021 16:32	The terms of the surface water diversion permit associated with Righetti Reservoir are under the purview of the State Water Board. To the extent that any review of the permit conditions results in any additional water being released to West Corral de Piedras Creek, it will be beneficial to the basin. Monitoring well EV-18 is intended to document the groundwater divide between Edna Valley in SLO Basin and the Arroyo Grande Subbasin.. Stream gages in Edna Valley are proposed.

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			substantial impact of the reservoir. Chapter 7.2.3.1 recommends two gauges for West and East Corral de Piedra at Orcutt Road. Why not a gauge above the Righetti Reservoir to better determine the actual stream diversion, rather just "estimating"? If we are to pay for measuring well #EV-18 which is outside the Basin, why not pay for a new gauge above the Basin, in the watershed for West Corral de Piedra?		
68	Brian Talley	DRAFT Chapter 7 - Monitoring Networks - 7.2 MONITORING NETWORKS	A consistent concern for me is that we don't have enough data to make informed decisions about pumping restrictions. Let's take the prudent approach of studying our basin over the next 5 years to insure that we don't make rash decisions that threaten the sustainability of agriculture in the basin. In particular, we need representative monitoring wells. Landowners, myself included, are willing to provide locations for these wells. We also need a better understanding of the amount of diversion that is occurring as a result of the Righetti Reservoir. In-stream gauges should be installed both above and below the dam to quantify the diversion and ensure compliance with state permits.	1/30/2021 8:50	The monitoring well network has been increased from 12 to 40 wells. If there are additional locations available for MWs in areas with data gaps it could be helpful as we contemplate installation of new dedicated MWs. We will stay in touch.

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69	Mark Capelli, Anthony Spina. NMFS	DRAFT Chapter 8 See letter dated June 3, 2021 appended to the Response to Comments.	Page 29: The draft Chapter 8 indicates the basin will be considered to have experienced undesirable results if any of the monitoring wells exceed the minimum threshold for two consecutive fall measurements. The standard of failing two consecutive fall measurements is not explained, and thus appears arbitrarily. Steelhead migration, spawning and rearing (beneficial uses of surface water as set by the Regional Water Quality Control Board1) are biological processes that can be impacted by a single streamflow depletion event. SGMA regulations require a minimum threshold be used to define an undesirable result, in this case streamflow depletion resulting in significant and unreasonable impact to beneficial uses of surface water. For a beneficial use such as steelhead rearing, a depletion of adequate streamflow can result in steelhead mortality, and is therefore irreversible. We therefore recommend that the standard for determining undesirable results be expressed in terms of minimum pool depth and/or surface flow during the summer and fall base flow periods.	6/3/21	The standard of two consecutive fall measurements was adopted to avoid triggering any far-reaching management actions such as pumping reductions on the basis of a single dry season. As has been discussed, groundwater systems react very slowly to changed conditions, and it was judged appropriate by the GSC and GSA members to utilize two consecutive measurements to avoid triggering any actions based on temporary conditions. Additionally, in the future more wells in the network will be equipped with transducers to gather continuous monitoring data. It may be appropriate to prioritize monitoring wells designated for depletion of ISW for transducers. At that point, the definition of the MT may need to be revised, as continuous data will be available. This text will be updated for clarification in Chapter 8. The GSP is intended to be a groundwater monitoring plan. Because there are numerous factors that affect instream flow conditions (rainfall, temperature, ET, etc.), it is not within the ability of this GSP to mandate instream flow conditions such as pool depth as an MT. The objective of the plan with respect to interconnected

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					surface water is to manage groundwater such that there is no significant or unreasonable increase in depletion of ISW. As such, MTs are defined to disallow water levels from declining lower than recently historically observed conditions. Stillwater Sciences has prepared a TM on GDEs in the Basin that will be included as an appendix to the GSP.
70	Mark Capelli, NMFS	DRAFT Chapter 8 See letter dated June 3, 2021 appended to the Response to Comments.	Page 29: Groundwater elevations may be necessary as a proxy for streamflow depletion due to a lack of data gathered to this point. However, there appears to be no attempt at correlating groundwater elevation thresholds with impacts to beneficial uses of surface water. In fact, many of the groundwater elevation minimum thresholds are set at the lowest (or below the lowest) groundwater elevations ever recorded within the basin. These thresholds are likely associated with severe groundwater over-pumping during dry periods, when groundwater depletion was greatest, and surface water discharge the lowest. Managing streamflow depletion conditions comparable with the severest drought conditions is not protective of surface water beneficial uses that support ESA-listed steelhead, and likely would result in adversely affecting steelhead and its identified critical habitat (see enclosed steelhead critical habitat and intrinsic potential maps for San Luis Obispo Creek and Pismo Creek). If the GSAs uses groundwater levels as a proxy for streamflow depletion, it should explain how the chosen minimum thresholds and measurable objectives adequately avoid adversely impacting surface water beneficial uses that support steelhead survival throughout the SLO Basin. If that effort proves problematic due to a lack of data at the present time, the GSAs should follow guidance by the California Department of Fish and Wildlife that recommends a conservative approach to groundwater dependent ecosystem protection in those situations (CDFW 2019).	6/3/21	The primary rationale for the selection of the MTs is protection of domestic water wells. Initially MTs were proposed that would be no lower than the observed low point in 2015, under the rationale that the stakeholders had managed to obtain household supplies and proceed with their operations under those extreme conditions, and so could do it again. See text on evaluating reduced water levels compared to domestic well depths. Ultimately the GSC members agreed that an additional 10 feet below observed low GW elevations would help protect agricultural businesses in the Edna Valley. For now, in the lack of data collection outlined in Chapter 7 (Monitoring Network) and Stillwater Sciences TM on GDEs, three existing wells located adjacent to streams are selected to monitor, and

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					the MTs are set so that groundwater elevations will go no lower than observed seasonal low water levels, and by extension, surface water/groundwater interaction will not be negatively impacted in these areas. The MTs associated with the observed severe droughts is proposed as the MT, which should not be exceeded (I.e., water levels lower) under normal operating conditions. The MTs are not proposed to be the normal operating conditions of the aquifer.
71	Mark Capelli, NMFS	DRAFT Chapter 8 See letter dated June 3, 2021 appended to the Response to Comments.	Page 29, Section 8.9.2: The draft includes the following statement: *To avoid management conditions that allow for lower groundwater elevations than those historically observed, MTs [Minimum Thresholds]for these wells were set at the historic low water levels indicated on the hydrographs, which occur with regularity during every extended dry period evident in the record (Figures 8-9, 8-10).* As noted above, managing to perpetuate historically low groundwater elevations is not appropriate as a management threshold, since it does not adequately define the undesirable result of streamflow depletion on aquatic biological resources such as federally threatened South-Central Coast steelhead. Based upon fundamental hydrogeologic principles where the depletion rate is proportional to the difference between the water table and surface water, the amount of streamflow depletion associated with the proposed minimum thresholds would be the greatest on record (Sophocleous 2002, Bruner et al. 2011, Barlow and Leake 2012). This level of streamflow depletion would likely impact surface water beneficial uses to the extent that threatened steelhead would experience "harm" under the ESA as well	6/3/21	It is not the intent that the MTs are to "perpetuate historically low groundwater conditions." It is the intent that the basin should be managed such that water levels do not go lower than the MTs. And for the MTs associated with GW/SW interaction, these MTs have been commonly observed in the historical period of record of water levels, and so are assumed to be appropriate to local conditions. Projects and supplemental water sources in Edna Valley are intended to improve streamflow conditions.

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			as result in adverse impacts to Groundwater Dependent Ecosystems (GDE) supporting a variety of native aquatic species.		
72	Mark Capelli, NMFS	DRAFT Chapter 8 See letter dated June 3, 2021 appended to the Response to Comments.	Page 30: Following the discussion on the relation between flow conditions in San Luis Obispo Creek and the underlying aquifer, the draft Chapter 8 asserts, "in both cases the amount of flux between the surface water and the groundwater system is small compared to the volume of water flowing down the creek." The point of this statement is unclear but seems to suggest that groundwater levels are not significantly influenced by the volume (including duration) of stream flow. However, this implication is contradicted by the statement, "In wetter years, when flows in the San Luis Obispo Creek are high there is [sic] greater amounts of discharge from the creek to the groundwater system." In general, higher and longer the duration flows in SLO Creek will increase the area of wetted stream bottom (i.e., the area of infiltration) as well as the duration of the infiltration of surface flows to the underlying groundwater basin. Furthermore, the assertion that stable groundwater levels at a specific well "suggest that the mechanisms of surface water/groundwater interaction have not been negatively impacted since the early 1990's" does not address the question of whether these stable conditions have had and are resulting in streamflow depletion impacts as defined under SGMA. Currently stable groundwater levels are not an indicator of sustainable groundwater conditions, or, more specifically, avoidance of significant and unreasonable effects on streamflow. The revised draft Chapter 8 should address this issue and clearly indicate how existing stable groundwater conditions are protective of GDE, such as rearing habitat for juvenile steelhead.		The text in this chapter has been revised to address these issues in greater detail, including discussion of Darcy's law and flow direction between stream and aquifer, more detailed hydrograph analysis of SLO Creek and Corral de Piedras Creeks, and a conceptual modeling evaluation of surface water/groundwater interaction. It is important to recognize that many factors contribute to instream flow conditions that are beyond the ability of a groundwater management plan to control (rainfall, temperature, etc.). The objective with respect to interconnected surface water (ISW) is to avoid groundwater conditions that result in significant or unreasonable increase in ISW depletion.

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73	Mark Capelli, NMFS	DRAFT Chapter 8 See letter dated June 3, 2021 appended to the Response to Comments.	Page 31: The draft Chapter 8 states that, "by defining minimum thresholds in terms of groundwater elevations….the GSA will….manage potential changes in depletion of interconnected surface (sic [flows?])." The draft Chapter 8, however, has not established the required correlation between groundwater elevations and surface flows that would justify groundwater levels as a proxy for streamflow depletion, and has not quantified what level of streamflow depletion represents significant and unreasonable impacts to GDE, including but not limited to rearing habitat for juvenile steelhead. The draft Chapter 8 should identify the data needed to analyze the relationship of groundwater levels, streamflow depletion rates, and impacts to GDE, specifically spawning, rearing and migration of ESA-listed steelhead.		There is no technology or field method to directly measure depletions in surface water flow attributable to groundwater development. Estimates must be made using interpretation, modeling, and other methods of analysis. A discussion of Darcy's Law and direction of flow between the stream and aquifer has been added to the text of this section, as well as additional well hydrograph analysis, and a conceptual modeling exercise..However, it is a commonly accepted hydrologic principle that correlates groundwater elevations higher than the stream elevation and aquifer discharge to the stream. Survey data must be collected on stream channels and groundwater elevations to confirm this relationship. Proposed improvements to the monitoring network discussed in Chapter 7 and the Stillwater TM will improve the understanding of this dynamic.
74	Mark Capelli, NMFS	DRAFT Chapter 8 See letter dated June 3, 2021 appended to the Response to Comments.	Page 31: The draft Chapter 8 establishes minimum thresholds for streamflow depletions as "the lowest water levels observed in the period of record" for the chosen monitoring wells. As noted earlier, according to SGMA regulations a minimum threshold is used to define an undesirable result, in this case streamflow depletion resulting in significant and unreasonable impact to GDE, including, but not limited to rearing juvenile steelhead. The use of a streamflow depletion thresholds associated with the lowest recorded groundwater levels are inappropriate because they will not avoid significant and unreasonable impacts to GDE. The thresholds are inappropriate for		If groundwater elevations have not been observed to decline below historical levels in the vicinity of a stream, as is the case along SLO Creek, this is an indicator that anthropogenic activities have not impacted stream conditions in this area in the period of record. The objective of the GSP with respect to ISW is to

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			avoiding impacts to ESA-listed steelhead resulting from streamflow depletion. To be consistent with the requirements of SGMA, the GSAs must develop thresholds that are likely to avoid adversely impacting steelhead, as well as other GDE.		avoid groundwater conditions that will significantly or unreasonably increase depletion of ISW. Hydrograph analysis of wells along corral de Piedras Creeks indicate that this creek is seasonally disconnected from the aquifer; additional monitoring data can confirm or deny this assumption. Additional stream corridor characterization and monitoring is recommended in Chapter 7, Monitoring Networks, and in the Stillwater TM on GDEs that will be included as an appendix to the GSP. . .
75	Mark Capelli, NMFS	DRAFT Chapter 8 See letter dated June 3, 2021 appended to the Response to Comments.	Page 32: The draft Chapter 8 includes no information or analysis that supports the assertion that "maintaining groundwater levels close to historically observed ranges will continue to support groundwater dependent ecosystems." As noted above, there is an assumption embedded within the assertion that current groundwater levels support groundwater dependent ecosystems; this has not been supported by any data or analysis because such information is not presented in the draft document. Managing groundwater levels at historical lows is likely to adversely affect ESA-listed steelhead, and designated critical habitat for this species. To be consistent with the requirements of SGMA, the GSAs must develop minimum thresholds that are likely to avoid adversely impacting steelhead, as well as other GDE.		The statement "maintaining groundwater levels close to historically observed ranges will continue to support groundwater dependent ecosystems." is intended to apply to SLO Creek, where there have been no trends of declining GW levels. If WLs have not declined, and fish populations have existed during the period of record, it is argued that by extension, if GW levels continue at levels approximately equal to those observed in the past 30 years, then groundwater management will not have allowed conditions that lead to significant or unreasonable deletion of interconnected surface water.. Conditions in Corral de Piedras Creek will be better characterized after the

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					implementation of the proposed monitoring plan discussed in Chapter 7 and in the Stillwater TM on GDEs.
76	Keith Watkins	General Comments	Chapter 9: Projects & Management ActionsEdna Valley Growers are willing to take the excess water that now flows to the ocean with no quantity guarantees from the City of San Luis Obispo. Edna Valley Growers are focused on beneficially utilizing excess water which is currently being wasted to the ocean for crop irrigation. The Growers can utilize San Luis Obispo's recycled water in the winter months when City demand is at its lowest. Water can be applied to dormant vineyards to build the soil moisture profile for the spring and summer. Deep rooted grape vines can utilize the water through the spring and summer lowering well water demand through out the valley. Citrus also can be irrigated in the winter months to offset later irrigation demand in drier periods. While we acknowledge that the available amount of water may decrease over time as the City develops additional internal programs, we recommend that grower deliveries not be characterized as a short term program, but a project that will continue to utilize excess water supplies whenever they may be available.The City acknowledges that it has excess capacity in the winter months and can not utilize all the recycled water it produces. Edna Valley Growers are willing to pay the cost to connect to the City recycled water system with no obligation by the City to deliver a guaranteed amount. Edna Valley growers want to partner with the City to maintain the City's greenbelt for the benefit of all in the area.Connecting to the City's current 8" waterline system will provide acceptable capacity to the Edna Valley with no need for infrastructure improvements. Again, we will take what the system can provide. If water need to be boosted from the delivery point, Edna Valley Growers will install a booster pump and cover the costs of operation. Edna Valley Growers are willing to pay for the water supply which now flows to the ocean, including some level of profit to the City above the cost of pumping and electricity are covered. Based on some of our initial pricing concepts, up to $200,000 could be recouped annually by	6/30/2021 2:05:00 PM	Your comments are noted. It is our understanding that negotiations with the City continue regarding this project, which could potentially help augment the overdraft in Edna Valley.

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			the City to provide lower costs to city customers.Edna Valley Growers want to work collaboratively with the City of San Luis Obispo to provide supplemental water to the City's Greenbelt. The current assumed water deficiency threatens not only the agricultural production and residential use in the Edna Valley but also the viability of the City's Greenbelt., as well as the City's economy which benefits from ag tourism, tasting rooms and event centers in the Edna Valley. I believe these comments should be incorporated into Chapter 9, Projects & Management Actions to show the potential more clearly for utilizing recycled water to offset agricultural demand and reduce assumed basin over-draft.		
77	Dan Dooley	Draft_SLO_GSP_Chapters_9_10.pdf - 9.5 Management Actions	See attached file submitted on behalf of Edna Ranch East.	7/21/2021 12:34:00 PM	De minimis users refers to individual that pump less than 2 AFY for personal residences. It is recognized that Edna Ranch MWCs per connection supply is less than 2 AFY/household, but that does not make the MWC a de minimis user, because they MWC as an entity pumps more than 2 AFY. It is recognized that ERMWC has implemented significant conservation measures since 2015, and that their use is a small but important water use category that is part of the overall sustainable use in the Basin.

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78	Tim Walters	Draft_SLO_GSP_Chapters_9_10.pdf	I understand the objective of managing the basin in a manner that sustains the existing water use patterns, however the objectives and goals ignore potential for agricultural, residential or commercial expansion in the future. In my opinion, it is naive to expect that the basin development whether ag or otherwise will remain static over time. the sustainable goals should recognize and include goals for sustaining existing conditions and forecast future growth within the basin.	6/24/2021 8:39:00 AM	Residential or commercial expansion in the City will be supplied from the City's water supply portfolio, which currently includes surface water from various sources, but does not include groundwater. However, as there have been no declines in groundwater levels in the San Luis Valley subarea, and the water budget for that subarea indicates a surplus, there is likely available groundwater for expansion in that subarea. It is documented in Chapter 6, and confirmed from hydrograph analysis, that the Edna Valley is in overdraft. If expansion of agricultural pumping is pursued in Edna Valley, the goal of sustainability in the Basin will be difficult to achieve.
79	Timothy Delany, Central Coast Salmon Enhancement, dba Creeklands Conservation	Final Draft TechMemo_GDE_Assessment_SLO.pdf See letter dated June 22, 2021 appended to the Response to Comments.	Note: Please refer to attachment for proper line and page numbers, as well as formatting.	7/22/2021 5:15:00 PM	A letter from Creeklands was attached. Specific comments are addressed below.

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80	Timothy Delany, Central Coast Salmon Enhancement, dba Creeklands Conservation	SLO Valley GDE Technical Memo, Chapter 7, Chapter 8 See letter dated June 22, 2021 appended to the Response to Comments.	Comment 1: "...we interpret the SLO Valley GDE Technical Memo to be a supporting document for the achievement of these steps. We respectfully request that the information and recommendations provided within the SLO Valley GDE Technical Memo be consistently incorporated into the Draft GSP Chapters to a greater degree than currently exists."	7/22/2021 5:15:00 PM	The recommendations for improved monitoring locations of the surface water network were directly incorporated into recommendations presented in Chapter 7, Monitoring Network. Text regarding SMCs in Chapter 8 for Depletion of ISW RMSs also references the eventual construction of new gages and development of rating curves for existing gages.
81	Timothy Delany, Central Coast Salmon Enhancement, dba Creeklands Conservation	Chapter 7 (Monitoring Network) See letter dated June 22, 2021 appended to the Response to Comments.	Comment 2: "Groundwater levels and GDEs should have different representative monitoring site (RMS) selection criteria. Whereas groundwater RMSs require a longer historical record to establish the definition for undesirable results, GDE undesirable results are straight-forward and actionable without 1 10 prior years of data for whatever given SMC and MT that is defined. For example, if a relationship between groundwater pumping at Well "A" can be correlated with critical habitat impairment using a nearby stream gage at Site "X", There is no need for Site X to have multiple years of data to establish a trend." "...The RMSs do not appear to anticipate the 10 eventual inclusion of the stream gage network in future revisions of the GSP."	7/22/2021 5:15:00 PM	The establishment of a quantifiable relationship between pumping and critical habitat impairment that you suggest is not straight-forward. Streamflow is dependent on multiple other factors not manageable in this GSP (rainfall, temp, ET, etc.). The goal of this groundwater management plan is to avoid groundwater conditions that can lead to significant or unreasonable deletion of interconnected surface water. To that end, groundwater levels are recommended as a proxy measurement, and conditions that unreasonably lower water levels in the vicinity of the ISW RMSs are intended to be avoided. Text in Chapters 7, 8, and 10 recognizes the data gap in the present surface water monitoring network and

ID	Name	Comment Subject	Comment	Date/Time	Response
					discusses the necessity to obtain better surface water flow data to assess surface water/groundwater interaction in the future.
82	Timothy Delany, Central Coast Salmon Enhancement, dba Creeklands Conservation	Chapter 8 (Sustainable Management Criteria) See letter dated June 22, 2021 appended to the Response to Comments.	Comment 3: “We find no explanation earlier in Chapter 8, nor in Chapter 7, for why the flux between the aquifer and the interconnected stream must be measured to create a minimum threshold that is protective of GDEs... A rate of flow depletion can be correlated with changes in stage...”		Creeklands emphasizes the terms “rate or volume of surface water depletions” from SGMA regs but does not acknowledge the significance of the text immediately following, “...caused by groundwater use...”. It is beyond the ability of this groundwater management plan to control all variables that affect surface water depletions. Therefore, the management criteria proposed are that groundwater elevations around the ISW RMSs are not reduced such that depletion of ISW is significantly or unreasonably increased. If water levels near San Luis Creek are maintained near current levels, Darcy’s Law implies that the direction of flow will not be reversed from recent conditions. (Additional survey data of creek channel elevations and groundwater elevations is recommended.)

ID	Name	Comment Subject	Comment	Date/Time	Response
83	Timothy Delany, Central Coast Salmon Enhancement, dba Creeklands Conservation	Chapter 8 (Sustainable Management Criteria) See letter dated June 22, 2021 appended to the Response to Comments.	Comment 4: "This section does not adequately address how groundwater level measurements at the RMSs will be indicative of undesirable results to depletions of interconnected surface water. In other words, there is no language that qualifies well level measurements at the selected RMSs as useful indicators for harm that could be done to GDEs that rely on interconnected surface water or groundwater.		Additional text has been added to discuss the significance of Darcy's Law, and the relative elevations of groundwater and stream flow with respect to the direction of flow between groundwater in the aquifer and surface water in the stream. In the case of San Luis Creek, it is stated that because water levels in the ISW RMS have not declined in the past 30 years, that this represents recent conditions. Therefore, if water levels are not significantly or unreasonably lowered below these elevations, no significant or unreasonable change in depletion of ISW will occur. In Edna Valley, additional text was added presenting hydrograph analysis that indicates that West Corral de Piedras are seasonally disconnected from the surrounding aquifer, and that this has been the case going back to the 1950s as is seen in the hydrograph for EV-01; therefore the character of the relationship between GW and ISW has not been significantly or unreasonably changed due to groundwater management practices in recent years.

ID	Name	Comment Subject	Comment	Date/Time	Response
84	Timothy Delany, Central Coast Salmon Enhancement, dba Creeklands Conservation	Chapter 8 (Sustainable Management Criteria) See letter dated June 22, 2021 appended to the Response to Comments.	Comment 5: "Groundwater levels intermittently measured at the proposed wells (SLV-12, EV-01, EV-11) will not necessarily alert groundwater managers to imminent risks to instream habitat that is reliant on interconnected streamflow..."		It is acknowledged that conditions of groundwater/surface water interaction vary in time more quickly and frequently than groundwater levels distant from streams or creeks, and that twice-annual measurements may not capture important characteristics of this interaction. It is expected that pressure transducers will be installed in additional selected network monitoring wells to collect continuous monitoring data during the coming 5-year implementation period. It is recommended that ISW RMSs may be prioritized for installation of transducers over other wells more distant from the creeks.
85	Timothy Delany, Central Coast Salmon Enhancement, dba Creeklands Conservation	General Comments, Chapters 7 and 8 See letter dated June 22, 2021 appended to the Response to Comments.	"Although the importance of monitoring the gaining and losing reaches of streams within the groundwater basin is highlighted in Chapter 7, and referenced in Chapter 8, neither of these chapters give concrete or consequential future steps toward integrating the monitoring of these features with SMCs or MTs. Furthermore, none of the SMCs or MTs properly address GDEs that may be directly reliant on groundwater. The SLO Valley GDE Technical Memo highlights riparian and oak woodland GDEs in Table 2 of that document and suggests that groundwater levels could be used to determine sustainability indicators for them. More work will need to be done to find the appropriate thresholds for GDEs that are directly reliant on groundwater levels, but the current draft only discusses GDEs in the context of interconnected surface water and does not lay the foundation for GDEs that do not rely directly on surface water depletion."		Specific future steps to monitor stream conditions will be incorporated into scopes of work for implementation of data collection and annual reporting required under SGMA. The entities to perform this work have not yet been identified, and the scopes of work have not yet been specified. It is stated in the implementation plan *Chapter 10) that these actions will be pursued. One of the stated objectives of this GSP with respect is to avoid groundwater conditions that significantly or unreasonably alter

ID	Name	Comment Subject	Comment	Date/Time	Response
					groundwater conditions due to pumping that will significantly or unreasonably increase deletion of ISW. This objective should address conditions for all GDEs.
86	Timothy Delany, Central Coast Salmon Enhancement, dba Creeklands Conservation	General Comments, Chapters 7 and 8 See letter dated June 22, 2021 appended to the Response to Comments.	"The authors of the SLO Valley GDE Technical Memo note (on page 5, paragraph 2) that several monitoring wells are screened at unknown depths... Creek Lands has not evaluated the veracity of this particular statement but, if it is true, the potential use of these wells for establishing an indicator of interconnected surface water SMCs or other GDE indicators is cast in doubt until the exact screening depths are determined."		Specific knowledge of some well construction details is an acknowledged data gap. However, given that the HCM indicates that the geologic formations in the Basin function as a single hydrogeologic unit, with no laterally continuous confining layers existing between formations, this data gap is not considered a reason to preclude any wells from the monitoring network.,
87	Timothy Delany, Central Coast Salmon Enhancement, dba Creeklands Conservation	General Comments, Chapters 7 and 8 See letter dated June 22, 2021 appended to the Response to Comments.	"Although they may not be able to establish numerical MTs for particular interconnected surface water undesirable results or GDE impacts, what is preventing the GSP from incorporating tentative or placeholder MTs? It would be much more promising to have an interconnected surface water MT that stated how the monitoring network would be used to monitor GDE impacts, without necessarily committing to a numerical value. ○ For example: "Discharge changes between the Andrews Street Gage and the Marsh Street 43 Gage will be used to establish a minimum threshold when better data becomes available" ○ or "Minimum surface water elevations dependent on interconnected 1 groundwater in Stenner Creek will be established when a correlation between near-stream groundwater elevations and the stream gage monitoring network are established."		It is beyond the scope or ability of this GSP to define instream flow conditions as potential objective criteria for SMCs. This is a groundwater management plan, and the objective with respect to ISW is to avoid changes in groundwater conditions that results in significant or unreasonable increases to depletion of interconnected surface water.

ID	Name	Comment Subject	Comment	Date/Time	Response
			○ These examples do not hold groundwater managers accountable to any thresholds that are not supported by good science, but create the necessary impetus for future research to address data gaps that are directly applicable to creating MTs that meet SGMA requirements for the proper consideration of GDEs. More specificity at this stage of the GSP development will benefit everyone in the future.”		
87	Timothy Delany, Central Coast Salmon Enhancement, dba Creeklands Conservation	General Comments, Chapters 7 and 8 See letter dated June 22, 2021 appended to the Response to Comments.	As it stands, the current Draft GSP does not create a catalyst for future research or GSP revisions that achieve the proper level of protection for GDEs. The current drafts only list the types of data and analyses that may be sought in the future, without enough actionable language that will hold the GSC accountable for implementing effective research in pursuit of a monitoring network that protects GDEs.		SGMA requirements mandate the completion of annual reports for the Basin throughout the SGMA planning horizon (through 2042). These annual reports will document the implementation of many of the recommendations put forth in the implementation plan. The specific scopes of work or contractors to perform this work are not yet developed or selected.

UNITED STATES DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
NATIONAL MARINE FISHERIES SERVICE
West Coast Region
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Long Beach, California 90802-4213

May 29, 2020

John Diodati
Interim Director, Public Works Department
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976 Osos St #207
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Re: NOAA's National Marine Fisheries Service comments on the draft Groundwater Sustainability Plan (Chapter 5) for the San Luis Obispo Valley Groundwater Basin

Dear Mr. Diodati:

Enclosed with this letter are NOAA's National Marine Fisheries Service's (NMFS) comments on "Chapter 5: Groundwater Conditions" of the San Luis Obispo Valley Groundwater Basin (SLO Valley Basin) Groundwater Sustainability Plan (GSP).

The GSP is intended to meet the requirement of the California Sustainability Groundwater Management Act (SGMA). The SMGA includes specific requirements to identify and consider impacts to Groundwater Dependent Ecosystems (GDE) that have significant and unreasonable adverse impacts on all recognized beneficial uses of groundwater and related surface waters (Water Section 10720), including fish and wildlife and botanical resources.

As explained more fully in the enclosed comments, the draft Chapter 5 does not adequately address the recognized instream beneficial uses of the SLO Valley Basin, which underlies San Luis Obispo Creek and Pismo Creek, or other GDE, potentially affected by the management of groundwater within the SLO Valley Basin. In particular, the draft Chapter 5 does not adequately recognize or analyze the important relationship between the groundwater extractions and potential adverse effects on the federally threatened South-Central California Coast steelhead (*Oncorhynchus mykiss*). The reasons for this assessment are set forth in the enclosure. NMFS recommends that the revised draft Chapter 5 be re-circulated to give interested parties an opportunity to review and comment before it is finalized.

NMFS appreciates the opportunity to provide the enclosed comments on the draft Chapter 5. If you have a question regarding this letter or enclosure, please contact Mr. Mark H. Capelli in our Santa Barbara Office (805) 963-6478 or mark.capelli@noaa.gov. Mr. Rick Rogers (707-578-8552; rick.rogers@noaa.gov) in our Santa Rosa Office.

Sincerely,

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Enclosure

NOAA's National Marine Fisheries Service's Comments on the draft Groundwater Sustainability Plan (Chapter 5) for the San Luis Obispo Valley Groundwater Basin (March 2020)

May 29, 2020

Introduction

NOAA's National Marine Fisheries Service (NMFS) is responsible for protecting and conserving anadromous fish species listed under the Endangered Species Act, including the federally threatened South-Central California Coast (SC-CCS) Distinct Population Segment (DPS) of Steelhead (*Oncorhynchus mykiss*) which utilize San Luis Obispo Creek and Pismo Creek. NMFS listed SC-CCS, including the populations in the Santa San Luis Obispo Creek and Pismo Creek watersheds (which overlies a portion of the SLO Valley Basin), as threatened in 1997 (62 FR 43937), and reaffirmed the threatened listing in 2006 (71 FR 5248).

On March 12, 2020, the California Department of Water Resources (DWR) has designated the SLO Valley Basin a "Medium" priority for groundwater management, requiring the development of a final Groundwater Sustainability Plan (GSP) by January 31, 2022, pursuant to the 2014 SGMA. Several watercourses that overlie portions of the SLO Valley Basin, including San Luis Obispo Creek and the headwaters of Pismo Creek, support federally threatened SC-CCS DPS of steelhead.

Surface water and groundwater are hydraulically linked in the SLO Valley Basin, and this linkage is critically important in creating seasonal habitat for threatened SC-CCS steelhead. Where the groundwater aquifer supplements streamflow, the influx of cold, clean water is essential for maintaining suitable water temperature and surface flow. Pumping from these aquifer-stream complexes can adversely affect freshwater rearing areas for juvenile steelhead by lowering groundwater levels and interrupting the hyporheic flow between the aquifer and the stream, particularly during the naturally low flow summer and fall months. Thus, groundwater extraction in the SLO Valley Basin can and is expected to adversely affect threatened S-CCC steelhead through a reduction in the amount and extent of freshwater rearing sites for this species.

Steelhead Life History: Habitat Requirements

While adult steelhead spend a majority of their adult life in the marine environment, much of this species' life history phase (migration to and from spawning areas, spawning, incubation of eggs and the rearing of juveniles) occurs in the freshwater environment, including in the main stem and tributaries. Many of the natural limiting factors (such as seasonal variation in rainfall, runoff, and ambient air and water temperatures) are exacerbated by the artificial modification of these freshwater habitats. This includes both surface and sub-surface extractions that lower the water table and can, in turn, affect the timing, duration, and magnitude of surface flows essential for steelhead migration, spawning and rearing, based on NMFS' extensive experience assessing the influence of surface and groundwater withdrawals on this species.

Seasonal instream conditions can prevent the species from completing its life cycle. In particular, the over-summering period can be challenging to juvenile steelhead survival and growth. Lowered water tables that are hydrologically connected to surface flows and subjected to groundwater pumping during the dry season can affect rearing individuals by reducing vegetative cover, and directly by reducing or eliminating the summertime surface flows. (Barlow and Leake 2012, Heath 1983).

Groundwater inputs to surface flows can buffer daily temperature fluctuations in a stream (Hebert 2016, Barlow and Leake 2012, Brunke et al. 1996, Heath 1983). Artificially reducing the groundwater inputs would likely expand or shrink the amount of fish habitat and feeding opportunities for rearing juvenile steelhead, and reduce the likelihood that juvenile steelhead would survive the low-flow period and successfully emigrate to the estuary and the ocean (CBEC and Podlech 2015, Croyle 2009, Glasser et al. 2007, Sophocleous 2002, Fetter 1997).

NMFS' South-Central California Steelhead Recovery Plan identifies groundwater extraction from San Luis Obispo Creek and Pismo Creek as likely caused by both surface water diversions and pumping hydraulically connected groundwater, and is ranked as a "Very High Threat" to steelhead survival in San Luis Obispo Creek and Pismo Creek (NMFS 2013. Table 12-2. Threat source rankings in the San Luis Obispo Terrace Biogeographic Population Subgroup. p. 12-17).

San Luis Obispo Creek and Pismo Creek: Steelhead Recovery

NMFS' South-Central California Steelhead Recovery Plan (2013) designated both San Luis Obispo Creek and Pismo Creek as Core 1 populations within the San Luis Obispo Terrace Biogeographic Population Group. Core 1 populations are populations identified as having the highest priority for recovery based on a variety of factors, including:

- the intrinsic potential of the population in an unimpaired condition;
- the role of the population in meeting the spatial and/or redundancy viability criteria;
- the current condition of the populations;
- the severity of the threats facing the populations;
- the potential ecological or genetic diversity the watershed and population could provide to the species; and,
- the capacity of the watershed and population to respond to the critical recovery actions needed to abate those threats.

(NMFS 2013, Table 7.1 Core 1, 2, and 3 *O. mykiss* populations within the South-Central California Steelhead Recovery Planning Area. pp. 7-7 – 7-8.)

As part of NMFS' recovery planning for the threatened SC-CCS DPS of steelhead, the intrinsic potential of individual watersheds to support a viable population of steelhead in an unimpaired state is assessed and ranked. The intrinsic potential habitat for San Luis Obispo Creek and Pismo Creek ranked in the upper half of all the watersheds within the threatened SC-CCS DPS of steelhead based on the amount of potential habitat (in an unimpaired state) in each watershed within the SC-CCS DPS. See Figure 1 and 2, "Intrinsic Potential Steelhead Spawning and Rearing Habitat maps for San Luis Obispo Creek and Pismo Creek included as part of Enclosure

NMFS also designated critical habitat for the threatened SC-CCS DPS of steelhead in 2005 (70 FR 52488). This designation included the main stem and tributaries of San Luis Obispo Creek and Pismo Creek, portions of which traverse the SLO Valley Basin. Critical habitat provides: 1) freshwater spawning habitat with water quality and quantity conditions and substrate supporting spawning, incubation, and larval development, 2) freshwater rearing sites with water quality and floodplain connectivity to form and maintain physical habitat conditions and support juvenile growth and mobility, water quality and forage supporting juvenile development, and natural cover such as shade, submerged and overhanging vegetation, and 3) freshwater migration corridors free of passage obstructions to promote adult and juvenile mobility and survival.

Critical habitat throughout the threatened SC-CCS DPS of steelhead has been adversely affected by loss and modification of primary constituent elements (substrate, water quality and quantity, water temperature, channel morphology and complexity, riparian vegetation, passage conditions, etc.) through activities such as groundwater extractions and related surface-water diversions (NMFS 2013). Thus many of the constituent elements of critical habitats have been significantly degraded (and in some cases lost) in ways detrimental to the biological needs of steelhead. These habitat modifications have hindered the ability of designated critical habitat to provide for the survival and ultimately recovery of the threatened SC-CCS DPS of steelhead. See Figures 3 and 4, "Critical Steelhead Habitat maps for San Luis Obispo Creek and Pismo Creek included as part of this Enclosure.

NMFS has developed a South-Central California Steelhead Recovery Plan (NMFS 2013) that provides a strategy for the recovery of the species (including a threats assessment, recovery actions, and recovery criteria). Among the threats to the steelhead habitats in the San Luis Obispo Creek and Pismo Creek watersheds identified in this recovery plan are surface-water diversions for groundwater replenishment, and related groundwater extractions, to support agricultural and urban developments that utilize groundwater resources (NMFS 2013. pp. 12-1 through 12-20) .

NMFS has also issued a 5-Year Status Review: Summary and Evaluation of the South-Central California Coast Steelhead Distinct Population Segment (NMFS 2016). This Status Review noted that the ". . . SWRCB generally lacks the oversight and regulatory authority over groundwater development comparable to surface water developments for out-of-stream beneficial uses, though SGMA in 2014 partially addresses this inadequacy for some water basins." (p. 38). The Status Review further noted that:

> "The below normal precipitation and reduced runoff has adversely affected aquatic habitat for steelhead in a variety of other ways, resulting in: 1) depleted groundwater basins which provide base flows that support critical over-summering habitat for rearing *O. mykiss*; 2) reduced hydrological connectivity between seasonally wet and dry stream sections in interrupted streams; 3) restricted instream movement of rearing *O. mykiss*; 4) delayed or reduced breaching time of sandbars at the mouth of coastal estuaries, affecting water quality, and limiting both the upstream migration of adult *O. mykiss* and the

> downstream emigration of juveniles and kelts. Riparian habitat has also been adversely affected by the reduction in groundwater levels and the reduction of surface flows, affecting water temperatures and food availability." (p. 48).

To address the identified threats to threatened steelhead in the San Luis Obispo Creek and Pismo Creek watersheds NMFS' South-Central California Steelhead Recovery Plan identifies a number of recovery actions targeting surface diversions and groundwater extraction (NMFS 2013, Table 8-1. Recovery Actions Glossary. pp. 8-7 – 8-8).

These include for San Luis Obispo Creek:

> SLO-SCCCS-6.1 Conduct groundwater extraction analysis and assessment. Conduct hydrological analysis to identify groundwater extraction rates, effects on the natural stream pattern (timing, duration and magnitude) of surface flows in the mainstem and tributaries, and the estuary, and effects on all *O. mykiss* life history stages, including adult and juvenile *O. mykiss* migration, spawning, incubation, and rearing habitats.
>
> SLO-SCCCS-6.1 Develop and implement groundwater monitoring and management program. Develop and implement groundwater monitoring program to guide management of groundwater extractions to ensure surface flows provide essential support for all *O. mykiss* life history stages, including adult and juvenile *O. mykiss* spawning, incubation and rearing habitats.
>
> Table 12-12. South-Central California Steelhead DPS Recovery Action Table for San Luis Obispo Creek, p 12-58.

Similarly for Pismo Creek:

> Pis-SCCCS-6.1 Conduct groundwater extraction analysis and assessment. Conduct hydrological analysis to identify groundwater extraction rates, effects on the natural stream pattern (timing, duration and magnitude) of surface flows in the mainstem and tributaries, and the estuary, and effects on all *O. mykiss* life history stages, including adult and juvenile *O. mykiss* migration, spawning, incubation, and rearing habitats.
>
> Pis-SCCCS-6.1 Develop and implement groundwater monitoring and management program. Develop and implement groundwater monitoring program to guide management of groundwater extractions to ensure surface flows provide essential support for all *O. mykiss* life history stages, including adult and juvenile *O. mykiss* spawning, incubation and rearing habitats.
>
> Table 12-13. South-Central California Steelhead DPS Recovery Action Table for Pismo Creek, p. 12-63.

Both San Luis Obispo Creek and Pismo Creek currently supports a threatened population of steelhead that is critical to the future survival and recovery of the broader threatened SCCCS DPS of Steelhead.

Management of the groundwater of the SLO Valley Basin has affected the water resources and other related natural resources throughout the San Luis Obispo Creek and Pismo Creek watersheds. When analyzing impacts on steelhead or other aquatic organisms resulting from groundwater and related streamflow diversions, identifying flow levels that effectively support essential life functions of this organism is critical (Barlow and Leake 2012). Specifically, it is essential to explicitly provide for the protection of habitats, including those recognized instream beneficial uses that are dependent on groundwater such as fish migration, spawning and rearing, as well as other Groundwater Dependent Ecosystems GDE (California Department of Water Resources 2016, Heath 1983).

Specific Comments

On page 21, the draft Chapter 5 states the following with regard to decreasing groundwater storage in the northern portion of the basin:

> *"The long-term stability of groundwater elevations in these hydrographs indicates that groundwater extractions and natural discharge in the areas of these wells are in approximate equilibrium with natural recharge and subsurface capture, and that no trends of decreasing groundwater storage are evident."*

However, in Figure 5-11, three of the graphs depicting groundwater trends over time for the northern basin do not include data from the last few decades (e.g., graphs #1, #3, and #4 present data up to 1995, 2005, and 2012, respectively). Relying on data that has gaps ranging from several years to a few decades limits their utility in describing recent or current trends in groundwater storage. The revised draft should recognize and address this limitation. In addition, to improve the utility of the graphs, each should include the respective ground-surface elevation at the well location. Finally, it appears that data collection at some wells was not systematically collected on a set time schedule. This limitation should recognized and addressed as well.

On page 24, the draft Chapter 5 states:

> "The Percolation Zone Study of Pilot-Study Groundwater Basins in San Luis Obispo County, California identified areas with relatively high natural percolation potential that, through management actions, could enhance local groundwater supplies for human and ecological benefits to the aquatic environment for steelhead habitat."

However, it not clear what specific management actions are referred to here. If the management actions involve diversion of flows from either San Luis Obispo Creek or Pismo Creek, the effects of these diversions must be assessed on steelhead use, as well as other GDE.

On page 30, the draft Chapter 5 references a 30-foot difference in surface water and groundwater elevation as a determinant for evaluating hydraulic disconnection between the two. The 30-foot metric, as referenced in Rohde *et al.* (2019), is based upon rooting depths of oak trees. How groundwater supports oak tree ecology is very different from how groundwater accretion to surface flow supports stream-dwelling organisms for other GDE (explained below), and the former should not be used to inform the latter.

This same issue arises in Section 5.8.2 in a discussion of GDE impacts within East and West Corral de Piedras creeks. Finally, the draft Chapter 5 recognizes that oak rooting depths can be up to 70 feet (page 34), which would appear to contradict the basis for using 30 feet within their GDE analysis.

The life-cycle of steelhead often requires occupying seasonal habitat that may only have flowing water during wetter periods of the year (Quinn 2015, Boughton et al. 2009), especially in more arid regions at the southern extent of their range (e.g., central and southern California). The extent of connection is seasonally transient, and changes in the water table and river flow can and do alter the state of connection (Cook et al. 2010, Brunner et al. 2011). In short, whether a stream or river reach is gaining or losing, or whether 30 feet separates groundwater/surface water at a specific time of year, is not; what is important is how groundwater use influences the seasonal duration and quality of surface water and, by extension, instream habitat.

The mechanism by which stream-dwelling organisms are impacted by groundwater pumping is habitat degradation caused by the draw-down of surface flows (Barlow and Leake 2012), and can occur in both "gaining" and "losing" stream reaches. The impacts can be both physical (e.g., pool volume shrinks as water surface elevation declines) and physicochemical (e.g., water quality can suffer as pools and riffles lose connectivity). Thus, the appropriate method to determine whether pumping is having "significant and unreasonable adverse impacts" on beneficial uses of surface water is to understand the level of impact (i.e., volume of streamflow depletion) and how habitat quality and functionality change because of that impact. Further data is required throughout the 180/400-foot sub-basin to establish localized relationships between streamflow depletion and the resulting instream habitat characteristics.

The final GSP should address this data gap by including studies that develop an appropriate threshold preventing significant and unreasonable impacts to beneficial users of surface water. The final GSP should also elaborate sufficiently as to when, where, and how this data will be collected during the first few years of GSP implementation, or at the very least, clearly commit to developing a detailed data collection plan with interested stakeholders at a later date.

NMFS recommends the final GSP follow guidance from California Department of Fish and Wildlife (2019) and develop conservative streamflow depletion thresholds as a precautionary approach until the surface flow/groundwater dynamic in the 180/400 foot sub-basin is better studied and understood.

Page 30 of the draft chapter 5 states "*…s*ince, as presented in the discussion of hydrographs in the San Luis Valley in Section 5.2, there has been no long- term water level declines in this area, there is no evidence of long-term depletion of interconnected surface water in this area.*"*

This statement is not consistent with basic principles of groundwater hydrology or SGMA regulations. First, as noted above, several of the groundwater elevation plots referenced in Section 5.2 do not contain full records, and are thus inappropriate for discerning recent trends and concluding water levels have not been declining in the area. Second, whether or not groundwater levels are steady over time has no probative value informing streamflow depletion impacts – the proper method for determining potential streamflow depletion is developing and using an analytical groundwater/surface water, as required by SGMA regulations.

Page 31 of the draft Chapter 5 notes that:

> "Observations of stream conditions indicate a perennial reach of Pismo Creek that flows through Price Canyon and supports year-round critical habitat for threatened steelhead just south of the Basin Boundary."

A recent study of instream flows of Pismo Creek also indicates, "Groundwater discharge into the channel (gaining reaches) tends to occur within localized areas in the steep Franciscan Mélange formations, and within localized areas of Price Canyon, while stream reaches tend to lose water as they cross the Quaternary sedimentary deposits of Edna Valley (Stillwater 2016).

Rearing juvenile steelhead (as well a resident O. *mykiss*) respond to changing water conditions (including seasonal desiccation of stream reaches) by moving to areas with more suitable habitat conditions, including surface flow conditions. This behavioral response is common in streams that naturally exhibit diverse flow regimes such as ephemeral, intermittent, or interrupted flow (i.e., alternating reaches of surface and non-surface flow). In some situations, *this* situation can create enhanced feeding and growing conditions for juvenile *O. mykiss when they re-occupy previously desiccated stream reaches.* See, Boughton, et al. 2009. Spatial patterning of habitat for *Oncorhynchus mykiss* in a system of intermittent and perennial stream. *Ecology of Freshwater Fishes* 18:92-105.

Page 47 of the draft Chapter 5 provides references, which appear incomplete. For instance, Bennett (2015) does not appear in the reference list.

Finally, DWR's analysis suggests streamflow depletion are potentially influencing GDEs in the SLO Valley Basin, as evidenced by their updated basin prioritization work (DWR 2018). The SLO Valley Basin received extra priority points for water quality and streamflow/habitat impacts during the 2018 basin prioritization process[1]. The DWR prioritization handbook (DWR 2018) makes clear that those points reflect potential impacts to GDEs and their habitat, noting that:

> "…habitat and/or streamflow point(s) were not applied to basin prioritization until it was determined that one or more of the habitats and/or streamflows were potentially being adversely impacted."

NMFS suggests that the final GSP develop conclusions regarding streamflow depletion impacts based on reliably estimating streamflow-depletion rates or volumes using the required groundwater/surface water model, and relating those depletions to instream habitat impacts that limit steelhead survival. See for example, Sophocleous 2002, Mercer and Faust 1980.

[1] See the SGMA Basin Prioritization Dashboard tool at https://gis.water.ca.gov/app/bp-dashboard/final/ Also, The Nature Conservancy. 2018. Groundwater Dependent Ecosystems under the Sustainable Groundwater Management Act. Guidance for Preparing Groundwater Sustainability Plans.

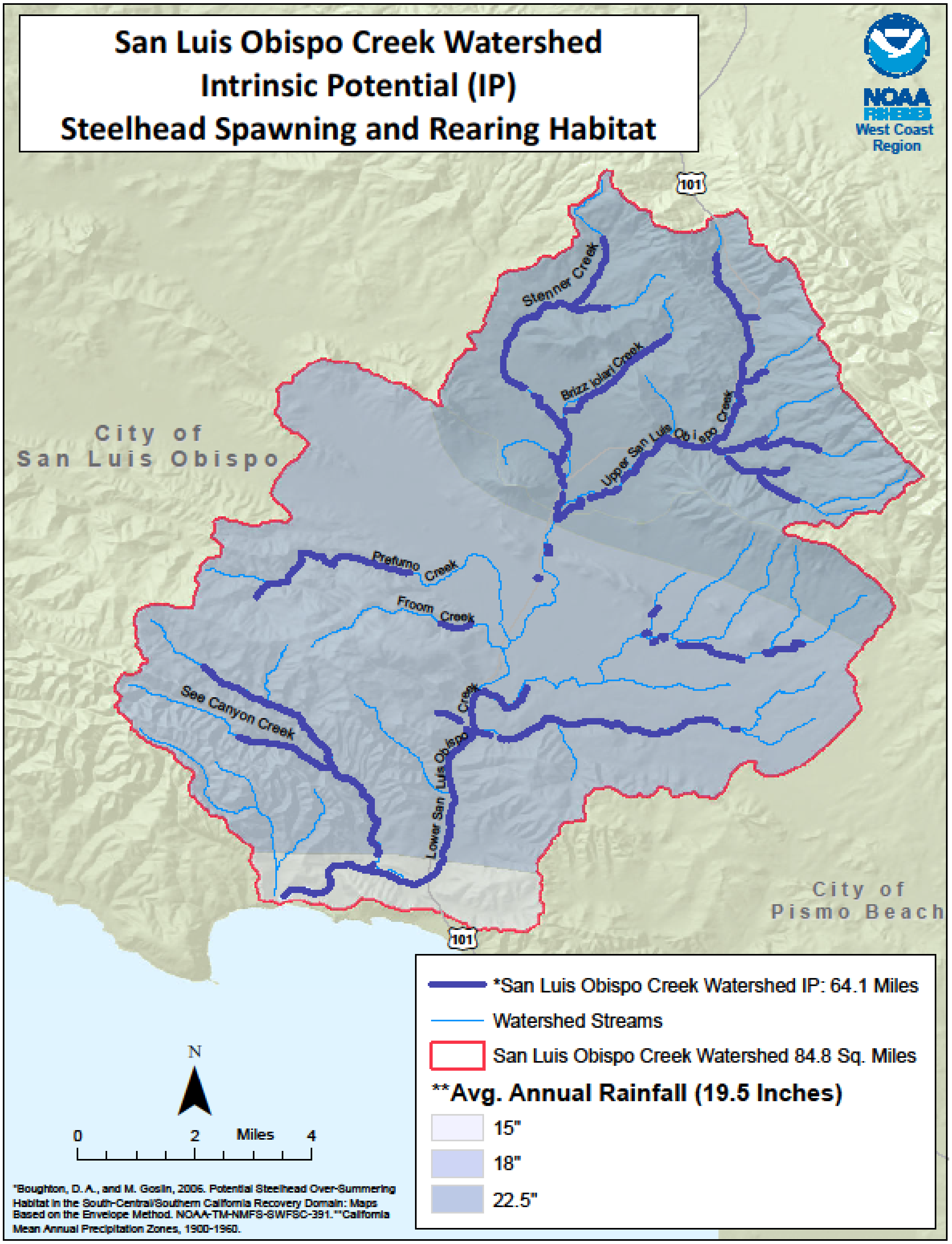

Figure 1. San Luis Obispo Creek Intrinsic Potential Steelhead Spawning and Rearing Habitat.

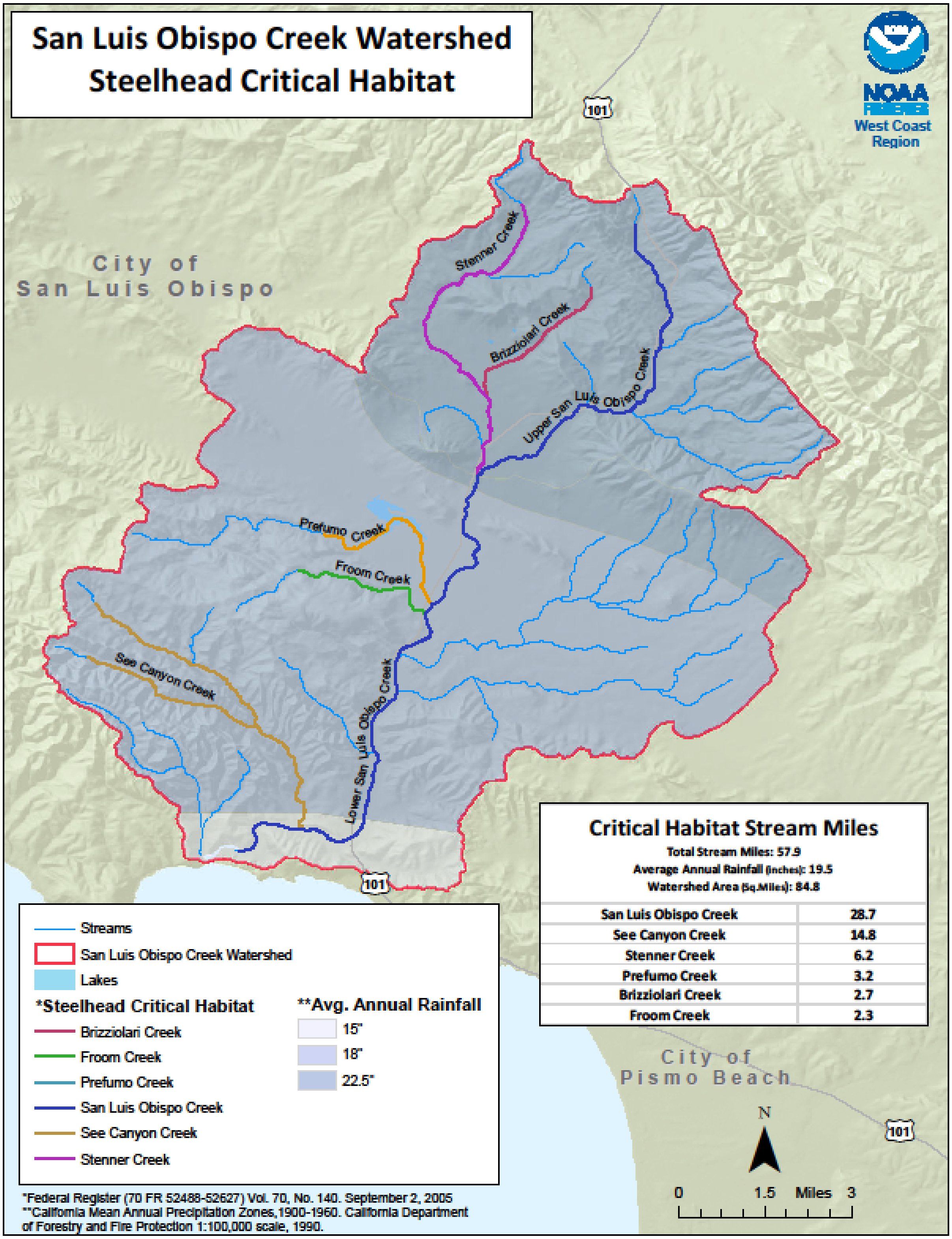

Figure 2. San Luis Obispo Creek Critical Steelhead Habitat.

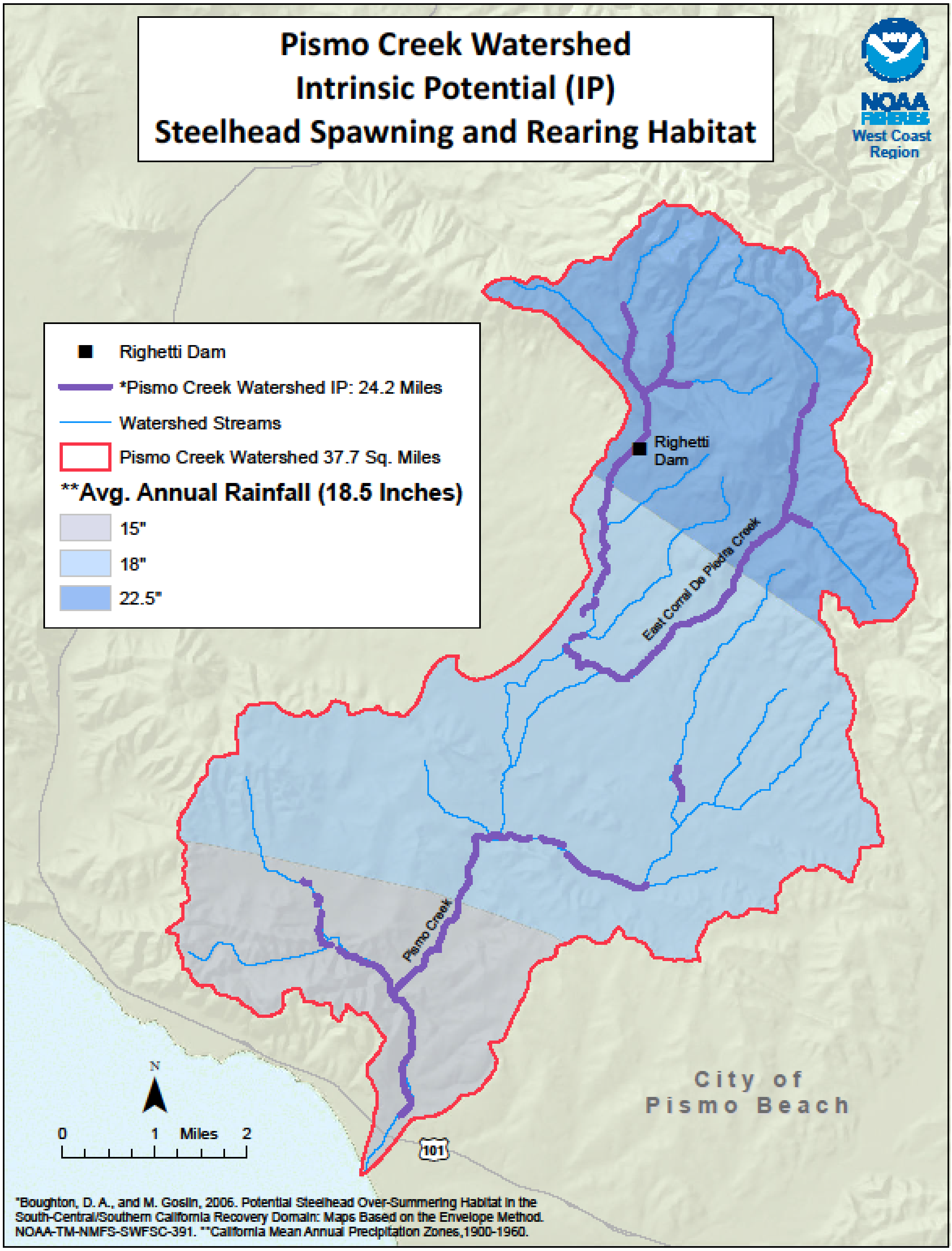

Figure 3.Pismo Creek Intrinsic Potential Steelhead Spawning and Rearing Habitat.

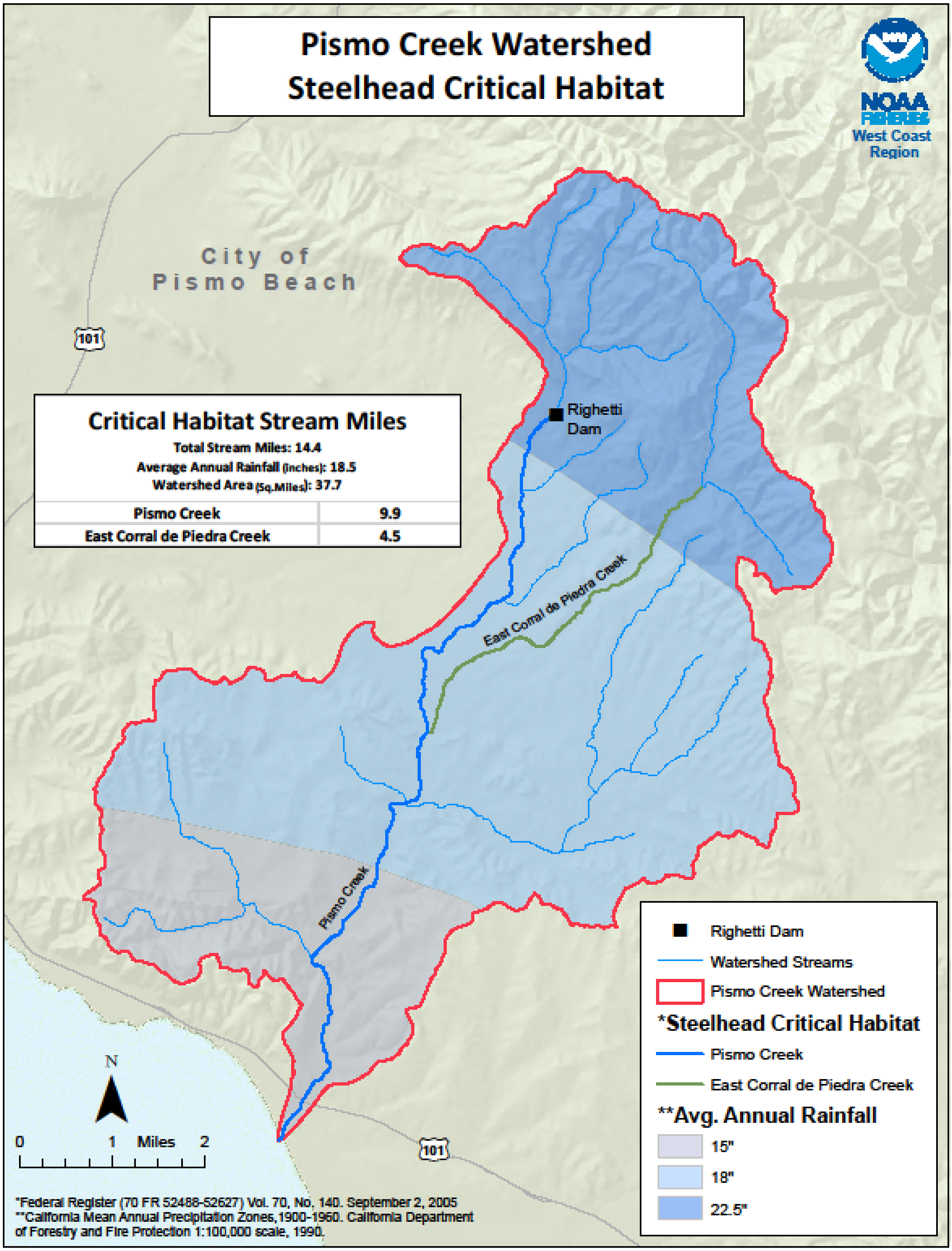

Figure 4. Pismo Creek Critical Steelhead Habitat.

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MEMORANDUM

Date: November 11, 2020

To: San Luis Obispo Valley Groundwater Sustainability Commission

From: Board of Directors
Varian Ranch Mutual Water Company
Edna Ranch East Mutual Water Company

Via: Rob Miller, PE

REGISTERED PROFESSIONAL ENGINEER
ROBERT S. MILLER
No. 57474
CIVIL
STATE OF CALIFORNIA

Subject: Policy Considerations for Groundwater Sustainability Plan

Edna Ranch East and Varian Ranch Mutual Water Companies (Companies) are currently participating in the preparation of a Groundwater Sustainability Plan (GSP) for the San Luis Obispo Valley Groundwater Basin (Basin). Based on information provided in June 2020 by the consultant team, the Edna Subarea of the Basin may be in overdraft by an estimated deficit of 1,100 acre feet per year (AFY). As a result, one of the strategies that may be suggested in the coming months is the mandatory reduction of pumping within the Edna Subarea.

Over the last six years, the Companies have implemented aggressive conservation measures in response to Basin conditions and severe drought. These measures represent a permanent shift in water policies, technology, and customer demands. Key conservation measures and metrics are summarized in this memorandum, resulting in the following findings:

- New monitoring technology, combined with conservation policies, have resulted in a reduction in well water production of 35% compared to the 2013 baseline year, and 26% compared to the 10-year period of 2005 through 2014.
- Given that some customer growth has occurred during the analysis period, the extent of the conservation is even greater when analyzed on a per customer basis. In the Edna Ranch East area, the customer base has increased by approximately 10% since 2009, and the average use per connection has dropped by approximately 40%.
- The combined well production of the Companies represents approximately 2% of the overall basin production/yield for the Edna Valley Subarea.

Table 1 below summarizes the conservation measures implemented by the Companies. Of particular note is the use of technology to drive both management and customer decision making. Both systems have installed the Beacon Automated Meter Reading (AMR) system. This system provides hourly customer used data to Company management and to each connected customer, including customizable text alerts and automated leak detection. The typical customer interface is shown in Figure 1 below. Combined with enforceable penalties, the AMR system has resulted in substantial demand reductions as noted above. In addition to customer meters, water supply wells and water tanks are remotely monitored by management.

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Figure 1 - AMR Customer Portal

Table 1: Summary of Conservation Measures Implemented (2014 to Present)		
Calendar Year	**Varian Ranch Mutual Water Company**	**Edna Ranch East Mutual Water Company**
2014	Enforced historical per lot maximum water use of 1,500 gallons per day on bi-monthly basis, with penalty charge of 4 times normal water rate.	Enforced historical per lot maximum water use of 1,161 gallons per day (424,000 gal/year), with penalty charge
2015	Reduced allowable usage to 1,200 gallons per day with continued penalties, enforced bi-monthly.	Continued enforcement
2016	Enforced previously approved policies	Implemented Automated Meter Reading with continuous customer access to data and leak notification
2017	Implemented Automated Meter Reading with continuous customer access to data and leak notification	Continued enforcement of maximum use, with real time customer data
2018	Amended bylaws to allow for tiered rates and continued enforcement	Continued enforcement of maximum use, with real time customer data. Board increased penalty charges.
2019	Previous measures remain in effect post drought. Continued enforcement of maximum use, with real time data.	Continued enforcement of maximum use, with real time data
Results Summary	Significant reductions began in 2015. Production reduced by 31% based on current 5-year average.	Significant reductions began in 2015 and accelerated in 2016. Production reduced by 23% based on current 4-year average.

Water production data from the time period of 2005 through 2019 has been compiled and analyzed. Figures 2 through 4 have been assembled to illustrate the water production trends that have resulted from the recent conservation measures. The attached figures are described below:

- Figure 2 displays the annual well production for both Varian and Edna East as separate entities.
- Figure 3 provides a summary of the combined production of both Companies
- Figure 4 illustrates the combined production of the Companies in comparison to the Edna Valley Subarea estimated yield.

Given the substantial reductions in groundwater production that have already been achieved by the Companies, the following management principles are recommended for consideration in the stakeholder discussion for the preparation of the GSP:

1. The recent reductions in groundwater production documented by the Edna Ranch East and Varian Ranch Mutual Water Companies, if maintained over time, satisfy the adjustments required to achieve Basin sustainability.
2. Periodic monitoring and reporting should be implemented to confirm continued adherence to the average well production from the period of 2015 through 2019, and no further reductions are contemplated at this time.
3. The total production of the Companies represents approximately 2% of the estimated Edna Valley Subarea yield, and therefore the continued implementation of recent conservation strategies is a sufficient contribution to overall Basin management.

Please let me know if you have any questions, or if you need more information.

Figure 2
Annual Production by Year - Edna Ranch East and Varian Mutual Water Companies

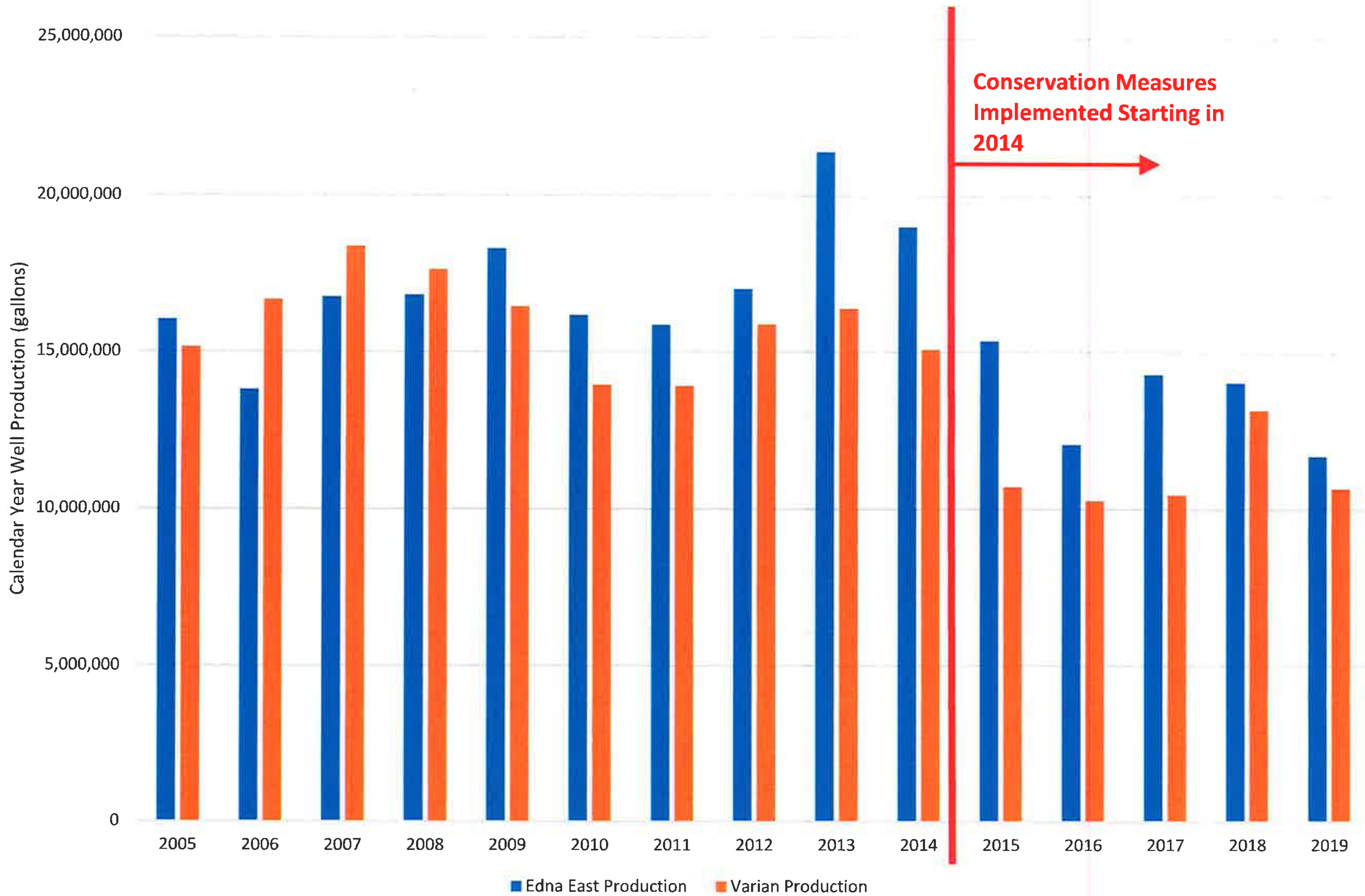


Figure 3: Combined Annual Production by Year - Edna Ranch East and Varian Mutual Water Companies

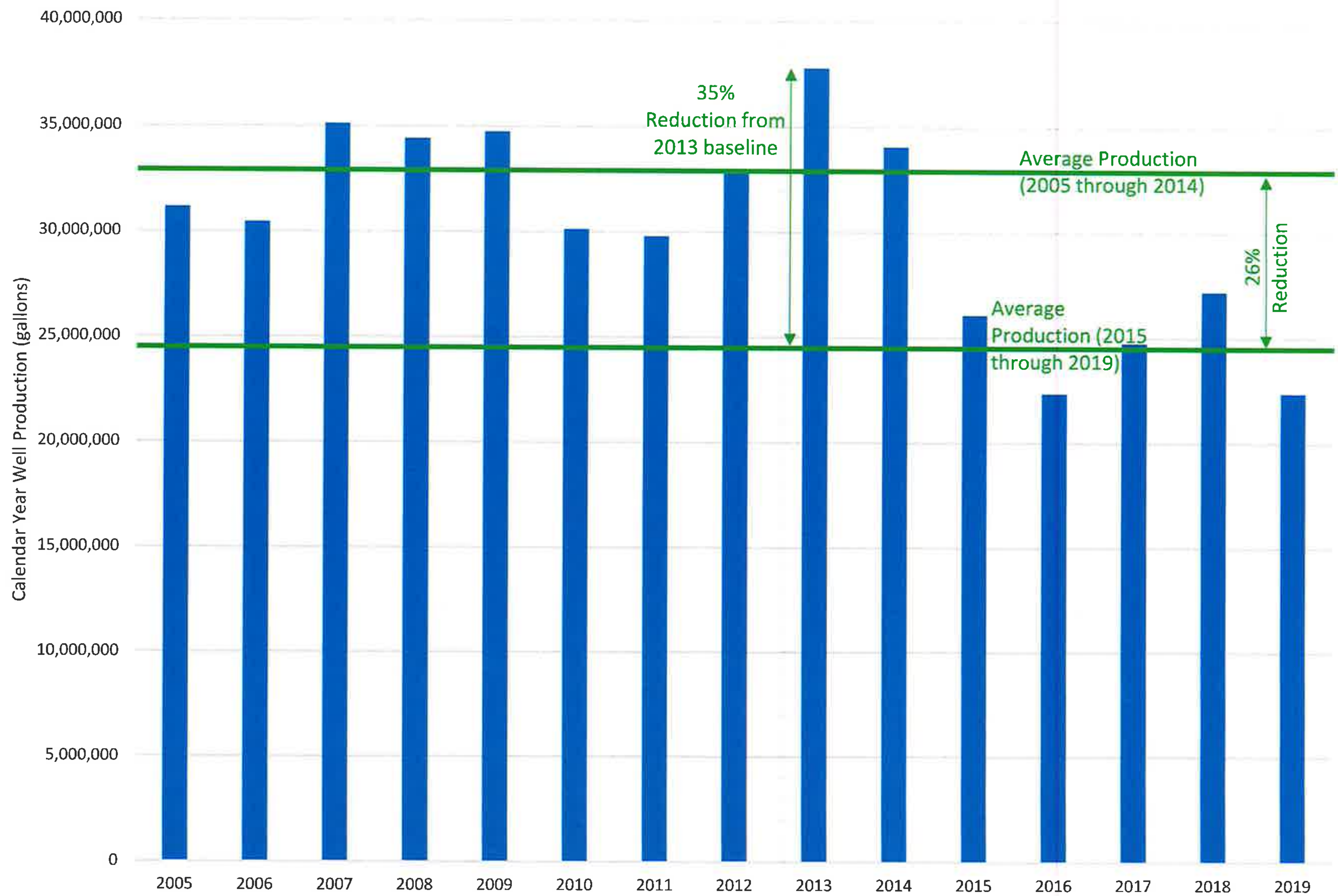
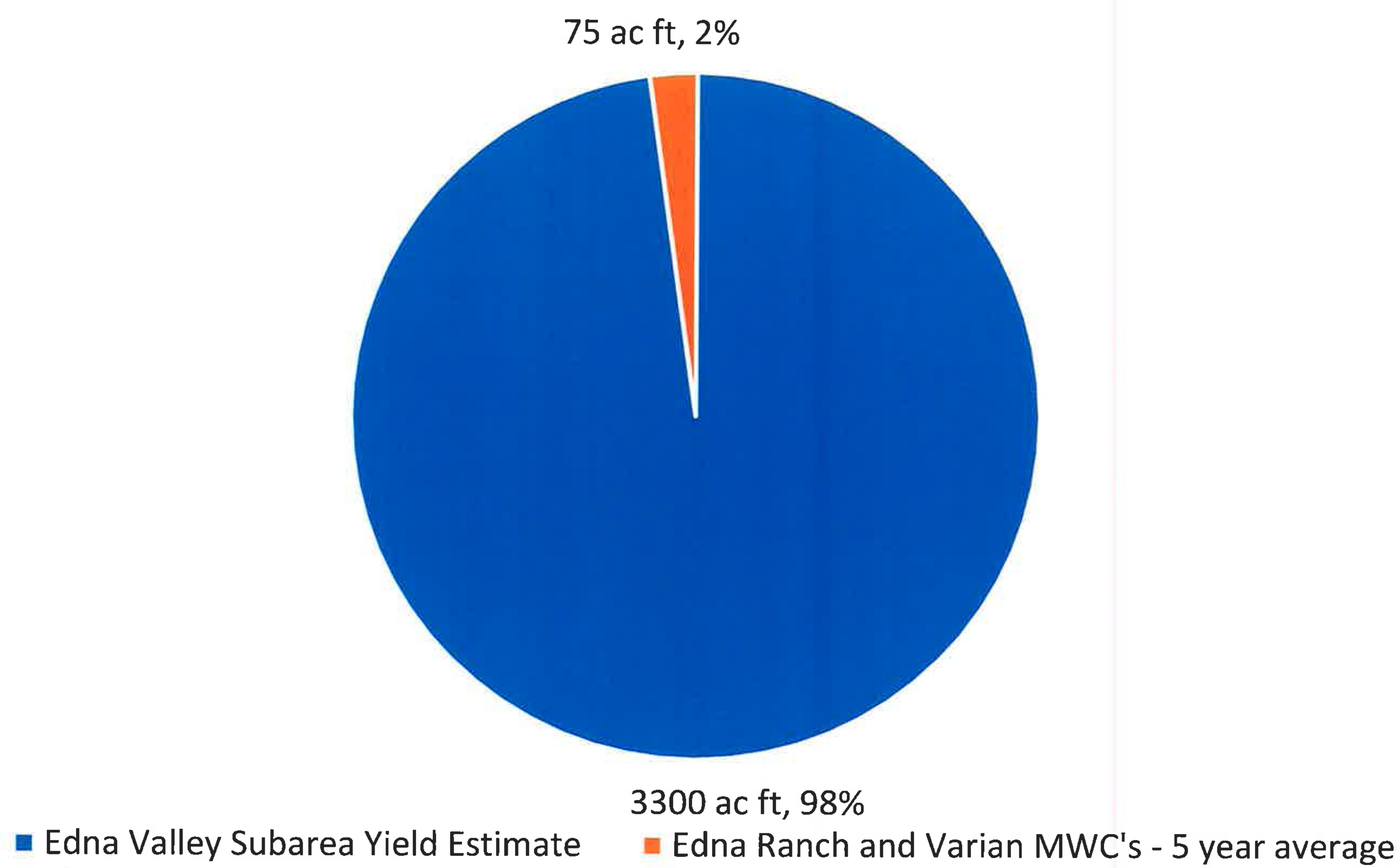


Figure 4: Basin Yield vs Edna/Varian Annual Well Production



Public Utilities
879 Morro Street, San Luis Obispo, CA 93401-2710
805.781.7215
slocity.org

DATE: 2/7/2021

TO: The Groundwater Sustainability Commission

FROM: Mychal Boerman, Utilities Deputy Director - Water

SUBJECT: City of San Luis Obispo Recycled Water Limitations

The City of San Luis Obispo has been utilizing recycled water as a component of its multi-source water supply since 2006. The City's goal is to use this water source to the highest and most beneficial use. The City is committed to the expansion of its non-potable recycled water programs and to the development of a potable reuse program to supplement groundwater supplies.

The cumulation of past groundwater usage has resulted in an imbalance in the Edna Valley area's groundwater elevation. The delivery of the City's recycled water to parties within the Edna Valley area has been identified as a potential short-term augmentation project to offset further lowering of groundwater levels.

The purpose of this memo is to provide the Commission with a clear understanding of the City's long-term intent to put recycled water to the greatest beneficial use. While not conclusively detailing all constraints of future recycled water availability, this memo should serve to document the nature of the City's concerns regarding physical constraints on recycled water availability and delivery, as well as the City's intention of prioritizing the needs of in-City users above those of outside-City users. This memo does not discuss other topics such as pricing, contract terms, permitting, water rights, etc.

Seasonal Availability

The quantity of recycled water available for use to City customers is dependent on the quantity of untreated wastewater flowing into the City's Water Resource Recovery Facility (WRRF). Unlike most cities that experience relatively uniform recycled water availability throughout the year, the City of San Luis Obispo's availability is drastically impacted by the students from Cal Poly vacating the community during the summer months and thus decreasing the wastewater influent into the WRRF. This decrease in wastewater influent occurs during the summer months when the City's 50+ recycled water accounts increase irrigation to combat the warm, dry conditions. This decrease in availability, coupled with a substantial increase in demand, abnormally limits the recycled water available during the summer months.

Long-Term Versus Short-Term Availability

While there is currently surplus recycled water available year-round, with over 150 acre-feet per month available in some winter and spring months, it is anticipated that the City will not have a significant volume of recycled water supply available to sell to any outside users from June-October once the internal City demands increase to support new residential and commercial developments.

Recycled water demands from Avila Ranch, San Luis Ranch, Righetti Ranch, and other future in-City developments are expected to result in increased recycled water demand of roughly 400-500 acre-feet per year with most of this demand occurring during the summer. These developments are currently being constructed with many of the Orcutt Area developments already receiving recycled water deliveries. The City continues to update its recycled delivery projections as any amounts obligated for delivery beyond availability would need to be made up by use of City potable water supplies. This concern will continue to increase as both in-City and Cal Poly users continue to improve in their conservation of water.

As the City continues to develop its groundwater pumping program, it has been identified that there is significant recharge potential (upwards of 400 acre-feet per year) within the City's portion of the SLO Valley Groundwater Basin adjacent to the WRRF. Recharge projects in other areas of the City have not yet been studied but are anticipated to increase the amount of water that could be recharged within the basin. As the City resumes its groundwater pumping, additional capacity will likely be created within the basin, increasing the City's need for recycled water for recharge projects that may ultimately be used for a potable reuse project. As surface water supplies are adversely impacted by climate change, augmentation of the groundwater basin will be the City's major water supply expansion strategy and will limit water availability for outside-City interests as augmentation projects come online. Potable reuse through storage in the groundwater basin may also address the issues with seasonal availability by creating a prolonged time lag between highly treated wastewater injection and its withdrawal for use.

Physical Delivery Constraints

The City's recycled water storage and distribution system was designed to provide intermittent in-City deliveries within the southern half of the City. The City's storage tank, pumps, telemetry, and pipelines were not designed to provide recycled water to outside-City customers and may require upgrades in order to accommodate continuous 24/7 delivery. Additionally, the two potential pipeline alignments that could be utilized to deliver water to the Edna Valley area are undersized and limit the ability to deliver recycled water during the winter and spring months when it is most abundantly available. One pipeline located within Broad Street near the airport is 6" diameter C900 pipe. The other, located within Tank Farm road, is 8" diameter ductile iron pipe. It is estimated that the larger of the two pipelines could deliver approximately 100/acre-feet of recycled water per month if operated 24-hours per day for a full month. This undersized pipeline significantly restricts the amount of water that could be delivered to outside City customers during the winter and spring months.

Summary

While the City is actively pursuing opportunities to sell recycled water in the short-term, it must be conveyed that the long-term prioritization of recycled water is for irrigation of in-City uses where it can offset current potable supplies, and for use as a potable reuse project. When examining available basin augmentation projects, the City's recycled water supply should not be assumed to be available as a permanent augmentation project that will provide a consistent amount of water for basin augmentation through 2042 and beyond. With current in-City recycled water demands and influent, it is anticipated that the City could provide 500-800 acre-feet of recycled water annually with quantities decreasing as new in-City users come online and as the City develops potable reuse projects to supplement its supplies. In-City groundwater basin augmentation efforts, new regulations, drought, additional in-City customers, and the like could reduce the quantity available to outside users by several hundred acre-feet in the foreseeable future.

Please contact me with any questions related to the City's use of recycled water.

Mychal Boerman
mboerman@slocity.org
(805)781-7237

UNITED STATES DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
NATIONAL MARINE FISHERIES SERVICE
West Coast Region
501 West Ocean Boulevard, Suite 4200
Long Beach, California 90802-4213

June 3, 2021

John Diodati
Interim Director, Public Works Department
County of San Luis Obispo
976 Osos St #207
San Luis Obispo, California 93408

Re: NOAA's National Marine Fisheries Service comments on the May 6, 2021, draft Groundwater Sustainability Plan for the San Luis Obispo Valley Groundwater Basin

Dear Mr. Diodati:

Enclosed with this letter are NOAA's National Marine Fisheries Service's (NMFS) comments on "Chapter 8: Groundwater Conditions" of the draft Groundwater Sustainability Plan (GSP) for the San Luis Obispo (SLO) Valley Groundwater Basin.

The GSP is intended to meet the requirements of the California Sustainability Groundwater Management Act (SGMA). The SMGA includes specific requirements to identify and consider impacts to Groundwater Dependent Ecosystems (GDE) that have significant and unreasonable adverse impacts on all recognized beneficial uses of groundwater and related surface waters (Water Section 10720), including fish and wildlife and botanical resources.

As explained more fully in the enclosed comments, the draft Chapter 8 does not adequately address the recognized instream beneficial uses of the SLO Valley Basin, which underlies San Luis Obispo Creek and Pismo Creek, or other GDE, potentially affected by the management of groundwater within the SLO Valley Basin. In particular, the draft Chapter 8 does not adequately analyze or identify Sustainable Management Criteria that have the potential to affect the federally threatened South-Central California Coast steelhead (*Oncorhynchus mykiss*). This information is necessary because management of the SLO Valley Basin has consequences for the amount and extent of surface flows in San Luis Obispo Creek and Pismo Creek, both of which support populations of threatened steelhead.

Our enclosed comments include recommendations for revisions that are intended to assist the County of San Luis Obispo develop a final GSP that meets the requirements of the SGMA. To this end, NMFS recommends that the revised draft Chapter 8 be re-circulated to give interested parties an opportunity to review and comment before it is finalized.

NMFS appreciates the opportunity to provide the enclosed comments on the draft Chapter 8. If you have a question regarding this letter or enclosure, please contact Mr. Mark H. Capelli in our Santa Barbara Office (805) 963-6478 or mark.capelli@noaa.gov, or Mr. Andres Ticlavilca in our Santa Rosa Office (707-575-6054) andres.ticlavilca@noaa.gov.

Sincerely,

Anthony P. Spina
Chief, Southern California Branch
California Coastal Office

cc:

Natalie Stork, Chief, DWR, Groundwater Management Program
James Nachbaur, SWRCB
Annette Tenneboe, Region 4, CDFW
Julie Vance, Regional Manager, Region 4, CDFW
Steve Slack, CDFW
Kristal Davis-Fadtke, Water Branch, CDFW
Dennis Michniuk, District Fisheries Biologist, Region 4, CDFW
Annee Ferranti, Environmental Program Manager Resource Conservation, CDFW
Suzanne De Leon, Region 4, CDFW
Don Baldwin, Region 4, CDFW
Christopher Diel, Ventura Field Office, USFWS
Ronnie Glick, CDP&R
Fred Otte, City of San Luis Obispo

Enclosure

NOAA's National Marine Fisheries Service's Comments on the draft Groundwater Sustainability Plan (Chapter 8: Sustainable Management Criteria) for the San Luis Obispo Valley Groundwater Basin (May 6, 2021)

June 3, 2021

Background

NOAA's National Marine Fisheries Service (NMFS) is responsible for protecting and conserving anadromous fish species listed under the U.S. Endangered Species Act (ESA), including the federally threatened South-Central California Coast (SCCC) Distinct Population Segment (DPS) of Steelhead (*Oncorhynchus mykiss*), which utilize San Luis Obispo Creek and Pismo Creek. NMFS listed SCCC, including the populations in the San Luis Obispo Creek and Pismo Creek watersheds (which overlies a portion of the SLO Valley Basin), as "threatened" in 1997 (62 FR 43937), and reaffirmed the threatened status of the species in 2006 (71 FR 5248).

On March 12, 2020, the California Department of Water Resources (DWR) designated the SLO Valley Basin a "Medium" priority for groundwater management, requiring the development of a final Groundwater Sustainability Plan (GSP) by January 31, 2022, pursuant to the 2014 SGMA. Several watercourses that overlie portions of the SLO Valley Basin, including San Luis Obispo Creek and the headwaters of Pismo Creek, support federally threatened steelhead.

The available information establishes that surface water and groundwater are hydraulically linked in the SLO Valley Basin, and this linkage is critically important in creating seasonal habitat for threatened SCCC steelhead. Where the groundwater aquifer supplements streamflow, the influx of cold, clean water is essential for maintaining suitable water temperature and surface flow (Brunke and Gosmer 1997). Pumping from these aquifer-stream complexes can adversely affect freshwater rearing areas for juvenile steelhead by lowering groundwater levels and interrupting the hyporheic flow between the aquifer and the stream, particularly during summer and fall months when streamflow is already low. Thus, groundwater extraction in the SLO Valley Basin has the potential to adversely affect threatened SCCC steelhead through a reduction in the amount and extent of freshwater rearing sites for this species.

NMFS has previously commented on Chapter 5: Groundwater Conditions of the SLO Valley Basin GSP and provided background information on steelhead life history habitat requirements, and the role of both Pismo Creek and San Luis Obispo Creek in NMFS' South-Central Steelhead Recovery Plan (2013). See NMFS' May 29, 2020 letter to John Diodati, Interim Director, Public Works Department County of San Luis Obispo County).

Specific Comments

Page 29: The draft Chapter 8 indicates the basin will be considered to have experienced undesirable results if any of the monitoring wells exceed the minimum threshold for two consecutive fall measurements. The standard of failing two consecutive fall measurements is not explained, and thus appears arbitrarily. Steelhead migration, spawning and rearing (beneficial uses of surface water as set by the Regional Water Quality Control Board[1]) are biological processes that can be impacted by a single streamflow depletion event. SGMA regulations require a minimum threshold be used to define an undesirable result, in this case streamflow depletion resulting in significant and unreasonable impact to beneficial uses of surface water. For a beneficial use such as steelhead rearing, a depletion of adequate streamflow can result in steelhead mortality, and is therefore irreversible. We therefore recommend that the standard for determining undesirable results be expressed in terms of minimum pool depth and/or surface flow during the summer and fall base flow periods.

Page 29: Groundwater elevations may be necessary as a proxy for streamflow depletion due to a lack of data gathered to this point. However, there appears to be no attempt at correlating groundwater elevation thresholds with impacts to beneficial uses of surface water. In fact, many of the groundwater elevation minimum thresholds are set at the lowest (or below the lowest) groundwater elevations ever recorded within the basin. These thresholds are likely associated with severe groundwater over-pumping during dry periods, when groundwater depletion was greatest, and surface water discharge the lowest. Managing streamflow depletion conditions comparable with the severest drought conditions is not protective of surface water beneficial uses that support ESA-listed steelhead, and likely would result in adversely affecting steelhead and its identified critical habitat (see enclosed steelhead critical habitat and intrinsic potential maps for San Luis Obispo Creek and Pismo Creek). If the GSAs uses groundwater levels as a proxy for streamflow depletion, it should explain how the chosen minimum thresholds and measurable objectives adequately avoid adversely impacting surface water beneficial uses that support steelhead survival throughout the SLO Basin. If that effort proves problematic due to a lack of data at the present time, the GSAs should follow guidance by the California Department of Fish and Wildlife that recommends a conservative approach to groundwater dependent ecosystem protection in those situations (CDFW 2019).

Page 29, Section 8.9.2: The draft includes the following statement:

> *To avoid management conditions that allow for lower groundwater elevations than those historically observed, MTs* [Minimum Thresholds]f*or these wells were set at the historic low water levels indicated on the hydrographs, which occur with regularity during every extended dry period evident in the record (Figures 8-9, 8-10).*

As noted above, managing to perpetuate historically low groundwater elevations is not appropriate as a management threshold, since it does not adequately define the undesirable result of streamflow depletion on aquatic biological resources such as federally threatened South-Central Coast steelhead. Based upon fundamental hydrogeologic principles where the depletion rate is proportional to the difference between the water table and surface water, the amount of streamflow depletion associated with the proposed minimum thresholds would be the greatest on record (Sophocleous 2002, Bruner *et al*. 2011, Barlow and Leake 2012). This level of streamflow depletion would likely impact surface water beneficial uses to the extent that threatened steelhead would experience "harm" under the ESA as well as result in adverse impacts to Groundwater Dependent Ecosystems (GDE) supporting a variety of native aquatic species.

Page 30: Following the discussion on the relation between flow conditions in San Luis Obispo Creek and the underlying aquifer, the draft Chapter 8 asserts, "in both cases the amount of flux between the surface water and the groundwater system is small compared to the volume of water flowing down the creek." The point of this statement is unclear but seems to suggest that groundwater levels are not significantly influenced by the volume (including duration) of stream flow. However, this implication is contradicted by the statement, "In wetter years, when flows in the San Luis Obispo Creek are high there is [sic] greater amounts of discharge from the creek to the groundwater system." In general, higher and longer the duration flows in SLO Creek will increase the area of wetted stream bottom (i.e., the area of infiltration) as well as the duration of the infiltration of surface flows to the underlying groundwater basin. Furthermore, the assertion that stable groundwater levels at a specific well "suggest that the mechanisms of surface water/groundwater interaction have not been negatively impacted since the early 1990's" does not address the question of whether these stable conditions have had and are resulting in streamflow depletion impacts as defined under SGMA. Currently stable groundwater levels are not an indicator of sustainable groundwater conditions, or, more specifically, avoidance of significant and unreasonable effects on streamflow. The revised draft Chapter 8 should address this issue and clearly indicate how existing stable groundwater conditions are protective of GDE, such as rearing habitat for juvenile steelhead.

Page 31: The draft Chapter 8 states that, "by defining minimum thresholds in terms of groundwater elevations….the GSA will….manage potential changes in depletion of interconnected surface (sic [flows?])." The draft Chapter 8, however, has not established the required correlation between groundwater elevations and surface flows that would justify groundwater levels as a proxy for streamflow depletion, and has not quantified what level of streamflow depletion represents significant and unreasonable impacts to GDE, including but not limited to rearing habitat for juvenile steelhead. The draft Chapter 8 should identify the data needed to analyze the relationship of groundwater levels, streamflow depletion rates, and impacts to GDE, specifically spawning, rearing and migration of ESA-listed steelhead.

Page 31: The draft Chapter 8 establishes minimum thresholds for streamflow depletions as "the lowest water levels observed in the period of record" for the chosen monitoring wells. As noted earlier, according to SGMA regulations a minimum threshold is used to define an undesirable result, in this case streamflow depletion resulting in significant and unreasonable impact to GDE, including, but not limited to rearing juvenile steelhead. The use of a streamflow depletion thresholds associated with the lowest recorded groundwater levels are inappropriate because they will not avoid significant and unreasonable impacts to GDE. The thresholds are inappropriate for avoiding impacts to ESA-listed steelhead resulting from streamflow depletion. To be consistent with the requirements of SGMA, the GSAs must develop thresholds that are likely to avoid adversely impacting steelhead, as well as other GDE.

Page 32: The draft Chapter 8 includes no information or analysis that supports the assertion that "maintaining groundwater levels close to historically observed ranges will continue to support groundwater dependent ecosystems." As noted above, there is an assumption embedded within the assertion that current groundwater levels support groundwater dependent ecosystems; this has not been supported by any data or analysis because such information is not presented in the draft document. Managing groundwater levels at historical lows is likely to adversely affect ESA-listed steelhead, and designated critical habitat for this species. To be consistent with the requirements of SGMA, the GSAs must develop minimum thresholds that are likely to avoid adversely impacting steelhead, as well as other GDE.

Finally, it is unclear if the reference in the draft Chapter 8 to the Water Budget is to Chapter 5 and/or Chapter 6. If the draft Chapter 8 is referring to Table 6-20 (Current Water Budget – Basin Total), the comparison between the annual groundwater/ surface water interaction with an annual outflow volume of the watershed does not provide an indication of aquatic habitat conditions during low flow periods. We would note that intermittent stream reaches can provide seasonally important rearing habitat for juvenile steelhead. Reaches that temporarily lose surface flow through the natural seasonal reduction in groundwater levels can be re-occupied by fish rearing in other parts of the stream system as groundwater levels rebound and surface flows are reinitiated in the temporarily desiccated reaches (Boughton *et al.* 2009). However, artificially reduced groundwater levels can accelerate the temporary cessation of surface flows, and then delay the re-initiation of surface flows, thus reducing the amount and quality of rearing habitat with the stream system and adversely affect GDE.

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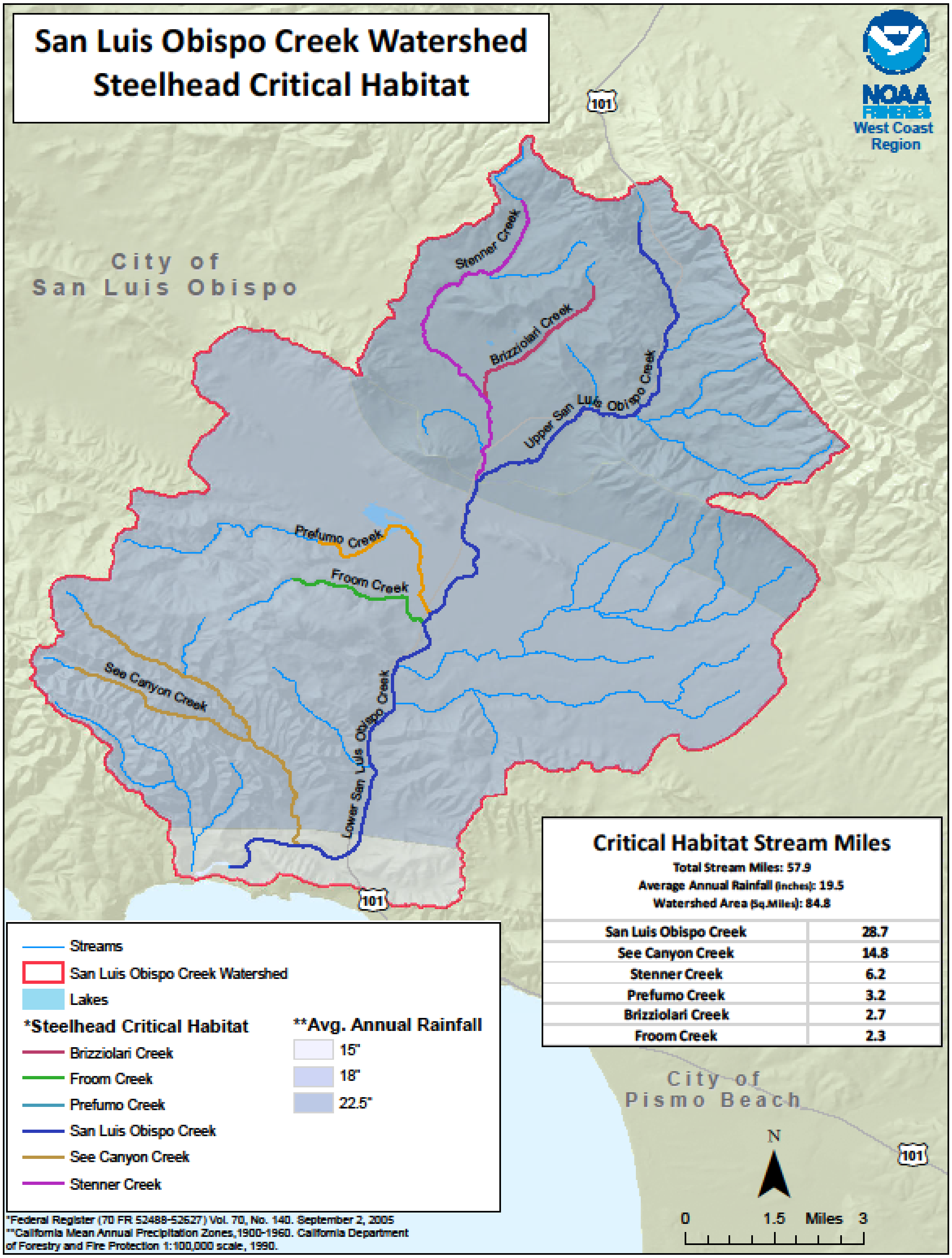
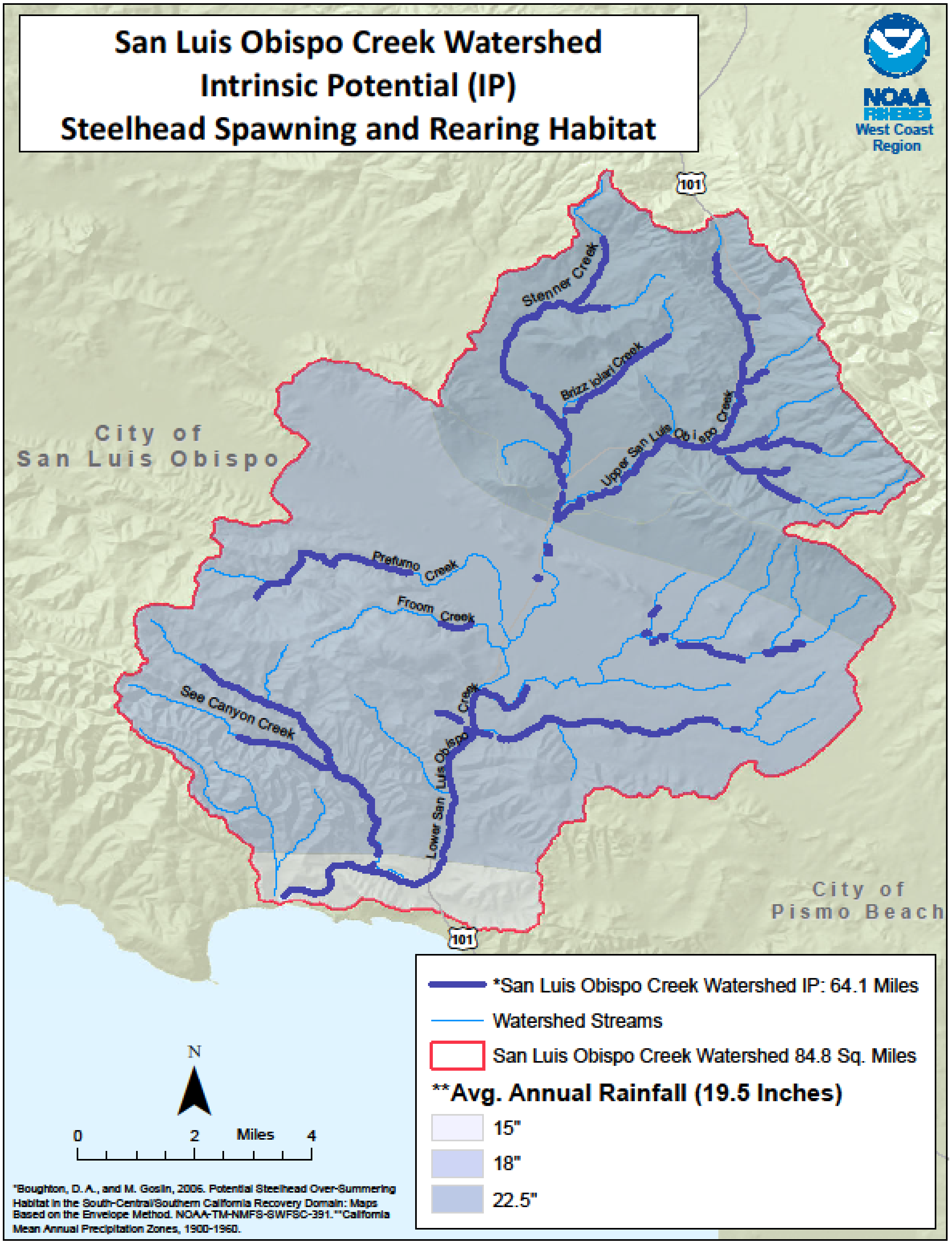
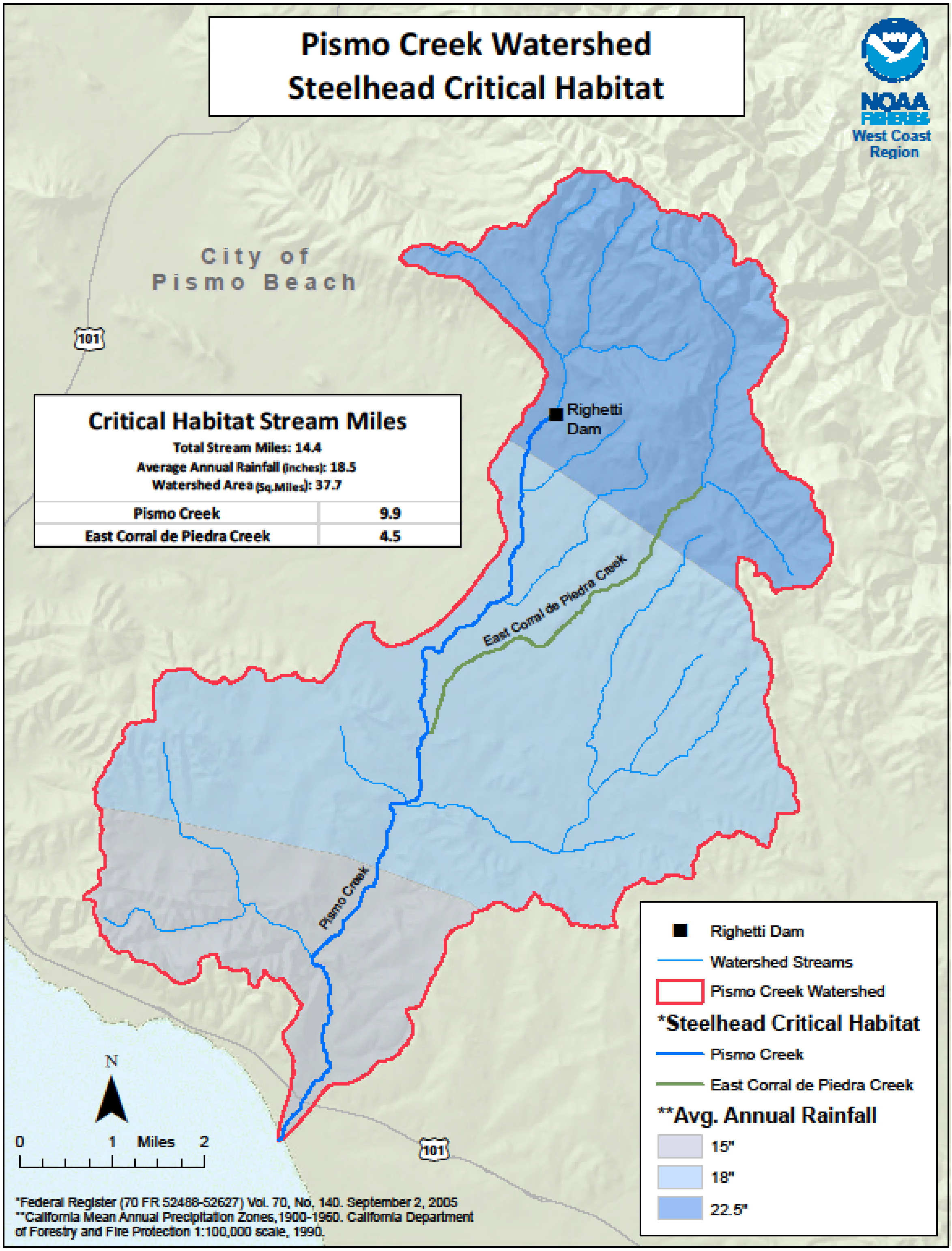
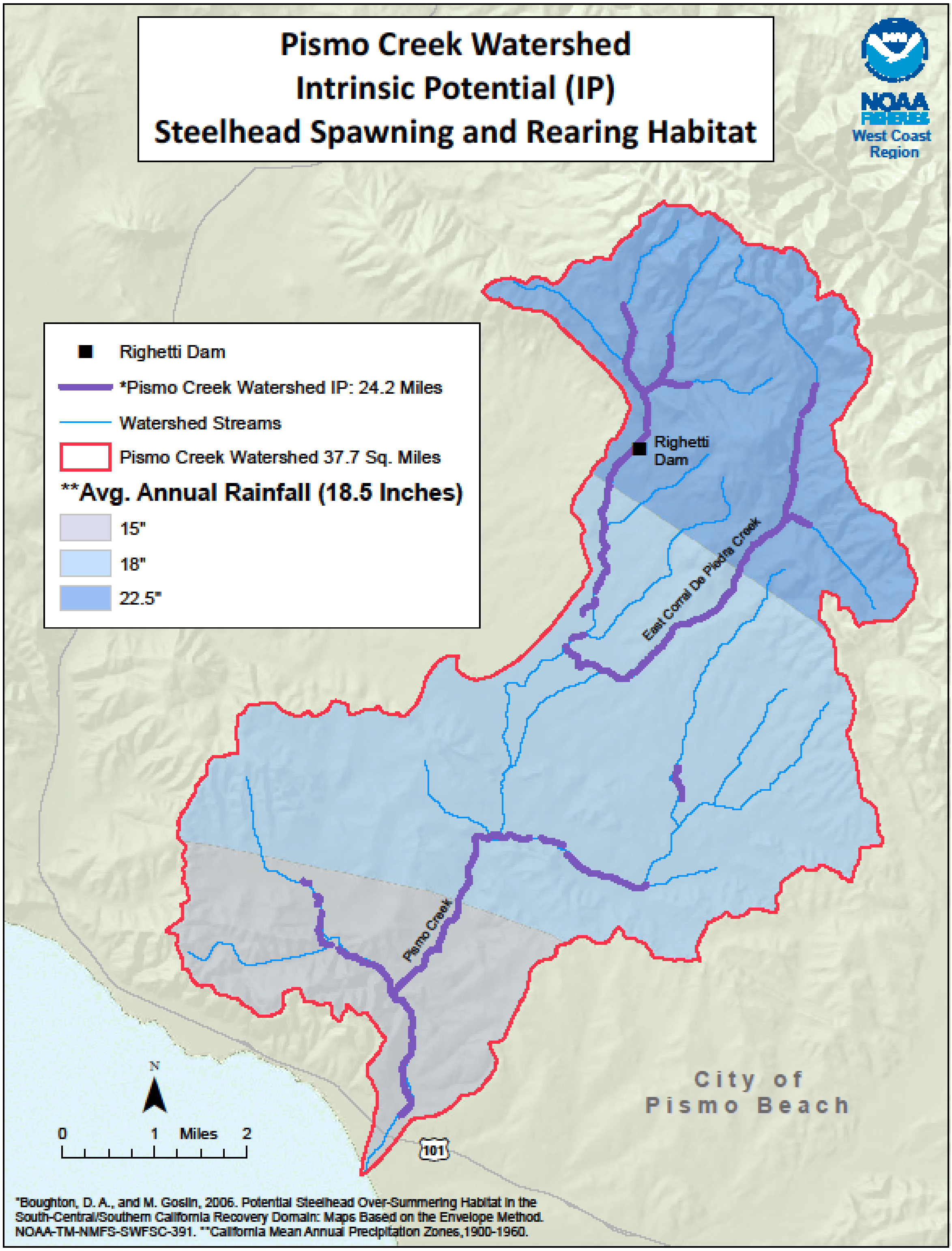


San Luis Obispo Creek	28.7
See Canyon Creek	14.8
Stenner Creek	6.2
Prefumo Creek	3.2
Brizziolari Creek	2.7
Froom Creek	2.3


San Luis Obispo Creek Watershed
Intrinsic Potential (IP)
Steelhead Spawning and Rearing Habitat
NOAA FISHERIES
West Coast Region
101
City of
San Luis Obispo
Stenner Creek
Brizziolari Creek
Upper San Luis Obispo Creek
Prefumo Creek
Froom Creek
See Canyon Creek
Lower San Luis Obispo Creek
City of
Pismo Beach
101
*San Luis Obispo Creek Watershed IP: 64.1 Miles
Watershed Streams
San Luis Obispo Creek Watershed 84.8 Sq. Miles
**Avg. Annual Rainfall (19.5 Inches)
15"
18"
22.5"
N
0
2
Miles
4
*Boughton, D. A., and M. Goslin, 2006. Potential Steelhead Over-Summering Habitat in the South-Central/Southern California Recovery Domain: Maps Based on the Envelope Method. NOAA-TM-NMFS-SWFSC-391. **California Mean Annual Precipitation Zones, 1900-1960.


Pismo Creek Watershed
Steelhead Critical Habitat
NOAA FISHERIES
West Coast Region
City of Pismo Beach
101
Critical Habitat Stream Miles
Total Stream Miles: 14.4
Average Annual Rainfall (inches): 18.5
Watershed Area (Sq.Miles): 37.7
Pismo Creek 9.9
East Corral de Piedra Creek 4.5
Righetti Dam
East Corral de Piedra Creek
Pismo Creek
N
0 1 Miles 2
Righetti Dam
Watershed Streams
Pismo Creek Watershed
*Steelhead Critical Habitat
Pismo Creek
East Corral de Piedra Creek
**Avg. Annual Rainfall
15"
18"
22.5"
*Federal Register (70 FR 52488-52627) Vol. 70, No. 140. September 2, 2005
**California Mean Annual Precipitation Zones,1900-1960. California Department of Forestry and Fire Protection 1:100,000 scale, 1990.


Pismo Creek Watershed
Intrinsic Potential (IP)
Steelhead Spawning and Rearing Habitat
NOAA FISHERIES
West Coast Region
Righetti Dam
*Pismo Creek Watershed IP: 24.2 Miles
Watershed Streams
Pismo Creek Watershed 37.7 Sq. Miles
**Avg. Annual Rainfall (18.5 Inches)
15"
18"
22.5"
Righetti Dam
East Corral De Piedra Creek
Pismo Creek
N
0
1
Miles
2
101
City of
Pismo Beach
*Boughton, D. A., and M. Goslin, 2006. Potential Steelhead Over-Summering Habitat in the South-Central/Southern California Recovery Domain: Maps Based on the Envelope Method. NOAA-TM-NMFS-SWFSC-391. **California Mean Annual Precipitation Zones,1900-1960.

NewCurrent
WATER AND LAND

July 21, 2021

San Luis Valley Groundwater Sustainability Agency

Re: Comments to Chapter 9 and 10

Dear GSA:

These comments are submitted by New Current Water and Land, LLC (NCWL) on behalf of Edna Ranch East and the Edna Ranch East Mutual Water Company (collectively "Edna Ranch East").

NCWL is an experienced water consulting company composed of 4 principals with a combined experience in California water matters of over 140 years. Some of the principals were engaged on behalf of the Association of California Water Agencies and the Governor's Office in negotiating the language of the Sustainable Groundwater Management Act (SGMA).

These comments cover three critical issues. First, they address the question of de minimis use. Second, they address the baseline period and the conservation of groundwater that has occurred since. Finally, they address the question of sustainable yield and how the Groundwater Sustainability Agency (GSA) intends to allocate management actions among various groundwater uses within the basin.

Edna Ranch East is located in the Edna Valley portion of the San Luis Obispo subbasin. It is comprised of a number of homesites with stock in a mutual water company for the purpose of providing domestic water to the homesites. In other words, each homeowner owns an interest in the mutual water company for the purpose of providing water to their home. No homesite extracts more than 2 acre feet of water per year through the mutual water company. California Water Code section 10721(e) defines a De minimis extractor as a person who extracts, for domestic purposes, two acre-feet or less per year. California Water Code section 10725.8 authorizes GSAs to require measuring methodologies of groundwater extractions for the purpose of achieving groundwater sustainability. Section 10725.8(e) states that the provisions of the section do not apply to de minimis extractors. Thus, Edna Ranch East asserts that SGMA does not apply to the homeowners at Edna Ranch East.

652 West Cromwell, Suite 101 · Fresno, CA 93711 · Ph: 559.449.1111 · NewCurrentWater.com

California Water Code section 10720.5(a) states that extractions after January 1, 2015 cannot be used as evidence of any claim of prescription. The effect of this section is to establish a base line of rights on January 1, 2015. In the case of Edna Ranch East, several actions have been taken since that date, which have had the effect of reducing homeowner water use. Such actions have included installation of an automated water metering system, tripling of excessive water use penalties, providing water audits to homeowners to reduce water use, installation of an enhanced water leak detection system, and direct engagement of the Board of Directors of the mutual water company with homeowners with high usage (on a weekly basis). Edna Ranch East asserts that the GSA should credit it with the efficiencies achieved through these and other measures undertaken by the mutual water company.

As noted above, Edna Ranch East believes homeowner extractions are de minimis and that it has undertaken several actions that have reduced average homeowner use. Further, we can find no determination that existing uses exceed the sustainable yield. If they do not, further management actions should not be necessary. Legally, the mutual is extracting water for use by homeowners on land overlying the subbasin. Their rights should be based upon the extraction of water as compared to sustainable yield. If the mutual water company extraction for homeowners is not determined to be as an overlying right holder, then they have prescribed against overlying right holders and could have a senior right.

Edna Ranch East is submitting these comments for the record. It fully intends to stay actively engaged in the process and support reasonable and equitable solutions to achieve a sustainably managed groundwater basin. In doing so, it requests the GSA recognize the nature of its rights, actions it has taken to more efficiently manage water.

Sincerely

Daniel M. Dooley

DMD:dt

CREEK LANDS
Conservation

Central Coast Salmon Enhancement, Inc. dba Creek Lands Conservation

7-22-2021

To whom it may concern:

Thank you for accepting my comments regarding the document titled "Groundwater-Dependent Ecosystems in the San Luis Obispo Valley Groundwater Basin Technical Memorandum" (SLO Valley GDE Technical Memo), as well as chapters from the Draft San Luis Obispo Valley Basin Groundwater Sustainability Plan. Creek Lands Conservation (CLC) works collaboratively with non-profits and local agencies to protect and enhance groundwater dependent ecosystems (GDEs) in SLO County on behalf of all freshwater aquatic species including but not limited to federally threatened steelhead trout (*Onchorychus mykiss*). GDEs are those ecosystems that rely on groundwater to supply surface water. When groundwater is in an overdraft condition, these systems suffer. Overdraft can result in the loss of plants and animals in a basin, or in the worst case, extinction. Groundwater dependent ecosystems in the San Luis Obispo Valley Basin include San Luis Obispo Creek and all its tributaries, Pismo Creek and all its tributaries, Laguna Lake, and various seeps, springs, and wetlands associated with these systems.

The Sustainable Groundwater Management Act (SGMA) contains numerous provisions to consider and address the environment in groundwater sustainability plans and actions. SGMA requires that all beneficial uses and users be considered in the development and implementation of Groundwater Sustainability Plans. GDE's are one type of beneficial user of groundwater. CLC hopes to continue to work with other non-profits, local, and state agencies to ensure that GDE's are clearly identified and mapped, to improve our understanding of surface-groundwater interactions, to identify potential adverse impacts on GDE's, and to help set appropriate minimum thresholds and measurable objectives for GDE's under SGMA.

The comments on the SLO Valley GDE Technical Memo and applicable Draft GSP Chapters herein are provided with the understanding that the SLO Valley GDE Technical Memo provides the most recent and most detailed study of GDEs within the groundwater basin as they relate to the SGMA process. With that understanding, CLC is commenting not only on the recently released SLO Valley GDE Technical Memo but also on Draft GSP Chapters 7 and 8, Monitoring Networks and Sustainable Management Criteria, respectively. Because the SLO Valley GDE Technical Memo was referenced in Chapter 7 prior to its release, and because sustainable management criteria (SMC) described in Chapter 8 rely on the monitoring network described in Chapter 7, CLC finds that the content of the GDE Memo is fundamentally tied to language within Chapter's 7 and 8. Thus, to provide meaningful comments on the GDE memo, CLC also provides comments on these draft chapters within this comment period.

General Comments

1. Using the best available science and expert review that includes water agencies, state agencies, academics, technical consultants, and NGO's, a framework on how to address GDE's under SGMA has been developed. This framework is titled "Groundwater Dependent Ecosystems under the Sustainable Groundwater Management Act (TNC 2018)". The framework is based on the structure provided by the Department of Water Resources (DWR) and proposes seven steps as follows:

1. Identify Groundwater Dependent Ecosystems (GDEs)
2. Determine Potential Effects on GDEs
3. Determine the Sustainability Goal
4. Set Minimum Thresholds
5. Establish Measurable Objectives and 5-year Interim Milestones
6. Incorporate GDEs into the Monitoring Network
7. Identify Projects and Management Actions

In the context of this framework, we interpret the SLO Valley GDE Technical Memo to be a supporting document for the achievement of these steps. We respectfully request that the information and recommendations provided within the SLO Valley GDE Technical Memo be consistently incorporated into the Draft GSP Chapters to a greater degree than currently exists. To our knowledge, there are no other publicly available studies on GDEs in the San Luis Obispo Valley Groundwater Basin that identify sustainable GDE indicators, nor any studies other than the technical memo that describe a monitoring network specifically suited to tracking GDE indicators and indicator target values. Therefore, we find that the SLO Valley GDE Technical Memo is a part of the best available science that the GSC has at its disposal for creating a GSP that describes both a monitoring network and SMC that sufficiently protects GDEs under SGMA.

Specific Comments on Chapter 7

2. Chapter 7, Page 3, Paragraph 2 and bulleted list, under heading 7.1.2 Representative Monitoring Sites

> *"Representative monitoring sites are the locations at which sustainability indicators are monitored, and for which quantitative values for minimum thresholds, measurable objectives, and interim milestones are defined. The criteria that were used to determine which wells to utilize are as follows:*
>
> - *A minimum 10-year period of record of historical measurements spanning wet and dry periods.*
> - *Available well information (well depth, screened interval).*
> - *Access considerations.*
> - *Proximity and frequency of nearby pumping wells.*
> - *Spatial distribution relative to the applicable sustainability indicators.*
> - *Groundwater use.*
> - *Impacts on beneficial uses and Basin users."*

Groundwater levels and GDEs should have different representative monitoring site (RMS) selection criteria. Whereas groundwater RMSs require a longer historical record to establish the definition for undesirable results, GDE undesirable results are straight-forward and actionable without 10 prior years of data for whatever given SMC and MT that is defined. For example, if a relationship between groundwater pumping at Well "A" can be correlated with critical habitat impairment using a nearby stream gage at Site "X", There is no need for Site X to have multiple years of data to establish a trend. Rather, undesirable effects correlated with Site X can be sufficiently defined using a relatively short data record. To expand on this example: we can know the stage at which Site X goes dry (an undesirable result) and, to the extent that this can be correlated to groundwater extraction, the stage or discharge data at Site X can be used immediately to set MTs for the interconnected surface flows.

Another limitation of the Draft GSP can be highlighted here. The RMSs do not appear to anticipate the eventual inclusion of the stream gage network in future revisions of the GSP. Although the exact criteria for determining undesirable results for interconnected surface water and GDEs has yet to be determined through scientific analysis, the Draft GSP should already be considering which surface water monitoring network components will become RMSs. If separate RMS selection criteria for interconnected surface water indicators are not developed now, groundwater managers will be delayed in properly protecting GDEs because the GSP will not provide a framework for the future studies that are referenced in chapters 7 and 8.

Specific Comments on Chapter 8

3. Chapter 8, Page 28, Paragraph 3 under heading 8.9 DEPLETION OF INTERCONNECTED SURFACE WATER SUSTAINABILITY INDICATOR § 354.28(C)(6)

> *"Direct measurement of flux between an aquifer and an interconnected stream is not feasible using currently available data."*

We find no explanation earlier in Chapter 8, nor in Chapter 7, for why the flux between the aquifer and the interconnected stream must be measured to create a minimum threshold that is protective of GDEs. Language cited under section 8.9.2 Minimum Thresholds (page 29) restates the following SGMA regulation language:

> *"…'The minimum threshold for depletions of interconnected surface water shall be the* ***rate or volume*** *of surface water depletions caused by groundwater use that has adverse impacts on beneficial uses of the surface water and may lead to undesirable results.'"* (emphasis added)

The next paragraph then continues:

> *"Current data are insufficient to determine the* ***rate or volume*** *of surface water [depletions] in the creeks. Therefore, groundwater elevations in the RMSs intended to monitor surface water/groundwater interaction (SLV-12, EV-01, EV-11) are used as a proxy for the Depletion of Interconnected Surface Water Sustainability Indicator."* (emphasis added)

The rate or volume of surface water depletions do not need to be synonymous with the flux measurement presently described in Chapter 8. A rate of flow depletion can be correlated with changes in stage and does not necessarily require a rating curve to draw a correlation between groundwater and surface water fluctuations. We do agree that the eventual development of rating curves for all existing and proposed stream gages is a wise step in creating the monitoring network, however.

Although the precise fluxes of groundwater in a given interconnected reach of these creeks have not yet been determined, the existing stream stage monitoring network, combined with existing low flow measurements (e.g. Stillwater Sciences 2014, Creek Lands Conservation 2019) and/or additional manual flow measurements in the dry season that could be collected in a few days of work effort would provide a basic, minimum supplement to the groundwater level indicator that is currently proposed.

4. Chapter 8, Page 28, Paragraph 1 under heading <u>8.9.1 Undesirable Results § 354.26(a)-(d)</u>

> *"The undesirable result for Depletions of Interconnected Surface Water is a result that causes significant and unreasonable adverse effects on beneficial uses of interconnected surface water within the Basin over the planning and implementation horizon of this GSP. As discussed in Section 8.9, measurement of the fluxes between the aquifer and Basin creeks is not feasible with currently available data. Therefore, water level measurements at the RMSs designated for the Depletion of Interconnected Surface Water Sustainability Indicator will be used as the basis MTs and Undesirable Results until better data becomes available under future monitoring activities."*

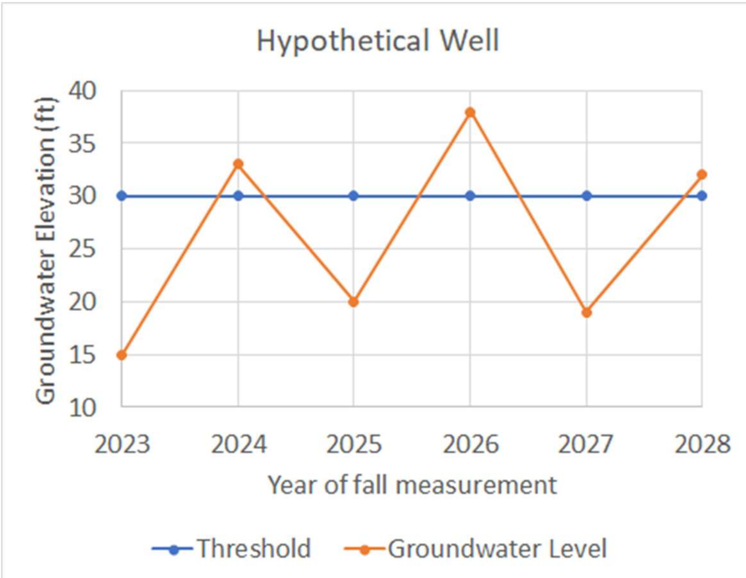
This section does not adequately address how groundwater level measurements at the RMSs will be indicative of undesirable results to depletions of interconnected surface water. In other words, there is no language that qualifies well level measurements at the selected RMSs as useful indicators for harm that could be done to GDEs that rely on interconnected surface water or groundwater.

5. Chapter 8, Page 29, Paragraph 2 under heading <u>8.9.1 Undesirable Results § 354.26(a)-(d)</u>

> *"The Basin will be considered to have undesirable results if any of the representative wells monitoring groundwater/surface water interaction display exceedances of the minimum threshold values for two consecutive Fall measurements."*

Groundwater levels intermittently measured at the proposed wells (SLV-12, EV-01, EV-11) will not necessarily alert groundwater managers to imminent risks to instream habitat that is reliant on interconnected streamflow. As stated in the quoted section above, at least two sequential years of exceedances will be required to generate an undesirable result. However, this does not properly address the life cycle constraints of organisms that make up our local GDEs.

For example, if the selected representative wells exceeded the minimum threshold value in the fall of year 1, leading to the stranding of some steelhead trout or desiccation of some California red-legged frog (CRLF) eggs, but then was not exceeding this threshold in the fall of year 2, the MT would indicate no problems with the groundwater extraction regime. Furthermore, we could see some hypothetical cycle such as this:



Where the indicator well oscillates around the minimum threshold value, but never triggers the two consecutive fall measurements rule for the MT. If the years where fall measurements fell below the minimum threshold value caused greater GDE species mortality, this MT would never correct for that. This is, of course, a hypothetical situation, but nonetheless shows a potential blind spot that could be mitigated with simple surface water monitoring that is less rigorous than the measurement of groundwater flux into the interconnected stream.

To expand on why this MT type is a weak indicator for the protection of GDEs, please consider this excerpt from Stanford's Water in the West document titled "Guide to Compliance with California's Sustainable Groundwater Management Act" by Alleta Belin:

> **1. Federal and/or State Endangered Species Act (ESA) surface flow or other surface water-dependent requirements are currently not being met at least partially due to groundwater diversions**
>
> - If it is determined that groundwater diversions are causing or contributing to unauthorized "take"[46] of listed species, that is an explicit violation of the ESA that needs to be addressed;
> - Even where there is no direct violation of the ESA, the following situations are problematic because of the high likelihood of unlawful take of the species:
>   - Where a federal Biological Opinion specifies minimum instream flows that are currently not being met;[47] or
>   - Where critical habitat[48] has been designated for a listed species[49] and features in the critical habitat considered essential for survival of the species are currently being destroyed or adversely modified; or
>   - Where groundwater diversions are causing or contributing to low instream flows that are likely to jeopardize the continued existence of listed species. This should be assumed to be a problem even where violations may be rare, or very sporadic.[50]
>
> 50 Even a single day of river-drying or mortally high water temperatures can kill a large number of fish, thereby causing longterm harm to the survivability of the species.

Source: Belin 2018, excerpt from page 9.

It is our opinion that the current SMCs will create a risk that groundwater managers will inadvertently cause or contribute to take of listed species or adversely affect critical habitat. As noted in footnote #50 from the excerpt above, even a single day of drying or mortally high water temperatures in our creeks can harm the long term survivability of listed species. The current MT for undesirable results defined in Section 8.9.1 relies solely on a metric that is only monitored once each year and is only actionable after a minimum of two years. The MT in this draft of Chapter 8 will not provide the appropriate temporal resolution for protecting listed species.

Although future revisions of the GSP might include better indicators that use a higher temporal resolution, the protection of endangered and threatened species cannot be subordinated to the timelines that govern those future revisions. Those administrative timelines are even slower to respond to the immediate needs of GDEs than the currently proposed MT. This should be especially salient when there is an opportunity in the current process to avoid that.

<u>General Comments on Chapter 7 and Chapter 8</u>

- Although the importance of monitoring the gaining and losing reaches of streams within the groundwater basin is highlighted in Chapter 7, and referenced in Chapter 8, neither of these chapters give concrete or consequential future steps toward integrating the monitoring of these features with SMCs or MTs.

  Furthermore, none of the SMCs or MTs properly address GDEs that may be directly reliant on groundwater. The SLO Valley GDE Technical Memo highlights riparian and oak woodland GDEs in Table 2 of that document and suggests that groundwater levels could be used to determine sustainability indicators for them. More work will need to be done to find the appropriate thresholds for GDEs that are directly reliant on groundwater levels, but the current draft only discusses GDEs in the context of interconnected surface water and does not lay the foundation for GDEs that do not rely directly on surface water depletion.

- The authors of the SLO Valley GDE Technical Memo note (on page 5, paragraph 2) that several monitoring wells are screened at unknown depths.

  "...however, the screening depth is known only for 6 of the 17 wells. Wells where the screened depth is unknown may be measuring groundwater levels for deeper aquifers that are unconnected to the shallow groundwater system and thus ***groundwater deeper than 30 ft for a given well may not reflect the absence of shallow groundwater, but instead reflects the absence of data.****"* (emphasis added)

  Creek Lands has not evaluated the veracity of this particular statement but, if it is true, the potential use of these wells for establishing an indicator of interconnected surface water SMCs or other GDE indicators is cast in doubt until the exact screening depths are determined.

- Although they may not be able to establish numerical MTs for particular interconnected surface water undesirable results or GDE impacts, what is preventing the GSP from incorporating tentative or placeholder MTs? It would be much more promising to have an interconnected surface water MT that stated how the monitoring network would be used to monitor GDE impacts, without necessarily committing to a numerical value.

  - For example: "Discharge changes between the Andrews Street Gage and the Marsh Street Gage will be used to establish a minimum threshold when better data becomes available"

- or “Minimum surface water elevations dependent on interconnected groundwater in Stenner Creek will be established when a correlation between near-stream groundwater elevations and the stream gage monitoring network are established.”
- These examples do not hold groundwater managers accountable to any thresholds that are not supported by good science, but create the necessary impetus for future research to address data gaps that are directly applicable to creating MTs that meet SGMA requirements for the proper consideration of GDEs. More specificity at this stage of the GSP development will benefit everyone in the future.

- As it stands, the current Draft GSP does not create a catalyst for future research or GSP revisions that achieve the proper level of protection for GDEs. The current drafts only list the types of data and analyses that may be sought in the future, without enough actionable language that will hold the GSC accountable for implementing effective research in pursuit of a monitoring network that protects GDEs.

Creek Lands Conservation appreciates the opportunity to comment on this document and participate in the SGMA process. We also value the public process and the willingness of the other participants to consider our comments. We hope that these comments will inspire more conversation about how our groundwater resources support critical habitat within the SLO Valley Groundwater Basin. Responses or questions about these comments are welcome, and you may reach out to us using the contact information below.

Sincerely,

Timothy Delany
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tim@creeklands.org
Office: (805) 473-8221

Cited Works

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