				GSP Document References				
				Page Numbers of Plan	Or Section Numbers	Or Figure Numbers	Or Table Numbers	Notes
		(A)	Formation names, if defined.	65:68	7.1.4			
		(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.	65:68	7.1.4		HCM-2	
		(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.	65:68	7.1.4	HCM-1:HCM-2		
		(D)	General water quality of the principal aquifers, which may be based on information derived from existing technical studies or regulatory programs.	65:68	7.1.4	HCM-5:HCM-6		
		(E)	Identification of the primary use or uses of each aquifer, such as domestic, irrigation, or municipal water supply.	65:68	7.1.4	HCM-7		
	(5)		Identification of data gaps and uncertainty within the hydrogeologic conceptual model	68:69	7.1.5			
(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.	69:70	7.2	HCM-8:HCM-10		
(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.	71	7.3.1	HCM-11		
	(2)		Surficial geology derived from a qualified map including the locations of cross-sections required by this Section.	71:72	7.3.2	HCM-10		
	(3)		Soil characteristics as described by the appropriate Natural Resources Conservation Service soil survey or other applicable studies.	72	7.3.3	HCM-12		
	(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.	72:73	7.3.4	HCM-13		
	(5)		Surface water bodies that are significant to the management of the basin.	74	7.3.5	HCM-14		
	(6)		The source and point of delivery for imported water supplies.	74	7.3.6			
			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.	91:92	8.2.1	GWC-1:GWC-2		
	(2)		Hydrographs depicting long-term groundwater elevations, historical highs and lows, and hydraulic gradients between principal aquifers.	94:95	8.2.3	GWC-3:GWC-5	GWC-1	
(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.	95:97	8.3	GWC-6:GWC-7	GWC-3	

				GSP Document References				
				Page Numbers of Plan	Or Section Numbers	Or Figure Numbers	Or Table Numbers	Notes
(c)			Seawater intrusion conditions in the basin, including maps and cross-sections of the seawater intrusion front for each principal aquifer.	98	8.4			
(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.	98:103, 324:359	8.5, Appendix E	GWC-8:GWC-12	GWC-4:GWC-5	
(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.	104	8.6	GWC-13		
(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.	104:107	8.7	GWC-14		
(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.	107:109, 361:394	8.8, APPENDIX F:Appendix G	GWC-15:GWC-16	GWC-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.	126:158, 396:478	9, Appendix H:Appendix I	WB-1:WB-21	WB-8:WB-9	
(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.	132:134	9.2.1	WB-4:WB-5	WB-2	
	(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.	134:136	9.2.2	WB-6:WB-7	WB-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.	134:136	9.2.2	WB-6:WB-7	WB-3	
	(4)		The change in the annual volume of groundwater in storage between seasonal high conditions.	136:140	9.2.3	WB-8:WB-11	WB-4	
	(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.	140:141	9.2.4			
	(6)		The water year type associated with the annual supply, demand, and change in groundwater stored.	136:140	9.2.3	WB-10:WB-11	WB-5	
	(7)		An estimate of sustainable yield for the basin.	141:142	9.2.5		WB-7	
(c)			Each Plan shall quantify the current, historical, and projected water budget for the basin as follows:					

				GSP Document References				
				Page Numbers of Plan	Or Section Numbers	Or Figure Numbers	Or Table Numbers	Notes
	(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.	143:145	9.3.1	WB-13:WB-14		
	(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.	146:147	9.3.2			
		(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.	146:147	9.3.2	WB-15:WB-16		
		(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.	146:147	9.3.2			
	(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.	148:155	9.4			
		(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.	148:155	9.4	WB-19		
		(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.	148:155	9.4	WB-19		

				GSP Document References				
				Page Numbers of Plan	Or Section Numbers	Or Figure Numbers	Or Table Numbers	Notes
(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.	128:129	9.1.3		WB-1	
	(2)		Current water budget information for temperature, water year type, evapotranspiration, and land use.	128:129	9.1.3			
	(3)		Projected water budget information for population, population growth, climate change, and sea level rise.	128:129, 149:152	9.1.3, 9.4.2	WB-17:WB-18		
(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.	126:131	9.1			
(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.	126:158	9		WB-6	
			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.	180	10			
(b)			A basin that includes one or more management areas shall describe the following in the Plan:					
	(1)		The reason for the creation of each management area.	180	10			
	(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.	180	10			
	(3)		The level of monitoring and analysis appropriate for each management area.	180	10			
	(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.	180	10			
(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.	180	10			
			Note: Authority cited: Section 10733.2, Water Code.					
			Reference: Sections 10733.2 and 10733.4, Water Code.					

Article 5.			Plan Contents for the Castac Lake Valley Basin Groundwater Sustainability Plan	GSP Document References				
				Page Numbers of Plan	Or Section Numbers	Or Figure Numbers	Or Table Numbers	Notes
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.	30, 182	2, 12			
			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**					
(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.	183:192	13			
(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.	183:184, 185, 186:187, 188, 190:191	13.1.1, 13.2.1, 13.4.1, 13.5.1, 13.6.1			
	(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.	184, 185, 187, 189, 191	13.1.2, 13.2.2, 13.4.2, 13.5.2, 13.6.2		SMC-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.	184:185, 185:186, 188, 191	13.1.3, 13.2.3, 13.4.3, 13.6.3			
(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.	183:192	13			
(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.	183:192	13			

				GSP Document References				
				Page Numbers of Plan	Or Section Numbers	Or Figure Numbers	Or Table Numbers	Notes
			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.	193:205	14			
(b)			The description of minimum thresholds shall include the following:					
	(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.	196:199	14.1	SMC-1	SMC-2:SMC-3	
	(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.	199:201, 204:205	14.2, 14.6		SMC-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.	196:199	14.1			
	(4)		How minimum thresholds may affect the interests of beneficial uses and users of groundwater or land uses and property interests.	198:199	14.1.2	SMC-2		
	(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.	201:203	14.4			
	(6)		How each minimum threshold will be quantitatively measured, consistent with the monitoring network requirements described in Subarticle 4.	196:201	14.1, 14.2			
(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.	196:199	14.1			
		(B)	Potential effects on other sustainability indicators.	196:199	14.1			
	(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.	199:201	14.2			

				GSP Document References				
				Page Numbers of Plan	Or Section Numbers	Or Figure Numbers	Or Table Numbers	Notes
	(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.	201	14.3			
		(B)	A description of how the seawater intrusion minimum threshold considers the effects of current and projected sea levels.	201	14.3			
	(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.	201:203	14.4			
	(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.	203:204	14.5			
		(B)	Maps and graphs showing the extent and rate of land subsidence in the basin that defines the minimum threshold and measurable objectives.	203:204	14.5			
	(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.	204:205	14.6			
		(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.	204:205	14.6			
(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.	204:205	14.6			
(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.	204:205	14.6			

				GSP Document References				
				Page Numbers of Plan	Or Section Numbers	Or Figure Numbers	Or Table Numbers	Notes
			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.	206:208	15.1		SMC-4:SMC-6	
(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.	206:208	15.1			
(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.	206:208	15.1			
(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.	208	15.2			
(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.	206:209	15			
(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.					Not applicable - no additional Plan elements were incorporated into Sustainability Criteria.
(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.					Not applicable - all measurable objectives tied to reasonable margin of operational flexibility.
			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**					

				GSP Document References				
				Page Numbers of Plan	Or Section Numbers	Or Figure Numbers	Or Table Numbers	Notes
(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.	213:222	16.1		MN-1:MN-2	
(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.	213:222	16.1			
	(2)		Monitor impacts to the beneficial uses or users of groundwater.	213:222	16.1			
	(3)		Monitor changes in groundwater conditions relative to measurable objectives and minimum thresholds.	213:222	16.1			
	(4)		Quantify annual changes in water budget components.	213:222	16.1			
(c)			Each monitoring network shall be designed to accomplish the following for each sustainability indicator:					
	(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.	216:220	16.1.1		MN-1	
		(B)	Static groundwater elevation measurements shall be collected at least two times per year, to represent seasonal low and seasonal high groundwater conditions.	216:220	16.1.1			
	(2)		Reduction of Groundwater Storage. Provide an estimate of the change in annual groundwater in storage.	220	16.1.2			
	(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.	220:221	16.1.3			
	(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.	221	16.1.4			
	(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.	222	16.1.5			
	(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:					

				GSP Document References				
				Page Numbers of Plan	Or Section Numbers	Or Figure Numbers	Or Table Numbers	Notes
		(A)	Flow conditions including surface water discharge, surface water head, and baseflow contribution.	222	16.1.6			
		(B)	Identifying the approximate date and location where ephemeral or intermittent flowing streams and rivers cease to flow, if applicable.	222	16.1.6			
		(C)	Temporal change in conditions due to variations in stream discharge and regional groundwater extraction.	222	16.1.6			
		(D)	Other factors that may be necessary to identify adverse impacts on beneficial uses of the surface water.	222	16.1.6			
(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.	213:222	16.1			
(e)			A Plan may utilize site information and monitoring data from existing sources as part of the monitoring network.	213:222	16.1			
(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.	213:222	16.1			
	(2)		Aquifer characteristics, including confined or unconfined aquifer conditions, or other physical characteristics that affect groundwater flow.	213:222	16.1			
	(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.	213:222	16.1			
	(4)		Whether the Agency has adequate long-term existing monitoring results or other technical information to demonstrate an understanding of aquifer response.	213:222	16.1			
(g)			Each Plan shall describe the following information about the monitoring network:					
	(1)		Scientific rationale for the monitoring site selection process.	213:222	16.1			
	(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.	213:222	16.1			
	(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.	213:222	16.1			
(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.	213:222	16.1	MN-1	MN-2	
(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.	223:226	16.2			

				GSP Document References				
				Page Numbers of Plan	Or Section Numbers	Or Figure Numbers	Or Table Numbers	Notes
(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.	220:221, 222	16.1.3, 16.1.5			
			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					
§ 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.	227:228	16.3	MN-1		
(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.	199:201, 204:205, 227:228	14.2, 14.6, 16.3		MN-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.	206:207, 223, 227:228	15.1.1, 16.2.1, 16.3			
(c)			The designation of a representative monitoring site shall be supported by adequate evidence demonstrating that the site reflects general conditions in the area.	227:228	16.3			
			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.	229:230	16.4			
(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.	229:230	16.4.2, 16.4.3			
(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.	229:230	16.4.2, 16.4.3			
	(2)		Local issues and circumstances that limit or prevent monitoring.	229:230	16.4.2, 16.4.3			
(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.	230	16.4.3			
(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:					

Article 5.			Plan Contents for the Castac Lake Valley Basin Groundwater Sustainability Plan	GSP Document References				
				Page Numbers of Plan	Or Section Numbers	Or Figure Numbers	Or Table Numbers	Notes
	(1)		Minimum threshold exceedances.	230	16.4.4			
	(2)		Highly variable spatial or temporal conditions.	230	16.4.4			
	(3)		Adverse impacts to beneficial uses and users of groundwater.	230	16.4.4			
	(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.	227:228	16.3			
			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.	233:246, 480:534	17, Appendix J	PMA-1	PMA-1	
(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:					
		(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.	239	17.3			
		(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.	239	17.4			
	(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.	239:240	17.5			

Article 5.			Plan Contents for the Castac Lake Valley Basin Groundwater Sustainability Plan	GSP Document References				
				Page Numbers of Plan	Or Section Numbers	Or Figure Numbers	Or Table Numbers	Notes
	(3)		A summary of the permitting and regulatory process required for each project and management action.	240:241	17.6			
	(4)		The status of each project and management action, including a time-table for expected initiation and completion, and the accrual of expected benefits.	241:242	17.7			
	(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.	242:244	17.8	PMA-2		
	(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.	244	17.9			
	(7)		A description of the legal authority required for each project and management action, and the basis for that authority within the Agency.	245	17.10			
	(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.	245:246	17.11		PMA-1	
	(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.	246	17.12			
(c)			Projects and management actions shall be supported by best available information and best available science.	233:246	17			
(d)			An Agency shall take into account the level of uncertainty associated with the basin setting when developing projects or management actions.	234:238, 245:246	17.2, 17.11			
			Note: Authority cited: Section 10733.2, Water Code.					
			Reference: Sections 10727.2, 10727.4, and 10733.2, Water Code.					

Appendix B

Joint Powers Agreement and Memorandum of Agreement

20 March 2018

Kern County

Agt. # 166-2018

JOINT POWERS AGREEMENT
FOR FORMATION OF A GROUNDWATER SUSTAINABILITY AGENCY FOR THE CASTAC LAKE VALLEY GROUNDWATER BASIN UNDER THE SUSTAINABLE GROUNDWATER MANAGEMENT ACT

THIS JOINT POWERS AGREEEMENT (JPA) is made and effective as of March 20, 2018, by and between **Tejon-Castac Water District** (TCWD), **Lebec County Water District** (LCWD), and the **County of Kern** (County), each a "Party" and collectively the "Parties," with reference to the following facts:

A. In 2014, the State of California enacted the Sustainable Groundwater Management Act (Water Code Sections 10720 et seq.), referred to in this JPA as the "SGMA" or "Act," as subsequently amended, pursuant to which certain public agencies may become or participate in a "Groundwater Sustainability Agency" (GSA) and adopt a "Groundwater Sustainability Plan" (GSP) in order to manage groundwater in underlying groundwater basins. The Act defines "basin" as a basin or subbasin identified and defined in California Department of Water Resources (DWR) Bulletin 118.

B. The Castac Lake Valley Groundwater Basin (Basin No 5-29) has been designated very low priority pursuant to SGMA. The Legislature encourages and authorizes but does not require basins designated as very low priority to be managed pursuant to SGMA (Water Code section 10720.7) Very low priority basins are not subject to Chapter 11 of SGMA providing for "State Intervention" in certain circumstances. Accordingly, the Parties voluntarily create the GSA as hereinafter provided.

C. TCWD, LCWD and the County are the agencies qualified to be a GSA under the Act for the Castac Lake Valley Groundwater Basin, and collectively encompass the entire Basin. The map attached hereto as Exhibit A designates the boundaries of the Castac Lake Valley Groundwater Basin, and the boundaries of TCWD, and LCWD are shown on said map, along with that portion of Kern County that is not within the boundaries of one of the other Parties.

D. Lands within the Castac Lake Valley Groundwater Basin that have been developed to uses that utilize any significant groundwater are located within TCWD, and LCWD. The Castac Lake Valley Groundwater Basin lands which are not located within these districts but which are within the County, are believed to utilize small or de minimis quantities of groundwater.

E. The Parties wish to provide a framework to form a GSA and to voluntarily implement SGMA in the Castac Lake Valley Groundwater Basin, such that the implementation is through local control and management and is implemented effectively, efficiently, fairly and at a reasonable cost.

F. As authorized by the Joint Exercise of Powers Act (Government Code Section 6500 et seq.), the parties are entering into this JPA to form a GSA, share certain costs, and other matters provided for herein, but are not currently creating a separate entity or authority.

THEREFORE, in consideration of the mutual promises set forth below and to implement the goals described above, the Parties agree as follows:

1. Formation of the Castac Lake Valley Groundwater Basin GSA. The purpose of this JPA is to form a GSA for the Castac Lake Valley Groundwater Basin and to facilitate a cooperative and ongoing working relationship between the Parties that will allow them to explore, study, evaluate, develop and implement mutually beneficial approaches and strategies for development and implementation of a GSP for the Castac Lake Valley Groundwater Basin. By execution of this JPA, the Parties collectively determine and elect to be the GSA for the Castac Lake Valley Groundwater Basin ("Castac Basin GSA"), subject to the procedures provided for in the Act. It is presumed that this Castac Basin GSA will be the sole GSA for the Castac Lake Valley Groundwater Basin. By entering into this JPA, the Parties are not currently creating a separate entity or joint powers authority.

2. Development of a Groundwater Sustainability Plan. The GSP for the Basin ("Castac Basin GSP") will be prepared by the Castac Basin GSA. The TCWD will coordinate efforts of the Parties and be the point of contact with DWR, as defined by the Act, to meet and cooperatively develop the Castac Basin GSP. In developing the Castac Basin GSP, the Castac Basin GSA shall consider all beneficial uses and users of groundwater in the Basin, including the interests listed at Section §10723.2 of the Act.

3. GSA Governing Body. There is hereby established a GSA Committee for the Castac Basin GSA, which shall be subject to the following:

a. TCWD and LCWD ("Voting Parties") will be represented by -person(s) designated by the respective entities, with TCWD and LCWD each having two Committee members. The County shall be a non-voting member of the GSA Committee and will be represented by a designated person. Each Party may appoint one or more alternate GSA Committee members.

b. The GSA Committee may adopt resolutions, bylaws and policies to provide further details for conducting its affairs consistent with this JPA and applicable law and amend the same from time to time. Meetings of the GSA Committee shall be called, noticed and conducted subject to the provisions of the Ralph M. Brown Act (California Government Code Sections 54950 et seq.)

c. A quorum of the GSA Committee to transact business shall be three GSA Committee members representing Voting Parties. In order to pass any proposition or resolution, an affirmative vote of a majority of the GSA Committee members representing Voting Parties present and voting will be required, provided that to adopt or make any amendment to the GSP, the unanimous consent of the Voting Parties shall be required.

d. The composition, voting procedures and powers of the GSA Committee shall be reviewed and reaffirmed or modified as part of the process to adopt a GSP, including determining, if any of the Parties deems appropriate, forming a joint powers authority as a separate entity to submit and/or implement the GSP.

4. Powers/Development of GSP.

(a) Under the conditions and with the exceptions set forth in the Agreement, the Castac Basin GSA shall have all the powers that a GSA is authorized to exercise as provided by the Act, including, but not limited to, developing a GSP that is consistent with the Act and DWR's regulations.

(b) The Castac Basin GSA shall not have the power to control, limit or empower a Party's rights and authorities over its own surface water supplies, facilities, operations, water management, water supply projects and financial affairs. As provided in Water Code Section 10720.5 of the Act, the Castac Basin GSA and all of its Parties confirm that groundwater management under this Castac Basin GSA shall not modify rights or priorities to use or store groundwater consistent with Section 2 of Article X of the California Constitution and that any groundwater management plan adopted by the Castac Basin GSA shall not determine or alter surface water rights or groundwater rights under common law or any other provision of law that determines or grants surface water rights.

5. Matters Related to County Powers.

(a) If the County is requested by the Castac Basin GSA to use the County's police powers for a specific GSA purpose, then the Castac Basin GSA shall indemnify and defend, the County against any liability for such exercise of its police powers.

(b) The Parties agree that nothing in a GSP or any actions taken by this Castac Basin GSA will modify, limit or preempt the County's police powers, including, but not limited to, its land use authority. The County shall not designate or zone a specific project with the expectation that this GSA will provide a larger water allotment than that which is determined by any GSP allotment and policies, if there were such allotments. Likewise, the Castac Basin GSA will not restrict the use of groundwater within its boundaries to a specific use.

(c) In accordance with the terms and conditions of this JPA, the Castac Basin GSA will manage the areas of the Castac Basin Valley Groundwater Basin that are not within the boundaries of TCWD, and LCWD.

(d) Consistent with Water Code Section 10726.4(b), well permitting (which is presently codified in Kern County's Code of Ordinances at Section 14.08) is under the County's jurisdiction. The Castac Basin GSA shall not issue permits for the construction, modification, and/or abandonment of groundwater wells except as authorized by the County. The Castac Basin GSA will not transform, or trigger the transformation of, the well-permitting process from a ministerial function (which does not trigger CEQA) to a discretionary function (which may trigger CEQA) without prior consultation with the County. If the Castac Basin GSA causes CEQA to be triggered with respect to any particular well permitting application within the Castac Basin GSA, then the Castac Basin GSA shall indemnify and defend, the County against any liability, costs and attorney's fees.

(e) Water transfers within the Basin will be considered as part of the Castac Basin GSP development. In the event the adopted GSP includes extraction allocations pursuant to Water Code section 10726.4, the GSP will include conditions under which those allocations will be transferrable within the Basin without materially adversely affecting others, including, but not limited to, providing that any such transfer does not materially harm any Party to this Agreement, any portion of the Basin, degrade water quality, or materially harm any other groundwater user within the Basin. The Parties acknowledge that material harm is difficult to determine objectively in advance and agree to work to include a hydrologic review process for any transfers that are authorized in the GSP. Notwithstanding the foregoing, the respective Parties reserve all applicable rights they have with respect to preserving water supplies within their boundaries.

(f) The Castac Basin GSA will ensure that any additional local agencies have a continuous opportunity to participate in the preparation, review and adoption of the Castac Basin GSP. The term "participate" in this context means access to all non-privileged drafts, reports, technical information and other materials and communications, and an ability to actively engage in all open meetings related to the preparation, review and adoption of the Castac Basin GSP. With respect to the County, as an Additional Entity and signatory to this JPA, its opportunities for participation and review are more than members of the general public and the County will be afforded access to all documents, drafts, reports, technical information and other materials and communications of the GSA.

(g) The Castac Basin GSA will actively work with the County to preserve and protect available water supplies. Before adopting any GSP covering the Castac Basin GSA's jurisdiction or agreeing to the coordination of the GSP with other GSPs, the Castac Basin GSA shall consider the mitigation measures adopted in the County's certified Final Oil and Gas Environmental Impact Report (SCH# 2013081079), which was adopted by the Kern County Board of Supervisors on November 9, 2015, to address the creation of any GSP practices related to the implementation of SGMA and the Oil and Gas permitting.

6. Costs. Each Party shall bear its own costs incurred with respect to activities under this JPA to participate on the GSA Committee and its proceedings and related matters. Costs incurred to retain consultants to assist with development of the Castac Basin GSP and perform related studies as approved by the GSA Committee and to implement the Castac Basin GSP shall be borne by TCWD.

The Parties may consider levying a charge pursuant to the Act, or other legal authority. Certain costs for special projects may be funded under separate agreements among the benefited Parties.

7. Staff. Each Party shall designate a principal contact person, if other than the designated GSA Committee members, and other appropriate staff members and consultants to participate on such Party's behalf in activities undertaken pursuant to this JPA. The TCWD shall be responsible for coordinating meetings and other activities under this JPA with the GSA Committee and principal contact persons for the other Parties. Informal staff meetings may occur as needed.

8. Ongoing Cooperation. The Parties acknowledge that activities under this JPA will require the frequent interaction between them in order to pursue opportunities and resolve issues that arise. The Parties shall work cooperatively and in good faith.

9. Notices. Any formal notice or other formal communication given under the terms of this JPA shall be in writing and shall be given personally, by facsimile, by electronic mail (email), or by certified mail, postage prepaid and return receipt requested. Any notice shall be delivered or addressed to the Parties at the addressees' facsimile numbers or email addresses set forth below under each signature and at such other address, facsimile number or email address as shall be designated by notice in writing in accordance with the terms of this JPA. The date of receipt of the notice shall be the date of actual personal service, confirmed facsimile transmission or email, or three days after the postmark on certified mail.

10. Entire Agreement/Amendments/Counterparts. This JPA incorporates the entire and exclusive agreement of the Parties with respect to the matters described herein and supersedes all prior negotiations and agreements (written, oral, or otherwise) related thereto. This JPA may be amended only in a writing executed by all of the Parties. This JPA may be executed in two or more counterparts, each of which shall be deemed an original, but all of which together shall constitute one and the same instrument.

11. Termination/Withdrawal.

(a) This JPA shall remain in effect unless terminated by the unanimous consent of the Voting Parties.

(b) Upon 60 days written notice, any of the Parties may withdraw from this JPA and the JPA shall remain in effect for the remaining Parties. A withdrawing Party shall be liable for expenses incurred through the effective date of the withdrawal (that is 60 days after the written notice, unless a later date is specified in the notice) and for its share of any contractual obligations incurred by the Castac Basin GSA while the withdrawing Party was a party to this JPA, however, as provided a paragraph 6, the County is not participating in GSP development costs. Upon withdrawal as a Party, whether occurring before or after June 30, 2017, it is contemplated the withdrawing Party may concurrently become (or designate) a GSA for the lands within its boundaries, so that such lands of the withdrawing Party would continue to be subject to a GSA, and if applicable a GSP and the powers of such withdrawing Party within its boundaries would not be limited by this JPA. In such event this GSA and its remaining Parties (i) shall not object to or interfere with the lands in the withdrawing Parties' boundaries being in a GSA, as designated by such withdrawing Party, (ii) shall facilitate such transition to the extent necessary, and (iii) this GSA shall withdraw from managing the Basin as a GSA (if it has already elected to be a GSA) for that portion of the Basin within the boundaries of the withdrawing Party and so notify DWR. In such event, the withdrawing Party shall reconcile and reach agreement with any other Party with respect to overlapping boundaries of the Parties to determine which GSA the respective overlapping lands will be within.

12. Assignment. No rights or duties of any of the Parties under this JPA may be assigned or delegated without the express prior written consent of all of the other Parties, and any attempt to assign or delegate such rights or duties without such written consent shall be null and void.

13. Indemnification. No Party, nor any officer, director, employee or agent of a Party, shall be responsible for any damage or liability occurring by reason of anything done or omitted to be done by another Party under or in connection with this JPA. The Parties further agree, pursuant to California Government Code Section 895.4, that each party shall fully indemnify and hold

harmless each other Party and its officers, directors, employees and agents from an against any claims, damages, losses, judgments, liabilities, expenses, and other cost, including litigation costs and attorney fees, arising out of, resulting from, or in connection with any action taken or omitted to be taken by such Party under this JPA. Notwithstanding the foregoing, the Voting Parties agree to fully indemnify and hold harmless the County and its officers, directors, employees and agents from and against any claims, damages, losses, judgements, liabilities, expenses or other costs, including litigation costs and attorney fees, arising out of, resulting from, or in connection with any action taken or omitted to be taken by the GSA, except to the extent directly caused by the County, or its officers, directors, employees or agents, negligence or wrongful acts, provided that the forgoing exception shall not apply to any claim that the COUNTY was negligent in entering into this Agreement, providing oversight of the GSA, the actions of GSA or the Voting Parties.

IN WITNESS WHEREOF, the Parties have executed this JPA as of the date first above written.

Tejon-Castac Water District

By: ______________________

Address: ______________________

____

Email ______________________

Facsimile ______________________

Lebec County Water District

By: ______________________

Address: 501 Castac Vien Road

____

Email ______________________

Facsimile ______________________

County of Kern

MAR 20 2018

By: ______________________

Address: 1115 Truxtun Ave, 5th Fl.
Bakersfield, CA 93301

Email ______________________

Facsimile ______________________

APPROVED AS TO FORM
Office of County Counsel
Kern County
By ______________________

Appendix C

Stakeholder Communication and Engagement Plan

5 October 2018

Stakeholder Communication and Engagement Plan

Castac Lake Valley Groundwater Basin

Prepared by:

EKI Environment & Water, Inc.

for:

Castac Basin GSA

5 October 2018

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Glossary / Abbreviations

CASGEM	California Statewide Groundwater Elevation Monitoring
CCR	California Code of Regulations
CWC	California Water Code
DWR	California Department of Water Resources
GDE	Groundwater Dependent Ecosystems
GSA	Groundwater Sustainability Agency
GSP	Groundwater Sustainability Plan
HCM	Hydrogeologic Conceptual Model
JPA	Joint Powers Agreement
KC	Kern County
KMWC	Krista Mutual Water Company
LCWD	Lebec County Water District
NCCAG	Natural Communities Commonly Associated with Groundwater
NWI v2.0	National Wetlands Inventory, Version 2.0
SCEP	Stakeholder Communication and Engagement Plan
SGMA	Sustainable Groundwater Management Act
SWP	State Water Project
SWRCB	State Water Resources Control Board
TCWD	Tejon-Castac Water District
TMV	Tejon Mountain Village
TRC	Tejon Ranch Corporation
USGS NHD	U.S. Geological Survey National Hydrography Dataset

1. INTRODUCTION

California Code of Regulations, Title 23, Div. 2, Ch. 1.5, Subchapter 2. § 354.10.

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.

(b) A list of public meetings at which the Plan was discussed or considered by the Agency.

(c) Comments regarding the Plan received by the Agency and a summary of any responses by the Agency.

(d) A communication section of the Plan that includes the following:

(1) An explanation of the Agency's decision-making process.

(2) Identification of opportunities for public engagement and a discussion of how public input and response will be used.

(3) A description of how the Agency encourages the active involvement of diverse social, cultural, and economic elements of the population within the basin.

(4) The method the Agency shall follow to inform the public about progress implementing the Plan, including the status of projects and actions.

The Castac Basin Groundwater Sustainability Agency (GSA) has developed this Stakeholder Communication and Engagement Plan (SCEP) to describe the GSA's approach to communication and engagement while developing the Groundwater Sustainability Plan (GSP) for the Castac Lake Valley Groundwater Basin (Basin; DWR 5-029). This SCEP was prepared in accordance with California Water Code (CWC), the GSP Regulations (Title 23 of the California Code of Regulations [CCR] §354.10 [see above]), and the California Department of Water Resources (DWR) Guidance Document for Groundwater Sustainability Plan Stakeholder Communication and Engagement (DWR, 2018), as well as additional reference documents recommended by DWR for guidance.

Communications efforts carried out as described in this SCEP will help to ensure that beneficial uses and users of groundwater are adequately considered in the GSP development process as required by GSP Regulations (23-CCR §354.10). Specifically, in this SCEP:

- Section 2.2 describes the GSA decision-making process (23-CCR §354.10(d)(1));
- Section 3 identifies stakeholders in the Basin and how the GSA intends to engage with them;
- Section 4 describes how the GSA intends to build upon its current understanding of stakeholders in the Basin (23-CCR §354.10(d)(3) and CWC §10723.4);
- Section 5 outlines key messages that will form the foundation of all GSA communication efforts with stakeholders (23-CCR §354.10(c));

- Section 6 identifies opportunities for public engagement and how public input and response will be used to inform GSP development (23-CCR §354.10(d)(2)); and
- Section 7 describes the communications implementation timeline, including when this SCEP will be updated with a procedure for public communication regarding GSP implementation progress, including the status of projects and actions (23 CCR §354.10(d)(4)).

2. GOALS AND DESIRED OUTCOMES

This stakeholder engagement and communication program is designed to effectively engage a variety of relevant stakeholders in GSP development which will guide the GSA to demonstrate sustainable use of groundwater in the Basin by January 2042, and which also will maintain sustainability through the Sustainable Groundwater Management Act (SGMA)'s 50-year planning timeline.

2.1. GSA Description and Boundary

Lebec County Water District (LCWD), Tejon-Castac Water District (TCWD), and Kern County (County) formed the GSA to voluntarily comply with SGMA. The GSA covers the entirety of the Basin, as shown in **Figure 1**. As of 18 May 2018, DWR designated the Basin as "very low priority" through its 2018 SGMA draft prioritization, thus the Basin does not currently have a mandated GSP submission deadline.

2.2. GSA Structure and Decision-Making Process

Key GSP development and implementation decisions are made by the GSA Board of Directors (Board). The Ad-Hoc committee, which is appointed by the GSA Board, helps to guide the GSP development technical consultant team and provides feedback on draft work products.

2.2.1. GSA Board Structure and Meetings

Per the Joint Powers Agreement (JPA) executed on 20 March 2018, the GSA Board is composed of two voting representatives each from LCWD and TCWD, one non-voting representative from the County, and other non-voting entities invited to participate by the GSA Board.

Board meetings are open to the public, and are held on the first Tuesday of every third month (i.e., September, December, March, and June) at Lebec County Water District's Office, 323 Frazier Mountain Park Road, Lebec, California. Board meeting agendas and packets will be posted to the GSA website (https://www.castacgsa.org) at least 72 hours before each Board meeting.

2.2.2. Ad-hoc Technical Committee Structure and Meetings

The ad-hoc committee is composed of one to two representatives from each voting party of the GSA. The ad-hoc committee does not have regular meetings and instead meets as necessary to provide feedback to and guide the GSP development technical consultant team. The ad-hoc committee helps to identify and compile key data sources, refine key GSP components, and to translate technical GSP components for presentation to the Board and stakeholders.

2.3. Desired Outcome

The GSA aims to develop a GSP that sets the Basin on a path to maintain sustainability through SGMA's 50-year planning timeline.

2.4. Communication Objectives to Support the GSP

The GSA's stakeholder communication and engagement efforts aim to support development of a GSP that best meets the needs of beneficial uses and users of groundwater in the Basin, and reflects and incorporates stakeholder input, as appropriate. The GSA aims to understand and anticipate stakeholder interests and concerns.

2.5. Challenges for the Plan Area

The GSA is aware of and plans to address the following challenges and/or changed conditions within the Basin:

- Stakeholders may exhibit various concerns about the long-term reliability of the groundwater supply and/or effects or restrictions of SGMA compliance. The GSA will be open and transparent in any decisions that have a substantial impact on beneficial uses and users of groundwater in the Basin and will aim to engage stakeholders early in the decision-making process, in order to effectively consider stakeholder interests and concerns.

- The Basin is a part of a chain of groundwater basins, some of which have experienced water level declines, especially during the recent historic drought. The GSP will discuss cross-boundary flows from the adjacent upgradient basin, and will strive to ensure that future groundwater conditions in the Basin do not impact the ability of upgradient basins to manage their groundwater sustainably.

- A major residential and commercial development (i.e., Tejon Mountain Village, or "TMV") is under development in a portion of the Basin. Imported water from the State Water Project (SWP) and recycled water from the development is expected to meet TMV's entire water demand, but the GSP will need to consider ways in which the TMV project may affect the groundwater system.

- Groundwater Dependent Ecosystems (GDEs) cover almost 26% of the total Basin area, with 11% classified as wetland (including Castac Lake) and 14% classified as vegetation, according to DWR's mapped Natural Communities Commonly Associated with Groundwater (NCCAG)[1]. The location and nature of these GDEs will be described in the GSP, especially with respect to historic and projected future groundwater conditions.

[1] https://gis.water.ca.gov/app/NCDatasetViewer/

3. STAKEHOLDER IDENTIFICATION

Grazing (both dry and irrigated pasture) is the primary land use in the Basin, followed by residential and commercial land use. The GSA identified current beneficial uses and users of groundwater within the Basin in its notice of formation submitted to DWR on 19 April 2018, in accordance with the "Interests of All Beneficial Uses and Users of Groundwater" listed in CWC §10723.2.

The following are the identified beneficial uses and users of groundwater within the Basin. Representatives of specific organizations on this list form the basis of the GSA's "Interested Persons List", required by CWC §10723.4.

3.1. Holders of overlying groundwater rights

3.1.1. Agricultural Users

Tejon Ranch Corporation (TRC) uses groundwater pumped from several wells within the Basin for stock watering and irrigated agriculture (pasture, vineyards, and orchards) in the Basin. Other agricultural groundwater users, if any, in areas outside of TRC's service area will be engaged through the public outreach process prior to and during the development and implementation of the GSP.

3.1.2. Domestic Well Owners

Aerial photographs of the Basin indicate that a limited number of residential areas are located outside of the service areas of the municipal water suppliers (discussed below). Water supplies for these residences presumably come from private domestic wells, but the quantity and distribution of domestic well owners within the Basin currently are unknown. The GSA seeks to compile information on the number, location, and other information about domestic wells in the Basin, as well as the concerns and interests of domestic well owners, through the Landowner Data Request form, described in Section 4.

3.1.3. Commercial and Industrial Users

Commercial groundwater users are located in Lebec, California, adjacent to Interstate-5. Although not explicitly required under CWC §10723.2, these users will be contacted and engaged through the public outreach process during development and implementation of the GSP.

3.2. Municipal Well Operators

The TCWD is the water supplier for portions of the TRC property in the eastern part of the Basin, including for the planned TMV development, but does not operate any potable supply wells in the Basin.

The LCWD supplies water to parts of Lebec, an unincorporated census-designated place located along the western edge of the Grapevine Canyon portion of the Basin. The LCWD operates supply wells in both the Basin and the upgradient Cuddy Canyon Valley Groundwater Basin.

Krista Mutual Water Company (KMWC) supplies water to the Los Padres Estates area, which is located in the O'Neil Canyon portion of the Basin (i.e., a westward-extending valley in the northern portion of the

Basin, accessed by Lebec Oaks Road). KMWC operates a single well in the Basin, but recently initiated efforts to drill a second well in the Basin on TRC lands.

3.3. Public Water Systems

In addition to the municipal well operators mentioned above, several smaller public water systems are located within the Basin. Below are the names and State Water Resources Control Board (SWRCB) drinking water system numbers for all known public water systems in the Basin (i.e., those serving a least 25 individuals daily for at least 60 days out of the year [California Health and Safety Code §116275]).

Public Water System Name	SWRCB System Number
Lebec County Water District	1510051
Krista Mutual Water Company	1500475
Tejon Ranch Main Headquarters	1500413
El Tejon Elementary School	1502074
California State Parks - Fort Tejon	1510301
Tejon Ranch Grapevine Water	1500415

While publicly available data have been examined to identify Public Water Systems in the Basin[2], the GSA acknowledges that this information may be incomplete, and thus seeks to identify and engage any additional water systems during the development and implementation of the GSP.

3.4. Local Land Use Planning Agencies

The entire Basin is comprised of unincorporated County land. Kern County Planning and Community Development is the agency responsible for land use planning in the Basin. Thus, as part of the GSA, the County will be notified of GSA activities and implementation and development of a GSP within the Basin.

3.5. Environmental Users of Groundwater

Flow between groundwater and surface water is understood to occur in the Basin. Data from the U.S. Fish & Wildlife Service National Wetlands Inventory, Version 2.0 (NWI v2.0)[3] show GDEs (both vegetation and wetlands) in the Basin. The U.S. Geological Survey National Hydrography Dataset (USGS NHD) maps two springs within the Basin, and several more in tributaries to the Basin. Of the total Basin area, 11% is classified as wetland (including Castac Lake) and 14% is classified as vegetation.[4]

To the extent that additional environmental users of groundwater are identified, they will be considered and contacted, as appropriate, during the development and implementation of the GSP.

[2] Including the California Environmental Health Tracking Program Water System Map Viewer (http://www.cehtp.org/page/water/water_system_map_viewer).
[3] https://gis.water.ca.gov/app/NCDatasetViewer/
[4] https://gis.water.ca.gov/app/NCDatasetViewer/

3.6. Surface Water Users

Surface water features in the Basin include ephemeral streams draining the Tehachapi and San Emigdio Mountains, Cuddy Creek, Grapevine Creek, and Castac Lake. The groundwater system is understood to be hydraulically connected to surface water in Castac Lake, and groundwater has been determined to be both a source and a sink for the lake (Bookman Edmonston, 1965; Trihey and Associates, 1997; Dudek & Associates, 1999). Historically, TRC has pumped groundwater to supplement inflows to Castac Lake.

3.7. The Federal Government

No federally-managed lands have been identified within the Basin.

3.8. California Native American Tribes

The California Indian Tribal Homelands and Trust Land Map, published by DWR in 2011, indicates that no California Native American tribal lands exist within the Basin[5].

3.9. Disadvantaged Communities

According to the DWR Water Management Planning Tool[6], the Disadvantaged Community Block ID Number 060290033061, and Tract ID Number 06029003306 both overlie a portion of the Basin. This block includes 696 households, a population of 1,985, and a median household income of $34,083 and this tract includes 1,751 households, a population of 5,152, and a median household income of $45,996 (U.S. Census, 2015). The GSA aims to engage residents of disadvantaged communities during the development and implementation of the GSP through identification in the stakeholder survey and coordination with relevant community groups.

3.10. Groundwater Monitoring Entities

According to the DWR Water Management Planning Tool[7], no California Statewide Groundwater Elevation Monitoring (CASGEM) Designated Monitoring Entities are located within the Basin. TCWD currently conducts routine monitoring of its wells and plans to initiate coordination of the SGMA monitoring effort on behalf of the GSA.

[5] https://water.ca.gov/LegacyFiles/tribal/docs/maps/CaliforniaIndianTribalHomelands24x30_20110719.pdf
[6] https://gis.water.ca.gov/app/boundaries/
[7] https://gis.water.ca.gov/app/boundaries/

4. LANDOWNER DATA REQUESTS

The GSA intends to update its list of stakeholders based on new information as it is obtained. To learn more about stakeholders in the Basin, the GSA plans to distribute a landowner data request form (Appendix A) by:

- Posting a downloadable and fillable copy of the form on the GSA website (https://www.castacgsa.org);
- Providing copies of the form at all Board meetings and stakeholder workshops;
- Mailing copies of the form in water bills or other correspondence from TCWD, LCWD, KMWC, and the GSA; and
- Coordinating with existing community organizations (e.g., Mountain Communities Water Issues Discussion Group, Self-Help Enterprises, etc.) to distribute the form to various members of the population that otherwise may not be reached.

Based on its current knowledge of stakeholders, the GSA has completed a "Lay of the Land" exercise in **Table 1**, identifying (a) specific stakeholder organizations or individuals, (b) stakeholder types, (c) key interests and issues, (d) the sections of the GSP likely to be relevant to this stakeholder, and (e) the level of engagement expected with each stakeholder organization or individual.

Given that the GSA will gain more knowledge of the interests, issues, and challenges of stakeholders over the course of GSP development, **Table 1** will be updated as needed over time. Should the GSA need to learn more about specific stakeholders, individual meetings will be arranged to find out more about their issues, interests, and challenges.

In addition to the more detailed stakeholder survey, the GSA intends to maintain a simple form on its webpage for individuals to provide contact information by enrolling in the GSA interested parties list.

Table 1 Stakeholder Constituency – "Lay of the Land" Exercise

Organization/ Individual	Type of Stakeholder (a)	Anticipated Key Interests	Anticipated Key Issues (b)	Relevant GSP Sections	Level of Engagement and Rationale (c)
Agricultural Water Users	Agricultural Users	Preserving access to high quality groundwater for irrigation	• Potential curtailment of pumping • GSP development and implementation costs	• Sustainable Management Criteria • Projects and Management Actions	Inform and involve to avoid negative impact to these users
Domestic Well Users	Domestic Well Owners	Preserving access to high quality groundwater for domestic users	• Water quality degradation • Declining water levels • Potential curtailment of pumping • GSP development and implementation costs	• Sustainable Management Criteria • Projects and Management Actions	Inform and involve to avoid negative impact to these users
Businesses adjacent to Interstate-5 at Lebec	Commercial User	*(Dependable access to high quality groundwater for business operation*	• Water quality degradation • Declining water levels • *Other?*	• Sustainable Management Criteria	Inform and involve to avoid negative impact to these users
Tejon-Castac Water District (d)	Potential Well Operator	Preserving access to groundwater	• Potential curtailment of pumping • GSP development and implementation costs	• Basin Setting • Sustainable Management Criteria • Projects and Management Actions	Collaborate to ensure sustainable management of groundwater
Lebec County Water District	Public Water System	Continue to provide potable water service	• Potential curtailment of pumping • GSA Committee participation costs	• Basin Setting • Sustainable Management Criteria • Projects and Management Actions	Collaborate to ensure sustainable management of groundwater
Krista Mutual Water Company	Public Water System	Continue to provide potable water service	• Potential curtailment of pumping	• Basin Setting • Sustainable Management Criteria • Projects and Management Actions	Collaborate to ensure sustainable management of groundwater
Tejon Ranch Main Headquarters	Public Water System	Preserving access to groundwater for agricultural supply	• Water quality degradation • Declining water levels • *Other?*	• Basin Setting • Sustainable Management Criteria • Projects and Management Actions	Collaborate to ensure sustainable management of groundwater
El Tejon Elementary School	Public Water System	Preserving access to high quality groundwater for potable water service	• Water quality degradation • Declining water levels • *Other?*	• Sustainable Management Criteria • Projects and Management Actions •	Inform and involve to avoid negative impact to these users
CSP – Fort Tejon	Public Water System	Preserving access to high quality groundwater for potable water service	• Water quality degradation • Declining water levels • *Other?*	• Sustainable Management Criteria • Projects and Management Actions •	Inform and involve to avoid negative impact to these users

Organization/ Individual	Type of Stakeholder (a)	Anticipated Key Interests	Anticipated Key Issues (b)	Relevant GSP Sections	Level of Engagement and Rationale (c)
Tejon Ranch Grapevine Water	Public Water System	*Need to identify*	• Water quality degradation • Declining water levels	• Sustainable Management Criteria • Projects and Management Actions •	Inform and involve to avoid negative impact to these users
Kern County Planning and Community Development	Local Land Use Planning Agency	Managing County-wide land use	• Water quality degradation • Declining water levels •	• Plan Area • Projects and Management Actions	Consult and involve to ensure land use policies are supporting GSPs
Groundwater Dependent Ecosystems	Environmental User of Groundwater	Preserving interconnected surface water and groundwater interactions	• Water quality degradation • Declining water levels • *Other?*	• Basin Setting • Sustainable Management Criteria • Projects and Management Actions	Ensure sustainable management of interconnected surface and groundwater
Castac Lake	Surface Water User and Environmental User of Groundwater	Preserving interconnected surface water and groundwater interactions	• Declining water levels	• Basin Setting • Sustainable Management Criteria • Projects and Management Actions	Ensure sustainable management of interconnected surface and groundwater
Ephemeral streams, Cuddy Creek and Grapevine Creek	Surface Water User and Environmental User of Groundwater	Preserving interconnected surface water and groundwater interactions	• Declining water levels	• Basin Setting • Sustainable Management Criteria	Ensure sustainable management of interconnected surface and groundwater

Abbreviations:
CWC = California Water Code
DWR = California Department of Water Resources
GSA = Groundwater Sustainability Agency
GSP = Groundwater Sustainability Plan
SGMA = Sustainable Groundwater Management Act

Notes:
(a) Type of stakeholder based on CWC §10723.2 (e.g., agricultural groundwater users, municipal well operators, etc.).
(b) Any documented issues (media coverage, statements, reports, etc.), specific issues such as past events, or issues that have been otherwise communicated to or are anticipated by the GSA.
(c) Level of engagement based on the International Association of Public Participation Spectrum of Public Participation, as referenced in DWR's Guidance Document for Groundwater Sustainability Plan Stakeholder Communication and Engagement (DWR, 2018).

5. PRINCIPLES

The GSA aims to communicate consistently with all stakeholders throughout development and implementation of the GSP. The following three key principles will guide communication efforts:

1. The GSA aims to engage with diverse stakeholders to best represent their interests in the GSP development process;
2. Key GSP development decisions will be made in an open and transparent fashion during public GSA Board meetings; and
3. Technical aspects of the GSP will be communicated in an accessible manner as much as practicable, to encourage understanding and effective input by stakeholders.

The GSA will maintain these three principles in all venues for engaging the public, as described in Section 6. **Table 2** lists anticipated questions from stakeholders, as well as possible responses. **Table 2** will be updated periodically to add additional frequently-asked questions and enhance listed responses based on GSP development progress.

Table 2 - Potential Questions and Responses

Potential Questions	Current Responses
How can I participate in the GSP development and implementation process?	GSA Board meetings are open to the public, and are held on the first Tuesday of every third month (September, December, March, and June) at Lebec County Water District's Office: 323 Frazier Mountain Park Road, Lebec, CA 93243. Stakeholder workshops also will be held periodically during the GSP development process. Meetings and workshops will be publicized on the GSA website (https://www.castacgsa.org), and notices will be posted at the LCWD office and local post office.
What types of management actions or projects are planned in my area?	The GSA has begun initial phases of GSP development with an effort to collect and analyze relevant data. Projects and management actions to achieve sustainability cannot be planned until analysis is complete. These advanced GSP phases will be proposed and discussed later in the GSP process, with opportunity for stakeholder input.
Who is paying for GSP development and implementation?	TCWD will pay for the majority of GSP development and implementation, with LCWD providing support in its capabilities.

6. VENUES FOR ENGAGING

The GSA intends to provide a variety of opportunities for engagement with stakeholders. Stakeholder input received will inform and be incorporated into corresponding sections of the GSP, as appropriate.

6.1. GSA Board Meetings

As described in Section 2.2.1, the Board meetings are open to the public and are held at a consistent venue for public engagement. Each Board meeting will have a Public Comment period, as outlined on each meeting agenda. The Board will consider public comments received, and will respond to comments at the next Board meeting.

6.2. Stakeholder Workshops

Stakeholder workshops will be held to communicate progress on GSP technical components to stakeholders, and to receive input on upcoming decisions and work efforts. At least two stakeholder workshops and one public hearing will be held during GSP development:

- **Stakeholder Workshop #1** – SGMA Overview, draft results of Basin Setting Information, Preliminary definitions of Undesirable Results, and Introduction to Sustainable Management Criteria.
- **Stakeholder Workshop #2** – Draft Sustainable Management Criteria and Discussion of Projects and Management Actions.
- **Public Hearing** – Review of the draft GSP.

The GSA will publicize all stakeholder workshops on its website (https://www.castacgsa.org) and will provide notice to the GSA list of interested parties. The GSA also will coordinate with individual GSA member bodies (TCWD, LCWD, and County) and community organizations (e.g., Mountain Communities Water Issues Discussion Group, Self-Help Enterprises, etc.) to distribute additional emails and postal mailings, as deemed necessary and appropriate.

Additional stakeholder workshops may be held during GSP implementation. The timing and content of these stakeholder workshops will be determined when the GSP Implementation Plan is developed shortly before GSP submission.

6.3. Fact Sheets/Newsletters

The GSA intends to develop at least two concise brochures (fact sheets) to inform the public during GSP development. These fact sheets will be coordinated with and complement the information presented during the stakeholder workshops described in Section 6.2. They will be distributed at the workshops, on the GSA website, and through the GSA parties and community organizations.

6.4. Website Communication

The GSA will update its website (https://www.castacgsa.org) with GSA Board meeting materials as described in Section 2.2.1, and will additionally update the website with key GSP updates.

6.5. Landowner Data Request Forms

The GSA intends to learn about stakeholder interests using data request forms that will be distributed as discussed in Section 4. An example landowner data request form is included as Appendix A.

7. IMPLEMENTATION TIMELINE

The GSA's communications implementation timeline aligns with a four phase GSP development timeline, as described in **Table 3** below.

Table 3 GSP Development and Communications Efforts by Phase

Phase	Timeframe	Overall GSP Efforts	Communications Efforts
GSP Foundation	Sept 2018 – Dec 2018	• Submit Initial Notification of GSP development • Select and design a Data Management System (DMS) • Conduct a data gaps assessment • Evaluate numerical groundwater model options	• Develop SCEP • Distribute Stakeholder Survey • Assess communications progress based on survey results • Update Stakeholder Constituency Table • Develop and distribute SGMA Fact Sheet #1
Basin Characterization and Analysis	Dec 2018 – Mar 2019	• Implement plan for filling data gaps • Develop Hydrogeologic Conceptual Model (HCM) and definition of groundwater conditions • Develop water budget • Assess existing monitoring programs	• Develop and distribute SGMA Fact Sheet #2 • Conduct Stakeholder Workshop #1 • Assess communications progress based on results of Stakeholder Workshop #1 • Update Stakeholder Constituency Table
Sustainability Planning	Apr 2019 – Jul 2019	• Evaluate potential management areas • Develop sustainable management criteria • Identify projects and management actions • Create GSP implementation plan • Finalize monitoring network and protocols	• Develop and distribute SGMA Fact Sheet #3 • Conduct Stakeholder Workshop #2 • Assess communications progress based on results of Stakeholder Workshop #2 • Update Stakeholder Constituency Table • Update SCEP to reflect plan for communications efforts during GSP Implementation
GSP Preparation and Submittal	Aug 2019 – Dec 2019	• Compile complete draft GSP • Revise draft GSP (if necessary) per stakeholder feedback • Finalize GSP and submit to DWR	• Distribute draft GSP • Hold Public Hearing on draft GSP • Assess communications progress and plan for communications related to GSP Implementation • Update Stakeholder Constituency Table

The GSA will update this SCEP while creating a GSP Implementation Plan, as well as during each phase of GSP development as needed. These updates will focus on informing the public about GSP implementation progress, including the status of projects and actions (23-CCR §354.10(d)(4)).

8. EVALUATION AND ASSESSMENT

The GSA intends to assess its communications implementation during each phase of GSP development, as shown in **Table 3**. The Ad-Hoc Committee and/or the technical consultant team will present brief summaries of communications progress at Board meetings, and will lead a discussion about ways to improve the next phase of GSP development. The following questions will guide communications evaluation:

- What worked well?
  - What allowed insight into stakeholder concerns?
  - What types of materials best communicated GSP development to stakeholders?
- What didn't work as planned?
  - Could materials (e.g., presentation slides, fact sheets, website pages) have been improved to better communicate GSP development progress?
  - Are certain stakeholder groups less represented in the GSP development process than they should be?
- What should be done differently during the next phase, based on past results and observations?
- What is the communications budget status? Does sufficient budget remain to complete the communications plan?

REFERENCES AND TECHNICAL STUDIES

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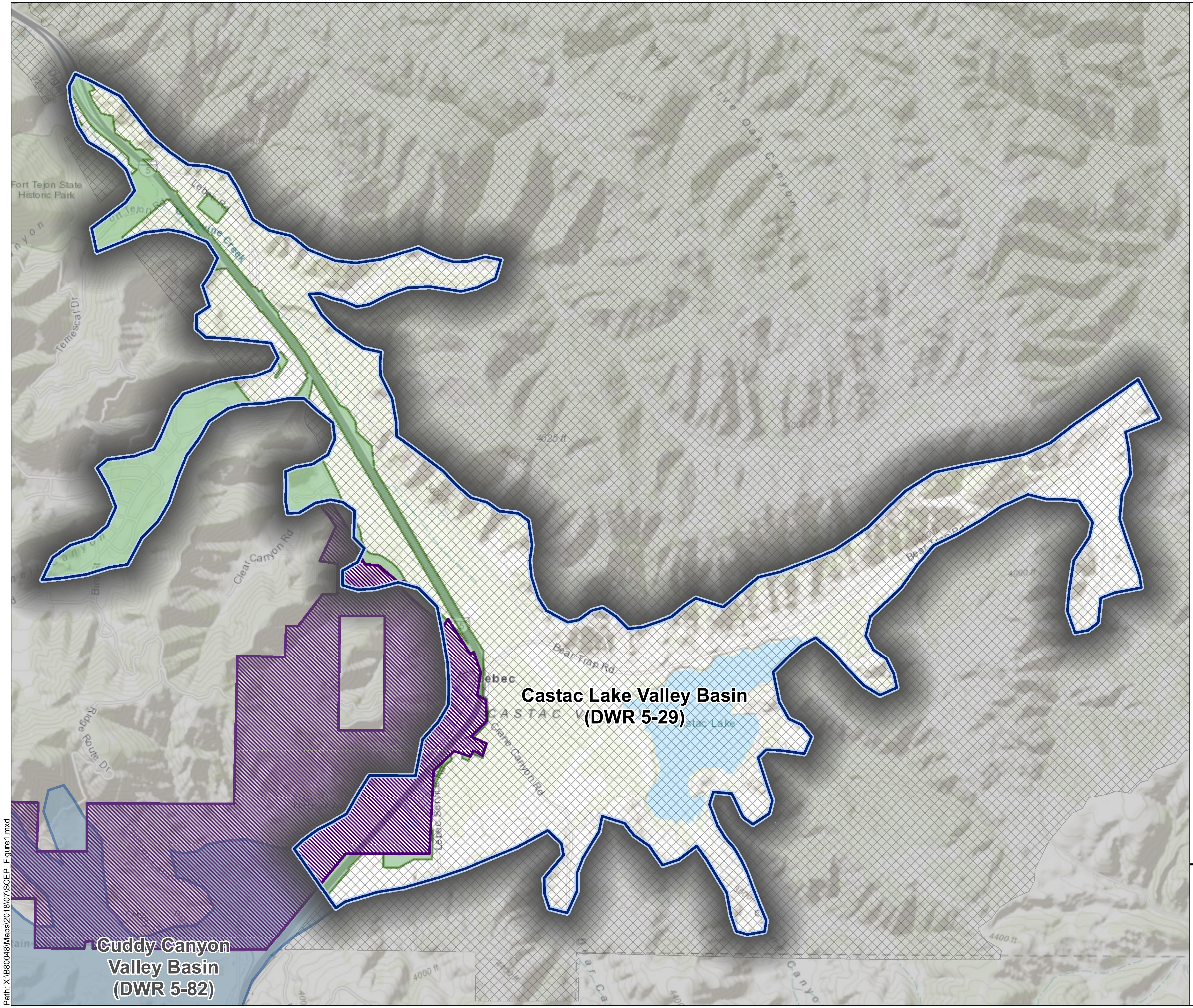


Path: X:\B80048\Maps\2018\07\SCEP_Figure1.mxd

Legend

- Castac Basin GSA
- Lebec County Water Disctrict
- Tejon-Castac Water District
- Kern County (outside of LCWD and TCWD service areas)
- Other Groundwater Basin

Abbreviations

DWR = California Department of Water Resources
LCWD = Lebec County Water District
TCWD = Tejon-Castac Water District
GSA = Groundwater Sustainability Agency

Notes

1. All locations are approximate.
2. Castac Basin GSA boundary is coterminous with the Castac Lake Valley Groundwater Basin (5-029) boundary.

Sources

1. DWR groundwater basin boundary as defined in California's Groundwater Bulletin 118 - Update.
2. Basemap is ESRI's ArcGIS Online world topographic map, obtained 11 July 2018.
3. LCWD service area obtained from LCWD on 16 March 2017.
4. TCWD service area obtained from TCWD on 11 May 2017.

Castac Basin GSA Jurisdictional Boundaries

DRAFT

eki environment & water

Tejon-Castac Water District
Kern County, CA
October 2018
EKI B80048.00

Figure 1

APPENDIX A – LANDOWNER DATA REQUEST FORM

Castac Basin Groundwater Sustainability Agency
Stakeholder Survey

The Castac Basin Groundwater Sustainability Agency (GSA) is conducting this survey to understand more about groundwater users (stakeholders) in the Castac Basin. Any answers provided to these questions will help support the development of a more accurate, fair, and useful Groundwater Sustainability Plan (GSP) for the Castac Basin. For more information please visit the GSA website at https://www.castacgsa.org

Date: _______________

Affiliated organization or business name (if applicable): ____

Contact information[1]:

Name: ____

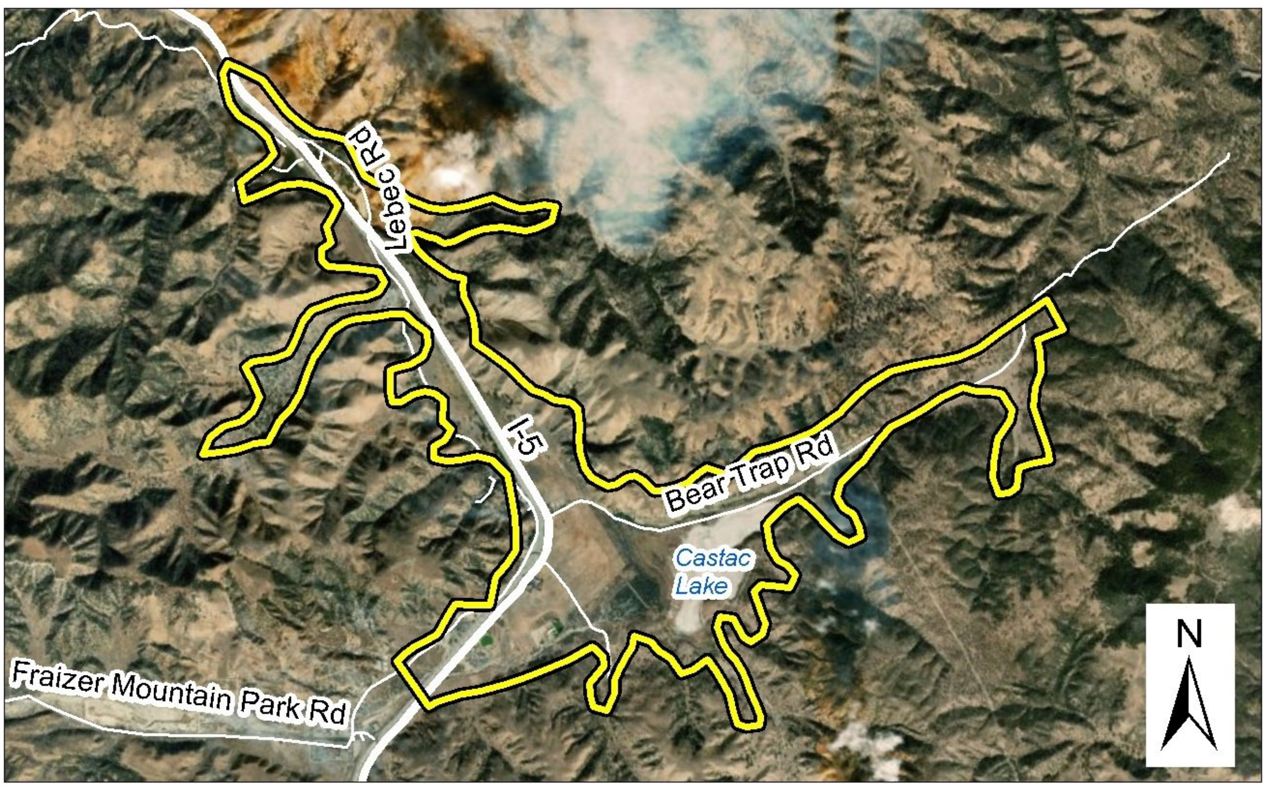
Email: ____

Phone Number: ____

Address: ____

Website: ____

Please mark the approximate location of your land, home, business, or well(s) with a dark-colored X on the map below of the Castac Basin:



Stakeholder Type (check all that apply):

- ☐ Agricultural Groundwater User
- ☐ Domestic Well Owner/User
- ☐ Municipal Well Operator
- ☐ Commercial/Industrial Groundwater User
- ☐ Public Water System
- ☐ Local Land Use Planning Agency
- ☐ Environmental User
- ☐ Surface Water User
- ☐ Federal Government
- ☐ Native American Tribe
- ☐ Disadvantaged Community Resident /Organization
- ☐ City Resident
- ☐ Groundwater Monitoring Entity

[1] Personal records pertaining to a utility customer will not be available for public inspection, except by an agent or authorized family member of the customer in question, governmental or law enforcement agencies when appropriate, or unless disclosure is specifically required by law.

Castac Basin Groundwater Sustainability Agency
Stakeholder Survey

Questions:

1. Are you familiar with the Sustainable Groundwater Management Act (SGMA) regulations?
   - ☐ Never heard of it; don't understand what it's about
   - ☐ Basic understanding of the legislation
   - ☐ Basic understanding of the legislation & regulations
   - ☐ Solid understanding of the legislation & regulations
   - ☐ Other:

2. Are you currently engaged in activities or discussions regarding groundwater management in this region?

3. Do you own or manage land in this region?

4. Where do you get your water supply?
   - ☐ City or Community Water System
   - ☐ Surface Water
   - ☐ Groundwater
   - ☐ Both Groundwater and Surface Water
   - ☐ Unknown

5. What is your primary interest in land or water resources management?

6. (For agricultural and domestic well owners/users): Are you willing to share the following data with the Castac Basin GSA to support GSP development?[2] (check all that apply). Please provide as much information as you can on the attached data request forms.
   - ☐ Location
   - ☐ Total Depth
   - ☐ Screened Interval
   - ☐ Reference Point Elevation
   - ☐ Well Completion Report(s)
   - ☐ Pumping test report(s)
   - ☐ Water level data
   - ☐ Water quality data
   - ☐ Other: ________________________

7. (For agricultural and domestic well owners/users): Have any of your supply wells ever gone dry or otherwise been affected by declining water levels? If so, which wells and when?

8. Do you have concerns about groundwater management? If so, what are they?

9. Do you have recommendations that you would like the Castac Basin GSA to consider while developing a GSP? If so, what are they?

[2] Documents and data can be sent to the Castac Basin GSA at amartin@tejonranch.com or to Angelica Martin at PO Box 478, Lebec, CA 93243

Castac Basin Groundwater Sustainability Agency

Well Construction Data Request Form

Available at **https://www.castacgsa.org**

The Sustainable Groundwater Management Act of 2014 (SGMA) is a framework for managing the state's groundwater resources in a way that will benefit all Californians, especially future generations. The Castac Basin Groundwater Sustainability Agency (CBGSA) is gathering groundwater-related data in the Castac Lake Valley Basin to understand challenges faced by residents as they advance toward sustainable groundwater use. If you can provide information regarding wells, groundwater levels, pumping, crops, or other pertinent data, please do! **Realistic, science-based decisions require good data**. The information you provide will support better-informed decisions, and will **help save your water for the future**. Thank you!

Data Provider / Owner:	
Contact Address:	
Phone / Email (optional):	

Groundwater Well Construction Data (Form #1 of 3)

All fields are optional, but please complete as much information as you can, and email the completed PDF form back to **amartin@tejonranch.com**. You also can print the form, fill it out manually, and mail it to Angelica Martin at **PO Box 478, Lebec, CA 93243**. If you have driller's reports, well logs, e-logs, other geophysical logs, pumping test reports, chemical analytical reports, driller's invoices, or other documents that can help us understand your well's construction or use, please include copies of these documents (but please do not send originals). If you need more copies of these forms, please email us, or download forms from the CBGSA website at **https://www.castacgsa.org**. Thank you for your help!

		(Well #1)	*(Well #2)*	*(Well #3)*	***(EXAMPLES)***
Owner's Well Number or Name					*Smith #2*
Well Location Address *(if different than owner's address)*					*123 Main Street Anytown, CA 93243*
California State Well Number					*09N/19W/35G12S*
Well Location Data, As Available *(can use mobile phone coordinates)*	**Latitude *(°N)***				*34.827360° N*
	Longitude *(°E)*				*-118.869217° E*
	Elevation *(ft, MSL)*				*3647.63 ft MSL*
	Township				*9 N*
	Range				*19 W*
	Section				*35*
	Tract				*G*
Primary Well Use *(e.g., Agricultural, Domestic, Industrial, Monitoring)*					*Agricultural*
Casing Diameter *(inches)*					*14-in*
Casing Material *(e.g., PVC, mild steel, stainless steel, other)*					*Steel*
Total Cased Well Depth *(ft, BGS)*					*400*
Screened Interval Depth(s) *(ft, BGS)*					*310-340, 380-400*
Pump Intake Depth *(ft, BGS)*					*300*
Nominal Pump Rating *(HP)*					*30*
Date of Well Drilling / Construction					*1986*
Please Provide Logs, Reports, or Data if Available	**Geologic Log?**				*Yes, attached*
	Geophysical Logs ? (e-logs)				*Yes, attached*
	Pumping Test?				*Yes, attached*
	Water Quality Data?				*Yes, attached*

Abbreviations:

ft, MSL = feet above mean sea level

ft, BGS = feet below ground surface

HP = Horsepower

Castac Basin Groundwater Sustainability Agency

Water Level Data Request Form

Available at **https://www.castacgsa.org**

Data Provider / Owner:	
Contact Address:	
Phone / Email (optional):	

Groundwater Depth Measurements (Form #2 of 3)

Please be sure to complete Form #1 (Well Construction Info) for all wells with water-level data recorded on this form

All fields are optional, but please complete as much information as you can, and email the completed PDF form back to **amartin@tejonranch.com**. You also can print the form, fill it out manually, and mail it to Angelica Martin at **PO Box 478, Lebec, CA 93243**. Thank you for your help!

Owner's Well Number or Name	**Date of Water Level Measurement**	**Depth to Water Below Measuring Point *(ft, BMP)***	**Description of Measuring Point** *(e.g., top of casing, sounding port, pump plate, etc.)*	**Elevation of Measuring Point *(ft, MSL)***	**Above-Ground Height of Measuring Point *(ft, AGS)***	**Method Used to Measure Water Level** *(e.g., air line, electric sounder, sonic sounder, chalk line, tape)*
Smith #2	*7/1/2018*	*62.54 ft*	*3/4-inch threaded port in top plate*	*3647.63 ft MSL*	*1.63 ft*	*100-ft steel tape with chalk*

Abbreviations:

ft, AGS = feet above ground surface
ft, BMP = feet below measuring point
ft, MSL = feet above mean sea level

Castac Basin Groundwater Sustainability Agency

Pumping and Crops Data Request Form

Available at https://www.castacgsa.org

Data Provider / Owner:	
Contact Address:	
Phone / Email (optional):	

Groundwater Pumping Measurements (Form #3 of 3)

Please be sure to complete Form #1 (Well Construction Info) for all wells with pumping data recorded on this form

All fields are optional, but please complete as much information as you can, and email the completed PDF form back to **amartin@tejonranch.com**. You also can print the form, fill it out manually, and mail it to Angelica Martin at **PO Box 478, Lebec, CA 93243**. If your well is not metered, please estimate "typical" pumping rates, pumping hours per day, and pumping days per month over the year. If pumping rates, cropping, etc. have changed significantly in the last few years, please get additional copies of this form, and provide data or estimates for each period, one per form. Thank you for your help!

Owner's Well Number or Name		*(Well #1)*	*(Well #2)*	*(Well #3)*	***(EXAMPLES)*** *Smith #2*
Usual Pumping Rate *(estimate if not metered)*					*725*
Pumping Rate Units *(e.g., GPM, CFS, MGD, AFD, AFY)*					*GPM*
Calendar Year (or Years) for Pumping Data					*2010 - 2017*
January	**Hours per Day**				*0*
	Days per Month				*0*
February	**Hours per Day**				*0*
	Days per Month				*0*
March	**Hours per Day**				*0*
	Days per Month				*0*
April	**Hours per Day**				*0*
	Days per Month				*0*
May	**Hours per Day**				*24*
	Days per Month				*2.5*
June	**Hours per Day**				*18*
	Days per Month				*10*
July	**Hours per Day**				*18*
	Days per Month				*10*
August	**Hours per Day**				*18*
	Days per Month				*10*
September	**Hours per Day**				*18*
	Days per Month				*5*
October	**Hours per Day**				*0*
	Days per Month				*0*
November	**Hours per Day**				*0*
	Days per Month				*0*
December	**Hours per Day**				*0*
	Days per Month				*0*

Abbreviations:

GPM = gallons per minute
CFS = cubic feet per second
MGD = million gallons per day
AFD = acre-feet per day
AFY = acre-feet per year

Appendix D

GSP Public Comments

Appendix D. Summary of Public Comments Received on Draft Groundwater Sustainability Plan

The Castac Lake Valley Groundwater Basin draft Groundwater Sustainability Plan (GSP) was released for a 30-day public review and comment period. Below is a summary of public comments received to date.

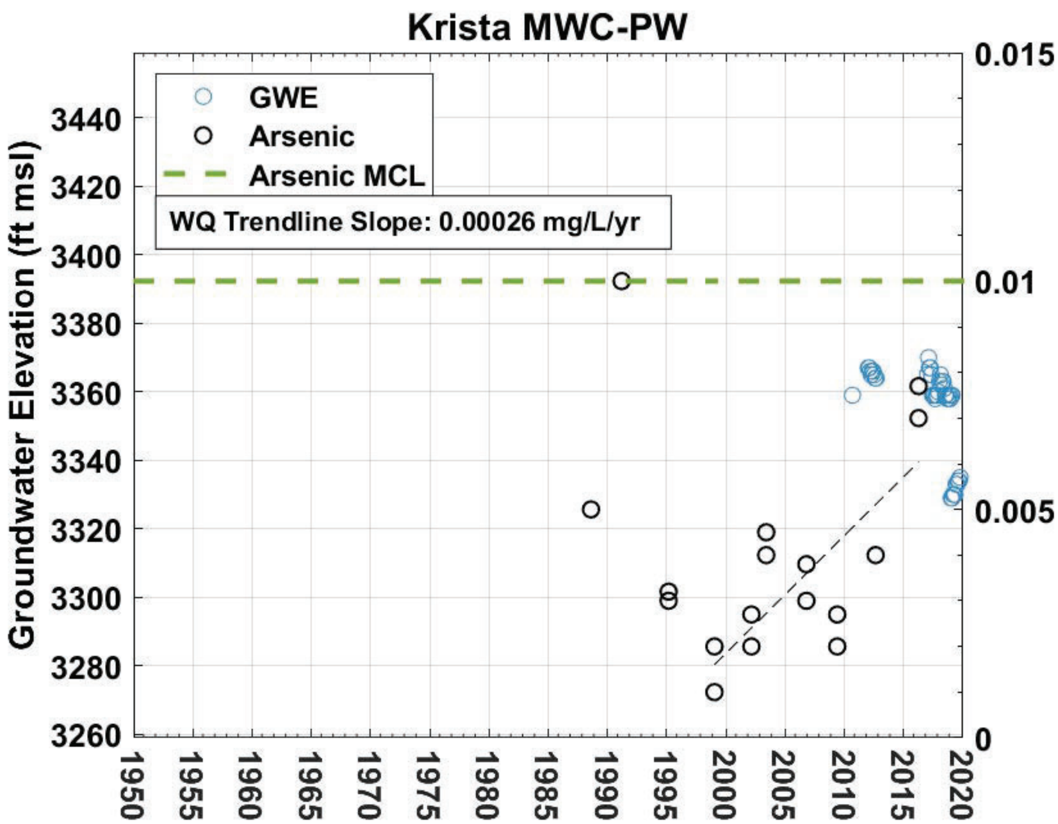
Table D-1. Comments Received on Public Draft GSP

Organization	Primary Subject	Comment Date	Response to Comments
Stakeholders	Written: • "My only concern would be that those corporations, organizations, water purveyors, water customers, and owners within the district be treated equitably with favor shown to no one particular interest over another." • "Overdevelopment in the mountain communities, with such a limited water resource." • "Running out of clean water" • "Conservation/sustainability"	January and February 2019	The GSP addresses future developments by incorporating land use changes in the projected water budget scenarios. The results indicate that planned future development that relies on imported surface water brings a net benefit to the Basin. The GSP sets a sustainability goal for the Basin, which outlines that the GSA aims to cooperatively manage groundwater sustainably to support current and future beneficial uses of groundwater.
Stakeholders	Verbal comment: "Trillions of gallons of groundwater are being pumped"	7/16/2019	The historical water budget quantifies the historical pumping volumes based on well counter readings or estimates from power records for the main production wells in the Basin.

Organization	Primary Subject	Comment Date	Response to Comments
Stakeholders	Summarized verbal comments: • What is the deepest well in the basin? • Interbasin ties under SGMA? Are water transfers legal under SGMA? • How is precipitation between upgradient basins and Castac handled? For example, sometimes upgradient basins receive different amounts of precipitation than in Castac.	11/15/2019	The deepest active well in the basin has well depth of 400 feet below ground surface. The GSP also documents the deepest groundwater extraction based on well construction information in Table HCM-1. Water transfer between different basins by individual landowners is a water rights issue, and as such is not explicitly addressed under SGMA. Precipitation records within the basin is measured from the Lebec climate station operated by the National Oceanic and Atmospheric Administration (NOAA). Precipitation and streamflow are the two major components of surface water inflows to the basin. Precipitation on upgradient basins contributes to the streamflow into the basin. The GSP estimates historical annual precipitation and streamflow in Table WB-2. An orographic scaling factor is used to estimate precipitation in upslope watersheds. The approach of applying precipitation orographic scaling factor is documented in Appendix H of the GSP.

Appendix E

Temporal Characteristics of Available Groundwater Data



Krista MWC-PW
GWE
Arsenic
Arsenic MCL
WQ Trendline Slope: 0.00026 mg/L/yr
Groundwater Elevation (ft msl)
Arsenic concentration (mg/L)
3440
3420
3400
3380
3360
3340
3320
3300
3280
3260
0.015
0.01
0.005
0
1950
1955
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1965
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1975
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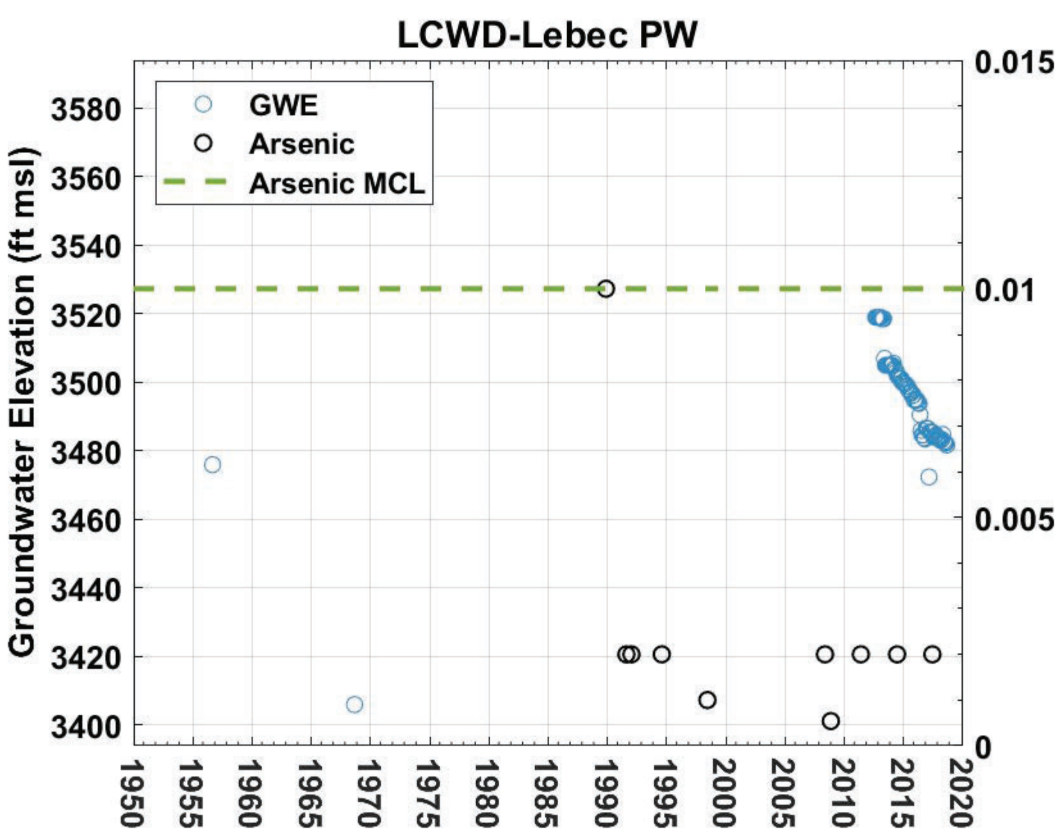
2005
2010
2015
2020



LCWD-Lebec PW
GWE
Arsenic
Arsenic MCL
Groundwater Elevation (ft msl)
Arsenic concentration (mg/L)
3580
3560
3540
3520
3500
3480
3460
3440
3420
3400
0.015
0.01
0.005
0
1950
1955
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1965
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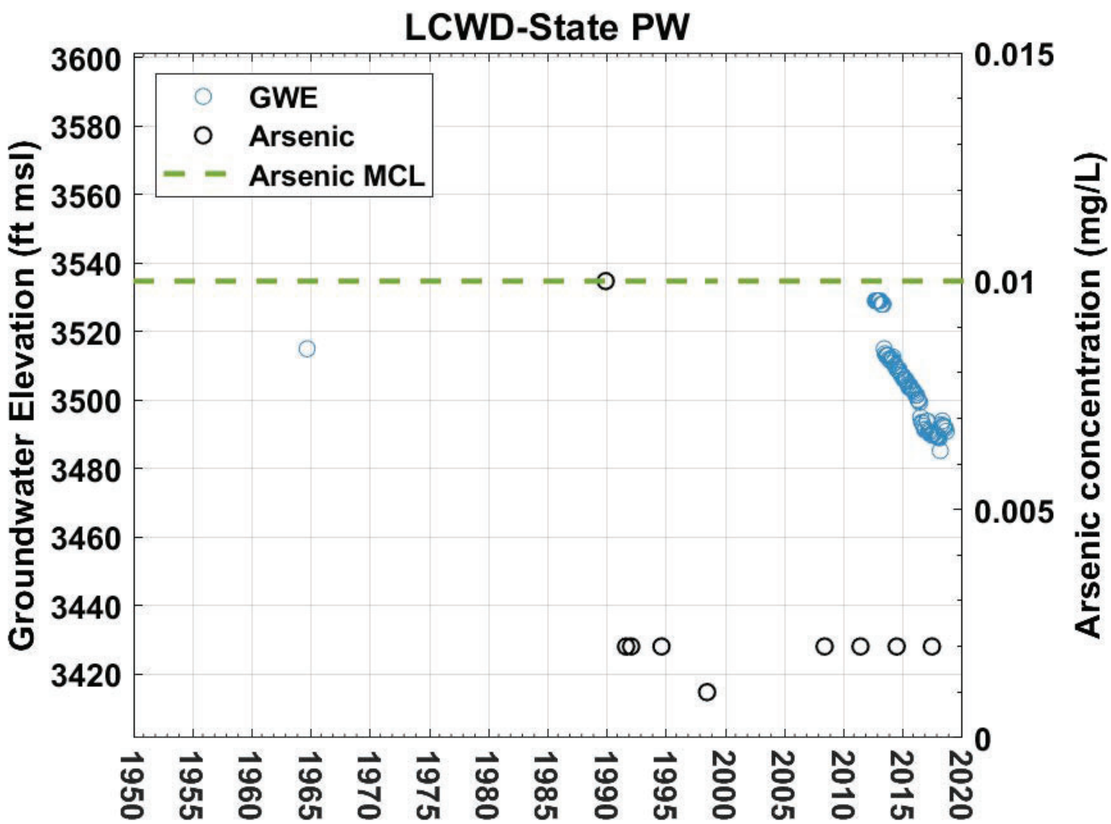
2010
2015
2020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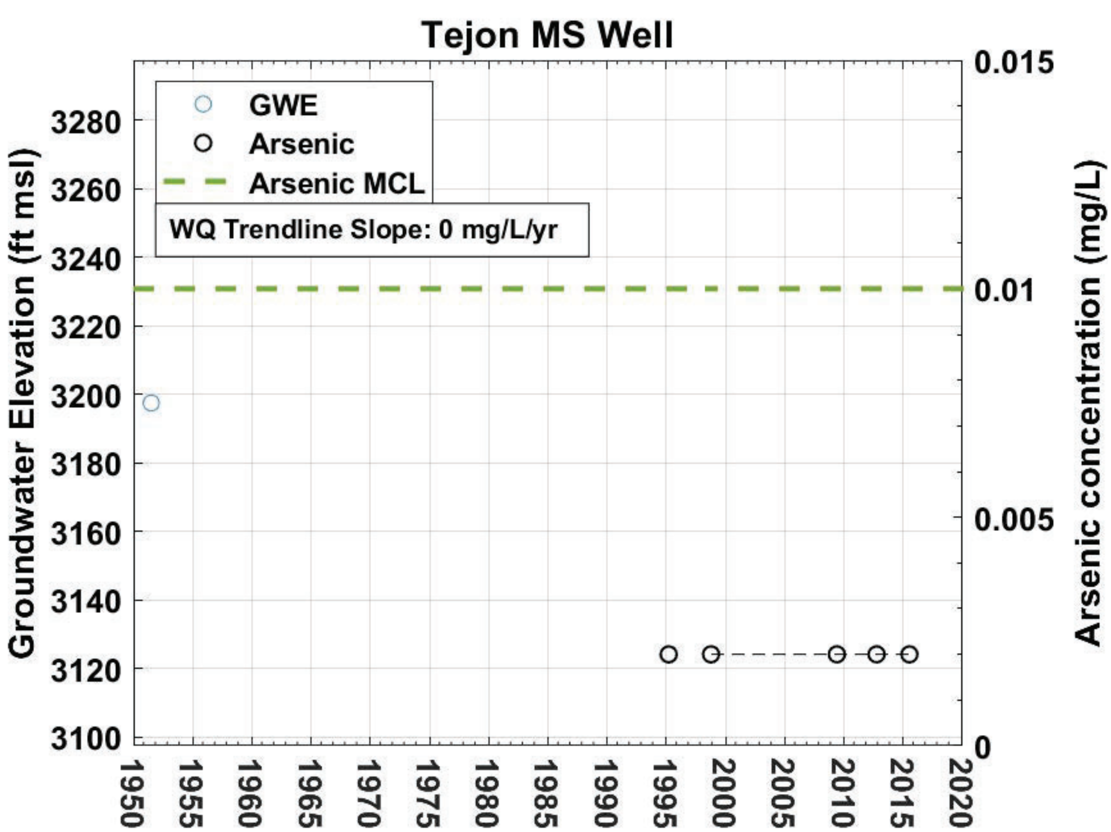
GWE
Arsenic
Arsenic MCL
Groundwater Elevation (ft msl)
Arsenic concentration (mg/L)
3600
3580
3560
3540
3520
3500
3480
3460
3440
3420
0.015
0.01
0.005
0
1950
1955
1960
1965
1970
1975
1980
1985
1990
1995
2000
2005
2010
2015
2020


Tejon MS Well
GWE
Arsenic
Arsenic MCL
WQ Trendline Slope: 0 mg/L/yr
Groundwater Elevation (ft msl)
Arsenic concentration (mg/L)
3280
3260
3240
3220
3200
3180
3160
3140
3120
3100
0.015
0.01
0.005
0
1950
1955
1960
1965
1970
1975
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1985
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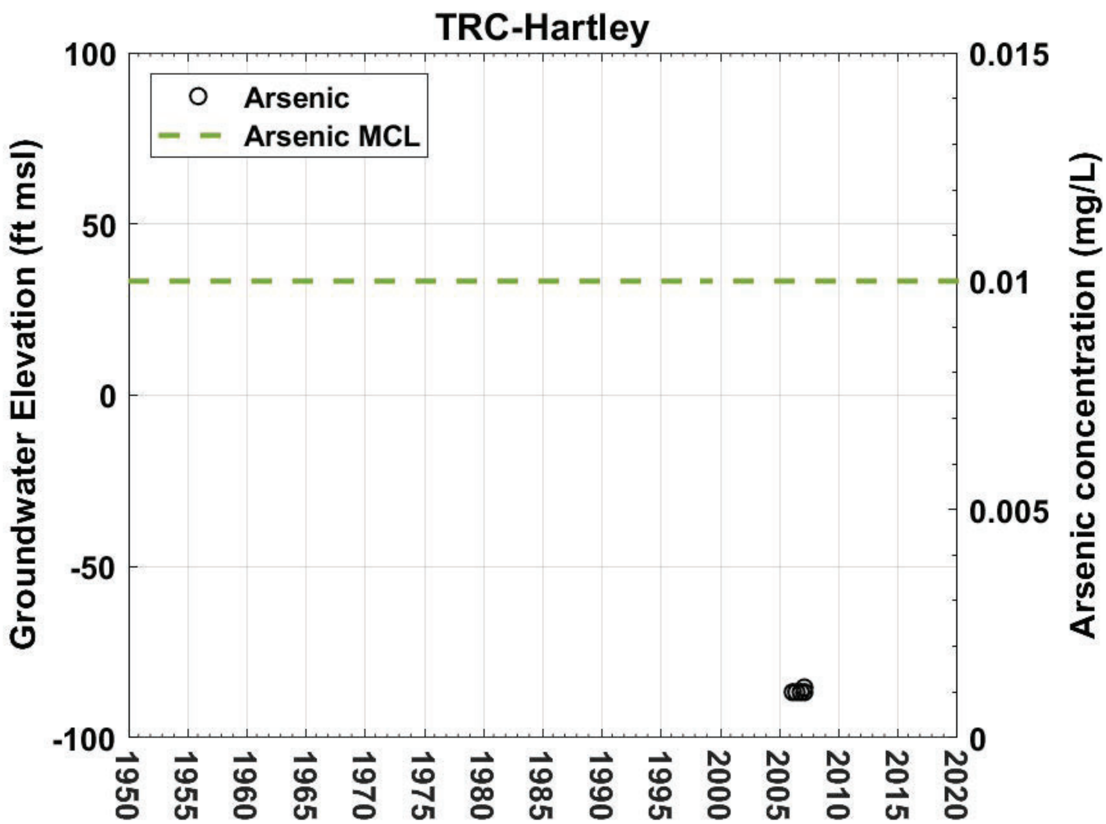
2005
2010
2015
2020


TRC-Hartley
Arsenic
Arsenic MCL
Groundwater Elevation (ft msl)
Arsenic concentration (mg/L)
100
50
0
-50
-100
0.015
0.01
0.005
0
1950
1955
1960
1965
1970
1975
1980
1985
1990
1995
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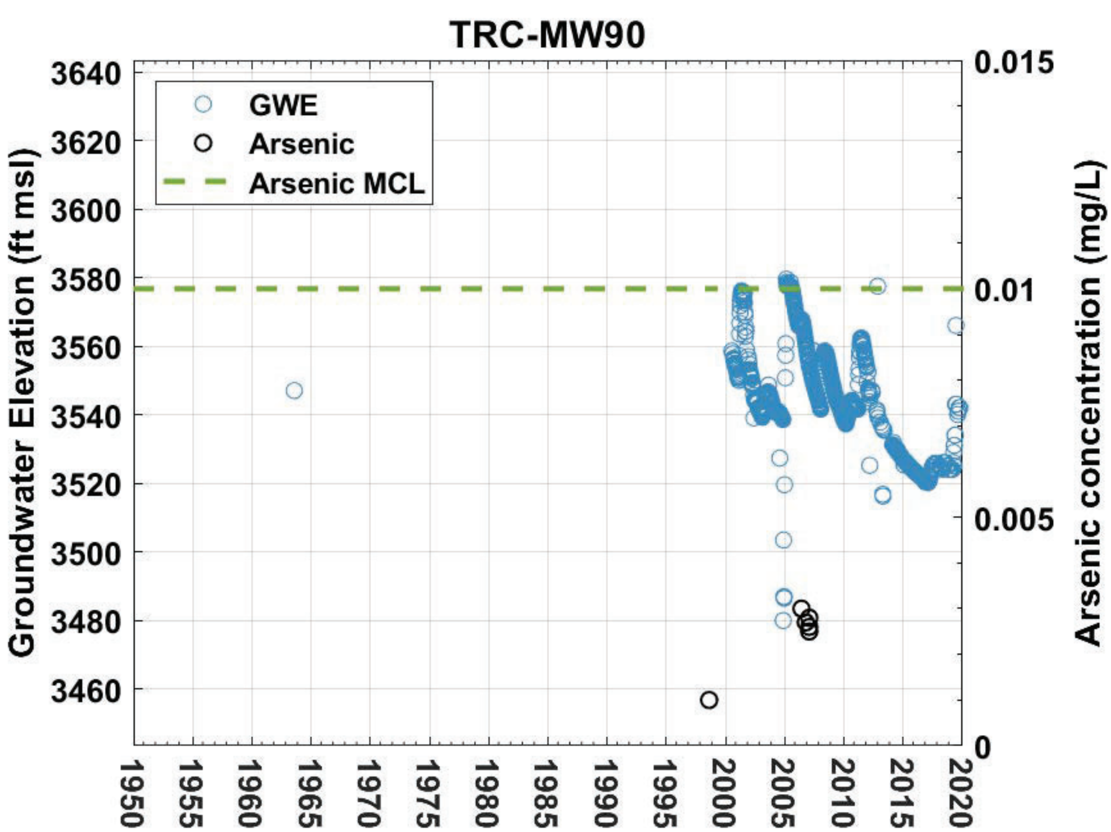
2005
2010
2015
2020


TRC-MW90
GWE
Arsenic
Arsenic MCL
Groundwater Elevation (ft msl)
Arsenic concentration (mg/L)
3640
3620
3600
3580
3560
3540
3520
3500
3480
3460
0.015
0.01
0.005
0
1950
1955
1960
1965
1970
1975
1980
1985
1990
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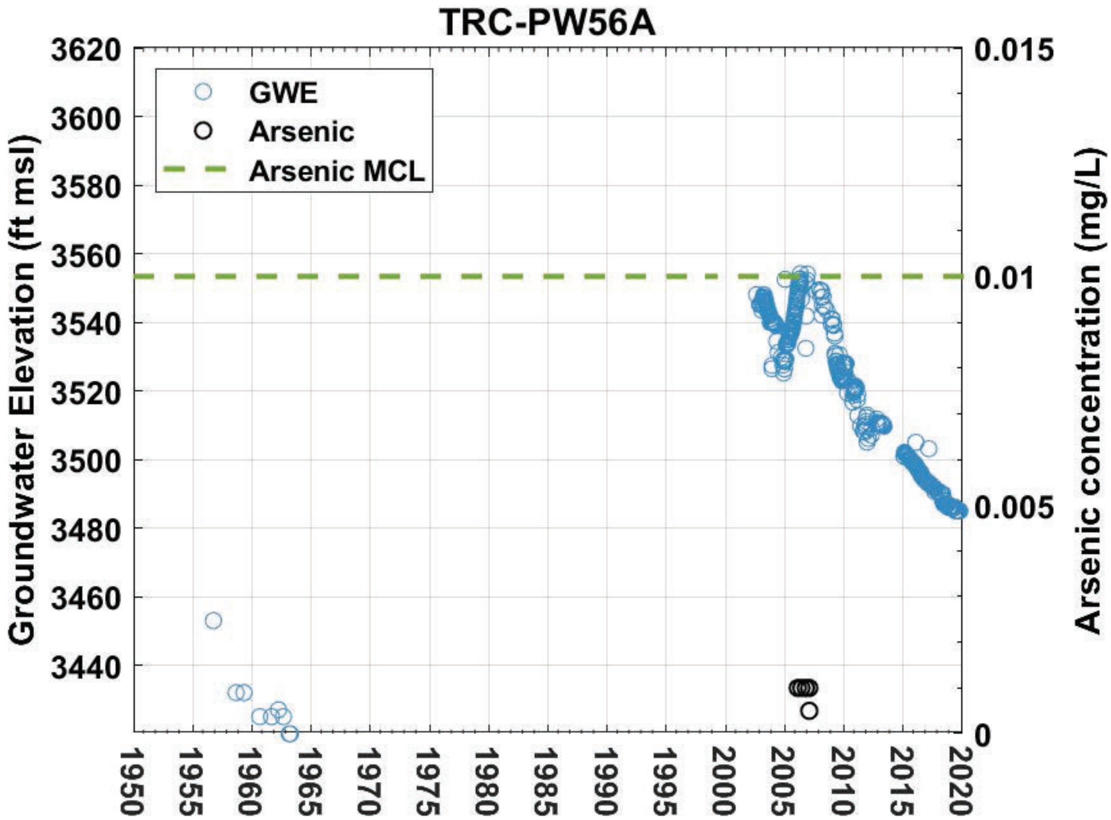
2005
2010
2015
2020



TRC-PW56A
GWE
Arsenic
Arsenic MCL
Groundwater Elevation (ft msl)
Arsenic concentration (mg/L)
3620
3600
3580
3560
3540
3520
3500
3480
3460
3440
0.015
0.01
0.005
0
1950
1955
1960
1965
1970
1975
1980
1985
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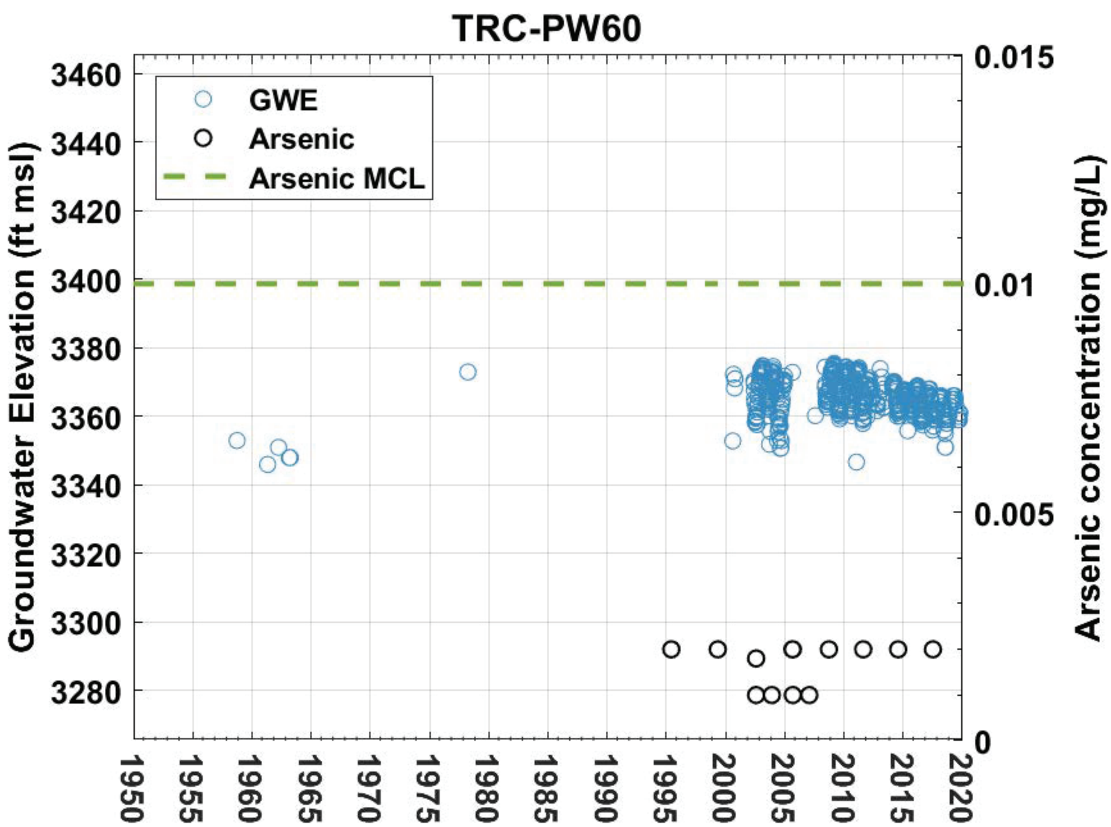
2005
2010
2015
2020



TRC-PW60
GWE
Arsenic
Arsenic MCL
Groundwater Elevation (ft msl)
Arsenic concentration (mg/L)
3460
3440
3420
3400
3380
3360
3340
3320
3300
3280
0.015
0.01
0.005
0
1950
1955
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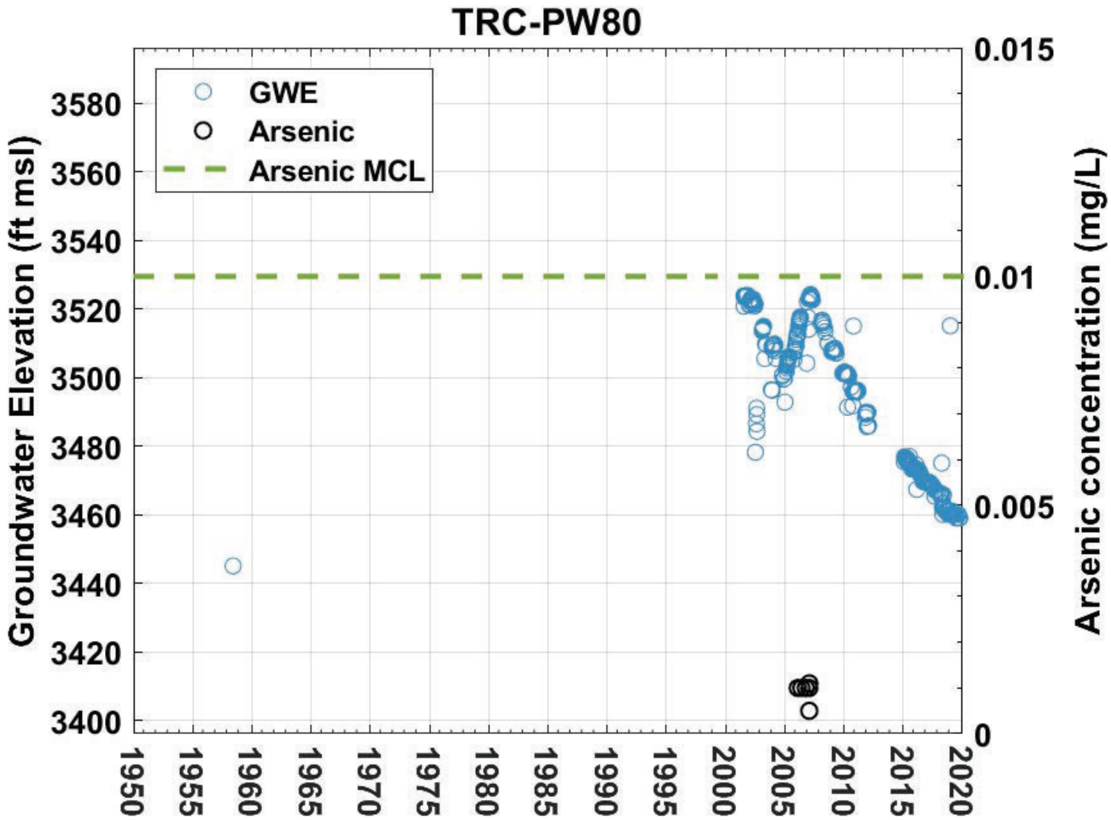
2015
2020



TRC-PW80
GWE
Arsenic
Arsenic MCL
Groundwater Elevation (ft msl)
Arsenic concentration (mg/L)
3580
3560
3540
3520
3500
3480
3460
3440
3420
3400
0.015
0.01
0.005
0
1950
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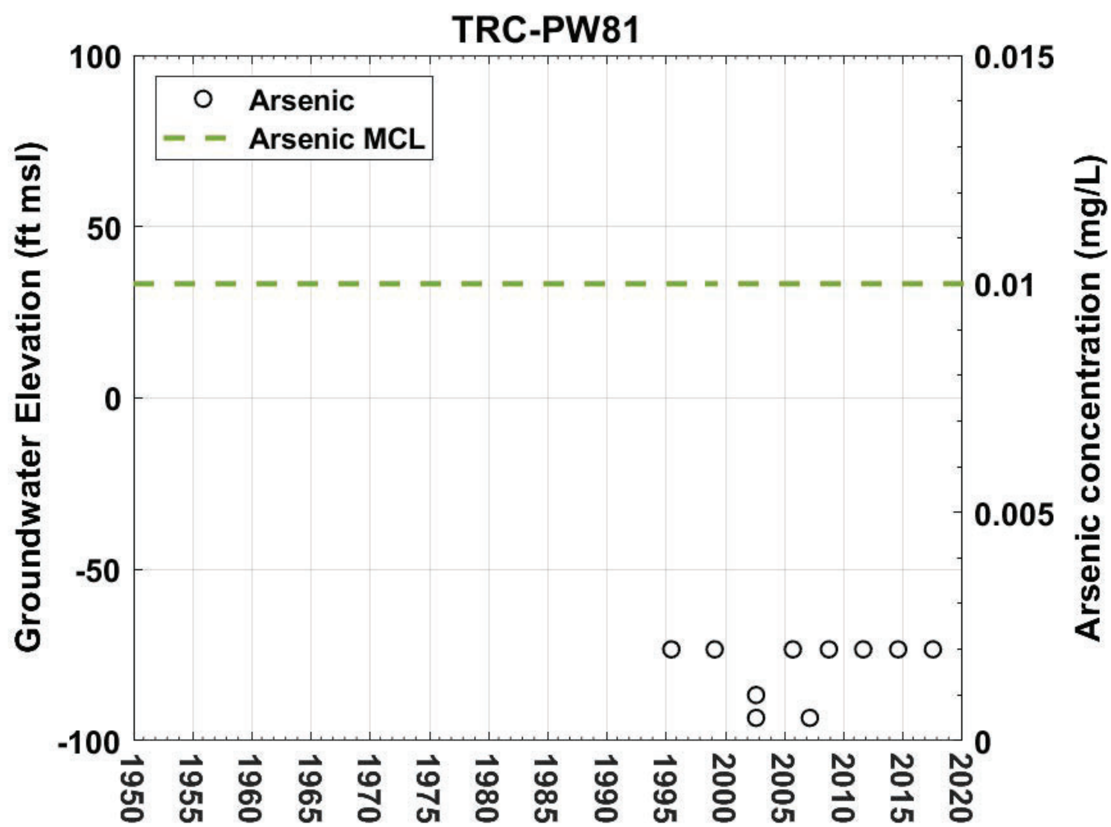
2015
2020



TRC-PW81
Arsenic
Arsenic MCL
Groundwater Elevation (ft msl)
Arsenic concentration (mg/L)
100
50
0
-50
-100
0.015
0.01
0.005
0
1950
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1960
1965
1970
1975
1980
1985
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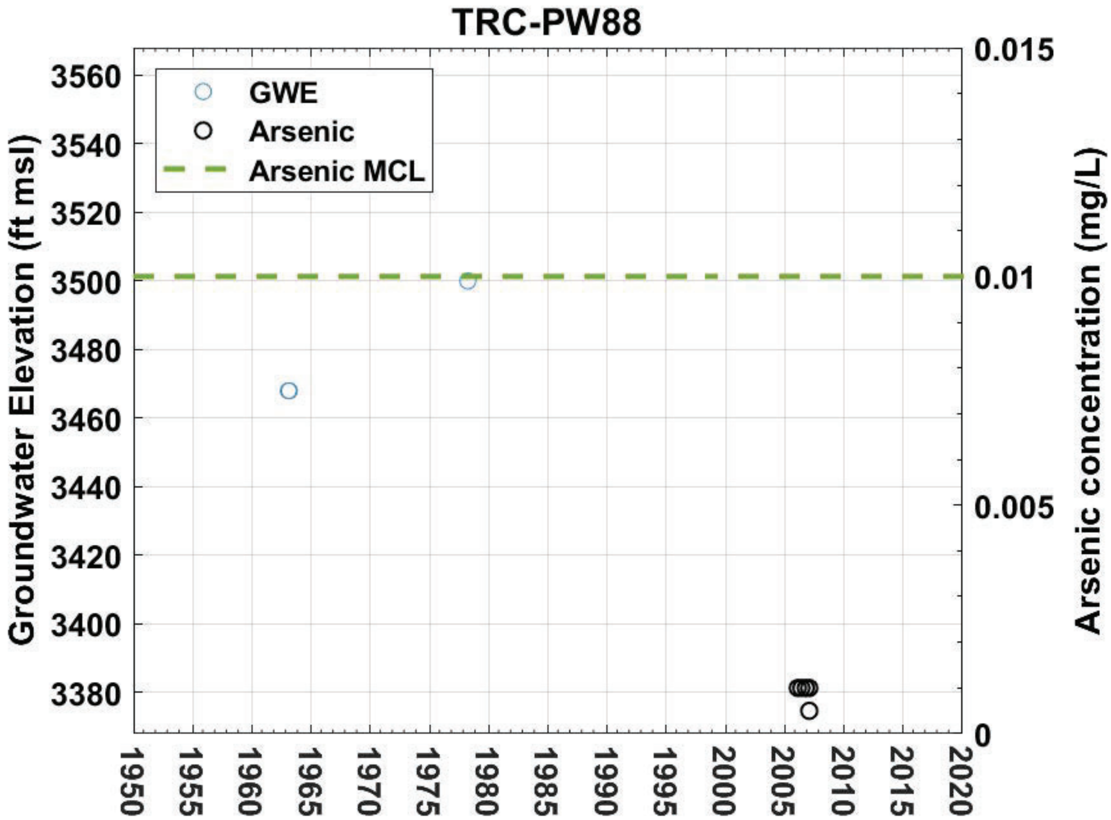
2010
2015
2020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GWE
Arsenic
Arsenic MCL
Groundwater Elevation (ft msl)
Arsenic concentration (mg/L)
3560
3540
3520
3500
3480
3460
3440
3420
3400
3380
0.015
0.01
0.005
0
1950
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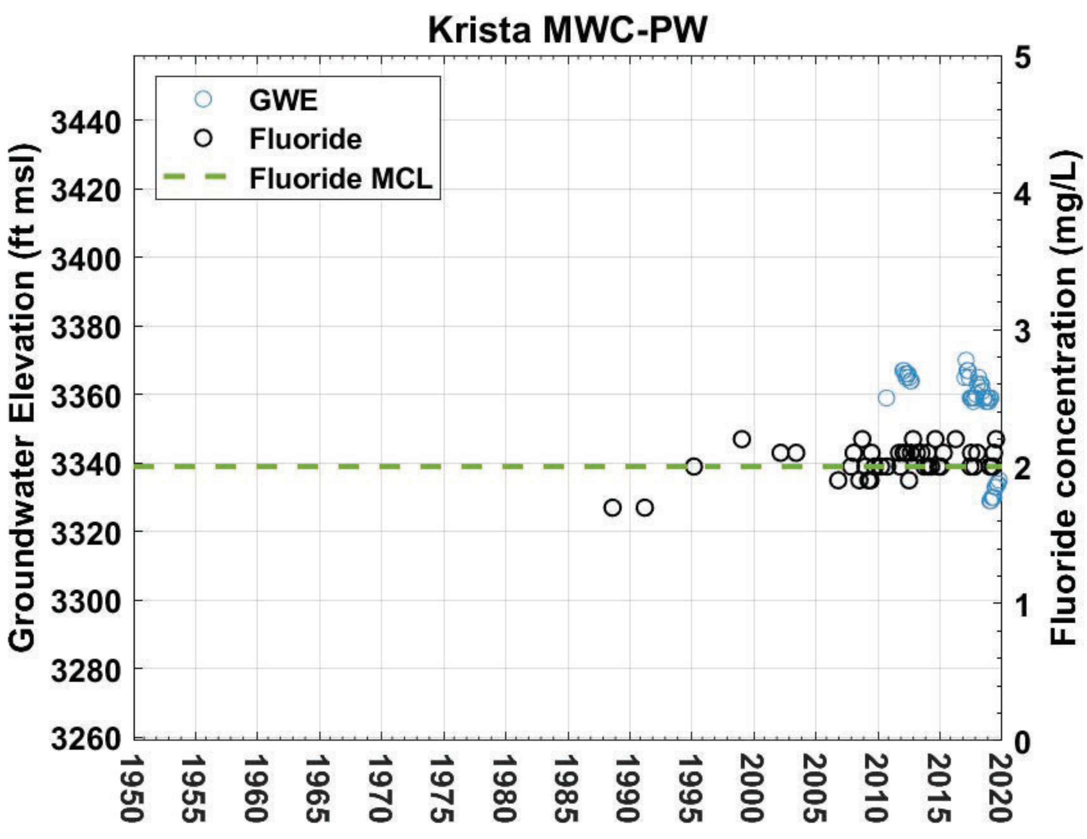
2015
2020


Krista MWC-PW
GWE
Fluoride
Fluoride MCL
Groundwater Elevation (ft msl)
Fluoride concentration (mg/L)
3440
3420
3400
3380
3360
3340
3320
3300
3280
3260
5
4
3
2
1
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1950
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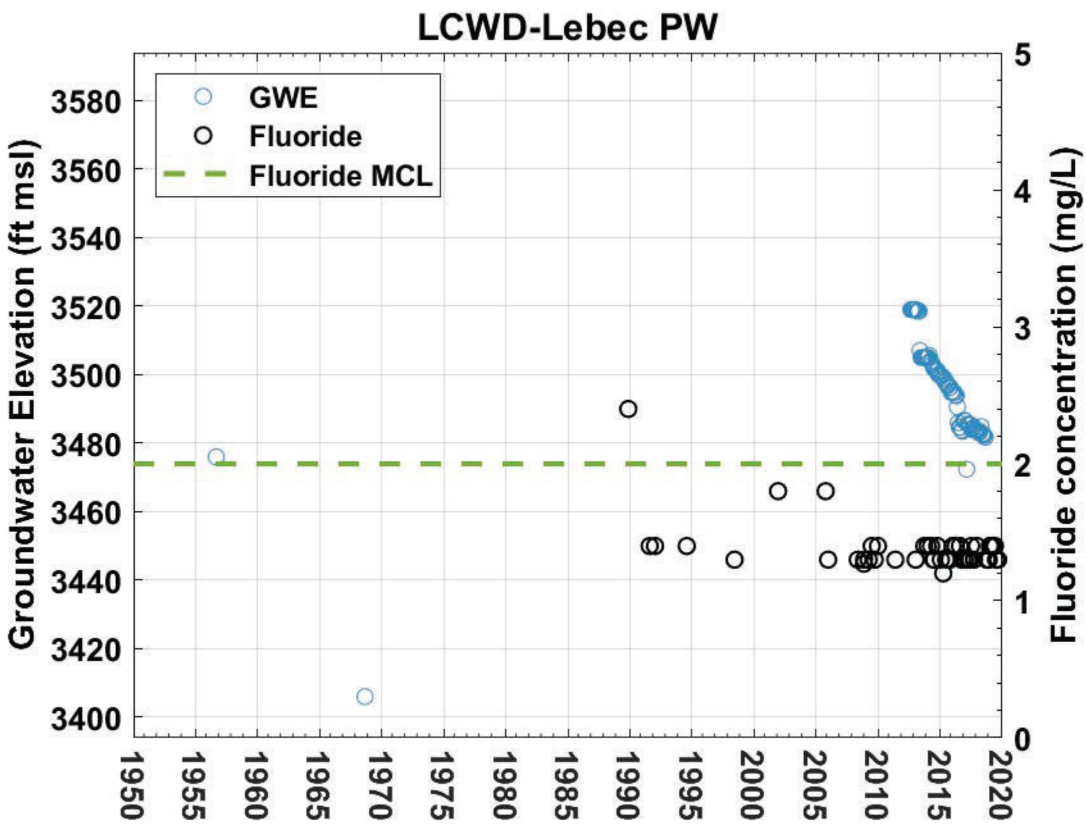
2015
2020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GWE
Fluoride
Fluoride MCL
Groundwater Elevation (ft msl)
Fluoride concentration (mg/L)
3580
3560
3540
3520
3500
3480
3460
3440
3420
3400
5
4
3
2
1
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1950
1955
1960
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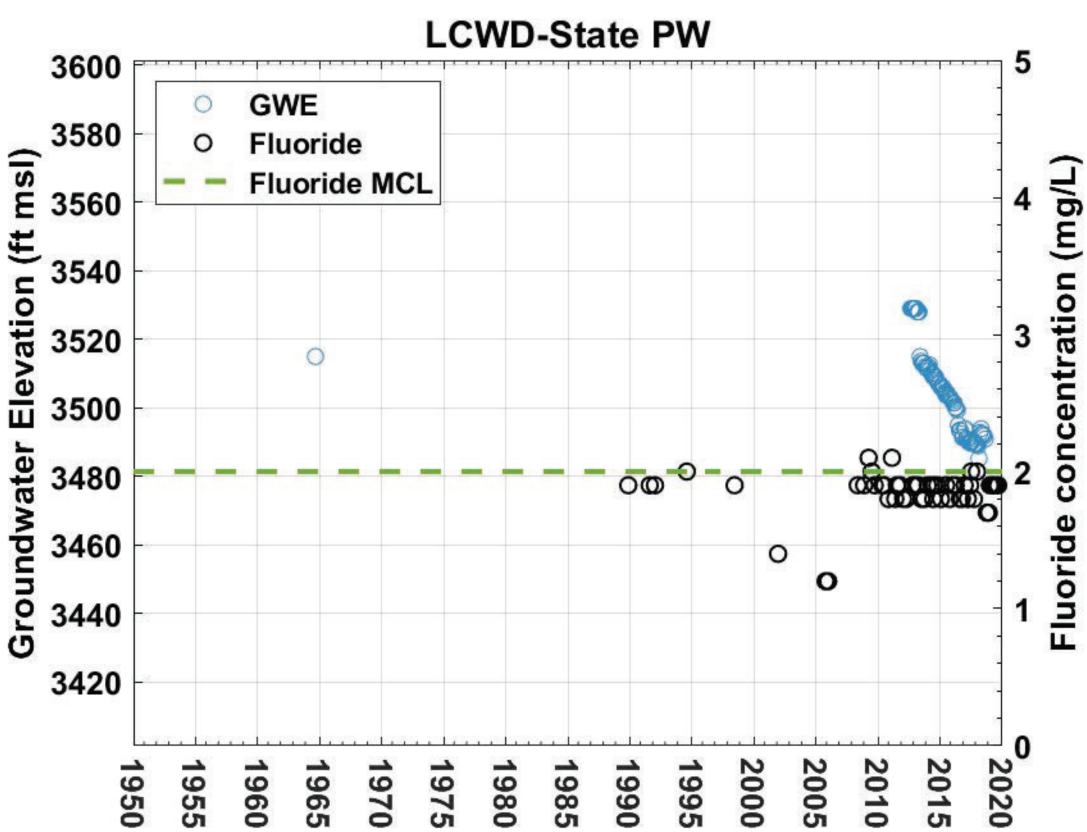
2010
2015
2020


LCWD-State PW
GWE
Fluoride
Fluoride MCL
Groundwater Elevation (ft msl)
Fluoride concentration (mg/L)
3600
3580
3560
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3520
3500
3480
3460
3440
3420
5
4
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2
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1955
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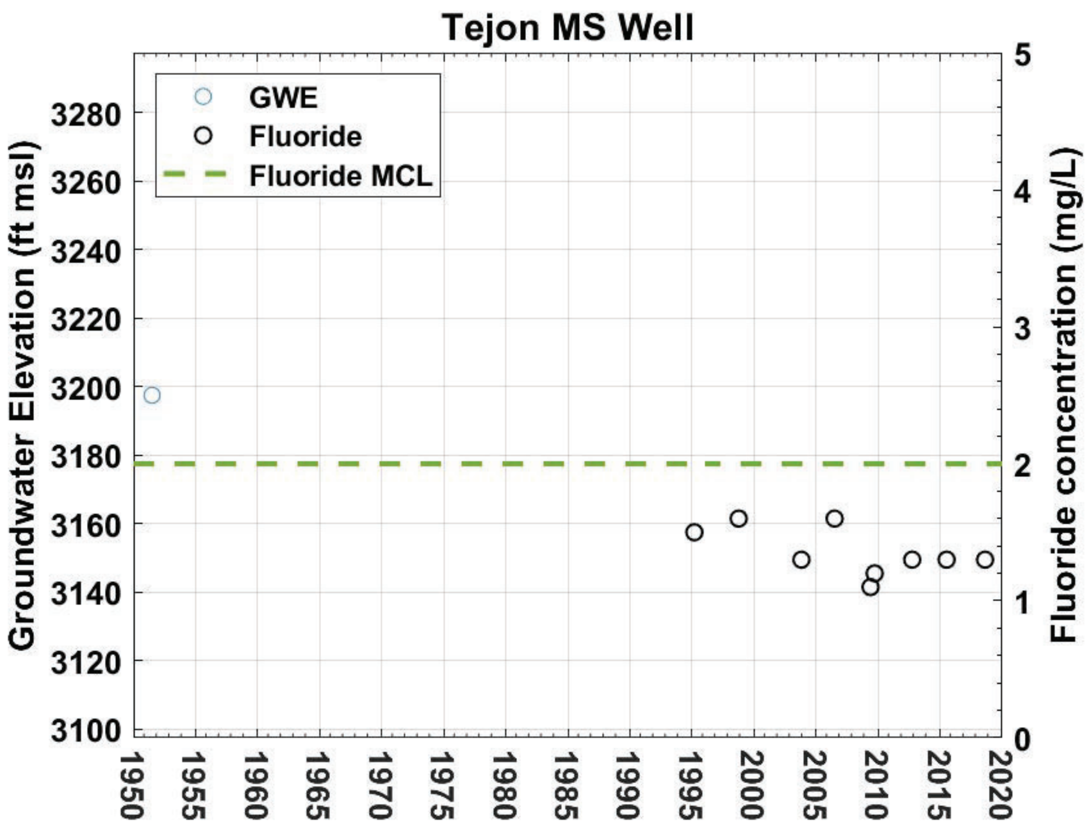
2015
2020



Tejon MS Well
GWE
Fluoride
Fluoride MCL
Groundwater Elevation (ft msl)
Fluoride concentration (mg/L)
3100
3120
3140
3160
3180
3200
3220
3240
3260
3280
0
1
2
3
4
5
1950
1955
1960
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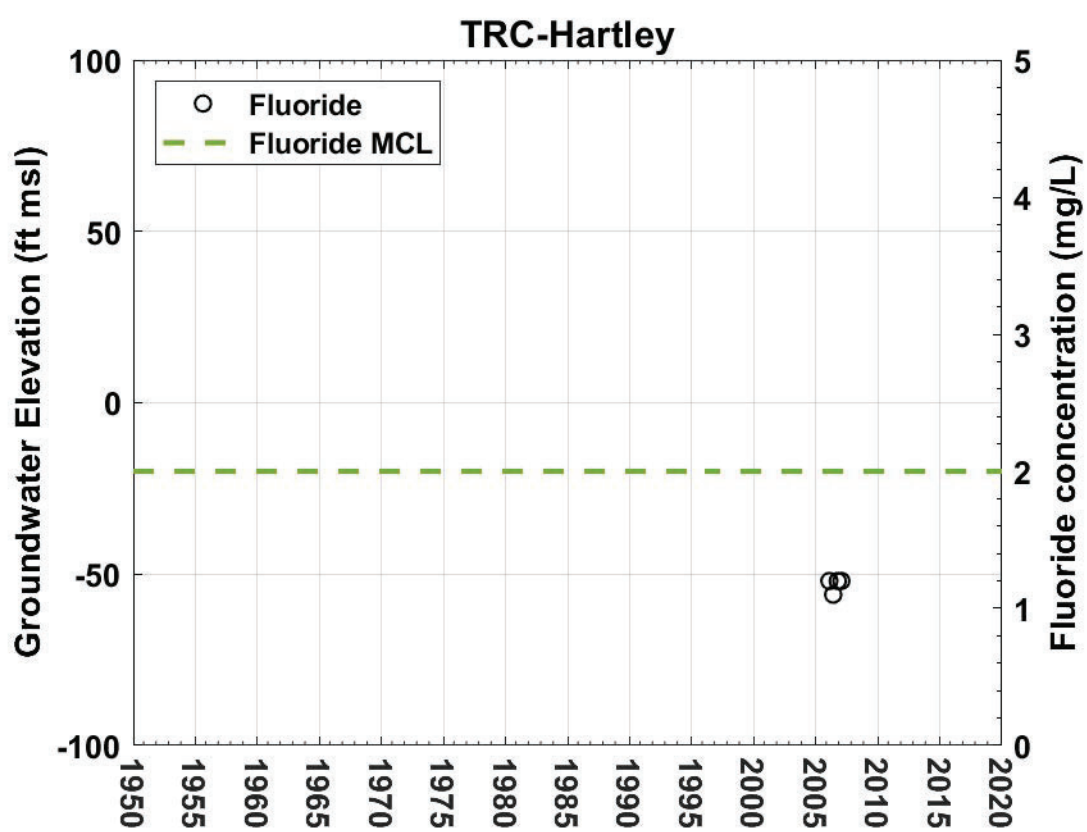
2015
2020



TRC-Hartley
Fluoride
Fluoride MCL
Groundwater Elevation (ft msl)
Fluoride concentration (mg/L)
-100
-50
0
50
100
0
1
2
3
4
5
1950
1955
1960
1965
1970
1975
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1985
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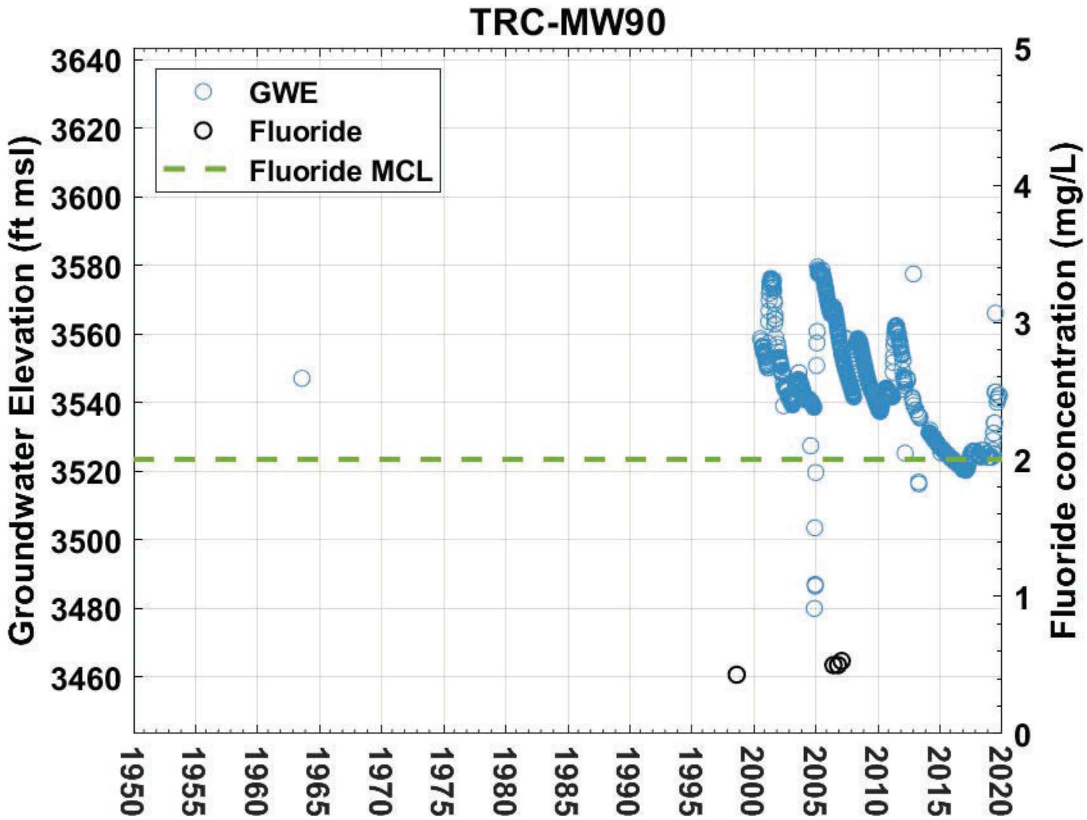
TRC-MW90
GWE
Fluoride
Fluoride MCL
Groundwater Elevation (ft msl)
Fluoride concentration (mg/L)
3640
3620
3600
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3560
3540
3520
3500
3480
3460
5
4
3
2
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1950
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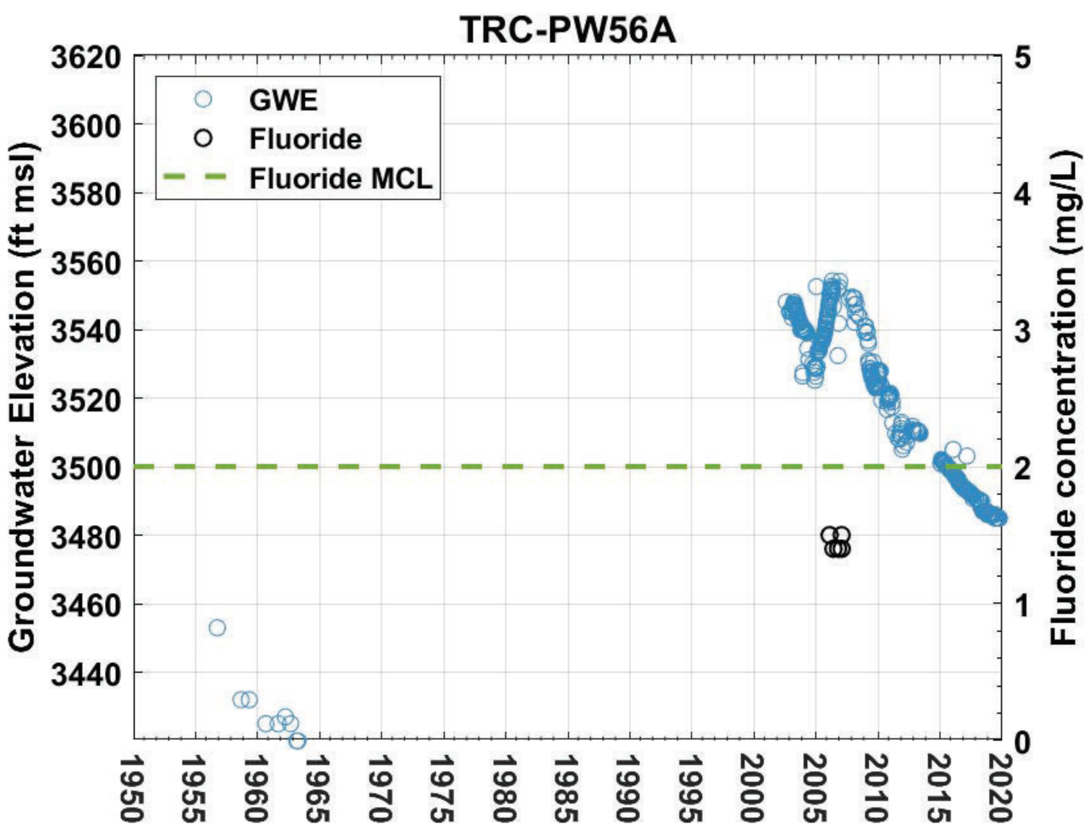
2020


TRC-PW56A
GWE
Fluoride
Fluoride MCL
Groundwater Elevation (ft msl)
Fluoride concentration (mg/L)
3620
3600
3580
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3540
3520
3500
3480
3460
3440
5
4
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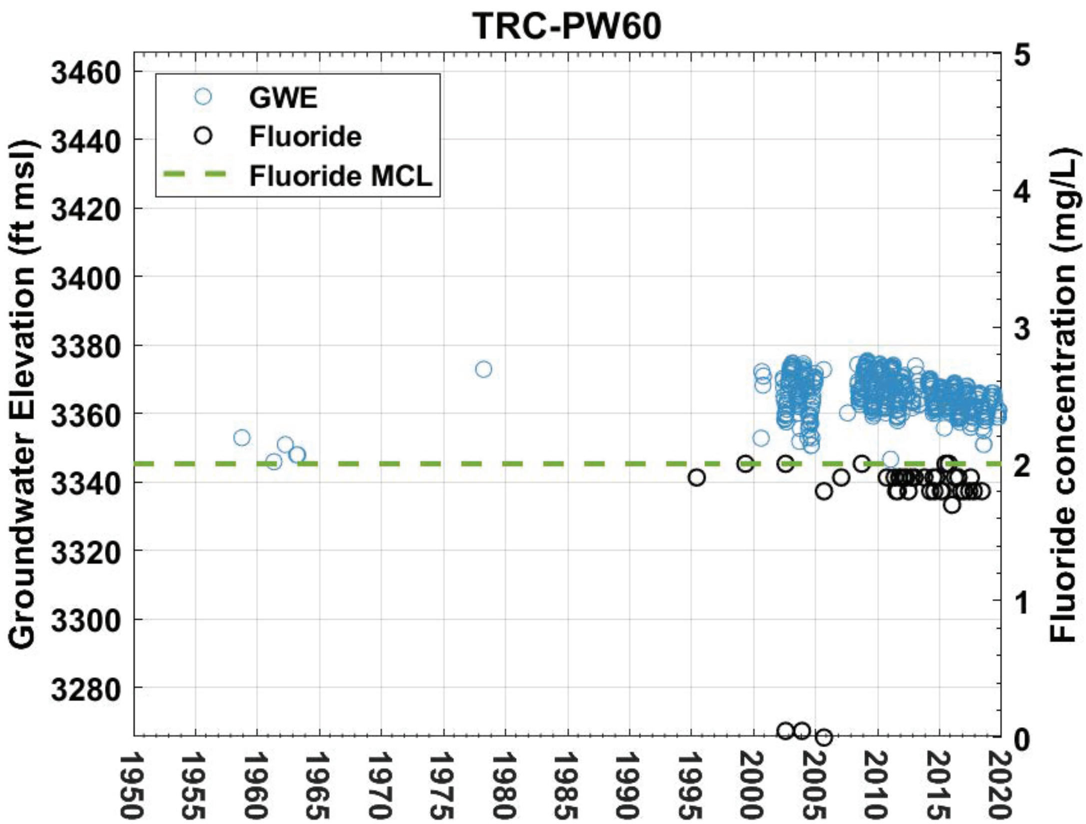
2020



TRC-PW60
GWE
Fluoride
Fluoride MCL
Groundwater Elevation (ft msl)
Fluoride concentration (mg/L)
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3440
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3300
3280
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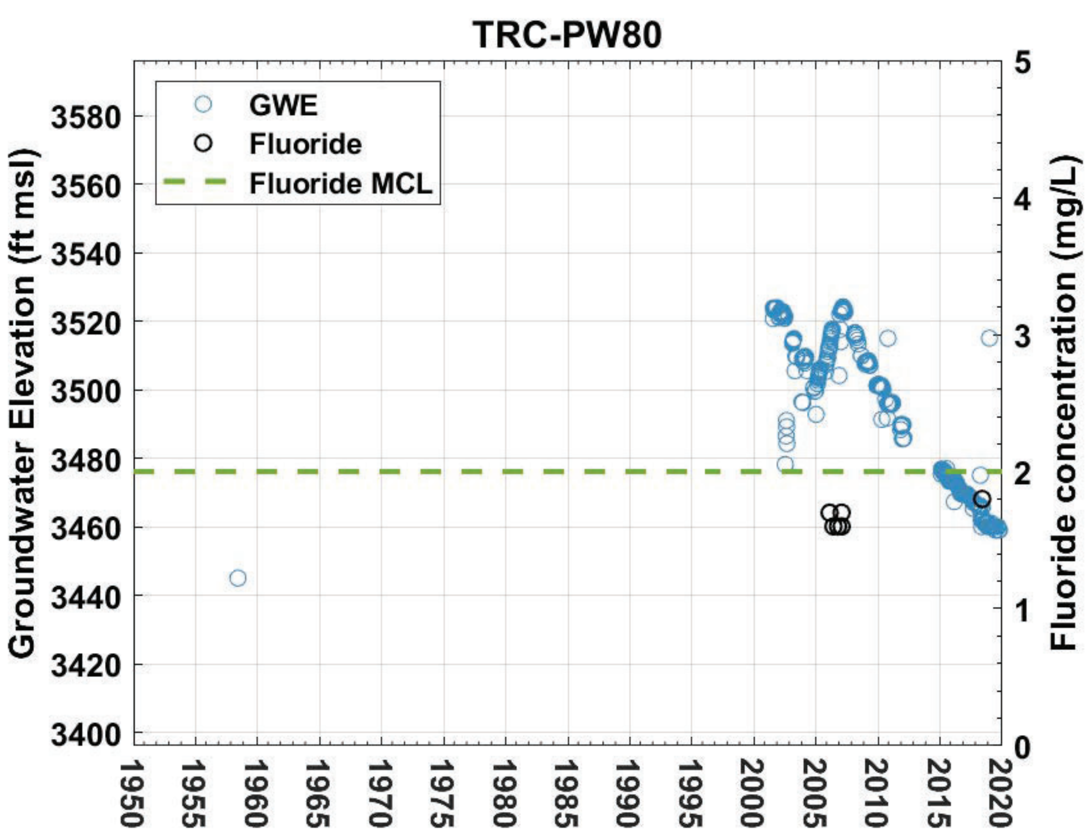

TRC-PW80
GWE
Fluoride
Fluoride MCL
Groundwater Elevation (ft msl)
Fluoride concentration (mg/L)
3580
3560
3540
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3500
3480
3460
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3420
3400
5
4
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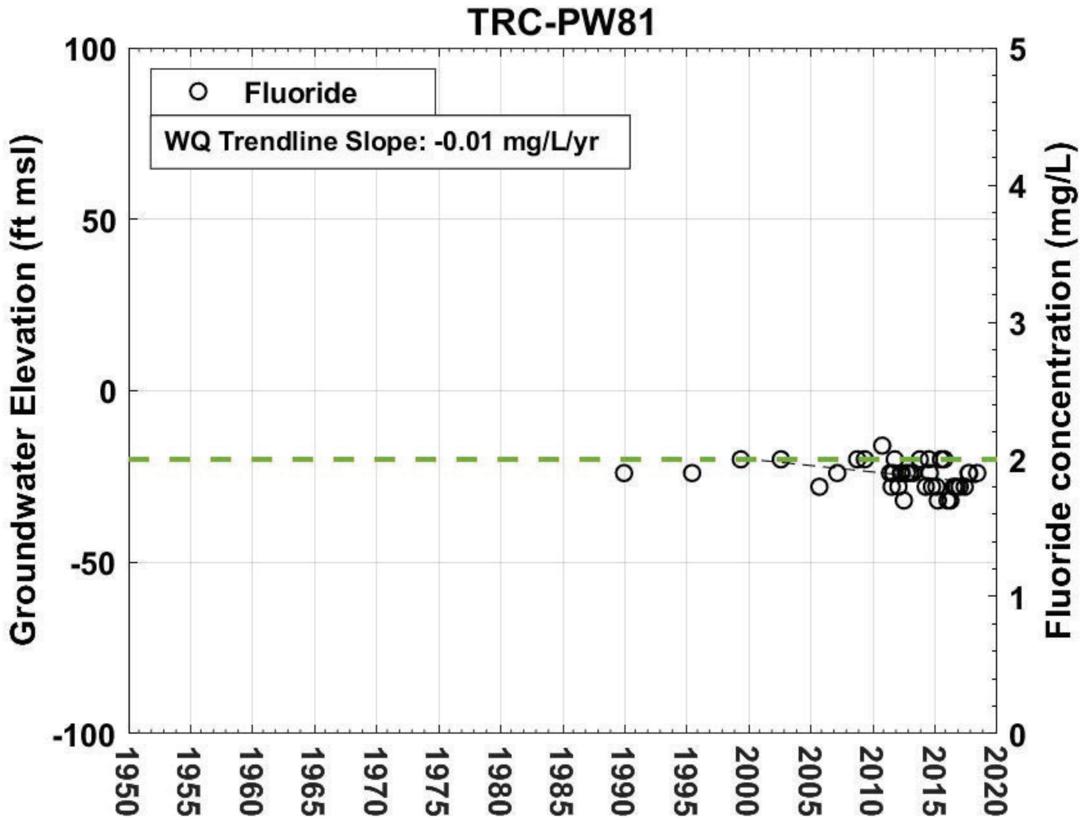
TRC-PW81
Fluoride
WQ Trendline Slope: -0.01 mg/L/yr
Groundwater Elevation (ft msl)
Fluoride concentration (mg/L)
100
50
0
-50
-100
5
4
3
2
1
0
1950
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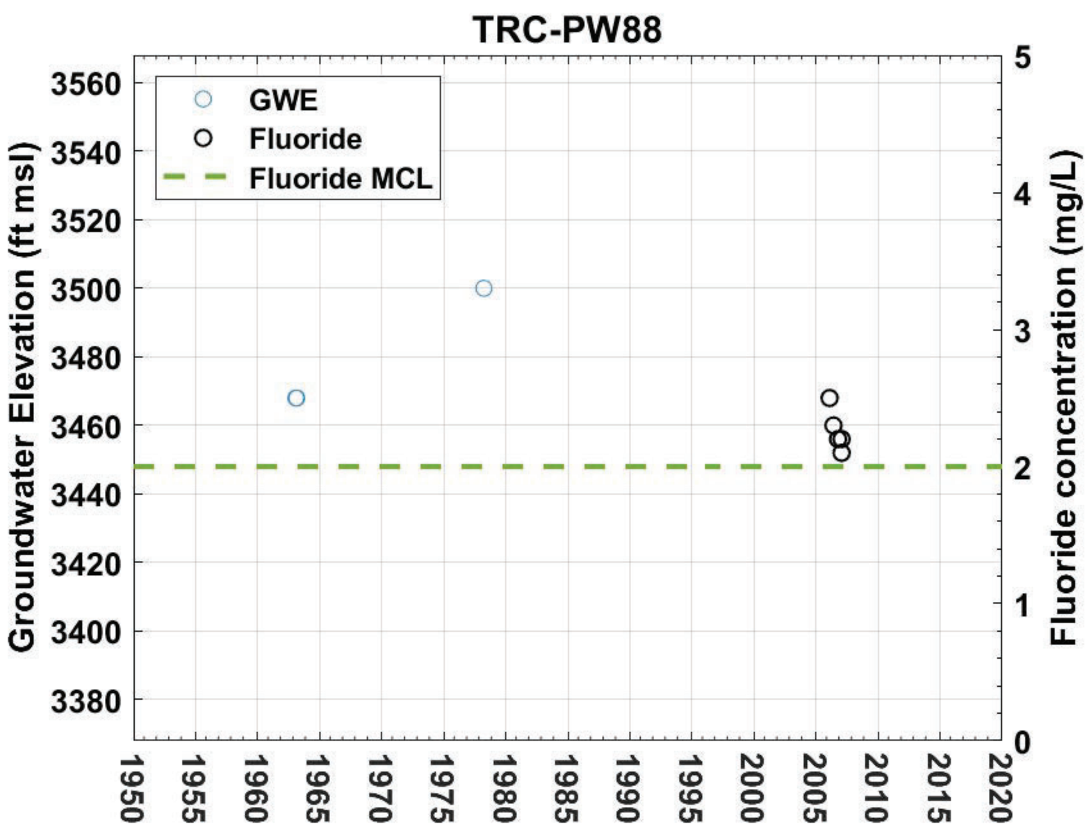
2015
2020


TRC-PW88
GWE
Fluoride
Fluoride MCL
Groundwater Elevation (ft msl)
Fluoride concentration (mg/L)
3560
3540
3520
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3480
3460
3440
3420
3400
3380
5
4
3
2
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1950
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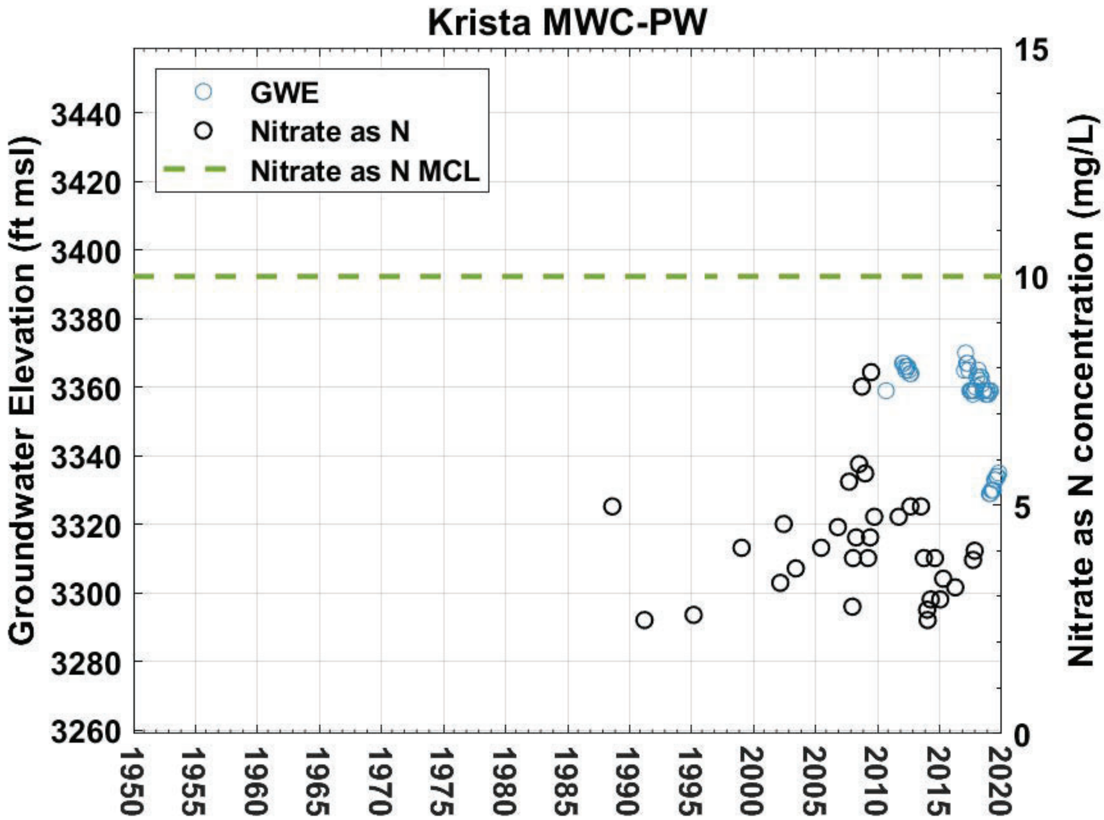
2020



Krista MWC-PW
GWE
Nitrate as N
Nitrate as N MCL
Groundwater Elevation (ft msl)
Nitrate as N concentration (mg/L)
3260
3280
3300
3320
3340
3360
3380
3400
3420
3440
0
5
10
15
1950
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1960
1965
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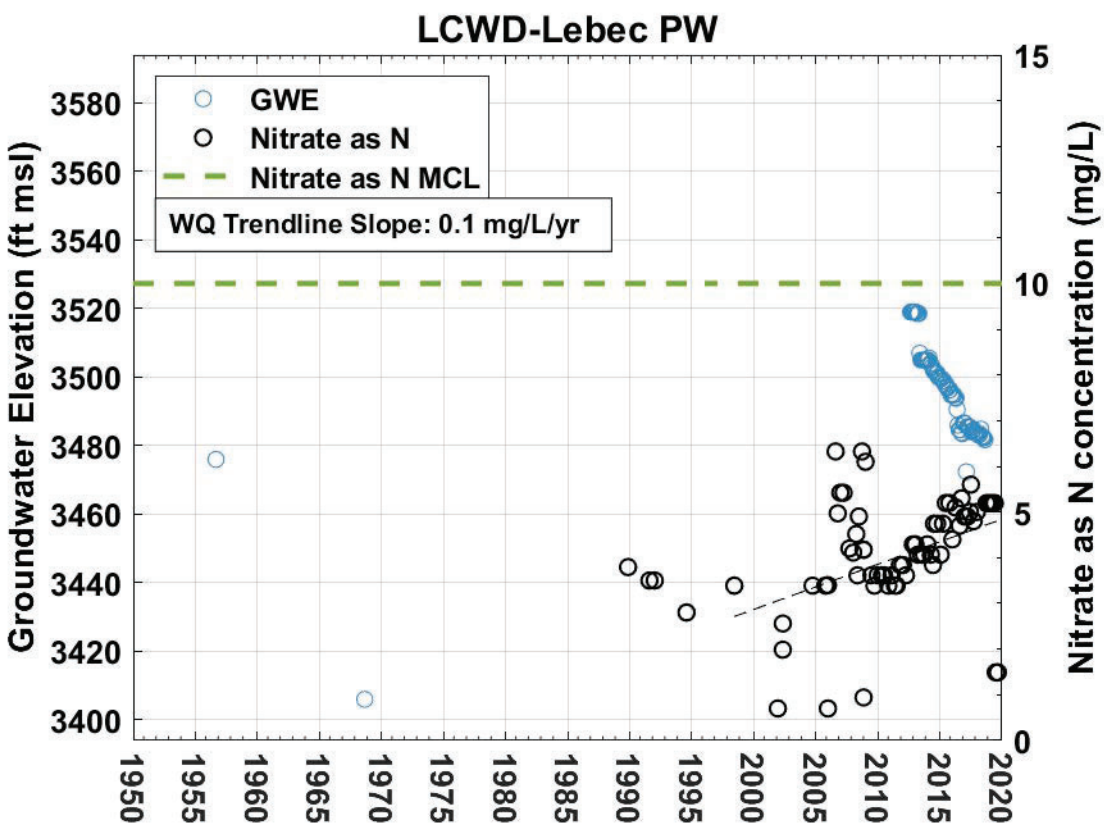
2010
2015
2020



LCWD-Lebec PW
GWE
Nitrate as N
Nitrate as N MCL
WQ Trendline Slope: 0.1 mg/L/yr
Groundwater Elevation (ft msl)
Nitrate as N concentration (mg/L)
3400
3420
3440
3460
3480
3500
3520
3540
3560
3580
0
5
10
15
1950
1955
1960
1965
1970
1975
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1985
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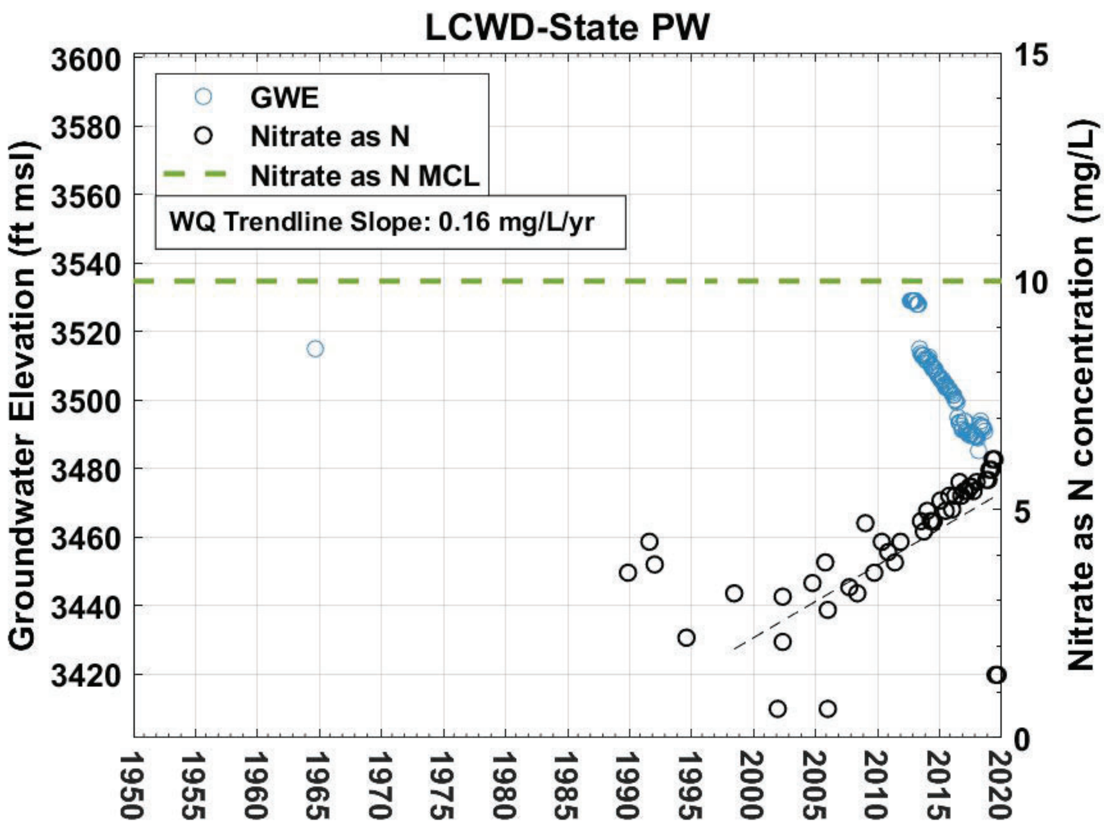
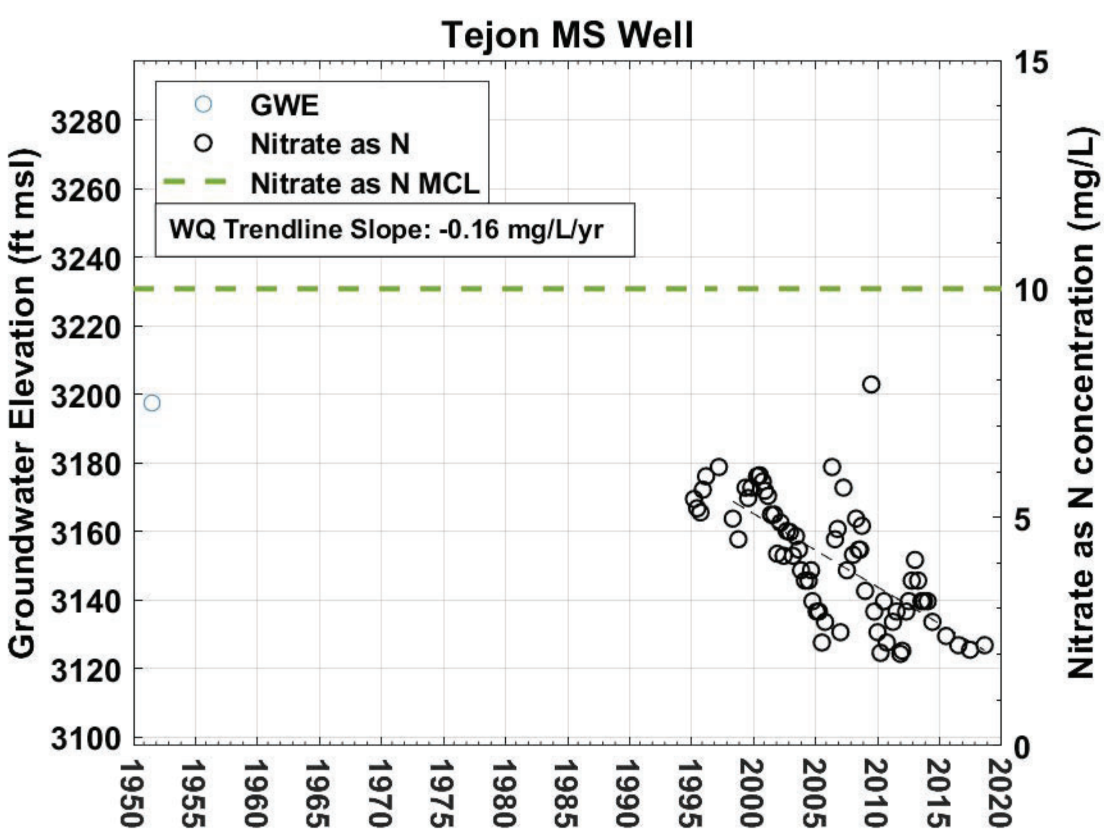
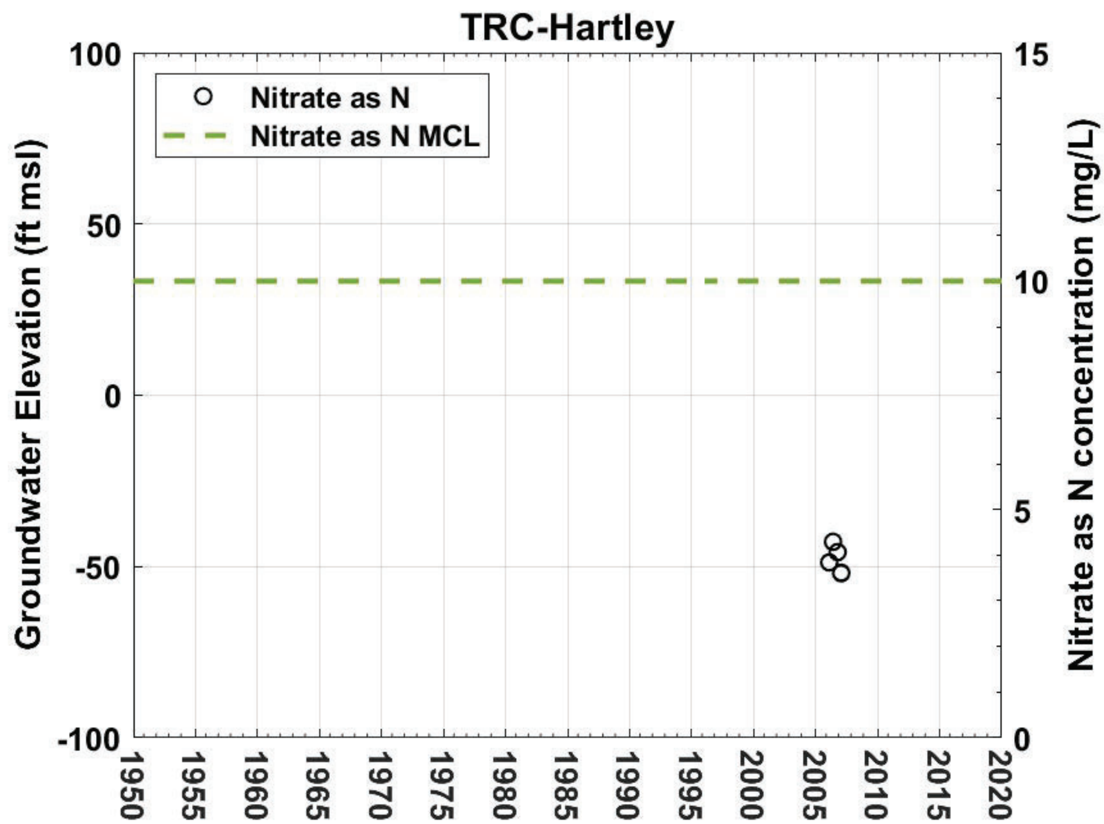
2010
2015
2020

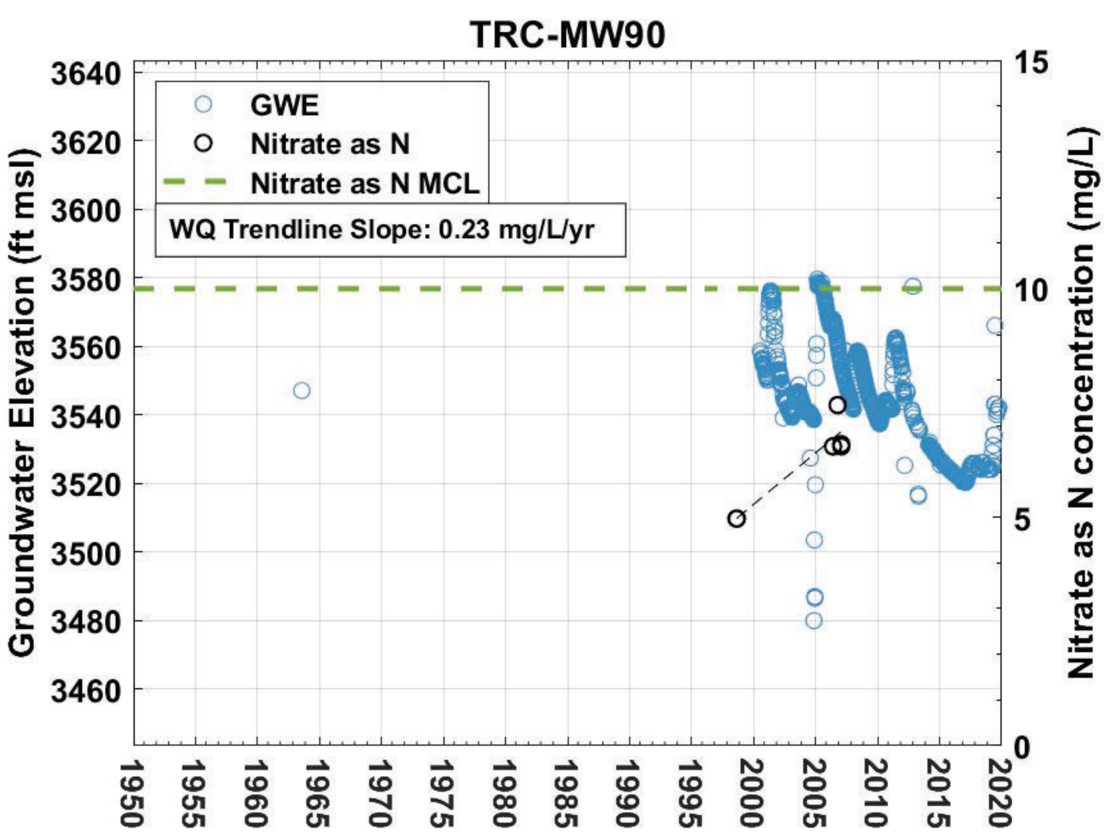


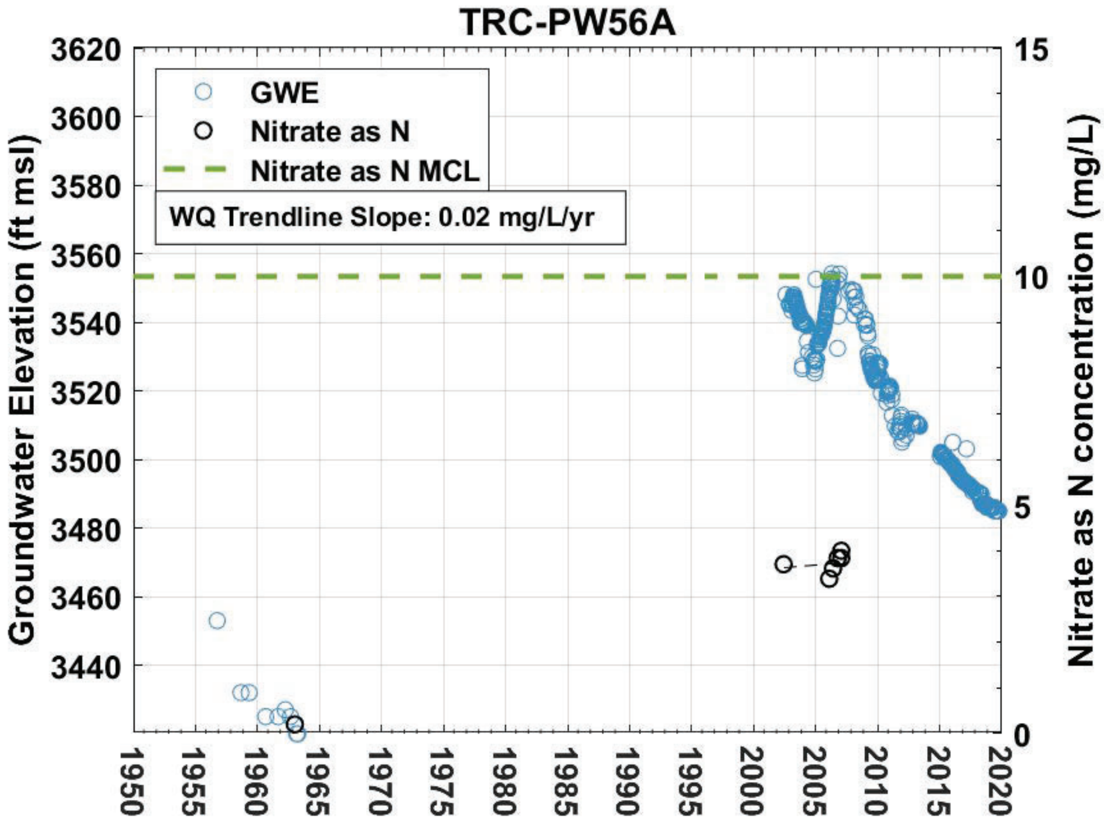
LCWD-State PW
GWE
Nitrate as N
Nitrate as N MCL
WQ Trendline Slope: 0.16 mg/L/yr
Groundwater Elevation (ft msl)
Nitrate as N concentration (mg/L)

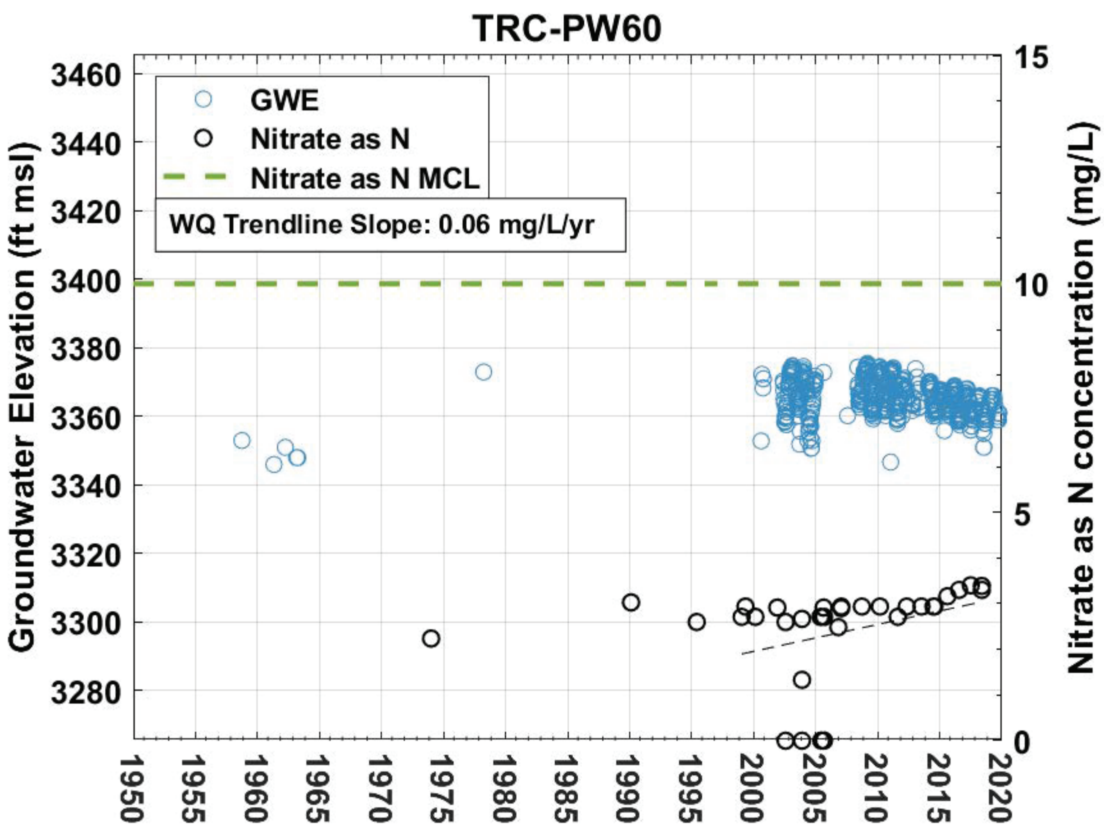


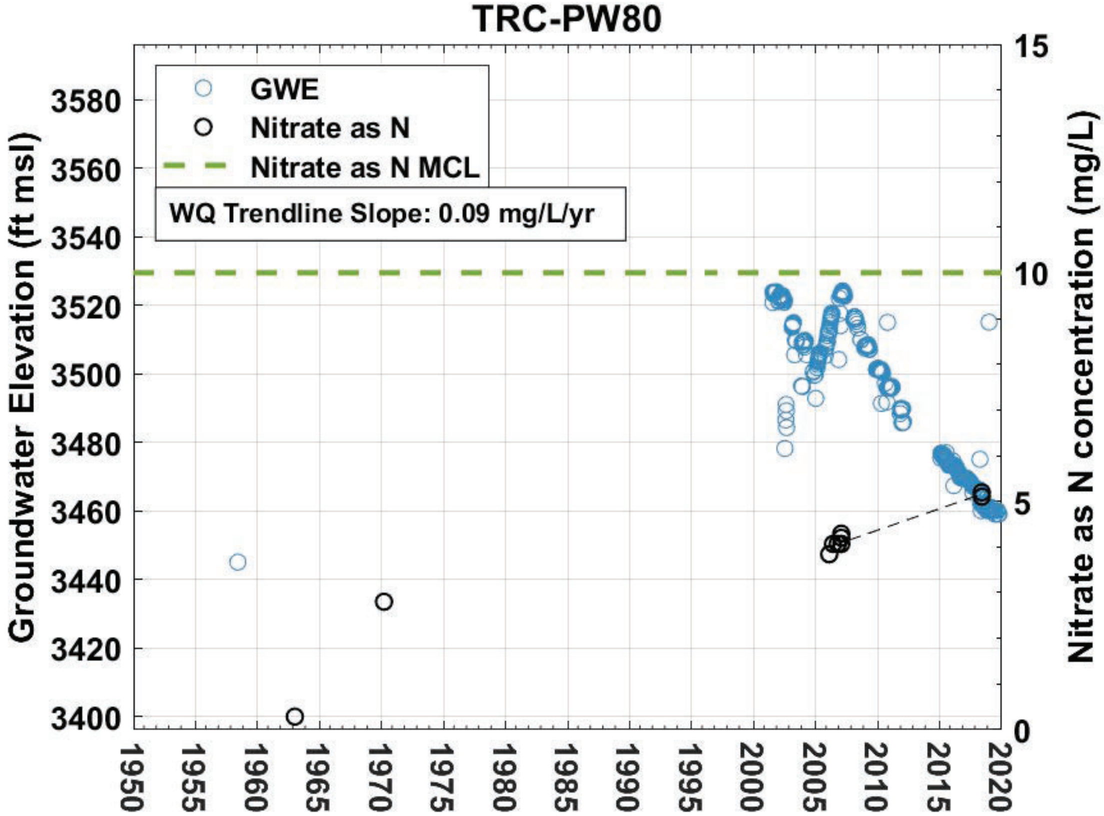
Tejon MS Well
GWE
Nitrate as N
Nitrate as N MCL
WQ Trendline Slope: -0.16 mg/L/yr
Groundwater Elevation (ft msl)
Nitrate as N concentration (mg/L)

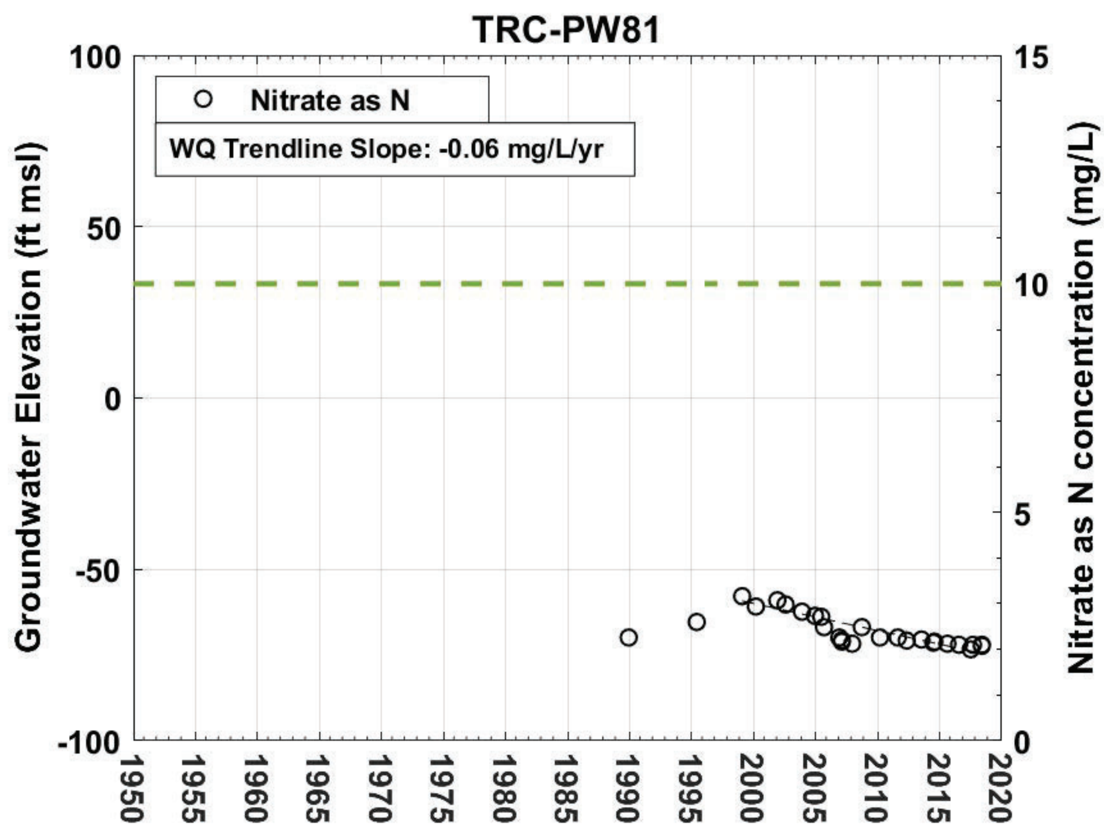

TRC-Hartley
Nitrate as N
Nitrate as N MCL
Groundwater Elevation (ft msl)
Nitrate as N concentration (mg/L)
100
50
0
-50
-100
15
10
5
0
1950
1955
1960
1965
1970
1975
1980
1985
1990
1995
2000
2005
2010
2015
2020

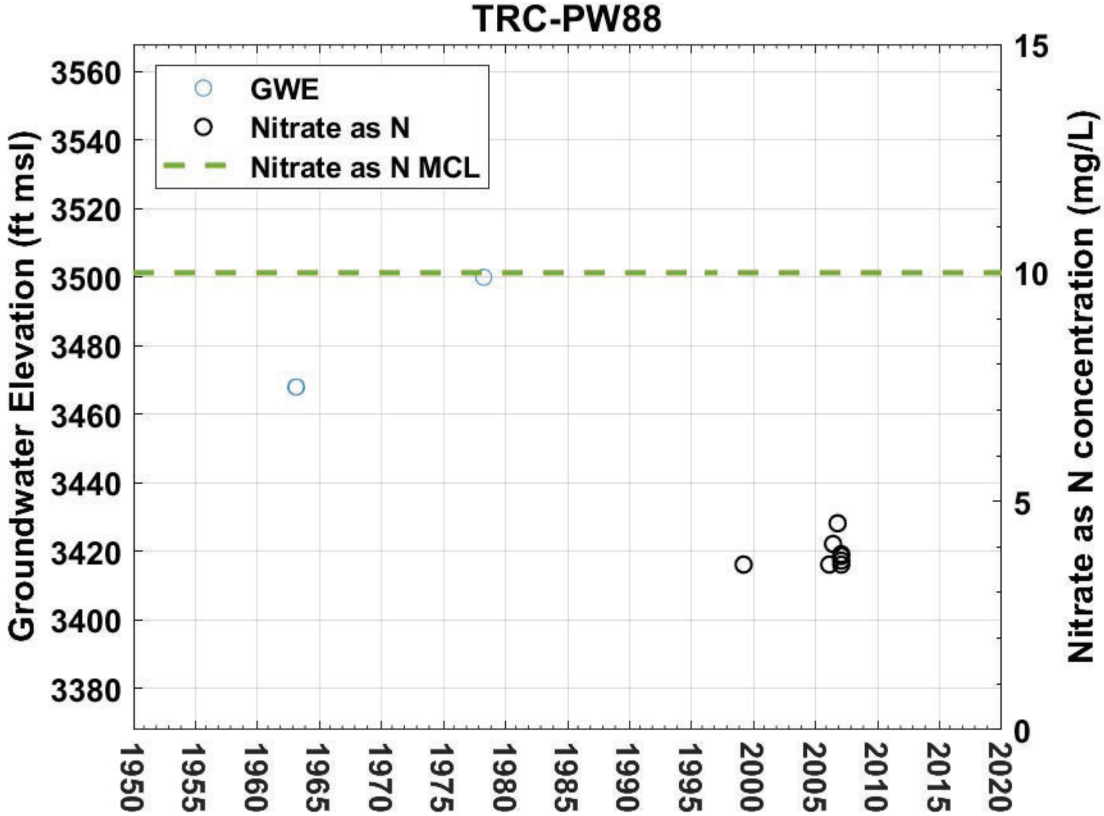

TRC-MW90
GWE
Nitrate as N
Nitrate as N MCL
WQ Trendline Slope: 0.23 mg/L/yr
Groundwater Elevation (ft msl)
Nitrate as N concentration (mg/L)
3640
3620
3600
3580
3560
3540
3520
3500
3480
3460
15
10
5
0
1950
1955
1960
1965
1970
1975
1980
1985
1990
1995
2000
2005
2010
2015
2020

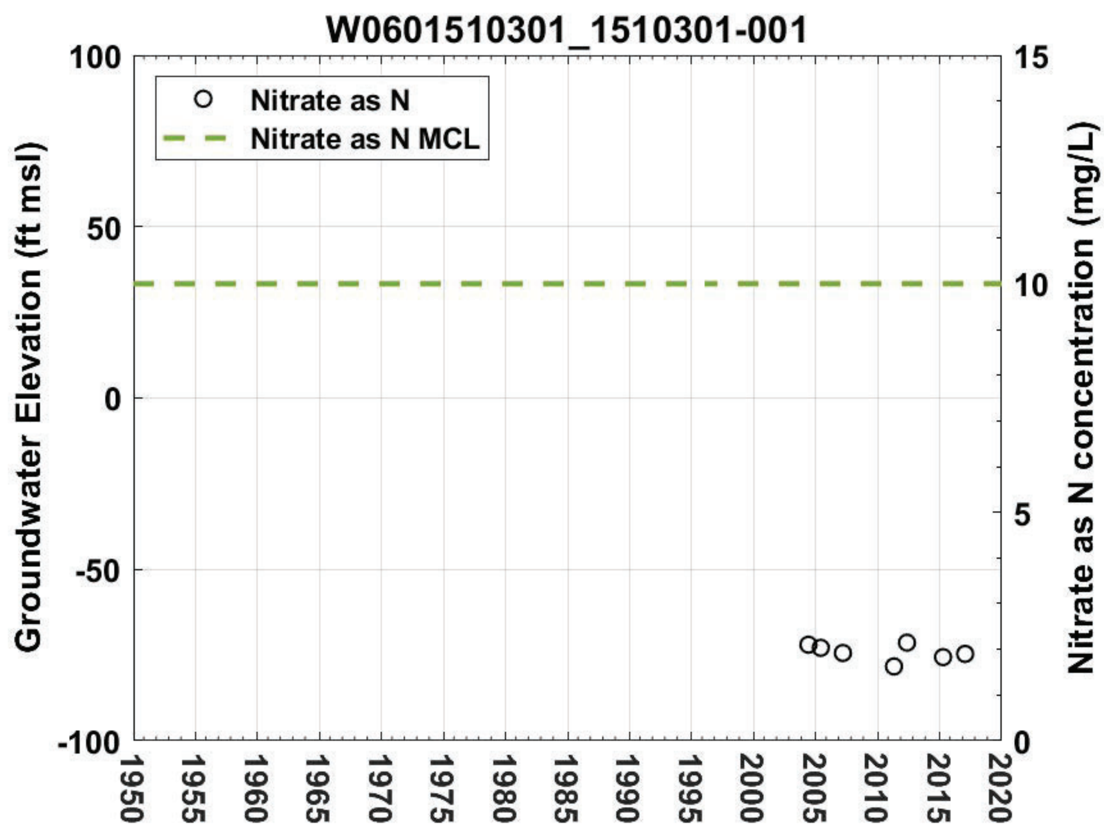

TRC-PW56A
GWE
Nitrate as N
Nitrate as N MCL
WQ Trendline Slope: 0.02 mg/L/yr
Groundwater Elevation (ft msl)
Nitrate as N concentration (mg/L)
3620
3600
3580
3560
3540
3520
3500
3480
3460
3440
15
10
5
0
1950
1955
1960
1965
1970
1975
1980
1985
1990
1995
2000
2005
2010
2015
2020

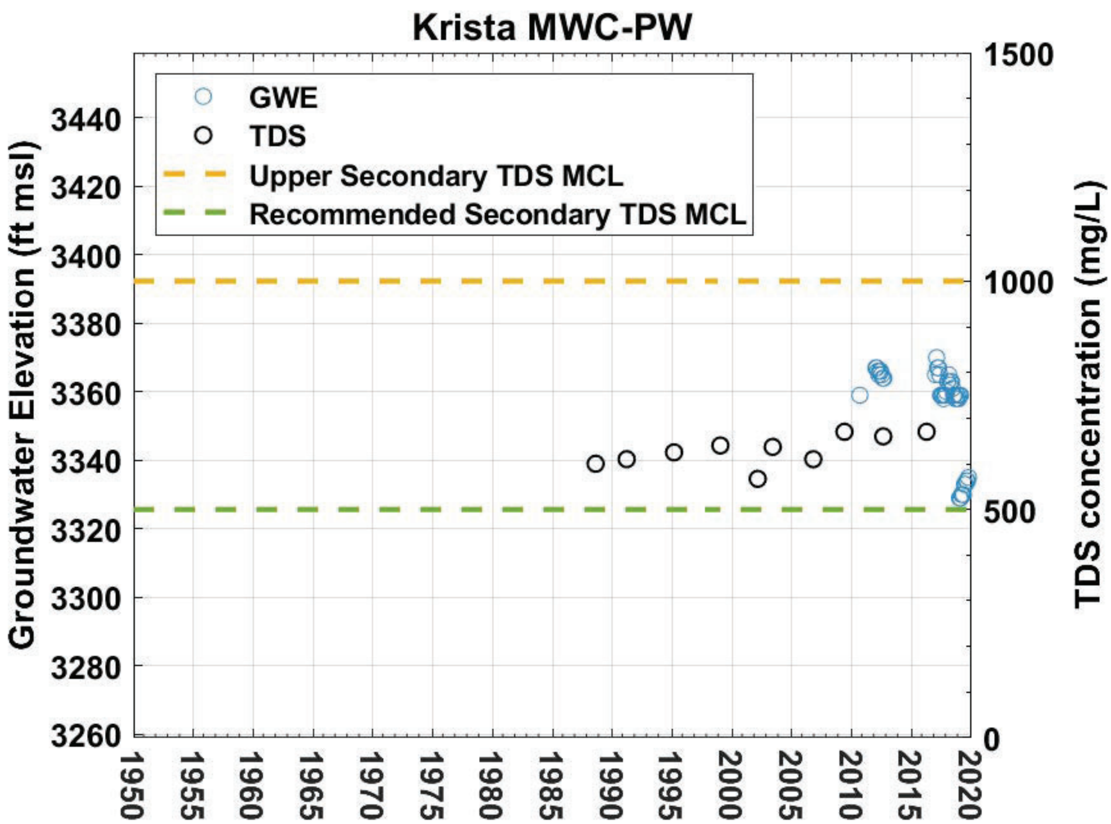

TRC-PW60
GWE
Nitrate as N
Nitrate as N MCL
WQ Trendline Slope: 0.06 mg/L/yr
Groundwater Elevation (ft msl)
Nitrate as N concentration (mg/L)
3460
3440
3420
3400
3380
3360
3340
3320
3300
3280
15
10
5
0
1950
1955
1960
1965
1970
1975
1980
1985
1990
1995
2000
2005
2010
2015
2020


TRC-PW80
GWE
Nitrate as N
Nitrate as N MCL
WQ Trendline Slope: 0.09 mg/L/yr
Groundwater Elevation (ft msl)
Nitrate as N concentration (mg/L)
3580
3560
3540
3520
3500
3480
3460
3440
3420
3400
15
10
5
0
1950
1955
1960
1965
1970
1975
1980
1985
1990
1995
2000
2005
2010
2015
2020

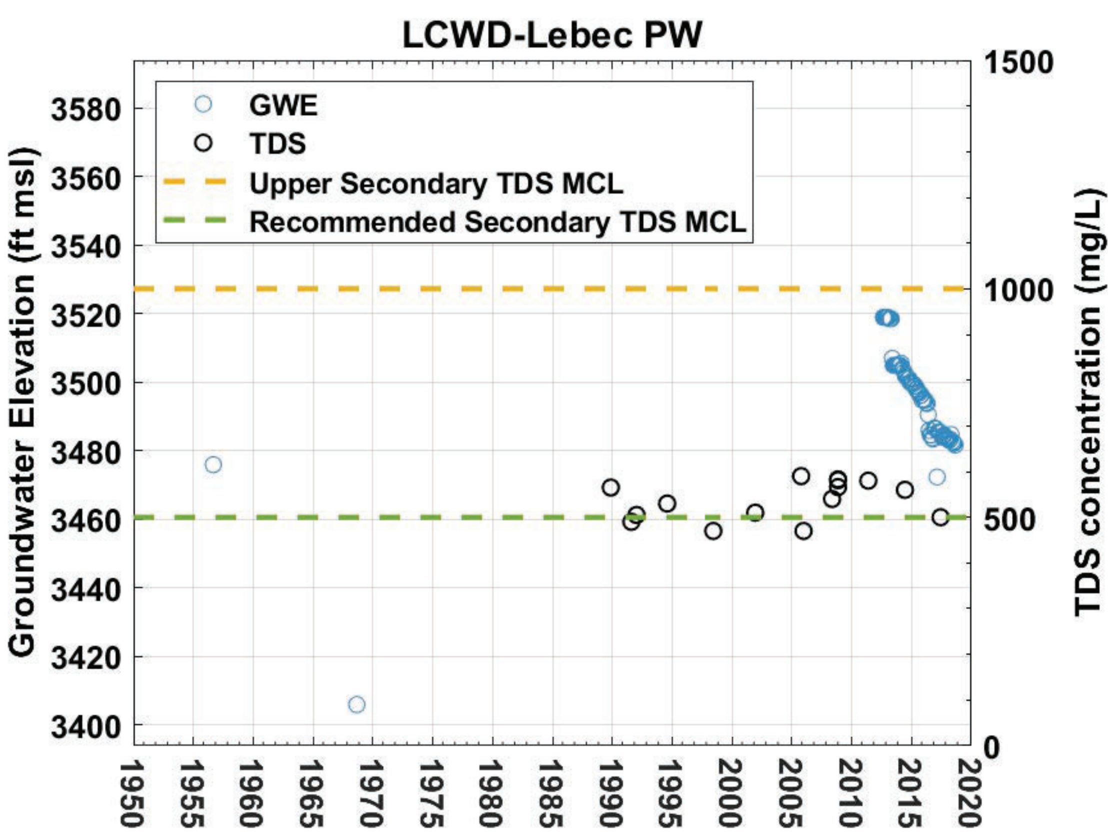

TRC-PW81
Nitrate as N
WQ Trendline Slope: -0.06 mg/L/yr
Groundwater Elevation (ft msl)
Nitrate as N concentration (mg/L)
100
50
0
-50
-100
15
10
5
0
1950
1955
1960
1965
1970
1975
1980
1985
1990
1995
2000
2005
2010
2015
2020


TRC-PW88
GWE
Nitrate as N
Nitrate as N MCL
Groundwater Elevation (ft msl)
Nitrate as N concentration (mg/L)
3560
3540
3520
3500
3480
3460
3440
3420
3400
3380
15
10
5
0
1950
1955
1960
1965
1970
1975
1980
1985
1990
1995
2000
2005
2010
2015
2020

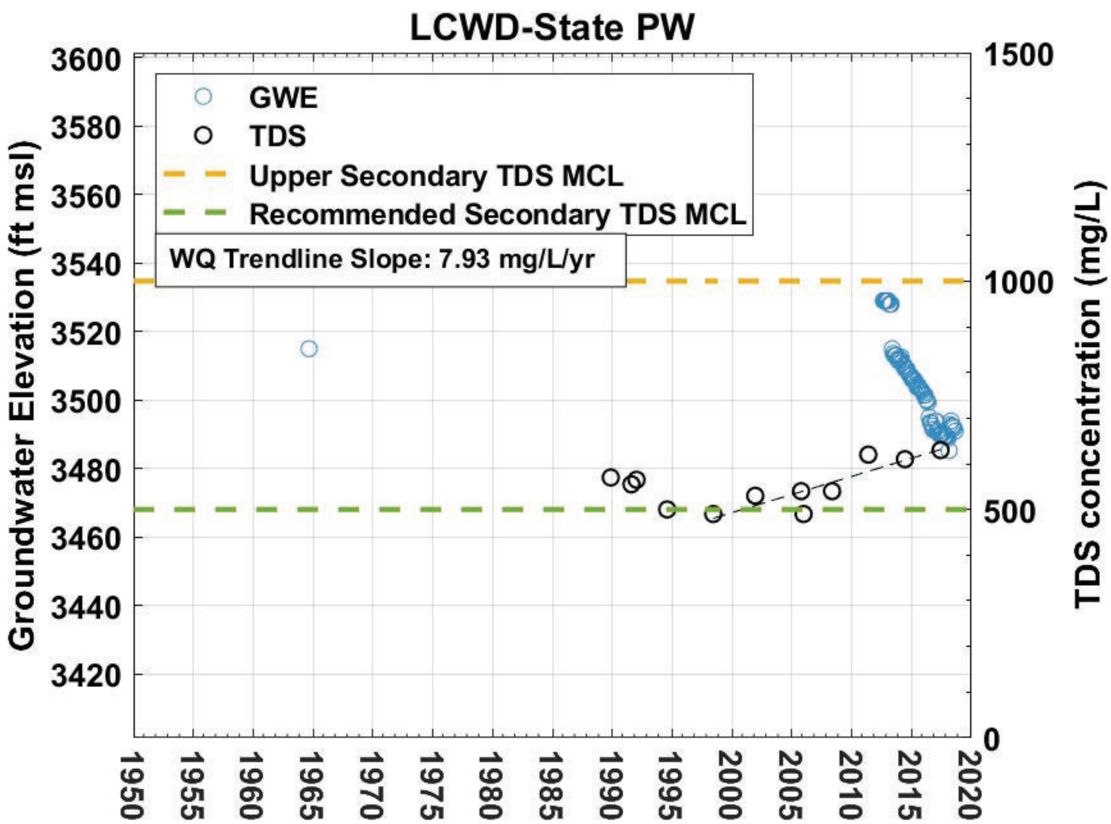

W0601510301_1510301-001
Nitrate as N
Nitrate as N MCL
Groundwater Elevation (ft msl)
Nitrate as N concentration (mg/L)
100
50
0
-50
-100
15
10
5
0
1950
1955
1960
1965
1970
1975
1980
1985
1990
1995
2000
2005
2010
2015
2020



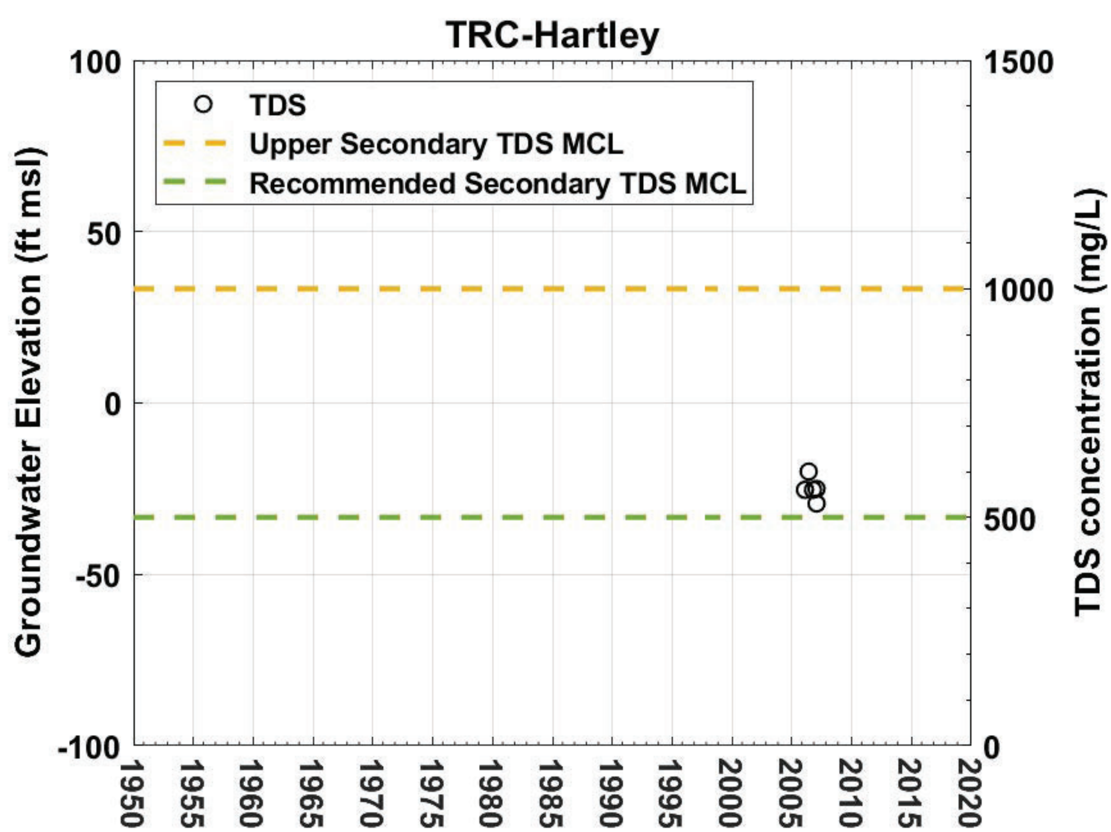
Krista MWC-PW
GWE
TDS
Upper Secondary TDS MCL
Recommended Secondary TDS MCL
Groundwater Elevation (ft msl)
TDS concentration (mg/L)
3440
3420
3400
3380
3360
3340
3320
3300
3280
3260
1500
1000
500
0
1950
1955
1960
1965
1970
1975
1980
1985
1990
1995
2000
2005
2010
2015
2020



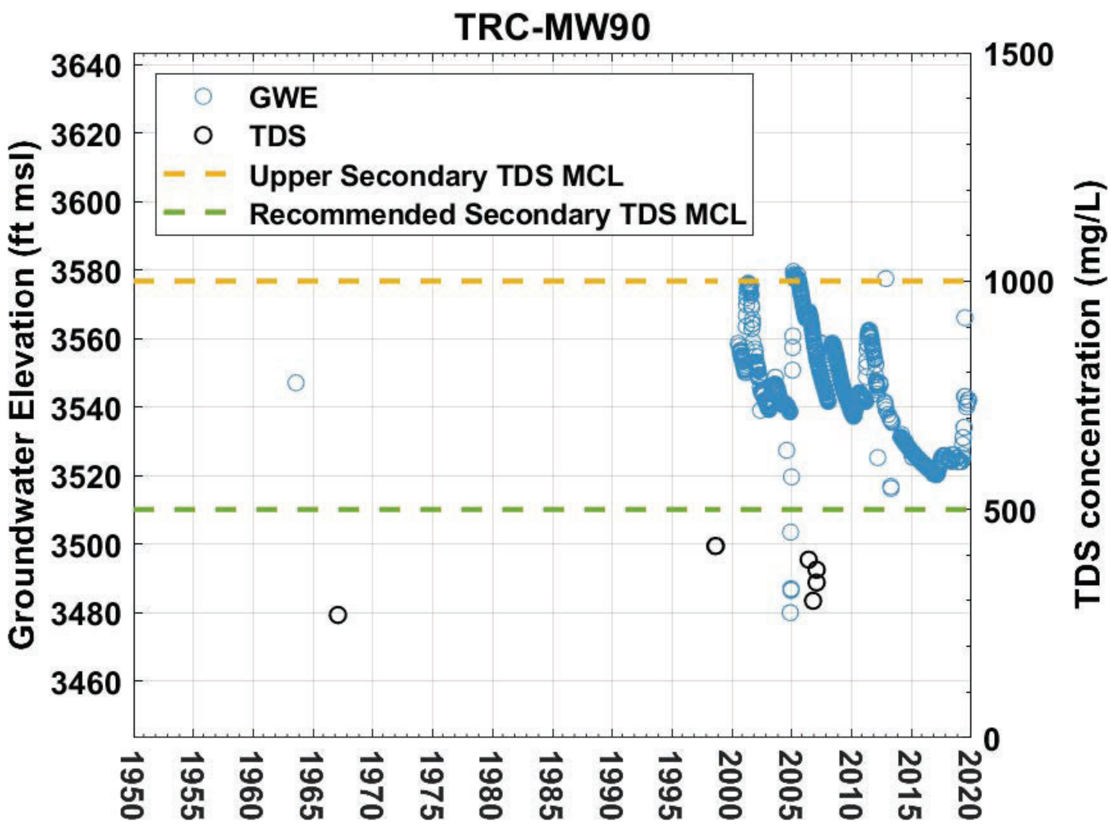
LCWD-Lebec PW
GWE
TDS
Upper Secondary TDS MCL
Recommended Secondary TDS MCL
Groundwater Elevation (ft msl)
TDS concentration (mg/L)
3580
3560
3540
3520
3500
3480
3460
3440
3420
3400
1500
1000
500
0
1950
1955
1960
1965
1970
1975
1980
1985
1990
1995
2000
2005
2010
2015
2020



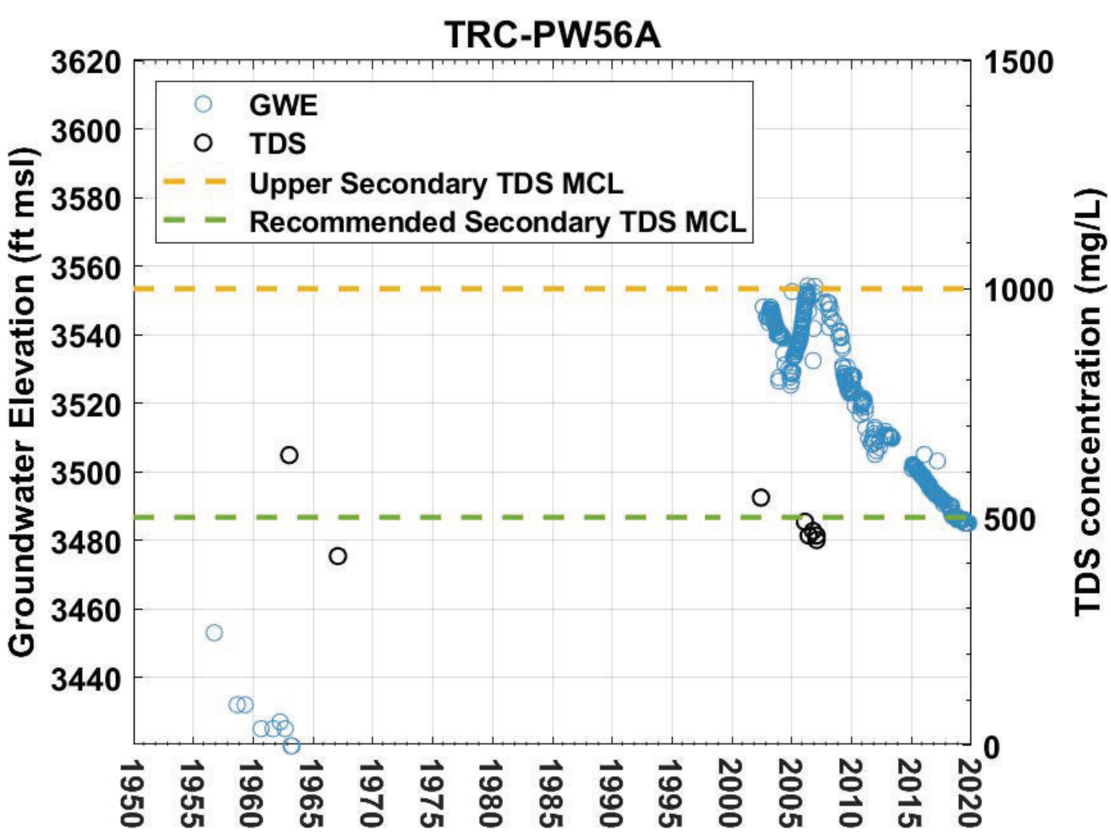
LCWD-State PW
GWE
TDS
Upper Secondary TDS MCL
Recommended Secondary TDS MCL
WQ Trendline Slope: 7.93 mg/L/yr
Groundwater Elevation (ft msl)
TDS concentration (mg/L)
3600
3580
3560
3540
3520
3500
3480
3460
3440
3420
1500
1000
500
0
1950
1955
1960
1965
1970
1975
1980
1985
1990
1995
2000
2005
2010
2015
2020



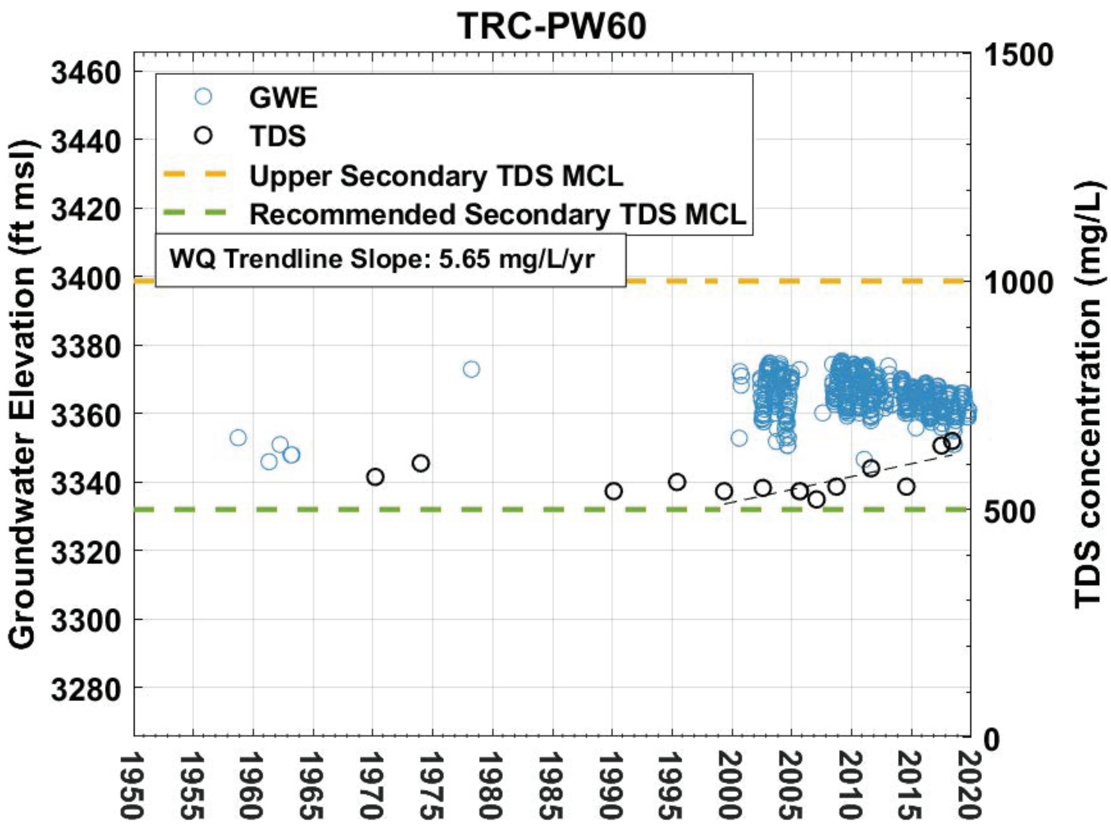
TRC-Hartley
TDS
Upper Secondary TDS MCL
Recommended Secondary TDS MCL
Groundwater Elevation (ft msl)
TDS concentration (mg/L)
100
50
0
-50
-100
1500
1000
500
0
1950
1955
1960
1965
1970
1975
1980
1985
1990
1995
2000
2005
2010
2015
2020

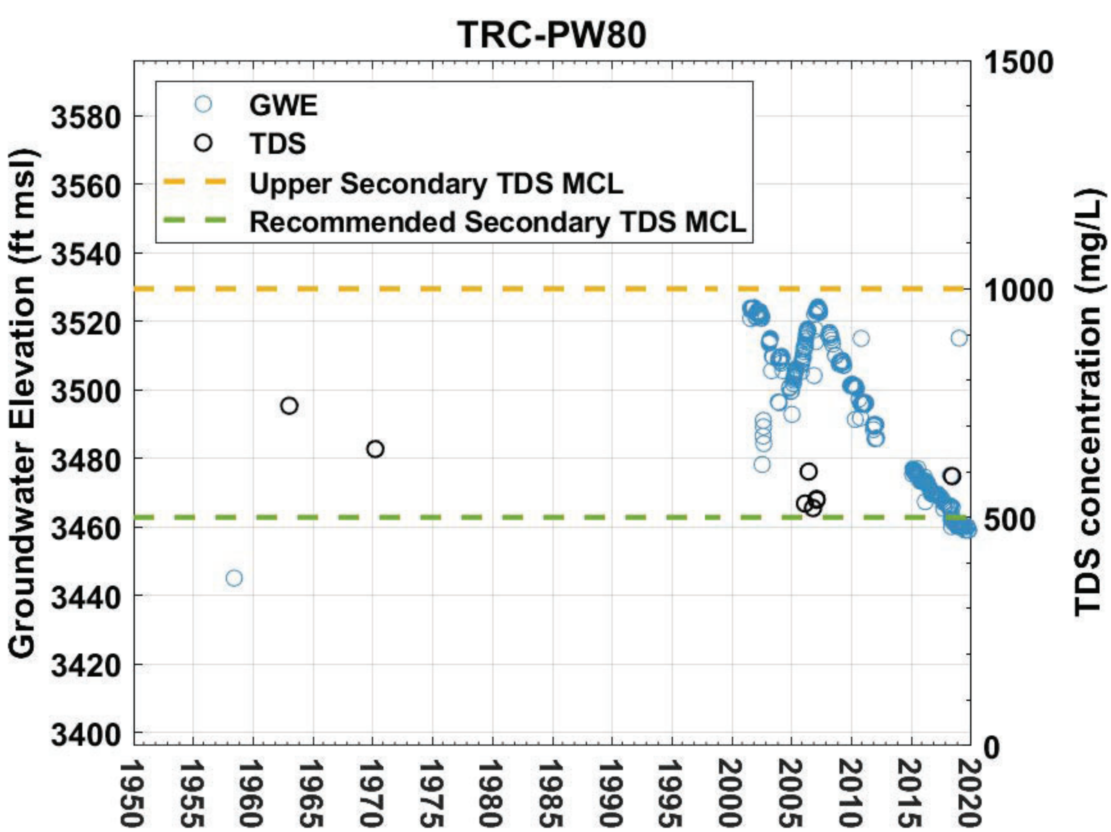


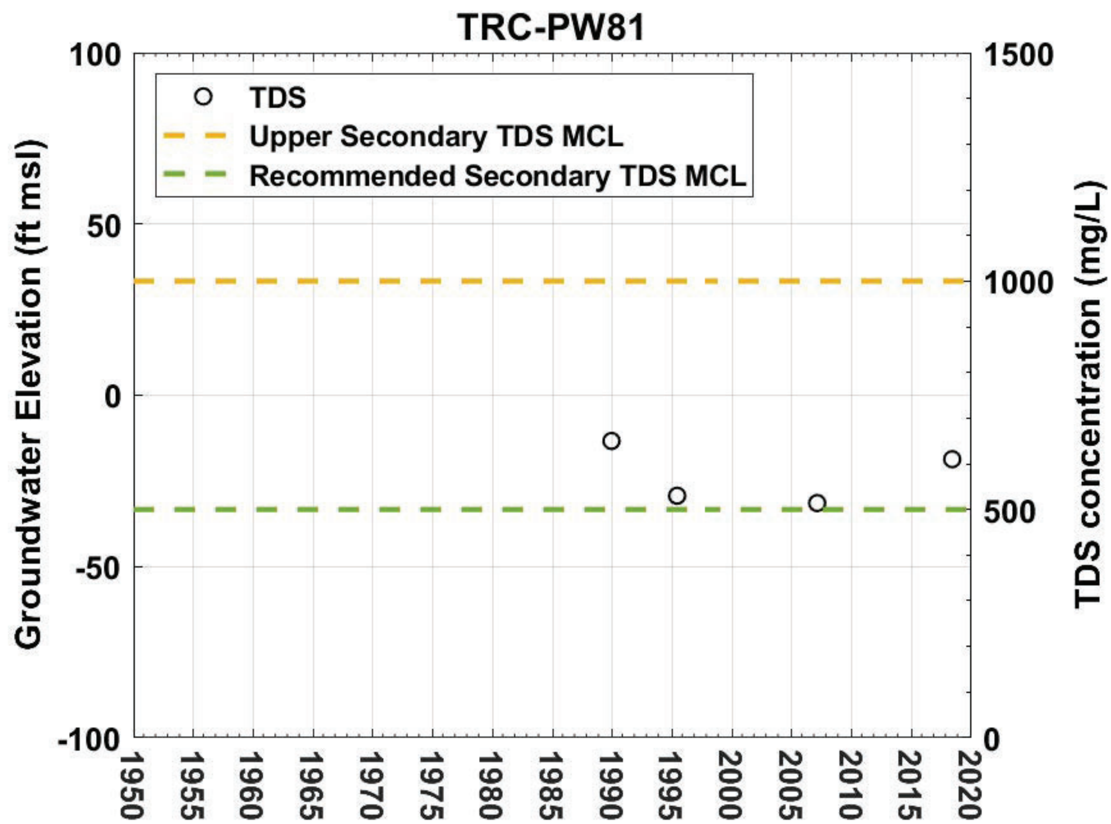
TRC-MW90
GWE
TDS
Upper Secondary TDS MCL
Recommended Secondary TDS MCL
Groundwater Elevation (ft msl)
TDS concentration (mg/L)
3640
3620
3600
3580
3560
3540
3520
3500
3480
3460
1500
1000
500
0
1950
1955
1960
1965
1970
1975
1980
1985
1990
1995
2000
2005
2010
2015
2020

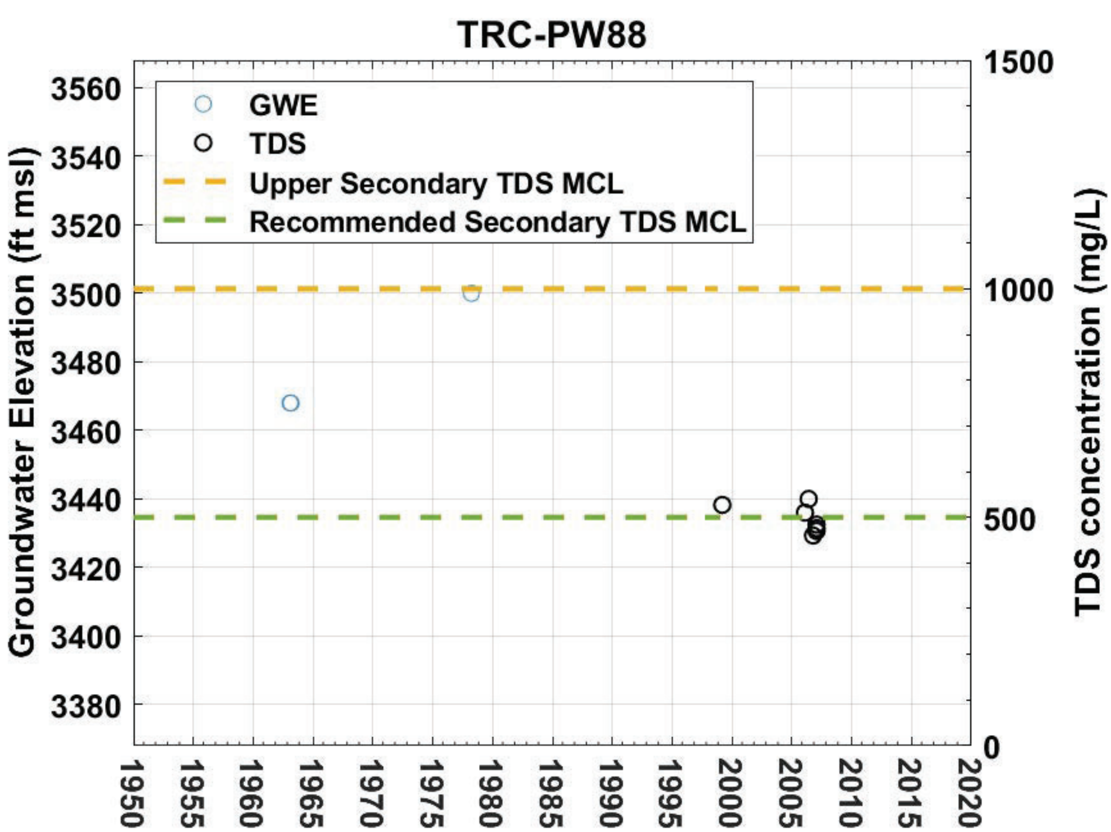


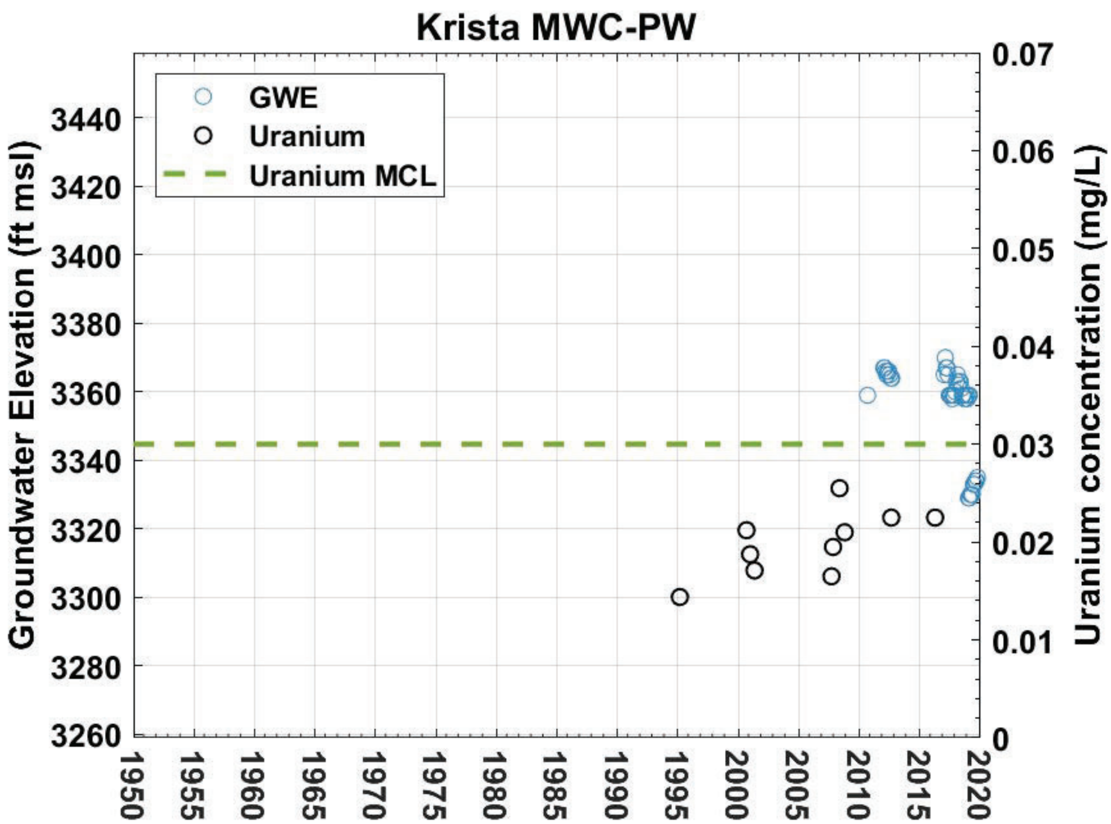
TRC-PW56A
GWE
TDS
Upper Secondary TDS MCL
Recommended Secondary TDS MCL
Groundwater Elevation (ft msl)
TDS concentration (mg/L)
3620
3600
3580
3560
3540
3520
3500
3480
3460
3440
1500
1000
500
0
1950
1955
1960
1965
1970
1975
1980
1985
1990
1995
2000
2005
2010
2015
2020


TRC-PW60
GWE
TDS
Upper Secondary TDS MCL
Recommended Secondary TDS MCL
WQ Trendline Slope: 5.65 mg/L/yr
Groundwater Elevation (ft msl)
TDS concentration (mg/L)
3460
3440
3420
3400
3380
3360
3340
3320
3300
3280
1500
1000
500
0
1950
1955
1960
1965
1970
1975
1980
1985
1990
1995
2000
2005
2010
2015
2020

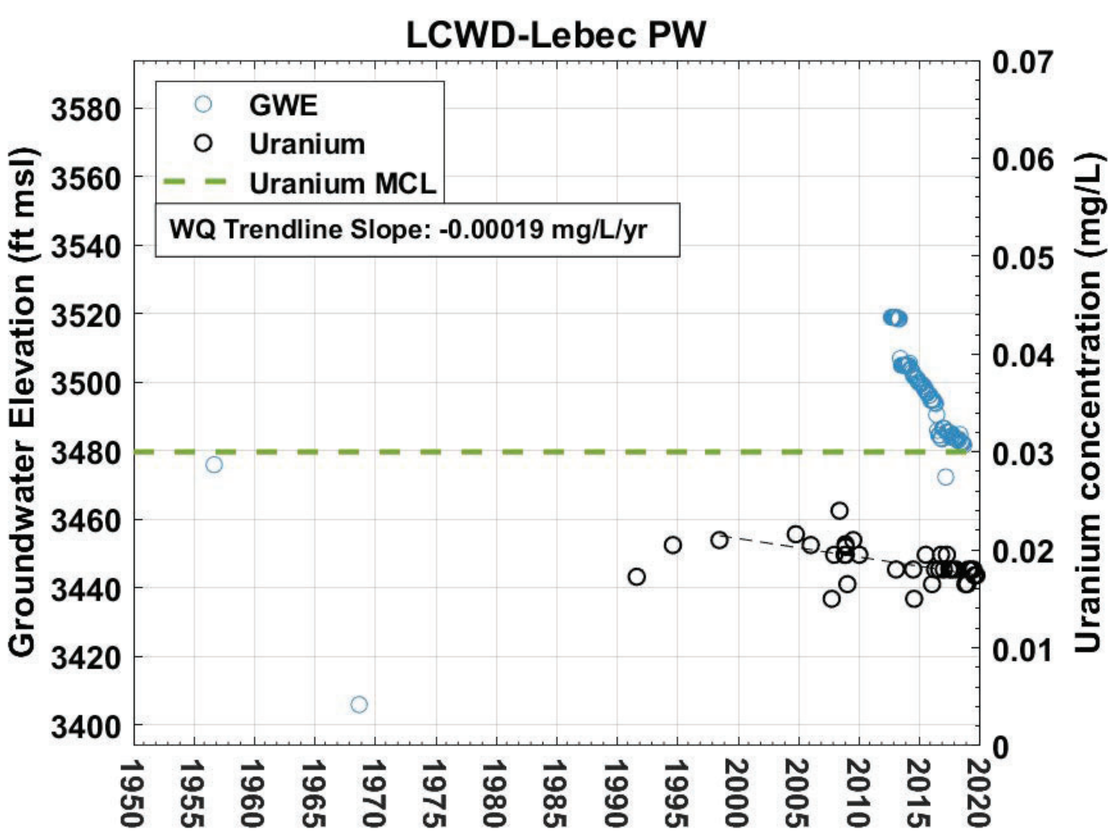

TRC-PW80
GWE
TDS
Upper Secondary TDS MCL
Recommended Secondary TDS MCL
Groundwater Elevation (ft msl)
TDS concentration (mg/L)
3580
3560
3540
3520
3500
3480
3460
3440
3420
3400
1500
1000
500
0
1950
1955
1960
1965
1970
1975
1980
1985
1990
1995
2000
2005
2010
2015
2020


TRC-PW81
TDS
Upper Secondary TDS MCL
Recommended Secondary TDS MCL
Groundwater Elevation (ft msl)
TDS concentration (mg/L)
100
50
0
-50
-100
1500
1000
500
0
1950
1955
1960
1965
1970
1975
1980
1985
1990
1995
2000
2005
2010
2015
2020

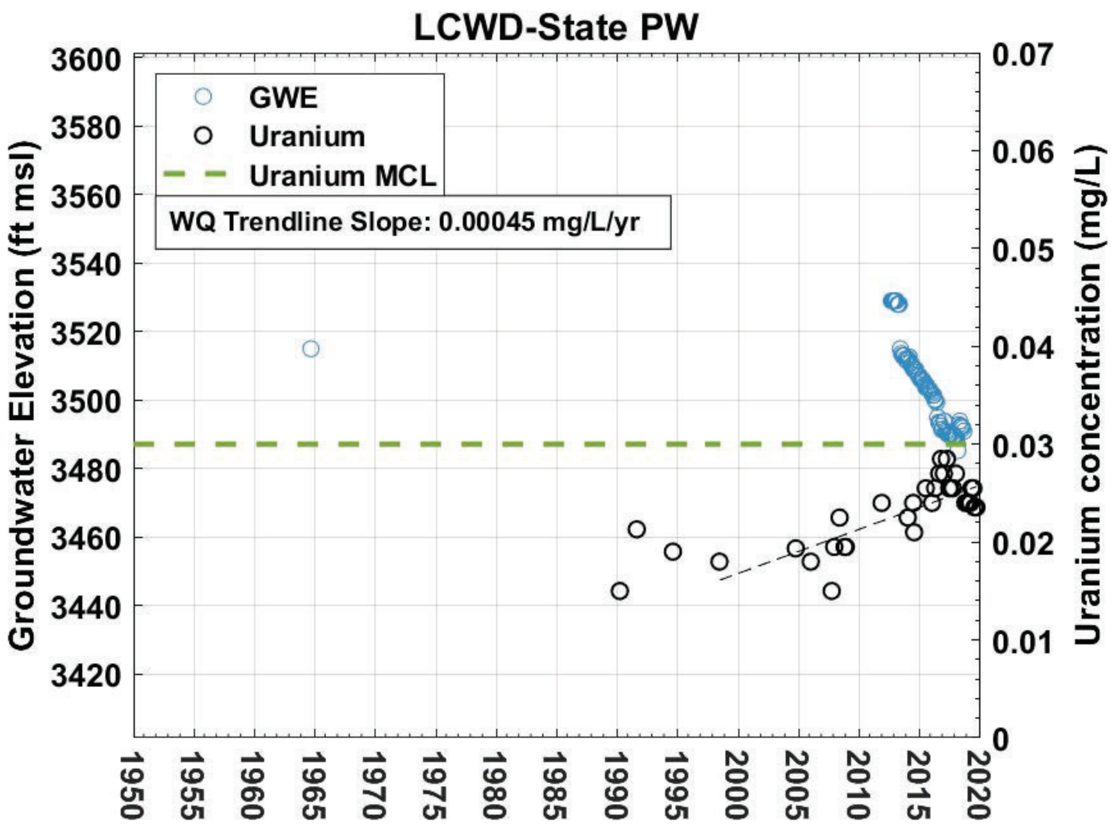

TRC-PW88
GWE
TDS
Upper Secondary TDS MCL
Recommended Secondary TDS MCL
Groundwater Elevation (ft msl)
TDS concentration (mg/L)
3560
3540
3520
3500
3480
3460
3440
3420
3400
3380
1500
1000
500
0
1950
1955
1960
1965
1970
1975
1980
1985
1990
1995
2000
2005
2010
2015
2020

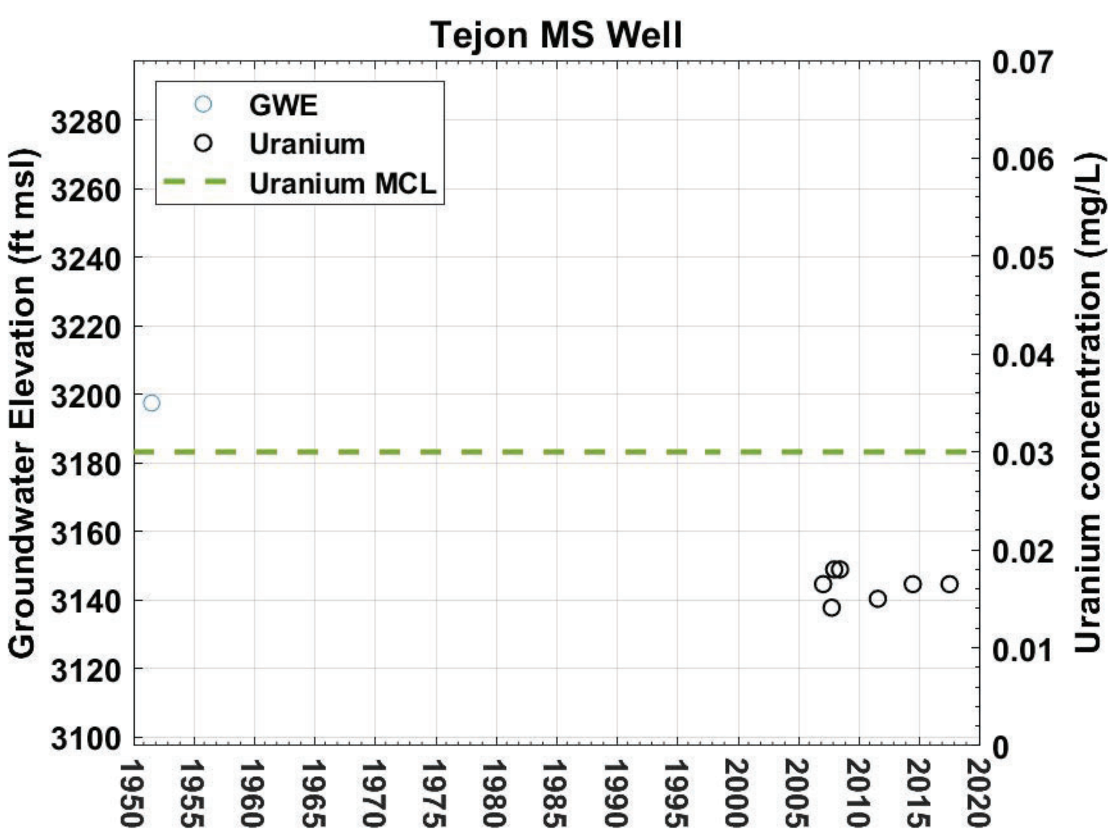


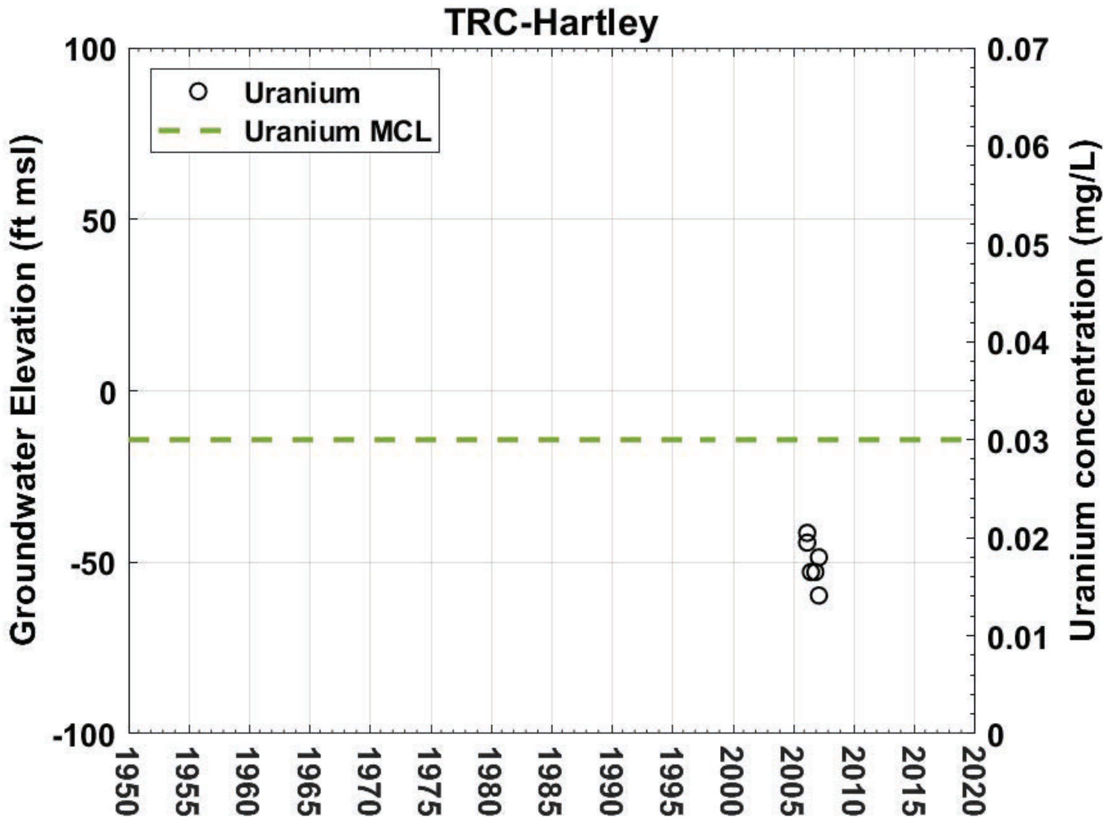
Krista MWC-PW
GWE
Uranium
Uranium MCL
Groundwater Elevation (ft msl)
Uranium concentration (mg/L)
3260
3280
3300
3320
3340
3360
3380
3400
3420
3440
0
0.01
0.02
0.03
0.04
0.05
0.06
0.07
1950
1955
1960
1965
1970
1975
1980
1985
1990
1995
2000
2005
2010
2015
2020



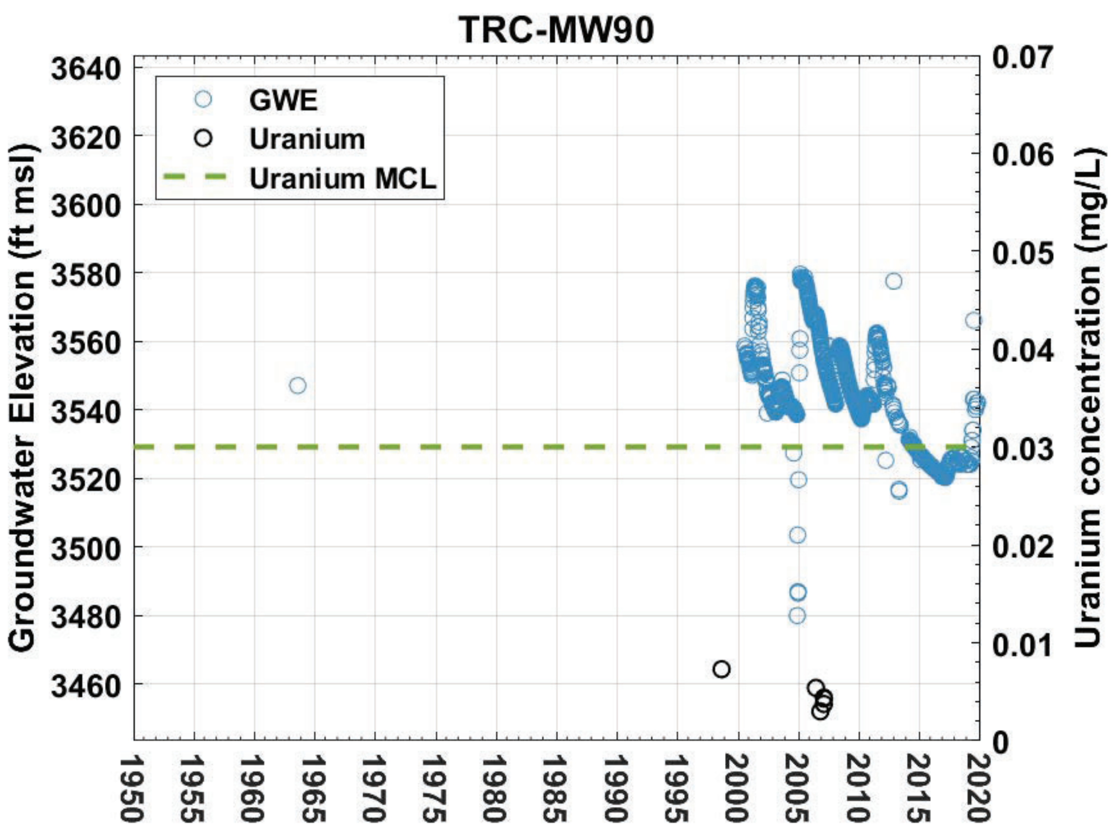
LCWD-Lebec PW
GWE
Uranium
Uranium MCL
WQ Trendline Slope: -0.00019 mg/L/yr
Groundwater Elevation (ft msl)
Uranium concentration (mg/L)
3400
3420
3440
3460
3480
3500
3520
3540
3560
3580
0
0.01
0.02
0.03
0.04
0.05
0.06
0.07
1950
1955
1960
1965
1970
1975
1980
1985
1990
1995
2000
2005
2010
2015
2020


LCWD-State PW
GWE
Uranium
Uranium MCL
WQ Trendline Slope: 0.00045 mg/L/yr
Groundwater Elevation (ft msl)
Uranium concentration (mg/L)
3600
3580
3560
3540
3520
3500
3480
3460
3440
3420
0.07
0.06
0.05
0.04
0.03
0.02
0.01
0
1950
1955
1960
1965
1970
1975
1980
1985
1990
1995
2000
2005
2010
2015
2020

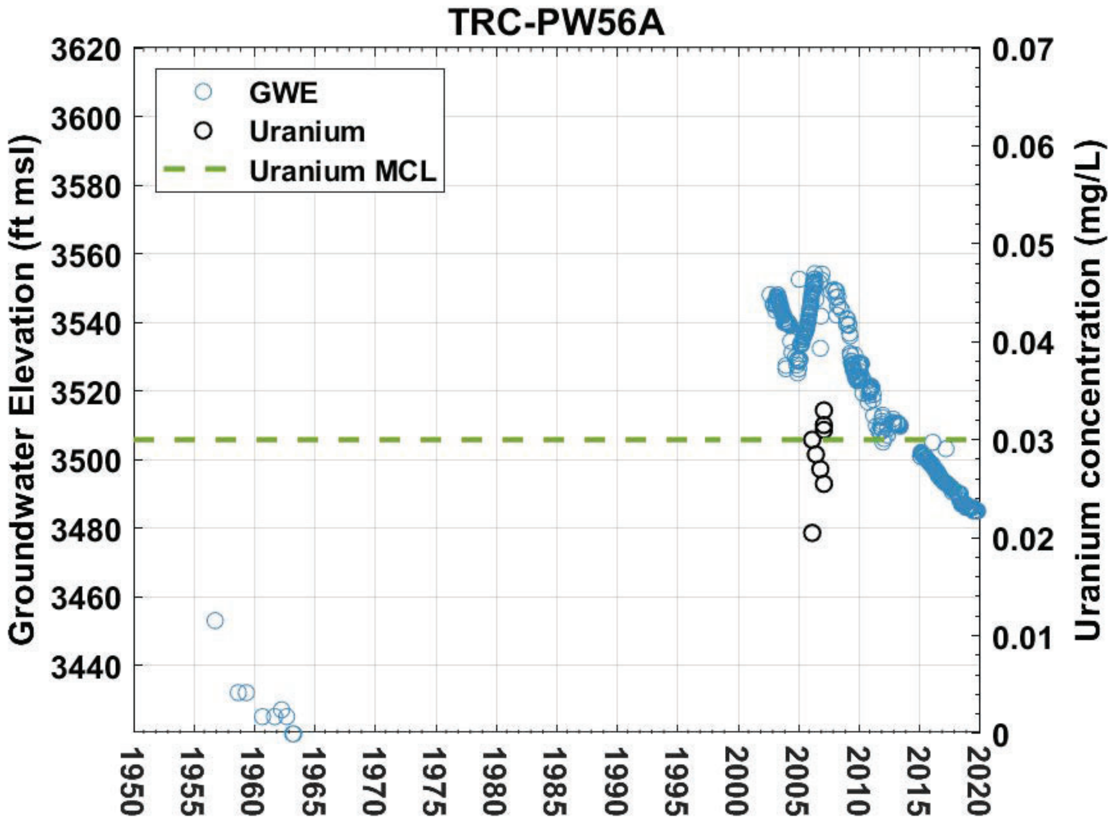

Tejon MS Well
GWE
Uranium
Uranium MCL
Groundwater Elevation (ft msl)
Uranium concentration (mg/L)
3280
3260
3240
3220
3200
3180
3160
3140
3120
3100
0.07
0.06
0.05
0.04
0.03
0.02
0.01
0
1950
1955
1960
1965
1970
1975
1980
1985
1990
1995
2000
2005
2010
2015
2020

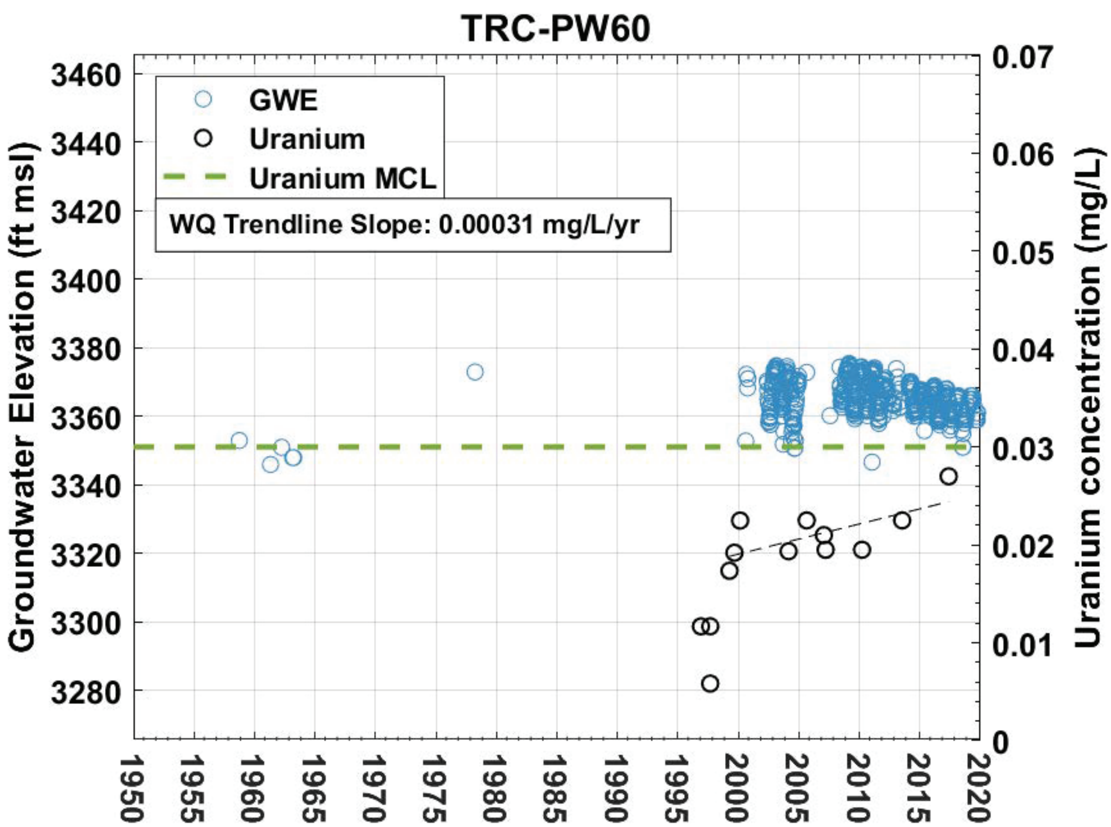


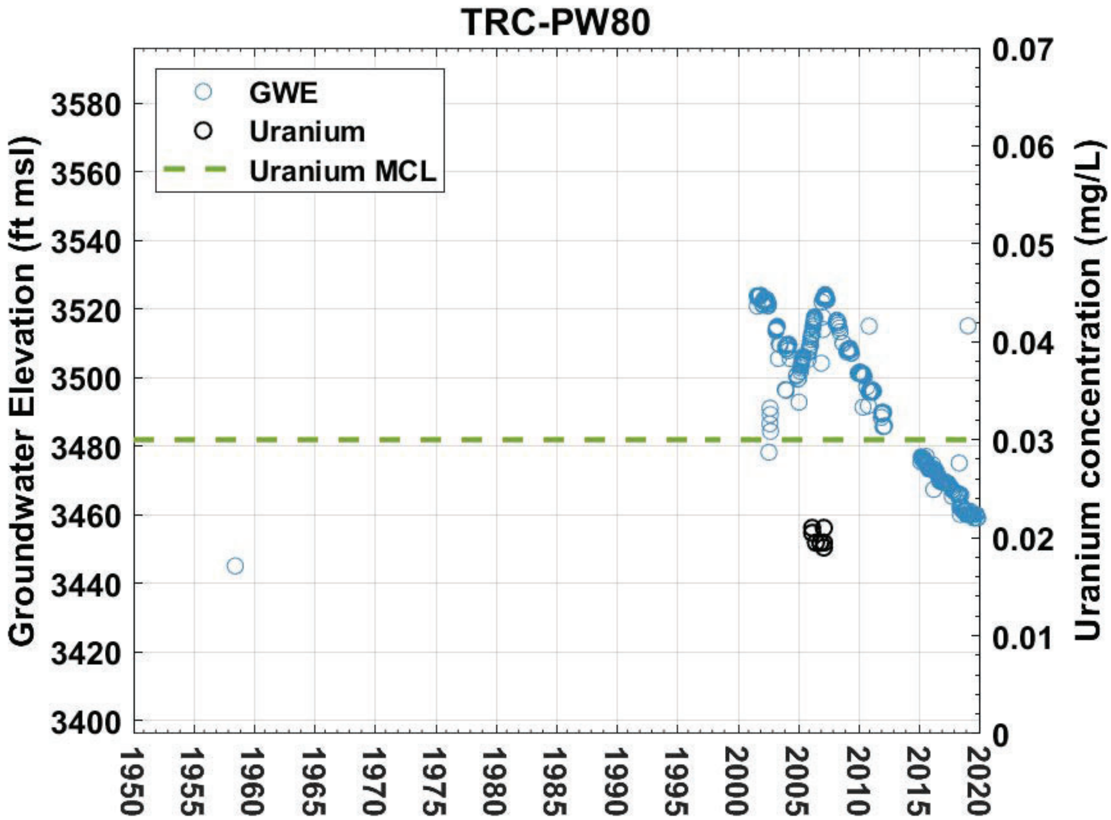
TRC-Hartley
Uranium
Uranium MCL
Groundwater Elevation (ft msl)
Uranium concentration (mg/L)
100
50
0
-50
-100
0.07
0.06
0.05
0.04
0.03
0.02
0.01
0
1950
1955
1960
1965
1970
1975
1980
1985
1990
1995
2000
2005
2010
2015
2020

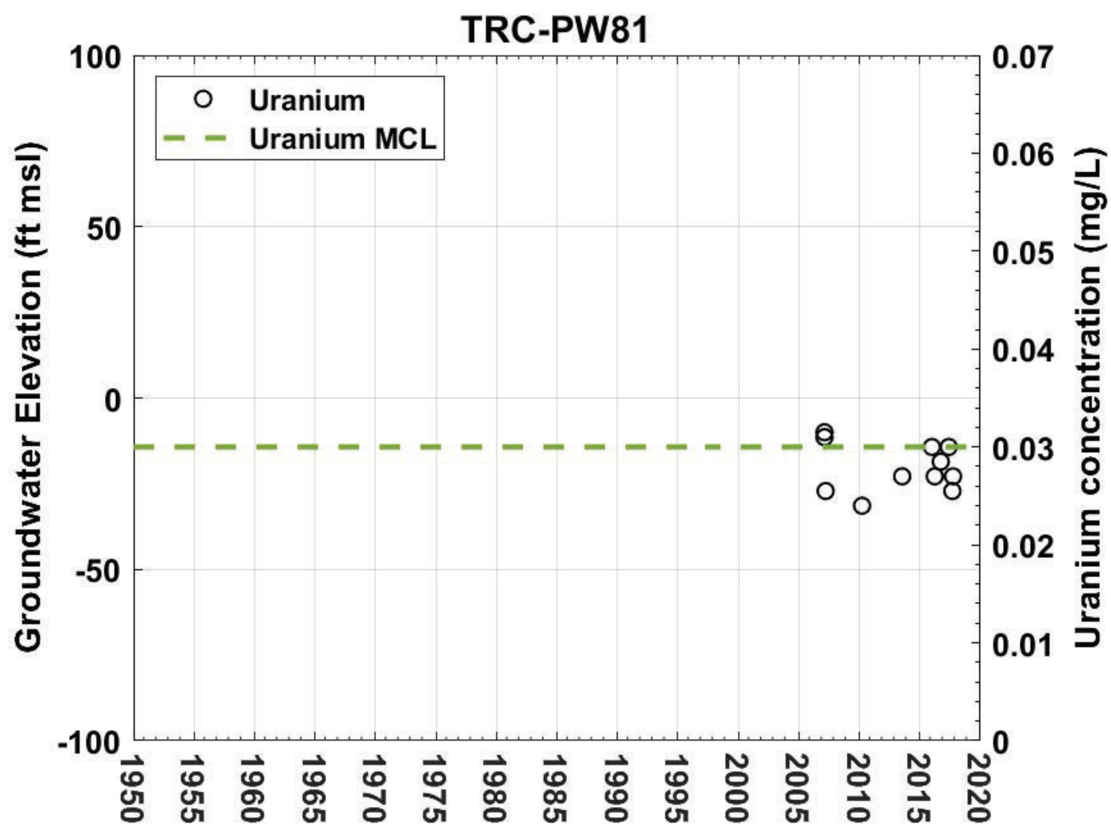


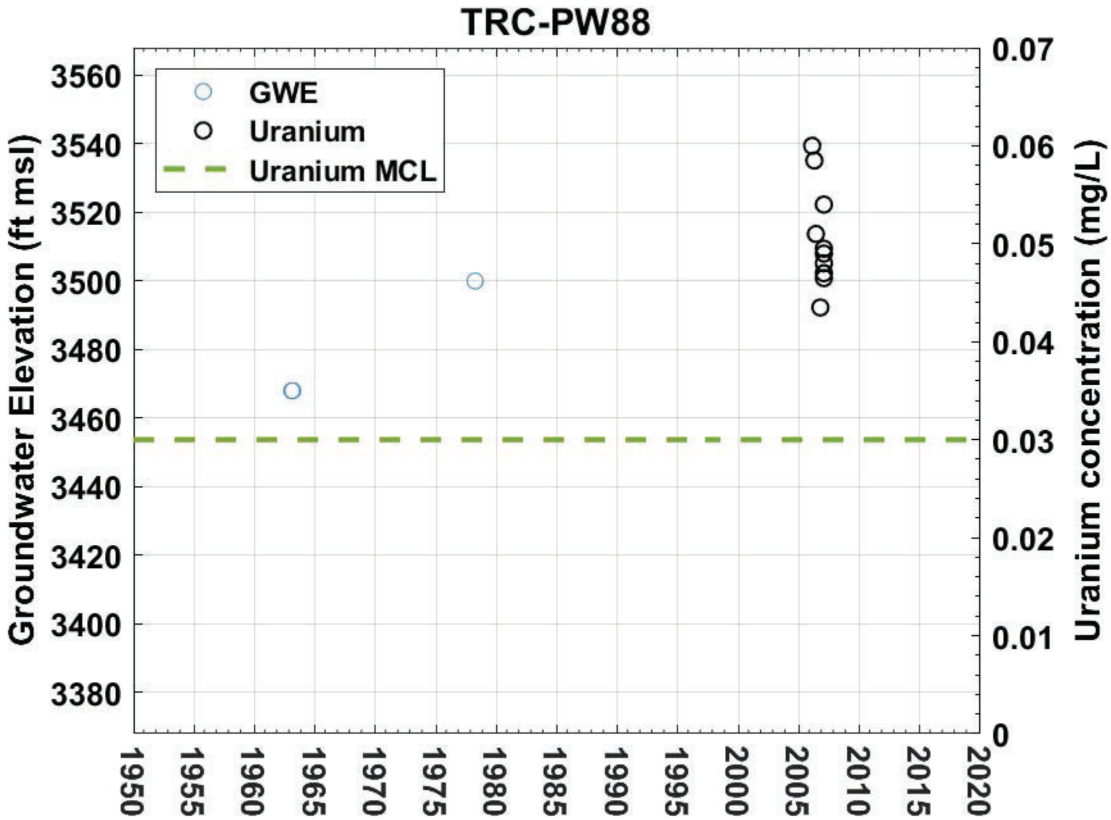
TRC-MW90
GWE
Uranium
Uranium MCL
Groundwater Elevation (ft msl)
Uranium concentration (mg/L)
3640
3620
3600
3580
3560
3540
3520
3500
3480
3460
0.07
0.06
0.05
0.04
0.03
0.02
0.01
0
1950
1955
1960
1965
1970
1975
1980
1985
1990
1995
2000
2005
2010
2015
2020


TRC-PW56A
GWE
Uranium
Uranium MCL
Groundwater Elevation (ft msl)
Uranium concentration (mg/L)
3620
3600
3580
3560
3540
3520
3500
3480
3460
3440
0.07
0.06
0.05
0.04
0.03
0.02
0.01
0
1950
1955
1960
1965
1970
1975
1980
1985
1990
1995
2000
2005
2010
2015
2020

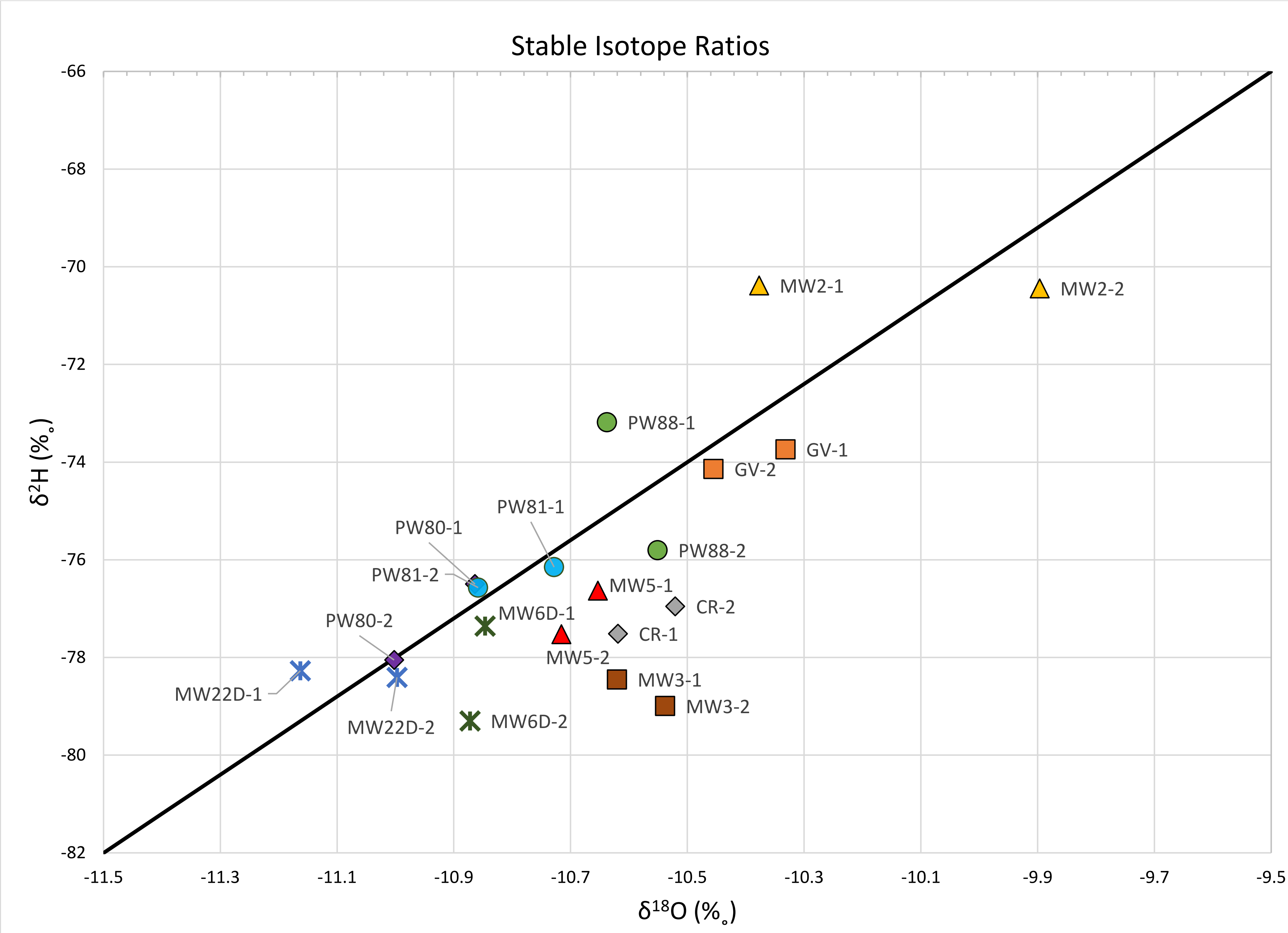

TRC-PW60
GWE
Uranium
Uranium MCL
WQ Trendline Slope: 0.00031 mg/L/yr
Groundwater Elevation (ft msl)
Uranium concentration (mg/L)
3460
3440
3420
3400
3380
3360
3340
3320
3300
3280
0.07
0.06
0.05
0.04
0.03
0.02
0.01
0
1950
1955
1960
1965
1970
1975
1980
1985
1990
1995
2000
2005
2010
2015
2020

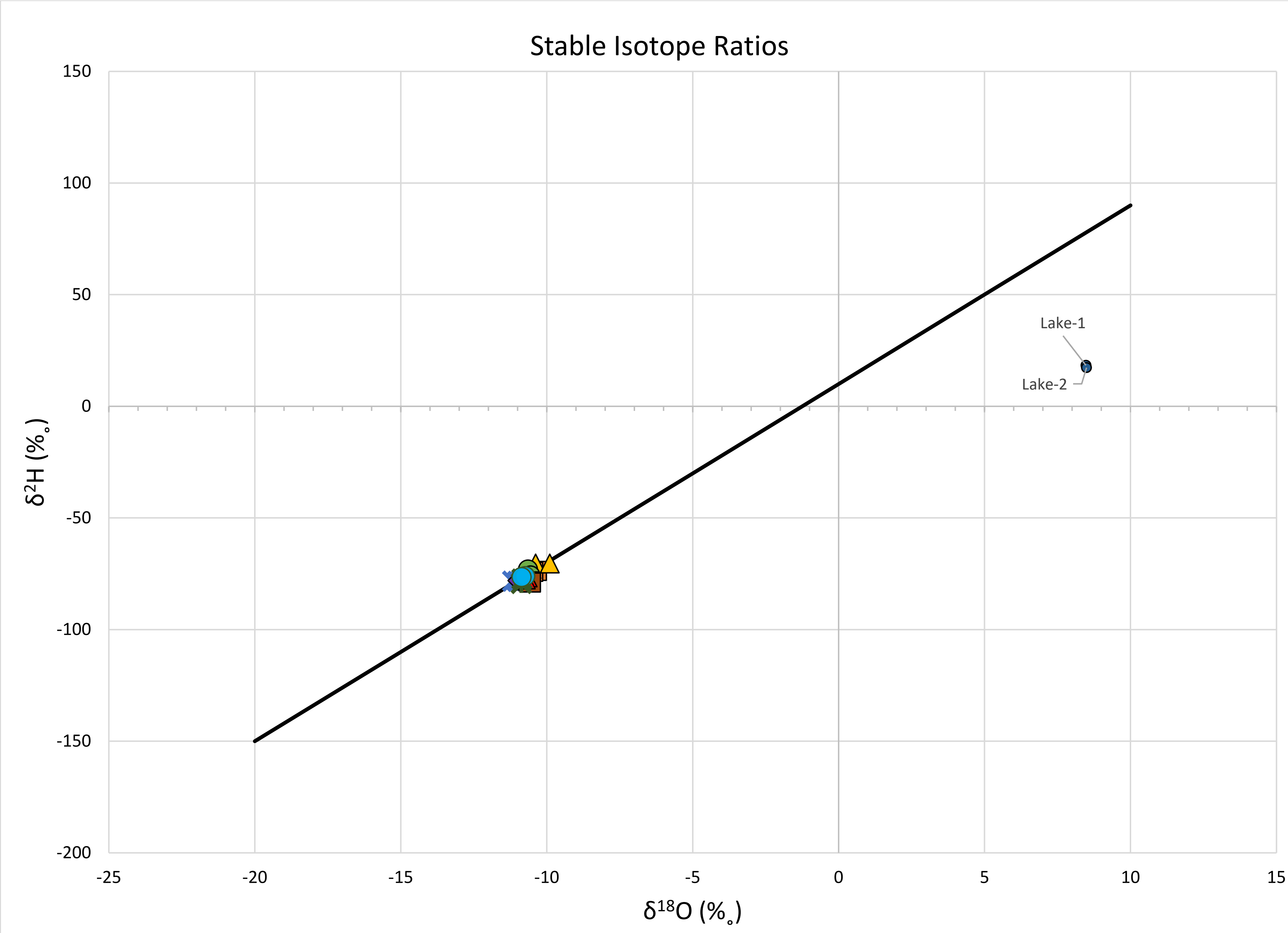

TRC-PW80
GWE
Uranium
Uranium MCL
Groundwater Elevation (ft msl)
Uranium concentration (mg/L)
3400
3420
3440
3460
3480
3500
3520
3540
3560
3580
0
0.01
0.02
0.03
0.04
0.05
0.06
0.07
1950
1955
1960
1965
1970
1975
1980
1985
1990
1995
2000
2005
2010
2015
2020


TRC-PW81
Uranium
Uranium MCL
Groundwater Elevation (ft msl)
Uranium concentration (mg/L)
-100
-50
0
50
100
0
0.01
0.02
0.03
0.04
0.05
0.06
0.07
1950
1955
1960
1965
1970
1975
1980
1985
1990
1995
2000
2005
2010
2015
2020

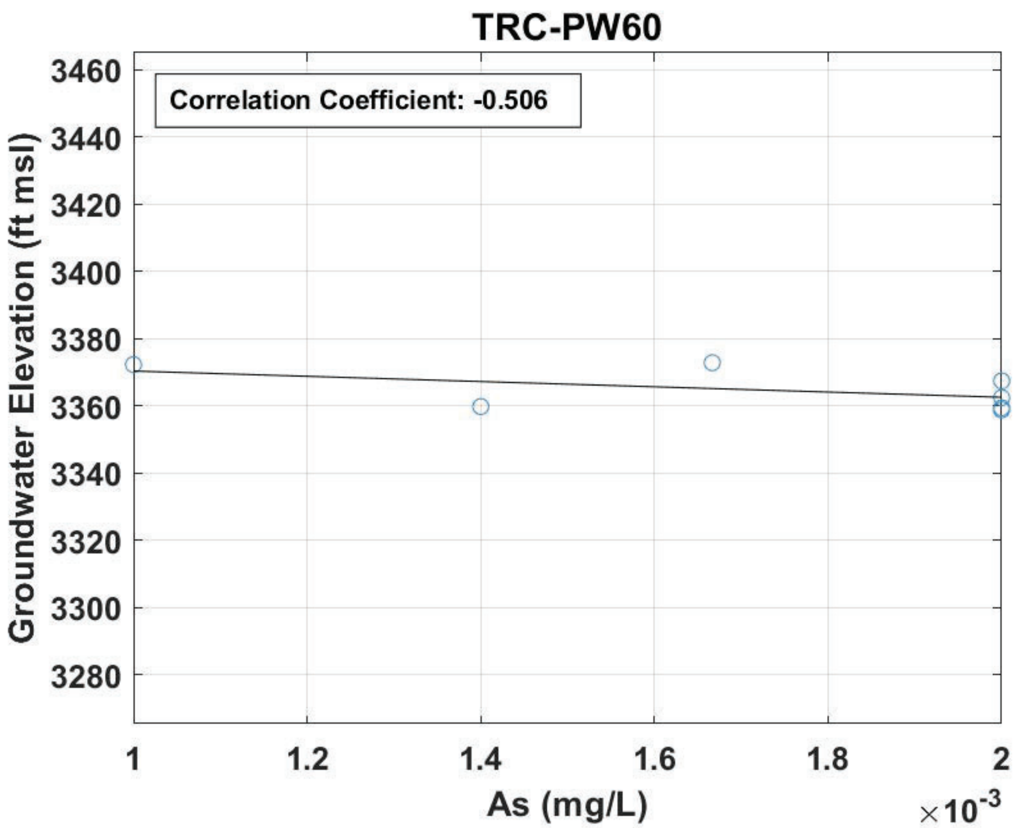


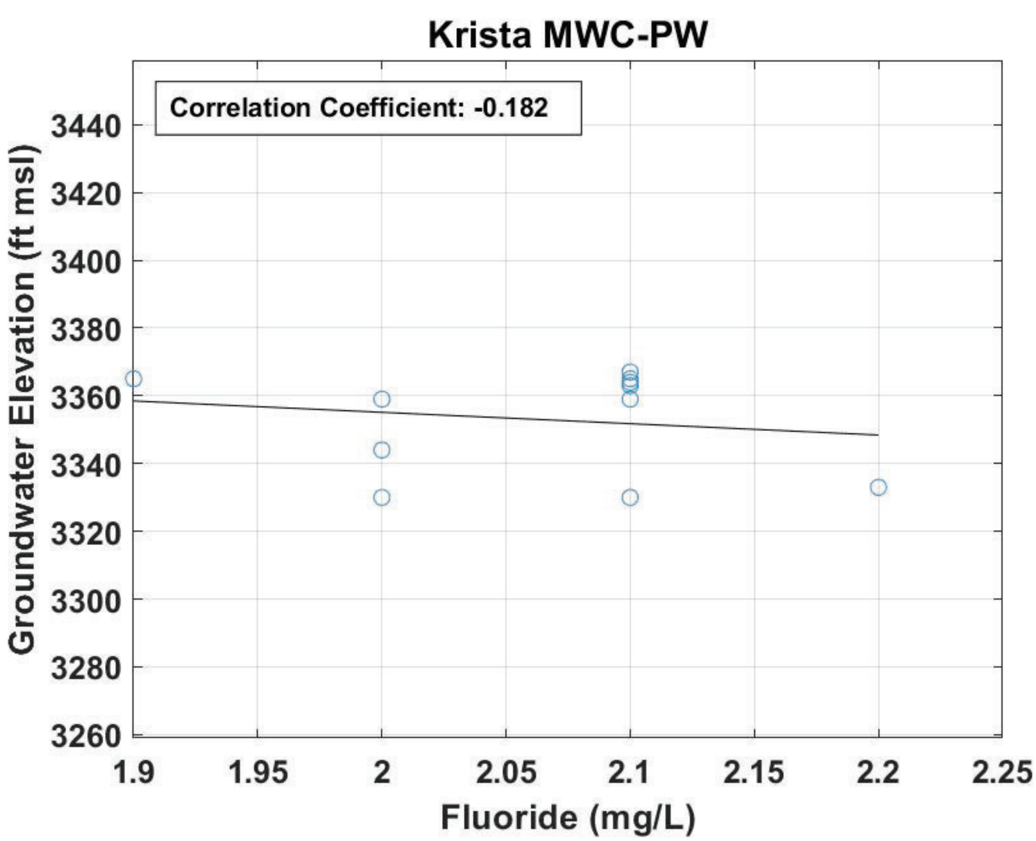
TRC-PW88
GWE
Uranium
Uranium MCL
Groundwater Elevation (ft msl)
Uranium concentration (mg/L)
3560
3540
3520
3500
3480
3460
3440
3420
3400
3380
0.07
0.06
0.05
0.04
0.03
0.02
0.01
0
1950
1955
1960
1965
1970
1975
1980
1985
1990
1995
2000
2005
2010
2015
2020

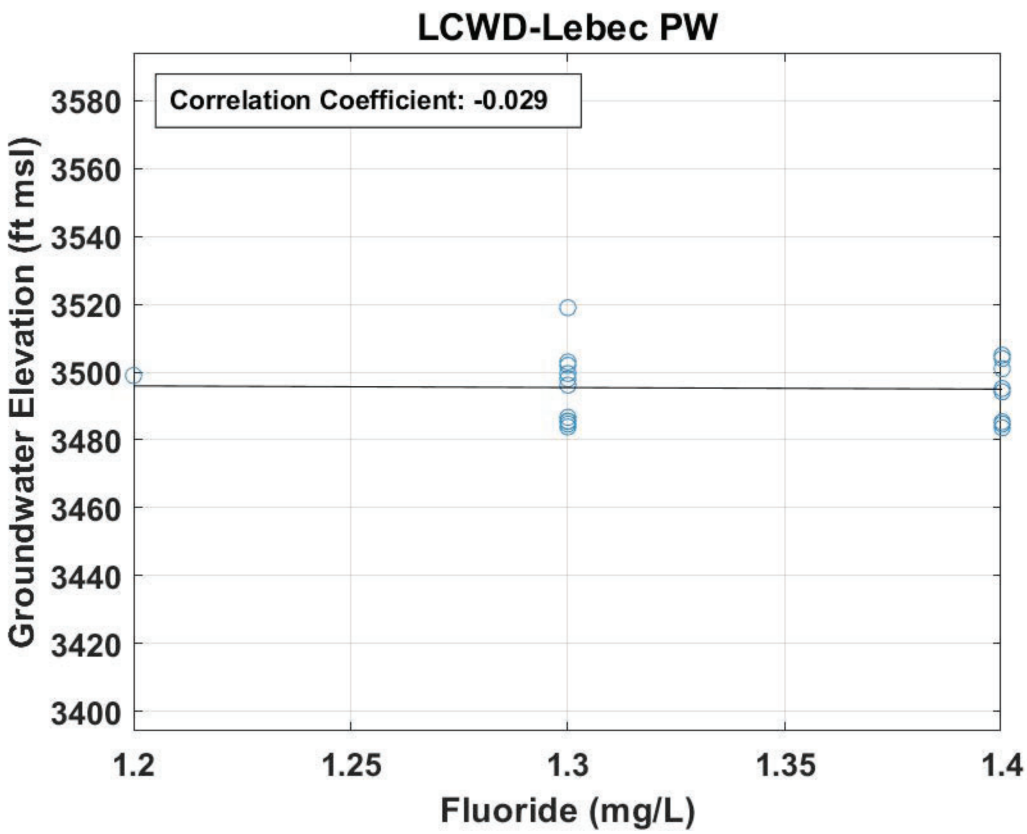

Stable Isotope Ratios
δ²H (‰)
δ¹⁸O (‰)
-66
-68
-70
-72
-74
-76
-78
-80
-82
-11.5
-11.3
-11.1
-10.9
-10.7
-10.5
-10.3
-10.1
-9.9
-9.7
-9.5
MW2-1
MW2-2
PW88-1
GV-1
GV-2
PW81-1
PW80-1
PW88-2
PW81-2
MW5-1
CR-2
MW6D-1
PW80-2
CR-1
MW5-2
MW3-1
MW22D-1
MW3-2
MW22D-2
MW6D-2

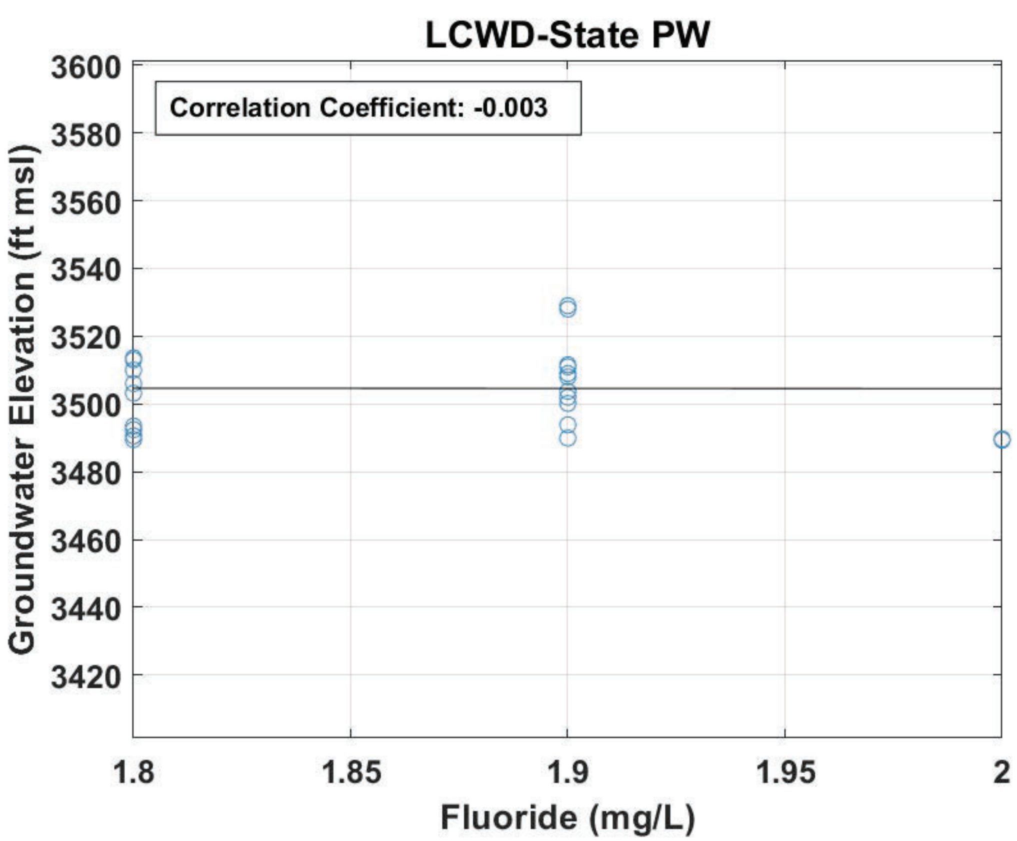


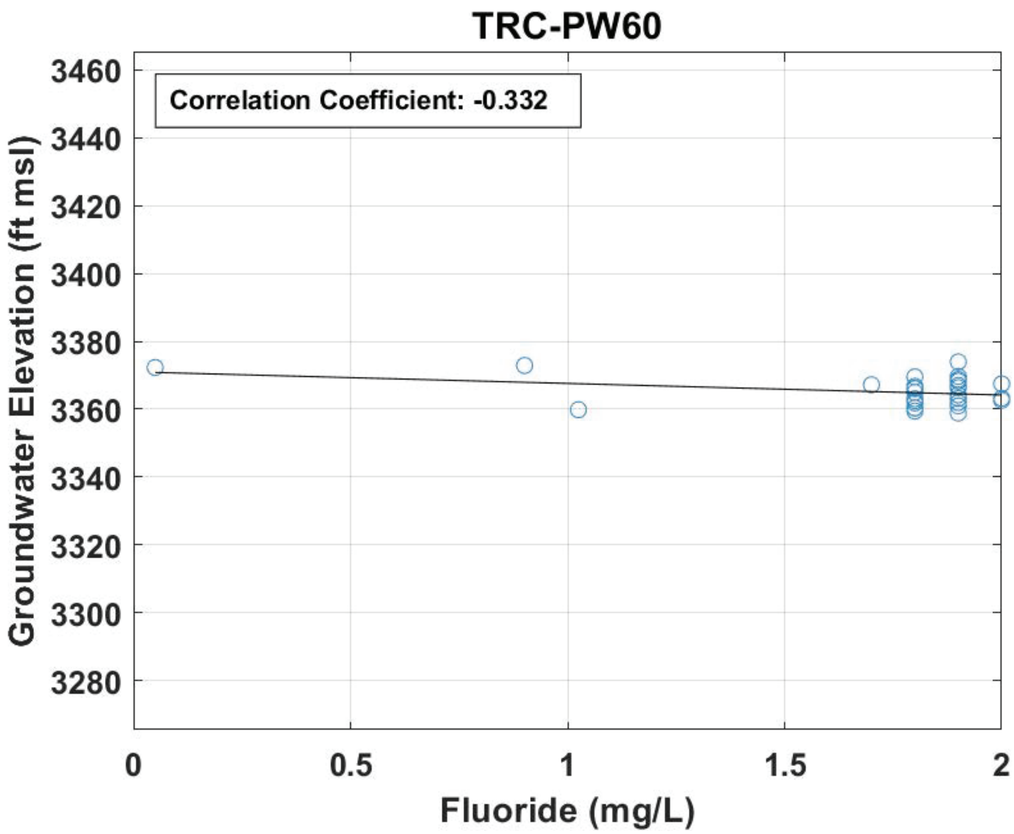
Stable Isotope Ratios
150
100
50
0
-50
-100
-150
-200
-25
-20
-15
-10
-5
0
5
10
15
Lake-1
Lake-2
δ^2H (%ₒ)
$\delta^{18}O$ (%ₒ)

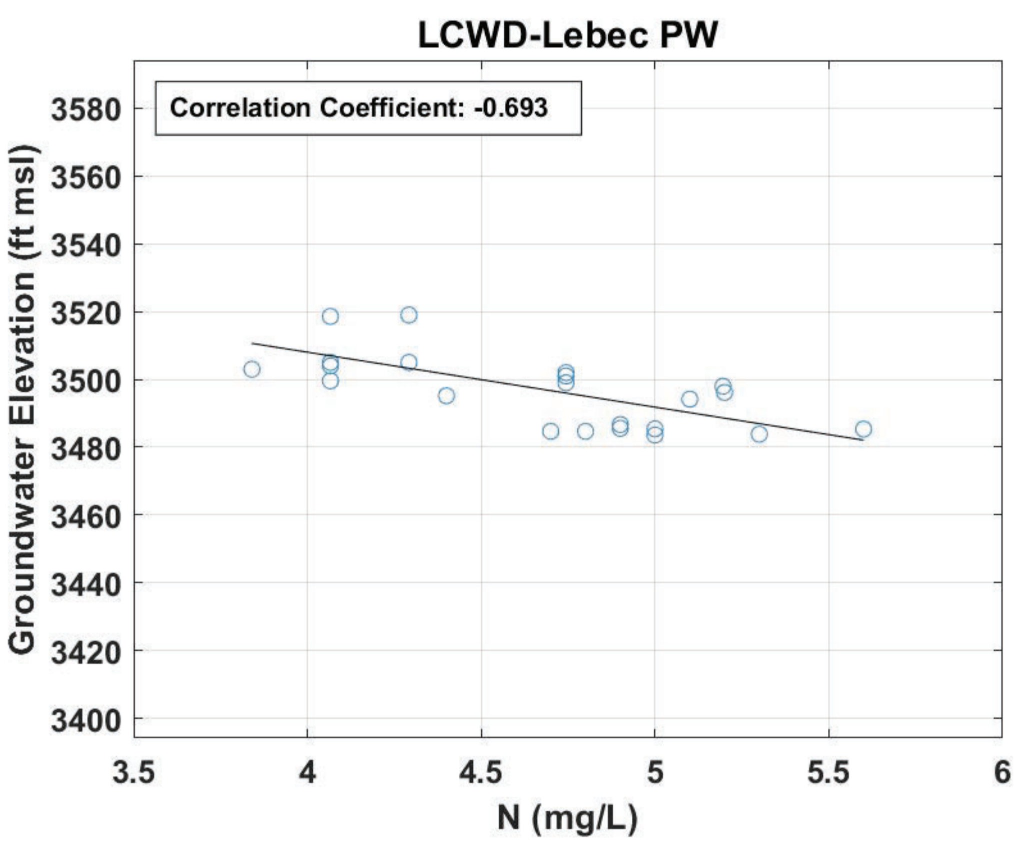

TRC-PW60
Correlation Coefficient: -0.506
Groundwater Elevation (ft msl)
3460
3440
3420
3400
3380
3360
3340
3320
3300
3280
1
1.2
1.4
1.6
1.8
2
As (mg/L)
×10^-3

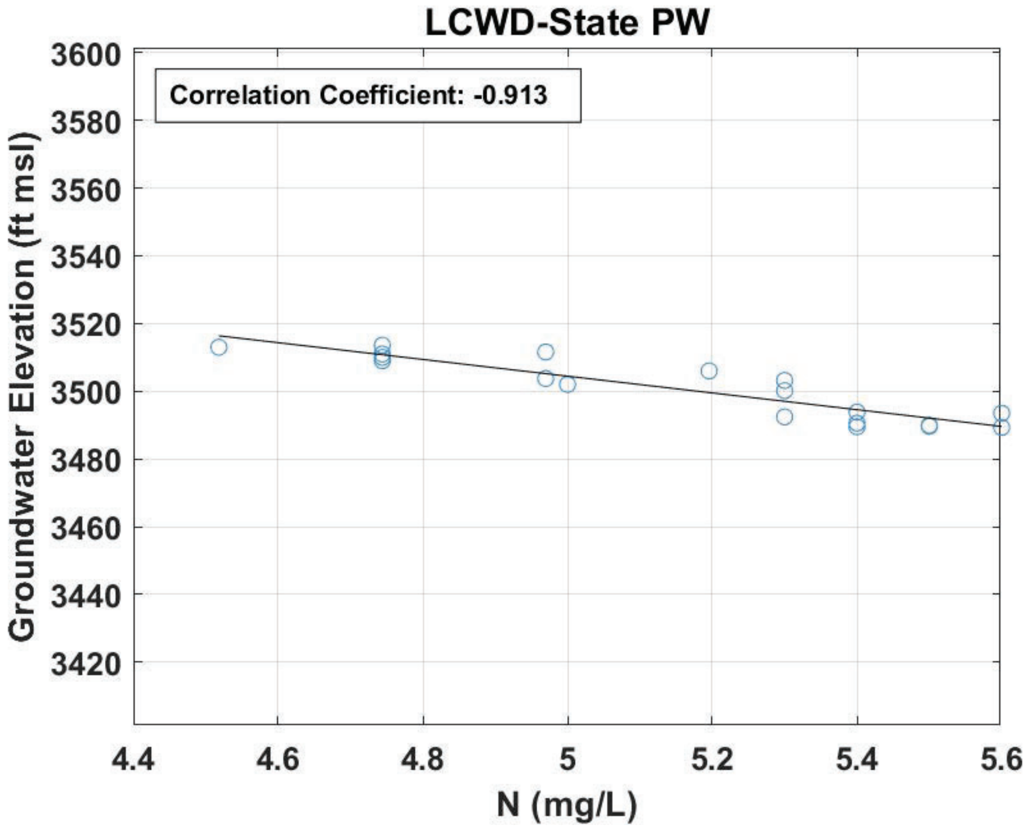

Krista MWC-PW
Correlation Coefficient: -0.182
Groundwater Elevation (ft msl)
3440
3420
3400
3380
3360
3340
3320
3300
3280
3260
1.9
1.95
2
2.05
2.1
2.15
2.2
2.25
Fluoride (mg/L)

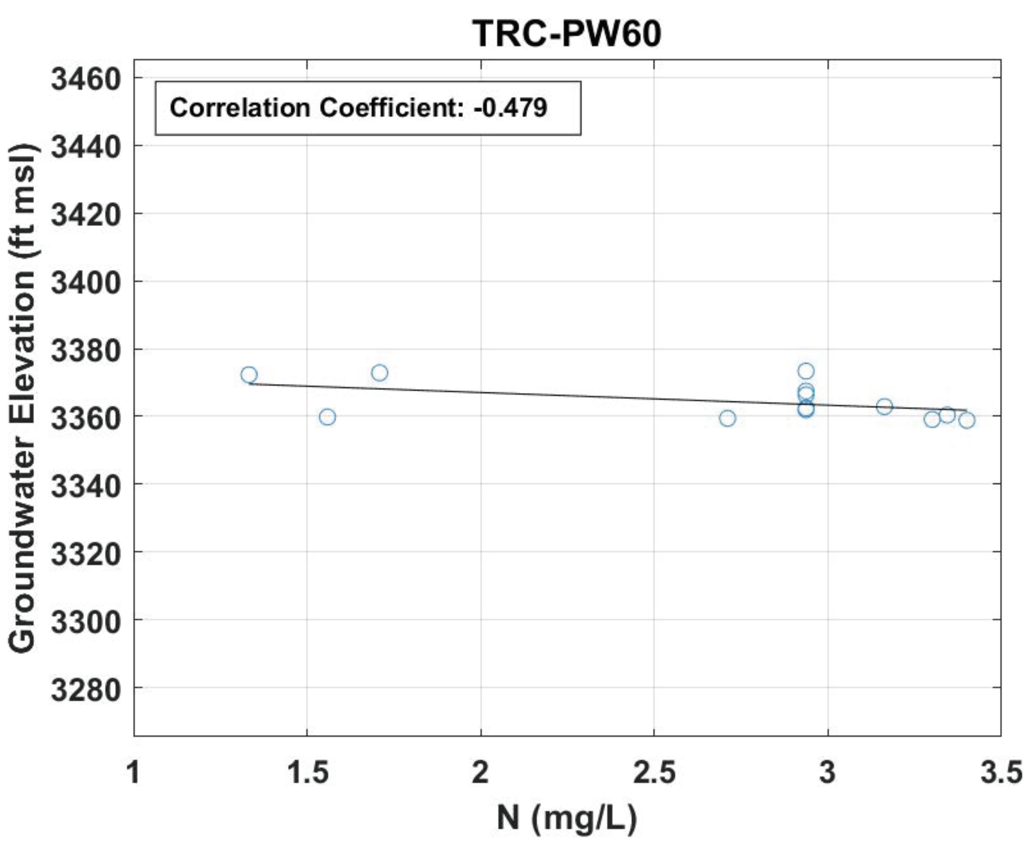

LCWD-Lebec PW
Correlation Coefficient: -0.029
Groundwater Elevation (ft msl)
3580
3560
3540
3520
3500
3480
3460
3440
3420
3400
1.2
1.25
1.3
1.35
1.4
Fluoride (mg/L)

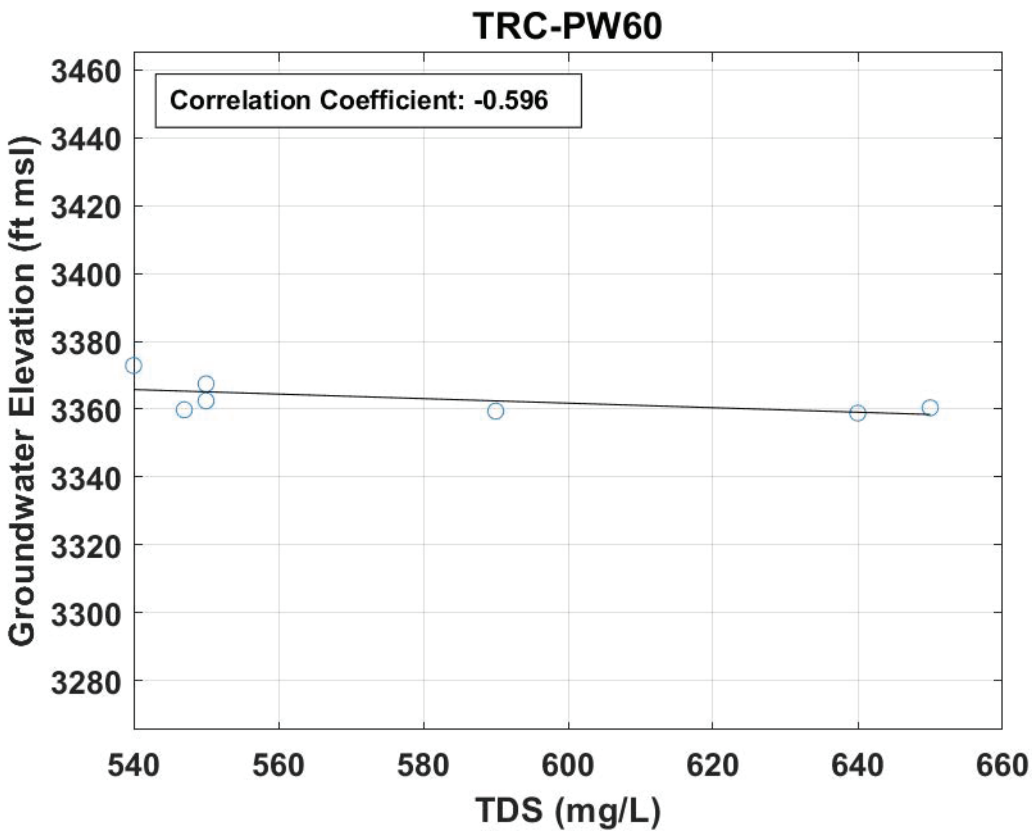

LCWD-State PW
Correlation Coefficient: -0.003
Groundwater Elevation (ft msl)
3600
3580
3560
3540
3520
3500
3480
3460
3440
3420
1.8
1.85
1.9
1.95
2
Fluoride (mg/L)

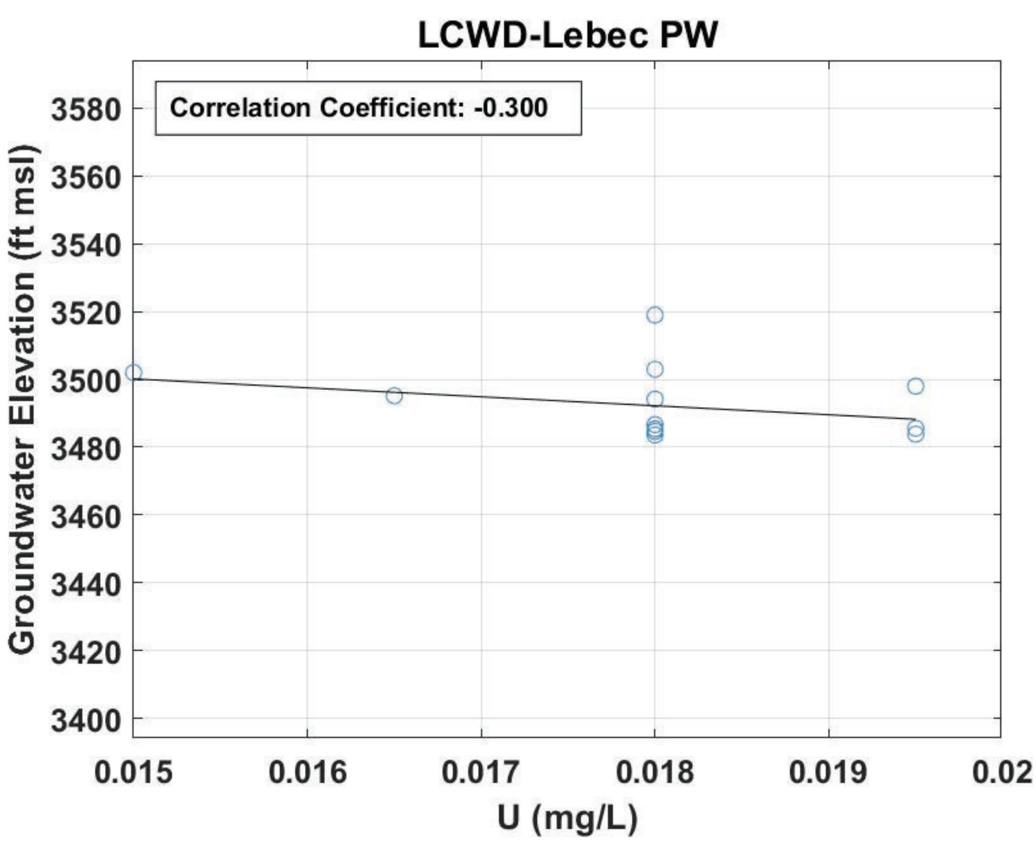

TRC-PW60
Correlation Coefficient: -0.332
Groundwater Elevation (ft msl)
3460
3440
3420
3400
3380
3360
3340
3320
3300
3280
0
0.5
1
1.5
2
Fluoride (mg/L)

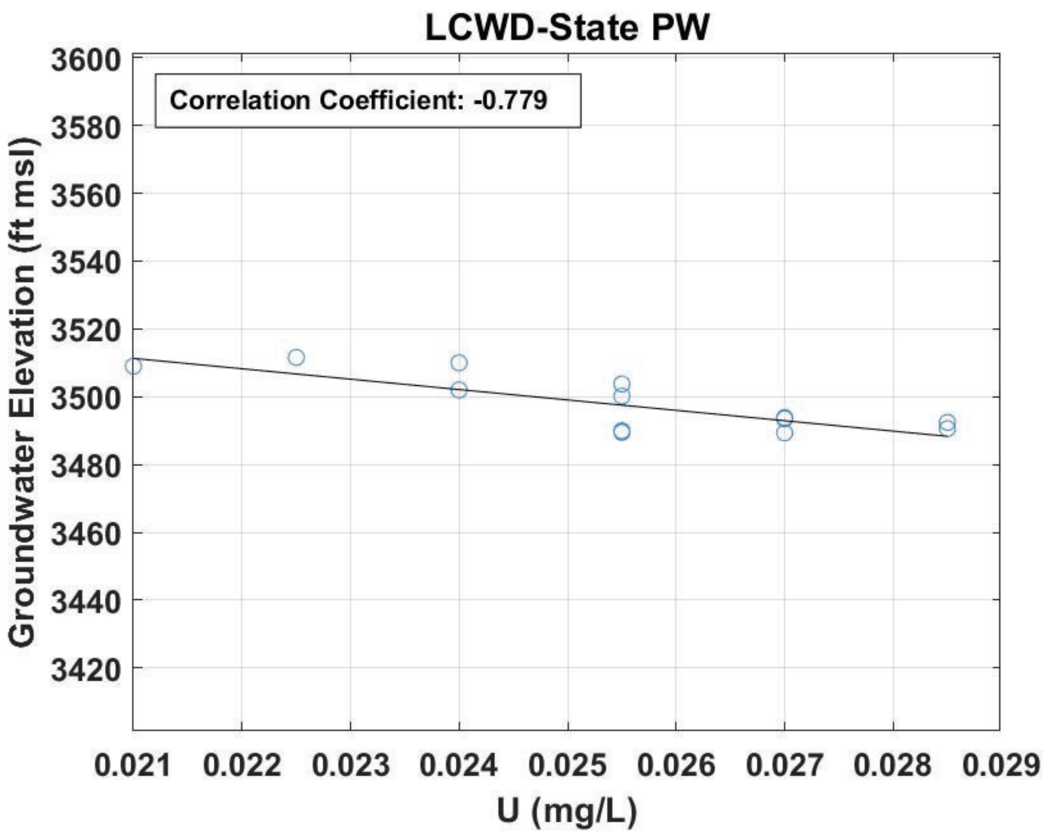

LCWD-Lebec PW
Correlation Coefficient: -0.693
Groundwater Elevation (ft msl)
3580
3560
3540
3520
3500
3480
3460
3440
3420
3400
3.5
4
4.5
5
5.5
6
N (mg/L)


LCWD-State PW
Correlation Coefficient: -0.913
Groundwater Elevation (ft msl)
3600
3580
3560
3540
3520
3500
3480
3460
3440
3420
4.4
4.6
4.8
5
5.2
5.4
5.6
N (mg/L)


TRC-PW60
Correlation Coefficient: -0.479
Groundwater Elevation (ft msl)
3460
3440
3420
3400
3380
3360
3340
3320
3300
3280
1
1.5
2
2.5
3
3.5
N (mg/L)


TRC-PW60
Correlation Coefficient: -0.596
Groundwater Elevation (ft msl)
3460
3440
3420
3400
3380
3360
3340
3320
3300
3280
540
560
580
600
620
640
660
TDS (mg/L)


LCWD-Lebec PW
Correlation Coefficient: -0.300
Groundwater Elevation (ft msl)
3580
3560
3540
3520
3500
3480
3460
3440
3420
3400
0.015
0.016
0.017
0.018
0.019
0.02
U (mg/L)



LCWD-State PW
Correlation Coefficient: -0.779
Groundwater Elevation (ft msl)
3600
3580
3560
3540
3520
3500
3480
3460
3440
3420
0.021
0.022
0.023
0.024
0.025
0.026
0.027
0.028
0.029
U (mg/L)

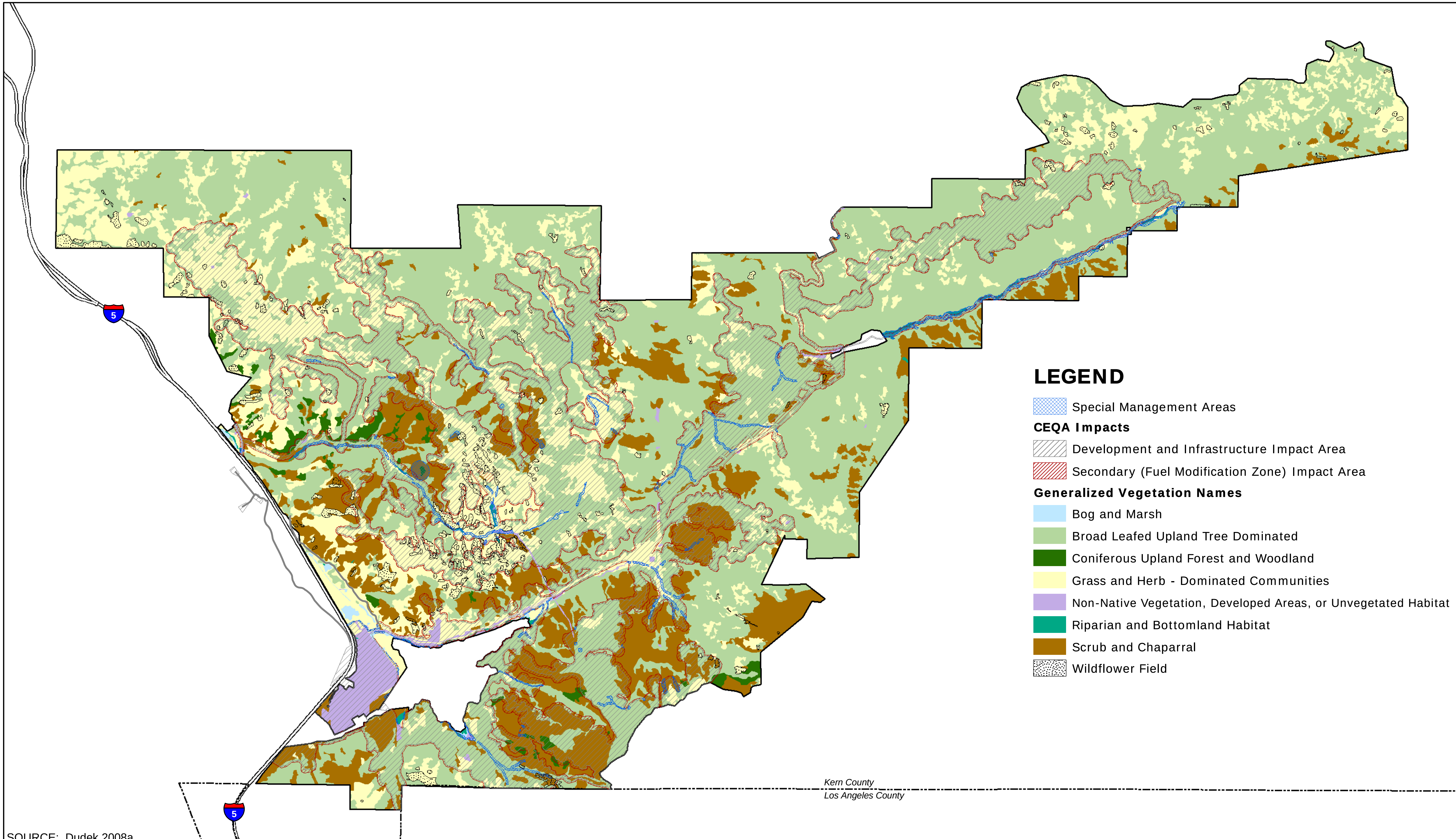
Appendix F

Supplemental Wetlands, Vegetation, and Special Species Maps

Map excerpts from Volume 1, Appendix E1 and Appendix E3 *in* Kern County Planning Department, 2009, Draft Environmental Impact Report Tejon Mountain Village by TMV, LLC SCH# 2005101018, dated May 2009

Map excerpts from Tejon Mountain Village – Habitat Management Plan, 2007

Screenshots from GDE Pulse Interactive Map https://gde.codefornature.org/#/map developed by The Nature Conservancy (TNC), accessed 17 March 2020



Tejon Mountain Village

EIR

Figure 4.4-4
VEGETATION MAP

Feet
0 1,000 2,000 3,000 4,000 5,000

May 2009

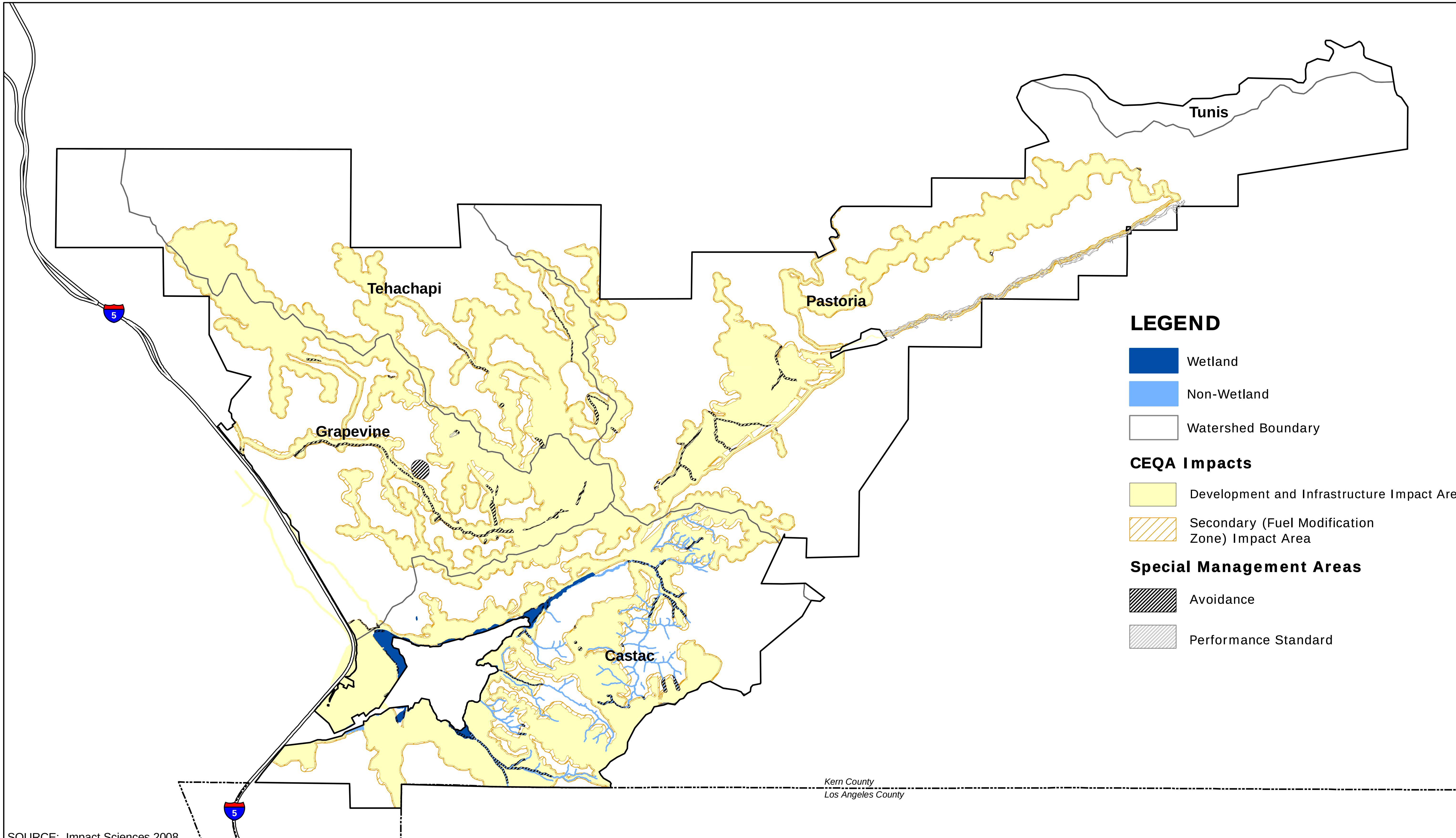


Figure 4.4-5
U.S. ARMY CORPS OF ENGINEERS JURISDICTIONAL AREAS

Tejon Mountain Village
EIR

0 1,000 2,000 3,000 4,000 5,000 Feet

May 2009

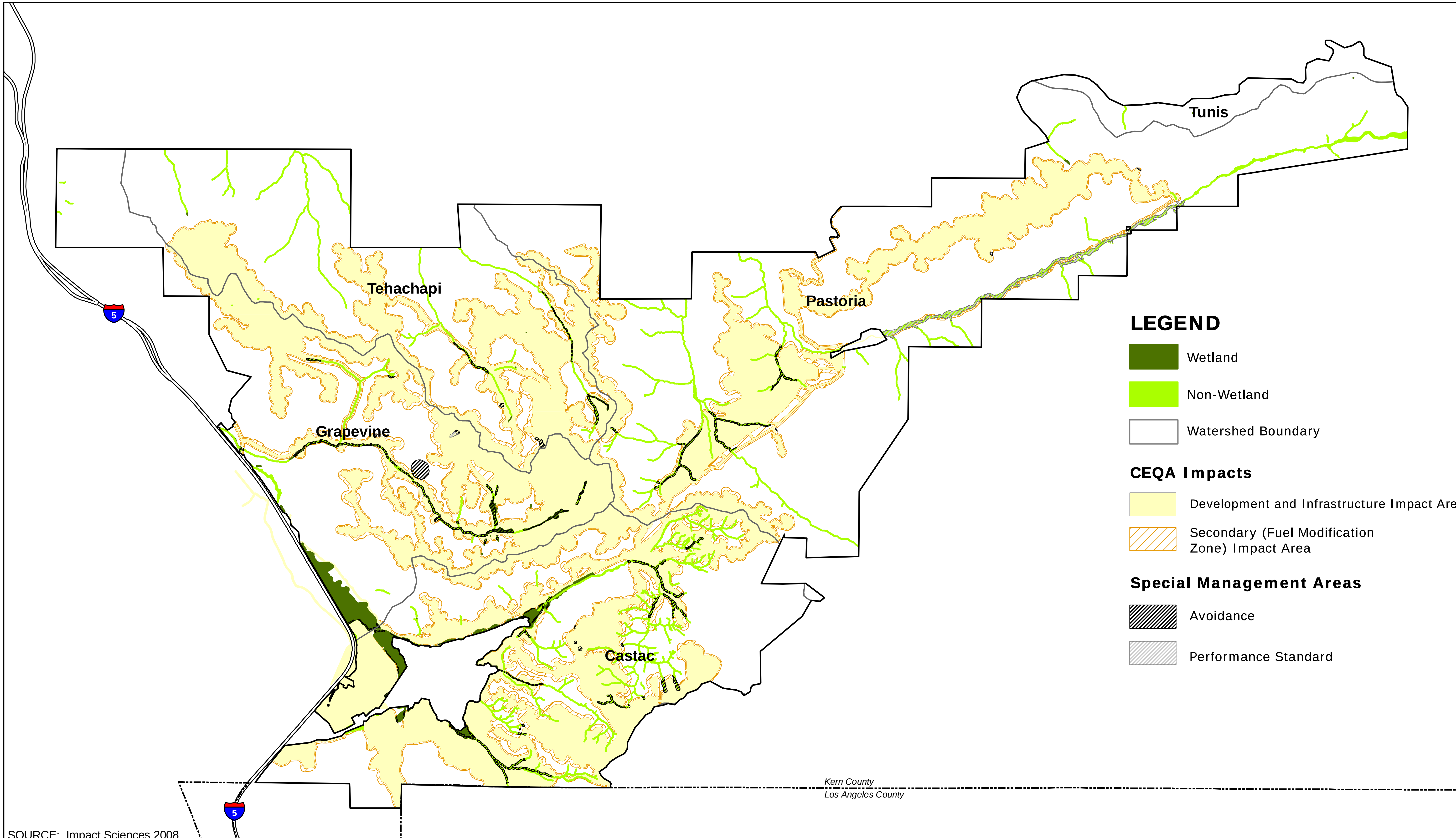
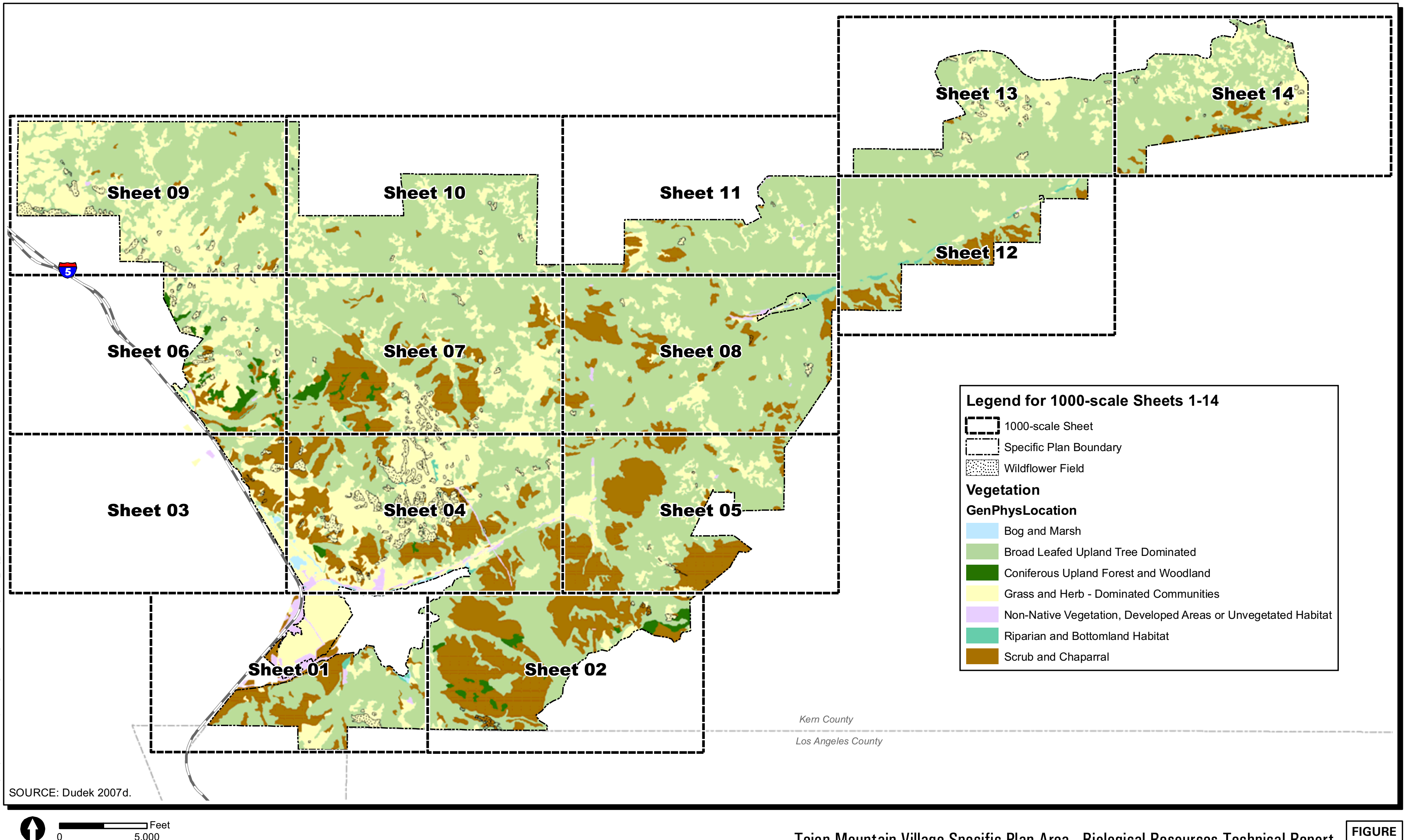


Figure 4.4-6
CALIFORNIA DEPARTMENT OF FISH & GAME
JURISDICTIONAL AREAS



DUDEK

Tejon Mountain Village Specific Plan Area - Biological Resources Technical Report

Vegetation Map - Index Map

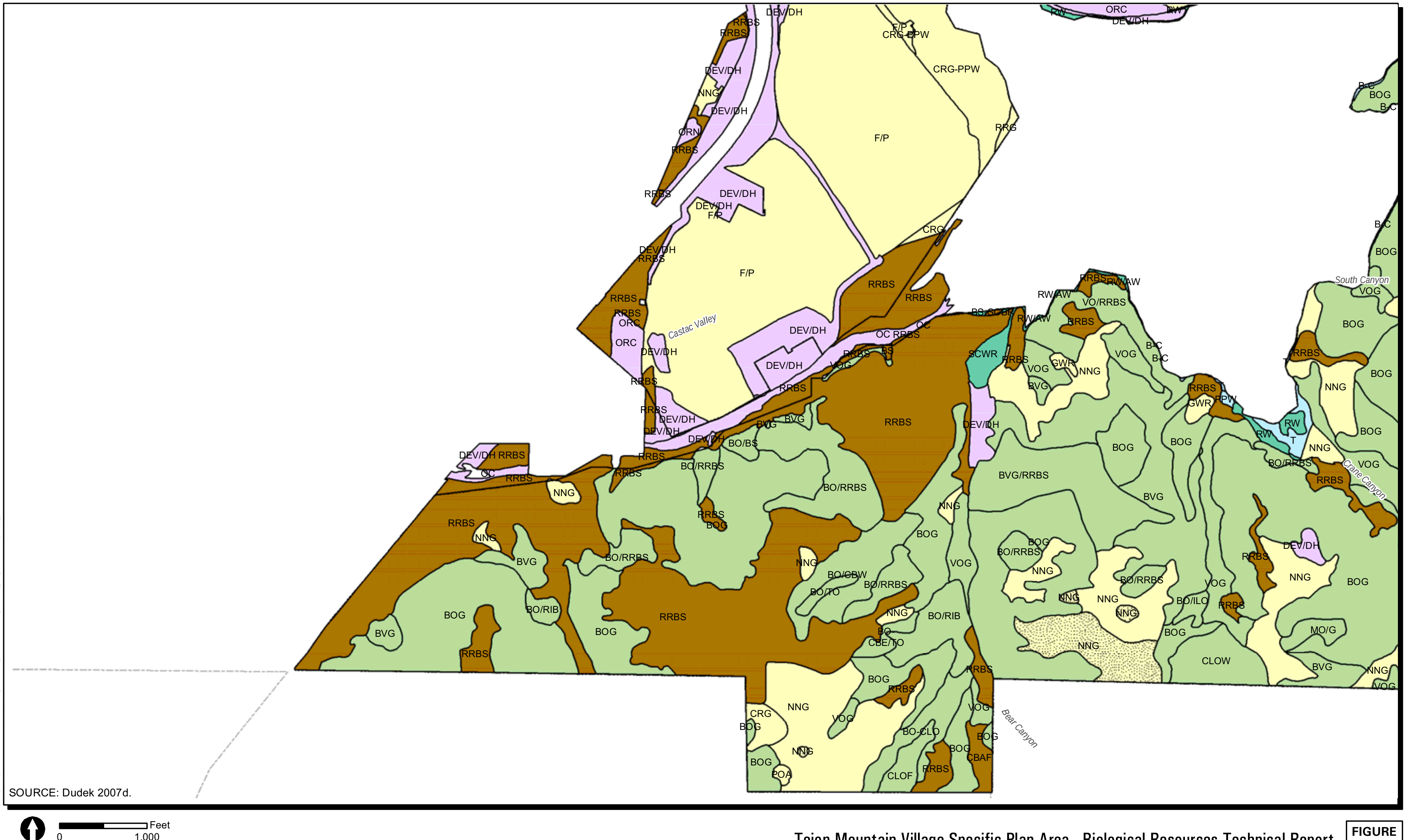
FIGURE
4.1-1A

Legend for Map Codes on 1000-scale Sheets 1-14

- B-C, Bulrush - Cattail
- BBM, Bigberry Manzanita
- BLC, Broad-Leafed Cattail
- BLMM, Birchleaf Mountain-Mahogany
- BLMM-CBW, Birchleaf Mountain-Mahogany - California Buckwheat
- BO/ILO, Blue Oak / Interior Live Oak
- BO/ILO-WC, Blue Oak / Interior Live Oak - Wedgeleaf Ceanothus
- BO/TO, Blue Oak / Tucker Oak
- BO/WC, Blue Oak / Wedgeleaf Ceanothus
- BOC, Brewer Oak Chaparral
- BOF, Black Oak Forest
- BOG, Blue Oak Grass
- BOVO, Black Oak - Valley Oak
- BOW, Black Oak Woodland
- BS, Big Sagebrush
- BSQT, Big Squirreltail
- BVG, Blue Oak - Valley Oak / Grass
- BW, Black Willow Riparian Forests and Woodlands
- CBAF, California Buckwheat Alluvial Fan
- CBEW, California Buckeye Woodland
- CBRW, California Bulrush Wetland
- CBW, California Buckwheat
- CCSAW, Central California Sycamore Alluvial Woodland
- CH-BBM, Chamise - Bigberry Manzanita
- CH-BBM-WC, Chamise - Bigberry Manzanita - Wedgeleaf Ceanothus
- CH-SO, Chamise - Scrub Oak Chaparral
- CH-WC, Chamise - Wedgeleaf Ceanothus
- CJWS, Cismontane Juniper Woodland and Scrub
- CLO-BKO, Canyon Live Oak - Black Oak
- CLO-HLR, Canyon Live Oak - Holly-Leaf Redberry
- CLOF, Canyon Live Oak Forest
- CLOS, Canyon Live Oak Shrub
- CLOW, Canyon Live Oak Woodland
- CM, Chaparral with Manzanita as principal indicator
- CP-CLOW, Coulter Pine - Canyon Live Oak Woodland
- CRG, Creeping Ryegrass Grassland
- CS, Coastal Scrub
- CTS, Common Three-Square
- DEV/DH, Developed / Disturbed Habitat
- FWS, Freshwater Seep
- GVVOR, Great Valley Valley Oak Riparian
- GWR, Giant Wild Rye
- ILO-CLO, Interior Live Oak - Canyon Live Oak
- ILO-SO, Interior Live Oak - Scrub Oak Chaparral
- ILOC, Interior Live Oak Chaparral
- ILOF, Interior Live Oak Forest
- ILOW, Interior Live Oak Woodland
- JOCW, Juniper Oak Cismontane Woodland
- MO-CBE, Mixed Oak - California Buckeye
- MO/G, Mixed Oak / Grass
- MWR, Mixed Willow Riparian Forests and Woodlands
- NNG, Non-Native Grassland
- OC, Unvegetated Areas
- OR, Oak Tree Planting
- ORC, Orchard and Vineyards
- ORN, Ornamental
- PNG, Purple Needlegrass
- POA, One-Sided Bluegrass
- PPW, Perennial Pepperweed
- RRBS, Rubber Rabbitbrush Scrub
- RRG, Rush Riparian Grassland
- RW, Red Willow
- RW/AW, Red Willow / Arroyo Willow
- SCWR, Southern Cottonwood - Willow Riparian
- SO, Scrub Oak
- SO-BBM, Scrub Oak - Bigberry Manzanita
- SO-BLMM, Scrub Oak - Birchleaf Mountain-Mahogany
- SO-WC, Scrub Oak - Wedgeleaf Ceanothus
- SO/CBE, Scrub Oak / California Buckeye
- SP, Singleleaf Pinyon Woodland
- T, Tule
- TOS, Tucker Oak Scrub
- VOG, Valley Oak / Grass
- WC, Wedgeleaf Ceanothus
- dCCSAW, disturbed Central California Sycamore Alluvial Woo
- dVOG, disturbed Valley Oak / Grass

Legend for Vegetation Map Codes and Vegetation Communities/Stand Types

FIGURE 4.1-1B



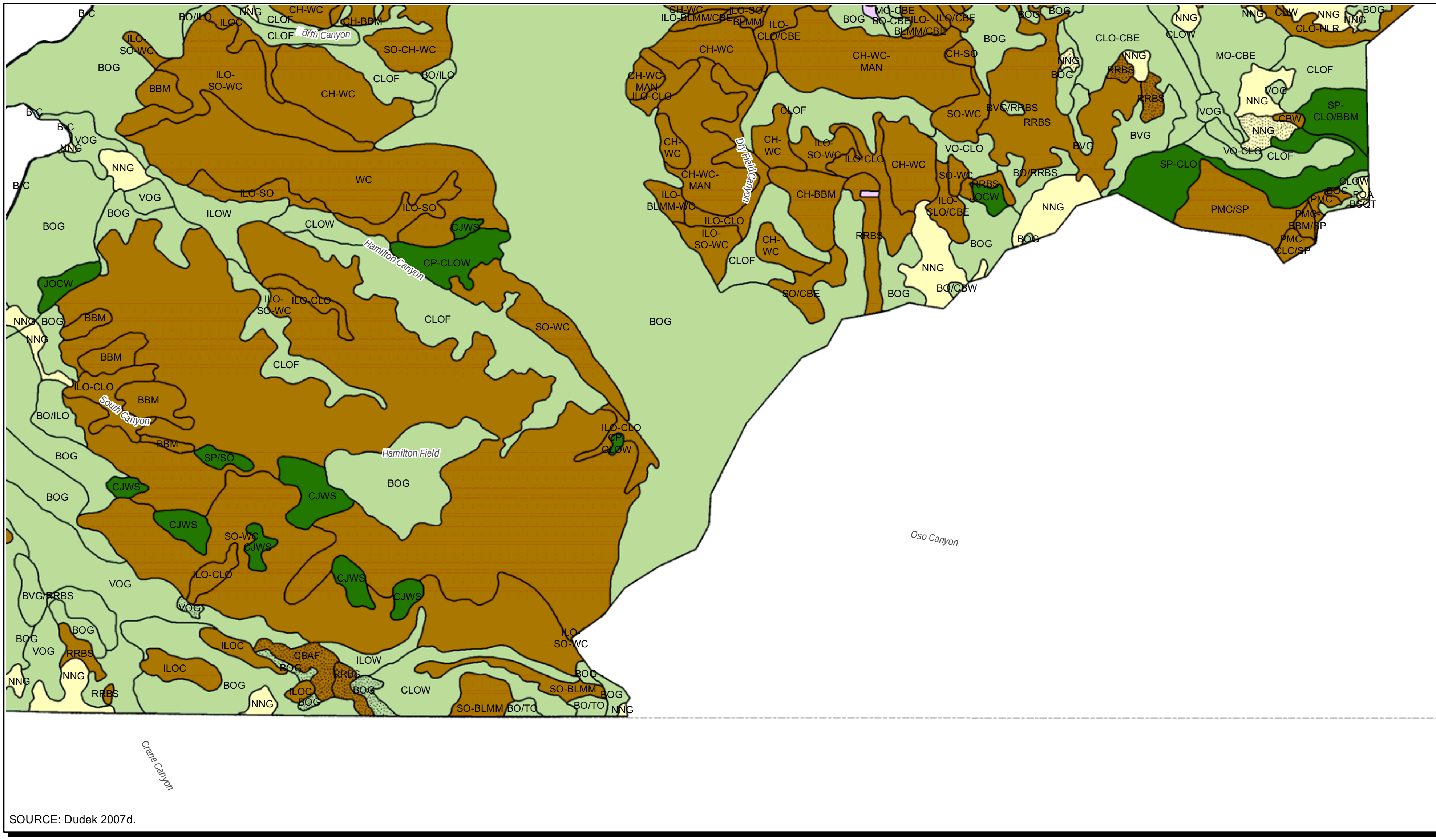
SOURCE: Dudek 2007d.

DUDEK

Tejon Mountain Village Specific Plan Area - Biological Resources Technical Report

Vegetation Community Map - Sheet 01

FIGURE 4.1-1C



Feet

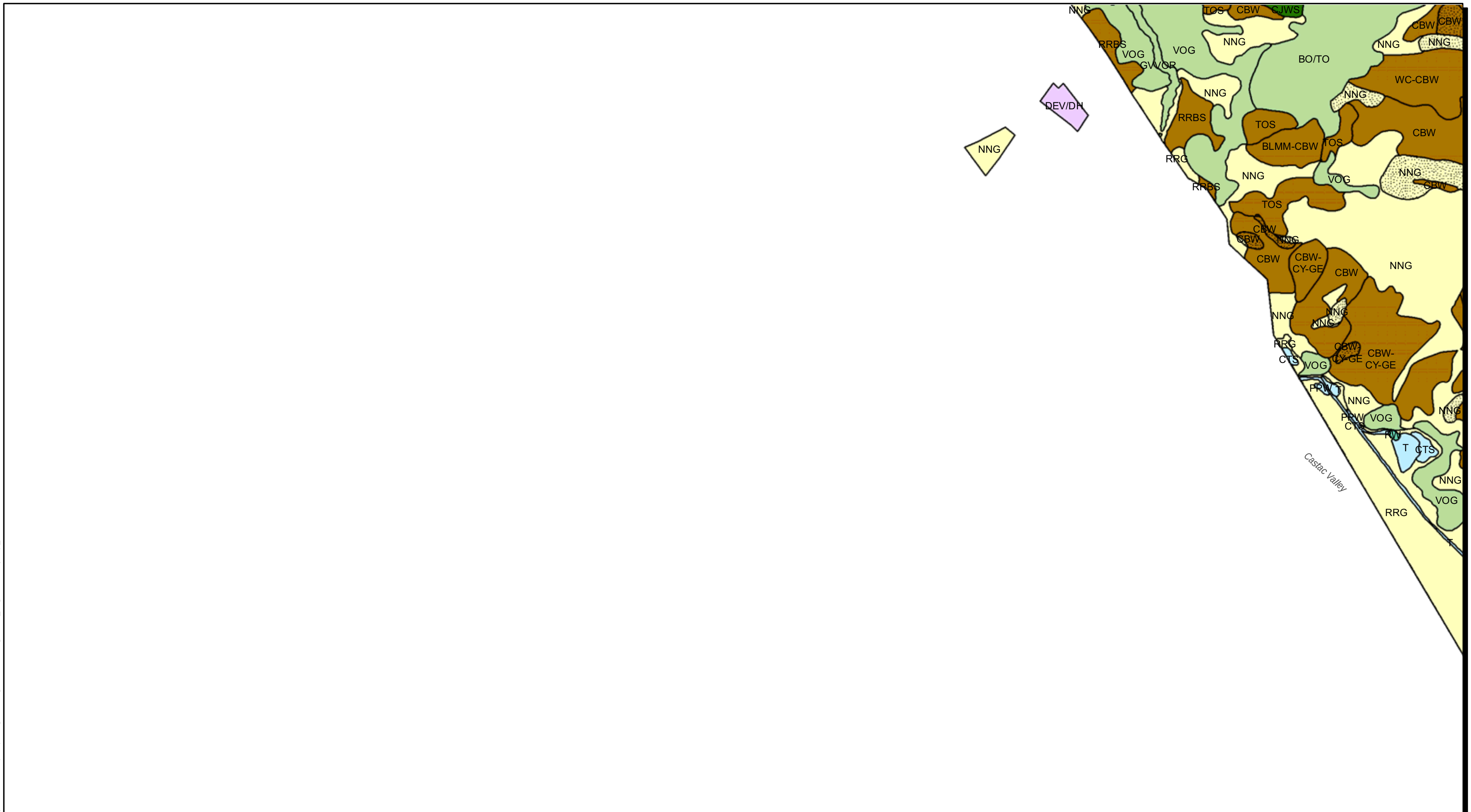
0 1,000

DUDEK

Tejon Mountain Village Specific Plan Area - Biological Resources Technical Report

Vegetation Community Map - Sheet 02

FIGURE 4.1-1D



SOURCE: Dudek 2007d.

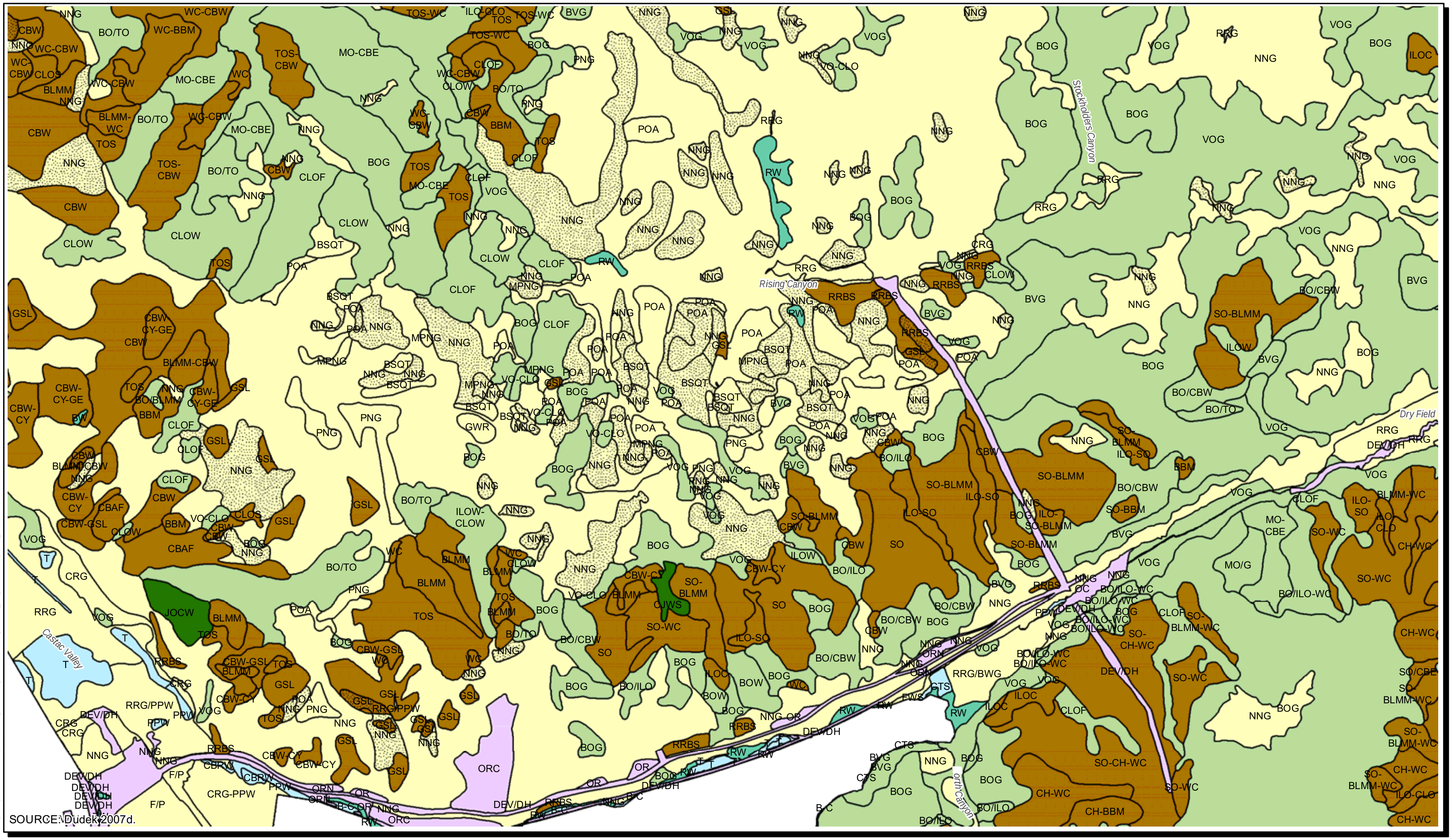
Feet
0 1,000

DUDEK

Tejon Mountain Village Specific Plan Area - Biological Resources Technical Report

Vegetation Community Map - Sheet 03

FIGURE
4.1-1E

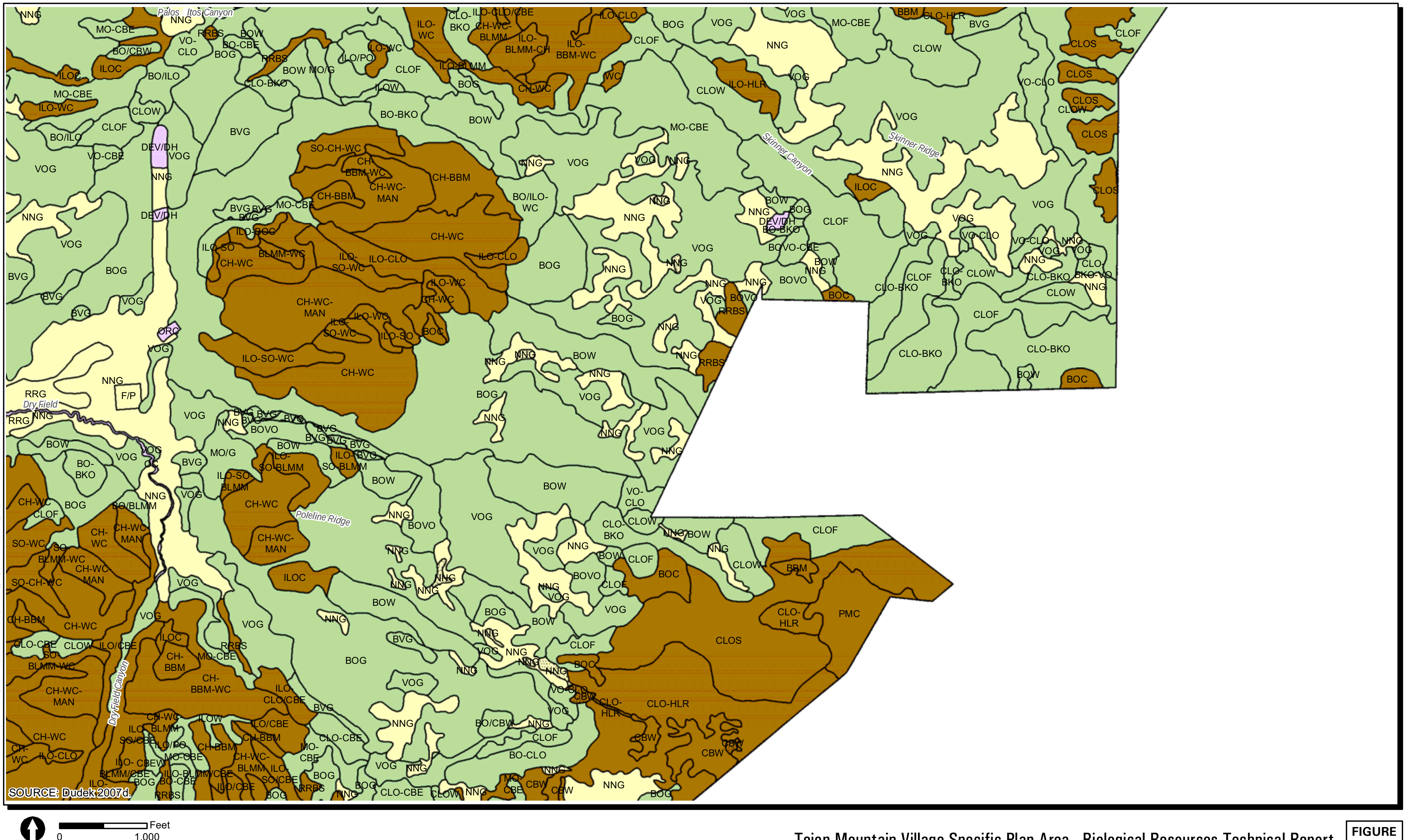


DUDEK

Tejon Mountain Village Specific Plan Area - Biological Resources Technical Report

Vegetation Community Map - Sheet 04

FIGURE 4.1-1F

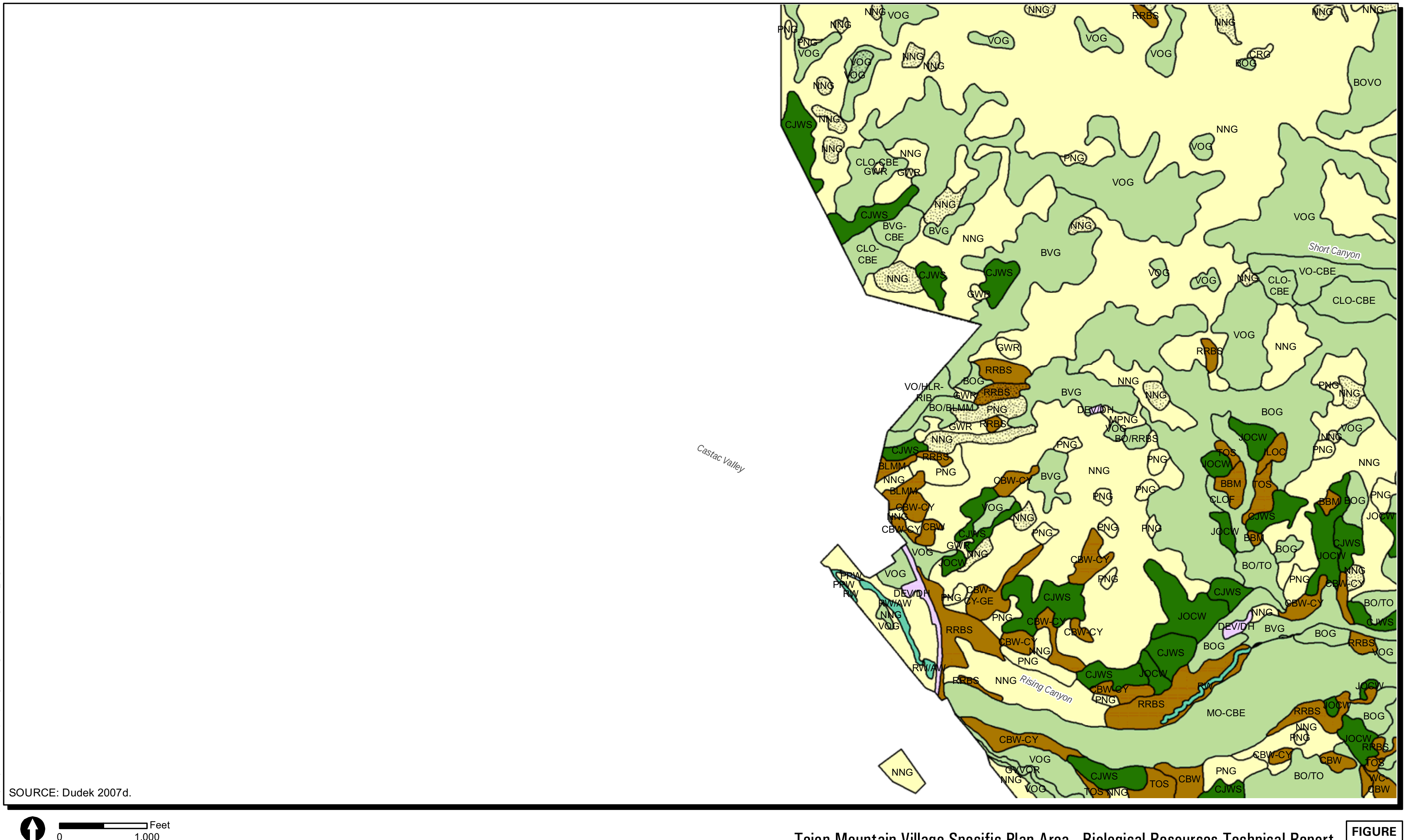


DUDEK

Tejon Mountain Village Specific Plan Area - Biological Resources Technical Report

Vegetation Community Map - Sheet 05

FIGURE 4.1-1G

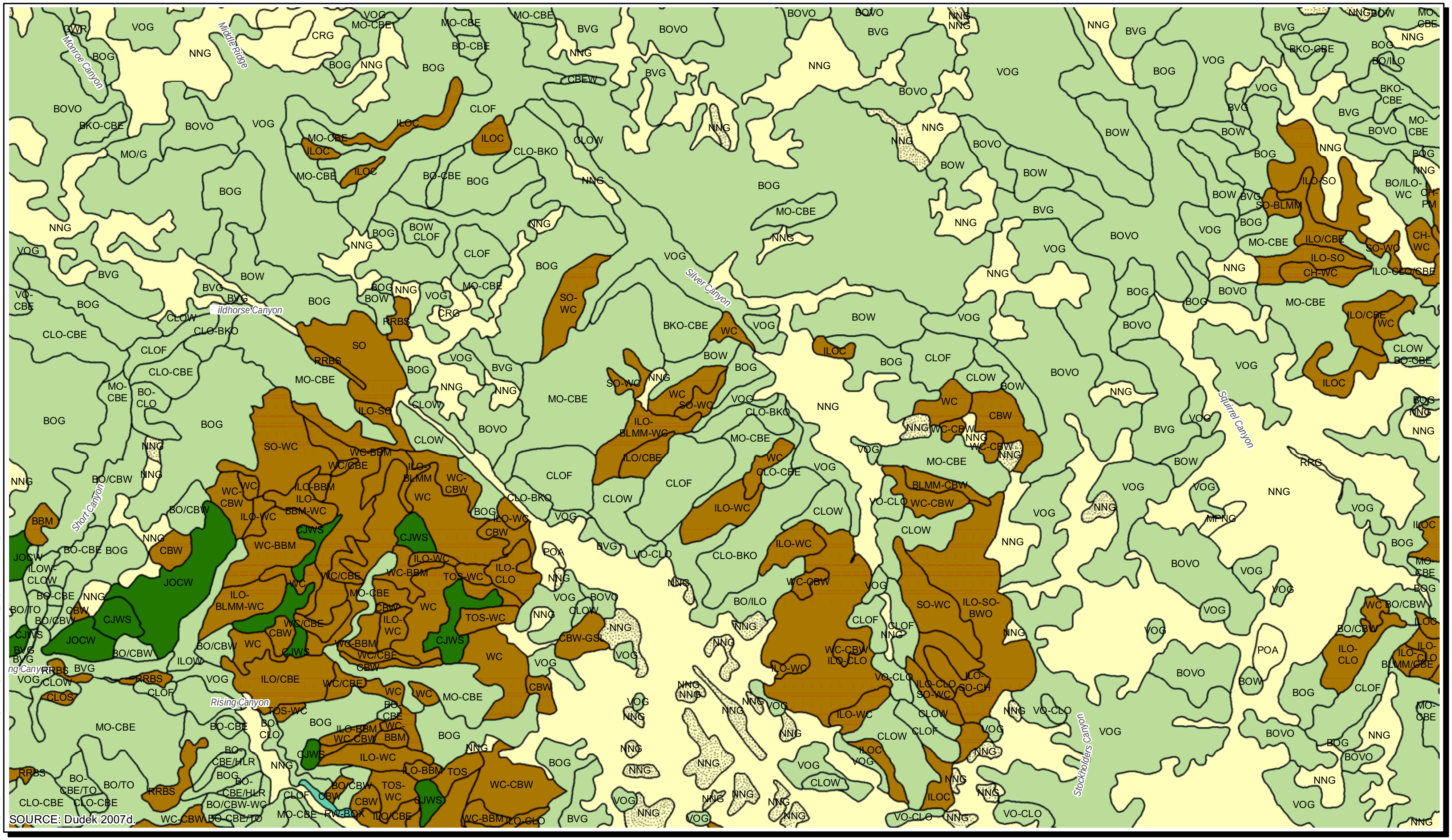


DUDEK

Tejon Mountain Village Specific Plan Area - Biological Resources Technical Report

Vegetation Community Map - Sheet 06

FIGURE 4.1-1H



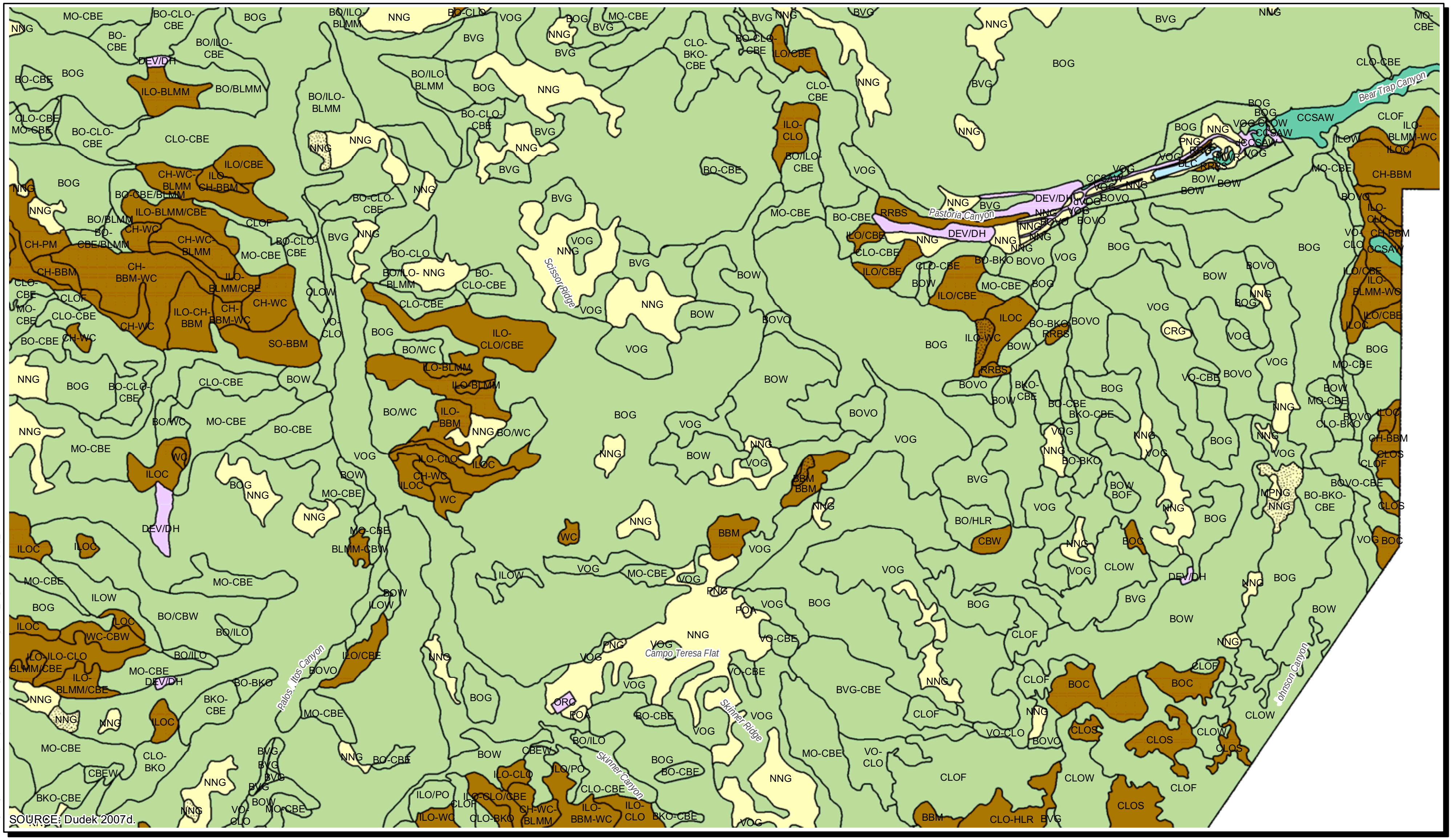
Feet
0 1,000

DUDEK

Tejon Mountain Village Specific Plan Area - Biological Resources Technical Report

Vegetation Community Map - Sheet 07

FIGURE
4.1-11



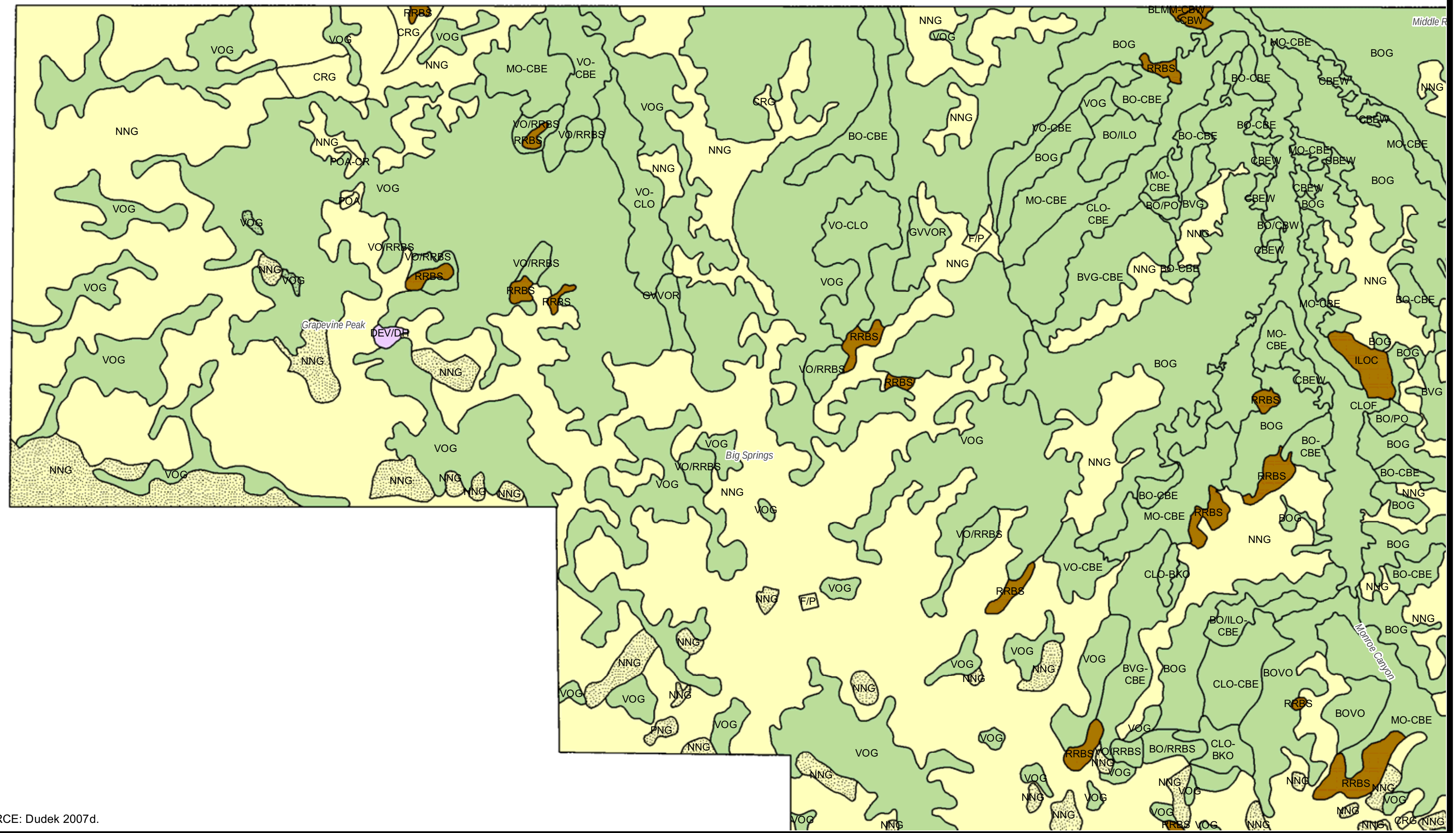
Feet
0 1,000

DUDEK

Tejon Mountain Village Specific Plan Area - Biological Resources Technical Report

Vegetation Community Map - Sheet 08

FIGURE 4.1-1J



SOURCE: Dudek 2007d.

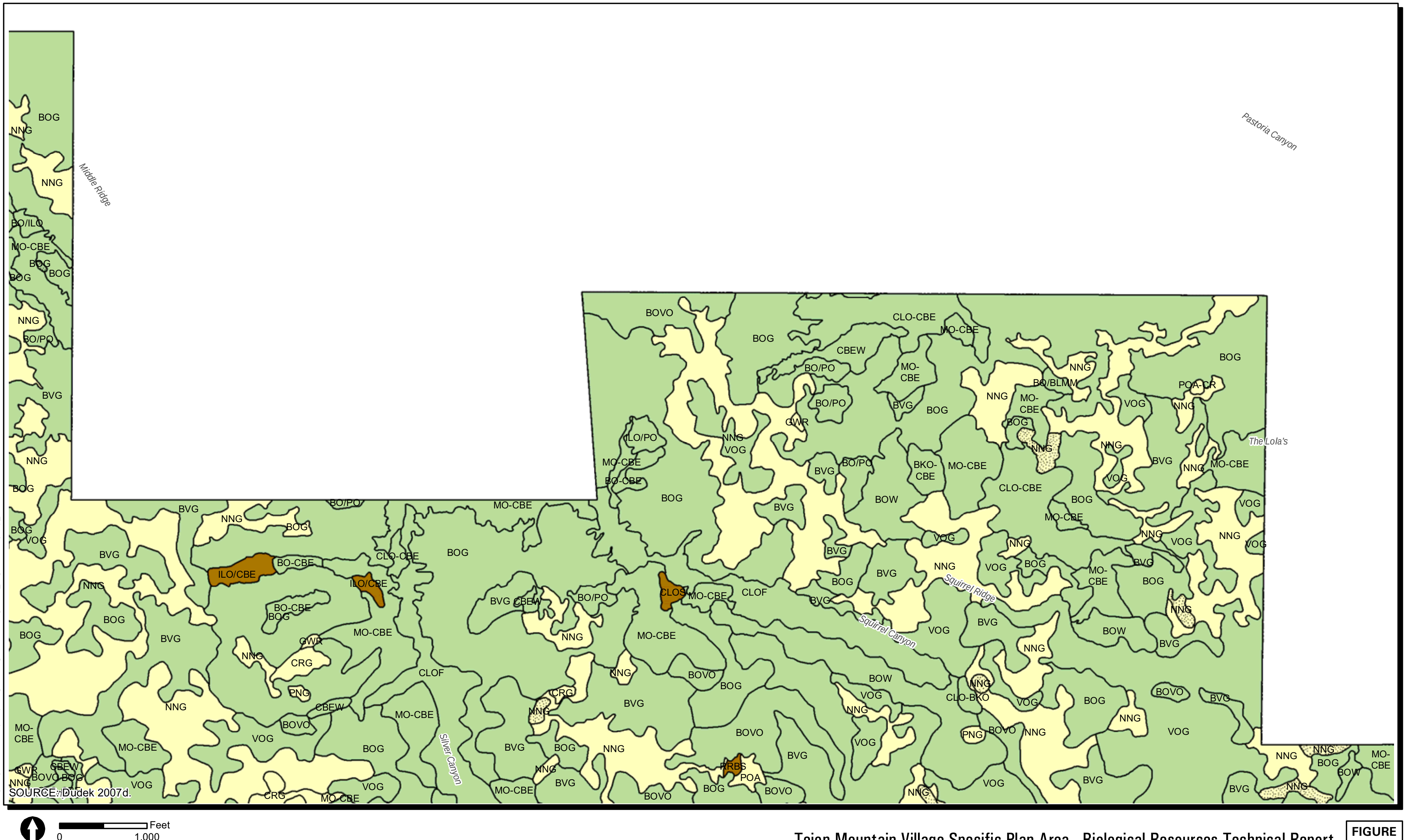
Feet
0 1,000

DUDEK

Tejon Mountain Village Specific Plan Area - Biological Resources Technical Report

Vegetation Community Map - Sheet 09

FIGURE 4.1-1K

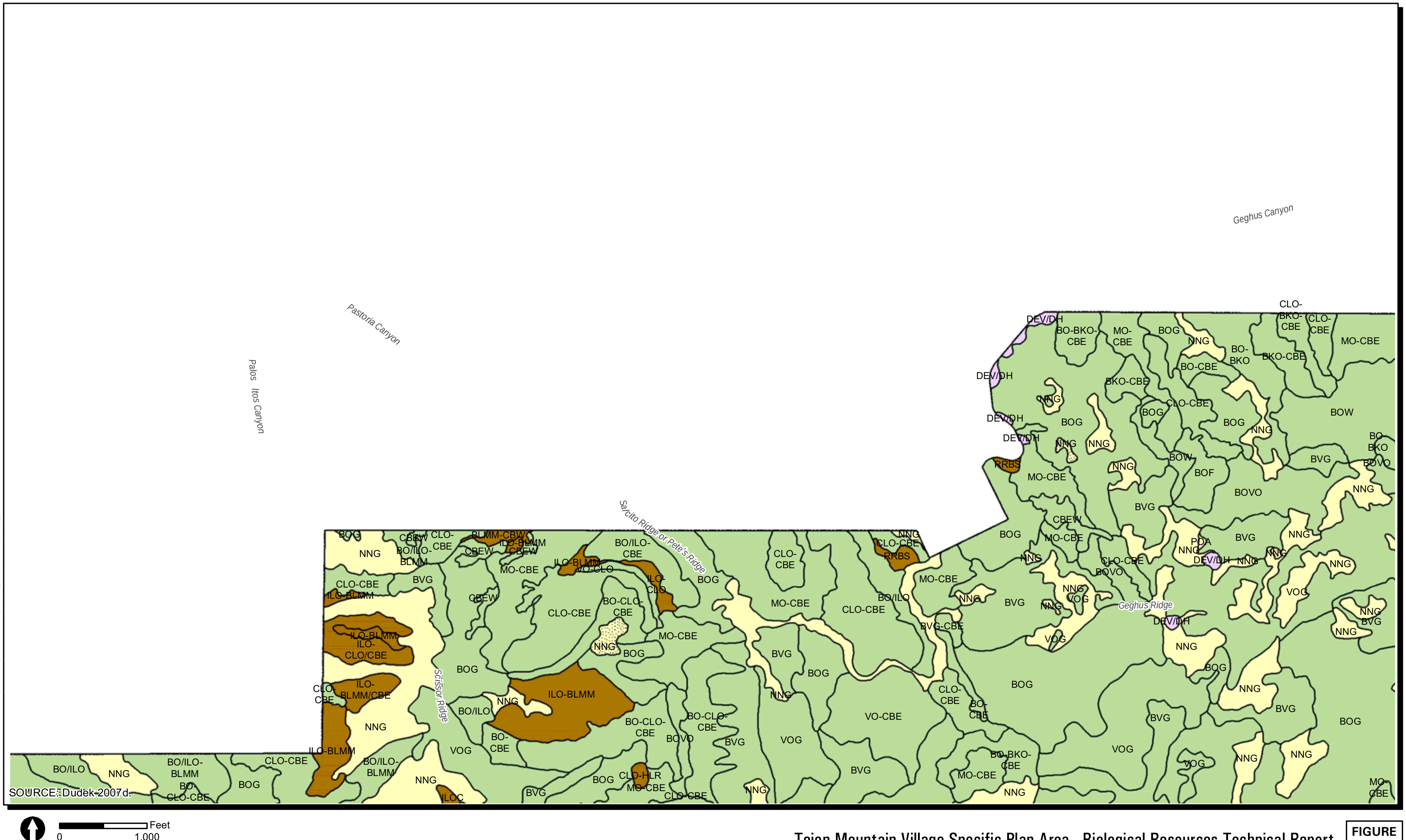


DUDEK

Tejon Mountain Village Specific Plan Area - Biological Resources Technical Report

Vegetation Community Map - Sheet 10

FIGURE 4.1-1L

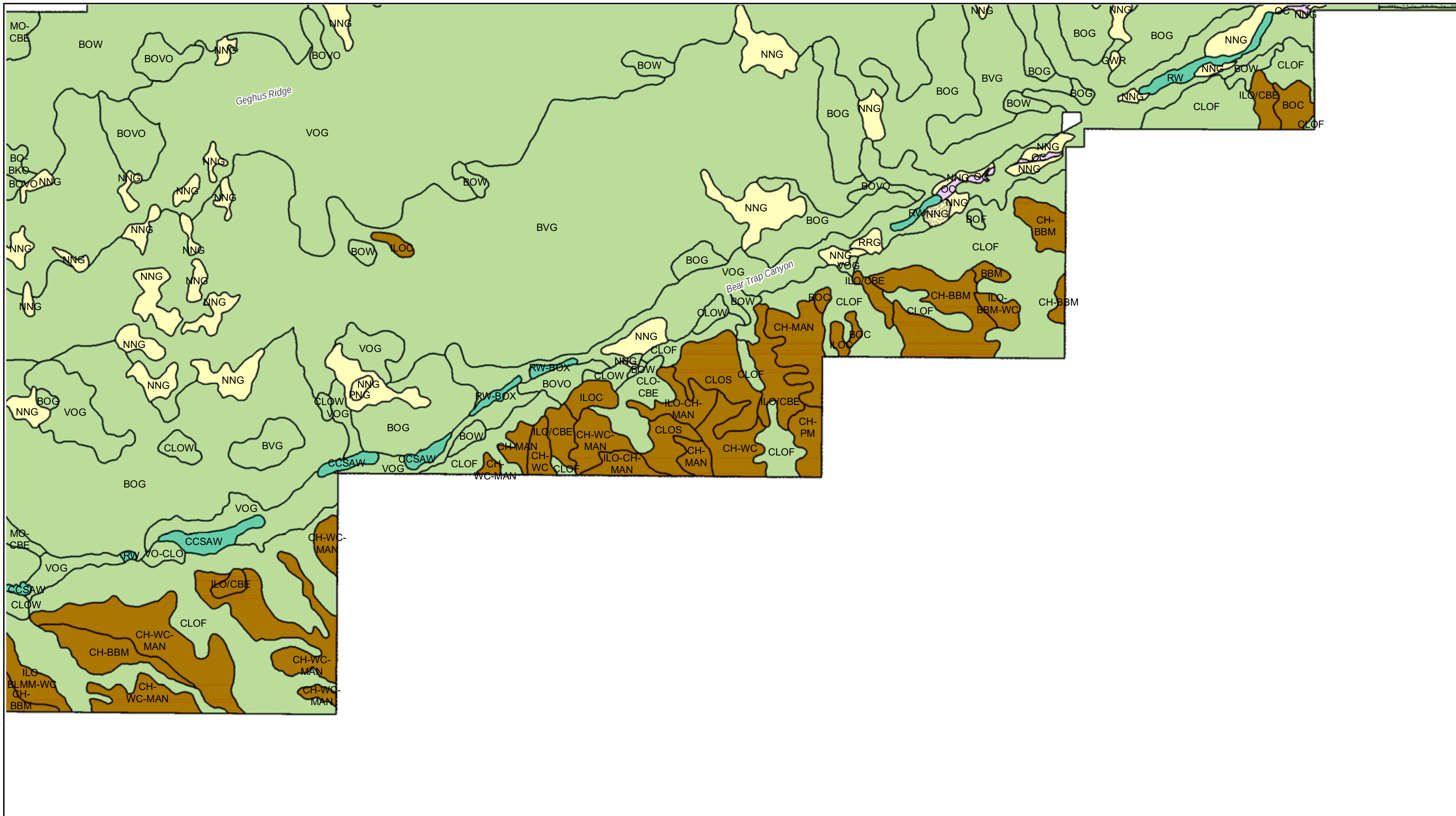


DUDEK

Tejon Mountain Village Specific Plan Area - Biological Resources Technical Report

Vegetation Community Map - Sheet 11

FIGURE 4.1-1M



SOURCE: Dudek 2007d.

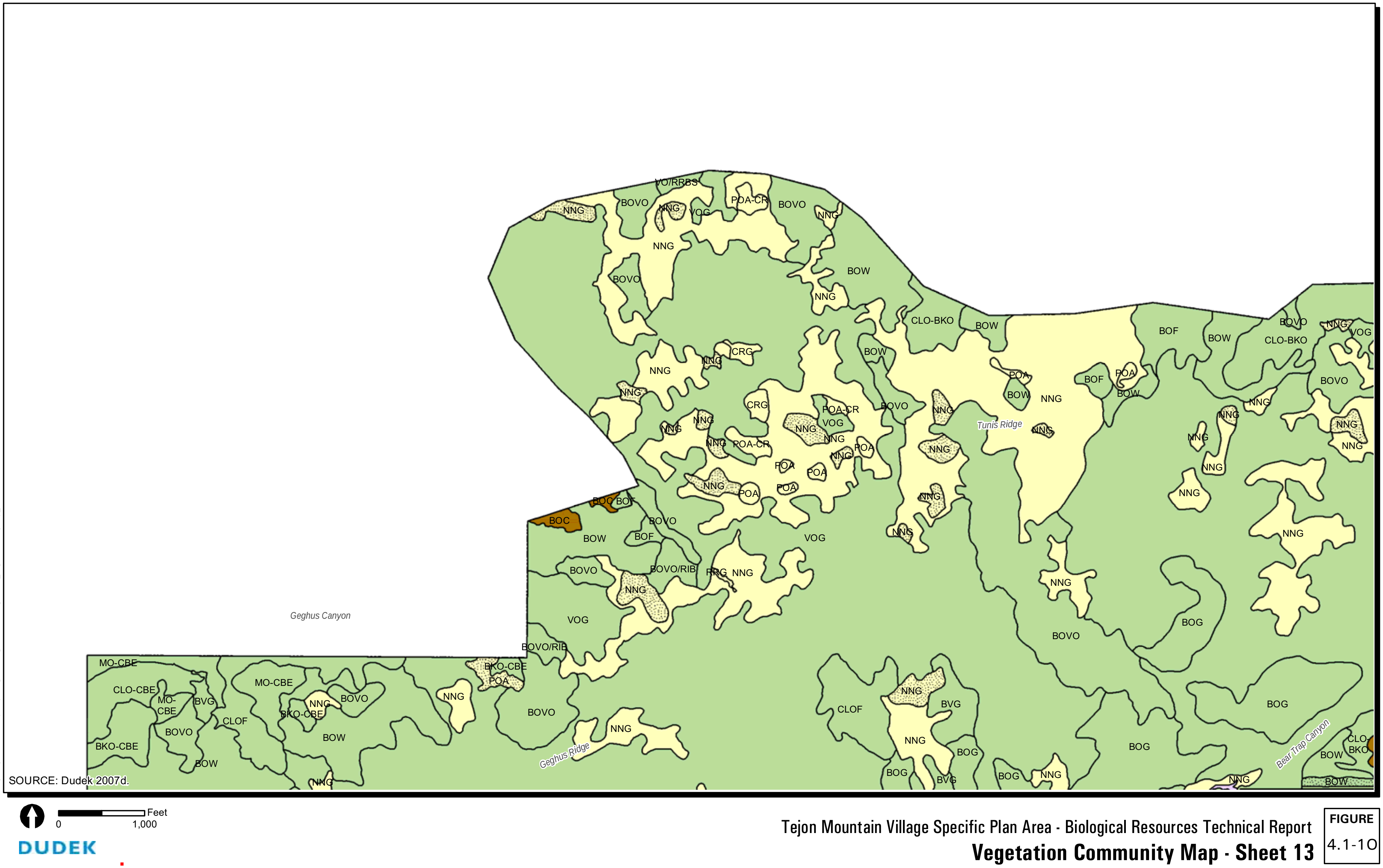
Feet
0 1,000

DUDEK

Tejon Mountain Village Specific Plan Area - Biological Resources Technical Report

Vegetation Community Map - Sheet 12

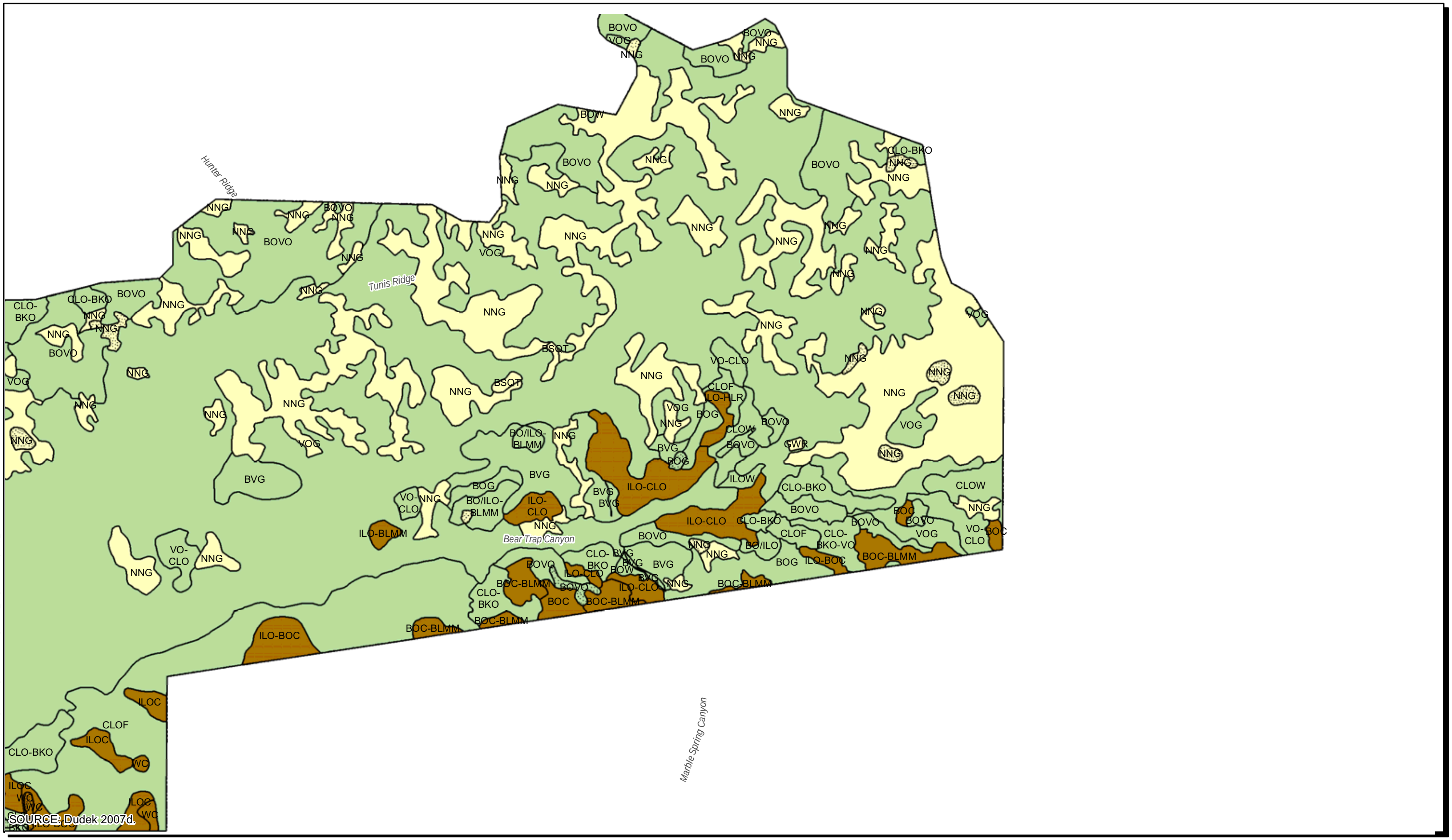
FIGURE 4.1-1N



Tejon Mountain Village Specific Plan Area - Biological Resources Technical Report

Vegetation Community Map - Sheet 13

FIGURE 4.1-10



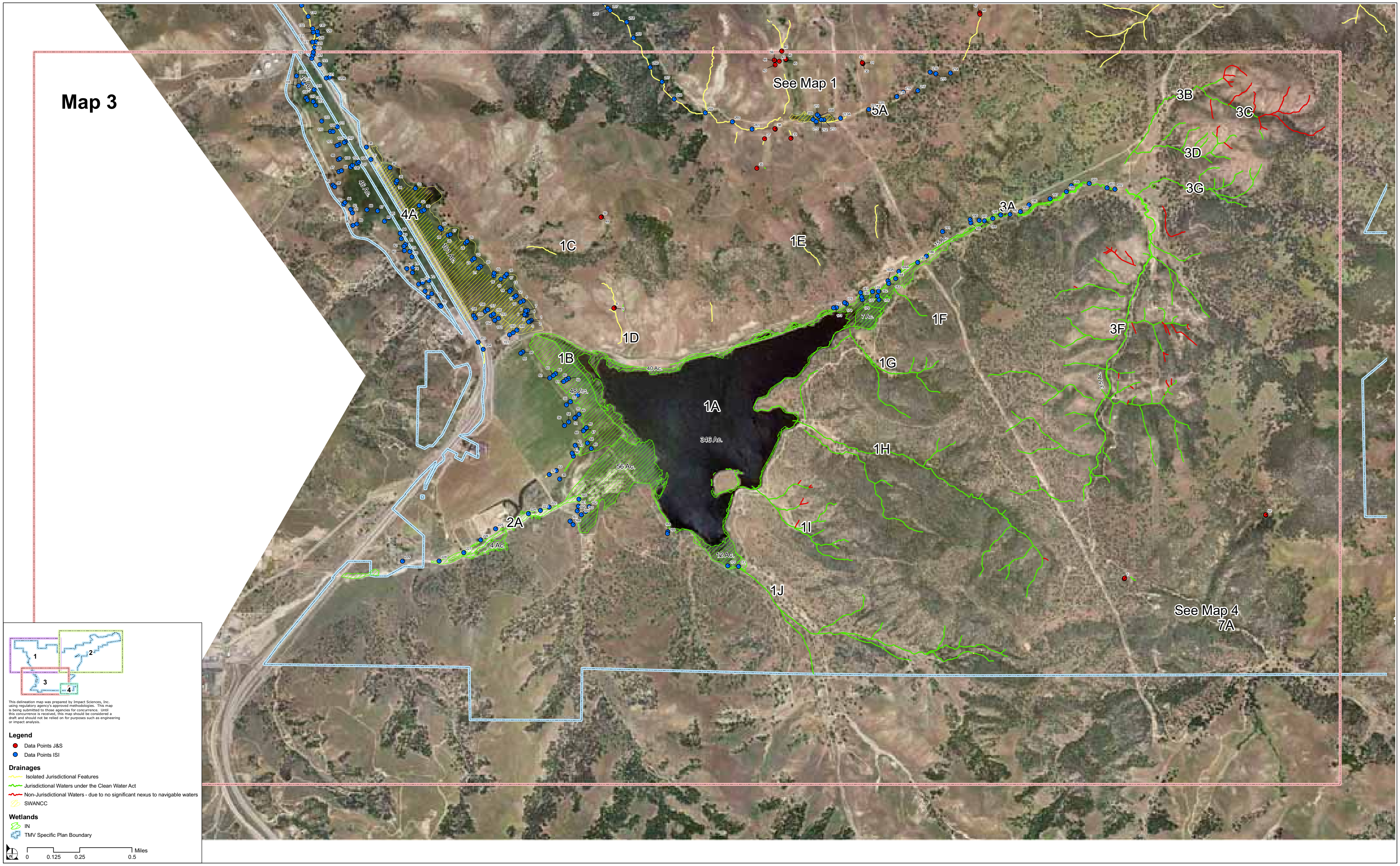
Feet
0 1,000

DUDEK

Tejon Mountain Village Specific Plan Area - Biological Resources Technical Report

Vegetation Community Map - Sheet 14

FIGURE
4.1-1P



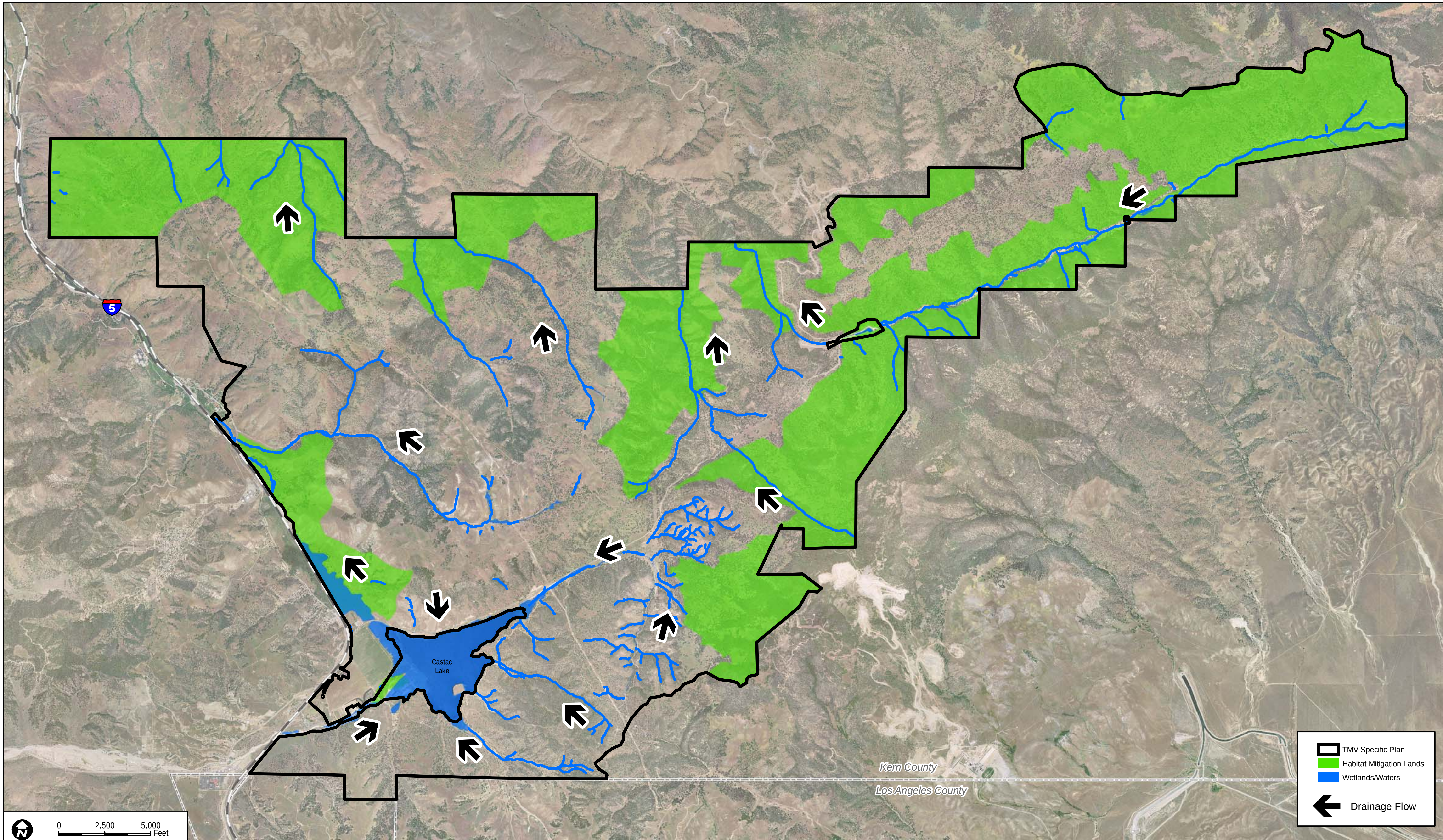
SOURCE: Impact Sciences, Inc. - November 2007

FIGURE 6

Castac Lake and Adjacent Wetlands

317-028•08/08

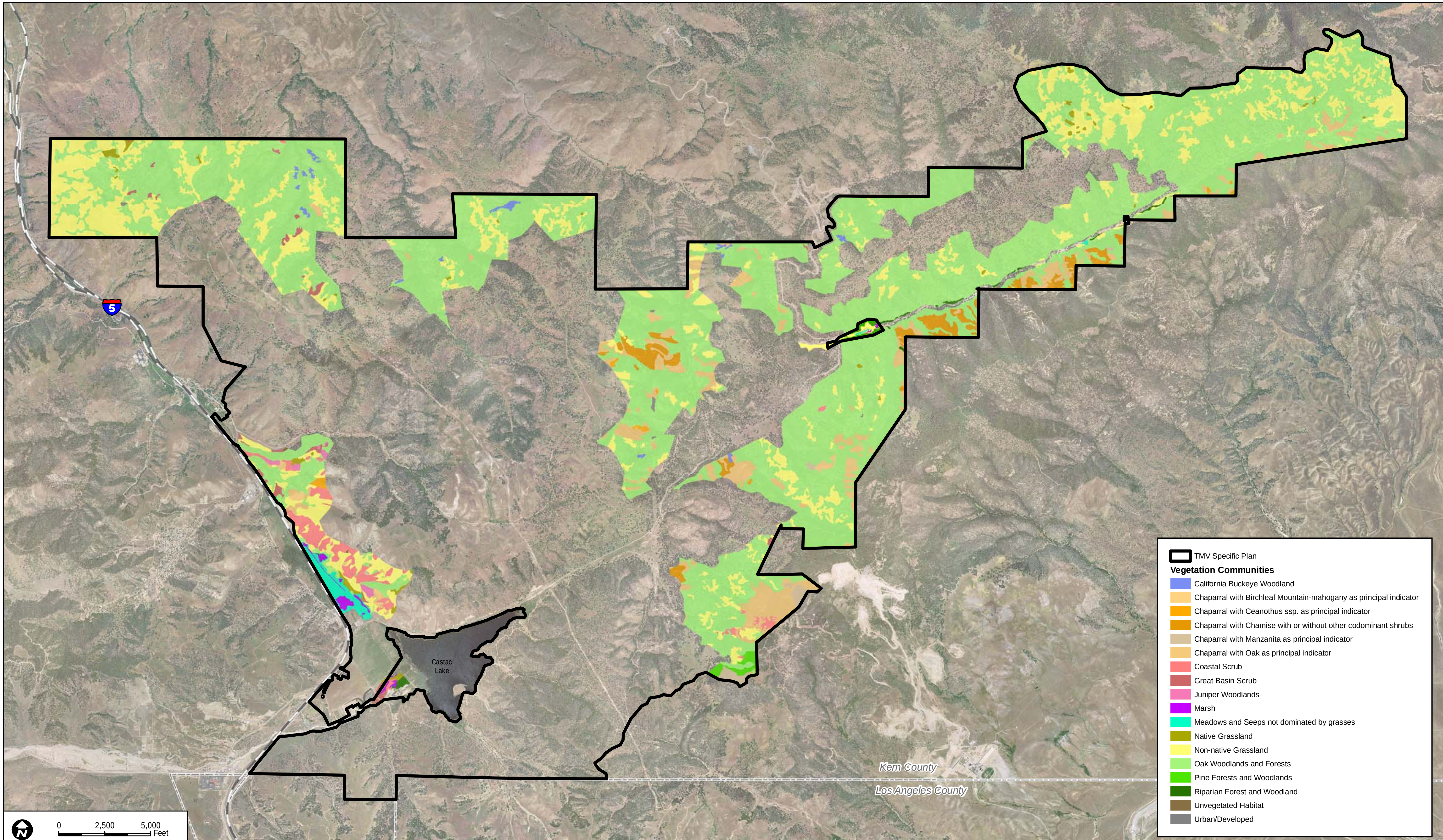
FILE: \\Prometheus\GIS-Data\317-025_Tejon\Mxd\Jurisdiction\Figures_073108\Figure6TejonLakeAdjacentWatersheds_24x36_073108.mxd



SOURCE: TRC 2007

FIGURE 2-9

Drainage Direction on Habitat Mitigation Lands



SOURCE: TRC 2007

FIGURE 3-1

Vegetation Communities on Habitat Mitigation Lands

NDVI Trend (1985-2018)


The Nature Conservancy
GDE Pulse
Home
Map
Methodology
Data
GDE Outlines
Groundwater Wells
Shallow aquifer
Uncertain aquifer type
Deep aquifer
Groundwater Dependent Ecosystems (GDEs)
NDVI Trend (1985 - 2018)
Large increase
Moderate increase
Little or no change
Moderate decrease
Large decrease
NDVI Trend (2009 - 2018)
NDVI Trend (2014 - 2018)
NDMI Trend (1985 - 2018)
NDMI Trend (2009 - 2018)
NDMI Trend (2014 - 2018)
Groundwater Basins
Lebec
VEGETATION
Wet Meadows
Dominant Species Common Name: Not applicable
Dominant Species Scientific Name: Not applicable
Year Vegetation was Mapped: 2002-01-01
GDE ID: 141124
Displaying data from 1985 - 2018
SUMMER NDVI (average from July 9 to Sept 7)
+ 0.02
0.5
0.4
0.3
1985
2018
SUMMER NDMI (average from July 9 to Sept 7)
- 0.02
0.2
0.1
0.0
-0.1
-0.2
1985
2018
ANNUAL PRECIPITATION (inches of rain from Oct 1 to Sept 30)
- 3.45
30
20
10
1985
2018
Download Data
Learn how to interpret these charts
Learn more about the downloadable data

NDMI Trend (1985-2018)


The Nature Conservancy
GDE Pulse
Home
Map
Methodology
Data
GDE Outlines
Groundwater Wells
Shallow aquifer
Uncertain aquifer type
Deep aquifer
Groundwater Dependent Ecosystems (GDEs)
NDVI Trend (1985 - 2018)
NDVI Trend (2009 - 2018)
NDVI Trend (2014 - 2018)
NDMI Trend (1985 - 2018)
Large increase
Moderate increase
Little or no change
Moderate decrease
Large decrease
NDMI Trend (2009 - 2018)
NDMI Trend (2014 - 2018)
Groundwater Basins
VEGETATION
Wet Meadows
Dominant Species Common Name: Not applicable
Dominant Species Scientific Name: Not applicable
Year Vegetation was Mapped: 2002-01-01
GDE ID: 141124
Displaying data from 1985 - 2018
SUMMER NDVI (average from July 9 to Sept 7)
+ 0.02
0.5
0.4
0.3
1985
2018
SUMMER NDMI (average from July 9 to Sept 7)
- 0.02
0.2
0.1
0.0
-0.1
-0.2
1985
2018
ANNUAL PRECIPITATION (inches of rain from Oct 1 to Sept 30)
- 3.45
30
20
10
1985
2018
Download Data
Learn how to interpret these charts
Learn more about the downloadable data

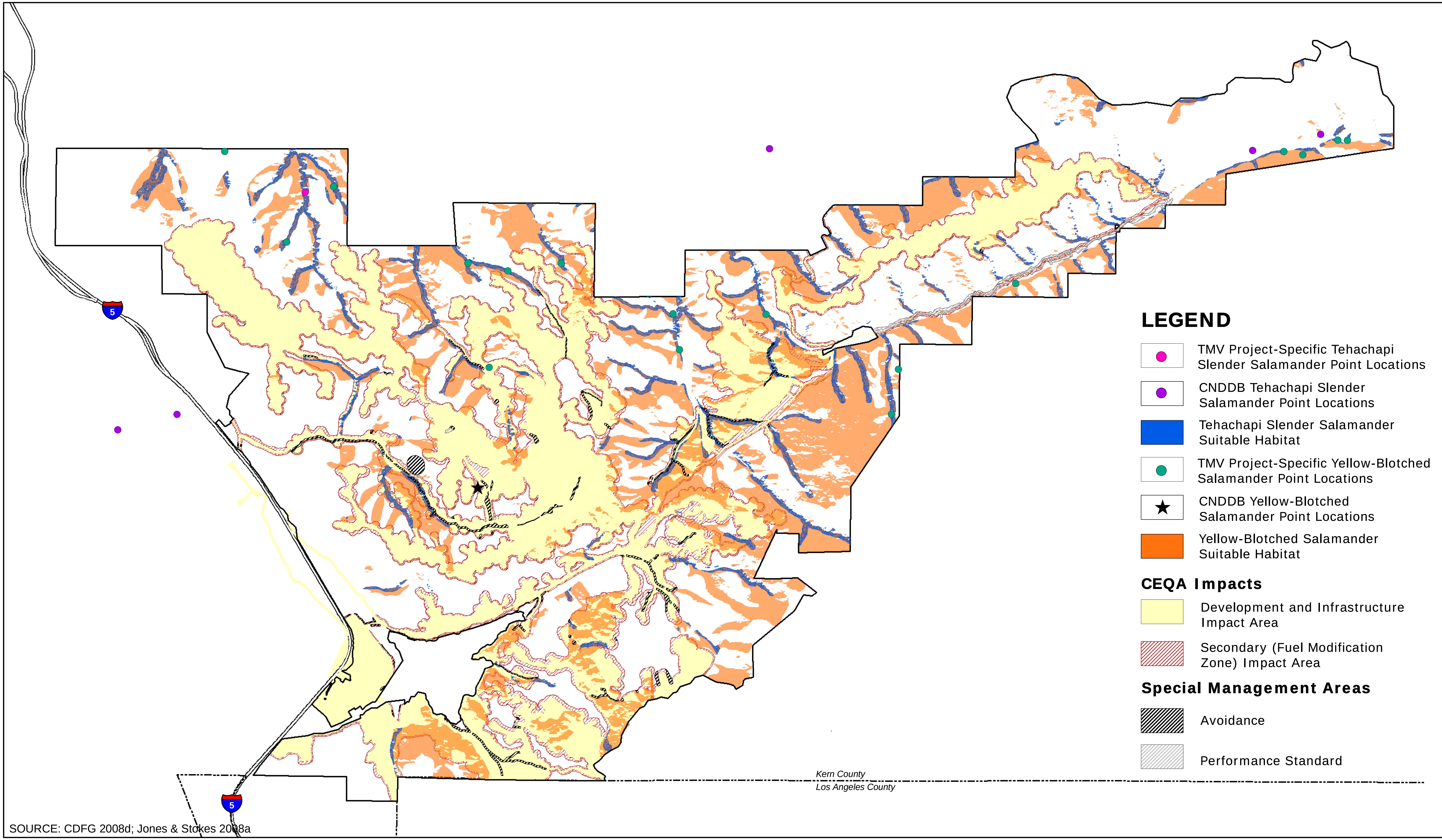
Appendix G

The Nature Conservancy Freshwater Species List for the Castac Lake Valley Basin

Freshwater Species List for the Castac Lake Valley GSA was made available by The Nature Conservancy (TNC) at https://groundwaterresourcehub.org/sgma-tools/environmental-surface-water-beneficiaries/

Header rows correspond to the following:

Attribute	Explanation
OBJECTID	Processing field - ignore
Elements_GROUP_	Taxonomic grouping (Mammal, Bird, Fishes, Herps, Mollusks, Crustaceans, Insects & other inverts, Plants)
Elements_ELM_SCINAM	Scientific name
Elements_ELM_COMNAM	Common name
Elements_Fed_list	Status on Federal Endangered Species List as of April 13, 2015
Elements_State_list	Status on California Endangered Species or Sensitive Species lists as of April 13, 2015
Elements_Other_list	Status on other sensitive species lists as of April 13, 2015
Elements_MgtAg_list	Status on land management agency (USFS, BLM) sensitive species lists as of April 13, 2015
ObservationType_ObsTyp_Name	Observation Type Name (e.g., observations, modeled habitat, range, critical habitat)
Format_Fmt_Name	Format Name (Point, Line, Polygon)
HabitatUsage_HabU_Name	Habitat Usage Name (e.g., spawning, migration, breeding, wintering)
Source_Source_Name	Short name for source of species occurrence information



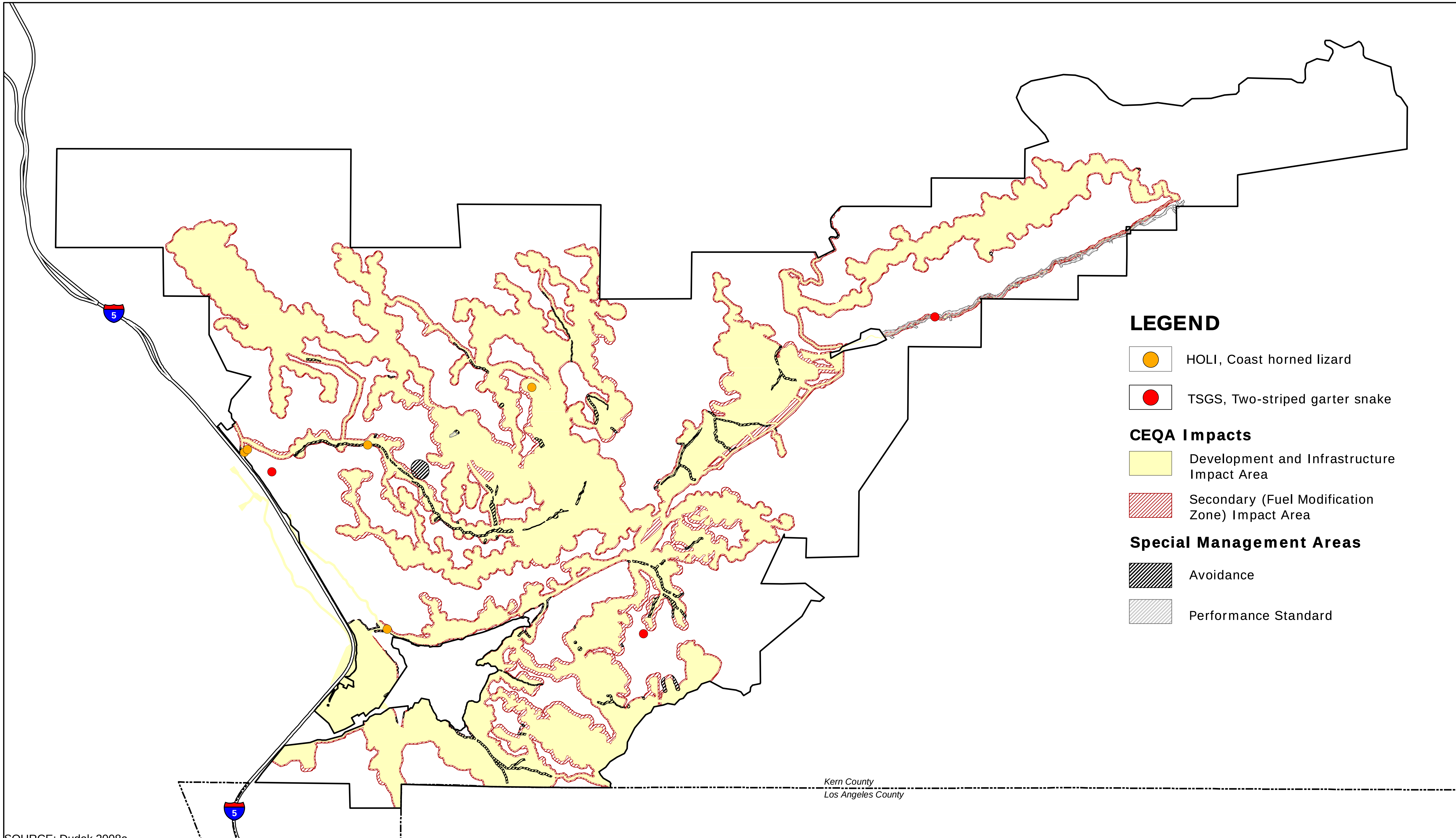
Tejon Mountain Village

EIR

Figure 4.4-8
SPECIAL STATUS SALAMANDERS

0 1,000 2,000 3,000 4,000 5,000 Feet

May 2009



SOURCE: Dudek 2008a

Tejon Mountain Village

EIR

Figure 4.4-9

SPECIAL-STATUS REPTILES

Feet
0 1,000 2,000 3,000 4,000 5,000

May 2009

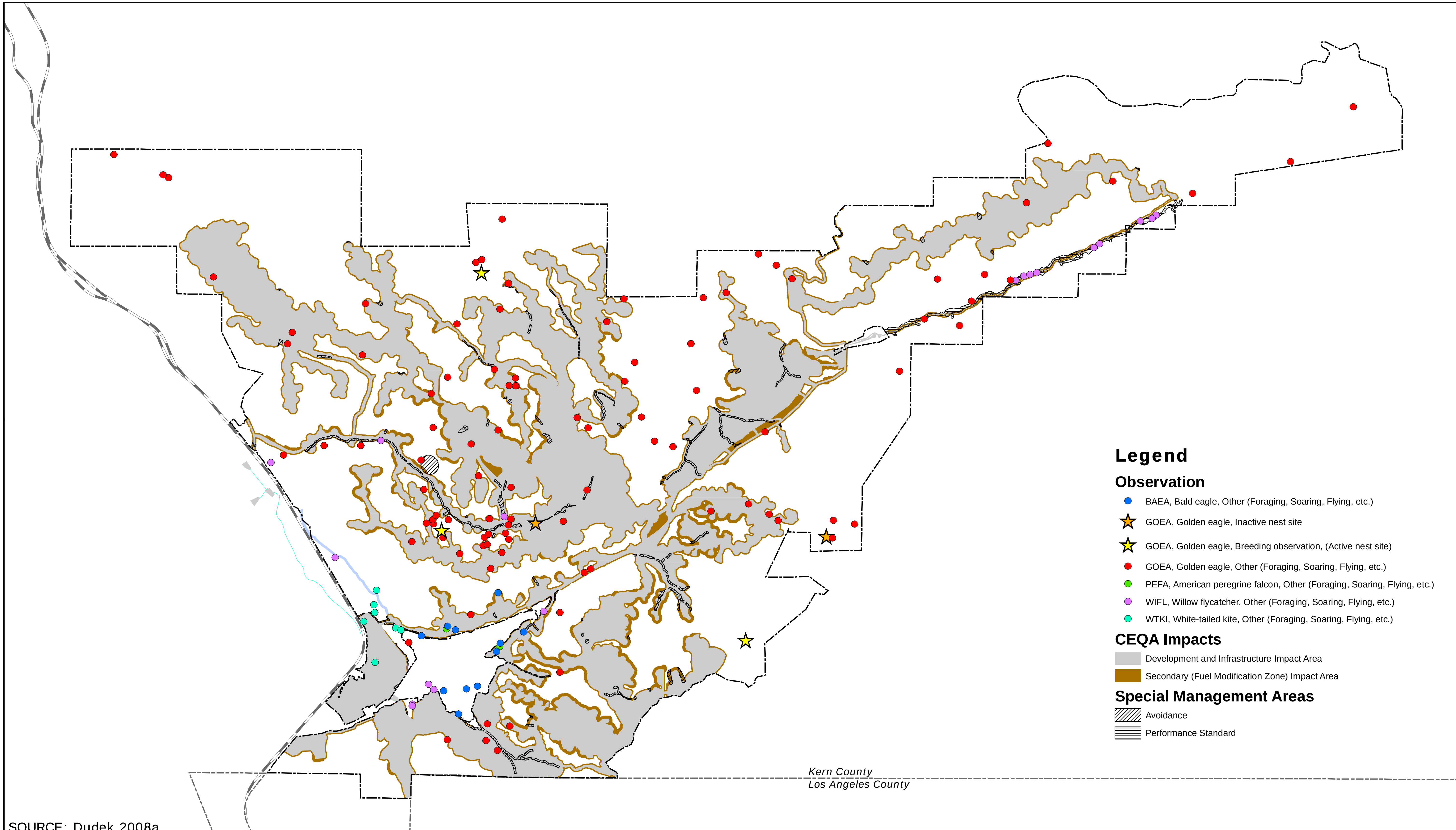


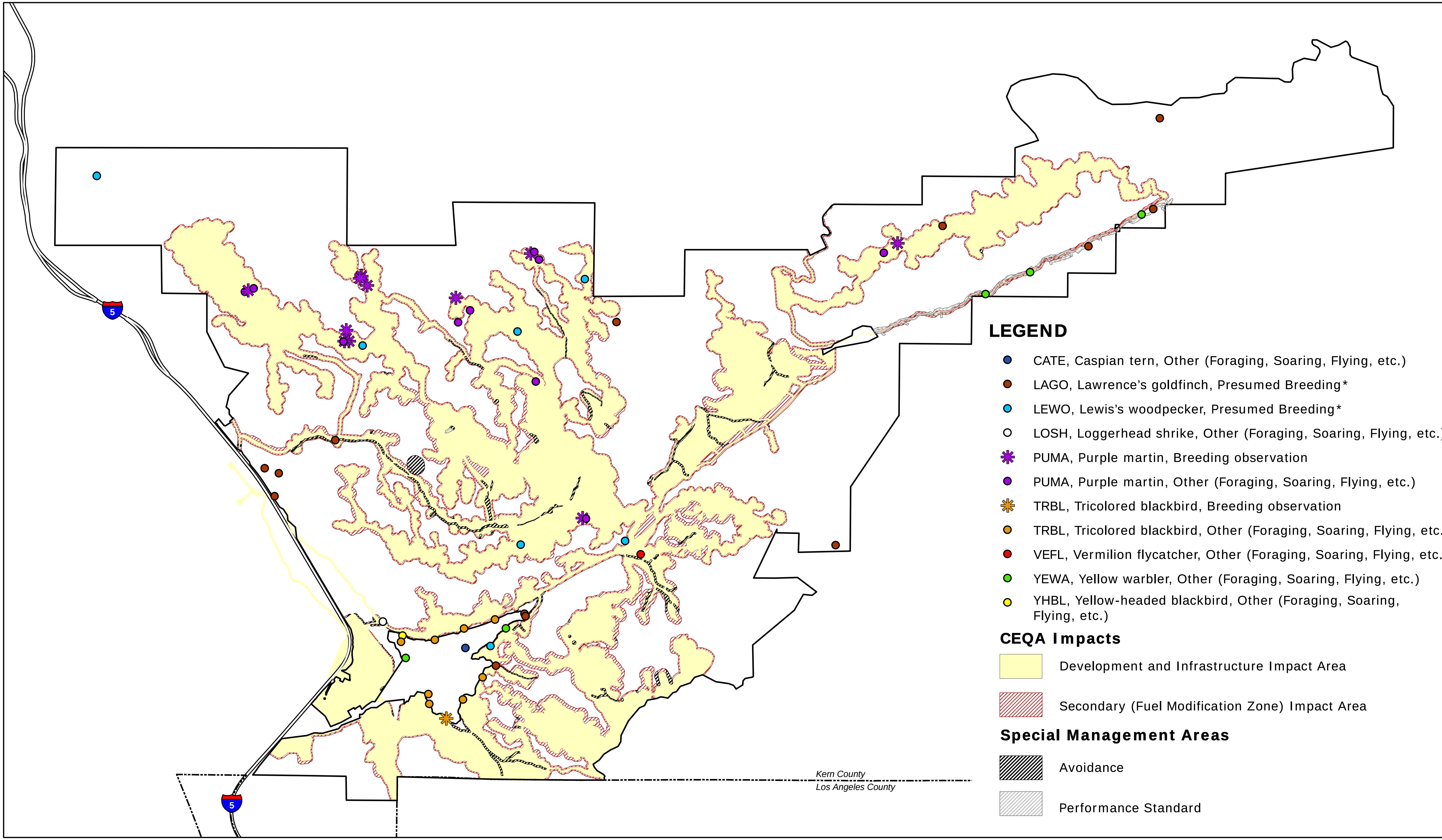
Figure 4.4-10

Tejon Mountain Village

EIR

FEDERALLY LISTED, STATE LISTED OR FULLY PROTECTED BIRDS

May 2009



Tejon Mountain Village

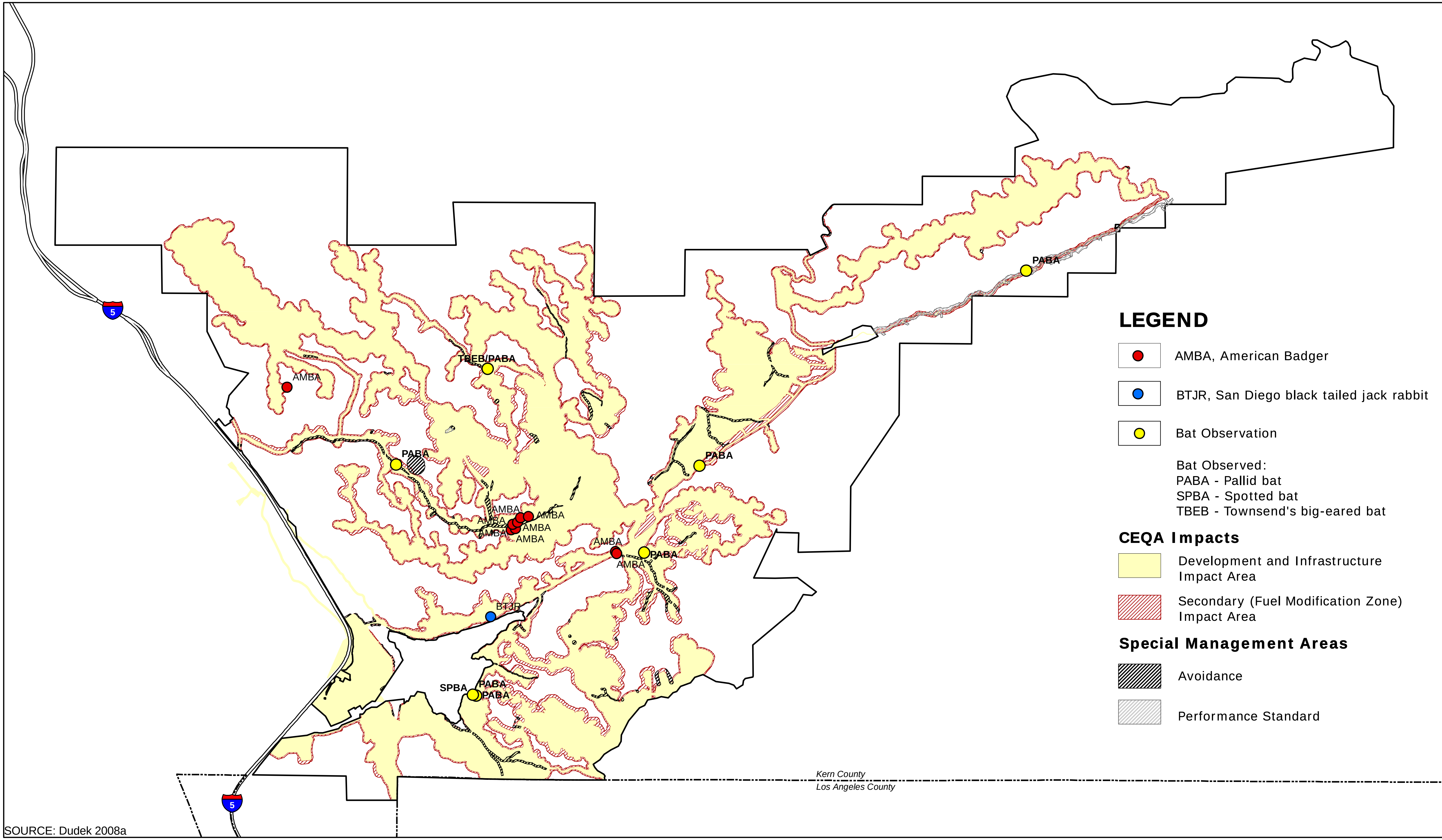
EIR

Figure 4.4-11

OTHER SPECIAL STATUS BIRDS

0 1,000 2,000 3,000 4,000 5,000 Feet

May 2009



SOURCE: Dudek 2008a

Tejon Mountain Village

EIR

Figure 4.4-12

SPECIAL-STATUS MAMMALS

0 1,000 2,000 3,000 4,000 5,000 Feet

May 2009

The Nature Conservancy Freshwater Species List for the Castac Lake Valley Basin

OBJECTID	Elements_GROUP_	Elements_ELM_SCINAM	Elements_ELM_COMNAM	Elements_Fed_list	Elements_State_list	Elements_Other_list	Elements_MgtAg_list	ObservationType_ObsTyp_Name	Format_Fmt_Name	HabitatUsage_HabU_Name	Source_Source_Name
1	Herps	Actinemys marmorata marmorata	Western Pond Turtle		Special Concern	ARSSC	BLM, USFS	Modeled habitat/ generalized observation	Polygon	Undefined	California Wildlife Habitat Relationships
2	Herps	Anaxyrus boreas boreas	Boreal Toad					Modeled habitat/ generalized observation	Polygon	Undefined	California Wildlife Habitat Relationships
3	Herps	Rana draytonii	California Red-legged Frog	Threatened	Special Concern	ARSSC		Modeled habitat/ generalized observation	Polygon	Undefined	California Wildlife Habitat Relationships
4	Herps	Thamnophis couchii	Sierra Gartersnake					Modeled habitat/ generalized observation	Polygon	Undefined	California Wildlife Habitat Relationships
5	Herps	Thamnophis sirtalis sirtalis	Common Gartersnake					Modeled habitat/ generalized observation	Polygon	Undefined	California Wildlife Habitat Relationships
6	Mollusks	Pyrgulopsis greggi	Kern River Pyrg		Special	E		Current observations (post 1980)	Polygon	Undefined	California Natural Diversity Database (4/2016)
7	Birds	Agelaius tricolor	Tricolored Blackbird	Bird of Conservation Concern	Special Concern	BSSC - First priority	BLM	Current observations (post 1980)	Point	Undefined	CLO EBIRD
9	Birds	Anas clypeata	Northern Shoveler					Current observations (post 1980)	Point	Undefined	CLO EBIRD
10	Birds	Anas cyanoptera	Cinnamon Teal					Current observations (post 1980)	Point	Undefined	CLO EBIRD
11	Birds	Anas platyrhynchos	Mallard					Current observations (post 1980)	Point	Undefined	CLO EBIRD
12	Birds	Anas strepera	Gadwall					Current observations (post 1980)	Point	Undefined	CLO EBIRD
13	Birds	Aythya americana	Redhead		Special Concern	BSSC - Third priority		Current observations (post 1980)	Point	Undefined	CLO EBIRD
14	Birds	Aythya collaris	Ring-necked Duck					Current observations (post 1980)	Point	Undefined	CLO EBIRD
15	Birds	Bucephala albeola	Bufflehead					Current observations (post 1980)	Point	Undefined	CLO EBIRD
16	Birds	Haliaeetus leucocephalus	Bald Eagle	Bird of Conservation Concern	Endangered		USFS, BLM	Current observations (post 1980)	Point	Undefined	CLO EBIRD
17	Birds	Oxyura jamaicensis	Ruddy Duck					Current observations (post 1980)	Point	Undefined	CLO EBIRD
18	Birds	Pelecanus erythrorhynchos	American White Pelican		Special Concern	BSSC - First priority		Current observations (post 1980)	Point	Undefined	CLO EBIRD
19	Birds	Setophaga petechia	Yellow Warbler			BSSC - Second priority		Current observations (post 1980)	Point	Undefined	CLO EBIRD
23	Herps	Anaxyrus boreas halophilus	California Toad			ARSSC		Unknown	Point	Undefined	MCZ Herp
24	Herps	Pseudacris cadaverina	California Treefrog			ARSSC		Unknown	Point	Undefined	USNM Amphibians & Reptiles
26	Herps	Pseudacris regilla	Northern Pacific Chorus Frog					Unknown	Point	Undefined	USNM Amphibians & Reptiles
30	Herps	Thamnophis hammondii hammondii	Two-striped Gartersnake		Special Concern	ARSSC	BLM, USFS	Unknown	Point	Undefined	USNM Amphibians & Reptiles
33	Plants	Baccharis salicina				Not on any status lists		Unknown	Point	Undefined	UCJEPS JEPS
34	Plants	Helenium puberulum	Rosilla					Unknown	Point	Undefined	UCJEPS JEPS
35	Plants	Juncus xiphioides	Iris-leaf Rush					Current observations (post 1980)	Point	Undefined	RSA
36	Plants	Perideridia pringlei	Pringle's Yampah		Special	CRPR - 4.3		Current observations (post 1980)	Point	Undefined	RSA
37	Plants	Phacelia distans	NA					Current observations (post 1980)	Point	Undefined	RSA
38	Plants	Salix laevigata	Polished Willow					Current observations (post 1980)	Point	Undefined	RSA
39	Plants	Schoenoplectus acutus occidentalis	Hardstem Bulrush					Unknown	Point	Undefined	DS DS
40	Plants	Typha domingensis	Southern Cattail					Current observations (post 1980)	Point	Undefined	RSA
41	Plants	Typha latifolia	Broadleaf Cattail					Current observations (post 1980)	Point	Undefined	RSA

Appendix H

Historical Water Budget Spreadsheet Model Approach

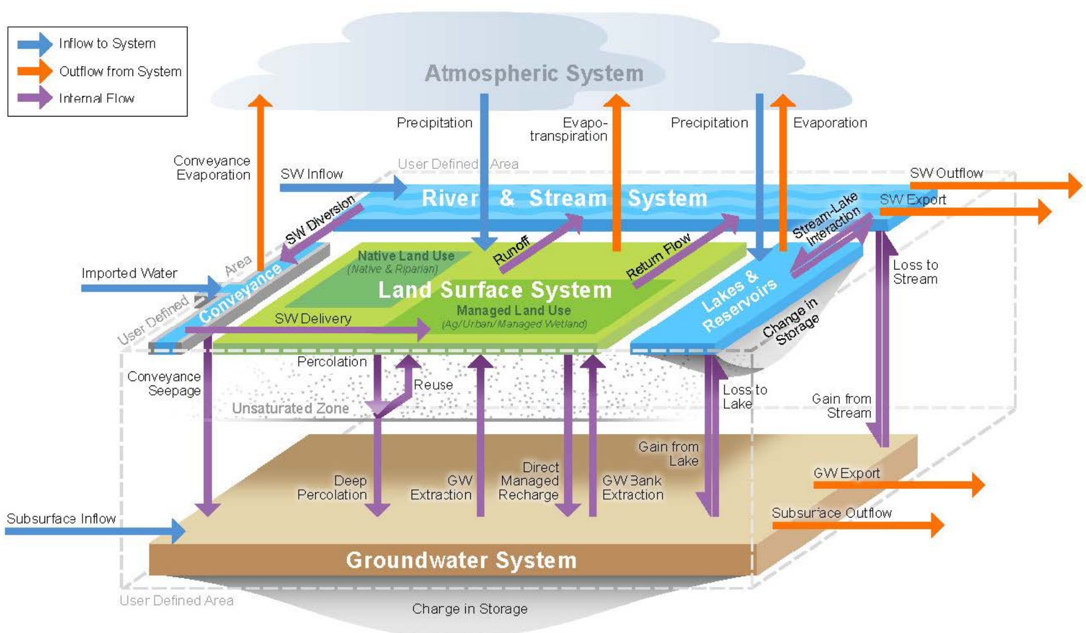
APPENDIX H
Spreadsheet Water Budget Model Overview

A water budget is an accounting of all water inflows to and outflows from a given spatial domain, and enforces the principle of mass balance through use of a change in water storage term. A water budget is expressed by the following simple equation:

Inflows - Outflows = Change in Storage

The above fundamental equation holds true for any defined domain (e.g., parcel, watershed, basin, etc.) and length of time (e.g., day, month, year, etc.) and, when properly constructed using process- and/or physics-based components, serves as a powerful tool for understanding water flow through a system.

Figure H-1: DWR Water Budget Schematic (Fig. 7 from DWR's SGMA BMP #4, pg. 30)



1 Description of Water Budget Framework

A water budget "framework" has been developed to inform the development of a water budget model for the Castac Lake Valley Groundwater Basin that is consistent with the requirements of the Sustainable Groundwater Management Act (SGMA) and further described below. The conceptual water budget model is depicted on **Figures WB-1 and WB-2** of the Castac Basin Groundwater Sustainability Agency (GSA)'s Groundwater Sustainability Plan (GSP) and is further described below.

1.1 Water Budget Subdomains

The water budget is divided into five internal subdomains, each influenced by a number of flow components and within which mass-balance is enforced (i.e., the sum of inflow components is balanced by the sum of outflow components and/or a change in storage component). **Figure WB-1** shows the water budget domain, and the following internal subdomains:

a. Natural Channels and Castac Lake
b. Irrigated Agricultural lands
c. Undeveloped non-irrigated lands
d. Developed Areas, and
e. Groundwater Basin system

In addition to the five internal subdomains, several external subdomains are incorporated into the spreadsheet model. These include the atmosphere which is a source of precipitation and sink for evapotranspiration, the watersheds that contribute streamflow to streams and small channels entering the Basin, and groundwater entering and leaving the Basin. The spreadsheet model does not explicitly account for the vadose (unsaturated) zone between the land surface and the (saturated) groundwater system. An implicit assumption in this approach, therefore, is that storage in the vadose zone is constant over time.

1.2 Water Budget Flow Components

Within and between each subdomain are 27 water budget flow components that route water through the Basin. **Figure WB-2** shows a conceptual diagram of the individual water budget flow components between subdomains as well as flow components that are external to the overall water budget domain (i.e., serve only as an inflow or outflow to the entire system, rather than a flow between subdomains).

Certain components are based on "raw" data which are directly measured and based on historical records. These "raw" components are considered to have a relatively high degree of certainty. Other components are estimated using a variety of analytical methods (e.g., Darcy's Law to calculate subsurface flows across the domain's external boundaries) and are thus subject to greater uncertainty based on the parameters used in their estimation. Some components (e.g., groundwater pumping for developed area use) constitute major proportions of the overall water budget and have thus been given significant attention. Others are relatively minor in magnitude (e.g., infiltration from developed areas) and are, to some degree, less significant to the overall water budget and less well defined.

While the various subdomains and linkages shown on **Figures WB-1** and **WB-2** indicate a complex system, the use of such a component-based bottom-up approach allows each component to be considered separately which can benefit model development and application. For example, if new data or methods become available for a certain component, they can be easily plugged into the appropriate component without disturbing the rest of the model.

1.3 Water Budget Time Period

DWR's Water Budget BMP requires quantification of historical water budget components for at least the past 10 years. Additionally, the water budget should represent average hydrology, with both wet and dry years. The long-term average precipitation recorded at the Lebec climate station between Water Years (WY) 1949 and 2018 is 12.0 inches per year (in/yr). The average precipitation recorded at the Lebec climate station between WY 1998 and 2018 is 11.5 in/yr, similar to the long-term average. Within this 21-year period, there were five wet years, three above-normal years, three below-normal years, five dry years, and five critical (dry) years based on DWR's San Joaquin Valley WY Index.[1] Therefore this 21-year period (WY 1998-2018) adequately represents average hydrologic conditions for quantifying the historical water budget. The water budget spreadsheet model was developed to estimate the magnitude of water budget flow components and the resulting change in groundwater storage to the Basin's aquifer system for the historical time period WY 1998 – 2018.

2 Water Budget Spreadsheet Model Functionality

The water budget spreadsheet model was developed using Microsoft Excel. The complete model consists of one Excel (.xlsx) workbook with several individual spreadsheet tabs which can generally be grouped into four categories:

- "Master" Model (green tab)
- "User Input Parameters" and Model Calibration (yellow tabs)
- Presentation and Reporting (blue tabs)
- "Backend" Data and Calculations (orange tabs)

2.1 "Master" Model

The final calculations for the historical (1998 - 2018) water budget components occur within the "master" tab **"HistoricalWB_GSP"**. Each column of the master spreadsheet represents an individual water budget flow component or associated calculation. Flow components are grouped by Water Budget Domain/Subdomain, and the main flow components are listed by number (1 through 27) in row 2 of the master tab. Each row of the master spreadsheet after the header rows represents a single month in the model period, as defined in column D. All values are listed in acre-feet (AF). Monthly values are subsequently summarized by water year at the bottom the master tab in rows 260-280.

The master tab has been fully populated with data via linkages with the "backend" data and calculation spreadsheets (described in further detail below) and/or through calculations made directly within the master tab, and in all cases <u>should not be directly edited</u> unless intending to override the existing data with updated inputs.

2.2 "User Input Parameters" and Model Calibration

Various "User Input Parameters" are included to assist in calibration of the historical water budget. These are listed in the **"Control"** and **"Area"** tabs, and include:

- Controls:
    - Hydraulic Conductivity along the upgradient Basin Boundary (to estimate Basin subsurface inflow; see **Section 3.7.6 below**)
    - Hydraulic Conductivity along the southern Basin Boundary (to estimate Basin subsurface outflow; see **Section 3.7.12** below)
    - Hydraulic Conductivity of the lake sediments (to estimate lake seepage to groundwater; see **Section 3.3.7** below)

[1] http://cdec.water.ca.gov/reportapp/javareports?name=WSIHIST

- Specific Yield (to estimate water level changes as a result of groundwater storage changes)
- Effective Precipitation Percentage
- Ineffective Precipitation Infiltration Fraction (to estimate evaporation, runoff, and deep percolation from ineffective precipitation; see **Section 3.5.3** below)
- Castac Watershed Consumptive Use Fraction (to estimate runoff and streamflows into the Basin; see **Section 3.2.2** below)
- Upgradient Watershed Consumptive Use Fraction (to estimate runoff and streamflow from Cuddy Creek into the Basin; see **Section 3.2.2** below)
- Precipitation Thresholds for Runoff (to estimate runoff and streamflows into and within the Basin; see **Section 3.2.2** below)
- Developed Area Consumptive Use Fraction (see **Section 3.6.4** below)
- Irrigation Infiltration Fraction (to estimate the fraction of applied irrigation water that percolates to groundwater; see **Section 3.4.8** below)
- Fraction of ET from Groundwater (to estimate the ET from shallow groundwater; see **Section 3.7.10** below)
- Streamflow Infiltration Fraction (see **Section 3.3.8** below)
- Surface Water baseflow factor (to estimate surface water outflow; see **Section 3.3.9** below)
- Surface Water Outflow Multiplier (to estimate surface water outflow; see **Section 3.3.9** below)
- Overtopping volume limit (threshold at which Castac Lake spills into Grapevine Creek; see **Section 3.3.9** below)
- Orographic Scaling Factor – upgradient watersheds (to estimate precipitation in upslope watersheds; see **Section 3.2.1** below)
- Orographic Scaling Factor – Castac watersheds (to estimate precipitation in upslope watersheds immediately surrounding the Basin; see **Section 3.2.1** below)

- Areas:
  - Upgradient Watershed areas
  - Basin area
  - Lake area – monthly time series, varies annually based on lake stage, lake area is held constant for each month within a year
  - Irrigated area – monthly time series, held constant
  - Non-irrigated area – monthly time series, varies based on Lake area
  - Developed area – monthly time series, held constant

Many of these “User Input Parameters” have been adjusted to reflect the best available information and/or calibrated to optimize model response but can be adjusted manually to reflect updated information or to test model response. Adjustments to the User Input Parameters are made within the **“Control”** tab of the model. Water budget calibration is achieved by aligning the historical water level trends calculated in the master model tab to average historical water levels measured in wells located in the central Castac Lake portion of the Basin. This is principally done via adjustment of select User Input Parameters specified above, and subsequent assessment of the resulting fit of the model-calculated water levels within the model period. The measured water levels used for this analysis are listed in the **“WaterLevelData”** tab of the Excel workbook. All user input parameter and calibration-related spreadsheets are denoted in yellow.

2.3 Presentation and Reporting

Live tables and figures that have been developed for inclusion in the GSP, as well as several associated presentation & reporting related tabs, can be found in the blue shaded tabs. These include:

- Exhibits used in the GSP, including:
    - **“Table WB-2”** – Annual Surface Water Inflows and Outflows by Source Type
    - **“Table WB-3”** – Annual Inflows to and Outflows from the Groundwater System, and Change in Storage
    - **“Table WB-4” –** Annual and Cumulative Change in Groundwater Storage between Seasonal Highs
    - **“Table WB-5” –** Annual Change in Groundwater Storage vs. DWR Water Year Type
    - **“Table WB-6”** – Sustainable Yield for Selected Time Periods
    - **“Table WB-7” –** Annual Total Inflows, Outflows, and Change in Groundwater Storage
    - **“Figures_GSP”** – includes all graphs used to develop GSP Figures
- Spreadsheets supporting development of GSP exhibits, including:
    - **“horiz_bar_chart”** – used to summarize water budget components for reporting in Figure WB-6 and Figure WB-15

2.4 “Backend” Data and Calculations

All other tabs within the Excel workbook contain various input data and calculations used to support water budget calculations in the Master tab and should not be edited. Orange tabs represent spreadsheets having raw input data or a calculation or series of calculations for incorporation into the historical Master tab. These include:

- **“LebecPptData” –** monthly precipitation rates (inches) measured at the National Oceanic and Atmospheric Administration (NOAA) Lebec climate station
- **“PptScale”** – calculation of orographic scaling factor (see **Table H-1**)
- **“EffPrecip”** – calculation of the average fraction of total precipitation that becomes effective precipitation

- **“ETData”** – monthly Reference Evapotranspiration (ETo) rates measured at the closest California Irrigation Management Information System (CIMIS) Stations and average monthly pan evaporation data measured at historical Tejon 56A weather station used to estimate evapotranspiration (ET) and evaporation (see **Sections 3.4.5** and **3.5.2** below)
- **“Pumping”** – monthly groundwater pumping rates in acre-feet
- **“Landuse_current”** – current (2016) land use acreage
- **“GW Outflow”** – calculates the groundwater outflow (see **Section 3.7.11** below)
- **“GW Inflow”** – calculates the groundwater inflow from up-gradient Cuddy Canyon Basin (see **Section 3.7.6** below)
- **“Lake Seepage to GW”** – calculates the monthly lake seepage to groundwater (see **Section 3.3.7** below)
- **“GW Seepage to Lake”** – calculates the monthly groundwater seepage to the lake (see **Section 3.3.5** below)
- **“SW Outflow”** - calculates the surface water outflow from the Basin that runs off (see **Section 3.3.9** below)
- **“WaterLevelData”** – measured water level data used for model calibration
- **“Lake Check”** – measured lake level data used for model calibration and calculating the average yearly lake elevation for lake area specification

3 Model Inputs & Outputs

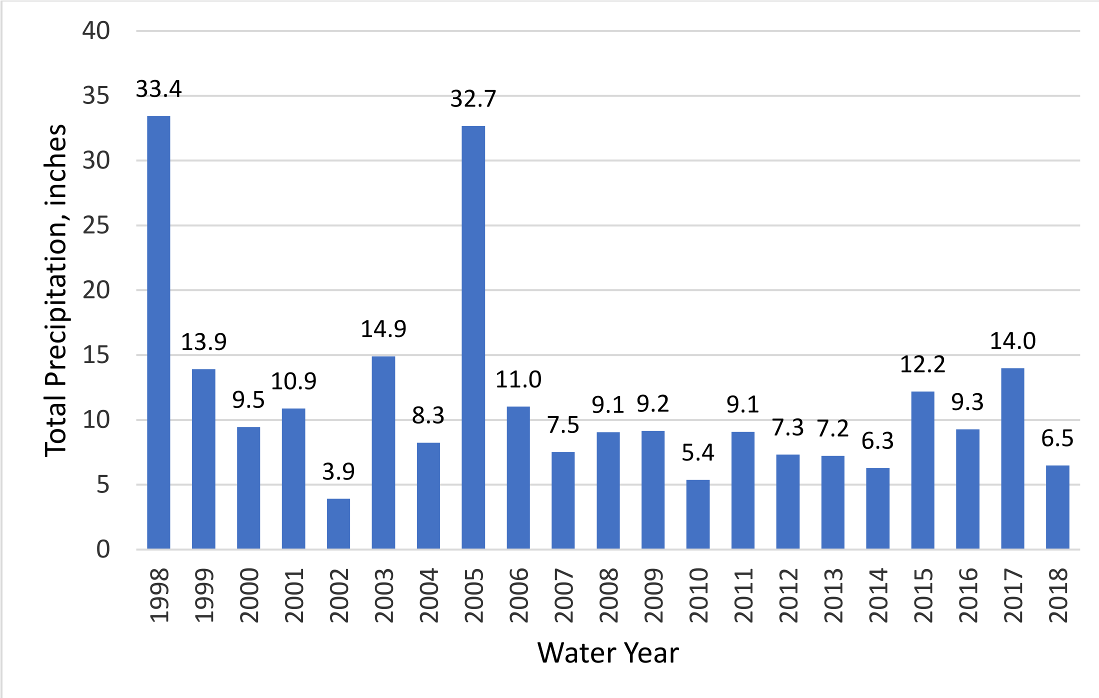
3.1 Atmospheric Domain

3.1.1 Precipitation

Precipitation on Basin lands is estimated from the Lebec climate station (NOAA Coop ID #44863)[2]. The Lebec Station reports monthly precipitation data (in inches per month; [in/mo]), for the entire water budget period October 1997 through September 2018. **Figure H-2** below shows the monthly precipitation values for the Lebec Station for WY 1998-2018.

[2] www.wrcc.dri.edu/cgi-bin/cliMAIN.pl?ca4863

Figure H-2: Precipitation Measured at the Lebec Climate Station, WY 1998-2018

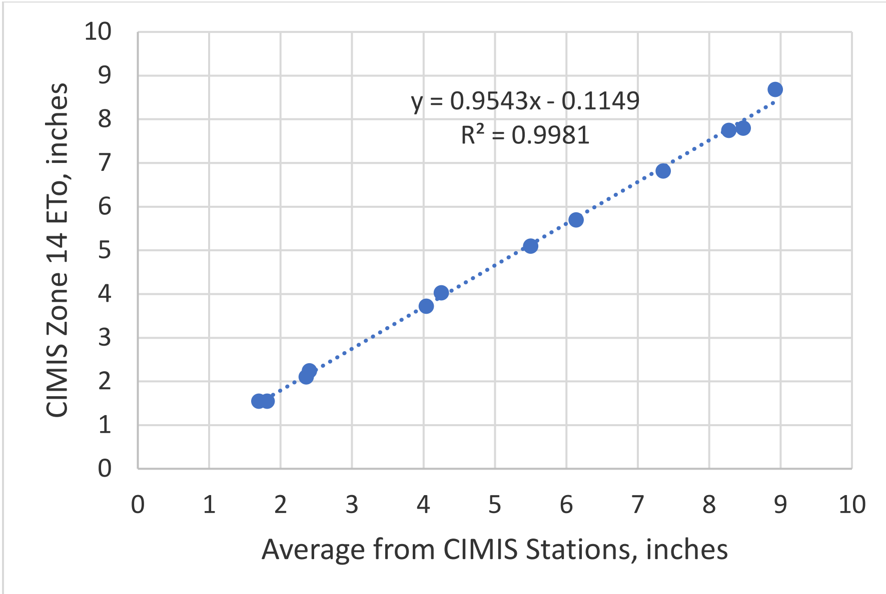


3.1.2 Reference Evapotranspiration

The Basin is located in CIMIS ETo Zone 14.[3] No nearby CIMIS stations exist, so monthly ETo rates were estimated from monthly ETo data obtained from CIMIS stations 125 (Arvin-Edison) and 88 (Cuyama). A regression was developed to determine the relationship between the average monthly ETo from these two stations and average monthly ETo for CIMIS Zone 14; there is a strong correlation between these two data sets (**Figure H-3**). Therefore, the regression equation was used to adjust the monthly ETo from these two stations to create a time series of monthly ETo values for the Basin.

[3] CIMIS, 1999, CIMIS Reference Evapotranspiration. Map prepared by DW Jones 1999, Data developed by RL Snyder, S Eching, and HG MacPherson. https://cimis.water.ca.gov/App_Themes/images/etozonemap.jpg

Figure H-3: Relationship between Average Monthly ETo from CIMIS Stations and CIMIS Zone 14



3.2 Watersheds Domain

3.2.1 Precipitation (Component 1)

There is an elevation difference of nearly 5,000 feet between the Basin lands and the peaks of the surrounding watersheds in the Tehachapi mountains that contribute to runoff and streamflow to the Basin. Precipitation falling on watersheds surrounding the basin is calculated as the product of the area of these watersheds, the Lebec station monthly precipitation rate, and an orographic scaling factor.

An orographic scaling was calculated for several sub-watersheds surrounding the Basin using the difference in average elevation of the sub-watershed and elevation at the Lebec Station, and the distance from the sub-watersheds to the Lebec station.[4]

The precipitation orographic scaling factor is calculated as: *1 + Dz*B*, where

Dz is the elevation difference between the sub-watershed and the Lebec Station and

B is the regression slope, set conservatively to 0.6 km^{-1}. The range for B in Daly et al. (1994) is 0.6 km^{-1} to 1.3 km^{-1}.

Table H-1 presents the approximate elevation (in feet above mean sea level; [ft msl]) and average orographic scaling factors employed in the water budget for the area immediately surrounding the Castac Basin (1.09) and the upgradient watersheds feeding into the Basin from Cuddy Creek (1.31).

[4] Daly, C., Neilson, R.P., Phillips, D.L., 1994, A Statistical-Topographic Model for Mapping Climatological Precipitation over Mountainous Terrain, Journal of Applied Meteorology, v. 33, pp. 140-158

Table H-1. Orographic Scaling Factor

Location	Average Elevation (ft msl)	Average Elevation (m msl)	Elevation Difference from Lebec Station (m)	Elevation Difference from Lebec Station (km)	Precipitation Orographic Scaling Factor (-)
Lebec Station	3,590	1094	-	-	-
Grapevine Creek Watershed	4,088	1246	152	0.15	1.09
Castac Lake Watershed	4,029	1228	134	0.13	1.08
				Castac Watersheds Average	**1.09**
Castac Lake Watershed	4,029	1228	134	0.13	1.08
Cuddy Canyon Watershed	5,321	1622	528	0.53	1.32
Cuddy Ranch Watershed	6,014	1833	739	0.74	1.44
Cuddy Valley Watershed	5,876	1791	697	0.70	1.42
				Upgradient Watersheds Average	**1.31**

Abbreviations:
km = kilometers
m = meters

3.2.2 Consumptive Use (Component 2)

The consumptive use of the rainfall falling on the watersheds was calculated as the product of the total precipitation on the watersheds and a "Watershed Consumptive Use Fraction" for both the watershed area immediately surrounding the Basin and the greater watershed surrounding the upgradient basins feeding through Cuddy Canyon Basin. The Castac Watershed Consumptive Use Fraction was calibrated to 0.95. This results in 5% of the rainfall on the uplands watershed areas running off and entering the Castac Basin as streamflow. This factor is generally consistent with values used by others, for example Bookman and Edmonston (1965)[5] approximated 5.4% of upland watershed areas is recharged to the Castac Basin. The Upgradient Watershed Consumptive Use Fraction was calibrated to 0.99. This results in 1% of the rainfall on the uplands upgradient watershed areas running off and entering the Castac Basin as streamflow from Cuddy Creek.

The consumptive use fraction was applied only in months where the precipitation exceeded a set "Precipitation Threshold for Runoff Initiation," set to 1.0 inch. In months where the precipitation was below the threshold, all precipitation was assumed to be consumptively used within the watershed. These parameters are defined as "User Input Parameters" in the Control tab.

3.2.3 Streamflow into Basin (Component 3)

Contributing streamflow into the District is calculated as the difference between total precipitation on the watersheds and the portion of water consumptively used.

[5] Bookman and Edmonston, 1965. Geology and Hydrology of the Lebec Groundwater Basin. Report prepared by Bookman and Edmonston, Consulting Civil Engineers, 1965.

3.3 Natural Channels & Castac Lake Domain

3.3.1 Streamflow into the Basin (Component 3)

Streamflow into the Basin is calculated in the Watershed Domain and considered as an input into this domain.

3.3.2 Runoff within the Basin (Component 9)

Runoff within the Basin is calculated in the Undeveloped Non-Irrigated Lands Domain as runoff of ineffective precipitation and considered an input into this domain.

3.3.3 Precipitation (Component 4)

Precipitation on Castac Lake is calculated as the product of the area of Castac Lake and the monthly precipitation rate. The area of Castac Lake changes annually based on the assumed lake elevation-area relationships.[6] For months when Castac Lake levels were measured, an average yearly lake elevation value was calculated. For months when no Castac Lake level information was available, aerial imagery was used to estimate the approximate lake area based on bathymetry contours.[7] The minimum lake area is specified as 81 acres, even when the lake is assumed to be dry, to allow the domain to remain active in which precipitation events may be large enough to minimally fill the base of the lake. Precipitation on stream channels (i.e., Grapevine Creek and Cuddy Creek) is negligible and is not included in the calculation.

3.3.4 Pumpage for Lake Filling (Component 5)

During Water Years 2002 through 2007, and again in Water Year 2012, groundwater was pumped by Tejon Ranch Company (TRC) to maintain water levels in Castac Lake. The volume of groundwater pumped into the lake was recorded by TRC; groundwater used to fill the lake was primarily pumped from wells TRC-PW80 and TRC-PW88, and intermittently from well TRC-PW90.[8] However, after processing monthly well-specific pumping rates as detailed in **Section 3.4.3** below, reported lake filling volumes exceeded reported well-by-well pumping volumes in some months during the 2002-2007 period. For these months, lake filling volumes were reduced so as not to exceed the total of reported well-specific pumping rates for the irrigation wells.

3.3.5 Groundwater Seepage into the Lake (Component 6)

A mass balance model developed for Castac Lake for Water Years 2001-2006 estimated seepage from groundwater into the lake.[9] A regression was developed using this estimated seepage rate and the difference in water level between well TRC-PW56A and Castac Lake to develop a relationship between the water level difference (independent variable) and groundwater seepage into the lake (dependent variable). Using this regression, groundwater seepage into the lake was calculated for the period December 1999 through October 2012 for the months having both well and lake water level data. Groundwater seepage into the lake for months with missing well or lake water level data during this period was estimated using linear interpolation between months with the required well and lake water level

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[6] NV5, 2018. Castac Lake Elevation – Volume-Area-Relationships excel file. Laura Bonich, personal communication, 28 August 2018.

[7] 1-foot bathymetry contours as mapped on "Castac Lake Water Level Analysis" provided by Leah Metzger, TCWD, on 9 July 2019

[8] EKI, 2008, Technical Memorandum No. 6 Preliminary Estimate of the Castac Lake Water Balance and Salt Balance Tejon Mountain Village, LLC. Technical Memorandum to David Friedman and Roberta Marshall, dated January 2008.

[9] *ibid* [8]

data. Prior to December 1999, monthly seepage of groundwater into the lake was estimated as the 2000-2001 average seepage for that month. Groundwater seepage into the lake for the period November 2012 through September 2018 was assumed to be zero. There is no lake level data available during this period for use in estimating the water level difference between the well and the lake and the lake was dry much of the time.

3.3.6 Evaporation (Component 7)

Evaporation from Castac Lake is calculated as the product of the lake area and average monthly pan evaporation measured between 2000 and 2003, as recorded by TRC staff at the Tejon weather station 56A.[10] This monthly time series repeats yearly. Evaporation from other natural channels is negligible and is not included.

3.3.7 Lake Seepage to Groundwater (Component 8)

Castac Lake seepage to groundwater was estimated using Darcy's Law equation, using the gradient between the lake and well TRC-MW3S, the cross-sectional area of the seepage region, and an estimated hydraulic conductivity of the lake sediments:

$Q = -K\frac{dh}{dl}A$, where:

Q is the volume of lake seepage, in acre-feet per day (acre-feet/d);

K is the hydraulic conductivity of lake sediments, in feet per day (ft/d);

dh/dl is the hydraulic gradient, in feet/feet (ft/ft); and

A is the cross-sectional area in acres.

The cross-sectional area of the seepage region was estimated to be 12 acres and the hydraulic conductivity of the lake sediments was estimated to be 5.25 ft/d, based on the average between the shallow aquifer zone hydraulic conductivity estimate based on pumping test in TRC-MW3S (10.5 ft/d)[11] and the calibrated lake bed sediment hydraulic conductivity from the numerical flow model (0.001 ft/d).

Water level data from the lake are available for most months from June 2000 through February 2007 and water level data from well TRC-MW3S are available for most months from December 2000 through October 2012. Between February 2007 and March 2012, lake levels are estimated based on a linear interpolation between lake level and TRC-MW3S water levels for periods when both were measured.

The seepage for months with missing well or lake water level data during this period was estimated using linear interpolation between months with known well and lake water level data. Prior to December 2000, monthly seepage from groundwater to the lake was estimated as the Water Year 2002-2003 average seepage for that month. Groundwater seepage from the lake for the period November 2012 through September 2018 was assumed to be zero. TRC-MW3S was dry during this period, there is no lake level data during this period, and based on inspection of aerial imagery, the lake was dry much of the time.

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[10] Attachment H in Kern County Planning Department, 2009, Final Environmental Impact Report Tejon Mountain Village by TMV, LLC. SCH# 2005101018 Volume XVIII Chapters 7 – Response to Comments dated 27 August 2009.

[11] Table 2-8 in EKI, 2008, Technical Memorandum No. 2 Preliminary Summary of Aquifer Hydraulic Testing Results Tejon Mountain Village, LLC. Technical Memorandum to David Friedman and Roberta Marshall, dated January 2008.

3.3.8 Groundwater Seepage from Streams (Component 10)

Groundwater seepage from the streams is calculated as the product of the streamflow into the Basin and a "Streamflow Infiltration Factor." The calibrated streamflow infiltration factor is 0.1.

3.3.9 Streamflow out of the Basin (Component 11)

Streamflow out of the Basin is the sum of (1) baseflow at the outlet of the Basin, (2) the fraction of other streamflow in the Basin that leaves the Basin, and (3) water that spills out of Castac Lake when lake levels exceed the top of the spillway.

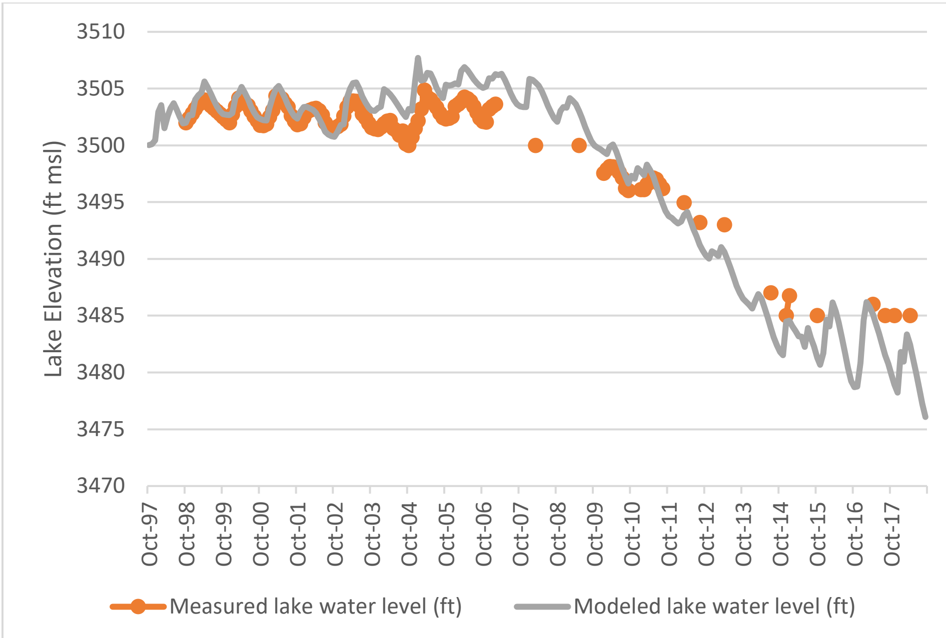
- The Grapevine Creek surface water outflow (baseflow) rate was set to be a multiple of the groundwater outflow rate, discussed below in "Groundwater Outflow". Through calibration, the surface water baseflow was estimated to be 50% of the groundwater outflow.
- The fraction of other streamflow that leaves the Basin was calibrated to 20%.
- When Castac Lake levels reach an elevation of 3,504 feet mean sea level, water spills out of the lake down Grapevine Creek. This typically occurs after a large precipitation event when the lake already contained a sufficient amount of water. The model simulates overtopping of Castac Lake when the volume of surface water inflow from two consecutive months exceeds a specified volume. When this occurs, all surface water inflow from that month is routed out of the Basin. The overtopping volume threshold was determined to be 2,000 acre-feet during the calibration process.

The fraction of other streamflow and the spilled overflow volumes flowing out of the Basin are used to remove water from this domain so that the net of inflow and outflow reasonably represents relative changes in Castac Lake storage. It does not affect the Groundwater Domain.

3.3.10 Castac Lake Storage Change (Component 12)

The difference between all inflows and outflows within the Natural Channels & Castac Lake domain represent changes in lake storage. To calibrate factors associated with the streamflow out of the Basin, monthly changes in simulated lake water levels were estimated by dividing the monthly change in lake storage by the lake acreage. These volumes were cumulatively summed starting at the first instance of known lake level (October 1998). The root-mean-squared-error (RMSE) representing the average deviation between measured and model-calculated lake levels is 1.9 feet. As shown in **Figure H-4** below, model-calculated lake elevations generally match the observed elevations although the model-calculated values tend to over-estimate the lake elevation in the early time period and under-estimate the lake elevation in the late time period. It should be noted that the Basin water budget is not intended to accurately represent changes in lake elevation and storage. The comparison between measured and estimated lake elevation is only used to provided validation that the relevant surface water components of the water budget are reasonable.

Figure H-4: Measured vs. Model-Calculated Castac Lake Elevation



3.4 Irrigated Agricultural Lands Domain

For purposes of this water budget, we have separated the irrigated agricultural portion of the Basin from the non-irrigated portion of the Basin (i.e., grazing and native vegetation lands) and the developed portion of the Basin. The area of irrigated agricultural land was estimated to be 129 acres based on land use shapefiles provided by TCWD[12], and correspond to irrigated pasture, apple orchards, and vineyards.

3.4.1 Precipitation (Component 13)

Precipitation on irrigated lands is calculated as the product of the area of irrigated lands and the monthly precipitation rate.

3.4.2 Effective Precipitation

Effective precipitation is the portion of precipitation that meets the evapotranspiration (ET) demand of growing crops. Effective precipitation is calculated as the product of total precipitation and the effective precipitation fraction. The effective precipitation fraction was calculated using an empirical equation developed by the U.S. Department of Agriculture Soil Conservation Service (USDA-SCS)[13] which considers monthly rainfall, ET, and an estimated depth of application. The fraction of effective precipitation was calculated for several combinations of rainfall (0-5 inches) and ET (0-7 inches). The effective precipitation fraction used in the water budget (0.67) is the average of the fractions calculated using these rainfall and ET rate combinations. Because effective precipitation is the portion of precipitation that meets the ET demand, effective precipitation can never be greater than the ET demand. Therefore, the monthly effective precipitation is capped by the monthly ET demand.

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[12] TCWD, 2019. Shapefile of current land use provided by Leah Metzger 31 May 2019.

[13] U.S. Department of Agriculture – Soil Conservation Service (USDA-SCS), 1970, *Irrigation Water Requirements*. USDA-SCS Technical Release No. 21. 88 pp.

3.4.3 Groundwater Pumping for Irrigation (Component 14)

Pumping for irrigation is assumed to come from wells TRC-56A, TRC-PW80, TRC-PW88, TRC-PW88A, and TRC-PW90. Monthly pumping rates were estimated from reported metered data or estimated from energy consumption records when available.[14] Since November 2000, metered data were provided as totalizer counter readings reported approximately weekly. An average daily rate was calculated for the period between readings and summed for each month. For months in which there is no reported data, pumpage was estimated using the monthly average for months having reported data.

Prior to November 2000, monthly Pacific Gas & Electric (PG&E) energy consumption usage reports were correlated to the available meter readings from 2000 to 2006 at each production well to establish a relationship between the groundwater pumped per kilowatt hour of electricity. These relationships were then used to estimate groundwater production between October 1997 and October 2000.

In some months reported agricultural pumpage is less than reported pumpage used to fill Castac Lake. In these months, it was assumed that all pumpage from agricultural wells was directed to the lake and pumpage for irrigated lands was assumed to be zero.

3.4.4 SWP Deliveries

There were no deliveries of SWP water to agricultural lands.

3.4.5 Evapotranspiration (Component 15)

Potential ET is calculated as the product of the irrigated area, reference ET (ETo), and a crop coefficient (Kc). The monthly Kc values for pasture land were calculated using ET data from the Irrigation Training Research Center (ITRC)[15] and ETo data discussed above in Section 3.1.2. The ITRC data used for the calculation is for a typical year and surface irrigation methods. In some months potential ET is greater than supply (effective precipitation and pumping). It is assumed that potential ET demand is not met in these months. Review of photos on Google Earth confirms this is a reasonable assumption. For example, the August 2017 photo on Google Earth shows that the irrigated pasture land is brown and dry. Reported agricultural pumpage for that month is very low (5 AF), but potential ET is 79 AF. It is likely the field was not irrigated that month and the potential ET demand was not met. The actual ET was calculated as the potential ET or the sum of the effective precipitation and the fraction of applied water (pumping) that does not infiltrate, whichever was less.

3.4.6 Evaporation of Ineffective Precipitation

Evaporation of ineffective precipitation is calculated as 50% of the ineffective precipitation.

3.4.7 Infiltration of Ineffective Precipitation

The portion of total precipitation that is not effective (i.e., does not meet the crop ET demand) is referred to as ineffective precipitation. Ineffective precipitation is calculated as total precipitation minus effective precipitation. Ineffective precipitation is available for evaporation, runoff, or infiltration. For the purposes of this water budget it was assumed that there was no runoff of precipitation on agricultural lands and the ineffective precipitation was split equally between evaporation and infiltration. Therefore, infiltration of precipitation is calculated as 50% of the ineffective precipitation.

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[14] TRC pumping volumes from (1) estimates of PGE records and (2) well counter units provided by TRC and TCWD.

[15] http://www.itrc.org/etdata/index.html

3.4.8 Infiltration of Applied Groundwater

A portion of the total groundwater applied to the agricultural fields is not used by the crops. From a holistic water budgeting perspective, total applied water that does not go towards satisfying crop ET will be subject to four main processes once it is applied to the land surface:

1) Evaporation to the atmosphere
2) Land surface runoff
3) Infiltration and accumulation in the root zone
4) Deep percolation below the root zone to the groundwater table (i.e., return flows)

This water budget model was developed on a Basin scale and a monthly timescale and therefore assumes that there is no long-term accumulation of water within the root zone, that land surface runoff of applied water is negligible, and that evaporation of excess irrigation water is considered to be a negligible flux component, and thus all "inefficient irrigation" of these lands will infiltrate through the root zone and percolate into the underlying principal aquifer. An "Irrigation Infiltration Factor" was assigned, which directly corresponds to the inverse of irrigation efficiency under these assumptions. The irrigation efficiency was assumed to be 85%, corresponding to an Irrigation Infiltration Factor of 0.15. This is consistent with the irrigation efficiency estimated for micro irrigation using spray emitters[16] and the same irrigation infiltration factor used by Kenneth D. Schmidt & Associates (2002).[17] The quantity of applied groundwater that infiltrates is calculated as the product of the total applied groundwater and the irrigation infiltration factor (0.15).

3.4.9 Groundwater Infiltration (Component 16)

Groundwater infiltration is the sum of infiltration of ineffective precipitation and infiltration of applied groundwater. In some months the "Irrigation Infiltration Factor" does not account for the all of the excess applied water greater than the ET demand. In those months the excess was added to the groundwater infiltration.

3.5 Undeveloped Non-Irrigated Lands Domain

The undeveloped non-irrigated lands consist of lands identified as grazing land, open space, pasture land (non-irrigated), park, vacant or disturbed land, and natural vegetation, including wetlands. These land use categories constitute approximately 2,595 acres of the Basin. The area of this domain changes annually based on the yearly area specified for Castac Lake. As the area of the lake increases and decreases in response to changes in the lake water level, the area of the undeveloped non-irrigated lands domain decreases and increases proportionally.

3.5.1 Precipitation (Component 17)

Precipitation on undeveloped non-irrigated lands is calculated as the product of the area of the undeveloped non-irrigated lands and the monthly precipitation rate.

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[16] Chapter 6, Table WA6-2 *in* U.S. Department of Agriculture National Resources Conservation Service, 1997, "Irrigation Guide" dated September 1997.

[17] Kenneth D. Schmidt & Associates, 2002, Groundwater Conditions in the Frazier Park / Lebec Specific Plan Area, dated August 2002.

3.5.2 Evapotranspiration (Component 18)

ET is calculated as the product of the area of the undeveloped non-irrigated lands, ETo, and Kc. The monthly Kc values for idle land were calculated from ITRC ET[18] and ETo data discussed above in Section 3.1.2. The ITRC data used for the Kc calculation is for a typical year.

3.5.3 Evaporation, Runoff, and Infiltration of Ineffective Precipitation (Component 19)

The portion of total precipitation that is not effective (does not meet the ET demand of natural vegetation) is referred to as ineffective precipitation. Ineffective precipitation is calculated as total precipitation minus effective precipitation. Ineffective precipitation is available for evaporation, runoff, or infiltration. The fraction of ineffective precipitation allocated to these categories was determined by the monthly precipitation and the precipitation runoff threshold. In months where the precipitation was below the threshold, ineffective precipitation was allocated to evaporation (50%) and infiltration (50%). In months where the precipitation was above the threshold, ineffective precipitation was allocated to evaporation (33%), runoff (33%), and infiltration (33%). Runoff of ineffective precipitation is routed to the Natural Channels & Castac Lake Domain as streamflow within the basin.

3.6 Developed Areas Domain

Developed area lands include land use categories identified as developed urban and built up land, rural residential land, semi-agricultural land, and roads and right of way. These land use categories constitute 558 acres of the Basin.

3.6.1 Groundwater Pumping for Developed Areas (Component 20)

Groundwater pumping for developed areas is assumed to come from the Krista Mutual Water Company (KMWC) production well, Lebec County Water District (LCWD) Lebec and State production wells, TRC-Hartley, TRC-PW60, TRC-PW81, and public water systems at the middle school and Fort Tejon. Although other domestic wells exist within the Basin, these are assumed to be de minimis users (i.e., less than 2 AFY) and are not accounted for in this model.

Monthly groundwater pumping for the developed areas is from reported data, when available:

- KMWC provided monthly production records for 2010 and 2012 through 2018;
- LCWD provided monthly production records for 2013 through 2018.
- Metered data were provided by TRC as totalizer counter readings reported approximately weekly between November 2000 and September 2018. An average daily rate was calculated for the period between meter readings and summed for each month. Prior to November 2000, monthly Pacific Gas & Electric (PG&E) energy consumption usage reports and energy consumption records were correlated with the available meter readings from 2000 to 2006 at each production well to establish a relationship between the groundwater pumped per kilowatt hour of electricity. These relationships were then used to estimate groundwater production between October 1997 and October 2000.

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[18] *ibid* [15]

- Monthly public water system pumping volumes associated with the Tejon Middle School (Water System No. 1502074) and Fort Tejon (Water System No. 1510301), as reported to the Drinking Water Information Clearinghouse (DRINC) portal[19] for 2015 and 2013 through 2015, respectively.

For months in which there is no reported data as detailed above, pumpage was estimated using the monthly average for months having reported data.

3.6.2 Precipitation (Component 21)

Precipitation on developed lands is calculated as the product of the area of developed lands and the monthly precipitation rate.

3.6.3 SWP Deliveries

There were no deliveries of SWP water to developed areas.

3.6.4 ET and Consumptive Use (Component 22)

ET and Consumptive Use is calculated as the product of the total water supply (precipitation and groundwater pumping) and a consumptive use factor. The developed area consumptive use factor is 0.5, which was determined during calibration. This factor is consistent with the 0.5 value used by Kenneth D. Schmidt & Associates (2002)[20].

3.6.5 Infiltration (Component 23)

Infiltration is calculated as the total water supply (rainfall and groundwater pumping) minus the ET and Consumptive Use.

3.7 Groundwater Domain

3.7.1 Groundwater Seepage from the Lake (Component 8)

Groundwater seepage from the lake is calculated in the Natural Channels & Castac Lake Domain.

3.7.2 Groundwater Seepage from Streams (Component 10)

Groundwater Seepage from streamflow is calculated in the Natural Channels & Castac Lake Domain.

3.7.3 Infiltration from Agricultural Lands (Component 16)

Infiltration from agricultural lands is calculated in the Agricultural Lands Domain.

3.7.4 Infiltration from Non-irrigated Lands (Component 19)

Infiltration from agricultural lands is calculated in the Undeveloped Non-irrigated Lands Domain.

3.7.5 Infiltration from Developed Areas (Component 23)

Infiltration from developed areas is calculated in the Developed Areas Domain.

3.7.6 Upgradient Groundwater Inflow (Component 24)

The inflow across the interface between upgradient Cuddy Canyon Valley Basin and the Basin was estimated using Darcy's Law equation, using the groundwater level gradient across the interface between the two basins, the cross-sectional area of the interface, and an assumed hydraulic conductivity at the interface:

[19] https://drinc.ca.gov/drinc/DWPRepository.aspx.

[20] *ibid* [17]

$Q = -K \frac{dh}{dl} A$, where:

Q is the volume of water, in cubic feet per day (ft^3/d);

K is the hydraulic conductivity, in feet per day (ft/d);

dh/dl is the hydraulic gradient, in feet/feet (ft/ft); and

A is the cross-sectional area in square feet (ft^2).

Water level data from up-gradient wells in the Cuddy Canyon Valley Basin are limited. Therefore, the hydraulic gradient was calculated using water levels from Basin wells TRC-MW16D and TRC-PW56A for the period 2007 through 2018 when both wells had measured water levels. For the time period prior to 2007, water levels in TRC-MW16D were estimated using a linear regression equation between TRC-PW56A (independent variable) and TRC-MW16D (dependent variable). For select months after 2007 with missing water level data, water levels were estimated by linear interpolation between measured values. For water years 1997 through 1999 when no water level data was available from either well, the average gradient for the years 2007-2008 was assumed and water levels in TRC-PW56A were linearly increased based on the rate of change between the 1978 and 1999 water level measurements.

The hydraulic conductivity value was calibrated to 240 ft/d. Although this value is greater than the range of hydraulic conductivity estimates from aquifer pumping tests within the Basin (i.e., 23-79 ft/d from TRC-PW56A and TRC-PW80)[21] and upgradient of the Basin (174 ft/d from Frazier Park Estates pumping well)[22], as discussed above, the gradient calculation only considers wells located within the Basin due to the lack of water level data from wells located near the Basin boundary in upgradient Cuddy Canyon Basin. The hydraulic conductivity value was increased to allow for a comparable volume of groundwater inflow based on the transient numerical groundwater flow model. Sensitivity testing of the numerical groundwater flow model found that the gradient at the Basin boundary is most likely 30% greater than that calculated as described above. Therefore, a 30% increase in gradient would be roughly equivalent to a 30% decrease of hydraulic conductivity (i.e., 168 ft/d), which does fall within the range of hydraulic conductivity estimates.

The cross-sectional area of the interface was estimated based on depth to water, assuming the cross-section area is a triangle with a flat top surface. The maximum saturated part of the cross-sectional area was assumed to be 232,720 square feet (ft^2) based on a total assumed alluvial sediment depth of 260 feet; the saturated cross-sectional area decreases as depth to water increases. The depth to water at the interface of the two basins was calculated using the estimated gradient, distance from the well to the basin boundary, and the approximate land surface elevation at the basin boundary.

3.7.7 Pumpage for Lake Filling (Component 5)

Pumpage of groundwater for filling of Castac Lake is described in the Natural Channels & Castac Lake Domain.

3.7.8 Pumpage for Irrigation (Component 14)

Pumpage for use in the agricultural lands is described in the Agricultural Lands Domain.

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[21] EKI, 2008, Technical Memorandum No. 2 Preliminary Summary of Aquifer Hydraulic Testing Results Tejon Mountain Village, LLC. Technical Memorandum to David Friedman and Roberta Marshall, dated January 2008.

[22] Kenneth D. Schmidt & Associates, 2007, Site Specific Groundwater Evaluation for Frazier Park Estates, Draft Report, dated May 2007.

3.7.9 Pumpage for Developed Areas (Component 20)

Pumpage for use in the developed areas is described in the Developed Areas Domain.

3.7.10 Evaporation from Shallow Groundwater & Groundwater Dependent Ecosystems (Component 25)

As an analytical model cannot represent spatial complexities, evaporation from the shallow groundwater table and from Groundwater Dependent Ecosystems (GDEs) is represented by a percentage of the groundwater recharge. The Fraction of ET from Groundwater was calibrated to be 20% for the beginning of the historical period when measured depth to groundwater levels were shallow and GDEs were prominent. When the precipitation cumulative departure from the long-term average measured at the Lebec climate station fell below 10 in/yr (i.e., water years 2014 through 2018), the Fraction of ET from Groundwater was calibrated to be 5%. This represents less evaporation from both the shallow water table and GDEs due to declining water levels as a result of the drought.

3.7.11 Seepage to Castac Lake (Component 6)

Seepage from groundwater into the lake is calculated in the Natural Channels & Castac Lake Domain.

3.7.12 Downgradient Groundwater Outflow (Component 26)

The groundwater outflow from the basin at the north end of Grapevine Canyon was estimated using Darcy's Law equation, as detailed above under Upgradient Groundwater Inflow.

A hydraulic conductivity of 40 ft/d was assumed, which falls within the range of hydraulic conductivity values estimated from the aquifer pumping test at TRC-PW60 which is located within the Grapevine Canyon portion of the Basin (i.e., 18-86 ft/d).[23]

The hydraulic gradient was calculated using water levels measured in wells MW-1A and MW-14 associated with the GeoTracker site SL205724284. Quarterly water levels were measured between December 1997 and March 2004; semi-annual water levels were measured between September 2004 and February 2009; and annual water levels were measured from February 2009 to January 2017. For months when water levels were not measured, a gradient was linearly interpolated between measured values. For months prior to December 1997 and after January 2017, the average monthly value from other years was specified.

The cross-sectional area of the saturated alluvial interface was estimated to be 95,000 ft^2 based on the hillslope geometry.[24]

3.7.13 Storage Change (Component 27)

Groundwater storage change is calculated as the difference between groundwater inflows and groundwater outflows.

A generalized model-calculated water level time series can be estimated for the central Castac Lake portion of the Basin where most of the pumping occurs and compared to measured average water levels.

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[23] Table 2-7 in EKI, 2008, Technical Memorandum No. 2 Preliminary Summary of Aquifer Hydraulic Testing Results Tejon Mountain Village, LLC. Technical Memorandum to David Friedman and Roberta Marshall, dated January 2008.

[24] EKI, 2008, Technical Memorandum No. 5 Preliminary Summary of the Geology and Hydrogeology of the Castac Groundwater Basin Tejon Mountain Village, LLC. Technical Memorandum to David Friedman and Roberta Marshall, dated January 2008

The monthly water level change is calculated using the monthly groundwater storage change divided by the area of the central Castac Lake portion of the Basin (2,145 acres) and an assumed specific yield. This estimated water level change is cumulatively added to an assumed initial water level to generate a monthly time series of estimated water levels based on the monthly storage change. Measured water level data prior to 2000 is sparse. Therefore, the calculation starts in December 2000 using the average water level measured in December 2000 for the wells located in the central portion of the Basin. The assumed specific yield is 0.12, which is generally consistent with the average calibrated specific yield value used in the numerical groundwater flow model for areas representing the central Castac Lake portion of the Basin.

Parameters specified above were adjusted during calibration to minimize the RMSE. The resultant RMSE representing the average deviation between measured and model-calculated groundwater levels in the central Castac Lake portion of the Basin is 6.8 feet. As shown in **Figure H-5** below, model-calculated groundwater levels generally match the average measured groundwater levels.

As a secondary check, the difference between October 2008 and September 2018 model-calculated water levels were compared to the average measured water level change between 2009 and 2018 for the wells within the central Castac Lake portion of the Basin. **Table H-2** presents the comparison; the model-calculated change in water levels is approximately equal to the change in the measured values signifying the model adequately predicts groundwater storage change during the extreme drought period.

Figure H-5: Average Measured vs. Model-Calculated Groundwater Elevation for the Castac Lake portion of the Basin

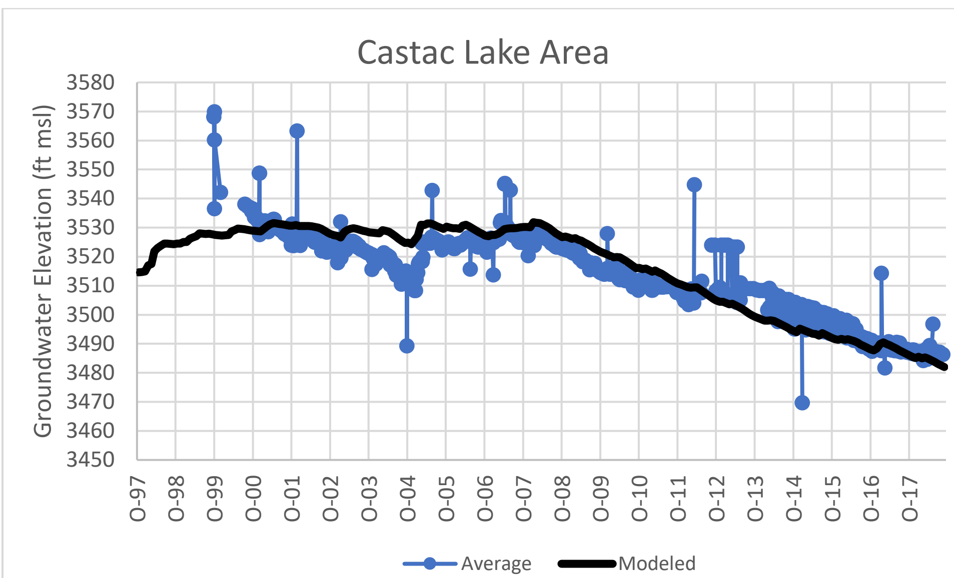

Table H-2. Average Water Level Change between Water Years 2009-2018 for the Castac Lake and Dryfield Canyon portions of the Basin

	Average Water Level Change 2009-2018 (feet)
Measured	-44.5
Model-Calculated	-44.7

Appendix I

Castac Basin Numerical Groundwater Flow Model Documentation

APPENDIX I

Castac Lake Valley Basin Numerical Groundwater Flow Model
Documentation of Model Development and Calibration Results

1. MODEL DEVELOPMENT OVERVIEW

The Castac Basin Groundwater Flow Model (CBGFM or model) generally leverages the assumptions and datasets used in the "Spreadsheet Analytical Model" to inform the initial estimates of the Basin's historical and current water budget[1]. These data and assumptions are summarized herein and are further described in **Section 9** and **Appendix H** of the Castac Basin GSP.

One key difference between the CBGFM and the Spreadsheet Analytical Model is that the CBGFM represents the spatial variability of the Basin, and can thus be used to quantitatively evaluate local hydrogeologic conditions associated with water inflows, outflows, and associated connectivity between adjacent groundwater basins. The purpose of the CBGFM is to quantify the historical, current, and projected water budgets for the Basin and their uncertainties, and to evaluate the impacts of future land use, hydrologic, and water supply/demand projections as well as any proposed management decisions (e.g., future active management of Castac Lake water levels) on groundwater conditions within the Basin. The model can also help identify gaps in available data and deficiencies in the conceptual understanding of groundwater conditions in the Basin. These results help prioritize plans for future data collection and other GSP implementation activities.

2. METHODOLOGY AND APPROACH

2.1. Model Source Code and Management of Spatiotemporal Data

The CBGFM utilizes the computer code MODFLOW to calculate the spatially-discretized the groundwater flow equation. MODFLOW is a widely used groundwater modeling code and is publicly available and supported by the United States Geological Survey (USGS). Its utility is enhanced by additional software processes for model development, processing, and analysis of results. Specific software packages utilized for this exercise include:

- Groundwater Vistas ver. 7 (Environmental Solutions, Inc. 2017) – a graphical user interface (GUI) used to help setup and visualize the model grid, incorporate input datasets, specify MODFLOW package utilities, and visualize model results; and

[1] EKI, 2019. *Technical Memorandum #3: Current and Historical Water Budget for the Castac Lake Valley Groundwater Basin*.

- ZONEBUDGET ver. 3 (Harbaugh, 1990) – a post-processor used to extract water budget results for user-defined model subareas; and

The specific version of MODLFOW employed to develop the model was "MODFLOW-NWT: A Newton-Raphson formulation for MODFLOW-2005" (USGS, 2018). MODFLOW-NWT was used in-lieu of MODFLOW-2005 as it allows aquifer cells to be rewetted, as opposed to permanently making them inactive if they become dry (i.e., calculated head below cell bottom) during a particular stress period. This functionality is particularly useful in modeling groundwater basins whose water levels vary significantly as a result of hydrologic conditions, as has been historically observed within the Basin.

Spatial data consisted of several Geographic Information System (GIS) datasets representing well and borehole locations and depth intervals, surface topography, surface water features, surficial geology and soils, land use/land cover and recharge areas, as well as various MODFLOW spatial datasets (e.g., grid areas, zonal aquifer parameters, etc.), amongst others, that were stored in an ArcGIS geodatabase.

Temporal data consisted of various hydrologic/climate, evapotranspiration, recharge, groundwater pumpage, groundwater level, Castac Lake stage, and other datasets in tabular form, that were stored in a project database as several Excel spreadsheet and/or text files.

When employing numerical models, time is discretized into "stress periods" and space is discretized into "model cells". The discretization of time is referred to as the temporal approach, and the discretization of space is the spatial approach. Both approaches are determined by the study objectives and available data and are further discussed below.

2.2. Temporal Approach

2.2.1. Steady-State Simulations

Groundwater levels and storage volumes in a groundwater basin fluctuate in response to seasonal, annual, or longer time period variations in recharge and pumping. When these fluctuations are averaged over a sufficiently long period of time (or repeated over a sufficient number of stress periods), the resulting groundwater levels may be approximately constant and the net changes in groundwater storage essentially equal zero. This pseudo-equilibrium condition can be approximated by the mathematical condition of "steady-state".

The steady-state groundwater modeling assumption can be useful for developing a preliminary calibration of aquifer parameters as it does not require consideration of temporal changes in water inflows and outflows. It can also serve as a valuable approach for defining initial groundwater level conditions for a transient simulation, especially when data are not readily available to represent initial conditions at the starting period of a transient simulation.

As a preliminary step of CBGFM development, steady-state simulations were developed for two unique Water Years[2] (WY) to help assist in preliminary model calibration and to estimate initial conditions for a subsequent transient simulation of historical conditions:

- **WY 2006** (i.e., October 2005 – September 2006) – to assist in evaluation and preliminary calibration of aquifer and lakebed parameters; and
- **WY 1999** (i.e. October 1998 – September 1999) – to approximate initial groundwater elevations (otherwise termed "initial heads") for input into Stress Period 1 of the transient historical simulation (more details below).

The preliminary calibration and initial head results from these steady-state simulations were subsequently used as initial conditions for development of the transient historical simulation, which is further described below.

2.2.2. Transient Historical Simulation

Per the GSP Emergency Regulations (23-CCR §354.18(b)(2)), GSPs are required to "provide a quantitative assessment of the historical water budget, starting with the most recently available data 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 future water budget information and future aquifer response to proposed sustainable groundwater management practices over the planning and implementation horizon."

Upon completion of the steady-state simulations, a monthly transient model was developed to simulate historical groundwater conditions within the Basin. The time period of the historical simulation was defined as **WY 1999 – 2018** (i.e., October 1998 – September 2018), in line with the Spreadsheet Analytical Model.

The transient historical simulation includes one stress period for each month between October 1998 and September 2018, or 240 stress periods in total. The historical simulation was used to validate results from the Spreadsheet Analytical Model and to refine calibration of the CBGFM based on historical observations of groundwater elevations and lake stages collected throughout the Basin (see **Section 2.4 *Calibration***) for subsequent use in developing projected (i.e., future) model scenarios.

2.2.3. Projected Simulations

Per the GSP Emergency Regulations (23-CCR §354.18(b)(3)), projected water budgets are required "to estimate future baseline conditions of supply, demand, and aquifer response to Plan implementation". The projected water budgets must use 50 years of historical precipitation,

[2] DWR defines a "Water Year" as October – September.

evapotranspiration (ET), and streamflow information as the basis for evaluating future conditions under baseline and climate-modified scenarios.

After finalizing calibration of the historical simulation, several projected scenarios were developed to evaluate aquifer response to future climate, land use, and water supply and demand conditions (See **Section 9.4** of the Castac Basin GSP for further details). Consistent with the GSP Emergency Regulations, each projected scenario consisted of a **50-year monthly transient simulation**, totaling 600 stress periods.

To develop the required 50 year- period of hydrologic input information, an "analog period" was created from 20 years of historical precipitation information by combining the years such that, on average, the long-term average hydrologic conditions were maintained. This approach allows for the creation of a complete 50-year period to inform the projected water budget analysis, even when certain component datasets are not available for that length of time. The sequence of actual years that were combined to create the 50-year analog period is as follows:

- Analog Years 1 to 12: Based on actual years 2003-2014
- Analog Years 13 to 32: Based on actual years 1995-2014
- Analog Years 33 to 50: Based on actual years 1995-2012

The above mapping of actual years to analog years within the required 50-year projected water budget period applies to both the precipitation and ET datasets.

2.3. Spatial Approach

MODFLOW represents the groundwater system as a set of discrete, rectangular blocks (cells) forming a grid in space. MODFLOW then computes an approximate solution to the mathematical equations describing groundwater flow at each model cell. The model's spatial resolution is determined by the relationships between the number and dimensions of the model cells and the spatial variability of the data assigned to the model cells.

2.3.1. Geometry and Layering

The CBGFM grid covers the entirety of the Basin (**Figure 1**). The grid is comprised of 190 rows and 202 columns, with 9,940 total active cells. An initial grid cell dimension was set at 200 by 200 feet; the grid was subsequently refined to 100 by 100 feet in the area representing Castac Lake as well as along the Cuddy Creek and Grapevine Creek stream corridors. The lateral extent (i.e., exterior boundary) of active model cells coincides with the 2018 DWR Bulletin 118 basin boundary [DWR 5-029], except for a small section in the Dryfield Canyon area where the active cell grid was extended to include well TRC PW-90 and another small section in the Grapevine Canyon where Dryfield Creek enters the Grapevine Creek corridor.

In the vertical direction, the CBGFM grid consists of three layers. Layer development was primarily informed by borehole and well log datasets, as well as prior hydraulic testing[3] and hydrogeologic studies[4] analyzing local hydrostratigraphy, whereby alluvial Basin deposits were grouped into three major hydrostratigraphic units:

- Near-surface zone (0 – 10 feet below ground surface [ft bgs]), generally comprised of fine-grained alluvial deposits;
- Shallow aquifer zone (20 – 100 ft bgs), generally comprised of fine-grained alluvial deposits; and
- Deep aquifer zone (below 100 ft bgs), generally comprised of medium-grained, coarse-grained, and some very coarse-grained alluvial deposits.

In line with the major hydrostratigraphic units described above, layers of the CBGFM grid were developed as follows:

- **Layer 1** represents the near-surface zone. The layer top is defined as the ground surface elevation, except for the cells representing Castac Lake, where the layer top is coincident with the maximum lake stage (i.e., 3,505 feet above mean sea level [ft msl]). The layer bottom is generally set at a depth of 10 ft bgs, except for the cells representing Castac Lake where the bottom elevation of the layer is coincident with lake bathymetry.
- **Layer 2** represents the shallow aquifer zone. The layer bottom varies in depth from 20 ft bgs near the Basin fringes to over 100 ft bgs in the Basin center (e.g., below Castac Lake).
- **Layer 3** represents the deep aquifer zone. The layer bottom varies in depth from 80 ft bgs near the Basin fringes to nearly 400 ft bgs in the Basin center (e.g., below Castac Lake).

A depiction of the top elevation and thickness of Layers 1 through 3 is presented in **Figure 2**.

2.3.2. Boundary Conditions

Boundary conditions attempt to reproduce physical conditions that exist at the edges of the groundwater system represented by the active model grid and along prominent surface water features within the Basin. **Figure 3** shows boundary conditions specified in the CBGFM.

Most of the lateral model boundaries are simulated as **no-flow boundaries** because they represent the contact between water-bearing alluvium in the valley and relatively low-permeability materials associated with the foothills and underlying bedrock (e.g., the outer edge of the model grid shown on **Figure 3**). The bottom of Layer 3 is also represented as a no-flow

[3] EKI, 2008b. *Technical Memorandum No. 2: Preliminary Summary of Aquifer Hydraulic Testing Results*
[4] EKI, 2008e. *Technical Memorandum No. 5: Preliminary Summary of the Geology and Hydrogeology of the Castac Groundwater Basin.*

boundary. No-flow boundaries are designated as inactive cells within the model grid and do not contribute to groundwater flow within the model domain.

Head-dependent flow boundaries (denoted as general head boundaries or GHB) allow for water flow into or out of the model in proportion to the model-calculated water level at the boundary, a specified water level external to the boundary, and the specified hydraulic conductivity between the specified head and the GHB cell(s). A GHB was used to represent groundwater inflow from the adjacent Cuddy Creek Canyon Basin, which constitutes a major source of groundwater inflow to the Basin. In total, six GHB cells were employed in Layer 3 of the model at the southwest corner of the Basin to represent baseflow from the Cuddy Creek Canyon Basin. Specified heads used in the GHB cells were approximated by extrapolating a transient groundwater gradient calculated between the two closest wells tangent to the boundary within the Basin – TRC MW-16D and TRC PW-56A (see **Appendix H** of the Castac Basin GSP), and were strategically adjusted during calibration to produce a closer fit to observed heads near the boundary.

Constant head boundaries are used to directly specify groundwater heads within areas of the groundwater system. A constant head boundary was used to represent the lower reach of Grapevine Creek near the northern edge of the Basin (i.e., north of the Lebec Rd. - Interstate 5 overpass), where shallow groundwater is known to discharge into the creek bed.[5] In total, 17 constant head cells were used to represent Grapevine Creek in Layers 1 – 3 of the model. Groundwater heads were set exactly to ground surface elevation within the constant head cells throughout the entire model period, so as to represent groundwater exchange with the creek bed.

Castac Lake is explicitly modeled in Layer 1 of the CBGFM using the MODFLOW's **Lake-3 (LAK)** package. The lake package was developed to simulate lake-groundwater interactions and allows for a transient computation of lake stage based on predefined inputs (precipitation, runoff, diversions) and outputs (withdrawals, evaporation) as well as computation of surface water-groundwater exchange based on lakebed conductance properties and underlying/adjacent groundwater heads. In total, 1,705 LAK cells were employed to simulate Castac Lake. The lakebed bathymetry was approximated from USGS-National Elevation Dataset (NED) rasters and verified by local maps of lakebed bathymetry provided by TRC. The lake extent was defined using a shapefile provided by TRC that generally traces the lakebed elevation contour of 3,505 ft msl.

For the ARP projected scenarios, TRC identified a target water level of 3,495 ft msl (i.e., a 10-foot stage) at which to manage Castac Lake stage. Thus, for these projected scenarios, the GHB package was employed in lieu of the LAK package to represent Castac Lake at a constant stage, whereby GHBs were assigned to all cells within the Castac Lake area whose bottom elevations were less than 3,495 ft msl (i.e., all wetted cells at a 10-foot stage). Vertical and horizontal

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[5] *Ibid* [7].

hydraulic conductivity in the GHB cells were adjusted to match the calibrated lake conductance value originally employed in the LAK package.

Several production wells exist within the Basin, contributing to outflows from the groundwater system. In total, groundwater pumpage from 13 wells were simulated using MODFLOW's **Well** package for the historical simulation, and 14 wells were simulated for all projected scenarios (accounting for a new production well proposed by the Lebec County Water District [LCWD]). All wells were set within the Deep Aquifer zone (Layer 3) based on available well screen and depth information.

2.3.3. Physiographic Zones

After examination of initial steady-state model results, model grid cells were grouped geographically into six physiographic zones to better represent spatial heterogeneities in aquifer parameters and associated groundwater conditions. Physiographic zones were generally defined based on groundwater level trends, topography, and surficial geology. **Figure 4** depicts the physiographic zones defined within the CBGFM, which include:

- Main Zone
- Dryfield Canyon Zone
- Northern Grapevine Canyon Zone
- Southern Grapevine Canyon Zone
- Castac Lake[6]
- Stream Corridors[6] (includes Cuddy Creek, Dryfield Creek, O'Neil Creek, and Upper Grapevine Creek)

2.4. Calibration

A trial-and-error approach was used to calibrate the modeled water-transmitting and storage properties for each of the physiographic zones described above by manually adjusting the parameter values to reduce the discrepancy between measured and model-calculated groundwater levels and Castac Lake stages (the model error or "residuals"). These adjustments were constrained within the ranges indicated by reported field-determined aquifer properties and/or other available relevant information (see **Section *3 Data Used to Construct and Calibrate the Model***). When the residuals were sufficiently minimized within and between physiographic zones, the adequacy of the calibration was assessed by confirming that the model reproduced the important aspects of the groundwater system by comparing measured and model-calculated water levels and lake stages.

The model calibration was completed in three steps. First, a preliminary calibration was performed on the WY 2006 steady-state model to provide a zonal distribution of modeled

[6] Castac Lake and Stream Corridor physiographic zones were only defined for the near-surface and shallow alluvium (Layers 1 and 2).

horizontal and vertical hydraulic conductivity values that resulted in model-calculated water levels that reasonably matched measured average water levels and Castac Lake stage during the period October 2005 – September 2006. This preliminary calibration was subsequently employed in the WY 1999 steady-state model to provide an estimate of initial heads for the transient WY 1999 – 2018 historical simulation period. Finally, a more detailed calibration was performed on the transient historical model to refine the zonal distribution of modeled horizontal and vertical hydraulic conductivity, specific yield and storativity, and lakebed conductance values so that model-calculated water levels reasonably matched the magnitude, seasonality, and trends in measured monthly water levels and Castac Lake stages during WY 1999 – 2018 (see **Section 4 *Model Calibration Results***).

3. DATA USED TO CONSTRUCT AND CALIBRATE THE MODEL

3.1. Key Prior Studies and Investigations

As mentioned previously, the CBWFM generally leverages the assumptions and datasets used to develop the "Spreadsheet Analytical Model" for initial historical and current water budgeting purposes[7]. The methodologies and assumptions used in development of the Spreadsheet Analytical Model are documented in greater detail in **Appendix H** of the Castac Basin GSP.

Parameterization and calibration of the CBGFM is further informed by several previous investigations conducted by EKI on behalf of TRC documenting local hydrology, hydrogeology, water level monitoring information, and historical water balance estimates. These investigations include:

- EKI, 2008a. *Technical Memorandum No. 1 - Preliminary Groundwater Monitoring Well Installation Report*
- EKI, 2008b. *Technical Memorandum No. 2 - Preliminary Summary of Aquifer Hydraulic Testing Results*.
- EKI, 2008c. *Technical Memorandum No. 3 - Preliminary Summary and Interpretation of the Available Groundwater Quality Data for Castac Groundwater Basin*.
- EKI, 2008d. *Technical Memorandum No. 4 - Preliminary Estimate of Site-Specific Evapotranspiration Rates, Plant Rooting Depths, and Soil Property Information*.
- EKI, 2008e. *Technical Memorandum No. 5 - Preliminary Summary of the Geology and Hydrogeology of the Castac Groundwater Basin*.
- EKI, 2008f. *Technical Memorandum No. 6 - Preliminary Estimate of the Castac Lake Water Balance and Salt Balance*.

3.2. Groundwater Pumpage Data

Metered groundwater pumpage data from TRC's production well network and from other public water system production wells within the Basin (including LCWD, Krista Mutual Water Company

[7] *Ibid* [4].

[KMWC], Fort Tejon [Water System No. 1510301], and the Tejon Middle School [Water System No. 1502074]) were incorporated into the historical simulations as available. Metered pumpage data were made available or acquired from the Drinking Water Information Clearinghouse (DRINC) portal for the following periods:

- **TRC** (TRC-Hartley, TRC-PW56A, TRC-PW60, TRC-PW80, TRC-PW81, TRC-PW88, TRC-PW88A, and TRC-PW90): November 2000 – September 2018
- **LCWD** (LCWD-Lebec PW, LCWD-State PW): January 2013 – September 2018
- **KMWC** (Krista MWC-PW): January – December 2010; January 2012 – September 2018
- **Tejon Middle School** (Tejon MS Well): January 2015 – December 2015
- **Fort Tejon** (W0601510301_1510301-001): January 2013 – December 2015

For the TRC production well network, prior to November 2000, monthly Pacific Gas & Electric (PG&E) energy consumption usage reports and energy consumption records were correlated with the available meter readings from 2000 to 2006 at each production well to establish a relationship between the groundwater pumped per kilowatt hour of electricity. These relationships were then used to estimate groundwater production between October 1998 and October 2000. In certain months after October 2000 in which there is no reported data, pumpage was estimated using the monthly average for months having reported data.

For all other public water system production wells, for the months in which there is no reported data as detailed above, pumpage was estimated using the monthly average for months having reported data.

For the projected simulations, groundwater pumpage is held constant by month at a rate equivalent to the average monthly pumped volumes over the last five years of the historical model (i.e., WY 2014 – 2018). As described in **Section 9.4.2** of the Castac Basin GSP, this approach was taken because no significant increases in groundwater production are anticipated in the Basin.

3.3. Evapotranspiration

Evapotranspiration (ET) within the Basin occurs primarily on: (1) irrigated lands; (2) native/undeveloped lands (including non-irrigated grazing and pasture lands and potential groundwater dependent ecosystem [GDE] habitat areas); and (3) from the Castac Lake surface (when the lake contains water).

The ET occurring from irrigated lands and native/undeveloped areas is not directly simulated in the model as it is factored into corresponding estimates of recharge. The methodology for estimating recharge is further detailed in **Section 3.4 *Recharge*** below and in **Appendix H** of the Castac Basin GSP.

The MODFLOW **Evapotranspiration (EVT)** package is uniquely suitable for calculating contributions of shallow groundwater to ET in GDEs. The EVT module allows the user to define rooting (extinction) depths and monthly potential (maximum) evapotranspiration (ETc) rates specific to the vegetation classes being simulated, and then calculates a volume of groundwater uptake that can be used to satisfy the ET demand of these vegetation classes based on the availability of shallow groundwater (i.e., groundwater above the rooting depth) for a given month.

The EVT package was used in Layer 1 of the model to simulate groundwater uptake from potential GDEs within the Basin. Potential GDEs were identified from DWR's Natural Communities Commonly Associated with Groundwater (NCCAG) dataset[8], and were incorporated into the CBGFM grid as shown in **Figure 5**. A monthly maximum ETc rate was specified for October 1998 – September 2018 using the values derived from DWR's Cal-SIMETAW dataset[9] for Riparian vegetation in the Kern-Grapevine Detailed Analysis Unit. This dataset includes estimated monthly ETc values by major land use class for WY 1999 – 2015. For the years where Cal-SIMETAW ETc data was unavailable, (i.e. WY 1998 and WY 2016 – 2018), the average monthly Riparian ETc value derived from WY 1999 – 2015 was used. Prior work by EKI[10] estimated a 90% cumulative rooting depth of approximately three (3) ft bgs for the various plant species mapped in the Basin, using methods from Zeng (2001), land cover from the National Land Cover Database (NLCD), and vegetation coefficients from the International Geosphere-Biosphere Program (IGBP). This 90% cumulative rooting depth is the extinction depth used in the CBGFM, and it is significantly less than TNC estimated maximum rooting depths listed in **Table GWC-1** of the Castac Basin GSP.

To simulate evaporation within Castac Lake, reference evapotranspiration (ETo) values were derived from a correlation model between the two nearest California Irrigation Management Information System (CIMIS) Stations (Arvin CIMIS Station 125 and Cuyama CIMIS Station 88), which measure monthly ETo rates, and the long-term average ETo rates reported for CIMIS zone 14, within which the Basin is actually located (see **Appendix H** of the Castac Basin GSP). An open water coefficient of one (1.0) was used to translate ETo into potential lake evaporation. Monthly lake evaporation rates were input directly to the LAK package, which subsequently calculates actual evaporation for a given stress period (month) based on the simulated wetted lake area.

For projected simulations, ET from GDEs and within Castac Lake were simulated using historical values consistent with the 50-year "analog period" described in **Section 2.2.3 *Projected Simulations***. For projected scenarios that considered potential climate change impacts, the "analog" historical ET rates were further adjusted by DWR's 2030 and 2070 climate change factors as further described in **Section 9.4.2.** of the Castac Basin GSP.

[8] https://gis.water.ca.gov/app/NCDatasetViewer/

[9] https://data.ca.gov/dataset/cal-simetaw-unit-values

[10] EKI, 2008d. *Technical Memorandum No. 4 - Preliminary Estimate of Site-Specific Evapotranspiration Rates, Plant Rooting Depths, and Soil Property Information.*

3.4. Recharge

Recharge (i.e., inflows to the groundwater system via infiltration of surface water) within the Basin can be generally classified into two categories: (1) “streamflow recharge” – i.e. recharge via infiltration from ephemeral stream channels that drain into the Basin; and (2) “distributed recharge” – i.e. recharge via infiltration of precipitation and applied water on agricultural, native/undeveloped, and developed lands within the Basin. The magnitude and distribution of these two classes of recharge were quantified using the methods described in further detail below.

Streamflow Recharge

The volume of monthly streamflow entering the Basin during the historical period was determined using a watershed-level analysis of precipitation, consumptive use, and streamflow runoff completed for the Spreadsheet Analytical Model as described in greater detail in **Appendix H** of the Castac Basin GSP.

Given that streamflow inflows are largely ephemeral within the Basin, and that most inflows will generally percolate into the subsurface upon entering the Basin[11], all monthly streamflow inflows to the Basin were applied into the groundwater system as a recharge source through the Stream Corridors physiographic zone described in **Section 2.3.3 *Physiographic Zones***. Four unique Stream Corridors were simulated as streamflow recharge sources within the CBGFM:

- Cuddy Creek (at the southwest Basin boundary);
- Dryfield Creek (in the southwest finger of the Basin);
- O’Neil Creek (in the northwest finger of the Basin); and
- Upper Grapevine Creek (in the northeast finger of the Basin).

For projected simulations, monthly streamflow recharge rates were estimated using historical precipitation values consistent with the 50-year “analog period” described in **Section 2.2.3 *Projected Simulations***. For projected scenarios that consider potential climate change impacts, the “analog” historical precipitation rates were further adjusted by DWR’s 2030 and 2070 climate change factors as further described in **Section 9.4.2.** of the Castac Basin GSP.

Distributed Recharge

To calculate monthly distributed recharge rates within the Basin, historical land use data obtained from TCWD, LCWD, and DWR GIS databases were first generalized into three main land use classes:

- Irrigated Areas – including all irrigated agricultural areas;

[11] On very rare flood events, Cuddy Creek and other ephemeral streams may partially flow into the Grapevine Creek stream channel and exit the Basin as surface water.

- Native/Undeveloped Lands – including all natural vegetation, wetlands, non-irrigated grazing and pasture lands, parks, and vacant or disturbed lands; and
- Developed Lands – including urban and built up lands, rural residential lands, semi-agricultural lands, and roads.

Monthly recharge rates from these three main land use classes were then calculated within the Spreadsheet Analytical Model using the processes described in **Appendix H** of the Castac Basin GSP. A brief summary of the recharge calculation for each major land class is described below:

- For irrigated areas, recharge was calculated as the sum of infiltration of ineffective precipitation (i.e., any precipitation not used to meet crop ET demands) plus infiltration of excess applied water (assumed to be 15% of total applied water);
- For native/undeveloped lands, recharge was calculated as the infiltration of ineffective precipitation (i.e., any precipitation not used to meet native/pasture ET demands); and
- For developed areas, recharge was calculated as the sum of all groundwater supplies to developed lands, minus all consumptive use of groundwater supplies (assumed to be 50%).

For the projected simulations, land use classes within the proposed TMV development area were revised to reflect the land use zoning from TMV's VTTM 7313 and Phase 1 Commercial Site Plan as described in the TMV Facility Plan[12]. Assumptions for Phase 1 agricultural and outdoor residential water demands were used to approximate projected applied water to irrigated and developed areas within TMV, respectively, and all demands were assumed to be met entirely with surface water or recycled water supplied by TMV. Land use classes from all other areas outside the proposed TMV development were assumed to remain unchanged.

For projected simulations, monthly distributed recharge rates were simulated using historical ET and precipitation values consistent with the 50-year "analog period" described in **Section 2.2.3 *Projected Simulations***. For projected scenarios that considered potential climate change impacts, the "analog" historical ET and precipitation rates were further adjusted by DWR's 2030 and 2070 climate change factors as further described in **Section 9.4.2.** of the Castac Basin GSP.

The final spatial distribution of recharge areas (including streamflow recharge areas and distributed recharge zones) for the historical and transient simulations is presented in **Figure 6**.

3.5. Aquifer Properties

The CBGFM relied on previous hydrogeologic studies and hydraulic testing[13] conducted within the Basin to inform initial parameterization of aquifer hydraulic conductivity and storage properties. **Table 1** below provides a summary of the estimated range in hydraulic conductivity (in feet per day [ft/d]) and storage (unitless) parameters within the Basin as derived from five

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[12] NV5, 2018. *Mountain Village Water. Wastewater, and Reclaimed Water Facility Plan*

[13] *Ibid* [6-7].

previous aquifer pumping tests conducted on TRC wells screening the shallow and deep aquifer zones.

Table 1
Ranges in Basin Aquifer Properties Based on Prior Aquifer Pumping Tests

Aquifer Zone	Pumping Wells	Horizontal Hydraulic Conductivity [ft/d]	Storativity [-]
Shallow	TRC MW-3	10	0.0025
Deep	TRC PW-56A TRC PW-80 TRC PW-60 TRC MW-22D	18 – 86	0.0006 – 0.0035

While these aquifer pumping tests did not directly characterize specific yield or porosity values, previous hydrogeologic studies[14] have assumed an average specific yield of 0.15 and a porosity of 0.2 within the Basin. Furthermore, prior studies[14] have assumed a vertical anisotropy ratio (i.e., the ratio of vertical to horizontal hydraulic conductivity) of 1:100 within the shallow aquifer zone and 1:10 within the deep aquifer zone, as is generally representative of fine-grained to coarse-grained, horizontally-bedded unconsolidated aquifer sediments[15].

Similarly, though previous studies have determined that Castac Lake is likely hydraulically connected to the underlying shallow aquifer, no prior information exists to quantify a range of plausible lakebed conductance (i.e., hydraulic conductivity) values. As such, initial parameterization of the lakebed conductance was based on the general range of hydraulic conductivities reported in the literature for fine grained clayey to silty sediments (i.e., 10^{-1} to 10^{-5} ft/d)[16], consistent with the Castac lakebed soil texture.

3.6. Groundwater Level Data

As described in **Section 2.4 *Calibration***, historical groundwater elevation data collected from wells located throughout the Basin were used to calibrate the CBGFM. In total, 3,914 groundwater elevation observations collected from 37 unique "observation wells" between October 1998 and September 2018 were used as for model calibration, including data from the following water level monitoring networks:

- **TRC** – 3,664 observations from 32 wells (MW-1, MW-2, MW-2S, MW-3, MW-3S, MW-4, MW-5, MW-6, MW-6D, MW-7, MW-8, MW-9, MW-10, MW-11, MW-12, MW-13, MW-14,

[14] *Ibid [3].*
[15] Freeze and Cherry, 1979. *Groundwater*. Prentice Hall, Englewood Cliffs, NJ, 604 pp.
[16] Heath, R.C., 1983. *Basic ground-water hydrology*, U.S. Geological Survey Water-Supply Paper 2220. 86 pp.

MW-14D, MW-15, MW-16D, MW-18D, MW-20D, MW-22, MW-22D, MW-23, MW-23W, MW-23D, PW-56A, PW-60, PW-80, PW-88A, PW-90);
- **LCWD** – 146 observations from two wells (LCWD-Lebec, LCWD-State);
- **Mobil M-1 Crude Oil Pipeline (Geotracker site no. SL205724284)** – 73 observations from two wells (SL205724284-MW1A, SL205724284-MW14); and
- **KMWC** – 31 observations from one well (Krista-MWC well).

Observation well locations used for model calibration are displayed in **Figure 7.**

3.7. Lake Stage Data

As described in **Section 2.4 *Calibration***, historical measurements of Castac Lake water levels (otherwise termed "lake stage") were also used to calibrate the CBGFM. Lake stage data were routinely collected by TRC between June 2000 – February 2007, and intermittently collected at other periods within the historical model timeframe. In total, 104 measurements of Castac Lake stage data were used to help calibrate lakebed conductance and underlying hydraulic conductivity parameters within the model.

4. MODEL CALIBRATION RESULTS

As described in **Section 2.4 *Calibration***, a preliminary calibration of hydraulic conductivity values was performed on the WY 2006 steady-state model that allowed for subsequent estimation of initial heads from the WY 1999 steady-state model. A more detailed calibration of aquifer properties was then performed on the transient historical model (WY 1999 – 2018) so as to minimize errors between model-calculated and observed groundwater elevations and Castac Lake stages throughout the entire 20-year historical period. The final calibration results for the historical transient simulation are presented in the following subsections below.

4.1. Model-Calculated Water Levels

A primary goal of model calibration was to minimize the residual (i.e., difference) between model-calculated and observed water levels throughout the Basin – including within individual wells, within physiographic zones, and at the Basin-level. For each model run during calibration, model-calculated water levels were compared to analogous historical measurements from the observation well network. Residuals were calculated for each observation, a hydrograph was created from model-calculated water levels and compared to the observed water level data at each observation well, and a total root-mean-squared error (RMSE)[17] value was calculated at each well. Residuals were then aggregated for all observations within the Basin, and a 1:1 scatter plot of model-calculated vs. observed water levels was created to visually inspect the overall model error across the Basin (**Figures 8a-b**). Similarly, water level RMSE and average residuals

[17] RMSE is a quantitative measure of the closeness of fit, and is calculated as the square root of the average squared residuals

were calculated for the entire Basin and by physiographic zone (**Table 2**), and trends in residuals were assessed spatially and temporally to determine whether they were generally evenly distributed or otherwise indicated a specific anomaly in the simulation results to address through further refinement of aquifer properties and/or boundary conditions.

As shown on **Figures 8a-b**, following model calibration, most model-calculated water levels closely align with historical observations as seen in the clustering of model-calculated vs. observed water levels near the 1:1 line. Furthermore, residuals are generally evenly distributed within observation wells throughout each major physiographic zone of the Basin, including the lower elevations of northern Grapevine Canyon zone all the way up to the higher areas of the Main zone. The total RMSE of the historical model was calculated at 8.65 feet, which corresponds to ~1.7% of the total range in observed water levels throughout the Basin (~3,100 – 3,600 ft msl). The RMSE by physiographic zone ranges from 3.88 feet in the Northern Grapevine Canyon zone to 9.27 feet in the Main zone, indicating a generally balanced model error in each major region of the Basin.

Table 2
Water Level RMSE and Average Residuals by Physiographic Zone

Physiographic Zone	Number of Observations	RMSE (ft)	Average Residual (ft)
Main Zone	2,209	9.30	-2.7
Dryfield Canyon	897	7.92	1.5
Southern Grapevine Canyon	735	7.77	-4.9
Northern Grapevine Canyon	73	3.93	3.1
Entire Basin	**3,914**	**8.65**	**-2.0**

Figure 9 depicts final RMSE values by observation well throughout the Basin, and **Figures 10a-c** show model-calculated vs. observed hydrographs for the three observation wells proposed to be included in the Basin's SGMA Representative Monitoring Well Network (TRC-MW-16D, TRC MW-18D, and TRC MW-23D; see **Section 16** of the Castac Basin GSP). As shown on **Figure 9**, model errors are generally evenly distributed throughout the Basin, with no discernable spatial trends in RMSE magnitudes or residual signs (i.e., positive or negative). Furthermore, as seen in **Figures 10a-c**, model-calculated water levels also track closely with historical observations at an individual well level, including capturing some of the short-term (e.g., seasonal) variability and long-term trends in water level behavior. Hydrographs showing model-calculated and observed water levels are provided for all 37 observation wells in **Attachment A**.

4.2. Model-Calculated Castac Lake Stage

Another primary goal of model calibration was to minimize the residual between model-calculated Castac Lake water levels (i.e. "stages") to historical observations collected by TRC. Similar to the water level calibration process, model-calculated Castac Lake stages as calculated by the LAK package were compared to observed measurements and a total RMSE was calculated to assess model fit to the lake. Refinements were subsequently made to the lakebed hydraulic conductivity and Layer 2 (shallow aquifer) hydraulic conductivity and storage parameters within the Main zone to minimize the lake stage residual.

Figure 11 shows the model-calculated vs. observed Castac Lake stage through WY 1999 – 2018 after final calibration of the historical model. As seen on **Figure 11**, the model-calculated Castac Lake stage matches well with observed values, with a total RMSE of **1.84 feet**. Model-calculated lake stage especially tracks well with observed measurements for the early historical period (i.e., WY 1999 – 2006) when TRC was regularly monitoring lake stage, indicating the model reasonably tracks both short-term (e.g., seasonal) variability and long-term trends in lake stage. That being said, the LAK package does appear to slightly overestimate lake stage to above its maximum design stage of 3,505 ft msl in WY 2004 – 2007.

4.3. Evaluation of Calibrated Aquifer Parameters

4.3.1. Hydraulic Conductivity

Table 3 below reports the final calibrated horizontal hydraulic conductivity values [ft/d] by layer for each physiographic zone within the model. The vertical anisotropy ratio was held constant at 1:100 in the near-surface and shallow aquifer zones (i.e., Layers 1 & 2 of the model), except for in the Stream Corridors physiographic zone where it was set at 1:10 to better represent the coarse unconsolidated deposits typically associated with ephemeral stream channels. The vertical anisotropy was set at 1:10 for all physiographic zones in the deep aquifer (i.e., Layer 3).

Table 3
Calibrated Horizontal Hydraulic Conductivity Values by Physiographic Zone and Layer

Physiographic Zone	Horizontal Hydraulic Conductivity K_H (ft/d)		
	Layer 1	Layer 2	Layer 3
Main Zone	10	10	35
Dryfield Canyon	10	10	70
Southern Grapevine Canyon	10	10	25
Northern Grapevine Canyon	10	10	70
Castac Lake	N/A[1]	10	N/A[2]
Stream Corridors	100	100	N/A[2]

Notes:
[1] Lakebed conductance parameter is used in the LAK package to define hydraulic conductivity of the lakebed.
[2] Stream Corridors and Castac Lake physiographic zones are not represented in the deep aquifer (i.e., Layer 3).

In all cases, the final calibrated hydraulic conductivity values fall within the range potential of values estimated from prior aquifer pumping tests, as reported in **Table 1**.

4.3.2. Storage Parameters

Table 4a below reports the final calibrated specific yield values [-], and **Table 4b** reports the final calibrated storativity values [-], by layer for each physiographic zone within the model.

Table 4a
Calibrated Specific Yield Values by Physiographic Zone and Layer

Physiographic Zone	Specific Yield S_y [-]		
	Layer 1	Layer 2	Layer 3
Main Zone	0.1	0.1	0.2
Dryfield Canyon	0.05	0.05	0.05
Southern Grapevine Canyon	0.1	0.1	0.15
Northern Grapevine Canyon	0.1	0.1	0.1
Castac Lake	N/A[1]	0.05	N/A[2]
Stream Corridors	0.2	0.2	N/A[2]

Notes:
[1] Castac Lake is modeled as a surface water body using the LAK package and is unaffected by storage parameters.
[2] Stream Corridors and Castac Lake physiographic zones are not represented in the deep aquifer (i.e., Layer 3).

Table 4b
Calibrated Storativity Values by Physiographic Zone and Layer

Physiographic Zone	Storativity S [-]		
	Layer 1	Layer 2	Layer 3
Main Zone	0.001	0.001	0.0001
Dryfield Canyon	0.0025	0.0025	0.0001
Southern Grapevine Canyon	0.001	0.001	0.0001
Northern Grapevine Canyon	0.001	0.001	0.0001
Castac Lake	N/A[1]	0.001	N/A[2]
Stream Corridors	0.0025	0.0025	N/A[2]

Notes:
[1] Castac Lake is modeled as a surface water body using the LAK package and is unaffected by storage parameters.
[2] Stream Corridors and Castac Lake physiographic zones are not represented in the deep aquifer (i.e., Layer 3).

Final calibrated specific yield values fall within the range of 0.05 – 0.2 within the model, which is generally consistent with values reported in the literature for fine-grained to coarse-grained unconsolidated aquifer sediments[18].

Final calibrated storativity values are in the 10^{-3} range within the shallow aquifer (Layers 1 and 2), and the 10^{-4} range within the deep aquifer. These storativity values generally fall near the lower end of the potential range of values estimated from prior aquifer pumping tests, as reported in **Table 1**. Calibrated storativity values in Layer 3 (0.0001) are somewhat lower than the low-end estimate provided by the aquifer pumping tests (i.e. 0.0006), but still within the same order of magnitude. It was determined that lowering the storativity value in this layer helped to better simulate seasonal variability in water levels for observation wells screening Layer 3 of the model, thus lowering the water level RMSE and improving overall model calibration. In all cases the final storativity values generally fall within the range of values reported in the literature for fine-grained to coarse-grained unconsolidated aquifer sediments[19].

4.3.3. Lakebed Conductance

The final calibrated hydraulic conductivity of the Castac lakebed was set at 0.001 ft/d. This value falls in the middle of the general range of hydraulic conductivities reported in the literature for fine grained clayey to silty sediments (i.e., 10^{-1} to 10^{-5} ft/d)[20], consistent with the Castac Lake lakebed soil texture.

[18] *Ibid* [17].
[19] *Ibid* [18].
[20] Heath, R.C., 1983. *Basic ground-water hydrology*, U.S. Geological Survey Water-Supply Paper 2220. 86 pp.

The resulting lake-aquifer interaction term calculated by the LAK package indicates a net groundwater inflow to Castac Lake of 570 acre-feet per year (AFY) throughout the historical model period. This net groundwater inflow condition is consistent with how Castac Lake-aquifer interactions have been conceptualized in previous studies. For example, in EKI, 2008(f), shallow groundwater seepage into Castac Lake was estimated to be 530 AFY on average between 2001 - 2006[21]. The Spreadsheet Analytical Model also calculates a net groundwater inflow to the lake of 300 AFY.

4.3.4. <u>Groundwater Inflows and Outflows</u>

As described in ***Section 2.3.2 Boundary Conditions***, groundwater inflows from the Cuddy Canyon Valley Basin and groundwater outflows through Grapevine Creek were simulated using general head (GHB) and constant head (CH) boundary conditions, respectively.

As no groundwater level data currently exists near the Cuddy Canyon Valley/Castac Lake Valley basin boundary, specified groundwater heads used in the GHB cells representing the groundwater inflow at this point were approximated by extrapolating a transient groundwater gradient calculated between the two closest wells tangent to the boundary within the Basin – TRC MW-16D and TRC PW-56A. Through model calibration, this gradient was multiplied by a scalar of 1.3 to achieve a better fit to historical groundwater level measurements collected from several nearby observation wells within the Main zone. This adjustment results in a long-term average annual groundwater inflow of 1,390 AFY, which aligns very closely with the groundwater inflow term estimated in the Spreadsheet Analytical Model (1,410 AFY).

Constant head cells representing the northernmost stretch of Grapevine Creek within the Basin were used to simulate the surfacing of shallow groundwater which has historically been observed in the area. As the Basin thins and pinches out at the northern tip, it is understood that most groundwater will surface into the Grapevine Creek stream channel before leaving the Basin as a surface water outflow. Setting the value of constant head cells to the ground surface elevation within the streambed resulted in an average annual groundwater outflow of 2,070 AFY to Grapevine Creek, which approximately 20% lower than the total outflow term through Grapevine Creek (including surface flows and baseflow) estimated in the Spreadsheet Analytical Model (2,610 AFY).

4.4. Model-Calculated Groundwater Balance and Relationship to "Spreadsheet Analytical Model"

Table 5 below reports the average annual inflows, outflows, and change in groundwater storage within the groundwater flow system during the historical period (WY 1999 – 2018) as output by

[21] EKI, 2008f. Technical Memorandum No. 6 - Preliminary Estimate of the Castac Lake Water Balance and Salt Balance.

the CBGFM. Also included are comparative values from the Spreadsheet Analytical Model for the same time period. All values are reported in AFY.

Table 5
Summary of CBGFM Historical Water Budget Model (WY 1999 – 2018) Results and Comparison to Spreadsheet Analytical Model

Water Budget Flow Component [1]		CBGFM (AFY)	Spreadsheet Analytical Model (AFY)
Inflows	Recharge	2,040	1,220
	Groundwater Inflow	1,390	1,410
	Seepage from Lake (to GW)	0	30
	TOTAL GROUNDWATER INFLOWS	**3,430**	**2,670**
Outflows	Groundwater Pumping	910	910
	Groundwater Outflow[1]	2,070	1,470
	Seepage to Lake (from GW)	570	330
	ET from GDEs	620	490
	TOTAL GROUNDWATER OUTFLOWS	**4,170**	**3,210**
Change in Groundwater Storage (Inflows – Outflows)		**-740**	**-550**

Abbreviations:
AFY = acre-feet per year; CBGFM = Castac Basin Numerical Groundwater Flow Model; CH = constant head; ET = evapotranspiration; GDEs = groundwater dependent ecosystems; GW = groundwater
Notes:
[1] Apparent discrepancy in total groundwater inflows/outflows reflects a different conceptualization of how streamflow inflows/outflows are treated in the Basin between the CBGFM and Analytical Spreadsheet Model. The CBGFM does not directly simulate streamflow through the Basin. Rather, as described in Sections 3.4 and 2.3.2, 100% of streamflow inflows to the Basin are included as recharge to the groundwater domain, and 100% of streamflow outflows from the Basin are included in the groundwater outflow term representing total outflows through the Grapevine Creek CH cells.

As shown in **Table 5**, the CBGFM estimates an annual net decline in groundwater storage of **-740 AFY** throughout the historical model period, or a cumulative decline of -14,800 AF between October 1998 – September 2018. For comparison, the Spreadsheet Analytical Model estimates a net decline in storage of -550 AFY over the same time period (see **Appendix H** of the Castac Basin GSP). As shown in **Figure 12** the annual change in groundwater storage calculated from the CBGFM tracks closely with storage change estimates produced by the Spreadsheet Analytical Model on a yearly basis and over the entire historical time-period. These results indicate that the two models are generally in close agreement. For perspective, the -190 AFY discrepancy in annual change in groundwater storage estimates between CBGFM and the Spreadsheet Analytical Model represents an overall uncertainty[22] in the volumetric water budget of ~4%. A more detailed discussion of water budget sensitivity and uncertainty is presented in the following section.

5. SENSITIVITY AND UNCERTAINTY ANALYSIS

The CBGFM approximates the real-world groundwater system, and is naturally limited by several factors: (1) the modeling approach and assumptions used to construct the model; (2) the errors and uncertainty in the input data; and (3) uncertainty in the calibrated aquifer parameter values. These limitations collectively contribute to the model's uncertainty. Identifying uncertainty is important when models are employed to analyze impacts from new stresses (e.g., increasing groundwater pumping rates) because they guide the appropriate interpretation of the model results. Additionally, characterizing uncertainty provides insight and guidance for effective data collection and monitoring activities to improve the groundwater system and reliability of model calculations.

As part of the CBGFM development process, we performed a sensitivity analysis on aquifer parameters and critical inputs (e.g., recharge) to the historical model to assess how systematically varying certains parameter and input values would impact model response. The results of this sensitivity analysis were then used to inform an uncertainty assessment of the historical water budget and on projected simulations. Further details of the sensitivity and uncertainty analyses are provided below.

5.1. Sensitivity and Uncertainty Analysis of Historical Model

A sensitivity analysis was conducted to evaluate the effects of changing aquifer parameters (hydraulic conductivity, vertical anisotropy, storage parameters, and boundary conditions) and critical model inputs (groundwater pumping and recharge) on model calibration and associated change in groundwater storage outputs. The analysis was conducted by adjusting an input or parameter within the model from its calibrated value, re-running the model with the modified value, and assessing the impact on model-calculated water levels and Castac Lake stages relative to observed values. Subsequent water level RMSEs were compared to the calibrated historical model results by well, layer, physiographic zone, and for the entire model domain. Additionally, the modified change in groundwater storage output was compared to the calibrated historical model output to examine the uncertainty of the historical water budget results owing to parameter and input uncertainties.

[22] "Overall uncertainty" is defined herein as the change in estimated annual groundwater storage relative to the total annual volumetric inflows into the Castac Basin.

Changes in parameter or input values were limited to a reasonable range of uncertainty based on available information regarding aquifer properties (see Section **3.5 *Aquifer Properties***). These changes included:

- **Groundwater pumping** transient inputs were adjusted by ±5% at all pumping wells;
- **Recharge** transient inputs were adjusted by ±10% (including streamflow recharge, distributed recharge, and total recharge terms);
- **Horizontal Hydraulic Conductivity (K_H) of Layers 1 and 2** was halved (to 5 ft/d) and doubled (to 20 ft/d);
- **Horizontal Hydraulic Conductivity (K_H) of Layer 3** was set to the lower and upper bounds of pumping test data (18 – 86 ft/d), both by physiographic zone and for the entire model domain;
- **Vertical Anisotropy Ratio (K_V:K_H) of Layers 1 and 2** was adjusted by one order of magnitude in both directions (1:1000 – 1:10);
- **Vertical Anisotropy Ratio (K_V:K_H), Layer 3** was adjusted by one order of magnitude in both directions (1:100 – 1:1);
- **Specific Yield (S_y) of Layers 1 and 2** was halved and doubled (variable values by zone);
- **Specific Yield (S_y) or Layer 3** was halved and doubled (variable values by zone);
- **Storativity (S), Layers 1 and 2** was adjusted by one order of magnitude in both directions (variable values by zone);
- **Storativity (S), Layer 3** was adjusted by one order of magnitude in both directions (0.00001 – 0.001);
- **Lakebed Conductivity (K_{lake})** was adjusted by two orders of magnitude in both directions (0.00001 – 0.1 ft/d) based on the range of values for typical clay lakebed sediments;
- **Steady-state constant head (CH) cells at the Grapevine Creek boundary** were reset to 5 ft bgs and 10 ft bgs to simulate a disconnect between the creek and shallow aquifer; and
- **Transient heads in the general head boundary (GHB) cells at the Cuddy Creek boundary** were adjusted to 1.0x – 1.5x of the TRC MW-16D/TRC PW-56A historical gradient to simulate a variable groundwater inflow rate from the neighboring Cuddy Canyon Basin.

A summary of the most sensitive parameters from the above analysis is presented in **Table 6** below. For each of the sensitivity tests, **Table 6** reports the resulting water level RMSE (for all water level observations used in model calibration) and Castac Lake stage RMSE, as well as their percent changes relative to the calibrated historical model. Additionally, **Table 6** reports the change in groundwater storage model output from each sensitivity test, as well as the percent change in groundwater storage relative to total (gross) volumetric inflows from the calibrated historical model (4,828 AFY). This is used as a metric to assess overall uncertainty in the historical water budget. A complete table of the sensitivity analysis results is provided in **Attachment B**.

Table 6
Summary of Most Sensitive Parameters from CBGFM Sensitivity Analysis

Parameter / Input	Original Value	Modified Value	Water Levels (all observation wells)		Castac Lake Stage		Change in Annual Groundwater Storage	
			RMSE (ft)	% change in RMSE	RMSE (ft)	% change in RMSE	Value (AFY)	% change relative to total inflows[1]
CALIBRATED HISTORICAL MODEL			**8.65**	**-**	**1.84**	**-**	**-743**	**-**
K_H, Layer 3 (Southern Grapevine)	25 ft/d	86 ft/d	24.08	178%	6.34	245%	-1048	-6.3%
K_H, Layer 3 (Main Zone)	35 ft/d	86 ft/d	23.73	174%	17.84	871%	-570	3.6%
K_H, Layer 3 (Northern Grapevine)	70 ft/d	18 ft/d	19.79	129%	2.79	62%	-366	7.8%
K_H, Layer 3 (all zones)	35 – 70 ft/d	86 ft/d	18.64	115%	5.67	208%	-877	-2.8%
K_H, Layer 3 (all zones)	35 – 70 ft/d	18 ft/d	18.16	110%	2.89	57%	-411	6.9%
K_{lake}	0.001 ft/d	0.00001 ft/d	13.39	55%	13.24	620%	-646	2.0%
S, Layers 1-2	0.001–0.0025	0.01 – 0.025	9.22	7%	2.06	12%	-1176	-9.0%
S, Layer 3	0.0001	0.001	9.12	5%	2.38	30%	-1139	-8.2%
S_y, Layer 3	0.05 – 0.2	0.1 – 0.4	8.62	-1%	2.20	20%	-1028	-5.9%
S_y, Layer 3	0.05 – 0.2	0.025 – 0.1	9.68	12%	1.63	-11%	-573	3.5%
Heads at Cuddy Creek GHB	1.3x historical gradient	1.0x historical gradient	11.27	30%	1.16	-37%	-786	-0.9%

Abbreviations:

AFY = acre-feet per year; CBGFM = Castac Basin Numerical Groundwater Flow Model; ft = feet; ft/d = feet per day; RMSE = root-mean-squared error

Notes:

[1] Gross volumetric inflows to the Basin were calculated at 4,828 AFY in the calibrated historical model. Percent change in groundwater storage term relative to total inflows is a metric used to assess overall uncertainty in the historical water budget.

As shown in **Table 6**, varying different parameter classes resulted in unique impacts on model-calculated water levels, Castac Lake stages, and change in groundwater storage outputs. Results of the sensitivity analysis are described below based on their impacts to these three unique classes of observation.

Water Levels

Figures 13a-d show an example of observed vs. model-calculated hydrographs at the District's SGMA Representative Monitoring Well TRC MW-16D for the sensitivity tests that appeared to have the greatest impact on simulated water levels, including: (a) horizontal hydraulic conductivity of Layer 3; (b) Castac lakebed conductivity; (c) Cuddy Creek boundary conditions; and (d) storage parameters. In general, model-calculated water levels were most sensitive to changes in the horizontal hydraulic conductivity (K_H) of Layer 3, where a majority of groundwater pumping and monitoring occurs within the Basin. Varying K_H in Layer 3 to the upper and lower bounds of pumping test data (18 – 86 ft/d) resulted in poorer overall calibration of model-calculated water levels, with the greatest impacts resulting from K_H adjustments in the Main and Southern Grapevine physiographic zones. The model appears to be sensitive to both the magnitude of the K_H value as well as the distribution in K_H values between different physiographic zones. Reduction in lakebed hydraulic conductivity (K_{lake}) and lowered heads at the Cuddy Creek boundary GHB cells also appeared to significantly impact water level calibration, especially for wells located in the Main zone. Changes to storage parameters (storativity [S], specific yield [S_y]) appeared to impact overall water level calibration to a lesser degree, but had greater impacts on change in groundwater storage outputs as further described below.

Castac Lake Stages

Figure 14a-b shows observed vs. model-calculated stages at Castac Lake for the sensitivity tests that appeared to have the greatest impact on simulated lake stages, including: (a) horizontal hydraulic conductivity of Layer 3; and (b) lakebed conductivity. In general, model-calculated Castac Lake stages were most sensitive to the horizontal hydraulic conductivity (K_H) of Layer 3, particularly in the Main zone. As mentioned above, this parameter will significantly impact water levels within the Main zone, including under Castac Lake, which will consequently impact the rate of groundwater exchange between the underlying aquifer and the lake. Similarly, lake stages were also very sensitive to the lakebed conductivity (K_{lake}), which will also impact the rate of groundwater exchange to and from the lake. In nearly all cases, the sensitivity tests resulted in poorer overall calibration of lake stages, with the exception of (1) halving the specific yield (S_y) in Layer 3, and (2) reducing the inflow gradient at the Cuddy Creek general head boundary (GHB) cells. Still, in these scenarios water level RMSEs increased relative to the calibrated historical model, indicating poorer overall model performance.

Change in Groundwater Storage

Figure 15a-b shows the model-calculated change in groundwater storage for the sensitivity tests that appeared to have the greatest impact on storage change outputs, including: (a) storage parameters; and (b) horizontal hydraulic conductivity of Layer 3. Model-calculated change in groundwater storage appeared to be most sensitive to the storage parameters (storativity [S], specific yield [S_y]) within all three layers of the model. A general trend exists where increasing the storage parameter value will result in a larger decline in groundwater storage throughout the historical model period, whereas decreasing the storage parameter value will result in a lesser decline in groundwater storage. Sensitivity tests show that ranges in storativity of 0.0001 to 0.025 in the shallow aquifer zone (i.e., Layers 1 and 2 of the model), and 0.00001 to 0.001 in the deep aquifer zone (i.e., Layer 3), contribute to an estimated overall uncertainty[23] in the water budget of +1.3% to -9.0%. Ranges in specific yield of 0.025 to 0.2 in Layers 1 and 2, and 0.05 to 0.4 in the Layer 3, contribute to an estimated overall uncertainty in the water budget of +3.5% to -5.9%.

Model-calculated change in groundwater storage also appeared to be sensitive to horizontal hydraulic conductivity (K_H) values in Layer 3 of the model. Sensitivity tests show that ranges in hydraulic conductivity of 18 – 86 ft/d in Layer 3 contribute to an estimated overall uncertainty in the water budget of +7.8% to -6.3%.

Model-calculated change in groundwater storage was less sensitive to the other parameters/inputs included in the sensitivity analysis. As mentioned above, the uncertainty in recharge is estimated at ±10%, which contributes to an estimated overall uncertainty in the water budget of ±0.7%. The estimated pumping uncertainty of ±5% contributes to an estimated overall uncertainty in the water budget of ±0.9%. Uncertainty in groundwater heads at the Grapevine Creek constant head cells contributes to an estimated overall uncertainty in the water budget of +1.0%, and uncertainty in groundwater heads at the Cuddy Creek general head cells contributes to an estimated overall uncertainty in the water budget of -0.9% to +0.5%.

5.2. Projection Uncertainty Analysis

As described in **Section 2.3.2 *Boundary Conditions***, no groundwater level data currently exists near the Cuddy Canyon Valley/Castac Lake Valley basin boundary, so specified groundwater heads used in the GHB cells representing the groundwater inflow at this point were approximated by extrapolating a transient groundwater gradient calculated between the two closest wells tangent to the boundary within the Basin – TRC MW-16D and TRC PW-56A. This estimated boundary condition is a source of uncertainty in the historical water budget, but causes even more uncertainty in the future projected water budgets. This uncertainty may be exacerbated by future changes in groundwater use and management patterns in the upgradient Cuddy Canyon,

[23] "Overall uncertainty" is defined herein as the change in estimated annual groundwater storage relative to the total annual volumetric inflows into the Basin from the calibrated historical model (4,828 AFY).

Cuddy Ranch, and Cuddy Valley Basins (e.g., replacement of the LCWD "Chimney" well), whose impacts on groundwater inflows at the Basin boundary are difficult to quantify. Furthermore, the historical gradient used to calculate groundwater inflows at the Cuddy Creek boundary showed a marked decrease in the latter half of the historical period, which did not appear to be correlated to climatic conditions or pumping rates within the Basin. A permanent reduction in groundwater inflows at the Cuddy Creek boundary would likely exacerbate any projected declines in groundwater storage when simulating future conditions.

As shown in **Figure 16**, employing a plausible range of projected groundwater inflows between zero, and the average inflow over the historical period (i.e., 1,380 AFY), results in an estimated change in groundwater storage of -20 AFY to 200 AFY under the Baseline projected climate scenario with TMV Development and implementation the Aquifer Replenishment Project, or an overall uncertainty in the projected future water budget of -0.8% to +4.4%.

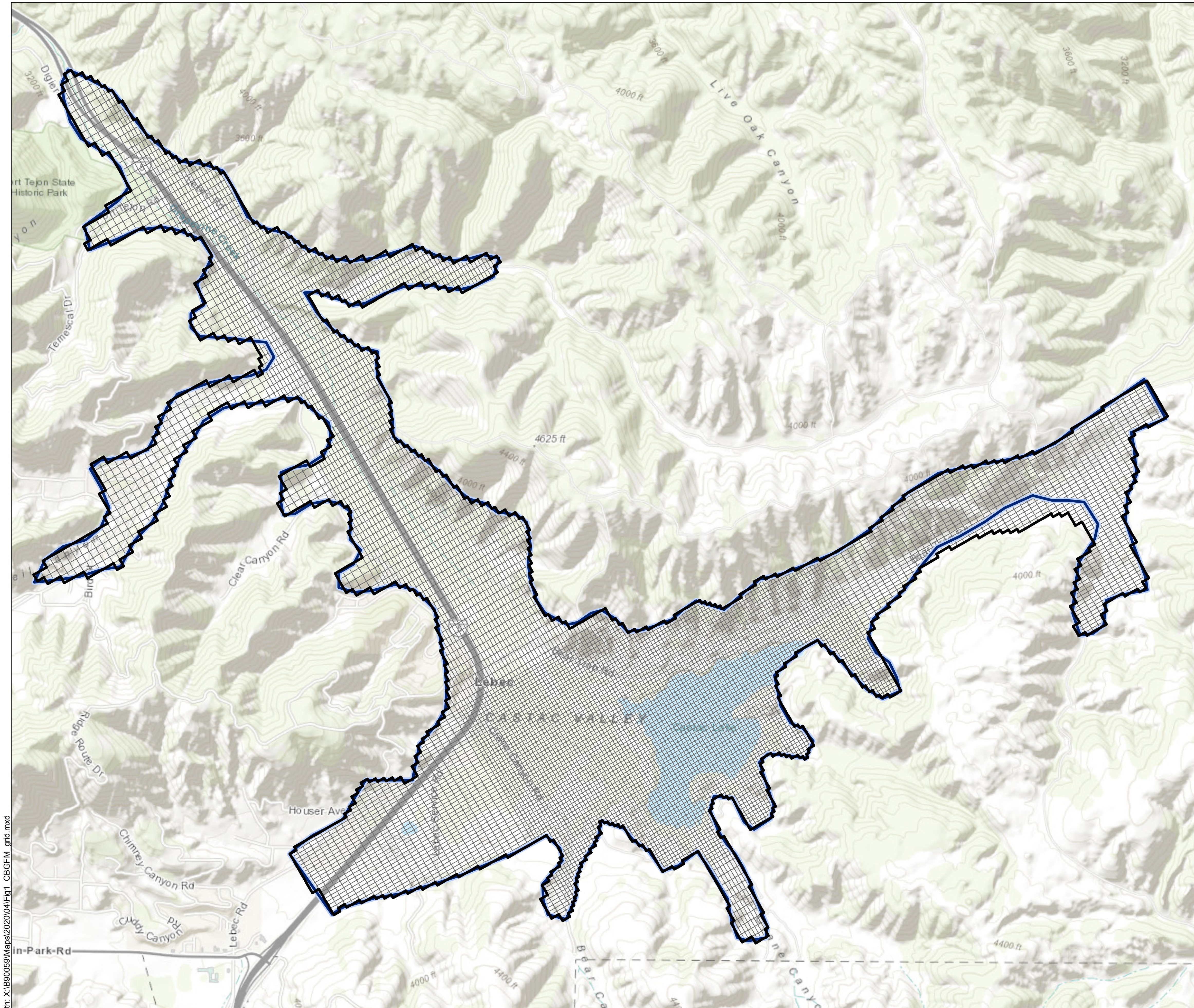
5.3. Model Limitations and Suggested Future Refinements

The results of the sensitivity and uncertainty analyses presented above indicate that predominant limitations of the model include: (1) magnitude and spatial distribution of aquifer properties, such as hydraulic conductivity and storage parameters; (2) quantification of Castac Lake interactions with the shallow groundwater system; and (3) quantification of groundwater inflows through the Cuddy Creek Basin boundary.

Uncertainties in aquifer properties within the model result from a general lack of spatially distributed pumping test and hydrostratigraphy data within the Basin. This ultimately led us to use a simplified, zone-based approach for defining aquifer properties, which can pose limitations in model performance as evident in the results of the sensitivity analysis (see **Section 5.1**). To reduce this uncertainty, future data gap-filling efforts in the Basin should prioritize collecting additional aquifer pumping test data across the Basin, analyzing borehole and well log information to further characterize heterogeneities in aquifer hydrostratigraphy, and/or performing a geophysical survey data to refine the spatial understanding of aquifer properties.

Limited data available from Castac Lake prevents an a priori estimate of lakebed conductance, which is critical to accurately quantifying fluxes between the lake and the shallow aquifer system. Furthermore, historical lake stage data is generally sparse and intermittent. To reduce uncertainties in characterizing lake-aquifer interactions, future data gap-filling efforts in the Basin should prioritize increased monitoring of Castac Lake stages and groundwater levels from shallow wells near the vicinity of the lakebed. A focused study of lakebed conductance would also be helpful for informing parameterization of the lakebed and would likely improve model performance.

Finally, a lack of available groundwater elevation data near the Cuddy Creek Basin boundary results in uncertainty in developing projections of future groundwater conditions. To reduce this uncertainty, future data gap-filling efforts in the Basin should prioritize quantifying the amount of groundwater inflow across the upgradient Basin boundary, either through installation of dedicated monitoring wells near the Basin boundary or through other indirect methods.



Legend

- Castac Lake Valley Groundwater Basin
- CBGFM Grid Cell
- Extent of Active CBGFM Grid

Abbreviations

CBGFM = Castac Basin Groundwater Flow Model
DWR = California Department of Water Resources
ft = feet

Notes

1. All locations are approximate.
2. Grid cell sizes vary from 10,000 ft^2 to 40,000 ft^2.

Sources

1. Groundwater basin boundaries from DWR Bulletin 118 Interim Update 2020.
2. Basemap is ESRI's ArcGIS Online world topographic map, obtained 28 April 2020.

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0 0.5 1

(Scale in Miles)

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Active CBGFM Grid

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Figure 1

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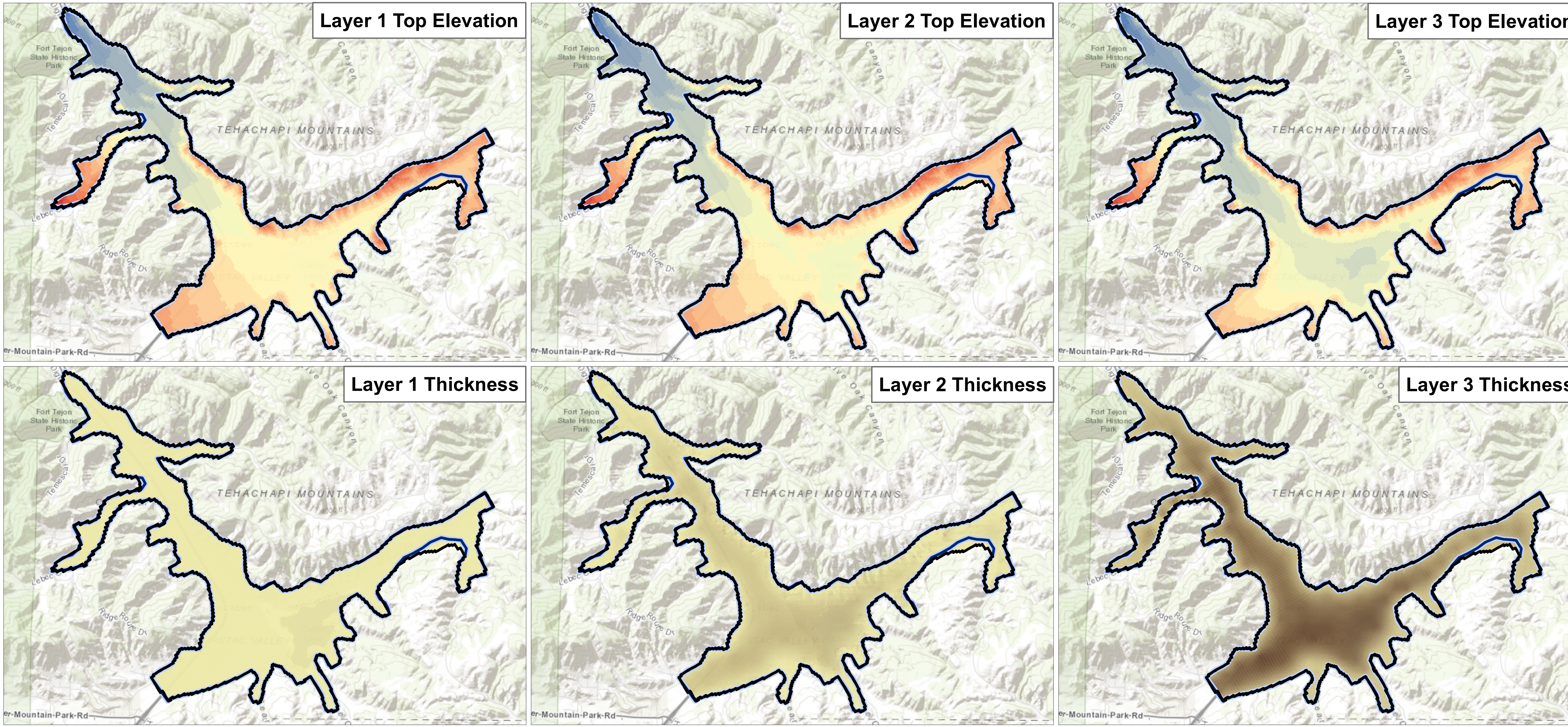

Legend

Castac Lake Valley Groundwater Basin

Extent of Active CBGFM Grid

Layer Top Elevation (ft msl)

4000

3500

3000

Layer Thickness (ft)

300

150

0

Abbreviations

CBGFM = Castac Basin Groundwater Flow Model
DWR = California Department of Water Resources
ft = feet
ft msl = feet above mean sea level

Notes

1. All locations are approximate.
2. All elevations reported in ft msl, and layer thicknesses reported in ft.

Sources

1. Groundwater basin boundaries from DWR Bulletin 118 Interim Update 2020.
2. Basemap is ESRI's ArcGIS Online world topographic map, obtained 28 April 2020.

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(Scale in Miles)

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CBGFM Layer Elevations and Thicknesses

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Figure 2

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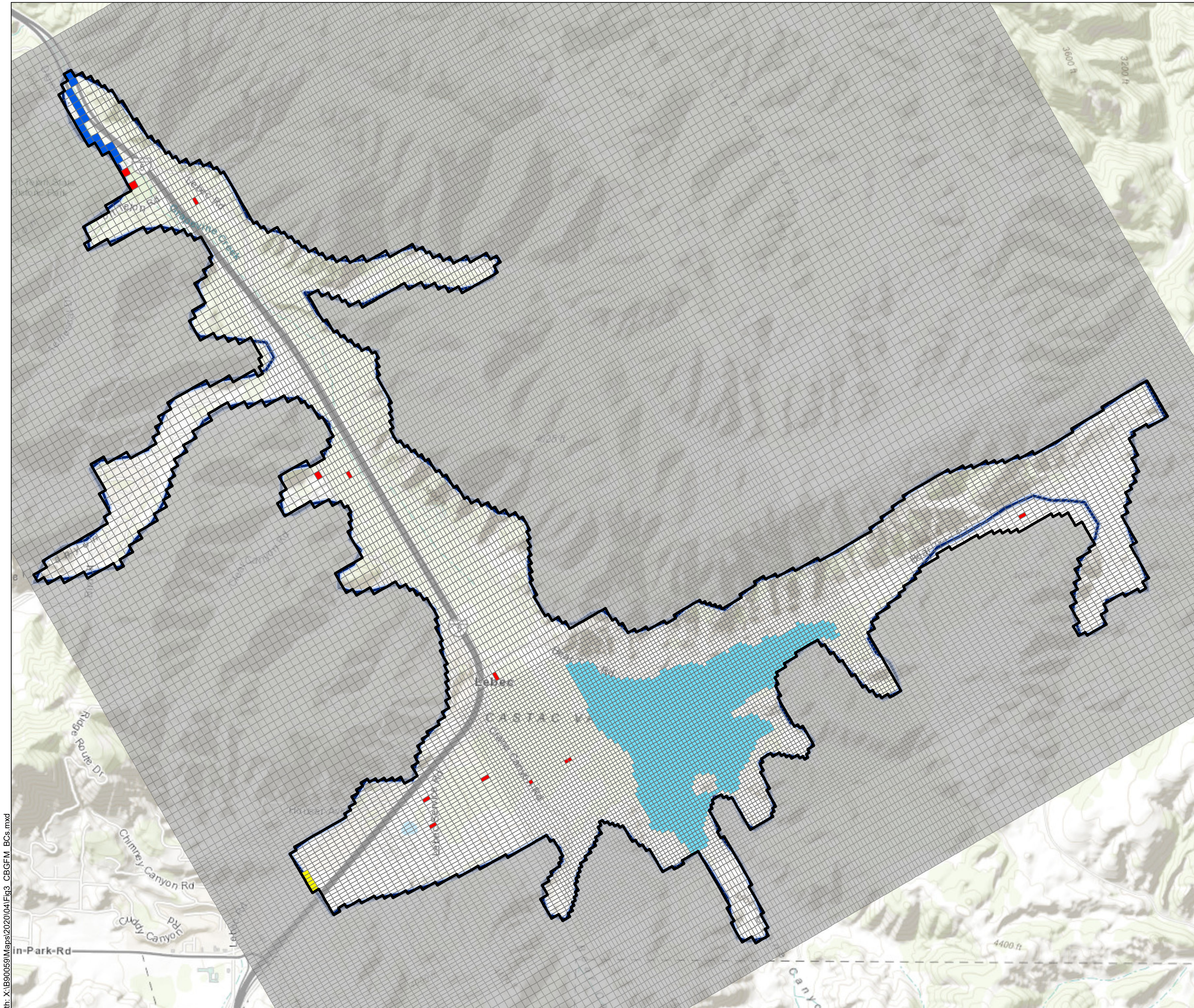

Legend

- Castac Lake Valley Groundwater Basin
- CBGFM Grid Cell
- Extent of Active CBGFM Grid

Boundary Conditions

- Constant Head
- General Head
- Well
- Lake
- Inactive (No-Flow)

Abbreviations

CBGFM = Castac Basin Groundwater Flow Model
DWR = California Department of Water Resources

Notes

1. All locations are approximate.

Sources

1. Groundwater basin boundaries from DWR Bulletin 118 Interim Update 2020.
2. Basemap is ESRI's ArcGIS Online world topographic map, obtained 28 April 2020.

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(Scale in Miles)

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CBGFM Boundary Conditions

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Figure 3

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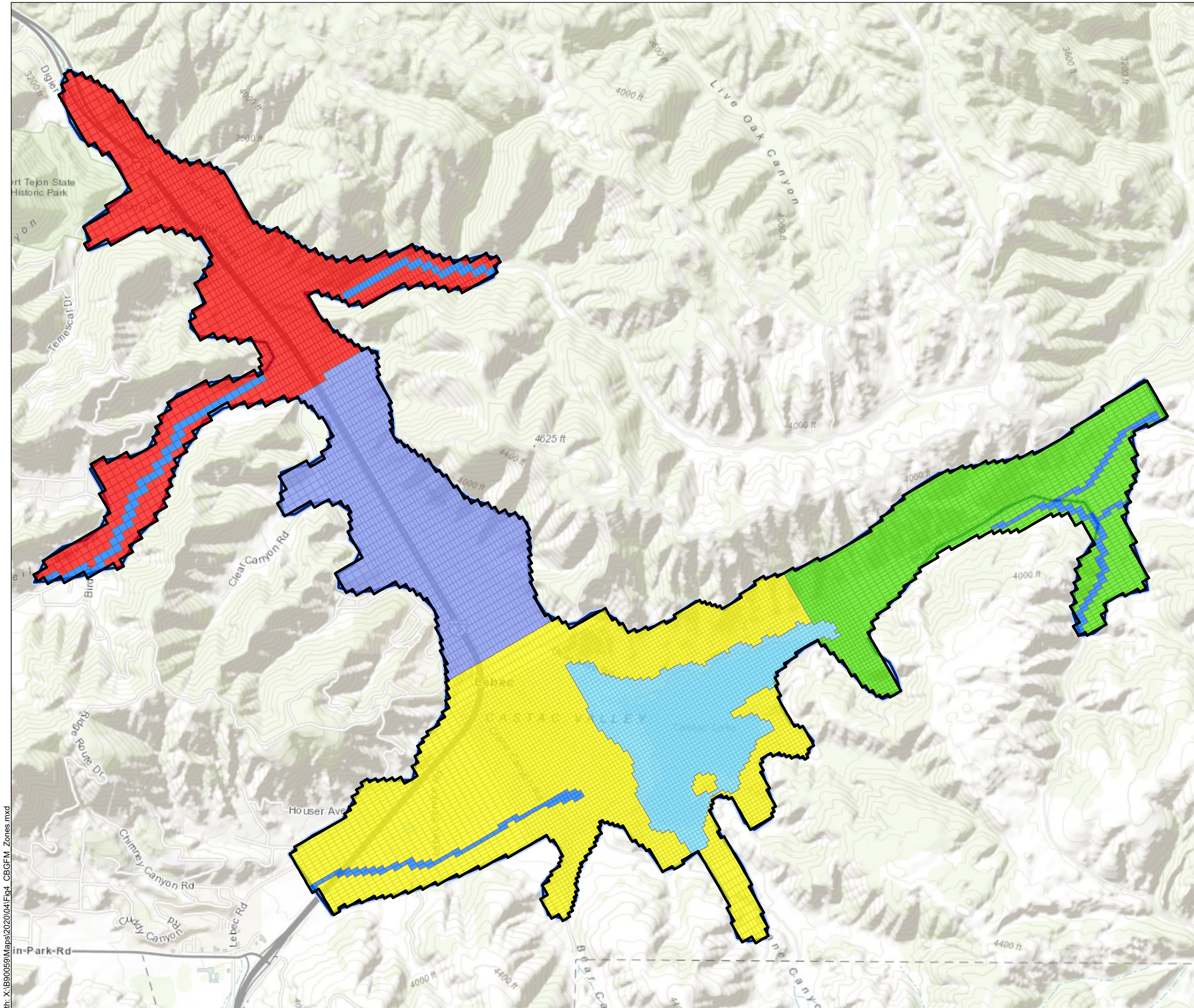

Legend
- Castac Lake Valley Groundwater Basin
- CBGFM Grid Cell
- Extent of Active CBGFM Grid

Physiographic Zones
- Main Zone
- Dryfield Canyon
- Northern Grapevine Canyon
- Southern Grapevine Canyon
- Castac Lake
- Stream Corridors

Abbreviations
CBGFM = Castac Basin Groundwater Flow Model
DWR = California Department of Water Resources

Notes
1. All locations are approximate.
2. Castac Lake and Stream Corridors physiographic zones are only defined for Layers 1 and 2 of the CBGFM.

Sources
1. Groundwater basin boundaries from DWR Bulletin 118 Interim Update 2020.
2. Basemap is ESRI's ArcGIS Online world topographic map, obtained 28 April 2020.

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0 0.5 1
(Scale in Miles)

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CBGFM Physiographic Zones

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Figure 4

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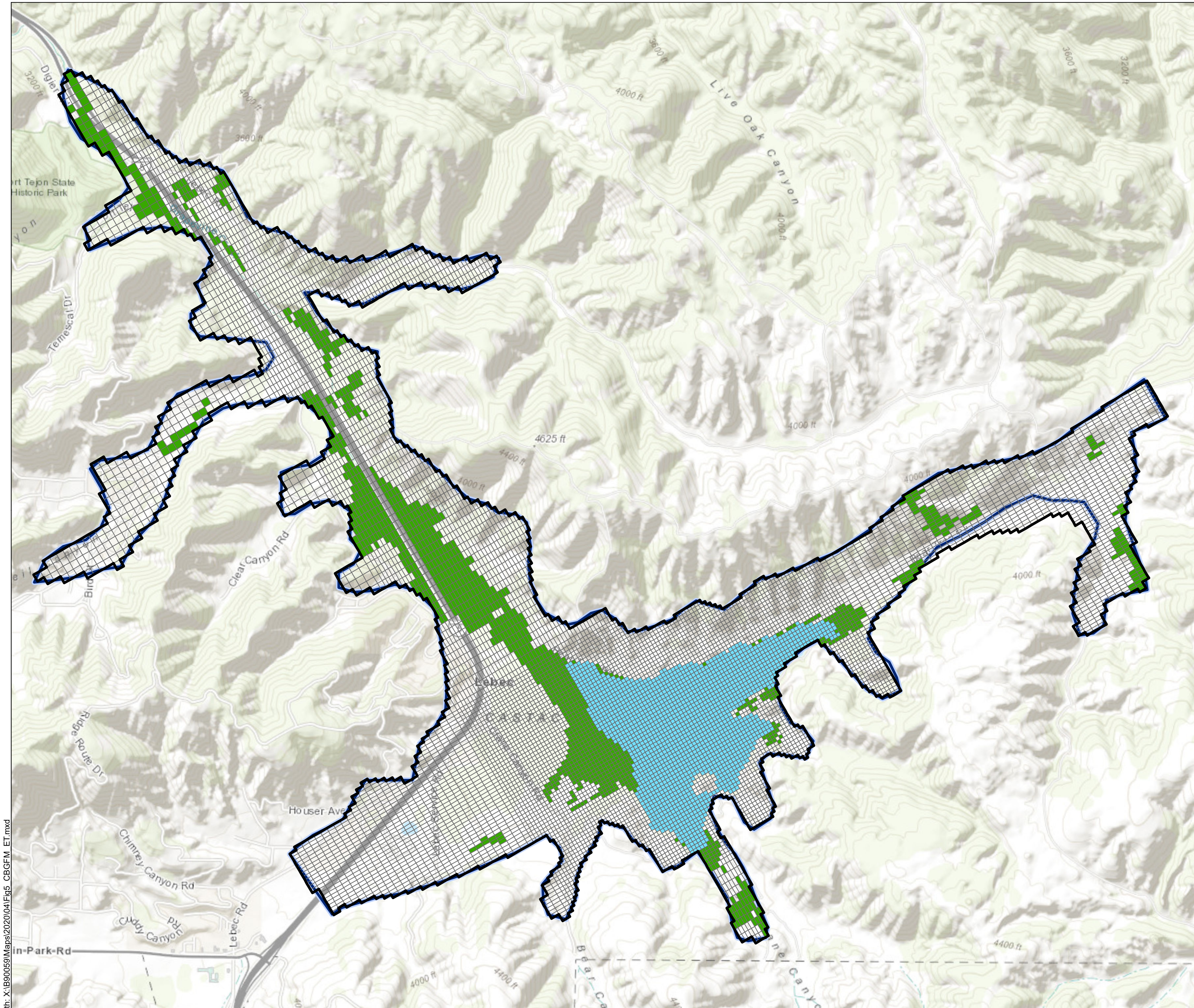

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Legend
- Castac Lake Valley Groundwater Basin
- CBGFM Grid Cell
- Extent of Active CBGFM Grid
- Evapotranspiration Cell
- Lake Cell

Abbreviations
CBGFM = Castac Basin Groundwater Flow Model
DWR = California Department of Water Resources
NCCAG = Natural Communities Commonly Associated with Groundwater

Notes
1. All locations are approximate.
2. Evapotranspiration cells are used in Layer 1 of the CBGFM to simulate groundwater uptake from groundwater dependent ecosystems.

Sources
1. Groundwater basin boundaries from DWR Bulletin 118 Interim Update 2020.
2. Basemap is ESRI's ArcGIS Online world topographic map, obtained 28 April 2020.
3. Location of potential groundwater dependent ecosystems based off DWR NCCAG dataset, https://gis.water.ca.gov/app/NCDatasetViewer/.

N
0 0.5 1
(Scale in Miles)

DRAFT

CBGFM Evapotranspiration Cells

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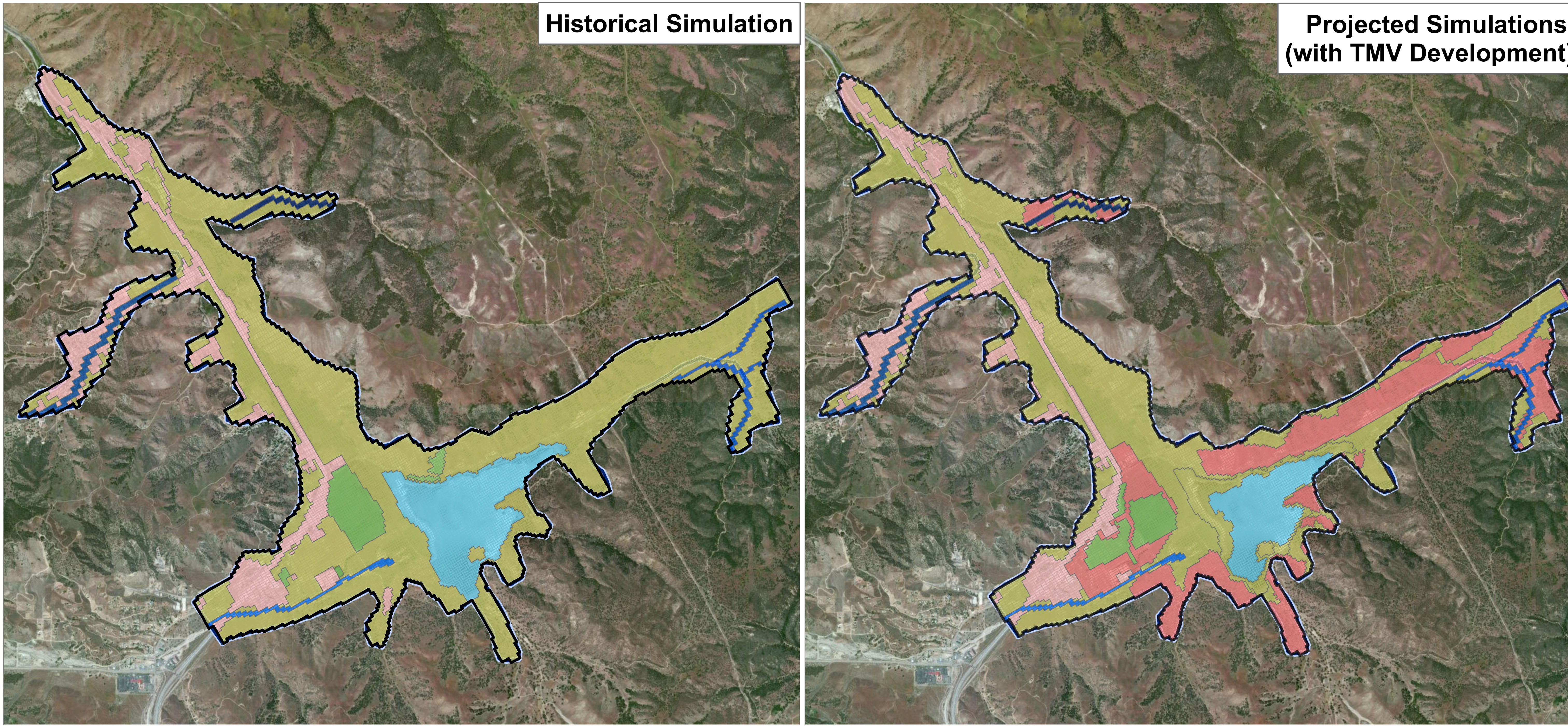
Figure 5



Legend

- Castac Lake Valley Groundwater Basin
- CBGFM Grid Cell
- Extent of Active CBGFM Grid

Recharge Areas

- Castac Lake
- Cuddy Creek
- Dryfield Creek
- O'Neil Creek
- Grapevine Creek
- Irrigated
- Non-Irrigated
- Developed (TMV)
- Developed

Abbreviations

CBGFM	=	Castac Basin Groundwater Flow Model
DWR	=	California Department of Water Resources
TMV	=	Tejon Mountain Village
VTTM 7313	=	Kern County Vesting Tentative Tract Map #7313

Notes

1. All locations are approximate.
2. Future land use based on TMV's VTTM 7313 and Phase 1 development plan.
3. Historical Castac Lake area as shown represents the maximum Castac Lake stage and does not indicate the model-calculated stage throughout the simulation period.
4. Projected Castac Lake area as shown represents Castac Lake at managed 10-foot stage.

Sources

1. Groundwater basin boundaries from DWR Bulletin 118 Interim Update 2020.
2. Basemap is ESRI's ArcGIS Online world imagery map, obtained 28 April 2020.
3. TMV future land use plan obtained from TMV's Water, Wastewater, and Reclaimed Water Facility Plan, NV5, Nov 2018.

N

0 1 2

(Scale in Miles)

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CBGFM Land Use and Recharge Areas

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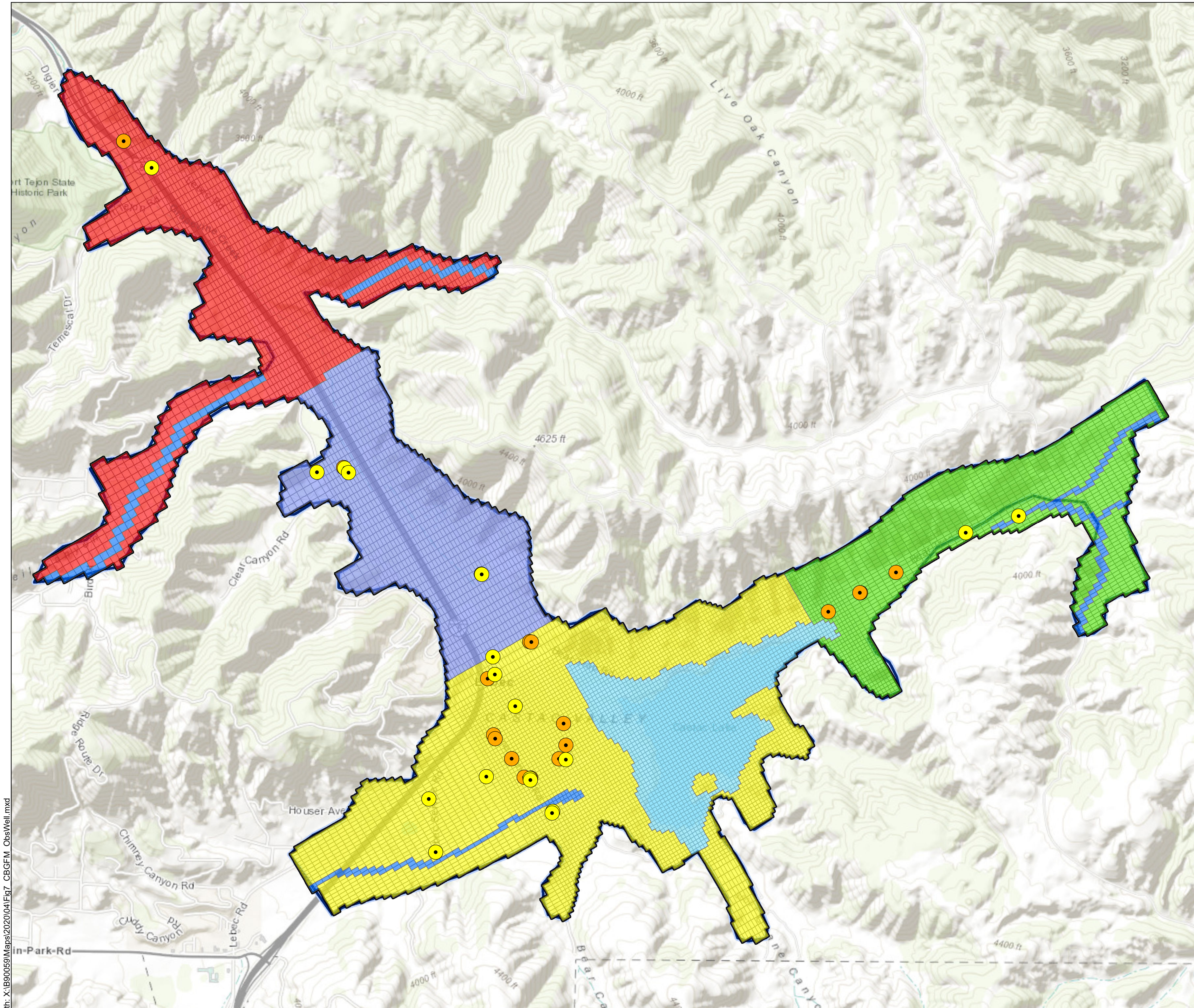
B90059.00

Figure 6

Path: X:\B90059\Maps\2020\04\Fig6_CBGFM_LandUse.mxd



Legend

- Castac Lake Valley Groundwater Basin
- CBGFM Grid Cell
- Extent of Active CBGFM Grid

Physiographic Zones

- Main Zone
- Dryfield Canyon
- Northern Grapevine Canyon
- Southern Grapevine Canyon
- Castac Lake
- Stream Corridors

Historical Observation Well

- Layer 2
- Layer 3

Abbreviations

CBGFM = Castac Basin Groundwater Flow Model
DWR = California Department of Water Resources

Notes

1. All locations are approximate.
2. Castac Lake and Stream Corridors physiographic zones are only defined for Layers 1 and 2 of the CBGFM.

Sources

1. Groundwater basin boundaries from DWR Bulletin 118 Interim Update 2020.
2. Basemap is ESRI's ArcGIS Online world topographic map, obtained 28 April 2020.

N

0 0.5 1

(Scale in Miles)

DRAFT

CBGFM Historical Observation Well Locations by Model Layer

Tejon-Castac Water District
Kern County, CA
April 2020
B90059.00

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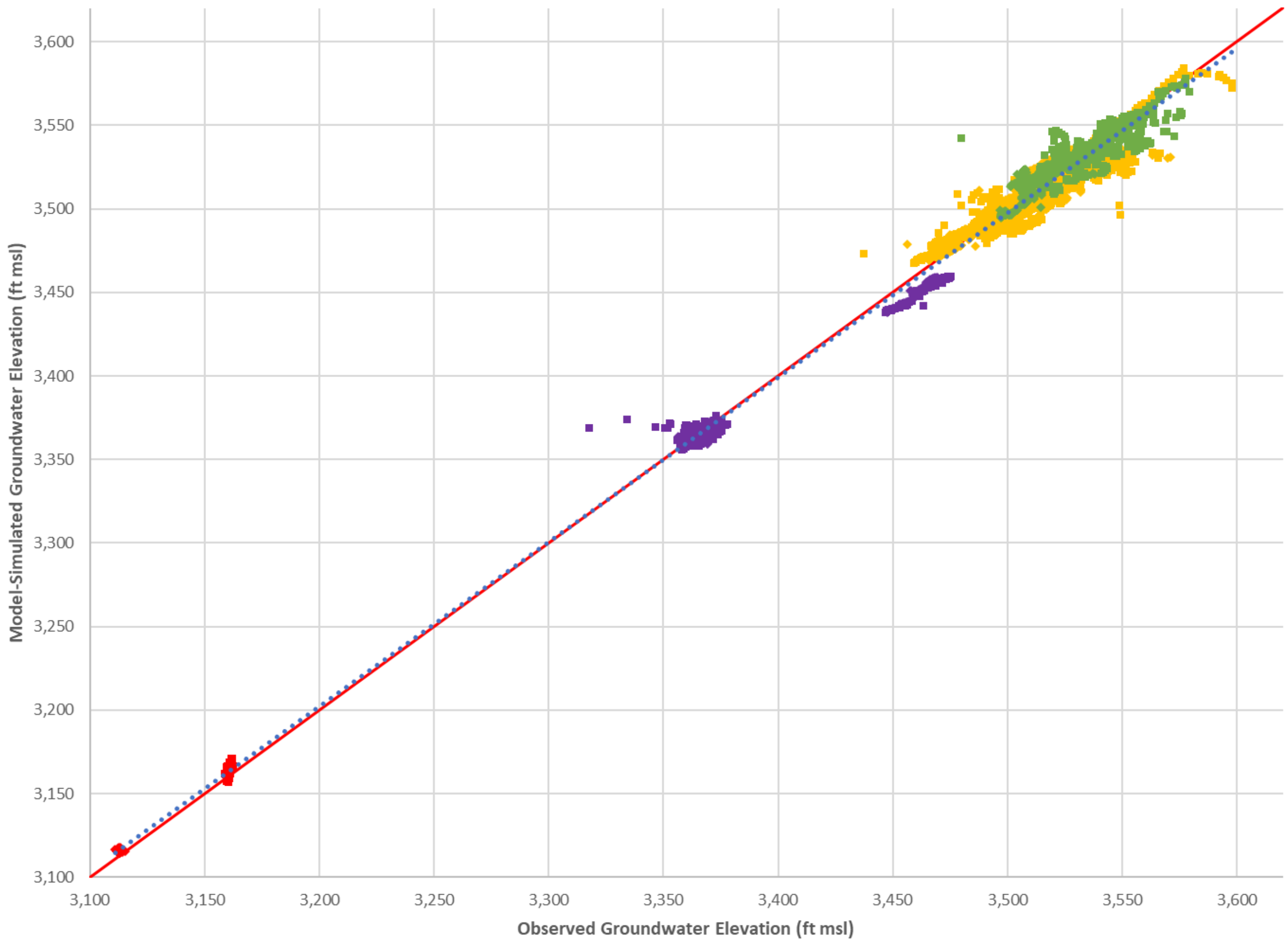
Figure 7

Path: X:\B90059\Maps\2020\04\Fig7_CBGFM_ObsWell.mxd



Legend

◆	=	Main Zone – Layer 2
■	=	Main Zone – Layer 3
◆	=	Dryfield Canyon – Layer 2
■	=	Dryfield Canyon – Layer 3
◆	=	Grapevine Canyon South – Layer 2
■	=	Grapevine Canyon South – Layer 3
◆	=	Grapevine Canyon North – Layer 2
■	=	Grapevine Canyon North – Layer 3
▬	=	1:1 Line
• • •	=	Trendline (all observations)

Abbreviations

CBGFM = Castac Basin Numerical Groundwater Flow Model

ft msl = feet above mean sea level

Notes

1. Model-simulated groundwater elevations are from the calibrated historical CBGFM.
2. Model-simulated groundwater elevations with zero residual will fall on the 1:1 line.

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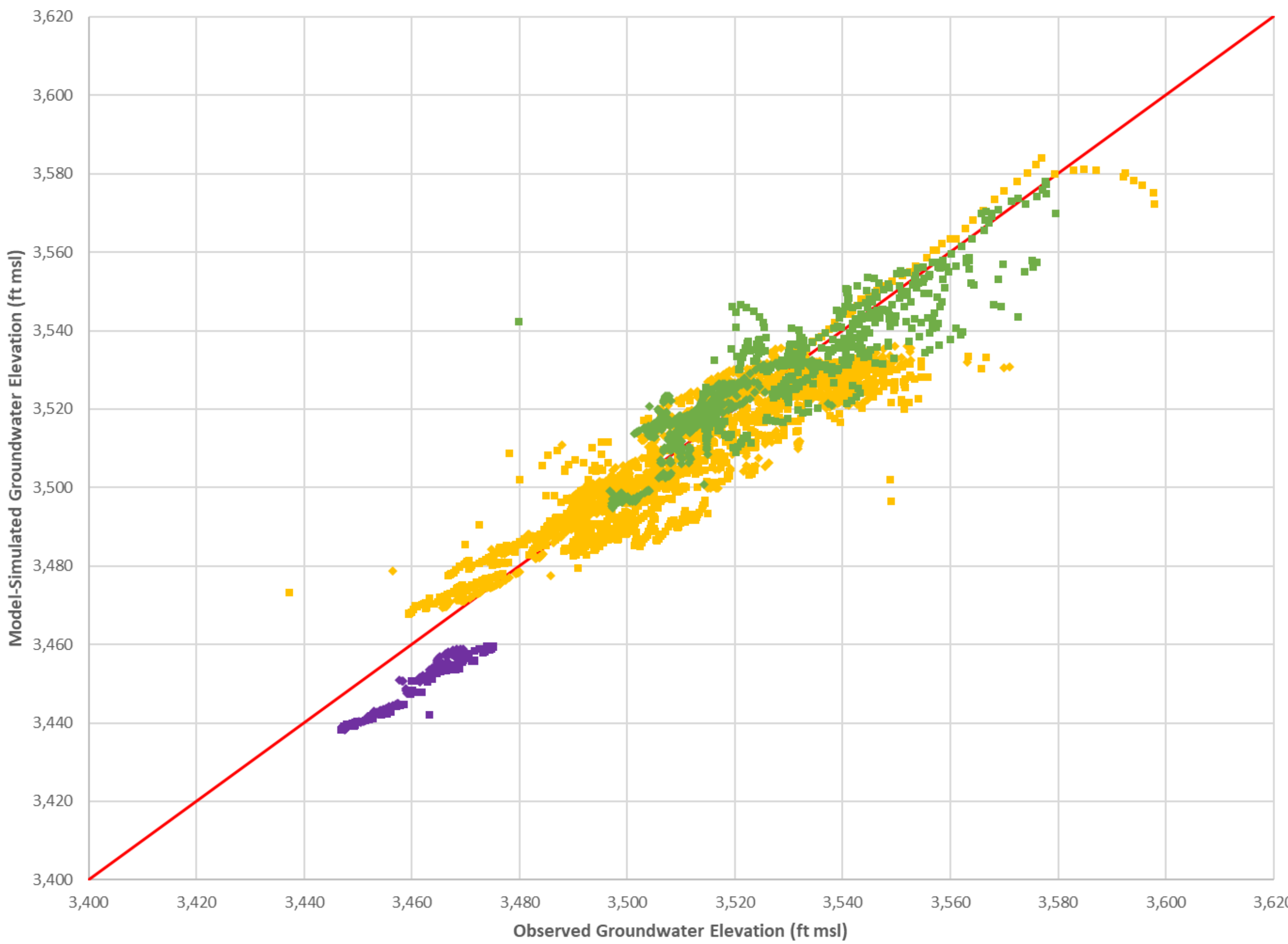
Water Level Observations vs. Model-Simulated Results – All Observations

Tejon-Castac Water District
Kern County, California
April 2020
EKI B90059.00

Figure 8a



Legend

- = Main Zone – Layer 2
- = Main Zone – Layer 3
- = Dryfield Canyon – Layer 2
- = Dryfield Canyon – Layer 3
- = Grapevine Canyon South – Layer 2
- = Grapevine Canyon South – Layer 3
- = 1:1 Line

Abbreviations

CBGFM = Castac Basin Numerical Groundwater Flow Model

ft msl = feet above mean sea level

Notes

1. Model-simulated groundwater elevations are from the calibrated historical CBGFM.
2. Model-simulated groundwater elevations with zero residual will fall on the 1:1 line.

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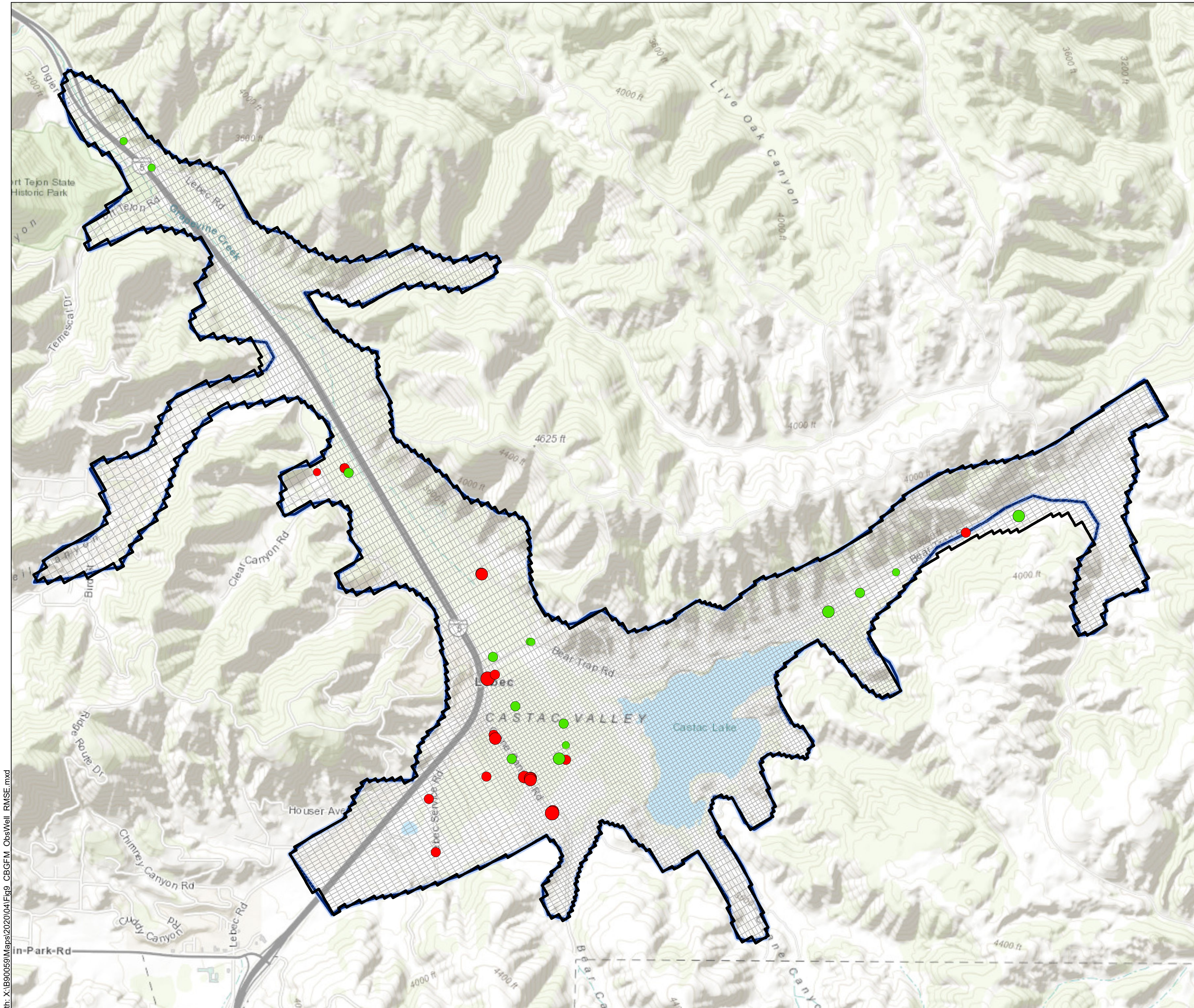
Water Level Observations vs. Model-Simulated Results – Castac Lake Area Observations

Tejon-Castac Water District
Kern County, California
April 2020
EKI B90059.00

Figure 8b



Legend

Castac Lake Valley Groundwater Basin

CBGFM Grid Cell

Extent of Active CBGFM Grid

Water Level RMSE (see Notes 3-4)

- 0 - 5 ft
- 5 - 10 ft
- 10 - 15 ft
- 15 - 20 ft
- 20 - 25 ft
- > 25 ft

Abbreviations

CBGFM	=	Castac Basin Groundwater Flow Model
DWR	=	California Department of Water Resources
ft	=	feet
RMSE	=	Root-Mean-Squared Error

Notes

1. All locations are approximate.
2. Water level residuals are calculated as the simulated (i.e., model-calculated) water level, minus the observed (i.e., measured water level).
3. RMSE is a quantitative measure of the closeness of fit between observed and model-calculated groundwater elevations, and is calculated as the square root of the average squared residuals.
4. Green wells indicate positive average residual (i.e., water levels generally overestimated) and red wells indicate negative average residual (i.e., water levels generally underestimated).

Sources

1. Groundwater basin boundaries from DWR Bulletin 118 Interim Update 2020.
2. Basemap is ESRI's ArcGIS Online world topographic map, obtained 28 April 2020.

N

0 0.5 1

(Scale in Miles)

DRAFT

CBGFM Water Level Residuals and RMSE by Observation Well

Tejon-Castac Water District

Kern County, CA

April 2020

B90059.00

Figure 9

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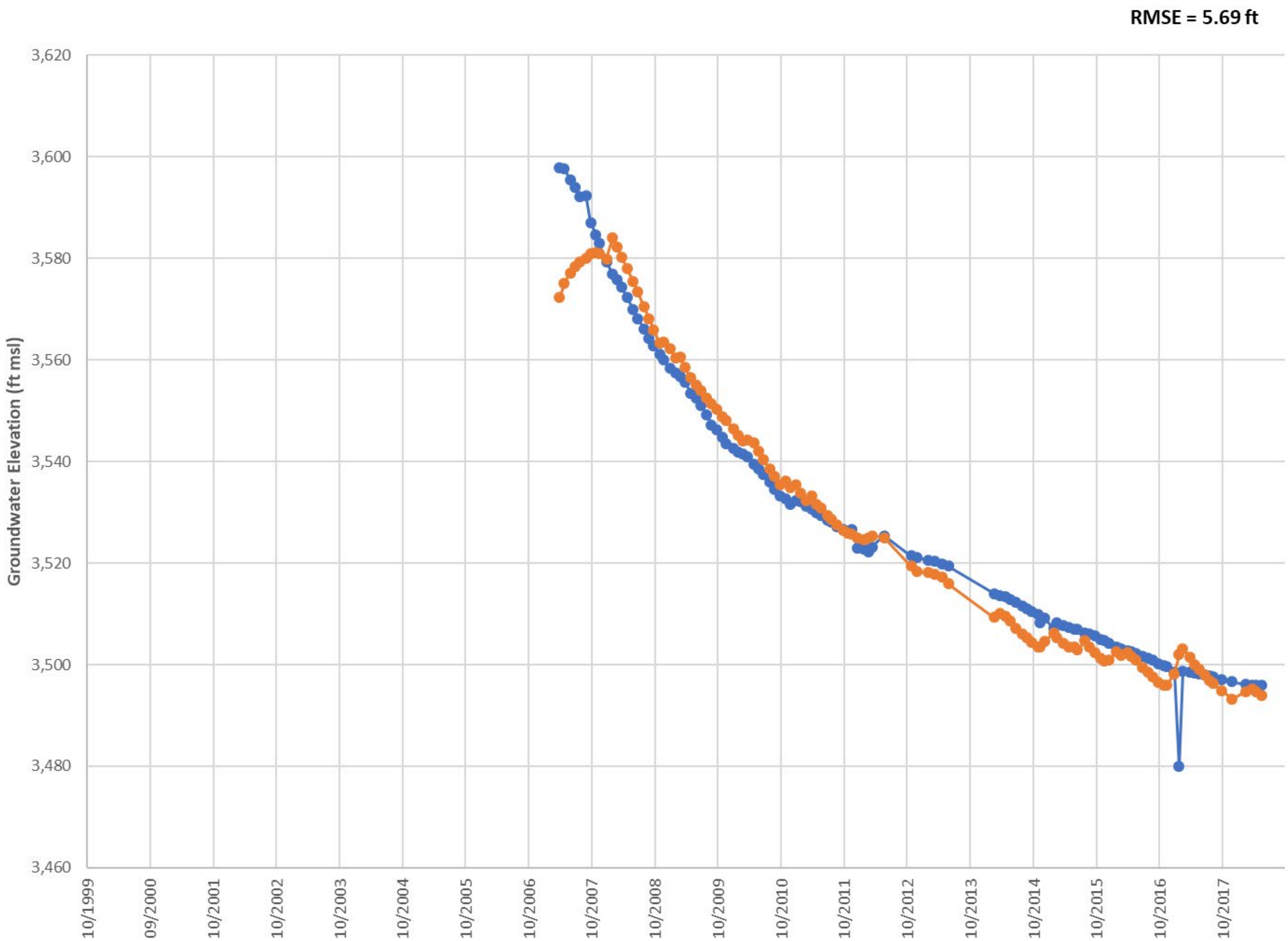
Path: X:\B90059\Maps\2020\04\Fig9_CBGFM_ObsWell_RMSE.mxd



Legend

= Observed Groundwater Elevation

= Model-Simulated Groundwater Elevation

Abbreviations

CBGFM = Castac Basin Numerical Groundwater Flow Model
ft = feet
ft msl = feet above mean sea level
RMSE = Root Mean-Squared Error

Notes

1. Model-simulated groundwater elevations are from the calibrated historical CBGFM.
2. RMSE is a quantitative measure of the closeness of fit, and is calculated as the square root of the average squared residuals between observed and model-simulated groundwater elevations.

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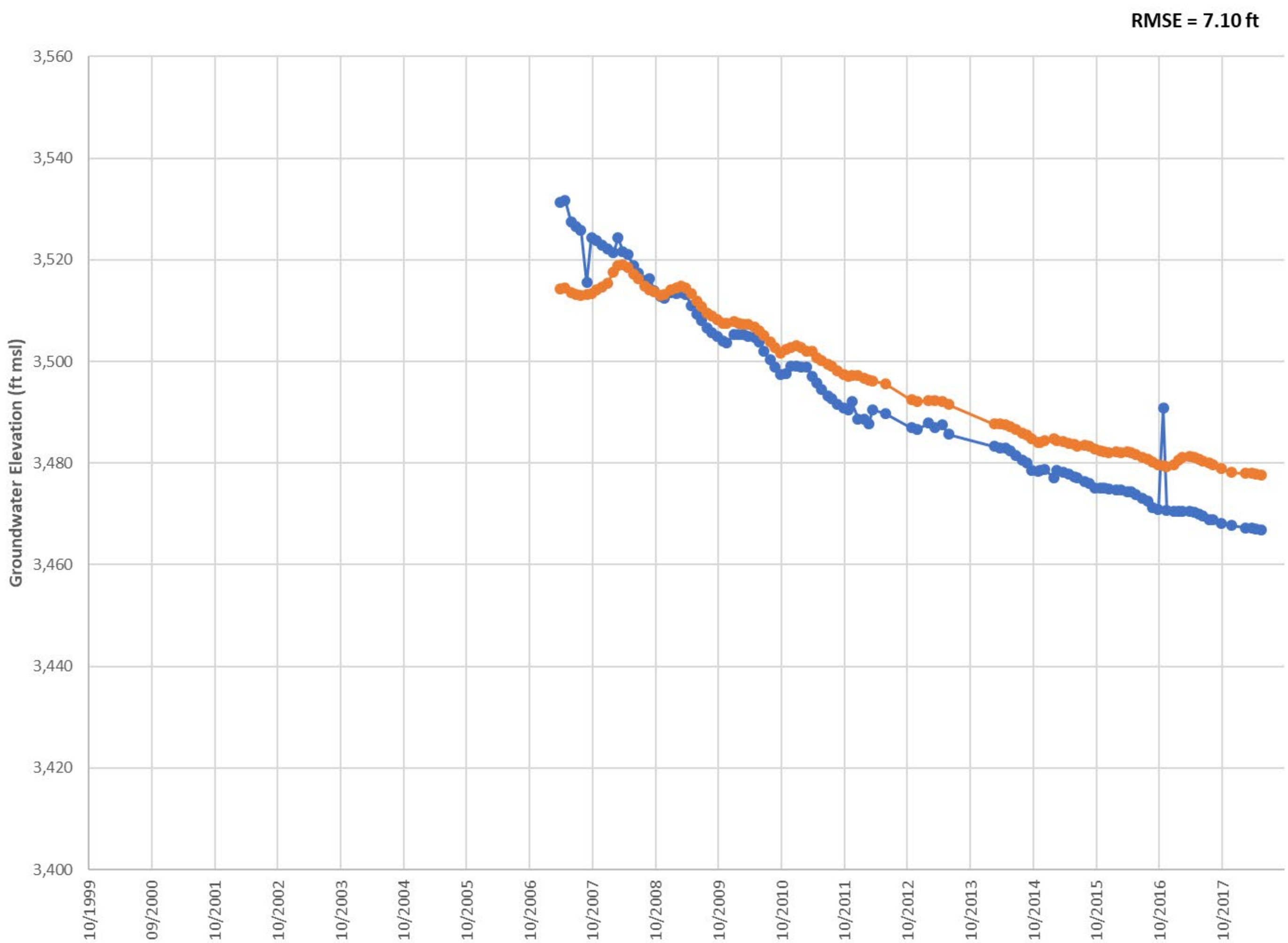
Water Level Observations vs. Model-Simulated Results – TRC MW-16D

Tejon-Castac Water District
Kern County, California
April 2020
EKI B90059.00

Figure 10a



Legend

= Observed Groundwater Elevation

= Model-Simulated Groundwater Elevation

Abbreviations

CBGFM = Castac Basin Numerical Groundwater Flow Model
ft = feet
ft msl = feet above mean sea level
RMSE = Root Mean-Squared Error

Notes

1. Model-simulated groundwater elevations are from the calibrated historical CBGFM.
2. RMSE is a quantitative measure of the closeness of fit, and is calculated as the square root of the average squared residuals between observed and model-simulated groundwater elevations.

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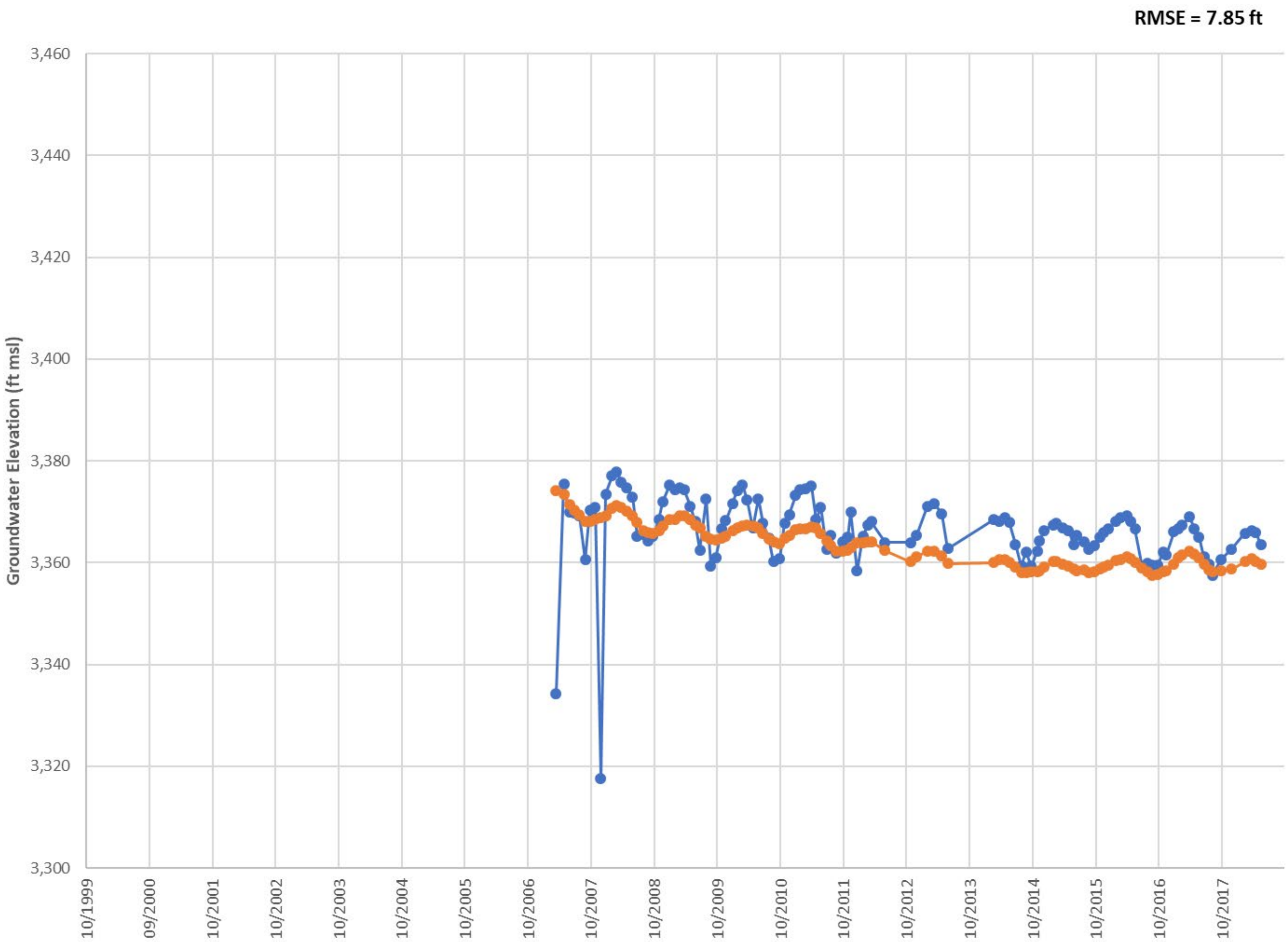
Water Level Observations vs. Model-Simulated Results – TRC MW-18D

Tejon-Castac Water District
Kern County, California
April 2020
EKI B90059.00

Figure 10b



Legend

= Observed Groundwater Elevation

= Model-Simulated Groundwater Elevation

Abbreviations

CBGFM = Castac Basin Numerical Groundwater Flow Model

ft = feet

ft msl = feet above mean sea level

RMSE = Root Mean-Squared Error

Notes

1. Model-simulated groundwater elevations are from the calibrated historical CBGFM.
2. RMSE is a quantitative measure of the closeness of fit, and is calculated as the square root of the average squared residuals between observed and model-simulated groundwater elevations.

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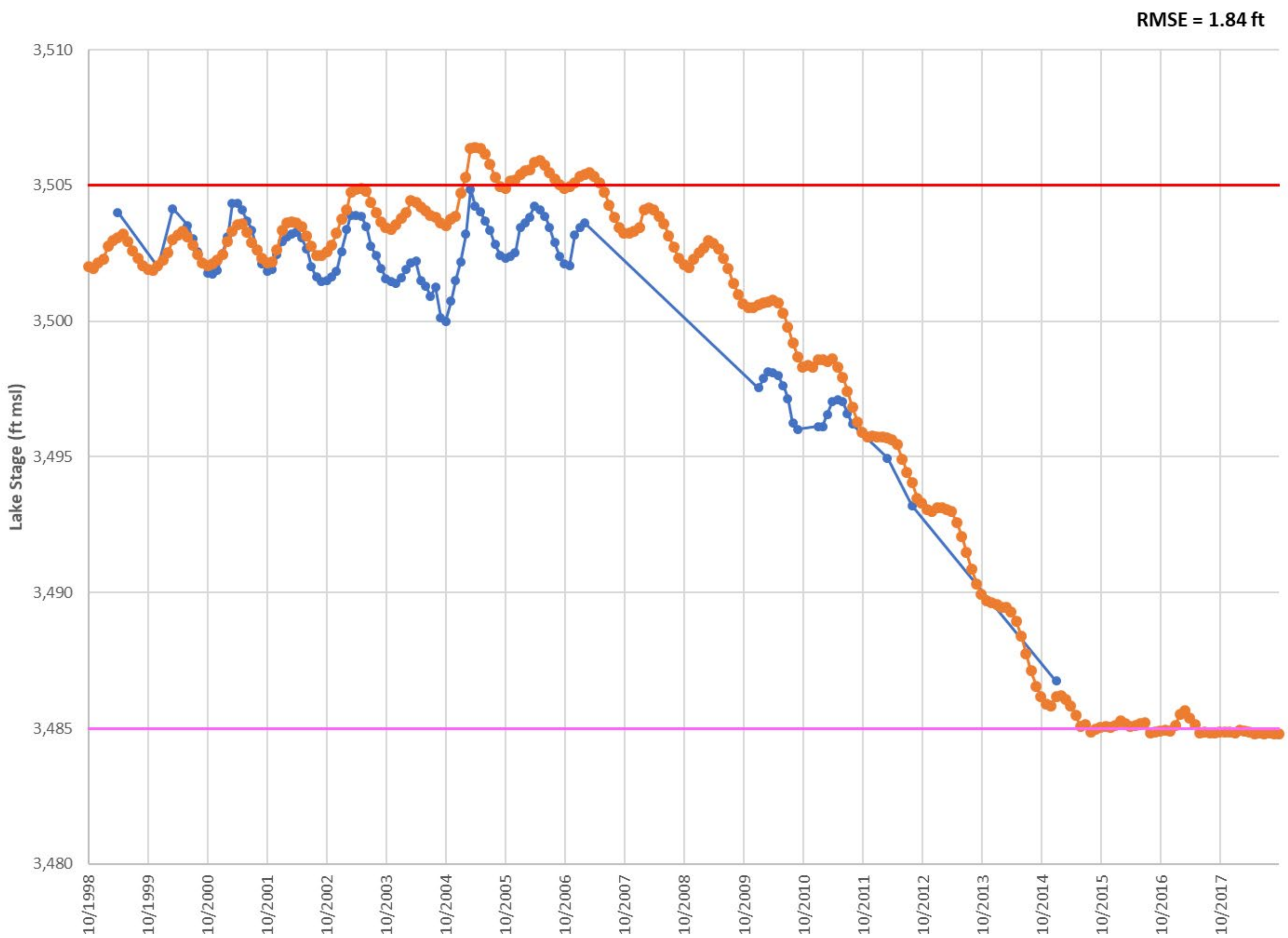
Water Level Observations vs. Model-Simulated Results – TRC MW-23D

Tejon-Castac Water District
Kern County, California
April 2020
EKI B90059.00

Figure 10c



Legend

= Observed Castac Lake Stage

= Model-Simulated Castac Lake Stage

= Castac Lakebed Elevation

= Castac Lake Maximum Stage Elevation

Abbreviations

CBGFM = Castac Basin Numerical Groundwater Flow Model
ft = feet
ft msl = feet above mean sea level
RMSE = Root Mean-Squared Error

Notes

1. Model-simulated Castac Lake stages are from the calibrated historical CBGFM.
2. RMSE is a quantitative measure of the closeness of fit, and is calculated as the square root of the average squared residuals between observed and model-simulated lake stages.

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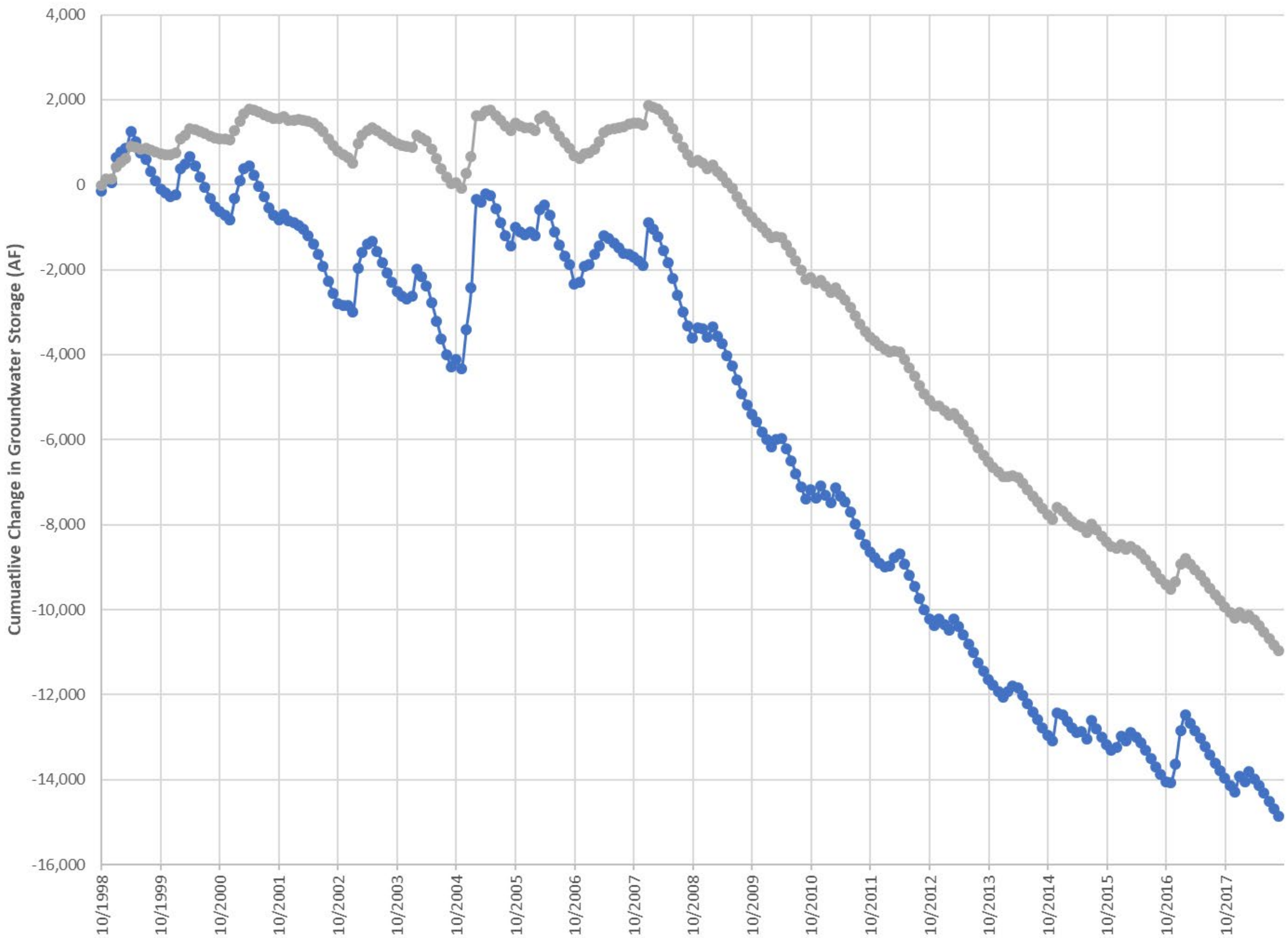
Castac Lake Stage Observations vs. Model-Simulated Results

Tejon-Castac Water District
Kern County, California
April 2020
EKI B90059.00

Figure 11



Legend

= CBGFM Simulated Change in Groundwater Storage

= Spreadsheet Analytical Model Simulated Change in Groundwater Storage

Abbreviations

AF = Acre-Feet

CBGFM = Castac Basin Numerical Groundwater Flow Model

Notes

1. CBGFM simulated change in groundwater storage values are from the calibrated historical CBGFM.

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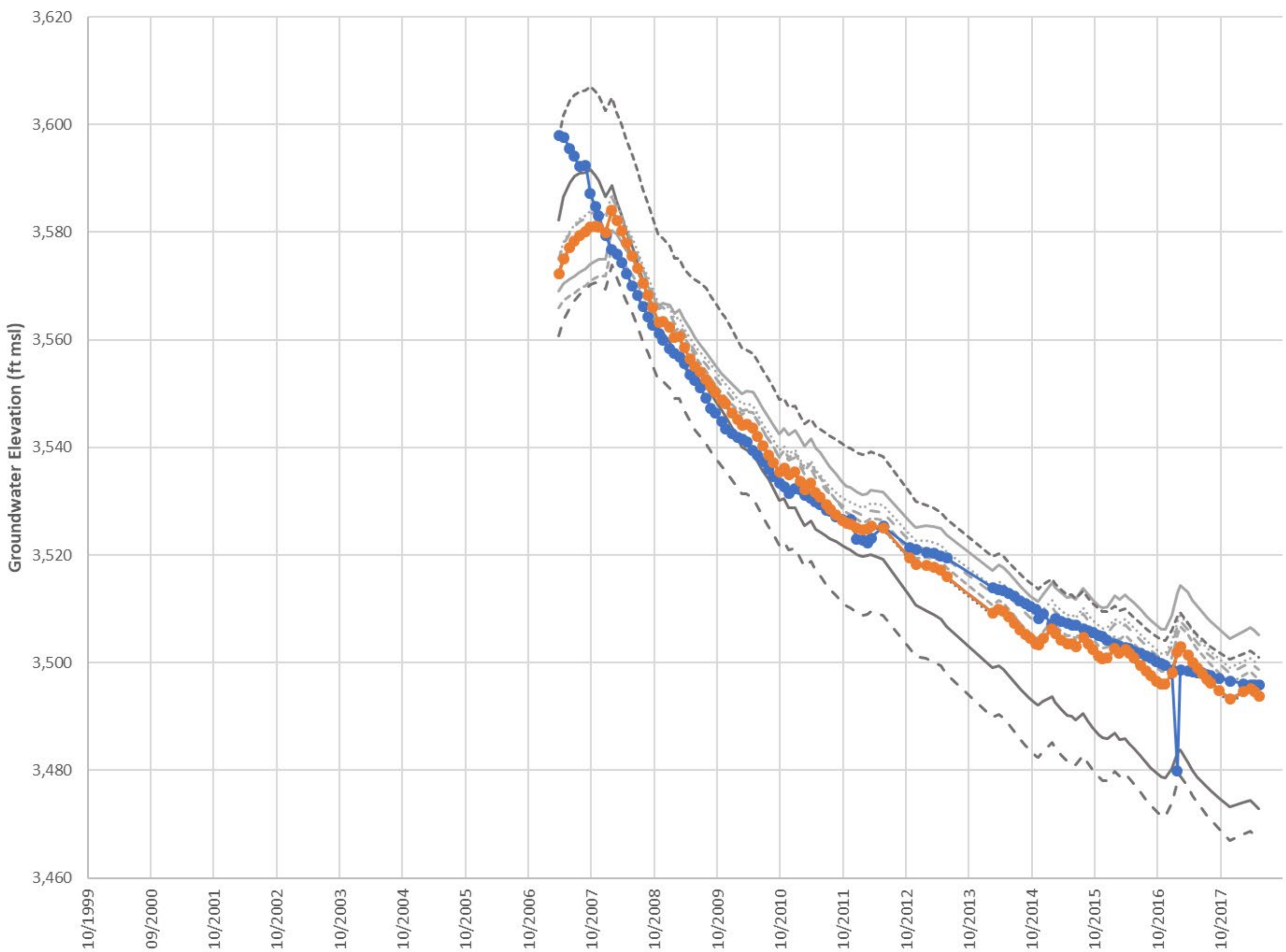
Simulated Change in Groundwater Storage – CBGFM vs. Analytical Spreadsheet Model Results

Tejon-Castac Water District
Kern County, California
April 2020
EKI B90059.00

Figure 12



Legend

= Observed Groundwater Elevation

= Calibrated CBGFM Groundwater Elevation

= K_{H3}, all zones = 18 ft/d

= K_{H3}, all zones = 86 ft/d

= K_{H3}, GVC North = 18 ft/d

= K_{H3}, GVC North = 86 ft/d

= K_{H3}, Main = 18 ft/d

= K_{H3}, Main = 86 ft/d

= K_{H3}, GVC South = 18 ft/d

= K_{H3}, GVC South = 86 ft/d

= K_{H3}, Dryfield = 18 ft/d

= K_{H3}, Dryfield = 86 ft/d

Abbreviations

CBGFM = Castac Basin Numerical Groundwater Flow Model
ft/d = feet per day
ft msl = feet above mean sea level
GVC = Grapevine Canyon
K_{H3} = Layer 3 Horizontal Hydraulic Conductivity

Notes

1. See Attachment B for complete results of sensitivity analyses.

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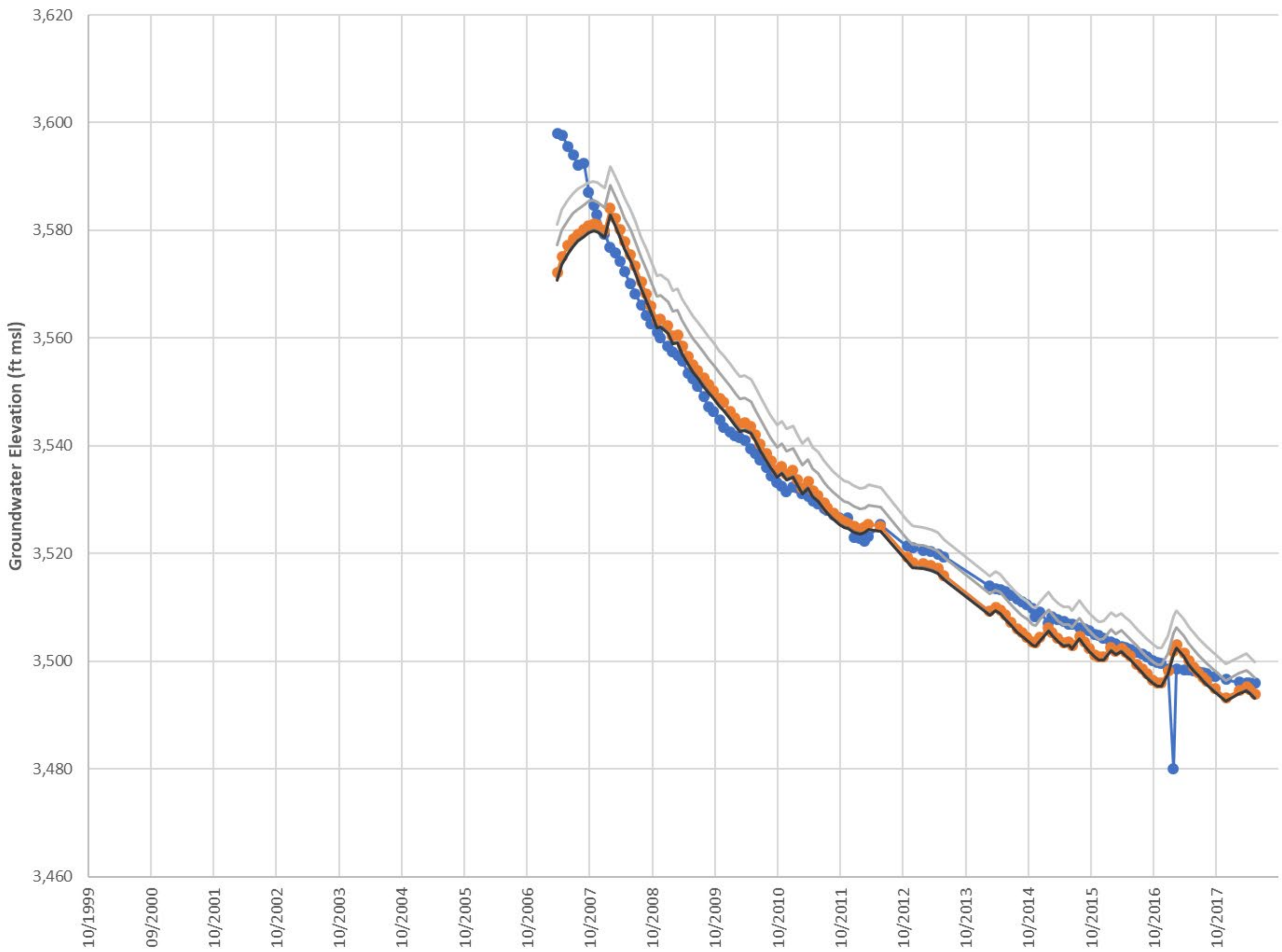
Water Level Sensitivity Analysis at TRC MW-16D – Layer 3 Horizontal Hydraulic Conductivity (K_{H3})

Tejon-Castac Water District
Kern County, California
April 2020
EKI B90059.00

Figure 13a



Legend

= Observed Groundwater Elevation

= Calibrated CBGFM Groundwater Elevation

= K_{lake} = 0.00001 ft/d

= K_{lake} = 0.0001 ft/d

= K_{lake} = 0.01 ft/d

= K_{lake} = 0.1 ft/d

Abbreviations

CBGFM = Castac Basin Numerical Groundwater Flow Model
ft/d = feet per day
ft msl = feet above mean sea level
GVC = Grapevine Canyon
K_{lake} = Castac Lakebed hydraulic conductivity

Notes

1. See Attachment B for complete results of sensitivity analyses.

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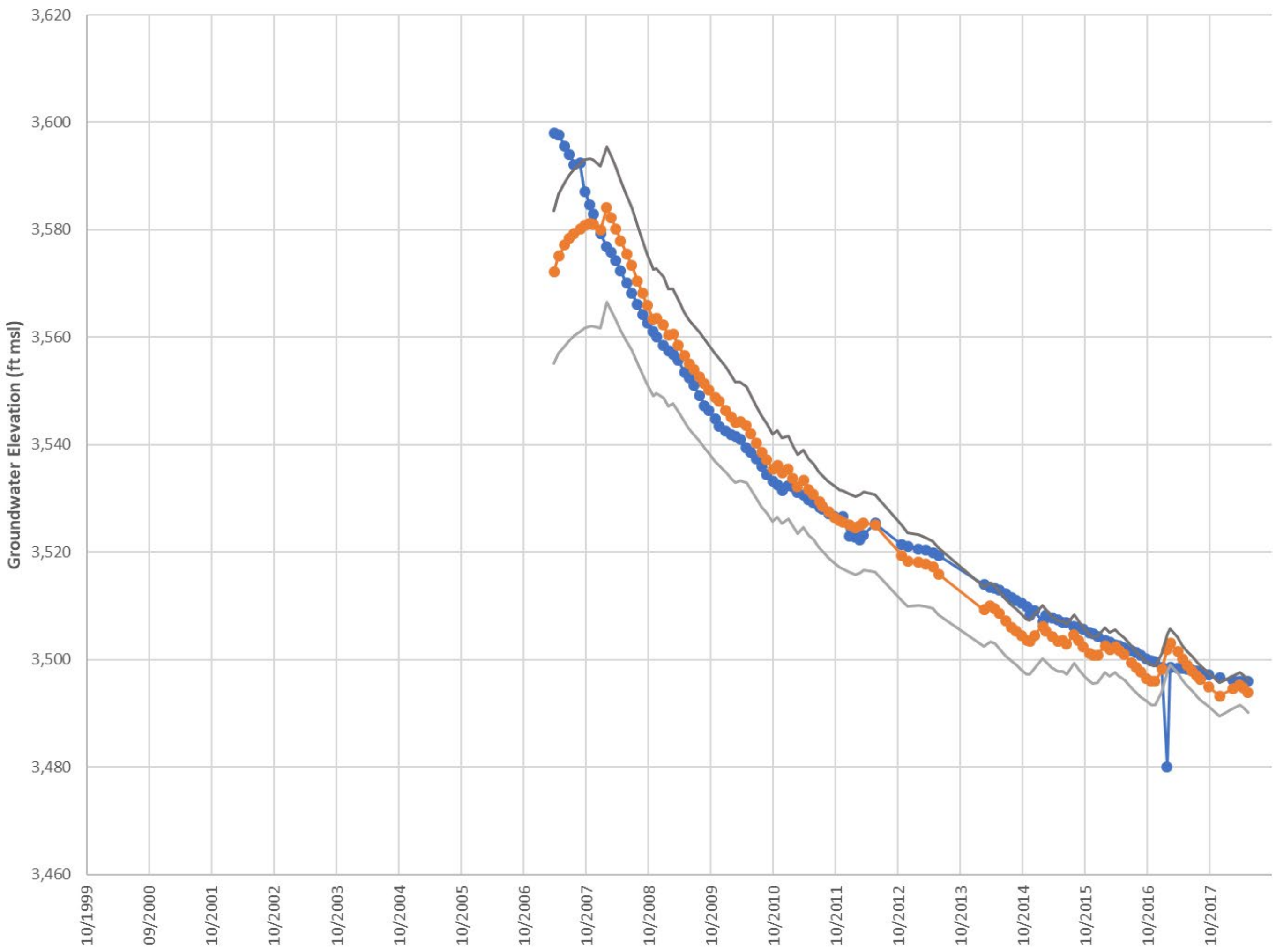
Water Level Sensitivity Analysis at TRC MW-16D – Castac Lakebed Hydraulic Conductivity (K_{lake})

Tejon-Castac Water District
Kern County, California
April 2020
EKI B90059.00

Figure 13b



Legend

= Observed Groundwater Elevation

= Calibrated CBGFM Groundwater Elevation

= GHB Heads = 1.0x historical TRC MW-16/PW-56A gradient

= GHB Heads = 1.5x historical TRC MW-16/PW-56A gradient

Abbreviations

CBGFM = Castac Basin Numerical Groundwater Flow Model

ft msl = feet above mean sea level

GHB = General Head Boundary

Notes

1. See Attachment B for complete results of sensitivity analyses.

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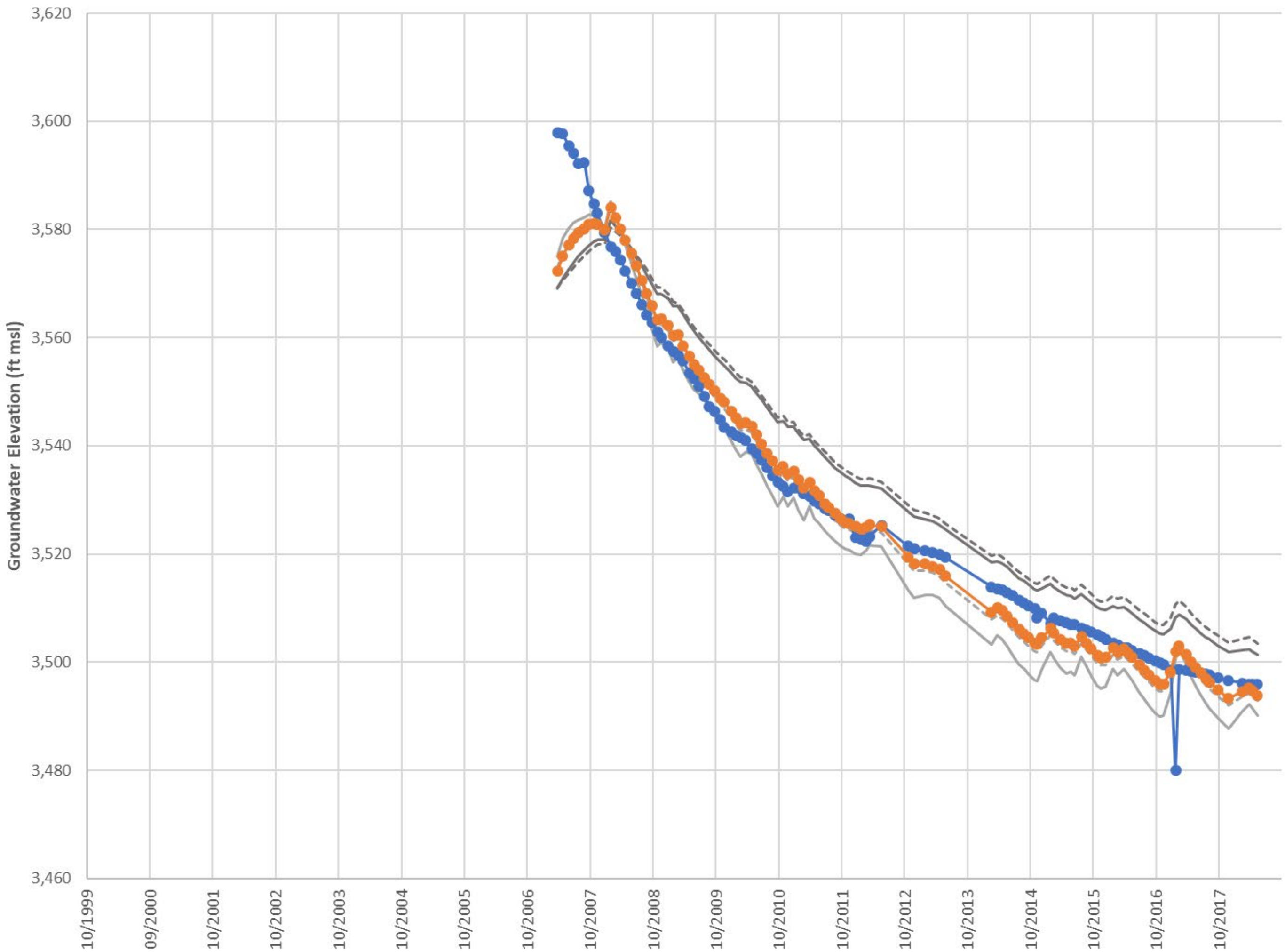
Water Level Sensitivity Analysis at TRC MW-16D – Cuddy Creek General Head Boundary (GHB) Transient Heads

Tejon-Castac Water District
Kern County, California
April 2020
EKI B90059.00

Figure 13c



Legend

= Observed Groundwater Elevation

= Calibrated CBGFM Groundwater Elevation

= S_{y3} halved

= S_{y3} doubled

= S_3 divided by 10x

= S_3 multipled by 10x

Abbreviations

CBGFM = Castac Basin Numerical Groundwater Flow Model

ft msl = feet above mean sea level

S_3 = Layer 3 Storativity

S_{y3} = Layer 3 Specific Yield

Notes

1. See Attachment B for complete results of sensitivity analyses.

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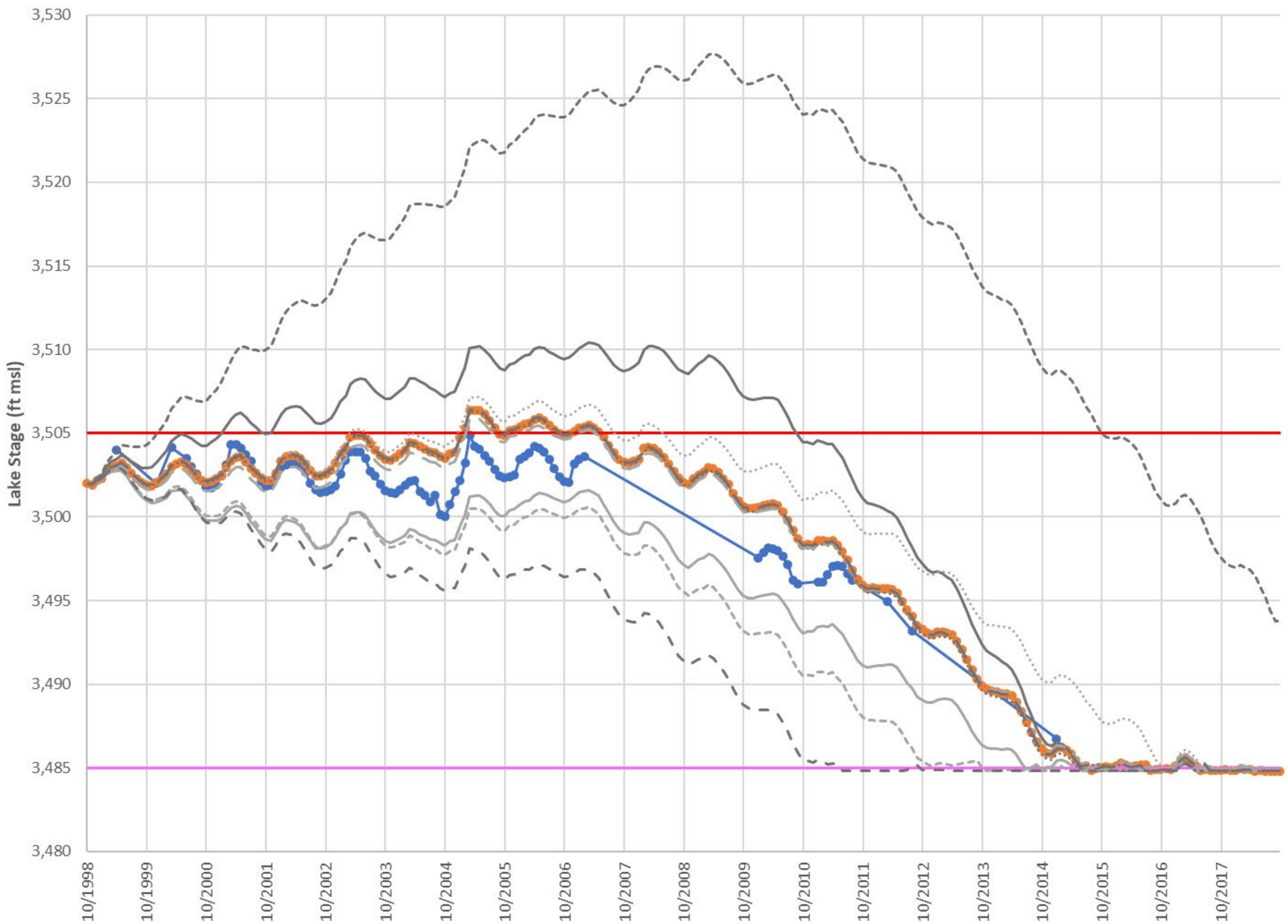
Water Level Sensitivity Analysis at TRC MW-16D – Layer 3 Specific Yield (S_{y3}) and Storativity (S_3)

Tejon-Castac Water District
Kern County, California
April 2020
EKI B90059.00

Figure 13d



Legend

= Observed Castac Lake Stage

= Calibrated CBGFM Lake Stage

= Castac Lakebed Elevation

= Castac Lake Maximum Stage

= K_{H3}, all zones = 18 ft/d

= K_{H3}, all zones = 86 ft/d

= K_{H3}, GVC North = 18 ft/d

= K_{H3}, GVC North = 86 ft/d

= K_{H3}, Main = 18 ft/d

= K_{H3}, Main = 86 ft/d

= K_{H3}, GVC South = 18 ft/d

= K_{H3}, GVC South = 86 ft/d

= K_{H3}, Dryfield = 18 ft/d

= K_{H3}, Dryfield = 86 ft/d

Abbreviations

CBGFM = Castac Basin Numerical Groundwater Flow Model

ft/d = feet per day

ft msl = feet above mean sea level

GVC = Grapevine Canyon

K_{H3} = Layer 3 Horizontal Hydraulic Conductivity

Notes

1. See Attachment B for complete results of sensitivity analyses.

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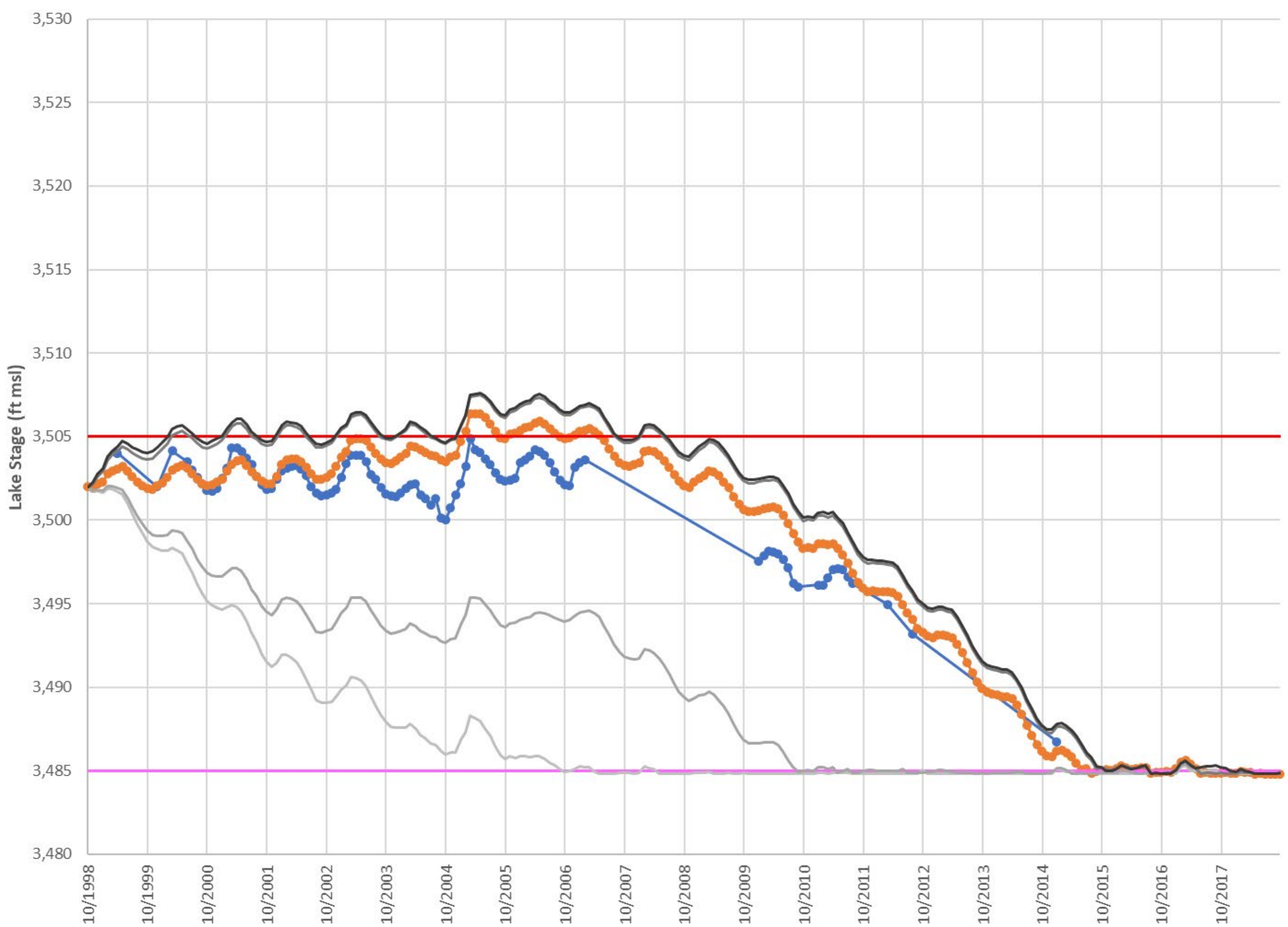
Castac Lake Sensitivity Analysis – Layer 3 Horizontal Hydraulic Conductivity (K_{H3})

Tejon-Castac Water District
Kern County, California
April 2020
EKI B90059.00

Figure 14a



Legend

= Observed Castac Lake Stage

= Calibrated CBGFM Lake Stage

= Castac Lakebed Elevation

= Castac Lake Maximum Stage

= K_{lake} = 0.00001 ft/d

= K_{lake} = 0.0001 ft/d

= K_{lake} = 0.01 ft/d

= K_{lake} = 0.1 ft/d

Abbreviations

CBGFM = Castac Basin Numerical Groundwater Flow Model

ft/d = feet per day

ft msl = feet above mean sea level

GVC = Grapevine Canyon

K_{lake} = Castac Lakebed hydraulic conductivity

Notes

1. See Attachment B for complete results of sensitivity analyses.

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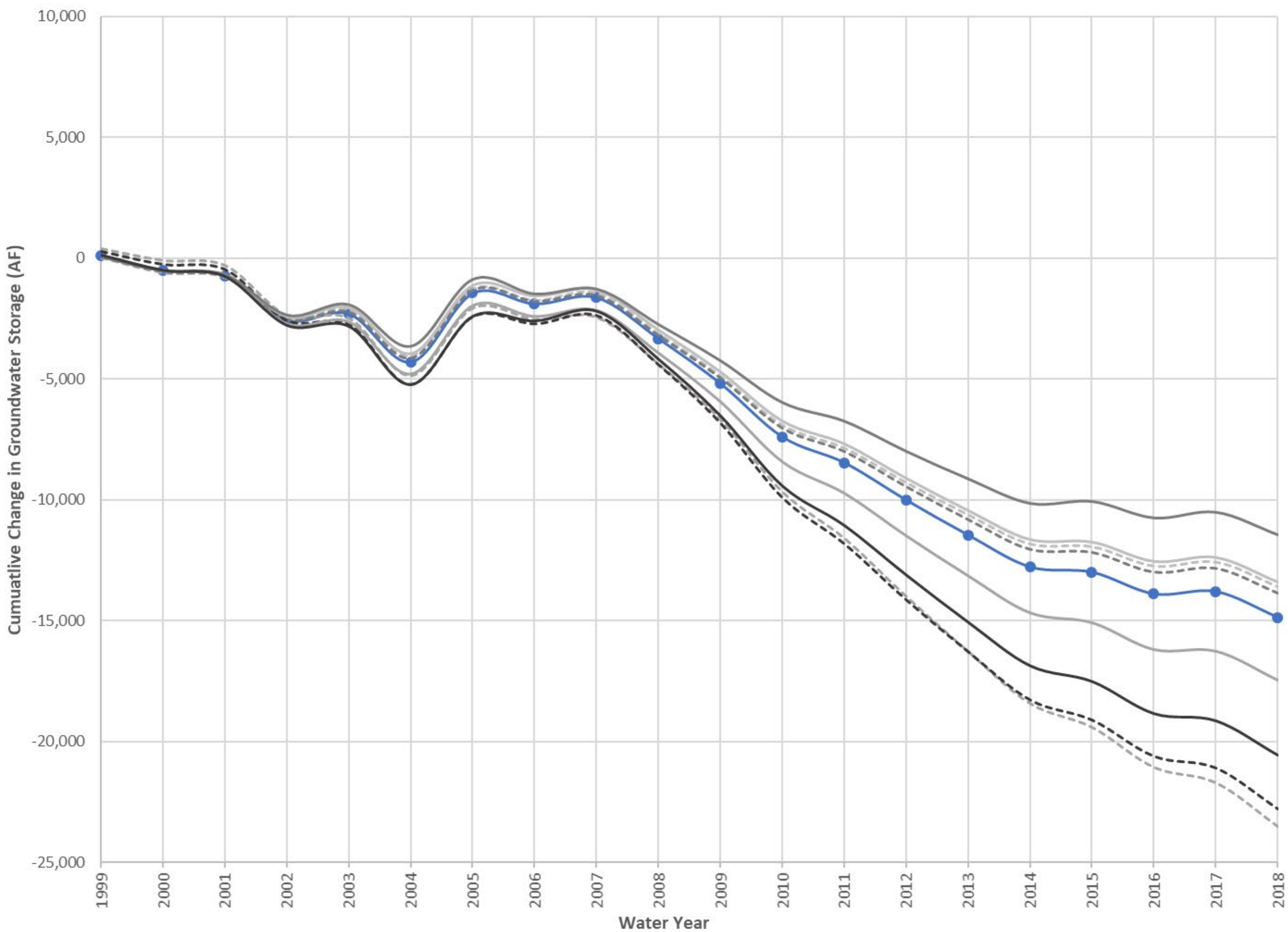
Castac Lake Sensitivity Analysis
Castac Lakebed
Hydraulic Conductivity (K_{lake})

Tejon-Castac Water District
Kern County, California
April 2020
EKI B90059.00

Figure 14b



Legend

- = Calibrated CBGFM Simulated Change in Groundwater Storage
- = S_{12} divided by 10x
- = S_{12} multiplied by 10x
- = S_3 divided by 10x
- = S_3 multiplied by 10x
- = S_{y12} halved
- = S_{y12} doubled
- = S_{y3} halved
- = S_{y3} doubled

Abbreviations

AF = Acre-Feet
CBGFM = Castac Basin Numerical Groundwater Flow Model
S_{12} = Layers 1 & 2 Storativity
S_3 = Layer 3 Storativity
S_{y12} = Layers 1 & 2 Specific Yield
S_{y3} = Layer 3 Specific Yield

Notes

1. See Attachment B for complete results of sensitivity analyses.

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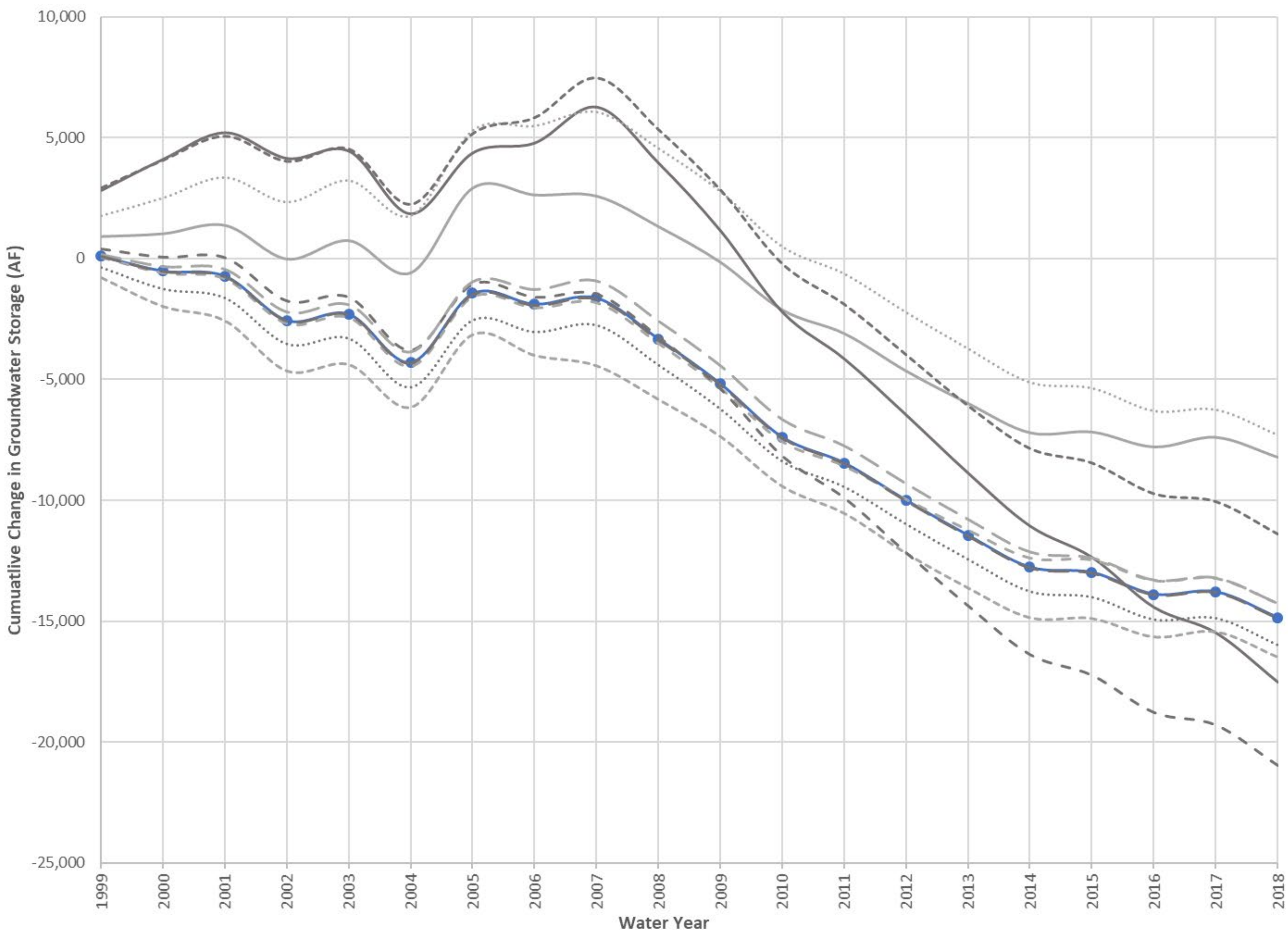
Simulated Change in Groundwater Storage Sensitivity Analysis – Specific Yield (S_y) and Storativity (S)

Tejon-Castac Water District
Kern County, California
April 2020
EKI B90059.00

Figure 15a



Legend

= Calibrated CBGFM Simulated Change in Groundwater Storage

= K_{H3}, all zones = 18 ft/d

= K_{H3}, all zones = 86 ft/d

= K_{H3}, GVC North = 18 ft/d

= K_{H3}, GVC North = 86 ft/d

= K_{H3}, Main = 18 ft/d

= K_{H3}, Main = 86 ft/d

= K_{H3}, GVC South = 18 ft/d

= K_{H3}, GVC South = 86 ft/d

= K_{H3}, Dryfield = 18 ft/d

= K_{H3}, Dryfield = 86 ft/d

Abbreviations

AF = Acre-Feet
CBGFM = Castac Basin Numerical Groundwater Flow Model
ft/d = feet per day
GVC = Grapevine Canyon
K_{H3} = Layer 3 Horizontal Hydraulic Conductivity

Notes

1. See Attachment B for complete results of sensitivity analyses.

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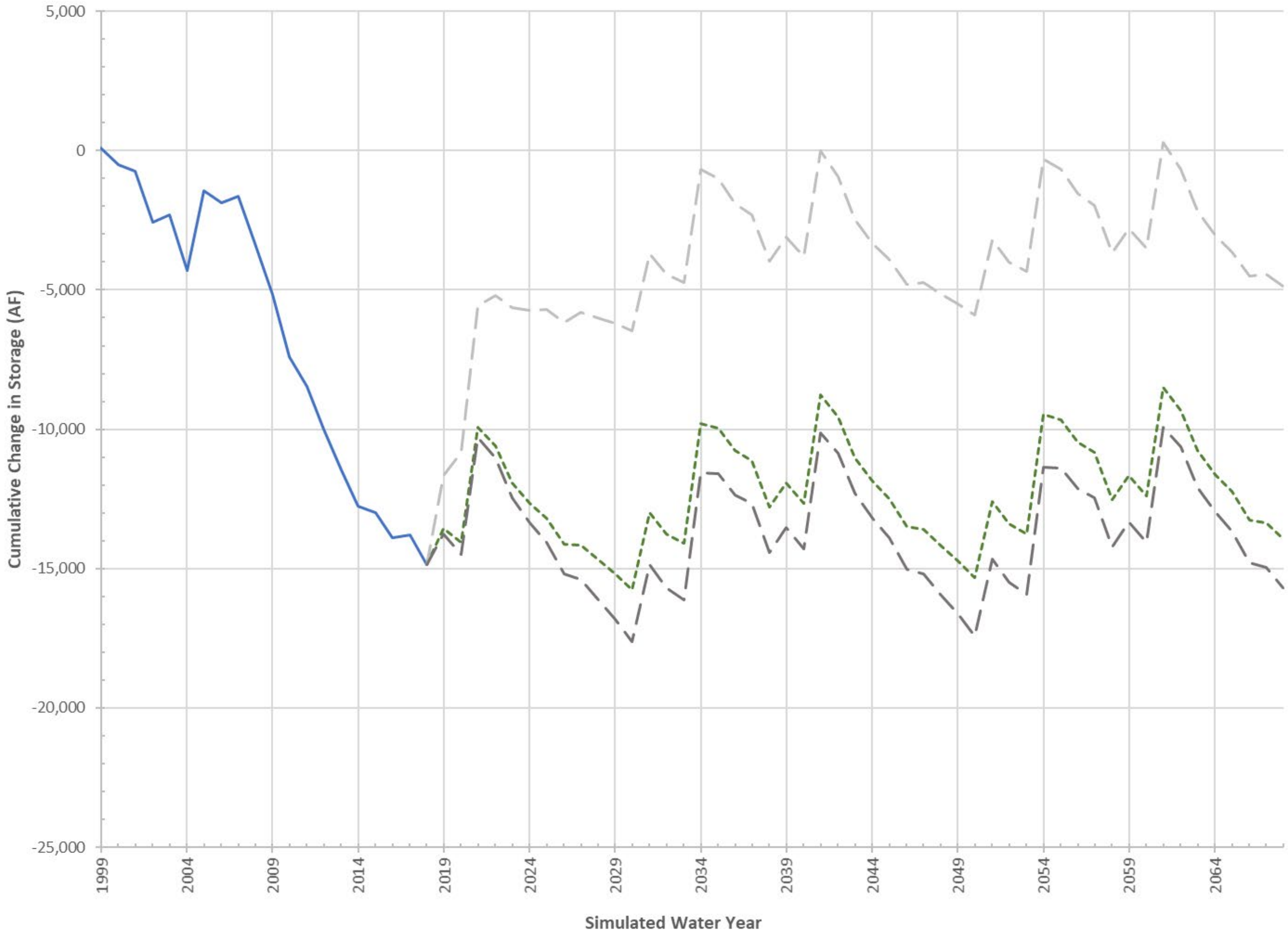
Simulated Change in Groundwater Storage Sensitivity Analysis – Layer 3 Horizontal Hydraulic Conductivity (K_{H3})

Tejon-Castac Water District
Kern County, California
April 2020
EKI B90059.00

Figure 15b



Legend

= Calibrated CBGFM Historical Simulated Change in Groundwater Storage

= Calibrated CBGFM Projected Change in Groundwater Storage for Baseline Climate Scenario with TMV Development and Aquifer Replenishment Project

= Projected Change in Groundwater Storage – Historical Average GW Inflow Rate (1,380 AFY)

= Projected Change in Groundwater Storage – Zero GW Inflows (0 AFY)

Abbreviations

AF = Acre-Feet
AFY = Acre-Feet per year
CBGFM = Castac Basin Numerical Groundwater Flow Model
GHB = General Head Boundary
GW = Groundwater
TMV = Tejon Mountain Village

Notes

1. Projected change in groundwater Storage values represent the Baseline projected climate condition with TMV Development and implementation of the Aquifer Replenishment Project. See Section 5.2. for further details.

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Projected Change in Groundwater Storage – Cuddy Creek General Head Boundary (GHB) Uncertainty Analysis

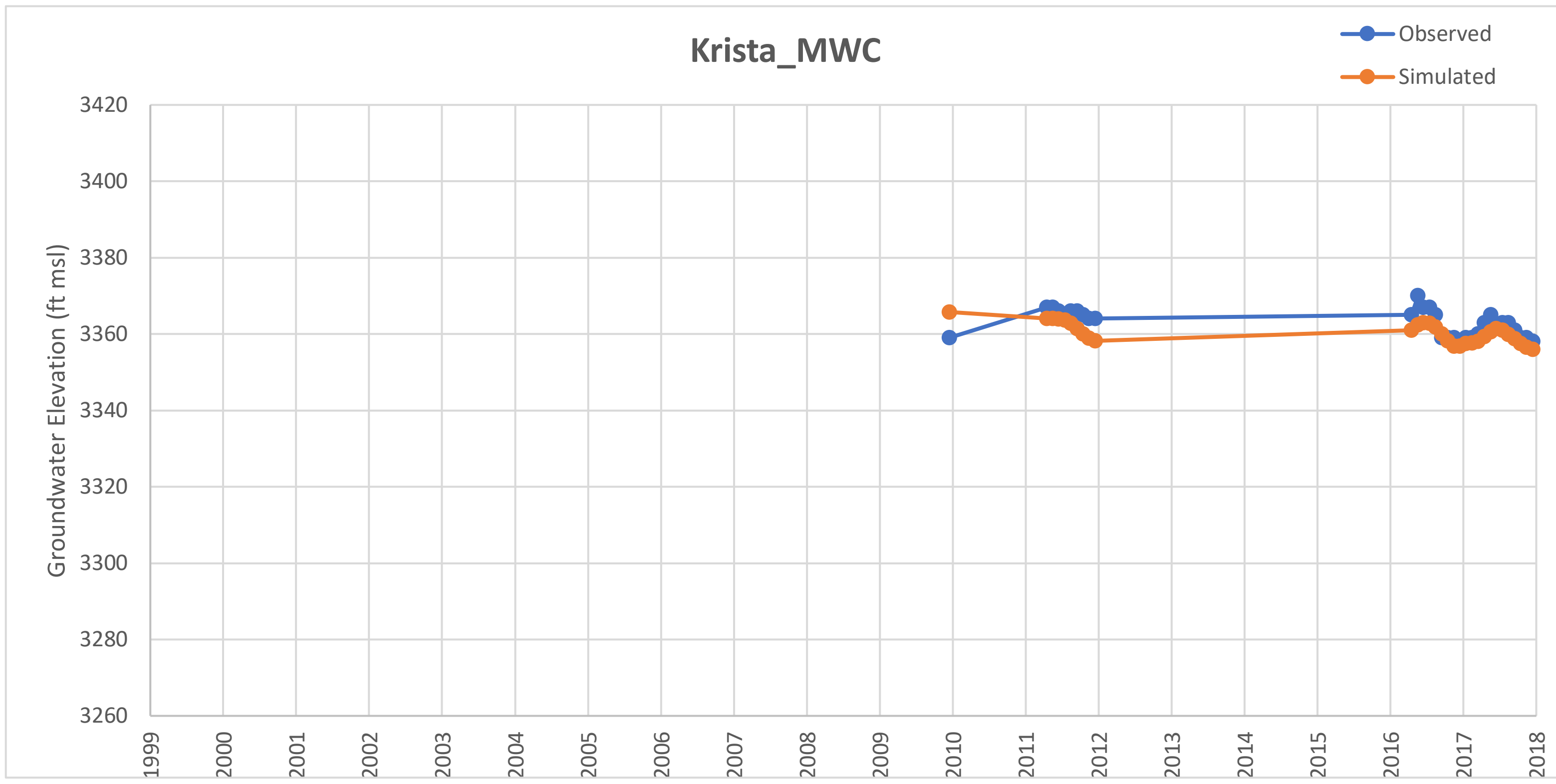
Tejon-Castac Water District
Kern County, California
April 2020
EKI B90059.00

Figure 16

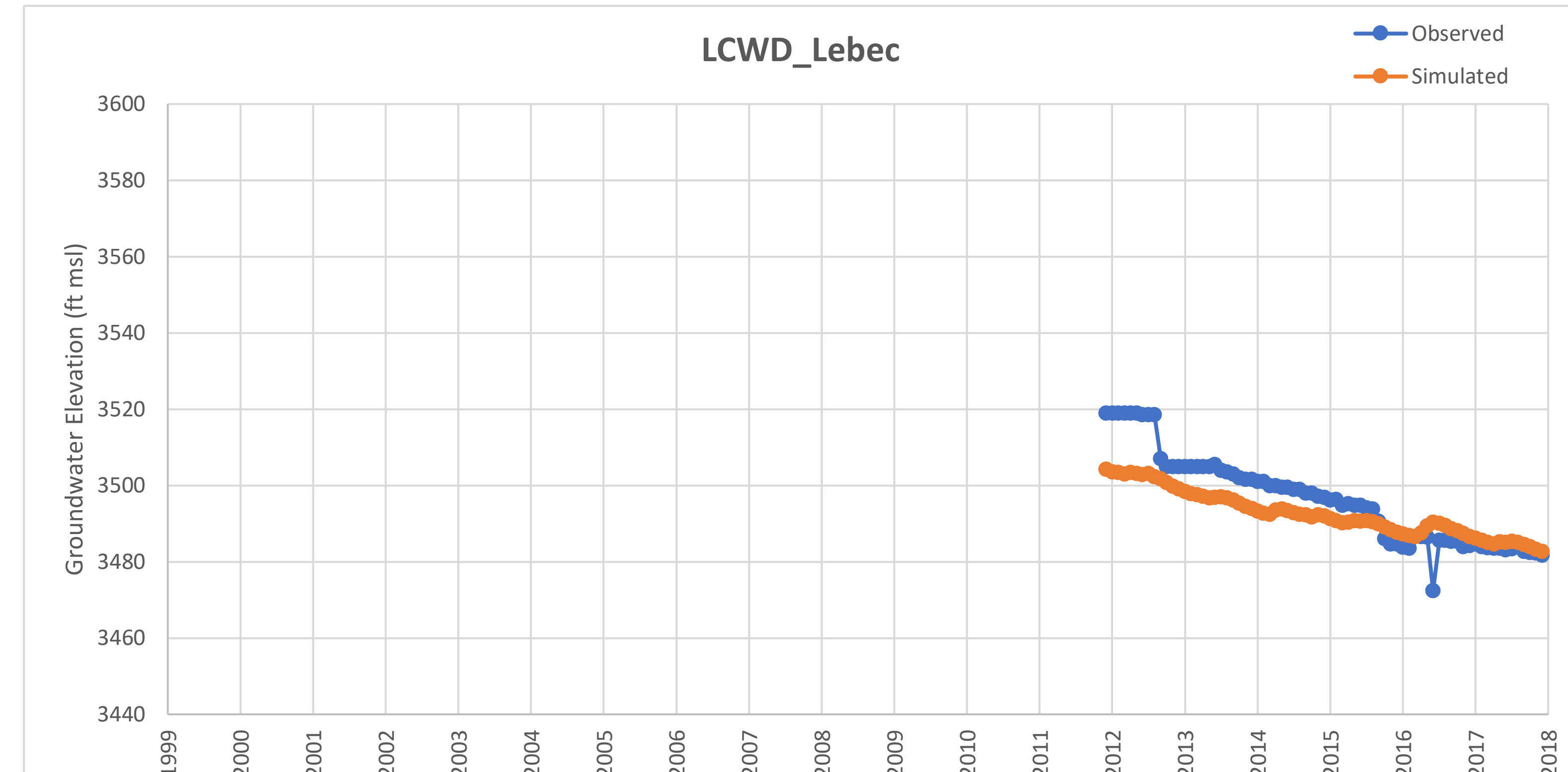
ATTACHMENT A

CBGFM HISTORICAL MODEL CALIBRATION HYDROGRAPHS

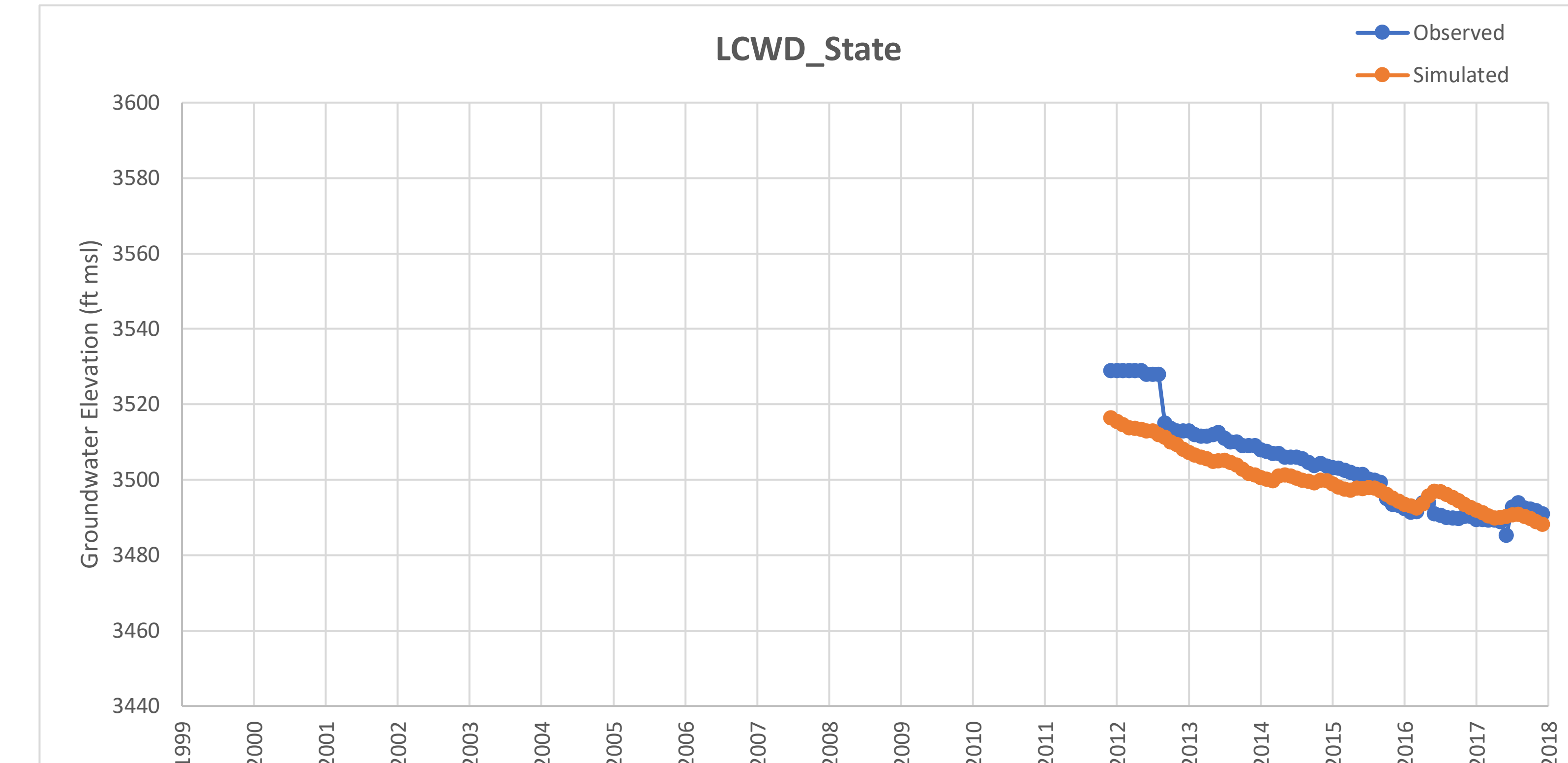
CBGFM CALIBRATION HYDROGRAPHS



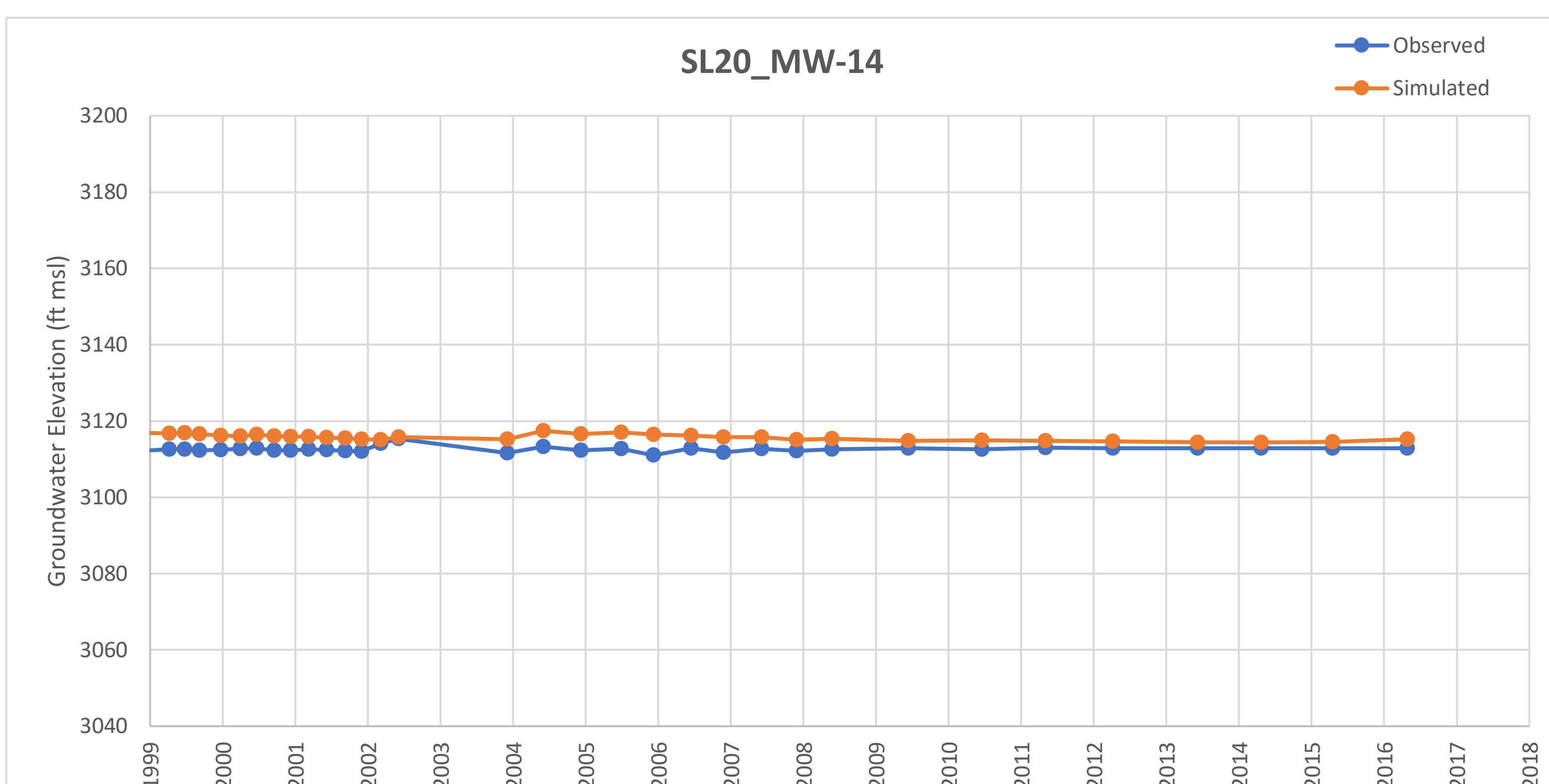
RMSE	3.51 ft		well:	**Krista_MWC**
Min	-7.6		area:	GVC S
Max	6.8		layer:	3
Average	-2.5		cells:	9:39
Median	-2.5			



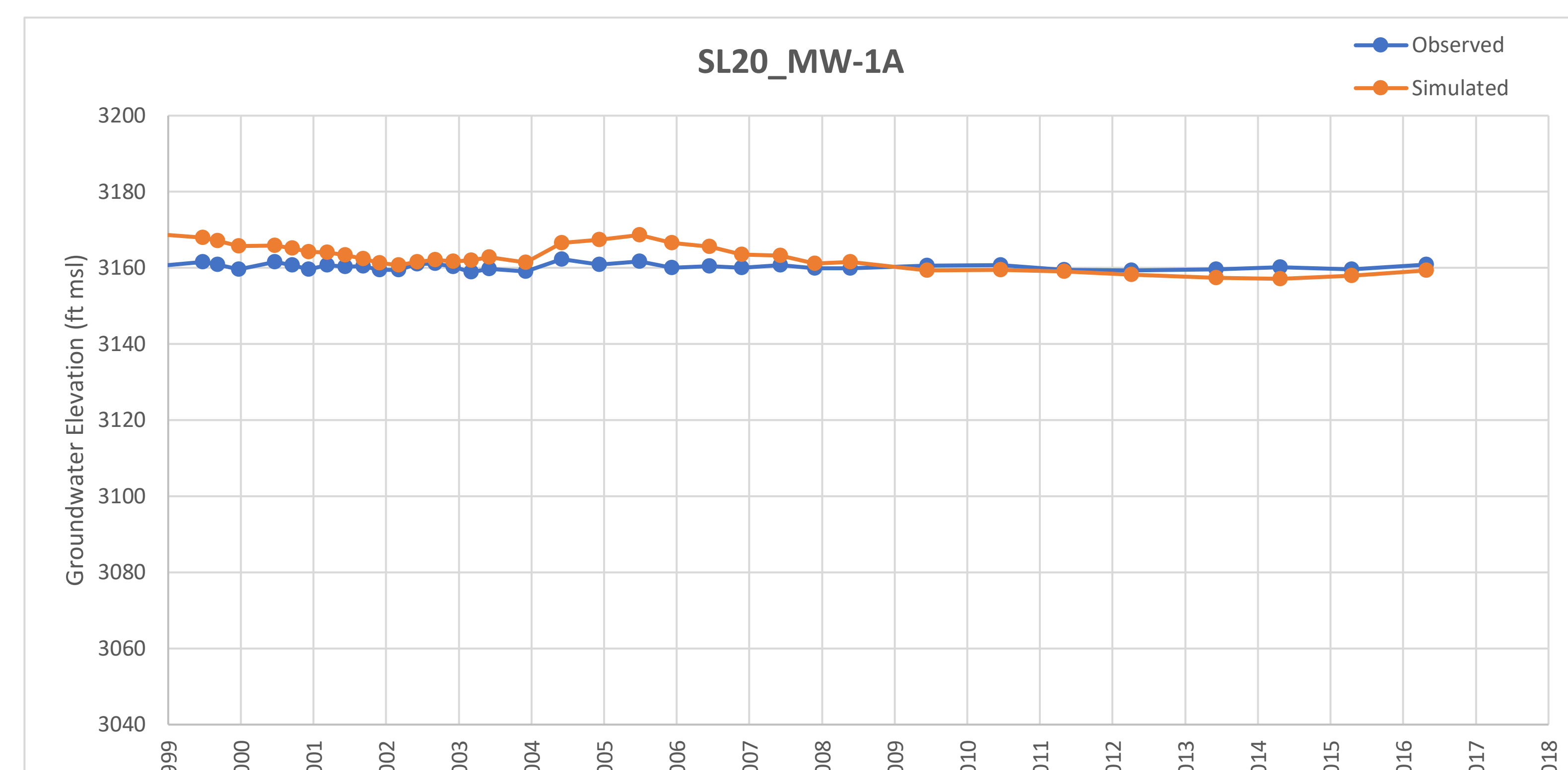
RMSE	7.48 ft		well:	**LCWD_Lebec**
Min	-16.2		area:	Main
Max	18.0		layer:	3
Average	-3.9		cells:	40:112
Median	-4.9			



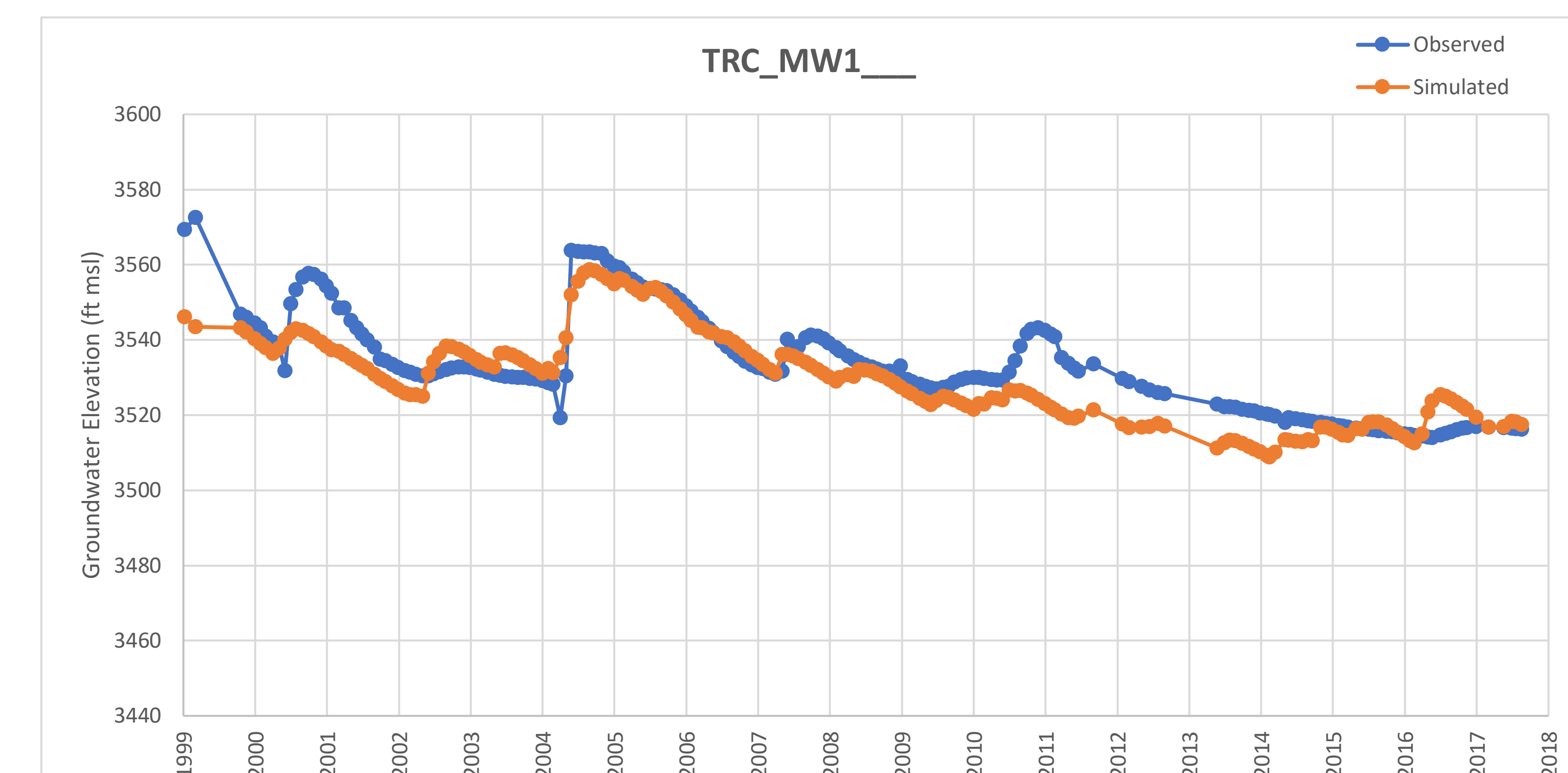
RMSE	6.75 ft		well:	**LCWD_State**
Min	-16.0		area:	Main
Max	6.2		layer:	3
Average	-3.9		cells:	113:185
Median	-4.2			



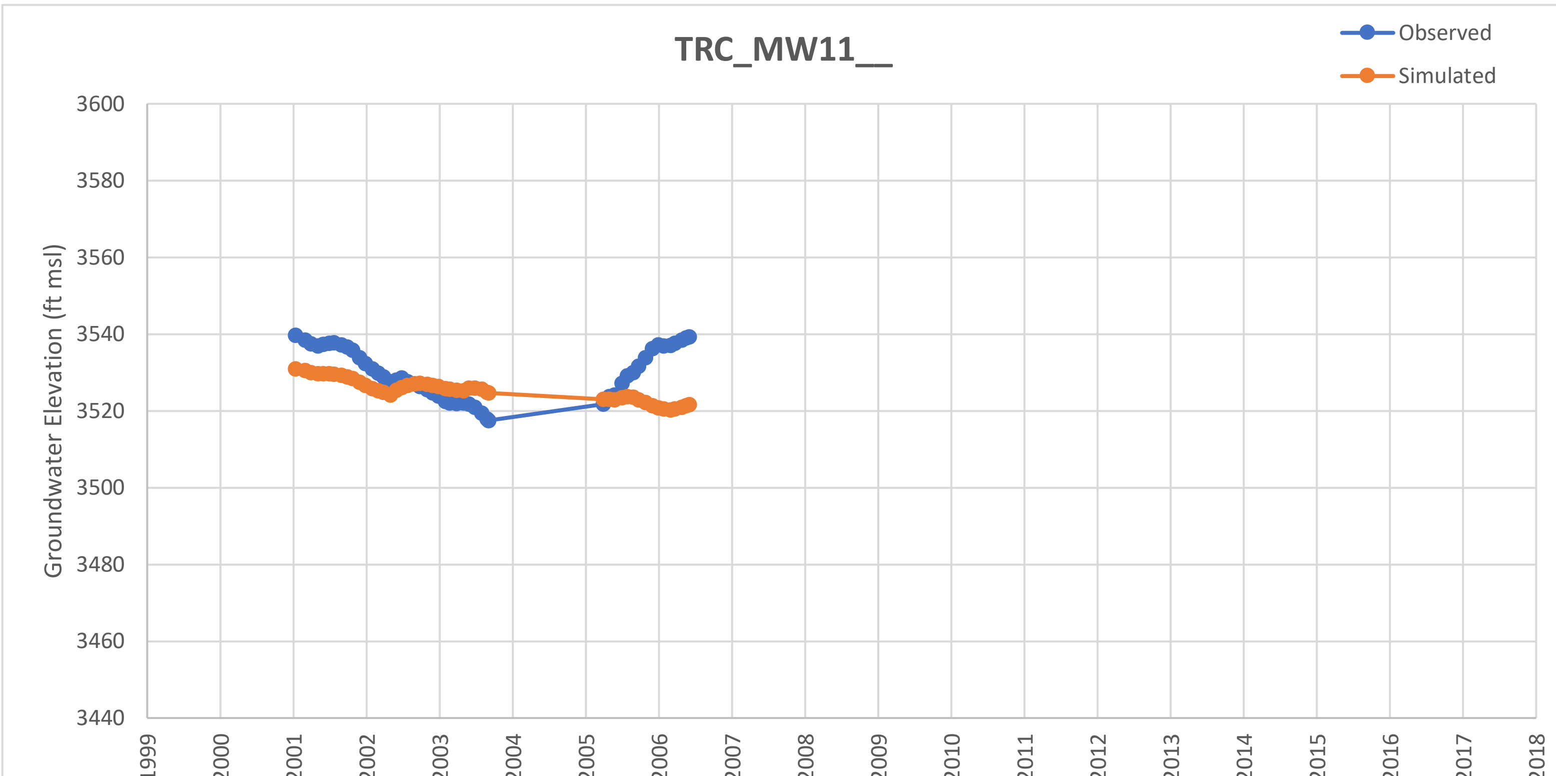
RMSE	3.47 ft	well:	**SL20_MW-14**	(no dry)	RMSE	3.47 ft
Min	0.4	area:	GVC N		Min	0.4
Max	5.4	layer:	2		Max	5.4
Average	3.3	cells:	186:221		Average	3.3
Median	3.4				Median	3.4



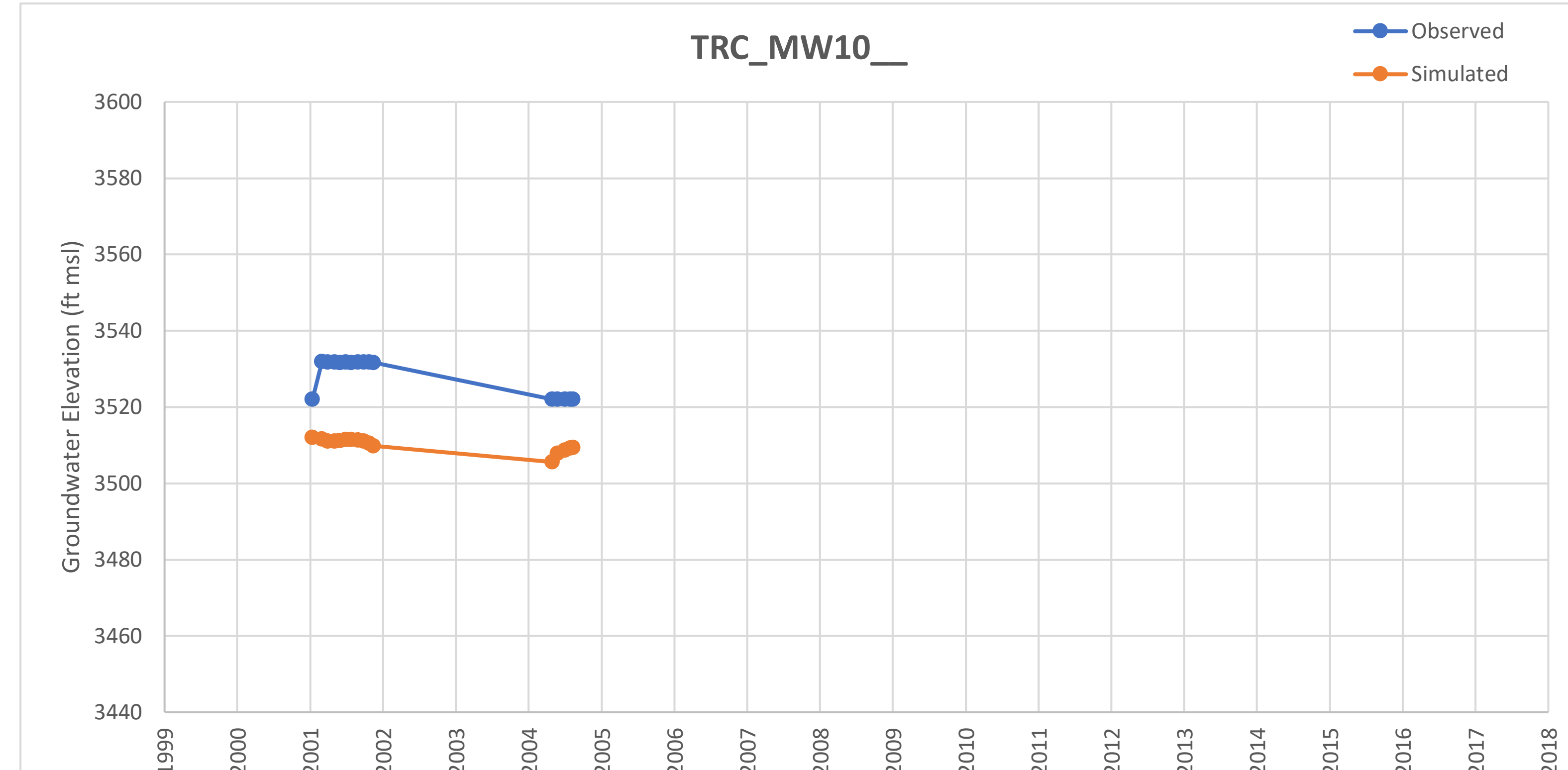
RMSE	4.34 ft		well:	**SL20_MW-1A**
Min	-3.0		area:	GVC N
Max	9.5		layer:	3
Average	2.9		cells:	222:258
Median	3.0			



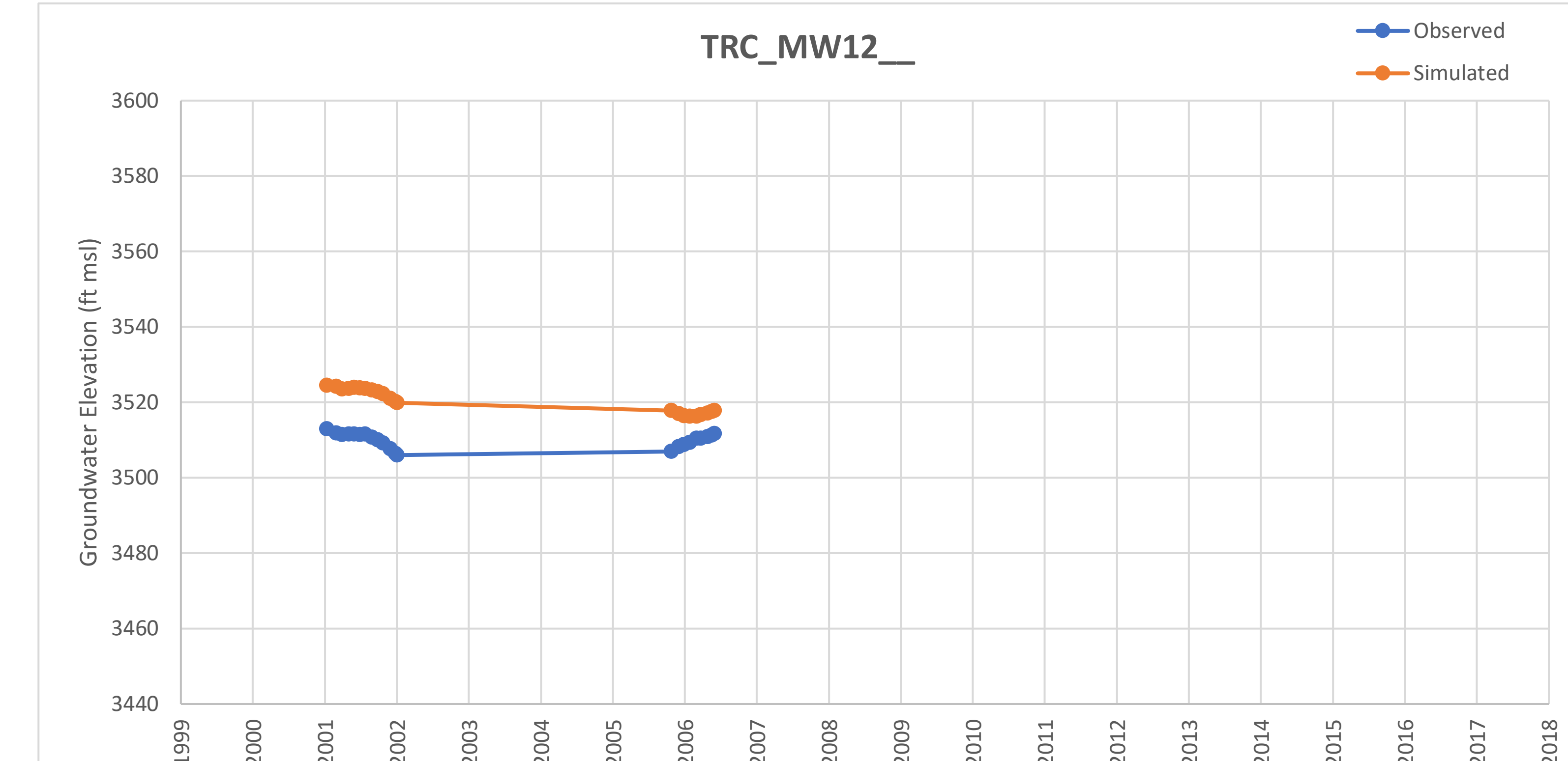
RMSE	7.92 ft		well:	**TRC_MW1___**
Min	-29.1		area:	Dryfield
Max	16.0		layer:	3
Average	-3.8		cells:	259:458
Median	-3.2			



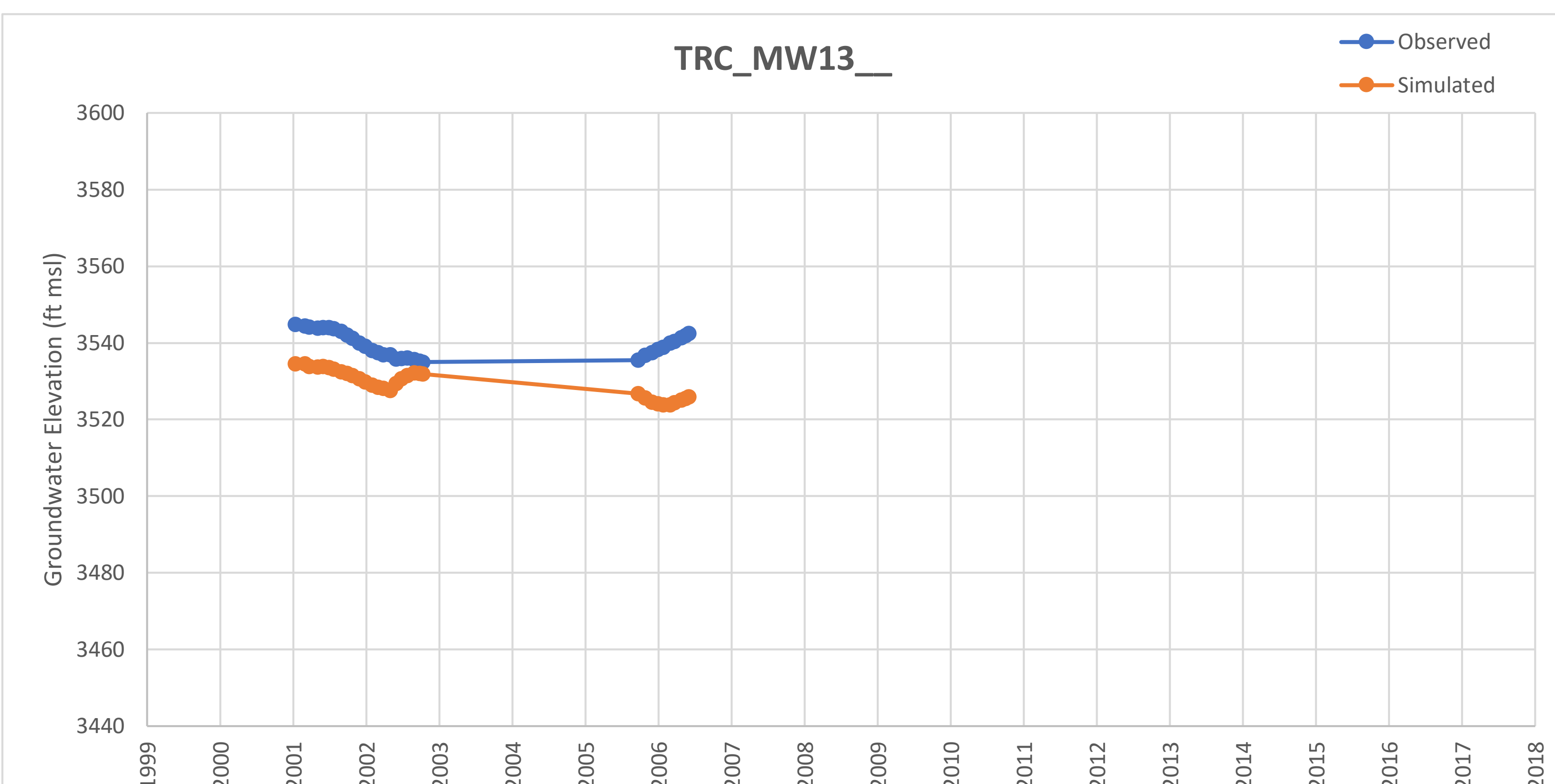
RMSE	8.54	ft	well:	TRC_MW11__
Min	-17.7		area:	Main
Max	7.2		layer:	2
Average	-4.8		cells:	459:507
Median	-5.2			



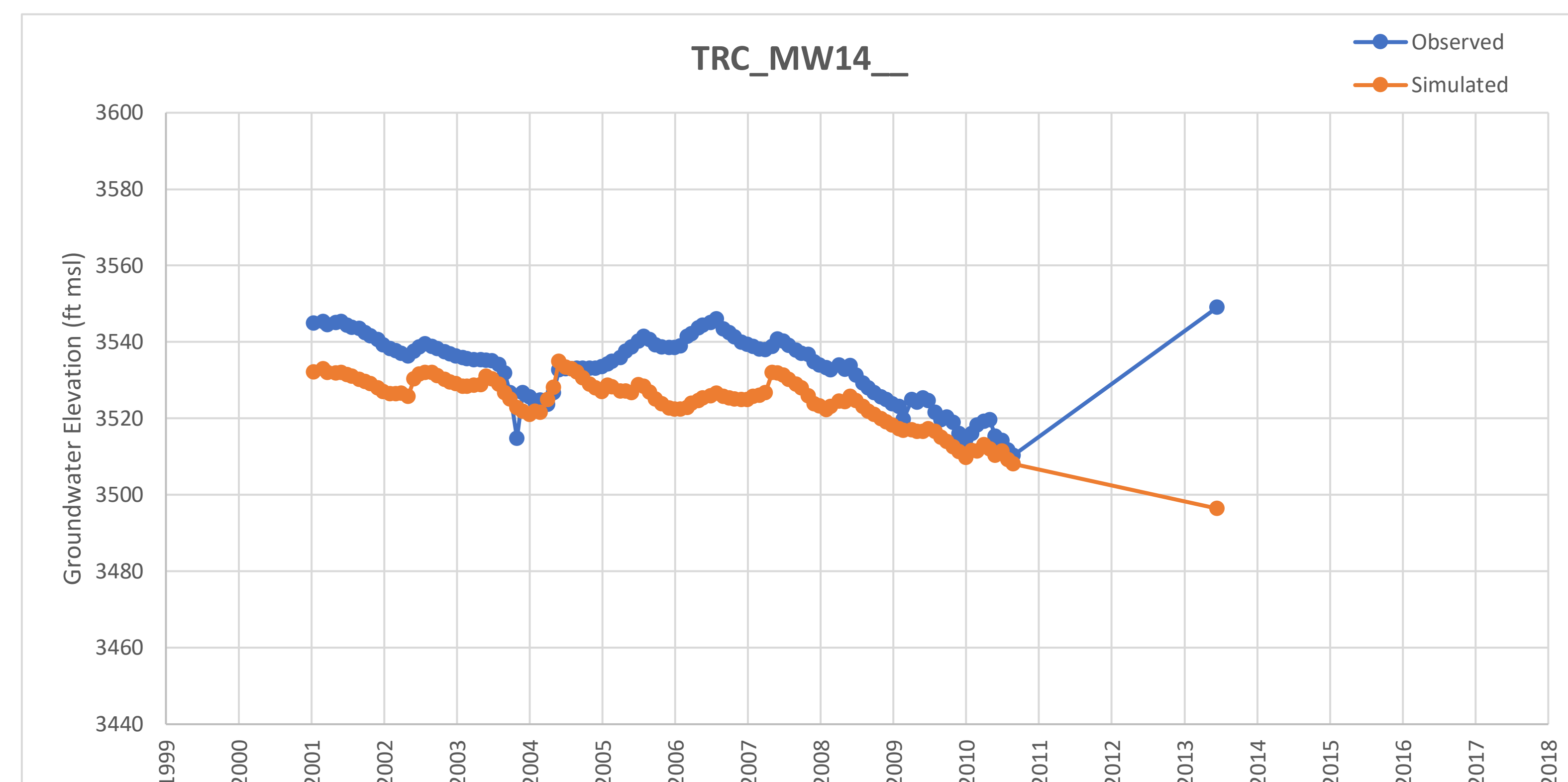
RMSE	18.27	ft	well:	TRC_MW10__
Min	-21.9		area:	Main
Max	-10.0		layer:	2
Average	-17.9		cells:	508:523
Median	-20.3			



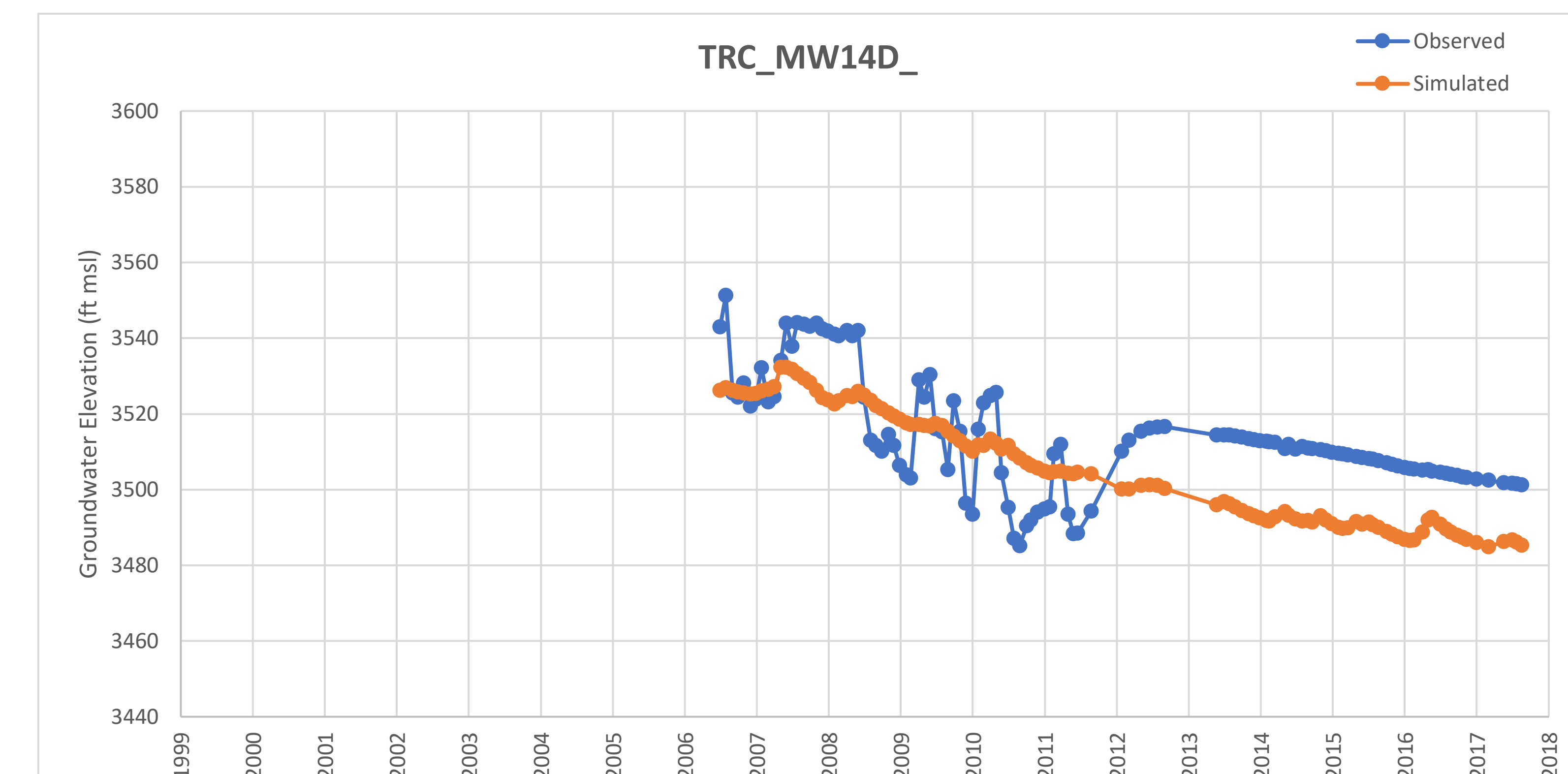
RMSE	10.82	ft	well:	TRC_MW12__
Min	5.9		area:	Main
Max	13.9		layer:	2
Average	10.4		cells:	524:545
Median	12.1			



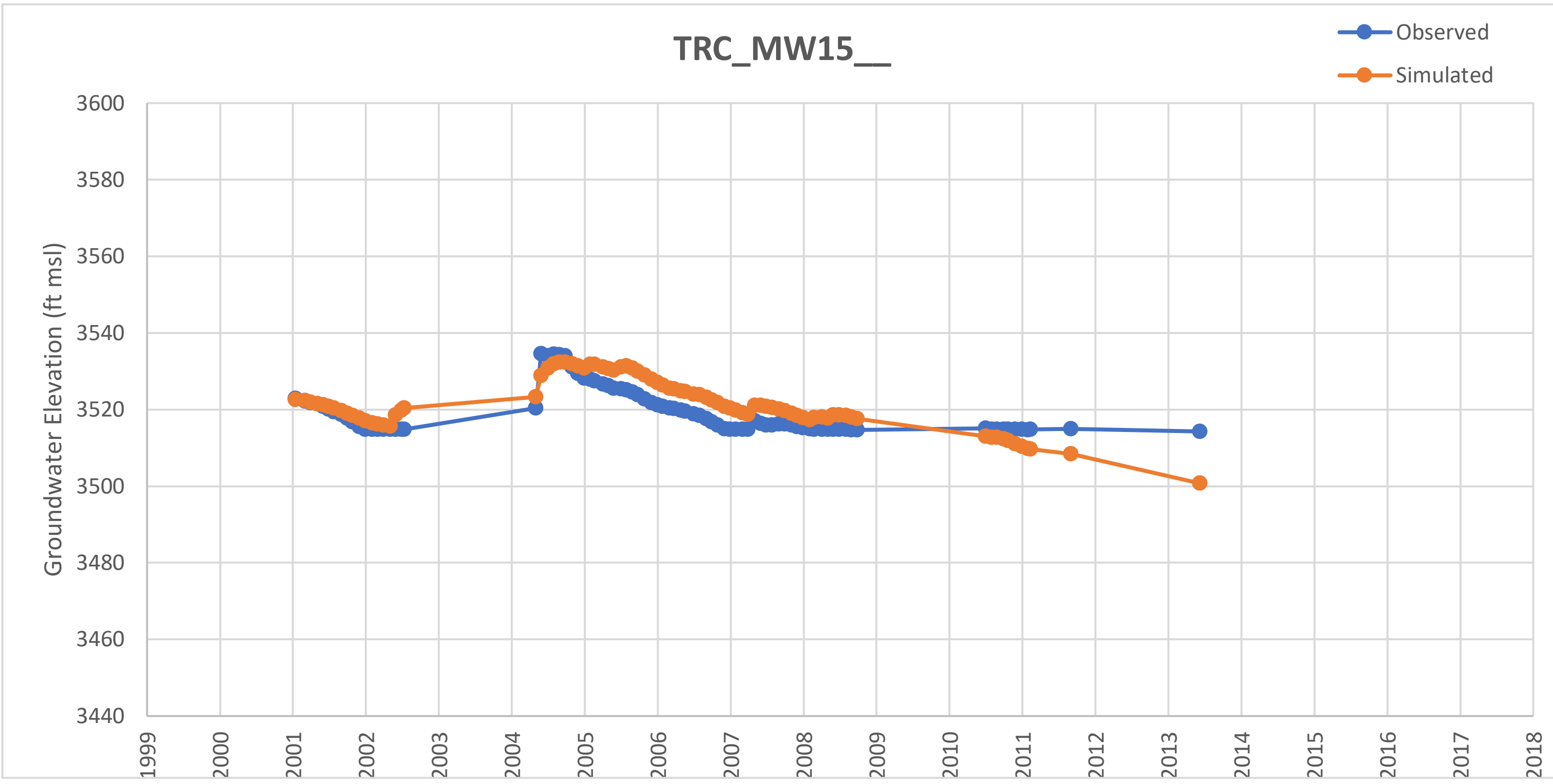
RMSE	10.88	ft	well:	TRC_MW13__
Min	-16.5		area:	Main
Max	-3.1		layer:	2
Average	-10.2		cells:	546:577
Median	-10.1			

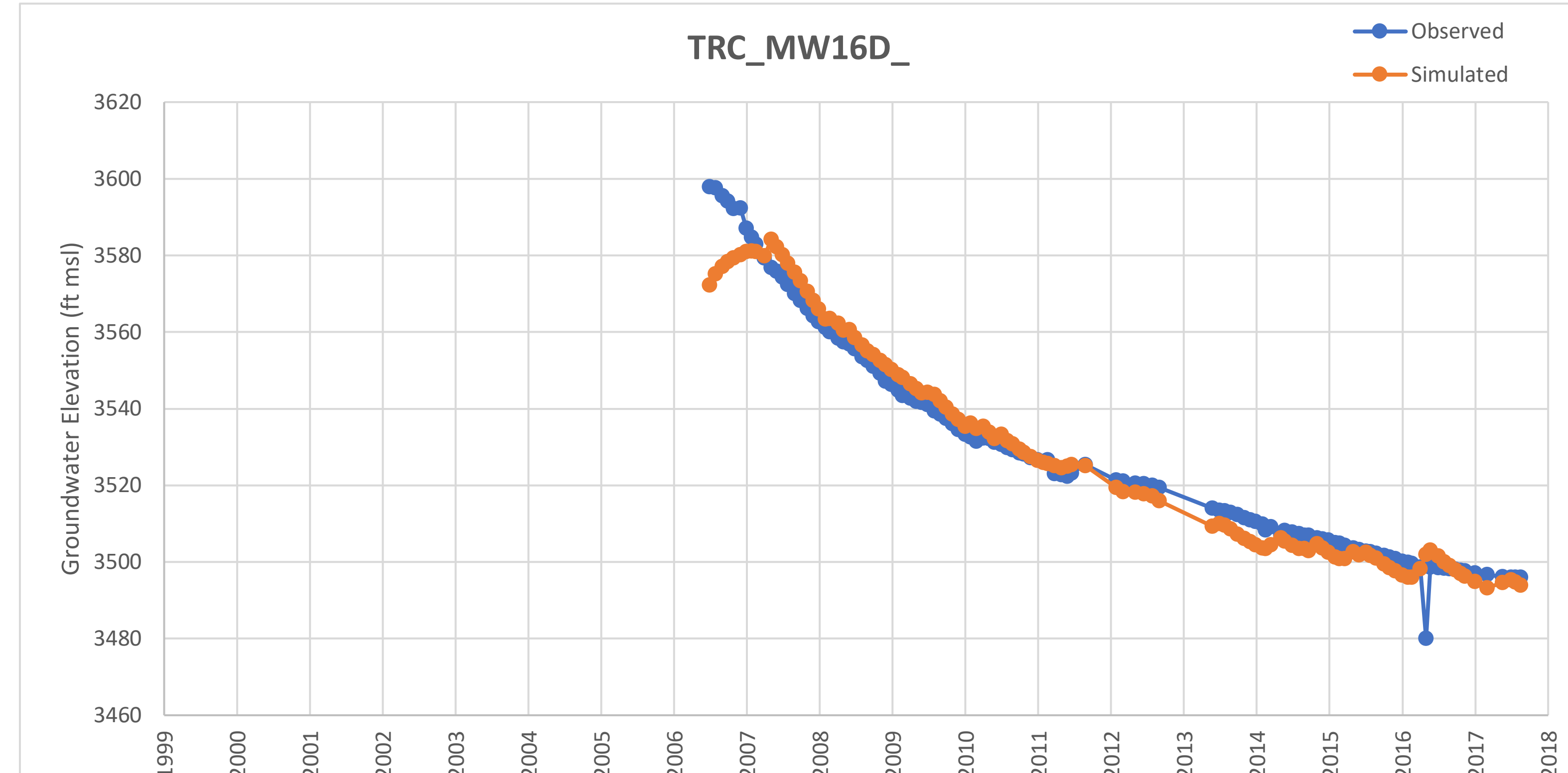


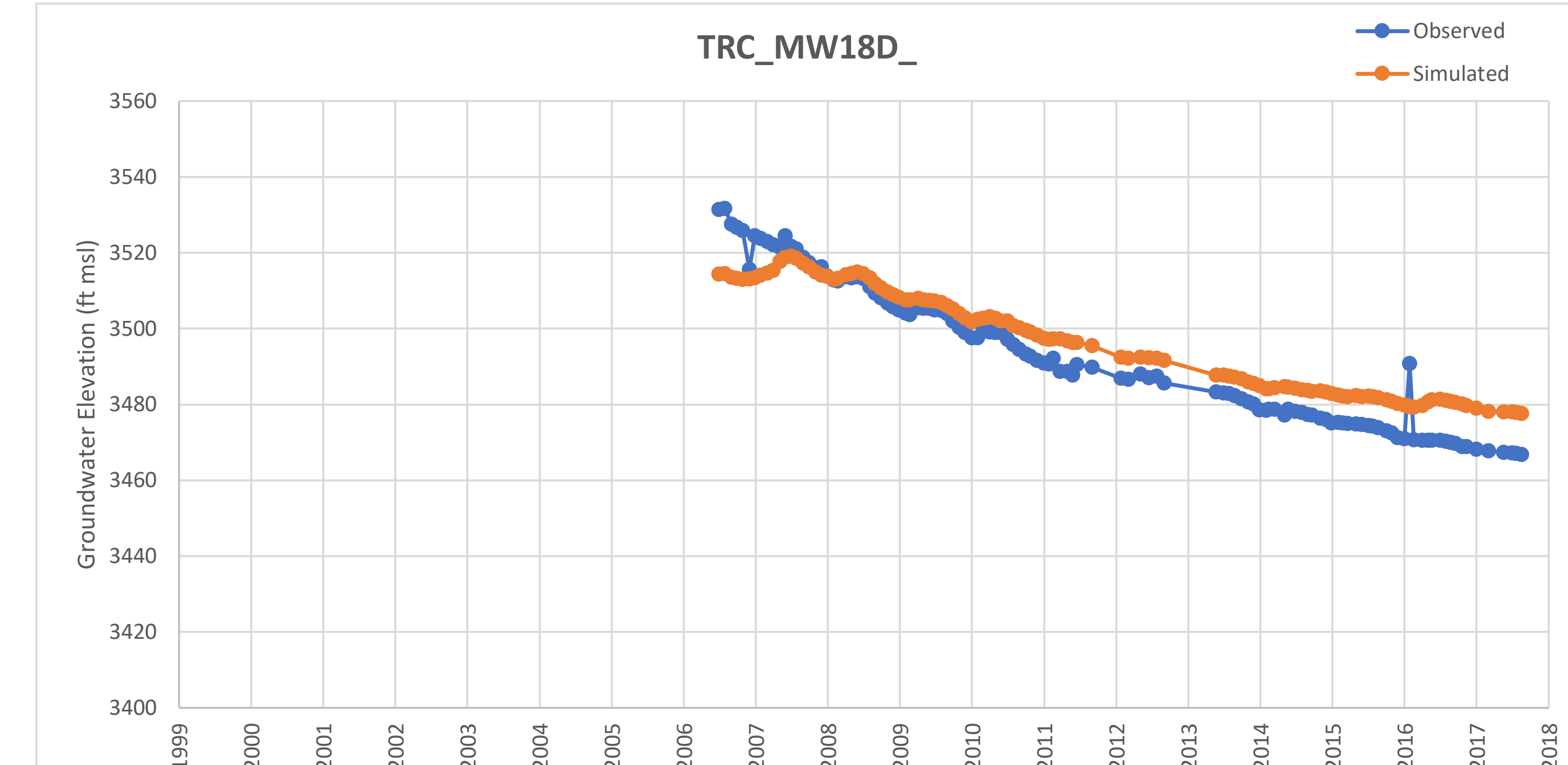
RMSE	11.05	ft	well:	TRC_MW14__
Min	-52.6		area:	Main
Max	7.9		layer:	3
Average	-9.0		cells:	578:694
Median	-7.7			



RMSE	15.00	ft	well:	TRC_MW14D_
Min	-24.4		area:	Main
Max	23.2		layer:	3
Average	-8.3		cells:	695:811
Median	-14.8			



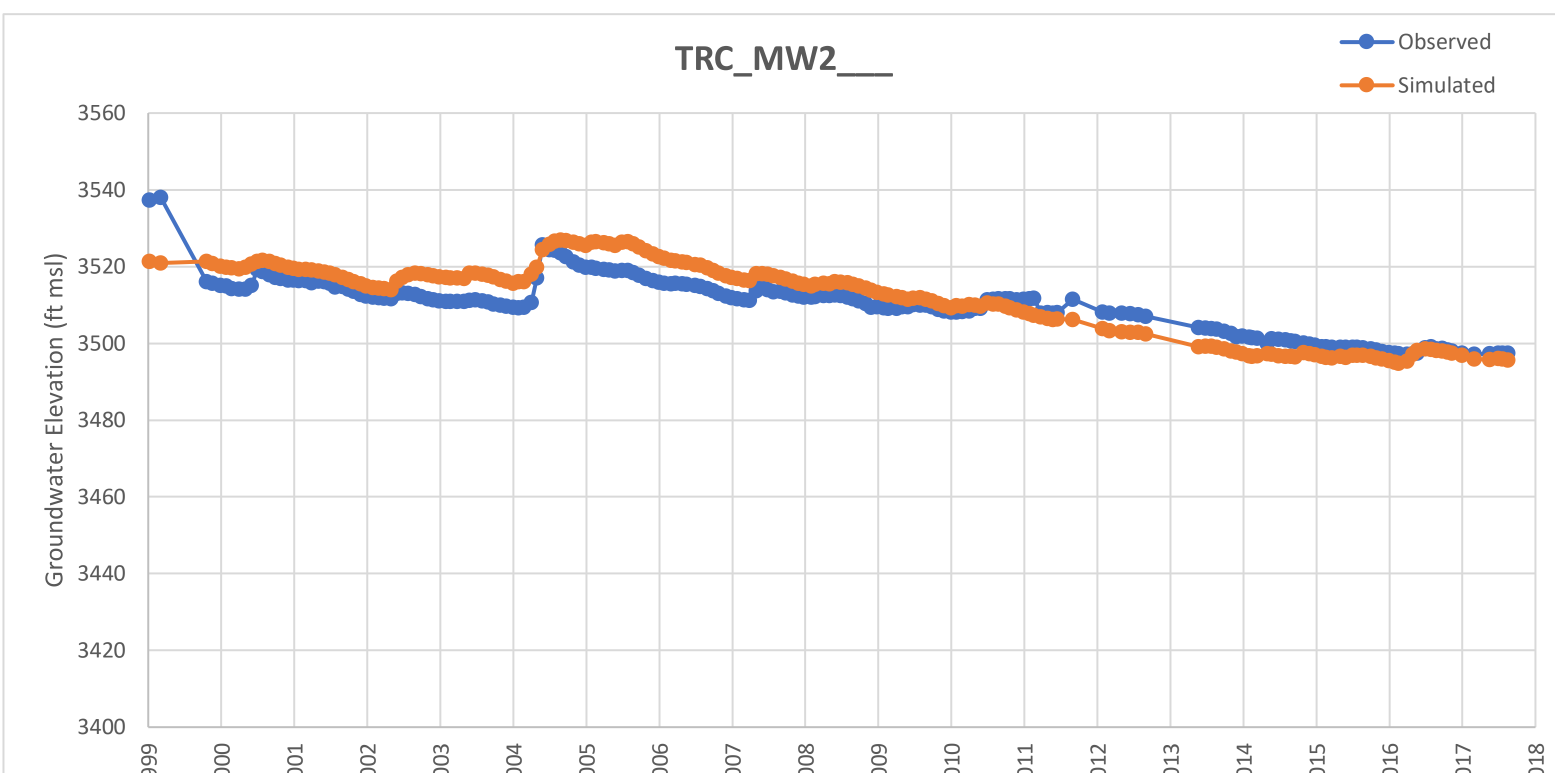


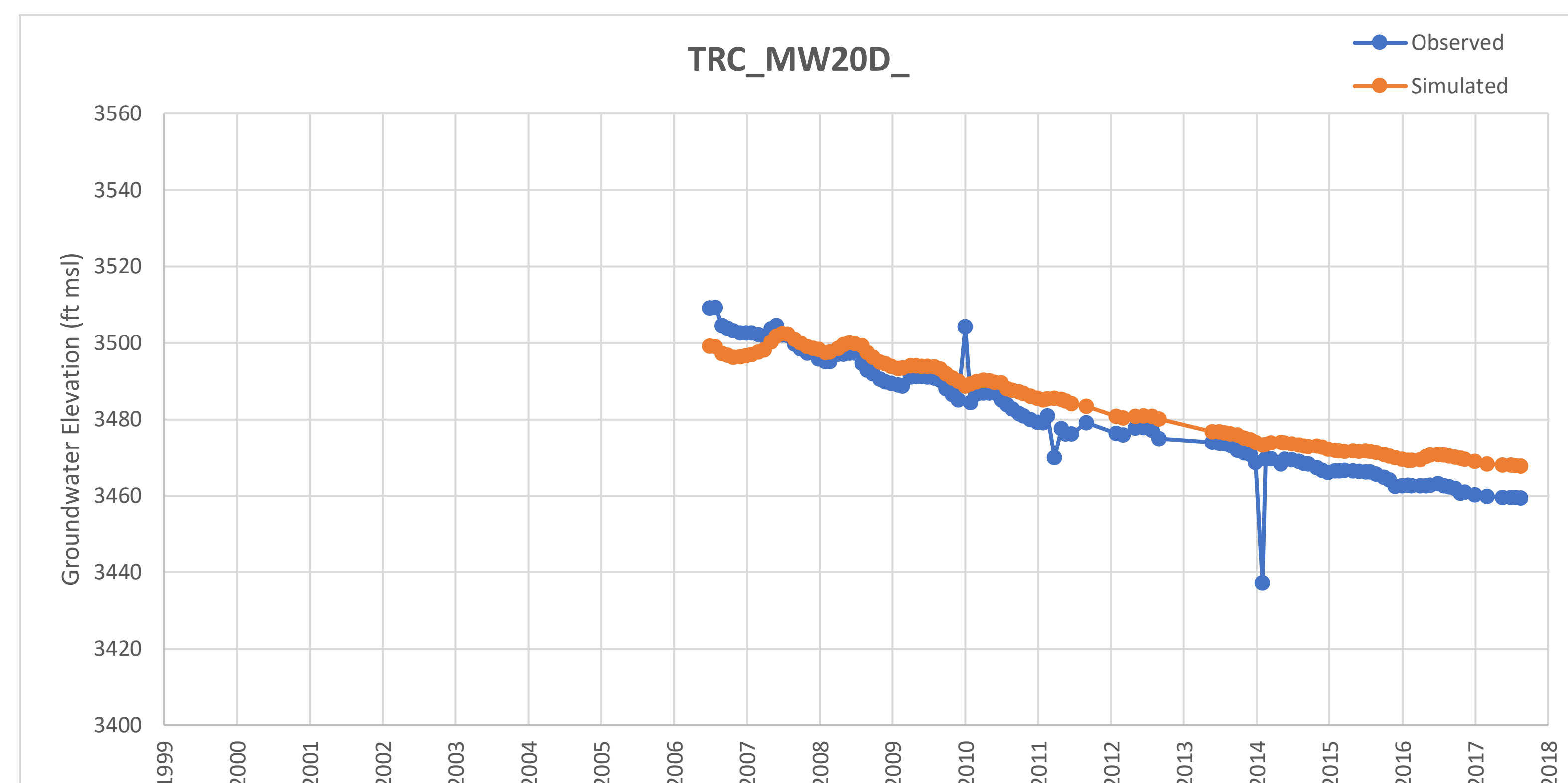


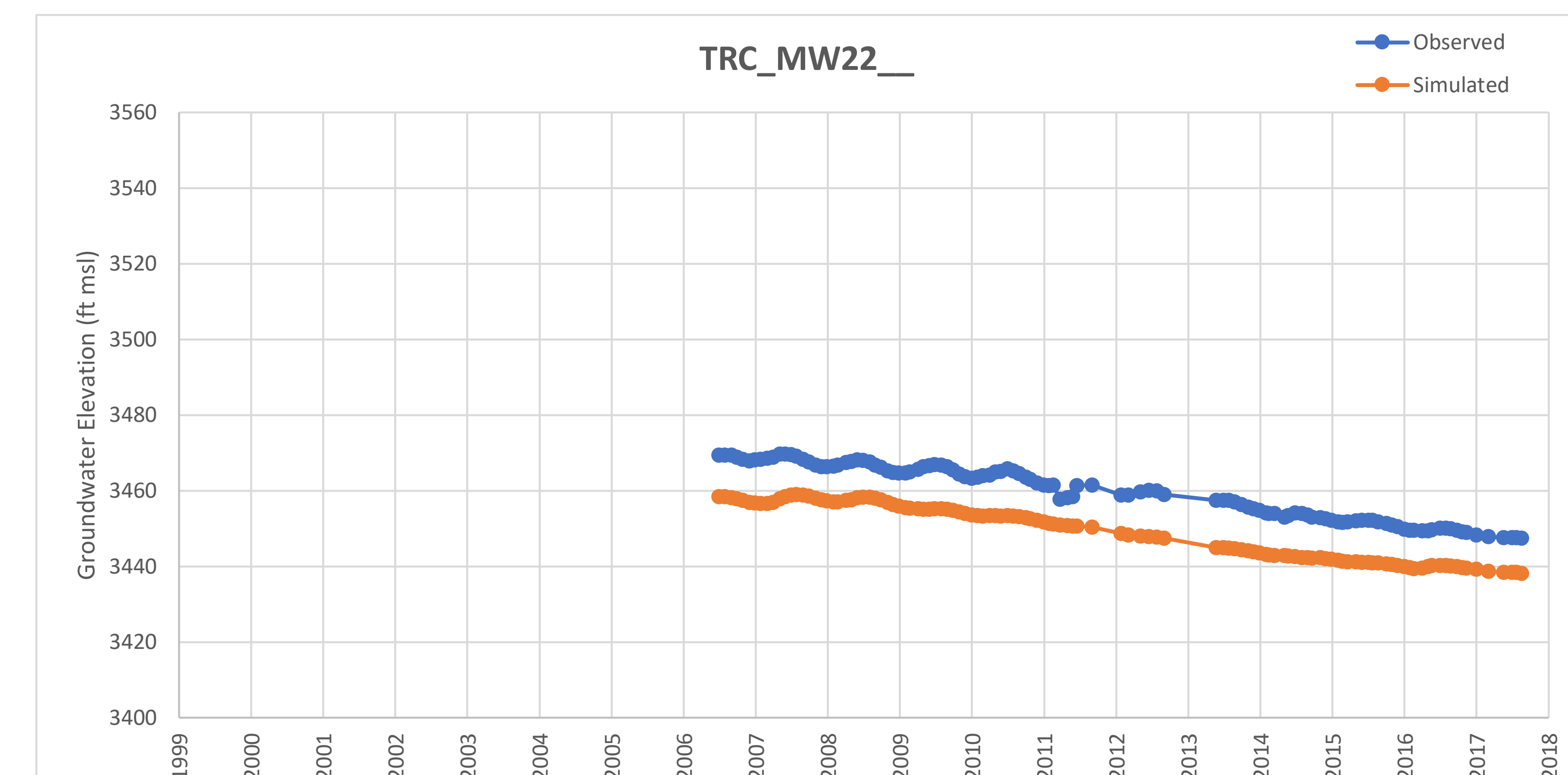
RMSE	4.23	ft	well:	TRC_MW15__
Min	-13.5		area:	Dryfield
Max	6.2		layer:	2
Average	2.1		cells:	812:895
Median	3.0			

RMSE	5.69	ft	well:	TRC_MW16D_
Min	-25.7		area:	Main
Max	22.0		layer:	3
Average	-0.7		cells:	896:1012
Median	-0.3			

RMSE	7.10	ft	well:	TRC_MW18D_
Min	-17.2		area:	Main
Max	11.2		layer:	3
Average	3.7		cells:	1013:1129
Median	5.2			



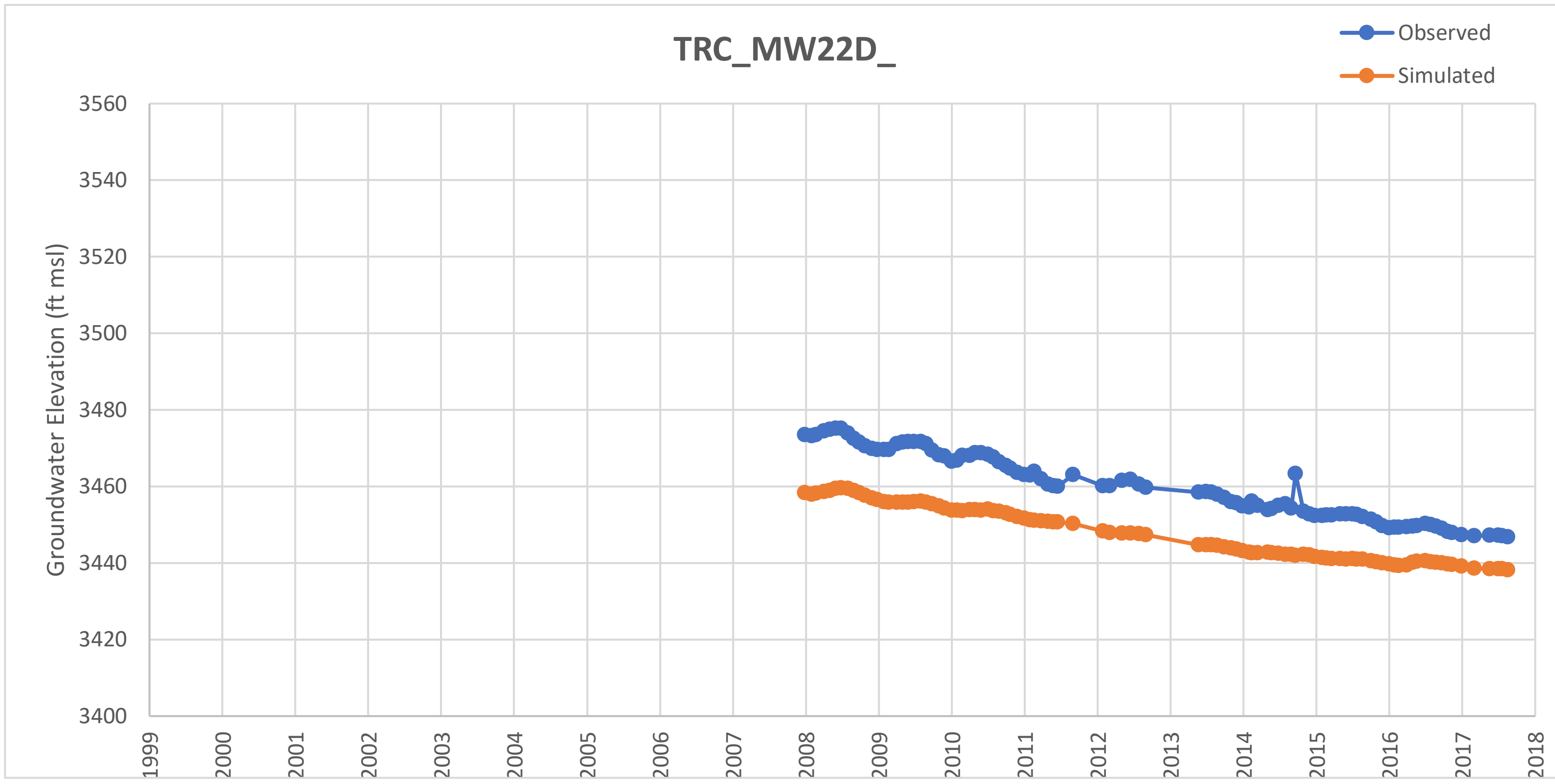




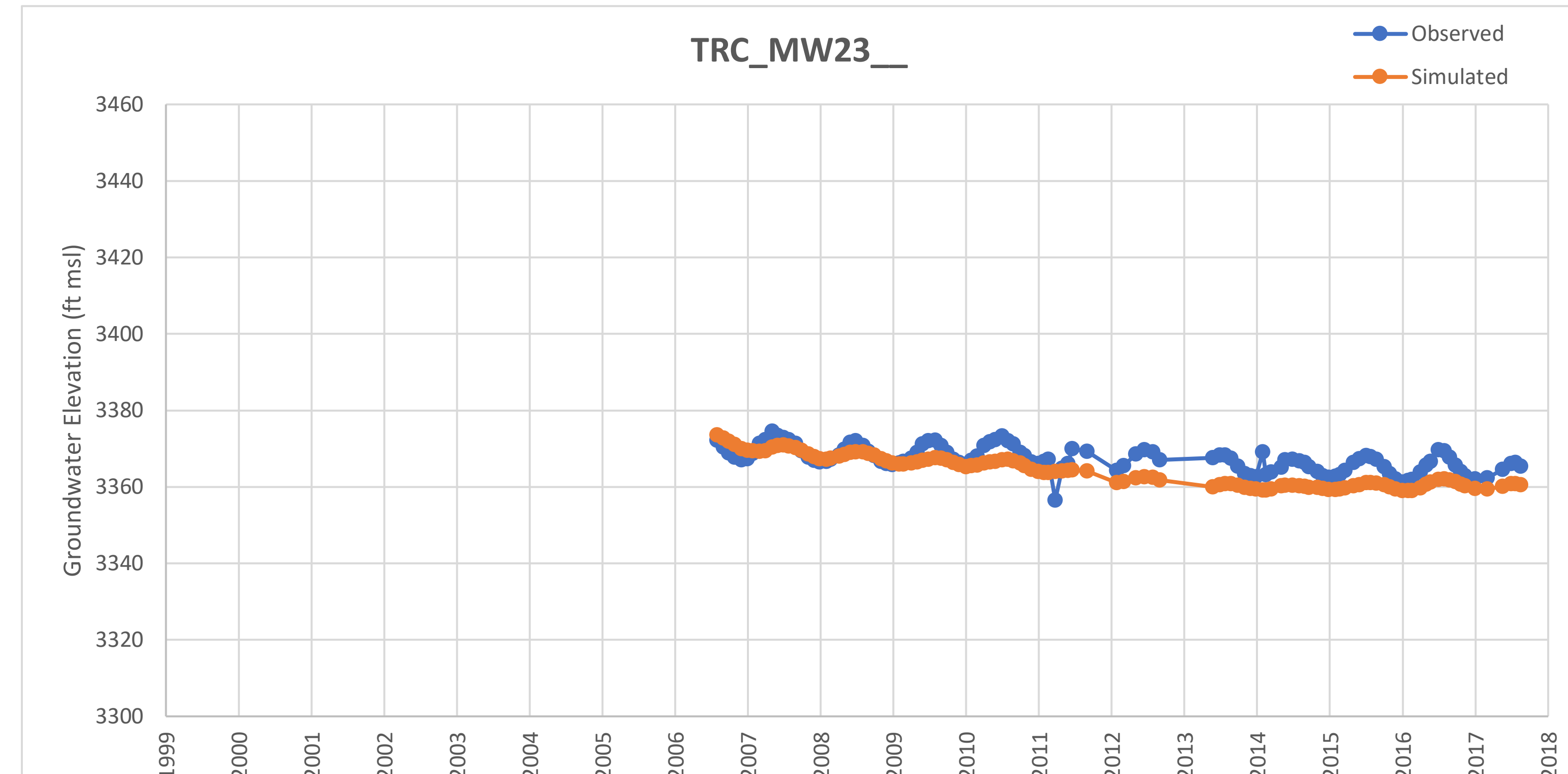
RMSE	4.52	ft	well:	TRC_MW2___
Min	-17.0		area:	Dryfield
Max	7.5		layer:	2
Average	1.7		cells:	1130:1328
Median	2.6			

RMSE	6.63	ft	well:	TRC_MW20D_
Min	-15.5		area:	Main
Max	36.1		layer:	3
Average	3.9		cells:	1329:1445
Median	4.4			

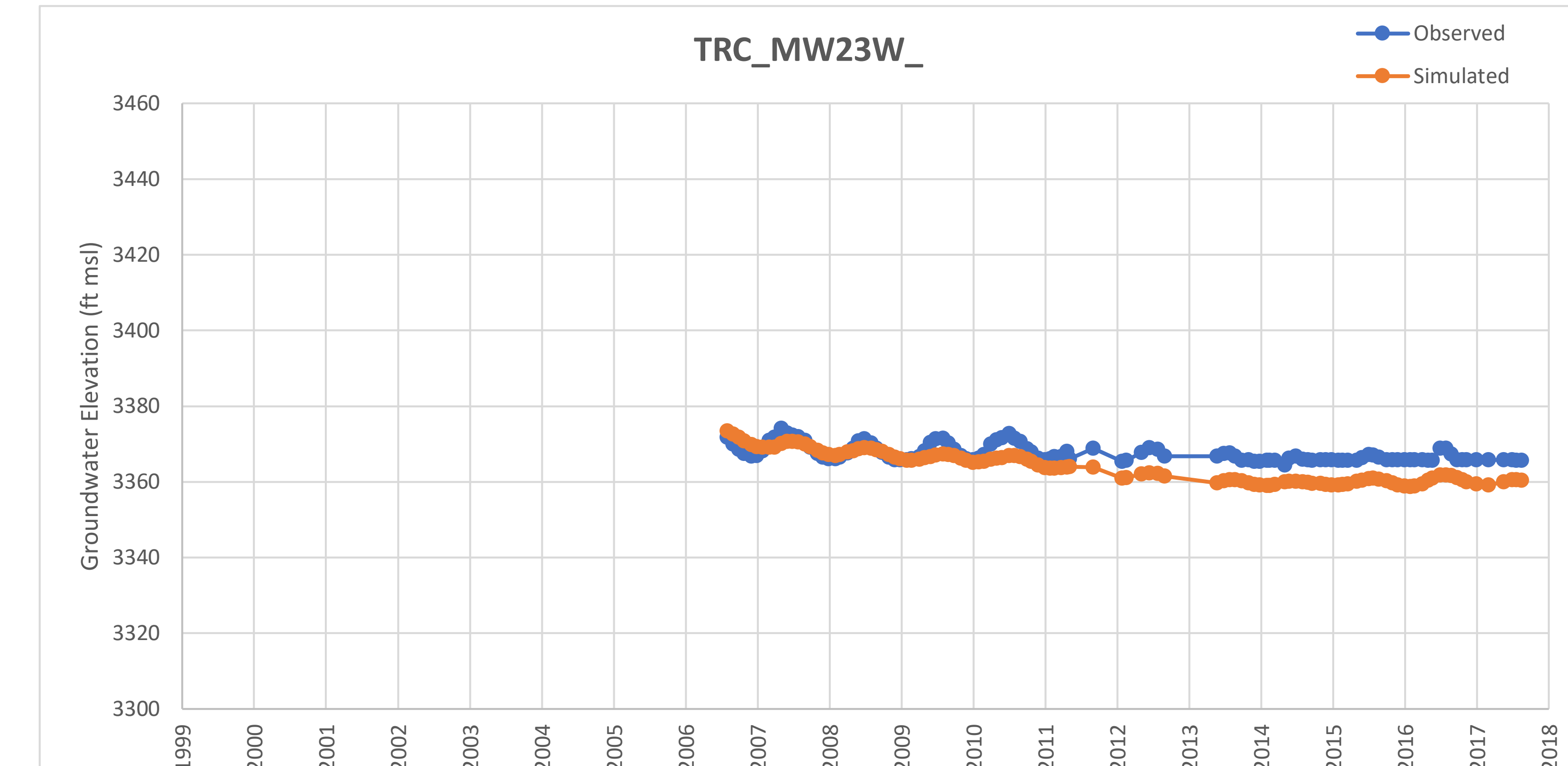
RMSE	10.48	ft	well:	TRC_MW22__
Min	-12.6		area:	Main
Max	-6.7		layer:	2
Average	-10.4		cells:	1446:1562
Median	-10.5			



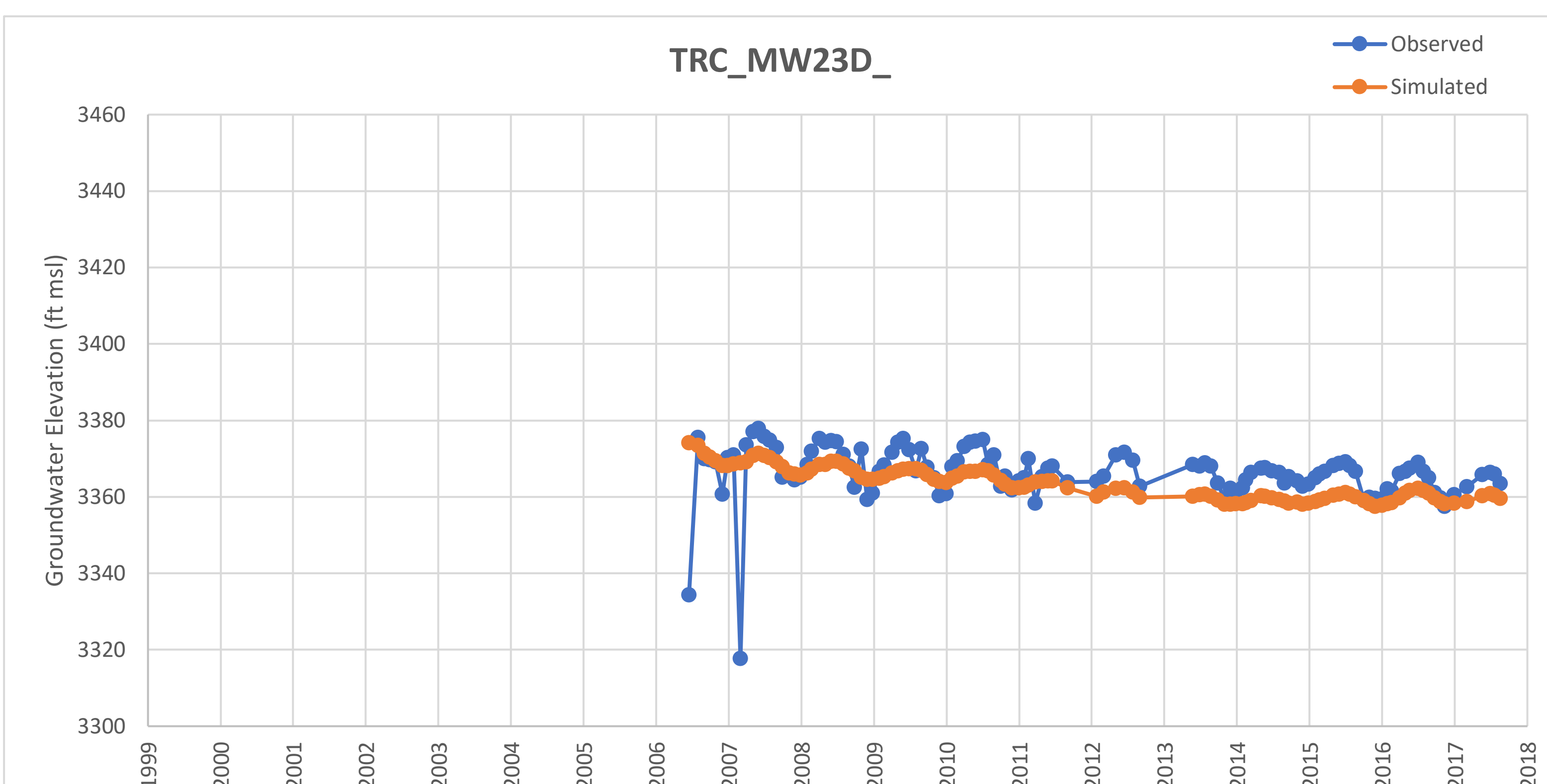
RMSE	12.54	ft	well:	TRC_MW22D_
Min	-21.3		area:	Main
Max	-8.3		layer:	3
Average	-12.3		cells:	1563:1661
Median	-12.3			



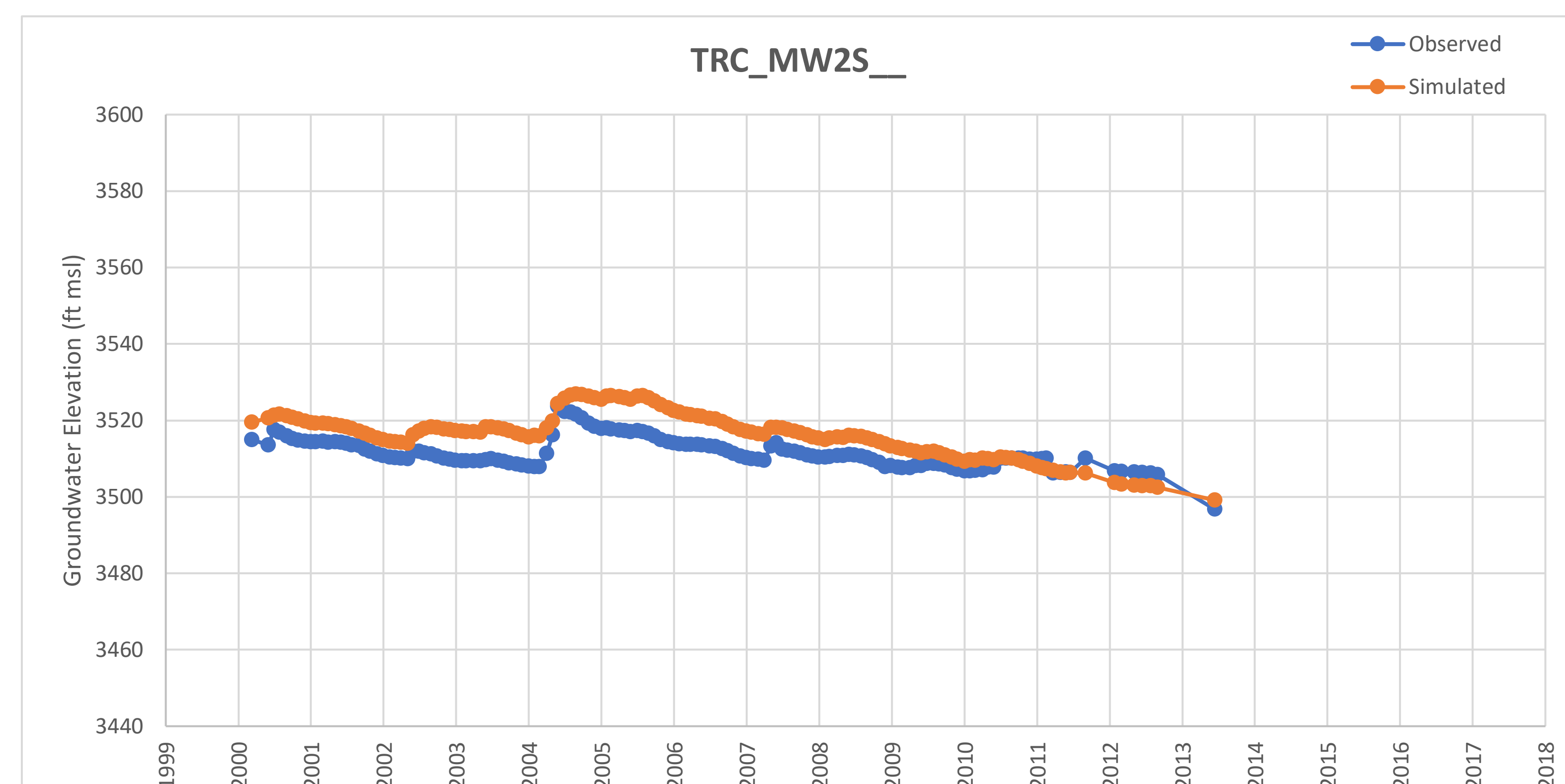
RMSE	4.25	ft	well:	TRC_MW23__
Min	-10.0		area:	GVC S
Max	7.4		layer:	2
Average	-3.1		cells:	1662:1777
Median	-3.3			



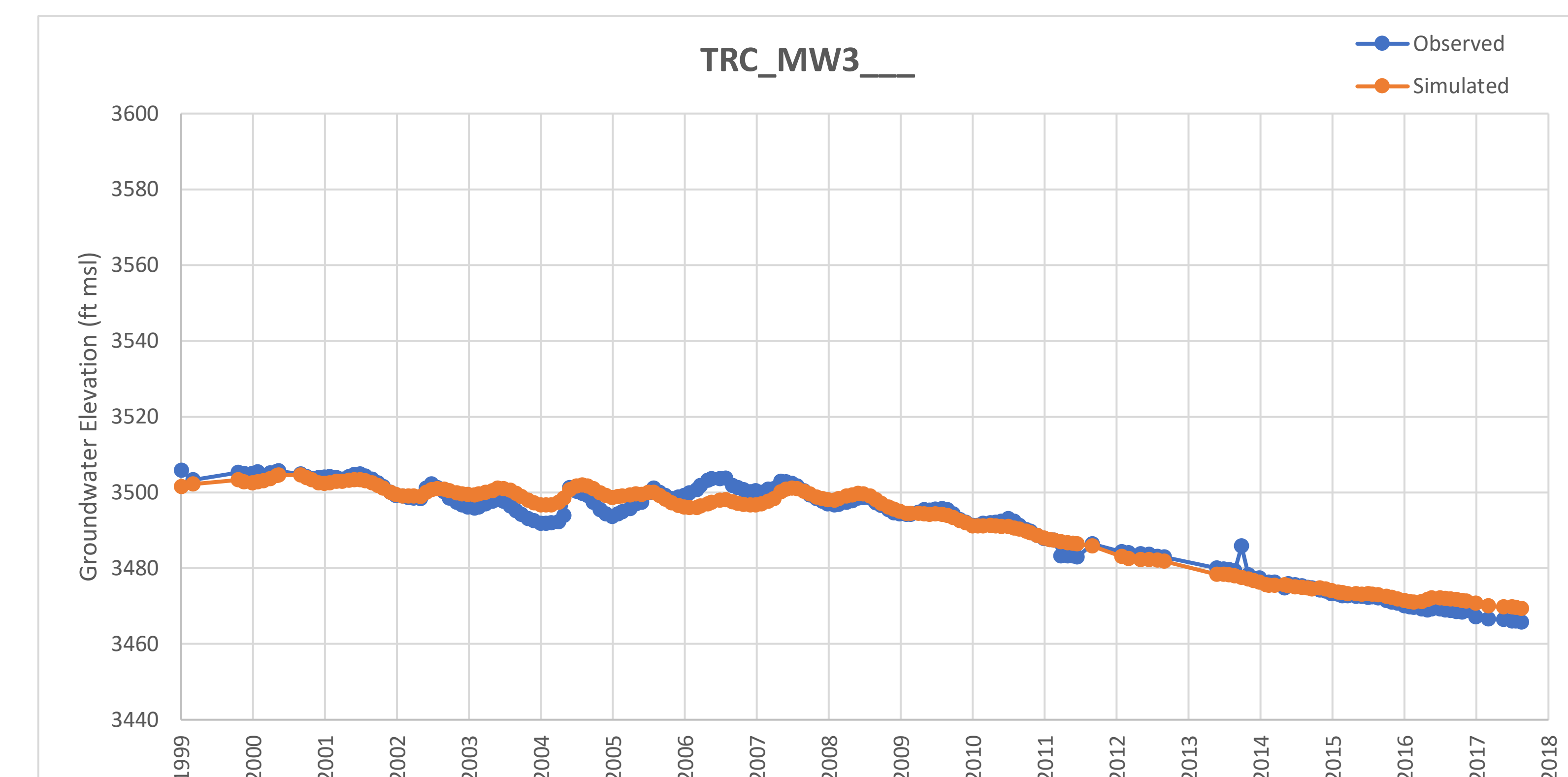
RMSE	4.62	ft	well:	TRC_MW23W_
Min	-7.2		area:	GVC S
Max	3.4		layer:	2
Average	-3.6		cells:	1778:1892
Median	-4.6			



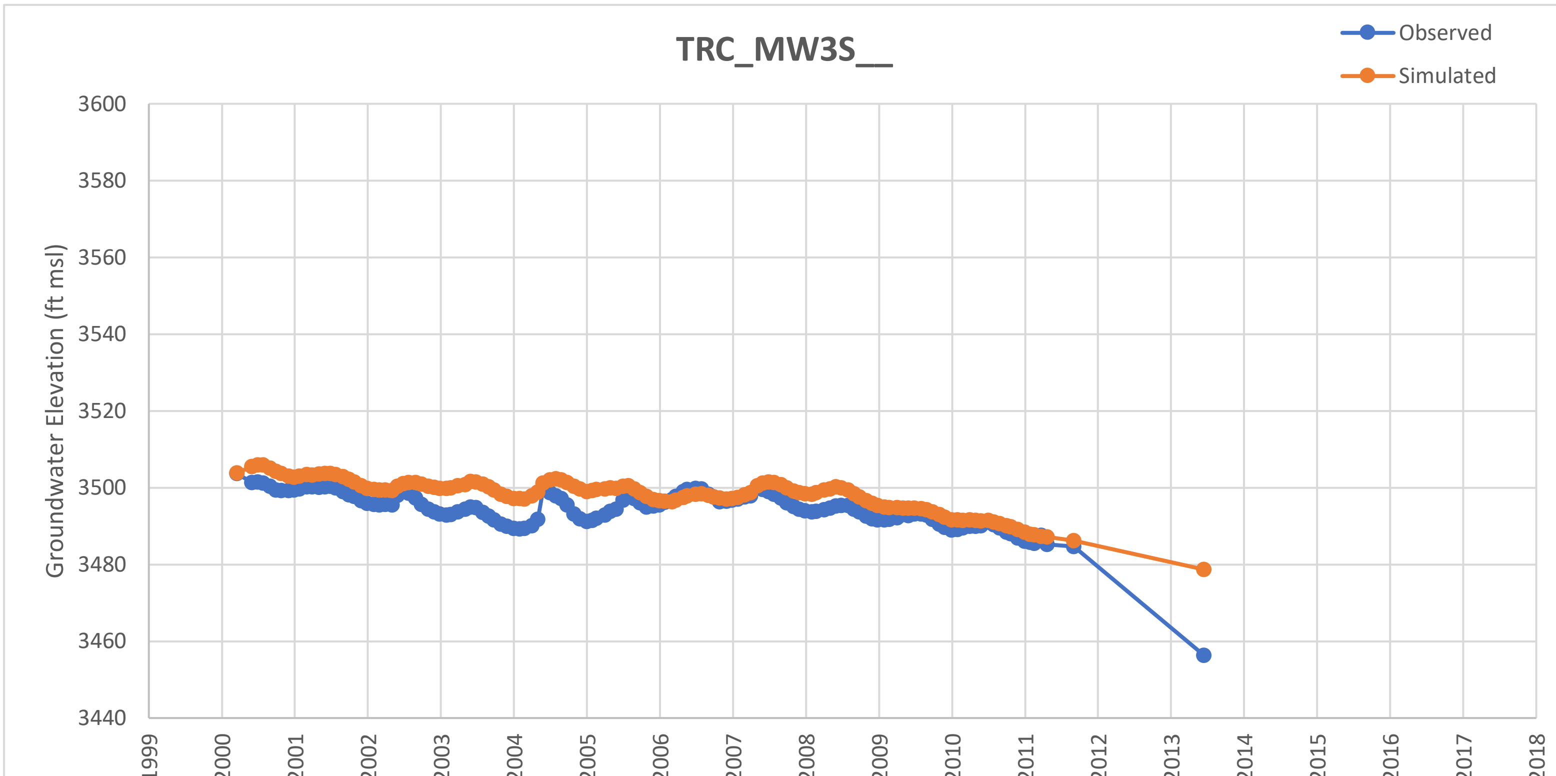
RMSE	7.85	ft	well:	TRC_MW23D_
Min	-9.4		area:	GVC S
Max	51.3		layer:	3
Average	-2.9		cells:	1893:2009
Median	-4.2			



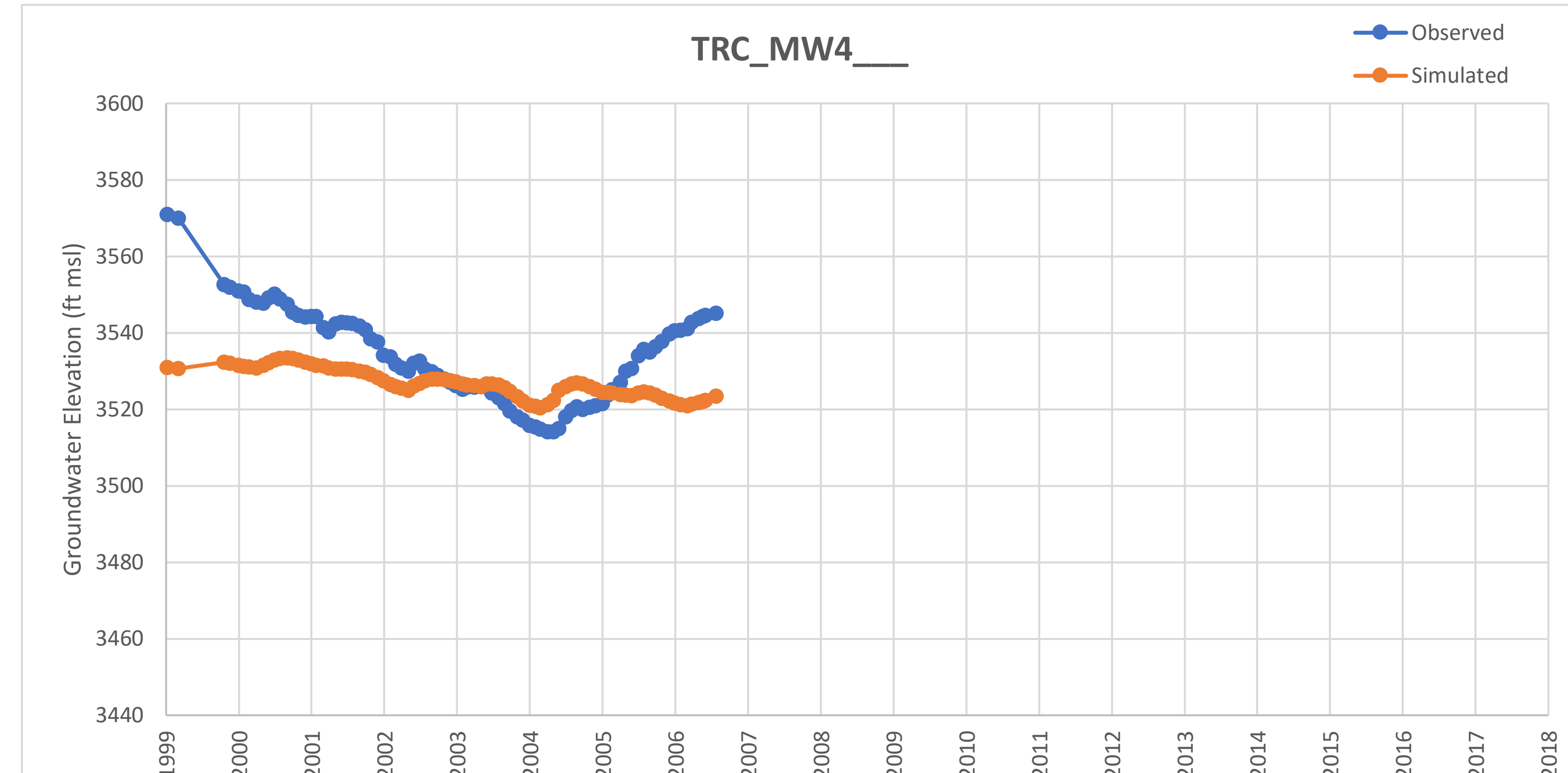
RMSE	5.73	ft	well:	TRC_MW2S__
Min	-3.9		area:	Dryfield
Max	9.3		layer:	2
Average	4.8		cells:	2010:2152
Median	5.1			



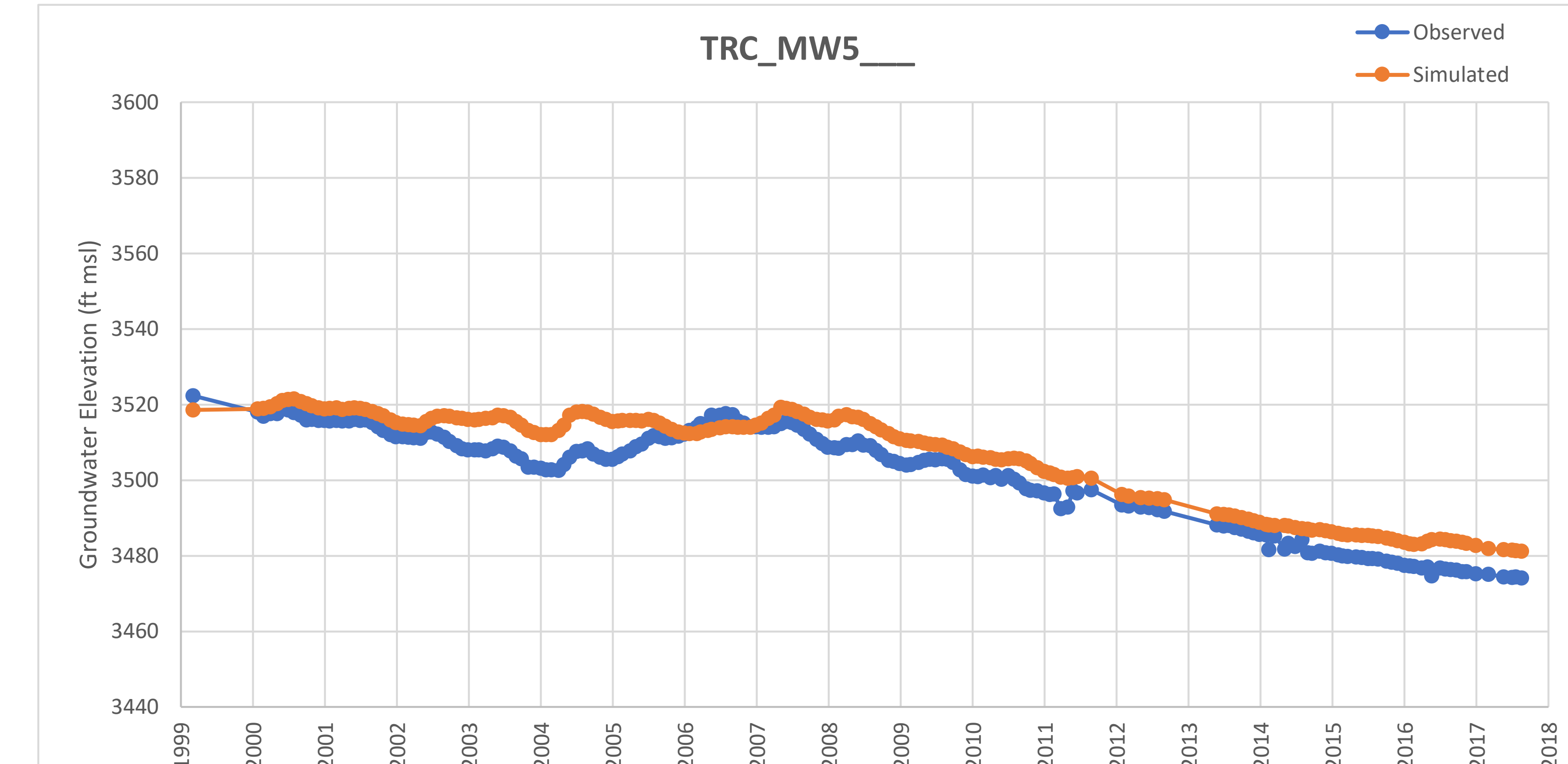
RMSE	2.50	ft	well:	TRC_MW3___	(no dry)	RMSE	2.50	ft
Min	-8.3		area:	Main		Min	-8.3	
Max	5.1		layer:	2		Max	5.1	
Average	0.2		cells:	2153:2349		Average	0.2	
Median	0.0					Median	0.0	



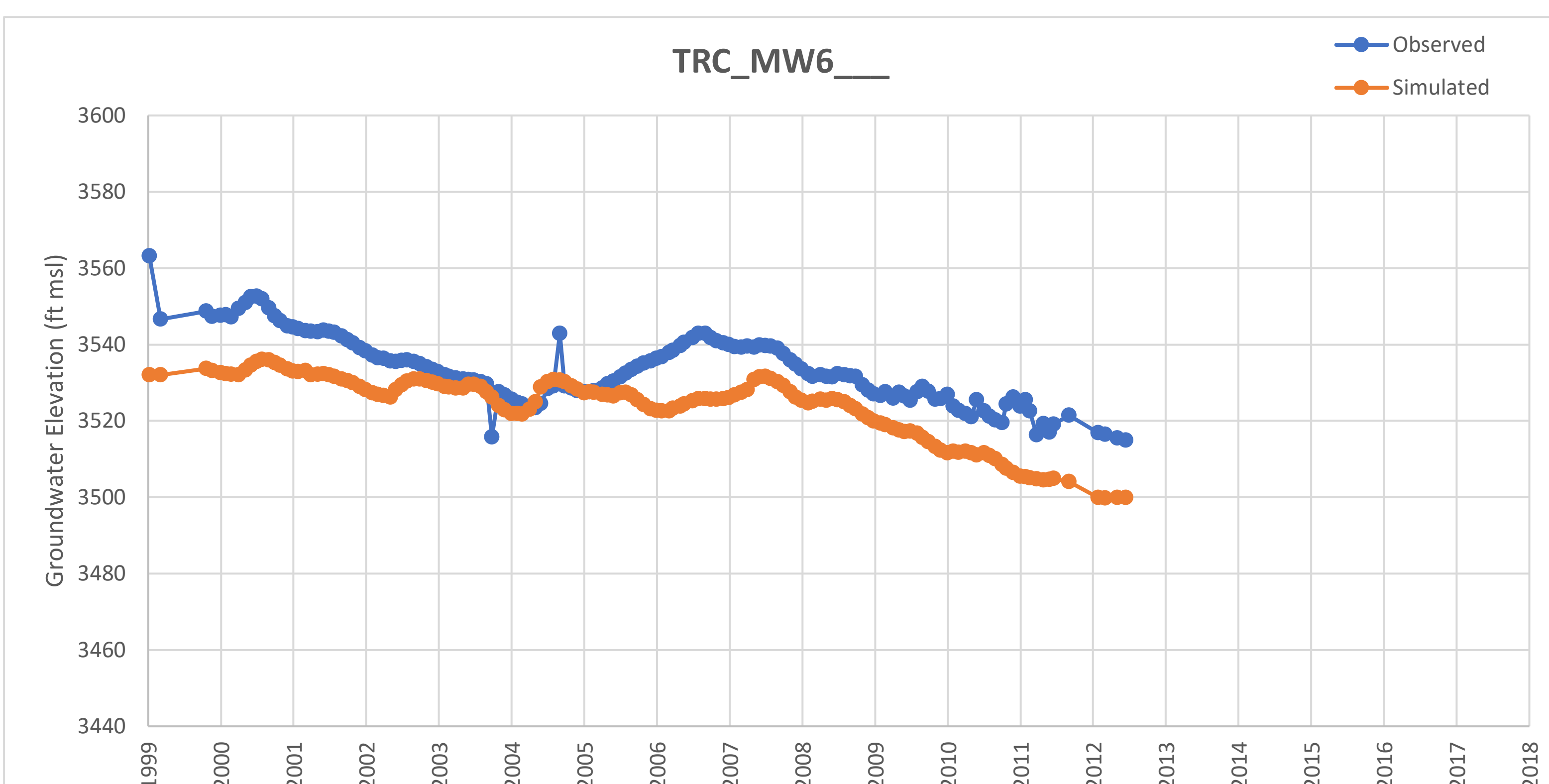
RMSE	4.63	ft	well:	TRC_MW3S__
Min	-1.7		area:	Main
Max	22.3		layer:	2
Average	3.6		cells:	2350:2484
Median	3.5			



RMSE	12.98	ft	well:	TRC_MW4___
Min	-40.1		area:	Main
Max	10.0		layer:	2
Average	-7.6		cells:	2485:2568
Median	-8.2			



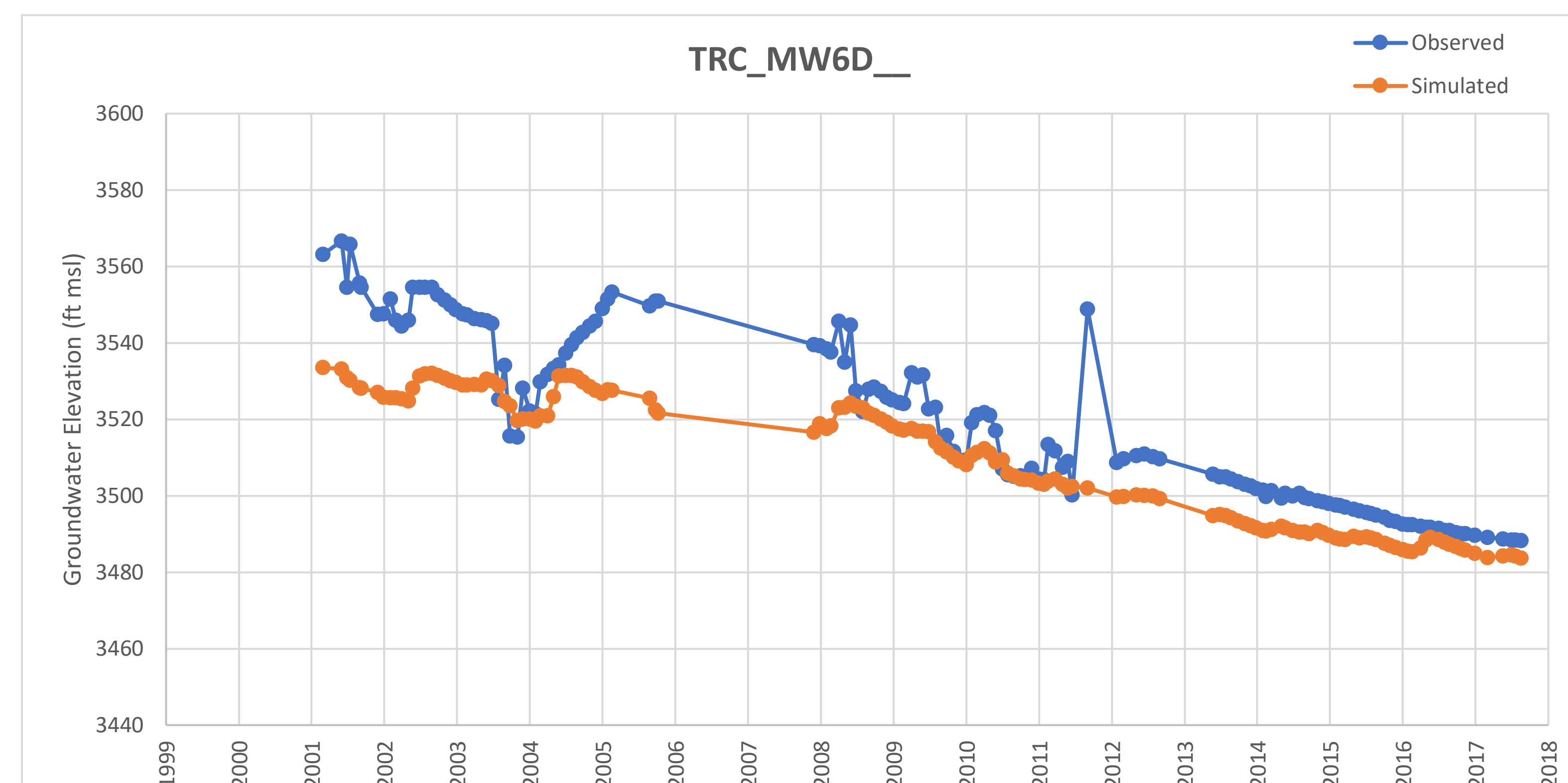
RMSE	5.86	ft	well:	TRC_MW5___
Min	-3.8		area:	Main
Max	11.1		layer:	2
Average	5.0		cells:	2569:2763
Median	5.4			



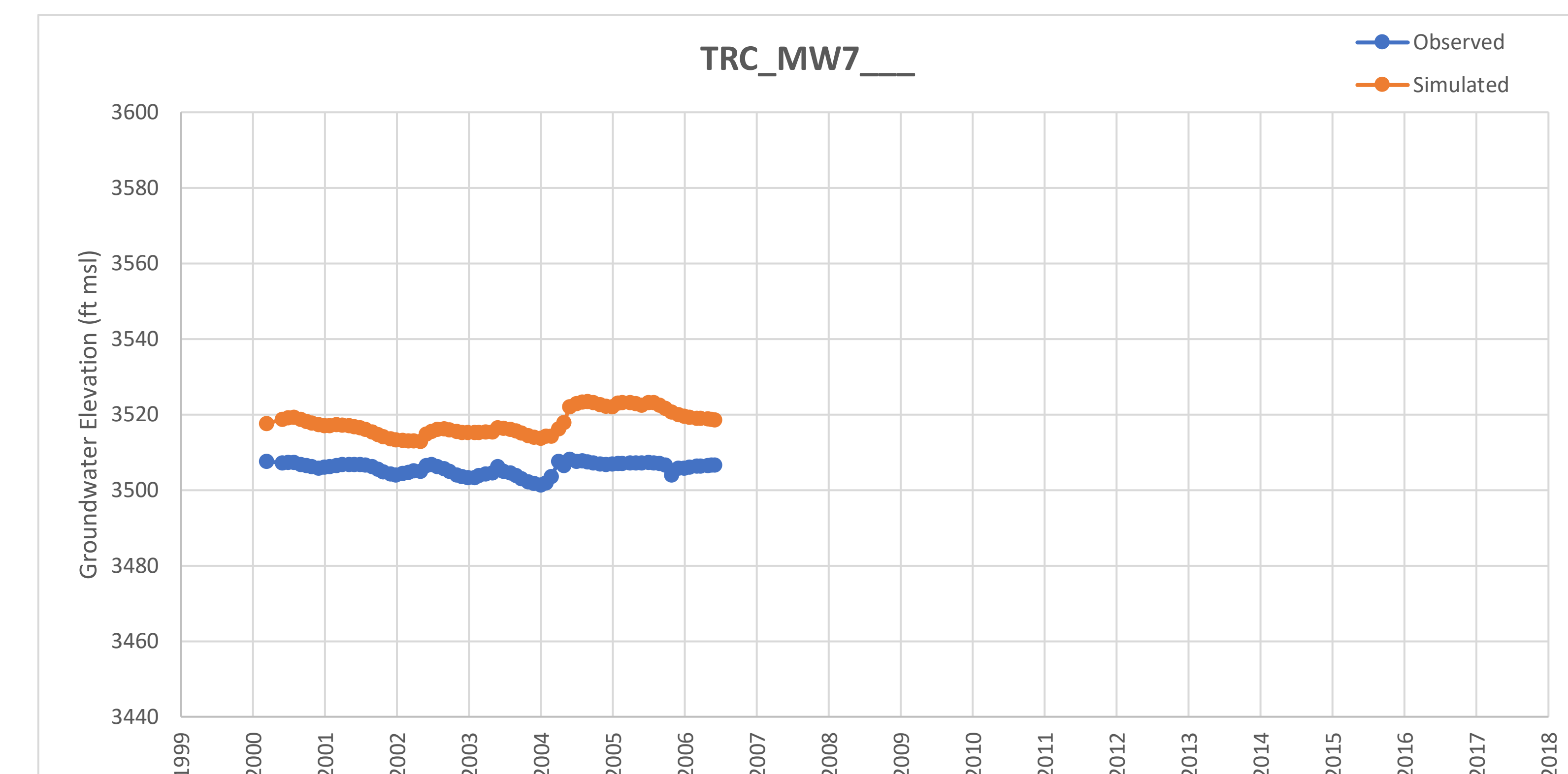
RMSE	11.18	ft	well:	TRC_MW6___
Min	-31.1		area:	Main
Max	10.5		layer:	2
Average	-9.5		cells:	2764:2911
Median	-10.1			

(no dry)

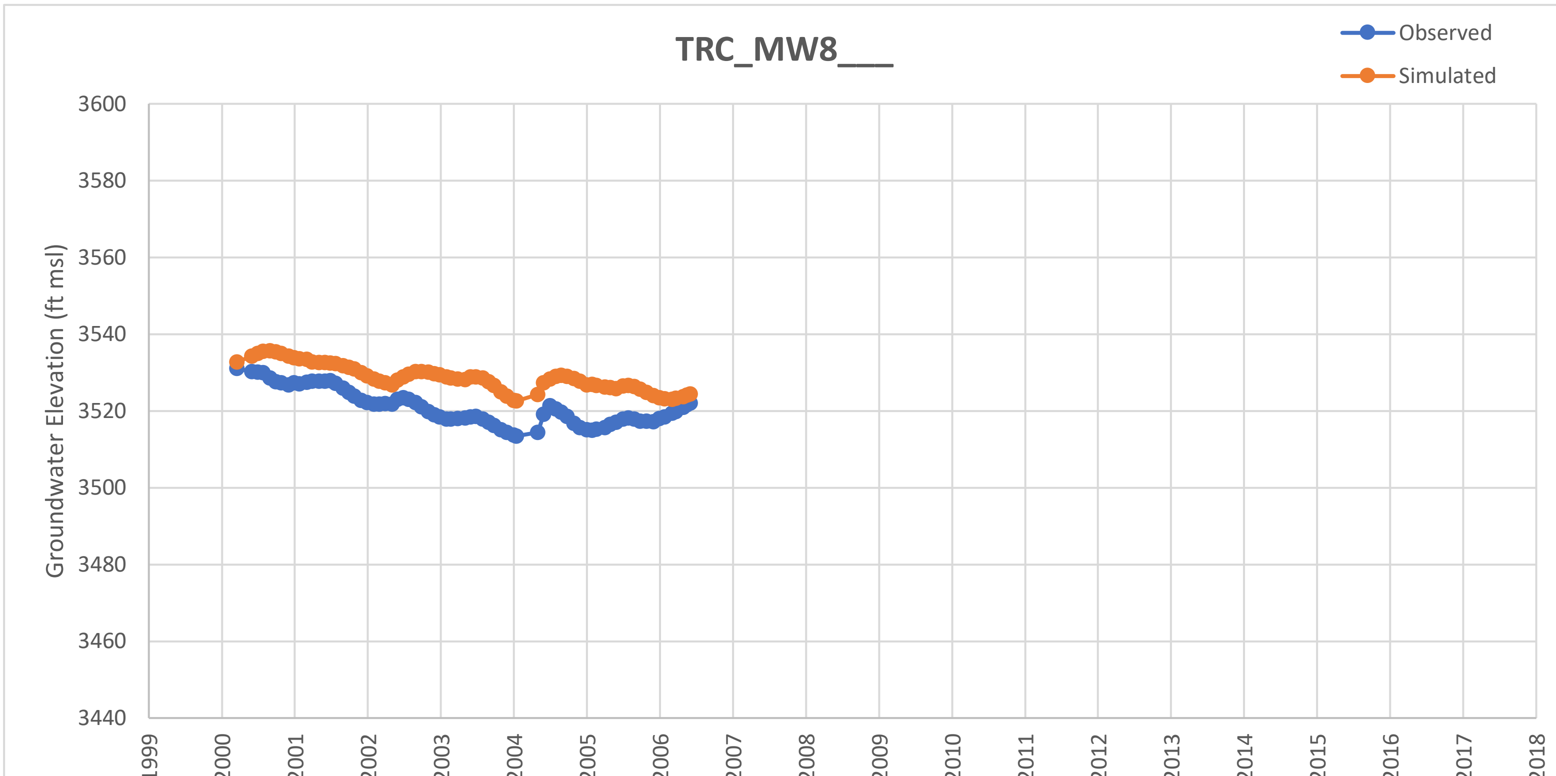
RMSE	11.18	ft
Min	-31.1	
Max	10.5	
Average	-9.5	
Median	-10.1	



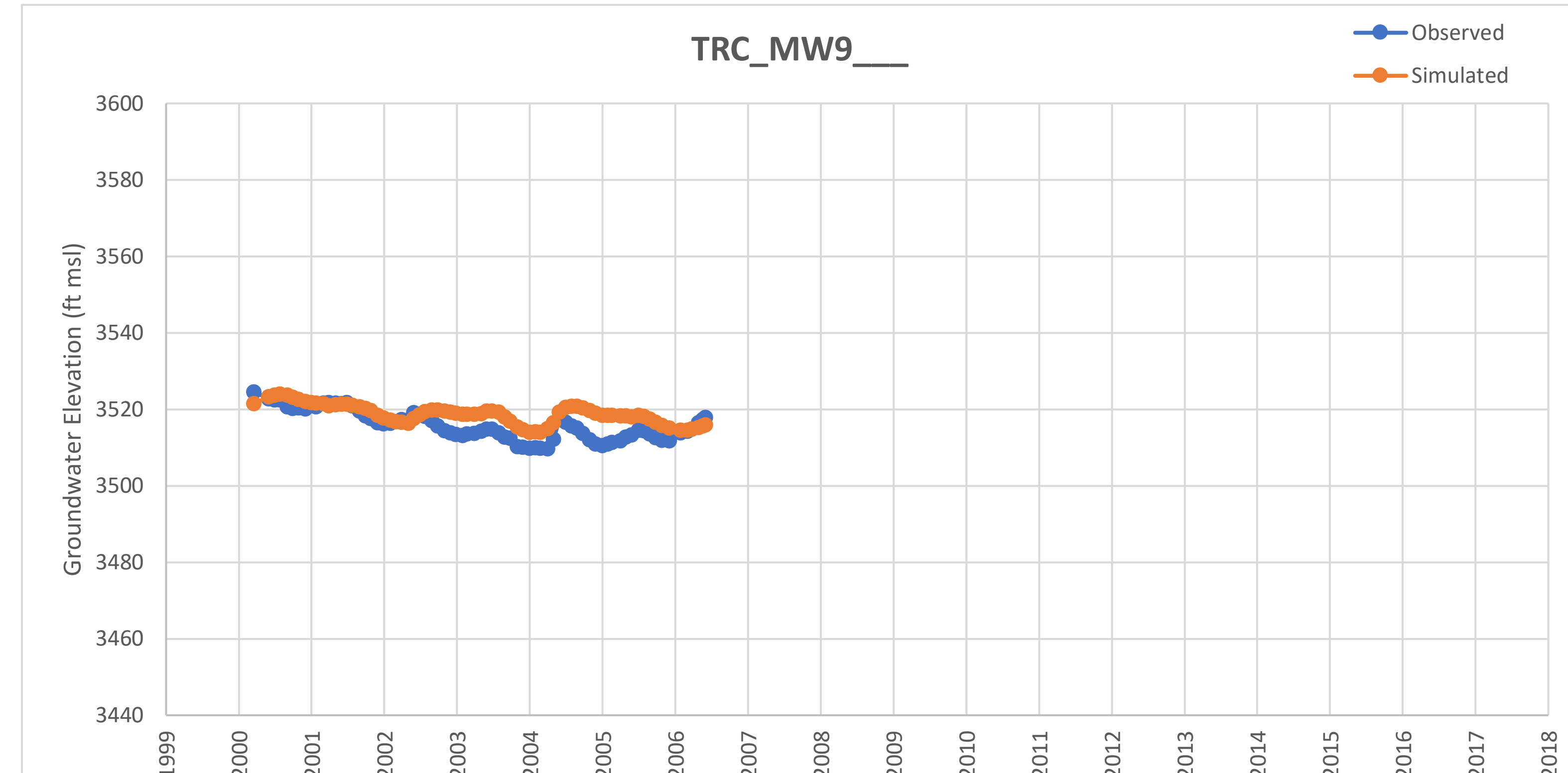
RMSE	14.03	ft	well:	TRC_MW6D__
Min	-46.8		area:	Main
Max	8.0		layer:	3
Average	-11.0		cells:	2912:3060
Median	-9.0			



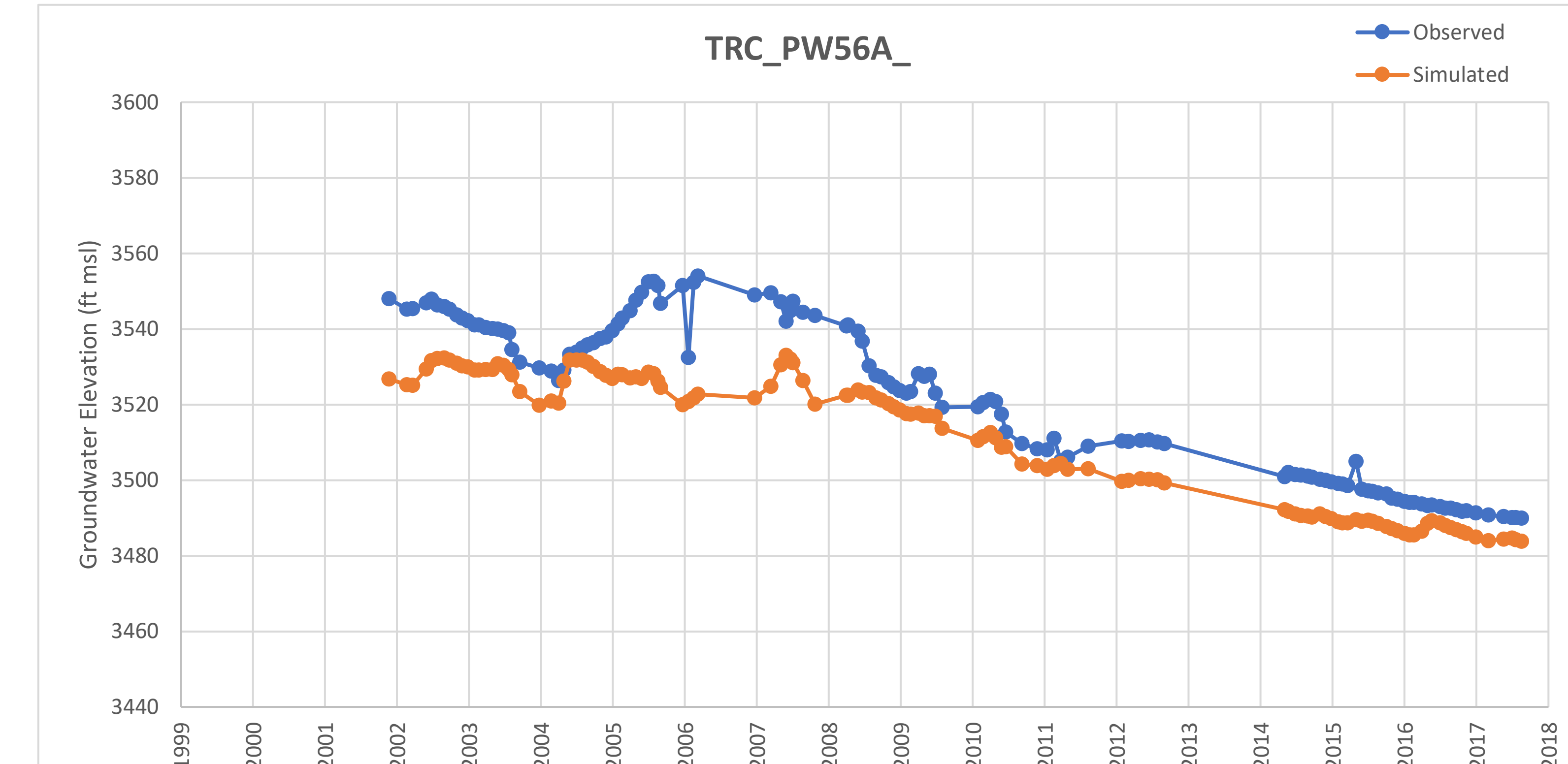
RMSE	12.28	ft	well:	TRC_MW7___
Min	7.9		area:	Dryfield
Max	16.7		layer:	2
Average	12.0		cells:	3061:3135
Median	11.7			



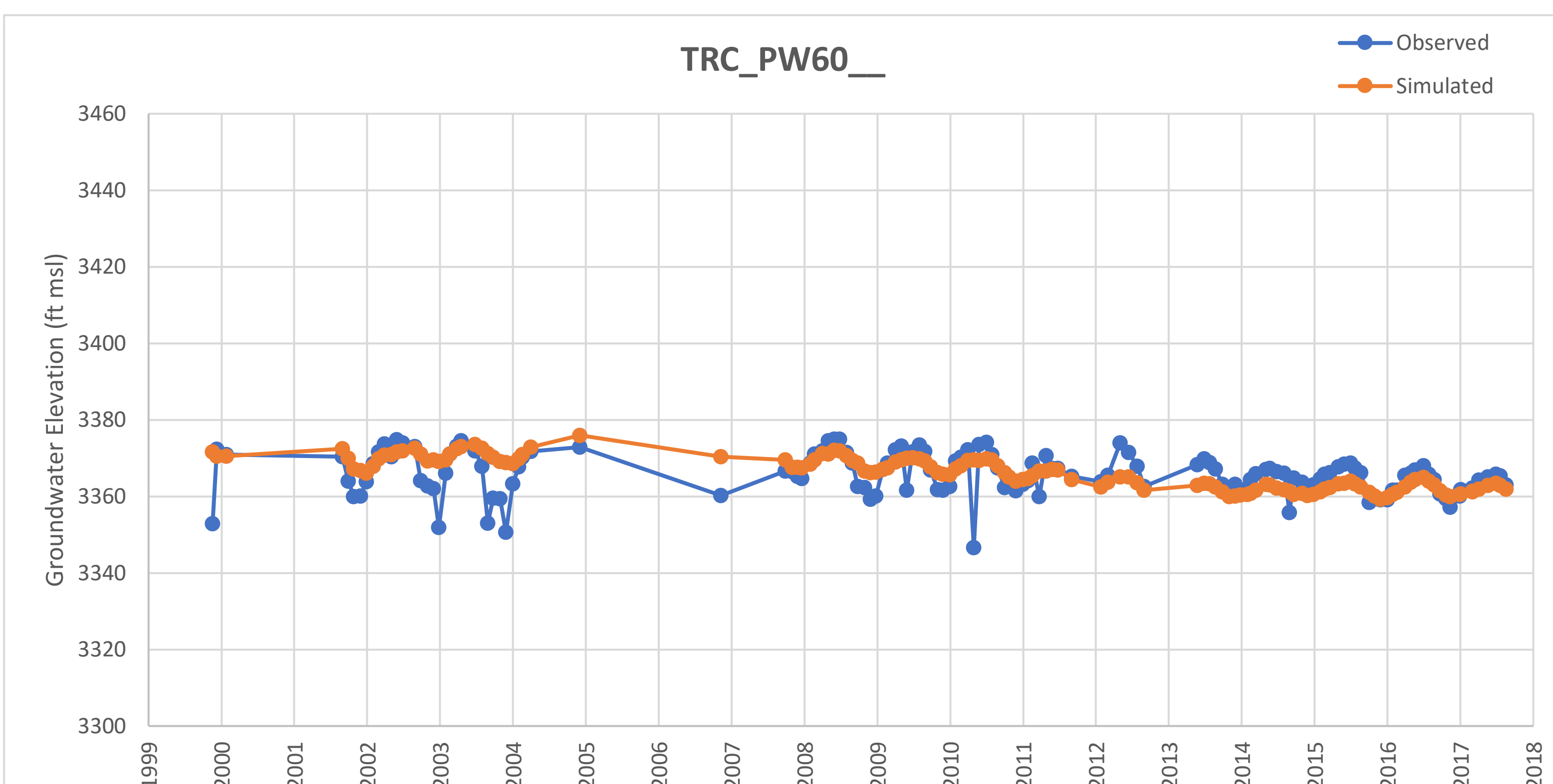
RMSE	8.10	ft	well:	TRC_MW8___
Min	1.7		area:	Main
Max	12.0		layer:	2
Average	7.7		cells:	3136:3208
Median	7.7			



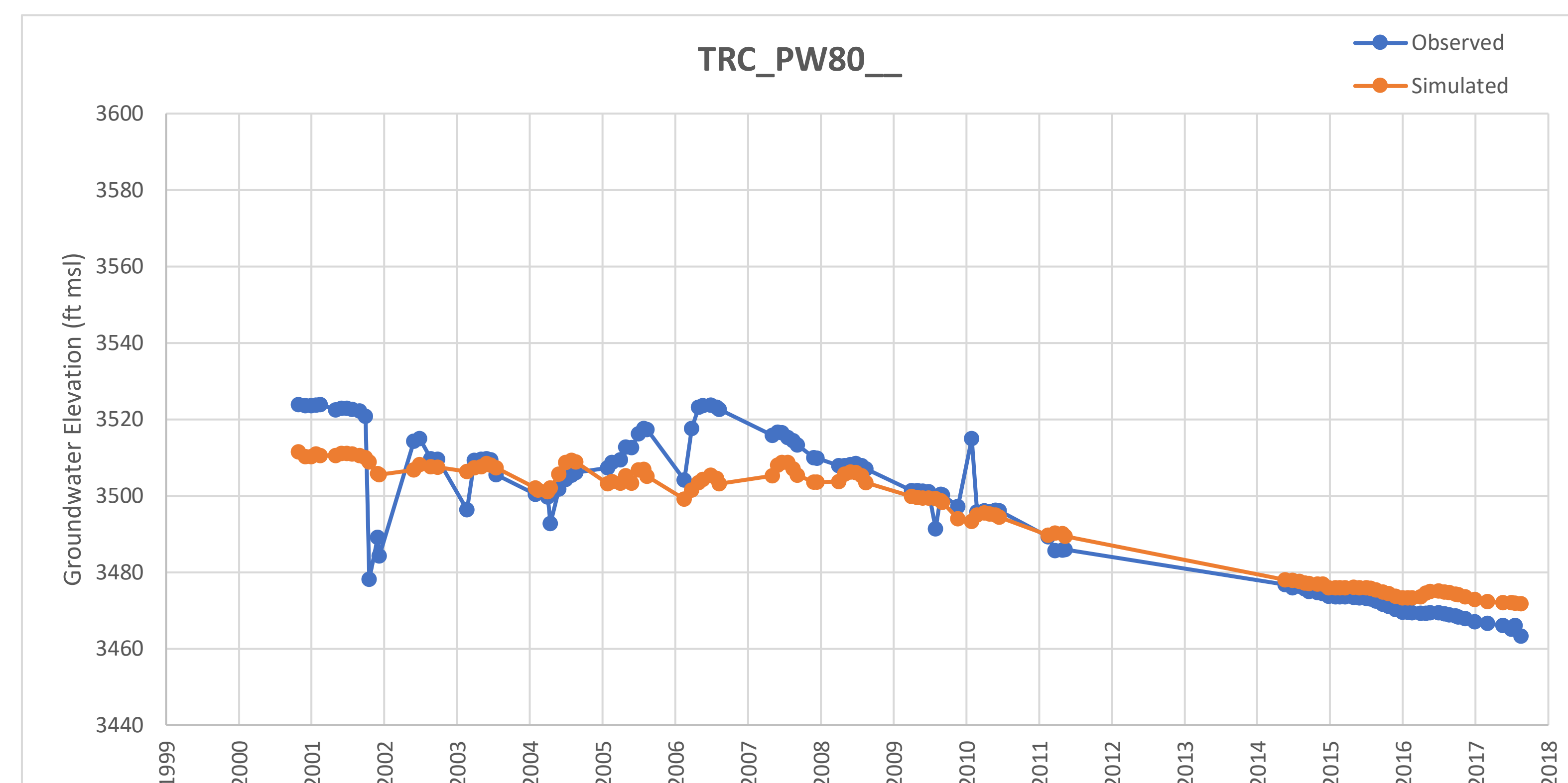
RMSE	3.95	ft	well:	TRC_MW9___
Min	-3.1		area:	Main
Max	8.1		layer:	2
Average	2.9		cells:	3209:3282
Median	3.5			



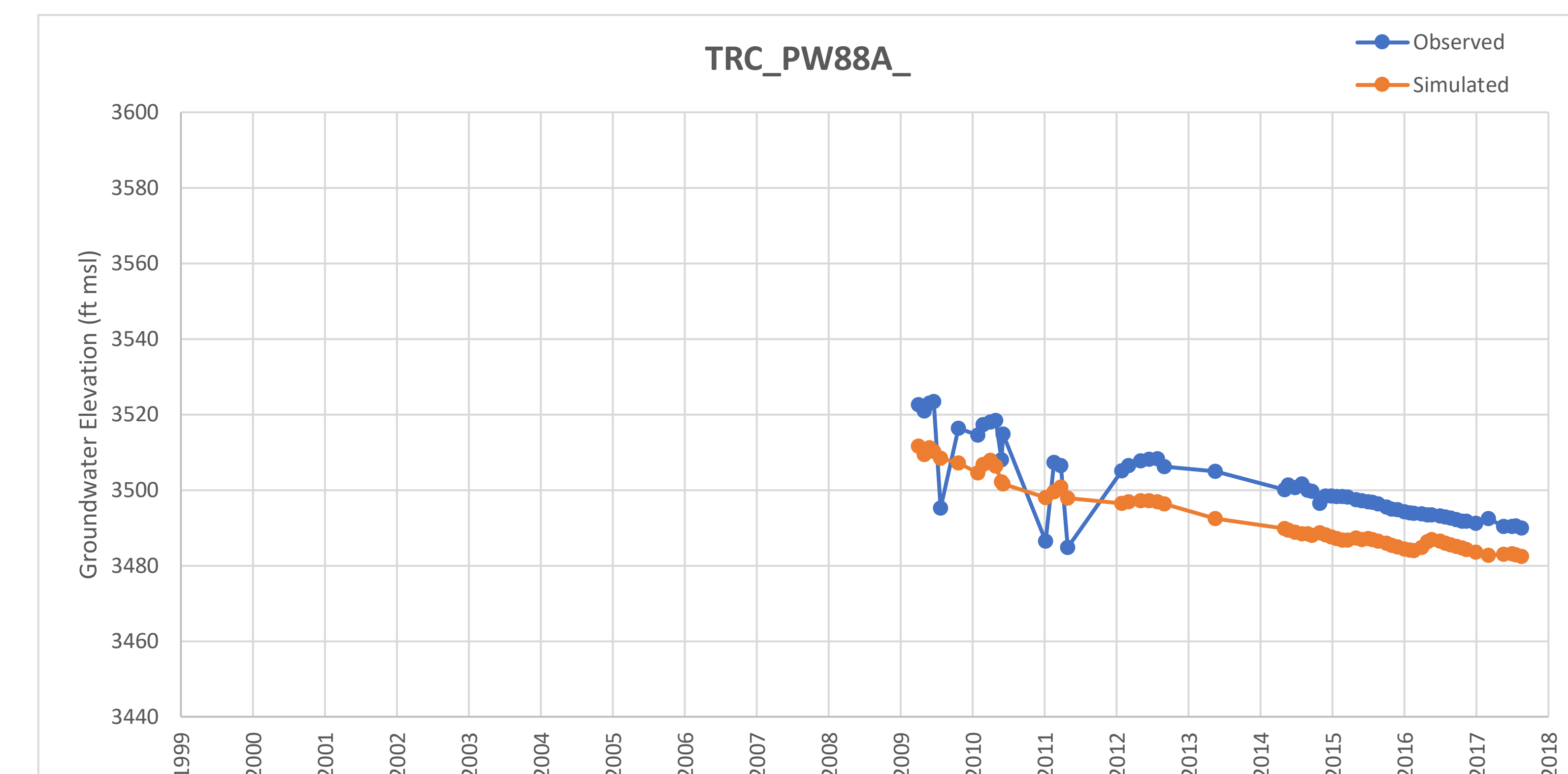
RMSE	12.56	ft	well:	TRC_PW56A_
Min	-31.6		area:	Main
Max	-0.6		layer:	3
Average	-10.9		cells:	3283:3409
Median	-9.5			



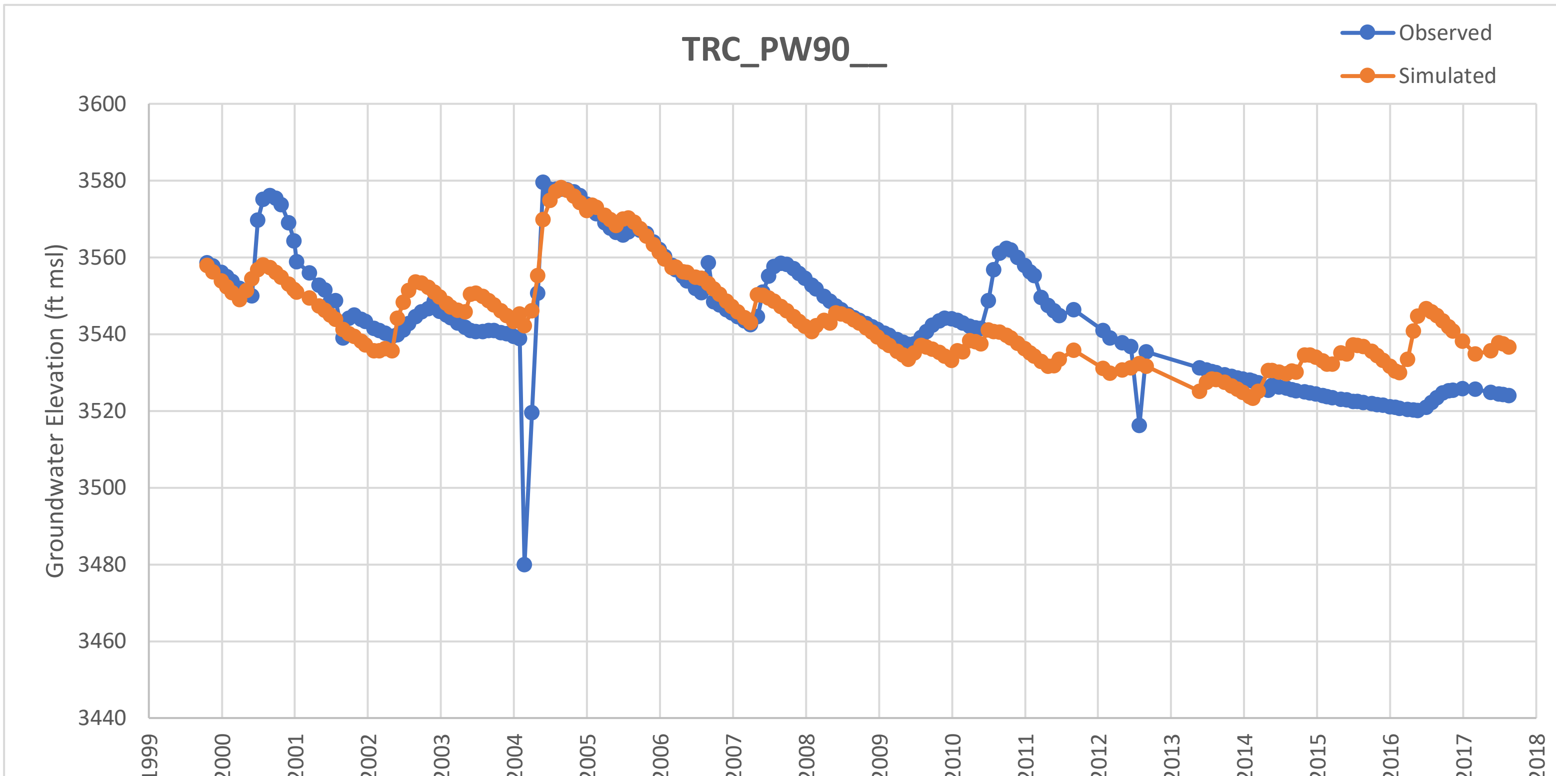
RMSE	5.18	ft	well:	TRC_PW60__
Min	-8.8		area:	GVC S
Max	22.9		layer:	3
Average	0.4		cells:	3410:3549
Median	-1.0			



RMSE	8.43	ft	well:	TRC_PW80__
Min	-21.7		area:	Main
Max	30.6		layer:	3
Average	-1.6		cells:	3550:3665
Median	-1.1			



RMSE	9.99	ft	well:	TRC_PW88A_
Min	-13.2		area:	Main
Max	13.1		layer:	3
Average	-8.6		cells:	3666:3726
Median	-9.8			



RMSE	10.62	ft	well:	**TRC_PW90__**
Min	-22.9		area:	Dryfield
Max	62.3		layer:	3
Average	0.0		cells:	3727:3922
Median	-0.7			

ATTACHMENT B

CBGFM HISTORICAL MODEL SENSITIVITY ANALYSIS RESULTS

TABLE B-1
Results of CBGFM Sensitivity Analysis
Tejon-Castac Water District

Parameter / Input Modified	Scenario	Root Mean-Squared-Error (RMSE) by Zone or Well (ft) (1)									Average Annual Change in Groundwater Storage (AFY) (2)
		All	Main	Dryfield Canyon	GVC South	GVC North	Castac Lake Stage	TRC MW-16D	TRC MW-18D	TRC MW-23D	
Calibrated Historical Model		**8.66**	**9.32**	**7.92**	**7.77**	**3.93**	**1.84**	**5.69**	**7.10**	**7.85**	**-743**
Recharge	**Streamflow +10%**	8.56	9.15	8.14	7.50	4.14	2.02	5.65	7.45	7.72	-727
	% change	*-1.1%*	*-1.8%*	*2.8%*	*-3.4%*	*5.2%*	*9.8%*	*-0.7%*	*5.0%*	*-1.8%*	*0.3%*
	Streamflow -10%	8.82	9.52	7.88	8.06	3.75	1.68	5.84	6.77	8.04	-759
	% change	*1.9%*	*2.2%*	*-0.5%*	*3.7%*	*-4.7%*	*-8.5%*	*2.7%*	*-4.7%*	*2.4%*	*-0.3%*
	Distributed +10%	8.54	9.15	8.14	7.33	4.14	2.07	5.65	7.62	7.62	-727
	% change	*-1.4%*	*-1.8%*	*2.8%*	*-5.6%*	*5.3%*	*12.7%*	*-0.7%*	*7.3%*	*-2.9%*	*0.3%*
	Distributed -10%	8.85	9.53	7.84	8.25	3.75	1.65	5.82	6.63	8.16	-759
	% change	*2.2%*	*2.3%*	*-1.0%*	*6.2%*	*-4.7%*	*-10.5%*	*2.3%*	*-6.5%*	*3.9%*	*-0.3%*
	All +10%	8.51	9.02	8.51	7.11	4.36	2.31	5.72	8.03	7.55	-711
	% change	*-1.7%*	*-3.2%*	*7.5%*	*-8.5%*	*10.9%*	*25.8%*	*0.6%*	*13.1%*	*-3.9%*	*0.7%*
	All -10%	9.08	9.77	7.97	8.57	3.58	1.48	6.06	6.35	8.40	-776
	% change	*4.9%*	*4.9%*	*0.6%*	*10.4%*	*-8.9%*	*-19.4%*	*6.6%*	*-10.5%*	*7.0%*	*-0.7%*
Layer 3 Horizontal Hydraulic Conductivity (K_{H3})	**K_{H3},all = 18 ft/d**	18.16	11.53	26.45	21.97	14.39	2.89	9.96	10.31	27.07	-411
	% change	*109.7%*	*23.8%*	*234.0%*	*182.9%*	*265.7%*	*57.1%*	*75.2%*	*45.3%*	*244.6%*	*6.9%*
	K_{H3},all = 86 ft/d	18.64	13.25	11.49	33.66	16.82	5.67	12.54	7.44	39.97	-877
	% change	*115.2%*	*42.2%*	*45.2%*	*333.5%*	*327.4%*	*208.4%*	*120.4%*	*4.8%*	*409.0%*	*-2.8%*
	K_{H3},GVC-North = 18 ft/d	19.79	10.04	8.30	40.84	18.12	2.97	6.85	12.72	50.13	-366
	% change	*128.6%*	*7.8%*	*4.8%*	*425.9%*	*360.7%*	*61.5%*	*20.4%*	*79.2%*	*538.4%*	*7.8%*
	K_{H3},GVC-North = 86 ft/d	9.30	9.43	7.89	10.75	3.80	1.74	5.77	6.72	11.61	-800
	% change	*7.4%*	*1.2%*	*-0.3%*	*38.5%*	*-3.5%*	*-5.1%*	*1.4%*	*-5.3%*	*47.8%*	*-1.2%*
	K_{H3},GVC-South = 18 ft/d	9.08	9.54	8.47	8.73	3.92	3.04	6.23	11.34	11.02	-713
	% change	*4.8%*	*2.4%*	*7.0%*	*12.4%*	*-0.4%*	*65.2%*	*9.6%*	*59.8%*	*40.3%*	*0.6%*
	K_{H3},GVC-South = 86 ft/d	24.08	27.20	12.23	25.61	15.64	6.34	19.73	24.68	22.81	-1048
	% change	*178.1%*	*192.0%*	*54.4%*	*229.7%*	*297.5%*	*244.7%*	*247.0%*	*247.8%*	*190.4%*	*-6.3%*
	K_{H3},Dryfield = 18 ft/d	15.06	9.40	26.88	7.77	3.93	1.54	5.70	7.20	7.84	-714
	% change	*74.0%*	*0.9%*	*239.5%*	*0.0%*	*-0.2%*	*-16.2%*	*0.1%*	*1.5%*	*-0.1%*	*0.6%*
	K_{H3},Dryfield = 86 ft/d	8.82	9.31	8.65	7.77	3.94	1.85	5.68	7.08	7.86	-745
	% change	*1.8%*	*-0.1%*	*9.2%*	*0.1%*	*0.0%*	*0.8%*	*0.0%*	*-0.2%*	*0.0%*	*0.0%*
	K_{H3},Main = 18 ft/d	14.03	15.37	7.89	16.17	3.76	3.75	7.77	10.79	12.58	-824
	% change	*62.1%*	*65.0%*	*-0.4%*	*108.2%*	*-4.4%*	*104.2%*	*36.6%*	*52.0%*	*60.2%*	*-1.7%*
	K_{H3},Main = 86 ft/d	23.73	26.45	23.06	15.60	4.98	17.84	14.02	30.75	16.69	-570
	% change	*174.1%*	*184.0%*	*191.3%*	*100.9%*	*26.5%*	*870.5%*	*146.6%*	*333.4%*	*112.6%*	*3.6%*
Layers 1-2 Horizontal Hydraulic Conductivity (K_{H12})	**K_{H12},all = 5 ft/d (x0.5)**	8.43	8.86	8.68	6.98	3.94	1.63	5.68	8.36	7.89	-720
	% change	*-2.7%*	*-4.9%*	*9.6%*	*-10.1%*	*0.2%*	*-11.2%*	*-0.2%*	*17.9%*	*0.4%*	*0.5%*
	K_{H12},all = 20 ft/d (x2)	9.34	10.32	7.78	8.32	4.11	1.84	6.25	6.24	7.49	-766
	% change	*7.9%*	*10.8%*	*-1.7%*	*7.1%*	*4.4%*	*-0.1%*	*10.0%*	*-12.0%*	*-4.6%*	*-0.5%*
Layers 1-2 Vertical Anisotropy (Kh/Kv_{12})	**Kh/Kv_{12},all = 1000 (x0.1)**	10.46	10.33	13.23	6.82	4.76	3.27	6.61	10.87	8.59	-673
	% change	*20.8%*	*10.9%*	*67.0%*	*-12.2%*	*20.9%*	*77.9%*	*16.2%*	*53.3%*	*9.4%*	*1.5%*
	Kh/Kv_{12},all = 10 (x10)	9.19	9.97	7.73	8.77	3.66	2.30	5.97	6.82	8.34	-756
	% change	*6.2%*	*7.1%*	*-2.4%*	*13.0%*	*-7.0%*	*25.4%*	*4.9%*	*-3.9%*	*6.2%*	*-0.3%*
Layer 3 Vertical Anisotropy (Kh/Kv_3)	**Kh/Kv_3,all = 100 (x0.1)**	8.55	9.16	8.00	7.55	4.01	1.71	5.53	7.09	7.79	-734
	% change	*-1.3%*	*-1.6%*	*1.1%*	*-2.7%*	*1.8%*	*-6.9%*	*-2.7%*	*-0.1%*	*-0.8%*	*0.2%*
	Kh/Kv_3,all = 1 (x10)	8.67	9.32	7.91	7.79	3.93	1.86	5.69	7.09	7.86	-744
	% change	*0.1%*	*0.1%*	*-0.1%*	*0.3%*	*-0.2%*	*1.3%*	*0.0%*	*-0.1%*	*0.1%*	*0.0%*

TABLE B-1
Results of CBGFM Sensitivity Analysis
Tejon-Castac Water District

Parameter / Input Modified	Scenario	Root Mean-Squared-Error (RMSE) by Zone or Well (ft) (1)									Average Annual Change in Groundwater Storage (AFY) (2)
		All	Main	Dryfield Canyon	GVC South	GVC North	Castac Lake Stage	TRC MW-16D	TRC MW-18D	TRC MW-23D	
Calibrated Historical Model		**8.66**	**9.32**	**7.92**	**7.77**	**3.93**	**1.84**	**5.69**	**7.10**	**7.85**	**-743**
Layers 1-2 Storativity (S_{12})	**S_{12} x 0.1**	8.89	9.47	7.99	8.48	3.82	1.84	5.83	6.20	8.20	-680
	% change	*2.7%*	*1.7%*	*0.9%*	*9.2%*	*-3.0%*	*0.2%*	*2.6%*	*-12.7%*	*4.5%*	*1.3%*
	S_{12} x 10	9.22	10.52	8.02	6.21	5.33	2.06	7.64	14.04	7.61	-1176
	% change	*6.5%*	*13.0%*	*1.3%*	*-20.1%*	*35.5%*	*12.1%*	*34.4%*	*97.9%*	*-3.1%*	*-9.0%*
Layer 3 Storativity (S_3)	**S_3 x 0.1**	8.88	9.49	8.10	8.20	3.88	1.78	5.71	6.26	8.05	-693
	% change	*2.5%*	*1.9%*	*2.3%*	*5.6%*	*-1.5%*	*-3.4%*	*0.5%*	*-11.8%*	*2.5%*	*1.0%*
	S_3 x 10	9.12	10.43	8.10	5.79	4.59	2.38	10.52	14.21	7.15	-1139
	% change	*5.3%*	*12.0%*	*2.3%*	*-25.5%*	*16.8%*	*29.6%*	*85.1%*	*100.2%*	*-9.0%*	*-8.2%*
Layers 1-2 Specific Yield (Sy_{12})	**$Sy_{1/2}$ x 0.5**	8.93	9.56	7.98	8.42	3.81	1.77	5.68	6.03	8.19	-671
	% change	*3.2%*	*2.7%*	*0.8%*	*8.4%*	*-3.1%*	*-4.0%*	*0.0%*	*-15.0%*	*4.3%*	*1.5%*
	$Sy_{1/2}$ x 2	8.44	9.21	7.90	6.83	4.20	1.97	6.14	9.13	7.39	-873
	% change	*-2.5%*	*-1.2%*	*-0.2%*	*-12.1%*	*6.8%*	*7.3%*	*7.9%*	*28.6%*	*-5.8%*	*-2.7%*
Layer 3 Specific Yield (Sy_3)	**Sy_3 x 0.5**	9.68	10.17	9.28	9.00	3.82	1.63	7.22	4.95	8.41	-573
	% change	*11.8%*	*9.2%*	*17.3%*	*15.9%*	*-2.8%*	*-11.3%*	*27.0%*	*-30.2%*	*7.1%*	*3.5%*
	Sy_3 x 2	8.62	9.62	7.85	6.38	4.17	2.20	9.50	11.45	7.29	-1028
	% change	*-0.5%*	*3.2%*	*-0.9%*	*-17.9%*	*5.9%*	*19.8%*	*67.0%*	*61.3%*	*-7.2%*	*-5.9%*
Castac Lakebed Hydraulic Conducitivity (K_{lake})	**K_{lake} = 1e-5 ft/d (x0.01)**	13.39	11.99	20.06	5.52	4.09	13.24	8.98	14.62	7.77	-646
	% change	*54.7%*	*28.8%*	*153.3%*	*-29.0%*	*4.0%*	*620.0%*	*57.9%*	*106.1%*	*-1.1%*	*2.0%*
	K_{lake} = 1e-4 ft/d (x0.1)	10.33	9.56	14.37	6.34	4.03	8.59	6.56	10.31	7.60	-694
	% change	*19.3%*	*2.7%*	*81.5%*	*-18.4%*	*2.5%*	*367.3%*	*15.3%*	*45.3%*	*-3.2%*	*1.0%*
	K_{lake} = 1e-2 ft/d (x10)	9.06	9.97	7.63	8.12	3.90	3.18	5.81	6.86	7.97	-754
	% change	*4.7%*	*7.0%*	*-3.6%*	*4.6%*	*-0.8%*	*72.9%*	*2.2%*	*-3.3%*	*1.4%*	*-0.2%*
	K_{lake} = 0.1 ft/d (x100)	9.18	10.09	7.80	8.17	3.90	3.34	5.83	6.86	7.98	-755
	% change	*6.0%*	*8.3%*	*-1.5%*	*5.2%*	*-0.9%*	*81.9%*	*2.6%*	*-3.4%*	*1.6%*	*-0.2%*
Grapevine Creek Constant Head (CH) cell heads	**CH = 5 ft bgs**	9.28	9.24	7.94	7.35	26.62	1.91	5.65	7.37	7.78	-694
	% change	*7.1%*	*-0.8%*	*0.2%*	*-5.3%*	*576.5%*	*3.9%*	*-0.7%*	*3.9%*	*-1.0%*	*1.0%*
	CH = 10 ft bgs	9.13	9.25	7.93	7.32	23.72	1.90	5.65	7.33	7.66	-700
	% change	*5.4%*	*-0.7%*	*0.2%*	*-5.7%*	*502.9%*	*3.4%*	*-0.6%*	*3.3%*	*-2.5%*	*0.9%*
Cuddy Creek General Head Boundary (GHB) cell transient heads	**GHB = 1x gradient**	11.27	13.01	7.84	9.54	3.88	1.16	12.40	7.32	8.58	-786
	% change	*30.2%*	*39.7%*	*-1.0%*	*22.9%*	*-1.5%*	*-36.8%*	*118.0%*	*3.1%*	*9.3%*	*-0.9%*
	GHB = 1.5x gradient	8.31	8.80	8.49	6.74	3.99	3.10	8.29	8.99	7.59	-716
	% change	*-4.0%*	*-5.5%*	*7.2%*	*-13.2%*	*1.4%*	*68.8%*	*45.8%*	*26.7%*	*-3.4%*	*0.5%*

Abbreviations

AFY = Acre-Feet per year
CBGFM = Castac Basin Numerical Groundwater Flow Model
ft = feet
ft/d = feet per day
ft bgs = feet below ground surface
ft msl = feet above mean sea level
GVC = Grapevine Canyon
RMSE = root mean-squared error

Notes

(1) Percent (%) change in water level/lake stage RMSE represent % change relative to comparative RMSE values from the calibrated historical CBGFM.
(2) Percent (%) change in average annual change in groundwater storage values represent % change relative to total (gross) volumetric inflows from the calibrated historical CBGFM (4,828 AFY).

Appendix J

Project / Management Action Information Forms

CASTAC BASIN GROUNDWATER SUSTAINABILITY AGENCY
PROJECT / MANAGEMENT ACTION
INFORMATION FORM

P/MA ID:
1

BASIN/MANAGEMENT AREA (if any):
Castac Lake Valley Groundwater Basin (DWR 5-029)

TITLE:
Aquifer Replenishment Project

DESCRIPTION[1]:

Castac Lake will be maintained at a total lake depth of 8 to 10 feet (stage of 3,493 to 3,495 ft msl) covering an area of approximately 200 acres via managed surface water deliveries to the lake.

Replenishment will be imported surface water through Tejon-Castac Water District (TCWD)'s existing capacity, delivered from the Bear Trap turnout.

EXPECTED ANNUAL BENEFIT (demand reduction or supply augmentation, in acre-feet per year):

70 - 100 AFY

AGENCY(s):

Primary/Lead: Tejon-Castac Water District

Supporting: Castac Basin GSA

LOCATION: ☐ Check here if Basin-wide

Township / Range: ____

Coordinates (Latitude / Longitude): 34°50'8.16"N, 118°50'36.35"W

Description: Castac Lake

AFFECTED SUSTAINABILITY INDICATOR (check all that apply):

- ■ Chronic Lowering of Groundwater Levels
- ■ Reduction of Groundwater Storage
- ☐ Seawater Intrusion
- ☐ Degraded Water Quality
- ☐ Land Subsidence
- ■ Depletions of Interconnected Surface Water

TYPE (check all that apply):

■ Water Supply Augmentation

- ■ Surface Water
- ■ Groundwater (Recharge)
- ☐ Recycled Water
- ☐ Transfer
- ☐ Stormwater
- ☐ Other

Source of Outside Water (if applicable): Imported surface water through TCWD

☐ Water Demand Reduction

- ☐ Conservation
- ☐ Land / Water Use Changes

☐ Infrastructure / Capital Project
☐ Policy Project
☐ Data Gap Filling / Monitoring
☐ Water Quality Improvement
☐ Other: ____

[1] *Please continue to next page or attach additional pages to this form as necessary*

COSTS & FUNDING SOURCE(s):

Capital / Up-front ($): 6,889,859

Source(s): TCWD / TMV developer

O&M / On-going ($ per year): 721,092

Source(s): TCWD

REGULATORY / LEGAL AUTHORITY REQUIREMENTS (describe all that apply):

Permits (name of authority, type of permit): Possibly NEPA/CDFW/U.S.FWS/USACE/SWPPP

CEQA: Possibly

Other: Castac GSA's authority per CWC Section 10726.2(b)

SCHEDULE / TIMING:

Implementation Trigger(s): Upon initiation of Tejon Mountain Village Phase 1 construction; estimated 2023 with 3 years to complete construction

Termination Trigger(s): water supply may change in the future, subject to re-evaluation should availability of imported surface water become more limited or be required for other beneficial uses

Timeframe to Accrue Expected Benefits: Augmented recharge anticipated to begin upon initiation

ADDITIONAL DETAILS (as necessary)**:**

Estimates of replenishment water volumes include an initial 2,500 acre-feet with 1,060 acre-feet to maintain lake depth thereafter.

A maintained lake will supplement emergency water supply for wildfire fighting, if needed.

If replenishment water supply changes in the future, permit requirements will need to be re-considered.

CASTAC BASIN GROUNDWATER SUSTAINABILITY AGENCY
PROJECT / MANAGEMENT ACTION
INFORMATION FORM

P/MA ID:	**BASIN/MANAGEMENT AREA** (if any): Castac Basin
TITLE: Krista Emergency Interconnect with Lebec County Water District	
DESCRIPTION[1]:	
EXPECTED ANNUAL BENEFIT (demand reduction or supply augmentation, in acre-feet per year):	
AGENCY(s): Primary/Lead: Krista Mutual Water Company Supporting:	
LOCATION: ☐ Check here if Basin-wide Township / Range: Lebec, CA Coordinates (Latitude / Longitude): Description:	
AFFECTED SUSTAINABILITY INDICATOR (check all that apply): ☐ Chronic Lowering of Groundwater Levels ☐ Seawater Intrusion ☐ Land Subsidence	☐ Reduction of Groundwater Storage ■ Degraded Water Quality ☐ Depletions of Interconnected Surface Water
TYPE (check all that apply): ☐ Water Supply Augmentation ☐ Surface Water ☐ Groundwater (Recharge) ☐ Recycled Water ☐ Transfer ☐ Stormwater ☐ Other Source of Outside Water (if applicable): ☐ Water Demand Reduction ☐ Conservation ☐ Land / Water Use Changes ☐ Infrastructure / Capital Project ☐ Policy Project ☐ Data Gap Filling / Monitoring ☐ Water Quality Improvement ☐ Other:	

[1] *Please continue to next page or attach additional pages to this form as necessary*

COSTS & FUNDING SOURCE(s):

Capital / Up-front ($): 565,794

Source(s): State Water Resource Control Board SRF Grant

O&M / On-going ($ per year): 37,800

Source(s): ______

REGULATORY / LEGAL AUTHORITY REQUIREMENTS (describe all that apply):

Permits (name of authority, type of permit): Construction permits

CEQA: Will be necessary and will be completed by QK Engineering

Other: ______

SCHEDULE / TIMING:

Implementation Trigger(s): ______

Termination Trigger(s): ______

Timeframe to Accrue Expected Benefits: ______

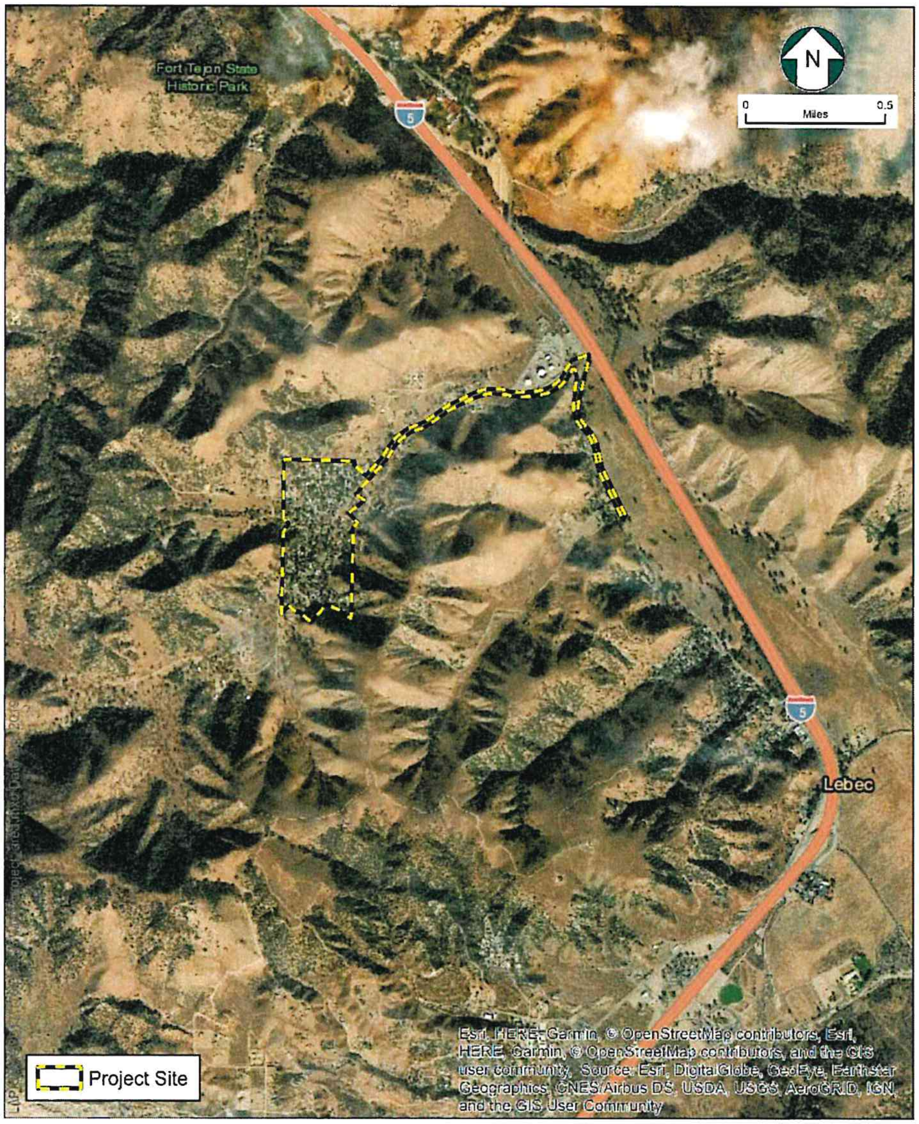
ADDITIONAL DETAILS (as necessary):

Please see attached Preliminary Engineering Report. Alternative V: Interconnect with LCWD

PRELIMINARY ENGINEERING REPORT

KRISTA MUTUTAL WATER COMPANY

FLUORIDE MITIGATION PROJECT



JUNE 2019

KRISTA MUTUAL WATER COMPANY
PRELIMINARY ENGINEERING REPORT

Prepared for:

Krista Mutual Water Company
3534 Mt. Pinos Way
Frazier Park, CA 93225
Contact Person: Sandi McElhenney, President
Phone: 661-245-5613

Consultant:

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Contact: Cathy Williams, P.E.
Phone: (661) 616-2600

June 2019

Project #170228

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Acronyms & Abbreviations

AA	activated alumina
ASCE	American Society of Civil Engineers
AWWA	American Water Works Association
BACT	Best Available Control Technology
CBC	California Building Code 2018
CEQA	California Environmental Quality Act
cfs	Cubic feet per second
County	County of Kern
CWWS	California Waterworks Standards
CRWA	California Rural Water Association
FEMA	Federal Emergency Management Agency
FY	Fiscal year
gpd	Gallons per day
gph	Gallons per hour
GPM	Gallons per minute
HDLPE	High Density Linear Polyethylene
HP	Horsepower
Hz	Hertz
KMWC	Krista Mutual Water Company
LCWD	Lebec County Water District
MCC	Motor control center
MCL	Maximum Contaminate Level
MDD	Maximum Day Demand
MG	Million Gallons
mgd	Million gallons per day
NPDWR	National Primary Drinking Water Regulation
NFPA	National Fire Protection Association
PER	Preliminary Engineering Report
PHD	Peak Hour Demand
PLC	programmable logic control
POPCC	Preliminary Opinion of Probable Construction Costs
PS	Pump Station
PWS	Public water supply system
psi	pounds per square inch
Q	Flow Rate
RO	reverse osmosis
ROW	Right of way
RTU	radio telemetry unit
SCADA	Supervisory Control and Data Acquisition
SWRCB	State Water Resources Control Board
TMF	technical, managerial, and financial
VFD	Variable Frequency Drive
WTEB	Water Treatment Equipment Building

SECTION 1 - Executive Summary

1.1 - Project Objective

QK is assisting Krista Mutual Water Company (KMWC) with a Planning Grant for Fluoride Contamination Planning Project (Project No. 1500475-002P) utilizing Proposition 1 funding. QK, through this planning grant, will analyze alternatives for mitigation to address high levels of fluoride within the KMWC water system. This Preliminary Engineering Report (PER) has been written per the requirements of the State Water Resources Control Board (SWRCB) and will be used in the State Water Board Proposition 1 application for future construction funding.

1.2 - Proposed Project

This report will identify treatment options, blending options, and system improvements needed to facilitate meeting water quality standards and system water demands. The report will also analyze all available alternatives for dealing with exceeded Maximum Contaminant Level (MCL) of fluoride in the KMWC water supply and recommend the best option or combination of options to bring the water system into compliance with State Water Board standards. Each alternative will include a construction cost estimate and an estimate of operation and maintenance (O&M) costs.

The alternatives for this project are (1) to consolidate with Lebec County Water District (LCWD), (2) install necessary equipment for blending through an interconnect with LCWD's existing water system, (3) construct a new well that will provide clean drinking water, (4) construct fluoride treatment facilities to bring the contaminant to safe levels, (5) install an emergency interconnect with LCWD's existing water system, or (6) take no action/variance.

1.3 - Report Scope

The intent of this PER is to provide KMWC with the necessary technical elements required for a project of this nature. The scope of the report includes the following items with respect to the project design and construction:

1. Preparation of preliminary site layouts that include proposed water supply well, water treatment facility, water storage tank and related appurtenances
2. Identification of piping route to connect all the KMWC and LCWD water supply wells
3. Development of preliminary process for the proposed treatment and storage system
4. Identification of any required permits (environmental, regulatory, state, and/or local) and anticipated schedule to obtain approvals
5. Preparation of an engineering estimate of probable construction cost

SECTION 2 - Introduction

2.1 - Project Purpose

The KMWC supplies water to a severely disadvantaged community of residential homes called Los Padres Estates, located in Southern Kern County since 1971. The water is supplied by a single KMWC well located outside of the Los Padres Estates boundary. Currently, the existing well exceeds the 2.0 milligrams per liter (mg/L) MCL for fluoride. The Fluoride Mitigation Project will address this problem by coordinating with KMWC and SWRCB to reach a feasible solution.

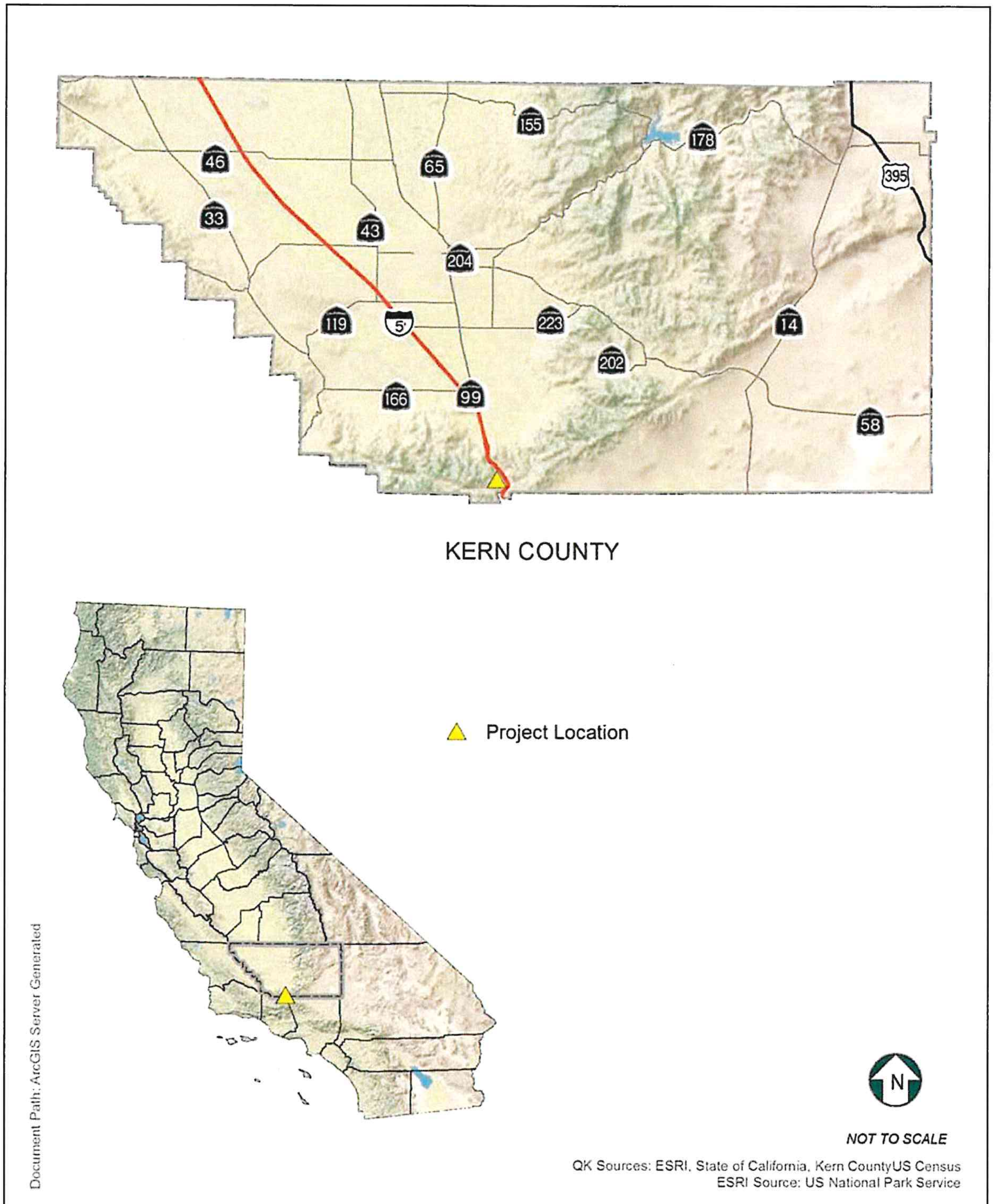
2.2 - Proposed Project

This report will identify water treatment or blending options and system improvements needed to facilitate meeting water quality standards and system water demands. The report will also analyze all available alternatives for dealing with exceeded MCL of fluoride in the KMWC water supply and recommend the best option or combination of options to bring the water system into compliance with SWRCB standards. Each alternative will include a construction cost estimate and an estimate of O&M costs.

The alternatives for this project include (1) to consolidate with Lebec County Water District (LCWD), (2) install necessary equipment for blending through an interconnection with LCWD's existing water system, (3) construct a new well that will provide clean drinking water, (4) construct fluoride treatment facilities to bring the contaminant to safe levels, (5) install an emergency interconnect with LCWD's existing water system, or (6) take no action/variance.

2.3 - Project Location

The KMWC's Los Padres Estates is approximately 1.2 miles west of Interstate 5 (I-5) and roughly 1.7 miles northwest of the unincorporated town of Lebec. The regional location of the project is shown on Figure 2-1. The project boundary includes the Los Padres Estates subdivision and accompanying roads as displayed on Figure 2-2.



QK

Figure 2-1
Regional Location

Figure 2-2
Project Boundary

2.4 - Existing Site Conditions

KMWC currently has one well producing enough water for 193 lots per Title 22 standards. Of the 193 lots, thirteen have been set aside to remain as undeveloped open space. Currently six of the buildable lots are vacant and two buildable lots have been merged into one lot. The well providing water for KMWC is located near the T-intersection of Clear Canyon Road and Lebec Road.

The KMWC service area falls predominately in Zone X (outside the 500-year flood zone) of FIRM panel 06029C3860E, with the exception of O'Neil Creak which falls in Zone A (100-year flood zone). Figure 2-3 shows the FEMA flood zone map.

2.5 - Current Water System Facilities

The current distribution system constructed in the mid-1970s has a grid layout comprised of 4- and 6-inch (in.) asbestos cement (AC) pipe. There is approximately 1,640 feet (ft) of 4-in. and 10,766 ft of 6-in. The system includes five 4-in. and thirty-one 6-in. inline gate valves along with 16 fire hydrants. Initial construction of the distribution system included 191 service connections of which 7 are single connections and 92 are double connections. These connections do not include meters and customers are charged a flat rate for services. Currently, there are 13 lots not needing a hook-up. The current water system for Los Padres Estates is shown in Appendix A.

There is an existing well located east of the service area near the T-intersection of Clear Canyon Road and Lebec Road that can produce approximately 200 gallons per minute (gpm). The groundwater well is operating from a shallow water source approximately 250 ft below ground and is tied directly into the distribution system feeding the storage tanks. There is a 8-inch steel transmission main connecting the well to the distribution system. The transmission main from the well runs north, along Lebec Road to Lebec Oak Road, and then turns west to the distribution system. Located within the service area, the water well fills four ground storage tanks located at the end of Krista Court. The storage tanks are welded steel and are located at a higher elevation than the community to maintain system pressure by gravity. Two tanks have an approximate volume of 25,000-gallons each and the remaining two tanks have a volume of 83,000-gallons and 43,000-gallons, respectively.

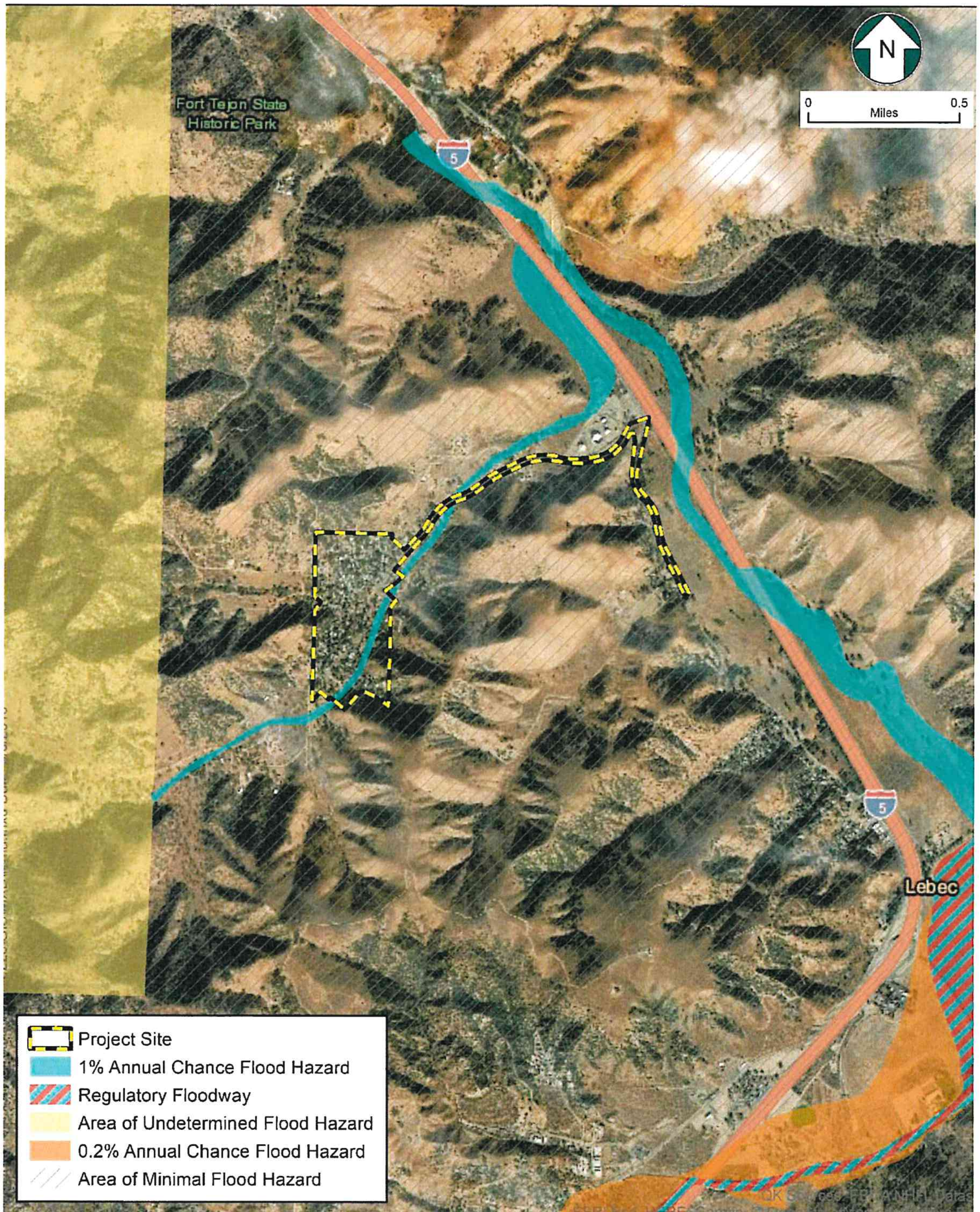


Figure 2-3
FEMA Flood Insurance Rate Map

SECTION 3 -Evaluation of Alternatives

3.1 - Overall Site Plan

In addressing the exceedance of the State's 2.0 mg/L MCL of fluoride in drinking water, KMWC has considered several alternatives to lower the fluoride levels at or below the MCL. These alternatives will be analyzed in the following sections to determine the feasibility of each. Alternatives will be compared with one another to determine which alternative is the recommended solution.

3.2 - Alternative I: Consolidation with LCWD

Consolidation is the joining of two or more water systems, which usually involves the smaller system being absorbed into the larger water system. The system absorbing the other system is known as the "receiving" water system, and the system being absorbed is known as the "subsumed" water system. In this case, KMWC's water system would be the subsumed water system by LCWD. A rule of thumb for water system consolidation is limiting the distance between the water systems by 3 miles in order to be considered cost-effective. However, in practice the actual distance limit decreases to 1 mile for current State funding programs. The distance between the connection points for KMWC's water system and LCWD's water system is approximately 0.4 miles (2,100 feet).

Before consolidation, the subsumed system must analyze the receiving system for:

1. Capacity of a neighboring system to supply water to the affect community
2. Geographical separation of the two systems
3. Cost of required infrastructure improvements
4. Costs and benefits to both systems
5. Access to financing for the consolidated entity

There are various forms of consolidation: physical consolidation, managerial consolidation, or a combination of both. Physical consolidation involves actual interconnection of the water distribution systems while managerial consolidation involves combining the management of the participating water systems. The following are examples of consolidation:

1) One water system takes over all responsibilities and costs for operating another water system
2) One water system provides another with infrastructure renovation, such as treatment plant backwash improvements, water tower maintenance and reducing distribution system water loss
3) One water system can partner with another water system simply to provide service; water system continues to operate and maintain its distribution system but contracts with another utility for regulatory compliance, billing, meter reading or other services

4) Partnering for assistance with emergency preparedness

The actual nature and structure of a consolidation will depend on local conditions and the needs and concerns of the parties, which may change over time. For ease of developing and analyzing this alternative, KMWC's water system would physically consolidate with LCWD's water system.

3.2.1- Project Description

In consolidating, LCWD would take ownership of KMWC's water system. In general, the water would be provided by the LCWD's water sources but the existing KMWC's water well could be kept on standby for emergency or fire flow conditions. It should be mentioned that the LCWD is currently searching for additional water sources to improve its own fluoride issues unrelated to KMWC. LCWD is meter based and would charge each lot within Los Padres Estates as necessary. Consolidation would take place by using an interconnecting pipeline to consolidate KMWC's water system with LCWD's water system. Because of the 2,100-foot interconnecting pipeline, there is not enough pressure from the LCWD's system to reach the Los Padres Estates. For this reason, booster pumps would be required.

The interconnecting pipeline would be constructed, connecting one side of the pipeline to the KMWC's transmission line near the T-intersection of Lebec Road and Clear Canyon Road, while the other end of the pipeline would be connected to a blow-off valve at the end of LCWD's transmission line on Lebec Road. Because there is an existing oil line on the east side of Lebec Road, the proposed interconnecting pipeline would be installed within the right of way (ROW) of Lebec Road on the west side. The booster pumps would be placed at the current KMWC's well site. The KMWC's well site has limited space,therefore, additional property would need to be acquired for the placement of the booster pumps.

Figure 3-1 shows the area enclosed where the interconnecting pipeline, booster pumps, LCWD's blow-off valve, and the connection to KMWC's transmission line would be located.

3.2.2- Project Analysis

Benefits

One of the benefits of consolidation is that the problems are addressed by making more efficient use of resources, increasing system capacity, and spreading debt services as well as administrative and operational costs over a larger customer base. This can allow for the purchase of time-saving equipment that neither water system could afford to purchase alone. Additionally, the ability to attract highly specialized employees who can provide value with in-house engineering, technical consulting, accounting, public relations, and other functions also increases. Another benefit to consolidation, is the opportunity to develop multiple alternative sources of supply; providing versatility in operations and service reliability.

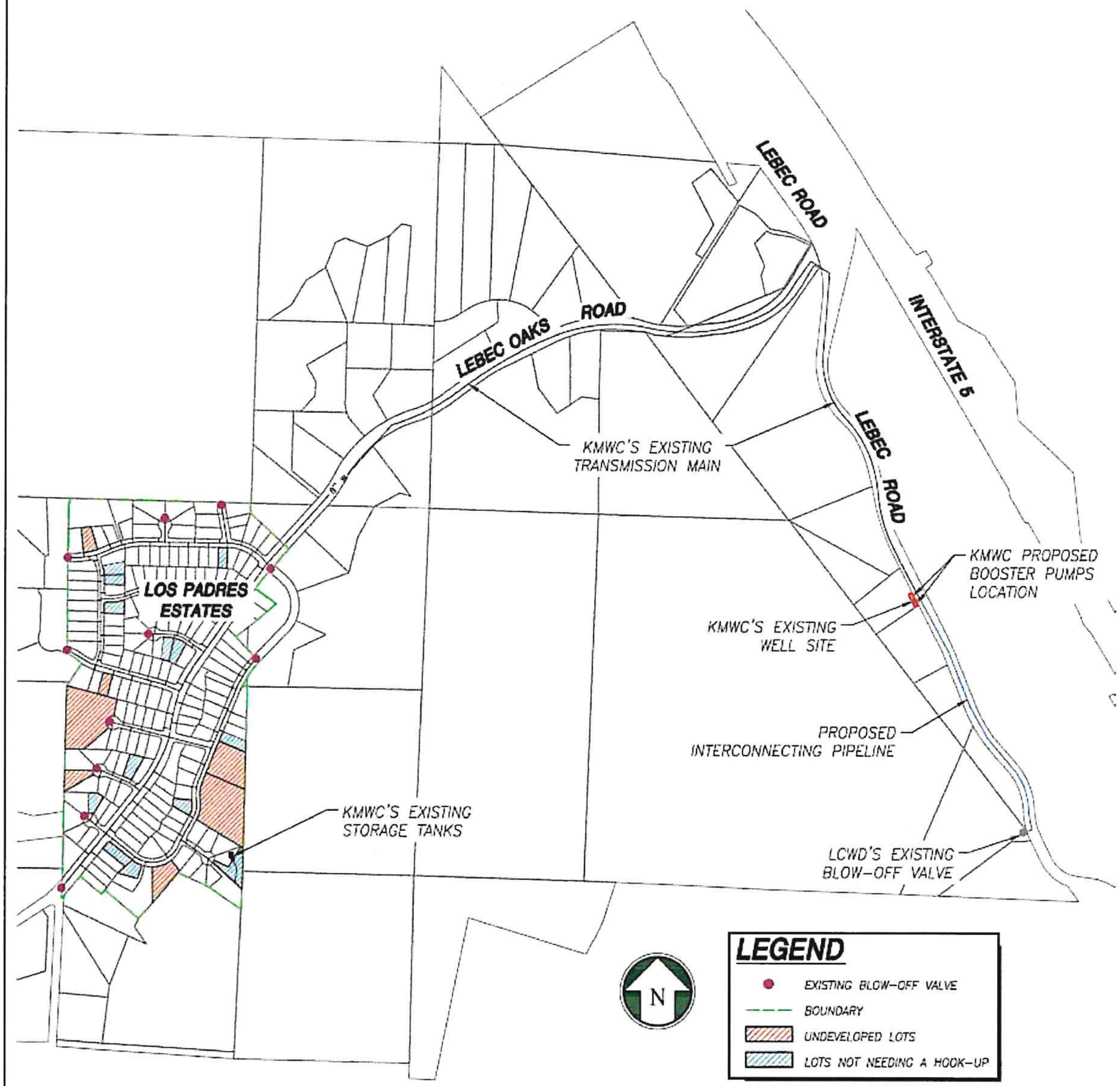


Figure 3-1
Alternative I: Consolidation with LCWD Project Area

Considerations

Rural water systems often underestimate the cost and complexity of consolidation. Water utilities must be aware of the hurdles of moving water over broad areas, including hydraulic issues. Rates, that have been kept low in the past, set up a situation where there is not enough money for future repairs and maintenance.

Furthermore, the challenges of engineering, digging lines underground, pumping, elevation changes, treatment and regulatory issues must also be addressed when water systems consolidate.

Water distribution systems that span long distances create a situation where water stays in the pipelines for longer periods. When this happens, disinfection agents can react with natural organic matter and produce harmful disinfection byproducts in the pipeline. This issue would need to be carefully monitored.

Furthermore, even when all parties are willing to consolidate, consolidation can take many years depending on the location of pipelines, availability of private versus public funding, concerns of community members, obtaining State permits and funding, compliance with system's internal rules to authorize consolidation, Local Agency Formation Commission (LAFCo) approvals, etc. The process can be difficult and overwhelming for small systems that lack technical, managerial, and financial (TMF) capacity to navigate through the process quickly and efficiently.

Krista has met with Lebec to discuss system interconnection and emergency water purchases. At this time Krista is not interested in consolidation. In the future, if conditions change, a letter of intent will be written between the two agencies describing actions moving forward.

3.3 - Alternative II: Blending with LCWD

Blending is the mixing of higher-quality water with lower-quality water to a calculated ratio in order to comply with the approved standards before delivering to customers.

3.3.1- Project Description

This alternative considers the installation of necessary infrastructure for blending through an interconnect with LCWD's water system to KMWC's water system. Similar to Alternative I, an interconnecting pipeline would attach to LCWD's blow-off valve and KMWC's transmission main. The major difference between this option and consolidation is both entities would continue to operate separately but a meter would be installed to determine KMWC's usage, upon which they would be billed by LCWD. The interconnecting pipeline would not be an emergency interconnect, but a full-time connection to be used to supply the necessary water to blend and reduce KMWC's water level of fluoride below the State's MCL.

In Alternative II, KMWC's water well would continue to be in service to meet the majority of the demand, but it would be augmented by water from LCWD. The quantity of water needed from LCWD is dependent on the current Fluoride concentrations generated by both systems and may vary over time. As mentioned above, LCWD is searching for additional water sources to increase capacity and improve its own Fluoride levels unrelated to KMWC. A calculation of the current volume of water needed by KMWC can be found below in Equation 3-1.

Water from both systems would flow through KMWC's existing transmission line. Special control valves would be installed at the booster pump inlet to adjust the flow so a certain percentage of raw water flowing from the LCWD's water system would mix with water produced by KMWC. Currently, the KMWC's transmission line travels north along Lebec Road, then west on Lebec Oaks Road until it reaches the service area and flows into the distribution system. Water would continue to flow north along Lebec Road and west along Lebec Oaks Road, but instead of distributing into the system, a new pipeline would be installed at the intersection of Lebec Oaks Road and Canyon Drive, diverting the water towards KMWC's four existing steel storage tanks at the end of Krista Court. From the elevated tanks, the water would then flow into the Los Padres Estates distribution system.

The interconnecting pipeline along Lebec Road would be approximately 2,100 feet, while the pipeline connecting to the storage tanks would be approximately 2,000 feet. The project area, including the interconnecting pipeline, the pipeline connecting the transmission main and storage tanks, location of the LCWD's blow-off valve, and KMWC's water well and booster pumps are shown in Figure 3-2.

The process of blending is done by blending in water from an external source to decrease the concentration of the contaminant in the existing source. Based on recent test results (June 2019), the existing level of Fluoride at the connection point to LCWD is 1.5 mg/L. Equation 3-1 was used to determine the estimated flow required to bring the MCL of fluoride in the KMWC's water well to be at or below the 2.0 mg/L.

$$x_1c_1 + x_2c_2 = x_tc_t \qquad \text{Equation 3-1}$$

Where, $x_t = x_1 + x_2$

Replacing x_t and rearranging the equation to solve for the water rate required from LCWD water well, x_2, Equation 3-2 was used and found to be approximately 100 GPM, which is about 50% of the consumed water. Based on KMWC's 2018 water consumption of 22.4 MG, KMWC would need to get approximately 11.2 MG of water from LCWD per year.

$$x_2 = \frac{x_1(c_1 - c_t)}{(c_t - c_2)} \qquad \text{Equation 3-2}$$

Where,

x_1 = 200 GPM (KMWC's water flow rate)

c_1 = 2.1 mg/L (KMWC's current water fluoride level)

c_2 = 1.5 mg/L (LCWD's current water fluoride level)

c_t = 1.8 mg/L (KMWC's desired water fluoride level)

3.3.2- Project Analysis

Benefits

In order to determine and optimize ratios, monitoring at the source is essential for blending to assure water is compliant. The following are benefits that result from blending:

1) Quick and simple assessment of source water usability
2) Optimize blending ratio on multiple source waters
3) Assure quality of treated water
4) Compliance with MCLs
5) Ensure public health and safety

Considerations

When blending, there are two different principles used to obtain the desired quality for process water. In the ratio control principle, the quality of the water from the input source must remain constant. In the quality control principle, two different water qualities are combined to achieve a predefined output quality. It must be kept in mind, blending can be temporary solution, as quality of water from additional sources may change and not continue to be compliant with SWRCB standards.

In order for this alternative to be used, permission must be granted from the LCWD. Part of this alternative will be to obtain written agreement from LCWD, authorizing the interconnecting pipeline between the two water systems.

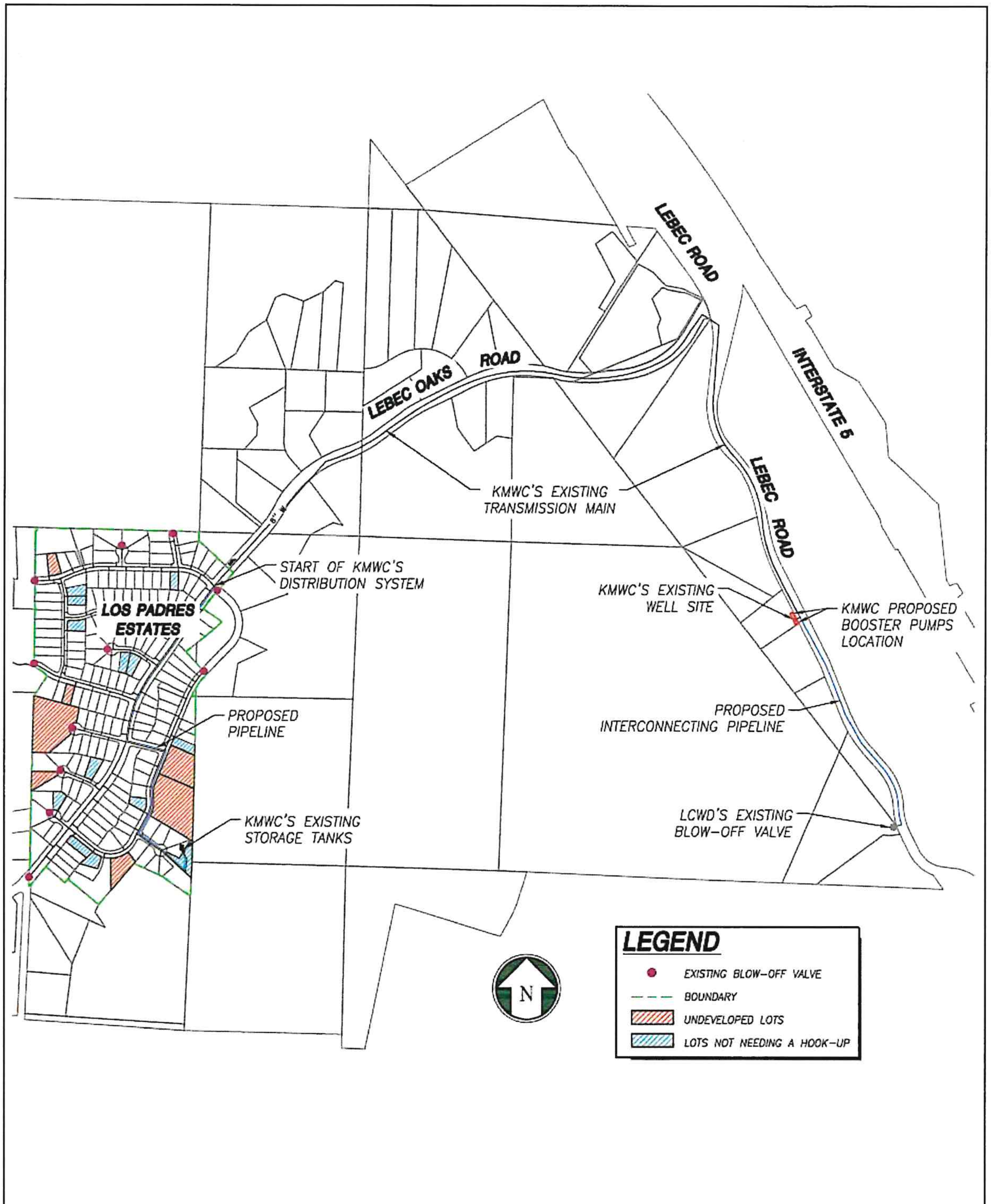


Figure 3-2
Alternative II: Blending with LCWD Project Area

3.4 - Alternative III: New Supply Well

3.4.1- Project Description

This alternative involves drilling a new well to potentially blend with the existing well. The SWRCB gave KMWC authorization to move forward with drilling a test well, which was completed in November 2018. The test well was drilled to locate groundwater in the area that is low in fluoride, that meets all other water quality standards, and that produces the same amount of water or more than the existing well.

Based on the information from the Hydrogeologist, Ken Schmidt, the only known locations in the vicinity where the well yields exceed several hundred gpm's are in the Castaic Valley or at the mouth of O'Neil Canyon, which are areas owned by Tejon Ranch. A Tejon property was identified and a non-exclusive License agreement between Tejon Ranch and KMWC was executed for use of the property on May 21, 2018.

The test well is located about 1,300 feet north of the T-intersection between Lebec Road and Lebec Oaks Road. The boundary surrounding the test well was approximately 110 feet by 142 feet. Figure 3-3 shows the location of the test well in reference to the Los Padres Estates and KMWC's existing water well.

Test Well Drilling Results

The test well was drilled to a depth of 230 feet using the casing hammer method. Table 3-1 shows the types of soil that were found and at their corresponding depths.

Table 3-1
Geologic Log for KMWC

Type of Soil	Depth (ft)
Saturated Deposits	165
Sand & Gravel	165-205
Alluvial Deposits	210
Weathered Rock	210-212
Granitic Rock (Hardrock)	212-230

Airlifted water samples were collected from two depth intervals (162 to 167 feet and 188 to 193 feet) and a pumped sample was collected from the latter interval (188 to 193 feet). The static water level was about 96 feet deep at the time of drilling, which indicates confined conditions. These water samples were analyzed for inorganic chemical constituents and trace organics. Table 3-2 shows the water quality results from the three samples.

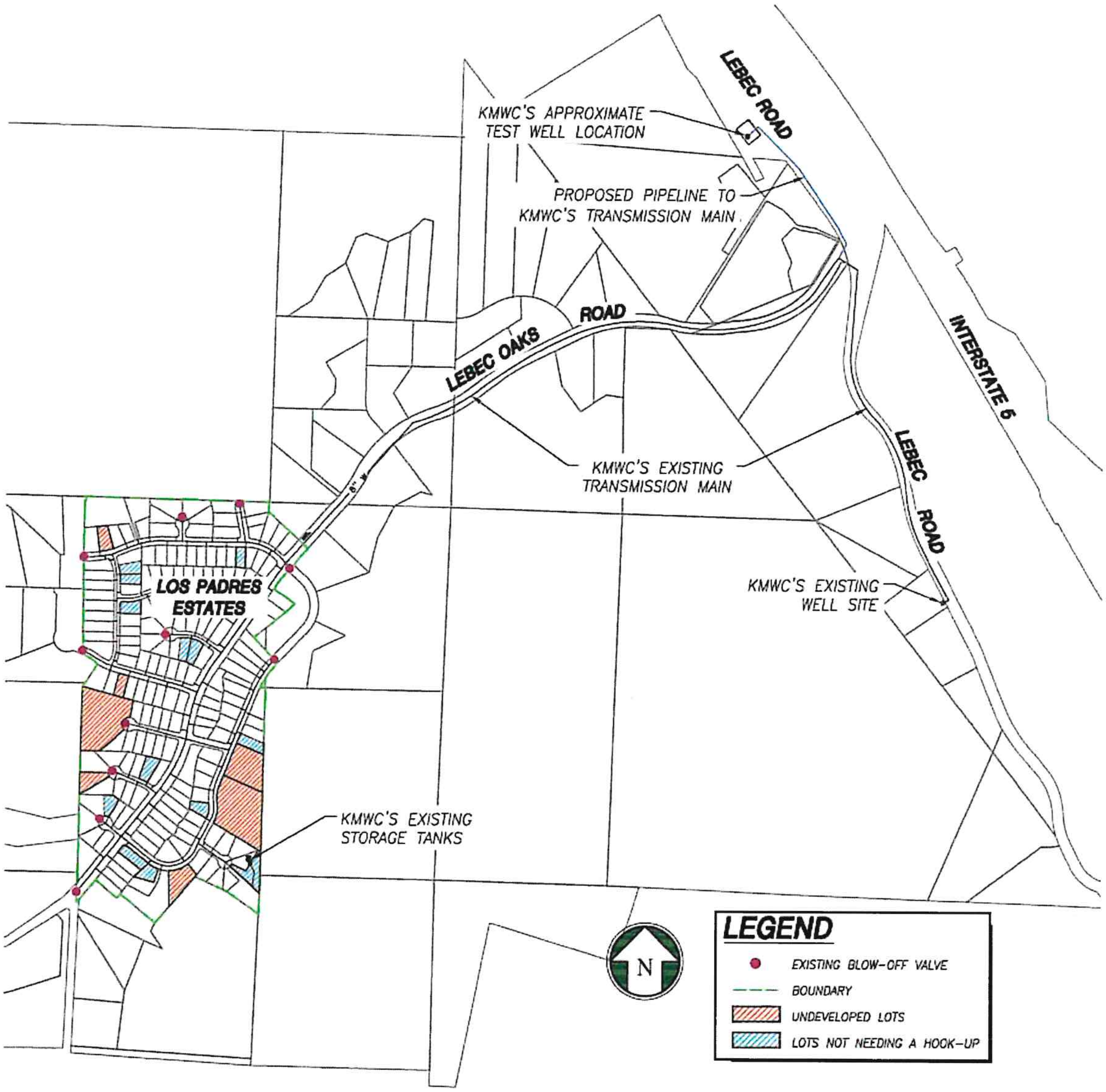


Figure 3-3
Alternative III: New Supply Well Project Area

Table 3-2
Depth Sampling Results for KMWC Test Well

Constituent	Depth Airlift 162- 167 (ft)	Depth Airlift 188- 193 (ft)	Depth Pumped 188- 193 (ft)
Nitrate-Nitrogen (mg/L)	1.4	1.5	1.5
Fluoride (mg/L)	2.4	2.0	2.1
pH (mg/L)	8.3	8.3	7.2
Iron (mg/L)	< 0.03	< 0.03	< 0.03
Manganese (mg/L)	0.094	0.066	< 0.01
Arsenic (ppb)	< 1	< 1	< 1
Hexavalent Chromium (ppb)	< 0.2	< 0.2	< 0.2
DBCP (ppb)	< 0.01	< 0.01	< 0.01
EDB (ppb)	< 0.01	< 0.01	< 0.01
1, 2, 3-TCP (ppt)	< 5	< 5	< 5
Uranium (pCi/L)	12.7	10.1	16.5
Pumping Rate (gpm)	22	50	65
Temperature (°F)	-	-	64
Static Water Level (ft)	-	-	95.5

The estimated yield of the well was determined to be about 80 to 90 GPM.

3.4.2- Project Analysis

Considerations

After discussions with the SWRCB and KMWC, it was decided to abandon the test well because the initial yield did not meet KMWC's needs and the fluoride level exceeded the MCL.

3.5 - Alternative IV: Treatment Facility

In treating for fluoride found in the KMWC water system, there are two possible solutions: Activated Alumina (AA) and Reverse Osmosis (RO). This alternative involves constructing a treatment facility which would consist of one of the two solutions. Figure 3-4 displays the locations of the existing KMWC water well and storage tanks, proposed booster pumps, pipeline, and treatment facility, which would be used to filter water either through RO or AA.

Activated Alumina is a highly effective absorbent in both gas and liquid applications. AA is well known for its water filtration applications, where it serves as a cost-effective absorbent for removing fluoride from water.

Reverse osmosis is known to be a highly effective water treatment process for reducing 97-99% of total dissolved solids (TDS) in water in high purity water systems.

3.5.1- Project Description: Activated Alumina

Activated alumina is a porous, solid form of aluminum oxide; also known as Al_2O_3 or just alumina. In being porous, its surface area is greater than its weight, therefore enabling it to adsorb large amounts of other molecules. Because AA adsorbs, when a chemical is drawn into its pores, it bonds with the solid material. Considerable heating must be applied for the chemical to be released. AA is very stable and when bonding with other substances, its own chemistry or form does not change. AA's high crush resistance, high porosity and very stable chemical and physical attributes make it an effective method in removing fluoride from drinking water.

Water is treated by passing through the device. In doing so, contaminants such as Fluoride, are adsorbed on to the activated alumina. There are two types of AA: granular activated alumina and spherical alumina. Granular AA comes in various sizes, making the internal active surface of the alumina more readily available. Spherical AA has the advantage of a lower pressure drop in packed bed systems.

In order for AA to be effective, various factors must be considered, including contact time, characteristics of the alumina, the device design, and the water quality. Generally, the efficiency of the AA for adsorbing fluoride is low on the first adsorption cycle unless the alumina is pretreated. Success of the AA treatment is pH dependent. For fluoride, the optimum pH level should be between 5 and 6 (Extension, 2010). If the pH is higher, pretreatment may be required to reduce the pH for AA to be effective.

Two factors in determining the total capacity of an AA device are flow rate and contaminant removal capacity. While the contaminant removal capacity depends mostly on the amount of the alumina in the device, the flow rate is dependent on the surface area flow, the pore size of the activated alumina granules, and the available water pressure.

This alternative would include placing a treatment facility near the four steel storage tanks at the end of Krista Court. As in Alternative II, a connection pipeline would be installed to divert water from the start of the distribution system at the intersection of Lebec Oaks Road and Canyon Drive to the treatment facility. The diverted water would be split such that only a portion of the water would be treated, and the remainder would bypass treatment to the storage tanks for blending. Booster pumps will be required to provide the increased system pressure needed to successfully filter the water.

3.5.2- Project Analysis: Activated Alumina

Benefits

Activated alumina's advantages include cost, ease of operation, adsorption capacity, potential for re-use, number of useful cycles, and the possibility of regeneration. Regeneration of alumina columns decrease the overall treatment costs as more treated water is produced. Additionally, it can remove a variety of contaminants besides fluoride, including arsenic and selenium.

Considerations

Exhausted alumina must be regenerated, and the filter media replaced when reaching the end of its life expectancy. As a result of this there are several factors to look at when considering the use of the activated alumina:

1) Regeneration: Exhausted alumina must be regenerated using acid and alkali.
2) Life Expectancy: The life expectancy is around 2.5 to 3 years for a maximum of 10 regeneration cycles; taking an average regeneration cycle is 2.5 to 3 months.
3) Pretreatment: The actual life expectancy depends on multiple parameters found in the raw water, as such pretreatment of raw water can increase the longevity of the filter media. Parameters include the fluoride concentration, alkalinity, pH, presence of external impurities like calcium, iron, silica, and the roughly 1 percent attrition lost in every cycle.
4) Disposal/Regeneration: Disposing or regenerating the activated alumina must be done carefully, as to avoid contaminating water supplies or landfills. Backwash water and expended media may be considered as hazardous waste.

3.5.3- Project Description: Reverse Osmosis

This alternative would provide RO treatment to KMWC's existing distribution system. A RO system is developed by applying pressure with a pump to force water, with a high concentration of dissolved solids, through a membrane. The water is referred to as product water and the dissolved solids that do not pass through the membrane are continually flushed to drain as waste. This flushing action keeps the membrane surface from fouling or scaling. Some reverse osmosis units have a 4-stage process for optimal water quality.

This alternative would include placing a RO system near the four steel storage tanks at the end of Krista Court. As in Alternative II, a connection pipeline would be placed to divert water from the start of the distribution system at the intersection of Lebec Oaks Road and Canyon Drive into the RO system. The diverted water would be split in two; one flow would be directed into the RO system to be filtered and the second flow would by-pass the RO system. The filtered and by-passed water would travel into the storage tanks to be blended and then be distributed. Booster pumps will be required to provide the increased system pressure needed to successfully filter the water.

3.5.4- Project Analysis: Reverse Osmosis

Benefits

Reverse osmosis improves taste, odor, and appearance of water by removing the contaminants that cause taste and odor problems. RO systems have very few moving and replaceable parts, making the system easy to clean and service.

Considerations

In treating for fluoride and other contaminants, the RO process can remove 92-99% of beneficial calcium and magnesium (Reverse Osmosis Water Exposed, 2019), among other minerals.

The addition of minerals may be required as post treatment to counteract potential adverse health effects caused by the RO process (Reverse Osmosis Water Exposed, 2019).

There are five performance factors that should be taken into consideration with RO: pressure, temperature, recovery, and pretreatment/post-treatment (Industrial Reverse Osmosis Systems, 2009).

1) Pressure: minimum threshold of pressure must initially be reached to overcome the natural osmotic pressure; without proper pressure, scaling or fouling problems may occur
2) Temperature: membrane flux is very dependent on temperature; RO units are volume rated at 77°F
3) Recovery: too high of a recovery rate requires a more concentrated waste system which increases the possibilities of membrane fouling
4) Pretreatment/Post-treatment: depending on water conditions and quality requirements, the need for additional water treatment steps before and/or after the RO process varies; raw water containing chlorine, hardness, iron, turbidity, and high total dissolved solids should consider pretreatment; if water quality requirements require ultra-pure or sterilized water, the posttreatment should be considered
5) RO uses membranes to remove contaminants, unlike filters who catch contaminants, membranes flush contaminants out and if concentrated water is considered hazardous, O&M cost will increase in properly disposing of hazardous material

3.5.5- Recommended Treatment

Historically, treatment of Fluoride for this size system is best accomplished through Activated Alumina. It is a proven method that doesn't strip the water of other essential minerals and has an overall lower capital and maintenance cost. For these reasons, if the treatment alternative is selected, it will include Activated Alumina.

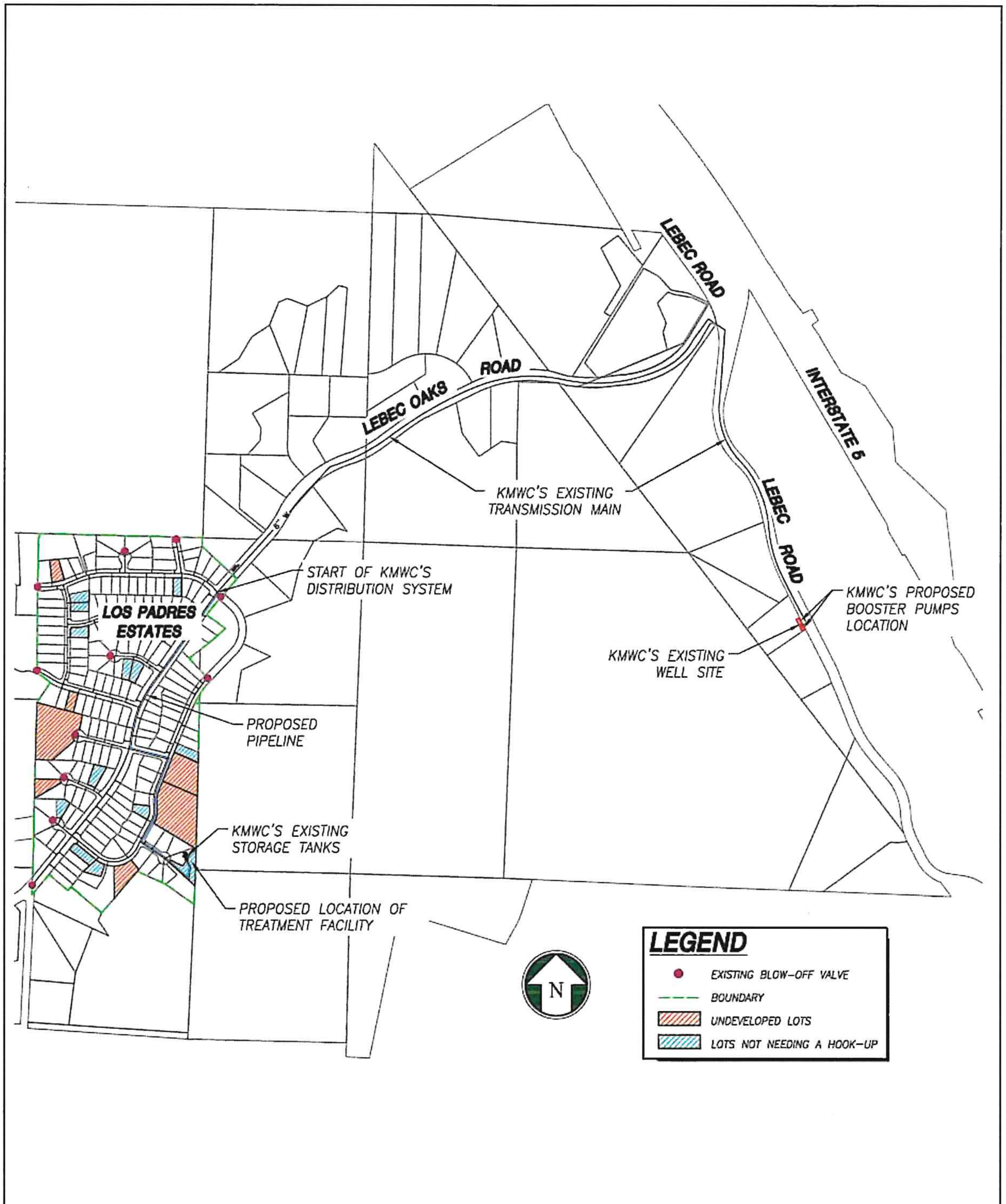


Figure 3-4
Alternative IV: Treatment Facility Project Area

3.6 - Alternative V: Emergency Interconnect with LCWD

3.6.1- Project Description

Through an emergency interconnect with LCWD, water would only be purchased and supplied by LCWD when needed by the community of KMWC. Water purchased from LCWD in this alternative would not be treated or blended with the water from KMWC's water well, but instead would completely provide the necessary water for KMWC. Usage of the emergency interconnect would be used in case of KMWC equipment or well failure causing KMWC the inability to supply water.

The emergency interconnecting pipeline would be constructed, connecting one side of the pipeline to the KMWC's transmission line near the T-intersection of Lebec Road and Clear Canyon Road, while the other end of the pipeline would be connected to a blow-off valve at the end of LCWD's transmission line on Lebec Road. Because there is an existing oil line on the east side of Lebec Road, the proposed interconnecting pipeline would be installed within the right of way (ROW) of Lebec Road on the west side. Because of the 2,100-foot emergency interconnecting pipeline, there is not enough pressure from the LCWD's system to reach the KMWC. For this reason, booster pumps would be required. The booster pumps would be placed at the current KMWC's well site. The KMWC's well site has limited space, therefore additional property would need to be acquired for the placement of the booster pumps.

Figure 3-5 shows the area enclosed where the emergency interconnecting pipeline, booster pumps, LCWD's blow-off valve, and the connection to KMWC's transmission line would be located.

3.6.2- Project Analysis

Benefits

This alternative would allow for the purchase of water in emergency situations. It would also allow for an easier transition in the future if the decision to consolidate with LCWD is made.

Considerations

This alternative will have no impact on lowering the fluoride level in the existing KMWC system. It only provides redundancy to the existing single water source system.

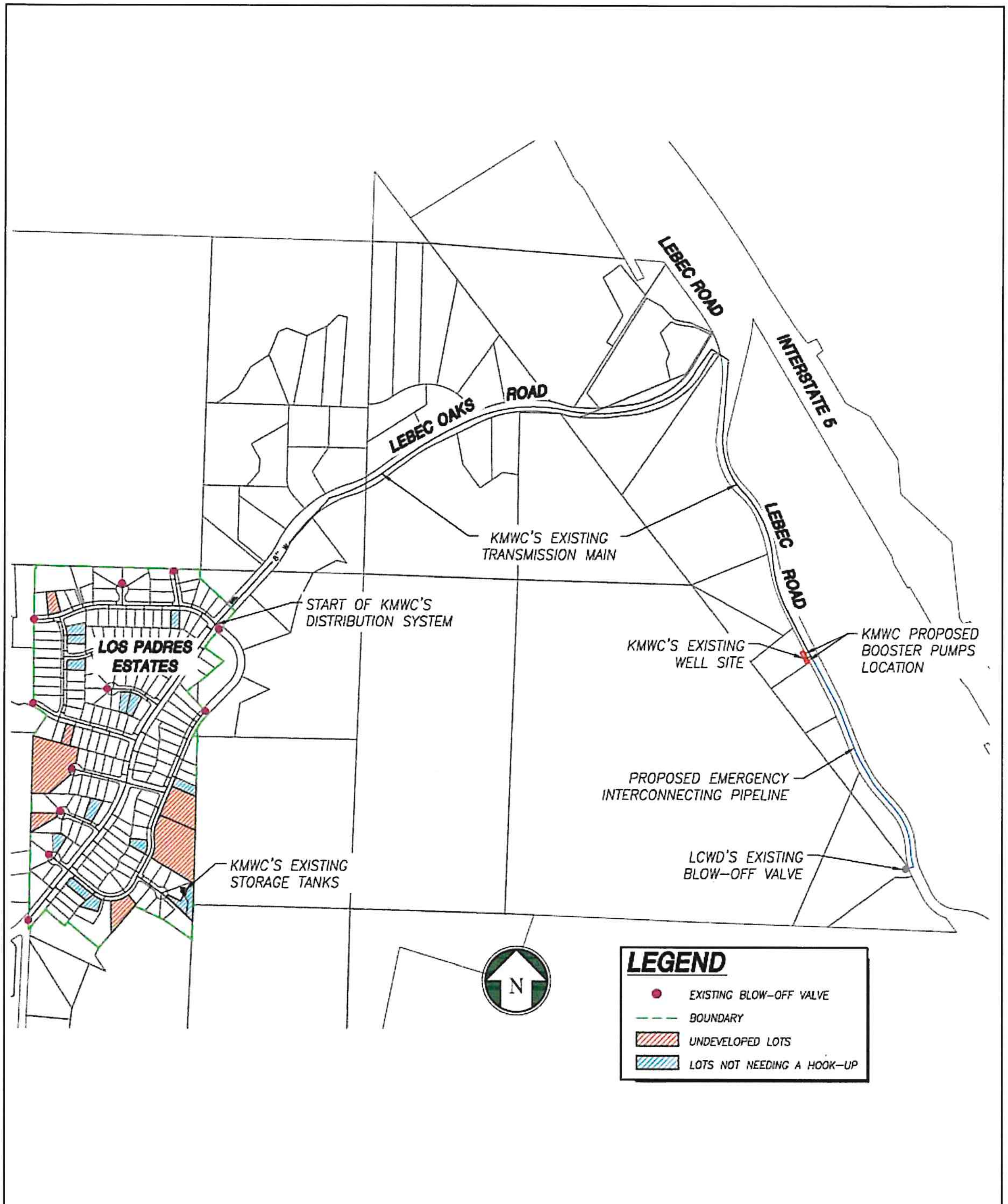


Figure 3-5
Alternative V: Emergency Interconnect with LCWD Project Area

3.7 - Alternative VI: No Action/Variance

3.7.1- Project Description

This alternative involves taking no action towards new infrastructure or improvements to existing infrastructure, and the continued use of KMWC's existing well as the only water source. In taking no action, fluoride levels in the water system would likely continue to be above the State's MCL of 2.0 mg/L. It should be mentioned the Federal MCL for fluoride is currently 4.0 mg/L.

In selecting the no action alternative, a variance may be the permanent solution. "Variances allow eligible systems to provide drinking water that does not comply with a National Primary Drinking Water Regulation (NPDWR) on the condition that the system installs a certain technology and the quality of the drinking water is still protective of public health" (United States Environmental Protection Agency, 2016). Variances are granted to water systems only under special conditions. State may grant a variance if treated water cannot meet the MCL, there are no PWS restructuring options, there are no other sources of water, and no affordable technology including operation and maintenance costs.

Without a variance KMWC's water could be used for other daily activities that do not include drinking water, such as landscape irrigation, bathing, washing dishes, and laundry. For a temporary solution, KMWC could provide bottled water to the residents of Los Padres Estates. In providing bottled water, KMWC would need to educate the residents of when it is appropriate to use tap water versus bottled water. Eventually, a permanent solution would need to be implemented.

There are two types of variances: general variance and small system variance.

1. General variance: intended for systems that are not able to comply with a NPDWR due to their source water quality and there is no feasible alternate source of water
2. Small system variance: intended for systems serving 3,300 persons or fewer that cannot afford to comply with a NPDWR (upon approval of EPA's Administrator, systems serving 3,301- 10,000 persons could also qualify for a variance)

There are certain affordability criteria that must be met in order to qualify for a variance. Such criteria include:

1) Small public water system is unable to afford to comply with a NPDWR through treatment
2) Small public water system is unable to afford to comply by developing an alternative source of water
3) Small public water system cannot implement necessary restructuring changes or consolidation with another system (State can make a written determination that restructuring, or consolidation is not practical in that situation)

If all the conditions are met, the State may grant a small systems variance, which is the variance most applicable to KMWC.

3.7.2- Project Analysis

Benefits

Variance would require no changes or updates to KMWC's existing infrastructure, nor construction of any new facilities. Hence, it would have no associated construction costs, or increased O&M costs. This alternative would therefore allow KMWC to maintain the same current rate for its customers.

Considerations

In receiving a variance, the water system must install, operate, and maintain a nationally listed variance technology. The following are some Federal exceptions to a variance:

1) Small system variances may not be granted for NPDWRs that do not list a small system variance technology (SSTV)
2) General variances may generally not be granted for the maximum contaminant level (MCL) for total coliforms or any of the treatment technique (TT) requirements of Subpart H of 40 CFR 141
3) Small system variances may not be granted for NPDWRs promulgated prior to 1986 or MCLs, indicators, and TTs for microbial contaminants

Additionally, the SWRB provides the following requirements to grant a fluoride variance:

1) Fluoride levels shall not be in excess of 75 percent of the maximum contaminant level established in the national primary drinking water regulation adopted by the United States Environmental Protection Agency for fluoride, or three milligrams per liter, whichever is higher
2) Each variance granted is valid for 30 years, and reviewed every 5 years and may be withdrawn if it is determined that the community served no longer accepts the fluoride level authorized by the variance or the variance poses an unreasonable risk to health
3) A variance will only be granted if the SWRCB determines, after a public hearing in the community, that there no substantial community opposition to the variance and that the variance poses no unreasonable health risk.
4) The public water system shall provide written notification, approved by the department, to all customers which shall contain the following information:

    A. The fact that a variance has been requested.
    B. The date, time and location of the public hearing conducted by the SWRCB
    C. The level of fluoride that will be allowed by the requested variance and how this level compares to the maximum contaminant levels prescribed by the state standard and the federal regulations.

D. A discussion of the types of health and dental problems that may occur when the fluoride concentration exceeds the maximum contaminant levels prescribed by the state standards and federal regulations.
E. If, at any time after a variance has been granted, substantial community concerns arise concerning the level of fluoride present in the water supplied by the public water system, the public water system shall notify the SWRCB, conduct a public hearing on the concerns expressed by the community, determine the fluoride level that is acceptable by the community, and apply to the department for an amendment to the variance which reflects that determination.

SECTION 4 -Project Costs

Table 4-1 shows the breakdown of KMWC's current O&M costs, which are approximately $121,000 per year. They currently charge a flat rate of $65/month/lot and their existing Median Household Income (MHI) is $38,000, which results in a rate/MHI ratio of 2.05%.

Table 4-1
KMWC's 2019 Budget

Item	Description	Expense
1	Office	$5,750
2	Consultants	$32,500
3	Payroll	$37,100
4	Insurance & Taxes	$9,800
5	Operations	$6,450
6	Utilities	$25,500
7	Rent	$3,000
8	Permits & Licensing	$1,100
	Total Expenses	**$121,200**

Table 4-2 is a summary of construction costs, O&M costs, and the approximate new rate needed to support the increase in O&M costs for each alternative (based on 193 customers). The new rate/MHI ratio is also provided for each alternative. Tables 4-3 through 4-12 are breakdowns of the estimated construction costs and O&M costs for each alternative.

Table 4-2
Comparison of Alternative Costs

	Construction Total	Additional O&M (per year)	Rate Increase (per month)	Rate/MHI ratio
Alternative I: Consolidation with LCWD	$567,767	$17,800	$7.49	2.29%
Alternative II: Blending with LCWD	$766,367	$111,800	$48.27	3.58%
Alternative III: New Supply Well	$603,192	$20,800	$8.75	2.33%
Alternative IV: Treatment Facility (AA)	$950,456	$39,800	$17.18	2.60%
Alternative V: Emergency Interconnect with LCWD	$565,794	$37,800	$16.32	2.57%
Alternative VI: No Action/Variance	$0	$0	$0	2.05%

4.1 - Alternative I: Consolidation with LCWD

Table 4-3
Alternative I Construction Costs

Item	Description	Quantity	Units		Unit Price	Total
1	Mobilization & Demobilization	5%		of	$407,200	$20,355
	Interconnecting Pipeline					
2	Booster Pump & Controls	2	EA	@	$30,000	$60,000
3	8" Pipe	2,100	LF	@	$95	$199,500
4	Water Valves	2	EA	@	$2,500	$5,000
5	6" Meter Installation	1	EA	@	$20,000	$20,000
6	Blow-Off Valve	1	EA	@	$750	$750
7	Shed	1	EA	@	$10,000	$10,000
8	Tee, Ductile Iron	1	EA	@	$2,250	$2,250
9	Concrete Slab	1	EA	@	$15,000	$15,000
10	Electrical Service	1	EA	@	$25,000	$25,000
11	Electrical Control Panel	1	EA	@	$15,000	$15,000
12	Trench Patching	8,400	SF	@	$6.50	$54,600
	Subtotal					$427,455
13	Construction Mgmt, Testing, Inspection	10%		of	$427,455	$42,746
	Subtotal					$470,201
14	Contingencies	15%		of	$464,426	$70,530
	Subtotal					$540,731
15	Allowance for 1-year inflation	5%		of	$534,089	$27,037
	Total					**$567,767**

Table 4-4
Alternative I O&M Costs

Item	Description	Expense
1	Office	$5,000
2	Consultants	$30,000
3	Payroll	$38,000
4	Insurance & Taxes	$10,000
5	Operations	$23,000
6	Utilities	$28,000
7	Rent	$3,000
8	Permits & Licensing	$2,000
	Total Expenses	**$139,000**

4.2 - Alternative II: Blending with LCWD

Table 4-5
Alternative II Construction Costs

Item	Description	Quantity	Units		Unit Price	Total
1	Mobilization & Demobilization	5%		of	$549,500	$27,475
	Interconnecting Pipelines					
2	Booster Pump & Controls	2	EA	@	$30,000	$60,000
3	8" Pipe	3,200	LF	@	$95	$304,000
4	Water Valves	4	EA	@	$2,500	$10,000
5	6" Meter Installation	1	EA	@	$20,000	$20,000
6	Blow-Off Valve	2	EA	@	$750	$1,500
7	Shed	1	EA	@	$10,000	$10,000
8	Tee, Ductile Iron	2	EA	@	$2,250	$4,500
9	Concrete Slab	1	EA	@	$15,000	$15,000
10	Electrical Service	1	EA	@	$25,000	$25,000
11	Electrical Control Panel	1	EA	@	$15,000	$15,000
12	Trench Patching	13,000	SF	@	$6.50	$84,500
	Subtotal					$576,975
13	Construction Mgmt, Testing, Inspection	10%		of	$571,725	$57,698
	Subtotal					$634,673
14	Contingencies	15%		of	$628,898	$95,201
	Subtotal					$729,873
15	Allowance for 1-year inflation	5%		of	$723,232	$36,494
	Total					**$766,367**

Table 4-6
Alternative II O&M Costs

Item	Description	Expense
1	Office	$6,000
2	Consultants	$33,000
3	Payroll	$38,000
4	Insurance & Taxes	$10,000
5	Operations	$23,000
6	Utilities	$30,000
7	Rent	$3,000
8	Permits & Licensing	$2,000
9	Connection Fee	$34,000
10	Water Purchases	$54,000
	Total Expenses	**$233,000**

4.3 - Alternative III: New Supply Well

Table 4-7
Alternative III Construction Costs

Item	Description	Quantity	Units		Unit Price	Total
1	Mobilization & Demobilization	5%		of	$432,500	$21,625
	Water Well					
2	Water Well	230	LF	@	$650	$149,500
3	Well Pump & Controls	1	EA	@	$100,000	$120,000
4	Valves, Meter & Fitting	1	EA	@	$20,000	$25,000
5	Water Main from Well to Transmission Line	1,000	LF	@	$105	$110,000
6	Electrical Services	1	EA	@	$25,000	$25,000
7	Electrical Control Panel	1	EA	@	$20,000	$20,000
8	Trench Patching	2,000	SF	@	$6.50	$13,000
	Subtotal					$454,125
9	Construction Mgmt, Testing, Inspection	10%		of	$454,125	$45,413
	Subtotal					$499,538
10	Contingencies	15%		of	$499,538	$74,931
	Subtotal					$574,468
11	Allowance for 1-year inflation	5%		of	$574,468	$28,723
	Total					**$603,192**

Table 4-8
Alternative III O&M Costs

Item	Description	Expense
1	Office	$6,000
2	Consultants	$35,000
3	Payroll	$38,000
4	Insurance & Taxes	$12,000
5	Operations	$15,000
6	Utilities	$30,000
7	Rent	$3,000
8	Permits & Licensing	$3,000
	Total Expenses	**$142,000**

4.4 - Alternative IV: Treatment Facility (Activated Alumina)

Table 4-9
Alternative IV Construction Costs

Item	Description	Quantity	Units		Unit Price	Total
1	Mobilization & Demobilization	5%		of	$681,495	$34,075
	Interconnecting Pipeline					
2	Booster Pump & Controls	2	EA	@	$20,000	$40,000
3	8" Pipe	2,100	LF	@	$95	$199,500
4	Water Valves & Fitting	1	EA	@	$20,000	$20,000
5	Blow-Off Valve	1	EA	@	$2,500	$2,500
6	Shed	1	EA	@	$15,000	$15,000
7	Tee, Ductile Iron	1	EA	@	$2,250	$2,250
8	Concrete Slab	1	EA	@	$15,000	$15,000
9	Trench Patching	13,000	EA	@	$6.50	$84,500
	Treatment Facility					
10	Grading	250	CY	@	$20	$5,000
11	Back Wash Tank	1	LS	@	$25,000.00	$25,000
12	Booster Pumps & Controls	2	EA	@	$20,000	$40,000
13	8" Water Main	1	LF	@	$45	$45
14	Water Valves, Meter & Fitting	1	EA	@	$10,000	$10,000
15	Check Valves	1	EA	@	$750	$750
16	Pressure Reducing Valve Station	1	EA	@	$1,500	$1,500
17	Flow Control Valve Station	1	EA	@	$2,500	$2,500
18	Pressure Relief Valve Station	1	EA	@	$2,500	$2,500
19	AA Treatment System	1	EA	@	$150,000	$150,000
20	Building for Plant	1	EA	@	$18,000	$18,000
21	Electrical for Plant	1	EA	@	$12,000	$12,000
22	Cross, Ductile Iron	1	EA	@	$450	$450
23	Tank Mixers	1	EA	@	$25,000	$25,000
24	Piping and Electrical	1	EA	@	$10,000	$10,000
	Subtotal					$715,570
25	Construction Mgmt, Testing, Inspection	10%		of	$715,570	$71,557
	Subtotal					$787,127
26	Contingencies	15%		of	$787,127	$118,069
	Subtotal					$905,196
27	Allowance for 1-year inflation	5%		of	$905,196	$45,260
	Total					**$950,456**

Table 4-10
Alternative IV O&M Costs

Item	Description	Expense
1	Office	$6,000
2	Consultants	$38,000
3	Payroll	$45,000
4	Insurance & Taxes	$15,000
5	Operations	$20,000
6	Utilities	$30,000
7	Rent	$3,000
8	Permits & Licensing	$4,000
	Total Expenses	**$161,000**

4.5 - Alternative V: Emergency Interconnect with LCWD

Table 4-11
Alternative V Construction Costs

Item	Description	Quantity	Units		Unit Price	Total
1	Mobilization and Demobilization	5%		of	$407,100	$20,355
	Interconnecting Pipeline					
2	Booster Pump & Controls	2	EA	@	$30,000	$60,000
3	8" Pipe	2,100	LF	@	$95	$199,500
4	Water Valves	2	EA	@	$2,500	$5,000
5	6" Meter Installation	1	EA	@	$20,000	$20,000
6	Blow-Off Valve	1	EA	@	$750	$750
7	Shed	1	EA	@	$10,000	$10,000
8	Tee, Ductile Iron	1	EA	@	$2,250	$2,250
9	Concrete Slab	1	EA	@	$15,000	$15,000
10	Electrical Service	1	EA	@	$25,000	$25,000
11	Electrical Control Panel	1	EA	@	$15,000	$15,000
12	Trench Patching	8,400	SF	@	$6.50	$54,600
	SUBTOTAL					$422,205
13	Construction Mgmt, Testing, Inspection	10%		of	$427,455	$42,746
	SUBTOTAL					$470,201
14	Contingencies	15%		of	$470,201	$70,530
	SUBTOTAL					$540,731
15	Allowance for 1-year inflation	5%		of	$540,731	$27,037
	Total					**$565,794**

Table 4-12
Alternative V O&M Costs

Item	Description	Expense
1	Office	$6,000
2	Consultants	$33,000
3	Payroll	$38,000
4	Insurance & Taxes	$10,000
5	Operations	$7,000
6	Utilities	$26,000
7	Rent	$3,000
8	Permits & Licensing	$2,000
9	Connection Fee	$34,000
	Total Expenses	**$159,000**

SECTION 5 -Recommended Alternative

5.1 - Introduction

After comparing the six alternatives for mitigating of high levels of fluoride within the KMWC water system, the recommended alternative is Alternative VI: Variance and Alternative V: Emergency Interconnect to provide a secondary water source. The following sections review the recommended alternative and discuss the reasoning for choosing Alternative VI.

5.2 - Alternative VI: Variance

In this alternative, KMWC would seek variance approval to continue to utilize its current well and provide water above the State's MCL of 2.0 mg/L of fluoride, and also construct the emergency interconnect to LCWD for use in emergency situations as a secondary water source.

5.3 - Reasons for Selection

Alternative VI: No Action/Variance is the recommended Alternative as the other alternatives were disqualified from further consideration.

Alternative I: Consolidation, would have required complete physical and managerial consolidation between LCWD and KMWC and subsuming control of the water network in Los Padres Estates from KMWC to LCWD. Through variance, KMWC continues to have control of their water system while adding an additional source of water to their system for and redundancy.

Alternative II: Blending was not selected as the O&M costs for the alternative were high enough to be disqualifying, and does not provide a permanent solution to the issue of the fluoride level being above the State's MCL of 2.0 mg/L. Both purchasing the water from LCWD and paying the connection fee would result in significant reoccurring costs being added to KMWC's O&M budget. Through a variance KMWC would not have to increase customer rates to offset the increased costs generated by blending.

Alternative III: Supply Well would have given an additional source of water to KMWC but would have required purchase of additional land from a neighboring property owner. More importantly, the completed test well showed that the water quality did not meet State standards and the water quantity was insufficient to meet the needs of KMWC. Therefore, Alternative III was eliminated from consideration.

Alternative IV: Treatment Facility was disqualified as the O&M costs for this alternative are prohibitively high. RO treats water for fluoride and other contaminants by removing more than 90% of contaminants. Water Board standards require a certain amount of minerals and vitamins to be present in drinking water for health benefits. As too much fluoride has the potential for adverse health effects and the removal of such elements can also result in negative side effects. Regardless of selecting AA or RO as the treatment, additional equipment for pre-treatment and post-treatment would be needed, increasing not only initial capital costs but also complicating the process and increasing O&M costs long-term for KMWC. This alternative is potentially harmful to the public and monetarily unfeasible in the long-term and was not considered further.

Alternative V: Emergency Interconnect with Lebec was disqualified as it would not provide a permanent solution in changing the water quality of KMWC's water well. However, it selected as a secondary water source. The emergency interconnect with LCWD would only be in use if KMWC's community had an emergency where the water could not be used for drinking and non-drinking activities. This would not solve the everyday problem of the fluoride level being above the State's MCL of 2.0 mg/L.

Alternative VI: No Action/Variance was not disqualified as it may not change the water quality provided to the residents, but with approval by the SWRCB and the system customers could be a feasible solution. Temporary supply of bottled water is possible but is expensive and is not a long-term solution. For this alternative to be effective, a variance approval by the SWRCB would need to be attained.

Based on this analysis, particularly the cost of the other alternatives, seeking variance approval is the best alternative. Table 5-1 shows the proposed O&M and water rate for each alternative. The estimated O&M is the summation of the KMWC's existing O&M, $121,200, plus the proposed increase in O&M per the corresponding alternative. The estimated water rate is the summation of the KMWC's existing flat rate, $65, plus the proposed rate increase calculated from the additional O&M, per alternative. The increase in O&M and increase in water rate values for each alternative can be found in Table 4-2.

Table 5-1
Estimated O&M and Water Rates

	Estimated O&M (per year)	Estimated Water Rate (per month)
Alternative I: Consolidation with LCWD	$139,000	$72.49
Alternative II: Blending with LCWD	$233,000	$113.27
Alternative III: New Supply Well	$142,000	$73.75
Alternative IV: Treatment Facility	$161,000	$82.18
Alternative V: Emergency Interconnect with LCWD	$159,000	$81.32
Alternative VI: No Action/Variance	$121,200	$65.00

Based on these values, the only alternative with a no change in O&M and water rate costs, is Alternative VI: No Action/Variance. The rest of the alternatives have an increase in water rates of as little as five dollars to as much as over forty-five dollars. Combining this option with Alternative V: Emergency Interconnect with LCWD would result in an increase of slightly over fifteen dollars to water rates.

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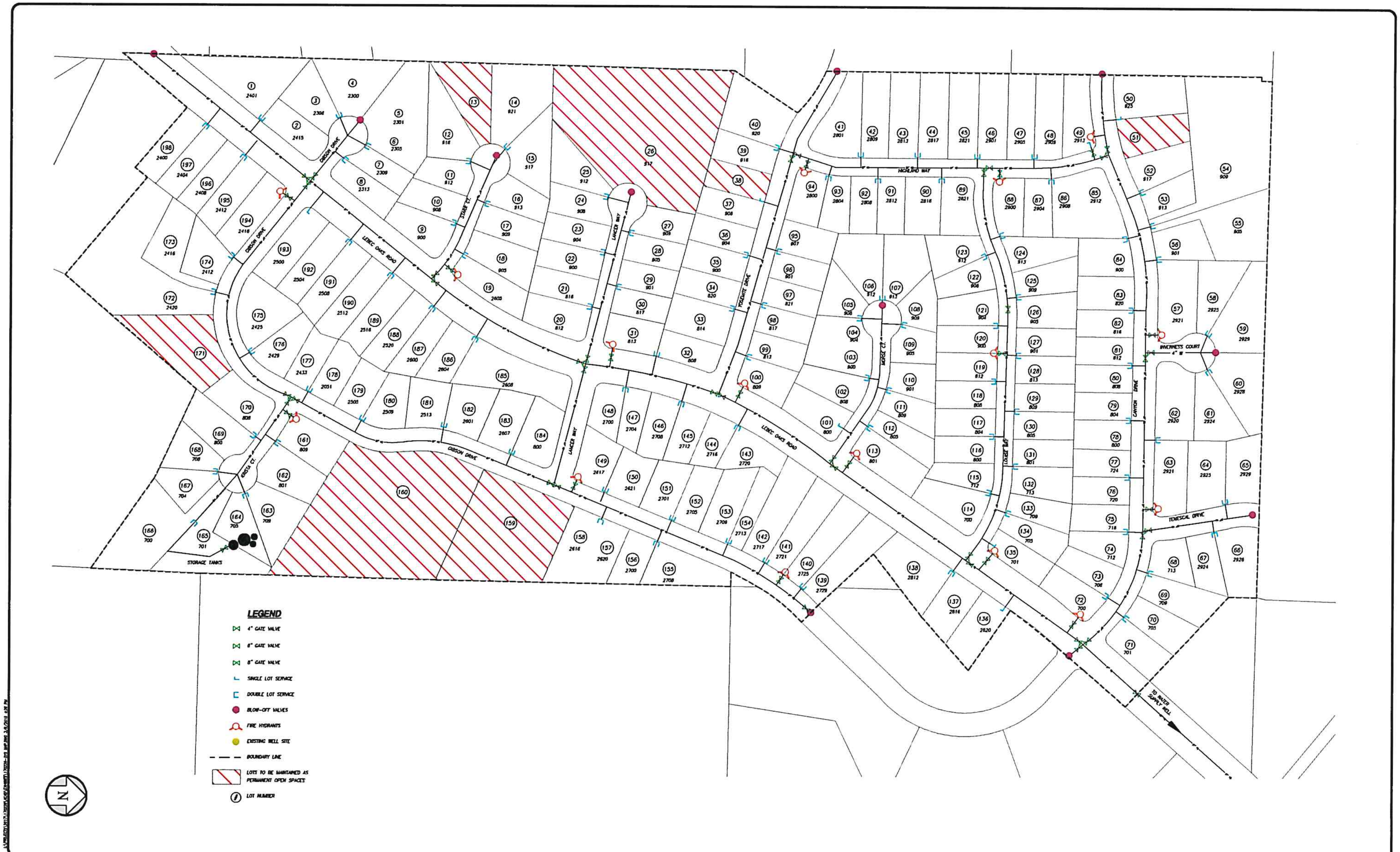
APPENDIX A

Water System Map of Los Padres Estates



SYSTEM MAP EXHIBIT

LOS PADRES ESTATES

KRISTA MUTUAL WATER COMPANY

SHEET NO.: 01 OF 01

CASTAC BASIN GROUNDWATER SUSTAINABILITY AGENCY
PROJECT / MANAGEMENT ACTION
INFORMATION FORM

P/MA ID: 4	**BASIN/MANAGEMENT AREA** (if any): Castac Lake Valley Groundwater Basin (DWR 5-029)

TITLE: Wastewater Reclamation

DESCRIPTION[1]:

Future highly-treated reclaimed water produced from the Tejon Mountain Village development will be used to maintain Castac Lake levels and meet some landscape irrigation demands.

EXPECTED ANNUAL BENEFIT (demand reduction or supply augmentation, in acre-feet per year):

70 - 100 AFY

AGENCY(s):

Primary/Lead: Tejon-Castac Water District

Supporting: Castac Basin GSA

LOCATION: ☐ Check here if Basin-wide

Township / Range: 9N/19W

Coordinates (Latitude / Longitude): 34°49'39.09"N, 118°52'0.76"W

Description: Tejon Mountain Village Water Resources Recovery Facility

AFFECTED SUSTAINABILITY INDICATOR (check all that apply):

- ☒ Chronic Lowering of Groundwater Levels
- ☒ Reduction of Groundwater Storage
- ☐ Seawater Intrusion
- ☐ Degraded Water Quality
- ☐ Land Subsidence
- ☒ Depletions of Interconnected Surface Water

TYPE (check all that apply):

☒ Water Supply Augmentation

- ☐ Surface Water
- ☐ Groundwater (Recharge)
- ☒ Recycled Water
- ☐ Transfer
- ☐ Stormwater
- ☐ Other

Source of Outside Water (if applicable): ______

☐ Water Demand Reduction

- ☐ Conservation
- ☐ Land / Water Use Changes

☒ Infrastructure / Capital Project

☐ Policy Project

☐ Data Gap Filling / Monitoring

☐ Water Quality Improvement

☐ Other: ______

[1] *Please continue to next page or attach additional pages to this form as necessary*

COSTS & FUNDING SOURCE(s):

Capital / Up-front ($): 2,583,132

Source(s): TCWD / TMV Developer

O&M / On-going ($ per year): 30,546

Source(s): TCWD

REGULATORY / LEGAL AUTHORITY REQUIREMENTS (describe all that apply):

Permits (name of authority, type of permit): SWRCB WDRs, NEPA/CDFW/U.S.FWS/ USACE/SW

CEQA: Possibly

Other: Permitting will be re-evaluated upon initiation of the project

SCHEDULE / TIMING:

Implementation Trigger(s): Upon initiation of TMV Phase 1 construction, estimated to begin in 2023
3 years to complete construction, multi-phase/complete to full capacity at buildout anticipated in 2041

Termination Trigger(s): N/A

Timeframe to Accrue Expected Benefits: Upon project initiation

ADDITIONAL DETAILS (as necessary)**:**

The volumetric benefits to the aquifer would be roughly the same as that for PM&A #1; this project would combine the highly-treated reclaimed water with the imported surface water supply to maintain Castac Lake levels and meet some landscape irrigation demands.

Water Resources Recovery Facility capacity is expected to be expanded as Tejon Mountain Village is developed; the amount of reclaimed water available will therefore increase through buildout.

CASTAC BASIN GROUNDWATER SUSTAINABILITY AGENCY
PROJECT / MANAGEMENT ACTION
INFORMATION FORM

P/MA ID:

BASIN/MANAGEMENT AREA (if any): Castac Lake Valley Groundwater Basin (DWR 5-029)

TITLE: Frazier Mountain High School Water Project

DESCRIPTION[1]: Lebec County Water District signed a Letter of Intent in 2019 to provide Drinking Water to FMHS. The Well owned by FMHS is iN Violation of Uranium Levels and has been ordered by the state to Find another source. Our New Well Grant will be combined with a Grant obtained by FMHS to annex and supply FMHS with Drinking Water from the New Well.

EXPECTED ANNUAL BENEFIT (demand reduction or supply augmentation, in acre-feet per year): LCWD will provide 2.5 million gallons of Drinking Water per year.

AGENCY(s):

Primary/Lead: Lebec County Water District

Supporting:

LOCATION: ☐ Check here if Basin-wide

Township / Range: Lebec, CA

Coordinates (Latitude / Longitude):

Description:

AFFECTED SUSTAINABILITY INDICATOR (check all that apply):

☐ Chronic Lowering of Groundwater Levels ☐ Reduction of Groundwater Storage
☐ Seawater Intrusion ☐ Degraded Water Quality
☐ Land Subsidence ☐ Depletions of Interconnected Surface Water

TYPE (check all that apply):

☐ Water Supply Augmentation
- ☐ Surface Water ☐ Groundwater (Recharge) ☐ Recycled Water
- ☐ Transfer ☐ Stormwater ☐ Other
- Source of Outside Water (if applicable):

☐ Water Demand Reduction
- ☐ Conservation ☐ Land / Water Use Changes

☒ Infrastructure / Capital Project ☐ Policy Project
☐ Data Gap Filling / Monitoring ☒ Water Quality Improvement
☐ Other:

[1] Please continue to next page or attach additional pages to this form as necessary

COSTS & FUNDING SOURCE(s):

Capital / Up-front ($): 1,027,600

Source(s): DWSRF, SB200, Prop 68

O&M / On-going ($ per year): 17,200

Source(s): Service connection user payment

REGULATORY / LEGAL AUTHORITY REQUIREMENTS (describe all that apply):

Permits (name of authority, type of permit): Construction Permit, Encroachment Permit & Transport

CEQA: mitigated Neg-dec

Other:

SCHEDULE / TIMING:

Implementation Trigger(s):

Termination Trigger(s):

Timeframe to Accrue Expected Benefits:

ADDITIONAL DETAILS (as necessary):

CASTAC BASIN GROUNDWATER SUSTAINABILITY AGENCY
PROJECT / MANAGEMENT ACTION
INFORMATION FORM

P/MA ID: 6	**BASIN/MANAGEMENT AREA** (if any): Castac Lake Valley Groundwater Basin (DWR 5-029; Castac Basin)

TITLE:
Well Flow Metering and Data Collection

DESCRIPTION[1]:

The Castac Basin Groundwater Sustainability Agency (GSA) may, at its sole discretion, exercise its right established under California Water Code (CWC) Section 10725.8 to collect quantitative monthly groundwater extraction volumes from individual wells within the Castac Basin. At the GSA's direction, groundwater extractors shall determine monthly pumping volumes and report it using equipment and methods approved by the GSA, in a format satisfactory to the GSA. The GSA may periodically confirm the accuracy of reported data and the calibration of installed flowmeters, using a method to be determined by the GSA.

For wells in which meters are not installed or monthly extraction volumes are not recorded or available, the GSA may, at its sole discretion (and at the sole expense of the groundwater extractor), require installation of temporary or permanent flow metering equipment satisfactory to the GSA, and may require monitoring and reporting of data, as described above.

De minimis extractors of groundwater, defined as "a person who extracts, for domestic purposes, two acre-feet or less per year" (CWC Section 10721(e)), are exempt from groundwater extraction reporting requirements (CWC Section 10725.8).

EXPECTED ANNUAL BENEFIT (demand reduction or supply augmentation, in acre-feet per year):

n/a

AGENCY(s):

Primary/Lead: Castac Basin GSA
Supporting: ____

LOCATION: ■ Check here if Basin-wide

Township / Range: ____
Coordinates (Latitude / Longitude): ____
Description: ____

AFFECTED SUSTAINABILITY INDICATOR (check all that apply):

- ☐ Chronic Lowering of Groundwater Levels
- ■ Reduction of Groundwater Storage
- ☐ Seawater Intrusion
- ☐ Degraded Water Quality
- ☐ Land Subsidence
- ☐ Depletions of Interconnected Surface Water

TYPE (check all that apply):

☐ Water Supply Augmentation
- ☐ Surface Water ☐ Groundwater (Recharge) ☐ Recycled Water
- ☐ Transfer ☐ Stormwater ☐ Other
- Source of Outside Water (if applicable): ____

☐ Water Demand Reduction
- ☐ Conservation ☐ Land / Water Use Changes

■ Infrastructure / Capital Project ☐ Policy Project
■ Data Gap Filling / Monitoring ☐ Water Quality Improvement
☐ Other: ____

[1] *Please continue to next page or attach additional pages to this form as necessary*

COSTS & FUNDING SOURCE(s):

Capital / Up-front ($): to be determined

Source(s): Well owner or operator, potential grant funds

O&M / On-going ($ per year): to be determined

Source(s): Well owner or operator

REGULATORY / LEGAL AUTHORITY REQUIREMENTS (describe all that apply):

Permits (name of authority, type of permit): none

CEQA:

Other: GSA right established under CWC Section 10725.8

SCHEDULE / TIMING:

Implementation Trigger(s): Upon adoption of the Groundwater Sustainability Plan (GSP)

Termination Trigger(s): N/A

Timeframe to Accrue Expected Benefits: Upon project initiation

ADDITIONAL DETAILS (as necessary)**:**

The following details are yet to be determined:
- Types of flow metering equipment to be installed (e.g., permanent or temporary acoustic flow meters);
- Selection of individual wells for installation of well metering equipment; and
- Methods to establish typical groundwater extraction volumes from different sectors (e.g., domestic wells, agricultural wells, or public supply wells).