Groundwater Sustainability Plan

Castac Lake Valley Groundwater Basin

Prepared by:

EKI Environment & Water, Inc.

for

Castac Basin GSA

DRAFT – 19 June 2020

TABLE OF CONTENTS

List of Tables

Plan Area

Basin Setting

Hydrogeologic Conceptual Model

Groundwater Conditions

Water Budget

Sustainable Management Criteria

List of Figures

Water Budget

List of Appendices

Glossary / Abbreviations

AF	acre-feet
AFY	acre feet per year
BMP	Best Management Practices
CalTrans	California Department of Transportation
CCR	California Code of Regulations
CDFW	California Department of Fish and Wildlife
CE	Categorical Exemption
CEQA	California Environmental Quality Act
cfs	cubic feet per second
CGS	California Geological Survey
COCs	constituents of concern
CVRWQCB	Central Valley Groundwater Water Quality Control Board
CWC	California Water Code
DEM	Digital Elevation Model
DAC	Disadvantaged Community
DMS	Data Management System
DOGGR	Division of Oil, Gas, and Geothermal Resources
DRINC	Drinking Water Information Clearinghouse
DTSC	Department of Toxic Substances Control
DWR	California Department of Water Resources
EIR	Environmental Impact Report
ET	Evapotranspiration
ETo	reference evapotranspiration
FEMA	Federal Emergency Management Agency
FMHS	Frazier Mountain High School
ft^3	cubic feet
ft bgs	feet below ground surface
ft msl	feet above mean sea level
ft/d	feet per day
ft/yr	feet per year
GAMA	Groundwater Ambient Monitoring and Assessment Program
GDEs	Groundwater Dependent Ecosystems
GIS	Geographic Information System
GPS	Global Positioning System
GSA	Groundwater Sustainability Agency
GSE	ground surface elevation
GSP	Groundwater Sustainability Plan
GWC	groundwater conditions
GWE	groundwater elevation

HCM	Hydrogeologic Conceptual Model
IM	Interim Milestone
in/yr	inches per year
InSAR	Interferometric Synthetic Aperture Radar
IRWMP	Integrated Regional Water Management Plan
IS	Initial Study
ITRC	Irrigation Training and Research Center
JPA	Joint Powers Authority
Kc	Crop coefficient
KCWA	Kern County Water Agency
KMWC	Krista Mutual Water Company
LCWD	Lebec County Water District
LUST	Leaking Underground Storage Tank
meq/L	milliequivalents per liter
MCL	Maximum contaminant level
mg/L	milligrams per liter
MN	Monitoring Network
MND	Mitigated Negative Declaration
MODFLOW-NWT	United States Geological Survey modular three-dimensional groundwater flow modeling software -a Newton formulation
MO	Measurable Objective
MPE	measuring point elevation
MT	Minimum Threshold
NA	not applicable
NAD83	North American Datum of 1983
NAVD88	North American Vertical Datum of 1988
NCCAG	Natural communities commonly associated with groundwater
ND	Negative Declaration
NDMI	Normalized Derived Moisture Index
NDVI	Normalized Derived Vegetation Index
NEPA	National Environmental Policy Act
NOAA	National Oceanic and Atmospheric Administration
NPDES	National Pollution Discharge Elimination System
NWIS	National Water Information System
O&M	operation and maintenance
P&MA	Projects and/or Management Action
PA	Plan area
PGE	Pacific Gas and Electric
PI	plan implementation
PLSS	Public Land Survey System
QA/QC	quality assurance/quality control

RMW	Representative Monitoring Well
RPE	reference point elevation
RWQCB	Regional Water Quality Control Board
SCEP	Stakeholder Communication and Engagement Plan
SDWA	Safe Drinking Water Act
SDWIS	Safe Drinking Water Information System
SGMA	Sustainable Groundwater Management Act
SJVAPCD	San Joaquin Valley Air Pollution Control District
SMCs	Sustainable Management Criteria
SRF	State Revolving Fund
SSURGO	US Department of Agriculture Soil Survey Geographic Database
SWP	State Water Project
SWPPP	Stormwater Pollution Prevention Plan
SWRCB	State Water Resources Control Board
TBD	to be determined
TCWD	Tejon-Castac Water District
TDS	Total dissolved solids
TMV	Tejon Mountain Village
TRC	Tejon Ranch Corporation
ug/L	micrograms per liter
USACE	United States Army Corps of Engineers
USDA-NRCS	U.S. Department of Agriculture Natural Resources Conservation Service
USEPA	United States Environmental Protection Agency
U.S.FWS	United States Fish and Wildlife Services
USGS	United States Geological Survey
VOCs	Volatile Organic Compounds
WB	water budget
WY	Water Year (begins 1 October of previous calendar year)

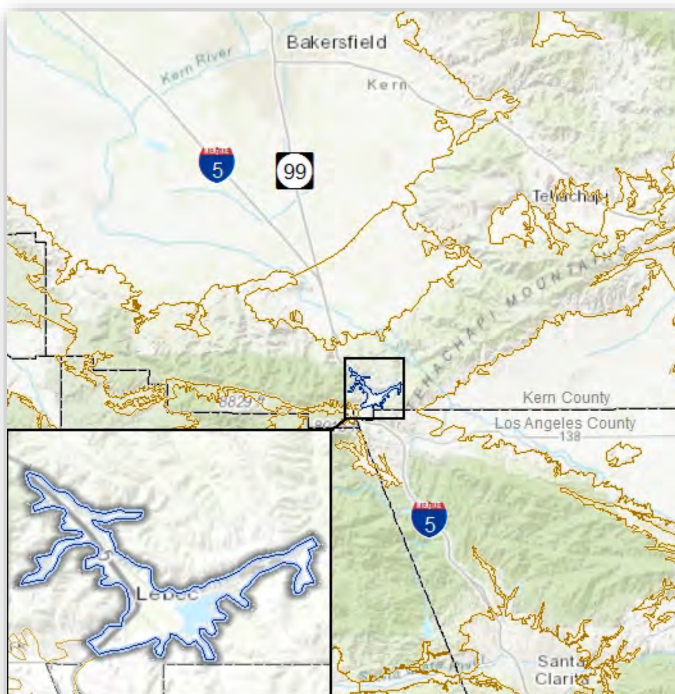
EXECUTIVE SUMMARY

§ 354.4. Each Plan shall include the following general information:
(a) An executive summary written in plain language that provides an overview of the Plan and description of groundwater conditions in the basin.

ES.1. Introduction

On 16 September 2014, the California legislature enacted the Sustainable Groundwater Management Act (SGMA) - the primary purpose of which is to achieve and/or maintain sustainability within the state's high and medium priority groundwater basins. Key tenets of SGMA are the concept of local control, the use of best available data and science, and the active engagement and consideration of all beneficial uses and users of groundwater. In high and medium priority basins, SGMA requires local agencies to form Groundwater Sustainability Agencies (GSAs) and to adopt Groundwater Sustainability Plans (GSPs) to manage basins sustainably. SGMA encourages and authorizes, but does not require, low- and very low- priority basins to be managed under a GSP or an alternative (California Water Code § 10720.7).

The Castac Lake Valley Groundwater Basin (also referred to herein as "the Basin"), California Department of Water Resources (DWR) Basin No. 5-029, is located at the southern end of Kern County. The Basin is identified by DWR as being a very low priority basin, and as such, this GSP and associated SGMA compliance efforts have been conducted on a voluntary basis.



Castac Lake Valley Groundwater Basin

The Castac Basin GSA is the exclusive GSA for the Basin. In 2018, in response to SGMA, a Joint Powers Agreement (JPA) was executed and the Castac Basin GSA Board was formed, which is comprised of two representatives from Tejon-Castac Water District (TCWD), two representatives from Lebec County Water District (LCWD), and one non-voting representative from Kern County. As part of a Memorandum of Agreement executed in 2018, a non-voting Board position was added for one representative from Krista Mutual Water Company (KMWC).

This GSP includes, among other things: (1) a description of the Hydrogeologic Conceptual Model of the Basin, (2) a description of current groundwater conditions, (3) estimates of the historical and projected water budgets, (4) an assessment of SGMA-defined Undesirable Results, (5) development of Sustainable Management Criteria, (6) identification of a monitoring network to demonstrate SGMA compliance, and (7) identification of Projects and/or Management Actions to increase the sustainability of the Basin.

This GSP has been developed on a voluntary basis to meet SGMA regulatory requirements[1] while reflecting local needs and preserving local control over groundwater resources. This GSP provides a path to maintain and document sustainable groundwater management within 20 years following GSP adoption, promoting the long-term sustainability of locally-managed groundwater resources now and into the future.

ES.2. Sustainability Goal

The Sustainability Goal is to cooperatively manage groundwater sustainably in the Basin to support current and future beneficial uses of groundwater (including municipal, agricultural, industrial, public supply, domestic, and environmental uses) and to avoid undesirable results throughout the planning horizon. Groundwater movement and storage in the Basin are primarily controlled by natural factors such as precipitation, temperature, and physical characteristics (e.g., geology and topography), which cannot be changed at the Basin scale. Nonetheless, the goal of the Castac Basin GSA's projects and management actions will be to maintain groundwater storage in the Basin to the extent possible, in order to supply beneficial uses and users of groundwater.

ES.3. Plan Area

The Basin encompasses 3,563 acres within the Tehachapi and San Emigdio Mountains at the southern end of Kern County. The entire Basin extent (as defined by DWR) is covered by the Castac Basin GSA. The Basin is bordered on the southwest by Cuddy Canyon Valley Groundwater Basin (DWR Basin No. 5-082); there are no other groundwater basins directly adjacent to the Basin.

[1] Regulations for GSP development are contained within Title 23 of the California Code of Regulations (CCR) Division 2 Chapter 1.5 Subchapter 2

Land use within the Basin is primarily range and undeveloped lands (69%); lake area (11%); and residential and commercial lands (9%). Forty-two acres of state-owned lands associated with Fort Tejon State Historic Park, managed by the California Department of Parks and Recreation, fall within the northwest corner of Basin. The unincorporated community of Lebec (with a population of approximately 1,500 residents) is located in the southwest portion of the Basin and is considered by the State of California to be a Disadvantaged Community[2] based on 2016 median household income reported by the U.S. Census Bureau.

Current (2016) Land Use

The potable consumption of groundwater in the Basin includes pumping by domestic and public water systems. The LCWD public water system (2 wells) serves the community of Lebec and the KMWC public water system (1 well) serves the Los Padres Estates area located in O'Neil Canyon. The active participation of both LCWD and KMWC on the Castac GSA Board and in the preparation of this GSP is an important mechanism in which the interests of disadvantaged communities have been considered herein.

ES.4. Stakeholder Outreach Efforts

The Castac Basin GSA developed and is implementing a Stakeholder Communication and Engagement Plan (SCEP) to fulfill SGMA notice and communication requirements, and to address the interests of beneficial users of groundwater within the Basin during the GSP development and implementation process. The goal of the outreach efforts to date has been to encourage open and transparent engagement by diverse Basin stakeholders, including the incorporation of knowledge and perspectives from various parties into the GSP process. Stakeholders have been asked to provide input and comments throughout GSP development at venues including the Castac Basin GSA Board meetings and Stakeholder Workshops. Other outreach to stakeholders during the GSP development process included distribution and collection of a *Landowner Data Request Form* and *Stakeholder Survey*, and direct outreach to public water systems within and up-gradient of the Basin. The Castac Basin GSA also hosts a website https://www.castacgsa.org/,

[2] The DWR presents information regarding U.S. Census Blocks, Tracts and Places that are defined as disadvantaged communities (DAC) or severely disadvantaged communities (SDAC) based on the median household income (MHI) of an area compared to the statewide MHI (https://sgma.water.ca.gov/webgis/?appid=SGMADataViewer). DAC communities are those with a MHI of less than 80% the statewide MHI, and SDAC communities are those with a MHI of less than 60% of the statewide MHI (California Code, Public Resources Code § 75005(g)).

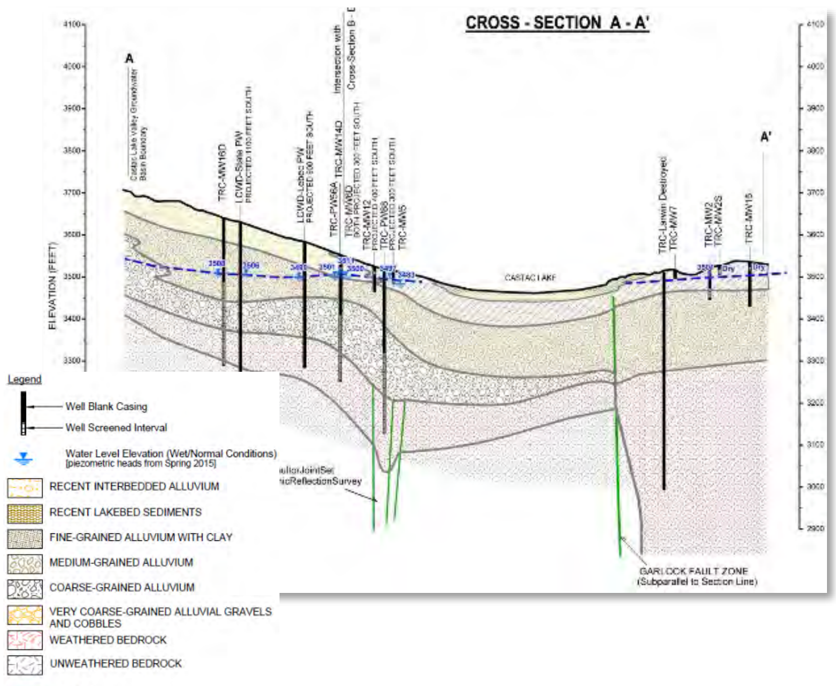
which contains outreach resources including GSA Board meeting dates and associated materials, the *Landowner Data Request Form* and *Stakeholder Survey*, and Fact Sheets developed by the Castac Basin GSA throughout the GSP development process.

ES.5. Hydrogeologic Conceptual Model

The Basin is located within the Tehachapi and San Emigdio Mountains, in a region of faulted, deformed, and uplifted igneous and metamorphic rocks near the intersection of the San Andreas and Garlock faults. The Basin can be divided generally into three areas: Castac Lake, Dryfield Canyon, and Grapevine Canyon. The Castac Lake area is bounded by the northern and southern splays of the Garlock Fault Zone, by the Cuddy Canyon Basin on the west, and by the western extent of alluvial fill in Dryfield Canyon on the east. The Grapevine Canyon area is bounded by the extent of alluvial fill on all sides but the south (i.e., where it abuts the Castac Lake area).

General Basin Areas

Available hydrogeologic information indicates that bedrock within the Basin generally is very low permeability and therefore forms the bottom of the Basin. Unconsolidated clastic sediments, including interbeds of sands and gravels with varying amounts of silts and clays, have filled the Basin over time. The Basin is comprised of one principal aquifer, which can be vertically divided into two hydrostratigraphic "zones" (i.e., the Shallow and Deep Aquifer zones). Based on water level data, results of aquifer pumping tests, and water quality data, these zones appear to be hydraulically connected, despite having variable but distinct sets of geologic and hydraulic properties.



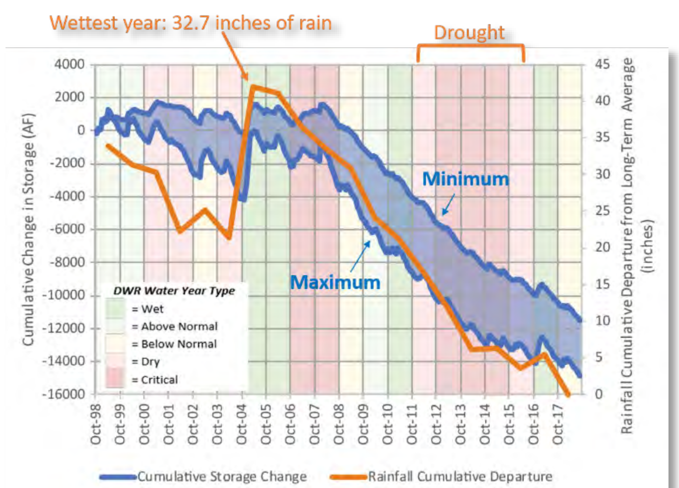
Sources of water to the Basin groundwater system include recharge from precipitation, surface inflow from Cuddy Creek, subsurface groundwater inflows from the up-gradient Cuddy Canyon Basin, return flows from irrigation and septic tanks, and Castac Lake seepage. Outflows from the Basin include groundwater pumping, evapotranspiration by phreatophytic plants and groundwater dependent ecosystems (GDEs; mostly located near the often-dry Castac Lake), inflow seepage to Castac Lake (under certain conditions), and surface outflow into Grapevine Creek.

ES.6. Existing Groundwater Conditions

Information on groundwater conditions in the Basin is presented with respect to the six "Sustainability Indicators" defined under SGMA, which include the following:

Chronic Lowering of Groundwater Levels: Groundwater levels are presented using both contour maps depicting recent (2015) seasonal high (spring) and seasonal low (fall) conditions, and hydrographs from various monitoring wells located throughout the Basin that have sufficient historical records. The available data indicate that groundwater generally flows from the southwest and southeast Basin margins toward the Castac Lake area in the center of the Basin, and then out through Grapevine Canyon to the north. Well hydrographs further indicate that groundwater levels correspond to climatic cycles, in which groundwater level changes are driven by observed trends in the rainfall cumulative departure from average. In the Castac Lake area of the Basin (where the period of record is longest), groundwater levels reached their historical low in the 1950s and 1960s, recovered through the 1990s, remained relatively high from the late 1990s through 2006 (when some wells were seasonally flowing artesian), declined again from 2007 through mid-2017, and stabilized from mid-2017 through 2019.

Reduction in Groundwater Storage: Change in groundwater storage was estimated for the historical water budget based on water level data, a spreadsheet analytical model, and a transient numerical flow model. During the historical water budget period (1998 through 2017), the Basin's mean annual groundwater storage change was approximately -400 acre-feet per year (AFY) while annual changes in groundwater storage between seasonal highs (February to March) were estimated to range from -1,700 AFY to +1,210 AFY. Similar to the groundwater level trends, change in Basin storage appears to be



Estimated Cumulative Groundwater Storage Change (1998-2018)

significantly influenced by climate whereby change in storage is negative during dry years (when the rainfall cumulative departure decreases), and generally positive during wet years (when the rainfall cumulative departure increases).

Seawater Intrusion: The Basin is located far from coastal areas, and therefore seawater intrusion is not considered to be a threat to groundwater resources.

Degraded Water Quality: Potable consumption is a significant use of groundwater within the Basin. Total dissolved solids (TDS), nitrate, arsenic, fluoride, and uranium concentrations have been detected in groundwater above drinking water standards. An evaluation of the available water level and water quality data show that: (1) some wells do show a weak correlation between water levels and certain constituent concentrations, (2) some wells show no correction between water levels and constituent concentrations, and (3) most wells have insufficient data to conduct statistical analyses.[3] Wells with available water quality data suggest that the constituents nitrate, TDS, uranium, and arsenic are increasing in at least one well, and that nitrate, uranium and fluoride are decreasing in other wells. Future monitoring efforts will include routine compilation of water quality data from public water systems and supplemental monitoring wells, which will fill the current water quality data gaps. These data will be reviewed periodically and water quality trends will be evaluated as part of future GSP implementation efforts.

Land Subsidence: There has been little to no historical land subsidence within the Basin. Given the geologic and stratigraphic characteristics of the Basin, namely the lack of thick clay layers in which declining water levels could cause irreversible compaction, land subsidence does not appear to have occurred historically, and is not likely to occur in the Basin. Existing groundwater levels are higher than the historical lows observed in the 1960s and therefore subsidence-related issues within the Basin are not considered a threat.

Depletions of Interconnected Surface Water: Castac Lake, while often dry, has historically been observed to be connected with the surrounding aquifer, and groundwater seepage has occurred both into and out of the lake, depending on the difference between groundwater levels and lake surface levels. The DWR dataset of Natural Communities Commonly Associated with Groundwater (NCCAG) shows potential GDEs located near and downgradient of Castac Lake primarily in the Grapevine Canyon area of the Basin. Furthermore, species reliant on freshwater may potentially inhabit the Basin. The water levels in the Grapevine Canyon area of the Basin show much less variability than those in the other areas of the Basin and are commonly near or within the maximum rooting depths of plant species associated with potential GDEs.

[3] Wells were considered for statistical analysis only when four or more water quality analyses were available for the well, starting no earlier than 1998.

ES.7. Water Budget

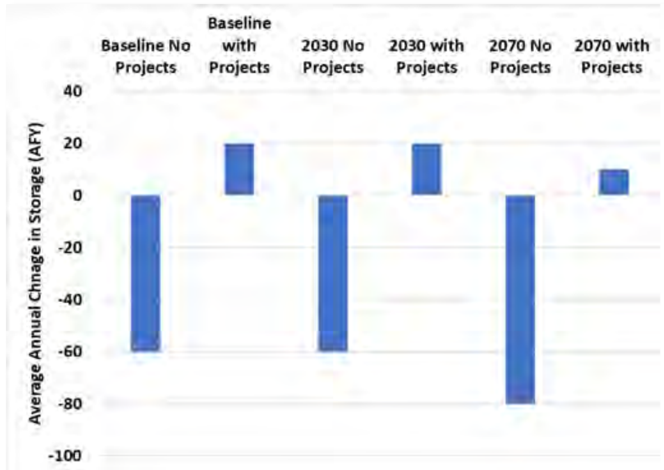
A spreadsheet analytical water budget was developed to simulate historical and current conditions (Water Years 1998 to 2018), which account for inflows to the Basin (including precipitation, subsurface inflows, and surface water inflows) and outflows from the Basin (including evapotranspiration by crops and native vegetation, agricultural and municipal use, subsurface outflows, and surface water outflows). Additionally, a numerical groundwater flow model, the "Castac Basin Numerical Model," was developed to support analysis of future conditions, including quantifying the effects of climate change and future Projects and Management Actions (P&MAs). The numerical groundwater flow model was calibrated to historical conditions (Water Years 1999 to 2018) and then extended to predict groundwater conditions 50 years into the future.

The analytical spreadsheet water budget for the Basin shows an average net change in groundwater storage of -360 AFY averaged over the historical 20-year period (Water Years 1998-2017), and -1,200 AFY during the current period (Water Year 2018).

The sustainable yield is the amount of pumping that can occur from a basin without causing an undesirable result. It can be estimated by subtracting the average annual groundwater pumping from the average annual change in storage, which corresponds to the volume of water that, if pumped over the water budget period of interest, would have resulted in zero storage change due to pumping. Based on the analytical water budget (Water Years 1998-2018), the Basin's estimated sustainable yield ranges from 500 AFY to 1,190 AFY depending on the time period considered; thus, sustainable yield estimates are time-dependent and contain significant uncertainty. Average Basin pumping over the historical water budget period (WYs 1998 - 2017) was approximately 920 AFY, which falls within the upper end of the sustainable yield estimates, however current (Water Year 2018) Basin pumping is estimated at 440 acre-feet, which is less than the estimated sustainable yield range.

Future water budget scenario projections were developed to account for projected water use and anticipated climate change effects using DWR-provided inputs for climate variables (i.e., adjusted precipitation and evapotranspiration; DWR, 2018): a Historical (Baseline) Climate Scenario reflecting no climate change effects, a DWR moderate (2030) Climate Change Scenario, and a DWR extensive (2070) Climate Change Scenario. In addition, three land-use scenarios were considered: current land-use, proposed Tejon Mountain Village (TMV) development, and proposed TMV Development with implementation of P&MA #1 *Aquifer Replenishment Project*.

Change in groundwater storage under all projected scenarios is generally stable, ranging from -80 AFY to 20 AFY. Projected scenarios with implementation of P&MA #1 show a net average annual surplus of groundwater in storage. However, each projected estimate has varying degrees of accuracy and uncertainty. Compared to the historical period, the future period has approximately half of the pumping, more recharge due to increased infiltration from imported and recycled water used within the TMV development, and reduced groundwater outflows, resulting in minimal changes in groundwater storage. However, as noted above, groundwater movement and storage in the Basin are primarily controlled by natural factors such as precipitation, temperature, and physical characteristics (e.g., geology and topography), which cannot be changed at the Basin scale.



Comparison of Average Annual Change in Storage Estimates (AFY) under Projected Scenarios

For example, projected scenarios are most sensitive to estimates of groundwater inflow from the upgradient Cuddy Canyon Basin; thus, future groundwater level monitoring at the Basin boundary would improve the conceptual understanding of groundwater inflow volumes. As part of GSP implementation, these groundwater inflow estimates will be refined as additional information is collected.

ES.8. Sustainable Management Criteria

Sustainable Management Criteria (SMCs) are the metrics by which groundwater sustainability is judged under SGMA. Key terms related to SMCs under SGMA include the following:

Sustainability Indicators refer to adverse effects caused by groundwater conditions occurring throughout the Basin that, when significant and unreasonable, cause undesirable results. The Sustainability Indicators identified by DWR are the following:

- Chronic lowering of groundwater levels
- Reduction in groundwater storage
- Seawater intrusion
- Degraded water quality
- Land subsidence

- Depletions of interconnected surface water

Undesirable Results are the significant and unreasonable occurrence of conditions, for any of the six Sustainability Indicators, that adversely affect groundwater use in the Basin. Where appropriate, groundwater levels are used as proxy for measuring Undesirable Results for other Sustainability Indicators.

Minimum Thresholds (MTs) are the numeric criteria for each Sustainability Indicator that, if exceeded, may cause Undesirable Results. Where appropriate, the MTs for the Sustainability Indicators have been set using groundwater levels as a proxy.

Measurable Objectives (MOs) are a specific set of quantifiable goals for the maintenance or improvement of groundwater conditions. MOs use the same units and metrics as the MTs and are thus directly comparable.

Interim Milestones are a set of target values representing measurable groundwater conditions in increments of five (5) years over the 20-year statutory deadline for achieving sustainability.

Summary of Undesirable Results Definition

Sustainability Indicator	Undesirable Results Definition
Chronic Lowering of Groundwater Levels	If groundwater levels decline below the MT in any two representative monitoring wells (RMWs) for four consecutive semi-annual sampling events.
Reduction of Groundwater Storage	If groundwater storage is reduced by an amount that causes groundwater levels to decline below the MT in any two RMWs for four consecutive semi-annual sampling events (*Chronic Lowering of Groundwater Levels to be used as a proxy*).
Seawater Intrusion	No Undesirable Results definition. Not applicable to the Basin due to geographic distance from the ocean.
Degraded Water Quality	No Undesirable Results definition. Limited historical water quality measurements are available and the relationship between water levels and water quality is not yet established. In addition to the public water system well water quality monitoring per Title 22, water quality samples will be collected from selected supplemental monitoring wells in the Basin to establish a current groundwater quality baseline. If data suggest that water quality is being affected by groundwater management practices, SMCs for water quality will be revisited.
Land Subsidence	No Undesirable Results definition. Not applicable to the Basin. No historical evidence of subsidence and geologic strata are unfavorable to inelastic deformation.
Depletions of Interconnected Surface Water	If groundwater levels decline below the MT in any two RMWs for four consecutive semi-annual sampling events; (*Chronic Lowering of Groundwater Levels used as a proxy*).

<ins>Chronic Lowering of Groundwater Levels</ins> is arguably the most fundamental Sustainability Indicator, as it influences several other key Sustainability Indicators, including Reduction of Groundwater Storage and Depletions of Interconnected Surface Water. The SMCs for Chronic Lowering of Groundwater Levels were developed through time-series analysis of long-term groundwater level data at the three representative monitoring wells (RMWs). The linear trend of groundwater elevations at each RMW between Water Years 2008 through 2018 was projected forward 10 years to establish the MO and 20 years to establish the MT. These SMCs were evaluated against known domestic and public supply well construction information to assess the potential for dewatering. The process for developing the MTs and MOs and the results were presented on multiple occasions in public meetings and workshops to allow for stakeholder input.

<ins>Reduction of Groundwater Storage</ins> is closely tied to Chronic Lowering of Groundwater Levels. The cumulative storage decline between March 2008 and March 2018 (as estimated using the Castac Basin Numerical Model) was approximately 13% of the total maximum aquifer storage. Because the water level declines over this period (and projected forward into the future as part of water level MO/MT development) is similar to historical conditions observed within the Basin, and results in a relatively small loss of groundwater storage, it was determined that the use of SMCs for Chronic Lowering of Groundwater Levels as a proxy for the SMCs for Reduction of Groundwater Storage would be sufficiently protective.

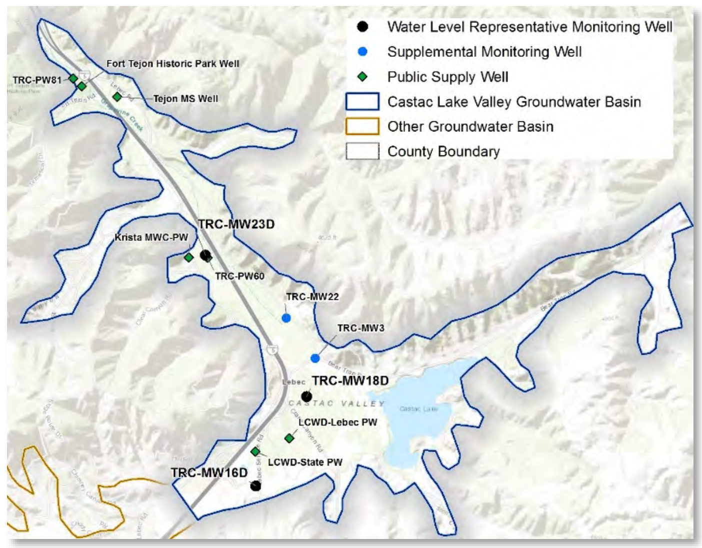
The SMCs for <ins>Degraded Water Quality</ins> are not currently defined for the Basin. An evaluation of the available water level and water quality data show that: (1) some wells do show a weak correlation between water levels and certain constituent concentrations, (2) some wells show no correction between water levels and constituent concentrations, and (3) most wells have insufficient data to conduct statistical analyses. Therefore, on-going compilation of water quality data from the public water systems within the Basin, supplemented with water quality sampling from other monitoring wells, will be used to establish a water quality baseline with which future GSP updates can better assess water quality conditions. If future data suggest that water quality is being affected by groundwater management practices, the need to develop SMCs for water quality will be revisited.

<ins>Depletions of Interconnected Surface Water</ins> is closely tied to Chronic Lowering of Groundwater Levels. Most creeks in the Basin are ephemeral under natural conditions, which means that flows are brief and generally occur following a rainfall event. Although it is often dry, Castac Lake is the most prominent surface water feature in the Basin and has been historically and intermittently full and/or interconnected to groundwater. Potential GDEs have been mapped near the lake and in the Grapevine Canyon area of the Basin, where groundwater levels typically are shallower. Given the observed shallow depths to groundwater in the Grapevine Canyon RMW (TRC-MW23D), the known range of GDE plant rooting depths, and the maximum water depth allowed by the MTs for Chronic Lowering of Groundwater Levels, these MTs also are protective of the

potential GDEs. As such, it was determined that the use of SMCs for Chronic Lowering of Groundwater Levels as a proxy for the SMCs for Depletions of Interconnected Surface Water was sufficiently protective.

As discussed above, Seawater Intrusion and Land Subsidence are not considered a threat to the Basin's groundwater resources. Therefore, no SMCs are defined for these Sustainability Indicators.

ES.9. Monitoring Network



SGMA Monitoring Network

The objectives of the SGMA Monitoring Network are to collect sufficient data for the assessment of the Sustainability Indicators relevant to the Basin and to evaluate potential impacts to the beneficial uses and users of groundwater. The proposed SGMA Monitoring Network was developed to ensure sufficient spatial distribution and spatial density and consists of three RMWs for groundwater levels and by proxy groundwater storage and interconnected surface water. The RMWs are TRC-MW16D near the upgradient border of the Basin, TRC-MW18D in the Castac Lake area of the Basin, and TRC-MW23D in the Grapevine Canyon area of the Basin. The spatial distribution of the RMWs provides the ability to collect data near the boundary with the sole adjoining basin (the Cuddy Canyon Valley Basin, located upgradient of the Castac Basin), which allows monitoring of future water level and groundwater storage trends at their common boundary. Thus, potential adverse effects on the upgradient basin due to groundwater management practices in the Basin can be monitored using the RMWs. Public water system wells are subject to water quality monitoring requirements (external to SGMA regulations); data collected from these wells will be assembled and analyzed to allow for ongoing future water quality trend analysis, supplemented by water quality samples collected from two supplemental monitoring wells in the Grapevine Canyon area of the Basin (e.g., TRC MW-3 and TRC-MW22).

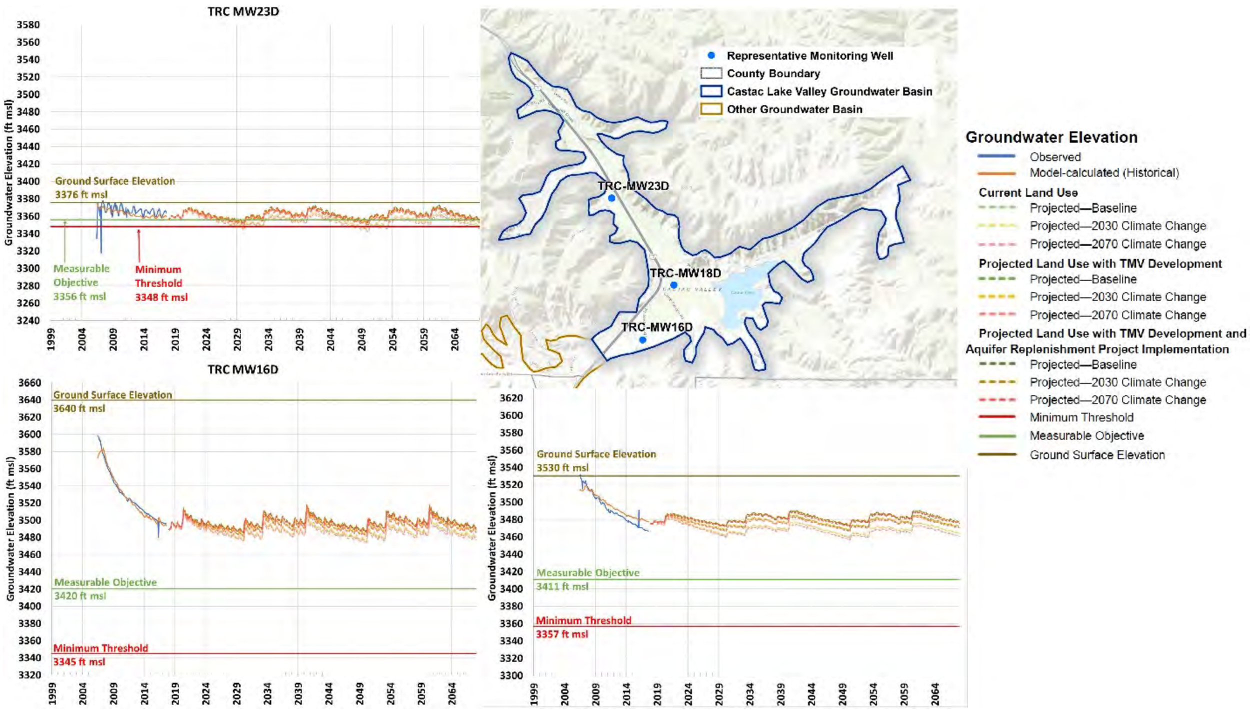
Data collected from the SGMA Monitoring Network will be uploaded to the Data Management System (DMS) maintained for the Basin and reported to DWR in accordance with the Monitoring Protocols developed by the Castac Basin GSA. Additional data collected by other entities as part of other regular monitoring programs may also be used for annual reporting and five-year updates or as otherwise deemed necessary.

ES.10. Projects and Management Actions

The Castac Basin GSA is proactively pursuing Basin management options and has identified several potential P&MAs, each with specific expected benefits. Certain P&MAs will be initiated within the first five years of GSP adoption, whereas others will be implemented incrementally on an as-needed basis to achieve the Sustainability Goal for the Basin. Most P&MAs have expected benefits related to water supply augmentation with other secondary benefits:

1. Enhanced Recharge: Aquifer Replenishment Project
2. Manage and/or Capture Floodwater: Cuddy Creek Bank Modifications Project
3. Increase Delivery Flexibility: KMWC Emergency Interconnect with LCWD
4. Develop New Supplies: Wastewater Reclamation Project
5. Water Quality Improvements: Frazier Mountain High School Water Project
6. Improved data collection for ongoing reporting compliance and water budget quantification: Well Metering and Data Collection

Based on the projected Castac Basin Numerical Model results, upon implementation, the P&MA#1 *Aquifer Replenishment Project* is estimated to add an additional 70 to 100 AFY of groundwater replenishment to the Basin (and up to 300 AFY on certain years), resulting in a net increase in groundwater storage of approximately 30 AFY under each climate scenario. Furthermore, projected groundwater elevations in all RMWs are expected to remain at or above the MTs under P&MA #1 *Aquifer Replenishment Project* implementation scenarios. The modeling results support the notion that the proposed P&MA implementation strategy is expected to result in sustainable management of groundwater levels within the Basin, as measured against the definition of Undesirable Results. It should be noted that the P&MA #1 scenario has been modeled assuming that surplus imported surface water supplies remain available. The effectiveness of P&MA #1 will be assessed periodically and should imported supplies become restricted in the future or be required for other beneficial uses, Basin conditions and the particulars of P&MA #1 implementation will be re-assessed at that time.



Projected RMW Hydrographs with and without P&MA #1 Implementation

Many of the P&MAs require further analysis, permitting, and water rights processes to determine feasibility and cost-effectiveness. In general, the P&MAs being considered for implementation will be discussed during regular Castac Basin GSA Board Meetings, which are open to the public. Additional stakeholder outreach efforts will be conducted prior to and during P&MA implementation, consistent with the SCEP.

ES.11. GSP Implementation

Key GSP implementation activities to be undertaken by the GSA over the next five (5) years include:

- Monitoring and data collection of water levels, water quality, groundwater extraction volumes, and surface water volumes, if applicable;
- Data gap filling efforts, including monitoring well installation, outreach to domestic well and public water system well owners, and use of new tools and guidelines;
- Intra-basin coordination;
- Continued outreach and engagement with stakeholders;
- Annual reporting;

- Evaluation and updates, as necessary, of the GSP as part of the required periodic evaluations (i.e., "five-year updates"); and
- P&MA implementation.

ES.12. GSP Implementation Costs and Funding

Costs to implement this GSP can be divided into several groups, as follows:

1. Costs of groundwater monitoring and reporting activities;
2. Costs associated with stakeholder outreach; and
3. Costs to implement P&MAs, including capital/one-time costs and ongoing costs.

Costs associated with continued GSA activities (groups 1 and 2) are estimated to range between approximately $64,000 to $165,000 per year, not including GSA and GSA member agency staff time. Estimated annual costs for individual P&MAs (group 3) will be determined in the future, as the Castac Basin GSA moves forward with specific P&MA implementation. The Castac Basin GSA will likely meet the estimated costs through a combination of contributions from landowners, grant funding, if available, and through rate payers.

ES.13. Conclusion

The passage of SGMA in 2014 ushered in a new era of groundwater management in California. The law and regulations emphasize the use of best available science, local control and decision making, and active engagement of affected stakeholders. Achieving and maintaining sustainability in the face of uncertain future water supply conditions while addressing and balancing the needs of all beneficial uses and groundwater users will require significant effort, creative solutions, and unprecedented collaboration. Although the Castac Basin is a very low priority basin in the eyes of DWR, the Castac Basin GSA recognizes the importance of maintaining groundwater sustainability to support the beneficial users within the Basin. Therefore, as the implementing agency, the Castac Basin GSA is committed to facing these challenges in a manner that upholds the interests of local landowners and constituents.

INTRODUCTION

1. PURPOSE OF THE GROUNDWATER SUSTAINABILITY PLAN

The purpose of this Groundwater Sustainability Plan (GSP) is to meet the regulatory requirements set forth in the three-bill legislative package consisting of Assembly Bill (AB) 1739 (Dickinson), Senate Bill (SB) 1168 (Pavley), and SB 1319 (Pavley), collectively known as the Sustainable Groundwater Management Act (SGMA). The SGMA defines sustainable groundwater management as "management and use of groundwater in a manner that can be maintained during the planning and implementation horizon without causing undesirable results." Undesirable results are defined by SGMA as any of the following effects caused by groundwater conditions occurring throughout the basin (California Department of Water Resources [DWR], 2017):

- Chronic lowering of groundwater levels indicating a significant and unreasonable depletion of supply;
- Significant and unreasonable reduction of groundwater storage;
- Significant and unreasonable seawater intrusion;
- Significant and unreasonable degraded water quality;
- Significant and unreasonable land subsidence; and
- Depletions of interconnected surface water that have significant and unreasonable adverse impacts on beneficial uses of the surface water.

The Castac Lake Valley Groundwater Basin (referred to herein as "the Basin"), DWR Basin No. 5-029, is prioritized as a "very low priority" basin (DWR, 2019). The SGMA Legislation does not require very low priority basins be managed under GSPs, however "encourages and authorizes" basins designated as very low priority to be managed under a GSP (Section 10720.7(b)).

This GSP has been developed to meet SGMA regulatory requirements (see *Appendix A*) while reflecting local needs and preserving local control over water resources. This GSP provides a path to achieve and document sustainable groundwater management within 20 years following GSP adoption, promoting the long-term sustainability of locally-managed groundwater resources now and into the future.

2. SUSTAINABILITY GOAL

§ 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.

The Sustainable Groundwater Management Act (SGMA) requires that a Sustainability Goal be defined for the Basin (CWC §10727(a)), and the Groundwater Sustainability Plan (GSP) Emergency Regulations further clarify that the sustainability goal "culminates in the absence of undesirable results within 20 years of the applicable statutory deadline" (23 CCR §354.24).

The Sustainability Goal of the Castac Basin GSA (Water Code §10721(u)) is to cooperatively manage groundwater sustainably in the Basin to support current and future beneficial uses of groundwater (including municipal, agricultural, industrial, public supply, domestic, and environmental uses) and to avoid undesirable results throughout the planning horizon.

Groundwater recharge in the Basin are primarily controlled by natural factors such as precipitation, temperature, and physical characteristics (e.g., geology and topography), which cannot be changed at the Basin scale. Nonetheless, the goal of Castac Basin GSA's projects and management actions will be to maintain groundwater storage in the Basin to the extent possible, in order to supply beneficial uses and users of groundwater.

3. AGENCY INFORMATION

§ 354.6. When submitting an adopted Plan to the Department, the Agency shall include a copy of the information provided pursuant to Water Code Section 10723.8, with any updates, if necessary, along with the following information:
(a) The name and mailing address of the Agency.
(b) The organization and management structure of the Agency, identifying persons with management authority for implementation of the Plan.
(c) The name and contact information, including the phone number, mailing address and electronic mail address, of the plan manager.
(d) The legal authority of the Agency, with specific reference to citations setting forth the duties, powers, and responsibilities of the Agency, demonstrating that the Agency has the legal authority to implement the Plan.
(e) An estimate of the cost of implementing the Plan and a general description of how the Agency plans to meet those costs.

3.1. Name and Mailing Address of the Groundwater Sustainability Agency (GSA)

The Castac Basin Groundwater Sustainability Agency (GSA) is the exclusive GSA for the Castac Lake Valley Groundwater Basin, California Department of Water Resources (DWR) Basin No. 5-029 (referred to herein as the "Basin").

The mailing address for the Castac Basin GSA is:

Castac Basin Groundwater Sustainability Agency
PO Box 478
Lebec, CA 93243

3.2. Organization and Management Structure of the GSA

As outlined in the Joint Powers Agreement (JPA) dated 20 March 2018 (*Appendix B*), the Castac Basin GSA is governed by five JPA Board Members. Tejon-Castac Water District (TCWD) and Lebec County Water District (LCWD) each have two votes on the GSA Board and are designated as "voting parties." Kern County is a non-voting Board member and is designated as an "Additional Entity." Additionally, Krista Mutual Water Company (KMWC) holds a non-voting position designated as an "Interested Party" established by a Memorandum of Agreement (MOA) approved by the GSA Board on 4 September 2018 (*Appendix B*). Information regarding current Castac Basin GSA Board members and representatives can be found on the GSA's website at https://www.castacgsa.org/board. Current Board members include:

- Board Co-Chairman – Angelica Martin, TCWD;
- Board Co-Chairman – William Hopper, LCWD;
- Allen Lyda, TCWD;

- Rick Puckett, LCWD;
- Alan Christianson, Kern County; and
- Sandi McElhenny, KMWC

Each Party may appoint one or more alternate GSA Board members, and as outlined on the Castac Basin GSA website (https://www.castacgsa.org/board), TCWD, LCWD, and KMWC all have alternates appointed.

3.3. Plan Manager

The Plan Manager is Angelica Martin, Co-Chairman of the Castac Basin GSA. Ms. Martin can be reached at:

Angelica Martin
4436 Lebec Road
Lebec, CA, 93243

Telephone: (661) 663-4262

Email: amartin@tejonranch.com

3.4. Legal Authority of the GSA

The Castac Basin GSA applied for and was granted exclusive GSA status under the Sustainable Groundwater Management Act (SGMA) (California Water Code [CWC] § 10723(c)). The Castac Basin GSA therefore has legal authority for the following actions outlined in this GSP:

- Implement P&MAs as defined in CWC Section 10726.2(b) and
- Collect groundwater extraction volumes and install well meters, if needed, as established under CWC Section 10725.8.

3.5. Estimated Cost of GSP Implementation and the Agency's Approach to Meet Costs

As discussed in more detail in Section *18.2 Plan Implementation Costs*, costs associated with continued GSA activities, including monitoring, reporting, and stakeholder outreach, are estimated to range between approximately $64,000 to $165,000 per year, not including GSA and GSA member agency staff time. Estimated annual costs for individual P&MAs will be determined in the future, as the Castac Basin GSA moves forward with specific P&MA implementation. The Castac Basin GSA will likely meet the estimated costs through a combination of contributions from landowners, grant funding, if available, and through rate payers.

4. GSP ORGANIZATION

This GSP is organized as follows:

- Sections 1 through 4 comprise the **Introduction**, including the following sections:
  - Section 1. Purpose of the Groundwater Sustainability Plan
  - Section 2. Sustainability Goal
  - Section 3. Agency Information
  - Section 4. GSP Organization
- Section 5 provides a **Description of the Plan Area**.
- Sections 6 through 10 present the **Basin Setting**, including the following sections:
  - Section 6. Introduction to Basin Setting
  - Section 7. Hydrogeologic Conceptual Model
  - Section 8. Current and Historical Groundwater Conditions
  - Section 9. Water Budget Information
  - Section 10. Management Areas (as Applicable)
- Sections 11 through 15 present the **Sustainable Management Criteria**, including the following sections:
  - Section 11. Introduction to Sustainable Management Criteria
  - Section 12. Sustainability Goal
  - Section 13. Undesirable Results
  - Section 14. Minimum Thresholds
  - Section 15. Measurable Objectives and Interim Milestones
- Section 16 presents the **Monitoring Network**.
- Section 17 presents the **Projects and Management Actions**.
- Section 18 presents **Plan Implementation**.
- **References and Technical Studies** are included at the end of this document.
- Supporting information is provided in Appendices as follows:
  - Appendix A. GSP Submittal Checklist
  - Appendix B. Joint Powers Agreement and Memorandum of Agreement

- Appendix C. Stakeholder Communication and Engagement Plan
- Appendix D. GSP Public Comments
- Appendix E. Temporal Characteristics *of* Available Groundwater Data
- Appendix F. Supplemental Wetlands, Vegetation, and Special Species Maps
- Appendix G. The Nature Conservancy Freshwater Species List for the Castac Lake Valley Basin
- Appendix H. Historical Water Budget Spreadsheet Model Approach
- Appendix I. Castac Basin Numerical Groundwater Flow Model Documentation
- Appendix J. Project / Management Action Information Forms

PLAN AREA

5. DESCRIPTION OF THE PLAN AREA

This section presents a description of the Basin Plan Area, and a summary of the relevant jurisdictional boundaries and other key land use features potentially relevant to the sustainable management of groundwater in the Basin. This section also describes the water monitoring programs, water management programs, and general plans relevant to the Basin and their influence on the development and execution of this Groundwater Sustainability Plan (GSP).

5.1. Summary of Jurisdictional Areas and Other Features

§ 354.8. Each Plan shall include a description of the geographic areas covered, including the following information:

(a) One or more maps of the basin that depict the following, as applicable:

- *(1) The area covered by the Plan, delineating areas managed by the Agency as an exclusive Agency and any areas for which the Agency is not an exclusive Agency, and the name and location of any adjacent basins.*
- *(2) Adjudicated areas, other Agencies within the basin, and areas covered by an Alternative.*
- *(3) Jurisdictional boundaries of federal or state land (including the identity of the agency with jurisdiction over that land), tribal land, cities, counties, agencies with water management responsibilities, and areas covered by relevant general plans.*
- *(4) Existing land use designations and the identification of water use sector and water source type.*
- *(5) The density of wells per square mile, by dasymetric or similar mapping techniques, showing the general distribution of agricultural, industrial, and domestic water supply wells in the basin, including de minimis extractors, and the location and extent of communities dependent upon groundwater, utilizing data provided by the Department, as specified in Section 353.2, or the best available information.*

(b) A written description of the Plan area, including a summary of the jurisdictional areas and other features depicted on the map.

5.1.1. Area Covered by the Plan

The Castac Lake Valley Basin (Basin; California Department of Water Resources [DWR] Basin No. 5-029) encompasses 3,563 acres within the Tehachapi and San Emigdio Mountains at the southern end of Kern County (**Figure PA-1**). The entire Basin extent is covered by the Castac Basin Groundwater Sustainability Agency (GSA), which is the exclusive GSA for the Basin. Along the southwest upgradient edge of the Basin lies the Cuddy Canyon Valley Groundwater Basin (Cuddy Canyon Basin or DWR Basin No. 5-082). There are no other groundwater basins directly adjacent to the Basin to the north or east.

5.1.2. Adjudicated areas, Other Agencies, and Alternative areas

The Basin is not adjudicated and does not contain any areas covered by an Alternative Plan. Krista Mutual Water Company (KMWC) is an "other agency" (i.e., not a Joint Powers Authority [JPA] member of the Castac Basin GSA) located within the Basin (**Figure PA-1**). Additionally, Kern County Water Agency's (KCWA) governance area includes all lands within Kern County, which includes the Basin.

5.1.3. Jurisdictional Boundaries

As shown on **Figure PA-1**, there are 42 acres of state-owned lands associated with Fort Tejon State Historic Park, managed by the California Department of Parks and Recreation, that fall within the northwest corner of Basin. There are no federally owned lands within the Basin. According to the information made available by DWR[4] in support of GSP development, there are no tribal lands within or in the vicinity of the Basin. No incorporated cities lie within the Basin, which falls entirely within Kern County. Lebec, an unincorporated community of approximately 1,500 residents and some commercial development (U.S. Census Bureau, 2012), is located within the Basin (**Figure PA-1**). As shown on **Figure PA-1**, agencies with water management responsibilities within the Basin include Tejon-Castac Water District (TCWD), Lebec County Water District (LCWD), and KMWC.

The DWR further presents information regarding U.S. Census Blocks, Tracts and Places that are defined as disadvantaged communities (DAC) or severely disadvantaged communities (SDAC) based on the median household income (MHI) of an area compared to the statewide MHI.[5] DAC communities are those with a MHI of less than 80% the statewide MHI and SDAC communities are those with a MHI of less than 60% of the statewide MHI (California Code, Public Resources Code § 75005(g)). **Figure PA-2** shows the DAC/SDAC designations within the Basin based on 2016 MHI from the 2013-2017 American Community Survey 5-Year Estimates. The area located to the west of Interstate-5 (I-5) comprising a substantial portion of the residential community of Lebec is considered a SDAC based on the Census Block Group and a DAC based on the Census Tract characterizations. Additionally, the unincorporated community of Lebec is defined as a SDAC based on the Census Place characterization. Most of the DAC/SDAC areas within the Basin are within a public water system service area.

The Basin is located within the Kern County General Plan area, which is discussed in more detail below in Section 5.3.1 *General Plans and Other Land Use Plans*. The Kern County General Plan further identifies several Specific Plan areas, including the Tejon Mountain Village (TMV), O'Neil Canyon, and Frazier Park/Lebec Specific Plans which cover portions of the Basin and are discussed in more detail below in Section 5.3.1 *General Plans and Other Land Use Plans*.

[4] SGMA Data Viewer: https://sgma.water.ca.gov/webgis/?appid=SGMADataViewer
[5] Ibid [4]

5.1.4. Existing Land Use and Water Use

Figure PA-3 shows land use within the Basin and **Table PA-1** summarizes land use by area. Land use within the Basin is primarily range and undeveloped lands (69%); lakebed area (11%); and residential and commercial lands (9%).

Table PA-1. Current Land Use

Land Use	Acres	Percent
Range / Undeveloped	2,438	69%
Lakebed Area	393	11%
Residential & Commercial	337	9%
Right of Way & Roadway	212	6%
Irrigated Land	171	5%

The potable consumption of groundwater in the Basin includes domestic well owners and public water systems. TCWD is the water supplier for portions of the Tejon Ranch Corporation (TRC) property in the eastern part of the Basin including the planned TMV development, but TCWD does not operate any potable supply wells within the Basin. LCWD supplies water to parts of Lebec along the western edge of the Basin; LCWD operates water supply wells in both the Basin and upgradient Cuddy Canyon Basin. KMWC operates one well within the Basin, which supplies water to the Los Padres Estates area located in the O'Neil Canyon portion of the Basin. LCWD also recently began efforts to drill an additional well in the Basin on TRC lands. Other public water systems include the TRC main headquarters, El Tejon Middle School, Fort Tejon Historic State Park, and Tejon Ranch Grapevine Water, each of which is serviced by one active groundwater well. The TRC main headquarters well serves as an emergency backup supply for the Tejon Ranch Grapevine Water supply system (Safe Drinking Water Information System [SDWIS], 2018). The TRC also uses groundwater from several wells within the basin for stock watering and irrigated agriculture (pasture, vineyards, and orchards).

5.1.5. Well Density Per Square Mile

Figure PA-4 shows approximate locations of supply wells in the Basin (obtained from non-DWR sources), and polygons published by DWR indicating the density of supply wells per square mile, based on DWR Well Completion Report records[6]. According to these records, 25 domestic wells, one production well, and no public supply wells have been constructed within the Public Land Survey System (PLSS) sections[7] that fall partially or entirely within the Basin. This summary conflicts with data from the Basin's Data Management System (DMS), which includes data obtained from private landowners and other sources. The DMS has records of two domestic

[6] DWR Well Completion Report Map Application website: https://dwr.maps.arcgis.com/apps/webappviewer/index.html?id=181078580a214c0986e2da28f8623b37, accessed 10/23/2018.
[7] Each PLSS section represents approximately 1 square mile of area (i.e., 640 acres).

wells, 20 production wells, and eight public supply wells that have been constructed within the Basin over time. Of these, four production wells have been abandoned. Based on the locally-obtained data, DWR records appear to be out of date.

As groundwater management in the Basin proceeds under the Sustainable Groundwater Management Act (SGMA), discrepancies between the databases (e.g., DWR vs. the various data from the DMS) will be corrected using improved field-based well locations, and other data.

Communities that are dependent upon groundwater include the unincorporated community of Lebec and residents of O'Neil Canyon served by KMWC or private domestic wells.

5.2. Water Resources Monitoring and Management Programs

§ 354.8. Each Plan shall include a description of the geographic areas covered, including the following information:

(c) Identification of existing water resource monitoring and management programs, and description of any such programs the Agency plans to incorporate in its monitoring network or in development of its Plan. The Agency may coordinate with existing water resource monitoring and management programs to incorporate and adopt that program as part of the Plan.

(d) A description of how existing water resource monitoring or management programs may limit operational flexibility in the basin, and how the Plan has been developed to adapt to those limits.

(e) A description of conjunctive use programs in the basin.

5.2.1. Existing Monitoring and Management Programs

Existing Monitoring Programs

- TRC currently conducts routine water level monitoring of its wells, however there is no officially established monitoring program.

- The Groundwater Ambient Monitoring and Assessment Program (GAMA) monitors groundwater quality trends throughout California. One well within the Basin was sampled once in 2008 under GAMA.

- The State Water Resources Control Board (SWRCB)'s Division of Drinking Water monitors groundwater quality from public water system wells. There are six public water systems located within 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]) with data available.

- Streamflow along Cuddy Creek is monitored by Kern County, in which the gaging station measures peak seasonal flow.

- Temperature and precipitation are measured at the National Oceanic and Atmospheric Administration (NOAA) Lebec station (ID 044863).

- Land subsidence data in the vicinity of the Basin is available through the University Navstar[8] Consortium (UNAVCO) Plate Boundary Observatory's continuous and conventional Global Positioning System (GPS) network.

Staff of TCWD, LCWD, and KMWC will coordinate to establish the SGMA Monitoring Network on behalf of the Castac Basin GSA. To the extent applicable, the GSA plans to incorporate these monitoring programs into its SGMA Monitoring Network, as appropriate. The Basin's SGMA Monitoring Network is described in more detail in Section *16 Monitoring Network* below.

Existing Management Programs

The Basin falls within the Tulare Lake Basin portion of the Kern County Integrated Regional Water Management Region (Kern Region) and is included in the March 2020 Kern County Integrated Regional Water Management Plan (Kern IRWMP; Provost & Pritchard, 2020). The Kern Region covers approximately 5,690 square miles of Kern County and a small portion of southern Kings County. The Kern Region is separated into nine subregions, in acknowledgement of the variation in geography, agency boundaries, and water management strategies. These subregions are: (1) Greater Bakersfield, (2) Kern Fan, (3) Mountains/Foothills, (4) Kern River Valley, (5) North County, (6) South County, (7) West Side, (8) Kern County Water Agency (KCWA) and (9) the County of Kern. The Basin falls within the Mountains/Foothills subregions (Provost & Pritchard, 2020).

The key issues, needs, challenges, and priorities for the Mountains/Foothills subregion, according to the Kern IRWMP (Provost & Pritchard, 2020), include the following:

- Groundwater overdraft;
- Watershed protection;
- Aging and/or duplicative infrastructure;
- Urban growth and water demand (South Mountains);
- Climate change; and
- Water quality/groundwater contamination.

5.2.2. Operational Flexibility Limitations

The existing water resources monitoring programs and infrastructure are not expected to limit operational flexibility in the Basin. In fact, the TRC monitoring well network will be integral to the

[8] Navstar is a network of U.S. satellites that provide GPS services.

on-going monitoring and reporting that will be conducted pursuant to this GSP (see Section *16 Description of Monitoring Network*).

The IRWMP and GSP development are complimentary management processes. To the extent that the issues identified for the greater IRWMP region affect the Basin, these issues will be discussed in the following sections of this GSP. The implementation of this GSP will contribute to the sustainable use of water supplies within the IRWMP region and the IRWMP is therefore not expected to limit operational flexibility in the Basin.

5.2.3. Conjunctive Use Programs

There are no formal conjunctive use programs within the Basin.

5.3. Land Use Elements or Topic Categories of Applicable General Plans

§ 354.8. Each Plan shall include a description of the geographic areas covered, including the following information:

(f) A plain language description of the land use elements or topic categories of applicable general plans that includes the following:
- *(1) A summary of general plans and other land use plans governing the basin.*
- *(2) A general description of how implementation of existing land use plans may change water demands within the basin or affect the ability of the Agency to achieve sustainable groundwater management over the planning and implementation horizon, and how the Plan addresses those potential effects.*
- *(3) A general description of how implementation of the Plan may affect the water supply assumptions of relevant land use plans over the planning and implementation horizon.*
- *(4) A summary of the process for permitting new or replacement wells in the basin, including adopted standards in local well ordinances, zoning codes, and policies contained in adopted land use plans.*
- *(5) To the extent known, the Agency may include information regarding the implementation of land use plans outside the basin that could affect the ability of the Agency to achieve sustainable groundwater management.*

5.3.1. General Plans and Other Land Use Plans

Kern County General Plan

The Basin is located with the Kern County General Plan area (Kern County, 2009). The current Kern County General Plan was first adopted in 2004 and has undergone several amendments, the most recent amendment approved in 2009 (i.e., the "2009 General Plan"). The County is currently working to update its General Plan through 2040 (i.e., the "2040 General Plan"). This section identifies relevant policies in the current General Plan that could: (1) affect water demands in the Basin (e.g., due to population growth and development of the built environment), (2) influence the GSP's ability to achieve sustainable groundwater use, and (3) affect implementation of the 2009 General Plan land use policies.

Figure PA-5 shows the current General Plan land use designations within the Basin. The land use designations primarily include designated Specific Plan areas and public or private recreation areas.

The Land Use, Open Space, and Conservation Element (Chapter 1) of the 2009 General Plan includes the following goals, policies, and implementation measures that are related to groundwater or land use management, and that could potentially influence the implementation of this GSP.[9] The following are direct excerpts from the 2009 Kern County General Plan:

Physical and Environmental Constrains

- **Implementation Measure C.** Cooperate with the KCWA to classify lands in the County overlying groundwater according to groundwater quantity and quality limitations.

Public Facilities and Services

- **Goal 5.** Ensure that adequate supplies of quality (appropriate for intended use) water are available to residential, industrial, and agricultural users within Kern County.
- **Goal 7.** Facilitate the provision of reliable and cost-effective utility services to residents of Kern County.
- **Policy 2.** The efficient and cost-effective delivery of public services and facilities will be promoted by designating areas for urban development which occur within or adjacent to areas with adequate public service and facility capacity.
- **Policy 2.a.** Ensure that water quality standards are met for existing users and future development

Residential

- **Goal 6.** Promote the conservation of water quantity and quality in Kern County.
- **Goal 7.** Minimize land use conflicts between residential and resource, commercial, or industrial land uses.

Industrial

- **Goal 2.** Promote the future economic strength and well-being of Kern County and its residents without detriment to its environmental quality.

Resource

[9] The 2009 General Plan goals, policies, and implementation measures were in effect at the time that components of this GSP were under development (i.e., 2018 and 2019). To the extent that these goals, policies, and implementation measures are updated as part of the 2040 General Plan, those will be incorporated and considered in future five-year GSP updates (i.e., in 2025).

- **Policy 7.** Areas designated for agricultural use, which include Class I and II and other enhanced agricultural soils with surface delivery water systems, should be protected from incompatible residential, commercial, and industrial subdivision and development activities.
- **Policy 10.** To encourage effective groundwater resource management for the long-term economic benefit of the County the following shall be considered:
  - **Policy 10.a.** Promote groundwater recharge activities in various zone districts.
  - **Policy 10.c.** Support the development of groundwater management plans.
  - **Policy 10.d.** Support the development of future sources of additional surface water and groundwater, including conjunctive use, recycled water, conservation, additional storage of surface water and groundwater and desalination.

General Provisions

- **Goal 1.** Ensure that the County can accommodate anticipated future growth and development while maintaining a safe and healthful environment and a prosperous economy by preserving valuable natural resources, guiding development away from hazardous areas, and assuring the provision of adequate public services.
- **Policy 40.** Encourage utilization of community water systems rather than the reliance on individual wells.
- **Policy 41.** Review development proposals to ensure adequate water is available to accommodate projected growth.
- **Policy 45.** New high consumptive water uses, such as lakes and golf courses, should require evidence of additional verified sources of water other than local groundwater. Other sources may include recycled stormwater or wastewater.
- **Implementation Measure U.** The Kern County Environmental Health Services Department will develop guidelines for the protection of groundwater quality which will include comprehensive well construction standards and the promotion of groundwater protection for identified degraded watersheds.

Specific and Community Plans (Specific Plans)

The General Plan identifies several Specific Plan areas, including the TMV, O'Neil Canyon, and Frazier Park/Lebec which cover the majority of the Basin (see **Figure PA-6**). Specific Plans are similar to the General Plan but include more detailed direction for a particular development:

- The Frazier Park/Lebec Specific Plan was approved in 2003 and targets the residential and commercial development of the Frazier Park/Lebec area. The plan main objectives were to enhance resident's life quality and increase the commercial and touristic appeal of the region. The plan is approaching its final stages, as the term of the Specific Plan is through the year 2020 (Kern County Planning Department, 2003).

- The O'Neil Canyon Specific Plan was approved in 1992, updating the prior Specific Plan adopted in 1978 to reflect policy changes (Kern County Department of Planning and Development Services, 1992); and
- The TMV development has an accepted Specific Plan document (2009) and is currently undergoing development. As such, only the TMV Specific Plan is described further below.

The TMV Specific Plan area covers most of the Basin to the east of I-5, excluding Castac Lake. The entire TMV area (a large part of which extends outside of the Basin) will include 5,082 acres designated to residential, commercial and recreational uses, including 160,000 square feet of commercial development adjacent to I-5, and two golf courses (Kern County Planning Department, 2009a).

The Specific Plan identifies the following planning principles and objectives outlined in its Introduction (Chapter 1) that are related to groundwater or land use management, which could potentially influence the implementation of this GSP.

- **Principal 5. Preserve key features of the natural environment**. Infrastructure and Building Areas are located to avoid existing streams, wetlands and riparian areas.
- **Principal 10. Conserve water resources.** To maximize conservation of the water supply, the water and wastewater plans will: utilize a state-of-the-art treatment plant design; incorporate provisions to require low-water use plant materials and irrigation systems; and require on-site recycling of water and solid wastes.
- **Principal 11. Protect water quality**. TMV shall implement a water quality program that will include: construction period Best Management Practices as required by the SWRCB General Permit pertaining to discharges associated with construction activities; and the design and construction of an extensive system of vegetative swales, basins, and landscape source controls as required to protect water quality standards.
- **Objective 5**. Incorporate planning, development and building practices that conserve and protect significant on-site natural resources and minimize consumption of energy and water.

Tejon Ranch Conservation & Land Use Agreement

As shown on **Figure PA-7**, 33 acres within the Basin are specified as a Future Dedicated Conservation Easement Area and are protected under the Tejon Ranch Conservation & Land Use Agreement ("Agreement"; TRC, 2008). The Agreement states in Exhibit M Paragraph 1(b)(3): "In managing Owner's future native groundwater extraction activities within the Conservation Easement Area, Owner will avoid changes to or expansion of groundwater extraction practices as of the Effective Date that would cause significant groundwater related adverse impacts to the surface Conservation Values existing as of the Effective Date. In addition, Owner shall not make any alterations or improvements to the surface of the Conservation Easement Area in connection with water storage, including storage of water in underground aquifers, except as permitted by Paragraph 1(b)(1)(G)."

5.3.2. Implementation of Existing Land Use Plans

The above goals, policies and implementation measures established by the General Plan are complementary to sustainable groundwater management of the Basin relative to future land use development and conservation (i.e., the plan encourages development of the County's groundwater supply to ensure that existing users have access to high quality water, and states that future growth should be accommodated only while ensuring that adequate high-quality water supplies are available to existing and future users). Successful implementation of this GSP will help to ensure that the Basin groundwater supply is managed in a sustainable manner. Therefore, implementation of General Plan policies is not expected to affect the Basin's ability to achieve groundwater sustainability. Given that the General Plan is being updated concurrently with the development of this GSP, and the County is engaged in the process of GSP development through its participation in the Castac Basin GSA, it is anticipated that the 2040 General Plan will consider this GSP and incorporate water supply assumptions consistent with this GSP over the 2040 planning horizon.

The above goals, policies and implementation measures established by the TMV Specific Plan are complementary to sustainable groundwater management of the Basin relative to future land use development and conservation (i.e., the plan encourages protecting the natural environment and water conservation). The TMV Specific Plan outlines changes in land use in which 710 acres within the Basin will shift from range and undeveloped lands to residential and commercial (**Figure PA-7**).

As outlined in the TMV Specific Plan and TMV Facilities Plan (NV5, 2018), if and when TMV is developed, <u>all potable water demands associated with the TMV development will be met by State Water Project (SWP) surface water imported from the California Aqueduct. Groundwater will not be pumped to meet any of the TMV development demands.</u> Non-potable water demands (e.g., irrigation to golf courses) will be met by blending SWP water and treated recycled water to the maximum extent possible, to reduce overall water demands. Therefore, the TMV development is anticipated to act as a net benefit to groundwater recharge within the Basin and implementation of TMV Specific Plan policies is not expected to negatively affect the Basin's ability to achieve groundwater sustainability.

The Tejon Ranch Conservation & Land Use Agreement specifically outlines that groundwater extractions cannot cause significant undesirable results, so it is complimentary to sustainable groundwater management, and is not expected to limit the Basin's ability to achieve groundwater sustainability.

5.3.3. Implementation of the GSP

Successful implementation of this GSP will help to ensure that the Basin groundwater supply is managed in a sustainable manner. Therefore, implementation of General Plan policies is not expected to affect the Basin's ability to achieve groundwater sustainability. In general, implementation of this GSP is not anticipated to significantly affect the County's current water supply assumptions or land use plans. However, implementation of this GSP may limit the availability of potential local groundwater sources to be used for future demands above current rates of groundwater extraction. It is anticipated that the 2040 General Plan will consider this GSP and utilize consistent water supply assumptions over the 2040 planning horizon.

Although the TMV development will result in a shift in land use and water supply assumptions, implementation of this GSP should not affect the water supply assumptions of the TMV Specific Plan, as all water demands for the development will be met by surface water imported from the California Aqueduct or local recycled water.

5.3.4. Well Permitting Process

Well permits with the Basin are issued by the Kern County Public Health Services Department Water Well Program. The Water Well Program issues permits to construct, reconstruct, and destroy water wells. All wells must be constructed in accordance with Kern County Ordinance Code, Section 14.08, and the DWR's Bulletin 74-81 and Bulletin 74-90, except as modified by subsequent revisions. The ordinance requires, among other things, that domestic and agricultural wells be installed a minimum distance from potential pollution and contaminant sources, water quality be tested for new and reconstructed wells, an NSF 61 approved flowmeter be installed, and the final well construction be inspected by County staff. It is expected that as part of GSP implementation, the Water Well Program may be more closely coordinated with Castac Basin GSA activities to support long-term sustainability within the Basin.

5.3.5. Implementation of Land Use Plans Outside the Basin

This section may include information as applicable regarding implementation of land use plans outside the Basin that could affect the ability of the GSA to achieve sustainable groundwater management, if identified by the GSA. Currently, no applicable land use plans have been identified.

5.4. Additional GSP Elements

§ 354.8. Each Plan shall include a description of the geographic areas covered, including the following information:
(g) A description of any of the additional Plan elements included in Water Code Section 10727.4 that the Agency determines to be appropriate.

Per California Water Code Section 10727.4, a GSP shall include, where appropriate and in collaboration with the appropriate agencies, all of the following:

1) *Control of saline water intrusion*

Because the Basin is located far from coastal areas, seawater intrusion is not considered to be a threat to groundwater resources and therefore no control measures for saline water intrusion have been established.

2) *Wellhead protection*

The Kern County Public Health Services Department Water Well Program issues permits to construct, reconstruct and destroy water wells (see Section 5.3.4 *Well Permitting Process*).

3) *Migration of contaminated groundwater*

The mitigation, remediation, and management of groundwater contamination plumes is regulated by the Regional Water Quality Control Board (RWQCB), Department of Toxic Substances Control (DTSC), and the County of Kern. As discussed in Section 8.5.4 *Point-Source Contamination Sites*, 12 Leaking Underground Storage Tank (LUST) sites and one cleanup program site are contained within the Basin, but all of the sites have achieved case closure. Identified contaminants of concern at the closed LUST sites include gasoline (ten sites), motor oil (one site), and lead (one site). The cleanup program site (Mobil M-1 Crude Oil Pipeline; SL205724284) was closed as of December 2018. A land disposal site (Lebec Sanitary Landfill; L10005571106) also is located directly up-gradient from the Basin. The landfill is closed, with active monitoring ongoing.

4) *Well abandonment and well destruction program*

The Kern County Public Health Services Department Water Well Program issues permits to construct, reconstruct and destroy water wells (see Section 5.3.4 *Well Permitting Process*).

5) *Replenishment of groundwater extractions*

The groundwater system underlying the Basin is recharged from multiple natural and anthropogenic sources, including percolation of precipitation, runoff from adjacent watershed areas, return flow from excessive irrigation water, subsurface inflow from up-gradient basins, and seepage from Castac Lake when gradients are favorable (see Section 7.3.4 *Recharge and Discharge Areas*).

6) *Conjunctive use and underground storage*

There are no formal conjunctive use projects within the Basin.

7) *Well construction policies*

The Kern County Public Health Services Department Water Well Program issues permits to construct, reconstruct and destroy water wells (see Section 5.3.4 *Well Permitting Process*).

8) Groundwater contamination cleanup, recharge, diversions to storage, conservation, water recycling, conveyance, and extraction projects

There are no open groundwater contamination cleanup sites within the Basin (see Section 8.5.4 *Point-Source Contamination Sites* for closed cleanup sites); oversight of groundwater contamination cleanup in this area is provided by the RWQCB, DTSC, and County of Kern.

No active recharge, diversions to storage, water recycling and conveyance projects exist within the Basin, although planning and permitting processes are underway for the TMV development water and wastewater infrastructure. LCWD has begun the process of drilling and construction of a new groundwater supply well within the Basin.

There are no major urban water suppliers (i.e., more than 3,000 connections or supplying more than 3,000 acre-feet of water annually) within the Basin, and therefore water conservation is not mandated.

9) Efficient water management practices

Groundwater use within the Basin is primarily (85%) for public and domestic supply. Efficient institutional and domestic water-use practices will be encouraged by the GSA. Irrigated farming practices and landscape irrigation are a small part (15%) of Basin water use, but the GSA will encourage implementation of efficient irrigation and water management techniques, potentially including zonal irrigation to address soil types, quantitative soil moisture monitoring, Geographic Information System (GIS) data management and analysis, and/or other methods.

10) Relationships with State and federal regulatory agencies

TCWD has a direct relationship with DWR related to the Beartrap turnout off of the State Water Project (SWP) system and via the purchase, use and transfer of SWP water.

11) Land use plans and efforts to coordinate with land use planning agencies to assess activities that potentially create risks to groundwater quality or quantity

Applicable land use planning documents and processes are discussed in Section 5.3 *Land Use Elements or Topic Categories of Applicable General Plans*.

12) Impacts on Groundwater Dependent Ecosystems

Groundwater Dependent Ecosystems (GDEs) have been identified within the Basin. An assessment of GDE presence is provided in Section 8.8 *Groundwater Dependent Ecosystems (GDEs)*.

5.5. Notice and Communication

§ 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 GSA adopted its Stakeholder Communication and Engagement Plan (SCEP) in October 2018 to fulfil notice and communication requirements. The SCEP is available on the GSA's website (https://www.castacgsa.org/) and is included herein as *Appendix C*.

5.5.1. Beneficial Uses and Users of Groundwater

Per 23-California Code of Regulations (CCR) §354.10(a), beneficial uses and users of groundwater shall include 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.

As part of the SCEP, beneficial uses and users of groundwater in the Basin were identified (see SCEP Section 3) including agricultural users, domestic well owners, commercial and industrial users, municipal well operators, public water systems, Kern County, groundwater dependent ecosystems and interconnected surface water users, and disadvantaged communities. Additionally, a Stakeholder Constituency "Lay of the Land" exercise was developed which identified Basin stakeholders, key interests and issues, and the level of engagement expected with each stakeholder (see SCEP Table 1). This information will be updated during select phases of GSP development and/or implementation.

5.5.2. Public Meetings Summary

The list below identifies public meetings, workshops, and direct outreach specific to GSP development. Detailed meeting minutes and materials are available on the GSA's website (https://www.castacgsa.org/).

GSA Board Meetings

Castac Basin GSA Board meetings are open to the public and regular meetings were previously held quarterly at 6:00 pm on the 1st Tuesday of the month at the LCWD office (323 Frazier Mountain Park Road, Lebec, CA 93243). The COVID-19 pandemic has interfered with some GSA Board activities, but following June 2020, Board meetings will be held on a regular quarterly schedule which will be posted on the GSA website when finalized. The list below provides a complete history of Castac Basin GSA Board meetings to date:

- 4 September 2018
- 10 October 2018
- 4 June 2019
- 3 September 2019
- 15 November 2019
- 6 March 2020
- 22 June 2020

The list above will be updated throughout GSP development and/or implementation.

Stakeholder Workshops

In order to inform the public on the GSP development, the following public workshops were held at the Lebec Community Church (2350 Lebec Road, Lebec, CA 93243):

- 16 July 2019
- 15 November 2019
- 26 May 2020

This list will be populated throughout GSP development and/or implementation.

5.5.3. Public Comments on the GSP

As described in the above sections and in the remainder of this section, the Castac Basin GSA has conducted stakeholder engagement throughout the GSP development process. During this time, input and feedback from the public has been encouraged. **Table PA-2** below summarizes key public comments and input received and how that input was incorporated into the GSP. In some cases, more detailed responses can be found in Appendix *D*.

Table PA-2. Public Comments and Input Received During GSP Development

Source	Date	Type of Input	How Input was Incorporated
Stakeholder Surveys	January and February 2019	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"	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.
Stakeholder Workshop #1	7/16/2019	Verbal comment: "Trillions of gallons of groundwater are being pumped"	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.

The Castac Basin GSA welcome further comments during GSP implementation. In addition to **Table PA-2** above, a detailed list of public comments received and the GSA response can be found in *Appendix D*.

5.5.4. Communication

The SCEP outlines the GSA's communication goals.

Decision-making process

The SCEP Section 2.2 outlines the Castac Basin GSA's decision-making process. Key GSP development and implementation decisions are made by the Castac Basin GSA's Board of Directors.

Public engagement opportunities

The SCEP Section 6 discusses public engagement opportunities and the SCEP Sections 5 and 6 discuss how public input and responses will be handled. These opportunities include Castac Basin GSA Board meetings, stakeholder workshops, the planned public hearing at which the Draft GSP will be available for public comments, and the Stakeholder Survey and Landowner Data Request Form.

Stakeholder Involvement

The SCEP Section 5 outlines the GSA's goals, including open and transparent engagement with diverse stakeholders. Additionally, the SCEP Section 4 describes the Stakeholder Survey and Landowner Data Request in which the GSA used to gain additional knowledge on Basin stakeholders. Surveys were sent to approximately 200 stakeholders within the Basin via direct mail and additionally the Survey is posted on the GSA's website and available in hard-copy form at all GSA Board meetings. Results from the seven Stakeholder Survey responses received indicate that:

- Most stakeholders who responded obtain their water supply from KMWC;
- Primary interests in water resource management are water conservation, sustainability and utilization of gray water;
- Most stakeholders are concerned about overdevelopment in the mountain communities with such limited water resources; and
- Some stakeholders are not familiar with SGMA.

As a result of the Stakeholder Survey and Data Request, two Basin stakeholders provided data on their wells to the Castac Basin GSA for consideration and inclusion in the GSP. Data included well location, well construction information, one water level measurement and one set of water quality data. These data were added to the Data Management System (DMS) for the Basin and considered during assessment of groundwater conditions.

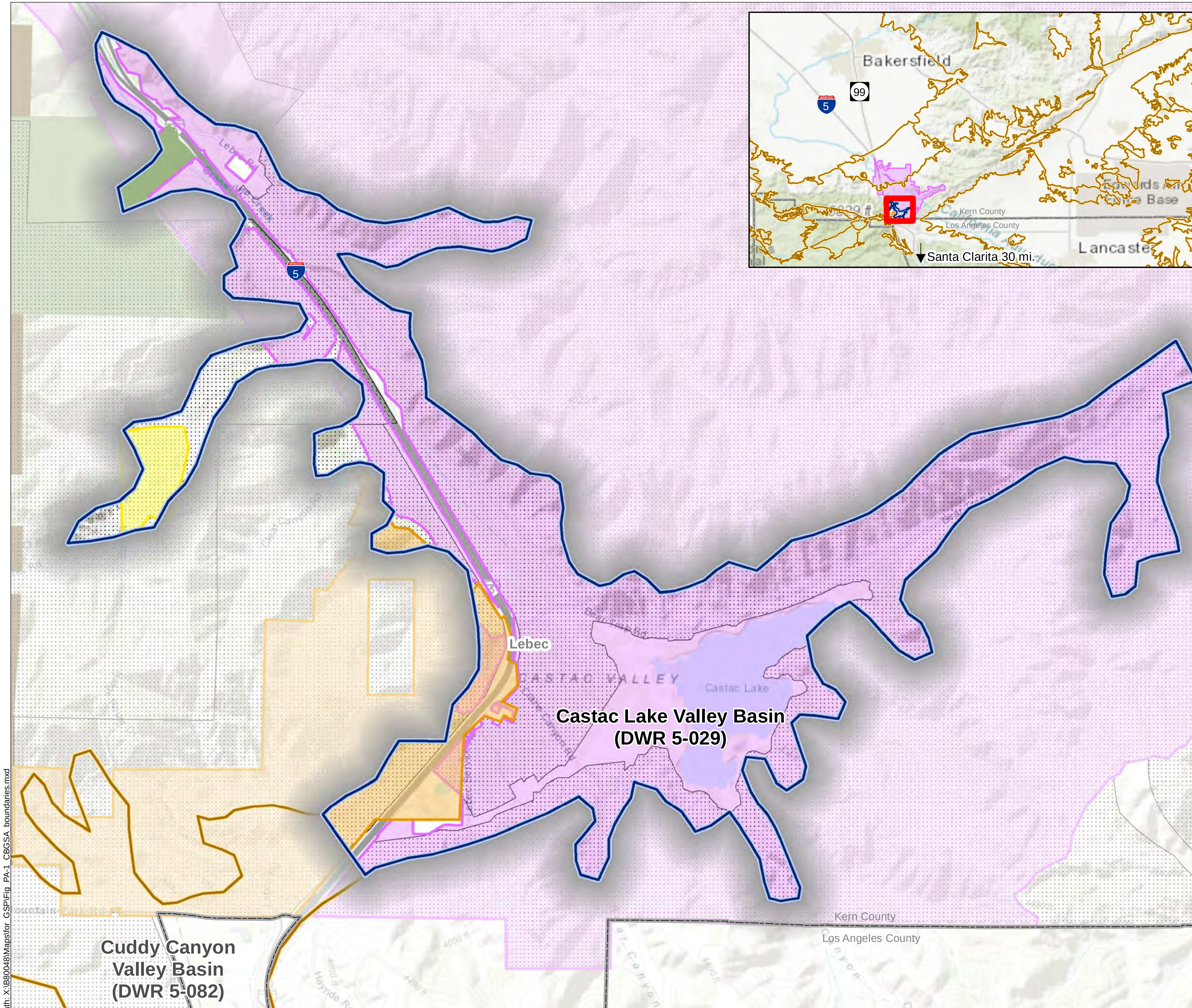
Data Requests were also sent to 15 public water supply systems located within the Basin and in upgradient basins. Four public water supply systems (TCWD, KMWC, Lake of the Woods Mutual Water Company, and LCWD) provided data on their wells. Data included well location, well construction information, water level data, water quality data, and pumpage data. These data were added to the DMS for the Basin and considered during assessment of groundwater conditions, development of the historical water budget, and development of Sustainable Management Criteria (SMCs).

Public Notification

The SCEP Sections 5 and 6 detail the methodology that is being followed to inform the public on GSP updates, status, and actions, which includes making key GSP development decisions in an open and transparent fashion during public GSA Board meetings and holding periodic stakeholder workshops to communicate progress on GSP technical components to stakeholders, and to receive input on upcoming decisions and work efforts. The GSA will publicize all Board meetings and 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) to distribute additional emails and postal mailings, as deemed necessary and appropriate.

Public Comment

Additional public comments received on the draft GSP will be listed in *Appendix D*, which will be updated and incorporated throughout the GSP drafting and development process.



Path: X:\B80048\Mapsfor_GSP\Fig_PA-1_CBGSA_boundaries.mxd

Legend

- Castac Lake Valley Groundwater Basin and Castac Basin GSA Boundary
- Other Groundwater Basin
- Tejon-Castac Water District
- Lebec County Water District
- Krista Mutual Water Company
- Federal Lands
- State Lands
- Specific Plan Area
- County Boundary

Abbreviations

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

Notes

1. All locations are approximate.
2. Castac Basin GSA boundary is coterminous with the Castac Lake Valley Groundwater Basin (5-029) boundary.
3. The entire displayed area within Kern County is covered by the Kern County General Plan.

Sources

1. Groundwater basin boundaries from DWR Bulletin 118 Interim Update 2016.
2. Basemap is ESRI's ArcGIS Online world topographic map, obtained 19 June 2020.
3. LCWD service area obtained from LCWD on 16 March 2017.
4. TCWD service area obtained from TCWD on 11 May 2017.
5. Federal and State Lands from California Protected Areas Database (CPAD) August 2017. www.calands.org
6. Kern County General Plan information obtained on 16 August 2018 from http://esps.kerndsa.com/gis/gis-download-data

N

0 0.5 1

(Scale in Miles)

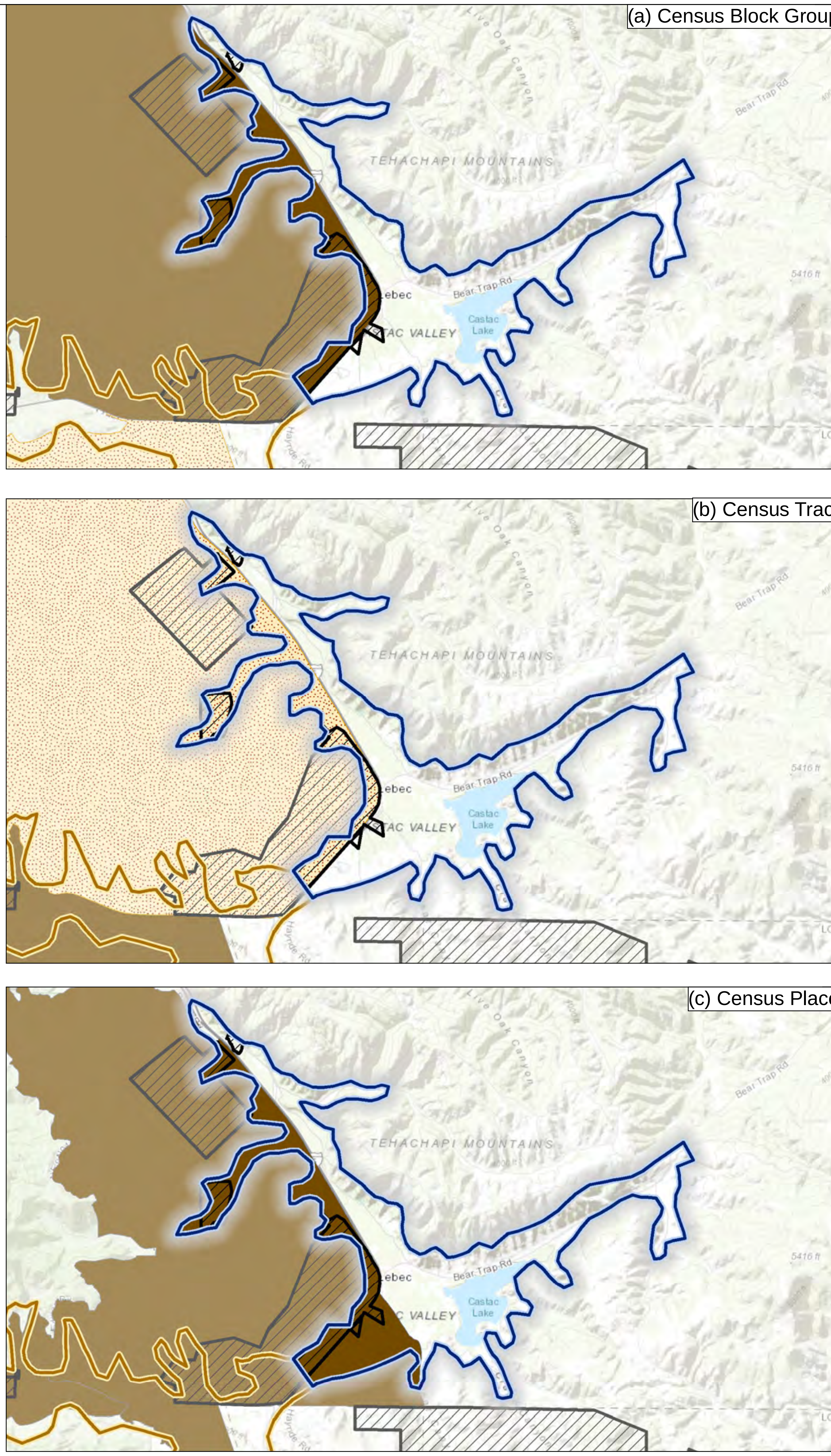
Castac Lake Valley Groundwater Basin Plan Area and Relevant Boundaries

DRAFT

Tejon-Castac Water District
Kern County, California
June 2020
B80048.00

eki environment & water

Figure PA-1



Legend

- Castac Lake Valley Groundwater Basin
- Other Groundwater Basin
- Public Water System Service Area

Disadvantaged Communities

- Severely Disadvantaged Communities
- Disadvantaged Communities

Abbreviations

DWR = California Department of Water Resources

Notes

1. All locations are approximate.
2. Not all public water system service areas are mapped.
3. Disadvantaged communities defined based on 2016 median household income.

Sources

1. Basemap is ESRI's ArcGIS Online world topographic map, obtained 19 June 2020.
2. DWR groundwater basins are based on the boundaries defined in California's Groundwater, Bulletin 118 - 2016 Update.
3. Disadvantaged Communities information downloaded on 4 October 2018 from the SGMA Data Viewer: https://sgma.water.ca.gov/webgis/?appid=SGMADataViewer. Last updated 2016.
4. Public Water System Service area boundaries are from the California Department of Public Health Drinking Water Systems Geographic Reporting Tool. (https://www.waterboards.ca.gov/waterrights/water_issues/programs/drought/water_supplier.shtml)

N

0 1 2

(Scale in Miles)

Disadvantaged and Severely Disadvantaged Communities

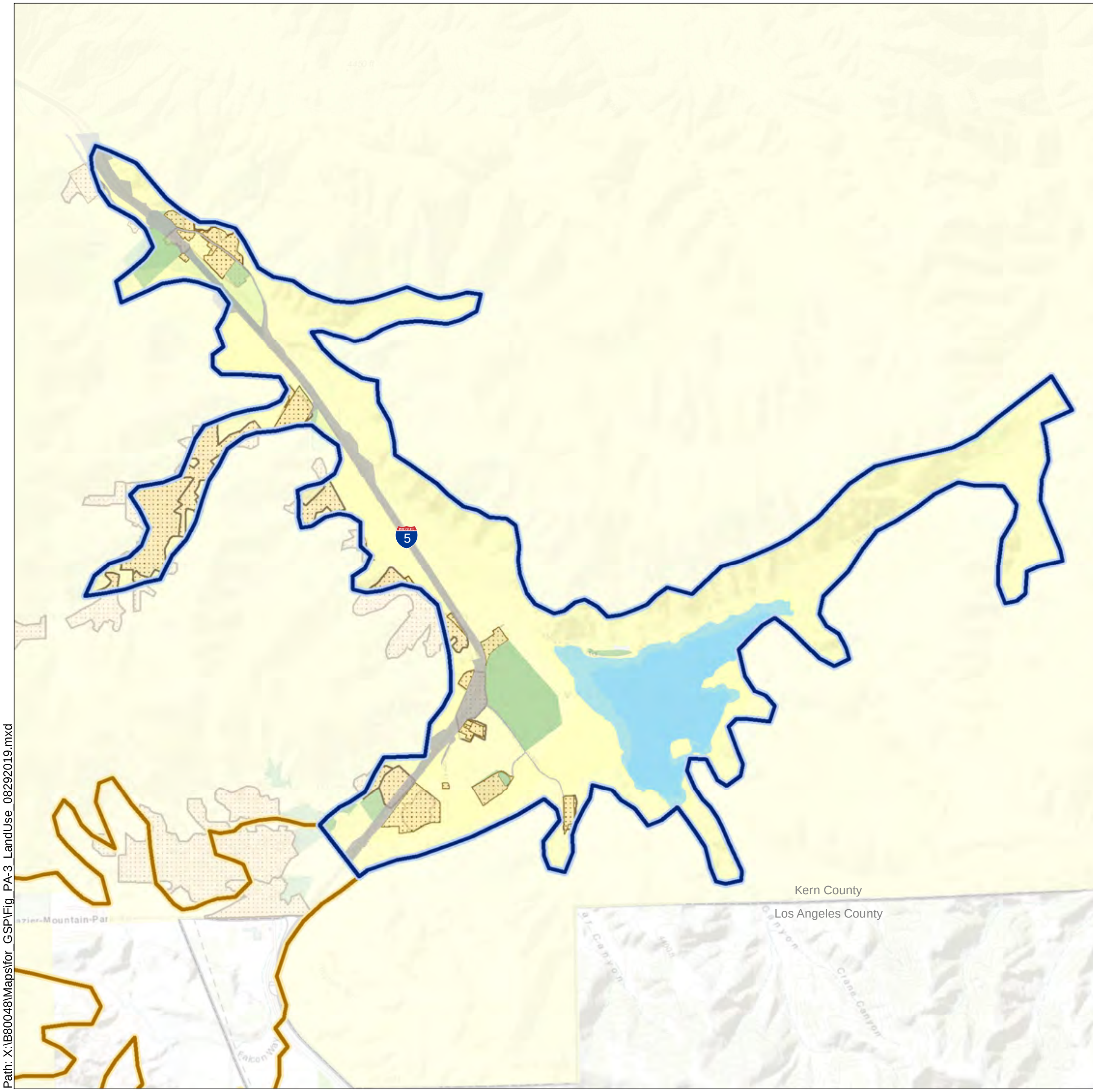
Tejon-Castac Water District
Kern County, California
June 2020
B80048.00

Figure PA-2

DRAFT

eki environment & water

Path: X:\B80048\Maps\for_GSP\Fig_PA-2_DACs.mxd



Legend

Castac Lake Valley Groundwater Basin

Other Groundwater Basin

Current (2016) Land Use

Roads

Irrigated Land

Residential & Commercial

Lake

Range/ Undeveloped Land

Abbreviations

DWR = California Department of Water Resources

TCWD = Tejon-Castac Water District

Notes

1. All locations are approximate.

Sources

1. Groundwater basin boundaries from DWR Bulletin 118 Interim Update 2016.
2. Basemap is ESRI's ArcGIS Online world topographic map, obtained 19 June 2020.
3. Current Land Use data from TCWD 31 May 2019 and California Department of Conservation Important Farmland, Kern County 2016.

N

0 0.5 1

Miles

DRAFT

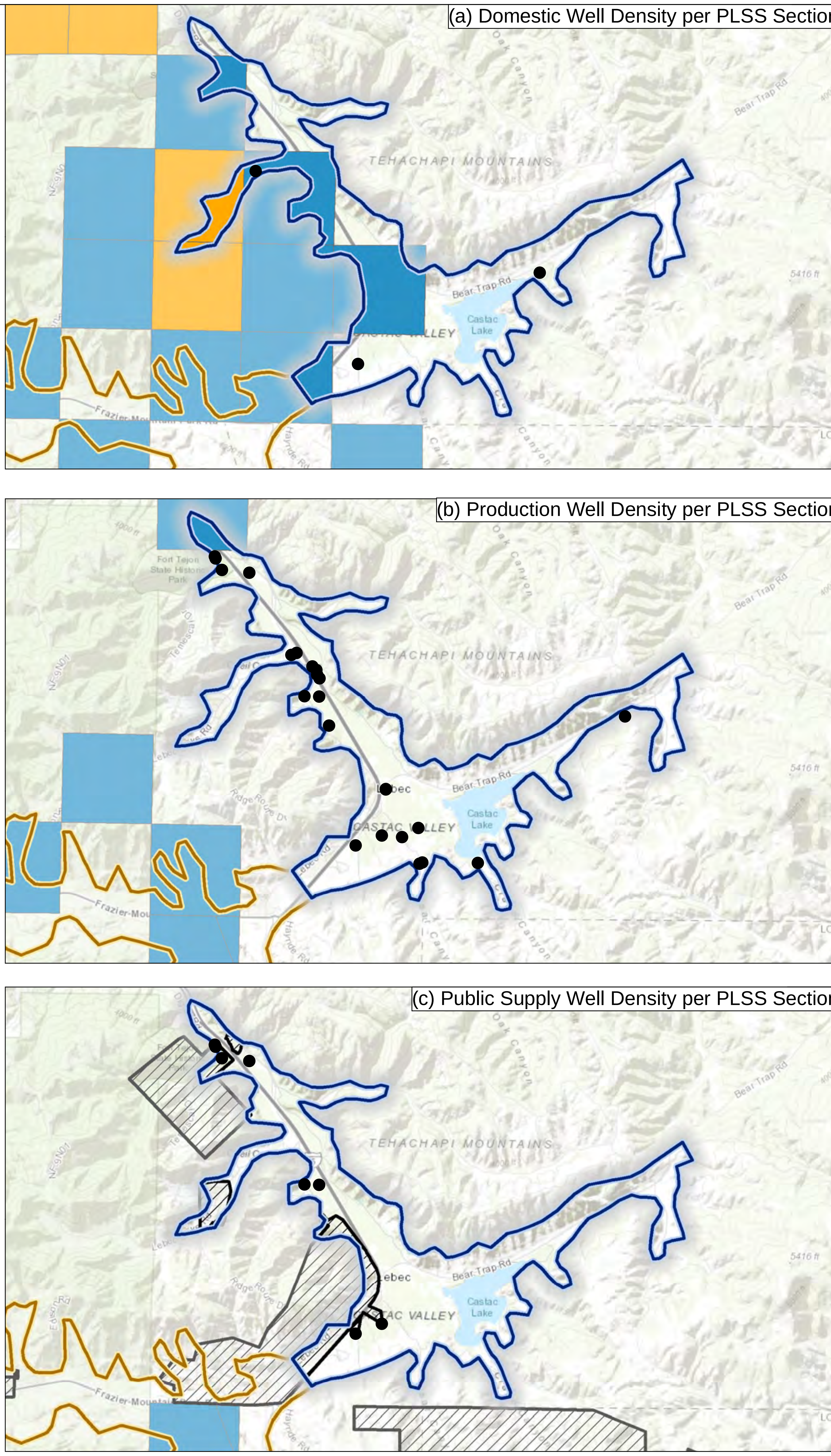
Current (2016) Land Use

eki environment & water

Tejon-Castac Water District
Kern County, California
June 2020
B80048.00

Figure PA-3

Path: X:\B80048\Maps\for_GSP\Fig_PA-3_LandUse_08292019.mxd



Legend

- Well
- Castac Lake Valley Groundwater Basin
- Other Groundwater Basin

Well Density per PLSS Section

- 1 - 2
- 2 - 3
- 3 - 4
- > 4

Public Water System Service Area

Abbreviations
DWR = California Department of Water Resources
PLSS = Public Land Survey System

Notes
1. All locations are approximate.
2. Not all public water system service areas are mapped.

Sources
1. Basemap is ESRI's ArcGIS Online world topographic map, obtained 19 June 2020.
2. DWR groundwater basins are based on the boundaries defined in California's Groundwater, Bulletin 118 - 2016 Update.
3. Well count per square mile (PLSS section) from DWR's Well Completion Report Map Application, obtained on 23 October 2018 (https://dwr.maps.arcgis.com/apps/webappviewer/index.html?id=181078580a214c0986e2da28f8623b37).
4. Public Water System Service area boundaries are from the California Department of Public Health Drinking Water Systems Geographic Reporting Tool. (https://www.waterboards.ca.gov/waterrights/water_issues/programs/drought/water_supplier.shtml)

N
0 1 2
(Scale in Miles)

Well Density from DWR Well Completion Reports and Basin Wells

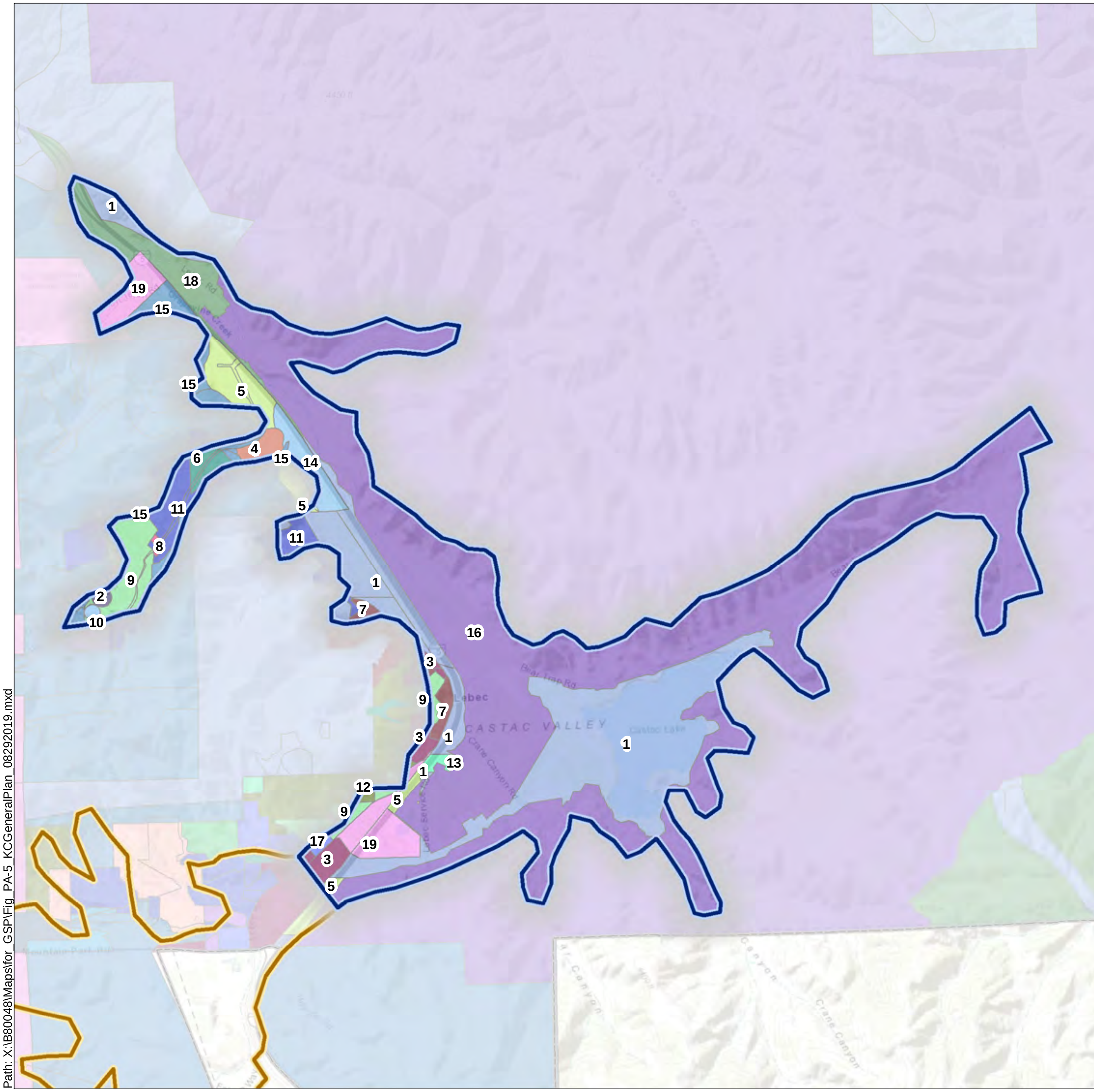
Tejon-Castac Water District
Kern County, California
June 2020
B80048.00

Figure PA-4

DRAFT

eki environment & water

Path: X:\B80048\Maps\for GSP\Fig_PA-4_WellDensity_DWR.mxd



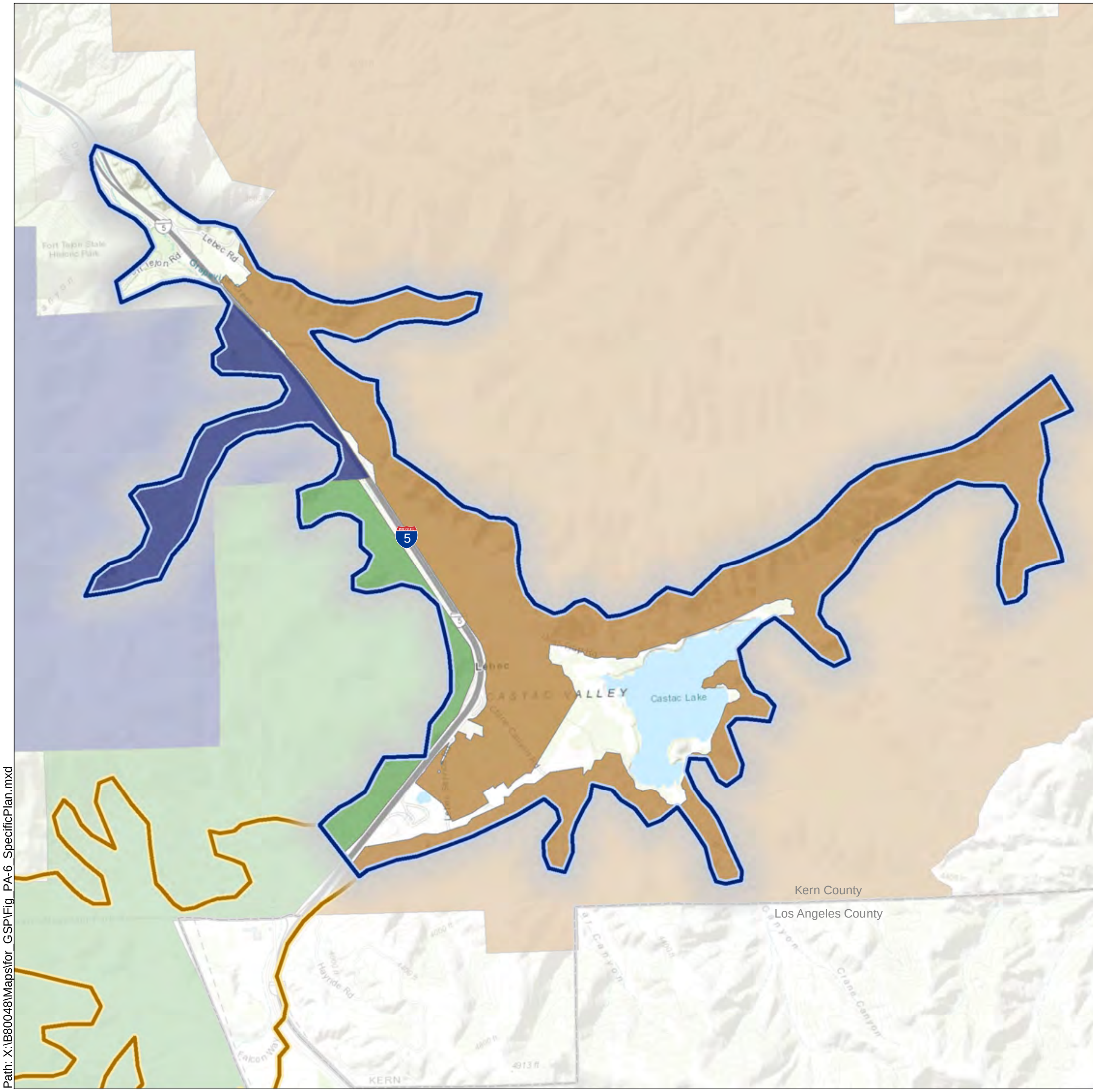
DRAFT

Kern County General Plan - Land Use Designation

Tejon-Castac Water District
Kern County, California
June 2020
B80048.00

eki environment & water

Figure PA-5



Legend

- Castac Lake Valley Groundwater Basin
- Other Groundwater Basin
- County Boundary

Specific Plan Area

- Frazier Park/Lebec
- O'Neil Canyon
- Tejon Mountain Village

Abbreviations

DWR = California Department of Water Resources

Notes

1. All locations are approximate.

Sources

1. Groundwater basin boundaries from DWR Bulletin 118 Interim Update 2016.
2. Basemap is ESRI's ArcGIS Online world topographic map, obtained 19 June 2020.
3. Kern County General Plan information obtained on 16 August 2018 from http://esps.kerndsa.com/gis/gis-download-data

N

0 0.5 1

Miles

DRAFT

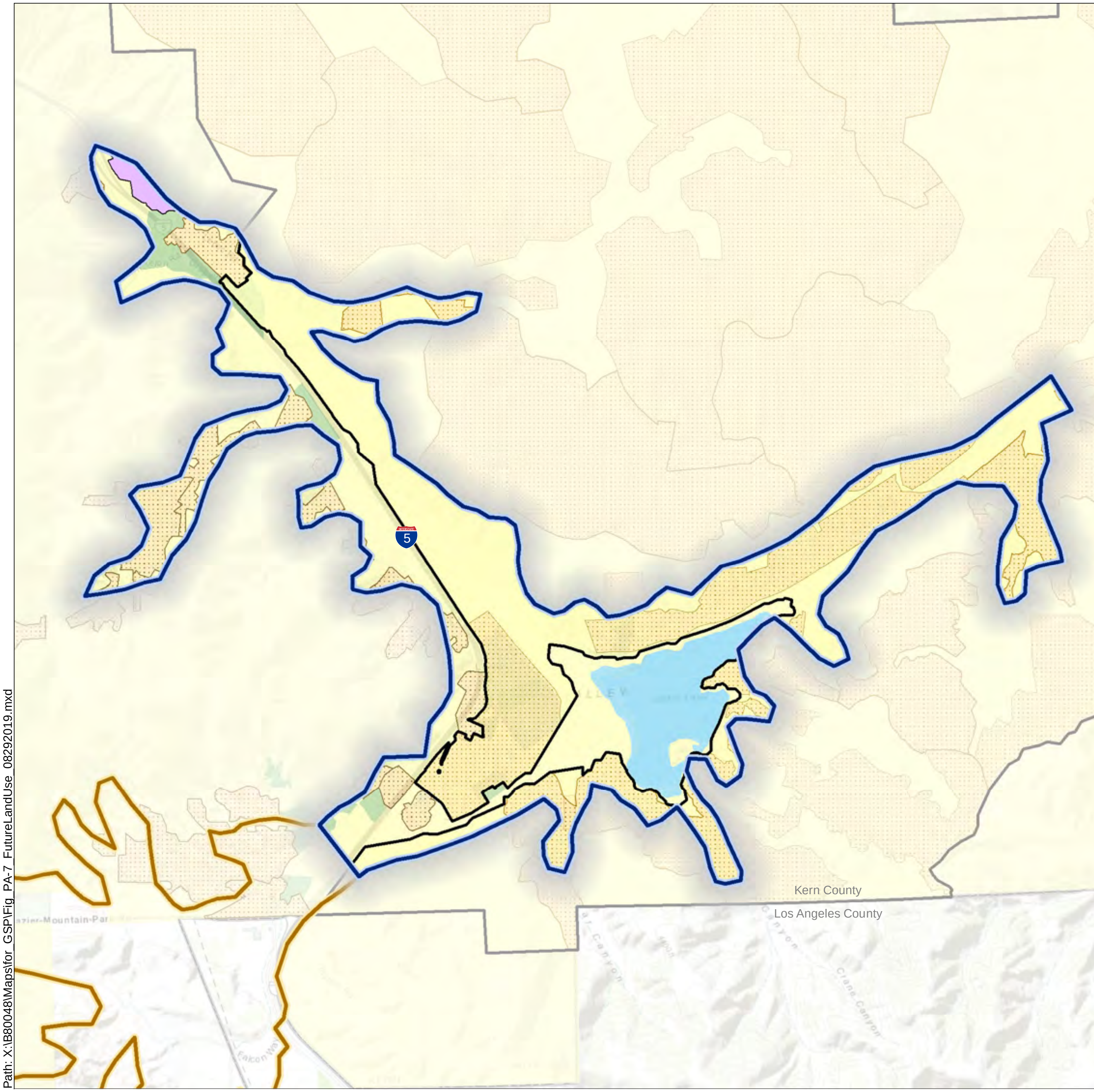
Kern County General Plan - Specific Plan Areas

eki environment & water

Tejon-Castac Water District
Kern County, California
June 2020
B80048.00

Figure PA-6

Path: X:\B80048\Maps\for_GSP\Fig_PA-6_SpecificPlan.mxd



Legend

- Castac Lake Valley Groundwater Basin
- Other Groundwater Basin
- TMV Boundary

Future Land Use

- Residential & Commercial
- Range / Undeveloped Land
- Irrigated Land
- Ranch Wide Agreement: Future Dedicated Conservation Easement Area

Abbreviations

DWR = California Department of Water Resources
TCWD = Tejon-Castac Water District
TMV = Tejon Mountain Village

Notes

1. All locations are approximate.
2. Future land use within the TMV Boundary is representative of projected TMV zoning at full build-out.

Sources

1. Groundwater basin boundaries from DWR Bulletin 118 Interim Update 2016.
2. Basemap is ESRI's ArcGIS Online world topographic map, obtained 19 June 2020.
3. Future land use data is from TCWD 31 May 2019.

DRAFT

Projected Future Land Use

eki environment & water

Tejon-Castac Water District
Kern County, California
June 2020
B80048.00

Figure PA-7

Path: X:\B80048\Maps\for_GSP\Fig_PA-7_FutureLandUse_08292019.mxd

BASIN SETTING

6. INTRODUCTION TO BASIN SETTING

> *§ 354.12. Introduction to Basin Setting*
> *This Subarticle describes the information about the physical setting and characteristics of the basin and current conditions of the basin that shall be part of each Plan, including the identification of data gaps and levels of uncertainty, which comprise the basin setting that serves as the basis for defining and assessing reasonable sustainable management criteria and projects and management actions. Information provided pursuant to this Subarticle shall be prepared by or under the direction of a professional geologist or professional engineer.*

This section presents Basin Setting information for the Basin (**Figure HCM-1**). In some cases, Basin Setting information for areas proximal to, but outside of, the Basin is provided for context. Basin Setting information includes the Hydrogeologic Conceptual Model (HCM), Groundwater Conditions, and Water Budget.

7. HYDROGEOLOGIC CONCEPTUAL MODEL

§ 354.14. Hydrogeologic Conceptual Model
(d) Each Plan shall include a descriptive hydrogeologic conceptual model of the basin based on technical studies and qualified maps that characterizes the physical components and interaction of the surface water and groundwater systems in the basin.

This section presents the HCM for the Basin. As described in the HCM Best Management Practices (BMP) document (California Department of Water Resources [DWR], 2016a), an HCM provides, through descriptive and graphical means, and understanding of the physical characteristics of an area that affect the occurrence and movement of groundwater, including geology, hydrology, land use, aquifers and aquitards, and water quality. This HCM serves as a foundation for subsequent Basin Setting analysis including water budgets (Section 9) and analytical models, monitoring network development (Section 16), and the development of sustainable management criteria (Sections 11 through 15).

7.1. General Description

§ 354.14. Hydrogeologic Conceptual Model
(b) The hydrogeologic conceptual model shall be summarized in a written description that includes the following:
(1) The regional geologic and structural setting of the basin including the immediate surrounding area, as necessary for geologic consistency.
(2) Lateral basin boundaries, including major geologic features that significantly affect groundwater flow.
(3) The definable bottom of the basin.
(4) Principal aquifers and aquitards, including the following information:
(A) Formation names, if defined.
(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.
(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.
(D) General water quality of the principal aquifers, which may be based on information derived from existing technical studies or regulatory programs.
(E) Identification of the primary use or uses of each aquifer, such as domestic, irrigation, or municipal water supply.
(5) Identification of data gaps and uncertainty within the hydrogeologic conceptual model

7.1.1. Geological and Structural Setting

The Basin lies within the Tehachapi and San Emigdio Mountains, in a region of faulted, deformed, and uplifted igneous and metamorphic rocks (**Figure HCM-1**). The mountains are part of an abrupt east-west trending range that is bisected by narrow, steep-sided linear valleys. This unusual geomorphic terrain is controlled by the presence of two very large strike-slip faults and their associated fault zones, the San Andreas Fault and the Garlock Fault, which intersect approximately 3.5 miles west of the western Basin boundary (Dibblee and Minch, 2006; Vedder and Wallace, 1970). Tectonic stresses induced by these major faults have produced much of the current landscape and have controlled, in large part, the structure and lithology of the local bedrock and the stratigraphy and lithology of alluvium within the local groundwater basins. The Basin contains a total aerial extent of 3,563 acres, and includes two linear valleys together shaped vaguely like an inverted "T". The primary axis of the Basin follows the local northeast-southwest trace of the Garlock Fault, and the Grapevine Canyon area of the Basin extends northwest at a high angle to the primary axis (**Figure HCM-1**).

The Basin can be divided generally into three areas: the Castac Lake area, the Dryfield Canyon area, and the Grapevine Canyon area (**Figure HCM-1**). The Castac Lake area of the Basin is structurally controlled, as it is bounded on the north and south by the extent of the Garlock Fault Zone, on the west by the Cuddy Canyon Basin, and on the east by the alluvial fill of Dryfield Canyon. The Grapevine Canyon area of the Basin is bounded by the extent of alluvial fill on all sides but the south (i.e., the portion which abuts the Castac Lake portion of the Basin). The Dryfield canyon area of the Basin is bounded by the extent of alluvial fill, except where it intersects the Castac Lake area.

Over geologic time, the movement of huge blocks of bedrock along the San Andreas Fault and to a lesser extent the Garlock Fault has provided a variety of local rock types for weathering and deposition into the Basin. Erosion has filled the Basin with several hundred feet of alluvial materials. Fault movement has redistributed the alluvial basin fill to varying degrees. Local bedrock may provide most of the material for alluvial fill within Grapevine Canyon, although alluvium from the upgradient basins has also been transported into the Basin and then into Grapevine Canyon.

7.1.2. <u>Lateral Basin Boundaries</u>

Various igneous and metamorphic bedrock units bound the Basin on all sides and at its base, as drawn in geologic maps produced by the California Geologic Survey (CGS) (Olson, 2014; Swanson and Olson, 2016; Olson and Swanson, 2017). These include Cretaceous age granite, granodiorite, and quartz diorite orthogneiss, with some schist and marble, See Section 7.3 *Physical Characteristics* below for additional discussion.

The Basin is located adjacent to, and immediately downgradient of, the Cuddy Canyon basin. The Cuddy Canyon basin is in turn downgradient of the Cuddy Ranch Area Groundwater Basin (DWR Basin No. 5-84) and the Cuddy Valley Groundwater Basin (DWR Basin No. 5-83). The location of these groundwater basins relative to the Basin and each other is shown on **Figure HCM-2**. These basins were formed by the same geological and tectonic processes that formed the Basin. The three upgradient groundwater basins and their associated watersheds are potential sources for water inflows to the Basin.

7.1.3. Bottom of the Basin

As described below, multiple sources of information can be relied on to define the "bottom of the basin" for purposes of the Sustainable Groundwater Management Act (SGMA), including elevation maps of the basement bedrock surface, information on the base of fresh water, the presence, location and depth of oil and gas fields, "exempted" aquifers under the Safe Drinking Water Act (SDWA), and depth of groundwater extraction. Each of these is discussed below and a summary comparison for depth information relevant to the bottom of the Basin definition is included in **Table HCM-1**.

Table HCM-1. Information Relevant to Definition of the Bottom of the Basin

Type of Information	Source(s)	Bottom of the Basin Depth Range (ft bgs)
Depth to Bedrock Basement	Well logs within Castac Basin DMS	95 to 355
Deepest Groundwater Extractions from Well Construction Information	Pumping well logs within Castac Basin DMS	166 to 400

Abbreviations:
DMS = data management system
ft bgs = feet below ground surface

Depth to Basement Bedrock

Available hydrogeologic information indicates that bedrock within the Basin is generally of very low permeability and therefore forms the bottom of the basin. In general, the Basin is mostly underlain by igneous granitic or granodioritic bedrock of Cretaceous age (Olson, 2014; Swanson and Olson, 2016; Olson and Swanson, 2017).

Figure HCM-3 displays depth to bedrock based on encountered bedrock depths in boreholes for several wells in the Basin. The total depth of alluvium in the basin is estimated to vary from approximately 95 feet below ground surface (ft bgs) near the southern margin of the Basin, to approximately 350 ft bgs near the center axis of the Basin. Boreholes drilled in the Grapevine Canyon area of the Basin generally encountered granitic bedrock at depths ranging from 280 to 300 ft bgs. The exception is a borehole drilled at the head of Grapevine Canyon at the boundary between the Castac Lake and Grapevine Canyon areas of the Basin, in which weathered bedrock was encountered at approximately 200 ft bgs.

Additionally, seismic reflection data infer a general bedrock depth of approximately 360 ft bgs in the central part of the Cuddy Creek alluvial fan deposits (Engeo, 2008).

Base of Fresh Water

In some deeper basins, it can be more appropriate to consider geochemical properties (i.e. water quality) in determining the definable bottom of the Basin (DWR, 2016a), specifically where water becomes unsuitable for consumption or irrigation, as defined by total dissolved solids (TDS) concentrations exceeding 3,000 milligrams per liter (mg/L).[10] Castac Basin, however, is relatively shallow and cannot easily be defined in terms of water quality. Samples collected from wells throughout the Basin indicate that the concentrations of TDS in groundwater are around 615 mg/L and range from 258 to 1,800 mg/L. Therefore, wells with available water quality all are screened within fresh water.

Oil and Gas Fields

No oil or gas fields have been mapped within the Basin, based on available published data (California Department of Conservation Division of Oil, Gas, and Geothermal Resources [DOGGR], 2019).

Exempted Aquifers

Under the SDWA, the United States Environmental Protection Agency (USEPA, and through a primacy agreement, the State Water Resources Control Board [SWRCB]) regulates injections into underground sources of drinking water. One such type of injections, known as Class II injections, involve either enhanced oil recovery or for disposal of fluids associated with oil and gas production. In general, Class II injections are prohibited under the SDWA, except in "exempted aquifers." The DOGGR and SWRCB consider proposals for aquifer exemptions on a case by case basis. No existing or proposed exempted aquifers have been designated within the Basin.[11]

Deepest Groundwater Extractions

The DWR BMP guidance for HCMs (DWR, 2016a) states that "the definable bottom of the basin should be at least as deep as the deepest groundwater extractions." As shown on **Figure HCM-4**, construction information is available for 15 existing pumping wells (i.e., well depth, screen interval, and/or borehole depth), and all wells have depths of 400 ft bgs or less[12].

---

[10] The United States Environmental Protection Agency (US EPA) defines water with a TDS concentration of less than 3,000 mg/L to be suitable for livestock consumption or crop irrigation. Water between 3,000 mg/L and 10,000 mg/L is defined as "usable quality water" and water exceeding 10,000 mg/L is defined as "brine." The United States Geological Survey (USGS) commonly refers to water with a TDS concentration of less than 1,000 mg/L as freshwater. A recent USGS report (Osborn et al., 2013) completed as part of the Brackish Groundwater Assessment defined saline groundwater as follows: "slightly saline" groundwater containing a TDS concentration between 1,000 and 3,000 mg/L; "moderately saline" groundwater containing a TDS concentration between 3,000 and 10,000 mg/L; "very saline" groundwater containing a TDS concentration between 10,000 and 35,000 mg/L; and "brine" containing a TDS concentration exceeding 35,000 mg/L.

[11] https://epa.maps.arcgis.com/apps/MapSeries/index.html?appid=426ef9d346f9487e96ee5899ab67a2e4

[12] One well, which has since been abandoned, had a depth of 562 ft bgs.

Given the above information, the controlling factor for the definable "bottom of the basin" is determined to be the depth to basement bedrock. Therefore, for the purposes of this GSP, the bottom of the basin is defined to be approximately 400 ft bgs in the Castac Lake area of the Basin.

7.1.4. Principal Aquifers and Aquitards

Principal aquifers are defined in the GSP Emergency Regulations (23-California Code of Regulations [CCR] §351) as "aquifers or aquifer systems that store, transmit, and yield significant or economic quantities of groundwater to wells, springs, or surface water systems" (23-CCR §351(aa)). Unconsolidated clastic sediments, including interbeds of sands and gravels with varying amounts of silts and clays, have filled the Basin over time. The Basin generally contains one Principal Aquifer, which can be vertically divided into two hydrostratigraphic "zones," each with a variable, but distinct, set of geologic and hydraulic properties.

Based on water level data, results of aquifer pumping tests, and water quality data, it appears that the Deep and Shallow Aquifer zones within the Basin are somewhat hydraulically connected. Water-level measurements from wells screened in the Deep Aquifer Zone indicate that it is semi-confined and historically under artesian pressure, with heads seasonally above ground surface in some wells during wet years. During aquifer pumping tests conducted in Deep Aquifer Zone wells within both the Castac Lake and Grapevine Canyon areas of the Basin, slight drawdowns were observed in Shallow Aquifer Zone wells (EKI, 2008b). The data suggest that connectivity to the Deep Aquifer Zone increases with depth within the Shallow Aquifer Zone (EKI, 2008b), which is attributed to the effect of interbedded sedimentary sequences of relatively finer and coarser materials within the shallow subsurface.

Formation Names and Occurrence

The **Shallow Aquifer Zone** coincides generally with Holocene sediments of the upper portion of a fine-grained alluvial unit generally located within the upper 100 ft bgs. This fine-grained alluvium consists of granitic-dominated alluvial sands with locally-extensive clays and minor gravels, locally coarsens downward, and extends from near the surface to as deep as 160 ft bgs (EKI, 2008e). Other, less-common shallow stratigraphic units include a shallow interbedded alluvial unit encountered only in two boreholes adjacent to the current Cuddy Creek channel, which is attributed to recent Cuddy Creek mixed alluvium (interbedded sands and gravels with variable clay content, clayey interbeds, and moderate to weak pervasive iron-oxide staining), and the fine-grained clayey-sand alluvium (interbedded granitic-dominated medium clayey sands, clays, and sand-clay interbeds with minor gravels, coarsening below 65 ft bgs), which was encountered only in upper Grapevine Canyon (EKI, 2008e).

The **Deep Aquifer Zone** is generally made up of the lower fine-grained alluvium, the medium-grained alluvium, and, where present, the coarse-grained alluvium and the very coarse-grained alluvium, terminating at the weathered bedrock contact generally located below 100 ft bgs. The medium-grained alluvium consists of interbedded sands and gravels of variable composition, with rare clay interbeds, and extends from as little as 50 ft bgs to as much as 400 ft bgs (EKI, 2008e). The coarse-grained alluvium consists mostly of gravels and sands of mixed igneous and metamorphic lithology, with rare interbeds of iron oxide-stained clay and silt and is encountered at depths between 200 to 270 ft bgs in two boreholes in the Basin (EKI, 2008e). The very coarse-grained alluvium consists of a coarse clastic basal sequence of gravel, cobbles, and local zones of boulders, comprised of mixed igneous and metamorphic rocks and is encountered in only one borehole within Basin, located near the axis of the Cuddy Creek alluvial fan west of Castac Lake (EKI, 2008e).

Physical Properties of Aquifer(s) and Aquitard(s)

Table HCM-2 provides estimates of the water storage and transmitting properties based on hydraulic testing of multiple deep and shallow-aquifer wells (EKI, 2008b).

Table HCM-2. Water Storage and Transmitting Properties

Aquifer	Zone	Approximate Depth (ft bgs)	Transmissivity (ft^2/d)	Hydraulic Conductivity (ft/d)	Storage Coefficient (unitless)
Principal	Shallow	0-100	430	10	0.0025
	Deep	100-400	3,100 – 12,000	18 – 86	$6x10^{-4}$ – $3.5x10^{-3}$
n/a	Bedrock	>400	4.3	0.014	n/a

Abbreviations:
ft/d = feet per day
ft^2/d = feet squared per day
ft bgs = feet below ground surface
n/a = not applicable

Structural Properties of the Basin that Restrict Groundwater Flow Within the Principal Aquifers

Based on the geomorphology of the Basin, the Castac Lake area of the Basin appears to be a sag feature related to bounding splays of the Garlock Fault on its northern and southern sides (Clark, 1973; DWR, 2003). The surface expression of the Garlock Fault in the Basin is obscure and discontinuous (**Figure HCM-1** and **Figure HCM-2**) and may indicate that (1) movement locally along the westerly portion of Garlock Fault is relatively minor and old relative to the more active, eastern portions of the Garlock Fault or that (2) the movement is highly distributed amongst numerous subparallel shear planes (Clark, 1973). ECI (2006) conducted a subsurface investigation using Cone Penetration Testing in the Castac Lake area of the Basin and interpreted fault vertical offsets of approximately 1 to 10 feet in shallow alluvial beds. ECI (2006) attributed the apparent vertical offset in the shallow alluvial beds to various splays of the Garlock Fault within the alluvium west of Castac Lake, and noted that this apparent, recent vertical movement actually may represent the vertical component of oblique or other complex fault movement.

Significantly steepened water level gradients observed in the vicinity of the intersection of the San Andreas and Garlock Fault (i.e., just east of Frazier Park) indicate that restrictions to groundwater flow may exist in this region. Complex geologic movement within fault zones such as the San Andreas and Garlock Fault can offset and deform alluvial beds and can create clay-rich gouge zones of increased weathering, either of which could impede groundwater flow within the affected aquifer area. However, the actual effects, if any, on aquifer hydrogeologic properties at the fault intersection and associated splays of the San Andreas and Garlock Faults are currently unknown (DWR, 2003). Further upgradient (i.e., west of the fault intersection), the degree of subsurface hydraulic connection between the Cuddy Canyon, Cuddy Valley, and Cuddy Ranch groundwater basins is also not well understood and may be limited by the presence of complex splays of the San Andreas Fault (DWR, 2003; Bookman and Edmonston, 1965; Barto, 1985).

Seismic reflection and resistivity profiling may indicate the presence of additional unmapped splays of the Garlock Fault or other related faults (Engeo, 2008). On a seismic profile constructed subparallel to the Garlock Fault, a set of three opposing faults were interpreted with uncertain strike orientation which apparently dip steeply toward the center of the Cuddy Creek alluvial fan, forming a graben-like feature with an apparent vertical movement of approximately 50 feet (Engeo, 2008; Norcal, 2007). On two seismic profiles constructed approximately perpendicular to the Garlock Fault, a different set of three, closely-spaced steeply-dipping to vertical faults or joints that may be traceable across the two seismic profiles were interpreted, indicating a possible north-northeast strike, subparallel to Grapevine Canyon on its eastern side (Engeo, 2008; Norcal, 2007). Displacement on this set of interpreted fault structures is not readily discernable from the seismic data, though they appear to be subparallel and along-strike of "inactive" faults mapped by ECI (2006) in Crane Canyon and Hamilton Canyon, on the south side of the Basin.

Aquifer pumping test results (EKI, 2008b) indicate that there is no substantial barrier to flow from the Castac Lake area of the Basin into Grapevine Canyon across the observed bedrock high (i.e., the observed bedrock high appears not to be high enough to impede flow, and no fault-related barriers appear to exist).

During hydraulic testing, drawdown was measured in observation wells in response to pumping in wells located across unmapped, but probable Garlock Fault splays (EKI, 2008b). The observed results suggest that the splays of the Garlock Fault do not appear to form an important hydraulic barrier to groundwater flow in the deep alluvium of the Basin (EKI, 2008b).

General Water Quality of the Principal Aquifer(s)

General water quality types can be inferred from the ionic composition of water samples, plotted on either a Piper Diagram or Stiff Diagrams which display the relative proportions of cations and anions in water samples. In a Piper Diagram, the proportions of anions (chloride, sulfate, bicarbonate and carbonate) and cations (calcium, magnesium, potassium, and sodium) are plotted as points in lower triangles and the data points are projected into the central diamond plotting field along parallel lines. The Stiff Diagram plots cations concentrations (sodium, calcium, and magnesium, in milliequivalents per liter [meq/L]) sequentially on each axis to the left of zero and anions concentrations (chloride, bicarbonate, and sulfate) sequentially on each axis to the right of zero. The resulting points are connected to give an irregular polygonal shape, which can provide a distinctive method of comparing water composition where the width of the pattern approximately indicates the sample's total ionic content. The Piper Diagram presented in **Figure HCM-5** plots samples collected between 1995 and 2018 and suggests water in the Principal Aquifer is predominately bicarbonate/carbonate. Stiff diagrams presented in **Figure HCM-6** plot the most recent well-water samples collected and suggest the Principal Aquifer is primarily bicarbonate-sulfate, except in Dryfield Canyon where wells show a calcium carbonate signature.

Further discussion of specific constituents of particular relevance to the beneficial uses within the Basin, including maps of these constituent distributions, is provided in Section 8.5 *Groundwater Quality Concerns* below.

Primary Uses of Each Aquifer

The predominant use of groundwater is for a source of public water supply by a small number of public water systems, irrigated agriculture, and to supply some private domestic wells. **Figure HCM-7** shows the distribution of wells within the Basin by well type (i.e., public supply, domestic, domestic/irrigation, irrigation, monitoring, or unknown) based on the best available data.

7.1.5. Data Gaps

Key data gaps and uncertainties identified during development of this HCM for the Basin include:

- Uncertainty in the restriction of groundwater flow between the Cuddy Canyon and Castac Basins;
- Current groundwater quality in monitoring wells, specifically for dates after 2008;
- Uncertainty about well construction details (i.e., well depth and screened intervals) for 28 wells that are mapped as being constructed within the Basin;
- Uncertainty about well measuring point elevations for 38 wells that are mapped as being constructed within the Basin;
- Uncertainty about well use and status (i.e., whether wells are active) for 17 wells that are mapped as being constructed within the Basin;
- Monthly pumping data from Tejon Middle School and Historical Fort Tejon public water system wells prior to 2013;
- Water level data from Tejon Middle School and Historical Fort Tejon public water system wells, and up-gradient wells;
- Measured evapotranspiration; and

- Stream flow measurements from Cuddy Creek and Grapevine Creek.

7.2. Cross Sections

§ 354.14. Hydrogeologic Conceptual Model
(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.

Two hydrogeologic cross-sections (A-A’ and B-B’) were developed for this HCM (see **Figure HCM-8** and **Figure HCM-9**, respectively). The locations of the cross-sections with respect to the surficial geology are shown on **Figure HCM-10**. These cross-sections cut approximately parallel to, and orthogonal to, the main axis of the Cuddy Creek and Grapevine Canyon valleys and are based on published maps, site-specific geologic information from drilling (EKI, 2008a; ECI, 2006; Schmidt, 2002; Galli, 2005; Stetson, 2001a,b; Dudek & Associates, 1999), and subsurface geophysical profiling (Engeo, 2008). Cross-section A-A' (**Figure HCM-8**) is drawn to extend from up-gradient Cuddy Canyon basin through the Basin from approximately southwest to northeast. Cross-section B-B' (**Figure HCM-9**) is drawn orthogonal to cross-section A-A' and runs approximately southeast to northwest through Grapevine Canyon. The cross-sections extend vertically down to an elevation of 2,900 feet mean sea level (ft MSL), include the entire thickness of aquifer materials down to unweathered bedrock, and therefore include all materials that could reasonably be tapped for groundwater supply purposes. The cross-sections and/or the HCM include data from the following sources:

- Land surface elevation extracted from the U.S. Geological Survey 30-meter digital elevation model (DEM), Cuddy Valley, Frazier Mountain, Grapevine, Lebec, and Pastoria Creek 1:24K topographic quadrangles;
- Surficial geologic units after Dibblee & Minch, 2006;
- Water supply and monitoring wells proximal to the cross-section lines, showing well depth and screened interval information. The locations of wells included on the cross-sections are shown on inset maps in the cross-section figures;
- Subsurface geologic units, informed by EKI, 2008a; ECI, 2006; Schmidt, 2002; Galli, 2005; Stetson, 2001a,b; Dudek & Associates, 1999; and Engeo, 2008;
- Groundwater levels from Spring 2015; and
- Depth to bedrock.

<u>Cross-Section A-A’</u>

Cross-section A-A’ (**Figure HCM-8**) extends for approximately three and a half miles in a southwest to northeast direction along the axis of the Basin. The cross-section is approximately parallel to the Garlock Fault zone and cuts through the center of the Basin and Castac Lake. The surficial geology encountered in the southwest portion of the Basin is mapped in **Figure HCM-10** as modern alluvium ("Qa"). Moving northeasterly, this transitions to modern alluvial fan deposits ("Qf") and then to lake deposits ("Ql") found beneath the historical extent of Castac Lake. To the east of Castac Lake in the Dryfield Canyon area of the Basin, the cross-section intersects mostly Qa with interspersed areas of older alluvium ("Qoa") and Qf.

The subsurface geologic units include the Shallow and Deep Aquifer zones in which deposits coarsen downward throughout the center of the Basin beneath Castac Lake. Shallow fine-grained alluvium with clay transitions to recent interbedded alluvial deposits to the west of Grapevine Canyon.

The Spring 2015 groundwater elevations range from 3,550 ft MSL on the southwestern part of the Basin to 3,482 ft MSL on the northeastern side of the Basin.

Cross-Section B-B'

Cross section B-B' (**Figure HCM-9**) extends for approximately four miles in a southeast to northwest direction along the axis of Grapevine Canyon. The cross-section is orthogonal to cross-section A-A' and is perpendicular to the Garlock Fault zone. The surficial geology mapped in **Figure HCM-10** includes a short amount of modern alluvial fan deposits ("Qf") at the start of the line, which transition to the modern alluvium ("Qa") found down the length of Grapevine Canyon. Near the end of the cross-section in the northwest, the cross-section crosses the mapped approximate surface expression of the Pastoria thrust fault, though the existing borehole data did not indicate the obvious presence of a thrust fault in this area and so no fault is shown on the cross section. Continuing northwesterly, an area of artificial fill ("af") associated with the crude oil pipeline site is mapped, which transitions to mostly Qf with Qa in Grapevine Creek's streambed.

Subsurface geologic units represented on the cross sections include the Shallow and Deep Aquifer zones in which deposits generally coarsen downward. In the southwestern portion of the Basin, where the cross-section intersects the Garlock Fault zone, a mixture of igneous and metamorphic gravel, cobbles, and boulders were encountered at depth above bedrock (EKI, 2008e). Alluvial aquifer materials decrease in thickness and lateral extent in the lower Basin, near Fort Tejon Historic Park.

The Spring 2015 groundwater elevations ranges from 3,510 ft MSL in the southeastern part of the Basin to 3,110 ft MSL in the northwestern part of the Basin.

7.3. Physical Characteristics

§ 354.14. Hydrogeologic Conceptual Model
(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.*
- *(2) Surficial geology derived from a qualified map including the locations of cross- sections required by this Section.*
- *(3) Soil characteristics as described by the appropriate Natural Resources Conservation Service soil survey or other applicable studies.*
- *(4) Delineation of existing recharge areas that substantially contribute to the replenishment of the basin, potential recharge areas, and discharge areas, including significant active springs, seeps, and wetlands within or adjacent to the basin.*
- *(5) Surface water bodies that are significant to the management of the basin.*
- *(6) The source and point of delivery for imported water supplies.*

7.3.1. Topographic Information

Figure HCM-11 shows topography within the Basin. The land generally slopes toward Castac Lake from the west, and then toward the northwest in Grapevine Canyon. Elevations within the Basin range from approximately 3,000 ft MSL in the northwest area of Grapevine Canyon to 3,700 ft MSL at the intersection with Cuddy Canyon basin.

The Basin is bordered by the San Emigdio Mountains and the Tehachapi Mountains. Elevations steepen moving outside the alluvium of the Basin into these mountain ranges, rising to approximately 5,000 ft MSL in the mountainous areas directly adjacent to the Basin.

7.3.2. Surficial Geology

Figure HCM-10 shows the surficial geology within the Basin, based on the Preliminary Geologic Maps of the Lebec, Frazier Mountain, and Grapevine 7.5' Quadrangles (Olson, 2014; Swanson and Olson, 2016; Olson and Swanson, 2017) and associated map explanations. Some details of surficial geology shown on this map were generalized on the cross-sections discussed in Section 7.2. The predominant surficial geologic units covering the Basin area are "Qa" and "Ql," late Holocene age Modern alluvium and Lake deposits, respectively. On the up-sloped areas and within the smaller drainage valleys, the predominant surficial geologic unit is "Qf," late Holocene age Modern alluvial fan deposits. Other minor units in the Basin include "Qoa" (Older alluvium), "Qof" (Older fan deposits), "Qw" (Wash deposits), and "Qya" (Younger alluvium and terrace deposits). Artificial fill and disturbed areas, "af," are primarily mapped in the north-west Grapevine area near the crude oil pipeline site, as well as along Quail Canal near the northern intersection of the Castac Lake "Ql" deposits, and along the Interstate-5 (I-5) interchange near Lebec.

In the Dryfield Canyon area of the Basin, metamorphic units of “Pzm” (Marble), “Pzh” (Hornfels), “Kle” (Lebec Granodiorite), and “Ktl” (Tejon Lookout Granite) are mapped along the northern side of the Garlock Fault Zone.

7.3.3. Soil Characteristics

Soils within the Basin are shown on **Figure HCM-12**, based on the U.S Department of Agriculture Natural Resources Conservation Service (USDA-NRCS) Soil Survey Geographic Database (SSURGO). Soils are relatively coarse in texture with the predominant type being sandy loam. The infiltration rate of the soils is generally in the range of 1.98 to 5.95 inches per hour (3.96 to 11.9 feet per day).

Hydrologic Soil Group identification provides an indication of the relative runoff and infiltration potential of the soils with Hydrologic Soil Group A having the lowest runoff potential and highest infiltration potential and Hydrologic Soil Group D having the highest runoff potential and the lowest infiltration potential. Soils are predominantly in the A and B Hydrologic Soil Groups, with some areas of Hydrologic Soil Group D mapped in the upper areas of Dryfield Canyon (**Figure HCM-12**).

7.3.4. Recharge and Discharge Areas

Figure HCM-13 shows existing and potential groundwater recharge and discharge areas within the Basin. Sources of water to the Basin groundwater system include recharge from precipitation, subsurface groundwater inflows from the Cuddy Canyon Basin, return flows from irrigation and septic tanks, and Castac Lake seepage. Outflows from the Basin include groundwater pumping, evapotranspiration by wetlands and Groundwater Dependent Ecosystems (GDEs) along the Castac Lake margins, surface outflow into Grapevine Creek, and subsurface groundwater outflow.

Some fraction of the rainfall that falls directly on the Basin floor percolates through the soil zone and reaches the groundwater table via deep percolation.[13] Rainfall that percolates into the soil on the slopes of the Basin watershed travels through fractures in the underlying bedrock or at the soil-bedrock interface until it reaches the valley floor and enters the alluvial aquifer in a process called mountain front recharge (Schmidt, 2002; Wilson and Guan, 2004).

Groundwater enters the Basin from the up-gradient Cuddy Canyon basin as subsurface inflow. Although the rate of groundwater inflows is not well understood, it is a function of the volume of upgradient groundwater available (i.e., as a function of local recharge), the slope of the water

[13] Under natural conditions a portion of the total precipitation (as measured in a rain gauge) will be intercepted by vegetation before it reaches the ground surface in a process called interception. This water will then evaporate and is hence unavailable for vegetative use or groundwater recharge. The fraction of rainfall that is intercepted depends on storm event characteristics such as depth and intensity, and vegetation characteristics such as leaf area index, and can range from approximately 10 to 30 percent of total measured rainfall (Shuttleworth, 1993).

table (i.e., the hydraulic gradient), the saturated cross-sectional area of the aquifer, and the permeability of the aquifer materials. As mentioned above in Section 7.1.4, the hydrologic connection across faults and between up-gradient basins in not well understood, however regardless of the possibility of a subsurface hydraulic disconnect, there is demonstrably an ephemeral surface water connection along Cuddy Creek. If groundwater were prevented from flowing in the subsurface across the San Andreas and Garlock fault zones intersection it would back up and spill over as surface flow, creating wetlands or springs on the upgradient side of fault splays, and re-infiltrating on the downgradient side. Therefore, although these features are not obvious in the Castac Basin, the upper groundwater basins (i.e., Cuddy Canyon basin above the fault zone, Cuddy Ranch basin, and Cuddy Valley basin) are considered to contribute flow to the Basin, either through surface or subsurface inflow.[14]

Agricultural and municipal demands are met with groundwater. Return flows represent the volume of water that is “returned” to the aquifer either as a result of deep percolation of water that is used for irrigation, or via seepage from individual residential septic fields. Additionally, a lined wastewater pond associated with the Caltrans rest stop is present next to I-5; this pond is lined so there is likely no seepage to groundwater. Surface water flows within Cuddy Creek and Grapevine Creek also can contribute to groundwater recharge, when flowing. Runoff from storms contribute to streamflow within the Basin, however storm flows are typically short-lived, limiting the time available for recharge.

Wetlands and GDEs found along the fringes of Castac Lake rely on shallow groundwater. Surface water in Castac Lake also can seep in or out, exchanging water with the aquifer beneath and near the lake, depending on hydraulic gradients. Between 2001 and 2008 and in 2012, pumped groundwater was added to Castac Lake to maintain lake levels; once supplemental additions ceased, Castac Lake levels declined. Without supplemental water additions, Castac Lake is seasonal, with some water retention after large precipitation events. The prevailing hydraulic gradients, discussed in more detail in Section 8.2 *Groundwater Elevations and Flow Direction,* show groundwater flows in a convergent pattern from the up-gradient basin and foothill areas towards Castac Lake, which then flows north into Grapevine Canyon. Because the water table in some years is close to or above the ground surface in the northern part of Grapevine Canyon, this is an area of potential “rejected” recharge where not all of the local recharge in the northern part of Grapevine Canyon can be accepted into groundwater storage, and therefore some fraction of the potential recharge may be lost from the Basin as surface outflow in Grapevine Creek.

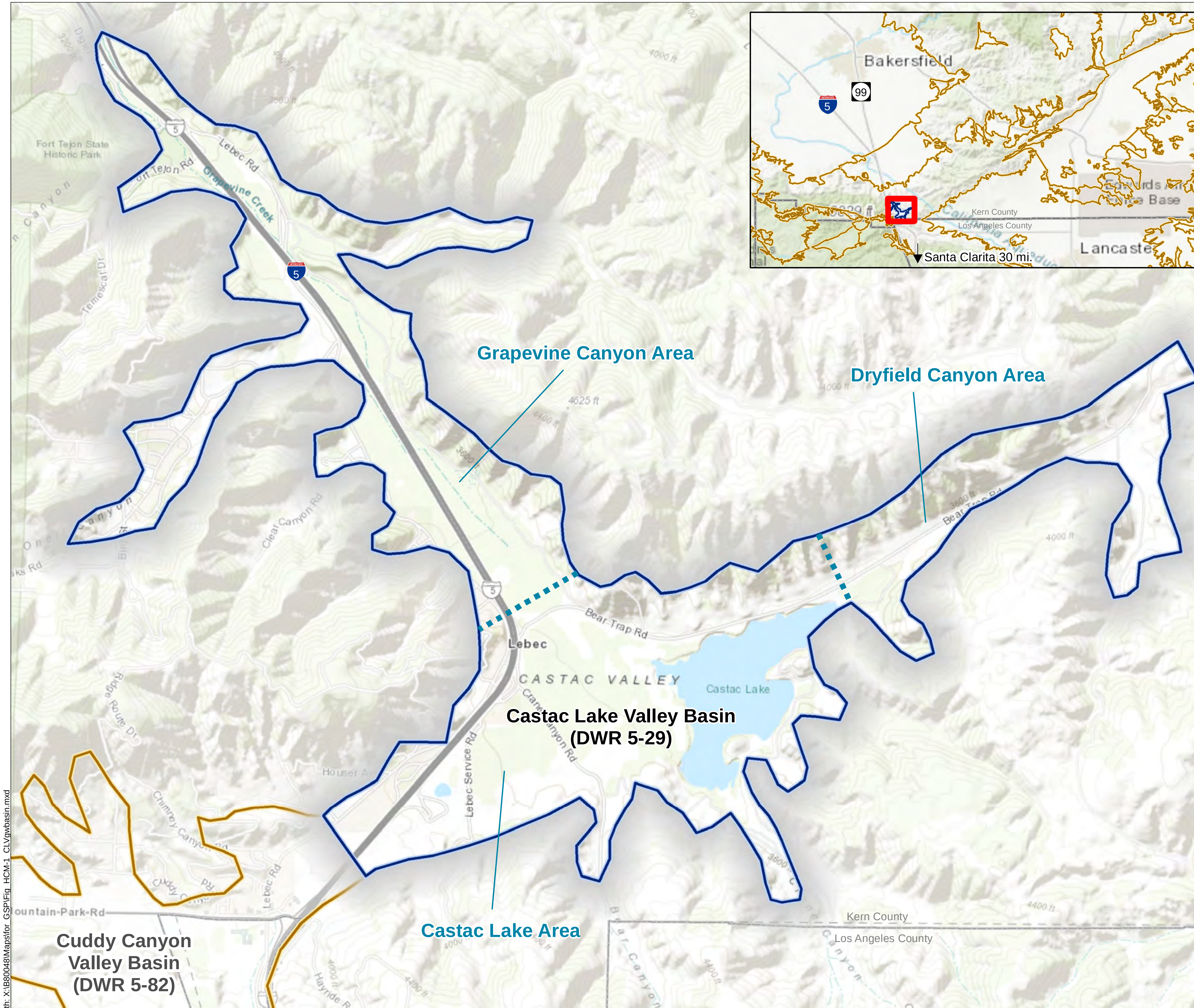
[14] Further support for the argument that the upstream watersheds and groundwater basins contribute flow to the lower basins is the fact that there are no other known sinks of sufficient size for the water (i.e., recharge from precipitation) that enters those upper basins, and therefore flow into the downstream basins is the only logical outflow mechanism.

7.3.5. Surface Water Bodies

Surface water bodies significant to the management of the Basin include Castac Lake, Cuddy Creek, and Grapevine Creek. **Figure HCM-14** depicts the location of the surface water features and the two watersheds that are assumed to contribute runoff to the Basin, Castac Lake Watershed and O'Neil Canyon-Grapevine Greek Watershed. The Basin is surrounded by approximately 47,100 acres of upland watershed and up-gradient groundwater basin areas that drain into the Basin. During individual storm events, when the soils are too saturated to accept more water from rainfall, or when the rainfall rate exceeds the infiltration capacity of the soil, surface runoff (i.e., stormflow) is generated, which travels downslope until it reaches Cuddy Creek, which flows to Castac Lake, then Grapevine Creek, and eventually may flow out of the Basin via Grapevine Creek. There are several smaller drainages that originate in the hills south, east and north of the Basin that contribute some surface water runoff to both the Basin and Castac Lake (Bookman Edmonston, 1965).

7.3.6. Source and Point of Delivery for Imported Water Supplies

Currently, the Basin does not receive any State Water Project (SWP) surface water supplies or any other surface water deliveries. Therefore, no infrastructure currently exists for the conveyance and distribution of imported water supplies. As part of the Tejon Mountain Village (TMV) development, Tejon-Castac Water District (TCWD) will import SWP water to meet all future TMV water demands.



Legend

- Castac Lake Valley Groundwater Basin
- Other Groundwater Basin
- County Boundary
- Fault Zone

Fault Traces

- Mapped
- Approximately Located
- Concealed
- Boundary Between Castac Lake Valley Groundwater Basin Subareas

Abbreviations
CGS = California Geological Survey
DWR = California Department of Water Resources

Notes
1. All locations are approximate.

Sources
1. Groundwater basin boundaries from DWR Bulletin 118 Interim Update 2016.
2. Basemap is ESRI's ArcGIS Online world topographic map, obtained 19 June 2020.
3. Fault trace and fault zone locations from CGS https://maps.conservation.ca.gov/cgs/EQZApp/app, accessed 6 November 2018.

N
0 0.5 1
(Scale in Miles)

Castac Lake Valley Groundwater Basin

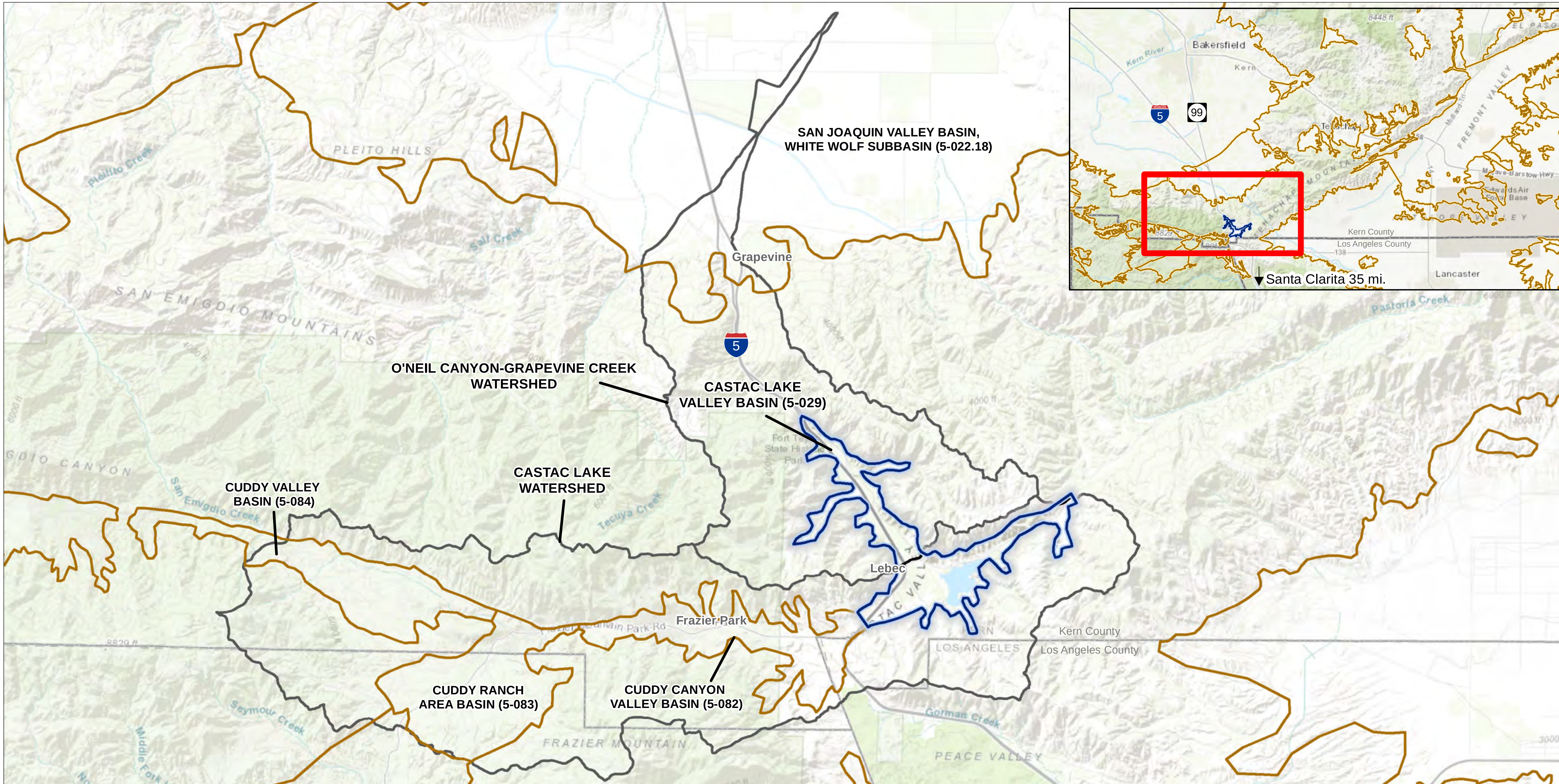
DRAFT

Tejon-Castac Water District
Kern County, California
June 2020
B80048.00

eki environment & water

Figure HCM-1

Path: X:\B80048\Maps\for_GSP\Fig_HCM-1_CLVgwbasin.mxd



Legend

- Castac Lake Valley Groundwater Basin
- Other Groundwater Basin
- Watershed Boundary
- County Boundary
- Fault Zones

Fault Traces

- Mapped
- Approximately Located
- Concealed

Abbreviations

DWR = California Department of Water Resources
CGS = California Geological Survey

Notes

1. All locations are approximate.
2. Only groundwater basins which are either directly upgradient or downgradient of Castac Lake Valley Groundwater Basin are shown.

Sources

1. Groundwater basin boundaries from DWR Bulletin 118 Interim Update 2016.
2. Basemap is ESRI's ArcGIS Online world topographic map, obtained 19 June 2020.
3. Watershed boundaries HUC12 obtained from USDA NRCS on 16 July 2018.
4. Fault trace and fault zone locations from CGS https://maps.conservation.ca.gov/cgs/EQZApp/app, accessed 6 November 2018.

N

0 2 4

(Scale in Miles)

DRAFT

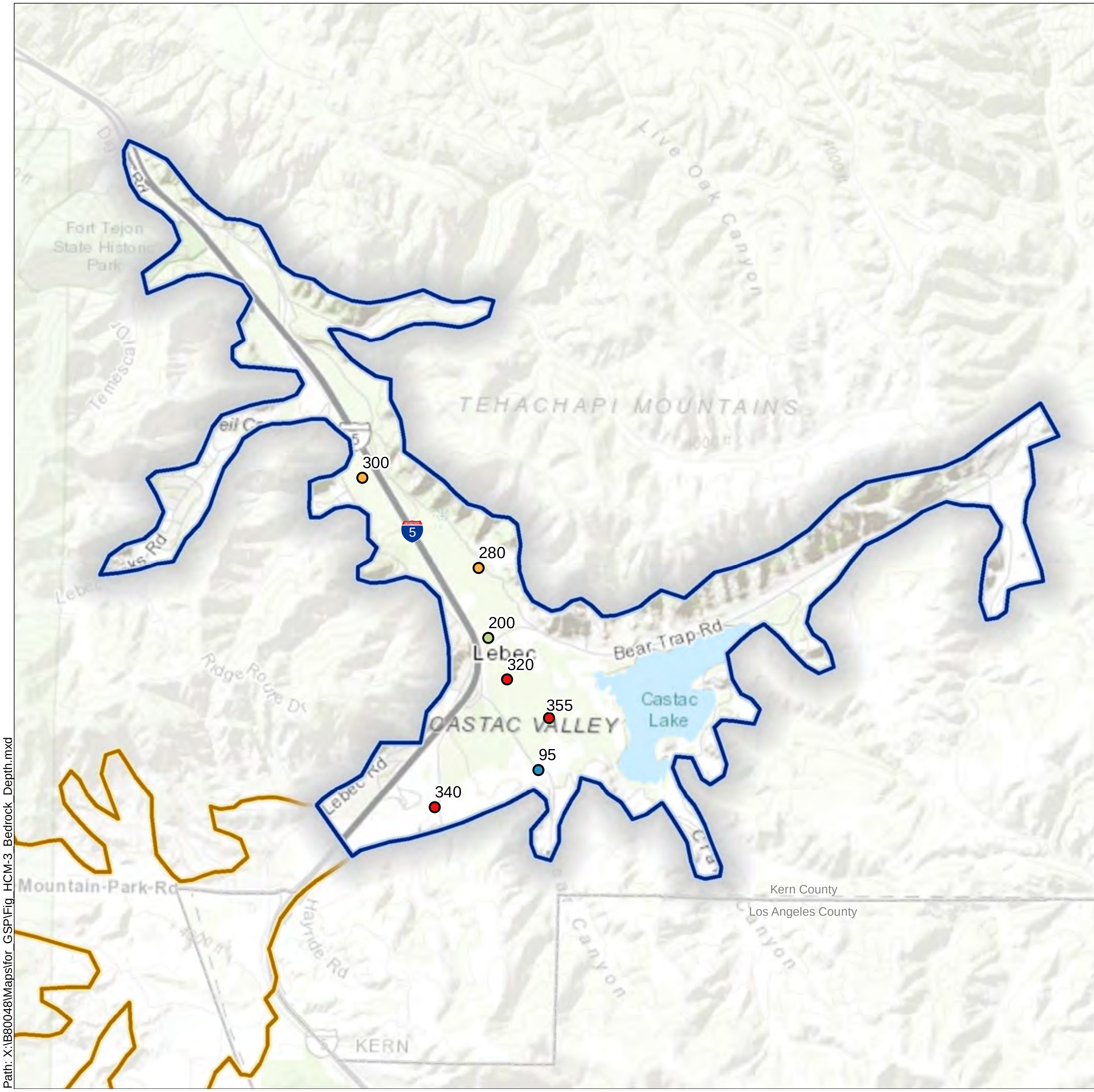
Castac Lake Valley Groundwater Basin and Upgradient Groundwater Basins

Tejon-Castac Water District
Kern County, CA
June 2020
EKI B80048.00

eki environment & water

Figure HCM-2

Path: X:\B80048\Maps\for_GSP\Fig_HCM-2_Basins_regional_08292019.mxd



Legend

Depth to Bedrock (ft bgs)

- < 100
- 101 - 200
- 201 - 300
- 300 - 400
- Castac Lake Valley Groundwater Basin
- Other Groundwater Basin
- County Boundary

Abbreviations

DWR = California Department of Water Resources
ft bgs = feet below ground surface

Notes

1. All locations are approximate.

Sources

1. Groundwater basin boundaries from DWR Bulletin 118 Interim Update 2016.
2. Basemap is ESRI's ArcGIS Online world topographic map, obtained 19 June 2020.

N

0 0.5 1
Miles

DRAFT

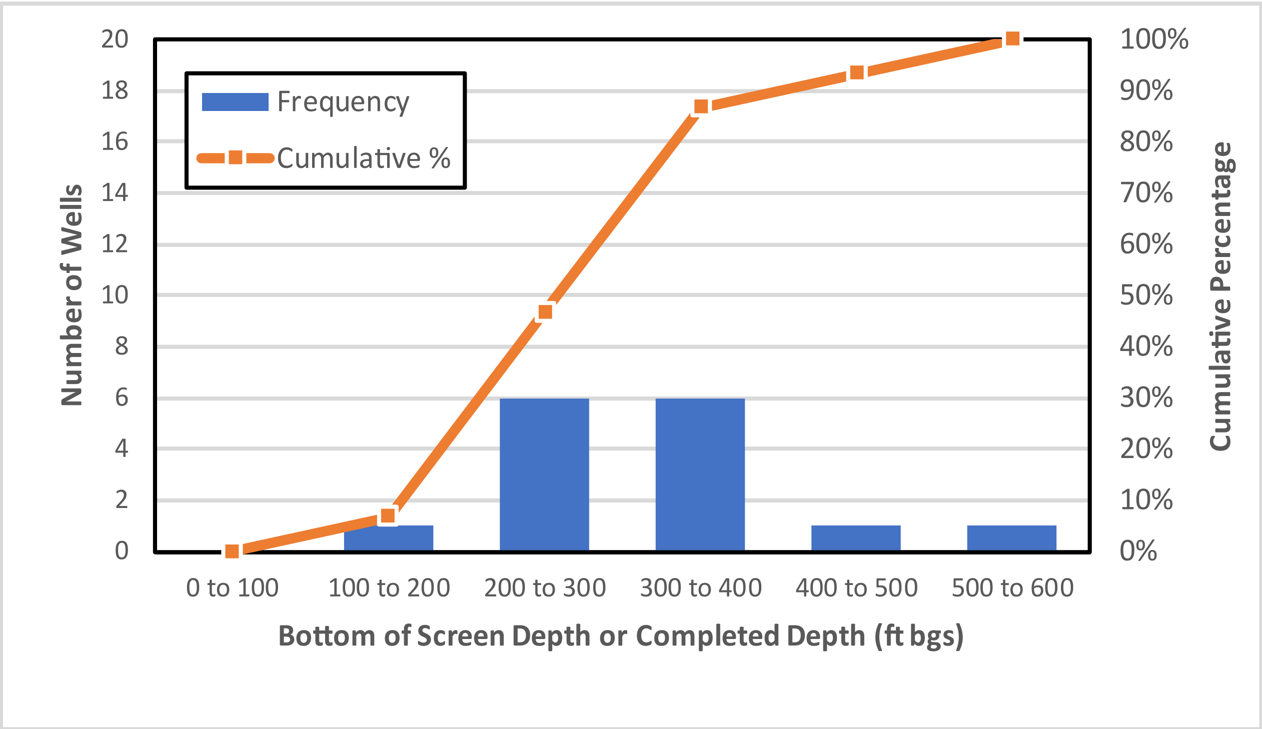
Depth to Bedrock

eki environment & water

Tejon-Castac Water District
Kern County, California
June 2020
B80048.00

Figure HCM-3

Path: X:\B80048\Maps\for_GSP\Fig_HCM-3_Bedrock_Depth.mxd



<u>Abbreviations</u>
ft bgs = feet below ground surface

<u>Notes</u>
1. Well depth data is based on well records for 15 wells in the Castac Lake Valley Basin.
2. Completed depth was used when bottom of screen depth was not available.

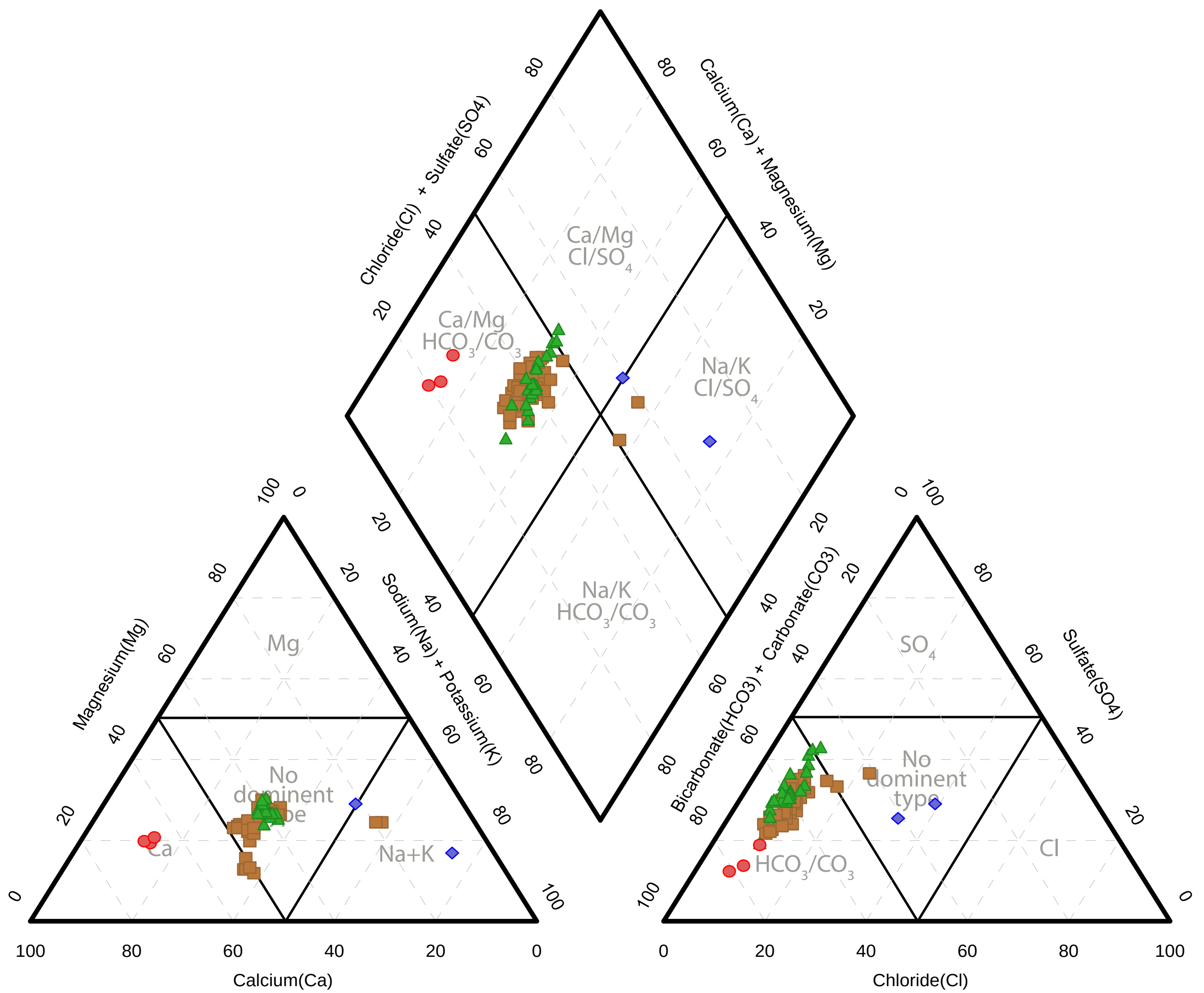
DRAFT

Summary of Pumping Well Depth Data

Tejon-Castac Water District
Kern County, California
June 2020
B80048.00

eki environment & water

Figure HCM-4



Legend

- Castac Lake Valley area Well
- Dryfield Canyon area Well
- Grapevine Canyon area Well
- Castac Lake

Notes

1. Samples collected between 1998 and 2019.
2. Dominant water type is labeled in grey.

Sources

1. Standard ion concentration data from the Castac Basin Data Management System.

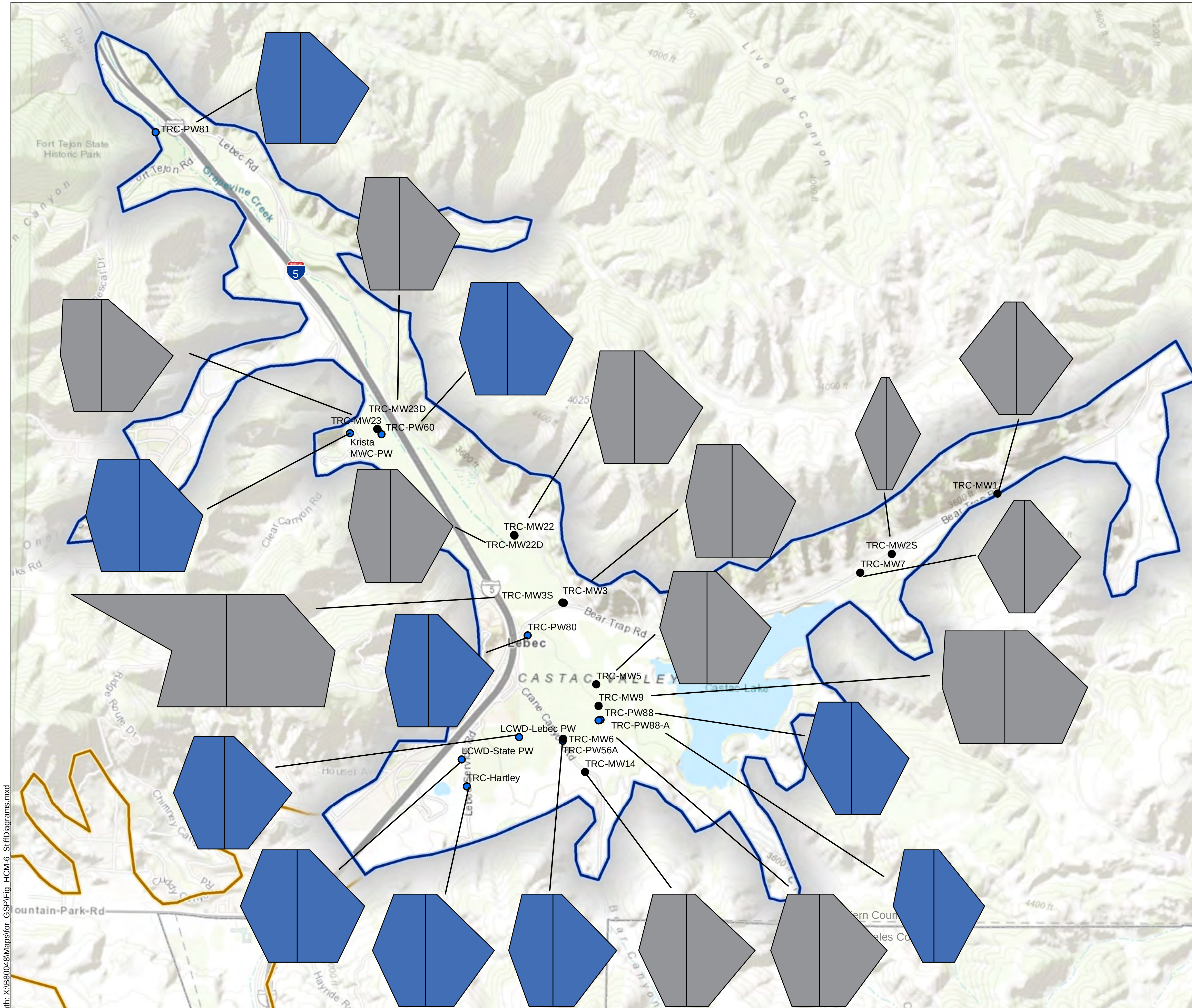
DRAFT

Piper Diagram

eki environment & water

Tejon-Castac Water District
Kern County, California
June 2020
B80048.00

Figure HCM-5



Legend

Well wtih Major Ion Data

- Monitoring Well
- Production Well
- Castac Lake Valley Groundwater Basin
- Other Groundwater Basin
- County Boundary

Stiff Diagram

Sodium — Chloride
Calcium — Bicarbonate
Magnesium — Sulfate

10 5 0 5 10
Milliequivalents per liter

Abbreviations

DWR = California Department of Water Resources

Notes

1. All locations are approximate.
2. Stiff diagrams show the most recent well-water sample collected between 1998 and 2019.
3. Grey stiff diagram indicates a monitoring well; blue stiff diagram indicates a production well.

Sources

1. Groundwater basin boundaries from DWR Bulletin 118 Interim Update 2016.
2. Basemap is ESRI's ArcGIS Online world topographic map, obtained 19 June 2020.

N
0 0.5 1
(Scale in Miles)

DRAFT

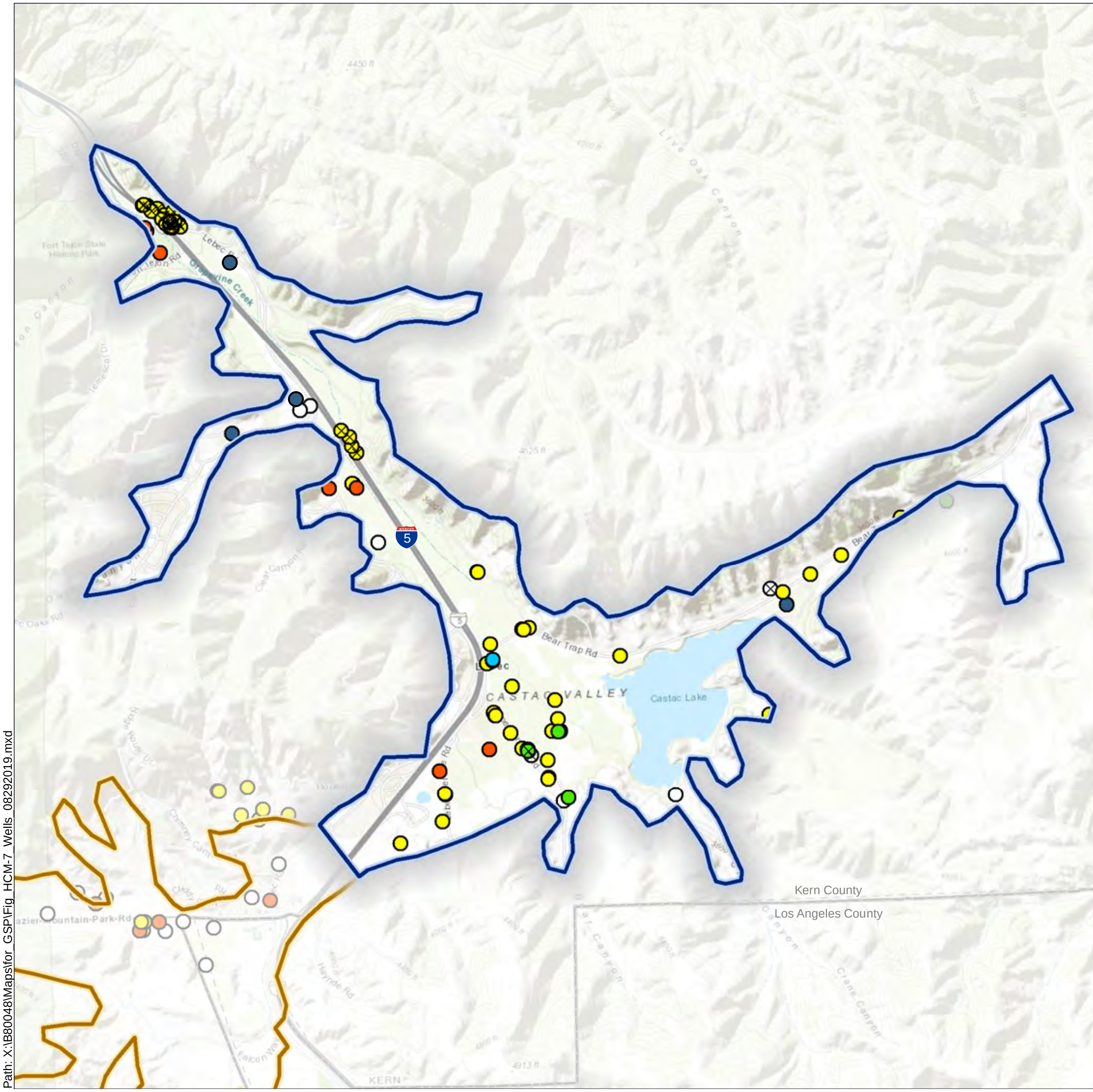
eki environment & water

Spatial Characteristics of Groundwater Chemistry

Tejon-Castac Water District
Kern County, California
June 2020
B80048.00

Figure HCM-6

Path: X:\B80048\Maps\for_GSP\Fig_HCM-6_StiffDiagrams.mxd



Legend

- Castac Lake Valley Groundwater Basin
- Other Groundwater Basin
- County Boundary

Well Use

- Public Supply
- Domestic
- Domestic/Irrigation
- Irrigation
- Monitoring
- Unknown
- Abandoned

Abbreviations

DWR = California Department of Water Resources

Notes

1. All locations are approximate.

Sources

1. Groundwater basin boundaries from DWR Bulletin 118 Interim Update 2016.
2. Basemap is ESRI's ArcGIS Online world topographic map, obtained 19 June 2020.

N

0 0.5 1
Miles

DRAFT

Well Location, Use, and Status

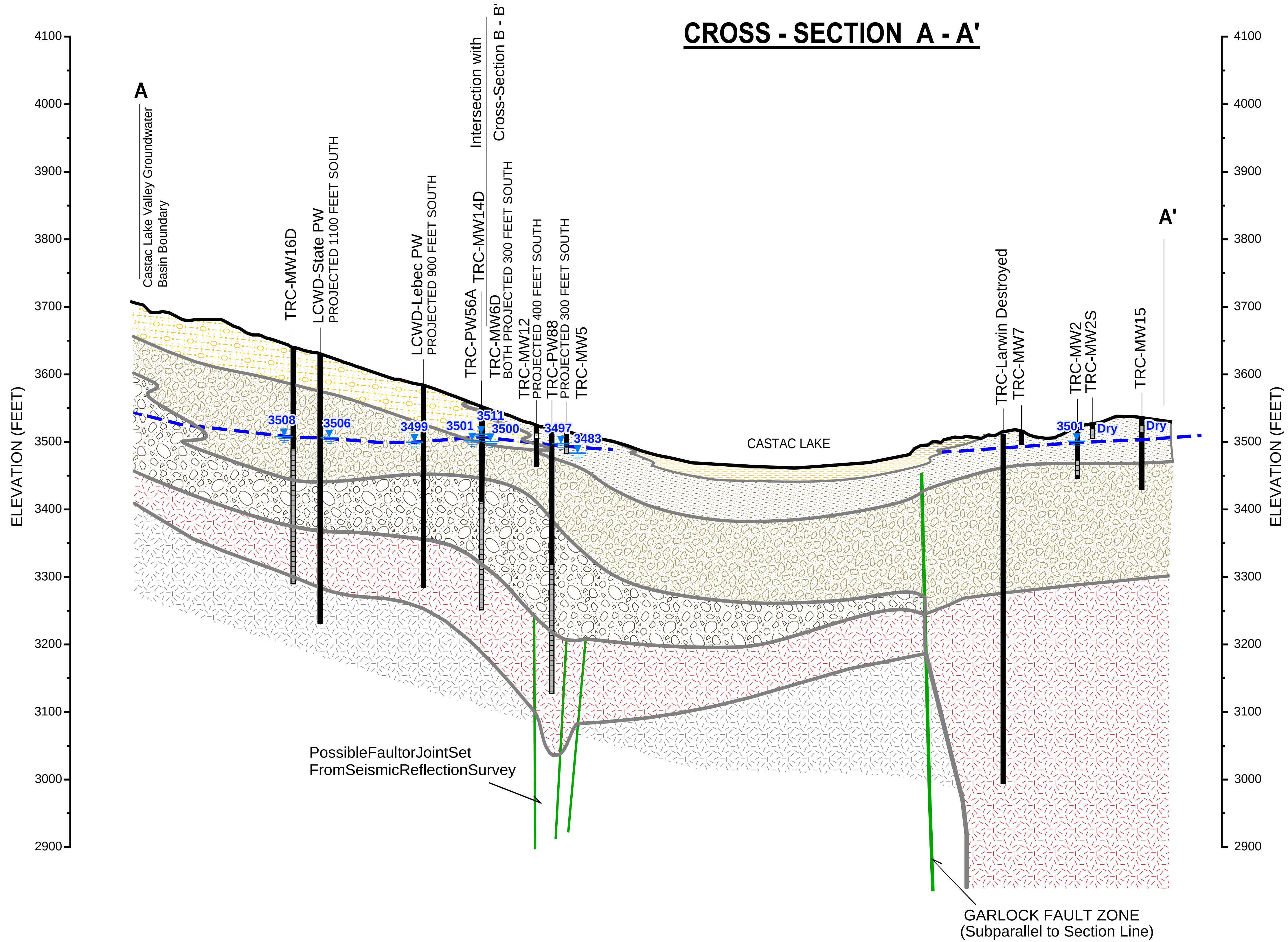
Tejon-Castac Water District
Kern County, California
June 2020
B80048.00

eki environment & water

Figure HCM-7

Path: X:\B80048\Maps\for_GSP\Fig_HCM-7_Wells_08292019.mxd

CROSS - SECTION A - A'

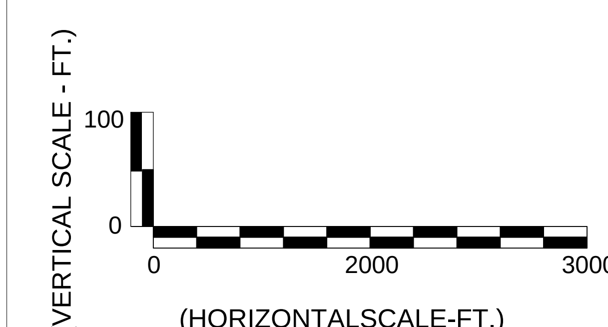


Legend

- Well Blank Casing
- Well Screened Interval
- Water Level Elevation (Wet/Normal Conditions) [piezometric heads from Spring 2015]
- RECENT INTERBEDDED ALLUVIUM
- RECENT LAKEBED SEDIMENTS
- FINE-GRAINED ALLUVIUM WITH CLAY
- MEDIUM-GRAINED ALLUVIUM
- COARSE-GRAINED ALLUVIUM
- VERY COARSE-GRAINED ALLUVIAL GRAVELS AND COBBLES
- WEATHERED BEDROCK
- UNWEATHERED BEDROCK
- Fault

NOTES:

1. All locations, depths, and dimensions are approximate.
2. Wells and boreholes are projected as much as 500 ft perpendicular to cross-section.
3. Wells with unknown screened intervals are shown with all blank casing.



Geologic Cross-Section A - A'

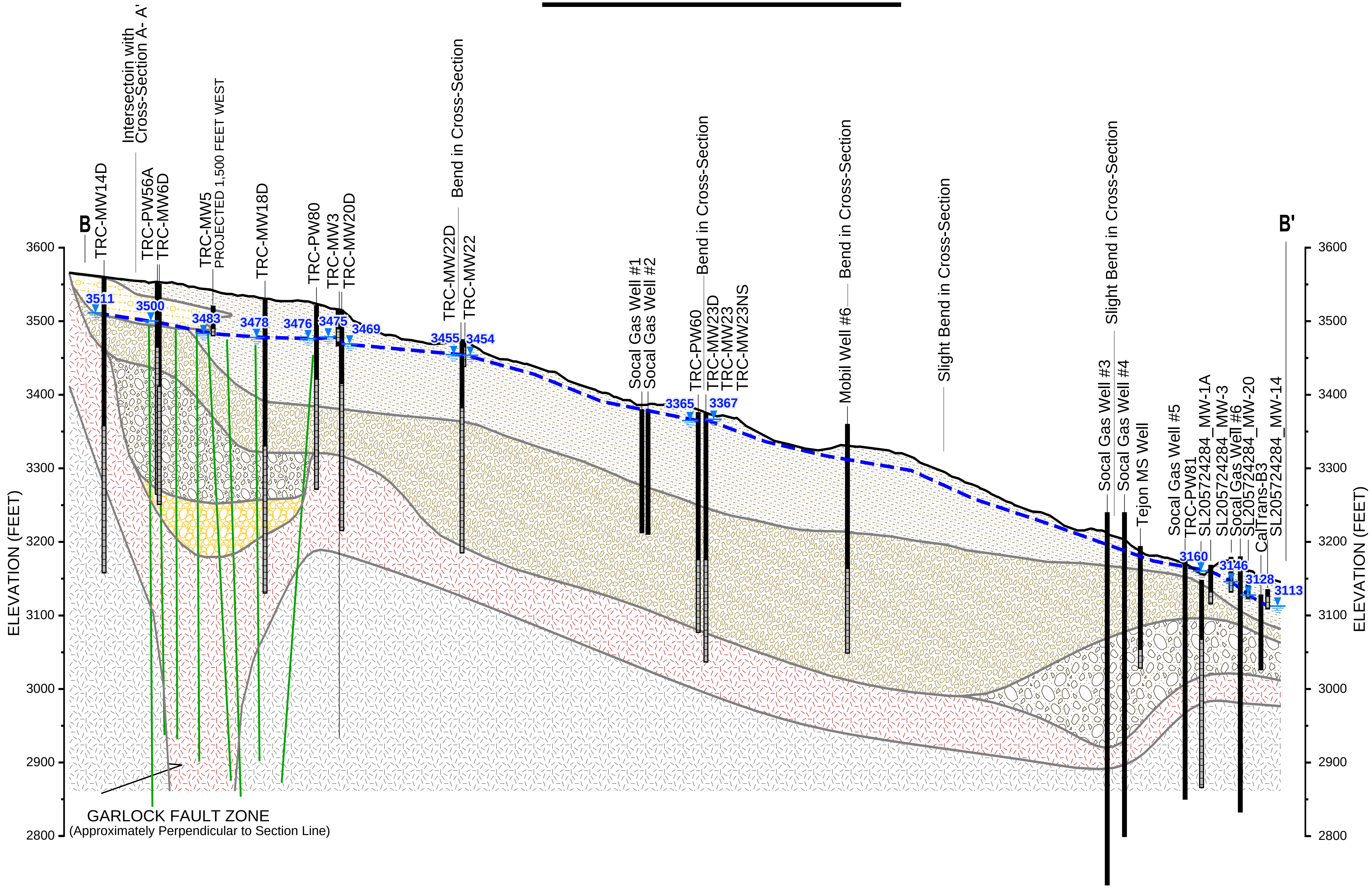
DRAFT

eki environment & water

Tejon-Castac Water District
Kern County, California
June 2020
B80048.00

Figure HCM-8

CROSS - SECTION B - B'



Legend

- Well Blank Casing
- Well Screened Interval
- Water Level Elevation (Wet/Normal Conditions) [piezometric heads from Spring 2015]
- RECENT INTERBEDDED ALLUVIUM
- RECENT LAKEBED SEDIMENTS
- FINE-GRAINED ALLUVIUM WITH CLAY
- MEDIUM-GRAINED ALLUVIUM
- COARSE-GRAINED ALLUVIUM
- VERY COARSE-GRAINED ALLUVIAL GRAVELS AND COBBLES
- WEATHERED BEDROCK
- UNWEATHERED BEDROCK
- Fault

NOTES:

1. All locations, depths, and dimensions are approximate.
2. Wells and boreholes are projected as much as 500 ft perpendicular to cross-section.
3. Wells with unknown screened intervals are shown with all blank casing.

(VERTICAL SCALE - FT.) 0 100

0 1000 2000

(HORIZONTALSCALE-FT.)

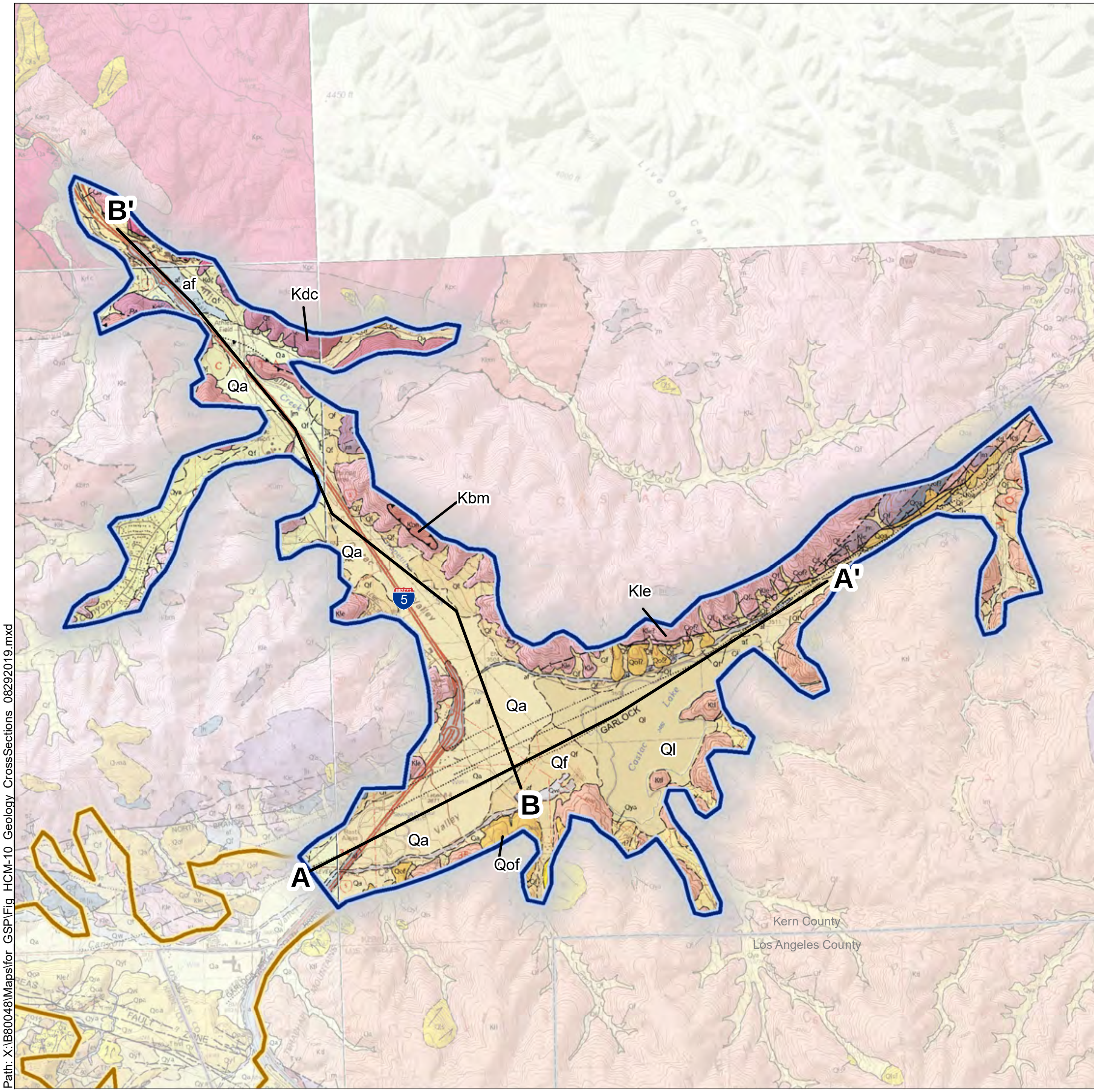
Geologic Cross-Section B - B'

DRAFT

eki environment & water

Tejon-Castac Water District
Kern County, California
June 2020
B80048.00

Figure HCM-9



Legend

Cross-Section Line

Castac Lake Valley Groundwater Basin

Other Groundwater Basin

County Boundary

af	Artificial fill and disturbed areas	Qyf	Younger alluvial fan deposits
Qw	Wash deposits	Qls	Landslide deposits
Qf	Modern alluvium fan deposits	Kle	Lebec Granodiorite
Qa	Modern alluvium	Ktl	Tejon Lookout Granite
Ql	Lake deposits	Kbm	Granite of Bush Mountain
Qof	Older fan deposits	Kdc	Digier Canyon Quartz Diorite Orthogneiss
Qoa	Older alluvium	Pzm	Marble
Qya	Younger alluvium and terrace deposits		

Abbreviations

DWR = California Department of Water Resources
CGS = California Geological Survey

Notes

1. All locations are approximate.

Sources

1. Groundwater basin boundaries from DWR Bulletin 118 Interim Update 2016.
2. Basemap is ESRI's ArcGIS Online world topographic map, obtained 19 June 2020.
3. Olson BPE, 2014. Preliminary Geologic Map of the Grapevine 7.5' Quadrangle, Kern County, California: A Digital Database. Version 1.0. CGS.
4. Olson BPE and Swanson BJ, 2017. Preliminary Geologic Map of the Lebec 7.5' Quadrangle, Kern, Los Angeles, and Ventura Counties, California. Version 1.0. CGS.
5. Swanson BJ and Olson BPE, 2016. Preliminary Geologic Map of the Frazier Mountain 7.5' Quadrangle, Kern, Los Angeles, and Ventura Counties, California. Version 1.0. CGS.

N

0 0.5 1

Miles

DRAFT

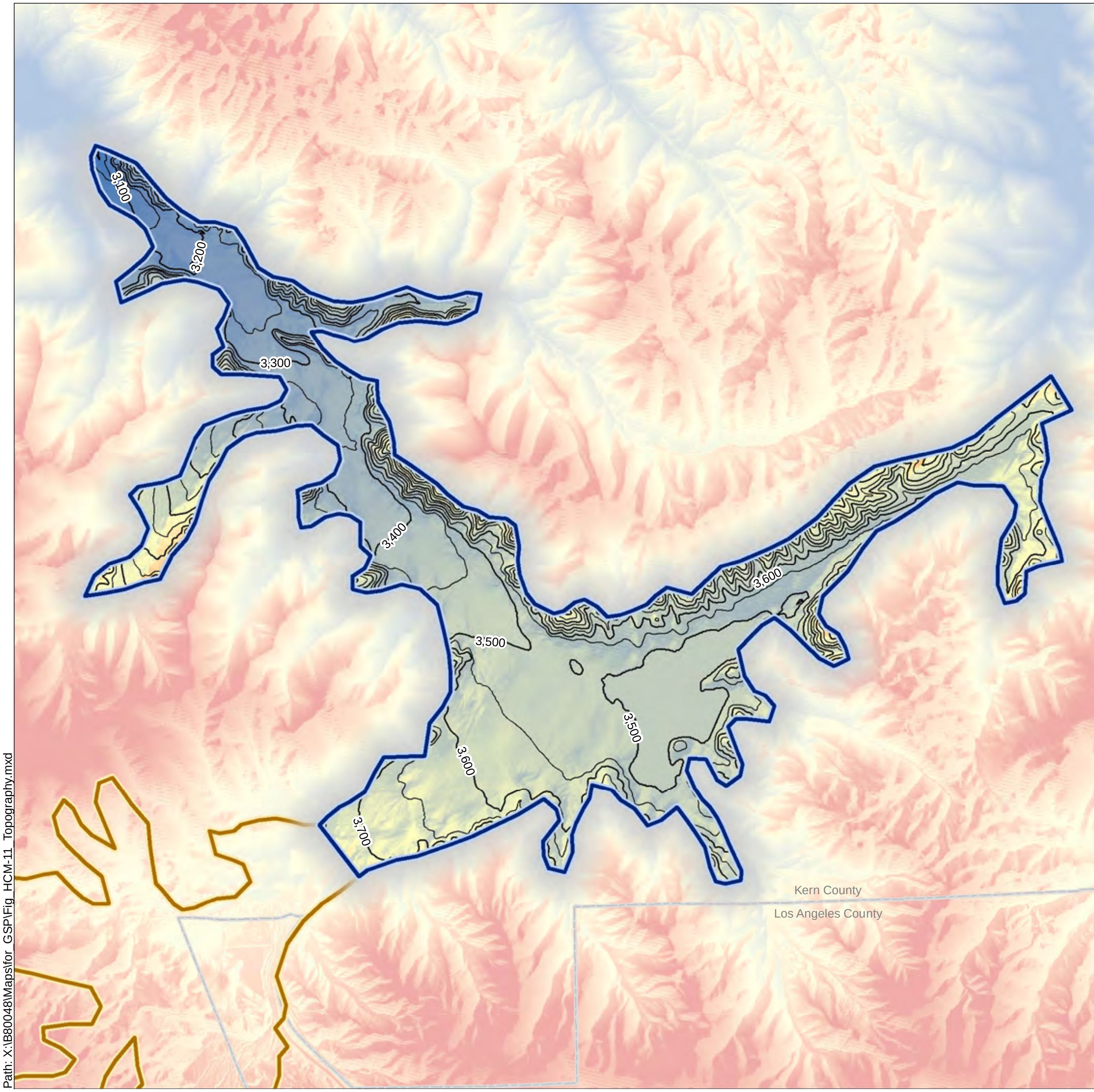
Geologic Map and Location of Cross-Section Lines

Tejon-Castac Water District
Kern County, California
June 2020
B80048.00

eki environment & water

Figure HCM-10

Path: X:\B80048\Maps\for_GSP\Fig_HCM-10_Geology_CrossSections_08292019.mxd



Legend

- Castac Lake Valley Groundwater Basin
- Other Groundwater Basin
- County Boundary
- Land Surface Elevation Contour (ft MSL)

Land Surface Elevation (ft MSL)

High : 5000

Low : 3000

Abbreviations

DWR = California Department of Water Resources
ft MSL = feet above mean sea level
NED = National Elevation Dataset
USGS = United States Geological Survey

Notes

1. All locations are approximate.
2. Color scale is based on minimum and maximum elevations within the Castac Lake Valley Basin.
3. Land surface elevation contours shown with a 50 foot contour interval.

Sources

1. Groundwater basin boundaries from DWR Bulletin 118 Interim Update 2016.
2. Basemap is ESRI's ArcGIS Online world topographic map, obtained 19 June 2020.
3. Land surface elevation data obtained from USGS NED (https://viewer.nationalmap.gov/basic/).

N

0 0.5 1

Miles

DRAFT

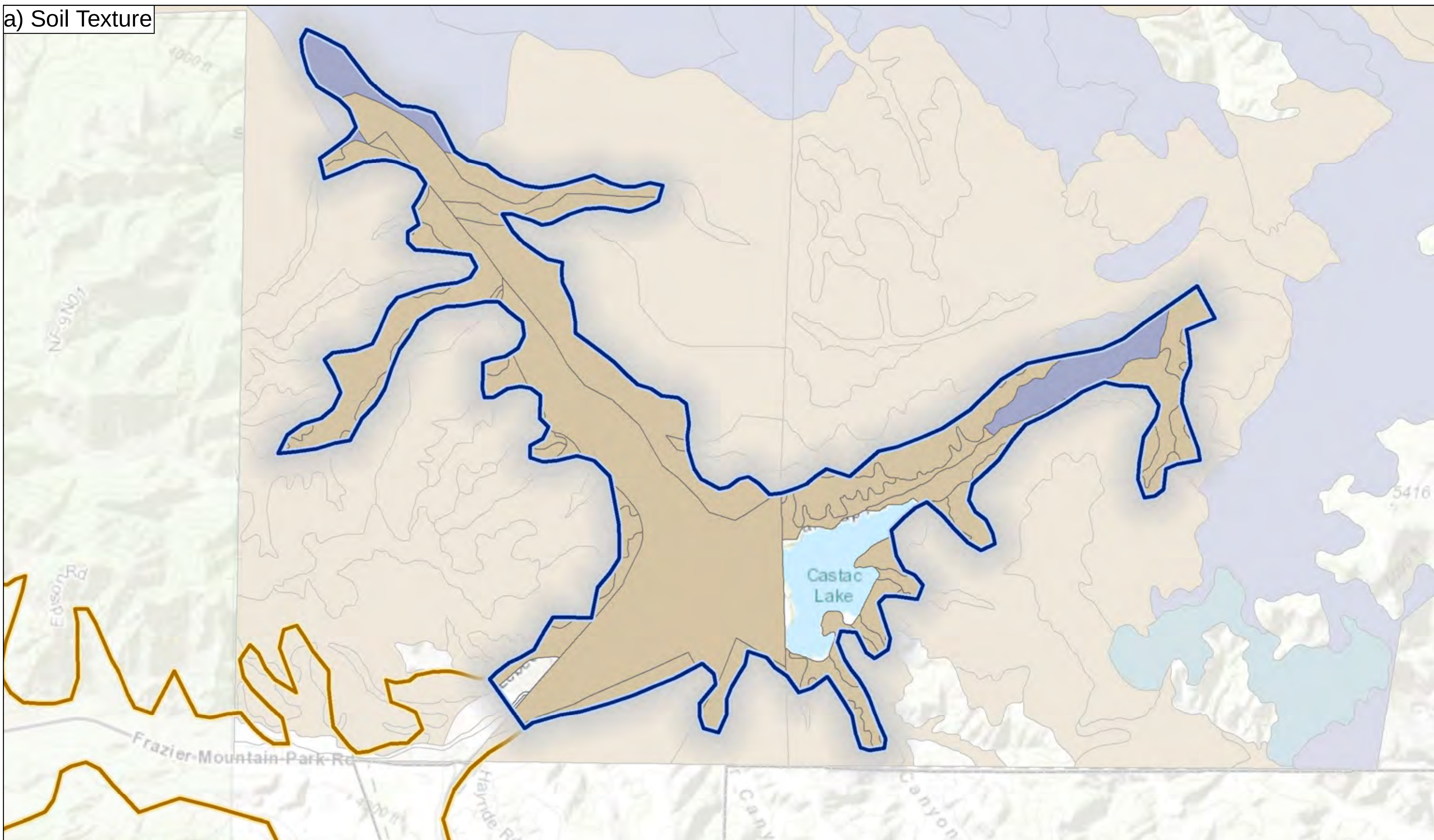
Topography

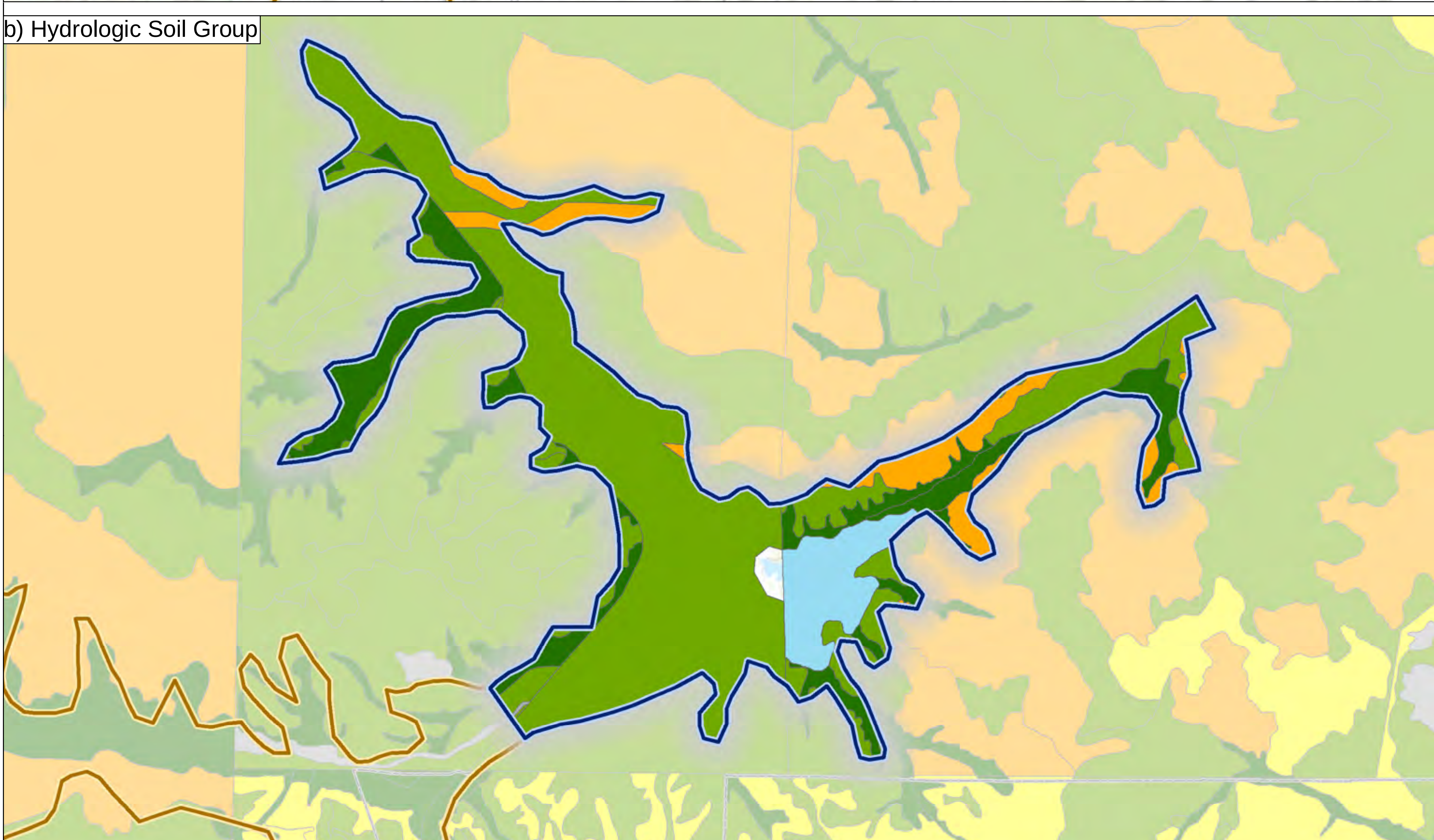
eki environment & water

Tejon-Castac Water District
Kern County, California
June 2020
B80048.00

Figure HCM-11

Path: X:\B80048\Maps\for_GSP\Fig_HCM-11_Topography.mxd





Legend
- Castac Lake Valley Groundwater Basin
- Other Groundwater Basin
- County Boundary

Soil Texture
- Sandy Loam
- Sandy Clay Loam
- Clay Loam
- Loamy Sand
- Loam
- Other
- Not Identified

Hydrologic Soil Groups
- A
- B
- C
- D
- Not Identified

N
0 0.5 1
(Scale in Miles)

Abbreviations
DWR = California Department of Water Resources
SSURGO = Soil Survey Geographic Database

Notes
1. All locations are approximate.
2. Only soil units of greatest extent are labeled.

Sources
1. Groundwater basin boundaries from DWR Bulletin 118 Interim Update 2016.
2. Basemap is ESRI's ArcGIS Online world topographic map, obtained 19 June 2020.
3. Soil data from United States Department of Agriculture SSURGO (https://gdg.sc.egov.usda.gov/GDGOrder.aspx#).

Soil Texture and Hydrologic Soil Group

DRAFT
eki environment & water

Tejon-Castac Water District
Kern County, California
June 2020
B80048.00

Figure HCM-12

Path: X:\B80048\Maps\for_GSP\Fig_HCM-12_Soils_08292019.mxd

Legend
- Castac Lake Valley Groundwater Basin
- Other Groundwater Basin
- Castac Lake
- Stream/Creek
- Active Pumping or Flowing Artesian Well
- Inactive Pumping Well
- County Boundary

Abbreviations

DWR = California Department of Water Resources

Notes
1. All locations are approximate.
2. Pumping wells shown are only those with known well uses.

Sources
1. Groundwater basin boundaries from DWR Bulletin 118 Interim Update 2016.
2. Basemap is ESRI's ArcGIS Online world topographic map, obtained 19 June 2020.

N

0 0.5 1

Miles

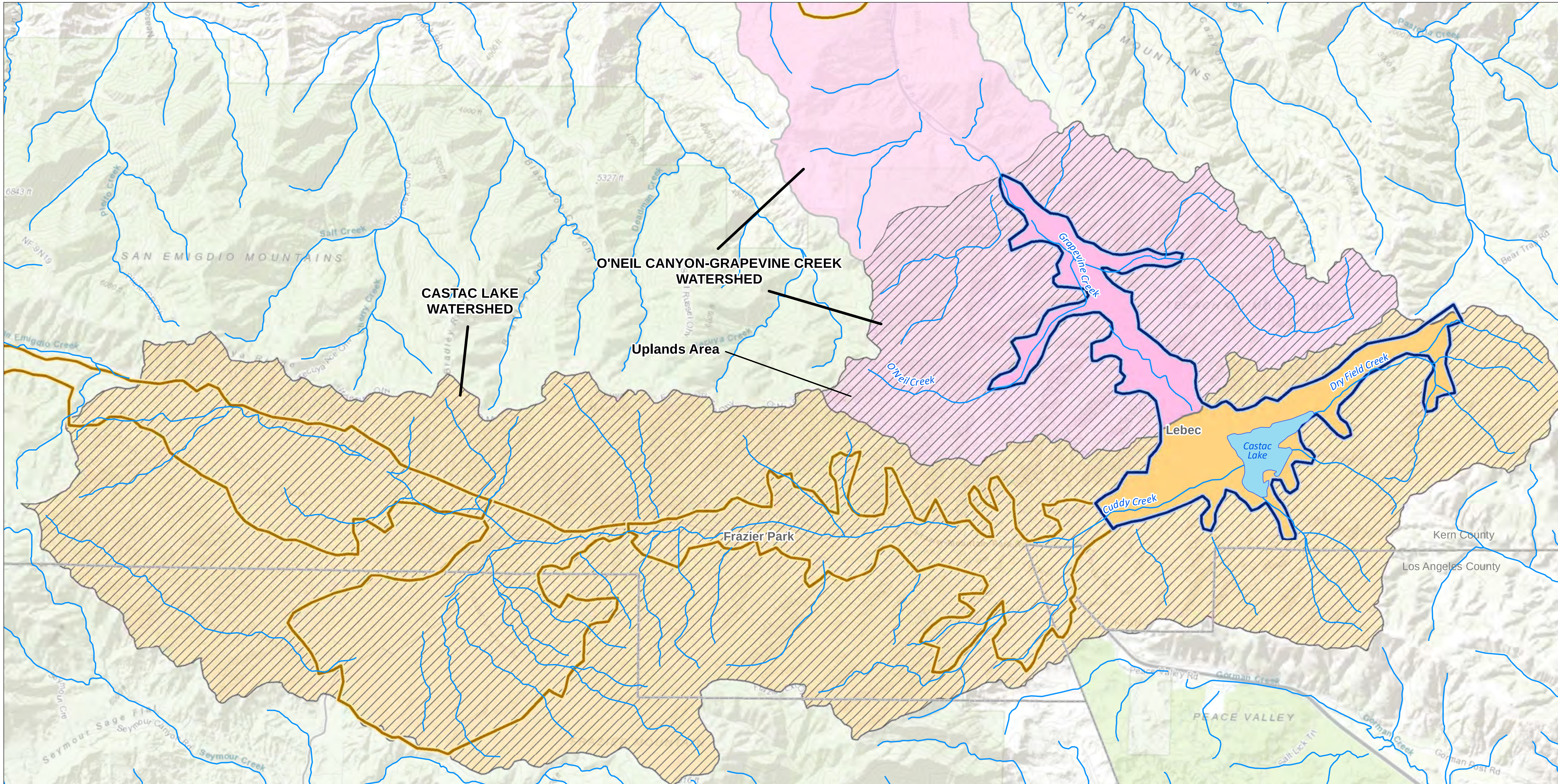
DRAFT **Recharge and Discharge Areas**

eki environment & water

Tejon-Castac Water District
Kern County, California
June 2020
B80048.00

Figure HCM-13

Path: X:\B80048\Maps\for_GSP\Fig_HCM-13_ConceptualModel_08292019.mxd



Legend

- Stream/Creek
- Castac Lake Valley Groundwater Basin
- Other Groundwater Basin
- County Boundary

Watershed Boundary

- Castac Lake
- O'Neil Canyon-Grapevine Creek
- Uplands Area

Abbreviations

DWR = California Department of Water Resources
NHD = National Hydrography Dataset

Notes

1. All locations are approximate.
2. Only groundwater basins which are either directly upgradient or downgradient of Castac Lake Valley Groundwater Basin are shown.
3. Uplands Area signifies the watershed area contributing runoff to Castac Lake Valley Groundwater Basin.

Sources

1. Groundwater basin boundaries from DWR Bulletin 118 Interim Update 2016.
2. Basemap is ESRI's ArcGIS Online world topographic map, obtained 19 June 2020.
3. Watershed boundaries HUC12 obtained from USDA NRCS on 16 July 2018.
4. Surface water features and watersheds from NHD (https://viewer.nationalmap.gov/basic/).

N 0 1 2 (Scale in Miles)

Natural Surface Water Features

DRAFT

eki environment & water

Tejon-Castac Water District
Kern County, CA
June 2020
EKI B80048.00

Figure HCM-14

Path: X:\B80048\Maps\for_GSP\Fig_HCM-14_SurfaceWater.mxd

8. CURRENT AND HISTORICAL GROUNDWATER CONDITIONS

§ 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:

This section presents information on historical and current groundwater conditions within the Basin based on available data. For the purpose of this assessment, "current conditions" refers to conditions in calendar year 2015 (i.e., the effective date of SGMA). For historical conditions, we've examined the last 22 years (i.e., 1998 through 2019) in detail, along with older data, when available.

8.1. Castac Basin Data Management System

The Castac Basin Data Management System (DMS) manages available well, groundwater level, groundwater quality, and other pertinent data for the Basin. The DMS consists of a Microsoft Access database file linked with a Geographic Information Systems (GIS) geodatabase. Data within the DMS include:

- Historical well location, well construction, water level, and water quality data from analyses conducted during 2006-2008;
- Historical soil borehole information;
- Water level data for monitoring and production wells, provided by Tejon-Castac Water District (TCWD);
- Water level and water quality data from Lebec County Water District (LCWD) production wells, provided by LCWD;
- Water level and water quality data from the Krista Mutual Water Company (KMWC) production well, provided by KMWC;
- Data from the State Water Resources Control Board (SWRCB) online public GeoTracker environmental database[15], including well locations, well construction information, water level data, and water quality data for the Mobil M-1 Crude Oil Pipeline site (SL205724284) and the Lebec Sanitary Landfill site (L10005571106);
- Data from United States Geological Survey (USGS) National Water Information System (NWIS)[16] including water quality data from one public supply well within the Basin and six wells located in up-gradient basins; well construction and elevation data for existing wells

[15] https://geotracker.waterboards.ca.gov/
[16] https://waterdata.usgs.gov/nwis

in the DMS; and available peak streamflow measurements from Cuddy Creek during the late 1970s;

- Measured streamflow along Grapevine Creek for 2000-2007;
- Peak streamflow measurements from Cuddy Creek at Lebec and Grapevine Creek below the Basin for 1980-2017 and 2005-2017, respectively, provided by Kern County;
- Pumping data as counter units from Tejon Ranch Corporation (TRC) production wells through 2019, provided by TCWD;
- Pumping estimates from TRC production wells calculated from electrical use records for 1997-2001;
- Monthly pumping data provided by KMWC and LCWD from their production wells for 2010-2019 and 2013-2019, respectively; and
- Monthly pumping data from public water systems as reported to the Drinking Water Information Clearinghouse (DRINC) portal[17] for 2013 through 2015, as available.

The DMS will continue to be updated as additional data are received through Castac Basin GSA-led stakeholder outreach and data collection efforts.

During DMS preparation and population, quality assurance/quality control (QA/QC) checks were conducted prior to analysis of groundwater conditions. These QA/QC efforts included:

- Removing duplicate wells and combining records for wells with multiple names and multiple entries, renaming data associated with previous well names to the standardized well name, and reconciling location, use, status, and data inventory information for each well;
- Plotting well locations and flagging wells whose locations are incorrect based on topographic maps and aerial imagery;
- Comparing well-specific ground surface elevation (GSE) information to the USGS Digital Elevation Model (DEM) data for the Basin to help determine that wells are plotted in the correct locations;
- Comparing GSE for a given well to its measuring point elevation (MPE) as a check on the validity of the MPE;
- Formatting water quality data to ensure flags such as non-detected concentrations were accurately represented, and standardizing the analyte names;
- Converting depth to water data to water level elevations based on the MPEs;

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

- Flagging suspect water level data in pumping wells. Inspection of hydrographs provided evidence for differentiation between non-pumping and pumping water levels in production wells based on observed differences in water levels, so likely pumping water levels were flagged; and
- Removing duplicate water level and water quality data entries.

The resulting dataset used to inform the analysis and discussion of groundwater conditions herein consists of:

- 15,614 groundwater elevation data points from 72 wells over the period from 9/1/1946 to 6/4/2019; and
- Groundwater quality data from 56 wells over the period from 1/7/1963 to 8/27/2018 which include 651 sample dates.

8.2. Groundwater Elevations and Flow Direction

> *§ 354.16. Groundwater Conditions*
> *(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.*
> *(2) Hydrographs depicting long-term groundwater elevations, historical highs and lows, and hydraulic gradients between principal aquifers.*

For the purposes of this analysis, the periods of Spring and Fall 2015[18] are used to represent seasonal high and low conditions under current land and water use.

8.2.1. Groundwater Elevation Contour Maps

Groundwater elevation contour maps for "current conditions" – Spring 2015 and Fall 2015 – are presented on **Figure GWC-1** and **Figure GWC-2**, respectively for the Principal Aquifer. Groundwater flow is driven by differences in potentiometric head (i.e., groundwater gradients) and groundwater generally flows perpendicular to groundwater elevation contours, moving from higher to lower hydraulic head.

Under 2015 conditions, groundwater levels decrease from west to east in the Castac Lake area of the Basin, from east to west in the Dryfield Canyon area of the Basin, and from south to north in the Grapevine Canyon area of the Basin. This indicates that groundwater flows towards Castac

[18] Spring 2015 includes water level measurements taken between 1/15/15 and 4/15/15. Fall 2015 includes water level measurements taken between 8/15/15 and 11/15/15.

Lake from the eastern and western areas of the Basin and then flows northward and out of Grapevine Canyon.

8.2.2. Vertical Gradients

Water levels in well pairs screened at various depths can indicate vertical flow between aquifer zones. Evaluation of vertical gradients can be accomplished by examination of water levels in well pairs where one well is representative of the upper aquifer zone (i.e., the Shallow Aquifer zone) and the other well is representative of the lower aquifer zone (i.e., the Deep Aquifer zone). This approach requires water level information from wells that:

a) have known well construction information;

b) are screened in different depth zones;

c) have contemporaneous measurements (i.e., water levels measured at least in the same year and season); and

d) are in close spatial proximity to each other (i.e., to reduce the influence of lateral gradients effects).

Two multi-depth monitoring well sites[19] (i.e., a pair of wells, one screened in the Shallow Aquifer zone, and the other screened in the Deep Aquifer zone) have been identified that meet the above criteria. Both sites are located within the Grapevine Canyon area of the Basin, and contemporaneous water level measurements are available for the time period 2007 through 2018. Vertical gradients are calculated for each site as the difference in groundwater elevation between the shallow and the deep well divided by the vertical distance between the midpoints of the screened intervals. A negative vertical gradient signifies upward flow between aquifer zones whereas a positive vertical gradient signifies downward flow between aquifer zones. Site locations and hydrographs are provided in **Figure GWC-3** and **Table GWC-1** summarizes the vertical gradients for "current conditions" – Spring 2015 and Fall 2015.

- Site 1, located in the southern part, closer to Castac Lake: Wells TRC-MW22 (screened 5-34 ft bgs) and TRC-MW22D (screened 89-289 ft bgs).

- Site 2, located more northerly, farther from Castac Lake: Wells TRC-MW23 (screened 20-35 ft bgs) and TRC-MW23D (screened 140-340 ft bgs).

At Site 1, data show that water levels within the Shallow Aquifer and Deep Aquifer zones generally moved in similar patterns over time (**Figure GWC-3**). Between March 2007 and August 2008, TRC-MW22D was flowing artesian (i.e., water levels in the well were above ground surface, and groundwater flowed from the well without being pumped). Since water-level measurements are difficult to obtain under such conditions, groundwater elevations and the subsequent

[19] Three additional multi-depth monitoring well sites exist within the Basin, however the wells screened within the shallow aquifer zone were dry during 2015 and therefore no vertical gradient could be calculated.

gradient calculations for that period are based on the well head (top of casing) elevation. From 2007 through 2011, the groundwater elevations were greater in the Deep Aquifer zone than in the Shallow Aquifer zone, indicating that an upward vertical gradient existed between the zones during that time. Groundwater elevations generally declined between 2007 and 2018, but the Deep Aquifer zone lost hydraulic head more rapidly than the Shallow Aquifer zone between 2007 and 2011. As head in the Deep Aquifer zone declined, upward gradients diminished (i.e., became less negative). Piezometric head in the Deep Aquifer zone remains greater than in the Shallow Aquifer zone through May 2016; starting in June 2016, the gradient intermittently switches between negative and positive (upwards and downwards). "Current" gradients represented by Spring and Fall 2015 are both slightly upward with gradient values of -0.0056 and -0.0017 ft/ft, respectively (**Table GWC-1**). Measured gradient magnitudes are greater at Site 1, indicating a greater driving head for water movement, or potentially the presence of greater restriction to flow, i.e., a local aquitard, more pronounced bedding, or other forms of aquifer anisotropy at that site, as compared to Site 2 further down the valley.

At Site 2, data show that water levels within the Shallow Aquifer and Deep Aquifer zones changed more or less in unison over time. In contrast to Site 1, the Deep Aquifer zone well at Site 2 has a shallower declining trend in groundwater elevations between 2007 and 2011. Therefore, the gradients from 2007 through 2018 remain around zero and fluctuate between negative and positive (upwards and downwards) with the seasonal fluctuations observed in the wells. "Current" gradients represented by Spring and Fall 2015 are slightly upward in the spring and slightly downward in the fall with gradient values of -0.0005 and 0.0002 ft/ft, respectively (**Table GWC-1**).

Table GWC-1. Vertical Gradients

Site	Well	Screen Interval (ft bgs)		Aquifer Zone	Spring 2015[a] Groundwater Elevation (ft MSL)	Spring 2015[a] Gradient (ft/ft)	Fall 2015[b] Groundwater Elevation (ft MSL)	Fall 2015[b] Gradient (ft/ft)
		Top	Bottom					
1	TRC-MW22	5	34	Shallow	3453.71	-0.0056	3452.20	-0.0017
	TRC-MW22D	89	289	Deep	3454.66		3452.49	
2	TRC-MW23	20	35	Shallow	3366.57	-0.0005	3362.75	0.0002
	TRC-MW23D	140	340	Deep	3366.38		3362.68	

Abbreviations:

ft bgs = feet below ground surface
ft MSL = feet above mean sea level

Notes:

a) Spring 2015 represents average values between 1/15/15 and 4/15/15.
b) Fall 2015 represents average values between 8/15/15 and 11/15/15.

8.2.3. Long-Term Groundwater Elevation Trends

Long-term trends in groundwater elevations were evaluated based on examination of hydrographs for nine wells throughout the Basin (**Figure GWC-4**) . Wells were selected for hydrograph analysis based on their length of record, their spatial distribution throughout the Basin, and their representativeness of conditions in their area.

Water level data collected from wells screened in the Deep Aquifer zone of the Castac Lake area of the Basin indicate that in the 1950's and 1960's, groundwater elevations declined to historically low values that are approximately 140 feet lower than the maximum groundwater elevations observed in 2006. As discussed below, this decline in groundwater elevations appears to be caused by climatic conditions at the time.

Water levels in this area recovered in the late 1970's through the 1990's. The water levels remained relatively high from the late 1990's through 2006, with some of the wells seasonally flowing artesian. Water levels from wells screened in the Shallow Aquifer zone are only available from approximately 1999 onward. Both Shallow Aquifer and Deep Aquifer zone wells in the Grapevine Canyon area of the Basin show fairly stable water levels over the historical record. In contrast, both Shallow Aquifer and Deep Aquifer Zone wells in the Castac Lake and Dryfield Canyon areas of the Basin show water levels generally declined from 2000 through 2004, partially recovered from 2005 through 2006, and declined again from 2007 through mid-2017, and stabilized from mid-2017 through 2018.

Review of historical rainfall data indicates that the large historical fluctuations in groundwater elevations in the Castac Lake and Dryfield Canyon areas of the Basin are likely the result of climatic variability. **Table GWC-2**, below, shows the DWR Water Year (WY)[20] Hydrologic Classification Index for the San Joaquin Valley[21] (i.e., water year type) for WY 1998 through 2018. For the 21 water years from 1998 through 2018, there were five "critical" (dry) years, five dry years, three below normal years, three above normal year, and five wet years.

[20] DWR defines a Water Year as extending from October 1 of the previous year to September 30 of the year in question. For example, Water Year 2015 extends from October 1, 2014 through September 30, 2015.
[21] http://cdec.water.ca.gov/reportapp/javareports?name=WSIHIST

Table GWC-2. Summary of DWR Water Year Types, 1998-2018

Water Year	WY Index	Water Year	WY Index
1998	Wet	2009	Below Normal
1999	Above Normal	2010	Above Normal
2000	Above Normal	2011	Wet
2001	Dry	2012	Dry
2002	Dry	2013	Critical
2003	Below Normal	2014	Critical
2004	Dry	2015	Critical
2005	Wet	2016	Dry
2006	Wet	2017	Wet
2007	Critical	2018	Below Normal
2008	Critical	--	--

The climatic trends are reflected in the hydrographs for wells located within the Castac Lake and Dryfield Canyon areas of the Basin which tend to exhibit water level declines between 2000 and 2005 (dry years), water level increases between 2005 and 2006 (wet years), and water level decreases from 2007 onward (mostly dry and critically dry years). Hydrographs showing groundwater elevations in recent years (**Figure GWC-5**) show stabilization of and increases in water levels from mid-2017 onward.

The water levels at well TRC-PW60, which is located approximately a third of the way down Grapevine Canyon from Castac Lake (see **Figure GWC-4**), indicate that groundwater elevations have remained within 35 feet of the ground surface at that well throughout the historical record. Similarly, based on historical observations (Bookman and Edmonston, 1965), well TRC-PW81 remained flowing artesian throughout the 1950s and 1960s, which was a drought period. These data suggest that, in the Grapevine Canyon area of the Basin, long-term drought conditions have not historically resulted in significant groundwater elevation declines despite reduced recharge from precipitation and groundwater inflows from the Castac Lake area of the Basin.

8.3. Change in Groundwater Storage

> *§ 354.16. Groundwater Conditions*
> *(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.*

The Basin storage volume was estimated as the product of the aquifer volume and the assumed specific yield of the aquifer sediments. Based on a summation of sub-volumes for portions of the irregularly shaped Basin, the total volume of the aquifer materials is estimated to be approximately 2.02E+10 cubic feet (ft^3), or 465,000 acre-feet (AF). The total porosity of the aquifer materials was estimated to be 20 percent. This value has been previously used by both Schmidt (2002) and Galli (2005) for storage estimates of similar aquifer materials in the upgradient Cuddy Canyon Basin. Therefore, the maximum storage volume of the aquifer is estimated based on these assumptions to be approximately 93,000 AF.

An initial ("first-order") estimate for the Basin's change in groundwater storage was estimated using data for the most recent ten-year period (WY 2009-2018). This period encompasses the highest resolution water level data available, paired with extreme climatic conditions. The method used to estimate storage change for uses water level data collected at the start and end of the period, spatially-variable specific yield information, and the following relationship, applied in a distributed manner:

*Change in Storage = [Ending Water Level – Starting Water Level] * Specific Yield * Area*

Representative wells used in the long term and recent hydrographs, as shown on **Figure GWC-4** and **Figure GWC-5**, were selected to calculate changes in water levels. Since the Castac Lake and Dryfield Canyon areas of the Basin share similar aquifer and hydrogeologic properties, they were grouped together for the purpose of this analysis. The acreage of sub-areas is shown in **Table GWC-3**. Three representative wells are located within the Grapevine Canyon area of the Basin, and nine representative wells are within the Castac Lake and Dryfield Canyon areas of the Basin. An average trend from these representative wells over the most recent ten-year period (WY 2009-2018) were calculated for each sub-area, and represents the change in water level.

As part of the historical water budget approach, specific yield was calibrated using the average groundwater elevation for the Castac Lake and Dryfield Canyon areas, and a general assumption of unconfined conditions for the entire Basin. This calibrated specific yield value of 0.12 is greater than the storage coefficients estimated from aquifer pumping tests (**Table HCM-2**) likely due in part to the limited spatial variability represented in the historical water budget approach. Using 0.12 value as a Basin-wide specific yield therefore likely overestimates the average change in Basin groundwater storage.

Using the parameters specified in **Table GWC-3** below, and the equation presented above over the period WY 2009-2018, an estimate for the average change in storage within the Grapevine Canyon area was calculated to be a loss of 70 acre-feet per year (AFY), and the estimated average change in storage within the Castac Lake and Dryfield Canyon areas was calculated to be -1,150 AFY; thus, the total estimated groundwater storage loss over the period is approximately 1,200 AFY. As mentioned above, these values represent an upper-end range of the average change in storage. If the storage coefficient estimated from aquifer pumping tests in the Shallow Aquifer zone (0.0025) was used instead, the average change in storage would decrease to -1.5 AFY in Grapevine Canyon and -24 AFY in Castac Lake and Dryfield Canyon, totaling approximately 26 AFY of groundwater storage loss. The actual change in storage therefore likely falls somewhere between the two estimates.

Table GWC-3. Approximate Change in Storage Calculated from Water Levels, 2009-2018

Area	Acres	Storativity	Average Trend (ft/yr)	Average Change in Storage (AFY)
Grapevine	1,402	0.12	-0.43	-70
Castac Lake and Dryfield Canyon	2,161	0.12	-4.45	-1,150

Abbreviations:
AFY = acre-feet per year
ft/yr = feet per year

Notes:
1. Average change in storage is rounded to the nearest 10 AF.

Another, more detailed analysis of annual changes in groundwater storage was completed using output from the historical Water Budget model, described further in Section 9 *Water Budget Information* below. **Figure GWC-6** shows the estimated annual change in storage between seasonal water level highs (i.e., from March of each year to February of the following year) and WY type based on DWR's San Joaquin Valley WY Index for WY 1998-2018. As shown on **Figure GWC-6**, annual change in storage ranged from an increase of approximately +1,200 AF for the period from March 1998 – February 1999 to a decrease of approximately -1,700 AF for the period from March 2009 – February 2010, which approximately agrees with the first-order estimate shown in **Table GWC-3** above.

Change in Basin storage appears to be significantly influenced by climate. **Figure GWC-7** plots the estimated historical cumulative storage change and rainfall cumulative departure from average, based on the record measured at the Lebec National Oceanic and Atmospheric Administration (NOAA) station between 1948 and 2019.[22] As shown in **Figure GWC-7**, change in storage is negative during dry years when the cumulative departure decreases, and generally positive during wet years when the cumulative departure increases. **Figure GWC-7** also plots the estimated annual volume of groundwater pumping in the Basin. During the water budget period considered, groundwater pumpage decreased over time.

[22] NOAA Lebec climate station Coop ID #44863 www.wrcc.dri.edu/cgi-bin/cliMAIN.pl?ca4863

8.4. Seawater Intrusion

> *§ 354.16. Groundwater Conditions*
> *(c) Seawater intrusion conditions in the basin, including maps and cross-sections of the seawater intrusion front for each principal aquifer.*

The Basin is located far from coastal areas, therefore seawater intrusion is not considered to be a threat to groundwater resources.

8.5. Groundwater Quality Concerns

> *§ 354.16. Groundwater Conditions*
> *(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.*

Groundwater quality constituents that may affect the supply and beneficial uses of groundwater in the Basin were identified by comparing the highest measured concentration detected at individual wells for several constituents to applicable Maximum Contaminant Levels (MCLs). Primary MCLs are drinking water standards set by the United States Environmental Protection Agency (USEPA) and California Environmental Protection Agency (CalEPA) based on human health considerations. Secondary MCLs are non-health related standards set by the State Water Resources Control Board (SWRCB) based on aesthetic characteristics of drinking water such as taste, odor, and color. For four common constituents (i.e., total dissolved solids [TDS], specific conductance, chloride, and sulfate), the SWRCB sets three levels of secondary MCLs for consumer acceptance, referred to as (lowest to highest concentration): “recommended”, “upper”, and “short term”. Very limited water quality data is available from the last 10-years, therefore we examined water quality data between 1998 through 2019 for recent conditions. **Table GWC-4** below tabulates the MCLs and summarizes the number of wells sampled from 1998 through 2019 with MCL exceedances. In addition to data available from the Castac Basin DMS, the online water quality data sources identified in *Appendix E* were reviewed and used to supplement the analysis described in this and the following sections.

As discussed in more detail below, based on the limited water quality data for the Basin, constituents in well-water samples associated with potential health risks (i.e., exceeded the primary MCL) are identified as the primary potential water quality constituents of concerns within the Basin: arsenic, fluoride, uranium, and TDS.

Table GWC-4. Well-water samples exceeding MCLs, 1998-2019

Constituent	MCL (mg/L)		Number of Wells Sampled	Number of Wells Exceeding MCL
	Primary	Secondary		
Arsenic	0.01	-	25	1
Fluoride	2	-	28	8
Lead	0.015[(a)]	-	24	0
Nitrate as N	10	-	28	0
Selenium	0.05	-	24	0
Uranium	0.03	-	13	4
TDS	-	500	26	21
Chloride	-	250	25	0
Iron	-	0.3	22	5
Manganese	-	0.05	23	4
Sulfate	-	250	24	2

Abbreviations:
MCL = maximum contaminant level
mg/L = milligrams per liter

Notes:
(a) The MCL for lead was rescinded with the adoption of a Regulatory Action Level in 1995 in which systems must take certain actions if an Action Level is exceeded. The Action Level replaces the MCL.

8.5.1. Primary MCL Exceedances

Constituents for which samples exceeded the primary (i.e. health risk-based) MCL include arsenic, fluoride and uranium:

- **Arsenic** ingestion has been associated with an increased risk of cancer and other chronic health effects, and concentrations that exceed the MCL in drinking water sources are a significant human health concern (USEPA, 2001). The primary MCL for arsenic is 10 micrograms per liter (ug/L; 0.01 milligrams per liter [mg/L]) and the Agricultural Water Quality Goal is 100 ug/L (0.1 mg/L). As shown in **Figure GWC-8**, the maximum historical (prior to 1998) arsenic concentrations were detected at concentrations below the MCL, and only one well has had a detection above the MCL in recent (1998-2019) sampling events.

- **Fluoride** concentrations in drinking water can be a significant health concern, including bone disease and pain or bone tenderness, associated with concentrations exceeding 4 mg/L, and mottled teeth in children ("dental fluorosis") associated with concentrations exceeding the MCL (Title 22 CCR Article 18 § 64465). The primary MCL for fluoride is 2 mg/L. As shown in **Figure GWC-9**, eight wells have had detections above the MCL in recent (1998-2019) sampling events. High fluoride concentrations have been a concern for the

KMWC public supply well. As shown in the chemograph for the KMWC well in *Appendix E*, in recent years fluoride concentrations exceed the MCL, which has resulted in KMWC conducting a Fluoride Mitigation Project in which various alternatives for addressing increased levels of fluoride were analyzed (Quad Knopf, Inc., 2019).

- **Uranium** is a naturally-occurring groundwater constituent within the Basin, and is occasionally detected at low levels in some wells (LCWD, 2019). Ingestion of drinking water which contains uranium concentrations exceeding the MCL may cause kidney problems or an increased risk of cancer (Title 22 CCR Article 18 § 64465). The source of uranium and other radioactive trace groundwater constituents has been attributed to the slow weathering of granitic rocks in the Basin (EKI, 2008c). Associated alpha radiation also may be potentially driven by the movement of radon gas along local fault splays or fractured bedrock zones (EKI, 2008c). The primary MCL for uranium is 30 micrograms per liter (ug/L; 0.03 mg/L). Limited water samples analyzed for uranium (**Figure GWC-11**) show that wells exceeding the MCL in recent years are scattered throughout the Basin.

Nitrate can pose a significant health concern for pregnant women and infants if concentrations exceed the MCL, as elevated levels of nitrate can cause methemoglobinemia ("blue baby syndrome") (McCasland et al., 2012). The primary MCL for nitrate as nitrogen is 10 mg/L or nitrate as nitrate is 45 mg/L. The available analytical data, both historical (prior to 1998) and recent (1998-2019) for nitrate as nitrogen from sampled wells have been below the MCL (see **Figure GWC-10**). Two temporary grab groundwater samples collected in 1999 exceeded the MCL, but these are by their nature variable "snapshots", sampled under relatively uncontrolled conditions, which cannot be re-sampled for confirmation, thus they generally are not considered representative of long-term groundwater conditions. Therefore, although nitrate has been detected in samples from Basin groundwater, it is not considered a constituent of concern based on the existing data.

8.5.2. Secondary MCL Exceedances

Constituents for which samples exceeded the secondary (i.e. aesthetically-based) MCLs include TDS, iron, manganese, and sulfate:

- Historical (prior to 1998) and recent (1998-2019) TDS concentrations detected within Basin groundwater generally have been above the recommended secondary MCL of 500 mg/L. Concentrations exceeding the upper secondary MCL and short-term secondary MCLs (1,000 mg/L and 1,500 mg/L, respectively) were detected in a Shallow Aquifer zone monitoring well located down gradient of Castac Lake (see **Figure GWC-12**). The average measured TDS value for the Castac Lake water was approximately 1,600 mg/L. Additionally, elevated TDS concentrations measured in areas located adjacent to the Grapevine Canyon wetlands, where high evaporative losses are likely to occur, may have historically increased the concentration of constituents in the groundwater. Although TDS is not generally considered to effect human health, it is an indication of aesthetic characteristics of drinking water and can include an aggregated broad array of potential chemical contaminants. Therefore, TDS is considered a potential water quality COC for the Basin.

- Iron is an essential element in the metabolism of animals and plants, however if concentrations are excessive it can cause staining and is therefore considered an objectionable impurity (Hem, 1970). As detailed in **Table GWC-4** above, five wells have recent (1998-2019) concentrations which exceed the secondary MCL of 0.3 mg/L.
- Manganese is an essential element for plants and animals, but it is an undesirable impurity in water supplies as black oxide stains can occur if concentrations are sufficiently high (Hem, 1970). As detailed in **Table GWC-4** above, three wells within the Basin have recent (1998-2019) concentrations which exceed the secondary MCL of 0.05 mg/L.
- Sulfate occurs widely in soil and water (Hem, 1970). As detailed in **Table GWC-4** above, two wells (TRC-MW3S and TRC-MW23W) have recent (1998-2019) concentrations which exceed the recommended secondary MCL of 250 mg/L. These wells both are screened in the upper part of the shallow aquifer zone; concentrations from wells screened in the deeper aquifer zone do not have sulfate concentrations which exceed the secondary MCL.

8.5.3. <u>Water Quality Trends</u>

Available concentration data for constituents which exceeded the primary MCL or were considered a potentially significant health concern or COC were evaluated with respect to changes over time, and in relationship to groundwater levels. Available TDS, fluoride, arsenic, uranium, and nitrate chemographs (plots of concentration versus time) are presented in Appendix E. *Temporal Characteristics of Available Groundwater Data*. Several online sources from public agencies have been queried for additional data (see *Appendix E*), but additional available data are limited.

A total of 15 wells within the Basin have at least four water quality measurements between 1998 and present. A Mann-Kendall trend analysis was performed on these wells to determine whether concentrations exhibit a significant trend. For the purpose of this analysis, a trend identified from the Mann-Kendall test with p-value that is less or equal to 0.05 is considered to be significant. Among the 15 wells examined, three of the wells show statistically significant decreasing trends in fluoride (well TRC-PW81), nitrate (well TRC-PW81 and Tejon MS Well), and uranium (well LCWD-Lebec PW) concentrations. Seven of the wells show statistically significant increasing trends in arsenic (well Krista MWC-PW), nitrate (well TRC-MW90, TRC-PW56A, TRC-PW60, TRC-PW80, LCWD-Lebec PW and LCWD-State PW), TDS (well TRC-PW60 and LCWD-State PW), and uranium (well TRC-PW60 and LCWD-State PW). **Table GWC-5** below summarizes the number of wells exhibiting statistically significant trends for each COC.

Table GWC-5. Wells with Significant Water Quality Trends, 1998-2019

Constituent of Concern	Total Number of Wells[(a)]	Number of Wells with Decreasing Trend	Number of Wells with Increasing Trend
Arsenic	11	0	1
Fluoride	11	1	0
Nitrate as N	15	2	6
TDS	9	0	2
Uranium	11	1	2
Total Trend	-	4	11
Total Well	15	3	7

Notes:
a) Wells with at least four water quality measurements between 1998 and present.

Recent water quality concentration data within the Basin are very limited. An evaluation of the available water level and water quality data show that (1) some wells do show a weak correlation between water levels and certain potential COCs concentrations, (2) some wells show no correction between water levels and potential COCs concentrations, and (3) most wells have insufficient data to conduct statistical analyses.[23] As shown in *Appendix E*, in some cases when concentrations show a statistically significant increasing trend, water levels exhibit a decreasing trend in the same well, suggesting a potential correlation that may need further investigation once additional data are available.

Three correlation models, Pearson (linear), and Kendall and Spearman (non-linear), were considered when evaluating the potential relationship between water levels and water quality. The correlation is considered to be significant when the p-value of the correlation coefficient is less or equal to 0.05. Monthly average values were calculated for both water level and water quality data, and the correlation was evaluated when at least five data points were available in each well. As shown in *Appendix E*, only four wells (Krista MWC-PW, LCWD-Lebec PW, LCWD-State PW, and TRC-PW60) have more than five data points. All three correlation models suggest that the wells LCWD-Lebec PW and LCWD-State PW show negative correlation between water level and nitrate concentration. LCWD-State PW also shows negative correlation between water level and uranium concentration. In general, limited water level data exist for the wells for which water quality data are available. As discussed in Section *16 Description of Monitoring Network*, future monitoring efforts will include compilation of water quality data from public water system

[23] Wells were considered for statistical analysis only when four or more water quality analyses were available for the well, starting no earlier than 1998.

wells and the collection of water quality data from supplemental monitoring wells. These data and any associated trends will be evaluated in future reporting.

8.5.4. Point-Source Contamination Sites

In addition to the non-point source groundwater quality COCs detailed above, there are a small number of point-source contamination sites within the Basin as identified on the SWRCB GeoTracker website[24]. These sites, shown on **Figure GWC-13**, are typically associated with certain industrial or commercial land uses (e.g. gas stations). Within the Basin, there are 12 Leaking Underground Storage Tank (LUST) sites and one cleanup program site. All 12 LUST sites are closed and inactive and the identified contaminants of concern include gasoline (ten sites), motor oil (one site), and lead (one site).

The one cleanup program site (Mobil M-1 Crude Oil Pipeline; SL205724284) has been closed as of December 2018. Potential contaminants of concern in soil and groundwater included crude oil, gasoline, and polynuclear aromatic hydrocarbons (PAHs)[25]; the Basin aquifer was identified as a potentially affected media of concern. In 2017, a site assessment determined that residual hydrocarbon concentrations present in soil, soil vapor, and groundwater met the Low-Threat Closure Policy and therefore do not pose a significant risk to human health (Central Valley Regional Water Quality Control Board [CVRWQCB], 2018a). Water supply well TRC-PW81, which services the public water system associated with the TRC headquarters, is located approximately 750 feet in a cross-gradient direction from the plume area; water samples collected from TRC-PW81 did not contain detectable concentrations of hydrocarbons (CVRWQCB, 2018a). In December 2018, site data indicated that criteria for No Further Action status under the Low-Threat Underground Storage Tank Case Closure Policy was achieved and the site was granted closure (CVRWQCB, 2018b).

A land disposal site (Lebec Sanitary Landfill; L10005571106) is located directly up-gradient from the Basin. The landfill is closed, with active monitoring ongoing. Although the landfill is located outside of the Basin, groundwater flow is estimated at approximately 190 feet per year to the southeast (towards the Basin), based on estimated aquifer dimensions, monitoring well water-level data from 2017, and a hydraulic conductivity of $6.1x10^{-4}$ feet per day (Kern County Public Works Department, 2017). Volatile Organic Compounds (VOCs) and inorganic general chemistry are monitored within on-site monitoring wells. In April 2018, low concentrations of some VOCs were detected, but these generally have decreased from historical concentrations, suggesting effective site remediation by natural attenuation (Kern County Public Works Department, 2018). In April 2018, nitrate, sulfate and TDS exceeded their respective MCLs in samples collected from three monitoring wells, however concentrations were generally consistent with historical concentrations (Kern County Public Works Department, 2018).

[24] http://geotracker.waterboards.ca.gov
[25] https://geotracker.waterboards.ca.gov/profile_report.asp?global_id=SL205724284

8.6. Land Subsidence

> *§ 354.16. Groundwater Conditions*
> *(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.*

Publicly available recent data on land subsidence (Farr et. al, 2016) shows that it is not likely to be a significant concern in the Basin. **Figure GWC-14** reproduces recent subsidence maps produced from Interferometric Synthetic Aperture Radar (InSAR) data between May 2015 and July 2016[26], and shows no major subsidence has occurred in the recent period of groundwater level decline associated with dry climatic conditions. The amount of subsidence mapped within the Basin falls within the range of possible error in subsidence measurement methods using remote sensing (i.e., on the order of 0.25 to 1 inch [Farr et. al, 2016]).

The closest continuous subsidence monitoring site, Grapevine_CS2005, is located on bedrock or in very thin soil outside the Basin to the west (**Figure GWC-14**). This site has experienced 0.16 inches of accretion (increases in land surface elevation) between 2005 and 2018[27], which indicates bedrock movement along existing faults or fracture sets. This structural movement in the underlying bedrock may complicate interpretation of seismic data in alluvial sediments of the Basin.

Inspection of hydrographs presented in **Figure GWC-4** and **Figure GWC-5**, show that current groundwater elevations are approximately 20 to 60 feet above historical lows. Irreversible subsidence typically occurs when groundwater levels decline below historical lows and subsurface sediments contain a large fraction of clay-sized particles, or when clay interbeds make up a significant fraction of the stratigraphic thickness of the aquifer. The observed stabilization and general recovery in water levels over much drier conditions in the past fifty years has reduced the threat of subsidence in the Basin. Thus, subsidence-related problems within the Basin are not likely to be a concern as long as water levels remain above historical low levels observed in the 1960s.

8.7. Interconnected Surface Water Systems

> *§ 354.16. Groundwater Conditions*
> *(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.*

[26] https://data.cnra.ca.gov/dataset/nasa-jpl-insar-subsidence
[27] https://www.unavco.org/instrumentation/networks/status/pbo/data/P553

Interconnected surface water is defined in the GSP regulations [23-CCR §354(o)] as "surface water that is hydraulically connected at any point by a continuous saturated zone to the underlying aquifer and the overlying surface water is not completely depleted." Furthermore, the definition of interconnected surface water requires that the surface water feature not be completely depleted (i.e., not dry). **Figure GWC-15** depicts the location of potentially interconnected surface water systems, including Cuddy Creek, Grapevine Creek, and Castac Lake.

Cuddy Creek flows intermittently from the up-gradient Cuddy Canyon Basin towards Castac Lake. However, due to the permeable nature of the alluvium in the bottom of Cuddy Creek, flows from Cuddy Creek only reach Castac Lake during significant rainfall events (Wood, 1912). Very limited historical flow data is available for Cuddy Creek. Peak streamflow values measured between 1980 and 2017 near Lebec[28] ranged from 0 cubic feet per second (cfs) to 2,400 cfs (see **Figure GWC-15** for station location). As can be seen on **Figure GWC-15**, most of Cuddy Creek streamflow is associated with runoff from winter precipitation events, as very little to no flow occurs in the summer months (June to October). Depth to groundwater measurements in monitoring well TRC-MW16D, which is located near the Cuddy Creek gaging station, show a continual decline since measurements began in 2007. Spring 2015 depth to groundwater was greater than 60 feet below ground surface (ft bgs). As Cuddy Creek typically has very little to no flow and as of Spring 2015, the measured deep depth to groundwater in adjacent monitoring well TRC-MW16D (i.e., 134 ft bgs) suggests Cuddy Creek is disconnected from the groundwater system.

The channel of Grapevine Creek originates at Castac Lake, however overflows from Castac Lake into Grapevine Creek only occur on rare occasions when the lake has water in it and water surface elevations exceed the spillway elevation. Springs located near Fort Tejon and the TRC headquarters, approximately one-mile northwest of Castac Lake, are the primary source of perennial feedwaters (Wood, 1912; Bookman Edmonston, 1965). Grapevine Creek flows were measured intermittently between 2000 and 2007 (see **Figure GWC-15** for station locations). As can be seen on **Figure GWC-15**, streamflow measurements near the headwaters (Tejon Lake Drive) were less than those measured downstream (I-5 Undercrossing and Lebec Road). Spring 2015 depth to groundwater at the Grapevine Creek headwaters range from 30 ft bgs to 60 ft bgs, however moving northward (and downslope) into Grapevine Canyon, depth to groundwater decreases to typically less than 15 ft bgs. As shown in **Figure HCM-9** and **Figure HCM-10**, alluvial aquifer materials decrease in thickness and lateral extent moving north towards the Basin outlet which causes groundwater to discharge to the surface into Grapevine Creek as baseflow. Since Grapevine Creek has segments which seemingly are fed by groundwater, and depth to groundwater is shallow near the northern end of the Basin within Grapevine Creek, it appears that some segments of Grapevine Creek are a gaining stream in which surface flow rates increase due to inputs from groundwater.

---

[28] Kern County Station 108C Cuddy Creek (Lebec) M-35-9-20

Although it is often dry, Castac Lake historically has been observed to be connected with the surrounding aquifer, with groundwater seepage occurring both into and out of the lake when gradients are favorable (Bookman Edmonston, 1965; Trihey and Associates, 1997; Dudek & Associates, 1999). The volume of shallow groundwater seepage to and from the lake is difficult to quantify, however. Seepage out of the lake returning into the groundwater system ("return flow") only occurs when groundwater elevations at the mouth of Grapevine Canyon (i.e., at well TRC-MW3S) are less than the Castac Lake water elevation. Historically, Castac Lake has been partially full to empty over the past 100 years with rare instances of lake filling caused by large rainfall events (Bookman Edmonston, 1965; Laskowski, 1968; Trihey and Associates, 1997; Dudek & Associates, 1999). Further, between 2001 and 2008 and in 2012, groundwater was pumped into the lake by Tejon Ranch Corporation (TRC) to maintain lake water levels, which were consistently higher than nearby groundwater elevations. Once groundwater pumping into the lake ended, Castac Lake levels declined due to seepage and drought conditions. In recent years, Castac Lake has little to no water.

Return flow from Castac Lake to the Basin can be estimated using Darcy's Law in which groundwater flow (Q) is calculated by multiplying an estimated hydraulic gradient ($\frac{dh}{dl}$), hydraulic conductivity (K), and area of flow (A) as follows:

$$Q = K\frac{dh}{dl}A$$

where:

- K is estimated to be 5.25 feet per day (ft/d) based on the average horizontal hydraulic conductivity estimated for the Shallow Aquifer zone (10.5 ft/d) and the calibrated vertical hydraulic conductivity of the lake bed sediments from the Castac Basin Numerical Model (0.001 ft/d);
- dh is the change in water levels elevations between Castac Lake and the Shallow Aquifer zone groundwater elevation at the mouth of Grapevine Canyon, represented by well TRC-MW3S;
- dl is the distance between Castac Lake and TRC-MW3S; and
- A is the cross-sectional area through which the water seeps out of Castac Lake, estimated to be approximately 12 acres.

Castac Lake levels are only available between 2000 and 2007 and intermittently between 2010 and 2015; the average volume of water estimated to seep out of Castac Lake over this period was approximately 40 AFY. After 2015, Castac Lake was primarily dry, with seasonal shallow levels attributed to direct precipitation events. For example, Castac Lake contained water during Spring 2019, however lake levels were relatively shallow (less than 1-foot deep). High-resolution water level data collected from the lake, and shallow monitoring wells adjacent to the lake suggest lake levels and nearby groundwater elevations are affected by evapotranspiration. Furthermore, stable isotope data collected from the lake, nearby wells, and Grapevine Creek corroborates a highly evaporative signature within the lake that is also slightly evident in nearby wells (see Appendix *E* for stable isotope plot).

8.8. Groundwater Dependent Ecosystems (GDEs)

> *§ 354.16. Groundwater Conditions*
> *(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.*

Groundwater Dependent Ecosystems (GDEs) are those natural communities that depend on near-surface groundwater as a source of water. DWR has developed a map of natural communities commonly associated with groundwater (NCCAG) for use by GSAs in identifying land areas by vegetation categories that may indicate the potential for GDEs. **Figure GWC-16** shows the distribution of NCCAG areas identified within the Basin; approximately 26% of the Basin is covered by potential NCCAG areas, with 11% classified as potential wetland (including Castac Lake) and 14% classified as vegetation. These classifications are estimates based on remotely-obtained data and as such do not necessarily indicate the presence of actual GDEs.

As shown on **Figure GWC-16**, Castac Lake is the primary area in which NCCAG areas were identified, with emergent wetlands vegetation surrounding Castac Lake in the areas that historically were inundated with water during periods of high lake levels. A direct hydrologic connection may exist between the soil and alluvium beneath the lake, and the surrounding potential wetlands. During periods of relatively lower lake levels, lake water could be drawn into these wetlands through saturated lakebed sediments and alluvium to feed the evaporative demands of this vegetation.

The vegetation NCCAG located within the Basin may include groups or species such as Fremont Cottonwood, Riparian Mixed Hardwood, Valley Oak, Wet Meadows, Willow, and Willow (shrub). It is important to note that the actual presence of these plant species or groups has not been field-verified in the Basin for over a decade, and the true areas of GDEs under current groundwater depth conditions may vary widely from the NCCAG dataset.

Table GWC-6 (below) summarizes maximum plant rooting depths for the indicator species, as compiled by The Nature Conservancy (TNC), to assist in determining if vegetative species within the NCCAG dataset are accessing groundwater.[29] Groundwater depth measured in shallow wells near the NCCAG areas ranges from less than 15 ft bgs in the Grapevine Canyon area of the Basin, to greater than 30 ft bgs in the Castac Lake area of the Basin (**Figure GWC-16**). The groundwater depths in the Grapevine Canyon area of the Basin may support the maximum rooting depths of plants potentially included in the NCCAG, however, in the Castac Lake area of the Basin, current groundwater depths likely are below the GDE maximum rooting depths shown in **Table GWC-6**.

[29] https://groundwaterresourcehub.org/sgma-tools/gde-rooting-depths-database-for-gdes/

Thus, most of the existing plant community in the Basin is likely using little groundwater under current conditions. Ephemeral communities of phreatophytes may colonize areas of shallow groundwater in wet years, and become dormant or die out in dry periods, as has occurred in the past.

Mapping of vegetation and wetland areas was conducted in 2008 as part of the Tejon Mountain Village (TMV) Environmental Impact Report (Kern County Planning Department, 2009b). *Appendix F* contains copies of these maps, which generally agree with the NCCAG mapped areas. As part of the TMV Habitat Management Plan, some areas within the Grapevine Canyon area of the Basin were mapped as wetlands in 2007 (Appendix F).

Table GWC-6. Maximum Plant Rooting Depths (after TNC)

NCCAG	Maximum Rooting Depth (feet)[a]
Fremont Cottonwood	0.66 to 6.89
Riparian Mixed Hardwood	--
Valley Oak	24.02 to 24.31
Wet Meadows[b]	0.69 to 24.31
Willow	2.362
Willow (shrub)	2.362

Notes:

(a) Maximum rooting depth was not available for all NCCAG.

(b) Based on the maps provided in *Appendix F*, wet meadows may contain various species including red willow, common three-square, rush riparian grassland, valley oak, tule, creeping ryegrass grassland, and perennial pepperweed.

The GDE Pulse Interactive Map[30] developed by TNC, which uses remote sensing data from satellites to monitor the health of vegetation, can be used to assess long-term temporal trends of vegetation metrics in the Basin. The vegetation metrics include Normalized Derived Vegetation Index (NDVI) which estimates vegetation color ("greenness") and Normalized Derived Moisture Index (NDMI) which estimates vegetation moisture, both of which can indicate vegetation health for GDEs.

The GDE Pulse tool calculates linear trends in NDVI and NDMI over three timeframes: 1985-2018, 2009-2018, and 2010-2014. Over the long term (i.e., 1985 - 2018), Basin NDVI and NDMI trends generally have been stable, with local or shorter term declines or in some cases, increases. Over the past 10 years which have been primarily dry, both NDVI and NDMI show large decreasing trends in the central Basin, and NDVI shows a moderate increasing trend in the northern portions of the Basin. Over the drought period of 2010-2014, both NDVI and NDMI show large decreasing

[30] https://gde.codefornature.org/#/map, accessed on 17 March 2020.

trends in area southwest of the Castac Lake, and NDMI shows a large increasing trend in the central Basin.

Appendix F includes screenshots of the GDE Pulse Interactive Map for three selected polygons that are spatially representative of the Basin. The NDVI and NDMI trends shown in the GDE Pulse generally align with the long-term water level trend discussed in Section 8.2.3. Specifically, the Grapevine Canyon area of the Basin shows fairly stable water levels over the historical record. In contrast, water level in the Castac Lake and Dryfield Canyon areas of the Basin generally declined from 2000 through 2004, partially recovered from 2005 through 2006, declined again from 2007 through mid-2017, and stabilized from mid-2017 through 2018.

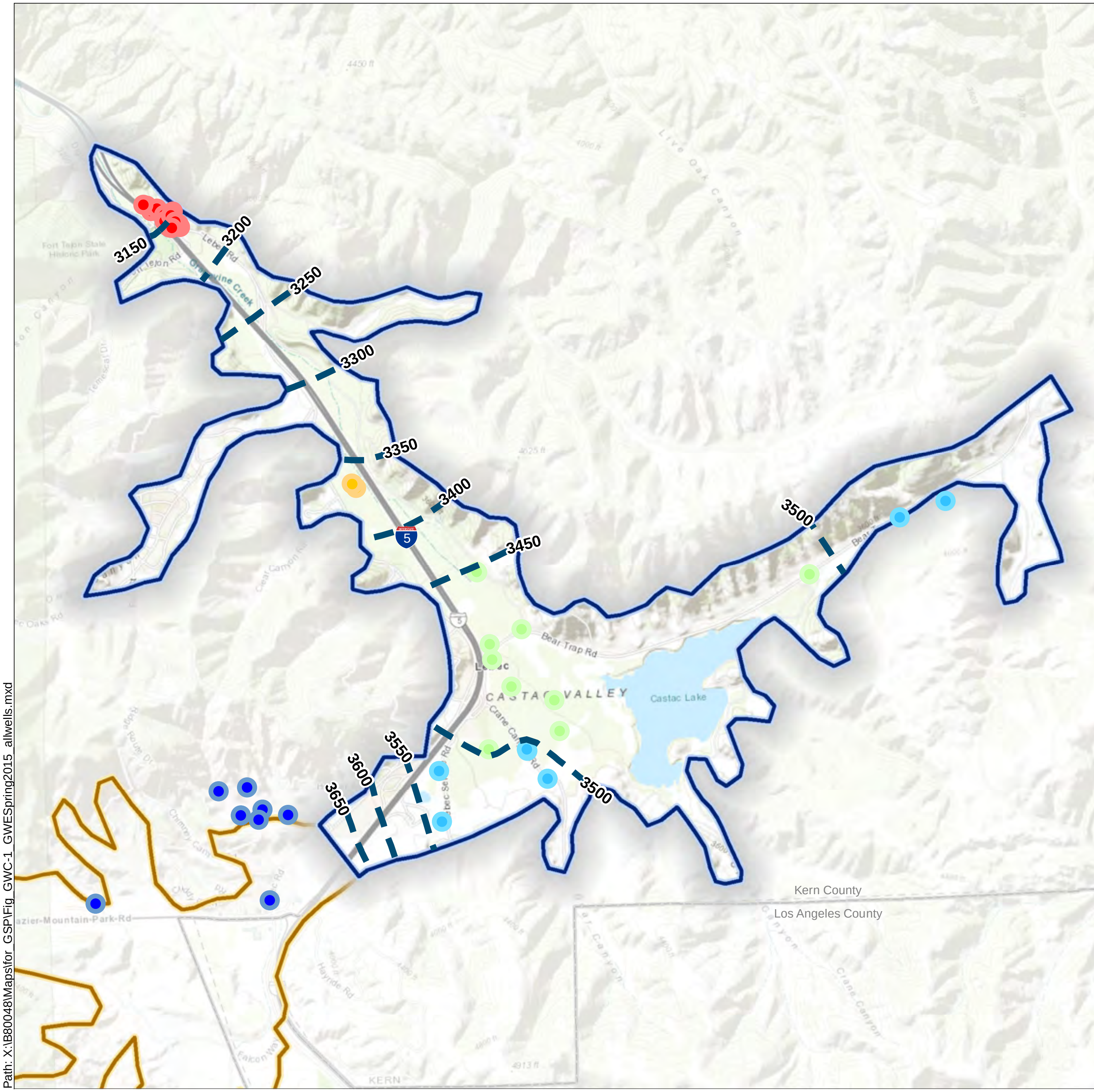
In addition to vegetation and wetland communities, other environmental users of groundwater also may include species reliant on surface water. TNC has compiled a list of freshwater species potentially located within each groundwater basin, for use by GSAs to evaluate the possible presence of these species[31]. *Appendix G* contains copies of this TNC list, which includes 31 unique species grouped into four taxonomic groups: herps (i.e., reptiles), mollusks, birds, and plants.

As of April 2015, the bald eagle and tricolored blackbird are on the Federal Endangered Species List as “Birds of Conservation Concern” and the California red-legged frog is listed as “Threatened”. Also, seven species on the California Endangered Species or Sensitive Species lists including the western pond turtle, California red-legged frog, tricolored blackbird, redhead, American white pelican, two-striped garter snake, and Pringles’ yampah (a member of the parsley family) are listed as of “Special Concern”, and the bald eagle is listed as “Endangered”.

Mapping of wildlife species conducted as part of the TMV Environmental Impact Report did not detect the California red-legged frog on the site, the bald eagle was observed infrequently during winter, and the tricolored blackbird was observed to be nesting near fresh water and emergent wetlands (Kern County Planning Department, 2009b). Appendix F *Supplemental Wetlands, Vegetation, and Special Species Maps* contains copies of the TMV Environmental Impact Report maps, which show occurrences of special status species within and surrounding the Basin. In general, the maps (completed in 2008 during wetter conditions) show a few spatially-limited occurrences of special-status species within the Basin, including Tehachapi slender salamander, coast horned lizard, two-striped garter snake,

As discussed above, before areas of the Basin can be classified as hosting GDEs, additional field-based data may need to be collected over different seasons, such as ground-mapping of plant and animal communities, examination of soil moisture and groundwater levels, and other factors.

[31] https://groundwaterresourcehub.org/sgma-tools/environmental-surface-water-beneficiaries/



Path: X:\B80048\Maps\for_GSP\Fig_GWC-1_GWESpring2015_allwells.mxd

Legend

Groundwater Elevation Contour (ft msl)

Spring 2015 Groundwater Elevation (ft msl)

- <3,200
- 3,200-3,400
- 3,400-3,500
- 3,500-3,600
- >3,600

Castac Lake Valley Groundwater Basin

Other Groundwater Basin

County Boundary

Abbreviations

DWR = California Department of Water Resources

ft msl = feet above mean sea level

Notes

1. All locations are approximate.
2. Contour interval: 50 feet
3. Groundwater elevation contours were created using an interpolation process called kriging and are less certain in areas with sparse data.

Sources

1. Groundwater basin boundaries from DWR Bulletin 118 Interim Update 2016.
2. Basemap is ESRI's ArcGIS Online world topographic map, obtained 19 June 2020.

N

0 0.5 1

Miles

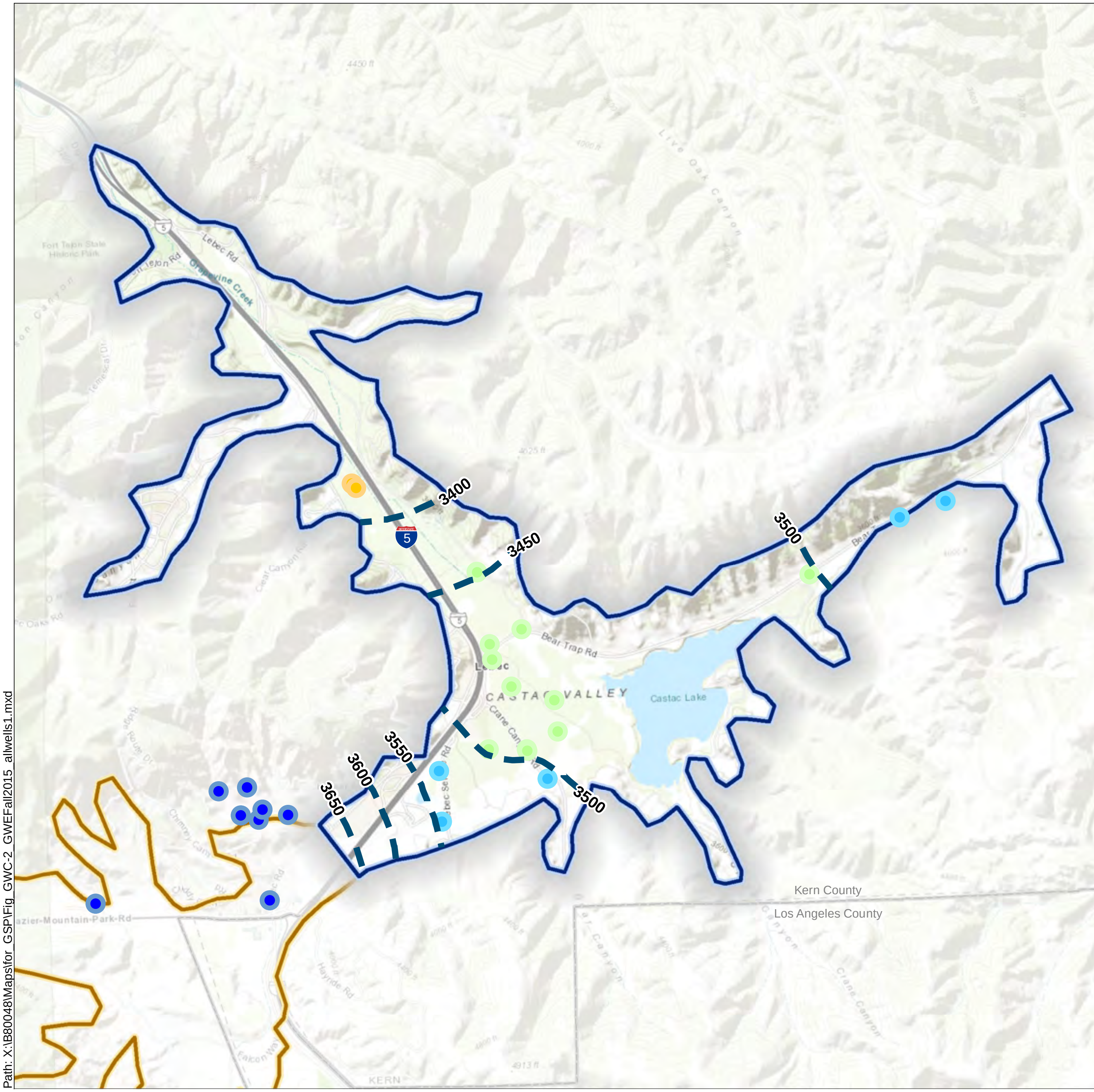
DRAFT

Groundwater Elevations Spring 2015

Tejon-Castac Water District
Kern County, California
June 2020
B80048.00

eki environment & water

Figure GWC-1



Legend

Groundwater Elevation Contour (ft msl)

Fall 2015 Groundwater Elevation (ft msl)

- <3,200
- 3,200-3,400
- 3,400-3,500
- 3,500-3,600
- >3,600

Castac Lake Valley Groundwater Basin

Other Groundwater Basin

County Boundary

Abbreviations

DWR = California Department of Water Resources
ft msl = feet above mean sea level

Notes

1. All locations are approximate.
2. Contour interval: 50 feet
3. Groundwater elevation contours were created using an interpolation process called kriging and are less certain in areas with sparse data.

Sources

1. Groundwater basin boundaries from DWR Bulletin 118 Interim Update 2016.
2. Basemap is ESRI's ArcGIS Online world topographic map, obtained 19 June 2020.

N

0 0.5 1
Miles

DRAFT

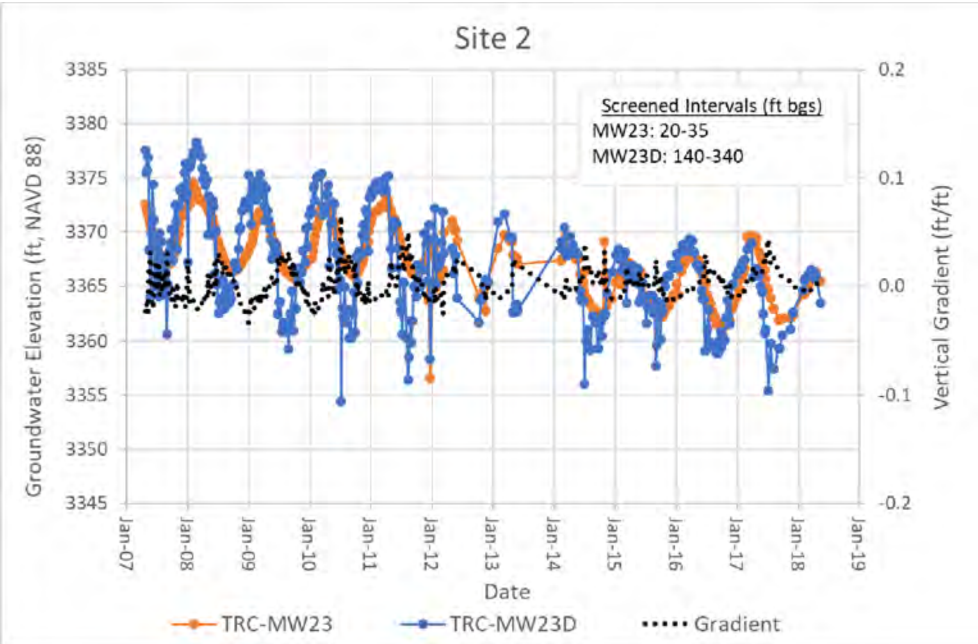
Groundwater Elevations Fall 2015

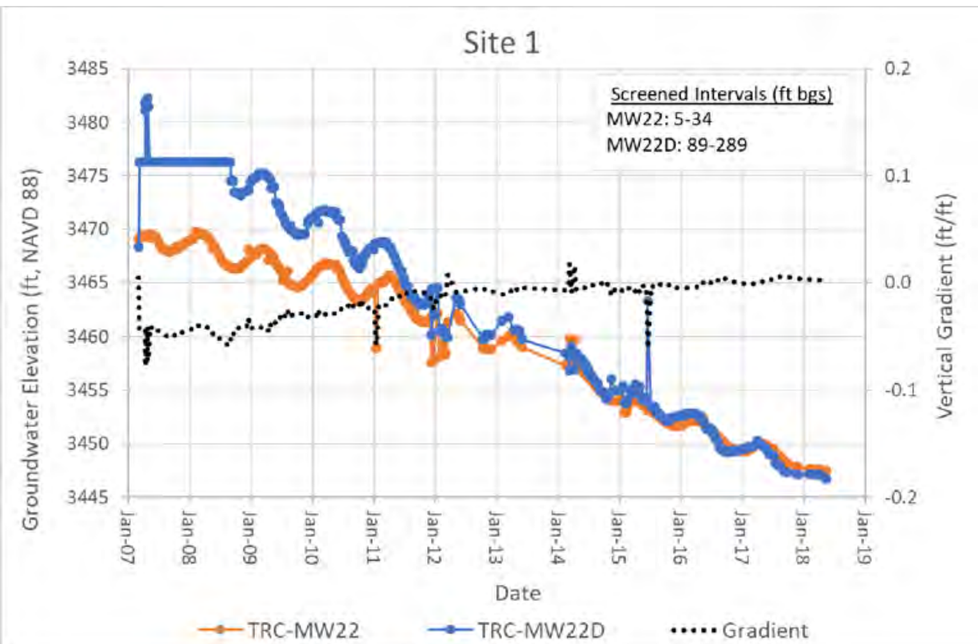
Tejon-Castac Water District
Kern County, California
June 2020
B80048.00

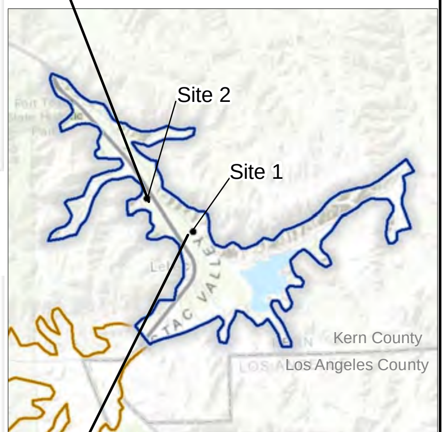
eki environment & water

Figure GWC-2

Path: X:\B80048\Maps\for_GSP\Fig_GWC-2_GWEFall2015_allwells1.mxd







Legend

- Castac Lake Valley Groundwater Basin
- Other Groundwater Basin
- County Boundary
- Monitoring Well

Abbreviations

DWR = California Department of Water Resources

Notes

1. All locations are approximate.

Sources

1. Groundwater basin boundaries from DWR Bulletin 118 Interim Update 2016.
2. Basemap is ESRI's ArcGIS Online world topographic map, obtained 19 June 2020.

N

0 2 4
Miles

DRAFT

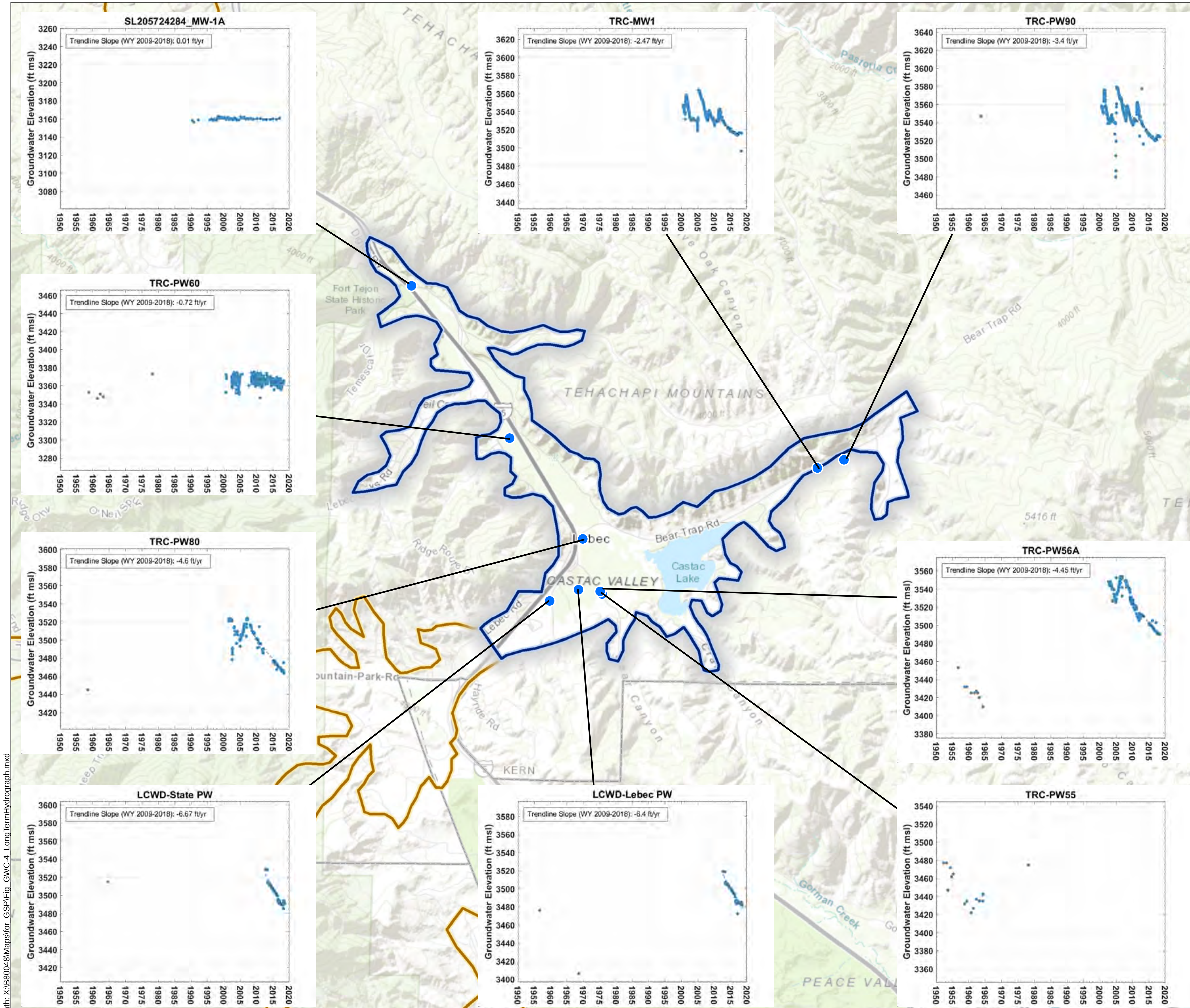
Vertical Gradient Hydrographs

eki environment & water

Tejon-Castac Water District
Kern County, California
June 2020
B80048.00

Figure GWC-3

Path: X:\B80048\Maps\for_GSP\Fig_GWC-3_VerticalGradients.mxd



Legend
- County Boundary
- Castac Lake Valley Groundwater Basin
- Other Groundwater Basin
- Groundwater Monitoring Well

Abbreviations
DWR = California Department of Water Resources
ft msl = ft above mean sea level
ft/yr = ft per year

Notes
1. All locations are approximate.

Sources
1. Groundwater basin boundaries from DWR Bulletin 118 Interim Update 2016.
2. Basemap is ESRI's ArcGIS Online world topographic map, obtained 19 June 2020.

N
0 1 2
(Scale in Miles)

Historical (1950-2018)
Groundwater Elevation Hydrographs

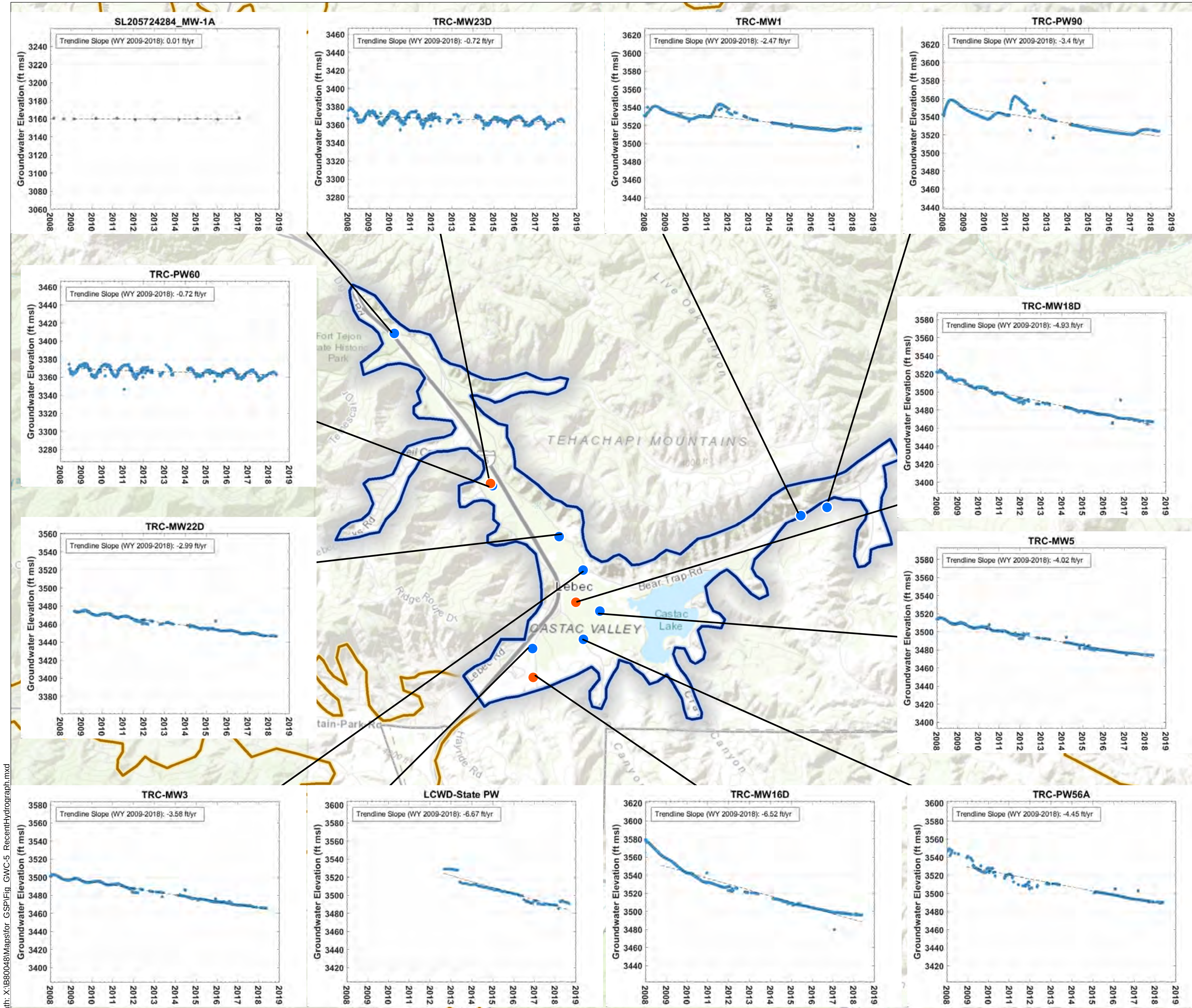
DRAFT

Tejon-Castac Water District
Kern County, California
June 2020
B80048.00

eki environment & water

Figure GWC-4

Path: X:\B80048\Maps\for_GSP\Fig_GWC-4_LongTermHydrograph.mxd



Legend

- County Boundary
- Castac Lake Valley Groundwater Basin
- Other Groundwater Basin
- Representative Monitoring Well
- Groundwater Monitoring Well

Abbreviations

DWR = California Department of Water Resources
ft msl = ft above mean sea level
ft/yr = ft per year

Notes

1. All locations are approximate.
2. Representative Monitoring Wells are those defined as the SGMA Monitoring Network (see Section 16).

Sources

1. Groundwater basin boundaries from DWR Bulletin 118 Interim Update 2016.
2. Basemap is ESRI's ArcGIS Online world topographic map, obtained 19 June 2020.

Recent (2009-2018)
Groundwater Elevation Hydrographs

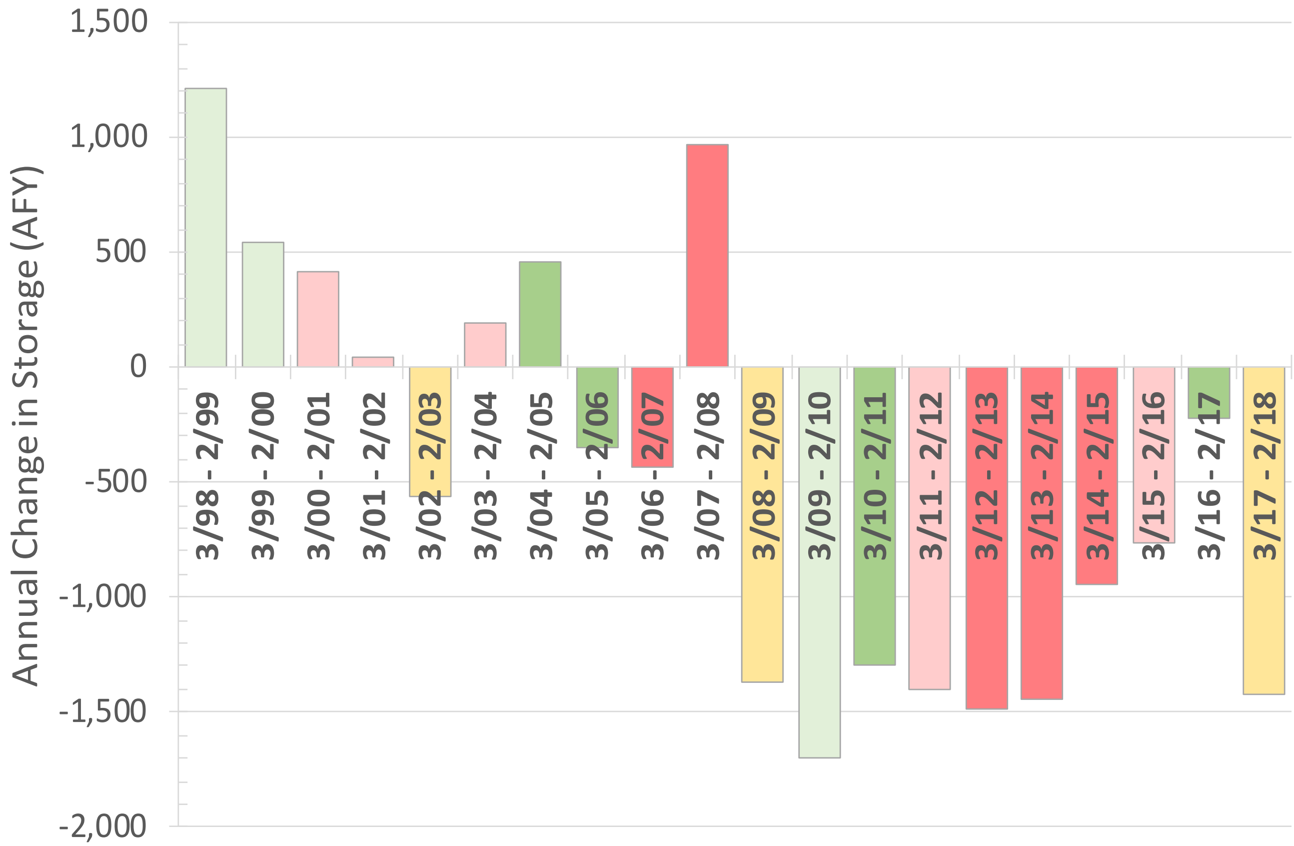
DRAFT

eki environment & water

Tejon-Castac Water District
Kern County, California
June 2020
B80048.00

Figure GWC-5

Path: X:\B80048\Maps\for_GSP\Fig_GWC-5_RecentHydrograph.mxd



Legend

DWR Water Year Type

- Wet
- Above Normal
- Below Normal
- Dry
- Critical

Abbreviations

AFY = acre-feet per year
DWR = California Department of Water Resources

Notes

1. "Seasonal high" condition is defined as March of the current year through February and the subsequent year.
2. The color of each bar chart is based on the Water Year type that begins in the October between the March and February represented by the bar.

Sources

DWR Water Year type is from DWR's Water Year Hydrologic Classification Indices for the San Joaquin Valley (http://cdec.water.ca.gov/reportapp/javareports?name=WSIHIST)

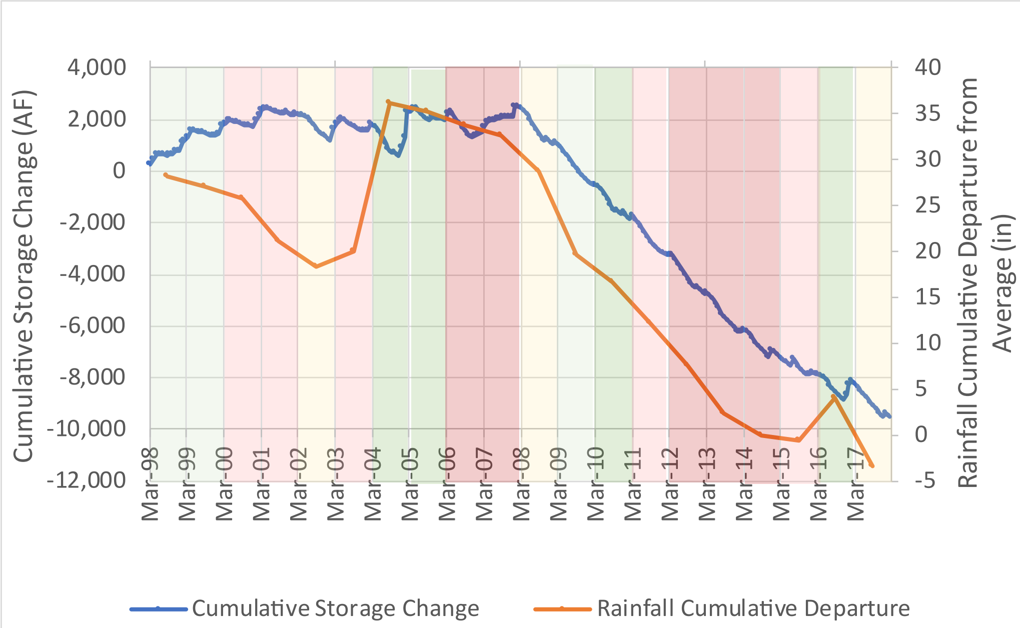
Annual Change in Storage Between Seasonal Highs vs. DWR Water Year Type

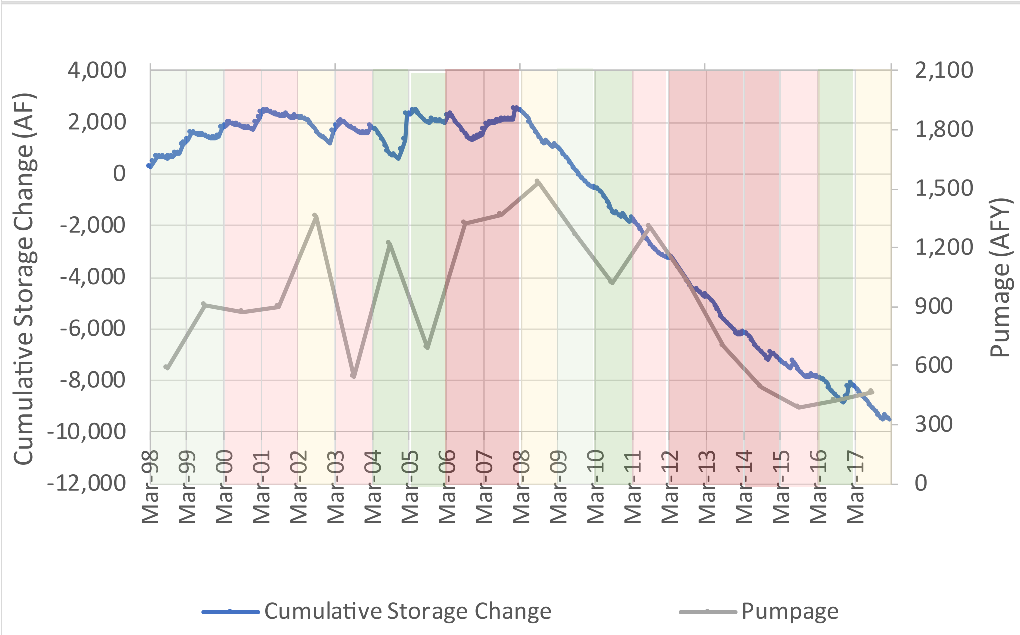
DRAFT

eki environment & water

Tejon-Castac Water District
Kern County, California
June 2020
B80048.00

Figure GWC-6





Legend

DWR Water Year Type

- Wet
- Above Normal
- Below Normal
- Dry
- Critical

- Cumulative Storage Change
- Rainfall Cumulative Departure
- Estimated Groundwater Pumpage

Abbreviations

AFY = acre-feet per year
DWR = California Department of Water Resources
NOAA = National Oceanic and Atmospheric Administration

Notes

1. "Seasonal high" condition is defined as March of the current year through February and the subsequent year.
2. The color of each bar chart is based on the Water Year type that begins in the October between the March and February represented by the bar.
3. Rainfall cumulative departure from average is calculated based on rainfall measured at the Lebec station between Water Years 1949 and 2018.

Sources

1. DWR Water Year type is from DWR's Water Year Hydrologic Classification Indices for the San Joaquin Valley (http://cdec.water.ca.gov/reportapp/javareports?name=WSIHIST)
2. NOAA Lebec climate station Coop ID #44863 (www.wrcc.dri.edu/cgi-bin/cliMAIN.pl?ca4863)

Modeled Cumulative Change in Storage, Rainfall Cumulative Departure from Average, and Pumpage vs. DWR Water Year Type

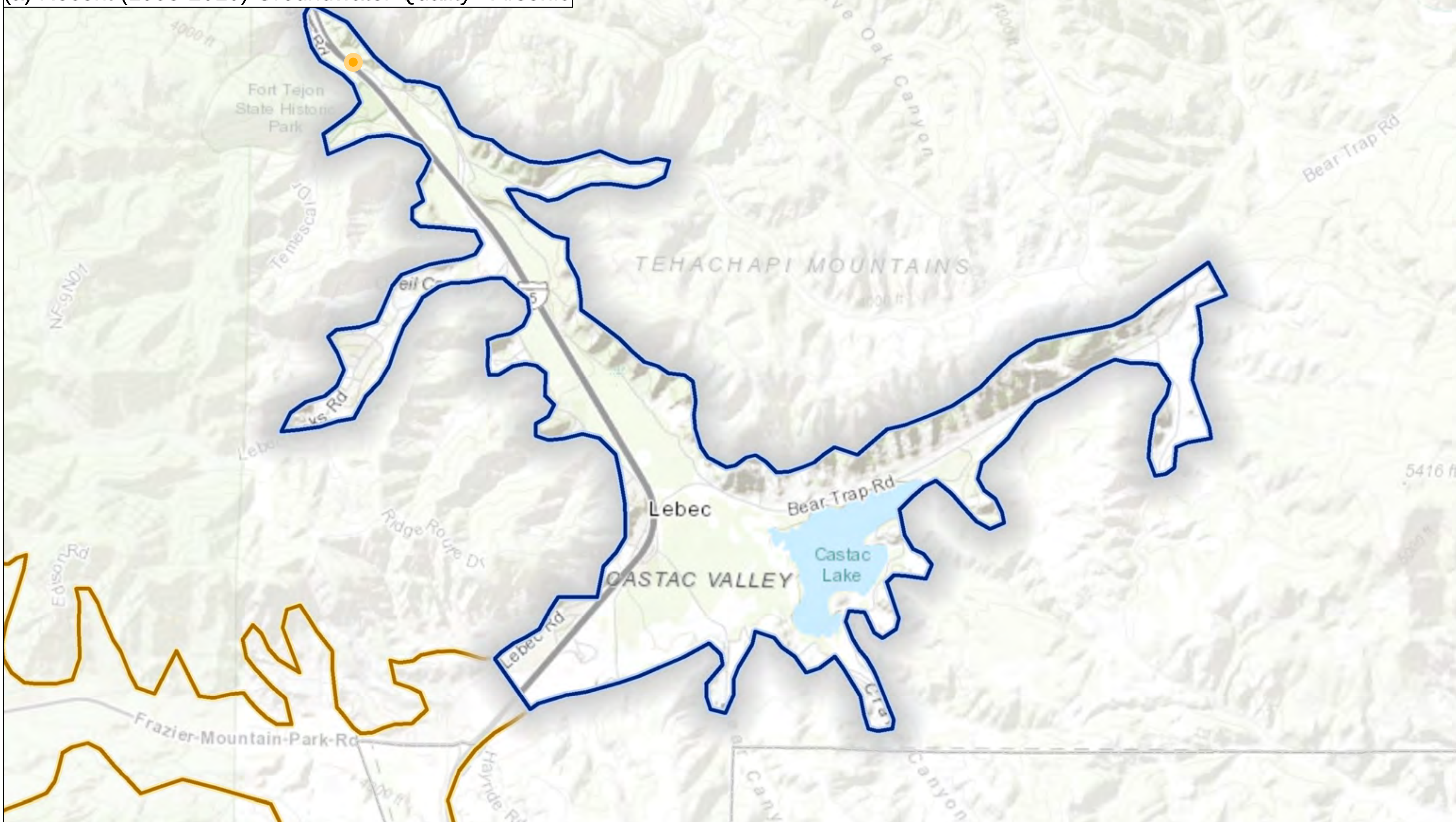
DRAFT

eki environment & water

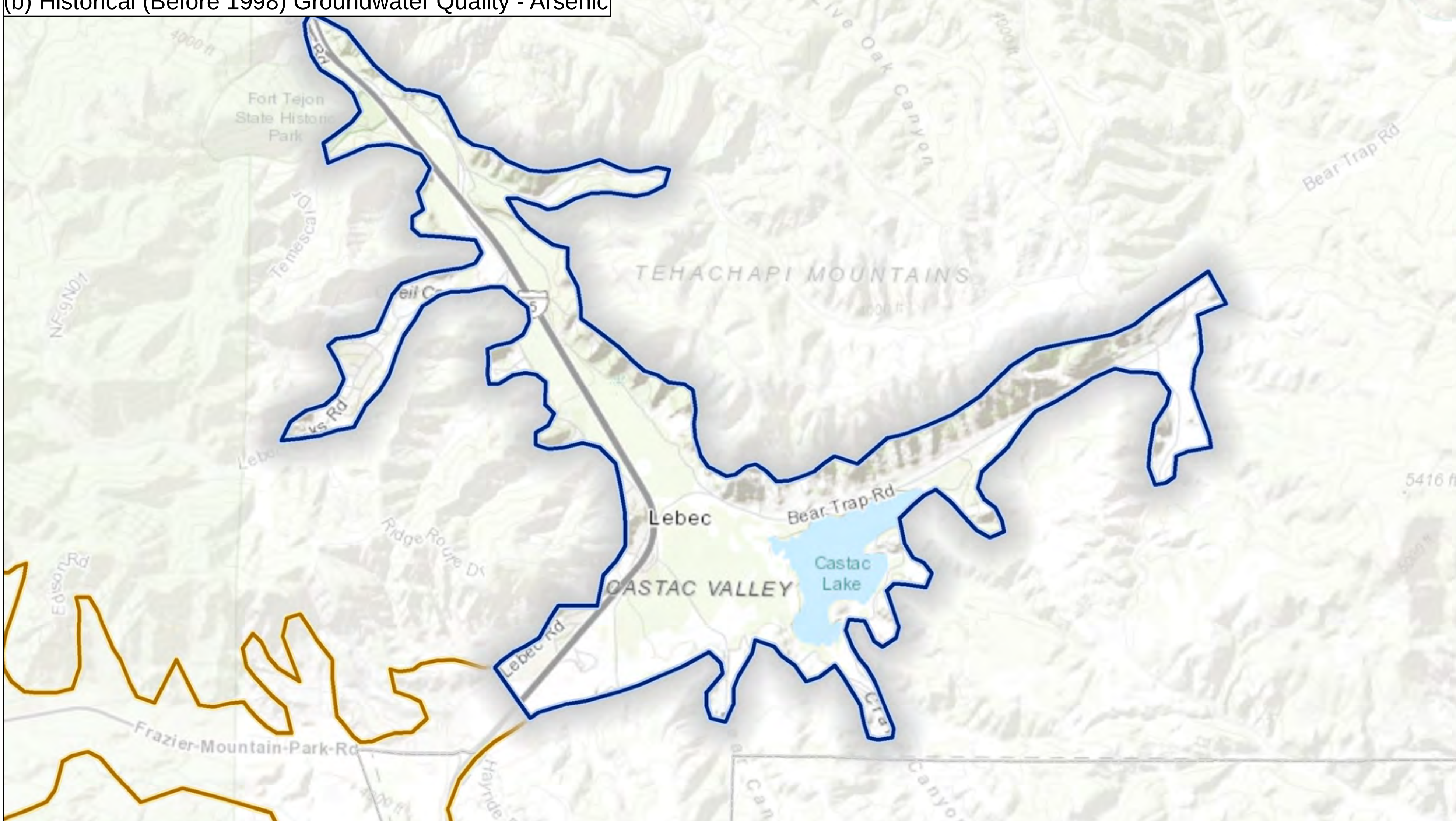
Tejon-Castac Water District
Kern County, California
June 2020
B80048.00

Figure GWC-7

(a) Recent (1998-2019) Groundwater Quality - Arsenic



(b) Historical (Before 1998) Groundwater Quality - Arsenic



Legend

- Castac Lake Valley Groundwater Basin
- Other Groundwater Basin
- County Boundary

Arsenic Concentration (mg/L)

- < 0.001
- 0.001 - 0.004
- 0.004 - 0.009
- > 0.01 (Exceeding MCL)

Abbreviations

DWR = California Department of Water Resources
MCL = Maximum Concentration Level
mg/L = miligrams per liter

Notes

1. All locations are approximate.
2. Constituent concentration is the maximum observed for each well between 1998 and 2019(Figure GWC-8(a)) and before 1998 (Figure GWC-8(b)).
3. Arsenic has a MCL of 0.01 mg/L.

Sources

1. Groundwater basin boundaries from DWR Bulletin 118 Interim Update 2016.
2. Basemap is ESRI's ArcGIS Online world topographic map, obtained 19 June 2020.

N

0 0.5 1
(Scale in Miles)

Groundwater Quality – Recent (1998 - 2019) and Historical (Before 1998) Aresnic Concentrations

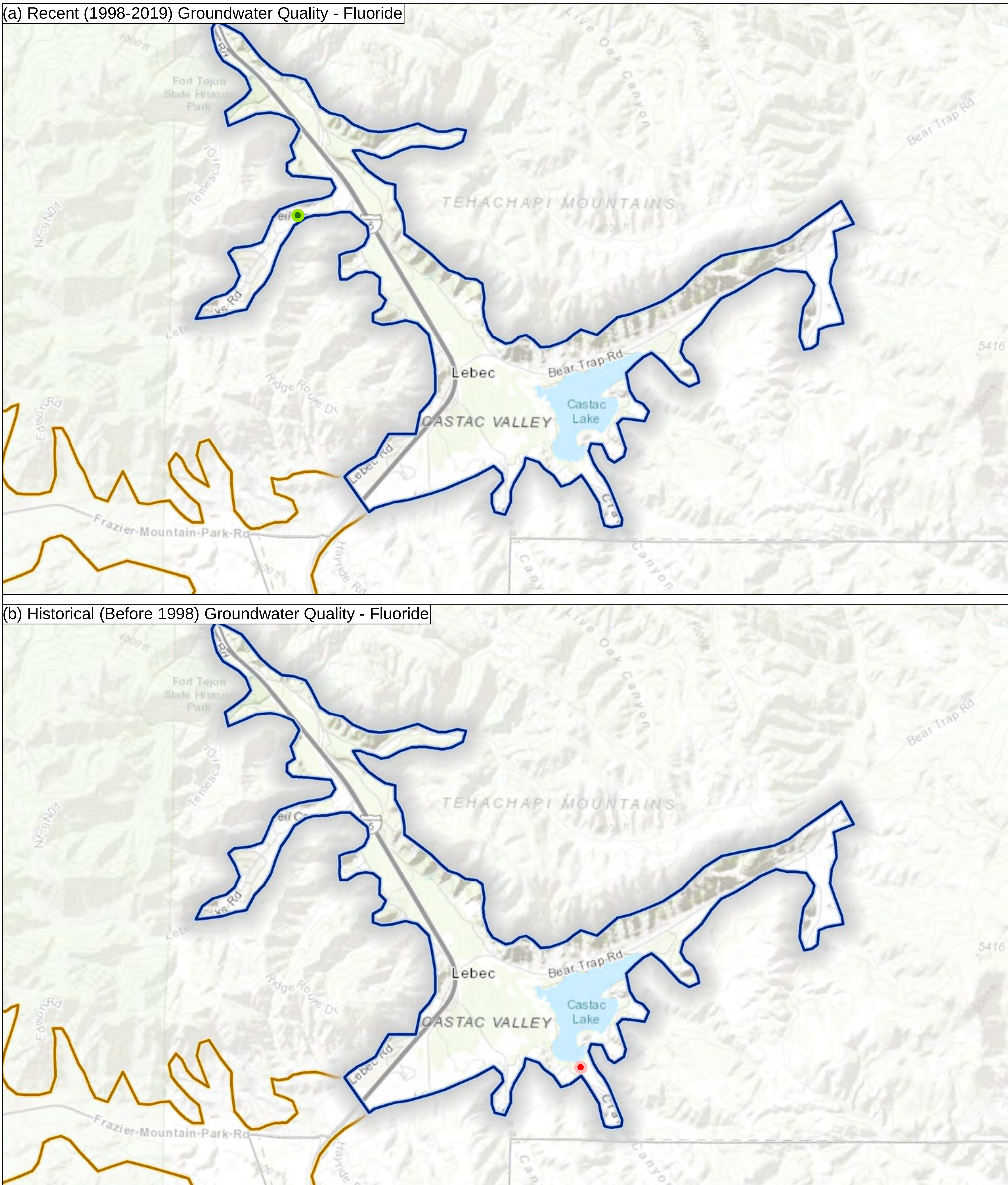
DRAFT

eki environment & water

Tejon-Castac Water District
Kern County, California
June 2020
B80048.00

Figure GWC-8

Path: X:\B80048\Maps\for GSP\Fig GWC-8 WQ Arsenic Current Historical.mxd



Legend

- Castac Lake Valley Groundwater Basin
- Other Groundwater Basin
- County Boundary

Fluoride Concentration (mg/L)

- < 0.5
- 0.5 - 1
- 1 - 2
- > 2 (Exceeding MCL)

Abbreviations

DWR = California Department of Water Resources
MCL = Maximum Concentration Level
mg/L = miligrams per liter

Notes

1. All locations are approximate.
2. Constituent concentration is the maximum observed for each well between 1998 and 2019 (Figure GWC-9(a)) and before 1998 (Figure GWC-9(b)).
3. Fluoride has a MCL of 2 mg/L.

Sources

1. Groundwater basin boundaries from DWR Bulletin 118 Interim Update 2016.
2. Basemap is ESRI's ArcGIS Online world topographic map, obtained 19 June 2020.

N

0 0.5 1
(Scale in Miles)

**Groundwater Quality –
Recent (1998 - 2019) and Historical (Before 1998)
Fluoride Concentrations**

DRAFT

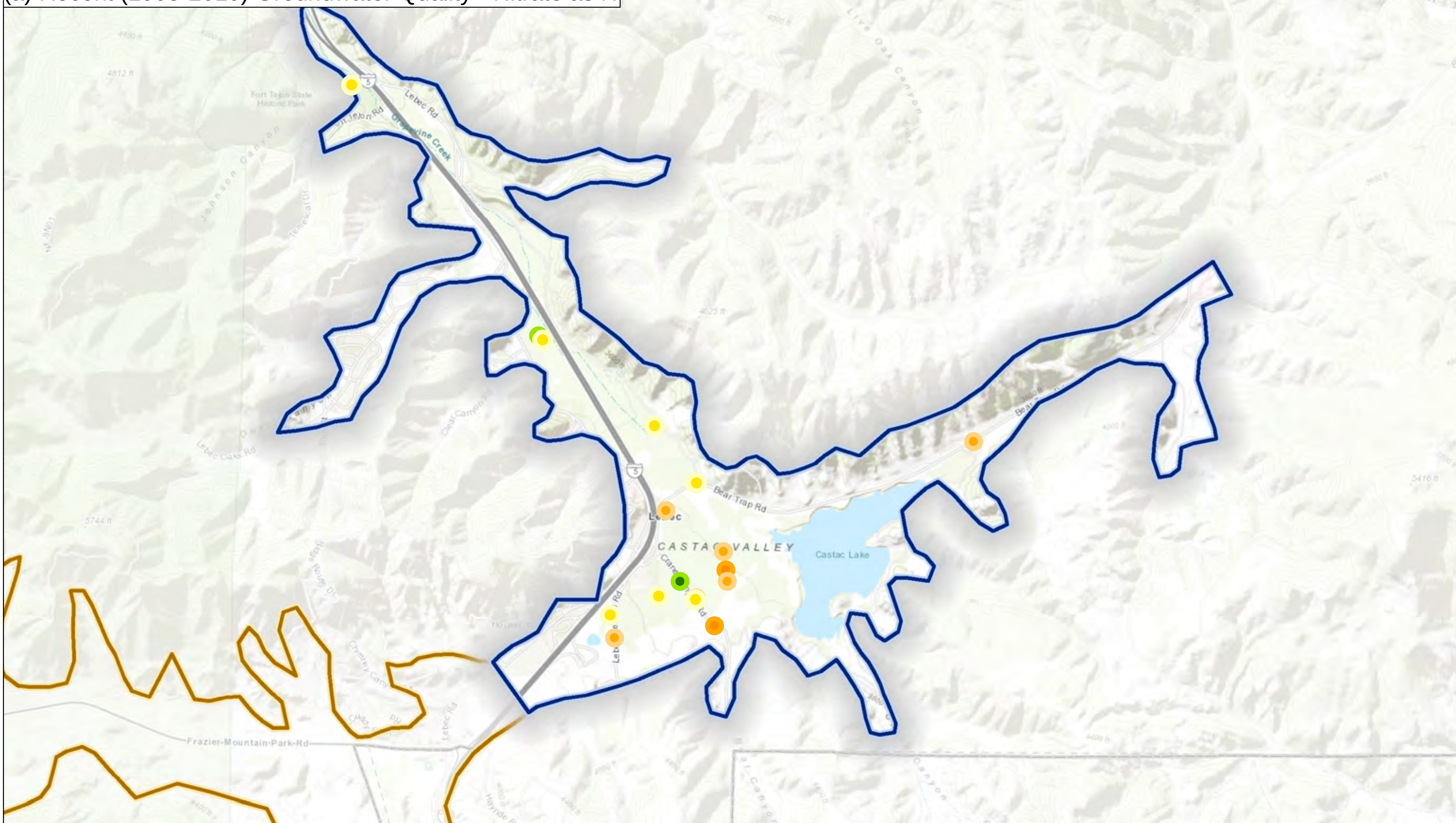
eki environment & water

Tejon-Castac Water District
Kern County, California
June 2020
B80048.00

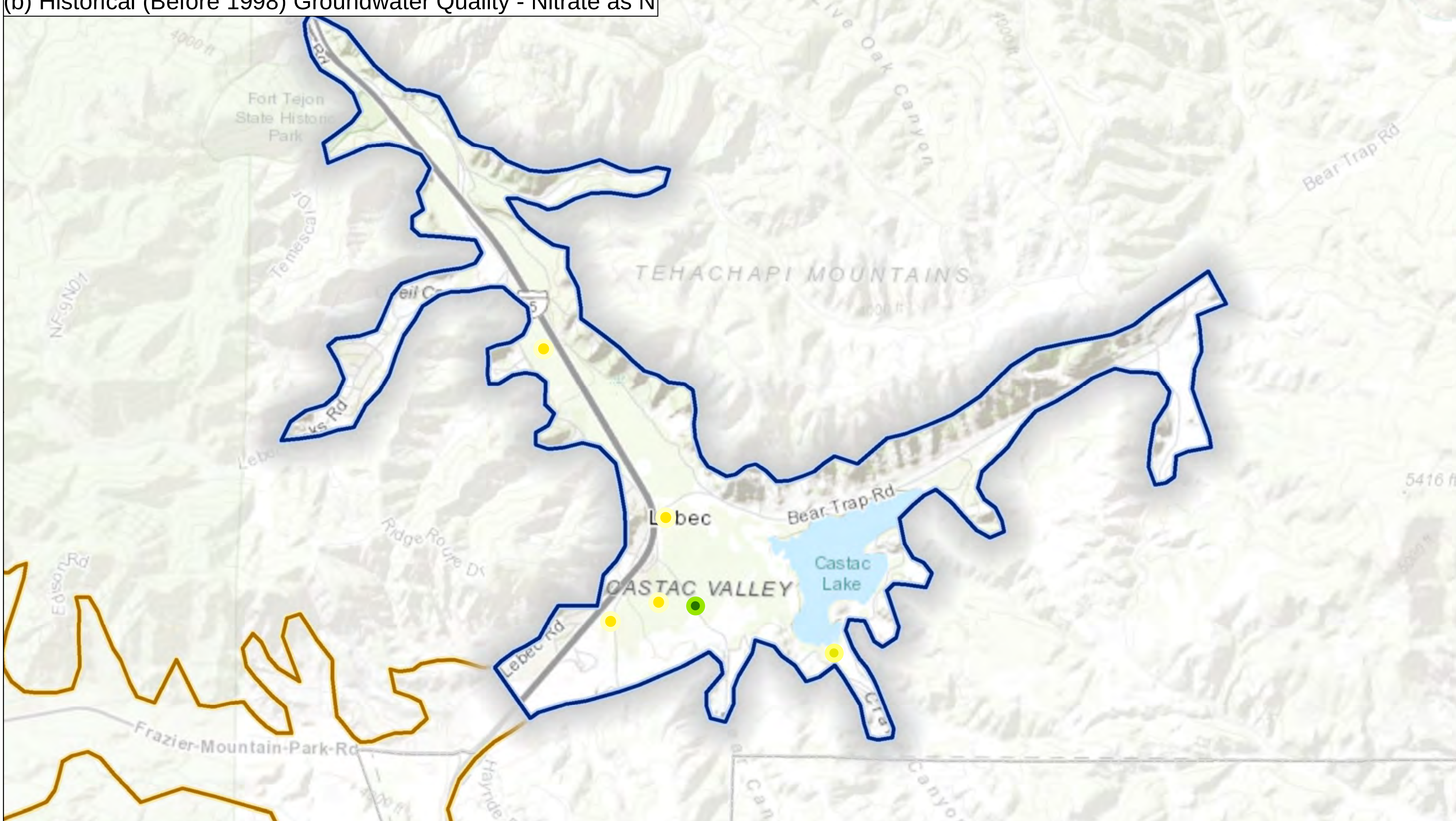
Figure GWC-9

Path: X:\B80048\Maps\for GSP\Fig GWC-9 WQ Fluoride Current Historical.mxd

(a) Recent (1998-2019) Groundwater Quality - Nitrate as N



(b) Historical (Before 1998) Groundwater Quality - Nitrate as N



Legend

- Castac Lake Valley Groundwater Basin
- Other Groundwater Basin
- County Boundary

Nitrate as N Concentration (mg/L)

- < 1
- 1 - 5
- 5 - 9
- > 10 (Exceeding MCL)

Abbreviations

DWR = California Department of Water Resources
MCL = Maximum Concentration Level
mg/L = miligrams per liter
N = Nitrogen

Notes

1. All locations are approximate.
2. Constituent concentration is the maximum observed for each well between 1998 and 2019 (Figure GWC-10(a)) and before 1998 (Figure GWC-10(b)).
3. Nitrate as N has a MCL of 10 mg/L.

Sources

1. Groundwater basin boundaries from DWR Bulletin 118 Interim Update 2016.
2. Basemap is ESRI's ArcGIS Online world topographic map, obtained 19 June 2020.

N

0 0.5 1
(Scale in Miles)

Groundwater Quality – Recent (1998 - 2019) and Historical (Before 1998) Nitrate as N Concentrations

DRAFT

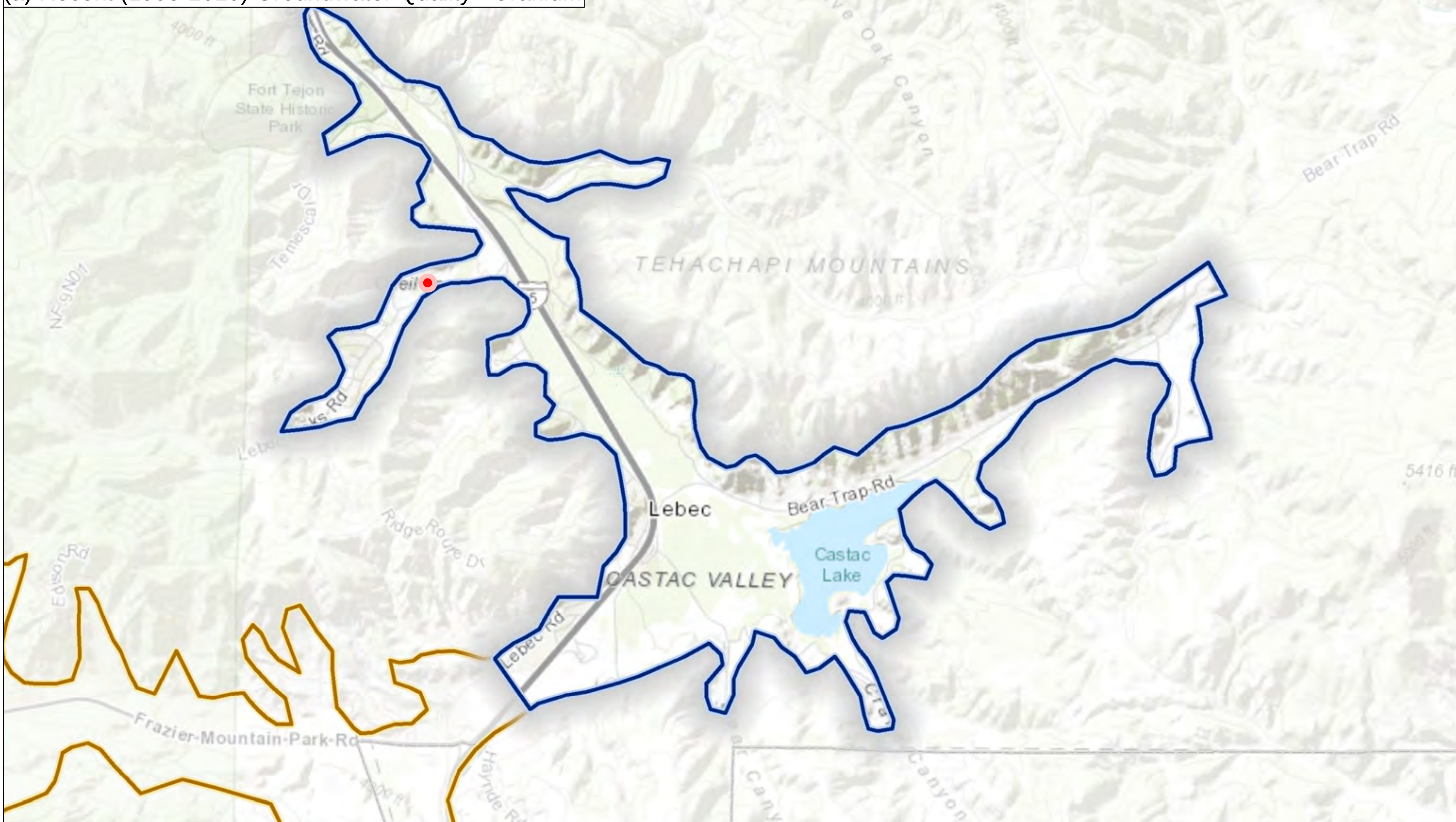
eki environment & water

Tejon-Castac Water District
Kern County, California
June 2020
B80048.00

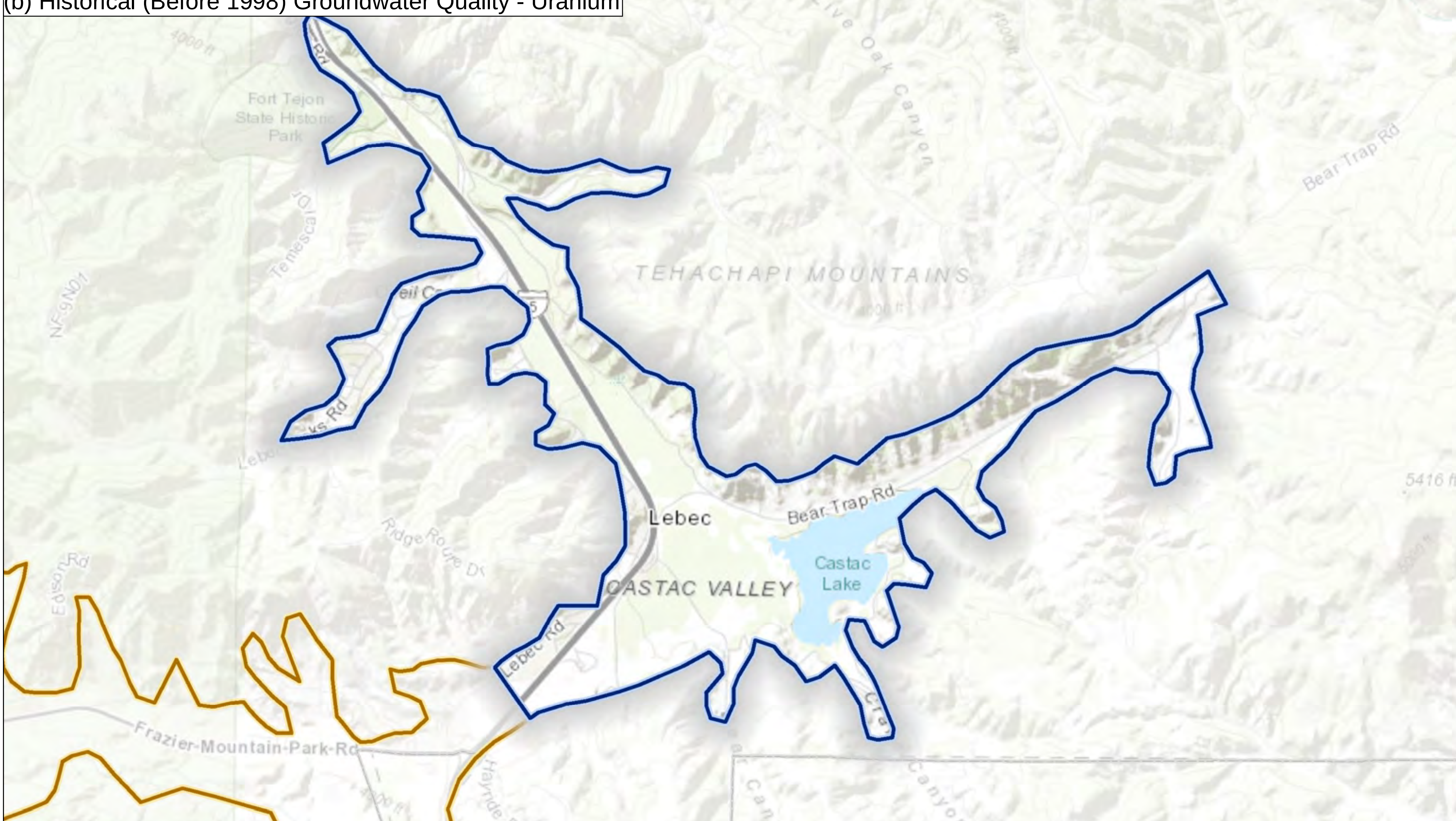
Figure GWC-10

Path: X:\B80048\Maps\for GSP\Fig GWC-10(mod) WQ Nitrate Current Historical.mxd

(a) Recent (1998-2019) Groundwater Quality - Uranium



(b) Historical (Before 1998) Groundwater Quality - Uranium



Legend

- Castac Lake Valley Groundwater Basin
- Other Groundwater Basin
- County Boundary

Uranium Concentration (mg/L)

- < 0.01
- 0.01 - 0.02
- 0.02 - 0.03
- > 0.03 (Exceeding MCL)

N

0 0.5 1 (Scale in Miles)

Abbreviations

DWR = California Department of Water Resources
MCL = Maximum Concentration Level
mg/L = miligrams per liter

Notes

1. All locations are approximate.
2. Constituent concentration is the maximum observed for each well between 1998 and 2019 (Figure GWC-11(a)) and before 1998 (Figure GWC-11(b)).
3. Uranium has an MCL of 0.03 mg/L

Sources

1. Groundwater basin boundaries from DWR Bulletin 118 Interim Update 2016.
2. Basemap is ESRI's ArcGIS Online world topographic map, obtained 19 June 2020.

Groundwater Quality – Recent (1998 - 2019) and Historical (Before 1998) Uranium Concentrations

Tejon-Castac Water District
Kern County, California
June 2020
B80048.00

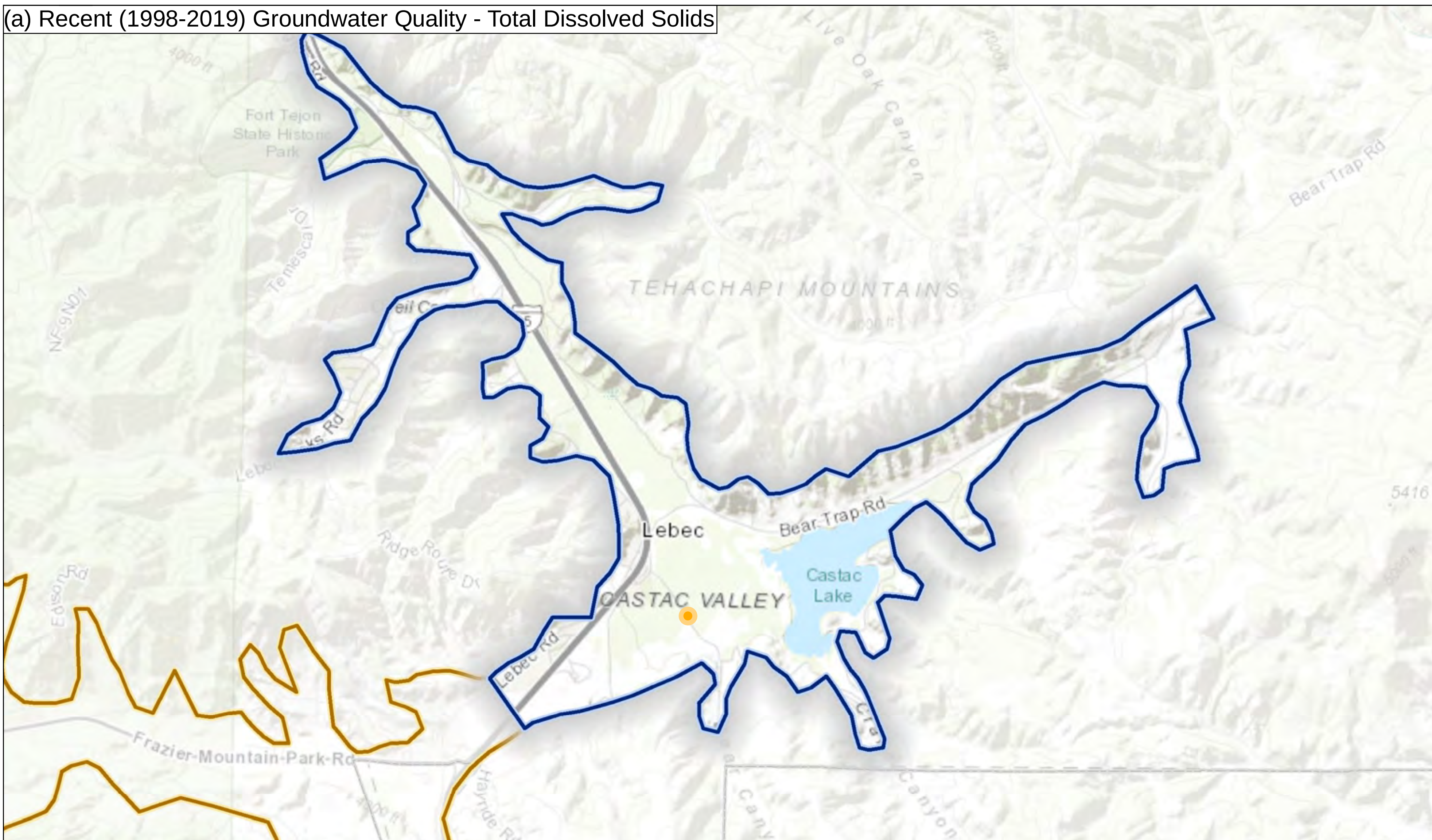
DRAFT

eki environment & water

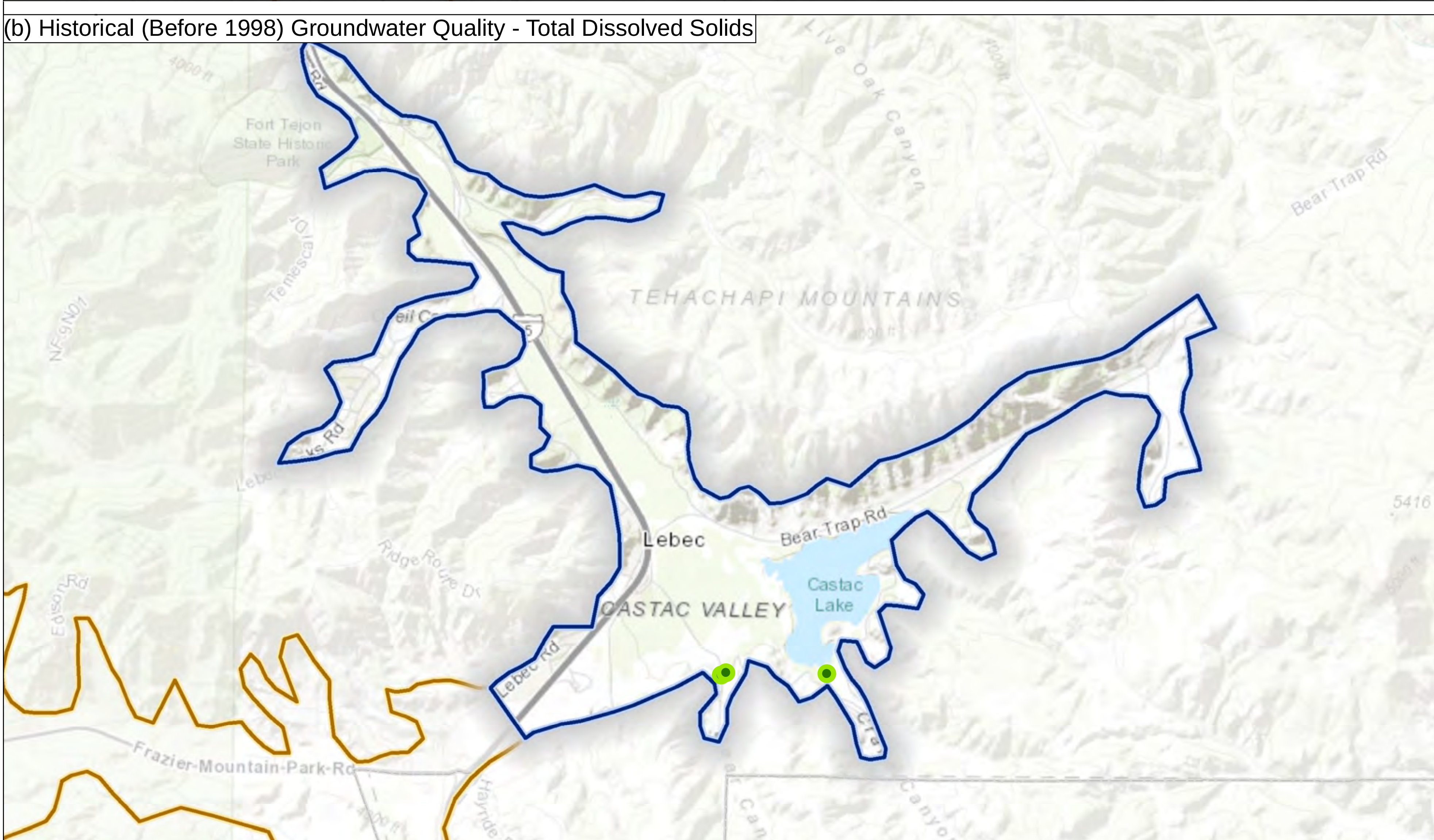
Figure GWC-11

Path: X:\B80048\Maps\for GSP\Fig GWC-11 WQ Uranium Current Historical.mxd

(a) Recent (1998-2019) Groundwater Quality - Total Dissolved Solids



(b) Historical (Before 1998) Groundwater Quality - Total Dissolved Solids



Legend

- Castac Lake Valley Groundwater Basin
- Other Groundwater Basin
- County Boundary

TDS Concentration (mg/L)

- < 400
- 400 - 500
- 500 - 1,000 (Exceeding MCL)
- > 1,000 (Exceeding MCL)

Abbreviations

DWR = California Department of Water Resources
MCL = Maximum Concentration Level
mg/L = miligrams per liter
TDS = Total Dissolved Solids

Notes

1. All locations are approximate.
2. Constituent concentration is the maximum observed for each well between 1998 and 2019 (Figure GWC-12(a)) and before 1998 (Figure GWC-12(b)).
3. TDS has a secondary MCL of 500 mg/L.

Sources

1. Groundwater basin boundaries from DWR Bulletin 118 Interim Update 2016.
2. Basemap is ESRI's ArcGIS Online world topographic map, obtained 19 June 2020.

N

0 0.5 1
(Scale in Miles)

Groundwater Quality – Recent (1998 - 2019) and Historical (Before 1998) TDS Concentrations

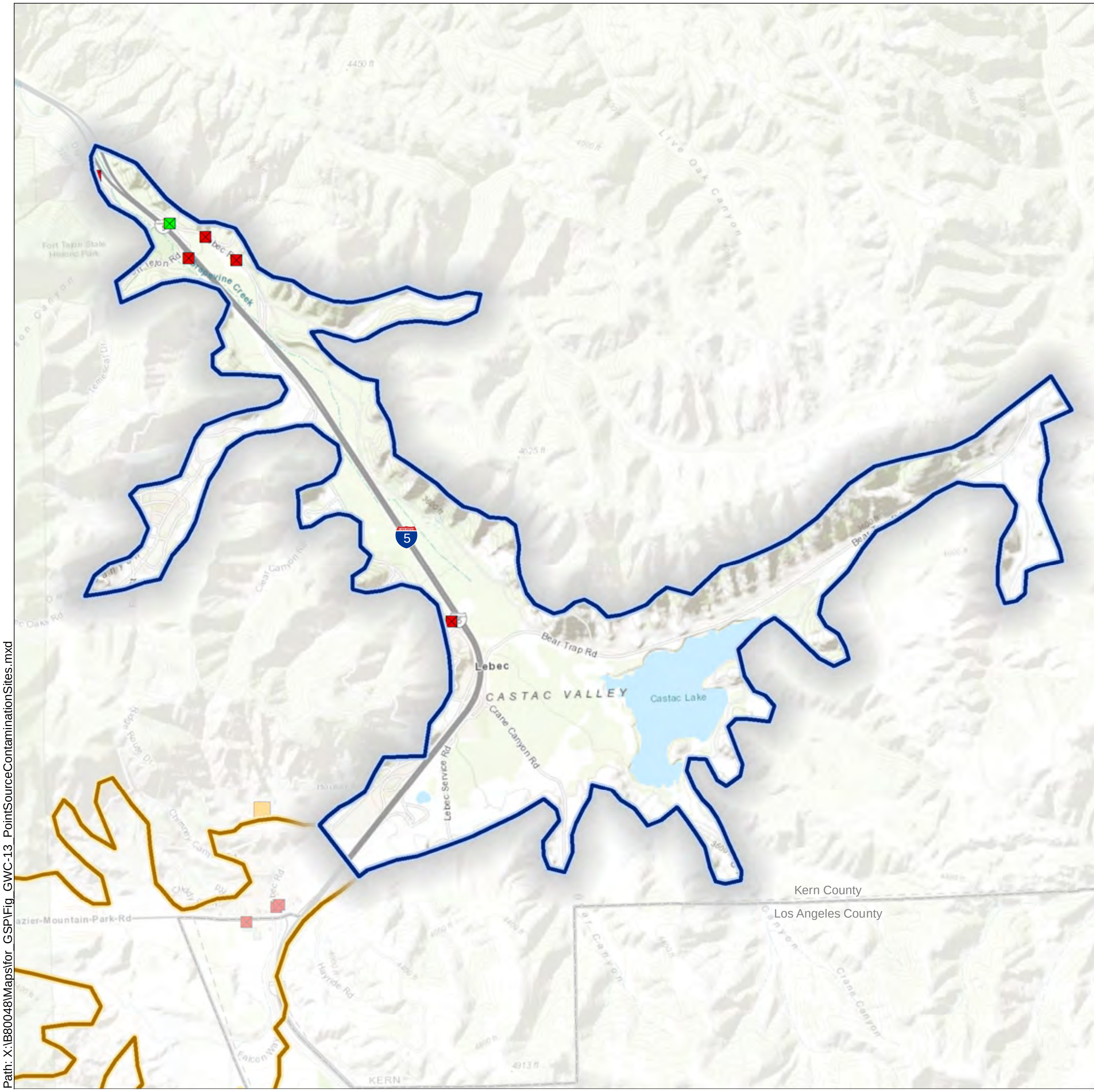
DRAFT

eki environment & water

Tejon-Castac Water District
Kern County, California
June 2020
B80048.00

Figure GWC-12

Path: X:\B80048\Maps\for GSP\Fig GWC-12 WQ TDS Current Historical.mxd



Legend

GeoTracker Sites

- LUST Cleanup Site, Closed
- Cleaup Program Site, Closed
- Land Disposal Site, Closed with Monitoring
- Castac Lake Valley Groundwater Basin
- Other Groundwater Basin
- County Boundary

Abbreviations

DWR = California Department of Water Resources
GSA = Groundwater Sustainability Agency
LUST = Leaking Underground Storage Tank
SWRCB = State Water Resources Control Board

Notes

1. All locations are approximate.
2. Some GeoTracker sites overlap at the scale shown.

Sources

1. Groundwater basin boundaries from DWR Bulletin 118 Interim Update 2016.
2. Basemap is ESRI's ArcGIS Online world topographic map, obtained 19 June 2020.
3. Locations of contamination sites from SWRCB GeoTracker website (http://geotracker.waterboards.ca.gov/datadownload) accessed 5 November 2018.

N

0 0.5 1

Miles

DRAFT

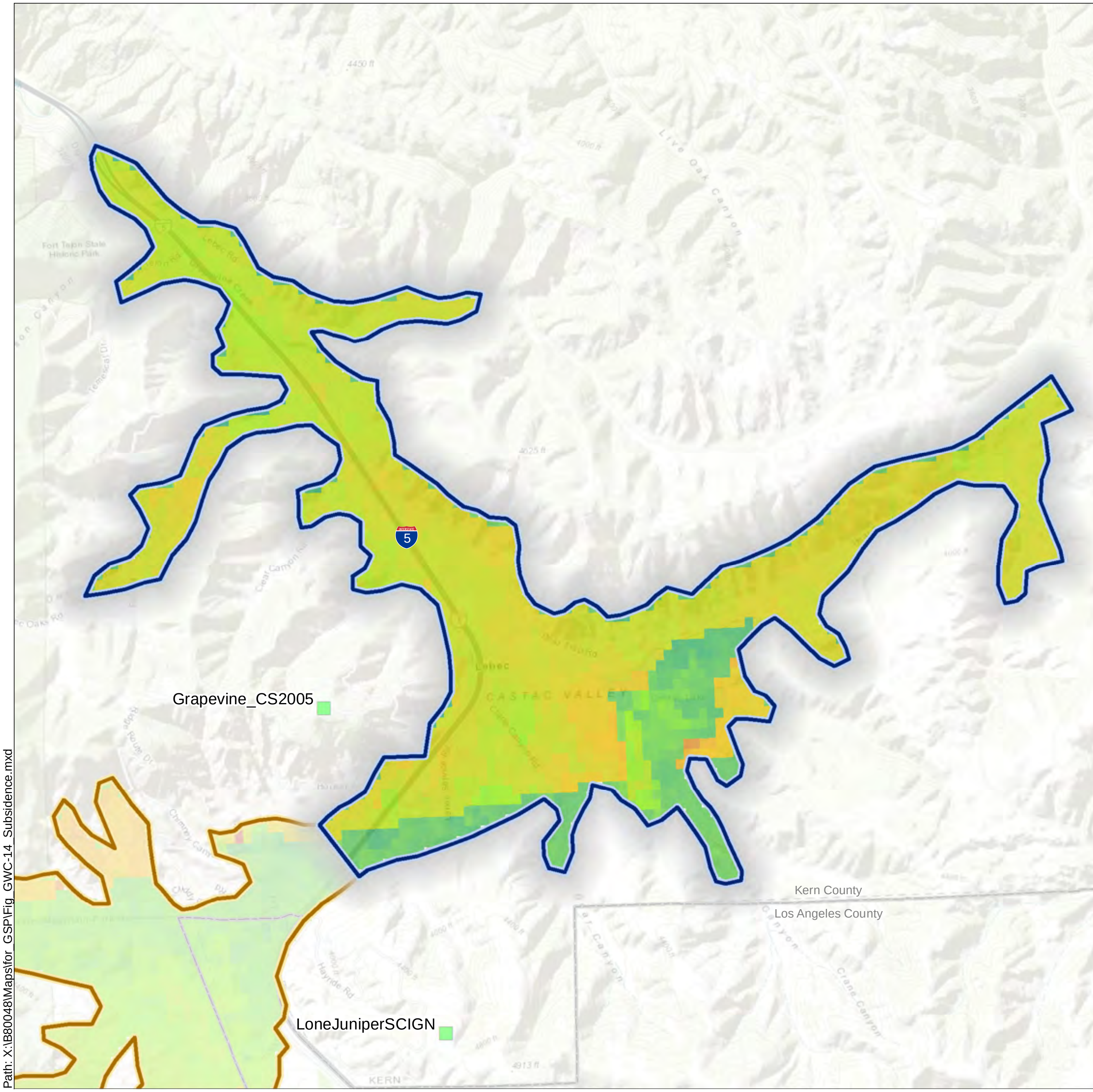
Known Point-Source Contamination Sites

eki environment & water

Tejon-Castac Water District
Kern County, California
June 2020
B80048.00

Figure GWC-13

Path: X:\B80048\Maps\for_GSP\Fig_GWC-13_PointSourceContaminationSites.mxd



Legend

- Castac Lake Valley Groundwater Basin
- Other Groundwater Basin
- County Boundary
- Subsidence Monitoring Station

Vertical Displacement (inches): 5/31/2015 - 7/31/2016

High : 2
1
0
-1
Low : -2

Abbreviations

DWR = California Department of Water Resources
JPL = Jet Propulsion Laboratory
NASA = National Aeronautics and Space Administration
UNAVCO = University NAVSTAR Consortium

Notes

1. All locations are approximate.
2. Positive vertical displacement signifies accretion; negative vertical displacement signifies subsidence.

Sources

1. Groundwater basin boundaries from DWR Bulletin 118 Interim Update 2016.
2. Basemap is ESRI's ArcGIS Online world topographic map, obtained 19 June 2020.
3. Subsidence monitoring stations are from UNAVCO's Plate Boundary Observatory database. (https://www.unavco.org/instrumentation/networks/map/map.html#/)
4. Vertical displacement data from DWR, provided by NASA JPL, accessed 26 June 2018 (https://data.cnra.ca.gov/dataset/nasa-jpl-insar-subsidence)

N

0 0.5 1
Miles

DRAFT

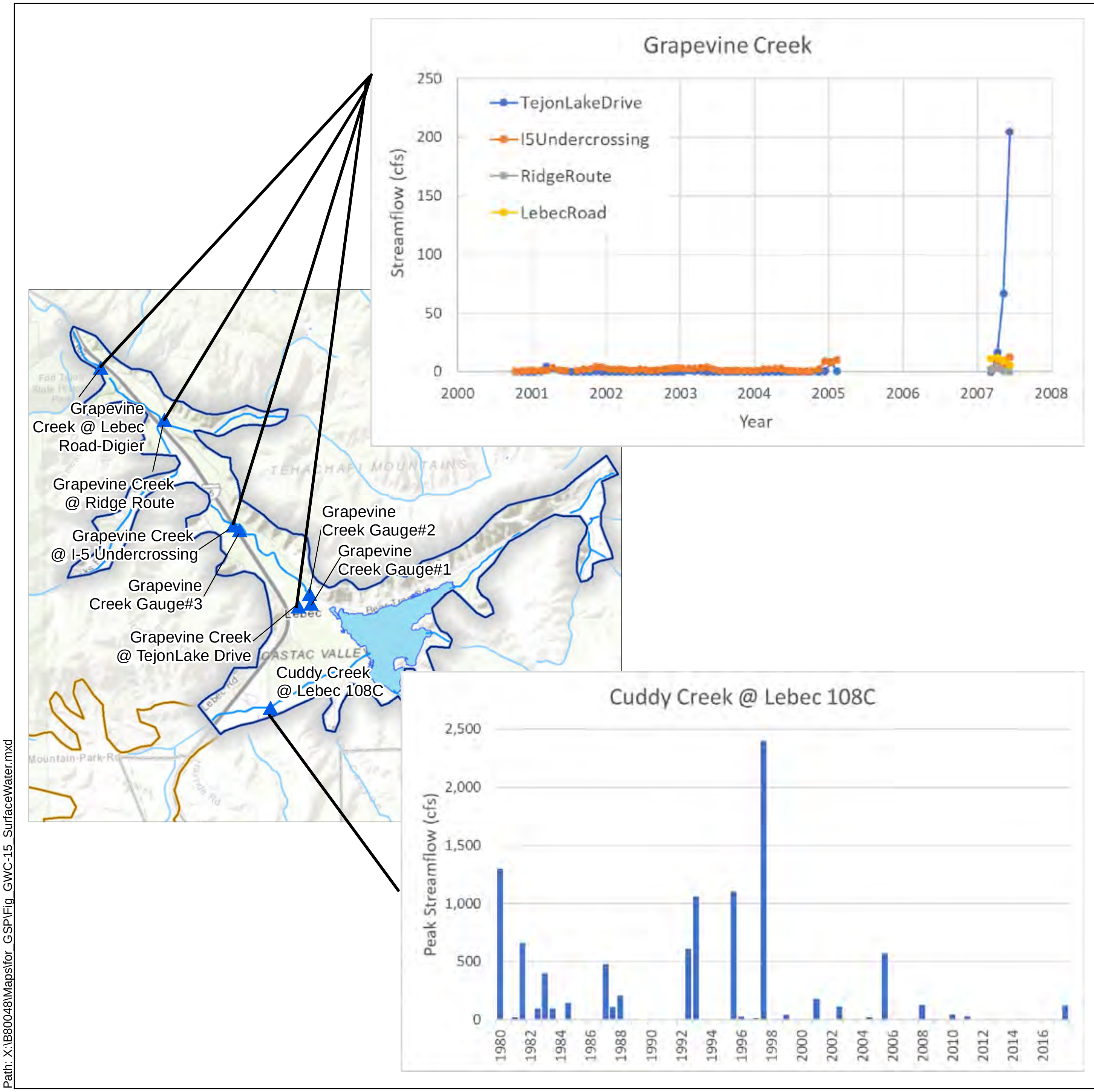
Recent (2015-2016) Land Subsidence

Tejon-Castac Water District
Kern County, California
June 2020
B80048.00

eki environment & water

Figure GWC-14

Path: X:\B80048\Maps\for_GSP\Fig_GWC-14_Subsidence.mxd



<u>Legend</u>

- Castac Lake Valley Groundwater Basin
- Other Groundwater Basin
- County Boundary
- Castac Lake
- Stream/River
- Surface Water Gauge

<u>Abbreviations</u>

DWR = California Department of Water Resources

<u>Notes</u>

1. All locations are approximate.

<u>Sources</u>

1. Groundwater basin boundaries from DWR Bulletin 118 Interim Update 2016.
2. Basemap is ESRI's ArcGIS Online world topographic map, obtained 19 June 2020.

N

0 1 2

Miles

DRAFT

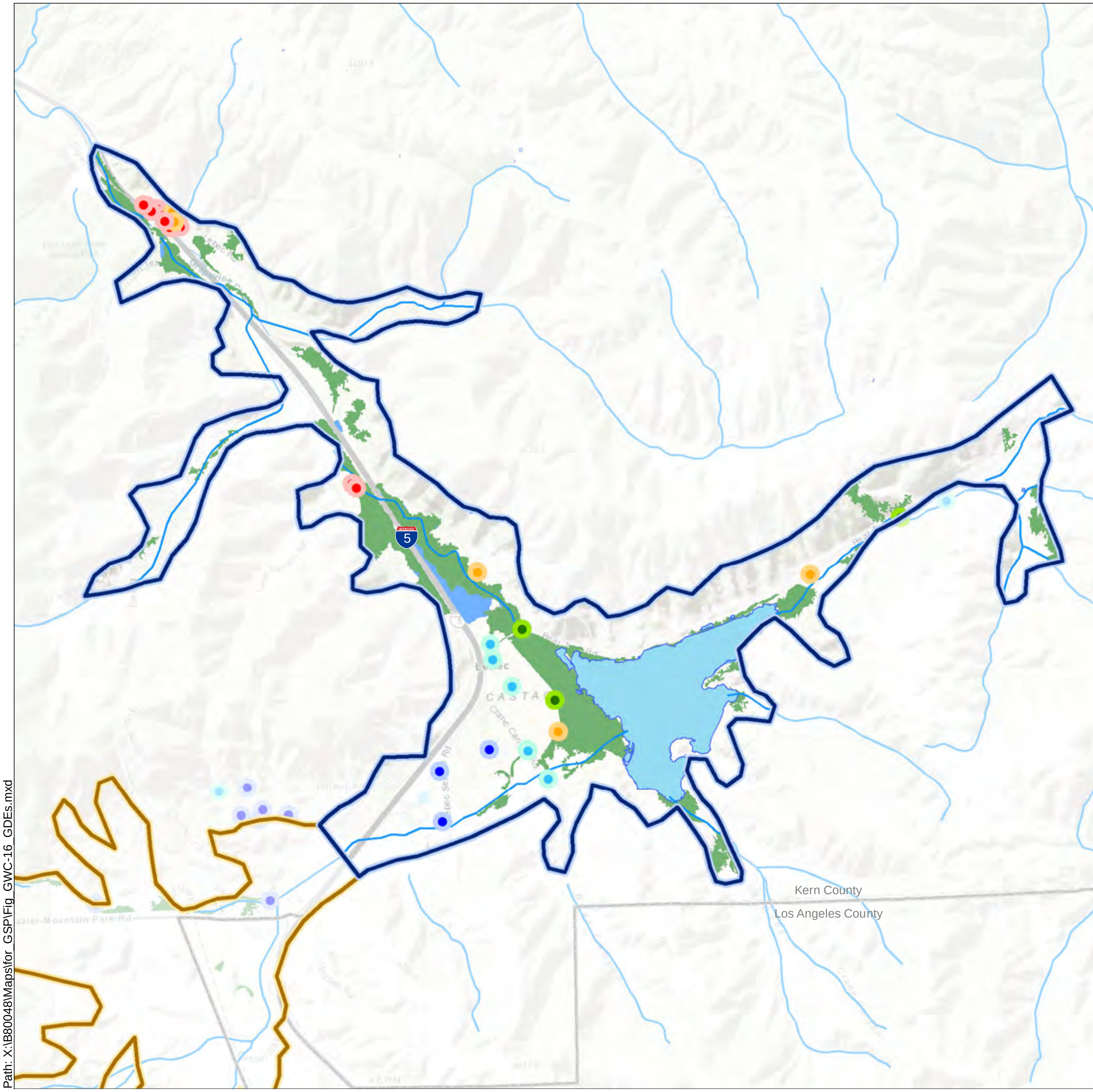
Surface Water Features

eki environment & water

Tejon-Castac Water District
Kern County, California
June 2020
B80048.00

Figure GWC-15

Path: X:\B80048\Maps\for_GSP\Fig_GWC-15_SurfaceWater.mxd



Legend

- Castac Lake Valley Groundwater Basin
- Other Groundwater Basin
- County Boundary
- Castac Lake
- NCCAG Vegetation
- NCCAG Wetland
- Stream/River

Spring 2015 Depth to Water (ft bgs)

- < 15
- 15 - 30
- 30 - 45
- 45 - 60
- > 60

Abbreviations

DWR = California Department of Water Resources
ft bgs = feet below ground surface
NCCAG = Natural Communities Commonly Associated with Groundwater

Notes

1. All locations are approximate.

Sources

1. Groundwater basin boundaries from DWR Bulletin 118 Interim Update 2016.
2. Basemap is ESRI's ArcGIS Online world topographic map, obtained 19 June 2020.

N

0 0.5 1
Miles

Natural Communities Commonly Associated with Groundwater

DRAFT

Tejon-Castac Water District
Kern County, California
June 2020
B80048.00

eki environment & water

Figure GWC-16

Path: X:\B80048\Maps\for_GSP\Fig_GWC-16_GDEs.mxd

9. WATER BUDGET INFORMATION

§ 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.

This section presents information on the water budget for the Basin. Consistent with the Groundwater Sustainability Plan (GSP) Regulations (23-California Code of Regulations [CCR] Division 2 Chapter 1.5 Subchapter 2) and California Department of Water Resources' (DWR) Water Budget Best Management Practices (BMP) (DWR, 2016b), this water budget provides an accounting of the total annual volume of water entering and leaving the Basin for historical, current, and projected future conditions.

9.1. Water Budget Methods and Data Sources

§ 354.18. Water Budget
(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.
(2) Current water budget information for temperature, water year type, evapotranspiration, and land use.
(3) Projected water budget information for population, population growth, climate change, and sea level rise.
(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.
(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.

The water budget information presented herein is based on the use of two complementary modeling approaches:

1) **A spreadsheet analytical model** which quantifies each flow component and uses a mass balance approach to estimate water movement between each "subdomain" (e.g., flows between groundwater in the Basin aquifer, natural surface water channels, and Castac

Lake) that collectively comprise the water budget domain (the Basin) for historical and current conditions, and

2) **A numerical groundwater flow model** for the Basin using the United States Geological Survey (USGS)'s Modular Three-Dimensional Groundwater Modeling software MODFLOW-NWT for projected future conditions.

Each of these approaches is discussed further below.

9.1.1. Spreadsheet Analytical Model Approach

The spreadsheet analytical model approach uses a variety of data and analytical methods to quantify each water budget flow component. It is not map-based. Instead, processes and groups of processes are grouped into "subdomains" and "flow components", which represent categories of water storage or movement but not necessarily spatially-distinct hydrogeologic features. These water budget flow components are quantified on a monthly basis ("monthly timestep") for the period from October 1997 through September 2018, representing Water Years (WY) 1998 through 2018. Water years represent the period of time of accumulation and depletion of precipitation, starting on 1 October of the preceding year and extending through September of the nominal water budget year. Water budget information from the spreadsheet model approach is presented in Section 9.3 below for historical and current conditions.

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 and Wetlands;
d. Developed Areas; and
e. Groundwater Basin system.

In addition to the five internal subdomains, three 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 and leaving the Basin, and groundwater entering the Basin from upgradient groundwater basins. 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 the vadose zone does not experience any change in storage over time.

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 (e.g., precipitation) 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 or indirectly measured using a variety of analytical methods (e.g., Darcy's Law to calculated subsurface flows across the domain's external boundaries) and are thus subject to uncertainty based on the parameters used in their estimation. Some components (e.g., groundwater pumping) 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 thus are less significant to the overall water budget and less well defined. Details of the methods and data used in the spreadsheet model approach are provided in *Appendix H*.

9.1.2. 3-D Numerical Model Approach

The numerical model approach is based on the application of a numerical groundwater flow model developed for the Basin, herein referred to as the "Castac Basin Numerical Model," using the USGS's Modular Three-Dimensional Groundwater Model platform MODFLOW-NWT. Like all numerical groundwater flow models, the Castac Basin Numerical Model divides the spatial model domain into a network of cells (a 3-D grid in the case of Castac Basin), applies assumptions of groundwater system properties at those cells, and calculates water fluxes between cells by solving a system of equations based on groundwater flow principles (see **Figure WB-3** for the grid and cell extents). Details on the development of the Castac Basin Numerical Model are provided in *Appendix I*. Water budget information from the numerical model approach is presented in Section 9.4 below for projected future scenarios.

9.1.3. Data Sources

Per 23-CCR §354.18(e), the best-available data were used to evaluate the water budget for the Basin and include the following:

- Precipitation records from the Lebec climate station operated by the National Oceanic and Atmospheric Administration (NOAA), Monthly resolution *[October 1948 – September 2018]*.

- Evapotranspiration (ET) and associated data:
  - Reference ET (ETo) from California Irrigation Management Information System (CIMIS) stations Arvin-Edison 125 and Cuyama 88, Monthly resolution *[October 1997 – September 2018]*.
  - Tejon weather station 56A, average monthly pan evaporation values measured between 2000 and 2003, recorded by Tejon Ranch Company (TRC) staff.
  - CIMIS ETo zone map and associated monthly average ETo by ETo zone (CIMIS, 1999).
  - Crop coefficients (Kc) for pasture and idle lands, Cal Poly Irrigation Training and Research Center (ITRC), monthly values for a typical year[32].
- Land use surveys and associated spatial data:
  - Tejon-Castac Water District (TCWD), 2019
  - Kern County, 2016, Important Farmlands
  - Groundwater basin boundaries defined by DWR 2019 Basin Prioritization
  - Watershed boundaries, HUC12 obtained from United States Department of Agriculture Natural Resources Conservation Service (USDA NRCS)[33]
- Well pumping records:
  - TRC flowmeter well counter units
  - Public water system monthly records provided by Krista Mutual Water Company (KMWC) for 2010 and 2012 through 2018
  - Public water system monthly records provided by Lebec County Water District (LCWD) for 2013 through 2018
  - Public water system monthly records for 2013 through 2015, downloaded from the Drinking Water Information Clearinghouse (DRINC) portal[34]
  - Estimates of TRC pumping based on Pacific Gas & Electric (PGE) energy consumption records
- Historical groundwater elevation records from selected wells within the Basin
- Historical Castac Lake elevations and estimates of seepage

[32] http://www.itrc.org/etdata/index.html
[33] https://www.nrcs.usda.gov/wps/portal/nrcs/main/national/water/watersheds/dataset/
[34] https://drinc.ca.gov/drinc/DWPRepository.aspx

9.1.4. Temporal Coverage

DWR's Water Budget BMP requires quantification of historical water budget components for at least the past 10 years (DWR, 2016b). 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 WY 1949 and 2018 is 12 inches per year (in/yr). As shown in **Table WB-1** and **Figure WB-4**, 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 (i.e., 12 in/yr). 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[35]. This 21-year period (WY 1998-2018) therefore adequately represents average hydrologic conditions for purposes of quantifying the Basin water budget.

Table WB-1. Precipitation Recorded at the Lebec Climate Station, WY 1998-2018

Water Year	Lebec Precipitation (inches)	Water Year Type[(a)]
1998	33.43	W
1999	13.91	AN
2000	9.45	AN
2001	10.88	D
2002	3.91	D
2003	14.91	BN
2004	8.25	D
2005	32.67	W
2006	11.02	W
2007	7.52	C
2008	9.06	C
2009	9.15	BN
2010	5.38	AN
2011	9.09	W
2012	7.32	D
2013	7.24	C
2014	6.29	C
2015	12.19	C
2016	9.28	D
2017	13.99	W
2018	6.49	BN
Average	***11.5***	**--**

Notes:

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

(a) DWR Water Year types are based on the San Joaquin Valley Index that is based on unimpaired natural water runoff to the San Joaquin Valley, and are as follows: W = wet, AN = above normal, BN = below normal, D = dry, C = critical. These types represent an average value over a large area of the state and only generally correlate with local conditions in Castac Basin.

9.2. Water Budget Results

§ 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.

(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.

(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.

(3) Outflows from the groundwater system by water use sector, including evapotranspiration, groundwater extraction, groundwater discharge to surface water sources, and subsurface groundwater outflow.

(4) The change in the annual volume of groundwater in storage between seasonal high conditions.

(5) If overdraft conditions occur, as defined in Bulletin 118, the water budget shall include a quantification of overdraft over a period of years during which water year and water supply conditions approximate average conditions.

(6) The water year type associated with the annual supply, demand, and change in groundwater stored.

(7) An estimate of sustainable yield for the basin.

This section presents historical results of the analytical spreadsheet water budget model. The 3-D numerical model was used for predictive future simulations and was compared to historical results using the analytical spreadsheet model output for past years.

Modeled historical values were calculated on a monthly time step period; however, results are presented below in terms of both annual values as well as long-term averages over the modeling period (WY 1998 to 2018)[36]. Information presented here thus aligns with the requirements of the current and historical water budgets described under Section 9.3 *Current and Historical Water Budget* below, and is therefore not repeated in the subsequent section.

[36] Water Years run from October of the previous year to September of the current year (e.g. WY 2015 is October 2014 to September 2015).

9.2.1. Surface Water Inflows and Outflows

Per 23-CCR §354.18(b)(1), **Table WB-2** presents annual summaries of the total surface water inflows to and outflows from the Basin for the historical and current periods (WY 1998-2018). Surface water inflows and outflows include: (1) precipitation, (2) natural streamflow into the Basin, and (3) natural streamflow out of the Basin. Infiltration of surface water shown in **Table WB-2** is one of the inflow sources to the groundwater system (**Table WB-3**). **Figure WB-5** shows the total surface water inflows and outflows by type. Total surface water inflows to the Basin average approximately 4,500 acre-feet per year (AFY) over WY 1998-2018 but have varied widely from year to year. On average, 76% of surface water inflows are from direct precipitation and 24% are streamflow from surrounding watersheds and up-gradient basins.

Table WB-2. Estimated Annual Surface Water Inflows and Outflows by Source Type

Water Year	INFLOWS (AFY)			OUTFLOWS (AFY)	
	Precipitation	Streamflow	Total Inflows	Streamflow	Total Outflows
1998	9,930	3,470	**13,400**	4,410	**4,410**
1999	4,130	1,340	**5,470**	1,140	**1,140**
2000	2,810	930	**3,740**	1,020	**1,020**
2001	3,230	1,090	**4,320**	1,060	**1,060**
2002	1,160	250	**1,410**	800	**800**
2003	4,430	1,550	**5,980**	1,170	**1,170**
2004	2,450	750	**3,200**	930	**930**
2005	9,700	3,390	**13,090**	4,290	**4,290**
2006	3,270	1,070	**4,340**	1,070	**1,070**
2007	2,230	590	**2,820**	900	**900**
2008	2,690	760	**3,450**	960	**960**
2009	2,720	790	**3,510**	950	**950**
2010	1,600	430	**2,030**	860	**860**
2011	2,700	880	**3,580**	1,000	**1,000**
2012	2,170	600	**2,770**	890	**890**
2013	2,150	550	**2,700**	870	**870**
2014	1,870	470	**2,340**	850	**850**
2015	3,620	1,120	**4,740**	1,060	**1,060**
2016	2,760	780	**3,540**	930	**930**
2017	4,160	1,390	**5,550**	1,150	**1,150**
2018	1,930	620	**2,550**	910	**910**
Average	**3,410**	**1,090**	**4,500**	**1,300**	**1,300**
%	*76%*	*24%*	--	--	--

Abbreviations:
AFY = acre-feet per year

Notes:
1. Values rounded to the nearest ten acre-feet.

Precipitation

Precipitation falling on lands within the Basin contributes a large percentage of water to the overall water budget and is grouped herein with "surface water inflows." Annual rainfall at the Lebec station over WY 1998 – 2018 ranged from approximately 3.9 inches in WY 2002 to over 33 inches in WY 1998, with an average of 11.5 in/yr (see **Figure WB-4** and **Table WB-1**). Overall, an average of approximately 3,400 AFY of precipitation fell on Basin lands during this period. This water serves to wet the near surface soil and then either evaporates, contributes to crop or native vegetation water demand, or (when a rainfall event is intense enough or long enough) percolates through the root zone to eventually recharge groundwater. "Effective precipitation" is the volume of precipitation that contributes to meeting evapotranspiration demands within the root zone, and is estimated to be approximately 67% of total precipitation within the Basin (see *Appendix H Section 3.4.2*). The remaining precipitation, "ineffective precipitation," either evaporates, runs off, or infiltrates the groundwater system.

Natural Streamflow into the Basin

As discussed in Section 7.3.5 *Surface Water Bodies*, Cuddy Creek drains into the Basin from the up-gradient Cuddy Canyon Basin. A stream gauge in Cuddy Creek that records peak streamflow data only is operated by Kern County in the stream channel near Lebec. The peak streamflow event data are limited, useful mostly for visualizing large streamflow events such as major storms, and periods of no flow. Peak streamflow data recorded between 1980 and 2017 indicate that most flow is minimal with large fluctuations during precipitation events (see **Figure GWC-15**). As detailed in *Appendix H,* streamflow into the Basin was estimated based on records of precipitation falling onto the up-gradient watershed areas and an assumed watershed consumptive use fraction of 95%, estimated during water budget calibration. That is, the assumption that on average only 5% of the amount of precipitation falling on the Castac Lake and O'Neil Canyon-Grapevine Creek watersheds immediately surrounding the Basin flows into the Basin as surface water through Cuddy Creek, Dry Field Creek, O'Neil Creek, and smaller drainages. A 5% recharge factor is consistent with other studies, for example Bookman and Edmonston (1965) used 5.4% for recharge from the upland watershed areas contributing to Castac Basin. For the greater Castac Lake watershed surrounding the upgradient basins feeding through Cuddy Canyon Basin, an assumed watershed consumptive use fraction of 99% was estimated during water budget calibration. 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.

Natural Streamflow out of the Basin

As discussed in Section 7.3.5 *Surface Water Bodies*, Grapevine Creek drains northward out of the Castac Basin. No current gauge exists on Grapevine Creek within the Basin, however historical streamflow measurements at various locations along the creek, as well as a gauge operated down-gradient of the Basin suggest streamflow within Grapevine Creek is generally stable with large influxes attributable to precipitation events. Additionally, during rare large storm events, Castac Lake overflowed, contributing surface water to Grapevine Creek. As detailed in *Appendix H*, streamflow out of the Basin is estimated to be the sum of baseflow at the Basin outlet and the fraction of streamflow from other parts of the Basin that becomes Basin outflow. Stream baseflow was estimated as 55-percent the amount of estimated groundwater subsurface outflow based on assumptions of aquifer cross-sectional area, hydraulic conductivity, piezometric (groundwater level) gradient, and canyon geometry. The fraction of streamflow from other parts of the Basin that leaves the Basin was estimated as 20-percent of total streamflow during water budget calibration. Finally, two overtopping events were estimated by the model during WY 1998 and WY 2005. Total surface water outflows averaged 1,300 AFY between WY 1998 - 2018.

9.2.2. Groundwater Inflows and Outflows

Per 23-CCR § 354.18(b)(2) and (b)(3), **Table WB-3** and **Figure WB-6** provide an annual summary of inflows to and outflows from the groundwater system by water source type for WY 1998 – 2018.

Sources of inflow to the groundwater system include:

- Infiltration from precipitation;
- Infiltration from applied groundwater (i.e., "return flows" from irrigation);
- Subsurface groundwater inflows from upgradient Cuddy Canyon Basin and to a lesser extent other tributary canyons; and
- Seepage from surface water systems (e.g., streams and Castac Lake).

Sources of outflow to the groundwater system include:

- Groundwater extraction (i.e., pumping);
- Seepage to the surface water system (e.g., Castac Lake);
- Evaporation of shallow groundwater and Groundwater Dependent Ecosystems (GDEs); and
- Subsurface groundwater outflows.

Table WB-3. Annual Inflows to and Outflows from the Groundwater System, and Change in Groundwater Storage

Water Year	INFLOWS (AFY) [(a)]									OUTFLOWS (AFY) [(a)]								CHANGE IN STORAGE [(a)]	
			Infiltration from Precipitation			Infiltration from Return Flows				Groundwater Extractions									
	Seepage from Lake to GW	Seepage from Streamflow to GW	Agricultural Areas	Non-Irrigated Areas	Developed Areas	Agricultural Areas	Developed Areas	Subsurface GW Inflow	Total Inflows	Pumpage for Lake Filling	Pumpage for Agricultural Areas	Pumpage for Developed Areas	*Total Pumpage*	Seepage to Lake	Evaporation of Shallow GW/GDEs	Subsurface GW Outflow	Total Outflows	Storage Change (AFY) [(b)]	Cumulative Storage Change since WY 1998 (AF)
1998	30	530	120	1,880	780	30	190	3,110	**6,670**	0	-170	-380	*-550*	-720	-1,330	-1,510	**-4,110**	2,560	2,560
1999	30	190	30	630	320	50	310	3,220	**4,780**	0	-230	-610	*-840*	-710	-960	-1,510	**-4,020**	760	3,320
2000	30	130	20	420	220	50	290	3,130	**4,290**	0	-280	-570	*-850*	-740	-860	-1,500	**-3,950**	340	3,660
2001	20	160	30	490	250	60	270	3,130	**4,410**	0	-310	-550	*-860*	-730	-880	-1,490	**-3,960**	450	4,110
2002	20	30	10	50	90	40	250	2,920	**3,410**	-450	-220	-500	*-1,170*	-700	-680	-1,480	**-4,030**	-620	3,490
2003	40	230	40	750	350	0	230	2,110	**3,750**	-460	0	-450	*-910*	-540	-750	-1,420	**-3,620**	130	3,620
2004	50	100	20	260	190	10	220	1,360	**2,210**	-480	-50	-440	*-970*	-370	-440	-1,450	**-3,230**	-1,020	2,600
2005	50	530	130	1,890	760	90	210	1,210	**4,870**	-290	-140	-410	*-840*	-300	-970	-1,500	**-3,610**	1,260	3,860
2006	50	160	20	510	260	40	230	2,410	**3,680**	-570	-240	-450	*-1,260*	-580	-730	-1,510	**-4,080**	-400	3,460
2007	30	80	10	180	170	220	220	4,020	**4,930**	-130	-640	-450	*-1,220*	-670	-990	-1,490	**-4,370**	560	4,020
2008	30	110	30	320	210	520	240	2,090	**3,550**	0	-1,000	-490	*-1,490*	-600	-710	-1,480	**-4,280**	-730	3,290
2009	50	110	20	330	210	520	220	970	**2,430**	0	-990	-440	*-1,430*	-370	-490	-1,470	**-3,760**	-1,330	1,960
2010	60	60	10	190	130	310	200	550	**1,510**	0	-730	-390	*-1,120*	-220	-300	-1,470	**-3,110**	-1,600	360
2011	70	130	20	480	210	420	180	400	**1,910**	0	-840	-360	*-1,200*	-70	-380	-1,480	**-3,130**	-1,220	-860
2012	100	80	10	230	170	320	220	360	**1,490**	-130	-640	-440	*-1,210*	-20	-300	-1,440	**-2,970**	-1,480	-2,340
2013	10	70	10	220	170	30	250	150	**910**	0	-200	-490	*-690*	-40	-180	-1,440	**-2,350**	-1,440	-3,780
2014	0	60	10	210	150	10	210	100	**750**	0	-70	-420	*-490*	-20	-40	-1,450	**-2,000**	-1,250	-5,030
2015	0	170	30	580	280	10	200	50	**1,320**	0	-50	-390	*-440*	0	-70	-1,460	**-1,970**	-650	-5,680
2016	0	100	20	330	220	10	190	30	**900**	0	-30	-380	*-410*	0	-40	-1,460	**-1,910**	-1,010	-6,690
2017	0	200	50	660	330	0	210	30	**1,480**	0	-10	-410	*-420*	0	-70	-1,480	**-1,970**	-490	-7,180
2018	0	90	10	260	150	0	210	30	**750**	0	-10	-430	*-440*	0	-40	-1,470	**-1,950**	-1,200	-8,380
Total	670	3,320	650	10,870	5,620	2,740	4,750	31,380	**60,000**	-2,510	-6,850	-9,450	-18,810	-7,400	-11,210	-30,960	**-68,380**	-8,380	-8,380
Average	40	160	30	520	270	130	230	1,490	**2,860**	-120	-330	-450	-900	-350	-530	-1,470	**-3,260**	-390	
%	*1%*	*6%*	*1%*	*18%*	*9%*	*5%*	*8%*	*52%*	--	*4%*	*10%*	*14%*	*28%*	*11%*	*16%*	*45%*	--	--	--

Abbreviations:

AF = acre-feet
AFY = acre-feet per year
GDEs = groundwater dependent ecosystems
GW = groundwater
WY = Water Year

Notes:

(a) Values rounded to the nearest ten acre-feet.
(b) Storage change calculated as total inflows minus total outflows.

Figure WB-7 provides a summary of the historical 20-year (WY 1998 - 2017) long-term annual average inflows to and outflows from the groundwater system. Total inflows to the groundwater system averaged 2,960 AFY. Approximately 28% of total inflows to the groundwater system were supplied from infiltration of precipitation, 53% from subsurface groundwater inflows, 6% from infiltration from surface water systems, and 12% by infiltration of applied water.

As shown on **Figure WB-7**, total outflows from the groundwater system averaged 3,320 AFY over WY 1998 – 2017. Approximately 28% of total outflows to the groundwater system were from groundwater extraction, 44% to subsurface groundwater outflows, 11% from seepage to Castac Lake, and 17% from evaporation of the shallow groundwater table and GDEs. Within the category of groundwater extraction, approximately 49% can be attributed to municipal and domestic use, 37% to agricultural pumpage, and the remaining 14% to lake filling operations, although lake filling operations only occurred throughout portions of the historical water budget period (i.e., WYs 2002 through 2007, and 2012).

9.2.3. <u>Change in Groundwater Storage</u>

Per 23-CCR § 354.18(b)(4), **Figure WB-8**, **Figure WB-9**, and **Table WB-4** present the annual and cumulative change in groundwater storage between seasonal high conditions, which are defined in this GSP to be March through February of the following year. Note that this time window is distinct from DWR's definition of the "Water Year", which runs from October of the previous year to September of the current year (e.g. DWR WY 2014 is October 2013 – September 2014); thus the values presented in **Table WB-4** are slightly different than the annual and cumulative change in storage estimates provided for DWR WYs 1998 – 2018 in **Table WB-3**, **Table WB-5**, **Table WB-7** and **Table WB-8**.

Annual change in groundwater storage averaged approximately -480 AFY between seasonal high conditions for the period of March 1998 through February 2018 (**Table WB-4**; **Figure WB-8**), with a cumulative change in storage equating to approximately -9,540 AF over the same period of record (**Table WB-4**; **Figure WB-9**). However, as seen in **Figure WB-8,** change in storage varied widely between years, from an approximate 1,210 AF increase in storage in 1998 to an approximate 1,700 AF decrease in storage in 2009.

Table WB-4. Annual and Cumulative Change in Groundwater Storage between Seasonal Highs (Mar – Feb)

Period of Reference (month/year)	Annual Change in Groundwater Storage (AFY)[a]	Cumulative Change in Groundwater Storage (AF)[a]
3/98 - 2/99	1,210	1,210
3/99 - 2/00	540	1,750
3/00 - 2/01	420	2,170
3/01 - 2/02	40	2,210
3/02 - 2/03	-560	1,650
3/03 - 2/04	190	1,840
3/04 - 2/05	460	2,300
3/05 - 2/06	-350	1,950
3/06 - 2/07	-430	1,520
3/07 - 2/08	970	2,490
3/08 - 2/09	-1,370	1,120
3/09 - 2/10	-1,700	-580
3/10 - 2/11	-1,290	-1,870
3/11 - 2/12	-1,400	-3,270
3/12 - 2/13	-1,490	-4,760
3/13 - 2/14	-1,440	-6,200
3/14 - 2/15	-940	-7,140
3/15 - 2/16	-760	-7,900
3/16 - 2/17	-220	-8,120
3/17 - 2/18	-1,420	-9,540
Total[b]	-9,540	-9,540
Average[b]	**-480**	**--**

Abbreviations:
AF = acre-feet
AFY = acre-feet per year
Feb = February
Mar = March

Notes:
(a) Values rounded to the nearest ten acre-feet.
(b) The total and average values do not cover the entire range of the water budget period.

Figure WB-10, **Figure WB-11**, and **Table WB-5** compare the annual and cumulative change in storage for each Water Year (October – September) between 1998 and 2018 to the Water Year type based on DWR's San Joaquin Valley Water Year Index. Annual change in groundwater storage averaged approximately -390 AFY from WY 1998 – 2018, with a cumulative change in storage amounting to approximately -8,380 AF over this period. These exhibits depict a clear relationship between change in groundwater storage to WY type, whereby change in storage becomes more positive with an increasing "wet" condition and more negative with an increasing "dry" condition. The net benefit of a "wet" period on groundwater conditions is especially evident in WYs 1998, 2005, and 2017, whereas the impact of a severe multi-year drought becomes increasingly evident over the period of WY 2007 - 2014. As evident from these two exhibits, as well as from the groundwater hydrographs shown in **Figure GWC-4** and **Figure GWC-5**, the groundwater system is highly sensitive to climatic conditions.

Table WB-5. Annual Change in Groundwater Storage vs. DWR Water Year Type

DWR Water Year (Oct - Sept)	Water Year Type[(a)]	Annual Change in Groundwater Storage (AFY)[(b)]	Cumulative Change in Groundwater Storage (AF)[(b)]
1998	W	2,560	2,560
1999	AN	760	3,320
2000	AN	340	3,660
2001	D	450	4,110
2002	D	-620	3,490
2003	BN	130	3,620
2004	D	-1,020	2,600
2005	W	1,260	3,860
2006	W	-400	3,460
2007	C	560	4,020
2008	C	-730	3,290
2009	BN	-1,330	1,960
2010	AN	-1,600	360
2011	W	-1,220	-860
2012	D	-1,480	-2,340
2013	C	-1,440	-3,780
2014	C	-1,250	-5,030
2015	C	-650	-5,680
2016	D	-1,010	-6,690
2017	W	-490	-7,180
2018	BN	-1,200	-8,380
Total		-8,380	-8,380
Average		**-390**	**--**

Abbreviations:

AF = acre-feet
AFY = acre-feet per year
DWR = California Department of Water Resources
Oct = October
Sept = September

Notes:

(a) DWR Water Year types are based on the San Joaquin Valley Index, and are as follows: W = wet; AN = above normal; BN = below normal; D = dry; C = critical
(b) Values rounded to the nearest ten acre-feet

Sources:
DWR's Water Year Hydrologic Classification Indices for the San Joaquin Valley.
http://cdec.water.ca.gov/reportapp/javareports?name=WSIHIST

Figure WB-12 shows a comparison of the analytical spreadsheet model-calculated monthly groundwater elevation through time (black line), against the average of water levels measured in wells located in the Castac Lake and Dryfield Canyon areas of the Basin (blue connected dots). The analytical model groundwater elevation is calculated assuming a specific yield value of 0.12, which is the average specific yield value employed in the Castac Basin Numerical Model calibrated for the Castac Lake and Dryfiled Canyon areas of the Basin. As shown on **Figure WB-12**, the spreadsheet-calculated values track closely to the available data, indicating that the modeled elevation correlates well with the average measured water level in the Basin over time.

Between WY 2009 to 2018, the model-calculated changes in groundwater elevation (-4.5 feet per year [ft/yr]) are approximately equal to the average measured change in groundwater elevation (-4.5 ft/yr) for the Castac Lake area of the Basin (see **Table GWC-3**) indicating that the model-calculated changes in groundwater elevation reasonably replicate measured values. Although the Castac Basin Numerical Model's primary function is to estimate the future water budget, we compared the numerical model-based change in groundwater storage and groundwater elevation for validation of the spreadsheet model results. As shown in **Table WB-6**, the Numerical Model estimates an annual net decline in groundwater storage of -740 AFY throughout the historical Numerical Model period (WY 1999 – 2018), 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 (WY 1999 – 2018; note this period is different than the historical water budget period). Furthermore, the annual change in groundwater storage calculated from the Numerical Model tracks closely with storage change estimates produced by the Spreadsheet Analytical Model on a yearly basis and over the entire historical time-period (see *Figure 12 of Appendix I*). 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 the historical Numerical Model and the Spreadsheet Analytical model represents an overall uncertainty[37] in the volumetric water budget of approximately 4%.

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

Table WB-6. Comparison of Numerical Model and Spreadsheet Analytical Model Results for WY 1999 – 2018

Water Budget Component[(a)]	Spreadsheet Analytical Model Result (AFY)	Numerical Model Result (AFY)
Total Groundwater Inflows	2,670	3,430
Total Groundwater Outflows	3,210	4,170
Change in Groundwater Storage	**-550**	**-740**

Abbreviations:
AFY = acre-feet per year

Notes:
(a) The differences shown between water budget components in the Numerical Model and the Analytical Spreadsheet Model reflect their slightly different approaches to modeling of Basin streamflow inflows and outflows . See *Appendix I* for more details.

9.2.4. Overdraft Conditions

The Basin has been classified by DWR in its 2019 Basin Prioritization (DWR, 2019) as a "very low priority" basin, and is designated as not being in a condition of critical overdraft. With respect to basins in overdraft conditions, DWR has made the following statements:

- "A basin is subject to critical conditions of overdraft when continuation of present water management practices would probably result in significant adverse overdraft-related environmental, social, or economic impacts." (DWR, 1980)
- Groundwater overdraft is "... the condition of a groundwater basin or subbasin in which the amount of water withdrawn by pumping exceeds the amount of water that recharges the basin over a period of years, during which the water supply conditions approximate average conditions. Overdraft can be characterized by groundwater levels that decline over a period of years and never fully recover, even in wet years. If overdraft continues for a number of years, significant adverse impacts may occur, including increased extraction costs, costs of well deepening or replacement, land subsidence, water quality degradation, and environmental impacts." (DWR, 2003)
- "Overdraft occurs where the average annual amount of groundwater extraction exceeds the long-term average annual supply of water to the basin. Effects of overdraft result can include seawater intrusion, land subsidence, groundwater depletion, and/or chronic lowering of groundwater levels".

While evaluating basins for critical overdraft conditions in its most recent Bulletin 118 update, DWR considered the time period from WY 1989 – 2009 (DWR, 2016c). This period excludes the recent drought which began in 2012, includes both wet and dry periods, is at least 10 years in length, and includes precipitation close to the long-term average; these were all criteria used in selecting the time period.

The water budget information discussed herein covers the period from WYs 1998 through 2018 (i.e., it does not cover the entire period used in DWR's evaluation). However, within the period covered by this water budget, the 12-year timeframe between WYs 1998 and 2009 (October 1997 through September 2009) meets all of the same criteria. The cumulative departure in statewide average precipitation increased by a total of 9% during this 12-year period, (DWR, 2016c, Figure 1), indicating that each year was wetter than the long-term average by a small amount (i.e., less than 1% annually). Over this time period, the cumulative change in storage within the Basin increased by approximately 1,960 AF, averaging approximately 160 AFY. Therefore, by this metric and using DWR's description of overdraft, the Basin as a whole is not in a condition of critical overdraft.

9.2.5. Sustainable Yield

The Sustainable Groundwater Management Act (SGMA) defines sustainable yield as "the maximum quantity of water, calculated over a base period representative of long-term conditions in the basin and including any temporary surplus, that can be withdrawn annually from a groundwater supply without causing an undesirable result" (California Water Code [CWC], §10721(w)). DWR's Water Budget BMP (DWR, 2016b), further states that "Water budget accounting information should directly support the estimate of sustainable yield for the basin and include an explanation of how the estimate of sustainable yield will allow the basin to be operated to avoid locally defined undesirable results." Inherent to the codified definition and the BMP statement is the avoidance of the SGMA-specified "Undesirable Results", which include significant and unreasonable effects for any of the six SGMA sustainability indicators. Therefore, determination of the sustainable yield for the Basin depends upon how the Undesirable Results are defined. Groundwater Sustainability Agencies such as the Castac Basin GSA have the ability to define Undesirable Results for their basin.

While no exact method for defining the sustainable yield is required by SGMA or promoted by DWR in its Water Budget BMP, the BMP does emphasize that water budget accounting information should be used. It follows that an estimate of the sustainable yield of the groundwater system in the Basin can be made by subtracting the average annual groundwater extraction, which is negative by definition, from the average annual change in storage (whether positive or negative). This simplified approach provides a sustainable yield estimate corresponding to the total volume of water that, if pumped over the water budget period of interest, would have resulted in zero change in storage due to pumping – a reasonable metric for sustainability.

For the Castac Basin, using the average annual change in groundwater storage over the water budget period from WYs 1998 – 2018 (i.e., -400 AFY) and the average annual groundwater extraction (i.e., -900 AFY), the sustainable yield is estimated at approximately +500 AFY under current supply and demand conditions. Use of other water budget periods produces a range of sustainable yield estimates for Castac Basin which vary from +500 AFY to +1,190 AFY, thus, these estimates are time-dependent and contain significant uncertainty.

Table WB-7 below provides a summary of the range of potential sustainable yield estimates for Castac Basin, based on different selected time periods. For comparison, current (WY 2018) groundwater extraction is approximately -440 AFY, which is less than the range of sustainable yield estimates.

Table WB-7. Estimated Sustainable Yield for Selected Time Periods

Time Period	Relevance of Time Period	Average Annual Change in Groundwater Storage (AFY)	Average Annual Groundwater Extraction (AFY)	Sustainable Yield (AFY)[(b)]
WY 1998 - 2018	Entire Water Budget Period	-400	-900	500
WY 1998 - 2017	Historical Water Budget Period	-360	-920	560
WY 1998 - 2009	Overdraft Evaluation Period (Section 9.2.4)	160	-1,030	1,190
WY 1998 - 2011	Water Budget Period Excluding the Recent Drought	-60	-1,050	990

Notes:

(a) Values rounded to the nearest ten acre-feet.

(b) Sustainable Yield is calculated as average annual change in groundwater storage minus average annual groundwater extraction.

9.3. Current and Historical Water Budget

> *§ 354.18. Water Budget*
>
> *(c) Each Plan shall quantify the current, historical, and projected water budget for the basin as follows:*
>
> *(1) Current water budget information shall quantify current inflows and outflows for the basin using the most recent hydrology, water supply, water demand, and land use information.*
>
> *(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.*
>
> *(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.*
>
> *(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.*

9.3.1. Current Water Budget

This section presents results for the "current" water budget, based on values extracted from the spreadsheet model for WY 2018.

Per 23-CCR §354.18(d)(1), **Table WB-8** and **Figure WB-13** provide a summary of total inflows to and outflows from the Basin for WY 2018, while **Table WB-3** and **Figure WB-14** provide a summary of groundwater-only inflows and outflows for WY 2018.

Total inflows to the Basin hydrologic system (including groundwater) were approximately 2,580 AFY for WY 2018, including subsurface groundwater inflow, precipitation, and surface water inflows. Total outflows from the Basin hydrologic system were approximately 4,140 AFY for WY 2018, including evapotranspiration (consumptive use by vegetation), evaporation, consumptive municipal and domestic water use, subsurface outflows, and surface outflows. The difference between total inflows and outflows to the Basin hydrologic system in WY 2018 was a net loss of approximately 1,560 AF.

Considering only the groundwater component of the Basin hydrologic system, inflows totaled approximately 750 AFY, which includes subsurface groundwater inflow, infiltration of ineffective precipitation, infiltration of streamflow, infiltration of return flows from agricultural applications, and infiltration of return flows from municipal/domestic water use. Outflows from the groundwater component of the Basin hydrologic system totaled approximately 1,950 AFY, including pumpage, developed areas consumptive use, net seepage to Castac Lake, evaporation from shallow groundwater and GDEs, and subsurface outflows. The difference between total inflows and outflows in the groundwater component of the hydrologic system was a net loss of approximately 1,200 AF.

Table WB-8. Annual Inflows to and Outflows from the Water Budget Domain, and Change in Storage

Water Year	INFLOWS (AFY)[a]				OUTFLOWS (AFY)[a]				CHANGE IN STORAGE[a],[b]		
	Total Precipitation	Surface Water Inflow	Subsurface GW Inflow	Total Inflows	Evapotranspiration, Evaporation, & Consumptive Use	Surface Water Outflow	Subsurface GW Outflow	Total Outflows	GW Storage Change (AFY)	Cumulative GW Storage Change since WY 1998 (AF)	Lake Storage Change (AFY)
1998	9,930	3,470	3,110	**16,510**	-7,290	-4,410	-1,510	**-13,210**	2,560	2,560	730
1999	4,130	1,340	3,220	**8,690**	-4,980	-1,140	-1,510	**-7,630**	760	3,320	300
2000	2,810	930	3,130	**6,870**	-4,200	-1,020	-1,500	**-6,720**	340	3,660	-190
2001	3,230	1,090	3,130	**7,450**	-4,430	-1,060	-1,490	**-6,980**	450	4,110	30
2002	1,160	250	2,920	**4,330**	-3,310	-800	-1,480	**-5,590**	-620	3,490	-630
2003	4,430	1,550	2,110	**8,090**	-4,450	-1,170	-1,420	**-7,040**	130	3,620	940
2004	2,450	750	1,360	**4,560**	-3,490	-930	-1,450	**-5,870**	-1,020	2,600	-290
2005	9,700	3,390	1,210	**14,300**	-6,650	-4,290	-1,500	**-12,440**	1,260	3,860	620
2006	3,270	1,070	2,410	**6,750**	-4,190	-1,070	-1,510	**-6,770**	-400	3,460	390
2007	2,230	590	4,020	**6,840**	-4,490	-900	-1,490	**-6,880**	560	4,020	-600
2008	2,690	760	2,090	**5,540**	-4,240	-960	-1,480	**-6,680**	-730	3,290	-410
2009	2,720	790	970	**4,480**	-4,050	-950	-1,470	**-6,470**	-1,330	1,960	-670
2010	1,600	430	550	**2,580**	-2,980	-860	-1,470	**-5,310**	-1,600	360	-1,140
2011	2,700	880	400	**3,980**	-3,450	-1,000	-1,480	**-5,930**	-1,220	-860	-730
2012	2,170	600	360	**3,130**	-3,220	-890	-1,440	**-5,550**	-1,480	-2,340	-930
2013	2,150	550	150	**2,850**	-2,960	-870	-1,440	**-5,270**	-1,440	-3,780	-970
2014	1,870	470	100	**2,440**	-2,280	-850	-1,450	**-4,580**	-1,250	-5,030	-890
2015	3,620	1,120	50	**4,790**	-2,940	-1,060	-1,460	**-5,460**	-650	-5,680	-20
2016	2,760	780	30	**3,570**	-2,440	-930	-1,460	**-4,830**	-1,010	-6,690	-250
2017	4,160	1,390	30	**5,580**	-3,190	-1,150	-1,480	**-5,820**	-490	-7,180	260
2018	1,930	620	30	**2,580**	-1,760	-910	-1,470	**-4,140**	-1,200	-8,380	-380
Total	71,710	22,820	31,380	**125,910**	-80,990	-27,220	-30,960	**-139,170**	-8,380	-8,380	-4,830
Average Historical (1998-2017)	3,490	1,110	1,570	**6,170**	-3,960	-1,320	-1,470	**-6,750**	-360	-7,180	-220
%	*57%*	*18%*	*25%*	*--*	*59%*	*20%*	*22%*	*--*	*--*	*--*	*--*

Abbreviations:

AF = acre-feet
AFY = acre-feet per year
GW = groundwater
N/A = not applicable
WY = Water Year

Notes:

(a) All values rounded to the nearest ten acre-feet.
(b) (Total inflows) + (total outflows) = (groundwater storage change) + (lake storage change), assuming inflows are positive and outflows are negative.

9.3.2. Historical Water Budget

Water budget results are presented above for the historical water budget period in Section 9.2 *Water Budget Results*, including associated figures and tables, and are not repeated here. Rather, this section focuses on providing:

(a) a quantitative evaluation of historical surface water availability and reliability (23-CCR §354.18(d)(2)(A)),

(b) a quantitative assessment of the historical water budget (23-CCR §354.18(d)(2)(B)), and

(c) a description of how historical conditions have impacted the ability of the Basin to be operated within its sustainable yield (23-CCR §354.18(d)(2)(C)).

Historical Surface Water Availability and Reliability

The Basin does not currently use surface water as a source of water supply.

Quantitative Assessment of Historical Water Budget

Based on DWR San Joaquin Valley WY Index for the 20-year period from WY 1998 through 2017, this period included five "critical" (dry) years, five dry years, two below normal years, three above normal year, and five wet years. The beginning of this period was relatively wet, the middle was a mix of wet and dry years, and the end of the period was extremely dry. This climatic factor is clearly reflected in the water budget, whereby the groundwater system shows consistent increases in storage with "wetter" conditions and decreases in storage under "drier" conditions (see **Figure WB-10**, **Figure WB-11**, and **Table WB-5**).

Table WB-8 and **Figure WB-15** provide a tabular breakdown for the entire Basin of total inflows and outflows for WYs 1998 - 2017, and **Figure WB-16** provides a graphical summary of average annual total inflows and outflows over the same period (similar information for just the groundwater system is provided in **Table WB-3** and on **Figure WB-6** and **Figure WB-7**).

Total annual inflows to the Basin of both surface water and groundwater averaged approximately 6,170 AFY for WYs 1998 - 2017, including subsurface groundwater inflow, precipitation, and surface water inflows. This resulted in an average inflow to the groundwater system of approximately 2,960 AFY, comprised of subsurface groundwater inflow, infiltration of ineffective precipitation, infiltration of streamflow, infiltration of return flows from agricultural applications, and infiltration of return flows from municipal/domestic water use.

Total annual outflows to the Basin of both surface water and groundwater averaged approximately 6,750 AFY between WY 1998 - 2017, including evapotranspiration (consumptive use by vegetation), consumptive municipal and domestic water use, evaporation, subsurface outflows, and surface outflows. This resulted in a total outflow from the groundwater system of approximately 3,320 AFY, including pumpage, developed areas consumptive use, net seepage to

Castac Lake, evaporation from the shallow groundwater table and GDEs, and subsurface outflows.

Operation within Sustainable Yield

Average annual change in groundwater storage amounted to approximately -360 AFY between WYs 1998 - 2017, resulting in a cumulative change in groundwater storage of approximately -7,180 AF during this period (**Table WB-8**; **Figure WB-11**).

Although the overall net change during this period is negative, the calculated transient change in storage and water levels measured in wells within the Basin (see **Figure GWC-7** and **Figure GWC-4**) demonstrate that the groundwater system is sensitive to climatic variability, with decreases in storage during drought followed by increases in storage during wet periods. Additionally, during the historical water budget period, groundwater pumping decreased over time. Since the change in storage became more negative during periods of declining pumping, Basin operations (e.g., groundwater pumping) appear not to drive the estimated decreases in groundwater storage. Average pumping over the historical water budget period (WYs 1998 - 2017) was 920 AFY (**Table WB-7**; **Figure WB-7**), which falls within the upper end of the sustainable yield estimates (500 to 1,190 AFY) shown in **Table WB-7**, however current (WY 2018) groundwater pumping is approximately 440 AFY, which is less than the range of sustainable yield estimates.

9.4. Projected Water Budget

§ 354.18. Water Budget

(c) Each Plan shall quantify the current, historical, and projected water budget for the basin as follows:

(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.

(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.

(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.

Per the Groundwater Sustainability Plan (GSP) Emergency Regulations (23-California Code of Regulations [CCR] §354.18(e)(2)), projected water budgets are required to estimate future conditions of water supply and demand within a basin, as well as the aquifer response to GSP implementation over the planning and implementation horizon. To develop a projected water budget for the Castac Lake Valley Groundwater Basin (Castac Basin), the Castac Basin Numerical Model was used, with updated inputs for climate variables (i.e., precipitation and evapotranspiration [ET]), land use changes, and project and management action (P&MA) implementation.

9.4.1. Development of 50-Year Analog Period

Per the GSP Emergency Regulations 23-CCR §354.18(e)(2)(A), the projected water budgets must use 50 years of historical precipitation, ET, and streamflow information as the basis for evaluating future conditions under baseline and climate-modified scenarios. To develop the required 50 years of projected hydrologic input information, an “analog period” was created by repeating select sequences of the 20-year historical hydrologic record in a way that maintains long-term historical average hydrologic conditions[38], as detailed below. This approach allows for the simulation of a continuous 50-year period of future hydrologic data 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.

9.4.2. Development of Projected Water Budget Scenarios

Three projected climate scenarios were used for this water budget analysis per the California Department of Water Resources (DWR)'s guidance (DWR, 2018):

- Historical Analog (Baseline) Climate Scenario,
- DWR moderate (2030) Climate Change Scenario, and
- DWR extensive (2070) Climate Change Scenario.

The Baseline Climate Scenario is for comparison purposes and does not include any expected effects of climate change, the 2030 Climate Change Scenario reflects a moderate level of climate change effects, and the 2070 Climate Change Scenario incorporates a more severe set of climate change assumptions. All three scenarios are used to project the water budget for the Basin through 2070 and are simulated through use of the Castac Basin Numerical Model.

In addition, three future land-use scenarios were considered for the water budget analysis, including:

- Current Land-Use Scenario,
- Tejon Mountain Village (TMV) Development Scenario, and
- TMV Development with Aquifer Replenishment Project Scenario.

The Current Land-Use Scenario is for comparison purposes and does not include completion of the TMV Development. The TMV Development Scenario includes the Phase 1 TMV development buildout within the Basin and the TMV Development with Aquifer Replenishment Project

[38] The 50-year analog period used to develop projected water budgets is informed by and consistent with the methodology employed in the Kern County Subbasin numerical groundwater flow model used for GSP development purposes (TODD Groundwater, 2020).

Scenario includes the Phase 1 TMV development plus implementation of the Aquifer Replenishment Project whereby Castac Lake levels are maintained, using imported and recycled water sources. All three scenarios are used to project the water budget for the Basin through 2070 and are simulated through use of the Castac Basin Numerical Model.

Baseline Scenario

Per the GSP Emergency Regulations 23-CCR §354.18(e)(2)(B) and 23-CCR §354.18(e)(2)(C), the projected water budgets must use "the most recent land use, evapotranspiration, and crop coefficient information" and "the most recent water supply information as the baseline condition for estimating future surface water supply." For the purpose of the Baseline Scenario, no climate change factors are applied. Instead, as described below, the Baseline Scenario represents the projected land use and water demands through the GSP implementation period (i.e., between 2020 and 2040).

- Current land use (TCWD, 2019a) (**Figure PA-3**).
- The projected groundwater extraction from the Basin includes known and anticipated public supply, domestic, and irrigation uses, and is estimated using the following assumptions:
    - The number of domestic, irrigation, and small public water system wells within the Basin is not expected to increase in the future. Therefore, modeled groundwater pumping from domestic and irrigation wells, as well as public supply system wells that support El Tejon School, Tejon Ranch Company (TRC) headquarters, and Fort Tejon is held constant (for each month) at a rate equivalent to the average monthly pumped volumes over the last five years of the historical model (i.e., DWR Water Years [WY] 2014 – 2018).
    - Lebec County Water District (LCWD) is in process of installing a new well within the Basin which will replace the existing LCWD "Chimney" well, located in the up-gradient Cuddy Canyon Basin. The replacement well is assumed to pump a total of approximately 50.6 acre-feet per year (AFY), equivalent to the average pumped volume from the Chimney Well between DWR WY 2014 - 2018. LCWD is in the process of annexing Frazier Mountain High School whose drinking water demand in 2019 was less than 1 acre-foot,[39] however anticipated delivery is 2.5 million gallons per year (approximately 7.6 acre-feet per year).[40] Based on historical trends, limited growth is expected within the LCWD service area in the future; therefore, groundwater extraction from the remaining LCWD public supply wells

[39] Personal communication, Jessica Carroll, Lebec County Water District, 6 November 2019, based on bottled water delivery volumes provided by Self-Help Enterprises.
[40] Project / Management Action Information Form "Frazier Mountain High School Water Project"

is held constant by month, based on the average monthly pumped volumes during DWR WY 2014 - 2018.

- Krista Mutual Water Company (KMWC) is currently at their maximum number of connections for their distribution system, and no additional growth can be accommodated[41]. Therefore, KMWC groundwater use is held constant by month based on the average monthly pumped volumes during DWR WY 2014 – 2018.
- Imported surface water is not currently used within the Basin. However, the TMV development will rely exclusively on imported State Water Project (SWP) water and recycled water to meet demands. No groundwater will be used (TCWD, 2008).

- Groundwater inflow from the upgradient Cuddy Canyon Basin was simulated by approximating a local gradient at the Cuddy Creek boundary using the average measured gradient between wells TRC-MW16D and TRC-PW56A over the last five years of the historical model (i.e., DWR WY 2014 – 2018), resulting in an average inflow of approximately 200 AFY. Based on the measured gradient between wells TRC-MW16D and TRC-PW56A, estimated groundwater inflow during that period was significantly reduced compared to the 20-year historical average, and as discussed in more detail in *Section 9.5.2* below, is a source of uncertainty in the projected model scenarios.

2030 Climate Change Scenario

To estimate the potential effects of climate change on the projected water budget during the GSP implementation period (i.e., between 2020 and 2040), a water budget scenario based on 2030 climate change factors published by DWR (DWR, 2018) was developed. The climate change factors published by DWR represent aerial changes in historical monthly precipitation and ET records from January 1915 through December 2011 based on various models of projected climate conditions centered around the years 2030 and 2070. For the 2030 Climate Change Scenario, Baseline monthly precipitation and ET were both adjusted based on DWR's climate change factors by up to ±75% and ±10% (depending on month), respectively, resulting in an average 0.5% decrease in precipitation and an average 3.7% increase in ET (**Figure WB-18**). For January 2012 through September 2014, analog years were assigned based on similar hydrology in which 2012, 2013, and 2014 were assigned the climate change factors associated with years 1959, 1960, and 1961, respectively. Land use, groundwater supplies, surface water supplies, and groundwater inflow are assumed to be the same as the Baseline Scenario.

2070 Climate Change Scenario

To estimate the potential effects of climate change on the projected water budget towards the end of the planning and implementation horizon (i.e., 50 years into the future), a water budget scenario based on 2070 "central tendency" climate change factors published by DWR (DWR,

[41] Personal communication, Krista Mutual Water Company, 7 November 2019.

2018) was developed. It should be noted that estimates of climate change impacts on water supplies this far into the future have significant uncertainty. For the 2070 Climate Change Scenario, Baseline precipitation and ET were both adjusted based on DWR's 2070 "central tendency" climate change factors using the same methodology described above for the 2030 Climate Change Scenario development. The 2070 Climate Change Scenario resulted in an average 3.5% decrease in precipitation and 8.1% increase in ET relative to the Baseline Scenario (**Figure WB-18**). Land use, groundwater supplies, surface water supplies, and groundwater inflow are assumed to be the same as the Baseline Scenario.

TMV Development Scenario

Current land use (**Figure PA-3**) was adjusted to reflect the planned development of TMV Phase 1 (**Figure WB-17**) by 2040 based on zoning from the Kern County Vesting Tentative Tract Map #7313 (TCWD, 2019b).

TMV Development with Aquifer Replenishment Project Scenario

To quantify the potential effects of proposed P&MAs on the projected water budget during the GSP implementation period (i.e., between 2020 and 2040), a water budget scenario was developed which simulates a managed lake scenario representing the P&MA #1 referred to as "Aquifer Replenishment Project." The Baseline Climate Change Scenario was employed with an assumption that the water level in Castac Lake would be maintained (using direct rainfall, imported surface water and/or recycled water) at a constant water depth of 10 feet, measured from the base of the lakebed, to cover approximately 200 acres.[42] This scenario has been modeled assuming that surplus imported surface water supplies remain available. However, the effectiveness of P&MA #1 will be assessed periodically and should imported supplies become restricted in the future or be required for other beneficial uses, Basin conditions and the particulars of P&MA #1 implementation will be re-assessed.

9.4.3. Projected Water Budget Results

Results of the projected water budget analyses are summarized in **Table WB-9** and **Figure WB-19**. As shown in **Table WB-9**, water budget components are presented as averages over the 20-year historical period, as simulated by the Castac Basin Numerical Model,[43] and averages over the 50-year analog period for the Baseline, 2030 Climate Change, and 2070 Climate Change Scenarios. Water budget components are grouped into inflows and outflows. Also shown in **Table WB-9** is the average annual change in groundwater storage for the historical period and for each projected scenario. Annual projected changes in storage over the 50-year analog period are

[42] Personal communication, Tejon-Castac Water District, 6 November 2019

[43] The Castac Basin Numerical Model simulates water years 1999-2018, whereas the discussion of the historical water budget presented in Section *9.3.2 Historical Water Budget* is informed by results from the analytical spreadsheet model which simulates a historical period of water years 1998-2017.

presented for each climate and development scenario in **Figure WB-20** and **Figure WB-21**, respectively.

In the Baseline Scenario, the water budget components differ from the historical period primarily due to differences between the modeled long-term historical period (WY 1999 to 2018) and the last 5-year period representing recent conditions, including: (1) a reduction in pumping, (2) a reduction in groundwater inflow based on an extrapolated gradient which decreases significantly from 1998 to 2018, and (3) a reduction in ET from shallow groundwater and groundwater dependent ecosystems (GDEs) due to groundwater levels falling below the modeled extinction depth in some areas[44].

Without the TMV Development or Aquifer Replenishment Project, the change in groundwater storage shows a small decline on average over the 50-year projected scenarios. The change in groundwater storage averages -60 AFY under the Baseline and 2030 Climate Change Scenarios, and -80 AFY under the 2070 Climate Change Scenario (**Table WB-9**). Projected climate change factors have a minimal effect on change in groundwater storage and Basin groundwater levels (**Figure WB-20**).

Under the TMV Development Scenarios, an additional 330 – 340 AFY of recharge is added to the Basin from TMV's use of imported surface water supplies, resulting in generally more stable groundwater conditions (**Figure WB-21**). The change in groundwater storage averages -10 AFY under the Baseline and 2030 Climate Change Scenarios, and -20 AFY under the 2070 Climate Change Scenario, with the TMV Development (**Table WB-9**).

Upon implementation, the Aquifer Replenishment Project is estimated to add an additional 70 to 100 AFY of groundwater replenishment to the Basin (and up to 300 AFY on certain years), resulting in a net increase in groundwater storage of approximately 30 AFY under each climate scenario (**Figure WB-21**). The change in groundwater storage averages 20 AFY under the Baseline and 2030 Climate Change Scenarios, and 10 AFY under the 2070 Climate Change Scenario (**Table WB-9**).

As discussed in more detail in *Section 9.5.2 Boundary Conditions*, one of the largest drivers for projected groundwater availability, and therefore groundwater storage, in the Basin is the amount of groundwater inflow from upgradient Cuddy Canyon Basin. Model sensitivity testing shows that projected groundwater storage would increase significantly if groundwater inflows

[44] ET for shallow groundwater and groundwater dependent ecosystems (GDEs) is estimated by the Castac Basin Numerical Model based on simulated groundwater levels and a specified extinction depth of three feet below ground surface (ft bgs). This extinction depth is based on prior work performed in the Basin by Tejon Ranch (EKI, 2008d) which estimated the 90% cumulative rooting depth for 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). When model-calculated groundwater levels decline below the extinction depth, ET demands within the model are reduced. Areas with trees and other deeper-rooted phreatophyte vegetation near Castac Lake and in narrow portions of the Grapevine Canyon area may extend the extinction depth beyond the 3 ft bgs extinction depth used in the model.

were to increase to rates similar to the 20-year historical average (i.e., an increase from 200 AFY to 1,390 AFY). Further, as discussed in more detail in *Section 17.8.2 Evaluation Relative to Water Level Sustainability Criteria*, it should be noted that the results from the Castac Basin Numerical Model scenarios show that the Basin is projected to maintain its Sustainability Goal (i.e., avoids Undesirable Results).

Table WB-9. Summary of Projected Water Budget Estimates

Scenario	Climate Period	Land Use	Average Water Budget Components (AFY)[a],[b]							
			Inflows			Outflows				Inflows – Outflows
			Recharge	Groundwater Inflow	Lake (to GW)	Pumping	Groundwater Outflow	Lake (from GW)	ET from GDEs	Change in Groundwater Storage
Historical[c]	DWR WY 1999-2018	Current	2,040	1,390	0	910	2,070	570	620	-740
Projected Baseline	50-year Synthetic Hydrologic Period	Current	2,170	260	0	490	1,960	10	40	-60
Projected 2030 Climate	Scaled from Baseline-moderate climate change	Current	2,180	260	0	490	1,960	10	40	-60
Projected 2070 Climate	Scaled from Baseline-extensive climate change	Current	2,090	280	0	490	1,930	10	30	-80
Projected Baseline with TMV Development	50-year Synthetic Hydrologic Period	Projected	2,510	200	0	490	2,060	80	100	-10
Projected 2030 Climate with TMV Development	Scaled from Baseline-moderate climate change	Projected	2,520	200	0	490	2,060	80	100	-10
Projected 2070 Climate with TMV Development	Scaled from Baseline-extensive climate change	Projected	2,420	210	0	490	2,030	50	80	-20
Projected Baseline with TMV Development and Aquifer Replenishment Project	50-year Synthetic Hydrologic Period	Projected	2,510	160	80	490	2,070	10	160	20
Projected 2030 Climate with TMV Development and Aquifer Replenishment Project	Scaled from Baseline-moderate climate change	Projected	2,520	160	80	490	2,080	0	160	20
Projected 2070 Climate with TMV Development and Aquifer Replenishment Project	Scaled from Baseline-extensive climate change	Projected	2,420	180	100	490	2,050	0	140	10

Abbreviations:

AFY = acre-feet per year
DWR = California Department of Water Resources
ET = Evapotranspiration
GDEs = groundwater dependent ecosystems
GW = groundwater
WY = Water Year

Notes:

(a) Water budget components are presented as an average over their respective simulation period (i.e., 20 years for the Historical and 50 years for the Projected scenarios).
(b) Values rounded to the nearest ten acre-feet.
(c) Historical water budget values presented are from the Castac Basin Numerical Model for consistency with Projected water budget values. The period shown is different than the historical water budget period presented in Section *9.3.2 Historical Water Budget* (i.e., Water Years 1998-2017).

9.5. Water Budget Uncertainty and Limitations

Each of the values in the annual water budget is an estimate subject to some uncertainty. Limitations are due primarily to data gaps and data uncertainty.

Data gaps refer to limitations in the spatial coverage of measured data, or periods of time when no measurements are available. These occur when the locations and timing of data points are insufficient to adequately characterize conditions in model areas of interest. Data gaps require that assumptions be made regarding trends in the available data, and these assumed trends then are extrapolated into areas or time periods where data are lacking. For example, because relatively few water level measurements have been recorded at the southwest Basin boundary, estimates of groundwater levels in that location had to be extrapolated from downgradient wells. The uncertainty created by this extrapolation creates associated uncertainty in groundwater inflow boundary conditions.

Data uncertainty refers to errors or inaccuracies in the actual data used to populate the model. For example, groundwater recharge is estimated from assumptions made in the historical analytical spreadsheet model, such as the percent of ineffective precipitation that infiltrates or the fraction of water that is consumptively used in developed areas. As these values cannot be measured, they must be inferred and are uncertain.

Limitations for the water budget presented herein can be grouped into three categories: (1) those affecting simulated stresses (i.e., recharge and groundwater pumping), (2) boundary conditions, and (3) modeled water transmitting and storage properties. An overall uncertainty and therefore potential range for each category was developed based on a sensitivity analysis of simulated stresses, the variability of values in aquifer properties, and professional judgement. A more detailed description of model sensitivity and uncertainty analyses can be found in Appendix *I*.

9.5.1. Recharge and Groundwater Pumping

As discussed in Section *9.2 Water Budget Results* and shown in **Table WB-9**, the groundwater system is highly sensitive to climate conditions, specifically the amount of precipitation, which becomes groundwater recharge. The magnitude and spatial distribution of groundwater recharge is based on the assumptions and estimates calculated in the historical analytical spreadsheet model. Recharge was calculated for three primary areas, including non-irrigated areas, developed areas, and irrigated agriculture areas. Additionally, recharge entering the Basin from up-gradient watersheds was estimated as some percentage of precipitation, scaled by an orographic factor.

The most sensitive parameters (i.e., factors used in the model that when changed affect outcomes most significantly) for calculating groundwater recharge include the up-gradient watershed consumptive use fractions, followed by the consumptive use fraction for the developed areas and the percent of ineffective precipitation that infiltrates in the non-irrigated areas. The uncertainty in recharge is estimated at ±10%, which contributes to an estimated overall uncertainty[45] in the water budget of ±0.7%.

The magnitude and spatial distribution of groundwater pumping is based on supply well locations, depths, and reported or estimated pumping volumes. Although many of the wells reported monthly pumping rates, these were not available for the entire historical time period, so average values were employed for some months. The water budget also does not account for pumping from some Basin domestic wells, due to the lack of data from these wells. Furthermore, there is uncertainty associated with projected groundwater use. For modeling, we estimated pumping uncertainty at ±5%, which contributes to an estimated overall uncertainty in the water budget of ±0.9%. This analysis illustrates that based on currently-available information, uncertainty in current and projected levels of groundwater pumping do not contribute greatly to uncertainty in groundwater storage changes in the Basin.

9.5.2. Boundary Conditions

One of the largest drivers for groundwater availability in the Basin is the amount of groundwater inflow from the upgradient Cuddy Canyon Basin, but very limited water level data are available near this boundary. As such, we estimated groundwater inflow based on an extrapolated gradient between two Basin wells (TRC-MW16D and TRC-PW56A) located some distance from the boundary. This initial estimate was then refined through calibration of the historical Castac Basin Numerical Model.

This estimated boundary condition is a source of uncertainty in the historical water budget, but causes even more uncertainty in the future projected water budget. This uncertainty may be exacerbated by future changes in groundwater use and management patterns in the upgradient Cuddy Canyon, 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. 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 overall uncertainty in the projected future water budget of -0.3% to +3.8%. To reduce this uncertainty, future efforts to address known data gaps in the Basin should prioritize quantifying the amount of groundwater inflow across the upgradient Basin boundary.

9.5.3. Aquifer Hydraulic Properties (Water Transmitting and Storage Characteristics)

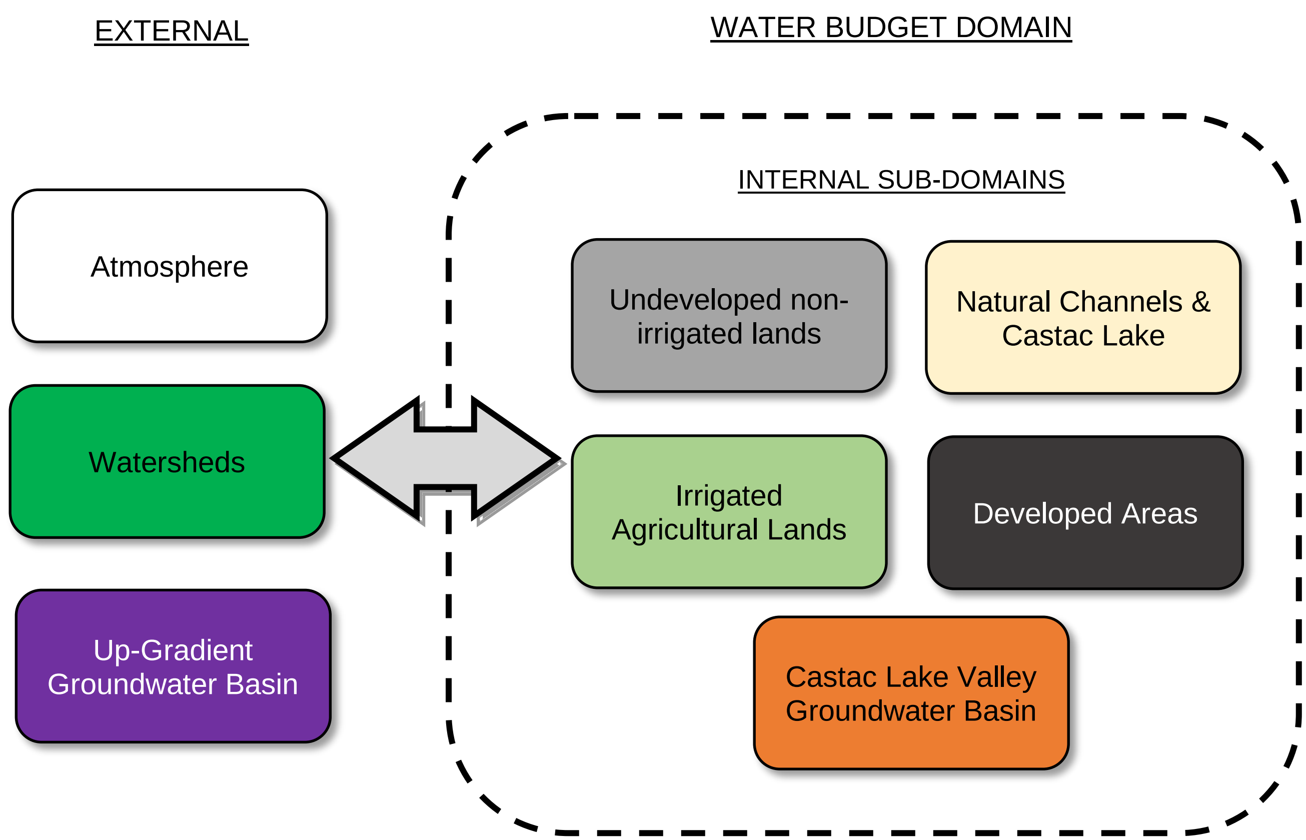
Hydraulic conductivity estimated from pumping tests conducted within the Basin range between 18 and 86 feet per day (ft/d) for the deep aquifer zone and 10 ft/d for the shallow aquifer zone (EKI, 2008a). Modeled hydraulic conductivity values were set at 10 ft/d in the shallow aquifer zone, and ranged from 25 to 70 ft/d (depending on location within the Basin) in the deep aquifer

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

zone, based on calibration to historical groundwater elevation data. Sensitivity tests show that ranges in hydraulic conductivity in the deep aquifer zone (i.e., Layer 3 of the model) contribute to an estimated overall uncertainty in the water budget of -6.3% to 7.8%.

Limited data available from Castac Lake prevents an a priori estimate of lakebed conductance. Modeled lake conductance is 0.001 ft/d, based on calibration to historical lake stage data. However, using the range of values for typical clay lakebed sediments (i.e., 1e-5 to 0.1 ft/d) results in an estimated overall uncertainty in the water budget of +2% to -0.2%.

Storativity values for the deep aquifer zone estimated from pumping tests conducted within the Basin range between 6e-4 and 0.004 (EKI, 2008a). Limited data exist to estimate specific yield properties for the shallow and deep aquifer zones. Modeled storativity values in the deep aquifer zone were set at 0.0001, and specific yield values in the shallow and deep aquifer zones ranged from 0.05 to 0.2, based on calibration to historical groundwater elevation data. Sensitivity tests show that ranges in storativity of $1x10^{-5}$ (0.00001) to 0.001 in the deep aquifer zone (i.e., Layer 3 of the model) contribute to an estimated overall uncertainty in the water budget of +1.3% to -9.0%, and ranges in specific yield of 0.025 to 0.4 in the shallow and deep aquifer zones contribute to an estimated overall uncertainty in the water budget of +3.5% to -5.9%. Thus, storativity (and to a lesser extent, hydraulic conductivity) of the aquifer materials in the Basin are the most sensitive parameters in the Castac Basin Numerical Model.



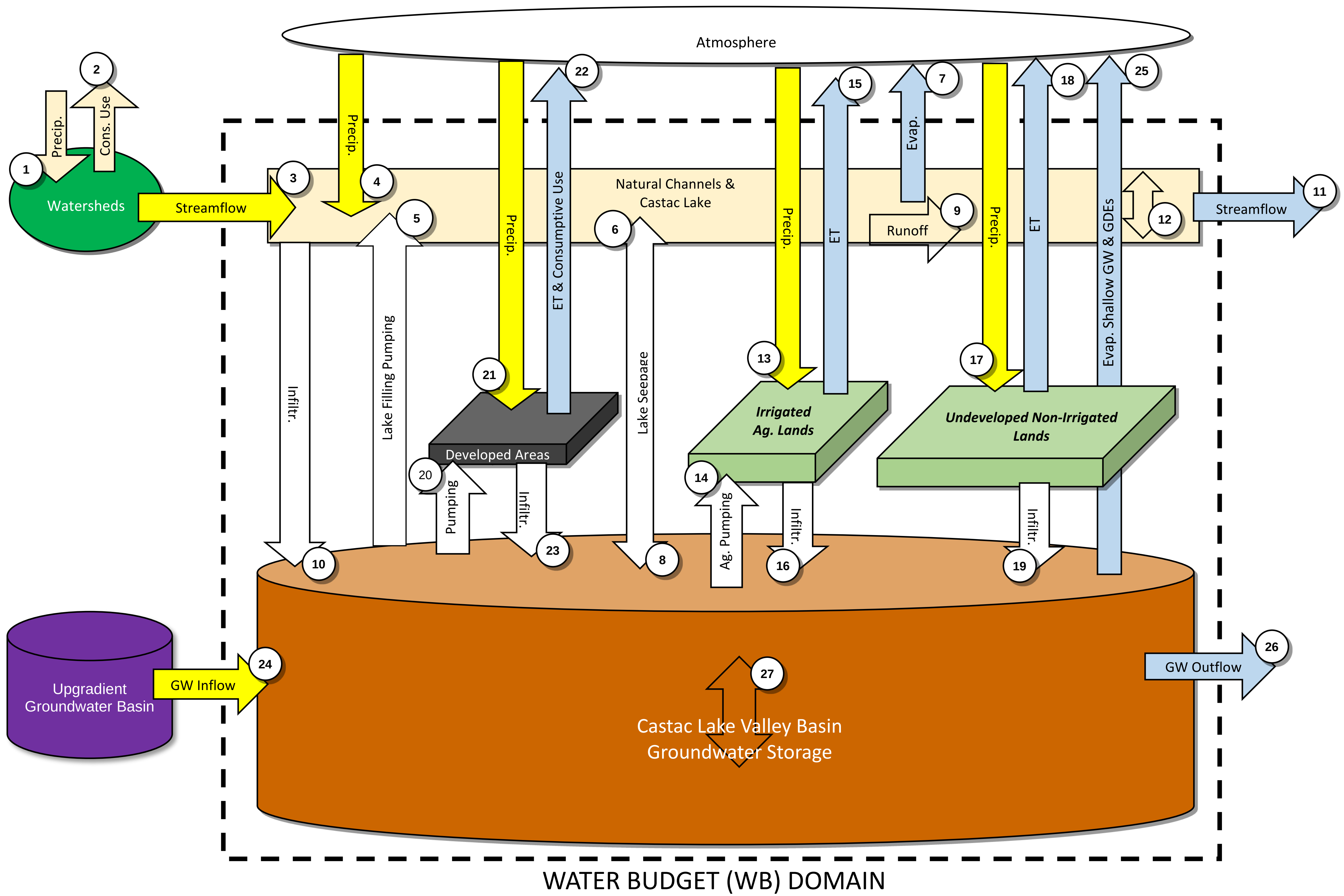
DRAFT

Conceptual Water Budget Domains and Subdomains

Tejon-Castac Water District
Kern County, California
June 2020
B80048.00

eki environment & water

Figure WB-1



Legend:

- External
- Inflow to WB Domain
- Internal
- Outflow from WB Domain

Abbreviations:

Ag	= agricultural
Cons.	= Consumptive
Evap.	= evaporation
ET	= evapotranspiration
GDEs	= groundwater dependent ecosystems
GW	= groundwater
Infiltr.	= infiltration
Precip.	= precipitation
WB	= water budget

Notes:

1. Component numbers correspond to columns contained in the spreadsheet water budget model.
2. See Appendix H for details on the calculation for each water budget flow component.

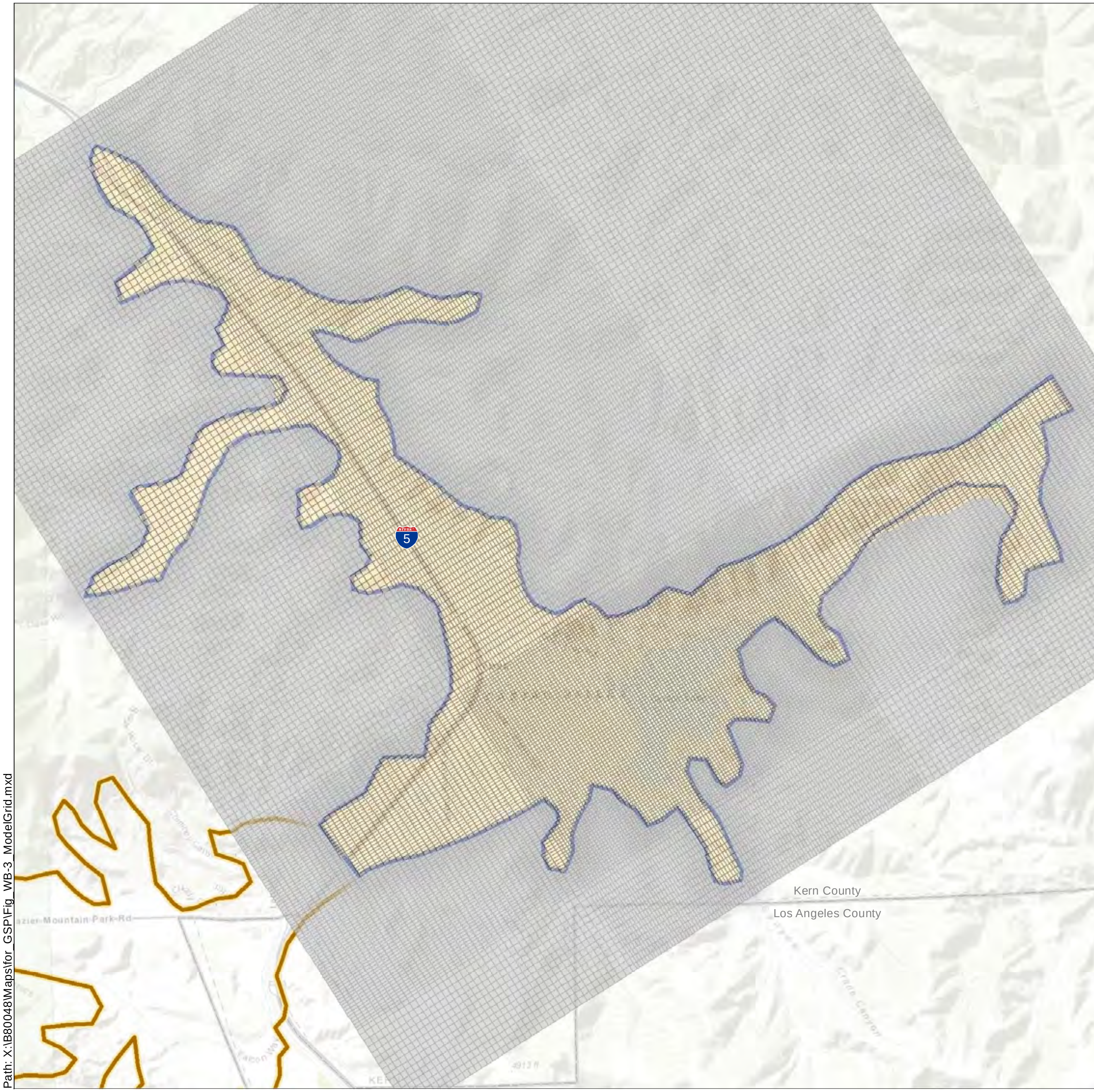
Conceptual Water Budget Flow Components/Linkages

DRAFT

Tejon-Castac Water District
Kern County, California
June 2020
B80048.00

eki environment & water

Figure WB-2



Legend

Castac Basin Model Grid

- Active Model Cell
- Inactive Model Cell
- Castac Lake Valley Groundwater Basin
- Other Groundwater Basin
- County Boundary

Abbreviations

DWR = California Department of Water Resources

Notes

1. All locations are approximate.
2. Active model cells are extended beyond the DWR basin boundary in one area of Dryfield Canyon, based on local topography and interpreted geology.

Sources

1. Groundwater basin boundaries from DWR Bulletin 118 Interim Update 2016.
2. Basemap is ESRI's ArcGIS Online world topographic map, obtained 10 October 2019.

N

0 0.5 1

Miles

Castac Basin Numerical Model Grid

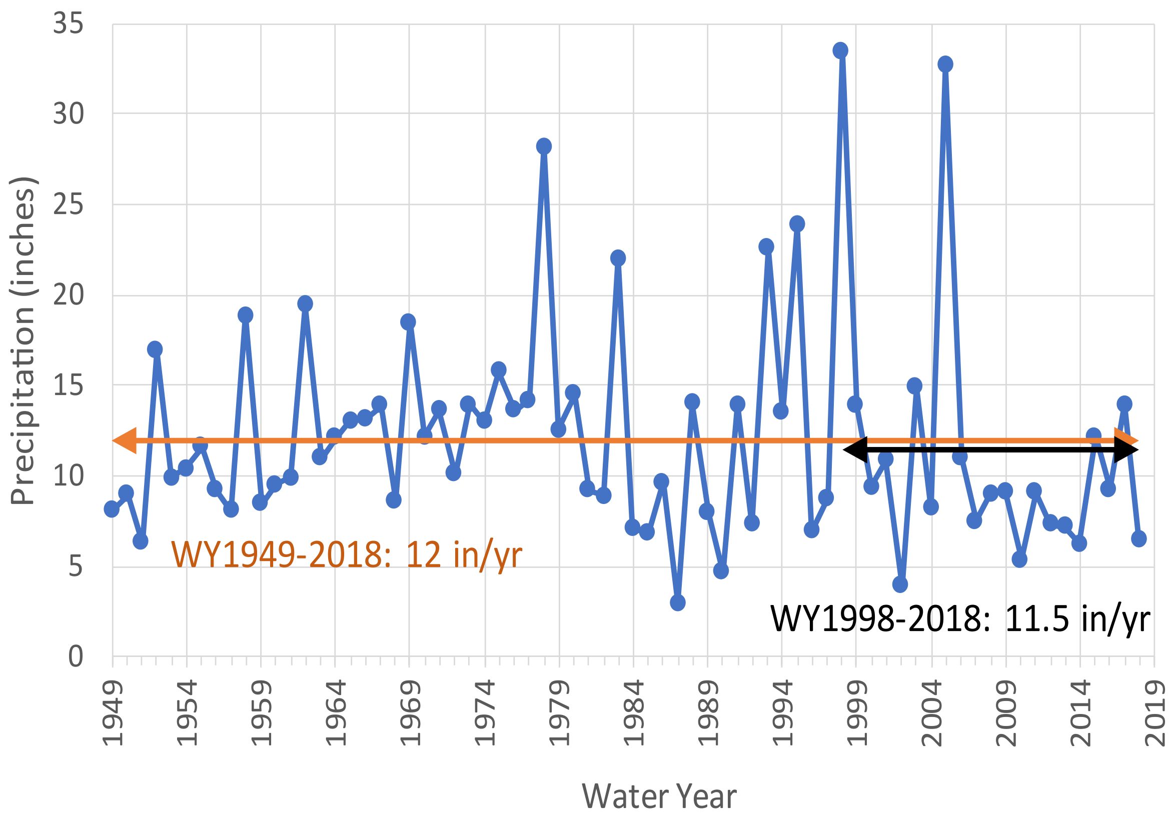
DRAFT

eki environment & water

Tejon-Castac Water District
Kern County, California
June 2020
B80048.00

Figure WB-3

Path: X:\B80048\Maps\for_GSP\Fig_WB-3_ModelGrid.mxd



Legend

- Annual Precipitation
- Long-Term Average Rainfall (WY 1949-2018)
- Average Rainfall (WY 1998-2018)

Abbreviations

in/yr = inches per year
NOAA = National Oceanic and Atmospheric Administration
WY = Water Year

Notes

1. Water Year is defined as the October of the previous year through September of the current year.

Sources

NOAA Lebec climate station Coop ID #44863.
www.wrcc.dri.edu/cgi-bin/cliMAIN.pl?ca4863

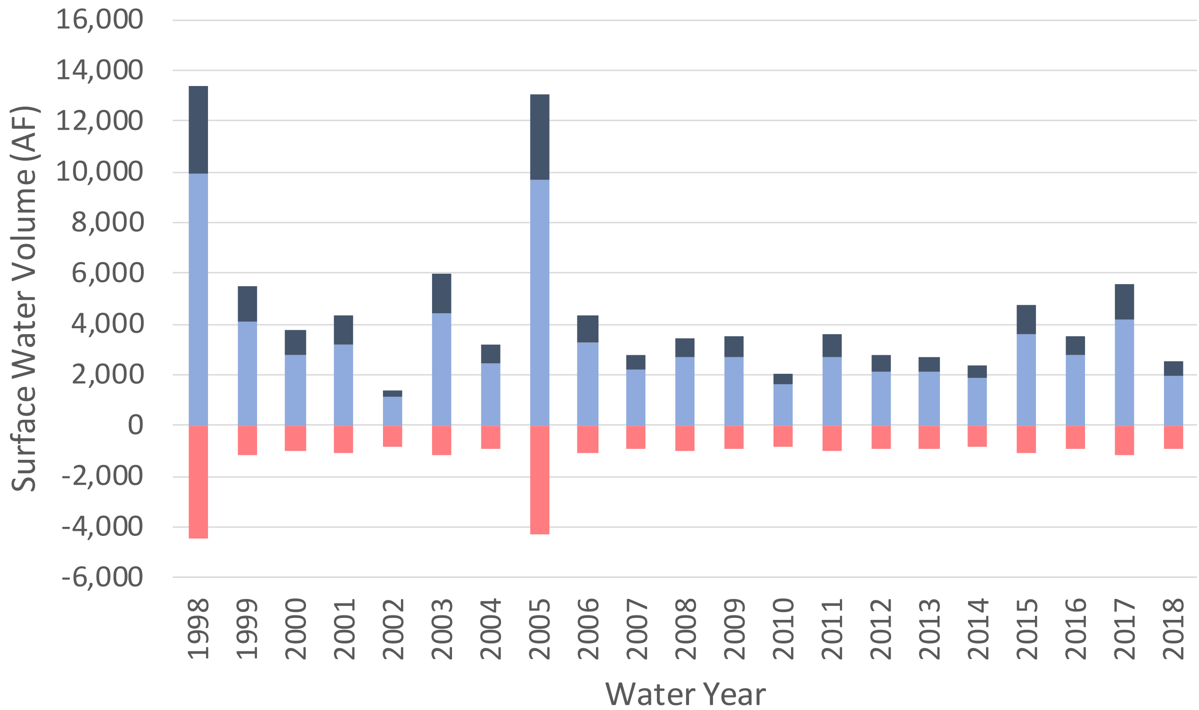
Long-Term Precipitation Record

DRAFT

eki environment & water

Tejon-Castac Water District
Kern County, California
June 2020
B800048.00

Figure WB-4



Legend

Surface Water Inflows

Streamflow

Precipitation

Surface Water Outflows

Streamflow

Abbreviations

AF = acre-feet

Notes

1. Water Year is defined as the October of the previous year through September of the current year.
2. A positive volume corresponds to a surface water inflow and a negative volume corresponds to a surface water outflow.

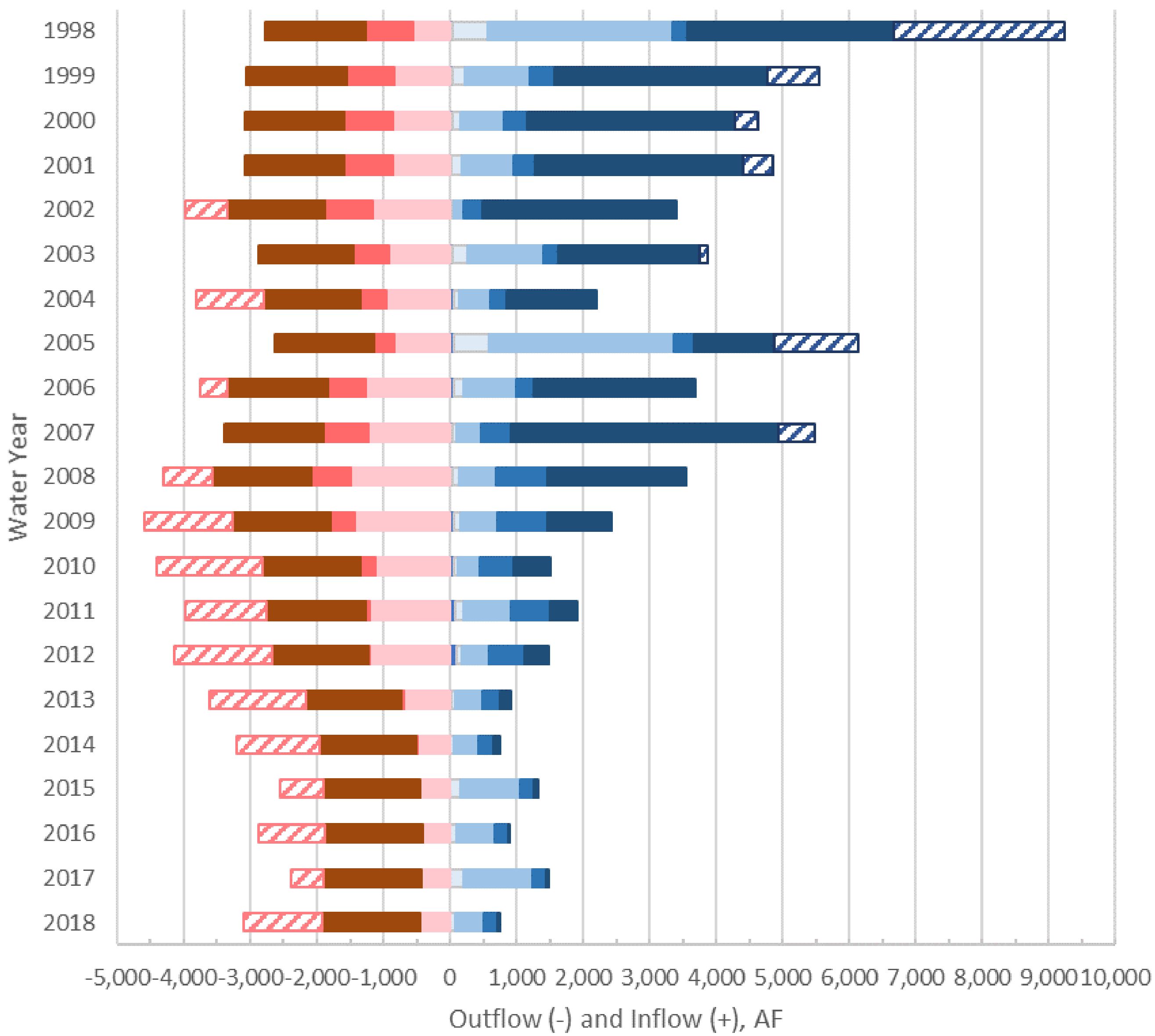
Annual Surface Water Inflows and Outflows by Source

DRAFT

eki environment & water

Tejon-Castac Water District
Kern County, California
June 2020
B800048.00

Figure WB-5



Legend

Groundwater Inflows

- Seepage From Lake
- Seepage from Streams
- Infiltration from Precipitation
- Infiltration from Return Flows
- Subsurface GW Inflow

Groundwater Outflows

- Groundwater Extractions
- Seepage to Lake
- Subsurface GW Outflow

Change in Groundwater Storage

- Gain in GW Storage
- Reduction in GW Storage

Abbreviations

AF = acre-feet
GW = groundwater

Notes

1. Water Year is defined as the October of the previous year through September of the current year.
2. A positive volume corresponds to a groundwater inflow and a negative volume corresponds to a groundwater outflow.

Annual Groundwater Inflows and Outflows

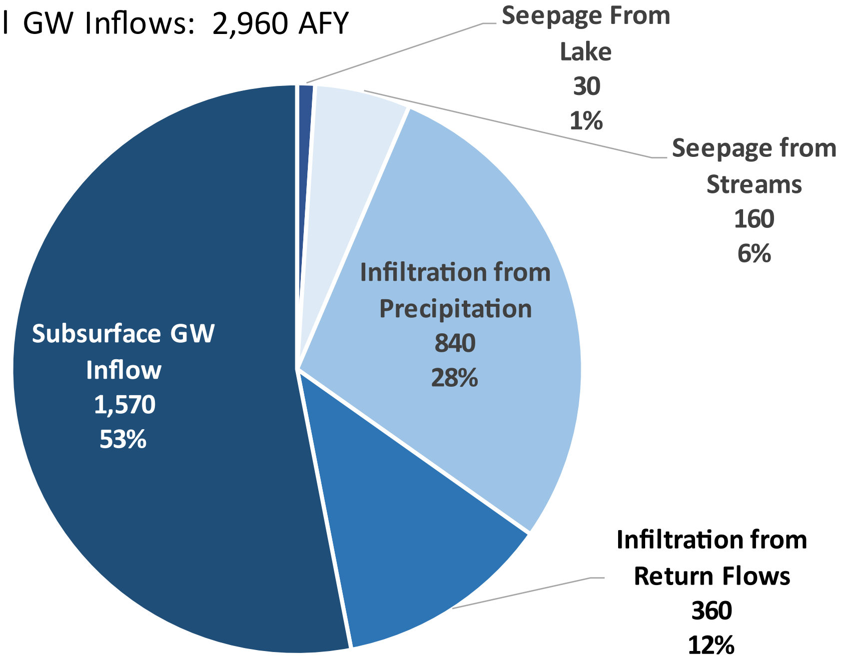
DRAFT

eki environment & water

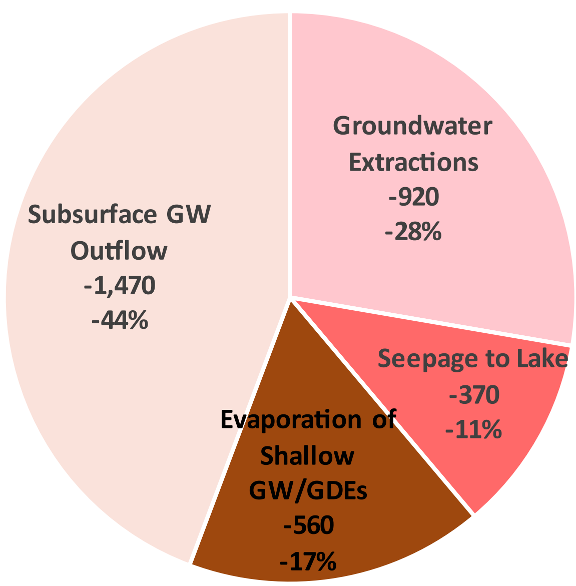
Tejon-Castac Water District
Kern County, California
June 2020
B800048.00

Figure WB-6

Average Annual GW Inflows: 2,960 AFY



Average Annual GW Outflows: -3,320 AFY



Abbreviations

AFY = acre-feet per year
GW = groundwater
WY = Water Year

Notes

1. Average values for the 20-year historical water budget period (WY 1998-2017).
2. All values are reported in AFY.

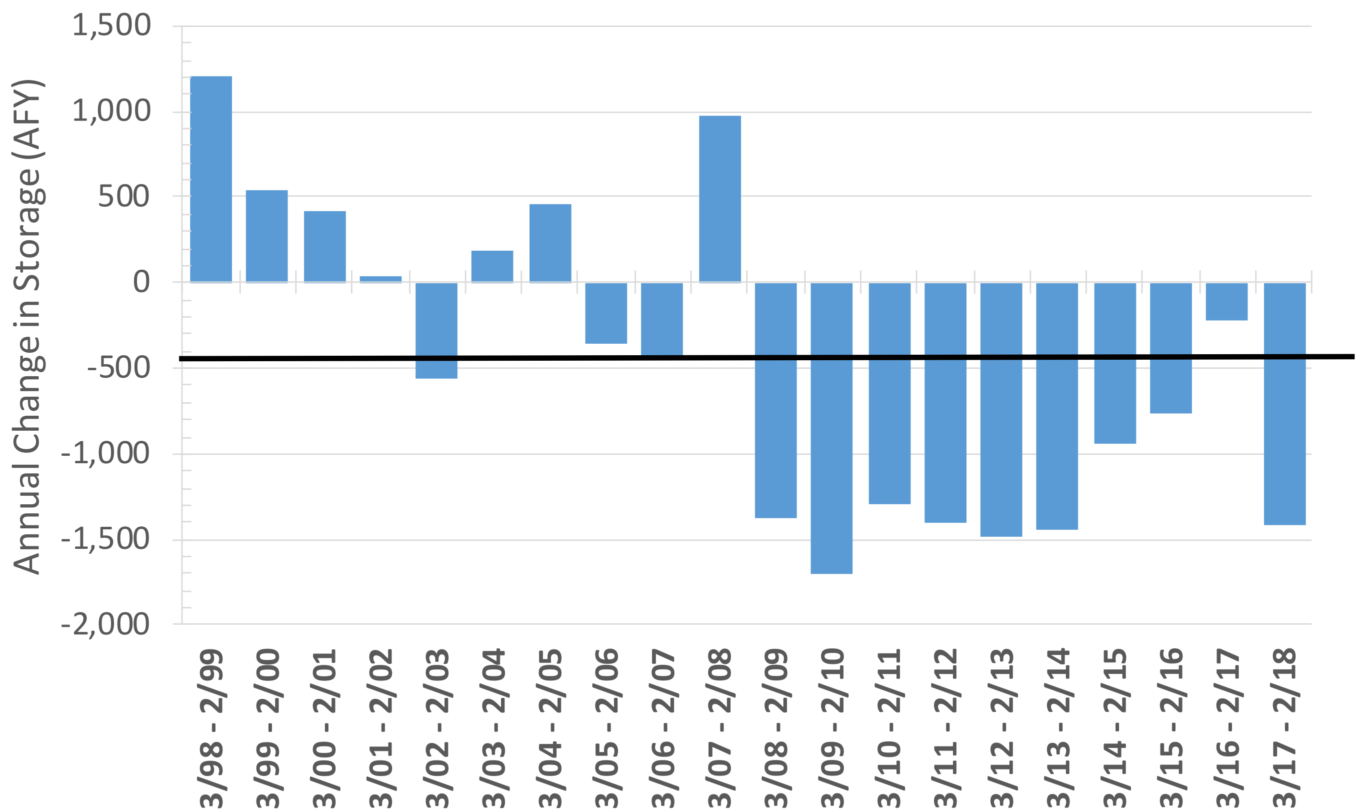
Summary of Historical Groundwater Inflows and Outflows, WY 1998-2017

DRAFT

eki environment & water

Tejon-Castac Water District
Kern County, California
June 2020
B800048.00

Figure WB-7



<u>Legend</u>

Annual Change in Storage between Seasonal Highs (Mar - Feb)

Average Annual Change in Storage, March 1998 - February 2018

<u>Abbreviations</u>

AFY = acre-feet per year

<u>Notes</u>

1. "Seasonal high" is defined as March of the current year through February of the following year.

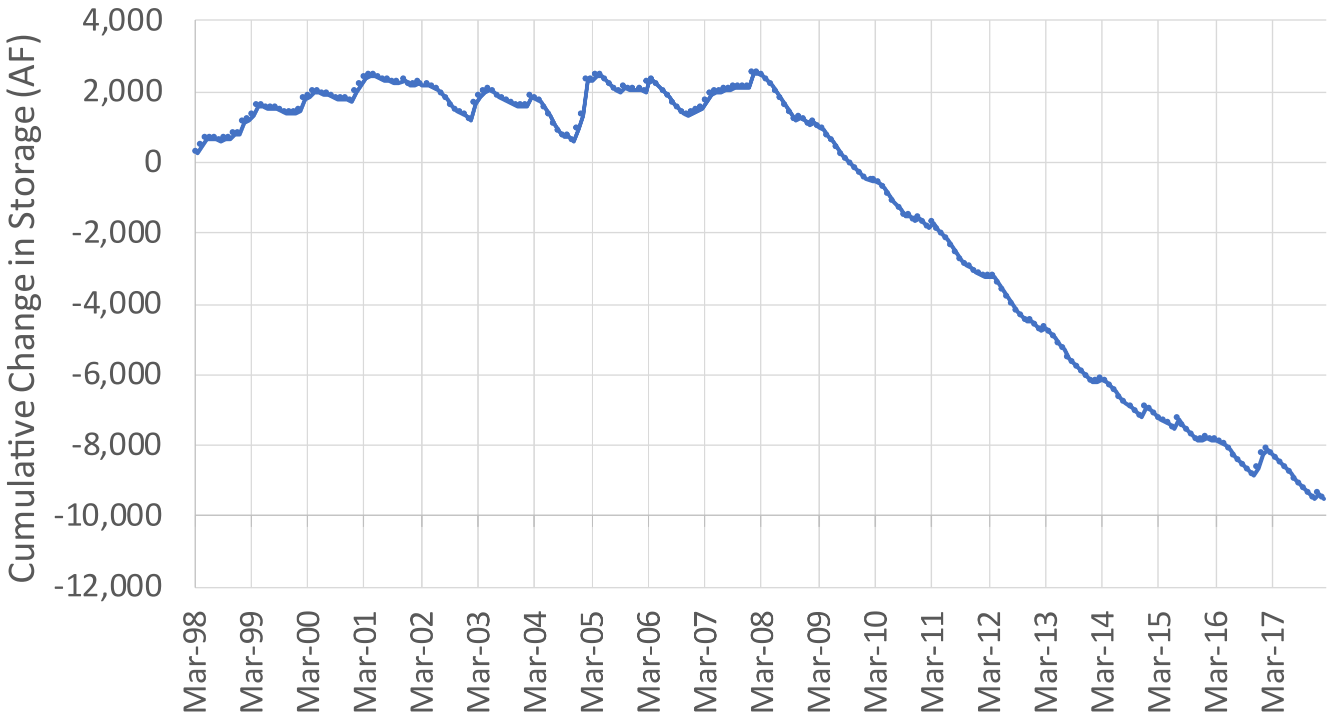
Annual Change in Storage between Seasonal Highs

DRAFT

eki environment & water

Tejon-Castac Water District
Kern County, California
June 2020
B800048.00

Figure WB-8



Legend

Abbreviations

AF = acre-feet

Notes

1. Values represent cumulative change in storage since the first "seasonal high" of the water budget period (March 1998).
2. "Seasonal high" is defined as March of the current year through February of the following year.

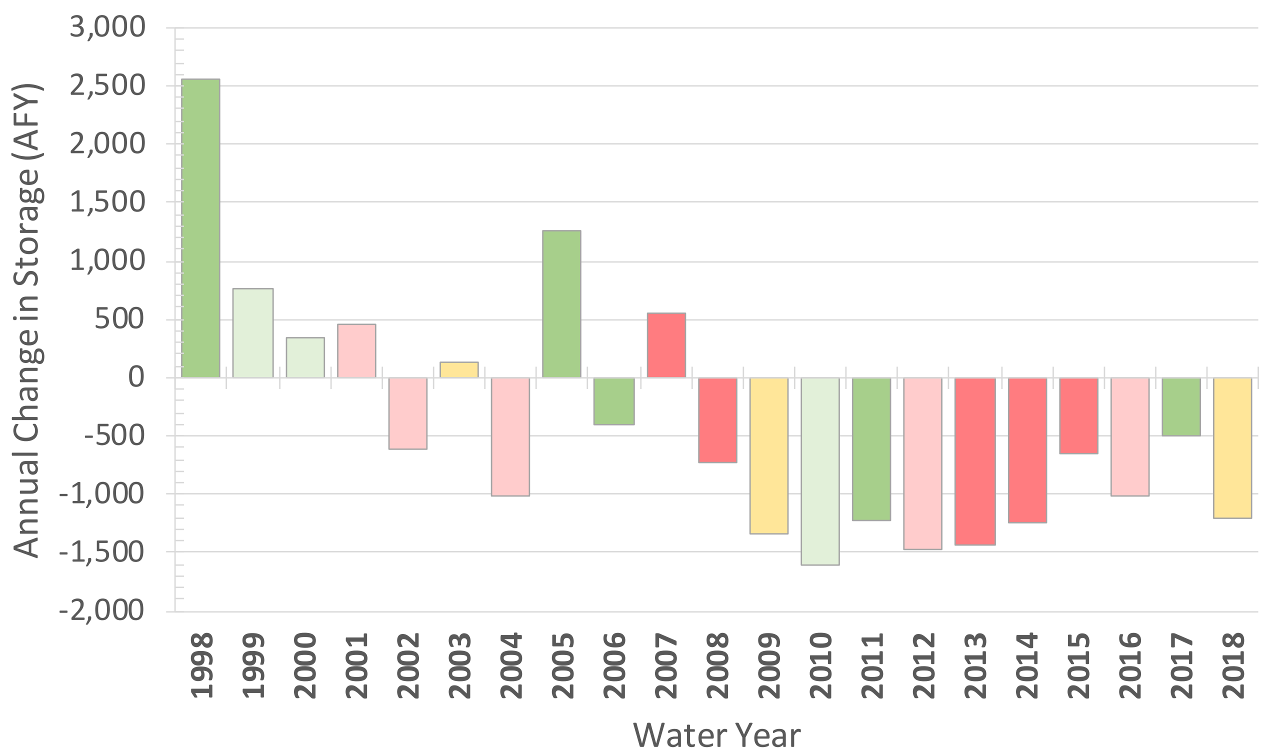
Cumulative Change in Storage, March 1998 - February 2018

DRAFT

eki environment & water

Tejon-Castac Water District
Kern County, California
June 2020
B800048.00

Figure WB-9



Legend

DWR Water Year Type

- Wet
- Above Normal
- Below Normal
- Dry
- Critical

Abbreviations

AFY = acre-feet per year
DWR = California Department of Water Resources

Notes

1. Water Year is defined as the October of the previous year through September of the current year.

Sources

DWR Water Year type is from DWR's Water Year Hydrologic Classification Indices for the San Joaquin Valley (http://cdec.water.ca.gov/reportapp/javareports?name=WSIHIST)

Annual Change in Storage vs. DWR Water Year Type

DRAFT

eki environment & water

Tejon-Castac Water District
Kern County, California
June 2020
B800048.00

Figure WB-10

Legend

DWR Water Year Type

- Wet
- Above Normal
- Below Normal
- Dry
- Critical

Abbreviations

AF = acre-feet
DWR = California Department of Water Resources

Notes

1. Water Year is defined as the October of the previous year through September of the current year.

Sources

DWR Water Year type is from DWR's Water Year Hydrologic Classification Indices for the San Joaquin Valley (http://cdec.water.ca.gov/reportapp/javareports?name=WSIHIST)

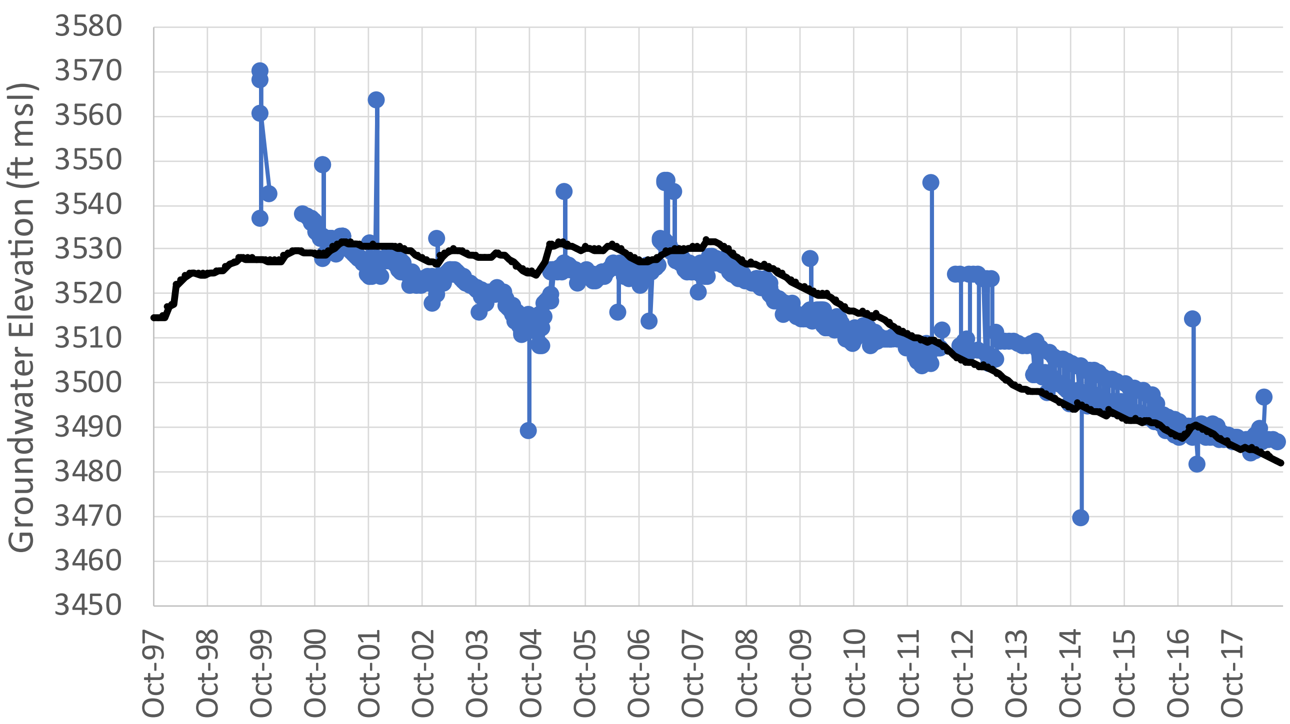
Cumulative Change in Storage vs. DWR Water Year Type

DRAFT

eki environment & water

Tejon-Castac Water District
Kern County, California
June 2020
B800048.00

Figure WB-11



Legend

Average Measured Water Level

Water Budget Spreadsheet Model-Calculated Water Level

Abbreviations

ft msl = feet above mean sea level

Notes

1. Average water level is calculated from wells with water level measurements located within the Castac Lake and Dryfield Canyon portions of the Basin, excluding flowing and dry measurements.
2. Model-calculated water levels calculated based on a specific yield value of 0.1, assuming the storage change occurs in the Castac Lake and Dryfield Canyon portions of the Basin.

Comparison of Model-Calculated Water Levels and Average Measured Water Levels

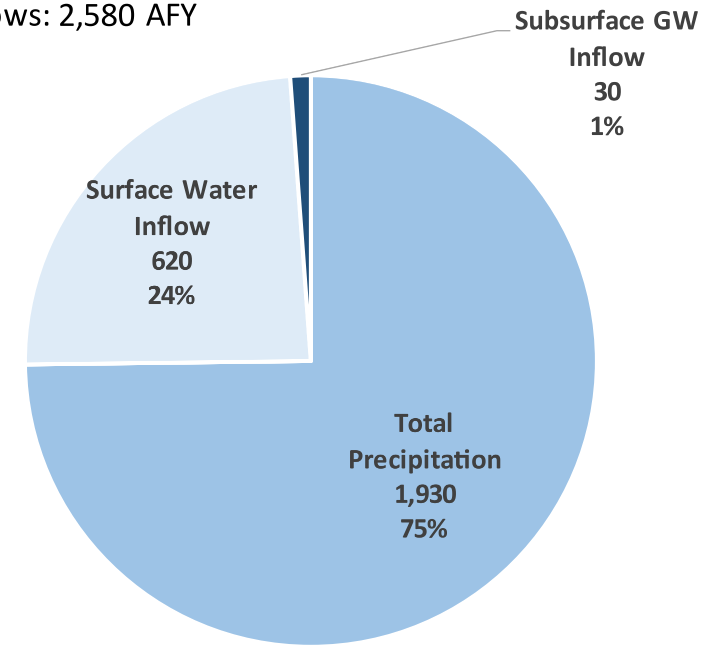
DRAFT

eki environment & water

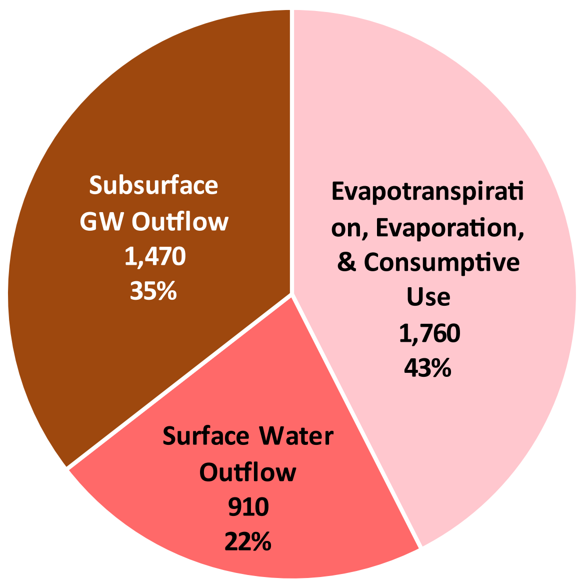
Tejon-Castac Water District
Kern County, California
June 2020
B800048.00

Figure WB-12

WY 2018 Inflows: 2,580 AFY



WY 2018 Outflows: 4,140 AFY



Abbreviations

AFY = acre-feet per year
GW = groundwater

Notes

1. All values are reported in AFY.

Summary of Current Surface Water and Groundwater Inflows and Outflows to the Water Budget Domain, WY 2018

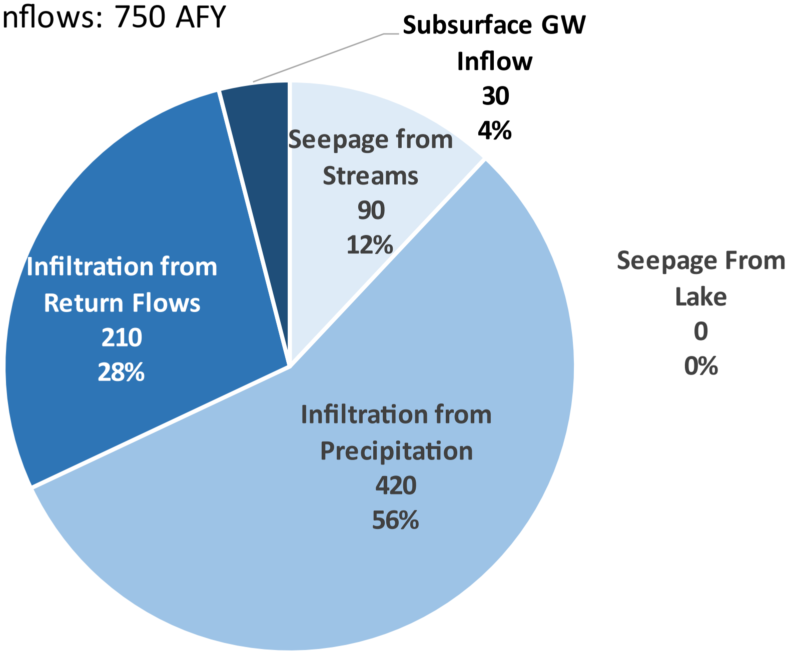
DRAFT

eki environment & water

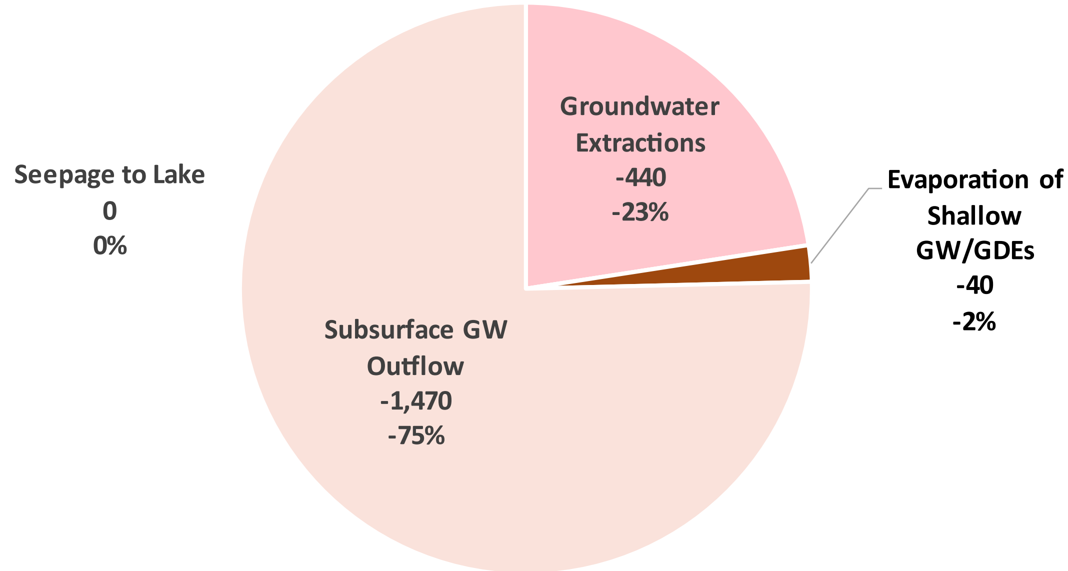
Tejon-Castac Water District
Kern County, California
June 2020
B800048.00

Figure WB-13

WY 2018 GW Inflows: 750 AFY



WY 2018 GW Outflows: -1,950 AFY



Abbreviations

AFY = acre-feet per year

GW = groundwater

Notes

1. All values are reported in AFY.

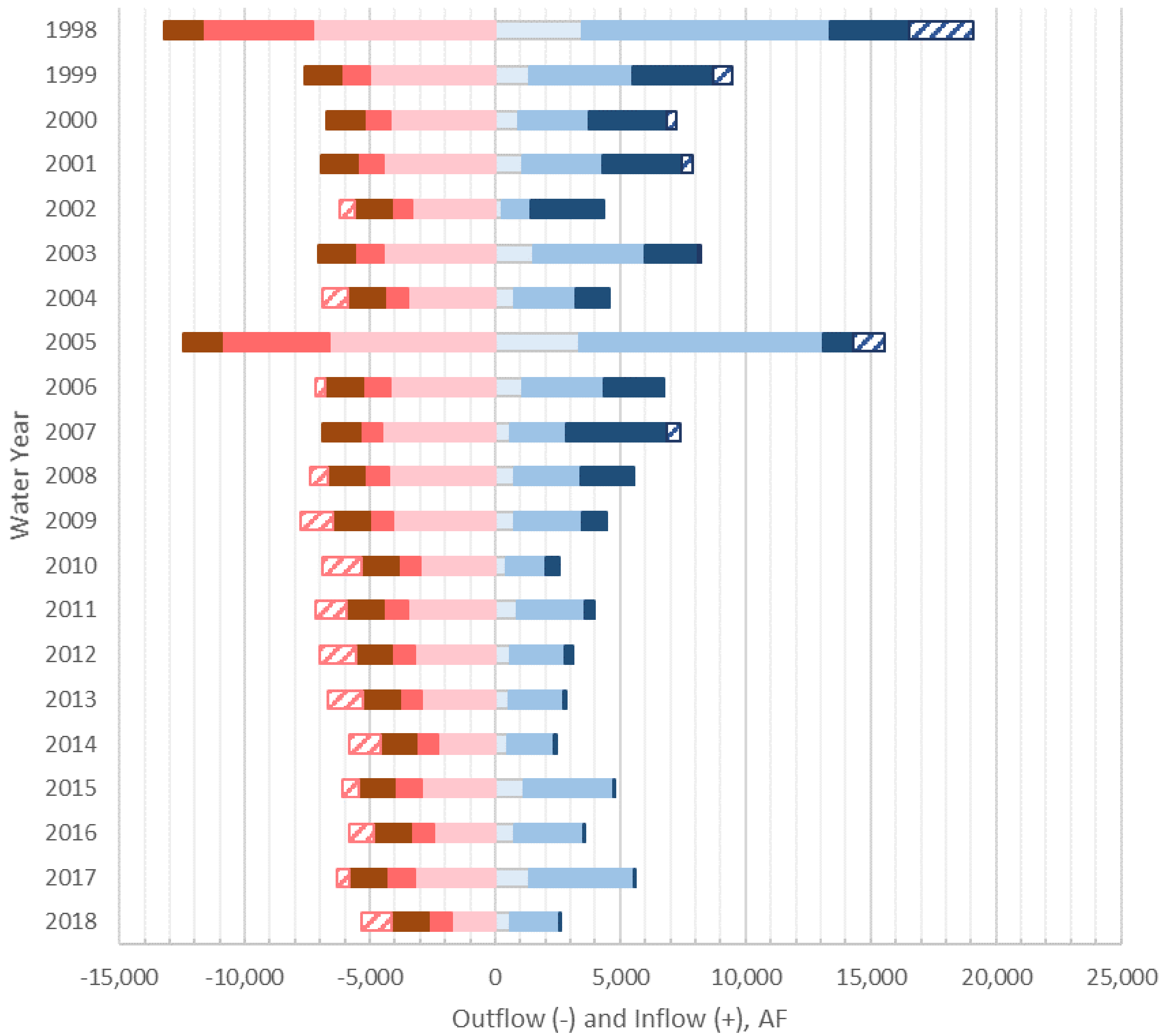
Summary of Current Groundwater Inflows and Outflows, WY 2018

DRAFT

eki environment & water

Tejon-Castac Water District
Kern County, California
June 2020
B800048.00

Figure WB-14



Legend

Inflows

Surface Water Inflow

Precipitation

Subsurface GW Inflow

Outflows

Evapo-transpiration, Evaporation, & Consumptive Use

Surface Water Outflow

Subsurface GW Outflow

Change in Groundwater Storage

Gain in GW Storage

Reduction in GW Storage

Abbreviations

AF = acre-feet
GW = groundwater

Notes

1. Water Year is defined as the October of the previous year through September of the current year.
2. A positive volume corresponds to an inflow and a negative volume corresponds to an outflow.

Annual Surface Water and Groundwater Inflows and Outflows to the Water Budget Domain

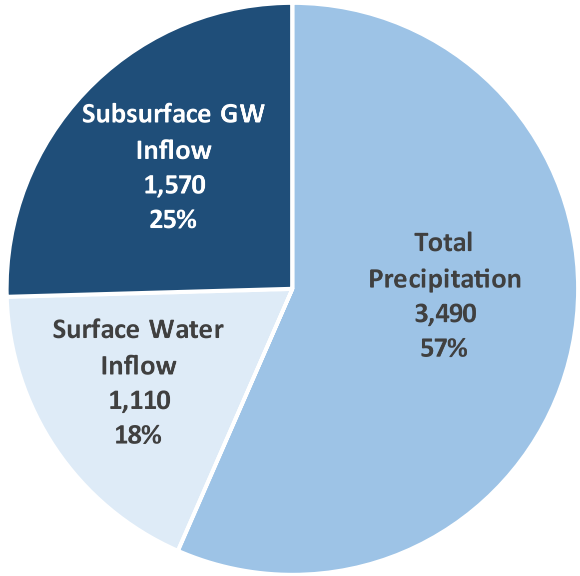
DRAFT

Tejon-Castac Water District
Kern County, California
June 2020
B800048.00

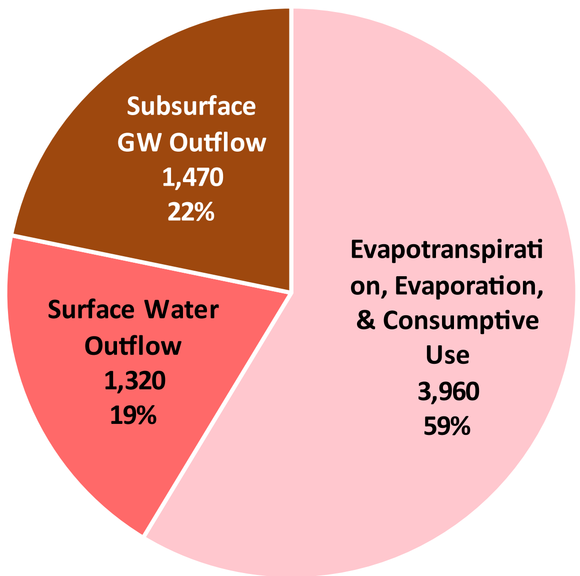
eki environment & water

Figure WB-15

Average Annual Inflows: 6,170 AFY



Average Annual Outflows: 6,750 AFY



Abbreviations

AFY = acre-feet per year
GW = groundwater

Notes

1. All values are reported in AFY.

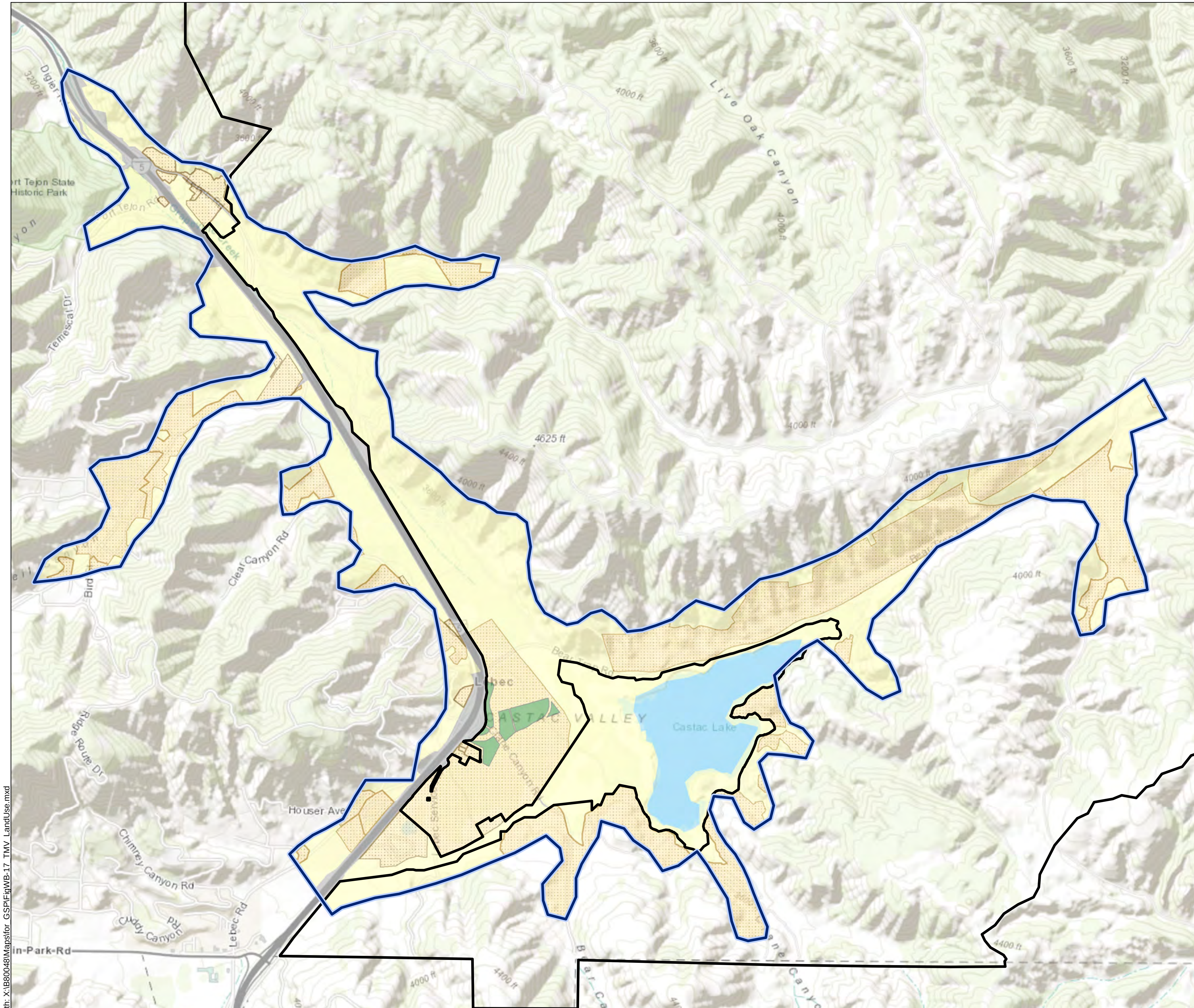
Summary of Historical Surface Water and Groundwater Inflows and Outflows to the Water Budget Domain, WY 1998-2017

DRAFT

eki environment & water

Tejon-Castac Water District
Kern County, California
June 2020
B800048.00

Figure WB-16



Legend

- Castac Lake Valley Groundwater Basin
- TMV Boundary

Future Land Use

- Roads
- Lake
- Residential & Commercial
- Range/ Undeveloped Land
- Irrigated Land

Abbreviations

DWR = Castac Basin Groundwater Flow Model
TMV =Tejon Mountain Village

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 23 April 2020.
3. Future land use data from TCWD, obtained 14 June 2019.

N

0 0.5 1

(Scale in Miles)

DRAFT

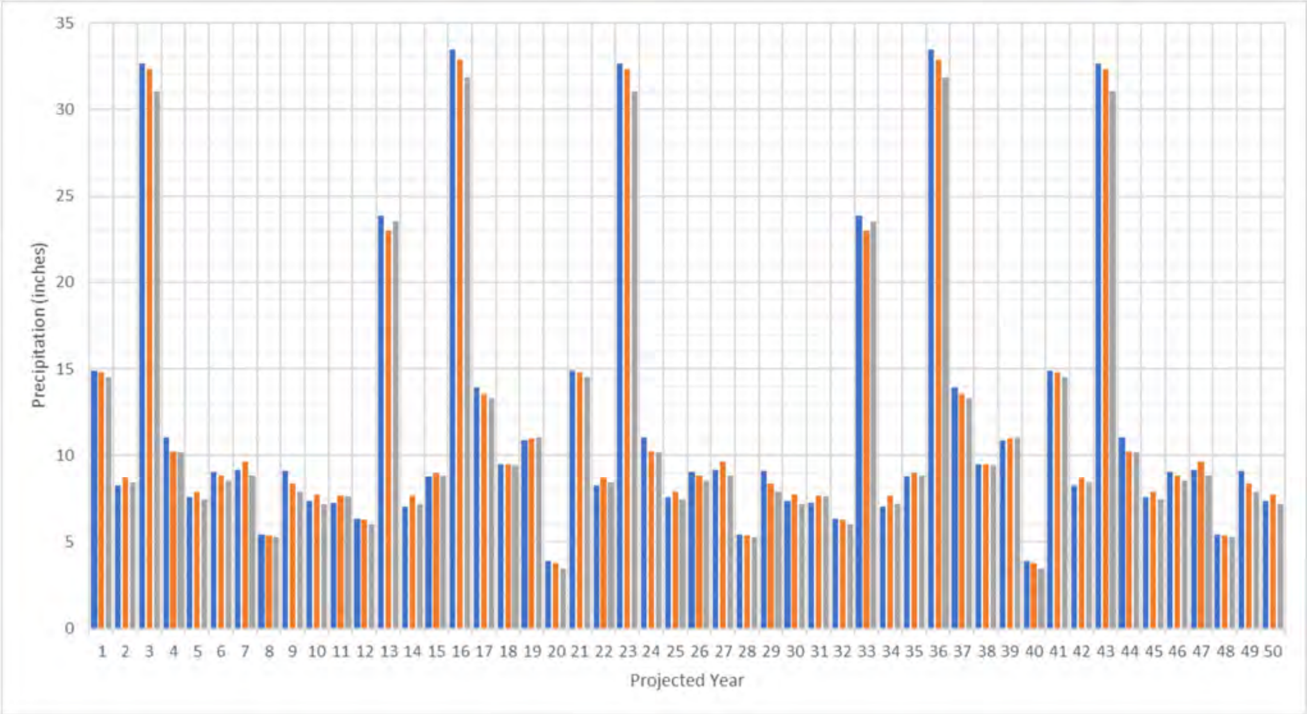
Projected Land Use for TMV Development Scenario

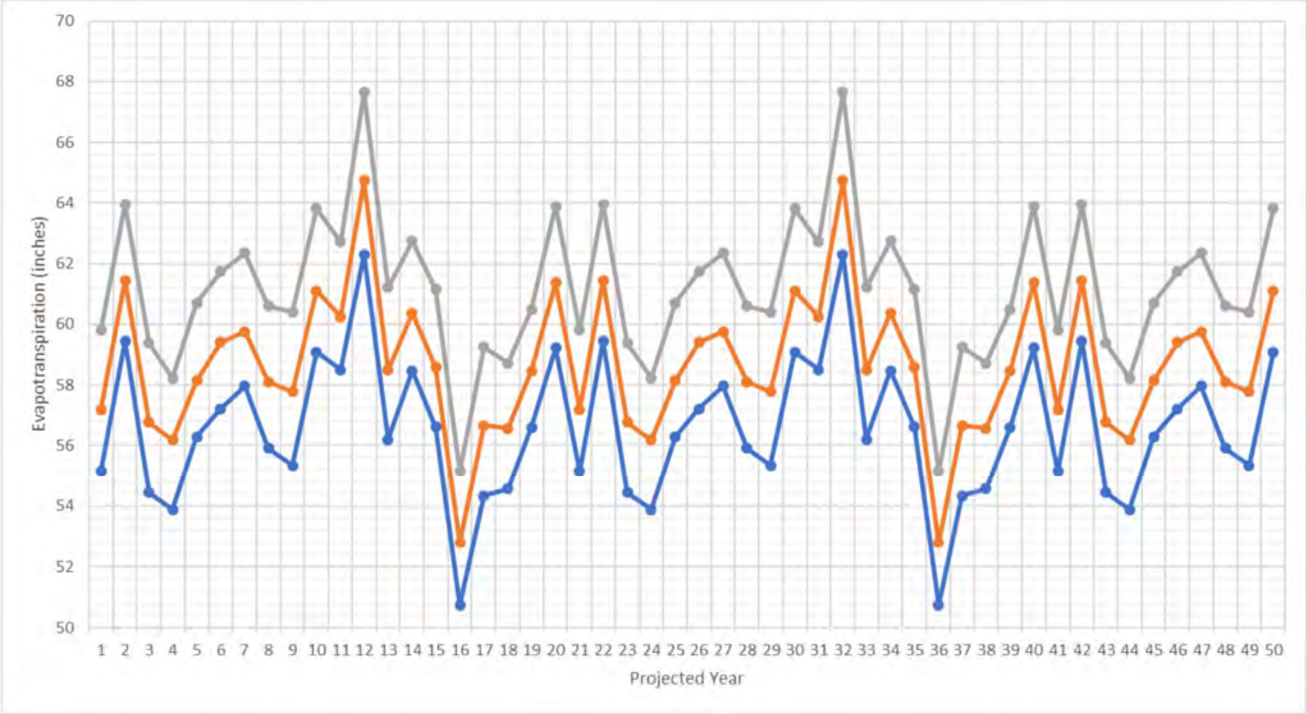
Tejon-Castac Water District
Kern County, CA
June 2020
B80048.00

eki environment & water

Figure WB-17

Path: X:\B80048\Maps\for GSP\FigWB-17 TMV LandUse.mxd





Legend

Projected Scenario

- Baseline
- 2030 Climate Change
- 2070 Climate Change

Notes

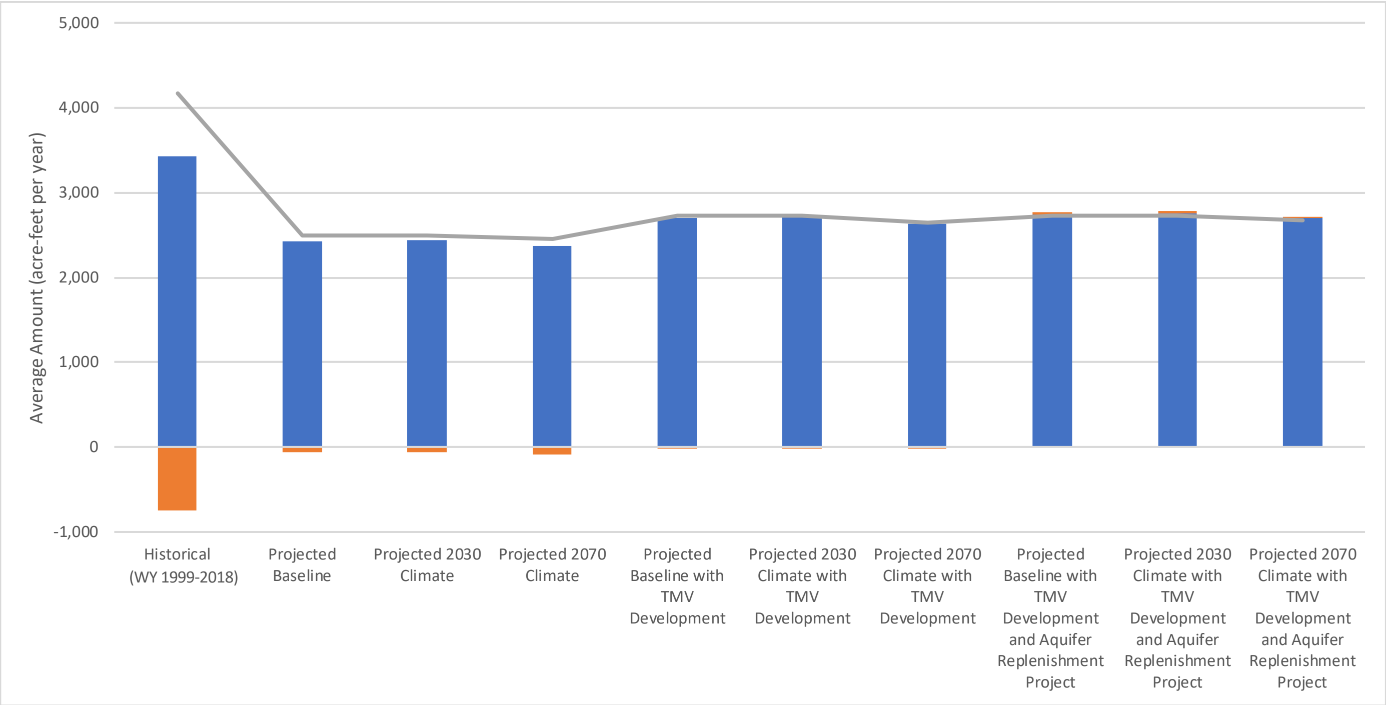
1. Precipitation and evapotranspiration were scaled using climate change factors provided by the California Department of Water Resources.

DRAFT

eki environment & water

Precipitation and Evapotranspiration Inputs for Project Scenarios

Castac Basin GSA
Kern County
June 2020
B80048.00
Figure WB-18



Legend

- Supply
- Storage Change
- Demand

Abbreviations

TMV = Tejon Mountain Village
WY = Water Year

Notes

1. Historical water budget values presented are from the Castac Basin Numerical Model for consistency with Projected water budget values. The period shown is different than the historical water budget period presented in Section 9.3.2 Historical Water Budget (i.e., WYs 1998-2017).

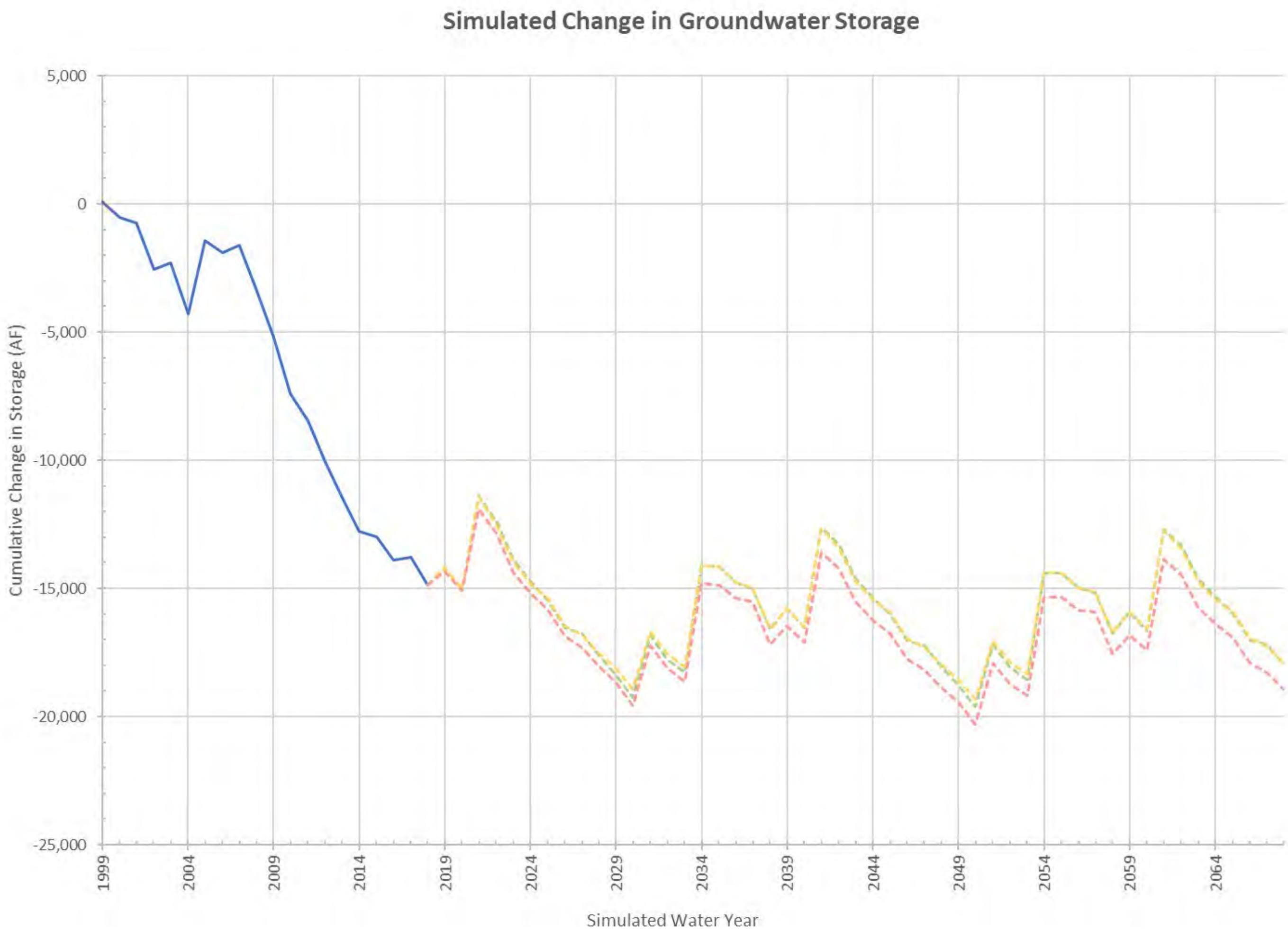
Projected Water Budget Supplies and Demands

DRAFT

eki environment & water

Tejon-Castac Water District
Kern County, California
June 2020
B800048.00

Figure WB-19



Legend

= Historical Simulation

= Baseline Scenario

= 2030 Climate Change Scenario

= 2070 Climate Change Scenario

Abbreviations

AF = acre-feet

TMV = Tejon Mountain Village

Notes

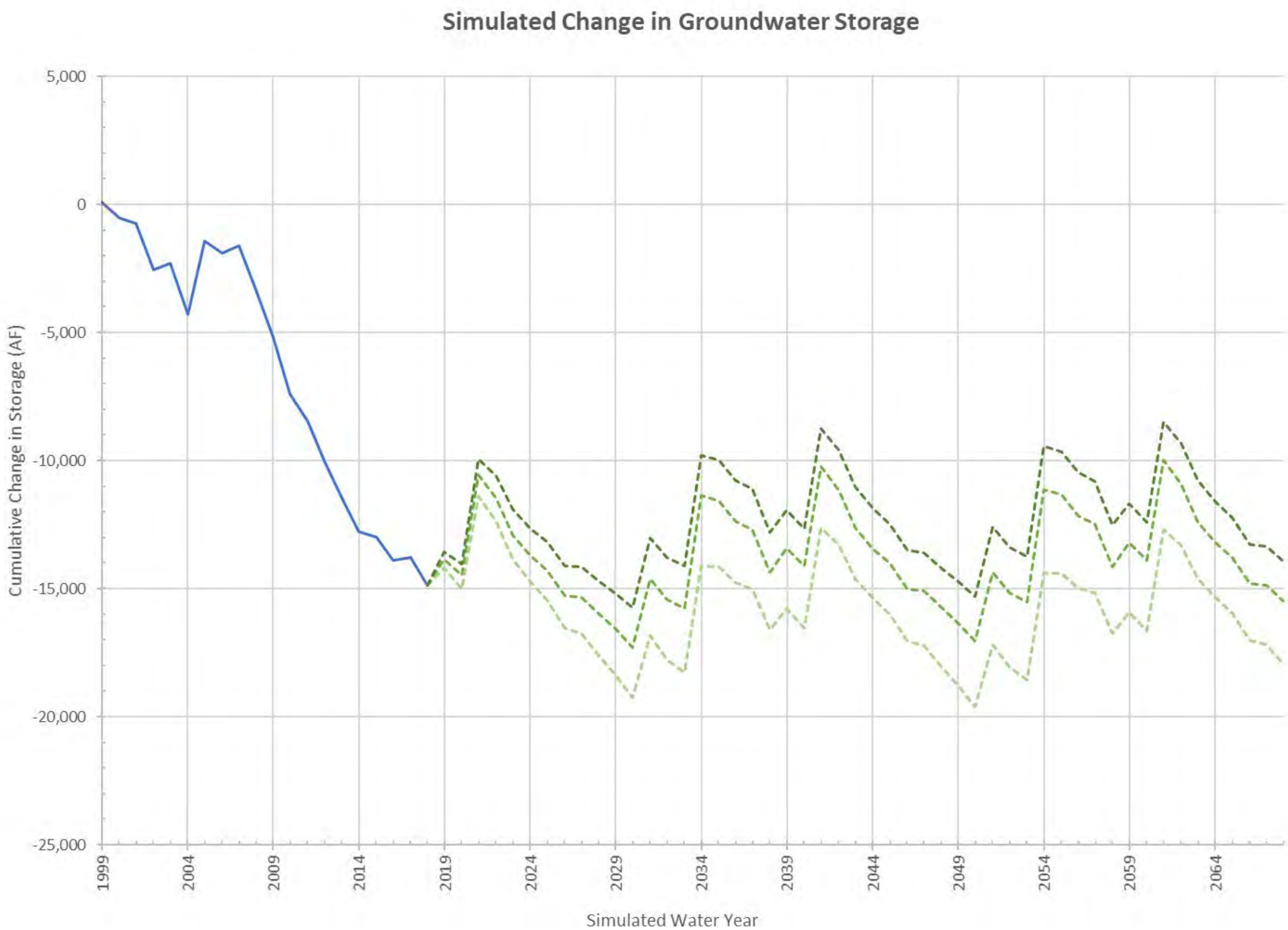
1. Scenarios shown represent Baseline (i.e., historical) land use under various climate change conditions

eki environment & water

Projected Change in Groundwater Storage for Baseline, 2030 Climate, and 2070 Climate Scenarios

Tejon-Castac Water District
Kern County, California
June 2020
EKI B80048.00

Figure WB-20



Legend
- = Historical Simulation
- = Baseline Scenario
- = TMV Development Scenario
- = TMV Development with Aquifer Replenishment Scenario

Abbreviations

AF = acre-feet

TMV = Tejon Mountain Village

Notes

1. Scenarios shown represent various future development scenarios under Baseline climate conditions.

eki environment & water

Projected Change in Groundwater Storage for Baseline, TMV Development, and TMV Development with Aquifer Replenishment Scenarios

Tejon-Castac Water District
Kern County, California
June 2020
EKI B80048.00

Figure WB-21

10.MANAGEMENT AREAS (AS APPLICABLE)

§ 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.

The Castac Basin Groundwater Sustainability Agency (GSA) is not considering Management Areas at this time.

SUSTAINABLE MANAGEMENT CRITERIA

11. INTRODUCTION TO 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.

The Sustainable Groundwater Management Act (SGMA) legislation defines a "Sustainability Goal" as "the existence and implementation of one or more groundwater sustainability plans [GSPs] that achieve sustainable groundwater management by identifying and causing the implementation of measures targeted to ensure that the applicable basin is operated within its sustainable yield" (California Water Code [CWC] § 10721(u)). SGMA requires Groundwater Sustainability Agencies (GSAs) to develop and implement GSPs to meet the Sustainability Goal (CWC § 10727(a)) and defines terms related to achievement of the Sustainability Goal, including:

- Interim Milestone (IM) – "a target value representing measurable groundwater conditions, in increments of five years, set by an Agency as part of a Plan" (Title 23, California Code of Regulations (23 CCR §351(q))
- Measurable Objective (MO) – "specific, quantifiable goals for the maintenance or improvement of specified groundwater conditions that have been included in an adopted Plan to achieve the sustainability goal for the basin" (23 CCR §351(s)); and
- Minimum Threshold (MT) – "a numeric value for each sustainability indicator used to define undesirable results" (23 CCR §351(t)).

Collectively, the Sustainability Goal, IMs, MOs, and MTs are referred to herein as Sustainable Management Criteria (SMCs).

The GSP Emergency Regulations specify how GSAs must establish SMCs for each applicable Sustainability Indicator. Sections *12, 13, 14*, and *15* of this GSP describe the Sustainability Goal, Undesirable Results, MTs, and MOs, respectively, developed as part of this GSP.

12. SUSTAINABILITY GOAL

> *§ 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.*

The Sustainable Groundwater Management Act (SGMA) requires that a Sustainability Goal be defined for the Basin (CWC §10727(a)), and the Groundwater Sustainability Plan (GSP) Emergency Regulations further clarify that the sustainability goal "culminates in the absence of undesirable results within 20 years of the applicable statutory deadline" (23 CCR §354.24).

The Sustainability Goal of the Castac Basin GSA (Water Code §10721(u)) is to cooperatively manage groundwater sustainably in the Basin to support current and future beneficial uses of groundwater (including municipal, agricultural, industrial, public supply, domestic, and environmental uses) and to avoid undesirable results throughout the planning horizon.

Groundwater recharge, movement, and storage in the Basin are primarily controlled by natural factors such as precipitation, temperature, and physical characteristics (e.g., geology and topography), which cannot be changed at the Basin scale. Nonetheless, the goal of Castac Basin GSA's projects and management actions will be to maintain groundwater storage in the Basin to the extent possible, in order to supply beneficial uses and users of groundwater.

13. UNDESIRABLE RESULTS

§ 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.

(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.

(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.

(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.

(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.

(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.

This section describes SGMA Undesirable Results for the Castac Lake Valley Groundwater Basin (Basin). Undesirable Results are defined in SGMA as "when significant and unreasonable effects for any of the sustainability indicators are caused by groundwater conditions occurring throughout the basin."

13.1. Undesirable Results for Chronic Lowering of Groundwater Levels

Undesirable Results for Chronic Lowering of Groundwater Levels are "if groundwater levels fall below the Minimum Threshold (MT) for Chronic Lowering of Groundwater Levels in any two representative monitoring wells for four consecutive semi-annual monitoring events."

13.1.1. Potential Causes of Undesirable Results

Potential causes of Undesirable Results due to Chronic Lowering of Groundwater Levels include increased pumping and/or reduced recharge, which in the Castac Basin is heavily influenced by natural climatic conditions.

Because the primary use of Basin groundwater is for municipal, domestic, and irrigation purposes, increased groundwater pumping could be driven by increases in the groundwater-dependent population, or an increase in the acreage of groundwater-irrigated agriculture.

A more significant impact to the Basin is reduced recharge, which is heavily influenced by climatic conditions. Reduced recharge could occur due to curtailed groundwater inflows from upgradient Cuddy Canyon Basin, or climate change that results in decreased precipitation and increased evapotranspiration (ET), as discussed in Section *9.4 Projected Water Budget*.

13.1.2. Criteria Used to Define Undesirable Results

Per Section 354.26(b)(2) of the GSP Emergency Regulations, the description of Undesirable Results must include a quantitative description of the number of MT exceedances that constitute an Undesirable Result. As detailed below in Section *14.1 Minimum Threshold for Chronic Lowering of Groundwater Levels* and shown on **Figure SMC-1**, MTs for groundwater levels have been established at three Representative Monitoring Wells (RMWs) in the Basin, based on historical trends observed over the 10-year period between DWR Water Years 2008 and 2018. This period includes the worst drought conditions on record, and the MTs were calculated assuming that these severe conditions continued unabated through 2038 (i.e., they project a "worst case scenario" that does not duplicate observed longer-term historical variation in conditions). An Undesirable Result for Chronic Lowering of Groundwater Levels would be identified if the MT is exceeded in any two of the three RMWs over four consecutive semi-annual monitoring events.

13.1.3. Potential Effects of Undesirable Results

The potential effects of Undesirable Results caused by Chronic Lowering of Groundwater Levels on beneficial uses and users of groundwater in the Basin may include interference with groundwater production from supply wells, increased pumping lift, and even potential dewatering of supply wells. Periodic well dewatering can lead to increased maintenance costs (e.g., well redevelopment, screen cleaning, pump lowering, or even well deepening or replacement) and reduced well lifespan due to corrosion of well casings and screens. Increased pumping lift results in reduced well efficiency (more energy use per unit volume of groundwater pumped) and corresponding higher pumping costs, as well as increased wear on well pumps and motors.

Other effects of Undesirable Results include lowering of groundwater levels below the root zone in areas with phreatophyte plant communities (i.e., groundwater dependent ecosystems or GDEs), which would adversely affect the biota living in these areas of shallow groundwater.

As detailed in Section *14.1.2 Well Impact Analysis* below, a Well Impact Analysis was conducted in which available well construction information was used to assess which wells would be partially or fully dewatered if groundwater levels decline to depth of MT of the closest RMW. If groundwater levels in the Basin decline to the MT values, no production wells would be fully dewatered; of the active wells with known well construction information, one irrigation well and two public supply wells would be partially dewatered.[46]

13.2. Undesirable Results for Reduction of Groundwater Storage

As discussed in more detail below, groundwater levels are used as proxy for measuring Undesirable Results for Reduction of Groundwater Storage. Therefore, the definition of Undesirable Results for Reduction of Groundwater Storage is the same as the definition of Undesirable Results for Chronic Lowering of Groundwater Levels, i.e., if groundwater levels fall below the MT for Chronic Lowering of Groundwater Levels in any two representative monitoring wells for four consecutive semi-annual monitoring events.

13.2.1. Potential Causes of Undesirable Results

Per Section 354.26(b)(1) of the GSP Emergency Regulations, Reduction of Groundwater Storage is generally correlated to Chronic Lowering of Groundwater Levels. Therefore, the potential causes of Undesirable Results due to Reduction in Groundwater Storage are generally the same as the potential causes listed above for Undesirable Results due to Chronic Lowering of Groundwater Levels (i.e., increased groundwater pumping and reduced recharge) and are predominantly influenced by climatic conditions in this Basin.

13.2.2. Criteria Used to Define Undesirable Results

Per Section 354.26(b)(2) of the GSP Emergency Regulations, the criteria used to define Undesirable Results for Reduction of Groundwater Storage generally are consistent with the criteria used to define Undesirable Results for Chronic Lowering of Groundwater Levels. Put simply, it would be considered significant and unreasonable (i.e., an Undesirable Result) if groundwater storage were to be reduced by an amount that would cause the groundwater levels at any two RMWs to exceed their MT for Chronic Lowering of Groundwater Levels over four consecutive semi-annual monitoring events. As such, the criteria set for Chronic Lowering of Groundwater Levels are "protective" and a reasonable proxy.

13.2.3. Potential Effects of Undesirable Results

The primary potential effect of Undesirable Results caused by Reduction of Groundwater Storage on beneficial uses and users of groundwater in the Basin would be reduced groundwater supply reliability, which would be most significant during periods of drought. As discussed in Section *9.2 Water Budget Results* and shown in **Table WB-9**, the groundwater system is highly sensitive to

[46] For purposes of the well impact analysis, the depth to groundwater at the Minimum Threshold in the nearest Representative Monitoring Well is used as a proxy depth to water in the supply well. A well is identified as partially dewatered if the MT is below the mid-point of the well screen interval and fully dewatered if the MT is below the bottom of the well screen. The perforated screened intervals for three public supply wells are unknown, however the pump intake depth is known for two public supply wells. If this depth to water at the projected MT is below the supply well's pump intake depth, the well is classified as partially dewatered.

climate conditions where water level response is directly related to precipitation, and a severe multi-year drought over the period of Water Years 2007-2016 caused increasingly evident reduction in groundwater storage.

13.3. Undesirable Results for Seawater Intrusion

The GSP Emergency Regulations state that “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” (23-California Code of Regulations [CCR] § 354.26(d)). Because the Basin is not located near any saline water bodies, seawater intrusion is not considered a threat to Basin groundwater resources, and no Undesirable Results for this Sustainability Indicator are defined in the Basin.

13.4. Undesirable Results for Degraded Water Quality

As discussed in more detail in Section *14.4 Minimum Threshold for Degraded Water Quality*, only limited groundwater quality data are available to assess the relationship between water quality and water levels in the Basin. Furthermore, water management actions available to the Castac Basin GSA (e.g., pumping restrictions) may have little effect on groundwater quality conditions within the Basin. Consequently, Undesirable Results for Degraded Water Quality have not been defined in this GSP.

If in the future the Castac Basin GSA initiates one or more projects, or if significant and unreasonable reductions in water quality occur and are determined to be related to water management actions available to the GSA, the criteria for development of Undesirable Results for Degraded Water Quality will be revisited as part of the next five-year GSP update.

13.4.1. <u>Potential Causes of Undesirable Results</u>

Potential causes of Undesirable Results due to Degraded Water Quality include the addition of constituents of concern (COCs) to groundwater in the principal aquifer through processes related to water management or land use activities. These potential processes include:

- Deep percolation of saline water associated with Castac Lake or its lakebed sediments. Potential COCs include total dissolved solids (TDS);
- Deep percolation of precipitation that mobilizes naturally occurring COCs such as uranium and fluoride;
- Deep percolation through shallow point-source contamination sites, although there currently are no known active contamination sites within the Basin; and

- Subsurface inflows from upgradient areas with degraded water quality (e.g., Lebec Sanitary Landfill, located upgradient of the Basin). Potential COCs include chlorinated solvents, nitrate and TDS.

13.4.2. Criteria Used to Define Undesirable Results

The State Water Resources Control Board's (SWRCB) Division of Drinking Water regulates the quality of water served by the public water systems in the Basin and the water quality criteria under which that program operates, i.e., State or Federal Maximum Contaminant Levels (MCLs). The authority of the SWRCB is not superseded by SGMA.

As discussed in Section *8.5 Groundwater Quality Concerns* and shown by the groundwater level hydrographs and groundwater quality chemographs (water chemistry time-series graphs) included in Appendix *E*, a Mann-Kendall trend analysis suggests some wells have statistically-significant[47] increasing or decreasing water quality trends for certain constituents. Among the 15 pairs of water level elevation and water quality constituent concentrations examined, three show statistically significant decreasing trends for nitrate, fluoride, or uranium, and seven wells show statistically significant increasing trends for nitrate, uranium, arsenic, or TDS.

Evaluation of the available water level and water quality data also show that some wells show a moderate correlation between water levels and certain water quality constituent concentrations, some show no correlation, and most wells have insufficient data to conduct statistical analyses.[48]

Water quality is not a primary focus for Undesirable Results in this GSP because: (1) very limited concurrent groundwater elevation and water quality concentration data exist for many of the wells in the Basin; (2) concentrations of potential COCs except TDS[49] remain below MCLs in most wells; and (3) except nitrate, potential COCs include TDS, uranium, and arsenic, all of which are naturally-occurring.

Additional data collection and analysis will be needed to discern the potential relationship between water management, water levels, and water quality, as discussed in more detail in Section *16.1.4 Monitoring Network for Degraded Water Quality*. Therefore, based on the existing and potential beneficial uses and users of groundwater within the Basin, Undesirable Results for Degraded Water Quality are not defined for the Basin. In the meantime, water quality issues related to drinking water will continue to be regulated by the SWRCB.

---

[47] A trend identified from the Mann-Kendall test with p-value that is less or equal to 0.05 is considered to be significant for purposes of this analysis.

[48] Wells were considered for statistical analysis only when four or more water quality analyses were available for the well, starting no earlier than 1998.

[49] TDS concentrations have exceeded the secondary recommended MCL of 500 milligrams per liter (mg/L) in some wells during recent sampling events, but all concentrations remain below the secondary upper MCL of 1,000 mg/L (*Appendix E*)

13.4.3. Potential Effects of Undesirable Results

Per Section 354.26(b)(3) of the GSP Emergency Regulations, potential effects of Undesirable Results must be identified. The potential effects of Undesirable Results caused by Degraded Water Quality on beneficial uses and users of groundwater may include: increased costs to treat groundwater to drinking water standards if it is to be used as a potable supply source; increased costs to blend relatively poor-quality groundwater with higher quality sources for drinking water users; or increased costs to procure and provide alternative potable water supplies.

As discussed in Section *16.1 Description of Monitoring Network*, the Castac Basin GSA will assemble, incorporate, and analyze water quality sampling from public water systems reported to the SWRCB Division of Drinking Water in future SGMA reporting (i.e., Annual Reports and GSP updates). Furthermore, select monitoring wells throughout the Grapevine Canyon will be sampled for select water quality constituents to establish a current baseline condition. If and when project(s) are being developed, the Castac Basin GSA will revisit defining SMCs for Degraded Water Quality, if deemed necessary.

13.5. Undesirable Results for Land Subsidence

The GSP Emergency Regulations state that "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" (23-CCR § 354.26(d)). As discussed in Section *8.6 Land Subsidence*, no known occurrences of significant impacts due to land subsidence have been measured within the Basin. Given the geologic and stratigraphic characteristics of the Basin, which appears to lack thick clay layers in which declining water levels could cause irreversible compaction, land subsidence is unlikely to occur in the Basin. The Land Subsidence Sustainability Indicator is therefore not applicable to the Basin and no Undesirable Results for this Sustainability Indicator are defined in the Basin.

13.5.1. Potential Causes of Undesirable Results

Per Section 354.26(b)(1) of the GSP Emergency Regulations, land subsidence can be caused by several mechanisms, but the mechanism most relevant to sustainable groundwater management is the depressurization of aquifers and aquitards due to lowering of groundwater levels, which can lead to compaction of compressible strata and lowering of the ground surface. Therefore, the potential causes of Undesirable Results due to Land Subsidence are generally the same as the potential causes listed above for Undesirable Results due to Chronic Lowering of Groundwater Levels. However, as discussed above, the geologic and structural properties of the Basin are such that land subsidence will most likely not occur in the future.

13.5.2. Potential Effects of Undesirable Results

Per Section 354.26(b)(3) of the GSP Emergency Regulations, potential effects of Undesirable Results caused by land subsidence on beneficial uses and users of groundwater and overlying land uses could include damage to above-ground and near-surface infrastructure, such as water conveyance channels, gas and petroleum pipelines, municipal water lines, etc. Potential effects could also include damage to below-ground infrastructure including groundwater well casing and surface appurtenances. As discussed above, no instances of impacts due to land subsidence have occurred within the Basin. Furthermore, the geologic and structural properties of the Basin are such that land subsidence will most likely not occur in the future. Therefore, although no Undesirable Results for Land Subsidence are defined, the potential effects from this Sustainability Indicator are minimal to non-existent for the Basin.

13.6. Undesirable Results for Depletions of Interconnected Surface Water

As discussed in Section *8.7 Interconnected Surface Water Systems*, potential seasonally-interconnected surface water systems within the Basin include Cuddy Creek, Grapevine Creek, and Castac Lake, all of which are ephemeral under natural conditions (i.e., streamflows and open water in the lake are brief and generally occur following a rainfall event). Since 2012, Castac Lake has been mostly dry, accumulating intermittent seasonal shallow water during some precipitation events.

The Undesirable Result associated with depletion of interconnected surface water in the Basin is the possible loss of GDE habitat. The Nature Conservancy (TNC) provides a map of Natural Communities Commonly Associated with Groundwater (NCCAG) for GSAs to identify potential GDEs (TNC, 2018). **Table GWC-*6*** summarizes the maximum estimated rooting depths of plants within the NCCAG dataset located in the Basin, based on data compiled by TNC[50]. As discussed in Section *8.8 Groundwater Dependent Ecosystems (GDEs)*, groundwater depths near these mapped potential GDEs in the Grapevine Canyon area of the Basin may vary over historical and projected future periods near the range of estimated maximum GDE rooting depths (**Table GWC-*6***; **Figure GWC-16**).

Most of the Castac Basin land identified as potentially hosting GDEs currently is covered in grasses and other presumably shallow-rooted plants. As described in Section 9.4.3, prior work by EKI (2008b) estimated a 90% cumulative rooting depth of approximately 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 Castac Basin Numerical Model, and it is significantly less than TNC estimated maximum rooting depths shown in **Table GWC-*6***. Further, the depth to groundwater measured in shallow wells near these

[50] TNC, 2018, *Maximum-rooting depth database.* The Nature Conservancy (https://groundwaterresourcehub.org/sgma-tools/gde-rooting-depths-database-for-gdes/), published 19 April 2018.

potential GDEs ranges from less than 15 ft bgs to 30 ft bgs or deeper (**Figure GWC-16**). Thus, most of the existing plant community in the Basin (particularly outside of the Grapevine Canyon area) likely uses limited groundwater under recent and current conditions. Ephemeral communities of phreatophytes may colonize areas of shallow groundwater in wet years, and become dormant or die out in dry periods, as has occurred in the past.

Based on the above analysis, the 3-ft bgs rooting depth specified in the Castac Basin Numerical Model is more likely to be appropriate for the grasses and shrubs currently growing in much of the GDE areas identified in the Basin, thus, its use likely provides a more accurate estimate of the Basin water budget and storage parameters.

As discussed in more detail in Section *14.6.1*, the MT for Chronic Lowering of Groundwater Levels in RMW TRC-MW23D and the Grapevine Canyon area of the Basin was determined through projection of recent groundwater level trends (2008 - 2018) observed in that well. Using this method, the MT is 28 ft bgs, below the maximum rooting depth of potential GDEs in this area (**Table GWC-*6***). Direct water level measurements in well TRC-MW23D indicate that local groundwater levels measured in wells within the Grapevine Canyon area have historically varied between zero and approximately 24 ft bgs. The longer-term historical low water level in well TRC-MW23D is estimated at 26 ft bgs[51], but this estimate is uncertain, due to its extrapolation back in time several decades.

The MTs are considered a minimum management limit for water levels. The GSA will strive to maintain water levels at the Measurable Objective (MO), which is approximately eight feet higher than the MT in the Grapevine Canyon area of the Basin (i.e., 20 ft bgs). Finally, in severe droughts, some GDEs can adapt to lowering groundwater levels depending on the speed, magnitude, and longevity of the drought stress endured (Rohde et al., 2019).

Given that (a) significant variability exists in the areal distribution of GDEs in the Basin, (b) the relationship between groundwater elevation and impacts to potential GDEs is uncertain, and (c) the interconnected surface water systems within the Basin are most greatly affected by variations in natural conditions, the MT for Chronic Lowering of Groundwater Levels is assumed to be protective of potential GDEs in the Basin. As such, Undesirable Results for Depletions of Interconnected Surface Water is not currently defined, and the criteria set for Chronic Lowering of Groundwater Levels are assumed to be "protective" and a reasonable proxy.

13.6.1. Potential Causes of Undesirable Results

Depletion of Interconnected Surface Water generally correlates with Chronic Lowering of Groundwater Levels in an interconnected groundwater aquifer system. Therefore, the potential

[51] The historical low is estimated by correlation of water levels in TRC-MW23D with water levels in supply well TRC-PW56A (the Basin well with the longest data record).

causes of these Undesirable Results are generally the same as the potential causes listed above for Undesirable Results due to Chronic Lowering of Groundwater Levels (i.e., increased groundwater pumping and reduced recharge) which are heavily influenced by climatic conditions in this Basin.

13.6.2. Criteria Used to Define Undesirable Results

Per Section 354.26(b)(2) of the GSP Emergency Regulations, the description of Undesirable Results must include a quantitative description of the combination of MT exceedances that constitute an Undesirable Result. The criteria used to define Undesirable Results for Depletions of Interconnected Surface Waters are the same criteria used to define Undesirable Results for Chronic Lowering of Groundwater Levels (Section 13.1), given the correlation between the two phenomena. As such, the criteria set for Chronic Lowering of Groundwater Levels are "protective" and a reasonable proxy.

13.6.3. Potential Effects of Undesirable Results

Potential effects of Undesirable Results of Depletions of Interconnected Surface Water may include reduced surface water flows to support downstream or in-stream uses. Furthermore, reduced surface water flows may impact environmental users, such as GDEs or freshwater species dependent on interconnected surface waters.

13.7. Undesirable Results Summary

Table SMC-1 below provides a summary of the Undesirable Results definitions for each Sustainability Indicator.

Table SMC-1. Summary of Undesirable Results Definitions

Sustainability Indicator	Undesirable Results Definition
Chronic Lowering of Groundwater Levels	If groundwater levels decline below the MT in any two Representative Monitoring Wells (RMWs) for four consecutive semi-annual sampling events.
Reduction of Groundwater Storage	If groundwater storage is reduced by an amount that causes groundwater levels to decline below the MT in any two RMWs for four consecutive semi-annual sampling events (*Chronic Lowering of Groundwater Levels to be used as a proxy*).
Seawater Intrusion	No Undesirable Results definition. Not applicable to the Basin due to geographic distance from the ocean.

Sustainability Indicator	Undesirable Results Definition
Degraded Water Quality	No Undesirable Results definition. Limited historical water quality measurements are available and the relationship between water levels and water quality is not yet established.
Land Subsidence	No Undesirable Results definition. Not applicable to the Basin. No historical evidence of subsidence and geologic strata are unfavorable to inelastic deformation.
Depletion of Interconnected Surface Water	If groundwater levels decline below the MT in any two RMWs for four consecutive semi-annual sampling events; (*Chronic Lowering of Groundwater Levels used as a proxy*).

14. MINIMUM THRESHOLDS

§ 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.

(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.

(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.

(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.

(4) How minimum thresholds may affect the interests of beneficial uses and users of groundwater or land uses and property interests.

(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.

(6) How each minimum threshold will be quantitatively measured, consistent with the monitoring network requirements described in Subarticle 4.

…

(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.

(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.

Minimum Thresholds (MTs) are the numeric criteria for each Sustainability Indicator that, if exceeded, may cause Undesirable Results. Like The GSP Emergency Regulations (23-CCR § 354.28(c)) state that the MT for Depletions of Interconnected Surface Water “shall be the rate or volume of surface water depletions **caused by groundwater use** that has adverse impacts on beneficial uses of the surface water and may lead to undesirable results” (emphasis added).

14.1.1. Use of Groundwater Levels as Proxy

Pursuant to the GSP Emergency Regulations (23-CCR § 354.28(d)) and as further described in the DWR Sustainable Management Criteria BMP (DWR, 2017), MTs for Depletions of Interconnected Surface Water may be set by using groundwater levels as a proxy, if it can be demonstrated that MTs for Chronic Lowering of Groundwater Levels are sufficiently protective to ensure prevention of significant and unreasonable depletions of interconnected surface water.

Castac Lake is the most prominent surface water feature in the Basin, and based on shallow well data near the lake, during periods when the lake contains water it likely is interconnected to groundwater. As discussed in Section *9.2 Water Budget Results*, the analytical water budget simulates net gaining lake conditions in which groundwater inflow into the lake exceeds groundwater outflow from the lake during the WY 1998-2018 time period. Under unmanaged conditions, Castac Lake levels primarily are influenced by climate and not groundwater pumping. Since 2012, Castac Lake has been mostly dry, and groundwater elevations in 2018 were below the bottom of the Lake. Other potentially interconnected surface water features include Cuddy Creek and Grapevine Creek, however the flows in these are ephemeral under natural conditions, which means that flows are brief and generally occur following a rainfall event.

Potential groundwater dependent ecosystems (GDEs) are a less obvious feature of interconnected surface water. GDEs have been mapped in the Grapevine Canyon area of the Basin, where groundwater levels typically are shallower than the main Castac Lake area of the Basin. RMW TRC-MW23D is located in the Grapevine Canyon area of the Basin.

The MT for Chronic Lowering of Groundwater Levels considered the groundwater level trends observed in Grapevine Canyon well TRC-MW23D. Although that MT is set at 28 feet below ground surface (ft bgs), below the likely maximum rooting depth of potential GDEs in this area (i.e., 24 ft bgs; see **Table GWC-6**), groundwater levels in well TRC-MW23D historically have fluctuated between land surface and approximately 24 ft bgs, and the estimated maximum depth to groundwater in TRC-MW23D is 26 ft bgs. Groundwater levels thus are unlikely to decline to the MT depth of 28 ft bgs.

MTs also are considered a *minimum* that water levels should reach, and the GSA will strive to maintain water levels at the Measurable Objectives (MO) which are approximately eight (8) feet higher than the MT in the Grapevine Canyon area of the Basin (i.e., 20 feet bgs), as described in detail in Section 15.1 *Measurable Objective and Interim Milestones for Chronic Lowering of Groundwater Levels*.

As discussed above, in Section *13.6 Undesirable Results for Depletions of Interconnected Surface Water*, the relationship between groundwater elevation and impacts to the potential GDEs is uncertain, as (1) the mixture of different phreatophyte plants at a given time in a given area (and their specific rooting depths) is not well known, and some GDEs can adapt to lowering groundwater levels depending on the speed, magnitude, and longevity of the stress (Rohde et al., 2019), and (2) the interconnected surface water systems within the Basin are affected by variation in natural conditions and precipitation events. Given the observed shallow depths to groundwater in RMW TRC-MW23D, the known range of GDE plant rooting depths, and the maximum water depth allowed by the MTs for Chronic Lowering of Groundwater Levels and Depletion of Groundwater Storage, these MTs also are likely protective of the potential GDEs. MTs specific to Depletions of Interconnected Surface Water therefore are not developed at this time, and MTs for Chronic Lowering of Groundwater Levels are used as proxy.

Measurable Objectives (MOs) discussed in Section 15, this section describes the MTs that have been developed to avoid Undesirable Results for each applicable Sustainability Indicator.

As shown in **Table SMC-2**, MTs within the Basin are defined at representative monitoring wells (RMWs) for relevant Sustainability Indicators. Where appropriate, the MTs for the Sustainability Indicators have been set using groundwater levels as a proxy, based on the demonstration "that there is a significant correlation between groundwater levels and other metrics" (California Department of Water Resources [DWR], Sustainable Management Criteria Best Management Practice [BMP], 2017).

Table SMC-2. Spatial Scale of Minimum Threshold Definition

Sustainability Indicator	**Minimum Threshold Metric(s) defined in GSP Emergency Regulations (CCR § 354.28(c))**	**Sites for Minimum Threshold Compliance**
Chronic Lowering of Groundwater Levels	Groundwater elevation	Three RMWs
Reduction of Groundwater Storage	Total volume of groundwater	Three RMWs (*Chronic Lowering of Groundwater Levels used as a proxy*)
Seawater Intrusion	Chloride concentration isocontour	No MTs defined. Not applicable to the Basin.
Degraded Water Quality	- Number of supply wells - Volume of groundwater - Location of isocontour	No MTs currently defined. Water quality data will be analyzed to help establish a baseline prior to any project implementation
Land Subsidence	Rate and extent of land subsidence	No MTs defined. Not applicable to the Basin.
Depletion of Interconnected Surface Water	Rate or volume of surface water depletions	Three RMWs (*Chronic Lowering of Groundwater Levels used as a proxy*)

14.1. Minimum Threshold for Chronic Lowering of Groundwater Levels

§ 354.28. Minimum Thresholds

(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.
(B) Potential effects on other sustainability indicators.

Chronic Lowering of Groundwater Levels is arguably the most fundamental Sustainability Indicator, as it influences several other key Sustainability Indicators, including Reduction of Groundwater Storage, Land Subsidence, Depletions of Interconnected Surface Water, and in certain ways, Degraded Water Quality. Groundwater levels in wells also are the most readily measurable metrics of groundwater conditions, and their use allows for a systematic, data-driven approach to MT development. There are no state, federal, or local standards that relate to this Sustainability Indicator.

14.1.1. Minimum Threshold Development

Consistent with the Groundwater Sustainability Plan (GSP) Emergency Regulations (23-CCR § 354.28(c)), the definition of MTs for Chronic Lowering of Groundwater Levels is based on consideration of historical and projected future trends in groundwater levels, and estimated potential impacts to groundwater users. Three RMWs within the Basin (i.e., monitoring network wells which have been assigned sustainable management criteria) were selected for calculation of MTs: TRC-MW16D, TRC-MW18D, and TRC-MW23D (see **Figure SMC-1)**. These wells were selected based on their spatial location and depth, the completeness of their construction and water level records, and their proximity to public supply wells (see Section *16.1.1 Monitoring Network for Chronic Lowering of Groundwater Levels*).

Minimum Threshold Algorithm

The MT values for Chronic Lowering of Groundwater Levels were developed for each RMW as shown on **Figure SMC-1,** using a simple process:

- Historical water level data were compiled from a given RMW over the 10-year period from Water Year (WY) 2008 to WY 2018;
- A best-fit linear trend was calculated for that period;
- The trend was projected 10 years into the future (from WY 2018 to WY 2028) using the same slope, to establish the MO water level elevation; and

- The trend was projected further still, 20 years into the future (to 2038) using the same slope, to establish the MT water level elevation.

Water levels in all three RMWs declined over the 10-year historical period, so trends all were negative, varying from -0.79 feet per year (ft/yr) in TRC-MW23D in the Grapevine area of the Basin, to -7.56 ft/yr in TRC-MW16D in the main Basin, near the upgradient boundary.

Water Years 2008 through 2018 were used to determine the historical trend as a conservative measure. The period includes the recent significant drought (WY 2012 to 2016), and therefore allows the MT to incorporate the possibility of another long-term drought in the future (e.g., a drought potentially exacerbated by climate change). This period also contains the most complete, highest resolution set of water level data collected from wells within the Basin.

The 20-year period of trend projection used to determine the MT was considered realistic for implementation of various Projects and Management Actions (P&MAs), some of which the Castac Basin GSA already is proactively pursuing. Twenty years also is the statutory duration of the SGMA implementation period, suggesting that by the end of the SGMA implementation period, the Basin should have achieved the Sustainability Goal.

Figure SMC-1 shows historical and projected hydrographs, MOs, and MTs for the three RMWs in the Basin, including factors considered during formulation of Sustainable Management Criteria (SMCs), such as the bottom of the well casing, and estimated[52] historical low water levels over the period of record for the Basin (1956 - 2018), for comparison to the MOs and MTs. Generally, estimated historical low water levels in the RMWs were below the MOs but above the MTs. These estimated data may not be accurate, as they are based on water levels recorded in a pumping well (TRC-PW56A) that in some cases is located some distance away from the RMW in another part of the Basin.

MTs and MOs calculated using the method described above vary as a function of their recent historical declines, which themselves vary in different parts of the Basin. In general, water levels in the RMWs located within the Castac Lake area of the Basin had steeper observed declines and greater differences between MOs and MTs (called margins of operational flexibility), while the RMW located within the Grapevine Canyon area of the Basin experienced significantly less change in water levels and has a narrower range of margins of operational flexibility (i.e., 8 feet).

[52] Significant and unreasonable impacts to beneficial uses and users of groundwater are not known to have occurred when Basin groundwater levels were at historical lows. RMWs are relatively new wells in the Basin (installed in 2007) and thus have comparatively short records of groundwater elevation measurements. Assumed historical low water levels were estimated using a best-fit linear model between historical water levels in each RMW and those from well TRC-PW56A, which has the longest record of water level measurements in the Basin, starting in 1956. The historical low for TRC-PW56A occurred in Spring 1964, with groundwater elevation of 3,410 feet above mean sea level (i.e., 143 feet below ground surface). The estimated historical low water level elevations for RMWs are shown on Figure SMC-1, and the correlation coefficients between the RMWs and TRC-PW56A are 99% (TRC-MW16D), 99% (TRC-MW18D), and 67% (TRC-MW23D), respectively.

MT values for Chronic Lowering of Groundwater Levels at each RMW are summarized in **Table SMC-3**, below.

Table SMC-3. Minimum Thresholds for Chronic Lowering of Groundwater Levels

RMW Name	**Area**	**GSE** (ft msl)	**MT** (ft msl)	**MT** (ft bgs)
TRC-MW16D	Castac Lake	3,640	3,345	295
TRC-MW18D	Castac Lake	3,531	3,357	173
TRC-MW23D	Grapevine	3,376	3,348	28

Abbreviations:

ft bgs = feet below ground surface
ft msl = feet above mean sea level
GSE = ground surface elevation
RMW = Representative Monitoring Well
MT = Minimum Threshold

14.1.2. Well Impact Analysis

If water levels in the RMWs decline, water levels in other wells in the Basin generally also will decline. A preliminary analysis was performed to examine the potential repercussions on other Basin wells of water levels declining to their MTs in each RMW, using the simplifying assumption that the depth to groundwater in any given Basin well will be similar to the depth to water in the nearest RMW. These estimated water depths were plotted graphically with available well construction information for several domestic, irrigation, and public supply wells (**Figure SMC-2**) to assess the potential for dewatering of the wells at the MT groundwater elevations.

For this analysis, wells are identified as *partially dewatered* if the water level is equal to or below the midpoint of the well screened interval, and *fully dewatered* if the water level is equal to or below the bottom of the well screen. Only wells with available well construction information could be assessed using this method. In some instances, pump intake depth was used as a surrogate for well screen.

Results from this well impact analysis are shown on Figure SMC-2. If water levels reach MTs in the Basin RMWs, approximately 31% of Basin wells will be partially dewatered, and no wells will be fully dewatered. Thus, impacts of declining water levels down to MTs are not considered to be significant and unreasonable for purposes of SGMA. As their name suggests, MTs are considered a minimum that water levels should reach, and the GSA will strive to maintain water levels at or above the MOs, which are in all cases above the MTs[53], as described in Section *15.1 Measurable Objective and Interim Milestones for Chronic Lowering of Groundwater Levels*.

The LCWD-Lebec PW and LCWD-State PW public supply wells, which could experience partial dewatering if water levels drop to MTs[54], are more than 50 years old and have remained viable through large water level fluctuations over the historical period of record. Historical minimum water levels in these wells are above MTs, but they are similar to what would be anticipated under MT conditions. For example, LCWD-Lebec PW measured a historical groundwater elevation low of 3,406 ft msl in 1968, which is only one foot higher than the MT elevation calculated from the depth to MT from the nearest RMW (e.g., TRC-MW18D).

14.2. Minimum Threshold for Reduction of Groundwater Storage

> *§ 354.28. Minimum Thresholds*
>
> *(c) Minimum thresholds for each sustainability indicator shall be defined as follows:*
> *(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.*

Groundwater storage is directly related to the level of the water table or piezometric surface in the Basin, and storage properties of the aquifer. Section 13.2 discusses how Undesirable Results for Reduction of Groundwater Storage are linked to a decline of groundwater levels below the MTs established in each RMW for groundwater levels.

Similarly, the MT for Reduction of Groundwater Storage is related to the MT for Chronic Lowering of Groundwater Levels, in that the MT for groundwater levels can be used as a proxy for the groundwater storage MT. As discussed in more detail below, because MTs for groundwater levels discussed above are protective of the beneficial uses and users of groundwater, a unique MT for Reduction of Groundwater Storage is not necessary. There are no state, federal, or local standards that relate to this Sustainability Indicator.

14.2.1. Estimate of Total Storage Volume

To support the use of MTs for Chronic Lowering of Groundwater Levels as a proxy for Reduction of Groundwater Storage, it is informative to estimate the storage volume of the Basin.

[53] MOs are approximately 65 feet higher than the MTs in the Castac Lake part of the Basin, and eight feet higher than the MTs in the Grapevine Canyon area of the Basin.
[54] LCWD-Lebec PW and LCWD-State PW do not have known well perforated screened interval information, and therefore the pump intake depth in each well was used in the well impact analysis. If the depth to MT in the nearest RMW is below the supply well's pump intake depth, the well is classified as partially dewatered.

As discussed in Section *8.3 Change in Groundwater Storage*, the Basin storage volume was estimated as the product of the aquifer volume and the assumed specific yield of the aquifer sediments. Based on a summation of sub-volumes for portions of the irregularly shaped Basin, the total volume of the aquifer materials is preliminarily estimated to be approximately 465,000 acre-feet (AF). Using a 20% estimated total porosity[55] of the aquifer materials, the maximum aquifer storage volume is estimated to be approximately 93,000 AF.

A different approach using the Castac Basin Numerical Model provides an estimated groundwater storage volume in rough agreement with the above analysis. The total volume of aquifer materials estimated by the sum of active cells within the model equals 691,519 AF. Assuming 20% porosity yields an estimated maximum aquifer storage volume of approximately 138,000 AF, if the aquifer were completely full, but groundwater typically is some depth below land surface in most of the Basin. Groundwater elevation hydrographs using historical water level data in Basin wells generally indicate a maximum around March 2005. Using the model-calculated heads from that period, the maximum available aquifer storage volume works out to approximately 100,000 AF.

14.2.2. Use of Groundwater Levels as Proxy

The GSP Emergency Regulations (23-CCR § 354.28(d)) and the DWR Sustainable Management Criteria BMP (DWR, 2017) state that MTs for Reduction of Groundwater Storage may use groundwater levels as a proxy, if the MTs for Chronic Lowering of Groundwater Levels are sufficiently protective to prevent significant and unreasonable reductions in groundwater storage.

To test this hypothesis, an estimate was made of the groundwater volume lost from the principal aquifer if water levels were to decline from their respective MOs to MTs (for Chronic Lowering of Groundwater Levels), in order to consider the loss as a percentage of the total estimated storage. The Castac Basin Numerical Model was used to calculate the historical cumulative storage decline that occurred during a drought-related decline in groundwater levels.

Over the ten-year period between March 2008 and March 2018, approximate declines in water levels measured in RMWs include 79 feet in TRC-MW16D, 56 feet in TRC-MW18D, and 12 feet in TRC-MW23D. The cumulative storage decline over this period estimated using the Castac Basin Numerical Model was approximately 12,800 AF, representing approximately 13% of the total maximum aquifer storage. Because (a) this water level decline exerts a small effect (13% loss) on Basin groundwater storage, (b) this would be a temporary, drought-driven condition, and (c) such declines are similar to historical conditions within the Basin, it is assumed that the MTs for Chronic Lowering of Groundwater Levels are sufficiently protective to ensure prevention of

[55] This porosity estimate is consistent with general guidance (Heath, 1983) as well as local hydrogeologic investigations. Schmidt (2002) and Galli (2005) each used 20% porosity for storage estimates of similar aquifer materials in the upgradient Cuddy Canyon Basin.

significant and unreasonable occurrences of Reduction of Groundwater Storage, and the same SMCs defined for Chronic Lowering of Groundwater Elevations can be used for the Groundwater Storage Sustainability Indicator.

14.3. Minimum Threshold for Seawater Intrusion

§ 354.28. Minimum Thresholds

(c) Minimum thresholds for each sustainability indicator shall be defined as follows:
(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.
(B) A description of how the seawater intrusion minimum threshold considers the effects of current and projected sea levels.

The GSP Emergency Regulations state that "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" (23-CCR § 354.28(e)).

Because the Basin is located far inland, away from the ocean, seawater intrusion is not a threat to groundwater resources and the Seawater Intrusion Sustainability Indicator is not applicable. Thus, no SMCs for this Sustainability Indicator are defined in the Basin.

14.4. Minimum Threshold for Degraded Water Quality

§ 354.28. Minimum Thresholds

(c) Minimum thresholds for each sustainability indicator shall be defined as follows:
(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.

The GSP Emergency Regulations (23-CCR § 354.28(c)) state that the MT of Degraded Water Quality shall be the "degradation of water, 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 GSP Emergency Regulations further state that the MT "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", and that "the Agency shall consider local, state, and federal water quality standards applicable to the basin."

MTs for Degraded Water Quality have not been defined for Castac Basin, due to factors which are discussed in Section *13.4 Undesirable Results for Degraded Water Quality* and include the following:

- The powers granted to Groundwater Sustainability Agencies (GSAs) to effect sustainable groundwater management under SGMA generally revolve around managing the quantity, location, and timing of groundwater pumping and/or implementing recharge projects. Except for groundwater recharge projects, Castac Basin GSA water management actions are likely to have only limited effects on groundwater quality conditions within the Basin. Potential recharge projects may cause changes in groundwater quality by affecting mobility and concentration of various chemical species in complex ways. Until specific details of a given recharge project and the project site are well understood, the effect of any potential project on water quality is uncertain.
- Very limited concurrent groundwater elevation and water quality concentration data exist for many of the wells in the Basin. In fact, an evaluation of the available water level and water quality data show that (1) some wells do show a weak correlation between water levels and certain potential COCs concentrations, (2) some wells show no correction between water levels and potential COCs concentrations, and (3) most wells have insufficient data to conduct statistical analyses.[56]
- In most wells, concentrations for potential COCs except TDS remain below regulatory thresholds (i.e., Maximum Contaminant Levels or MCLs) and potential COCs except nitrate but including TDS, uranium, and arsenic, are naturally-occurring.
- Undesirable Results for Degraded Water Quality are not defined currently in this GSP.
- Water quality standards generally are developed and enforced by other agencies such as the State Water Resources Control Board Division of Drinking Water and Kern County.

As discussed further in Section *16 Monitoring Network*, the GSA will compile water quality data from public water systems supplemented with water quality sampling from selected monitoring wells to establish a water quality baseline in which future GSP updates can assess a change in water quality conditions. As discussed below in Section *17 Projects and Management Actions*, the GSA may re-evaluate defining Undesirable Results for Degraded Water Quality and establishing SMCs for Degraded Water Quality if additional data analyses indicate the need for

[56] Wells were considered for statistical analysis only when four or more water quality analyses were available for the well, starting no earlier than 1998.

Water Quality SMCs, or as appropriate, when the Castac Basin GSA begins implementing one or more projects.

Consideration of State, Federal, and/or Local Standards

The State of California and the U.S. Environmental Protection Agency (USEPA) set MCLs for constituents which may cause potential human health risks. MCLs are appropriate to consider when establishing MTs for Degraded Water Quality, but given the limited regulatory authority of GSAs with respect to water quality, at present no MTs for Degraded Water Quality are proposed for the Castac Basin. Furthermore, public supply wells in the Basin sample for constituents with established primary MCLs and, except for Fluoride, concentrations are below primary MCLs.

Basing SMCs on established drinking water quality criteria would appropriately meet the requirement to consider the beneficial uses and users of groundwater, if the Castac Basin GSA obtains new information in the future that suggests the need for MTs for Degraded Water Quality.

14.5. Minimum Threshold for Land Subsidence

§ 354.28. Minimum Thresholds

(c) Minimum thresholds for each sustainability indicator shall be defined as follows:

(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.

(B) Maps and graphs showing the extent and rate of land subsidence in the basin that defines the minimum threshold and measurable objectives.

The GSP Emergency Regulations state that MTs for land subsidence shall be supported by "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" (23-CCR § 354.28(c)).

The GSP Emergency Regulations also state that "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" (23-CCR § 354.28(e)).

As discussed above in Section *8.6 Land Subsidence*, available data show that land subsidence is not likely to be a significant concern in the Basin. Given the geologic and stratigraphic characteristics of the Basin (a lack of thick clay layers), land subsidence is not known to have occurred and is not likely to occur in the Basin in the future, thus no SMCs are defined herein for the Land Subsidence Sustainability Indicator.

14.6. Minimum Threshold for Depletions of Interconnected Surface Water

§ 354.28. Minimum Thresholds

(c) Minimum thresholds for each sustainability indicator shall be defined as follows:
(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.
(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.

The GSP Emergency Regulations (23-CCR § 354.28(c)) state that the MT for Depletions of Interconnected Surface Water "shall be the rate or volume of surface water depletions **caused by groundwater use** that has adverse impacts on beneficial uses of the surface water and may lead to undesirable results" (emphasis added).

14.6.1. Use of Groundwater Levels as Proxy

Pursuant to the GSP Emergency Regulations (23-CCR § 354.28(d)) and as further described in the DWR Sustainable Management Criteria BMP (DWR, 2017), MTs for Depletions of Interconnected Surface Water may be set by using groundwater levels as a proxy, if it can be demonstrated that MTs for Chronic Lowering of Groundwater Levels are sufficiently protective to ensure prevention of significant and unreasonable depletions of interconnected surface water.

Castac Lake is the most prominent surface water feature in the Basin, and based on shallow well data near the lake, during periods when the lake contains water it likely is interconnected to groundwater. As discussed in Section *9.2 Water Budget Results*, the analytical water budget simulates net gaining lake conditions in which groundwater inflow into the lake exceeds groundwater outflow from the lake during the WY 1998-2018 time period. Under unmanaged conditions, Castac Lake levels primarily are influenced by climate and not groundwater pumping. Since 2012, Castac Lake has been mostly dry, and groundwater elevations in 2018 were below the bottom of the Lake. Other potentially interconnected surface water features include Cuddy

Creek and Grapevine Creek, however the flows in these are ephemeral under natural conditions, which means that flows are brief and generally occur following a rainfall event.

Potential groundwater dependent ecosystems (GDEs) are a less obvious feature of interconnected surface water. GDEs have been mapped in the Grapevine Canyon area of the Basin, where groundwater levels typically are shallower than the main Castac Lake area of the Basin. RMW TRC-MW23D is located in the Grapevine Canyon area of the Basin.

The MT for Chronic Lowering of Groundwater Levels considered the groundwater level trends observed in Grapevine Canyon well TRC-MW23D. Although that MT is set at 28 feet below ground surface (ft bgs), below the likely maximum rooting depth of potential GDEs in this area (i.e., 24 ft bgs; see **Table GWC-*6***), groundwater levels in well TRC-MW23D historically have fluctuated between land surface and approximately 24 ft bgs, and the estimated maximum depth to groundwater in TRC-MW23D is 26 ft bgs[57]. Groundwater levels thus are unlikely to decline to the MT depth of 28 ft bgs.

MTs also are considered a *minimum* that water levels should reach, and the GSA will strive to maintain water levels at the Measurable Objectives (MO) which are approximately eight (8) feet higher than the MT in the Grapevine Canyon area of the Basin (i.e., 20 feet bgs), as described in detail in Section 15.1 *Measurable Objective and Interim Milestones for Chronic Lowering of Groundwater Levels*.

As discussed above, in Section *13.6 Undesirable Results for Depletions of Interconnected Surface Water*, the relationship between groundwater elevation and impacts to the potential GDEs is uncertain, as (1) the mixture of different phreatophyte plants at a given time in a given area (and their specific rooting depths) is not well known, and some GDEs can adapt to lowering groundwater levels depending on the speed, magnitude, and longevity of the stress (Rohde et al., 2019), and (2) the interconnected surface water systems within the Basin are affected by variation in natural conditions and precipitation events. Given the observed shallow depths to groundwater in RMW TRC-MW23D, the known range of GDE plant rooting depths, and the maximum water depth allowed by the MTs for Chronic Lowering of Groundwater Levels and Depletion of Groundwater Storage, these MTs also are likely protective of the potential GDEs. MTs specific to Depletions of Interconnected Surface Water therefore are not developed at this time, and MTs for Chronic Lowering of Groundwater Levels are used as proxy.

[57] Using a calculated linear correlation between water levels observed in TRC-MW23D and TRC-PW56A, which has the longest water level record in the Basin.

15. MEASURABLE OBJECTIVES AND INTERIM MILESTONES

§ 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.

(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.

(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.

(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.

(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.

(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.

(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.

This section discusses the development of Measurable Objectives (MO) and Interim Milestones for all relevant Sustainability Indicators for the Basin.

15.1. Measurable Objective and Interim Milestones for Chronic Lowering of Groundwater Levels

15.1.1. Measurable Objectives for Chronic Lowering of Groundwater Levels

The MOs for Chronic Lowering of Groundwater Levels were developed using a similar trendline projection method described in Section *14.1.1* above, which calculated the MO as the Spring 2018 groundwater level minus the change in water levels based on recent trends (2008 – 2018) extended over 10 years. As described in the *Sustainable Management Criteria Best Management Practices* (BMP) document (DWR, 2017), "Measurable Objectives should be set such that there is a reasonable margin of operation flexibility (or 'margin of safety'), between the minimum threshold and measurable objective that will accommodate droughts, climate change, conjunctive use operations, or other groundwater management activities" (DWR, 2017).

Therefore, the margin of operational flexibility within the Basin is the difference between the MT and the MO. The MOs and margins of operational flexibility for RMWs within the Basin are shown in **Table SMC-4** below.

Table SMC-4. Measurable Objectives for Chronic Lowering of Groundwater Levels

RMW Name	**Area**	**GSE** (ft msl)	**MO** (ft msl)	**MO** (ft bgs)	**Margin of Operational Flexibility** (ft)
TRC-MW16D	Castac Lake	3,640	3,420	219	75
TRC-MW18D	Castac Lake	3,531	3,411	120	54
TRC-MW23D	Grapevine	3,376	3,356	20	8

Abbreviations:
ft = feet
ft bgs = feet below ground surface
ft msl = feet above mean sea level
MO = measurable objective
RMW = Representative Monitoring Wells

15.1.2. Interim Milestones for Chronic Lowering of Groundwater Levels

Interim Milestones (IMs) for Chronic Lowering of Groundwater Levels are defined herein using a trajectory for groundwater levels based on the current (Spring 2018) levels, the MTs, and the MOs. This trajectory allows for and assumes a continuation of current groundwater level trends for the first 5-year period, a deviation from that trend over the second 5-year period, a recovery to the 5-year IM in the third 5-year period, and recovery towards the MOs over the fourth (last) 5-year period. Specifically, the trajectory for groundwater levels prescribed in the IMs is as follows:

Table SMC-5. Interim Milestone Trajectory for Chronic Lowering of Groundwater Levels

Calendar Year	**Interim Milestone for Chronic Lowering of Groundwater Levels**	**Basis for Interim Milestone**
2020	Not applicable	Not applicable
2025	IM-5	*½ * ($GWL_{Spring2018}$ + MT)*
2030	IM-10	*½ * (IM-5 + MT)*
2035	IM-15	*½ * (IM-10 + MO)*
2040	MO	MO

where:

IM-5, IM-10, and IM-15 are the Interim Milestones for Chronic Lowering of Groundwater Levels after 5 years, 10 years and 15 years, respectively
$GWL_{Spring2018}$ is the measured groundwater elevations in Spring 2018;
MT is the Minimum Threshold for Chronic Lowering of Groundwater Levels (defined previously); and
MO is the Measurable Objective for Chronic Lowering of Groundwater Levels (defined previously)

Interim Milestones for Chronic Lowering of Groundwater Levels are presented in **Table SMC-6**, and are displayed relative to historical water levels at each RMW on **Figure SMC-1**.

Table SMC-6. Interim Milestones for Chronic Lowering of Groundwater Levels

Well Name	**Area**	**Spring 2018 GWE** (ft msl)	**MO** (ft msl)	**MT** (ft msl)	**IM-5** (ft msl)	**IM-10** (ft msl)	**IM-15** (ft msl)
TRC-MW16D	Castac Lake	3,496	3,420	3,345	3,420	3,383	3,401
TRC-MW18D	Castac Lake	3,464	3,411	3,357	3,411	3,384	3,397
TRC-MW23D	Grapevine	3,363	3,356	3,348	3,356	3,352	3,354

Abbreviations:
ft msl = feet above mean sea level
GWE = groundwater elevation
IM = interim milestone
MO = measurable objective
MT = minimum threshold

15.2. Measurable Objective and Interim Milestones for Reduction of Groundwater Storage

As discussed above, the Undesirable Results definition for Reduction of Groundwater Storage refers to a decrease in storage that would cause water levels to decline below MTs established in RMWs for Chronic Lowering of Groundwater Levels. These two Sustainability Indicators (Chronic Lowering of Groundwater Levels and Reduction of Groundwater Storage) are closely linked, as the amount of groundwater in storage is directly related to groundwater levels. Therefore, their MOs also are affected by the same factors and unique MOs for Reduction of Groundwater Storage were not developed. As stated above, the MOs for Chronic Lowering of Groundwater Levels provide an adequate Margin of Operational Flexibility and are used as proxy for the Reduction of Groundwater Storage Sustainability Indicator.

15.3. Measurable Objective and Interim Milestones for Seawater Intrusion

As discussed above in Section *14.3 Minimum Threshold for Seawater Intrusion*, because the Basin is located far inland, away from the ocean, seawater intrusion is not a threat to groundwater resources and the Seawater Intrusion Sustainability Indicator is not applicable. Thus, no SMCs for this Sustainability Indicator are defined in the Basin.

15.4. Measurable Objective and Interim Milestones for Degraded Water Quality

As discussed above in Section 13.4 *Undesirable Results for Degraded Water Quality*, and in Section *14.4 Minimum Threshold for Degraded Water Quality,* groundwater quality monitoring already being conducted as part of other regulatory compliance efforts will continue during GSP implementation, and at present no MOs or MTs currently are defined for Degraded Water Quality.

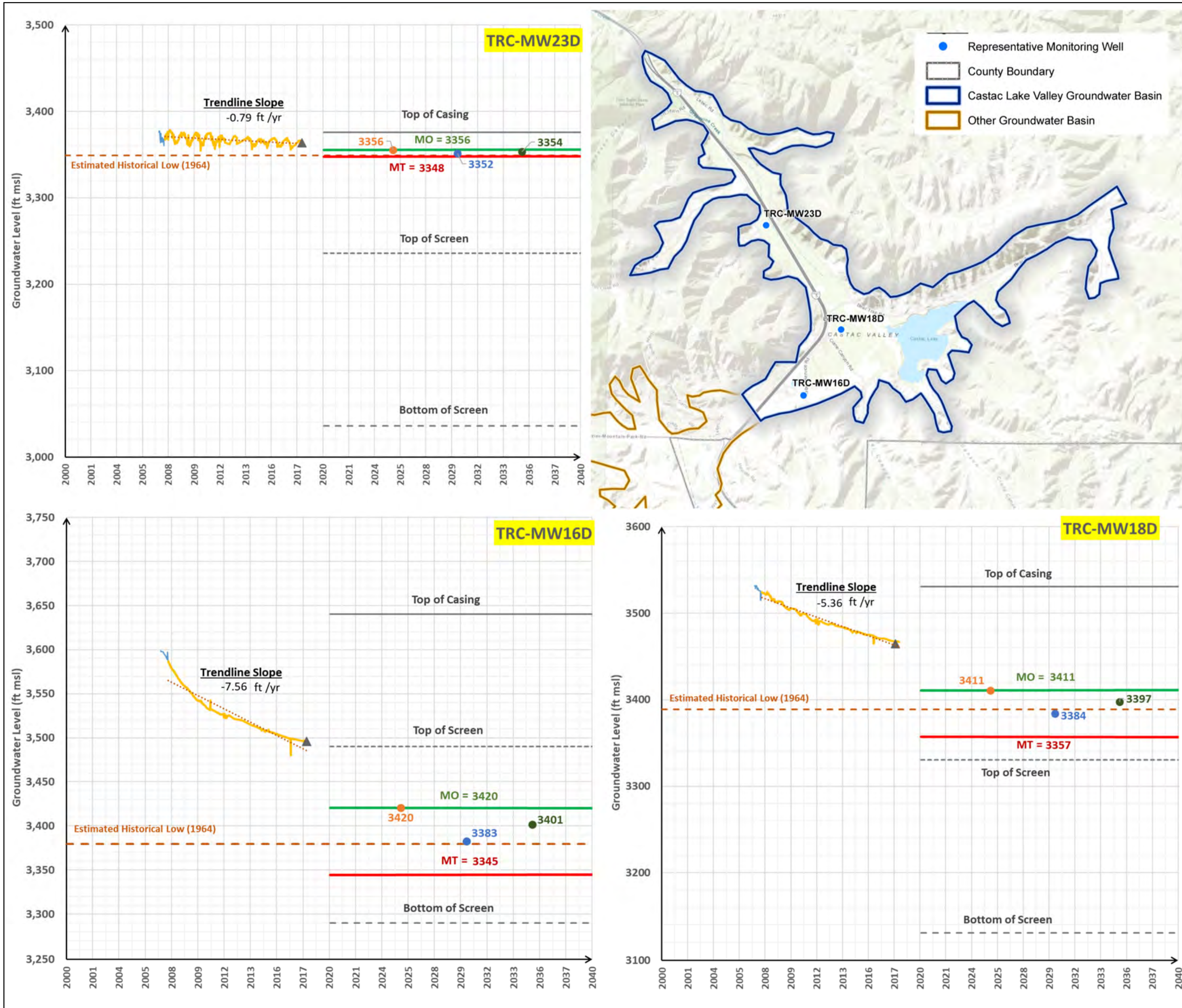
15.5. Measurable Objective and Interim Milestones for Land Subsidence

As discussed above in Section 13.5 *Undesirable Results for Land Subsidence*, and in Section *14.5 Minimum Threshold for Land Subsidence,* available data show that land subsidence is not likely to be a significant concern in the Basin. Given the geologic and stratigraphic characteristics of the Basin (a lack of thick clay layers), land subsidence is not known to have occurred and is not likely to occur in the Basin in the future, thus no SMCs are defined for the Land Subsidence Sustainability Indicator.

15.6. Measurable Objective and Interim Milestones for Depletion of Interconnected Surface Water

As discussed above in Section *13.6 Undesirable Results for Depletions of Interconnected Surface Water*, based on available data and information, interconnected surface water systems within the Basin are primarily influenced by climate. Potential GDEs have been mapped in both the Grapevine Canyon area of the Basin where groundwater levels are typically shallower and in the main Castac Lake area of the Basin where current groundwater levels exceed 30 feet below ground surface.

As discussed above, the Chronic Lowering of Groundwater Levels metrics will be used as proxy for the Depletions of Interconnected Surface Water Sustainability Indicator. The RMW TRC-MW23D is located in the Grapevine Canyon area of the Basin, and its MO for Chronic Lowering of Groundwater Levels is set at 20 ft bgs. This provides an adequate Margin of Operational Flexibility (i.e., 8 feet) while maintaining groundwater levels above maximum plant rooting depths (i.e., 24 ft bgs; see **Table GWC-6**).



Legend

- Water Level Measurement
- Trend Period
- (Estimated) Historical Low
- Spring 2018 Water Level
- Top of Casing
- Top of Screen
- Bottom of Screen
- MO
- MT
- IM-5
- IM-10
- IM-15
- Linear (Trend Period)

Abbreviation

DWR = California Department of Water Resources

ft msl = ft above mean sea level

ft/yr = ft per year

IM = Interim Milestone

MO = Measurable Objective

MT = Minimum Threshold

Notes

1. All locations are approximate.

Source

1. Groundwater basin boundaries from DWR Bulletin 118 Interim Update 2016.

2. Basemap is ESRI's ArcGIS Online world topographic map, obtained 3 March 2020.

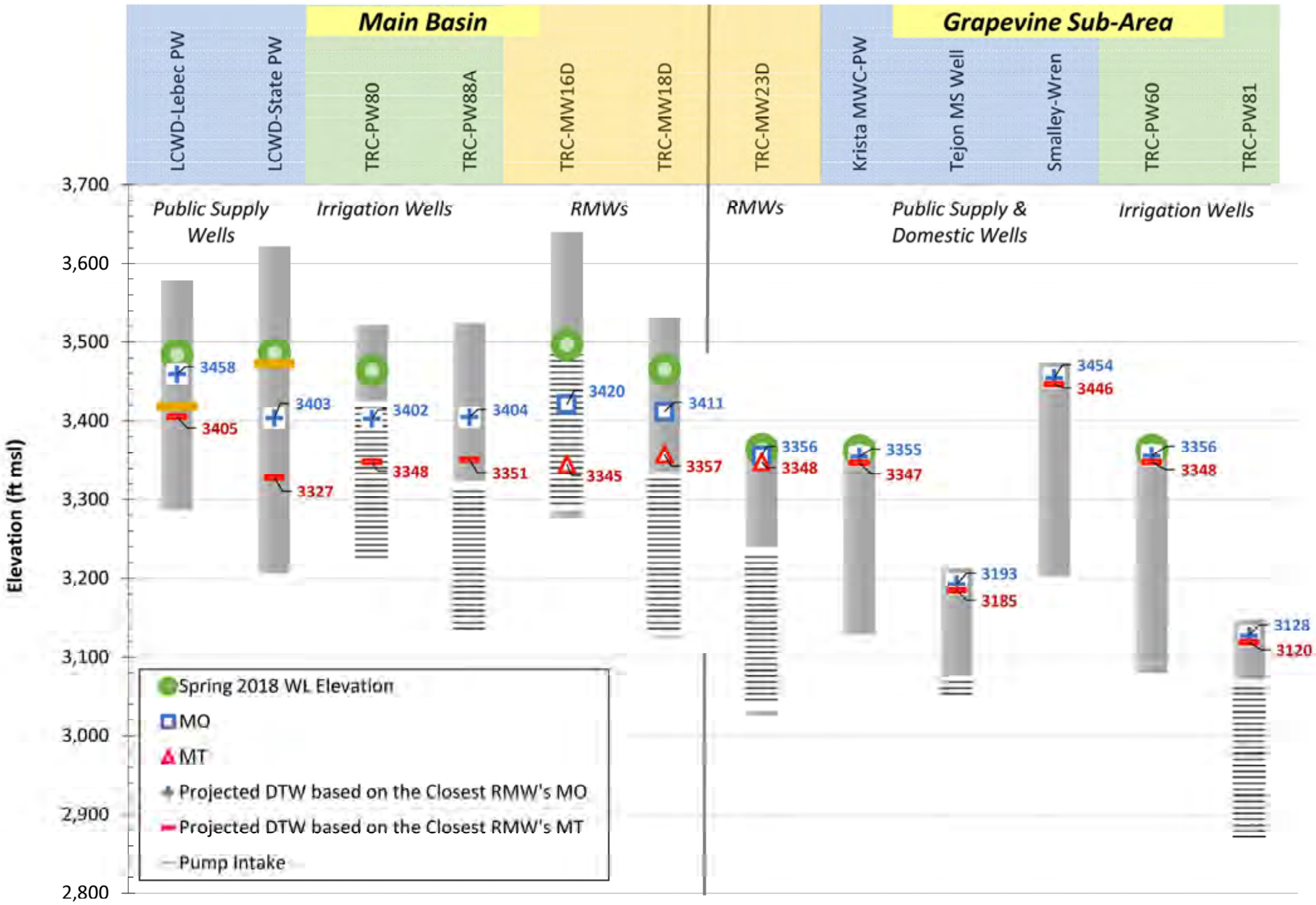
Representative Monitoring Well Hydrograph

DRAFT

Castac Basin GSA
Kern County, California
June 2020
B80048.00

eki environment & water

Figure SMC-1



Fraction of Wells Affected by Water Levels Declining to Sustainable Management Criteria	Top of Screen Dewatered	Bottom of Screen Dewatered
Measurable Objective (MO)	33%	0%
Minimum Threshold (MT)	44%	0%

Legend

Blank Casing (or Well with Unknown Screened Interval)

Well Screen Interval

Abbreviations

DTW = depth to water

ft msl = feet above mean sea level

RMWs = Representative Monitoring Wells

Notes

1. The fraction of wells affected shown in the table does not include wells without available screen depth (or pump intake) information.
2. Wells that used RMW TRC-MW18D's SMC information include LCWD-Lebec PW, TRC-PW80, and TRC-PW88A; Well that used RMW TRC-MW16D's SMC information include LCWD-State PW; Wells that used RMW TRC-MW23D's SMC information include Krista MWC-PW, Tejon MS Well, Smalley-Wren, TRC-PW60, and TRC-PW81.

Sources

1. Well information obtained from the Stakeholder Surveys distributed by the Castac Basin GSA in 2018-2019.

Well Construction Schematic and Sustainable Management Criteria

DRAFT

Castac Basin GSA

Kern County, California

June 2020

B80048.00

eki environment & water

Figure SMC-2

MONITORING NETWORK

16. MONITORING NETWORK

§ 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.

This section describes the Monitoring Network designed for the Basin, subsequently referred to as the "Sustainable Groundwater Management Act (SGMA) Monitoring Network." Pursuant to the Groundwater Sustainability Plan (GSP) Emergency Regulations (23-California Code of Regulations [CCR] Division 2 Chapter 1.5 Subchapter 2), the objective of a Monitoring Network is to collect sufficient data for the correct assessment of the Sustainability Indicators relevant to the Basin (see Section 13 *Undesirable Results*), and the impacts to the beneficial uses and users of groundwater.

Per 23 CCR § 354.32(e), the SGMA Monitoring Network incorporates elements from the existing monitoring programs occurring within the Basin (see Section *5.2.1 Existing Monitoring and Management Programs*) and includes additional components to comply with the GSP Emergency Regulations. All monitoring will be performed in accordance with the protocols developed for the Basin, as described in Section *16.2 Monitoring Protocols for Data Collection and Monitoring*.

16.1. Description of Monitoring Network

§ 354.34. Monitoring Network

(a) Each Agency shall develop a monitoring network capable of collecting sufficient data to demonstrate short-term, seasonal, and long-term trends in groundwater and related surface conditions, and yield representative information about groundwater conditions as necessary to evaluate Plan implementation.

(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.

(2) Monitor impacts to the beneficial uses or users of groundwater.

(3) Monitor changes in groundwater conditions relative to measurable objectives and minimum thresholds.

(4) Quantify annual changes in water budget components.

…

(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.

(e) A Plan may utilize site information and monitoring data from existing sources as part of the monitoring network.

(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.

(2) Aquifer characteristics, including confined or unconfined aquifer conditions, or other physical characteristics that affect groundwater flow.

(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.

(4) Whether the Agency has adequate long-term existing monitoring results or other technical information to demonstrate an understanding of aquifer response.

§ 354.34. Monitoring Network

(g) Each Plan shall describe the following information about the monitoring network:

(1) Scientific rationale for the monitoring site selection process.

(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.

(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.

(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.

(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.

(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.

As discussed in the sections above, Sustainable Management Criteria (SMC) for Chronic Lowering of Groundwater Levels have been established for the Basin and will be used as a proxy for Reduction of Groundwater Storage and Depletion of Interconnected Surface Water. As shown on **Figure MN-1** the Basin's SGMA Monitoring Network includes three water level Representative Monitoring Wells (RMWs). Two water level RMWs (TRC-MW16D and TRC-MW18D) are located in the Castac Lake area of the Basin, and one water level RMW (TRC-MW23D) is located in the Grapevine Canyon area of the Basin.

Pursuant to 23-CCR §354.34(a)-(b), the objective of the SGMA Monitoring Network is to collect data with sufficient temporal frequency and spatial density necessary to evaluate this GSP implementation as it relates to:

- Monitoring short-term, seasonal, and long-term trends in groundwater (see Section *8 Current and Historical Groundwater Conditions*);
- Demonstrating progress toward achieving Measurable Objectives (MOs) described herein (see Section *15 Measurable Objectives and Interim Milestones*);

- Monitoring impacts to the beneficial uses and users of groundwater (see Section *5.5.1 Beneficial Uses and Users of Groundwater*);
- Monitoring changes in groundwater conditions relative to MOs (see Section *15 Measurable Objectives and Interim Milestones*) and Minimum Thresholds (MTs) (see Section *14 Minimum Thresholds*); and
- Quantifying annual changes in water budget components (see Section *9 Water Budget Information*).

The SGMA Monitoring Network, as discussed in more detail below, contains a subset of three RMWs to be monitored for Chronic Lowering of Groundwater Levels. These RMWs (1) were selected from existing monitoring programs active within the Basin (see Section *5.2.1 Existing Monitoring and Management Programs*), (2) are representative of groundwater conditions, (3) are located in proximity to beneficial uses and users of groundwater (e.g., public supply wells, production wells, and potential GDEs), and (4) have SMCs (i.e., MTs, MOs, or Interim Milestones) defined for at least one of the relevant Sustainability Indicators to the Basin (see Section 13 *Undesirable Results*):

- Chronic Lowering of Groundwater Levels;
- Reduction of Groundwater Storage[58] and
- Depletions of Interconnected Surface Water[59].

Pursuant to 23-CCR §354.34(e), water quality data collected from public water systems and reported to the State Water Resources Control Board (SWRCB) Division of Drinking Water Program through the Safe Drinking Water Information System (SDWIS) Drinking Water Watch website[60] will be utilized to supplement the monitoring network to allow for future water quality trend analyses.

Pursuant to 23-CCR §354.34(f), the Monitoring Network for Chronic Lowering of Groundwater Levels consists of three RMWs with sufficient spatial distribution and spatial density. Groundwater elevations in these wells will be measured bi-annually (Spring and Fall) to allow for characterization of groundwater conditions during seasonal highs and lows. These wells are spatially distributed in areas potentially affected by groundwater users in the Basin.

Per 23-CCR §354.34(g), other factors considered in the selection of the RMWs include:

- Availability of existing technical information about the RMW (e.g., well location, construction information, condition, status, etc.);
- Quality and reliability of historical data at the RMW;

[58] Reduction in Groundwater Storage sustainability indicator will be monitored by proxy using groundwater levels.
[59] Depletions of Interconnected Surface Water sustainability indicator will be monitored by proxy using groundwater levels.
[60] https://sdwis.waterboards.ca.gov/PDWW/index.jsp

- "Representativeness" to local groundwater conditions and nearby well populations (per 23-CCR §354.36); and
- Projected availability of long-term access to the RMW.

Table MN-1 summarizes the site type, site count, measured constituent(s), measurement frequency, and spatial density of the SGMA Monitoring Network for each of the relevant Sustainability Indicators mentioned above. Further details about the SGMA Monitoring Network for each Sustainability Indicator can be found in Sections 16.1.1 through 16.1.6.

Table MN-1. Summary of SGMA Monitoring Network

Sustainability Indicator	Site Type	Site Count	Measured Constituent(s)	Measurement Frequency	Spatial Density (# sites / 1 mi^2)[a]
Chronic Lowering of Groundwater Levels	Well	3	Water Level	Semiannually	0.5
Reduction of Groundwater Storage	Well	3	Water Level	Semiannually	0.5
Depletions of Interconnected Surface Water	Well	3	Water Level	Semiannually	0.5

Notes:

(a) Spatial density recommendations by DWR are between 0.2 and ten sites per 100 square miles. As the Basin is less than 6 square miles, one site would meet the density recommendations.

Pursuant to 23-CCR § 354.32(i), in all cases the SGMA Monitoring Network will adhere to the monitoring protocols specified for the Basin as described in Section *16.2 Monitoring Protocols for Data Collection and Monitoring*.

16.1.1. Monitoring Network for Chronic Lowering of Groundwater Levels

§ 354.34. Monitoring Network

(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.

(B) Static groundwater elevation measurements shall be collected at least two times per year, to represent seasonal low and seasonal high groundwater conditions.

The SGMA Monitoring Network for Chronic Lowering of Groundwater Levels consists of three RMWs that will be used to monitor depth to groundwater. SMCs (including MTs, MOs, and Interim Milestones) have been defined for the three RMWs for the Chronic Lowering of Groundwater Levels sustainability indicator in Sections 14.1 and 15.1, respectively. Specific details regarding each of the RMWs are listed in **Table MN-2**.

Table MN-2. Summary of Representative Monitoring Wells

Well ID [1]	Well Use	Well Category	Well Construction Details				Well Location Coordinates				Sustainability Metrics				
			Total Cased Depth (ft bgs)	Top of Screen Depth (ft bgs)	Bottom of Screen Depth (ft bgs)	Casing Diam. (in)	Easting (ft, SP5)	Northing (ft, SP5)	Ground Surface Elevation (ft, NAVD88)	Reference Point Elevation (ft, NAVD88)	Minimum Threshold (ft, NAVD88)	Interim Milestone #1 (5 yr) (ft, NAVD88)	Interim Milestone #2 (10 yr) (ft, NAVD88)	Interim Milestone #3 (15 yr) (ft, NAVD88)	Measurable Objective (ft, NAVD88)
TRC-MW16D	Monitoring	RMW	363	150	350	4	6,301,371.60	2,123,831.62	3639.57	3642.41	3345	3420	3383	3401	3420
TRC-MW18D	Monitoring	RMW	407	200	400	4	6,303,665.92	2,127,862.83	3530.56	3533.31	3357	3411	3384	3397	3411
TRC-MW23D	Monitoring	RMW	350	140	340	4	6,299,092.36	2,134,235.44	3375.97	3378.31	3348	3356	3352	3354	3356
LCWD-Lebec PW	Municipal Supply	SMW	295	160 [2]	295 [2]	10	6,302,890.00	2,125,983.00	3578.00	N/A	N/A	N/A	N/A	N/A	N/A
LCWD-State PW	Municipal Supply	SMW	400	150 [2]	400 [2]	12	6,301,349.00	2,125,385.00	3622.00	N/A	N/A	N/A	N/A	N/A	N/A
TRC-MW3	Monitoring	SMW	50	25	45	N/A	6,304,052.00	2,129,589.00	3504.50	3506.00	N/A	N/A	N/A	N/A	N/A
TRC-MW22	Monitoring	SMW	34	8	34	4	6,302,755.00	2,131,401.00	3473.56	3476.90	N/A	N/A	N/A	N/A	N/A
TRC-PW81	Municipal Supply	SMW	282	80	284	12.75	6,293,141.00	2,142,209.00	3148.00	N/A	N/A	N/A	N/A	N/A	N/A
Fort Tejon Historic Park Well	Municipal Supply	SMW	N/A	N/A	N/A	N/A	6,293,526.00	2,141,858.00	3176.85	N/A	N/A	N/A	N/A	N/A	N/A
Tejon MS Well	Municipal Supply	SMW	N/A	140	166	N/A	6,295,128.00	2,141,376.00	3212.99	N/A	N/A	N/A	N/A	N/A	N/A
Krista MWC-PW	Municipal Supply	SMW	250	168 [2]	250 [2]	12	6,298,354.00	2,134,132.00	3375.00	3405.00	N/A	N/A	N/A	N/A	N/A
TRC-PW60	Municipal Supply	SMW	299	80	284	16	6,299,202.00	2,134,109.00	3375.97	3375.97	N/A	N/A	N/A	N/A	N/A

Notes

(1) Only wells with known perforation depths and recently available data (i.e., water level measurements from 2015 onward) are included.
(2) Top and bottom of screen depth are not available. Pump intake depth is used as top of screen depth and total cased depth is used as bottom of screen depth.

Abbreviations

bgs = below ground surface
CASGEM = California Statewide Groundwater Elevation Monitoring
DWR = California Dep't of Water Resources
ft = feet
in = inches
N/A = not available or not applicable
NAD83 = North American Datum of 1983
NAVD88 = North Am. Vert. Datum of 1988
RMW = Representative Monitoring Well
SMW = Supplemental Monitoring Well
SP5 = Calif. State Plane Coord. Sys., Zone 5, NAD83

Source

Well information is compiled from the Castac Basin Groundwater Sustainability Agency Data Management System.

The RMW site locations and their spatial distributions (**Figure MN-1**) were selected based on the following considerations:

- **Availability of site-specific technical information** – As shown in **Table MN-2**, all three RMWs have known geographic coordinates, ground surface elevations, and reference point elevations surveyed to an accuracy of 0.01-feet. Well construction information, including total well depth and screened intervals, are known and well logs are available for all three RMWs. All three RMWs are dedicated monitoring wells and have been confirmed to be in suitable condition for recording water level measurements.

- **Quality, reliability, and availability of historical data** – Each of the RMWs have been monitored bi-monthly for at least the past ten years as part of Tejon Ranch Corporation (TRC)'s routine water level monitoring, and have associated water level records spanning back at least ten years.

- **"Representativeness" to local groundwater conditions** – The Castac Lake area of the Basin shows greater groundwater level fluctuations compared to the Grapevine Canyon area of the Basin. As such, two RMWs are located in the Castac Lake area and one RMW is located within the Grapevine Canyon subarea of the Basin (see **Figure MN-1**).

- **Proximity to beneficial uses and users of groundwater** – RMWs in both areas of the Basin were selected based on their proximity to public supply wells. As shown on **Figure MN-1**, TRC-MW16D and TRC-MW18D are located in the vicinity of both Lebec County Water District (LCWD)'s public supply wells, which provide drinking water to the Disadvantaged Community (DAC) of Lebec. Furthermore, TRC-MW23D is located near both the Krista Mutual Water Company (KMWC) public supply well, which supplies drinking water to O'Neil Canyon residents and TRC-PW60, which supplies drinking water to the TRC headquarters, and potential GDEs located in Grapevine Canyon.

- **Aquifer characteristics** – There is only one Principal Aquifer defined for the Basin, with shallow aquifer and deep aquifer zones. The three RMWs are screened in the deep aquifer zone, similar to the production wells in the Basin.

As discussed in Section *8.2 Groundwater Elevations and Flow Direction*, groundwater flow direction in the Castac Lake and Dryfield Canyon areas of the Basin are predominantly towards Castac Lake. Groundwater then flows northwest down through Grapevine Canyon. Given the location of the three RMWs, groundwater depths and flow directions can be understood through analysis of data collected using the SGMA Monitoring Network.

<u>Monitoring Well Density</u>

According to California Department of Water Resources' (DWR) "Best Management Practices #2 – Monitoring Network and Identification of Data Gaps" (DWR, 2016c), monitoring well density should be between 0.2 and ten wells per 100 square miles. The SGMA Monitoring Network is compliant with these criteria, having three RMWs per 5.5 square miles.

Monitoring Schedule

Water levels will be measured bi-annually (Spring and Fall) to document seasonal fluctuations in groundwater levels, among other things. Specifically, Spring levels will be measured in March to represent a seasonal high prior to summer irrigation demands. Fall levels will be measured in October to represent a seasonal low after the summer irrigation demands. All RMWs will be monitored in accordance with the monitoring protocol described in Section *16.2 Monitoring Protocols for Data Collection and Monitoring*. All data will be reported to DWR per the requirements specified under Section *17016.5 Reporting Monitoring Data to the Department*.

16.1.2. Monitoring Network for Reduction of Groundwater Storage

§ 354.34. Monitoring Network

(c) Each monitoring network shall be designed to accomplish the following for each sustainability indicator:
(2) Reduction of Groundwater Storage. Provide an estimate of the change in annual groundwater in storage

As described in Sections *14.2* and *14.2.2*, the criteria used to define Undesirable Results for Reduction of Groundwater Storage are the MTs established for Chronic Lowering of Groundwater Levels. As such, the SGMA Monitoring Network for Reduction of Groundwater Storage will be comprised of the same RMWs described in Section *16.1.1 Monitoring Network for Chronic Lowering of Groundwater Levels*. The information collected from this SGMA Monitoring Network will be sufficient to estimate the annual change of groundwater in storage.

16.1.3. Monitoring Network for Seawater Intrusion

§ 354.34. Monitoring Network

(c) Each monitoring network shall be designed to accomplish the following for each sustainability indicator:
(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.

…

(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.

As described in Section *13.3 Undesirable Results for Seawater Intrusion*, seawater intrusion is not present and not likely to occur within the Basin; therefore, the Seawater Intrusion Sustainability Indicator is not applicable and no Undesirable Results for this Sustainability Indicator are defined for the Basin. As such, per the stipulations defined under 23-CCR §354.34(j), a monitoring network has not been defined for the Seawater Intrusion Sustainability Indicator.

16.1.4. Monitoring Network for Degraded Water Quality

§ 354.34. Monitoring Network

(c) Each monitoring network shall be designed to accomplish the following for each sustainability indicator:

(4) Degraded Water Quality. Collect sufficient spatial and temporal data from each applicable principal aquifer to determine groundwater quality trends for water quality indicators, as determined by the Agency, to address known water quality issues.

As described in Section *13.4 Undesirable Results for Degraded Water Quality*, limited data for groundwater quality are available to assess the relationship between water quality and water levels in the Basin. Furthermore, water management actions legally available to the Castac Basin GSA are likely to have only limited effects on groundwater quality conditions within the Basin. Therefore, Undesirable Results for Degraded Water Quality are not defined currently in this GSP and a dedicated monitoring network for the purposes of assessing SMCs for Degraded Water Quality Sustainability Indicated has not been defined.

The public water system wells in the Basin are shown on **Figure MN-1.** Public water systems are subject to water quality monitoring requirements under the SWRCB Drinking Water Program. Water quality results and monitoring schedule are reported to the SWRCB and made publicly available through the Safe Drinking Water Information System (SDWIS) Drinking Water Watch website. Data from the SDWIS portal will be assembled and analyzed to allow for future water quality trend analyses.

Benefits of using public water system wells to aid in future analyses include: (1) public water systems consider the groundwater quality of the beneficial users of groundwater, (2) public water systems are required to sample for constituents of health concern, (3) public water system wells are pumped regularly and the water being sampled is representative of the formation water, and (4) public water system wells are well-distributed throughout the Basin.

Furthermore, water quality samples will be collected from selected monitoring wells in Grapevine Canyon (such as TRC-MW3 and TRC-MW22) to establish a current groundwater quality baseline in the shallow aquifer zone in areas of potential GDEs.

16.1.5. Monitoring Network for Land Subsidence

> *§ 354.34. Monitoring Network*
>
> *(c) Each monitoring network shall be designed to accomplish the following for each sustainability indicator:*
>
> *(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.*

As mentioned in Section *8.6 Land Subsidence* no significant subsidence has been historically observed within the Basin based on available data. Therefore, no Undesirable Results for the Subsidence Sustainability Indicator are defined for the Basin. As such, per the stipulations defined under 23-CCR §354.34(j), a Monitoring Network has not been defined for the Land Subsidence Sustainability Indicator.

16.1.6. Monitoring Network for Depletions of Interconnected Surface Water

> *§ 354.34. Monitoring Network*
>
> *(c) Each monitoring network shall be designed to accomplish the following for each sustainability indicator:*
>
> *(6) Depletions of Interconnected Surface Water. Monitor surface water and groundwater, where interconnected surface water conditions exist, to characterize the spatial and temporal exchanges between surface water and groundwater, and to calibrate and apply the tools and methods necessary to calculate depletions of surface water caused by groundwater extractions. The monitoring network shall be able to characterize the following:*
>
> *(A) Flow conditions including surface water discharge, surface water head, and baseflow contribution.*
>
> *(B) Identifying the approximate date and location where ephemeral or intermittent flowing streams and rivers cease to flow, if applicable.*
>
> *(C) Temporal change in conditions due to variations in stream discharge and regional groundwater extraction.*
>
> *(D) Other factors that may be necessary to identify adverse impacts on beneficial uses of the surface water.*

The SGMA Monitoring Network for Depletions of Interconnected Surface Water Sustainability Indicator is comprised of the same RMWs described in Section *16.1.1 Monitoring Network for Chronic Lowering of Groundwater Levels*. The three water level RMWs are located in close proximity to the potential interconnected surface water systems within the Basin. Specifically, RMW TRC-MW23D is located adjacent to Grapevine Creek in an area that has historically supported GDEs, RMW TRC-MW16D is located near Cuddy Creek, and RMW TRC-MW18D is located downgradient to Castac Lake. Specific details regarding the monitoring wells are listed in **Table MN-2** and the RMW locations are displayed on **Figure MN-1**. All RMWs will have groundwater level measurements collected semi-annually in accordance with the monitoring protocol described in Section *16.2 Monitoring Protocols for Data Collection and Monitoring.*

16.2. Monitoring Protocols for Data Collection and Monitoring

§ 352.2. Monitoring Protocols
Each Plan shall include monitoring protocols adopted by the Agency for data collection and management, as follows:

(a) Monitoring protocols shall be developed according to best management practices.

(b) The Agency may rely on monitoring protocols included as part of the best management practices developed by the Department,or may adopt similar monitoring protocols that will yield comparable data.

(c) Monitoring protocols shall be reviewed at least every five years as part of the periodic evaluation of the Plan, and modified as necessary.

Pursuant to 23-CCR § 354.34(i), in all cases the SGMA Monitoring Network will adhere to the monitoring protocols developed by the Castac Basin Groundwater Sustainability Agency (GSA). Protocols for data collection detailed below are compatible with DWR's guidance document *Groundwater Elevation Monitoring Guidelines* (DWR, 2010) for water level monitoring. Water levels should be collected from RMWs and reported annually to DWR. Well-water samples will be collected to establish current baseline conditions, as necessary.

16.2.1. Protocols for Groundwater Level Measurements

Groundwater level measurements shall be collected semi-annually (Spring and Fall) to document seasonal fluctuations in groundwater levels. Specifically, Spring levels will be measured in March and Fall levels will be measured in October. The following data collection protocols should be followed by the field technician:

- Upon arrival at the site, the field technician shall fill out a "Well Data Collection Form" which documents the date and time, condition at the well, and depth to groundwater measurement.
- Depth to groundwater shall be measured in feet, using an electric or acoustic sounder or datalogging pressure transducer. Data shall be recorded to the nearest 0.01 feet, if possible, given the resolution of the equipment used and the depth to water.
- Depth to groundwater shall be measured from a specific, easily identifiable, and clearly marked Reference Point on the well casing. The three RMWs were surveyed in February and April 2007 in which the elevation of the Reference Point (i.e., Reference Point Elevation [RPE]) was marked and surveyed relative to the North American Vertical Datum of 1988 (NAVD88) to an accuracy of 0.01 foot.
- Groundwater elevation (GWE) shall be calculated as GWE = RPE – depth to groundwater.
- Records of data collected shall be archived within the Castac Basin Data Management System (DMS), as described in Section *16.2.3* below.

16.2.2. Protocols for Water Quality Sampling

General steps for water quality sampling include depth to groundwater measurement prior to purging, multi-meter calibration, purging the well casing, water quality sample collection in lab-specified bottles, and following standard chain-of-custody guidelines for sample preservation and transport. The following data collection protocols should be followed by the field technician:

- A “Sampling Log” shall be completed for each sampling site which documents the date and time, condition at the well, and depth to groundwater measurement, at minimum.
- Ideally, a multi-meter shall be used to collect field parameters prior to sample collection. As applicable, multi-meter probes shall be calibrated per manufacturer specifications using standards closest to that of the anticipated well-water.
- Production wells shall be sampled while the well pump is running, with well-water collected from a spigot near the well-head. Monitoring wells shall be purged and sampled using a submersible pump or bailer. If applicable, field parameters shall be monitored using a multi-meter and flow cell during purging. Field parameters shall be allowed to stabilize during purging so that variation of each parameter is within appropriate pre-defined limits in three successive measurements collected at least three minutes apart.
- Prior to collection, new sample bottles appropriate to each analysis shall be obtained from the analytical lab contracted for chemical analysis. Each sample bottle shall be clearly labeled after sampling with the site identifier, date and time of sample collection.
- Based on the sampled constituent, water quality sample collection shall follow specific processing and treatment guidelines to assure the accuracy of the data.
- After collection, all sample bottles shall immediately be dried, labeled, sealed in zip-closure polyethylene bags, and placed on ice in an insulated cooler for temporary storage and transport to the analytical lab. All samples shall be delivered to the laboratory following standard chain-of-custody control guidelines within their prescribed holding times.
- Field duplicates monitor sample and laboratory consistency. One duplicate sample shall be collected for quality assurance purposes. Duplicate samples will be collected, processed, and analyzed in the field using the same methodology for the primary sample, with an assigned a dummy site identifier.
- One field blank sample shall be collected for quality assurances purposes. Field blank samples will be collected using deionized water, processed in the field, and then submitted to the laboratory with a dummy site identifier.
- Records of constituent concentrations shall be archived within the Castac Basin DMS, as described in Section *16.2.3* below.

16.2.3. Protocols for Data Reporting

Records of all data collected will be maintained in the Castac Basin DMS. Prior to importation, standard quality assurance and quality control (QA/QC) checks will be undertaken to help ensure the validity and accuracy of data.

- Depth to groundwater measurements shall be converted to groundwater elevation by subtracting the depth to groundwater from the reference point elevation following the protocols for groundwater level measurements described above.
- Groundwater elevation shall be plotted on individual well hydrographs. Groundwater elevations which vary by more than 20 feet between semi-annual measurements shall be flagged as questionable due to a high rate of change.
- Laboratory reports shall be checked to ensure all samples were analyzed within the prescribed holding times.
- Laboratory reports shall be checked to ensure all laboratory blank analyses were determined acceptable by the laboratory.
- Constituent detections in the field blank shall be tabulated and compared to their respective practical quantitation limit.
- Field duplicate results shall be compared to the main sample results. Ideally, concentrations should agree within 10% or have differences within their respective practical quantitation limit. If concentrations exceed by more than 25%, the GSA may ask the laboratory to re-run the constituent to confirm the result is reasonable.
- Major cations and anions represent a positive and negative charge, respectively, and therefore the sum of cations should equal the sum of anions in neutral groundwater. An anion-cation charge balance shall be calculated for each sample collected using concentrations of the major anions and cations in milliequivalents per liter (meq/L), with the difference between the two sums reported as a percentage where:

  $$\frac{Anions - Cations}{Anions + Cations} \times 100$$

  In general, a 5% percent difference is acceptable. Deviations can be greater if other constituents in the groundwater are not accounted for within the major anions and cations categories. If the anion/cation charge balance exceeds 15%, the GSA may ask the laboratory to re-run certain constituents or the entire sample to confirm the result is reasonable.
- TDS concentrations shall be plotted on individual well chemographs to ensure concentrations are reasonable.

After QA/QC, all data collected shall be imported into the Castac Basin DMS. Data will also be integrated into Annual Reports, as required by DWR, and will be uploaded to the SGMA data portal. Per the GSP Emergency Regulations (23-CCR § 352.4), the following reporting standards apply to all categories of information, unless otherwise indicated:

- Water volumes shall be reported in acre-feet (AF).
- Surface water flow shall be reported in cubic feet per second (cfs) and groundwater flow shall be reported in acre-feet per year (AFY).
- Field measurements of elevations of groundwater, surface water, and land surface shall be measured and reported in feet to an accuracy of at least 0.1 feet relative to NAVD88, or another national standard that is convertible to NAVD88, and the method of measurement described.
- Reference point elevations shall be measured and reported in feet to an accuracy of at least 0.5 feet, or the best available information, relative to NAVD88, or another national standard that is convertible to NAVD88, and the method of measurement described.
- Geographic locations shall be reported in GPS coordinates by latitude and longitude in decimal degree to seven decimal places, to a minimum accuracy of 30 feet, relative to NAD83, or another national standard that is convertible to NAD83.

16.3. Representative Monitoring

§ 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.

(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.

(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.

(c) The designation of a representative monitoring site shall be supported by adequate evidence demonstrating that the site reflects general conditions in the area.

As described in Section *15216.1 Description of Monitoring Network*, the Basin has defined a SGMA Monitoring Network for each relevant Sustainability Indicator to the Basin that will be used for SGMA reporting purposes to evaluate Plan implementation with respect to meeting the Sustainability Goal defined for the Basin through compliance with the MTs and MOs described herein.

As described in Sections *16.1.2* and *16.1.6*, the Monitoring Network for Chronic Lowering of Groundwater Levels will be used as a proxy to monitor the Reduction in Groundwater Storage and Depletions of Interconnected Surface Water Sustainability Indicators. As described in Sections *14.2* and *14.6* groundwater levels are considered sufficiently protective of Reduction in Groundwater Storage and Depletions of Interconnected Surface Water, and thus no SMCs have been separately defined for these Sustainability Indicators.

As shown on **Figure MN-1**, the RMWs for Chronic Lowering of Groundwater Levels include:

- **TRC-MW16D** is a dedicated monitoring well with known well construction and location information; is near LCWD's public supply wells, the upgradient basin boundary, and Cuddy Creek; and has consistent groundwater level measurements over the last 12 years. This well will provide adequate monitoring of groundwater levels in the main Castac Lake area of the Basin near wells used for beneficial uses. This well also provides the ability to collect water level data near the boundary with the sole adjoining basin (the Cuddy Canyon Valley Basin, located upgradient of the Castac Basin), which allows monitoring of future water level and groundwater storage trends at their common boundary. Thus, potential adverse effects on the upgradient basin due to groundwater management practices in the Basin can be monitored using the RMWs.

- **TRC-MW18D** is a dedicated monitoring well with known well construction and location information; is located in the center of the Basin and is screened at depths similar to nearby domestic production wells; and has consistent groundwater level measurements over the last 12 years. This well will provide adequate monitoring of groundwater levels in the main Castac Lake area of the Basin and help quantify any potential changes in groundwater gradients when used concurrently with the groundwater level measurements obtained from TRC-MW16D.
- **TRC-MW23D** is a dedicated monitoring well with known well construction and location information; is near Krista Mutual Water Company (KMWC)'s and TRC's public supply wells; is located partway down the Grapevine Canyon area of the Basin, in an area that has historically supported GDEs; and has consistent groundwater level measurements over the last 12 years. This well will provide adequate monitoring of groundwater levels in the Grapevine Canyon area of the Basin near wells used for beneficial uses and in areas that have historical supported beneficial users of groundwater (e.g., GDEs).

Additionally, water quality data collected from public supply wells (Krista MWC-PW, LCWD-Lebec PW, LCWD-State PW, Tejon MS Well, TRC-PW60, TRC-PW81, W0601500415_1500415-003, and W0601510301_1510301-001) will be used to inform trend analyses for the Degraded Water Quality Sustainability Indicator.

16.4. Assessment and Improvement of Monitoring Network

§ 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.

(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.

(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.

(2) Local issues and circumstances that limit or prevent monitoring.

(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.

(e) Each Agency shall adjust the monitoring frequency and density of monitoring sites to provide an adequate level of detail about site-specific surface water and groundwater conditions and to assess the effectiveness of management actions under circumstances that include the following:

(1) Minimum threshold exceedances.

(2) Highly variable spatial or temporal conditions.

(3) Adverse impacts to beneficial uses and users of groundwater.

(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.

16.4.1. Review and Evaluation of the Monitoring Network

Per the GSP Emergency Regulations (23-CCR § 354.38), the SGMA Monitoring Network will be reevaluated in each five-year GSP update, 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 (23-CCR § 354.38(a)), and will be adjusted, as necessary.

16.4.2. Identification and Description of Data Gaps

Available information for each RMW is shown in **Table MN-2**. The RMWs conform to DWR's BMPs for monitoring networks (DWR, 2016c) and have all required information to become integrated into the SGMA Monitoring Network.

Data collected from public water system wells and reported to the SWRCB will be downloaded from the SDWIS portal and compiled to supplement trend analyses for the Degraded Water Quality Sustainability Indicator. Five out of the eight public water system wells supplementing the RMWs for Degraded Water Quality are currently missing accurate spatial location information and well screen interval information.

As identified in Section *9.5 Water Budget Uncertainty and Limitations*, upgradient groundwater inflow is a source of uncertainty in the historical and future projected water budgets. Quantifying groundwater inflow via gradients between monitoring wells located up- and down-gradient of the boundary would help quantify the Basin's water budget.

Stream gaging data is currently unavailable for Cuddy Creek and Grapevine Creek. The stream gage on Cuddy Creek at Lebec is operated by Kern County, but only measures the peak seasonal flow and is not capable of recording real time flow or stage data.

16.4.3. Description of Steps to Fill Data Gaps

The Castac Basin GSA has proposed a plan to fill the data gaps associated with the upgradient groundwater inflow by installing a new monitoring well to monitor groundwater levels and enable a better quantification of the groundwater gradient near the Basin boundary.

16.4.4. Monitoring Frequency and Density of Sites

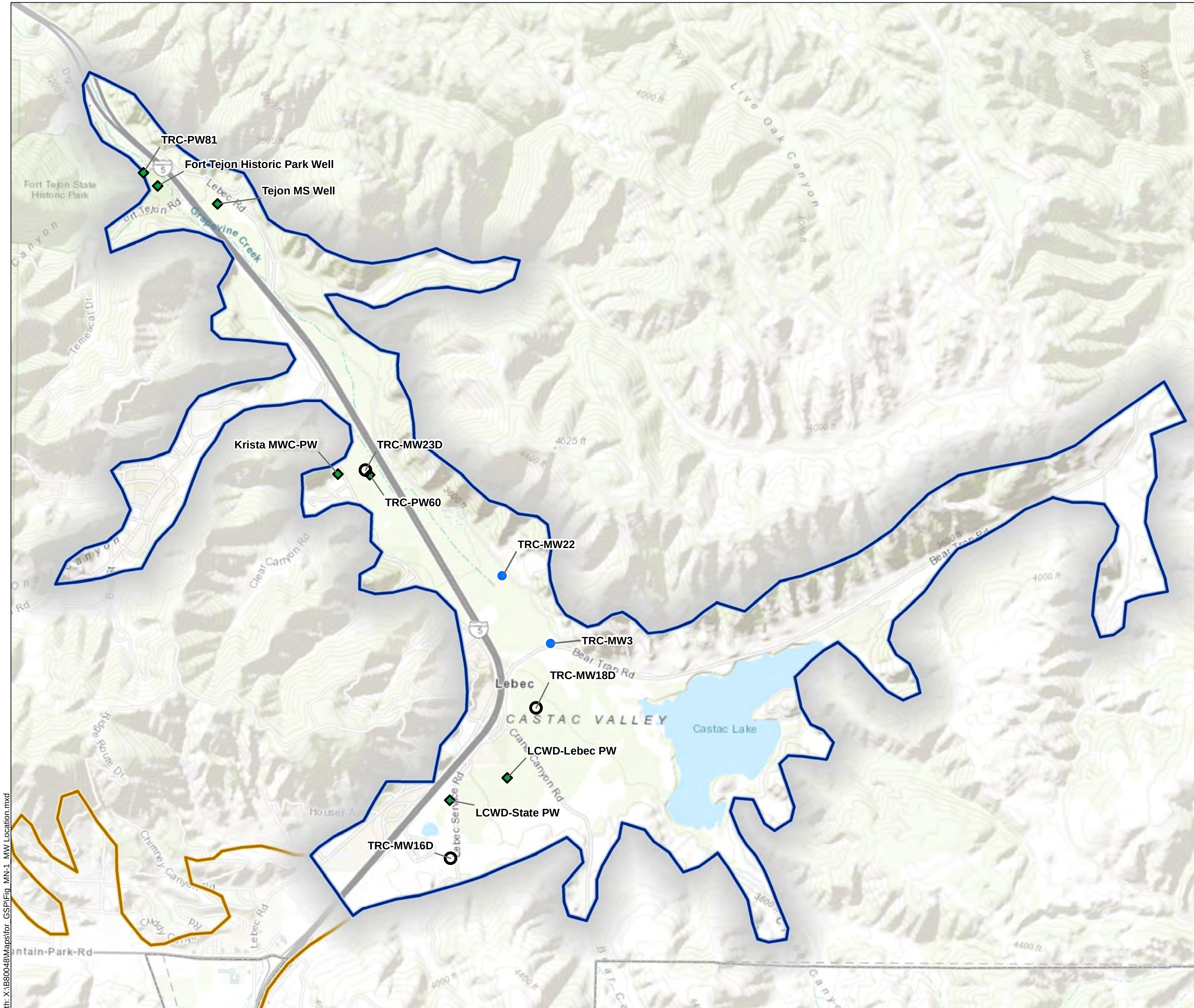
Groundwater level data will be collected from RMWs semi-annually, in compliance with the applicable monitoring protocols outlined in Section *16.2 Monitoring Protocols for Data Collection and Monitoring* above. The SGMA Monitoring Network developed for each Sustainability Indicator includes a sufficient frequency to meet the monitoring objectives outlined in Section *16.1 Description of Monitoring Network*

According to DWR's *Monitoring Network and Identification of Data Gaps* BMP (DWR, 2016c), monitoring well density should be between 0.2 and ten wells per 100 square miles. As Castac Basin is only 5.5 square miles, one RMW would be compliant with these criteria. However, based on the spatial distribution of production wells and groundwater level characteristics in the Basin, the GSA found it appropriate to establish three RMWs for the Chronic Lowering of Groundwater Levels Sustainability Indicator. Therefore, the density of RMWs is over 50 times that recommended by DWR.

16.5. Reporting Monitoring Data to the Department

> *§ 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.*

Data collected from the SGMA Monitoring Network will be uploaded to the Castac Basin DMS and reported to DWR in accordance with applicable monitoring and reporting protocols (see Section *16.2 Monitoring Protocols for Data Collection and Monitoring* above). Additional data collected as part of other regular monitoring programs within the Basin (i.e., water quality sampling as reported to the SWRCB) will be used in conjunction with data collected from the SGMA Monitoring Network to meet compliance with GSP regulations associated with Annual Reporting (23-CCR §356.2) or as otherwise deemed necessary.



Legend

- Water Level Representative Monitoring Well
- Supplemental Monitoring Well
- Public Supply Well
- Castac Lake Valley Groundwater Basin
- Other Groundwater Basin
- County Boundary

Abbreviations

DWR = California Department of Water Resources

Notes

1. All locations are approximate.
2. Water quality data monitored by public supply wells as part of their compliance with the Division of Drinking Water will be compiled to support the water quality data analysis.
3. Supplemental Monitoring Well will be monitored to establish water quality baseline conditions.

Sources

1. Groundwater basin boundaries from DWR Bulletin 118 Interim Update 2016.
2. Basemap is ESRI's ArcGIS Online world topographic map, obtained 10 March 2020.

N

0 0.5 1

(Scale in Miles)

Monitoring Network Well Locations

DRAFT

eki environment & water

Castac Basin GSA Kern County, California

June 2020

B80048.00

Figure MN-1

Path: X:\B80048\Maps\for_GSP\Fig_MN-1_MW Location.mxd

PROJECTS AND MANAGEMENT ACTIONS

17. 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.

Pursuant to the Groundwater Sustainability Plan (GSP) Emergency Regulations, this section presents the Projects and Management Actions (P&MAs) proposed to support achievement of the sustainability goal within the Castac Lake Valley Basin (Basin) (23-California Code of Regulations [CCR] § 354.42). To the extent that information was available, the P&MAs presented herein were developed by the Castac Basin Groundwater Sustainability Agency (GSA) with consideration of feasibility, costs and benefits. However, it is anticipated that some P&MAs will require further evaluation (e.g., engineering, economic, environmental, legal, etc.) prior to implementation.

This section first presents the goals and objectives of the P&MAs, including the relevant Sustainability Indicators they address and the categories of expected benefits. A list of specific P&MAs grouped by benefit category and type is presented, and provided in **Table PMA-1** (detailed P&MA Information Forms are included in Appendix *J*). This section also includes a discussion of how the P&MAs are anticipated to address Undesirable Results; a description of the various potentially applicable permitting and regulatory requirements; a discussion of the P&MA status and implementation timeline; a discussion of the expected benefits or how expected benefits will be evaluated; a description of the sources of water that will support P&MA implementation; a discussion of the legal authority required to implement the P&MAs; and a summary of estimated P&MA costs and how the GSA plans to fund PM&A implementation.

17.1. Goals and Objectives of Projects and Management Actions

17.1.1. Relevant Sustainability Indicators

Per the GSP Emergency Regulations, GSPs must include P&MAs to address any existing or potential future Undesirable Results for the identified relevant Sustainability Indicators (23-CCR § 354.44). As discussed in Sections *13, 14, 15,* and *16*, the relevant Sustainability Indicators in the Basin include: (1) Chronic Lowering of Groundwater Levels, (2) Reduction of Groundwater Storage, and (3) Depletions of Interconnected Surface Water. Because groundwater levels, groundwater storage, and interconnected surface water are directly correlated, P&MAs that address groundwater levels also address groundwater storage and interconnected surface water, and the three Sustainability Indicators are considered together in this discussion of P&MAs.

17.1.2. Benefit Categories

The primary water management "tools" by which GSAs can address conditions that may lead to Undesirable Results associated with water quantity (i.e., Chronic Lowering of Groundwater Levels and Reduction of Groundwater Storage) pertain to management of inflows (supplies) and outflows (demands). Therefore, the primary categories of expected benefits for these water quantity-related P&MAs include: (1) water supply augmentation, and (2) water demand reduction.

All of the P&MAs that have water quantity-related benefits are in the water supply augmentation category. In addition, some of the P&MAs also have secondary benefits, including:

1) Flood control;
2) Water management flexibility/efficiency;
3) Water quality improvements; and
4) Improved data collection for ongoing reporting compliance and water budget quantification.

17.2. List of Projects and Management Actions

§ 354.44. Projects and Management Actions

(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.

(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.

This section provides a list of the six P&MAs identified to date by the Castac Basin GSA. Details of the P&MAs are provided in **Table PMA-1** and in the P&MA forms included in Appendix *J*. **Figure PMA-1** shows the approximate locations of these P&MAs within the Basin. The P&MAs are classified into six types based on the mechanism by which the primary benefit is achieved.

The P&MAs listed below have supply augmentation as their primary expected benefit:

- Enhanced Recharge: The *Aquifer Replenishment Project* (P&MA #1) consists of importing surface water through TCWD's Bear Trap turnout on the California Aqueduct to maintain Castac Lake initially at a lake depth of eight to ten feet (stage of 3,493 to 3,495 feet above mean sea level, ft msl). As discussed in more detail in Section *17.8 Expected Benefits*, based on future projected scenarios using the Castac Basin Numerical Model, it is estimated that P&MA #1, if implemented as modeled, could increase groundwater recharge to the Basin by an average of 70 to 100 acre-feet per year (AFY). This lake management scenario has been modeled assuming that surplus imported surface water supplies remain available. However, the effectiveness of P&MA #1 will be assessed periodically and should imported supplies become restricted in the future or be required for other beneficial uses, Basin conditions and the particulars of P&MA #1 implementation will be re-assessed.

- Manage and/or Capture Floodwater: The *Cuddy Creek Bank Modifications Project* (P&MA #2) would entail modifying the bank of Cuddy Creek to retain floodwaters for a longer stretch of creek, thereby increasing the likelihood for groundwater recharge, subject to constraints of permitting and (as required by SGMA) in accordance with applicable water rights. The potential volumetric benefits of this project have not yet been quantified.

- Increase Delivery Flexibility: The *Krista Mutual Water Company (KMWC) Emergency Interconnect with Lebec County Water District (LCWD)* (P&MA #3) is an infrastructure project which would connect the LCWD and KMWC distribution systems so that KMWC could utilize groundwater pumped from the LCWD wells if KMWC is unable to utilize their existing public supply well. This project does not generate additional supply, but does increase water supply reliability for LCWD and KMWC and provide flexibility for shifting demands within the Basin in the event that Undesirable Results are observed.

- Develop New Supplies: The *Wastewater Reclamation Project* (P&MA #4) will combine future, highly-treated reclaimed water produced from the Tejon Mountain Village (TMV) development with imported surface water (as needed) to maintain Castac Lake levels and meet some landscape irrigation demands. The volumetric benefits to the aquifer would be similar to those of PM&A #1; this project just would reduce the demand for imported surface water through the use of recycled water.

Some P&MAs are anticipated to have other expected benefits, including:

- Water Quality Improvements: The *Frazier Mountain High School Water Project* (P&MA #5) aims to improve the drinking water quality delivered to Frazier Mountain High School, which has high uranium concentrations, by serving the high school with groundwater pumped from a planned new LCWD well located within the Basin.

- Improved data collection for ongoing reporting compliance and water budget quantification: The Management Action *Well Metering and Data Collection* (P&MA #6) entails installing meters on supply wells within the Basin and regularly collecting pumping data from those wells. Improved estimates of groundwater extraction in the Basin will aid in quantifying any relationships between groundwater use, groundwater levels, and groundwater quality, as well as provide the necessary information for annual reporting required under CCR § 356.2(b)(2). Metering pumping of wells under this project would not supersede existing requirements for metering and reporting pumping, water quality, and other data at municipal production wells in the Basin. De minimis users (i.e., those pumping 2 AFY or less) would be exempt from metering requirements.

Table PMA-1. Details of Projects and Management Actions

P&MA Name	Summary Description	Relevant Sustainability Indicators Affected: Groundwater Levels & Storage	Groundwater Quality	Interconnected Surface Water	Circumstances for Implementation	Public Noticing Process	Permitting and Regulatory Process Requirements	Status	Timetable / Circumstances for Initiation
Projects to Enhance Recharge									
#1 - Aquifer Replenishment Project	Castac Lake to be maintained initially at a lake depth of approximately 8 to 10 feet (stage of 3,493 to 3,495 ft msl) via imported surface water deliveries to the lake, subject to imported surface water availability.	x	TBD	x	Upon initiation of TMV Phase 1 construction	Will be dependent on Permitting and Regulatory Process Requirements	Possibly CEQA/NEPA/CDFW/U.S.FWS/ USACE/SWPPP	Not yet initiated	Upon initiation of TMV Phase 1 construction; estimated 2023
Projects to Manage and/or Capture Floodwater									
#2 - Cuddy Creek Bank Modifications	The banks of Cuddy Creek would be modified to increase floodwater and stormwater recharge during wet years.	x	TBD	x	TBD based on future Basin groundwater levels	Will be dependent on Permitting and Regulatory Process Requirements	Water rights permitting; possibly CDFW Lake and Streambed Alteration Agreement; CEQA/NEPA/USACE/U.S.FWS	Not yet initiated	Decision by the LCWD and Castac Basin GSA Board
Projects to Increase Delivery / Flexibility									
#3 - Krista Emergency Interconnect with LCWD	Construction of new intertie between LCWD and KMWC to facilitate water exchanges between the two public water systems in emergency situations.		x		Underway	Consistent with Permitting and Regulatory Process Requirements	Construction permits, CEQA compliance	Initiated in 2019	Underway
Projects to Develop New Supplies									
#4 - Wastewater Reclamation	Future highly-treated reclaimed water produced from the TMV development will be used to maintain Castac Lake levels and meet some landscape irrigation demands.	x		x	Upon initiation of TMV Phase 1 construction	Will be dependent on Permitting and Regulatory Process Requirements	SWRCB Waste Discharge Requirements; Possibly CEQA/NEPA/CDFW/U.S.FWS/ USACE/SWPPP	Not yet initiated	Upon completion of TMV Water Resources Recovery Facility; estimated 2023 to 2026
Projects to Improve Drinking Water Quality									
#5 - Frazier Mountain High School Water Project	LCWD to provide drinking water to FMHS (FMHS well is in violation of uranium levels and has been ordered by the state to find another source) by annexing and supplying FMHS with 2.5 million gallons of drinking water per year from the new LCWD well planned in the Basin.		x		Upon receipt of grant funding	Will be Dependent on Permitting and Regulatory Process Requirements	Title 22 Standards, construction permit, encroachment permit and transport, CEQA mitigated negative declaration	Not yet initiated	Upon receipt of grant funds
Management Action / Improved data collection for ongoing reporting compliance and water budget quantification									
#6 - Well Metering and Data Collection	At the GSA's direction, groundwater extractors shall determine and report monthly pumping volumes using equipment and methods approved by the GSA, in a format satisfactory to the GSA. For individual wells in which meters are not installed, or monthly extraction volumes are not recorded or available, the GSA may 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 groundwater extractors, 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).	x			Upon adoption of the GSP	District flyers, direct mail, public meetings	None	Not yet initiated	In preparation of the first Annual Report; estimated 2020-2021

Table PMA-1. Details of Projects and Management Actions (continued)

P&MA Name	Timetable for Completion	Timetable for Accrual of Expected Benefits	Expected Benefits						Source(s) of Water, if applicable	Legal Authority Required	Estimated Costs		
			Primary		Secondary								
			Water Supply Augmentation	Water Demand Reduction	Water Quality Improvement	Flood Control	Water Management Flexibility / Efficiency	Data Gap Filling/ Monitoring			One-time Costs	Ongoing Costs (per year)	Potential Funding Source(s)
Projects to Enhance Recharge													
#1 - Aquifer Replenishment Project	Initiation and completion dates are under evaluation	Augmented recharge is anticipated to begin upon project initiation	70 - 100 AFY		x		x		Imported Surface Water	Consistent with Castac Basin GSA authority pursuant to CWC Section 10726.2(b); Pursuant to TCWD's authority as a water district	$ 6,889,859	$ 721,092	TCWD/TMV Developer
Projects to Manage and/or Capture Floodwater													
#2 - Cuddy Creek Bank Modifications	TBD	TBD	TBD		x	x	x		Local stormwater	Consistent with Castac Basin GSA authority pursuant to CWC Section 10726.2(b)	TBD	TBD	LCWD
Projects to Increase Delivery / Flexibility													
#3 - Krista Emergency Interconnect with LCWD	Initiated in 2019, completion date TBD	Upon project completion			x		x		Groundwater	Consistent with LCWD authority as a water district and KMWC's authority as a public water system	$ 565,794	$ 37,800	SWRCB SRF Grant
Projects to Develop New Supplies													
#4 - Wastewater Reclamation	Initiate in 2023, infrastructure completed 2026, complete to full capacity in 2041	Upon project initiation	70 – 100 AFY				x		Reclaimed water	Consistent with Castac Basin GSA authority pursuant to CWC Section 10726.2(b); Pursuant to TCWD's authority as a water district	$ 2,583,132	$ 30,546	TCWD/TMV Developer
Projects to Improve Drinking Water Quality													
#5 - Frazier Mountain High School Water Project	2021	Upon project completion			x				Groundwater	Consistent with LCWD's authority as a water district	$ 1,027,600	$ 17,200	Grants: Drinking Water SRF, Senate Bill 200, Proposition 68; Service connection user payment
Management Action / Improved data collection for ongoing reporting compliance and water budget quantification													
#6 - Well Metering and Data Collection	Initiate in 2020-2021	Upon project initiation						x	NA	GSA right established under CWC Section 10725.8	TBD	TBD	Well owner or operator, potential grant funds

Abbreviations:

AFY = acre-feet per year
CDFW = California Department of Fish and Wildlife
CEQA = California Environmental Quality Act
CWC = California Water Code
GSA = Groundwater Sustainability Agency
GSP = Groundwater Sustainability Plan
FMHS = Frazier Mountain High School
KMWC = Krista Mutual Water Company
LCWD = Lebec County Water District
NA = Not Applicable
NEPA = National Environmental Protection Act
P&MA = Project and/or Management Action
SRF = State Revolving Fund
SWPPP = Stormwater Pollution Prevention Plans
SWRCB = State Water Resources Control Board
TBD = to be determine
TCWD = Tejon-Castac Water District
TMV = Tejon Mountain Village
USACE = United States Army Corps of Engineers
U.S. FWS = United States Fish and Wildlife Service

Note: Summary table developed based off information provided by the Castac Basin GSA, see *Appendix J* for details.

17.3. Circumstances for Implementation

The Castac Basin GSA is proactively pursuing P&MA implementation. As indicated in **Table PMA-1**, certain P&MAs will be initiated within the first five years of GSP adoption, whereas others will be implemented incrementally on an as-needed basis to achieve the Sustainability Goal for the Basin. For example, P&MA #6 *Well Metering and Data Collection* and P&MA #1 *Aquifer Replenishment Project* and are anticipated to be implemented beginning in 2020-2021 and 2023, respectively. Furthermore, the P&MA #5 *Frazier Mountain High School Water Project* and P&MA #3 *KMWC Emergency Interconnect with LCWD Project* are in engineering planning stages, pending grant funding approvals.

Other P&MAs, like P&MA #2 *Cuddy Creek Bank Modifications Project,* do not have a current timetable for implementation. It is anticipated that implementation of these P&MAs will be dependent upon the Basin response to climatic conditions throughout the GSP implementation horizon, or as deemed necessary by the Castac Basin GSA if minimum thresholds (MTs) for Chronic Lowering of Groundwater Levels are exceeded in Representative Monitoring Wells (RMWs). Additional triggers for implementation may include when grant funds are obtained, or upon completion of feasibility studies, economic evaluations, and/or other necessary planning studies.

17.4. Public Notice Process

Public notice requirements vary for the different P&MAs (see **Table PMA-1**). Some projects that involve infrastructure improvements may not require specific public noticing (other than that related to construction). In general, the P&MAs being considered for implementation will be discussed during regular Castac Basin GSA Board Meetings which are open to the public. Additional stakeholder outreach efforts will be conducted prior to and during P&MA implementation by the project proponent(s), as required by law.

17.5. Addressing Overdraft Conditions

§ 354.44. Projects and Management Actions

(b) Each Plan shall include a description of the projects and management actions that include the following:

…

(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.

As discussed in Section *9.2.3 Change in Groundwater Storage*, although the Basin shows a negative cumulative change in storage over the entire historical period (i.e., Water Years 1998 through 2018), the Basin is primarily driven by climatic impacts whereby prior to the extreme drought, the Basin would vary between positive and negative storage change. Moreover, as discussed in Section *9.2.4 Overdraft Conditions*, over the 12-year overdraft examination period that overlaps with that used by the California Department of Water Resources (DWR)'s overdraft evaluation (i.e., Water Years 1998 and 2009), the Basin's average change in storage was positive.

Groundwater levels have shown persistent decreasing trends since 2007, closely following the decreasing rainfall cumulative departure from average (see **Figure GWC-7**). Moreover, groundwater level trends show an inverse relationship to groundwater pumping (i.e., even though groundwater pumping volumes decreased since 2007, groundwater levels continued to decline; see **Figure GWC-7**), suggesting that the groundwater system is highly sensitive to climate rather than groundwater extractions.

The results from the Castac Basin Numerical Model runs indicate that under the 2030 Climate Change Scenario and the 2070 Climate Change Scenario, the projected Basin cumulative storage change remains fairly stable (see **Table WB-9** and **Figure WB-20**). The P&MAs presented herein are expected to result in benefits (discussed below) so as to avoid Undesirable Results and maintain sustainability in the Basin. For example, P&MA #1 *Aquifer Replenishment Project* is anticipated to increase groundwater recharge by 70 to 100 AFY and the Castac Basin Numerical Model scenarios which include the *Aquifer Replenishment Project* show a positive average annual change in groundwater storage (see **Table WB-9** and **Figure WB-20**).

17.6. Permitting and Regulatory Process

> *§ 354.44. Projects and Management Actions*
>
> *(b) Each Plan shall include a description of the projects and management actions that include the following:*
>
> *…*
>
> *(3) A summary of the permitting and regulatory process required for each project and management action.*

As shown in **Table PMA-1**, the permitting and regulatory requirements vary for the different P&MAs depending on whether they are infrastructure projects, recharge projects, demand reduction management actions, and so forth. The various types of permitting and regulatory requirements (not all applicable to every P&MA) include the following, if applicable:

1. Federal
    - National Environmental Policy Act (NEPA) documentation, if federal grant funds are used;

- National Pollution Discharge Elimination System (NPDES) stormwater program permit administered by the California State Water Resources Control Board (SWRCB) and associated Stormwater Pollution Prevention Plan (SWPPP);
- United States Fish and Wildlife Services (U.S. FWS) permit(s); and/or
- United States Army Corps of Engineers (USACE) permit(s).

2. State
    - California Environmental Quality Act (CEQA) documentation, including one or more of the following: Initial Study (IS), Categorical Exemption (CE), Negative Declaration (ND), Mitigated Negative Declaration (MND), Environmental Impact Report (EIR);
    - State Water Resources Control Board (SWRCB) permits and regulations regarding water rights permits and recycled water use; and/or
    - California Department of Fish and Wildlife (CDFW) Lake and Streambed Alteration Agreement.
3. Regional
    - San Joaquin Valley Air Pollution Control District (SJVAPCD) permit and regulations.
4. County/Local
    - Encroachment permits – Kern County, California Department of Transportation (CalTrans), and others;
    - Kern County grading permit; and/or
    - Kern County well construction permit.

Specific, currently-identified permitting and regulatory requirements for each P&MA are listed in **Table PMA-1**. Upon initiation of each P&MA, the regulatory and permitting requirements of the P&MA will be re-examined.

As with any Projects and Management Actions planned or implemented under SGMA, actions undertaken will remain in compliance with existing water rights constraints and processes under California law.

17.7. Status and Implementation Timetable

> *§ 354.44. Projects and Management Actions*
>
> *(b) Each Plan shall include a description of the projects and management actions that include the following:*
>
> *…*
>
> *(4) The status of each project and management action, including a time-table for expected initiation and completion, and the accrual of expected benefits.*

Table PMA-1 shows the current status of each P&MA. The Castac Basin GSA is proactively pursuing P&MA implementation. For example, as discussed above in Section *17.3 Circumstances* *for Implementation*, P&MA #6 *Well Metering and Data Collection* and P&MA #1 *Aquifer Replenishment Project* are anticipated to be initiated in 2020-2021 and 2023, respectively; P&MA #5 *Frazier Mountain High School Water Project* and P&MA #3 *KMWC Emergency Interconnect with LCWD Project* are in engineering planning stages, pending grant funding approvals. **Table PMA-1** presents preliminary estimates of the time required to complete/implement each P&MA and a timetable for accrual of expected benefits. These estimates will be refined, as necessary, upon further evaluation and/or initiation of the P&MAs.

17.8. Expected Benefits

§ 354.44. Projects and Management Actions

(b) Each Plan shall include a description of the projects and management actions that include the following:

…

(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.

The different categories of expected benefits are presented above in Section *17.1.2 Benefit Categories*, and the specific expected benefits of each P&MA are presented in **Table PMA-1**. Below is a discussion of how the expected benefits will be evaluated.

Most P&MAs have expected benefits related to water quantity. Once a P&MA is implemented, it is important to evaluate, and ideally to quantify, the benefits resulting from a given P&MA. The way in which P&MA benefits are evaluated/quantified depends on the P&MA.

Expected benefits from P&MA #1 *Aquifer Replenishment Project* include increased groundwater recharge, groundwater storage, and increases in groundwater levels downgradient of Castac Lake. These benefits to the groundwater system were estimated using the Castac Basin Numerical Model and can be confirmed over the long-term using water level measurements. As discussed in more detail in Section *9.4*, the *Aquifer Replenishment Project* was simulated using the Castac Numerical Model under the assumption that the water level in Castac Lake would be maintained at a constant water depth of eight to 10 feet, measured from the base of the lakebed. This assumption may not be achievable under future conditions, so lake management will be a dynamic process, subject to re-evaluation should availability of imported surface water become more limited, or if other beneficial uses require additional water supply.

Upon implementation, P&MA# 1 *Aquifer Replenishment Project* is estimated to add an additional 70 to 100 AFY of groundwater replenishment to the Basin (and up to 300 AFY on certain years), resulting in a net increase in groundwater storage of approximately 30 AFY under each climate scenario (**Figure WB-21**).

Furthermore, the Castac Basin Numerical Model was used to assess water level responses to GSP implementation relative to proposed Sustainable Management Criteria for Chronic Lowering of Groundwater Levels. As demonstrated in **Figure PMA-2**, projected groundwater elevations in all RMWs are expected to remain at or above the MTs under P&MA #1 *Aquifer Replenishment Project* implementation scenarios. The modeling results support the notion that the proposed P&MA implementation strategy is expected to result in sustainable management of groundwater levels within the Basin, as measured against the definition of Undesirable Results (i.e., if groundwater levels fall below the MT for Chronic Lowering of Groundwater Levels in any two representative monitoring wells for four consecutive semi-annual monitoring events). It should be noted that the P&MA #1 scenario has been modeled assuming that surplus imported surface water supplies remain available. The effectiveness of P&MA #1 will be assessed periodically and should imported supplies become restricted in the future or be required for other beneficial uses, Basin conditions and the particulars of P&MA #1 implementation will be re-assessed at that time.

Expected benefits from P&MA #2 *Cuddy Creek Bank Modifications Project* include increased groundwater recharge, and some amount of increased groundwater storage and groundwater levels in proximity to the creek. Once the project is better defined, these benefits could be quantified through modeling and measurement of groundwater levels in monitoring wells adjacent to Cuddy Creek (i.e., TRC-MW16D).

For P&MAs that involve indirect supply augmentation through, for example, increased delivery flexibility (P&MA #3) or use of reclaimed wastewater (P&MA #4), quantification of the benefit will require a comparison of the observed water supply condition (e.g., groundwater delivered to KMWC from LCWD wells) against a hypothetical condition where the P&MA was not in place (e.g., groundwater extractions from KMWC well). Once these P&MAs are better defined, these benefits could be quantified through modeling, water level measurements, and/or tracking of groundwater production volumes.

Expected benefits from P&MA #5 *Frazier Mountain High School Water Project* include the service of reliable drinking water with water quality constituent concentrations that fall below the State of California and the U.S. Environmental Protection Agency (USEPA) Maximum Contaminant Levels (MCLs). Benefits will be quantified by water quality sampling, as required of public water systems under CCR Title 22.

Finally, expected benefits of P&MA #6 *Well Metering and Data Collection* include a more accurate quantification of Basin groundwater extraction for both water budget accounting and Annual Reporting. Metered groundwater extraction volumes can improve the water budget accounting for the Basin. Benefits could be quantified by integrating future metered extraction volumes into the Castac Basin Numerical Model, conducting a post audit to validate the prior model calibration, and/or re-calibrating the model based on the new data collected.

The goals and objectives of P&MA implementation are not necessarily to achieve a certain water budget outcome, but rather to increase the likelihood that Undesirable Results for relevant Sustainability Indicators are avoided by the end of the Sustainable Groundwater Management Act (SGMA) implementation period (i.e., by 2040). For this reason, ultimately the success of the collective implementation of P&MAs will be determined by whether the Sustainability Goal is achieved.

17.9. Source and Reliability of Water from Outside the Basin

> *§ 354.44. Projects and Management Actions*
>
> *(b) Each Plan shall include a description of the projects and management actions that include the following:*
>
> *…*
>
> *(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.*

Several of the P&MAs discussed below and shown in **Table PMA-1** rely on additional water supplies from outside of the Basin. P&MA #1 *Aquifer Replenishment Project* and P&MA #4 *Wastewater Reclamation Project* rely on the availability of imported surface water and the associated availability of reclaimed water. Because of the nature of the Tejon-Castac Water District (TCWD) surface water contracts and management options (e.g., water banking operations) and access to other water sources that can be purchased outside of its contracts, TCWD's anticipated imported surface water supply (and therefore the reclaimed water) is projected to exceed total projected demand under various average year water reliability assumptions (TCWD, 2008). The TCWD supply also is projected to exceed the County-requested water bank storage volumes under multi-year drought scenarios and is therefore assumed to be very reliable for future use (TCWD, 2008). As previously discussed, P&MA #1 implementation assumes that surplus imported surface water supplies remain available. The effectiveness of P&MA #1 will be assessed periodically and should imported supplies become restricted in the future or be required for other beneficial uses, Basin conditions and the particulars of P&MA #1 implementation will be re-assessed at that time.

P&MA #2 *Cuddy Creek Bank Modifications Project* relies on the availability of rainfall runoff from upgradient watersheds during wet years to create significant flow in Cuddy Creek, thereby enabling stormwater capture. As rainfall runoff is naturally controlled by climate, the future frequency, volume and reliability of Cuddy Creek stormflows is uncertain. Additionally, constraints on increased capture due to existing water rights in the Basin and in other basins may limit the potential yield of this project.

17.10. Legal Authority Required

§ 354.44. Projects and Management Actions

(b) Each Plan shall include a description of the projects and management actions that include the following:

…

(7) A description of the legal authority required for each project and management action, and the basis for that authority within the Agency.

The Castac Basin GSA is organized as a Joint Powers Agreement (JPA) between TCWD, LCWD, and the County of Kern. Per California Water Code (CWC) § 10725 through 10726.8, the Castac Basin GSA possesses the legal authority necessary to implement the supply augmentation and demand management P&MAs described herein, and will enforce these P&MAs as necessary or will delegate authority to TCWD or LCWD, as appropriate, to enforce the GSP.

17.11. Estimated Costs and Plans to Meet Them

§ 354.44. Projects and Management Actions

(b) Each Plan shall include a description of the projects and management actions that include the following:

…

(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.

Estimated costs for each P&MA are presented in **Table PMA-1**. Given the uncertainty in the scope and timing of these P&MAs, the costs are presented as ranges. These costs include "one-time" costs and ongoing costs. The one-time costs may include capital costs associated with construction, feasibility studies, permitting, environmental (e.g., CEQA) compliance, or any other costs required to initiate a given P&MA. The ongoing costs are associated with operations & maintenance (O&M), water purchases, and/or costs to otherwise continue implementing a given P&MA. It should be noted that depending on the source and nature of funding for the P&MAs, the one-time costs may or may not be incurred entirely at the beginning of the P&MA; in some instances, grants or other financing options may allow for spreading out of "one-time" costs over time.

Potential sources of funding for the various P&MAs are also presented in **Table PMA-1**, and include TCWD funds, grant funding from sources including SWRCB State Revolving Fund (SRF) and Drinking Water SRF, LCWD or KMWC rate payers, and other potential sources. The lead agency proposing the P&MA will be responsible for securing funding for the P&MA. Upon implementation of any given P&MA, the available funding sources for that P&MA will be confirmed.

17.12. Management of Recharge and Groundwater Extractions

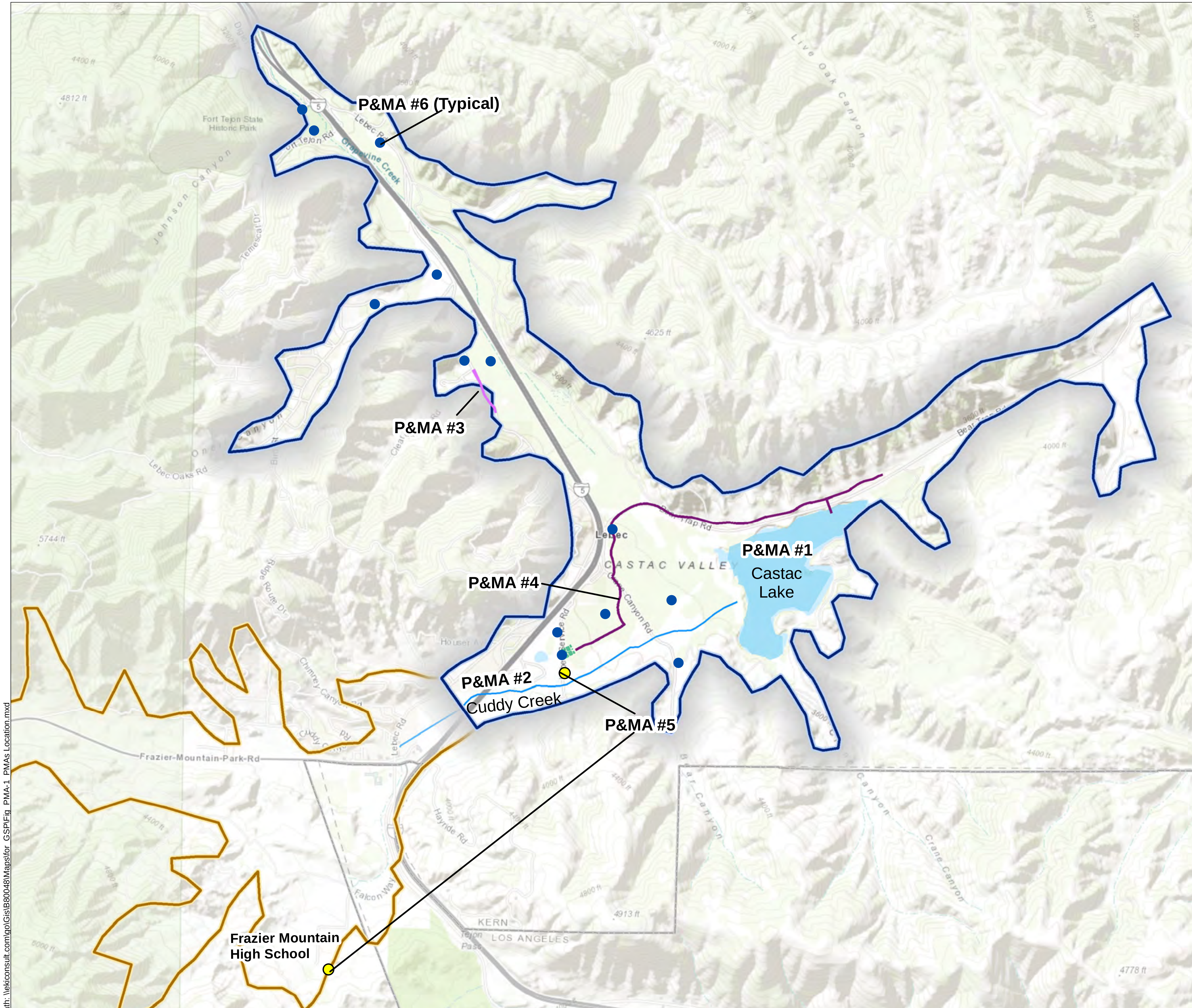
§ 354.44. Projects and Management Actions

(b) Each Plan shall include a description of the projects and management actions that include the following:

…

(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.

As stated previously in Section *9 Water Budget Information*, under historical conditions (Water Years 1998 – 2018), the cumulative storage for the Basin declined. Historical groundwater level trends and the historical water budget show that the declining trends observed in the Basin's groundwater levels and storage are primarily driven by climate, do not have a strong relationship with groundwater extraction volumes, and are sensitive to groundwater inflow volumes from up-gradient basins. The scenarios that were used to project future water budget conditions show that, on average, groundwater storage is projected to remain relatively stable, even under the modeled climate change conditions. If the P&MA #1 *Aquifer Replenishment Project* is implemented, a slight increase in groundwater storage is projected to occur (see **Figure WB-21**). Finally, the P&MA portfolio includes P&MA #2 *Cuddy Creek Bank Modifications Project* which, if implemented, would take additional advantage of wet year supplies (i.e., increased rainfall and runoff) to increase aquifer recharge, within the constraints of existing water rights in the Basin and in adjoining basins. Therefore, the Castac Basin GSA's P&MA efforts are designed to increase the likelihood that groundwater levels and storage declines during future drought periods will be offset, to the extent possible, by increases in groundwater levels and storage during other periods.



Legend

- Castac Lake Valley Groundwater Basin
- Other Groundwater Basin
- County Boundary
- P&MA #1 Aquifer Replenishment Project
- P&MA #2 Cuddy Creek Bank Modifications
- P&MA #3 Krista Emergency Interconnect with LCWD

P&MA #4 Reclaimed Wastewater

- WRRF Facilities
- Proposed Water Line
- P&MA #5 Frazier Mountain High School Water Project
- P&MA #6 Well Metering and Data Collection

Abbreviations

DWR = California Department of Water Resources
LCWD = Lebec County Water District
P&MA = Projects and Management Actions
WRRF = Water Resources Recovery Facility

Notes

1. All locations are approximate.
2. For details on each P&MA, see Table PMA-1 and Appendix A - Project / Management Action Information Forms.
3. Some P&MA #6 well locations shown may be de minimis pumpers, who are exempt from well metering requirements under California Water Code Section 10725.8.

Sources

1. Groundwater basin boundaries from DWR Bulletin 118 Interim Update 2016.
2. Basemap is ESRI's ArcGIS Online world topographic map, obtained 27 March 2020.
3. Cuddy Creek from National Hydrology Dataset.
4. P&MA#3 location from Krista Mutual Water Company Preliminary Engineering Report.
5. WRRF facilities shapefiles provided by Diana Hulburt, on 28 August 2018.
6. P&MA #5 well location provided by LCWD via email on 5 November 2019.
7. P&MA #6 well locations are based on the Castac Basin Data Management System.

N 0 0.6 1.2 (Scale in Miles)

Approximate Locations of Proposed Projects and Management Actions

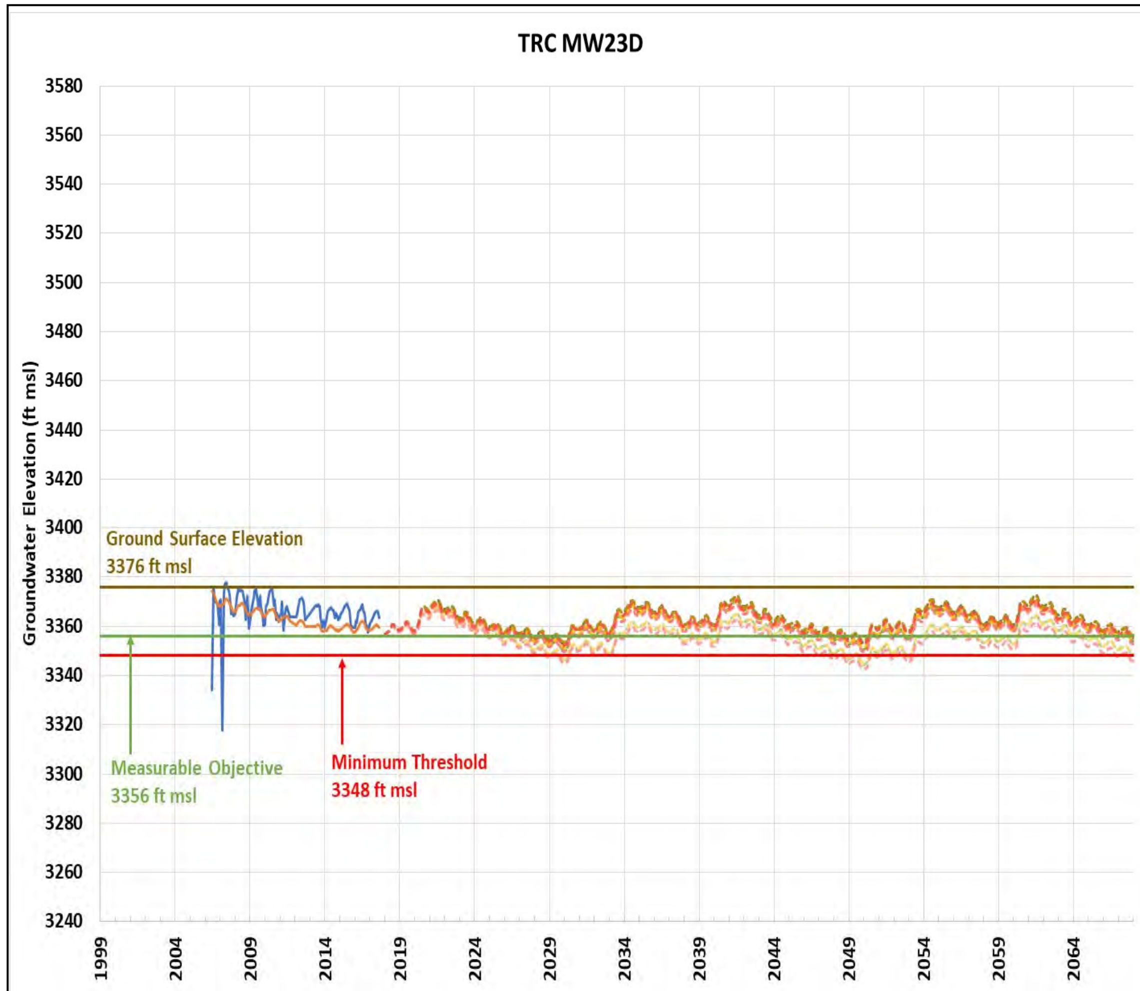
DRAFT

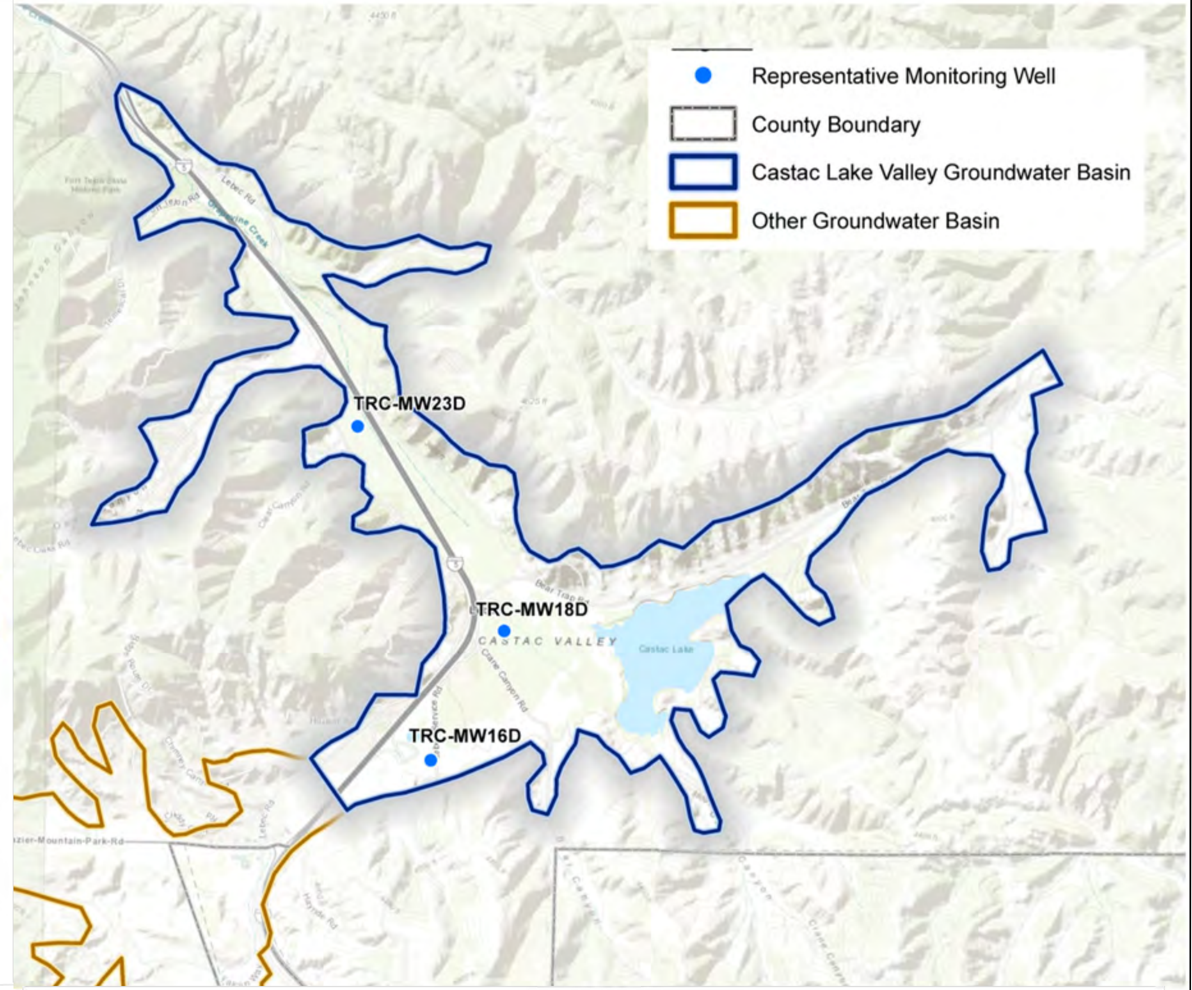
Castac Basin GSA
Kern County, California
June 2020
B80048.00

eki environment & water

Figure PMA-1

Path: \\ekiconsult.com\go\Gis\B80048\Maps\for_GSP\Fig_PMA-1_PMAs Location.mxd





Legend

Groundwater Elevation

- Observed
- Model-calculated (Historical)

Current Land Use

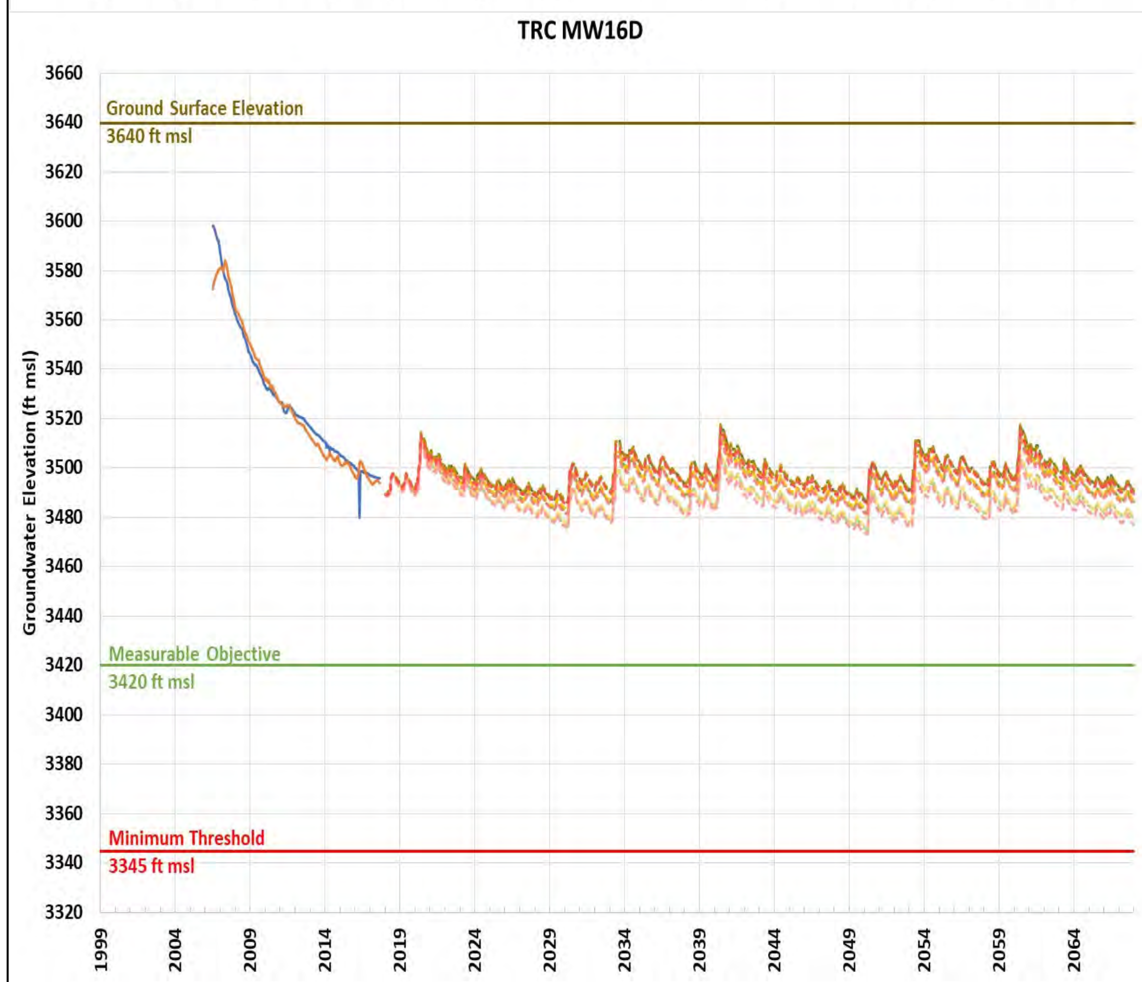
- Projected—Baseline
- Projected—2030 Climate Change
- Projected—2070 Climate Change

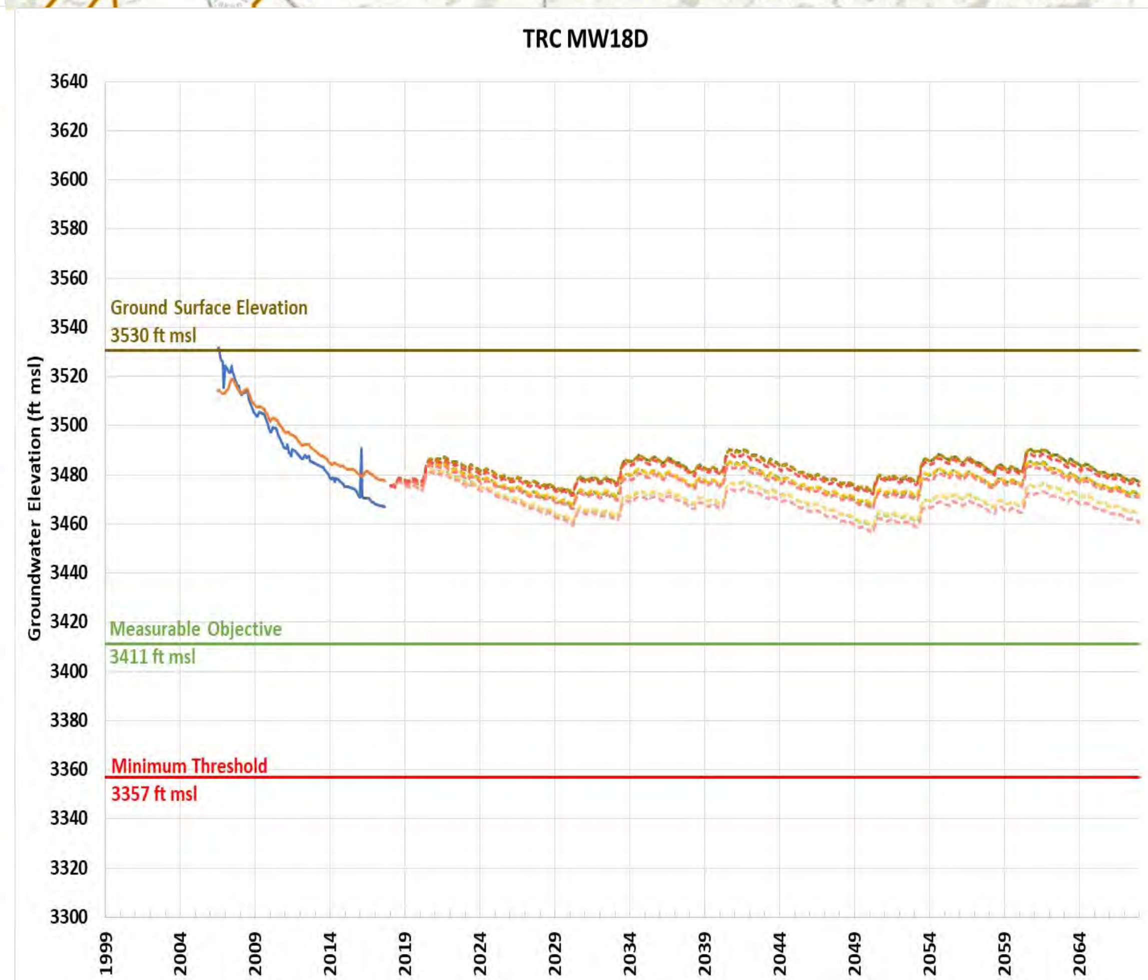
Projected Land Use with TMV Development

- Projected—Baseline
- Projected—2030 Climate Change
- Projected—2070 Climate Change

Projected Land Use with TMV Development and Aquifer Replenishment Project Implementation

- Projected—Baseline
- Projected—2030 Climate Change
- Projected—2070 Climate Change
- Minimum Threshold
- Measurable Objective
- Ground Surface Elevation





Abbreviation

DWR = California Department of Water Resources

ft msl = ft above mean sea level

TMV = Tejon Mountain Village

Notes

1. All locations are approximate.

Source

1. Groundwater basin boundaries from DWR Bulletin 118 Interim Update 2016.

2. Basemap is ESRI's ArcGIS Online world topographic map, obtained 3 March 2020.

Castac Basin Numerical Model Projected Hydrographs with and without Aquifer Replenishment Project Implementation

DRAFT

Castac Basin GSA

Kern County, California

June 2020

eki environment & water

B80048.00

Figure PMA-2

PLAN IMPLEMENTATION

18. PLAN IMPLEMENTATION

> *§ 351. Definitions*
>
> *(y) "Plan implementation" refers to an Agency's exercise of the powers and authorities described in the Act, which commences after an Agency adopts and submits a Plan or Alternative to the Department and begins exercising such powers and authorities.*

Per the Groundwater Sustainability Plan (GSP) Regulations, "plan implementation" refers to "an [Groundwater Sustainability] Agency's exercise of the powers and authorities described in the Act, which commences after an Agency adopts and submits a Plan or Alternative to the Department and begins exercising such powers and authorities" (23-California Code of Regulations [CCR] § 351(y)). This section describes the activities that will be performed by the Castac Basin Groundwater Sustainability Agency (GSA) as part of GSP implementation within the Castac Lake Valley Basin (Basin), with a focus on the first five years (i.e., through 2025). Key GSP implementation activities to be undertaken by the Castac Basin GSA over the next five years include:

- Monitoring and data collection;
- Data gap filling efforts;
- Intra-basin coordination;
- Continued outreach and engagement with stakeholders;
- Annual reporting;
- Evaluation and updates, as necessary, of the GSP as part of the required periodic evaluations (i.e., "five-year updates"); and
- Projects and/or Management Action (P&MA) implementation.

Each of these activities is discussed in more detail below.

18.1. Plan Implementation Activities

18.1.1. Monitoring and Data Collection

Successful sustainable groundwater management relies on a foundation of data to support decision making. As such, collection of data within the Basin will be a key part of GSP implementation. These data collection efforts include monitoring of applicable Sustainability Indicators to be collected from the Sustainable Groundwater Management Act (SGMA)

Monitoring Network, as well as other data and information required for management and reporting under the SGMA, as described below.

Section *16* discusses the SGMA Monitoring Network and associated Representative Monitoring Wells (RMWs) and protocols that will be used for the applicable Sustainability Indicators in the Basin, including Chronic Lowering of Groundwater Levels, Reduction of Groundwater Storage (using groundwater levels as proxy), and Depletions of Interconnected Surface Water (using groundwater levels as proxy). Those protocols will be followed as part of GSP implementation. Data collected will be incorporated into the Castac Basin's Data Management System (DMS) and will be used to support Annual Reporting (see Section *18.1.6 Annual Reporting*). Furthermore, monitoring results will be evaluated against applicable Sustainable Management Criteria (SMCs; i.e., Undesirable Results, Minimum Thresholds [MTs], and Measurable Objectives [MOs]) to support groundwater management decisions.

The Castac Basin GSA anticipates that within the first five years of GSP implementation (i.e., in the 2020 to 2025 timeframe), the following water level monitoring related efforts will be performed:

- Semi-annual water level monitoring at the RMWs, with the potential for monitoring of additional well site(s);
- Quality assurance and quality control checks;
- DMS importation; and
- Data gap filling efforts as it pertains to the monitoring network (see Section *18.1.2 Data Gap Filling Efforts* below).

Besides the data collected to support evaluation of Sustainability Indicators described above, collection and reporting of other types of information is required under SGMA (see further discussion below in Section *18.1.6 Annual Reporting*). These other types of information include:

- Groundwater extraction information. Groundwater extraction information is currently measured by totalizer counter units in select production and public supply wells. Additional wells will have meters installed once P&MA #6 *Well Metering and Data Collection* is implemented.
- Surface water supply data, if applicable. No imported surface water is currently used within the Basin and therefore is not currently applicable. However, once P&MA #1 *Aquifer Replenishment Project* is implemented, this tracking and reporting will be implemented.

Finally, as discussed in Section *16.1.4 Monitoring Network for Degraded Water Quality*, the Castac Basin GSA anticipates that the following water quality related monitoring efforts will be performed within the first five years of GSP implementation:

- Compilation and review of water quality data from public water systems made publicly available through the Safe Drinking Water Information System (SDWIS) Drinking Water Watch website, with the potential for monitoring of additional well site(s);
- Annual water quality sampling from two monitoring wells to establish baseline water quality conditions in Grapevine Canyon;
- Quality assurance and quality control checks; and
- DMS importation.

18.1.2. Data Gap Filling Efforts

The Castac Basin GSA will prioritize and begin to fill the key data gaps identified in this GSP related to the hydrogeological conceptual model, groundwater conditions, and water budgets, among other things. These data gap filling efforts will include, but not be limited to:

- Additional monitoring infrastructure to quantify subsurface groundwater inflows. The main uncertainty identified in the Basin water budget was the amount of subsurface groundwater inflow across the Cuddy Canyon Valley Basin and Castac Basin boundary. The primary recommended data gap filling effort is monitoring groundwater levels near the upgradient Cuddy Canyon Valley Basin to help quantify the water level gradient between Cuddy Canyon Valley Basin and RMW TRC-MW16D within the Basin. To the GSA's knowledge, there are no pre-existing wells with adequate location or infrastructure for monitoring water levels, and therefore a monitoring well is proposed to be installed near the Basin boundary. It is anticipated the monitoring well will be installed in 2022 and water level monitoring will be concurrent with that of the RMWs.

- Outreach to known domestic well owners in the Basin to estimate and meter their groundwater extraction volumes for Annual Reporting, if extractions are above those defined as de minimis (i.e., 2 AFY; CWC Section 10721(e)).

- Outreach to the Tejon Middle School and Fort Tejon Park public water systems to inquire about well construction information and historical and future water quality, water level and groundwater production data collection.

- High-resolution water level data monitoring to support lake/groundwater interactions analyses. An initial round of data collection occurred in 2019, to be supplemented with future data collection.

- Conducting additional data compilation and analysis of groundwater conditions using other public datasets and tools as they become available.

18.1.3. Intra-Basin Coordination

Intra-basin coordination efforts, including ad-hoc technical committee meetings, will occur on an approximately quarterly basis to facilitate data collection and management efforts and planning for stakeholder engagement opportunities.

18.1.4. Stakeholder Engagement

The GSA's Stakeholder Communication and Engagement Plan (SCEP; *Appendix C*) will continue to be refined, updated, and executed during GSP implementation. Anticipated stakeholder engagement activities include, but are not limited to:

- Continued semi-annual GSA Board meetings;
- Hosting annual stakeholder workshops, as needed; and
- Posting of relevant announcements and information on the GSA's website (https://castacgsa.org).

18.1.5. Project and Management Action Implementation

To prevent potential Undesirable Results, P&MAs are planned as part of GSP implementation. As described in Section *17 Projects and Management Actions*, a portfolio of P&MAs has been developed with the goal of proactively addressing relevant Sustainability Indicators. **Table PMA-1** provides the required details about each P&MA, including the circumstances under which they may be implemented.

The Castac Basin GSA plans to immediately begin implementation of selected P&MAs, as shown in **Table PMA-1**. In some cases, initial steps in implementation will include performing various studies or analyses to refine the concepts into actionable projects. Studies and work efforts may include, but are not limited to, California Environmental Quality Act (CEQA) studies and documentation; and engineering feasibility studies and preliminary design reports.

Once the necessary initial studies are completed, P&MAs will undergo, as necessary, final engineering design (in the case of infrastructure projects) and public noticing and outreach. At that point, construction of projects will occur, followed by ongoing operations and maintenance, as necessary. It is anticipated that each implemented P&MA will have its own set of monitoring or data collection components to allow for P&MA assessment and, if necessary, modification.

18.1.6. Annual Reporting

> *§ 356.2. Annual Reports.*
> *Each Agency shall submit an annual report to the Department by April 1 of each year following the adoption of the Plan. The annual report shall include the following components for the preceding water year:*
>
> *(b) A detailed description and graphical representation of the following conditions of the basin managed in the Plan:*
>
> *(1) Groundwater elevation data from monitoring wells identified in the monitoring network shall be analyzed and displayed as follows:*
>
> *(A) Groundwater elevation contour maps for each principal aquifer in the basin illustrating, at a minimum, the seasonal high and seasonal low groundwater conditions.*
>
> *(B) Hydrographs of groundwater elevations and water year type using historical data to the greatest extent available, including from January 1, 2015, to current reporting year.*
>
> *(2) Groundwater extraction for the preceding water year. Data shall be collected using the best available measurement methods and shall be presented in a table that summarizes groundwater extractions by water use sector, and identifies the method of measurement (direct or estimate) and accuracy of measurements, and a map that illustrates the general location and volume of groundwater extractions.*
>
> *(3) Surface water supply used or available for use, for groundwater recharge or in-lieu use shall be reported based on quantitative data that describes the annual volume and sources for the preceding water year.*
>
> *(4) Total water use shall be collected using the best available measurement methods and shall be reported in a table that summarizes total water use by water use sector, water source type, and identifies the method of measurement (direct or estimate) and accuracy of measurements. Existing water use data from the most recent Urban Water Management Plans or Agricultural Water Management Plans within the basin may be used, as long as the data are reported by water year.*
>
> *(5) Change in groundwater in storage shall include the following:*
>
> *(A) Change in groundwater in storage maps for each principal aquifer in the basin.*
>
> *(B) A graph depicting water year type, groundwater use, the annual change in groundwater in storage, and the cumulative change in groundwater in storage for the basin based on historical data to the greatest extent available, including from January 1, 2015, to the current reporting year.*

Per the GSP Emergency Regulations, an annual report on basin conditions and GSP implementation status is required to be submitted to the Department of Water Resources (DWR) by April 1 of each year following GSP adoption (23-CCR § 356.2). These annual reports will be prepared by the Castac Basin GSA using data collected during GSP implementation, as described above. Annual reports will include, but not be limited to, the following:

- Groundwater elevation contour maps for both Spring and Fall conditions;
- Hydrographs of groundwater elevations in the RMWs;
- Annual groundwater extraction volumes for the entire Basin, an explanation as to how groundwater extraction volumes were estimated, an accounting of accuracy, and an explanation as to how accuracy was determined;
- Annual surface water supply volumes used for the entire Basin, quantified by source type, as applicable;
- Annual total water use for the entire Basin, quantified by water use sector and type; and
- Estimates of annual change in groundwater storage. The Castac Basin Numerical Model will be updated and extended to include the groundwater elevation data, groundwater extraction volumes, and hydrology datasets (i.e., precipitation and evapotranspiration) to estimate the annual change in groundwater storage.

18.1.7. Enforcement and Response Actions

Part of successful Basin management involves the ability to adapt and respond to unforeseen or uncertain circumstances. To the extent possible, methods to address foreseeable problems should be developed before those problems arise. It is not anticipated that there will be a need to enforce compliance with this GSP and any policies adopted thereunder. However, if such actions are necessary, they will be taken by the Castac Basin GSA and/or its member agencies in accordance with applicable laws and authorities.

18.1.8. Periodic GSP Evaluations

§ 356.4. Periodic Evaluation by Agency
Each Agency shall evaluate its Plan at least every five years and whenever the Plan is amended and provide a written assessment to the Department. The assessment shall describe whether the Plan implementation, including implementation of projects and management actions, are meeting the sustainability goal in the basin, and shall include the following:

(a) A description of current groundwater conditions for each applicable sustainability indicator relative to measurable objectives, interim milestones and minimum thresholds.

(b) A description of the implementation of any projects or management actions, and the effect on groundwater conditions resulting from those projects or management actions.

(c) Elements of the Plan, including the basin setting, management areas, or the identification of undesirable results and the setting of minimum thresholds and measurable objectives, shall be reconsidered and revisions proposed, if necessary.

(d) An evaluation of the basin setting in light of significant new information or changes in water use, and an explanation of any significant changes. If the Agency's evaluation shows that the basin is experiencing overdraft conditions, the Agency shall include an assessment of measures to mitigate that overdraft.

(e) A description of the monitoring network within the basin, including whether data gaps exist, or any areas within the basin are represented by data that does not satisfy the requirements of Sections 352.4 and 354.34(c). The description shall include the following:

(1) An assessment of monitoring network function with an analysis of data collected to date, identification of data gaps, and the actions necessary to improve the monitoring network, consistent with the requirements of Section 354.38.

(2) If the Agency identifies data gaps, the Plan shall describe a program for the acquisition of additional data sources, including an estimate of the timing of that acquisition, and for incorporation of newly obtained information into the Plan.

(3) The Plan shall prioritize the installation of new data collection facilities and analysis of new data based on the needs of the basin.

(f) A description of significant new information that has been made available since Plan adoption or amendment, or the last five-year assessment. The description shall also include whether new information warrants changes to any aspect of the Plan, including the evaluation of the basin setting, measurable objectives, minimum thresholds, or the criteria defining undesirable results.

(g) A description of relevant actions taken by the Agency, including a summary of regulations or ordinances related to the Plan.

(h) Information describing any enforcement or legal actions taken by the Agency in furtherance of the sustainability goal for the basin.

(i) A description of completed or proposed Plan amendments.

(j) Where appropriate, a summary of coordination that occurred between multiple Agencies in a single basin, Agencies in hydrologically connected basins, and land use agencies.

> *§ 356.4. Periodic Evaluation by Agency*
>
> *(k) Other information the Agency deems appropriate, along with any information required by the Department to conduct a periodic review as required by Water Code Section 10733*
>
> *(l) Where appropriate, a summary of coordination that occurred between multiple Agencies in a single basin, Agencies in hydrologically connected basins, and land use agencies.*
>
> *(m) Other information the Agency deems appropriate, along with any information required by the Department to conduct a periodic review as required by Water Code Section 10733*

Per the GSP Regulations (23-CCR § 356.4), the Castac Basin GSA will conduct a periodic evaluation of its GSP, at least every five years, and will modify the GSP as necessary to ensure that the Sustainability Goal for the Basin is achieved. The GSP elements that will be covered in the periodic evaluation are described below. It is anticipated that the 2025 plan will require revision, especially on matters related to the Basin Setting, SMCs, and P&MAs sections.

Sustainability Evaluation

This section will evaluate the current groundwater conditions for each applicable Sustainability Indicator, including progress toward achieving Interim Milestones and MOs.

Plan Implementation Progress

This section will evaluate the current implementation status of P&MAs, along with an updated implementation schedule and any new P&MAs that are not included in this GSP.

Reconsideration of GSP Elements

Per 23-CCR § 356.4(c), elements of the GSP, including the Basin Setting, Basin Setting, SMCs, and P&MAs sections will be reviewed and revised if necessary.

Monitoring Network Description

This section will provide a description of the SGMA Monitoring Network, including identification of data gaps, assessment of monitoring network function with an analysis of data collected to date, identification of actions that are necessary to improve the monitoring network, and development of plans or programs to fill data gaps.

New Information

This section will provide a description of significant new information that has been made available since the adoption or amendment of the GSP, or the last five-year assessment, including data obtained to fill identified data gaps. As discussed above under *Reconsideration of GSP Elements*, if evaluation of the Basin Setting or SMCs definitions warrant changes to any aspect of the GSP, this new information would also be included.

Regulations or Ordinances

The Castac Basin GSA possesses the legal authority to implement regulations or ordinances related to the GSP. This section will provide a description of relevant actions taken by the Castac Basin GSA, including a summary of related regulations or ordinances, as appropriate.

Legal or Enforcement Actions

This section will summarize legal or enforcement actions taken by the Castac Basin GSA in relation to the GSP, along with how such actions support sustainability in the Basin.

Plan Amendments

This section will provide a description of proposed or complete amendments to the GSP.

18.2. Plan Implementation Costs

§ 354.6. Agency Information

When submitting an adopted Plan to the Department, the Agency shall include a copy of the information provided pursuant to Water Code Section 10723.8, with any updates, if necessary, along with the following information:

(e) An estimate of the cost of implementing the Plan and a general description of how the Agency plans to meet those costs.

Per the GSP Regulations (23-CCR § 354.6(e) and 354.44(b)(8)), this section provides estimates of the costs to implement this GSP and potential sources of funding to meet those costs.

18.2.1. Estimated Costs

The estimated costs for the Castac Basin GSA to implement this GSP can be divided into several groups, as follows:

1) Costs of groundwater monitoring and reporting activities;
2) Costs associated with stakeholder outreach; and
3) Costs to implement P&MAs, including capital/one-time costs and ongoing costs.

Table PI-1 provides a high-level estimate of the annual costs for the above groups 1 and 2 over the first 5-year period (i.e., 2020-2025). Costs associated with continued GSA activities (groups 1 and 2) are estimated to range between approximately $64,000 to $165,000 per year, not including GSA and GSA member agency staff time. Estimated annual costs for individual P&MAs (group 3) will be determined in the future, as the Castac Basin GSA moves forward with specific P&MA implementation.

Table PI-1. Estimated GSP Implementation Costs

Groundwater Management Activity	Estimated Average Annual GSP Implementation Costs[1]				
	Year 1	Year 2	Year 3	Year 4	Year 5
Part 1. Costs of Groundwater Monitoring and Reporting Activities					
Monitoring and Data Collection					
Water level monitoring at Representative Monitoring Wells	$2,600	$2,600	$2,600	$2,600	$2,600
Collection of water use data	$1,500	$1,500	$2,000	$2,000	$2,000
Public water system water quality data compilation	$3,000	$3,000	$3,000	$3,000	$3,000
Water quality sampling to establish baseline conditions	$2,600	$2,600	$2,600	$2,600	$2,600
Data Gap Filling					
Monitoring well installation and water level monitoring at upgradient Basin boundary	$0	$0	$52,000	$1,000	$1,000
Outreach to domestic and public supply well owners	$2,000	$2,000	$2,000	$2,000	$2,000
Groundwater conditions assessment using new DWR supported guidelines and tools, as available	$3,600	$3,600	$3,600	$3,600	$3,600
Intra-basin Coordination	$3,000	$3,000	$3,000	$3,000	$3,000
Annual Reporting	$35,000	$30,000	$30,000	$30,000	$30,000
Periodic Evaluation of GSP	$0	$0	$0	$100,000	$100,000
Annual Subtotal	**$53,300**	**$48,300**	**$100,800**	**$149,800**	**$149,800**
Part 2. Costs associated with Stakeholder Outreach					
Semi-annual GSA Board Meetings	$9,200	$9,200	$9,200	$9,200	$9,200
Stakeholder Workshop	$4,600	$4,600	$4,600	$4,600	$4,600
Website Maintenance	$1,200	$1,200	$1,200	$1,200	$1,200
Annual Subtotal	**$15,000**	**$15,000**	**$15,000**	**$15,000**	**$15,000**
Part 3. Costs to Implement Projects and Management Actions					
Annual Subtotal	To Be Determined; See **Table PMA-1**				
Total Required Costs of GSP Implementation	***$68,300 + P&MA costs***	***$63,300 + P&MA costs***	***$115,800 + P&MA costs***	***$164,800 + P&MA costs***	***$164,800 + P&MA costs***

Notes:

(1) Costs are estimated for technical consultant, laboratory, well driller, or other direct costs. It is assumed the Castac Basin GSA will conduct monitoring activities, however GSA personnel costs associated with data collection are not estimated herein.

18.2.2. Sources of Funding to Meet Costs

As shown in **Table PI-1**, required non-GSA/member agency staff costs for GSP implementation (i.e., groups 1 and 2) are estimated to range between approximately $64,000 to $165,000 annually over the next five years. The Castac Basin GSA will likely meet the estimated costs through a combination of contributions from landowners, grant funding, if available, and through rate payers.

18.3. Plan Implementation Schedule

This section discusses a general estimated schedule for GSP implementation. The GSP Emergency Regulations do not specifically require that a schedule for GSP implementation over the 20-year implementation period (i.e., 2020 through 2040) be provided, and any such schedule would be subject to considerable uncertainty. However, the following factors and constraints inherent to the GSP process guide the schedule for GSP implementation:

- The GSP Emergency Regulations require achievement of the Sustainability Goal (i.e., avoidance of Undesirable Results) within 20 years of GSP adoption, which means by 2040.
- Annual reports are due on April 1 of every year following GSP submission.

Periodic evaluations are required at least every five years, meaning this GSP will be updated no later than 2025.

REFERENCES AND TECHNICAL STUDIES

> *§ 354.4. General Information*
>
> *Each Plan shall include the following general information:*
> *(b) A list of references and technical studies relied upon by the Agency in developing the Plan. Each Agency shall provide to the Department electronic copies of reports and other documents and materials cited as references that are not generally available to the public.*

Barto, 1985. Hydrogeologic Study for Cuddy Valley Specific Plan Amendment, Kern County California, Prepared by Ron Barto and Associates, September 1985.

Bookman and Edmonston, 1965. Geology and Hydrology of the Lebec Ground Water Basin. Report prepared by Bookman and Edmonston, Consulting Civil Engineers, 1965.

Clark MM, 1973. Map Showing Recent Active Breaks Along the Garlock and Associated Faults, California. U.S. Geological Survey Miscellaneous Investigations Series Map I-741, 1:24,000 scale, 3 plates.

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

CVRWQCB, 2018a. Fact Sheet Mobil M-1 Crude Oil Pipeline Tejon Ranch Property, Lebec, CA 93243 Geotracker ID: SL205724284. 7 February 2018.

CVRWQCB, 2018b. Consideration of Request for No Further Action Required Determination, Mobil M-1 Crude Oil Pipeline, Tejon Ranch Property, Lebec, Kern County, Geotracker Case No. SL205724284. 6 December 2018.

Dibblee TW and Minch JA, 2006. Geologic map of the Frazier Mountain & Lebec quadrangles, Los Angeles, Ventura, & Kern Counties, California. Dibblee Geological Foundation, Dibblee Foundation Map DF-198, scale 1:24,000, 1 plate.

DOGGR, 2019, Field Boundaries shapefile, downloaded at: ftp://ftp.consrv.ca.gov/pub/oil/GIS/Shapefiles/Field_Boundaries.zip

Dudek & Associates, 1999. Preliminary Investigations of Hydrogeologic Conditions in the Vicinity of Tejon Lake. 22 December 1999.

DWR, 1980. Ground Water Basins in California, A Report to the Legislature in Response to Water Code Section 12924, dated January 1980, 73 pp.

DWR, 2003. California's Groundwater Bulletin 118, dated October 2003, 246 pp.

DWR, 2010. *Department of Water Resources Groundwater Elevation Monitoring Guidelines*, dated December 2010. https://water.ca.gov/-/media/DWR-Website/Web-Pages/Programs/Groundwater-Management/CASGEM/Files/CASGEM-DWR-GW-Guidelines-Final-121510.pdf

DWR, 2016a. California Department of Water Resources, Hydrogeologic Conceptual Model Best Management Practice, December 2016, 23pp.

DWR, 2016b. California Department of Water Resources, Water Budget Best Management Practice, dated December 2016, 51 pp.

DWR, 2016c, Monitoring Networks and Identification of Data Gaps Best Management Practice, dated December 2016, 34 pp.

DWR, 2017. Draft Best Management Practices for the Sustainable Management of Groundwater: Sustainable Management Criteria.

DWR, 2018. *Resource Guide DWR-Provided Climate Change Data and Guidance for Use During Groundwater Sustainability Plan Development*, dated July 2018.

DWR, 2019. Sustainable Groundwater Management Act 2019 Basin Prioritization Process and Results, April 2019, 64pp.

ECI, 2006. Fault Rupture Hazard Investigation for Planning the Tejon Mountain Village Specific Plan, Kern County, California. Report prepared for Tejon Ranch Co. by Earth Consultants International, Inc., dated 21 April 2006, 508pp.

EKI, 2008a, Technical Memorandum No. 1 Preliminary Groundwater Monitoring Well Installation Report Tejon Mountain Village, LLC. Technical Memorandum to David Friedman and Roberta Marshall, dated January 2008.

EKI, 2008b, 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.

EKI, 2008c, Technical Memorandum No. 3 Preliminary Summary and Interpretation of the Available Groundwater Quality Data for Castac Groundwater Basin Tejon Mountain Village, LLC. Technical Memorandum to David Friedman and Roberta Marshall, dated January 2008.

EKI, 2008d. *Technical Memorandum No. 4, Preliminary Estimate of Site-Specific Evapotranspiration Rates, Plant Rooting Depths, and Soil Property Information, Tejon Mountain Village, LLC*. Technical Memorandum to David Friedman and Roberta Marshall, dated January 2008.

EKI, 2008e, 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.

Engeo, 2008. Preliminary Geotechnical Exploration and Summary of Geologic Contraints: Tejon Mountain Village, Kern County, California, in press.

Farr TG, Jones CE, Liu Z, 2016. Progress Report: Subsidence in California, March 2015-September 2016. Jet Propulsion Laboratory California Institute of Technology, 37pp.

Galli, 2005. Groundwater Assessment Frazier Park Estates, Kern County. Prepared by The Galli Group, 23 November 2005. Heath RC, 1983, Basic Ground-Water Hydrology. USGS Water-Supply Paper 2220, 86 p.

Kern County, 2009. Land Use, Open Space, and Conservation Element (Chapter 1) Kern County General Plan, Kern County, 76pp.

Kern County, 2016. California Department of Conservation Important Farmland.

Kern County Department of Planning and Development Services, 1992, O'Neil Canyon Specific Plan, adopted 19 November 1992.

Kern County Planning Department, 2003, Final Draft Frazier Park/Lebec Specific Plan. County of Kern, dated May 2003.

Kern County Planning Department, 2009a. Tejon Mountain Village Specific and Community Plan. 118pp.

Kern County Planning Department, 2009b, Draft Environmental Impact Report Tejon Mountain Village by TMV, LLC. SCH# 2005101018 Volume I Chapters 1 through 11. dated May 2009.

Kern County Public Works Department, 2017, Lebec Sanitary Landfill, Self-Monitoring Report and Corrective Action Program Status Update 2017 First Half. Waste Discharge Requirements Order No. R5-2013-0057. Dated August 2017.

Kern County Public Works Department, 2018. Lebec Sanitary Landfill Self-Monitoring Report and Corrective Action Program Status Update 2018 – First Half Waste Discharge Requirements Order No. R5-2013-0057. August 2018.

Laskowski E, 1968. Tejon/Castac Lake 1968 Study. UCLA Ph.D. dissertation by Edward Laskowski, 1968.

LCWD, 2019, 2018 Consumer Confidence Report for Water System CA1510051 Lebec County Water District. Available online: https://drinc.ca.gov/ear/CCR/CCR2018CA1510051.pdf

McCasland M, Trautmann NM, Porter KS, Wagenet RJ, 2012, Nitrate: Health Effects in Drinking Water. Pesticide Safety Education Program (PSEP) Fact Sheet. http://psep.cce.cornell.edu/facts-slides-self/facts/nit-heef-grw85.aspx

Norcal, 2007. Geophysical Well-Logging Report, Tejon Ranch, Lebec, California. Report prepared by Norcal Geophysical Consultants, Inc. for Erler & Kalinowski, Inc. 19 June 2007, 9pp, 7 plates, 2 appendices.

NV5, 2018. Mountain Village Water, Wastewater, and Reclaimed Water Facility Plan Tejon Castac Water District. Prepared for Tejon Ranch Company by NV5, Inc., August 2018.

Olson BPE, 2014. Preliminary Geologic Map of the Grapevine 7.5’ Quadrangle, Kern County, California: A Digital Database. Version 1.0. California Geological Survey, scale 1:24,000, 1 plate.

Olson BPE and Swanson BJ, 2017. Preliminary Geologic Map of the Lebec 7.5’ Quadrangle, Kern, Los Angeles, and Ventura Counties, California. Version 1.0. California Geological Survey, scale 1:24,000, 1 plate.

Osborn NI, Smith SJ, Seger CH, 2013, Hydrogeology, distribution, and volume of saline groundwater in the southern midcontinent and adjacent areas of the United States: USGS Scientific Investigations Report 2013–5017, 58pp.

Provost & Pritchard, 2020. Tulare Lake Basin Portion of Kern County Integrated Regional Water Management Plan, Final Update, Kern County Water Agency. March, 2020.

Quad Knopf, Inc., 2019, Krista Mutual Water Company Fluoride Mitigation Project Preliminary Engineering Report, Prepared for Krista Mutual Water Company, dated June 2019.

Rohde MM, Sweet SB, Ulrich C, Howard J, 2019. *A Transdisciplinary Approach to Characterize Hydrologic Controls on Groundwater-Dependent Ecosystem Health.* Front. Environ. Sci. 7: 175. doi: 10.3389/fenvs.2019.00175.

Schmidt, 2002. Groundwater Conditions in the Frazier Park/Lebec Specific Plan Area, Kenneth D. Schmidt and Associates, August 2002.

SDWIS, 2018. Safe Drinking Water Information System, CA Drinking Water Water System Details (Water System No. CA1500413, CA1502074, CA1510301, and CA1500415) https://sdwis.waterboards.ca.gov/PDWW/index.jsp accessed 7 November 2018.

Shuttleworth WJ, 1993. Evaporation, in: Maidment DR, ed., Handbook of Hydrology, McGraw-Hill, Inc., New York, New York.

Stetson, 2001a. Results of Pump Test at Tejon Ranch Company's Wells 56A, 80, 88, and 90, Stetson Engineers, Inc. March 2001.

Stetson, 2001b. Tejon Groundwater Basin Monitoring Well Information, Stetson Engineers, Inc. December 2001.

Swanson BJ and Olson BPE, 2016. Preliminary Geologic Map of the Frazier Mountain 7.5' Quadrangle, Kern, Los Angeles, and Ventura Counties, California. Version 1.0. California Geological Survey, scale 1:24,000, 1 plate.

TCWD, 2008. Tejon Mountain Village Water Supply Assessment, dated 18 July 2008.

TCWD, 2019a. Shapefile of current land use provided by Leah Metzger 31 May 2019.

TCWD, 2019b. Shapefile of future land use, provided by TCWD 14 June 2019.

TNC, 2018. *Natural Communities Commonly Associated with Groundwater.* The Nature Conservancy (https://data.cnra.ca.gov/dataset/natural-communities-commonly-associated-with-groundwater).

TODD Groundwater, 2020. *SGMA Water Budget Development using C2VSimFG-Kern in support of the Kern County Subbasin Groundwater Sustainability Plans (GSPs).* Memorandum from Maley, Michael and Brush, Charles to Mark Mulkay and Patty Poire, dated 7 January 2020, included as Appendices 2 & 4 to the Kern County Subbasin Coordination Agreement, Attachment B to the Kern Groundwater Authority Groundwater Sustainability Plan Kern County, CA, dated January 2020.

TRC, 2008. Tejon Ranch Company, Conservation & Land Use Agreement, 280 pp., June 2008

Trihey and Associates, 1997. Tejon Lake Hydrology Study, Kern County, California. Prepared by M. Katzel, Trihey and Associates, June 1997.

U.S. Census Bureau, 2012. 2010 Census of Population and Housing, Population and Housing Unit Counts, CPH-2-6, California. U.S. Government Printing Office, Washington, D.C.

United States Environmental Protection Agency, 2001, Drinking Water Standard for Arsenic. EPA 815-F-00-015, January 2001. https://nepis.epa.gov/Exe/ZyPdf.cgi?Dockey=20001XXC.txt

USGS, variously dated, *National field manual for the collection of water-quality data: U.S. Geological Survey Techniques of Water-Resources Investigations*, book 9, chaps. A1-A10, available online at http://pubs.water.usgs.gov/twri9A.

Vedder JG and Wallace RE, 1970. Map showing Recently Active Breaks Along the San Andreas and Related Faults Between Cholame Valley and Tejon Pass, California. U.S. Geological Survey Miscellaneous Investigations Map I-574, scale 1:24,000, 2 plates.

Wilson JL and Guan H, 2004. Mountain-Block Hydrology and Mountain-Front Recharge, in: Hogan JF, Phillips FM, Scanlon BR, eds, Groundwater Recharge in a Desert Environment: The Southwestern United States, Water Science and Application 9, American Geophysical Union, Washington DC, 294pp.

Wood BD, 1912. Gazetteer of Surface Waters of California Part II. San Joaquin River Basin. United States Geological Survey Water-Supply Paper 296, Government Printing Office: Washington, 102pp.

Zeng, Xubin, 2001. *Global Vegetation Root Distribution for Land Modeling,* Journal of Hydrometeorology, v.2, issue 5, pp. 525-530

APPENDICES

Appendix A

GSP Submittal Checklist

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
§ 354.			**Introduction to Plan Contents**					
			This Article describes the required contents of Plans submitted to the Department for evaluation, including administrative information, a description of the basin setting, sustainable management criteria, description of the monitoring network, and projects and management actions.					
			Note: Authority cited: Section 10733.2, Water Code.					
			Reference: Section 10733.2, Water Code.					
SubArticle 1.			**Administrative Information**					
§ 354.2.			**Introduction to Administrative Information**					
			This Subarticle describes information in the Plan relating to administrative and other general information about the Agency that has adopted the Plan and the area covered by the Plan.					
			Note: Authority cited: Section 10733.2, Water Code.					
			Reference: Section 10733.2, Water Code.					
§ 354.4.			**General Information**					
			Each Plan shall include the following general information:					
(a)			An executive summary written in plain language that provides an overview of the Plan and description of groundwater conditions in the basin.	14:27	ES.1 - ES.13			
(b)			A list of references and technical studies relied upon by the Agency in developing the Plan. Each Agency shall provide to the Department electronic copies of reports and other documents and materials cited as references that are not generally available to the public.	260:265	References			
			Note: Authority cited: Section 10733.2, Water Code.					
			Reference: Sections 10733.2 and 10733.4, Water Code.					
§ 354.6.			**Agency Information**					
			When submitting an adopted Plan to the Department, the Agency shall include a copy of the information provided pursuant to Water Code Section 10723.8, with any updates, if necessary, along with the following information:					
(a)			The name and mailing address of the Agency.	30	3.1			
(b)			The organization and management structure of the Agency, identifying persons with management authority for implementation of the Plan.	30:31	3.2			
(c)			The name and contact information, including the phone number, mailing address and electronic mail address, of the plan manager.	31	3.3			
(d)			The legal authority of the Agency, with specific reference to citations setting forth the duties, powers, and responsibilities of the Agency, demonstrating that the Agency has the legal authority to implement the Plan.	31	3.4			
(e)			An estimate of the cost of implementing the Plan and a general description of how the Agency plans to meet those costs.	31, 257:259	3.5, 18.2		PI-1	
			Note: Authority cited: Section 10733.2, Water Code.					
			Reference: Sections 10723.8, 10727.2, and 10733.2, Water Code.					
§ 354.8.			**Description of Plan Area**					
			Each Plan shall include a description of the geographic areas covered, including the following information:					
(a)			One or more maps of the basin that depict the following, as applicable:					
	(1)		The area covered by the Plan, delineating areas managed by the Agency as an exclusive Agency and any areas for which the Agency is not an exclusive Agency, and the name and location of any adjacent basins.	34	5.1.1	PA-1		

				GSP Document References				
				Page Numbers of Plan	Or Section Numbers	Or Figure Numbers	Or Table Numbers	Notes
	(2)		Adjudicated areas, other Agencies within the basin, and areas covered by an Alternative.	35	5.1.2	PA-1		
	(3)		Jurisdictional boundaries of federal or state land (including the identity of the agency with jurisdiction over that land), tribal land, cities, counties, agencies with water management responsibilities, and areas covered by relevant general plans.	35	5.1.3	PA-1, PA-5:PA-6		
	(4)		Existing land use designations and the identification of water use sector and water source type.	36	5.1.4	PA-3	PA-1	
	(5)		The density of wells per square mile, by dasymetric or similar mapping techniques, showing the general distribution of agricultural, industrial, and domestic water supply wells in the basin, including de minimis extractors, and the location and extent of communities dependent upon groundwater, utilizing data provided by the Department, as specified in Section 353.2, or the best available information.	36:37	5.1.5	PA-4		
(b)			A written description of the Plan area, including a summary of the jurisdictional areas and other features depicted on the map.	34:37	5.1			
(c)			Identification of existing water resource monitoring and management programs, and description of any such programs the Agency plans to incorporate in its monitoring network or in development of its Plan. The Agency may coordinate with existing water resource monitoring and management programs to incorporate and adopt that program as part of the Plan.	37:38	5.2.1			
(d)			A description of how existing water resource monitoring or management programs may limit operational flexibility in the basin, and how the Plan has been developed to adapt to those limits.	38:39	5.2.2			
(e)			A description of conjunctive use programs in the basin.	39	5.2.3			
(f)			A plain language description of the land use elements or topic categories of applicable general plans that includes the following:					
	(1)		A summary of general plans and other land use plans governing the basin.	39:43	5.3.1	PA-5:PA-6		
	(2)		A general description of how implementation of existing land use plans may change water demands within the basin or affect the ability of the Agency to achieve sustainable groundwater management over the planning and implementation horizon, and how the Plan addresses those potential effects	43	5.3.2			
	(3)		A general description of how implementation of the Plan may affect the water supply assumptions of relevant land use plans over the planning and implementation horizon.	44	5.3.3			
	(4)		A summary of the process for permitting new or replacement wells in the basin, including adopted standards in local well ordinances, zoning codes, and policies contained in adopted land use plans.	44	5.3.4			
	(5)		To the extent known, the Agency may include information regarding the implementation of land use plans outside the basin that could affect the ability of the Agency to achieve sustainable groundwater management.	44	5.3.5			
(g)			A description of any of the additional Plan elements included in Water Code Section 10727.4 that the Agency determines to be appropriate.	44:46	5.4			
			Note: Authority cited: Section 10733.2, Water Code.					
			Reference: Sections 10720.3, 10727.2, 10727.4, 10733, and 10733.2, Water Code.					
§ 354.10.			**Notice and Communication**					
			Each Plan shall include a summary of information relating to notification and communication by the Agency with other agencies and interested parties including the following:					

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
(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.	47, 293:319	5.5.1, Appendix C			
(b)			A list of public meetings at which the Plan was discussed or considered by the Agency.	47:48	5.5.2			
(c)			Comments regarding the Plan received by the Agency and a summary of any responses by the Agency.	48:49, 320	5.5.3, Appendix D		PA-2	
(d)			A communication section of the Plan that includes the following:					
	(1)		An explanation of the Agency's decision-making process.	49:51, 293:319	5.5.4, Appendix C			
	(2)		Identification of opportunities for public engagement and a discussion of how public input and response will be used.	49:51, 293:319	5.5.4, Appendix C			
	(3)		A description of how the Agency encourages the active involvement of diverse social, cultural, and economic elements of the population within the basin.	49:51, 293:319	5.5.4, Appendix C			
	(4)		The method the Agency shall follow to inform the public about progress implementing the Plan, including the status of projects and actions.	49:51, 293:319	5.5.4, Appendix C			
			Note: Authority cited: Section 10733.2, Water Code.					
			Reference: Sections 10723.2, 10727.8, 10728.4, and 10733.2, Water Code					
SubArticle 2.			**Basin Setting**					
§ 354.12.			**Introduction to Basin Setting**					
			This Subarticle describes the information about the physical setting and characteristics of the basin and current conditions of the basin that shall be part of each Plan, including the identification of data gaps and levels of uncertainty, which comprise the basin setting that serves as the basis for defining and assessing reasonable sustainable management criteria and projects and management actions. Information provided pursuant to this Subarticle shall be prepared by or under the direction of a professional geologist or professional engineer.					
			Note: Authority cited: Section 10733.2, Water Code.					
			Reference: Section 10733.2, Water Code.					
§ 354.14.			**Hydrogeologic Conceptual Model**					
(a)			Each Plan shall include a descriptive hydrogeologic conceptual model of the basin based on technical studies and qualified maps that characterizes the physical components and interaction of the surface water and groundwater systems in the basin.	60:73	7	HCM-1:HCM-14	HCM-1:HCM-2	
(b)			The hydrogeologic conceptual model shall be summarized in a written description that includes the following:					
	(1)		The regional geologic and structural setting of the basin including the immediate surrounding area, as necessary for geologic consistency.	60:61	7.1.1	HCM-1		
	(2)		Lateral basin boundaries, including major geologic features that significantly affect groundwater flow.	61:62	7.1.2	HCM-2		
	(3)		The definable bottom of the basin.	62:64	7.1.3	HCM-3:HCM-4	HCM-1	
	(4)		Principal aquifers and aquitards, including the following information:					

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
		(A)	Formation names, if defined.	64:67	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.	64:67	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.	64:67	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.	64:67	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.	64:67	7.1.4	HCM-7		
	(5)		Identification of data gaps and uncertainty within the hydrogeologic conceptual model	67:68	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.	68:69	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.	70	7.3.1	HCM-11		
	(2)		Surficial geology derived from a qualified map including the locations of cross-sections required by this Section.	70:71	7.3.2	HCM-10		
	(3)		Soil characteristics as described by the appropriate Natural Resources Conservation Service soil survey or other applicable studies.	71	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.	71:72	7.3.4	HCM-13		
	(5)		Surface water bodies that are significant to the management of the basin.	73	7.3.5	HCM-14		
	(6)		The source and point of delivery for imported water supplies.	73	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, 322:357	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, 359:392	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, 394:476	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.					

				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.	29, 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			

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
			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**					

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
(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:					

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
		(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:					

				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, 478:532	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

TABLE OF CONTENTS

List of Tables

List of Figures

List of Appendices

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

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

CWC, 2015. *Collaborating for Success: Stakeholder Engagement for Sustainable Groundwater Management Act Implementation.* Community Water Center, July 2015.

Dudek & Associates, 1999. *Preliminary Investigations of Hydrogeologic Conditions in the Vicinity of Tejon Lake.* Report prepared by Dudek & Associates, 22 December 1999.

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

DWR Water Management Planning Tool, accessed 09 September 2016. https://gis.water.ca.gov/app/boundaries/

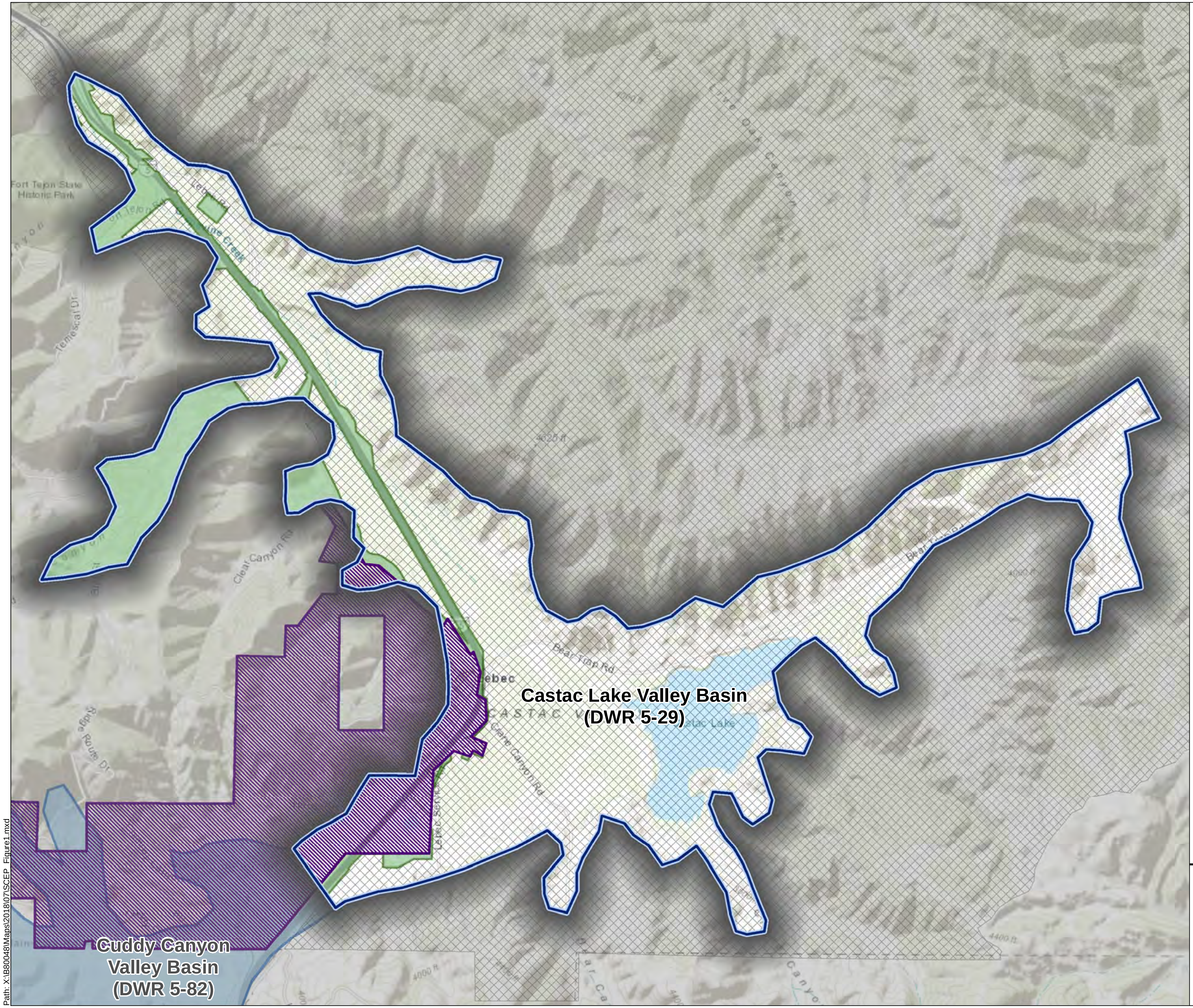
NWI v2.0. Fish & Wildlife Service National Wetlands Inventory, Version 2.0, accessed 27 June 2018. https://gis.water.ca.gov/app/NCDatasetViewer/

SDWIS. Safe Drinking Water Information System. Water System Details, accessed 14 May 2018. https://sdwis.waterboards.ca.gov/PDWW/JSP/WaterSystemDetail.jsp?tinwsys_is_number=1364&tinwsys_st_code=CA&counter=0.

Trihey and Associates, 1997. *Tejon Lake Hydrology Study, Kern County, California.* Prepared by M. Katzel, Trihey and Associates, June 1997.

U.S. Census, 2015. *US Census American Community Survey, 2010-2014.*

USGS NHD. U.S. Geological Survey National Hydrography Dataset, accessed 27 June 2018. https://gis.water.ca.gov/app/NCDatasetViewer/



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.

N

0 0.5 1

Miles

Castac Basin GSA Jurisdictional Boundaries

DRAFT

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

eki environment & water

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

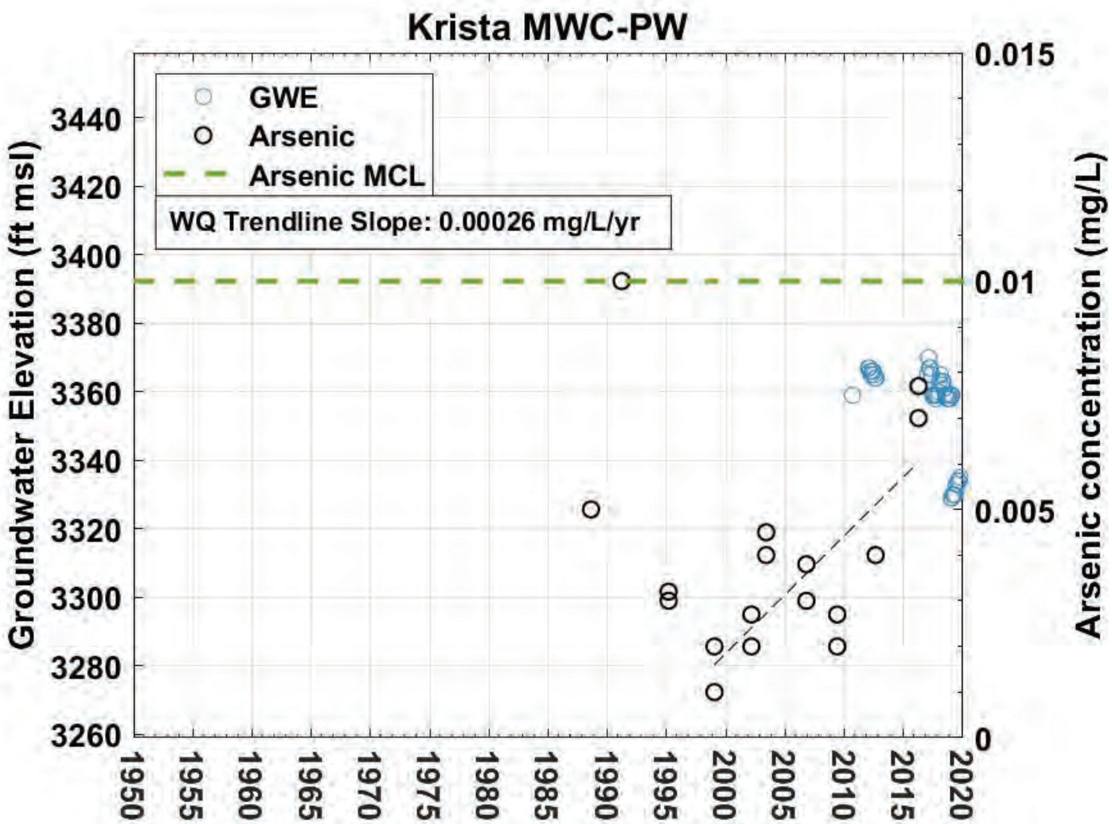
Appendix D

GSP Public Comments

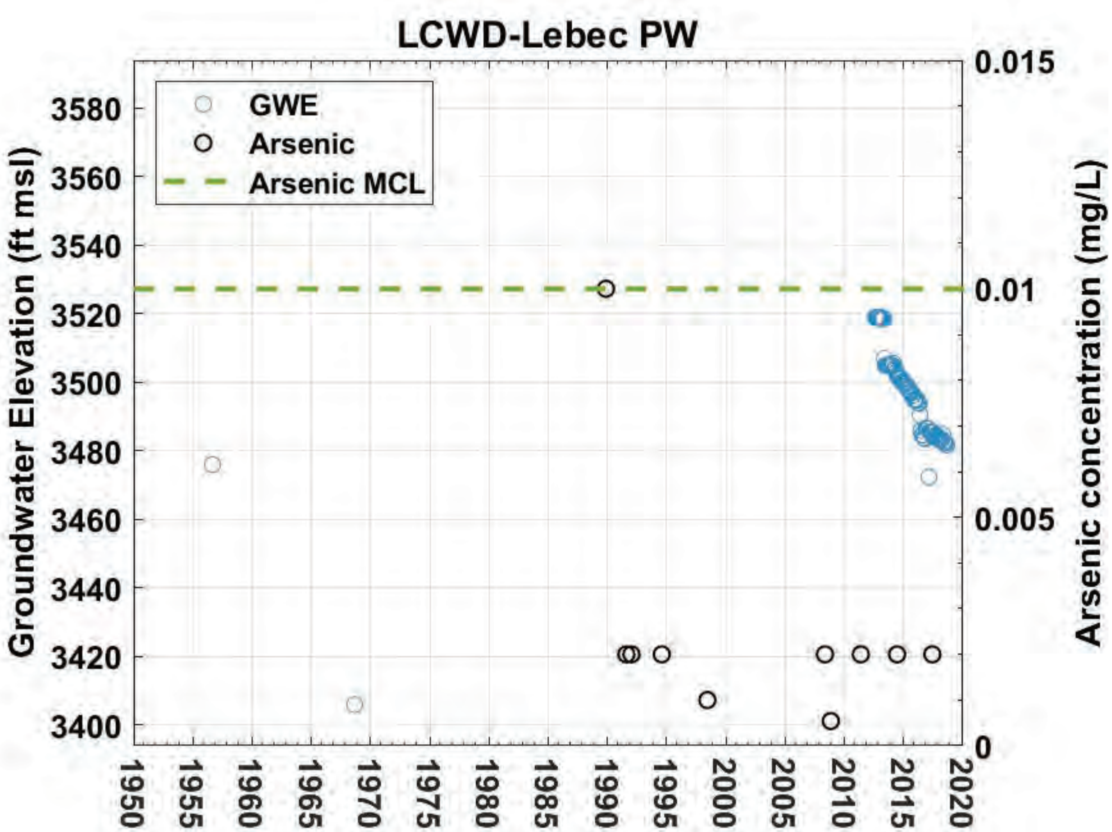
(IN-PROCESS, TO BE COMPLETED FOR FINAL DRAFT)

Appendix E

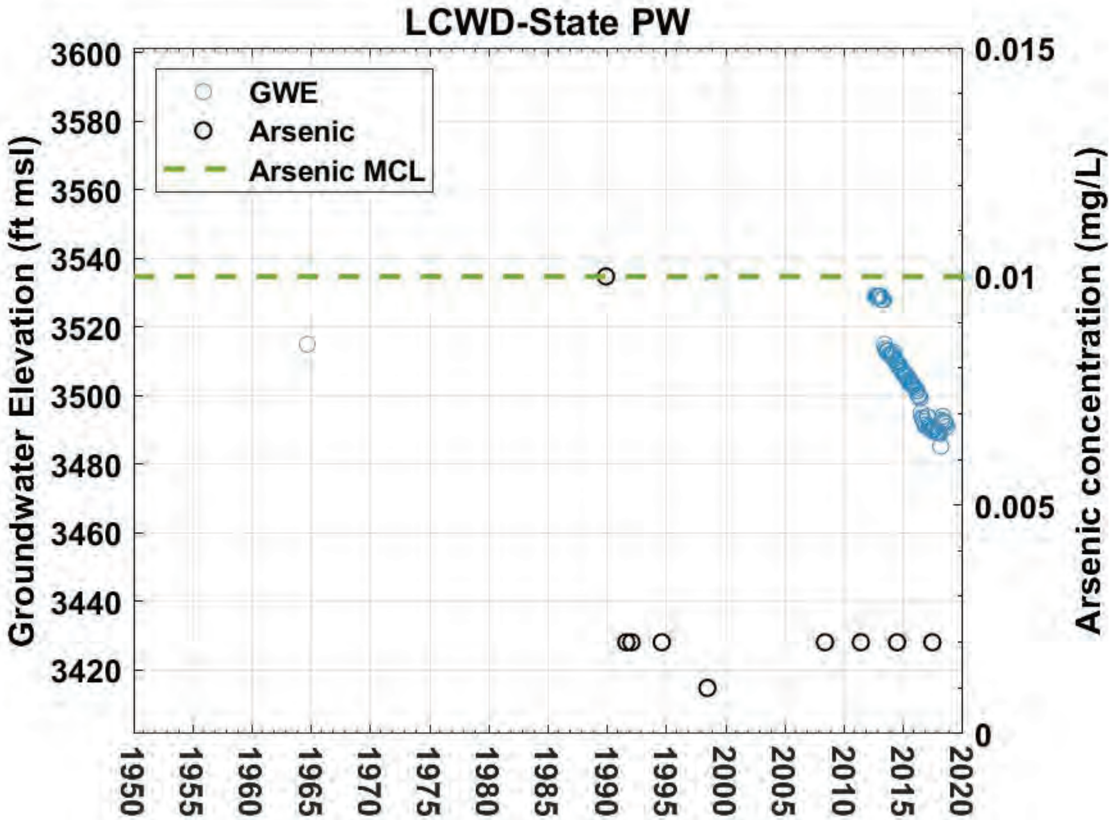
Temporal Characteristics of Available Groundwater Data

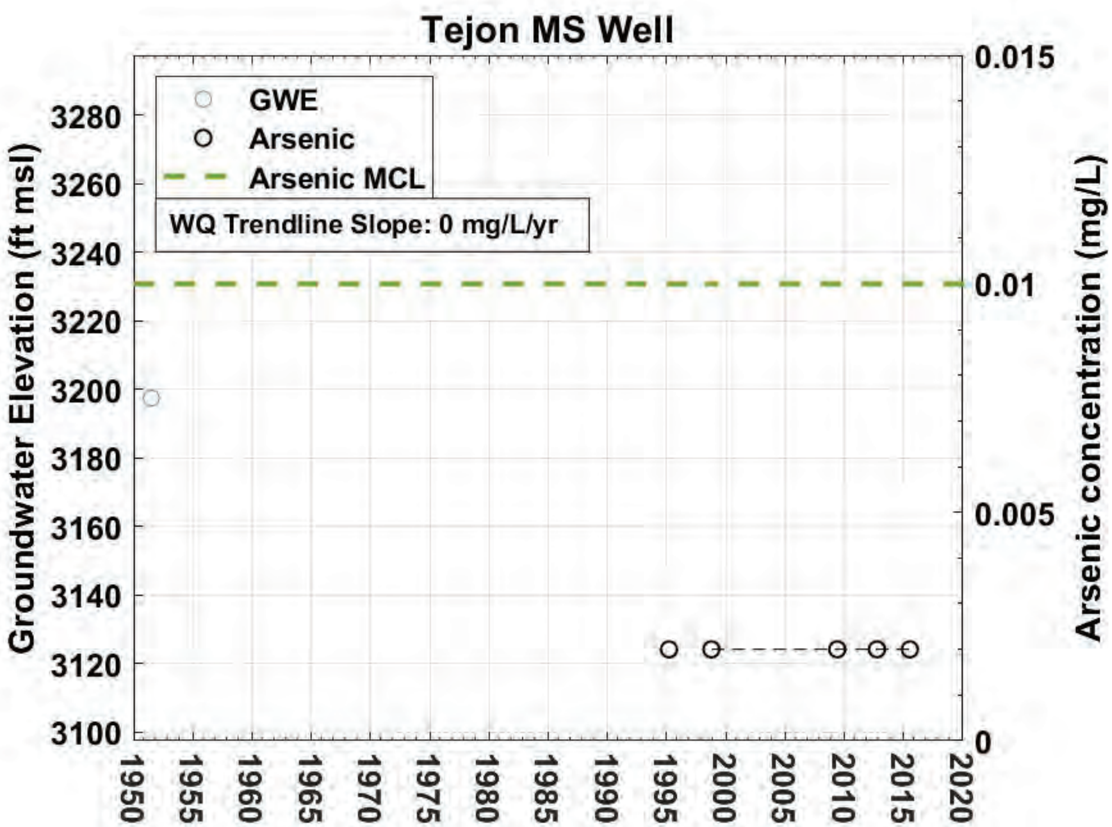


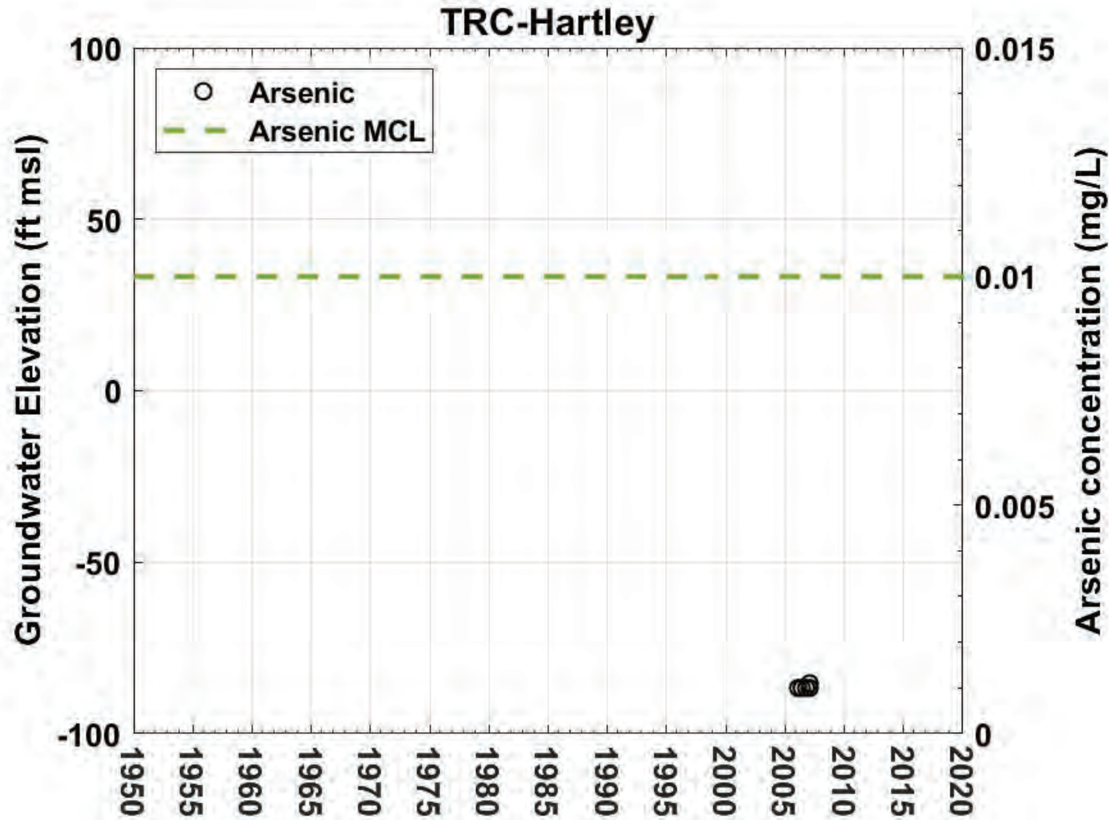
Krista MWC-PW
GWE
Arsenic
Arsenic MCL
WQ Trendline Slope: 0.00026 mg/L/yr
Groundwater Elevation (ft msl)
Arsenic concentration (mg/L)
3440
3420
3400
3380
3360
3340
3320
3300
3280
3260
0.015
0.01
0.005
0
1950
1955
1960
1965
1970
1975
1980
1985
1990
1995
2000
2005
2010
2015
2020

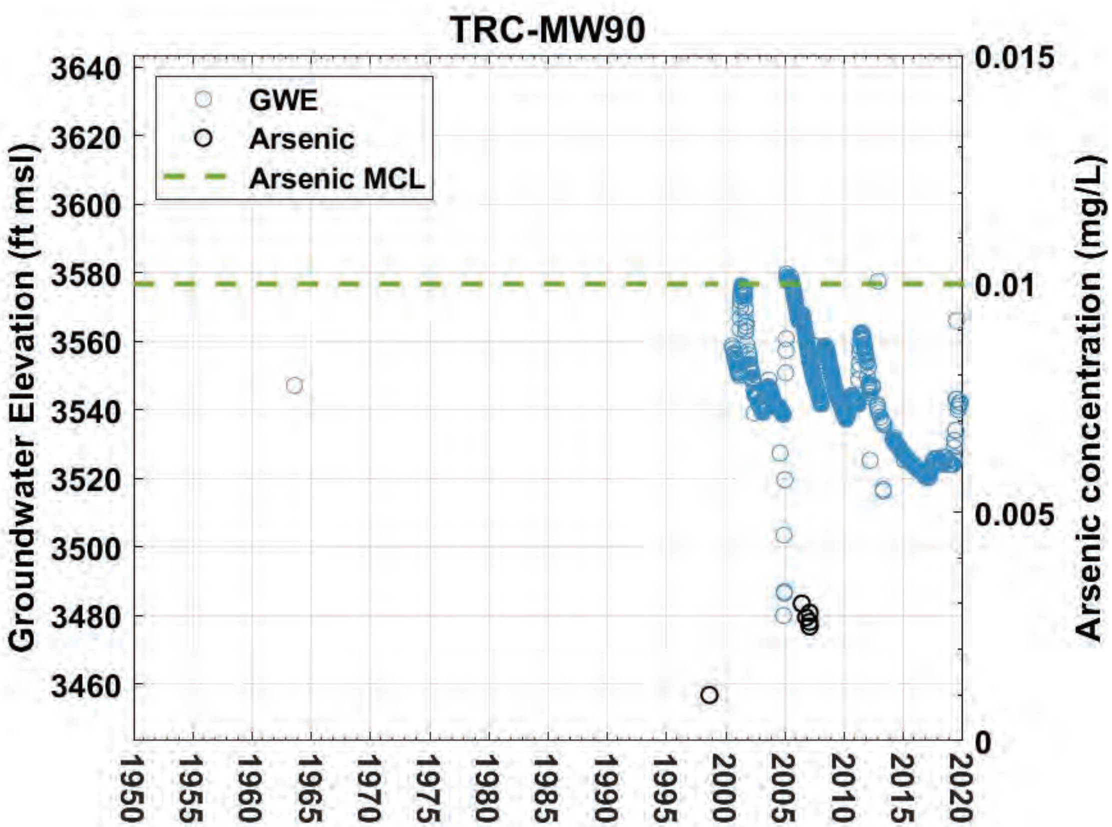


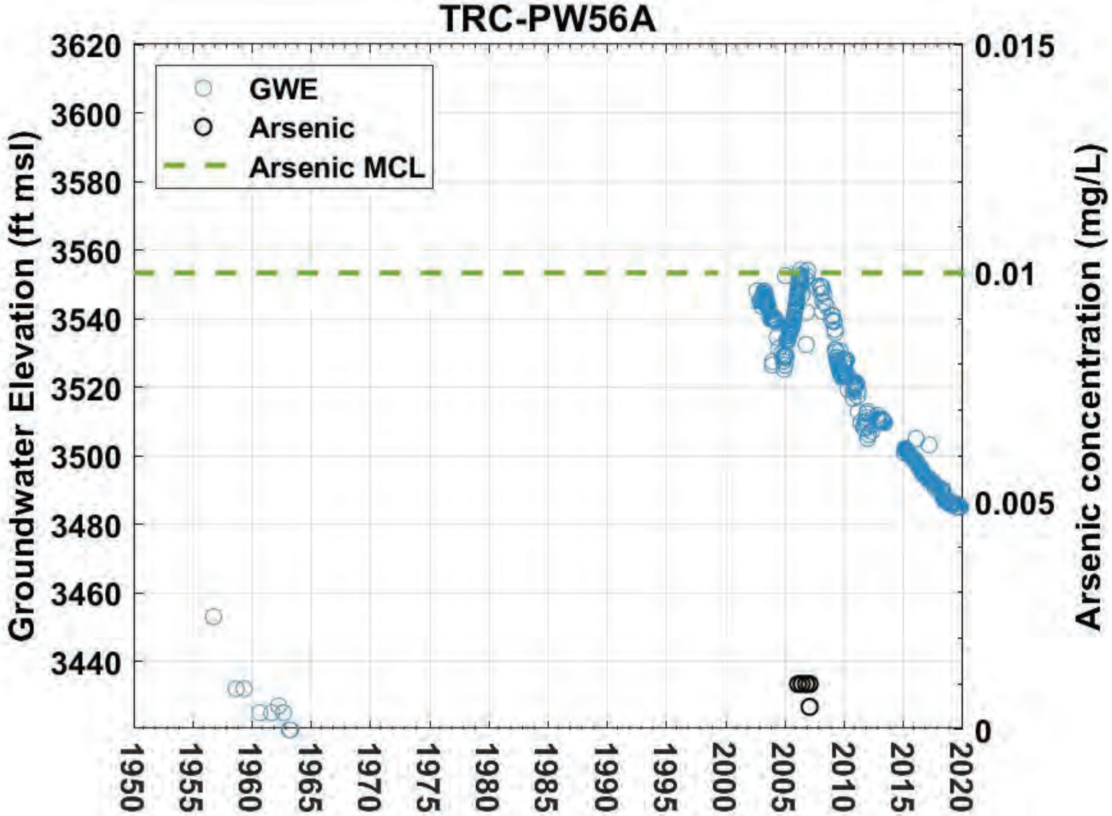
LCWD-Lebec PW
GWE
Arsenic
Arsenic MCL
Groundwater Elevation (ft msl)
Arsenic concentration (mg/L)
3580
3560
3540
3520
3500
3480
3460
3440
3420
3400
0.015
0.01
0.005
0
1950
1955
1960
1965
1970
1975
1980
1985
1990
1995
2000
2005
2010
2015
2020


LCWD-State PW
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

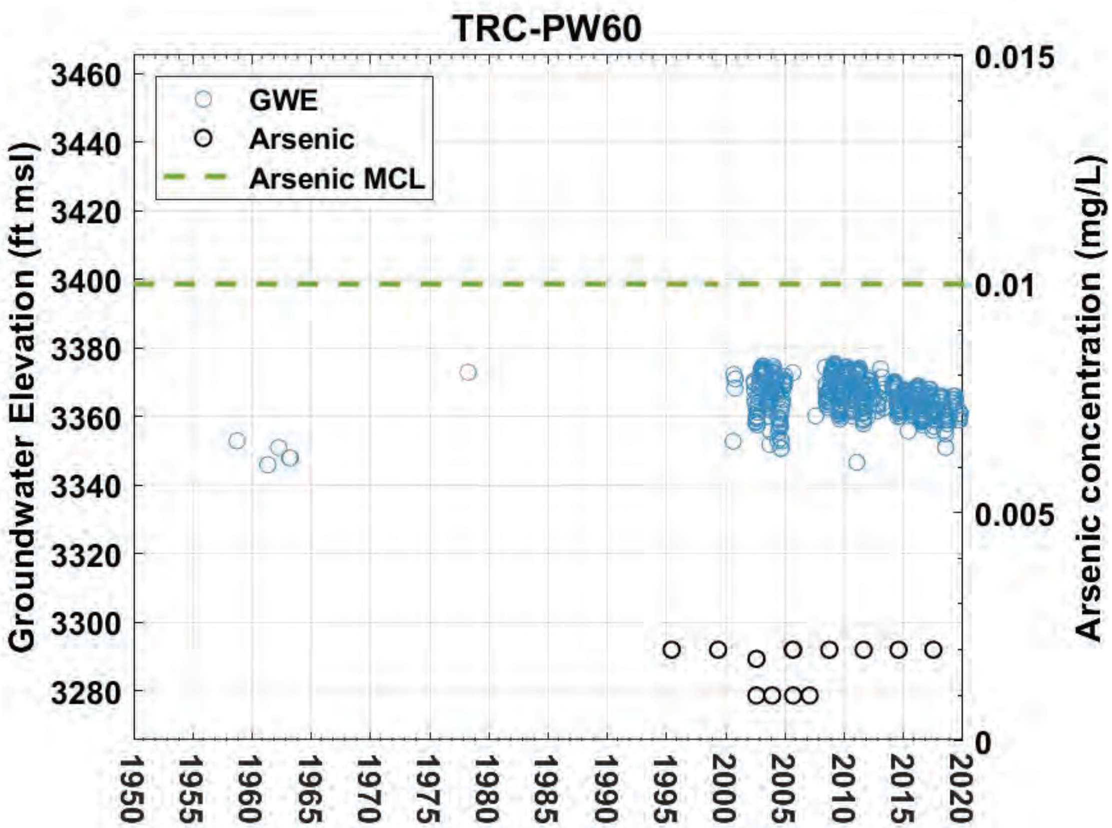

Tejon MS Well
GWE
Arsenic
Arsenic MCL
WQ Trendline Slope: 0 mg/L/yr
Groundwater Elevation (ft msl)
Arsenic concentration (mg/L)
3280
3260
3240
3220
3200
3180
3160
3140
3120
3100
0.015
0.01
0.005
0
1950
1955
1960
1965
1970
1975
1980
1985
1990
1995
2000
2005
2010
2015
2020


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
2000
2005
2010
2015
2020

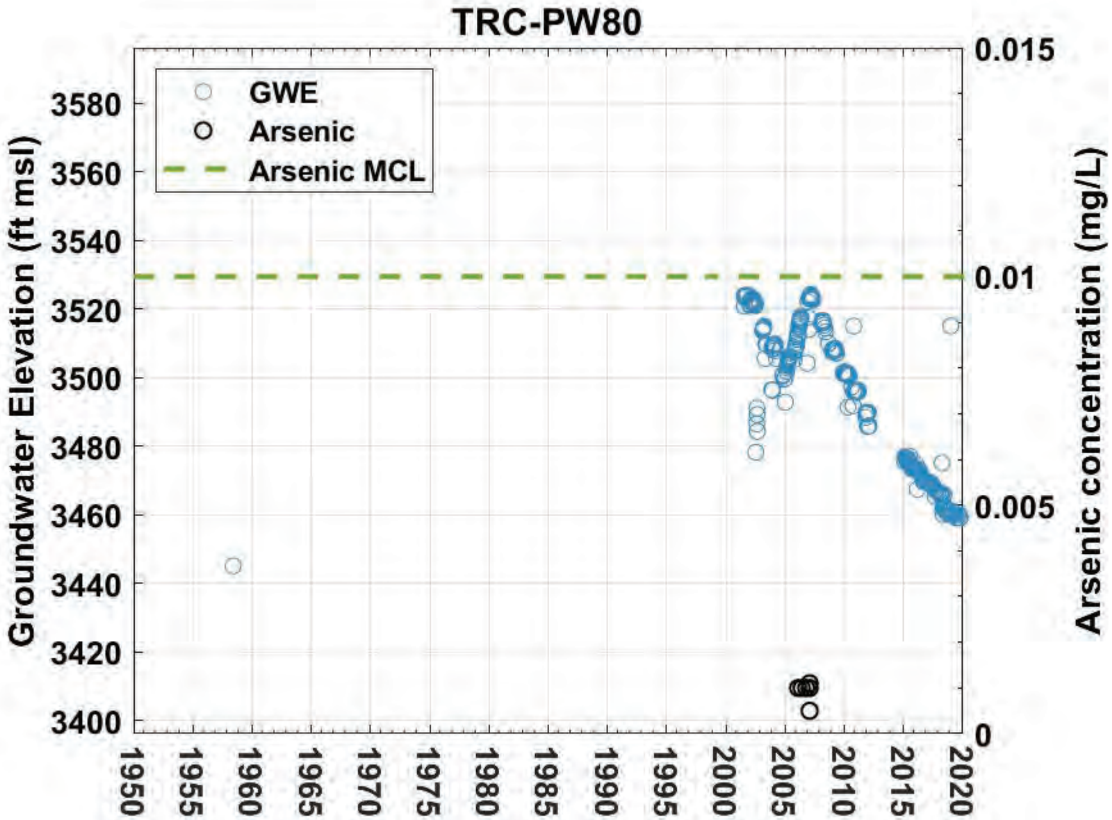

TRC-MW90
GWE
Arsenic
Arsenic MCL
Groundwater Elevation (ft msl)
Arsenic concentration (mg/L)
3640
3620
3600
3580
3560
3540
3520
3500
3480
3460
0.015
0.01
0.005
0
1950
1955
1960
1965
1970
1975
1980
1985
1990
1995
2000
2005
2010
2015
2020

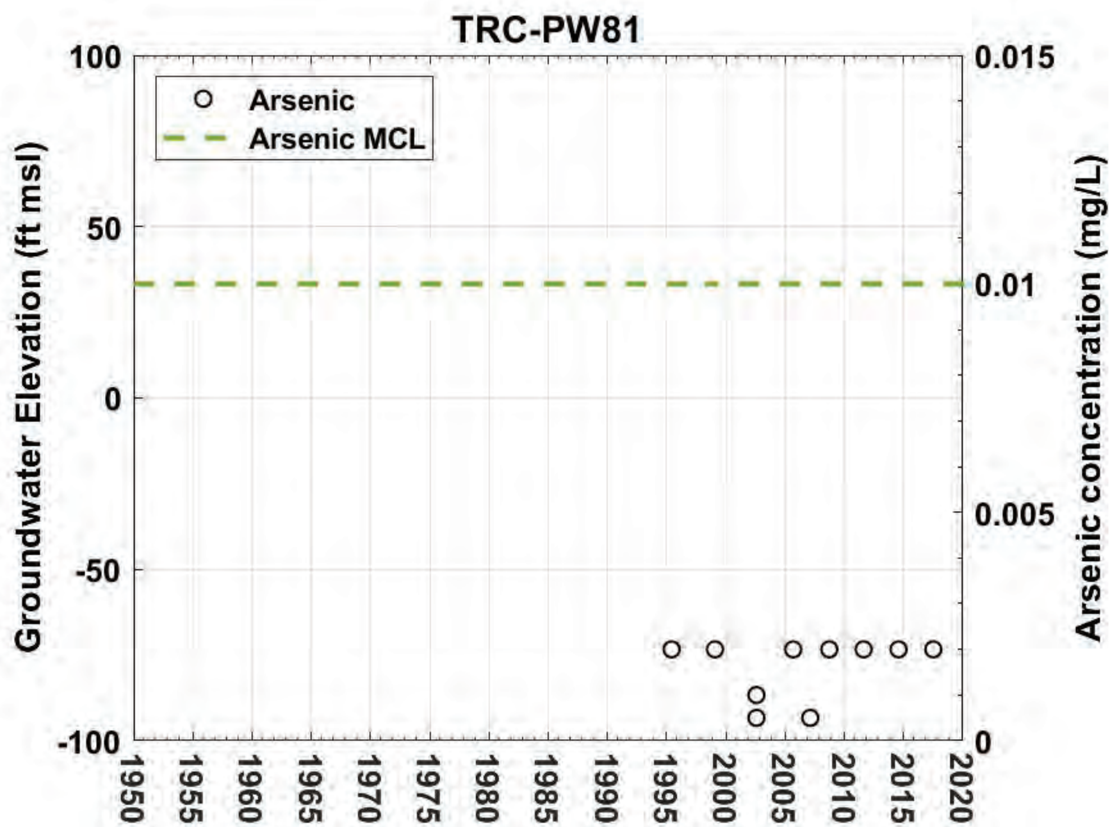


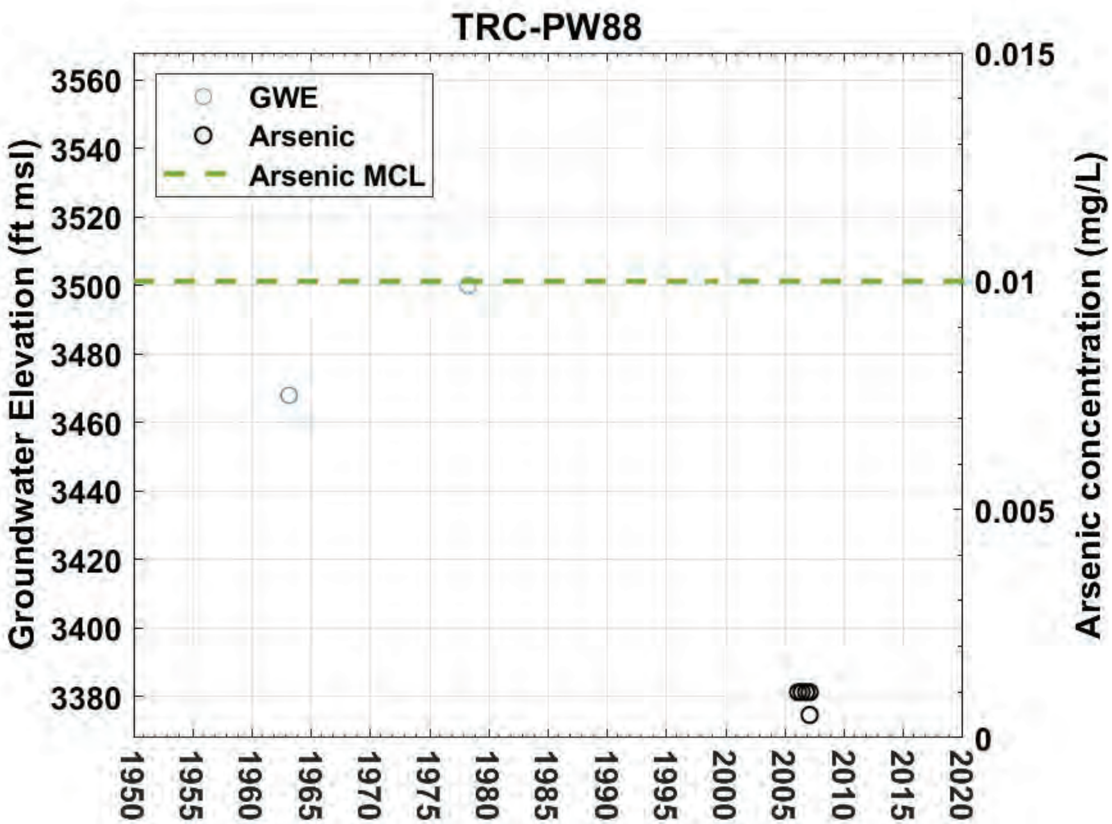
TRC-PW56A
GWE
Arsenic
Arsenic MCL
Groundwater Elevation (ft msl)
Arsenic concentration (mg/L)
3620
3600
3580
3560
3540
3520
3500
3480
3460
3440
0.015
0.01
0.005
0
1950
1955
1960
1965
1970
1975
1980
1985
1990
1995
2000
2005
2010
2015
2020



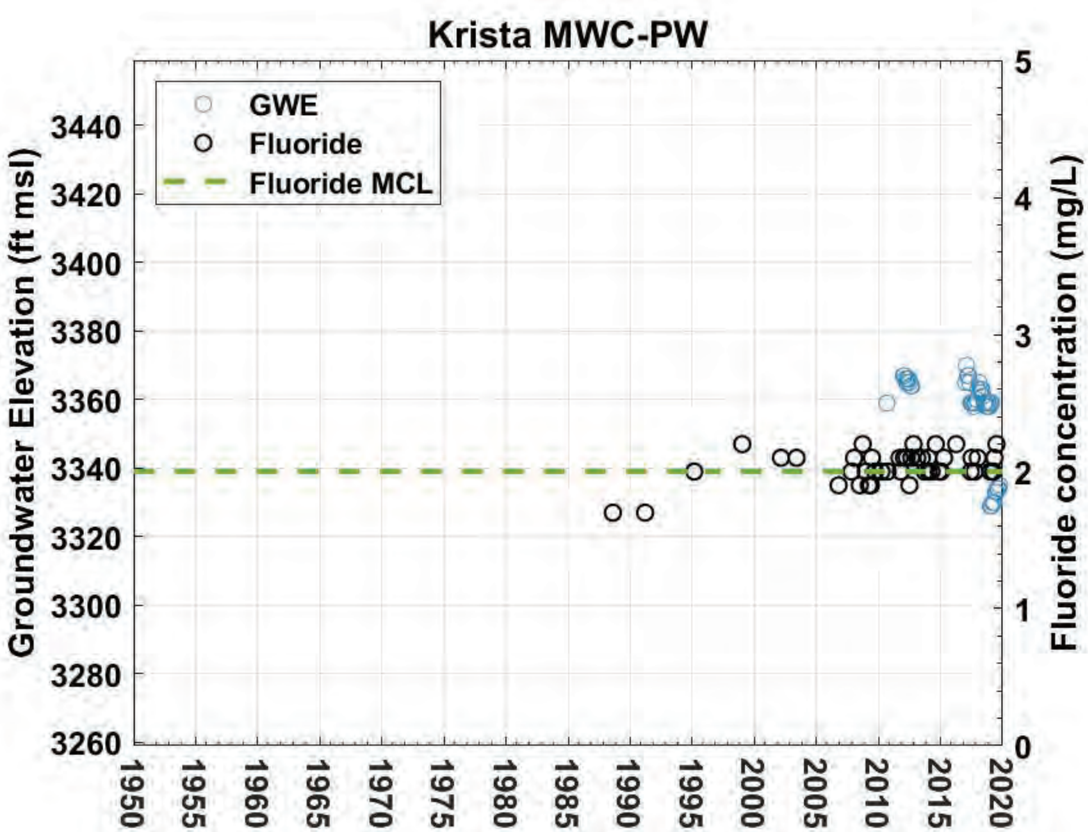
TRC-PW60
GWE
Arsenic
Arsenic MCL
Groundwater Elevation (ft msl)
Arsenic concentration (mg/L)
3460
3440
3420
3400
3380
3360
3340
3320
3300
3280
0.015
0.01
0.005
0
1950
1955
1960
1965
1970
1975
1980
1985
1990
1995
2000
2005
2010
2015
2020


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
1955
1960
1965
1970
1975
1980
1985
1990
1995
2000
2005
2010
2015
2020

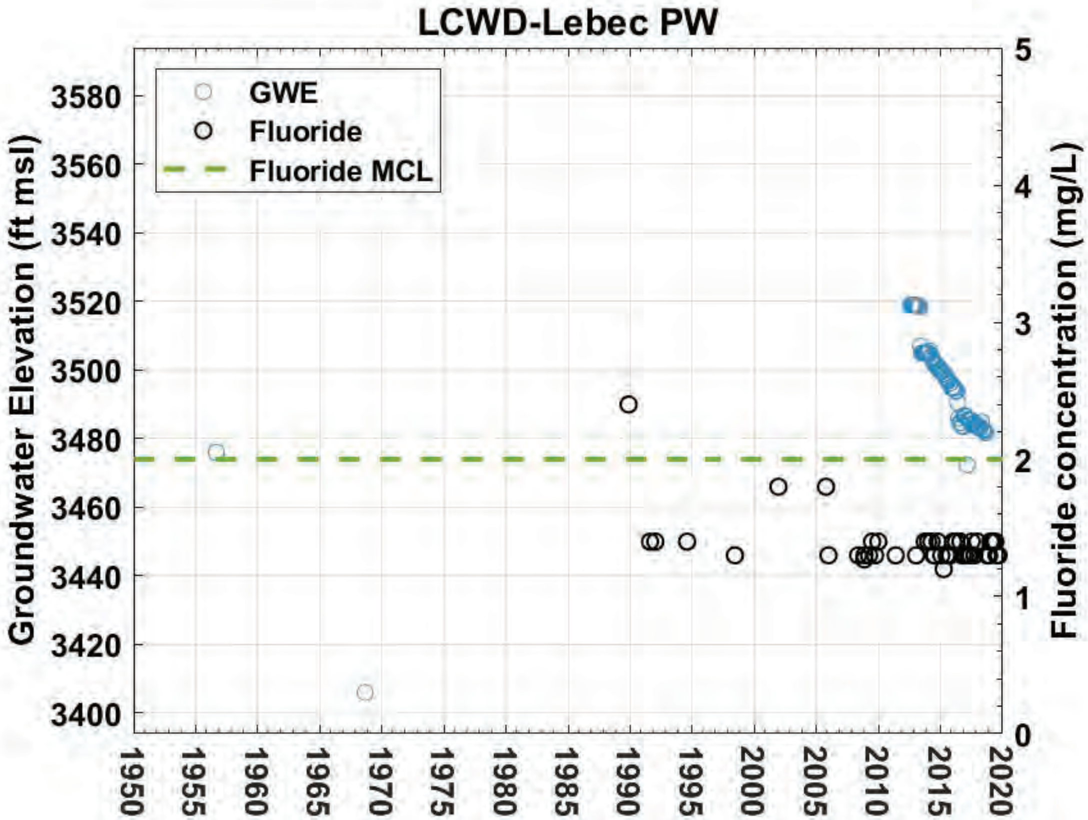

TRC-PW81
Arsenic
Arsenic MCL
Groundwater Elevation (ft msl)
Arsenic concentration (mg/L)
100
50
0
-50
-100
0.015
0.01
0.005
0
1950
1955
1960
1965
1970
1975
1980
1985
1990
1995
2000
2005
2010
2015
2020



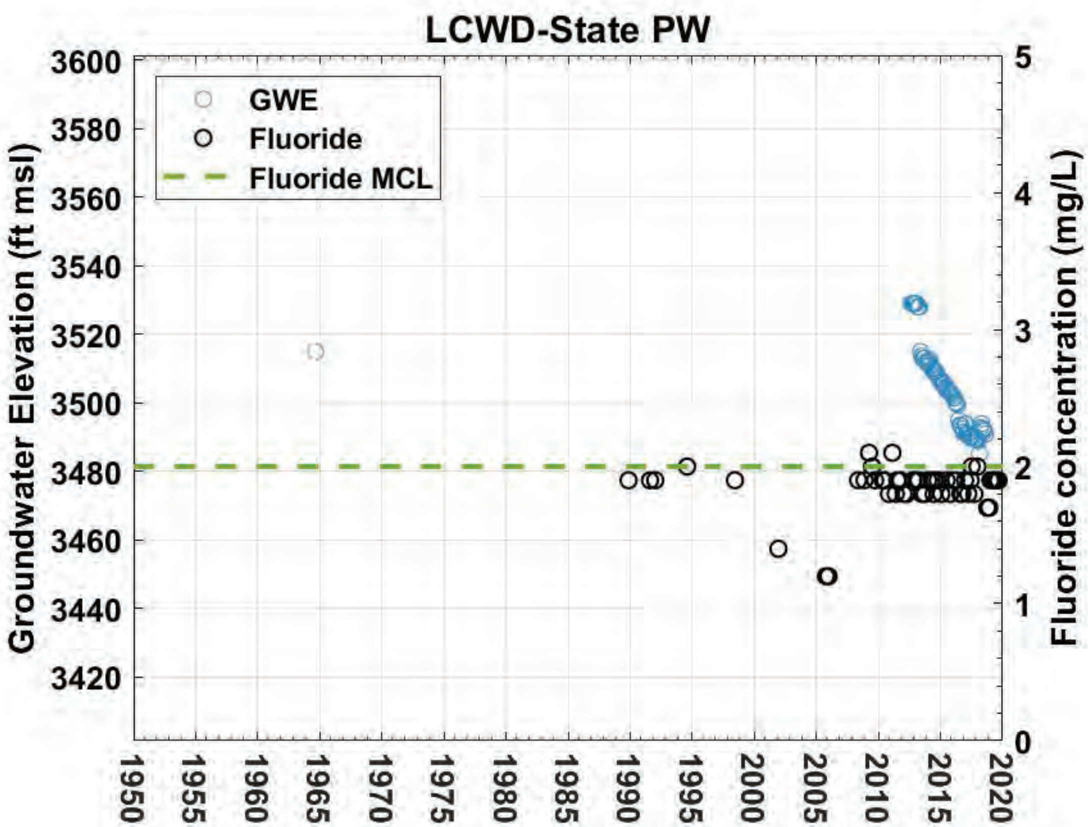
TRC-PW88
GWE
Arsenic
Arsenic MCL
Groundwater Elevation (ft msl)
Arsenic concentration (mg/L)
3560
3540
3520
3500
3480
3460
3440
3420
3400
3380
0.015
0.01
0.005
0
1950
1955
1960
1965
1970
1975
1980
1985
1990
1995
2000
2005
2010
2015
2020



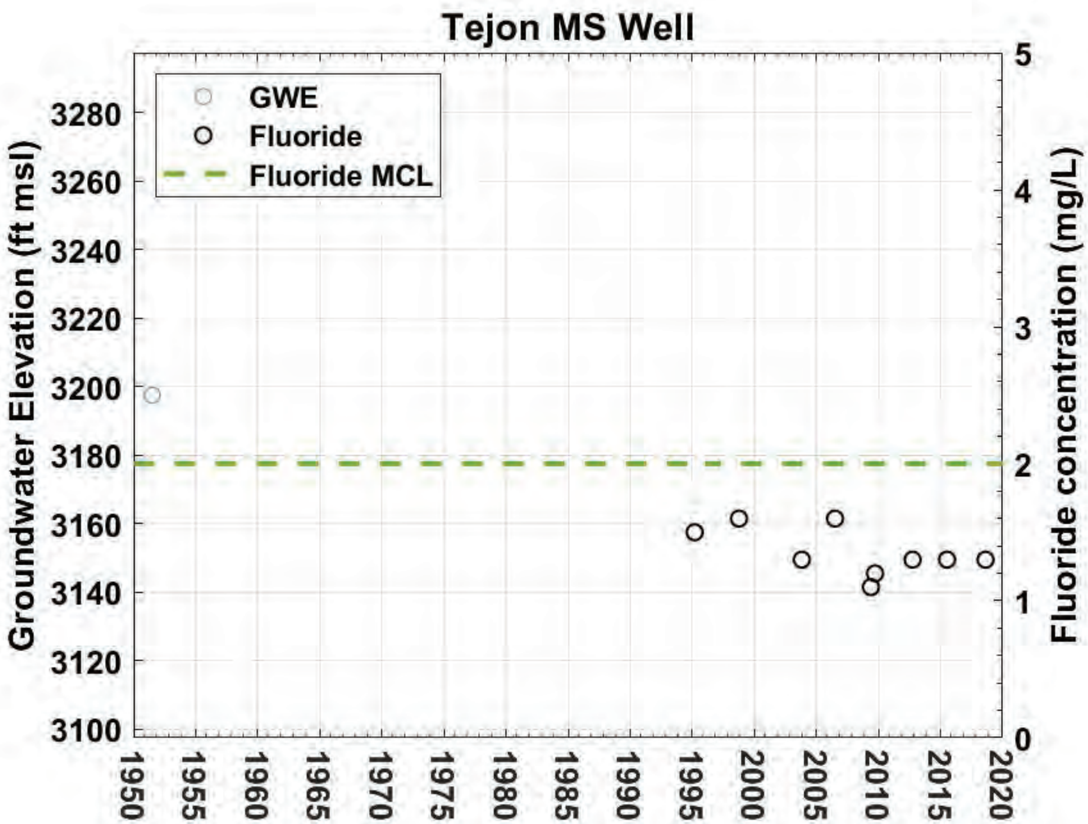
Krista MWC-PW
GWE
Fluoride
Fluoride MCL
Groundwater Elevation (ft msl)
Fluoride concentration (mg/L)
3440
3420
3400
3380
3360
3340
3320
3300
3280
3260
5
4
3
2
1
0
1950
1955
1960
1965
1970
1975
1980
1985
1990
1995
2000
2005
2010
2015
2020

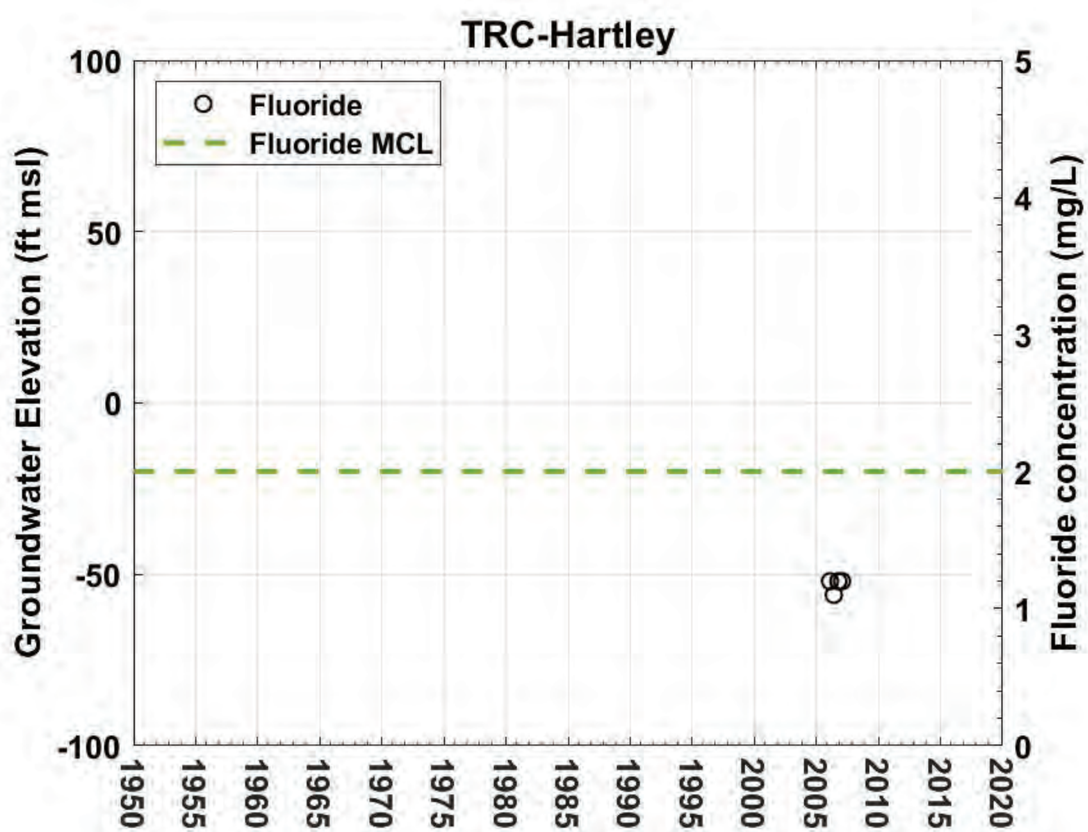


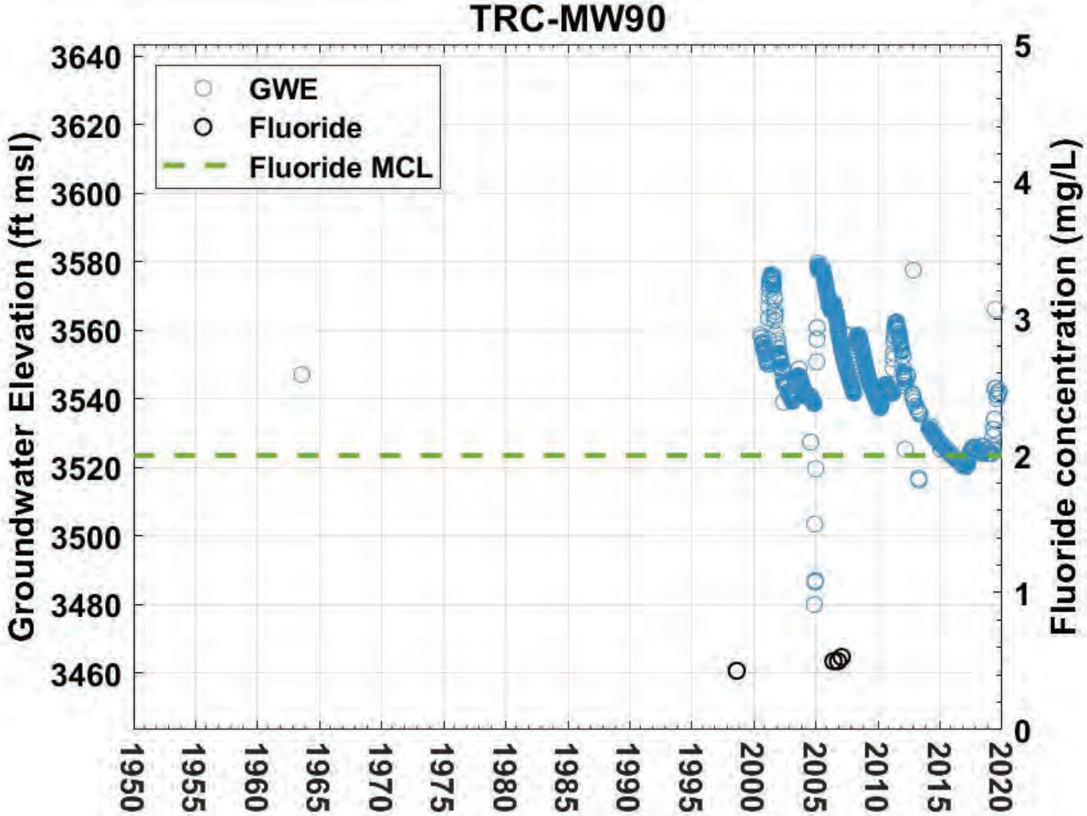
LCWD-Lebec PW
GWE
Fluoride
Fluoride MCL
Groundwater Elevation (ft msl)
Fluoride concentration (mg/L)
3580
3560
3540
3520
3500
3480
3460
3440
3420
3400
5
4
3
2
1
0
1950
1955
1960
1965
1970
1975
1980
1985
1990
1995
2000
2005
2010
2015
2020

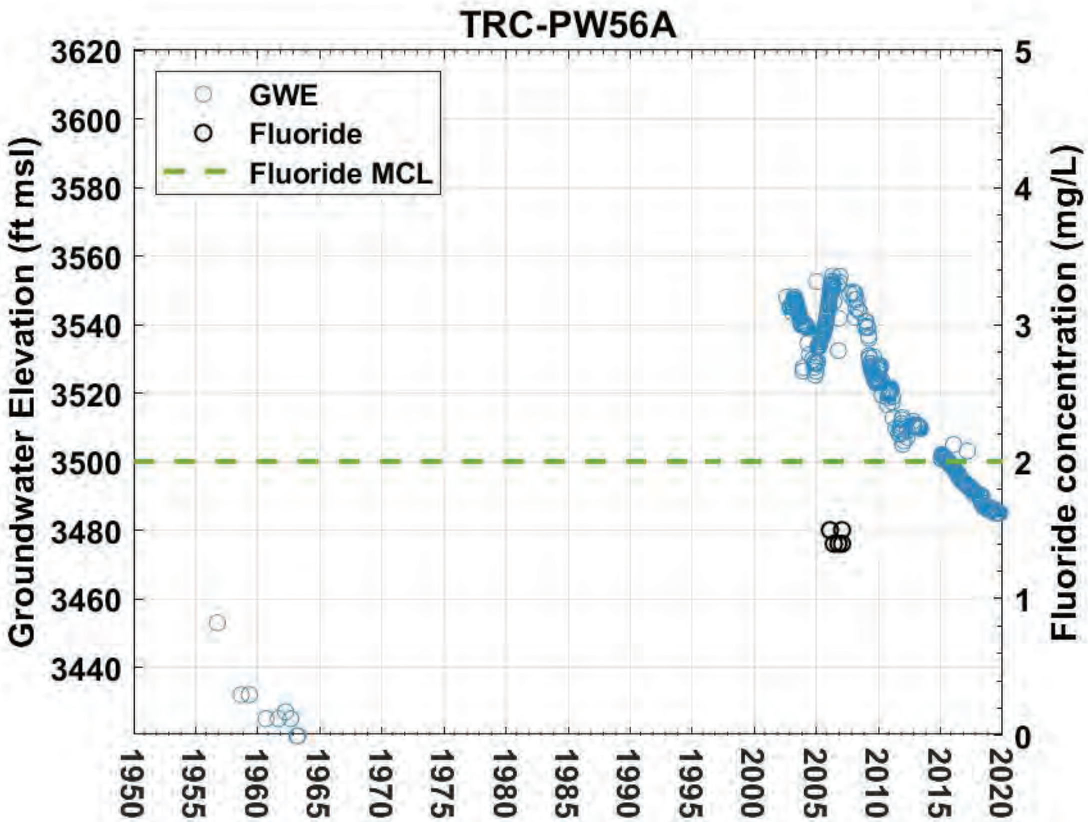


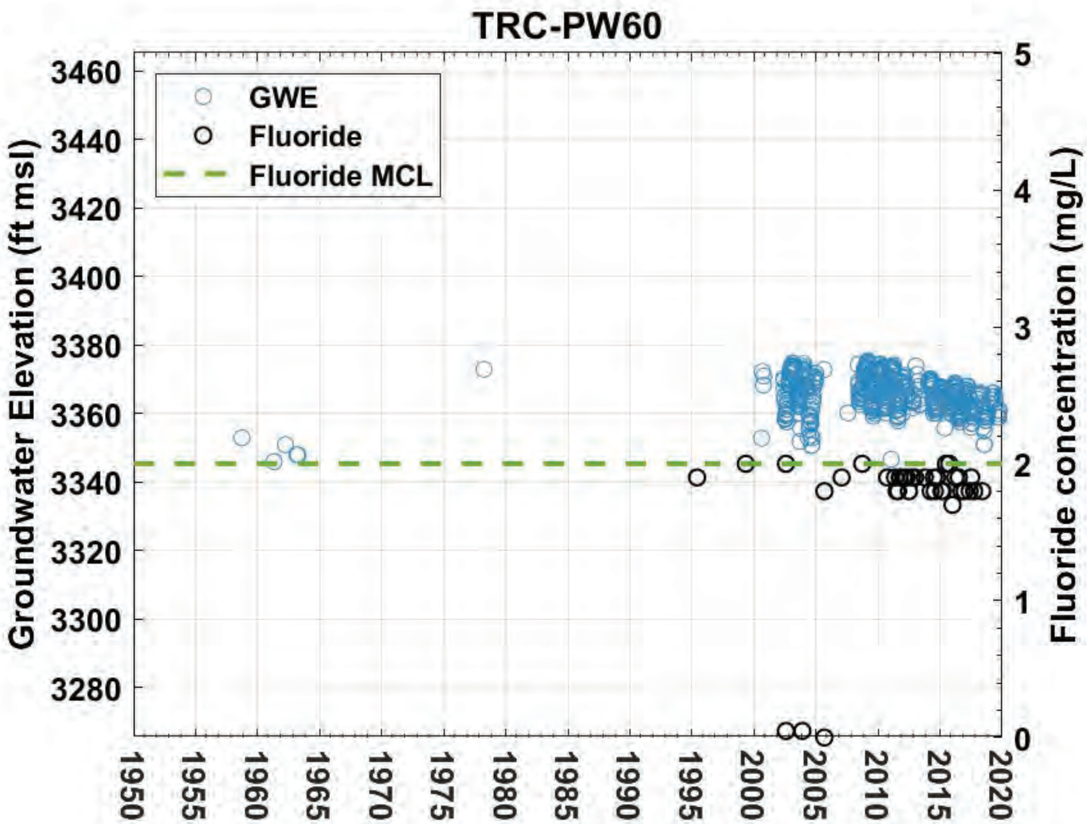
LCWD-State PW
GWE
Fluoride
Fluoride MCL
Groundwater Elevation (ft msl)
Fluoride concentration (mg/L)
3600
3580
3560
3540
3520
3500
3480
3460
3440
3420
5
4
3
2
1
0
1950
1955
1960
1965
1970
1975
1980
1985
1990
1995
2000
2005
2010
2015
2020

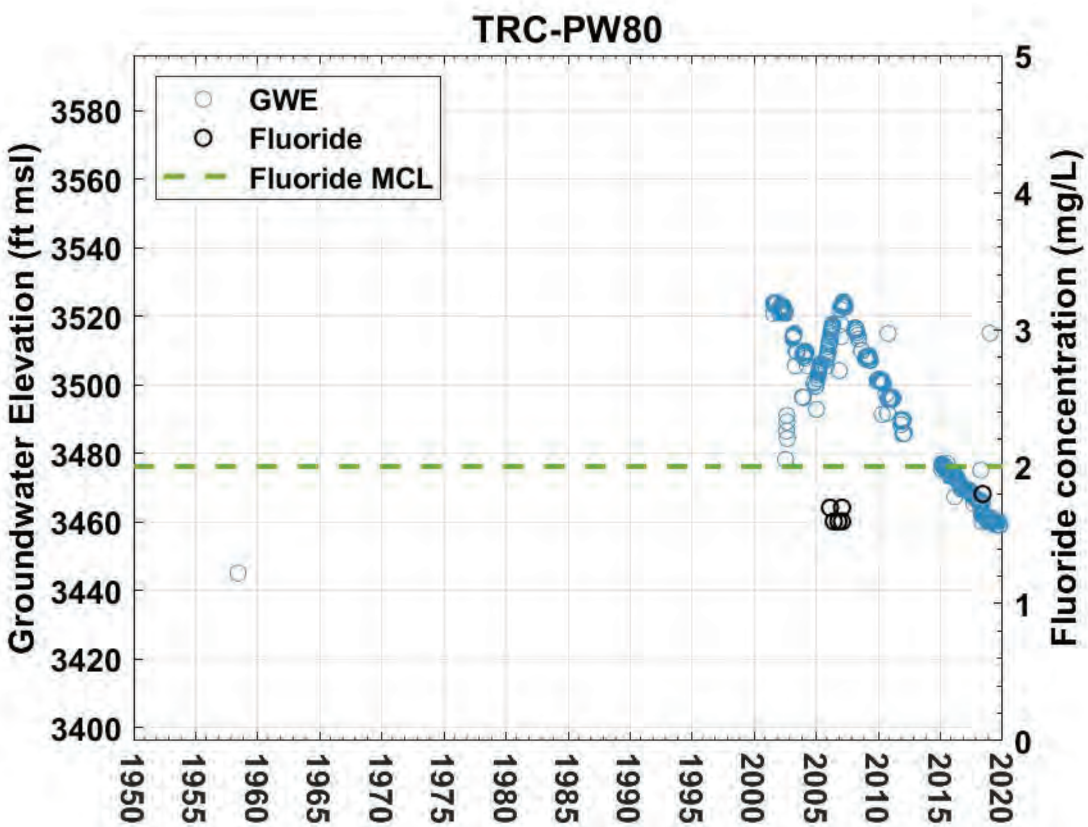

Tejon MS Well
GWE
Fluoride
Fluoride MCL
Groundwater Elevation (ft msl)
Fluoride concentration (mg/L)
3100
3120
3140
3160
3180
3200
3220
3240
3260
3280
0
1
2
3
4
5
1950
1955
1960
1965
1970
1975
1980
1985
1990
1995
2000
2005
2010
2015
2020

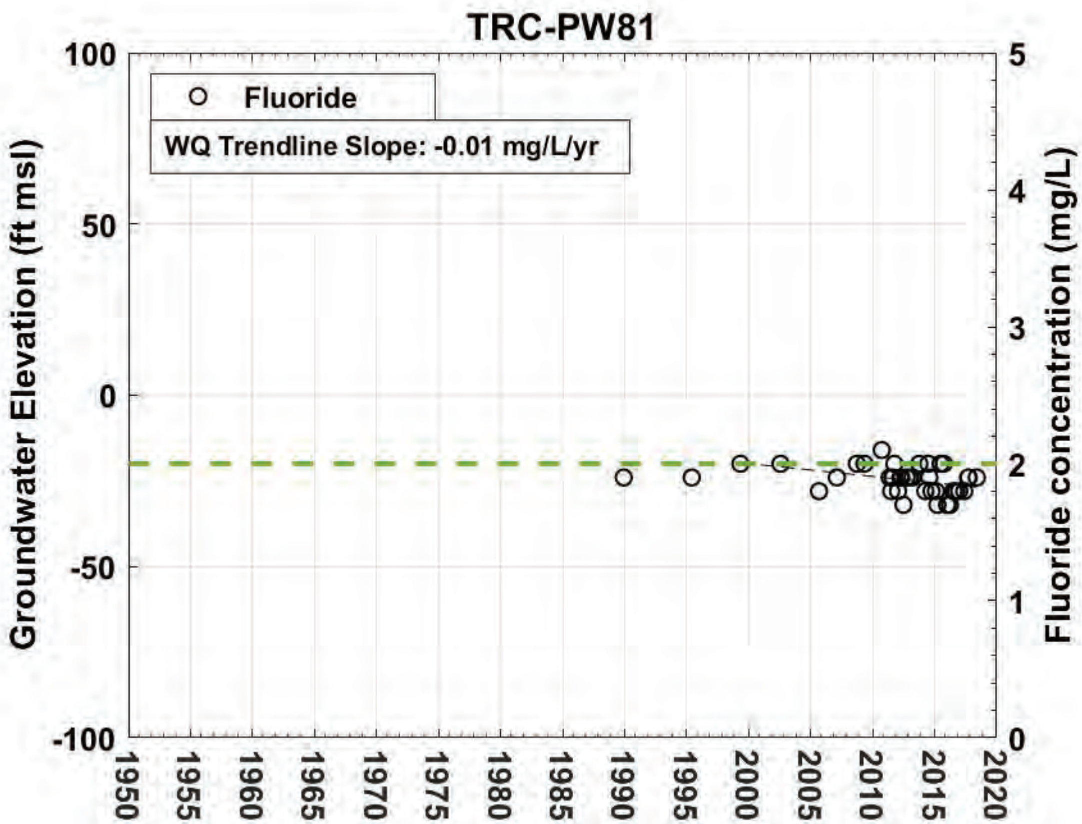

TRC-Hartley
Fluoride
Fluoride MCL
Groundwater Elevation (ft msl)
Fluoride concentration (mg/L)
-100
-50
0
50
100
0
1
2
3
4
5
1950
1955
1960
1965
1970
1975
1980
1985
1990
1995
2000
2005
2010
2015
2020

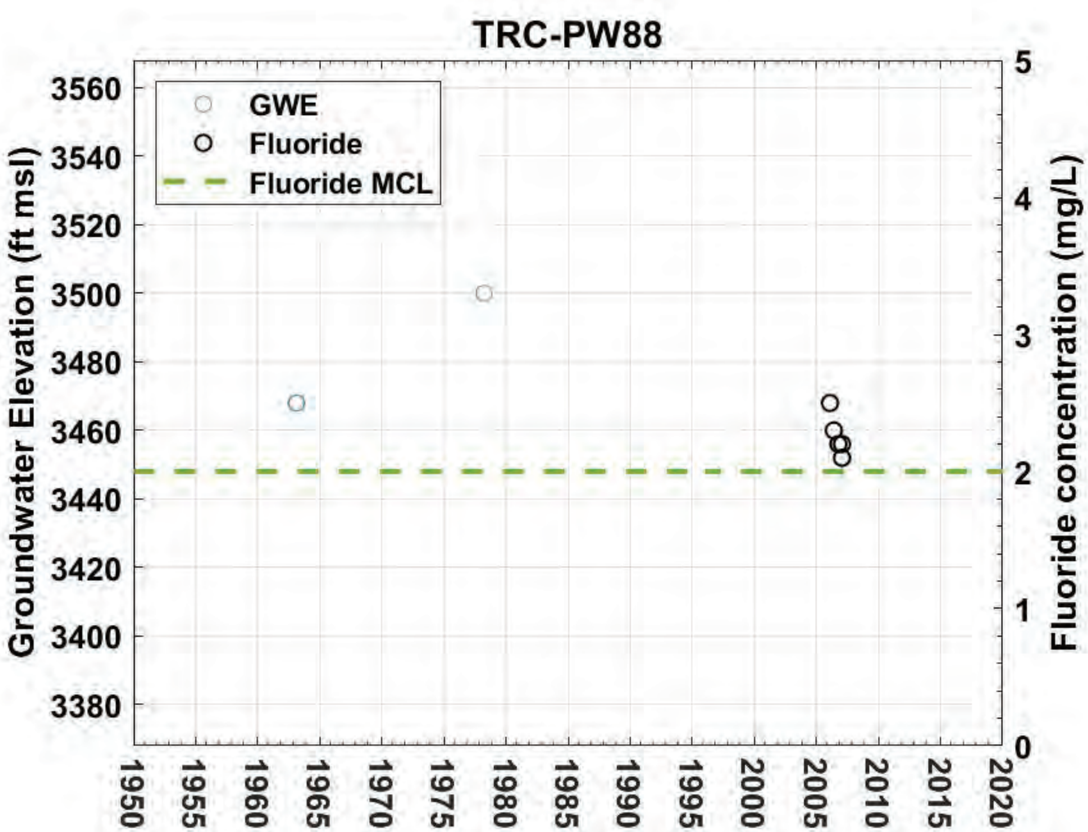

TRC-MW90
GWE
Fluoride
Fluoride MCL
Groundwater Elevation (ft msl)
Fluoride concentration (mg/L)
3640
3620
3600
3580
3560
3540
3520
3500
3480
3460
5
4
3
2
1
0
1950
1955
1960
1965
1970
1975
1980
1985
1990
1995
2000
2005
2010
2015
2020

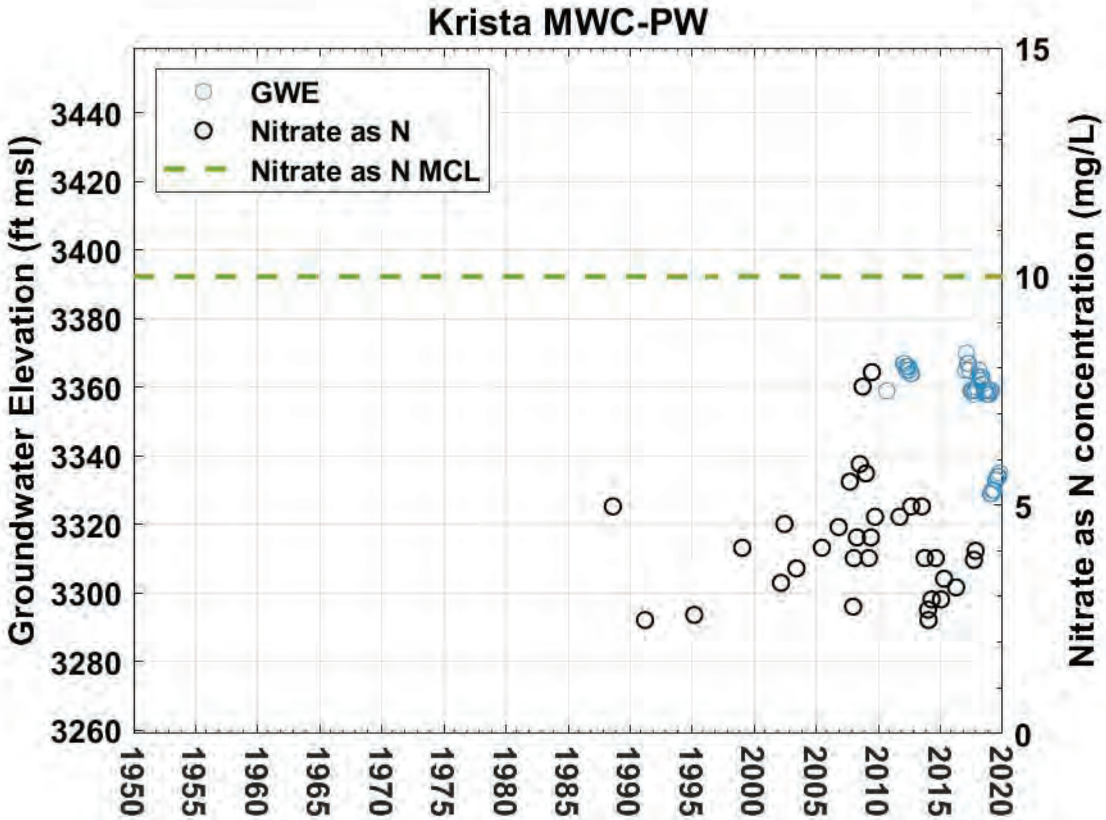

TRC-PW56A
GWE
Fluoride
Fluoride MCL
Groundwater Elevation (ft msl)
Fluoride concentration (mg/L)
3620
3600
3580
3560
3540
3520
3500
3480
3460
3440
5
4
3
2
1
0
1950
1955
1960
1965
1970
1975
1980
1985
1990
1995
2000
2005
2010
2015
2020


TRC-PW60
GWE
Fluoride
Fluoride MCL
Groundwater Elevation (ft msl)
Fluoride concentration (mg/L)
3460
3440
3420
3400
3380
3360
3340
3320
3300
3280
5
4
3
2
1
0
1950
1955
1960
1965
1970
1975
1980
1985
1990
1995
2000
2005
2010
2015
2020

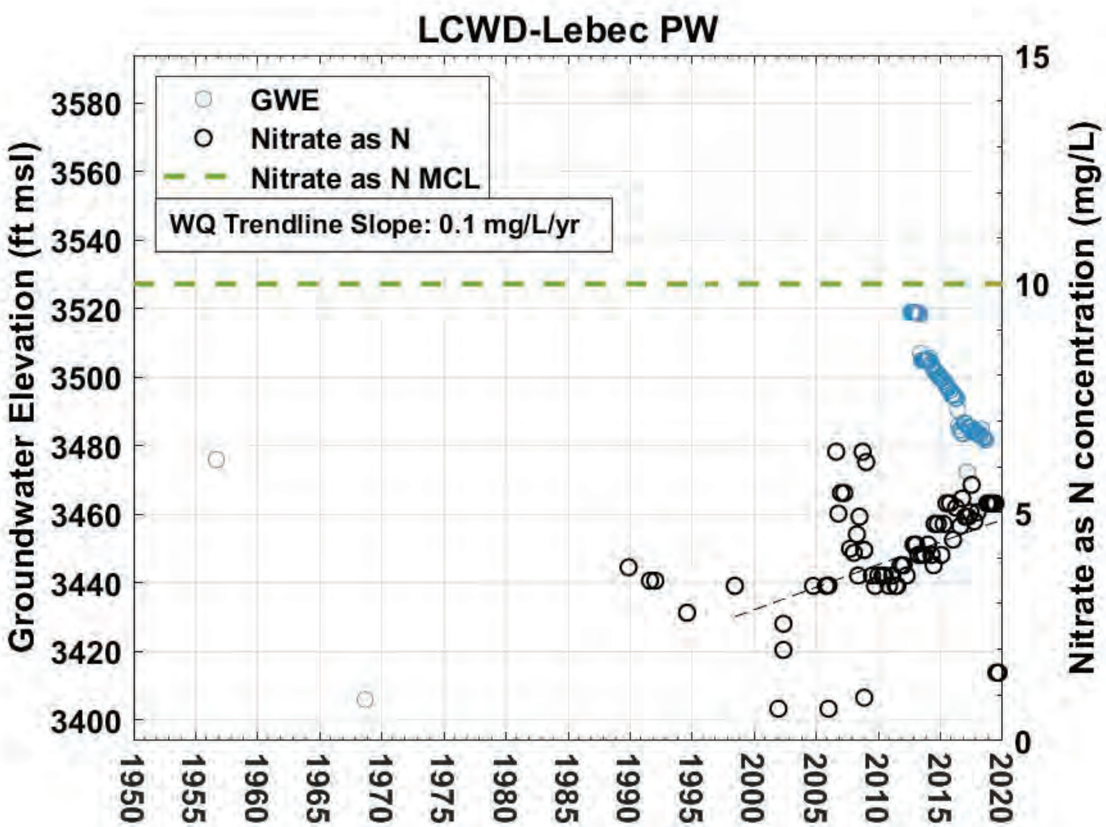

TRC-PW80
GWE
Fluoride
Fluoride MCL
Groundwater Elevation (ft msl)
Fluoride concentration (mg/L)
3580
3560
3540
3520
3500
3480
3460
3440
3420
3400
5
4
3
2
1
0
1950
1955
1960
1965
1970
1975
1980
1985
1990
1995
2000
2005
2010
2015
2020


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
1955
1960
1965
1970
1975
1980
1985
1990
1995
2000
2005
2010
2015
2020

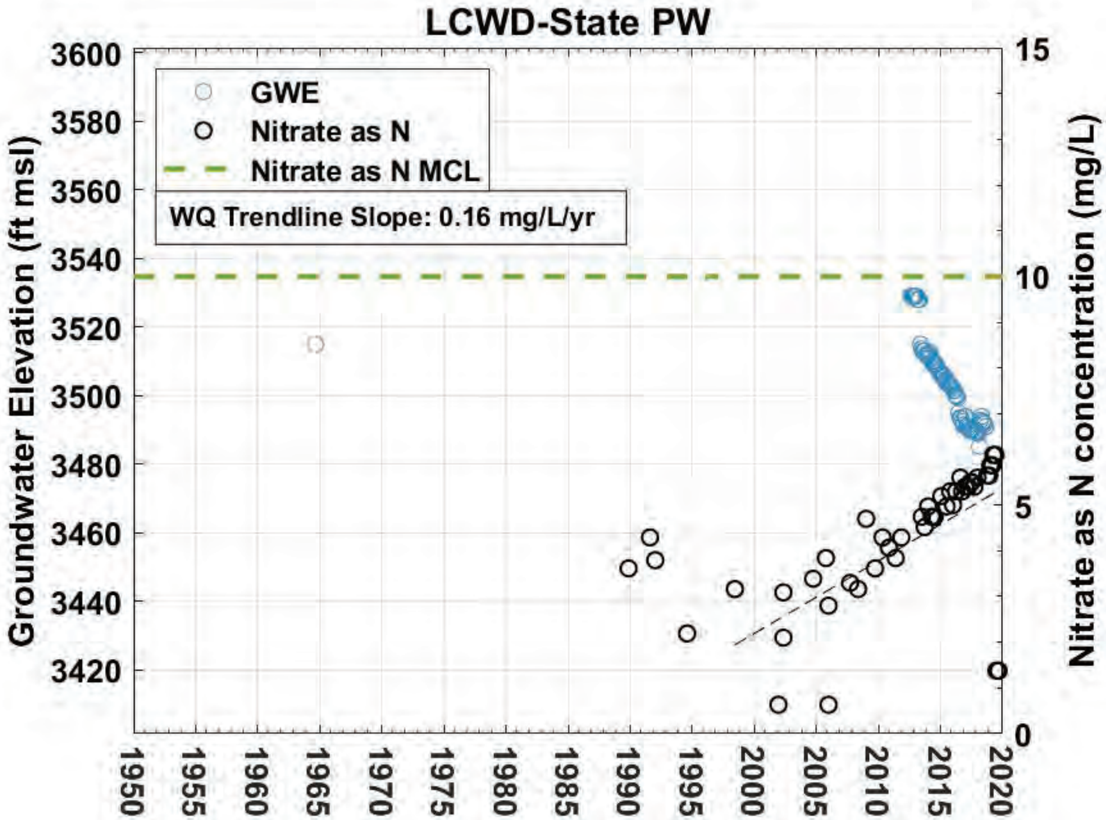

TRC-PW88
GWE
Fluoride
Fluoride MCL
Groundwater Elevation (ft msl)
Fluoride concentration (mg/L)
3560
3540
3520
3500
3480
3460
3440
3420
3400
3380
5
4
3
2
1
0
1950
1955
1960
1965
1970
1975
1980
1985
1990
1995
2000
2005
2010
2015
2020

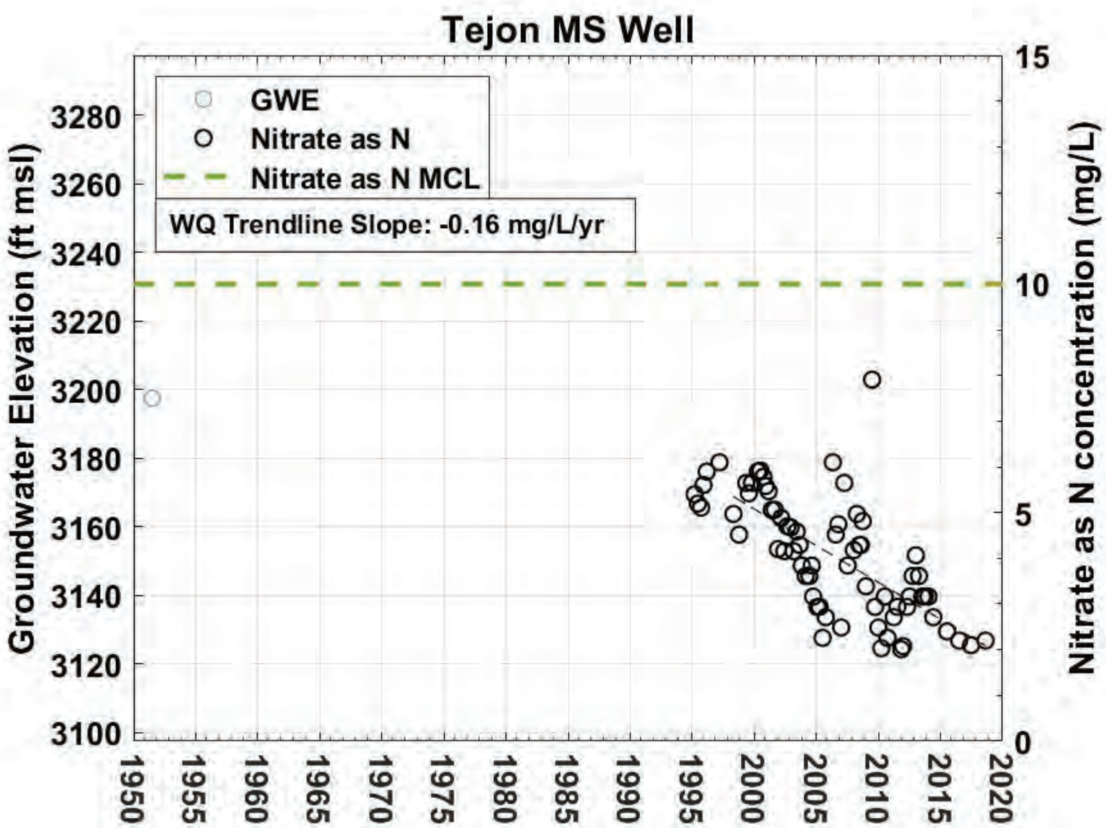


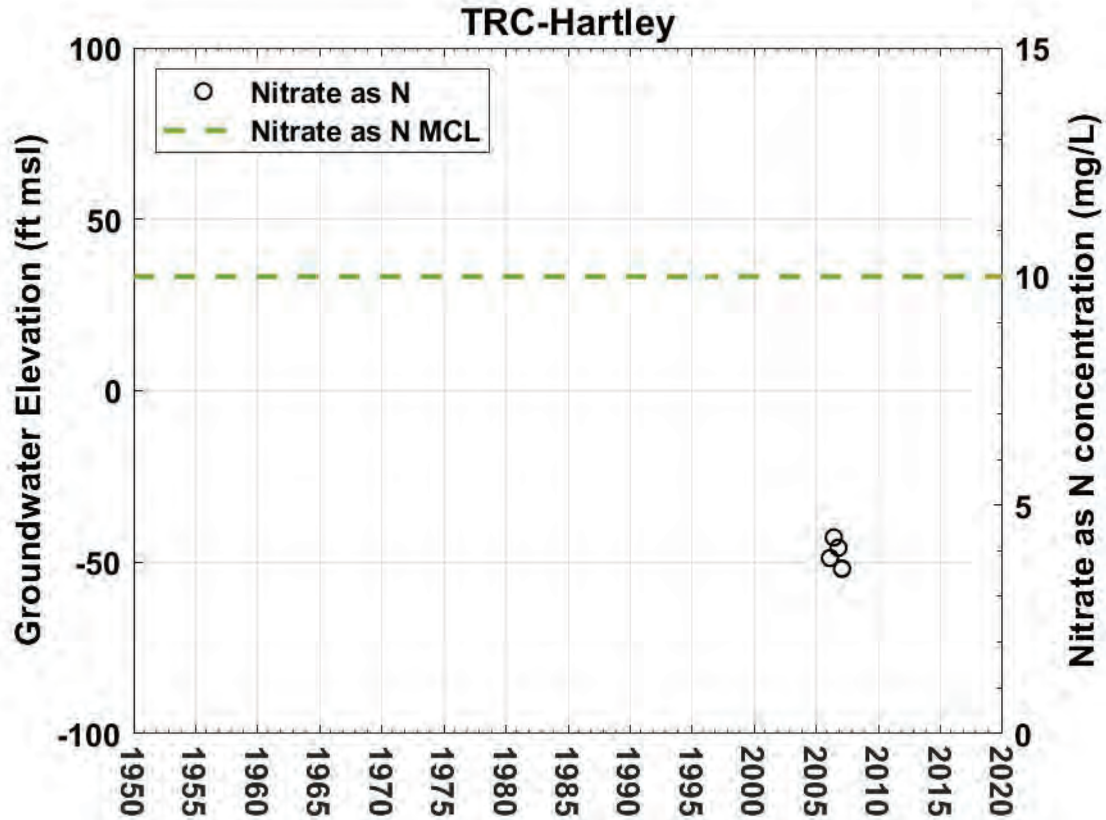
Krista MWC-PW
GWE
Nitrate as N
Nitrate as N MCL
Groundwater Elevation (ft msl)
Nitrate as N concentration (mg/L)
3440
3420
3400
3380
3360
3340
3320
3300
3280
3260
15
10
5
0
1950
1955
1960
1965
1970
1975
1980
1985
1990
1995
2000
2005
2010
2015
2020



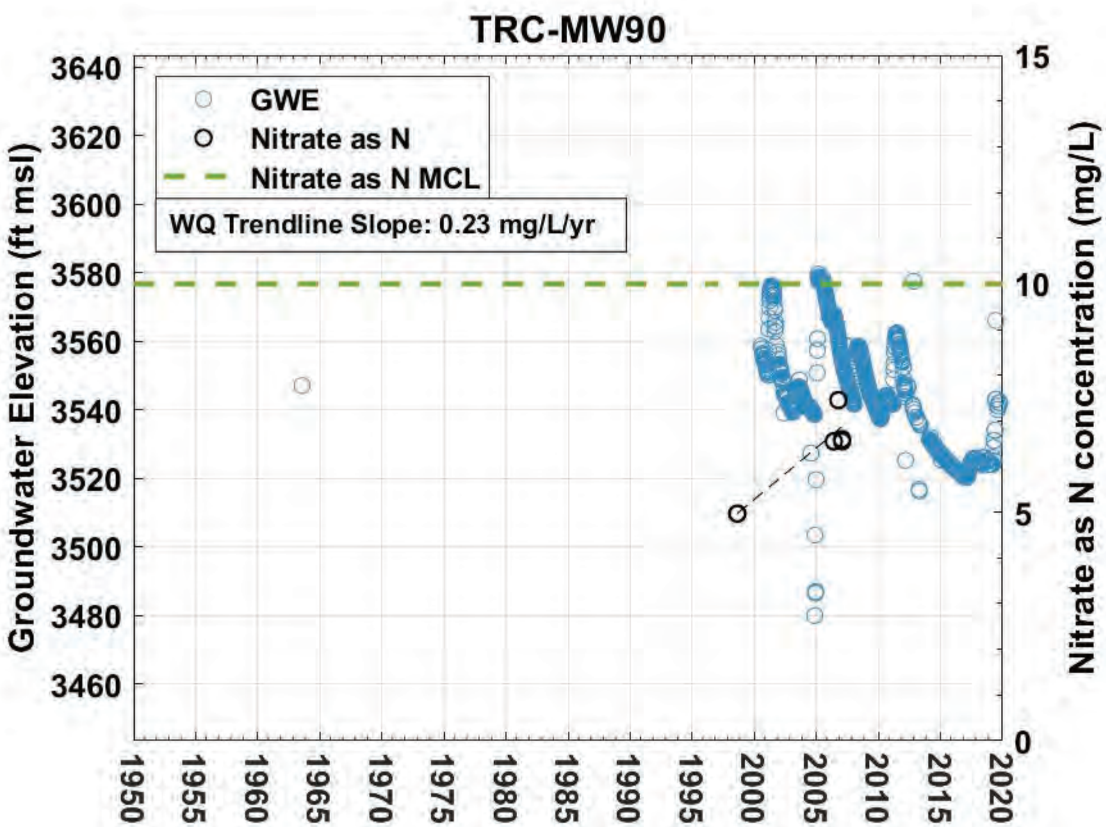
LCWD-Lebec PW
GWE
Nitrate as N
Nitrate as N MCL
WQ Trendline Slope: 0.1 mg/L/yr
Groundwater Elevation (ft msl)
Nitrate as N concentration (mg/L)
3580
3560
3540
3520
3500
3480
3460
3440
3420
3400
15
10
5
0
1950
1955
1960
1965
1970
1975
1980
1985
1990
1995
2000
2005
2010
2015
2020


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)
3600
3580
3560
3540
3520
3500
3480
3460
3440
3420
15
10
5
0
1950
1955
1960
1965
1970
1975
1980
1985
1990
1995
2000
2005
2010
2015
2020

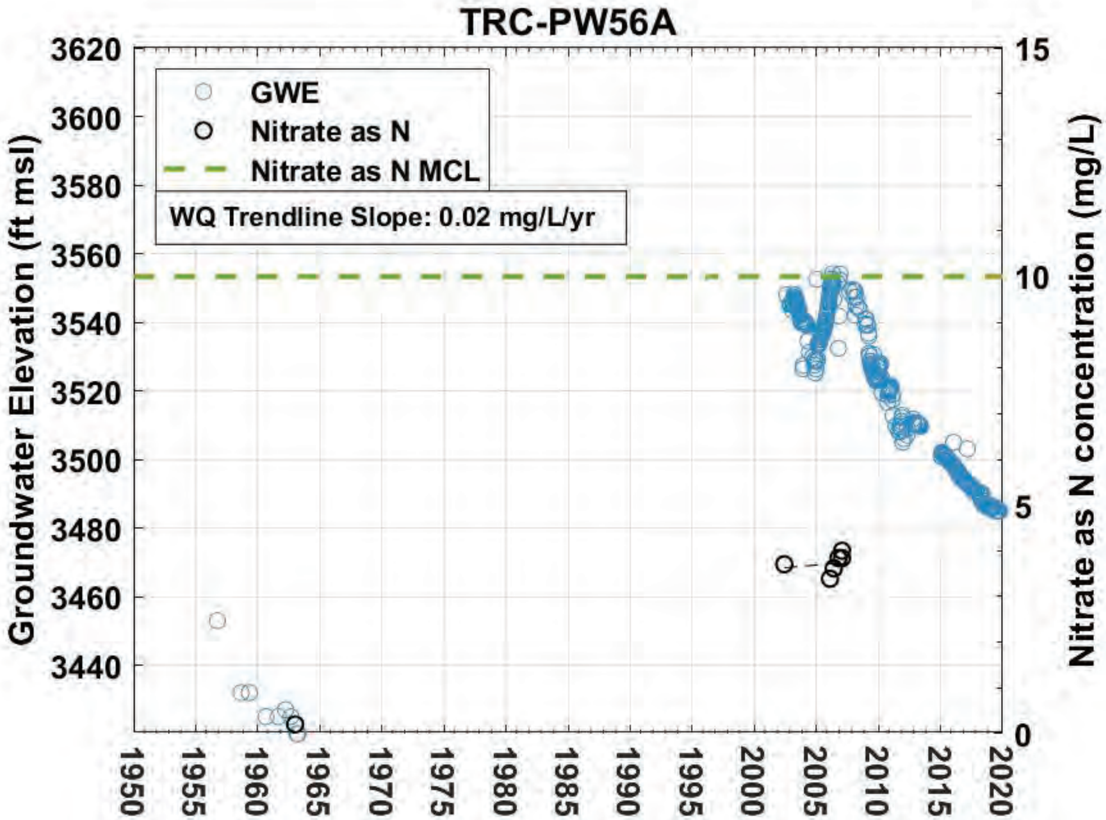

Tejon MS Well
GWE
Nitrate as N
Nitrate as N MCL
WQ Trendline Slope: -0.16 mg/L/yr
Groundwater Elevation (ft msl)
Nitrate as N concentration (mg/L)
3280
3260
3240
3220
3200
3180
3160
3140
3120
3100
15
10
5
0
1950
1955
1960
1965
1970
1975
1980
1985
1990
1995
2000
2005
2010
2015
2020



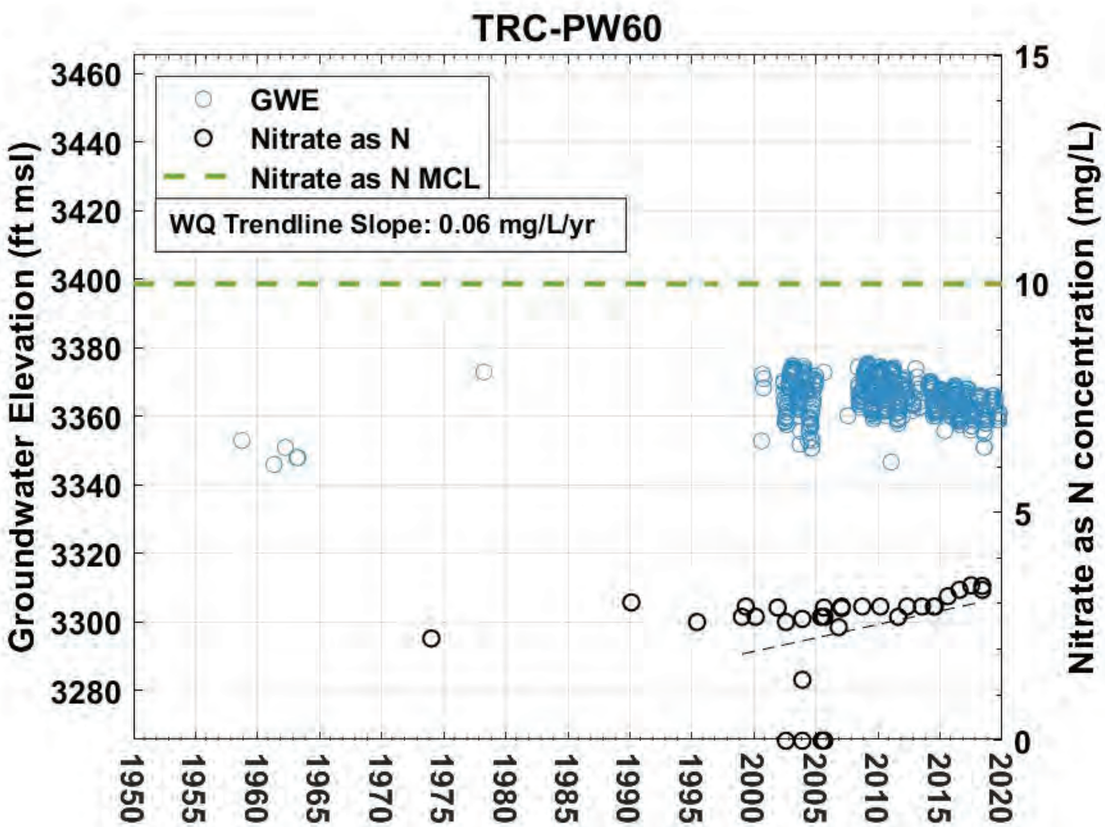
TRC-Hartley
Nitrate as N
Nitrate as N MCL
Groundwater Elevation (ft msl)
Nitrate as N concentration (mg/L)
100
50
0
-50
-100
15
10
5
0
1950
1955
1960
1965
1970
1975
1980
1985
1990
1995
2000
2005
2010
2015
2020



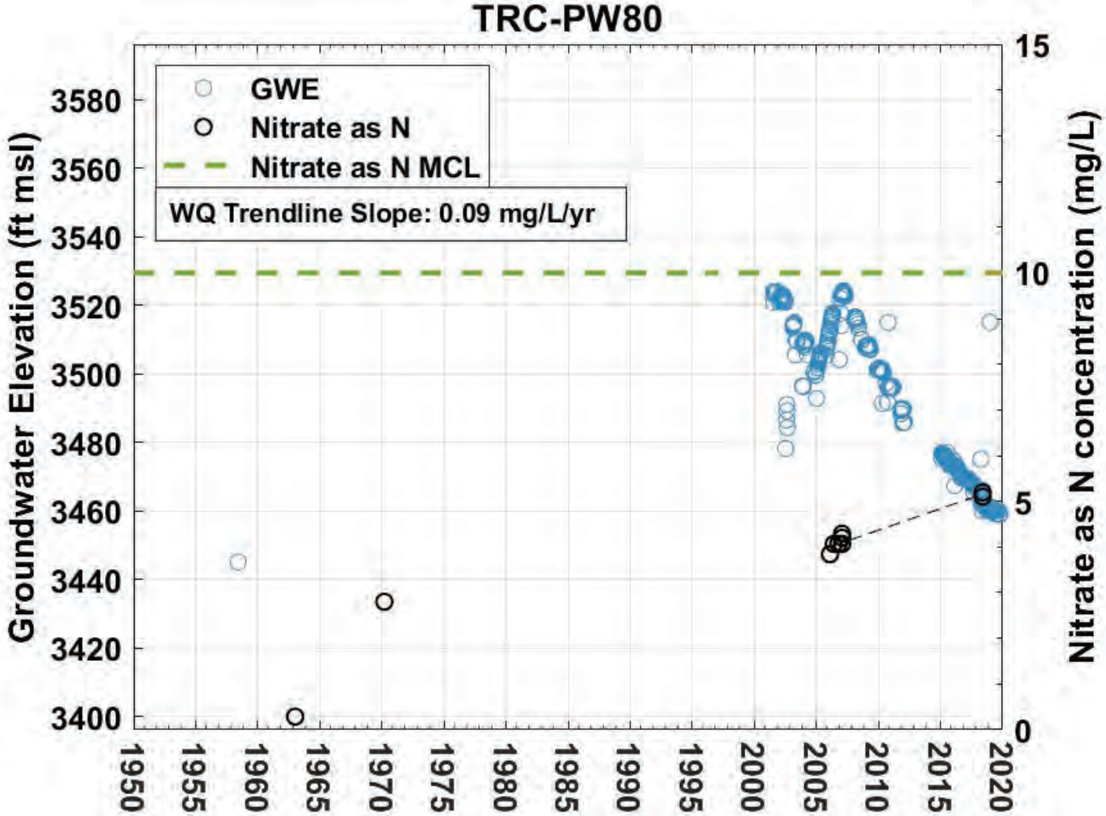
TRC-MW90
GWE
Nitrate as N
Nitrate as N MCL
WQ Trendline Slope: 0.23 mg/L/yr
Groundwater Elevation (ft msl)
Nitrate as N concentration (mg/L)
3640
3620
3600
3580
3560
3540
3520
3500
3480
3460
15
10
5
0
1950
1955
1960
1965
1970
1975
1980
1985
1990
1995
2000
2005
2010
2015
2020



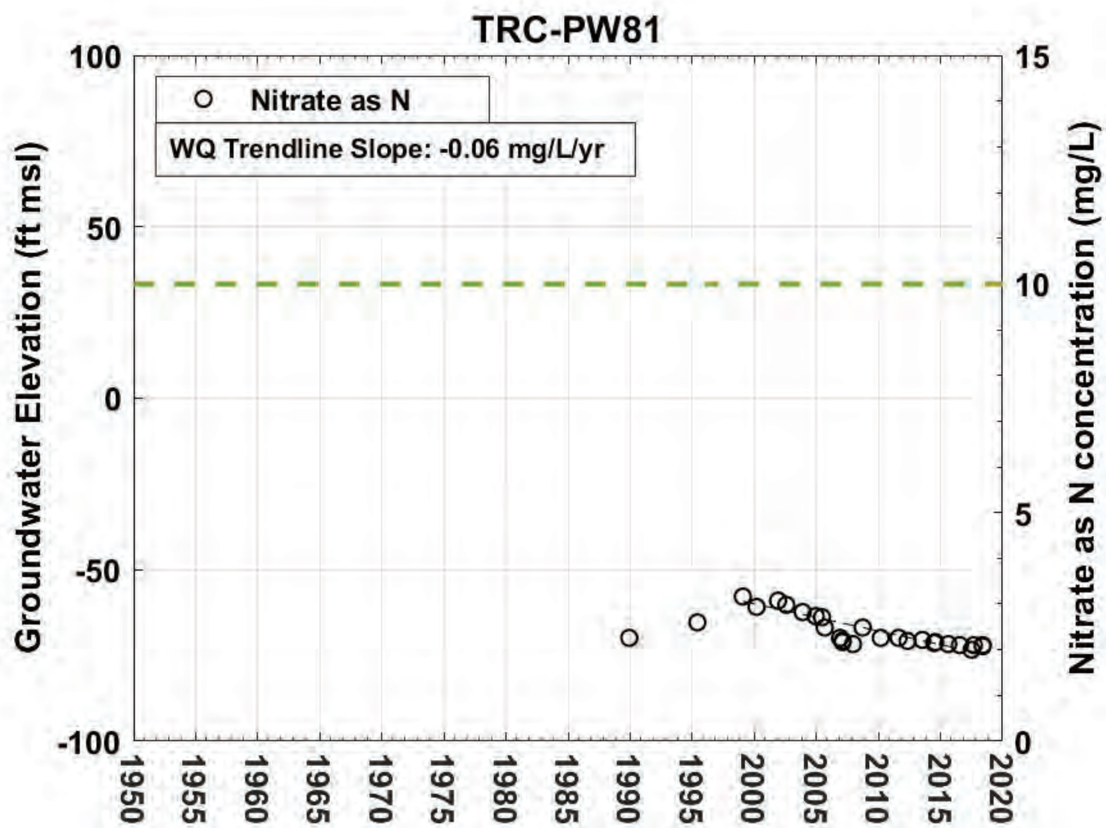
TRC-PW56A
GWE
Nitrate as N
Nitrate as N MCL
WQ Trendline Slope: 0.02 mg/L/yr
Groundwater Elevation (ft msl)
Nitrate as N concentration (mg/L)
3620
3600
3580
3560
3540
3520
3500
3480
3460
3440
15
10
5
0
1950
1955
1960
1965
1970
1975
1980
1985
1990
1995
2000
2005
2010
2015
2020



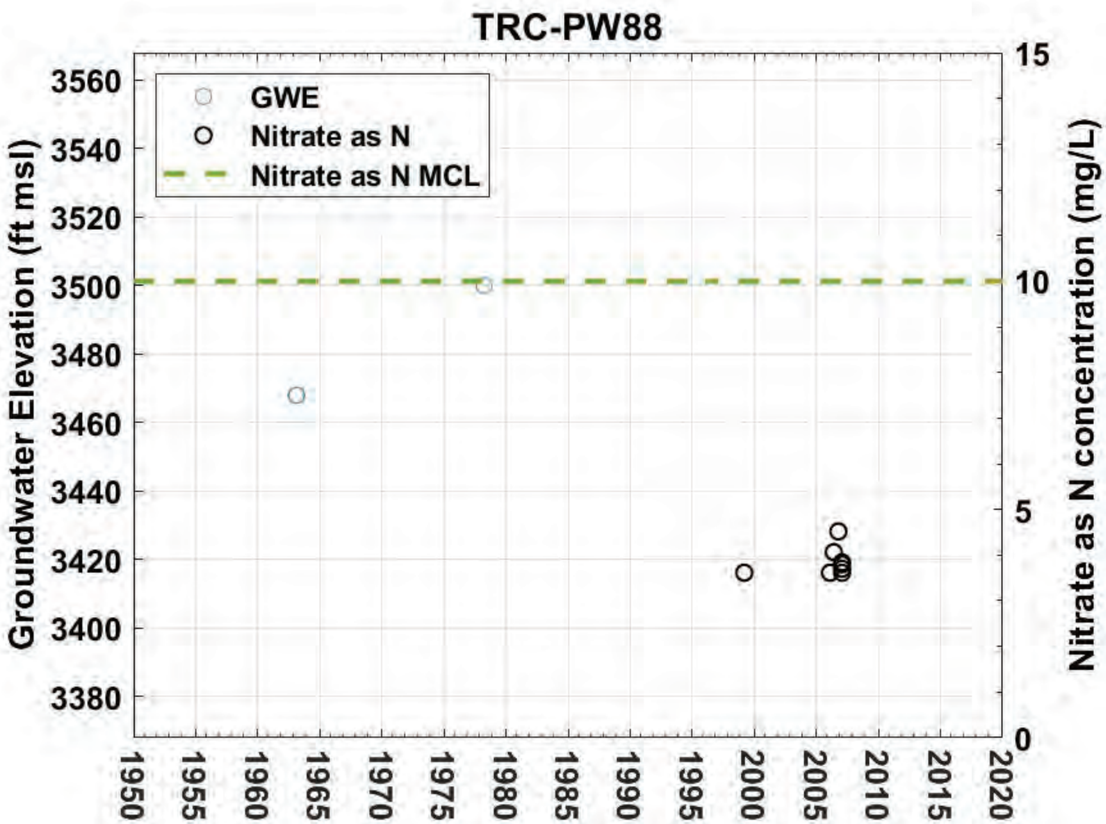
TRC-PW60
GWE
Nitrate as N
Nitrate as N MCL
WQ Trendline Slope: 0.06 mg/L/yr
Groundwater Elevation (ft msl)
Nitrate as N concentration (mg/L)
3460
3440
3420
3400
3380
3360
3340
3320
3300
3280
15
10
5
0
1950
1955
1960
1965
1970
1975
1980
1985
1990
1995
2000
2005
2010
2015
2020

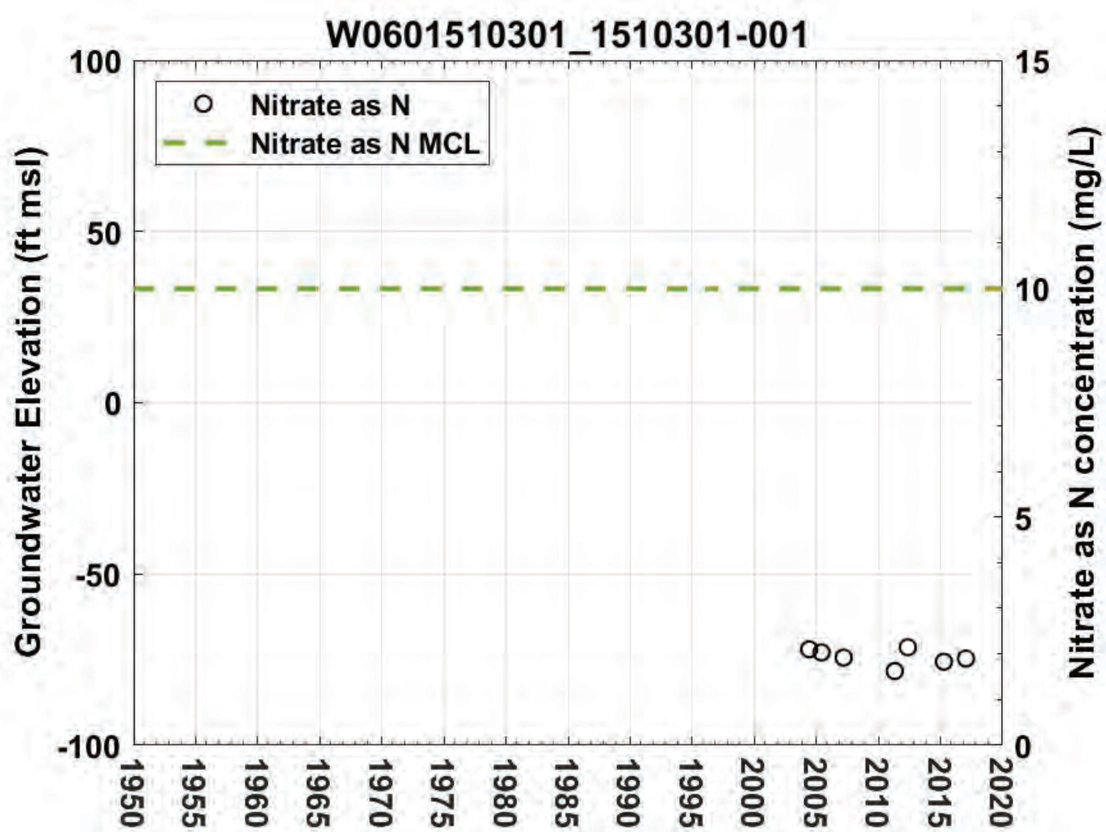


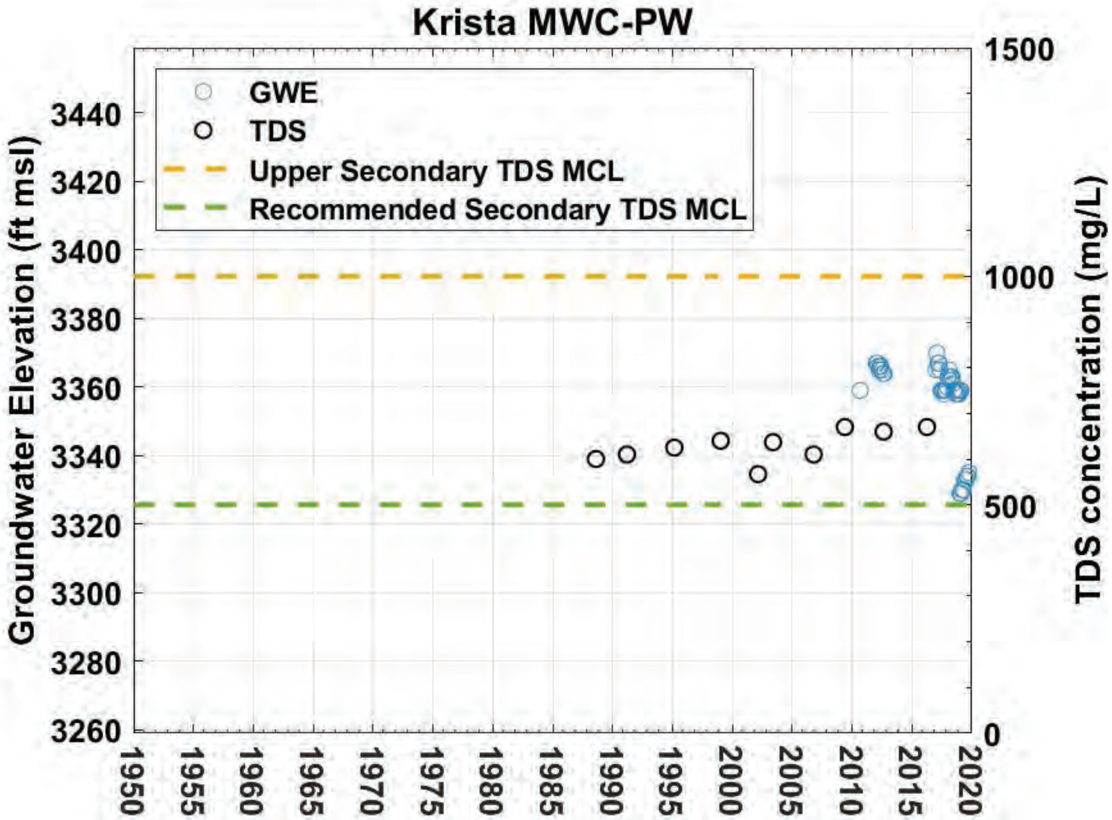
TRC-PW80
GWE
Nitrate as N
Nitrate as N MCL
WQ Trendline Slope: 0.09 mg/L/yr
Groundwater Elevation (ft msl)
Nitrate as N concentration (mg/L)
3400
3420
3440
3460
3480
3500
3520
3540
3560
3580
0
5
10
15
1950
1955
1960
1965
1970
1975
1980
1985
1990
1995
2000
2005
2010
2015
2020



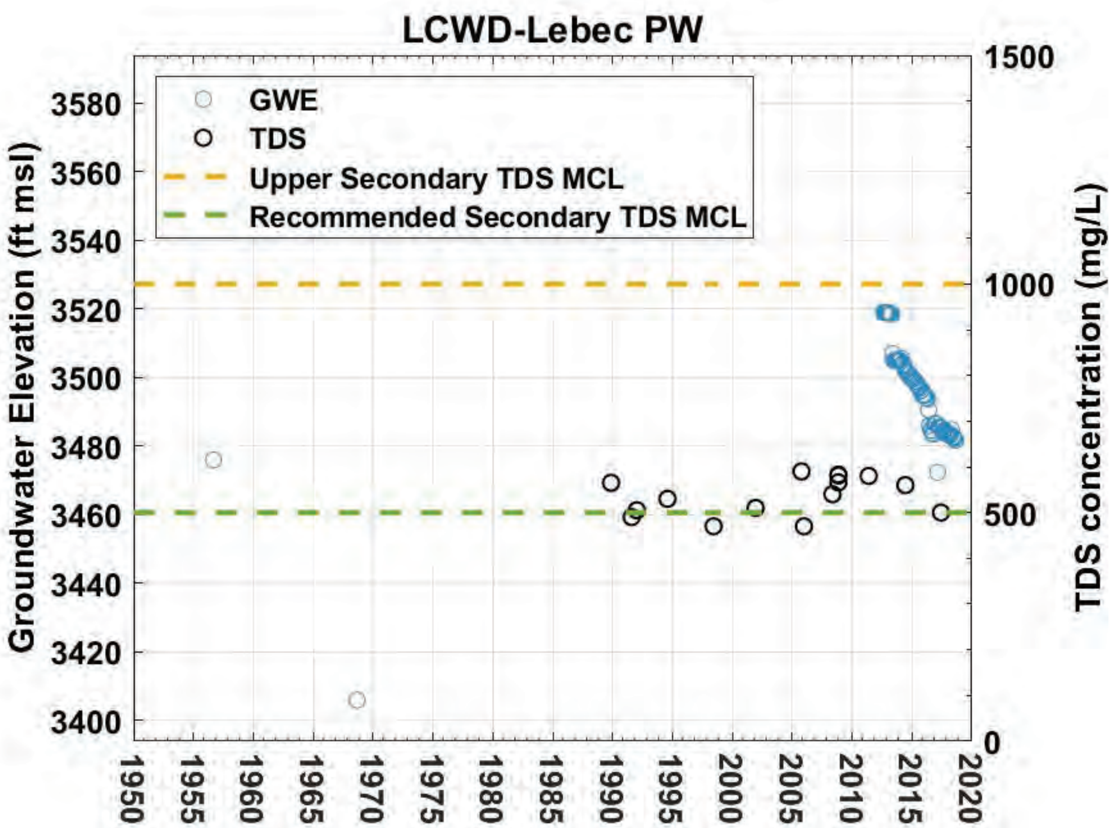
TRC-PW81
Nitrate as N
WQ Trendline Slope: -0.06 mg/L/yr
Groundwater Elevation (ft msl)
Nitrate as N concentration (mg/L)
-100
-50
0
50
100
0
5
10
15
1950
1955
1960
1965
1970
1975
1980
1985
1990
1995
2000
2005
2010
2015
2020


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

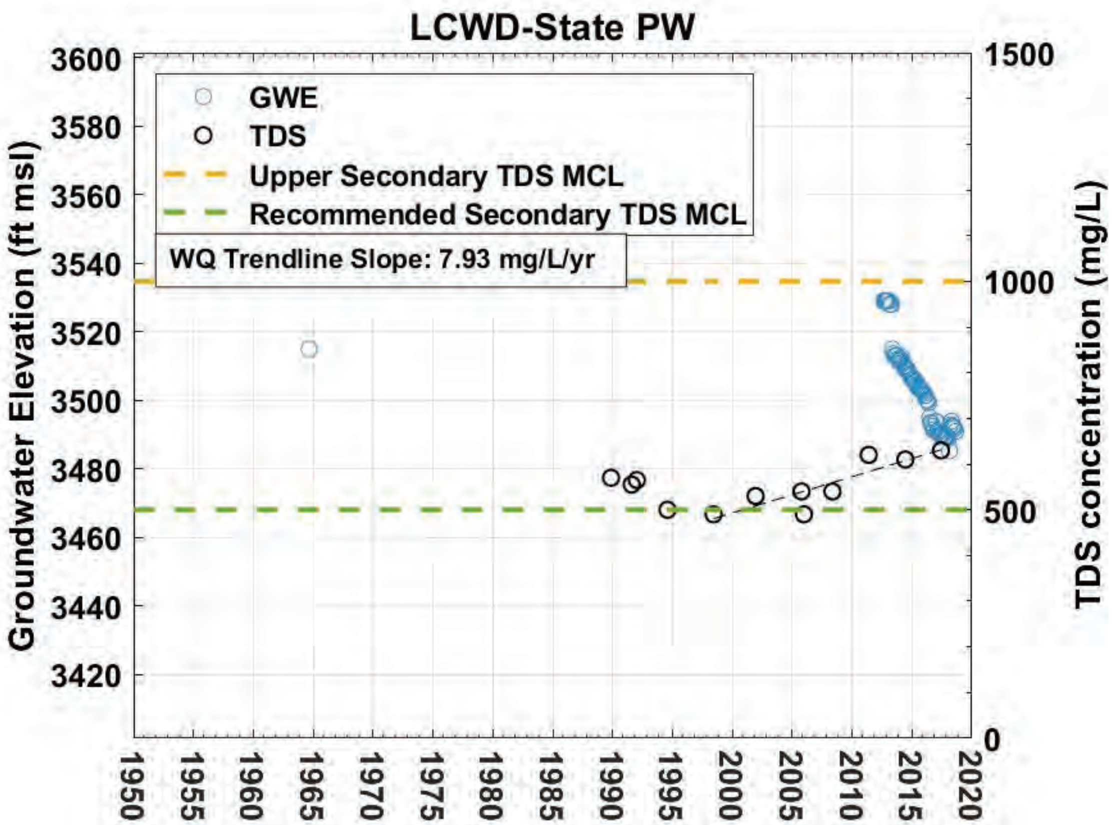

W0601510301_1510301-001
Nitrate as N
Nitrate as N MCL
Groundwater Elevation (ft msl)
Nitrate as N concentration (mg/L)
100
50
0
-50
-100
15
10
5
0
1950
1955
1960
1965
1970
1975
1980
1985
1990
1995
2000
2005
2010
2015
2020

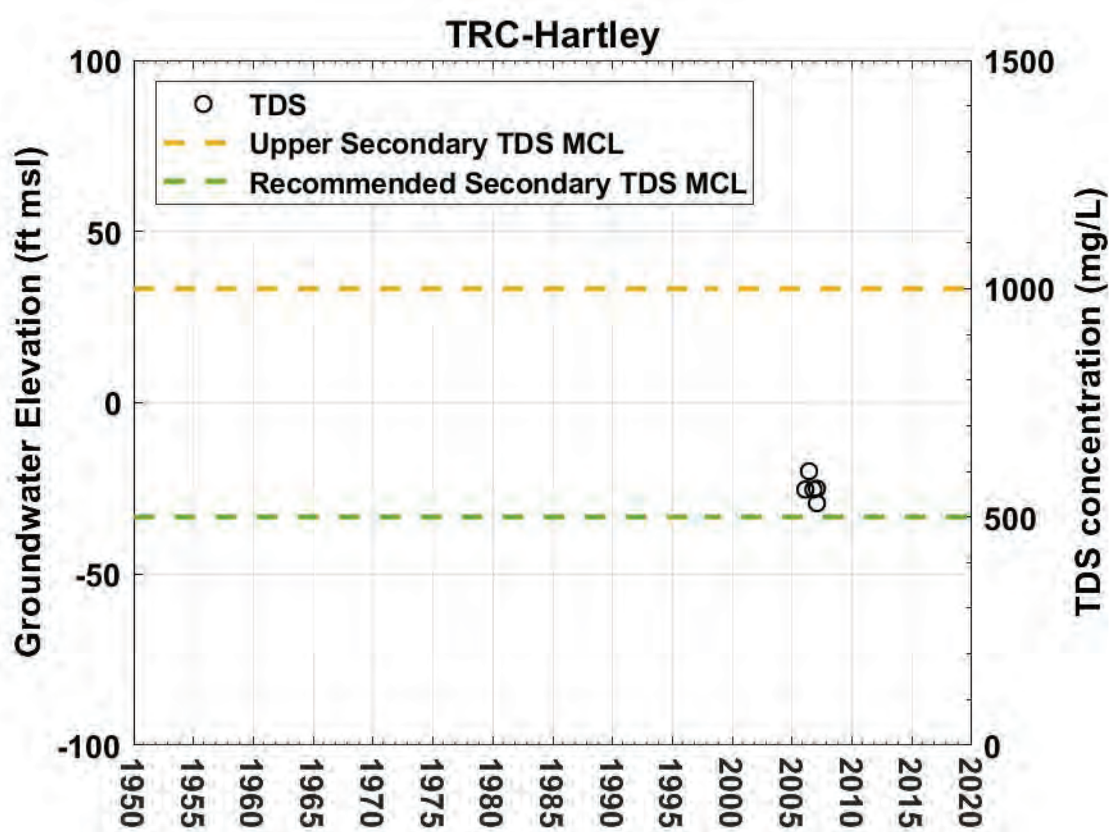


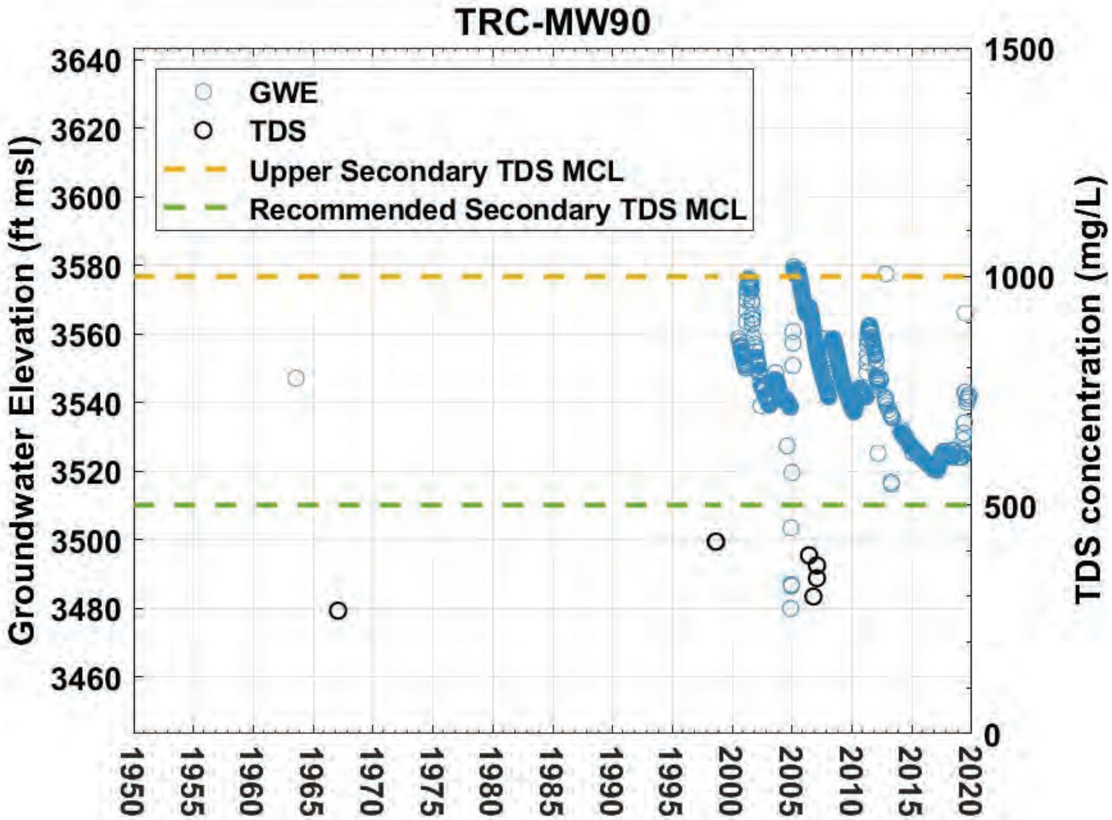
Krista MWC-PW
GWE
TDS
Upper Secondary TDS MCL
Recommended Secondary TDS MCL
Groundwater Elevation (ft msl)
TDS concentration (mg/L)
3260
3280
3300
3320
3340
3360
3380
3400
3420
3440
0
500
1000
1500
1950
1955
1960
1965
1970
1975
1980
1985
1990
1995
2000
2005
2010
2015
2020

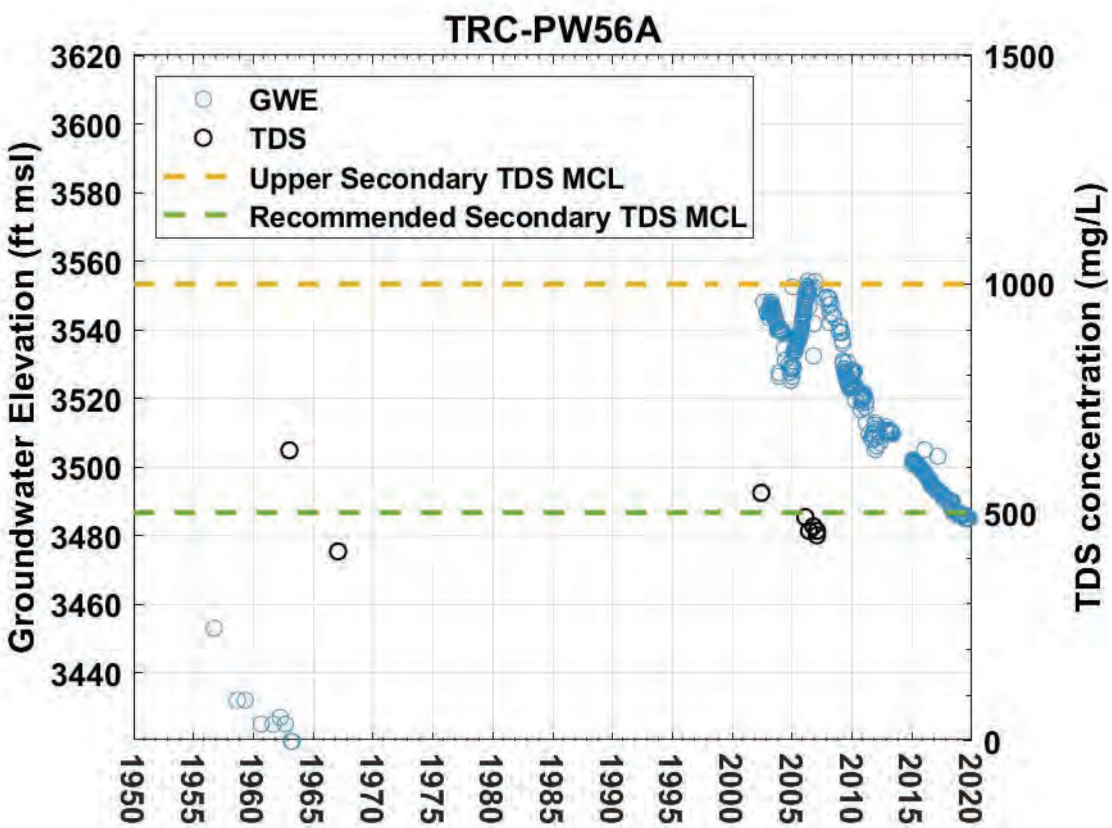


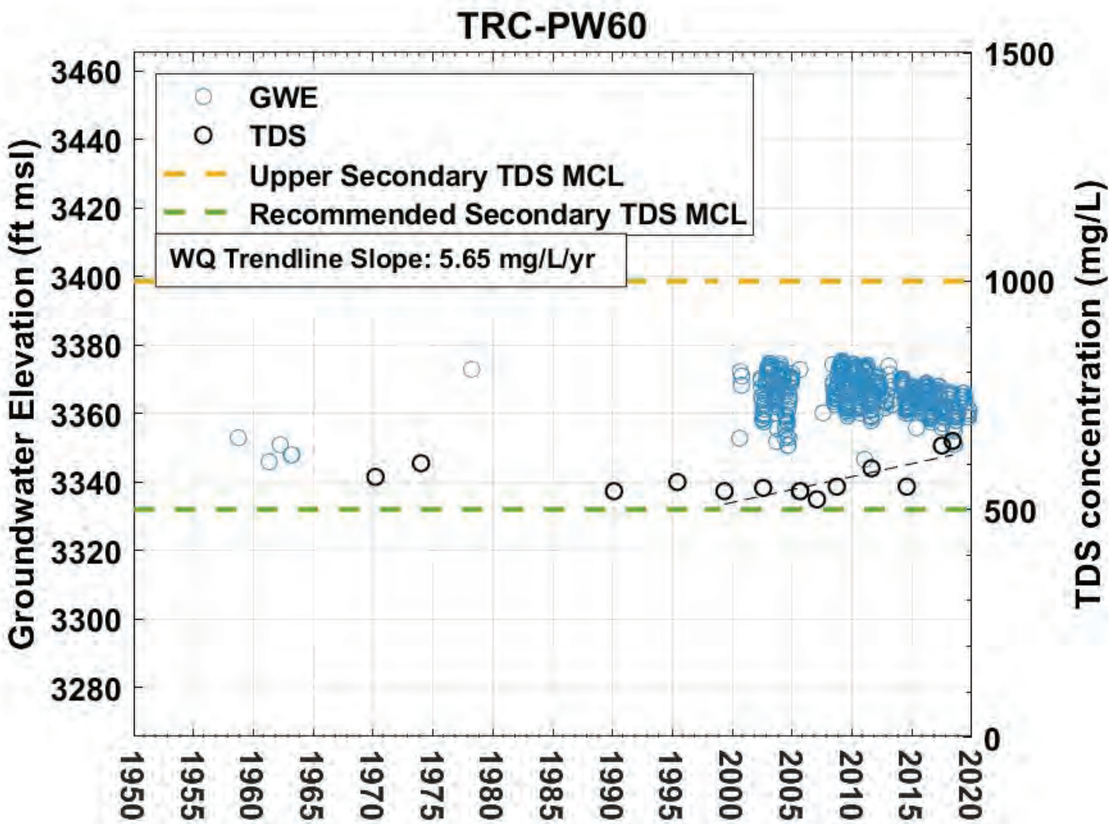
LCWD-Lebec PW
GWE
TDS
Upper Secondary TDS MCL
Recommended Secondary TDS MCL
Groundwater Elevation (ft msl)
TDS concentration (mg/L)
3400
3420
3440
3460
3480
3500
3520
3540
3560
3580
0
500
1000
1500
1950
1955
1960
1965
1970
1975
1980
1985
1990
1995
2000
2005
2010
2015
2020

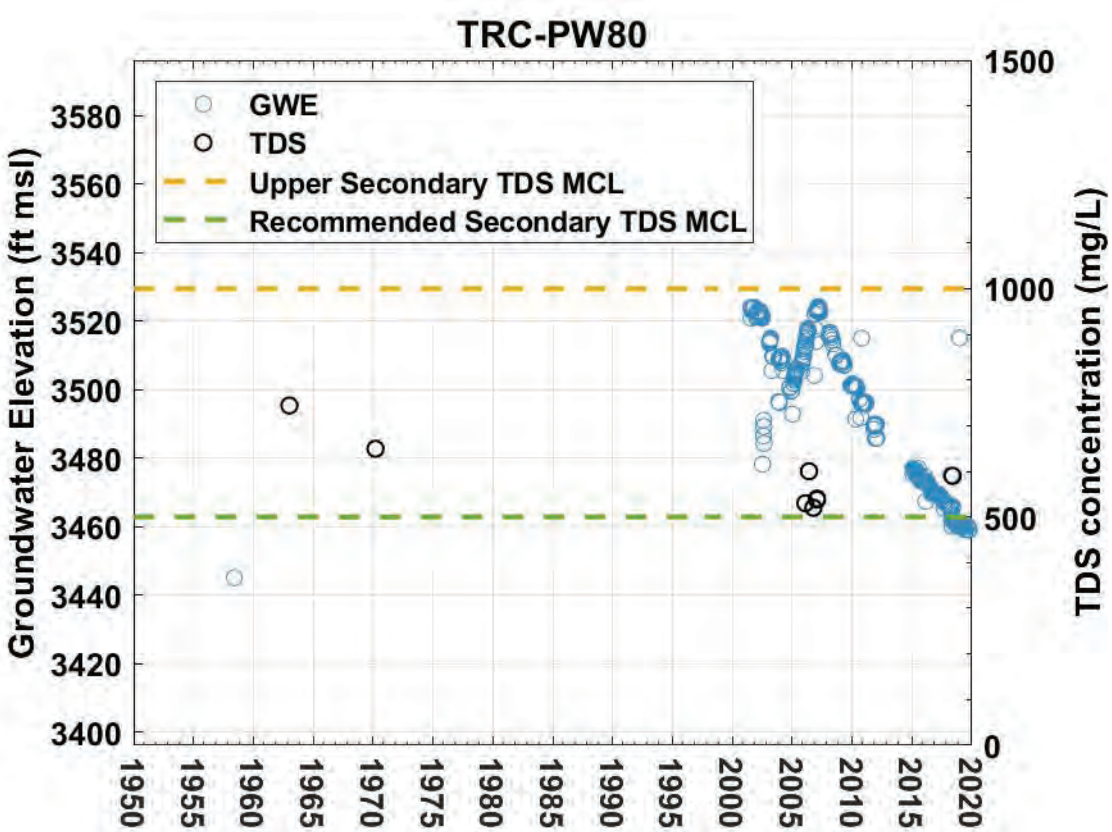

LCWD-State PW
GWE
TDS
Upper Secondary TDS MCL
Recommended Secondary TDS MCL
WQ Trendline Slope: 7.93 mg/L/yr
Groundwater Elevation (ft msl)
TDS concentration (mg/L)
3600
3580
3560
3540
3520
3500
3480
3460
3440
3420
1500
1000
500
0
1950
1955
1960
1965
1970
1975
1980
1985
1990
1995
2000
2005
2010
2015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

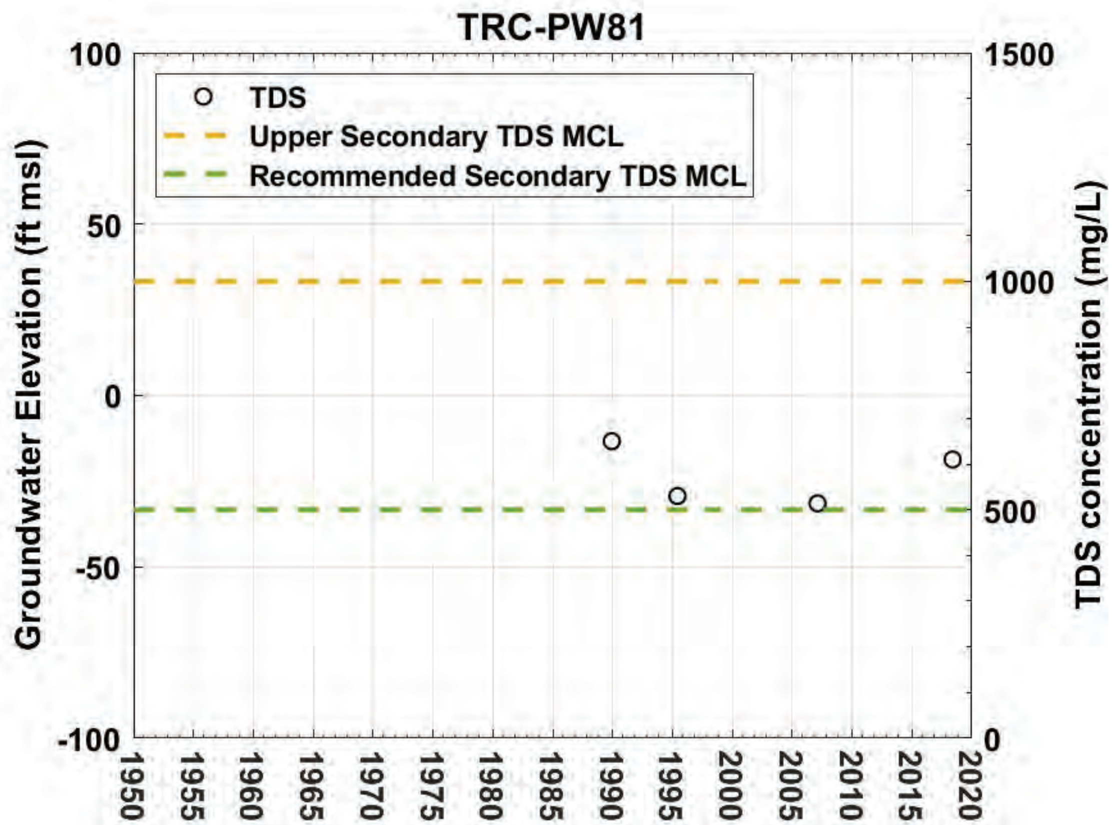

TRC-Hartley
TDS
Upper Secondary TDS MCL
Recommended Secondary TDS MCL
Groundwater Elevation (ft msl)
TDS concentration (mg/L)
100
50
0
-50
-100
1500
1000
500
0
1950
1955
1960
1965
1970
1975
1980
1985
1990
1995
2000
2005
2010
2015
2020

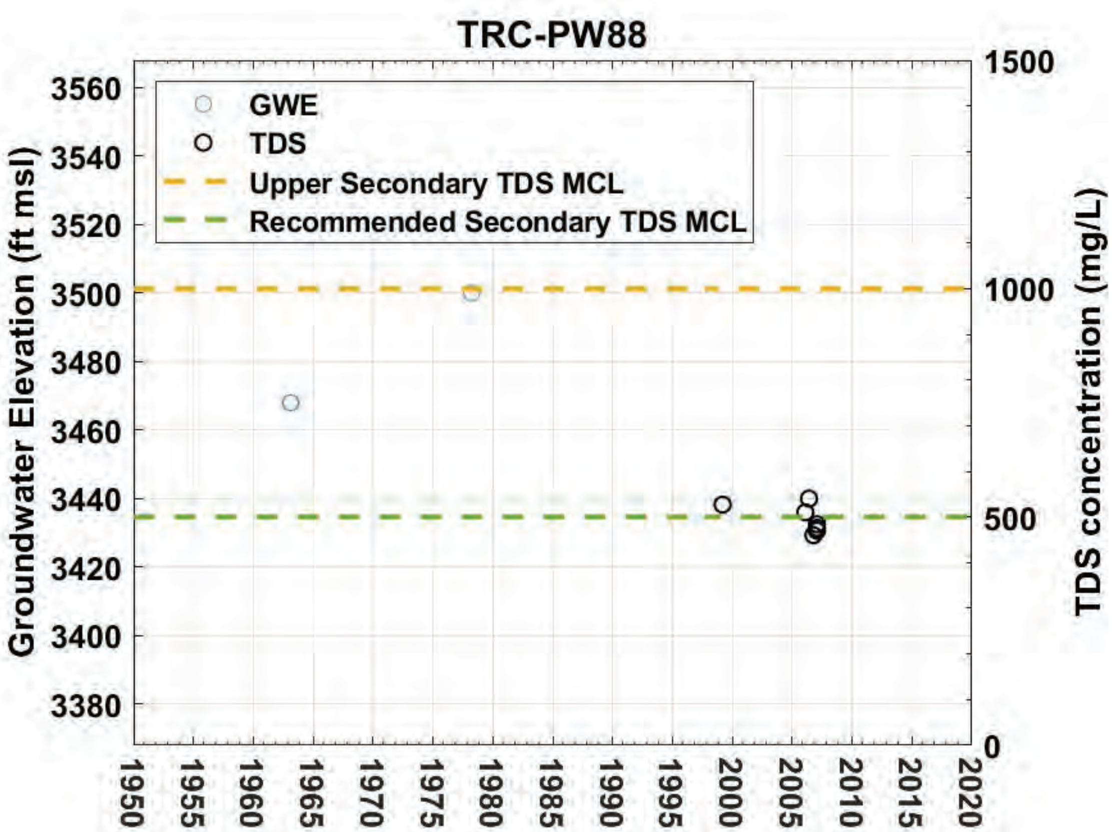

TRC-MW90
GWE
TDS
Upper Secondary TDS MCL
Recommended Secondary TDS MCL
Groundwater Elevation (ft msl)
TDS concentration (mg/L)
3640
3620
3600
3580
3560
3540
3520
3500
3480
3460
1500
1000
500
0
1950
1955
1960
1965
1970
1975
1980
1985
1990
1995
2000
2005
2010
2015
2020

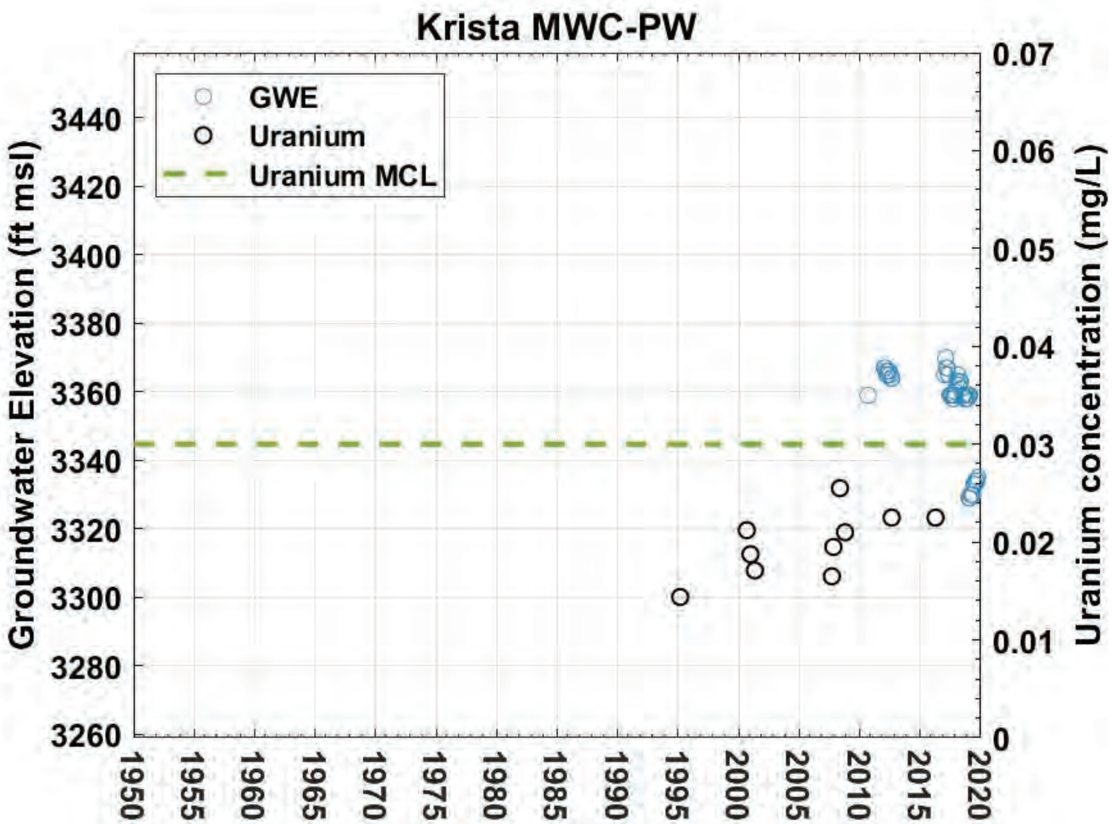

TRC-PW56A
GWE
TDS
Upper Secondary TDS MCL
Recommended Secondary TDS MCL
Groundwater Elevation (ft msl)
TDS concentration (mg/L)
3620
3600
3580
3560
3540
3520
3500
3480
3460
3440
1500
1000
500
0
1950
1955
1960
1965
1970
1975
1980
1985
1990
1995
2000
2005
2010
2015
2020

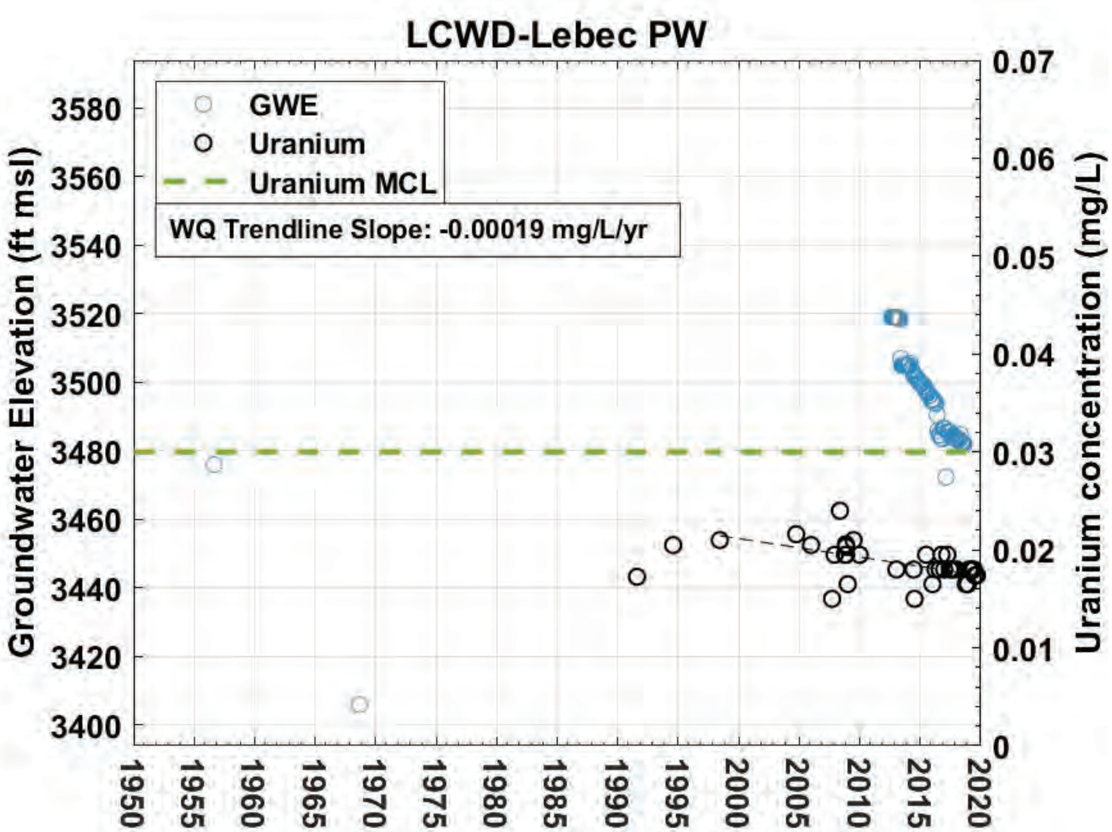

TRC-PW60
GWE
TDS
Upper Secondary TDS MCL
Recommended Secondary TDS MCL
WQ Trendline Slope: 5.65 mg/L/yr
Groundwater Elevation (ft msl)
TDS concentration (mg/L)
3460
3440
3420
3400
3380
3360
3340
3320
3300
3280
1500
1000
500
0
1950
1955
1960
1965
1970
1975
1980
1985
1990
1995
2000
2005
2010
2015
2020

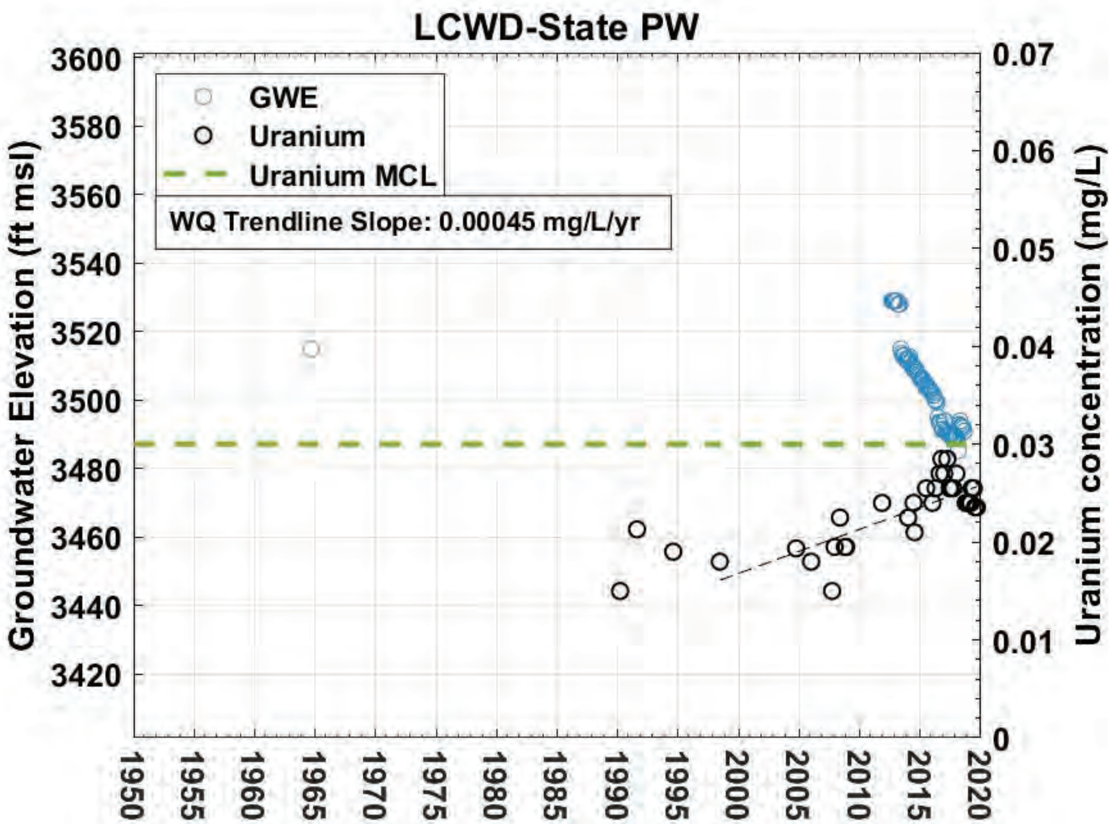

TRC-PW80
GWE
TDS
Upper Secondary TDS MCL
Recommended Secondary TDS MCL
Groundwater Elevation (ft msl)
TDS concentration (mg/L)
3580
3560
3540
3520
3500
3480
3460
3440
3420
3400
1500
1000
500
0
1950
1955
1960
1965
1970
1975
1980
1985
1990
1995
2000
2005
2010
2015
2020

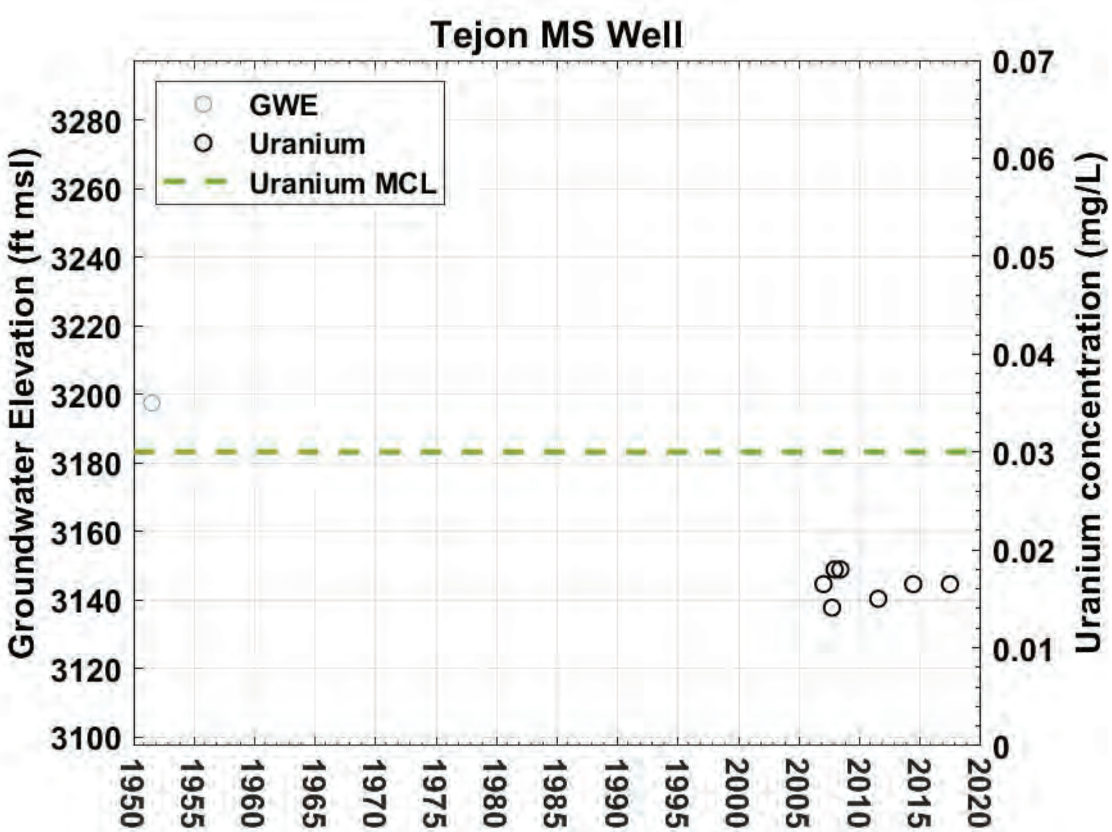

TRC-PW81
TDS
Upper Secondary TDS MCL
Recommended Secondary TDS MCL
Groundwater Elevation (ft msl)
TDS concentration (mg/L)
100
50
0
-50
-100
1500
1000
500
0
1950
1955
1960
1965
1970
1975
1980
1985
1990
1995
2000
2005
2010
2015
2020

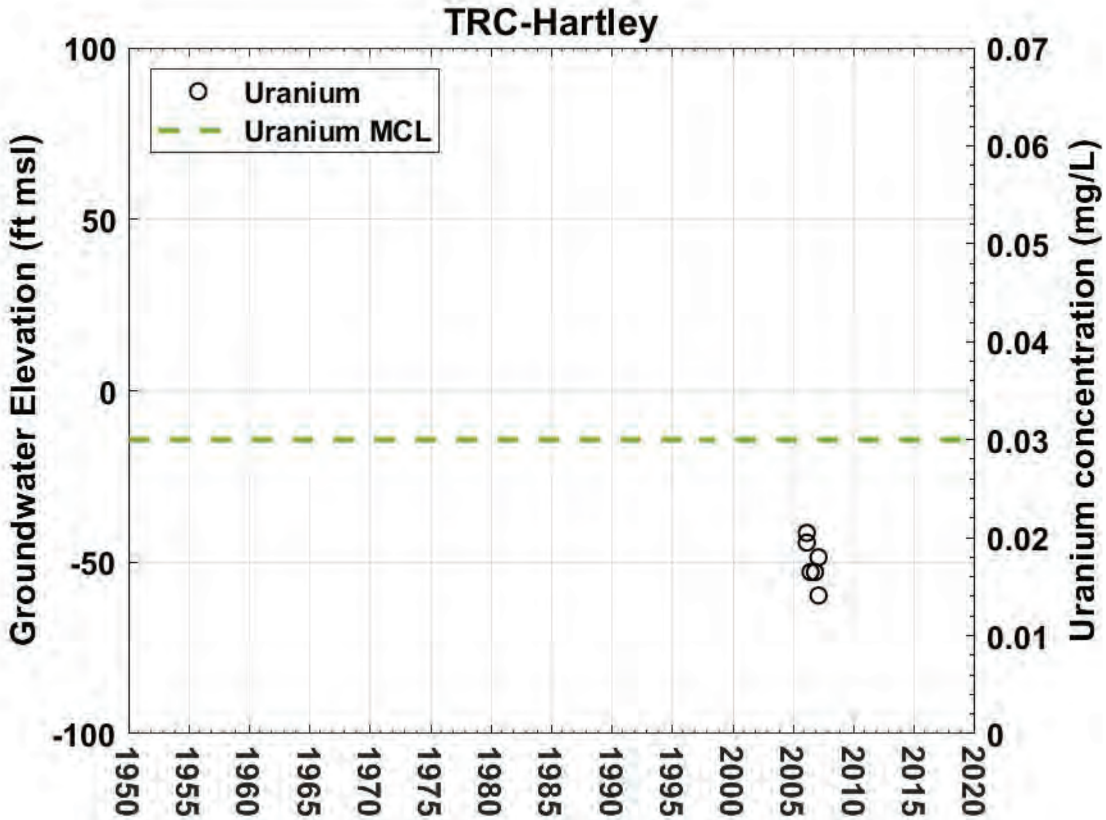

TRC-PW88
GWE
TDS
Upper Secondary TDS MCL
Recommended Secondary TDS MCL
Groundwater Elevation (ft msl)
TDS concentration (mg/L)
3560
3540
3520
3500
3480
3460
3440
3420
3400
3380
1500
1000
500
0
1950
1955
1960
1965
1970
1975
1980
1985
1990
1995
2000
2005
2010
2015
2020

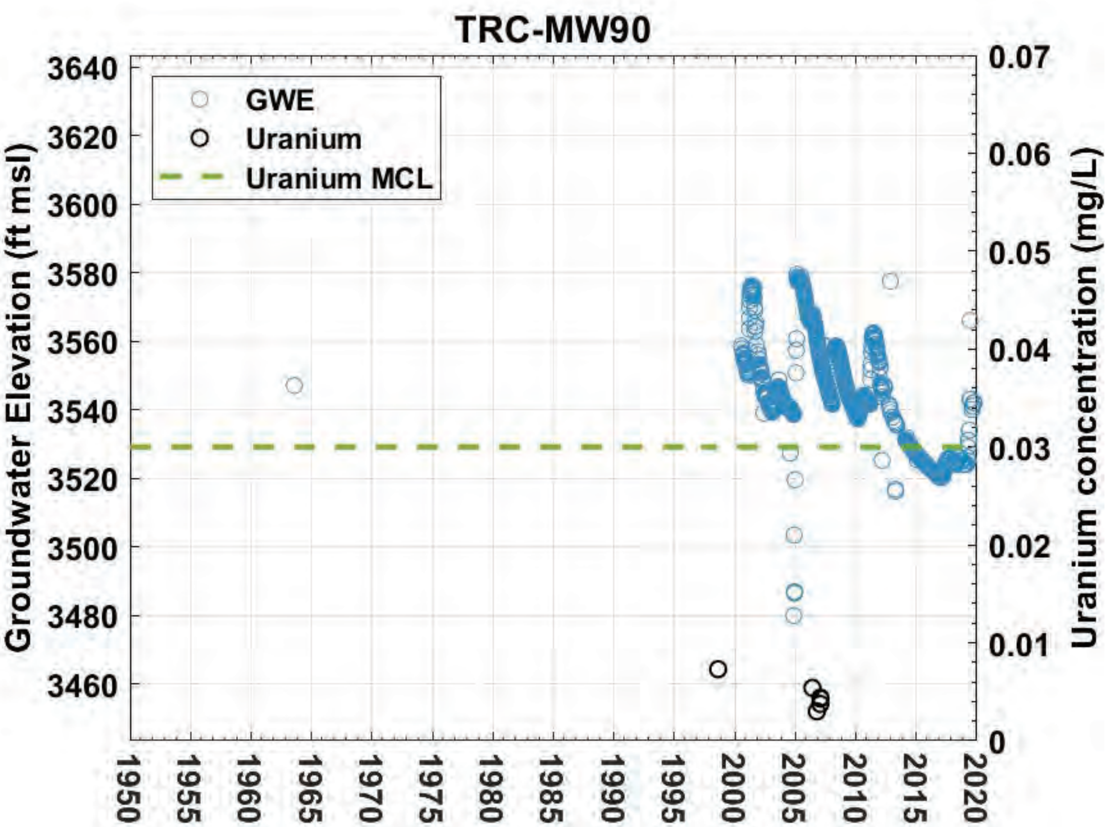

Krista MWC-PW
GWE
Uranium
Uranium MCL
Groundwater Elevation (ft msl)
Uranium concentration (mg/L)
3260
3280
3300
3320
3340
3360
3380
3400
3420
3440
0
0.01
0.02
0.03
0.04
0.05
0.06
0.07
1950
1955
1960
1965
1970
1975
1980
1985
1990
1995
2000
2005
2010
2015
2020

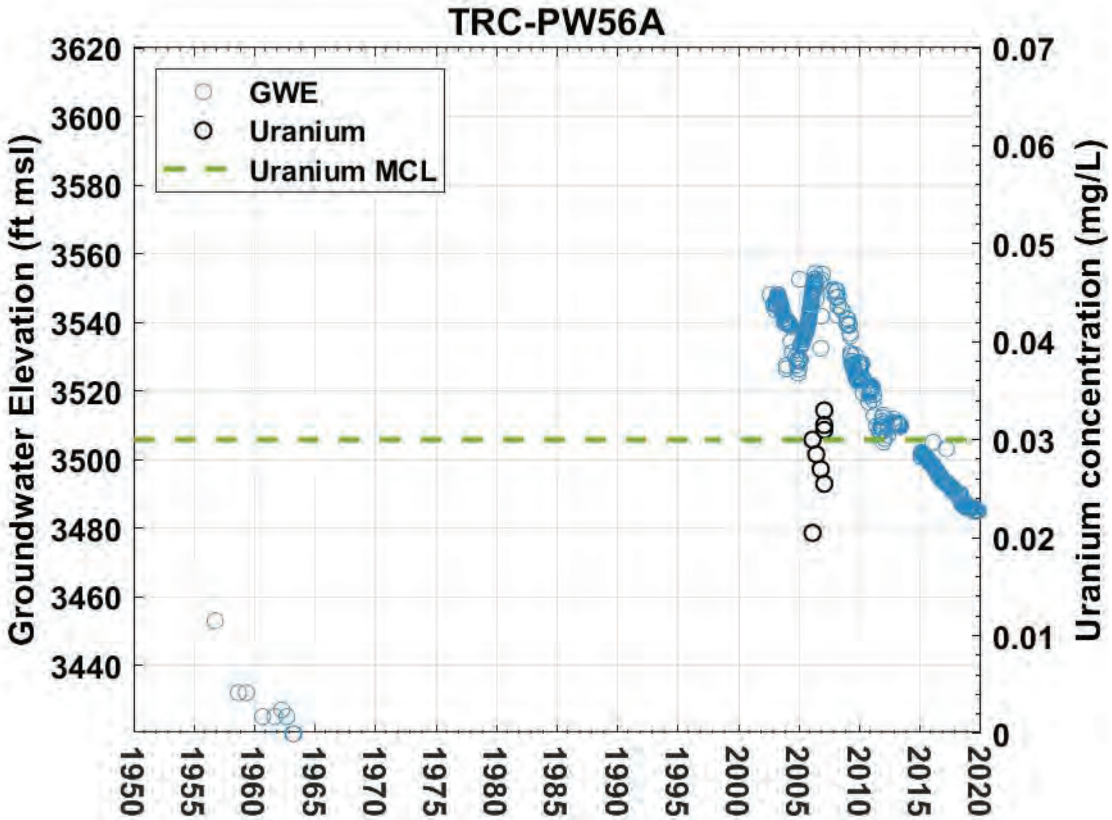

LCWD-Lebec PW
GWE
Uranium
Uranium MCL
WQ Trendline Slope: -0.00019 mg/L/yr
Groundwater Elevation (ft msl)
Uranium concentration (mg/L)
3400
3420
3440
3460
3480
3500
3520
3540
3560
3580
0
0.01
0.02
0.03
0.04
0.05
0.06
0.07
1950
1955
1960
1965
1970
1975
1980
1985
1990
1995
2000
2005
2010
2015
2020

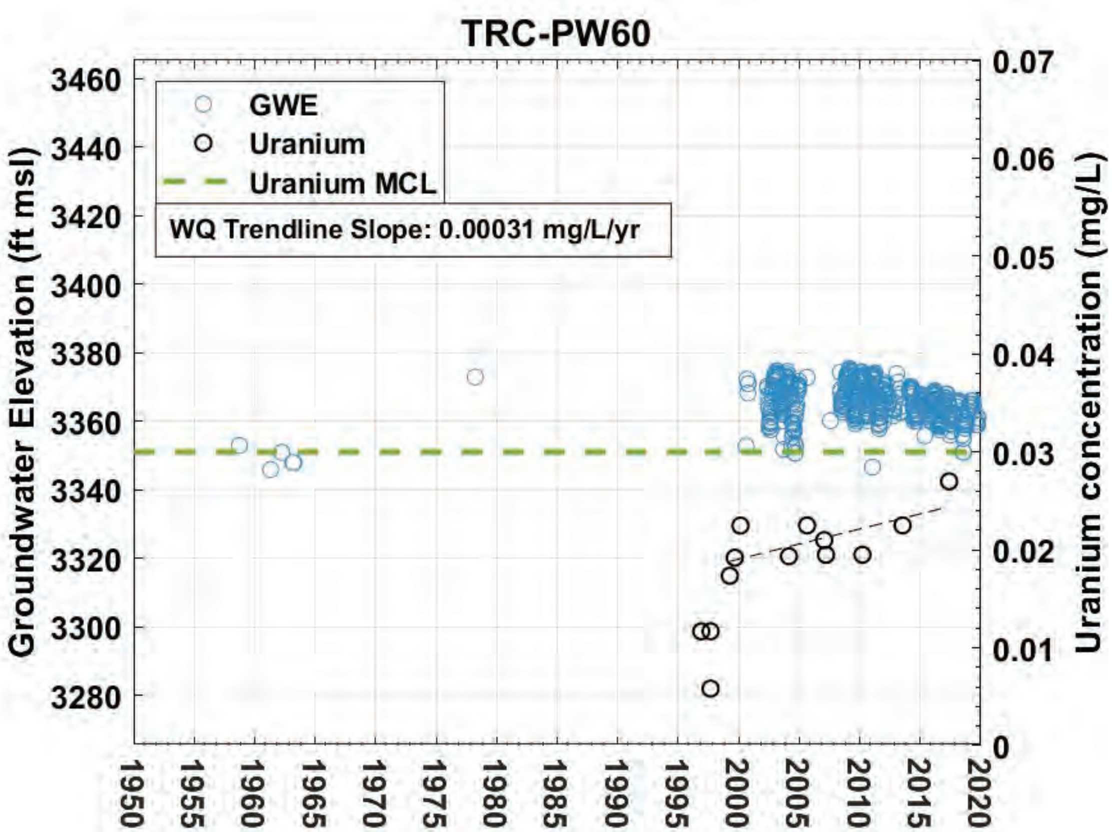

LCWD-State PW
GWE
Uranium
Uranium MCL
WQ Trendline Slope: 0.00045 mg/L/yr
Groundwater Elevation (ft msl)
Uranium concentration (mg/L)
3600
3580
3560
3540
3520
3500
3480
3460
3440
3420
0.07
0.06
0.05
0.04
0.03
0.02
0.01
0
1950
1955
1960
1965
1970
1975
1980
1985
1990
1995
2000
2005
2010
2015
2020

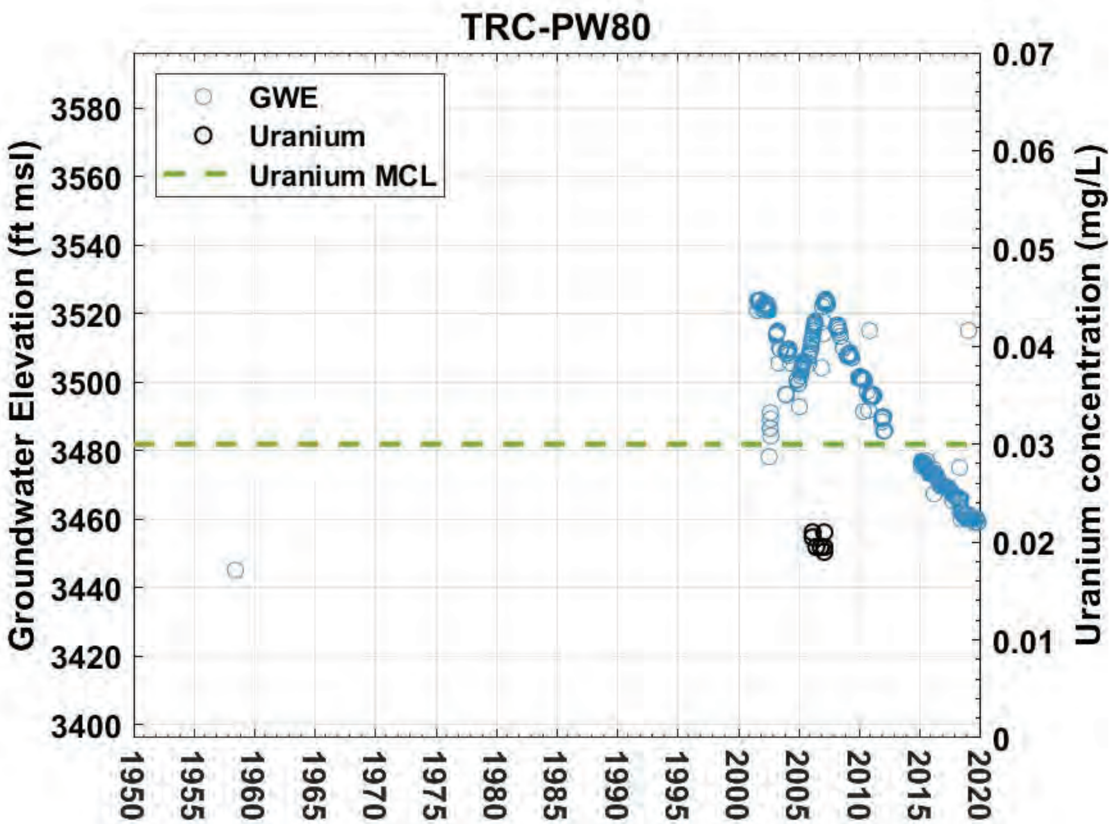

Tejon MS Well
GWE
Uranium
Uranium MCL
Groundwater Elevation (ft msl)
Uranium concentration (mg/L)
3280
3260
3240
3220
3200
3180
3160
3140
3120
3100
0.07
0.06
0.05
0.04
0.03
0.02
0.01
0
1950
1955
1960
1965
1970
1975
1980
1985
1990
1995
2000
2005
2010
2015
2020


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

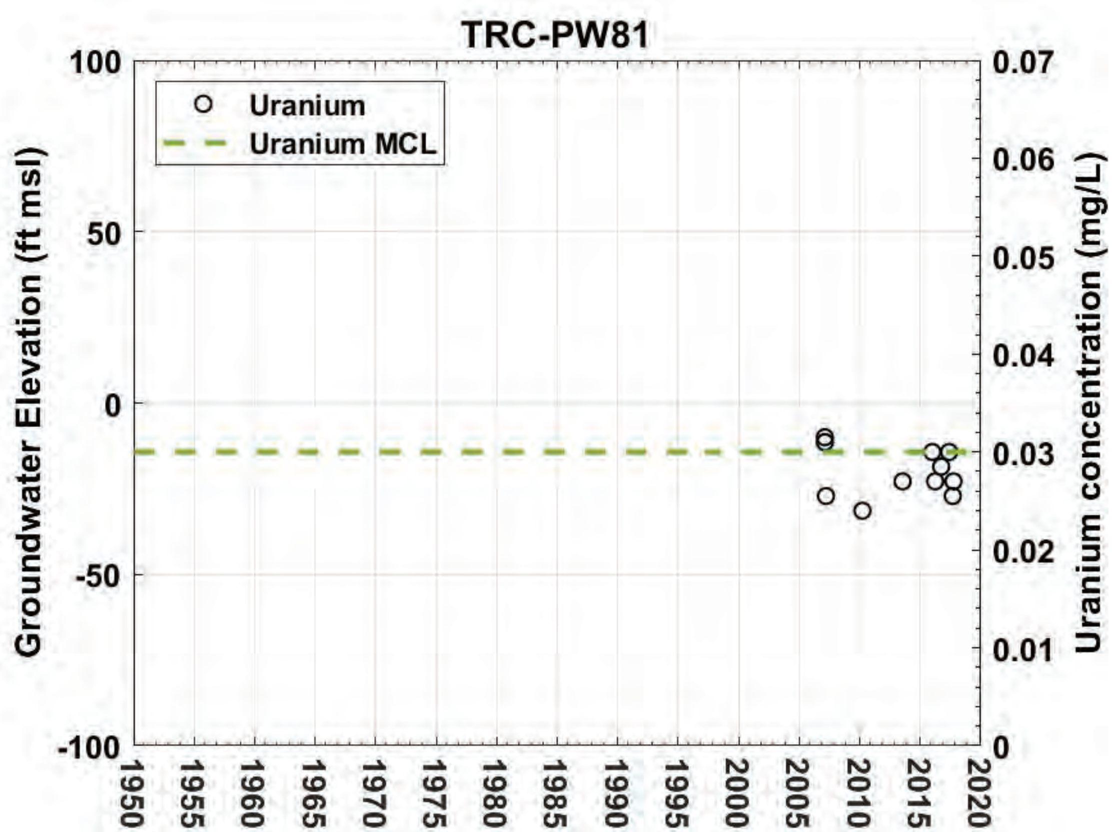

TRC-MW90
GWE
Uranium
Uranium MCL
Groundwater Elevation (ft msl)
Uranium concentration (mg/L)
3640
3620
3600
3580
3560
3540
3520
3500
3480
3460
0.07
0.06
0.05
0.04
0.03
0.02
0.01
0
1950
1955
1960
1965
1970
1975
1980
1985
1990
1995
2000
2005
2010
2015
2020


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

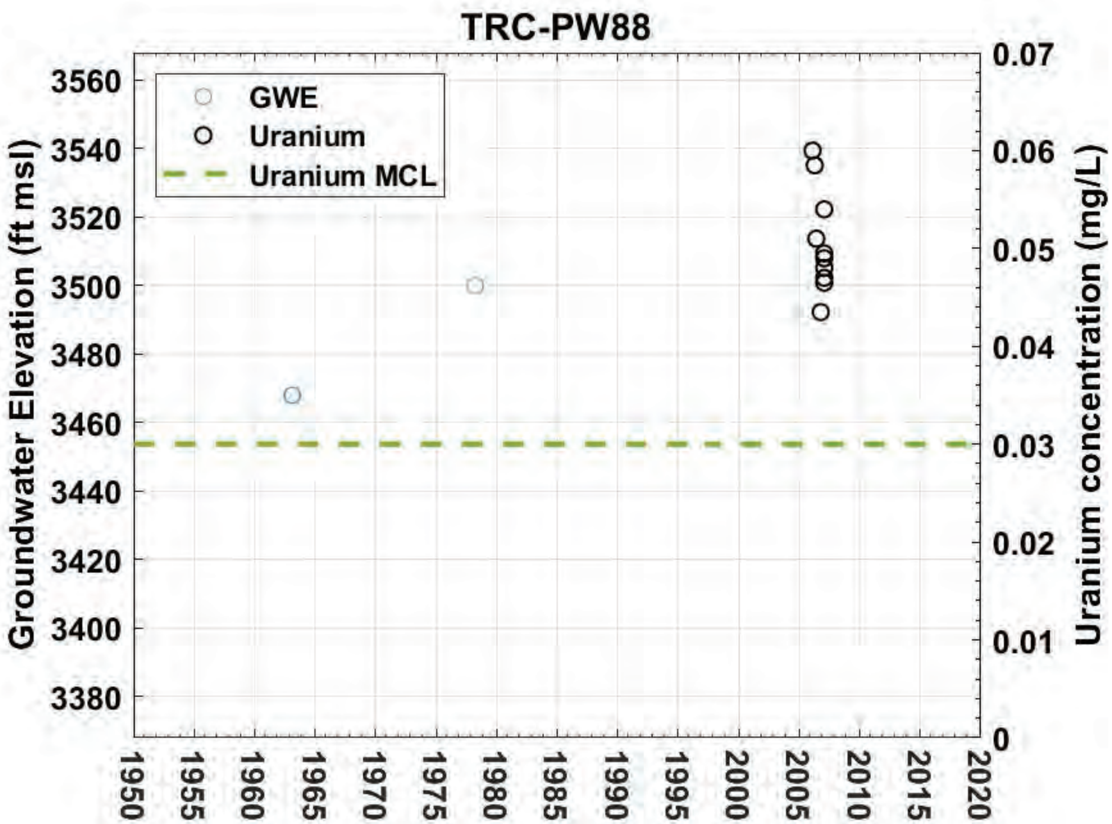

TRC-PW60
GWE
Uranium
Uranium MCL
WQ Trendline Slope: 0.00031 mg/L/yr
Groundwater Elevation (ft msl)
Uranium concentration (mg/L)
3460
3440
3420
3400
3380
3360
3340
3320
3300
3280
0.07
0.06
0.05
0.04
0.03
0.02
0.01
0
1950
1955
1960
1965
1970
1975
1980
1985
1990
1995
2000
2005
2010
2015
2020



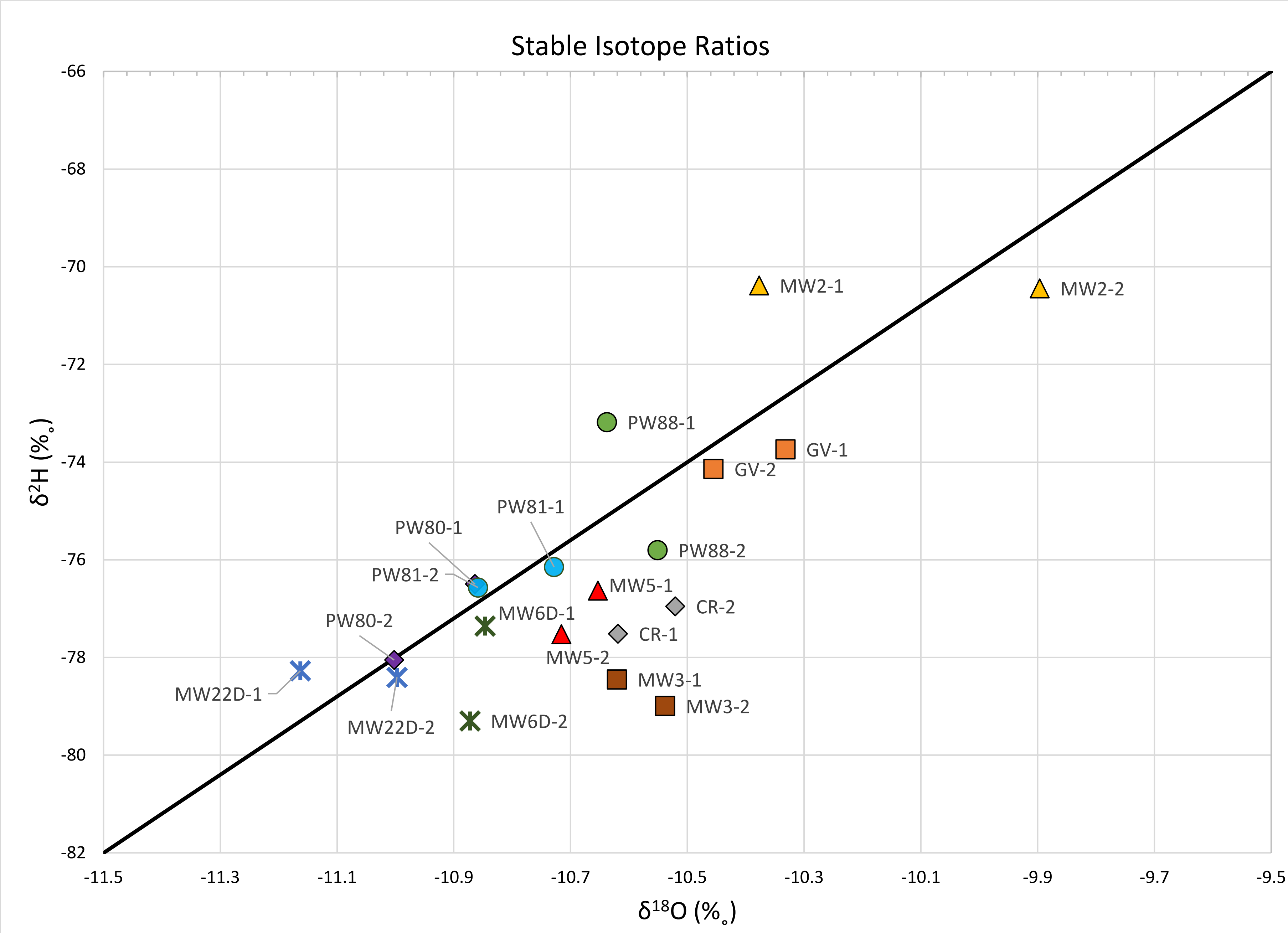
TRC-PW80
GWE
Uranium
Uranium MCL
Groundwater Elevation (ft msl)
Uranium concentration (mg/L)
3400
3420
3440
3460
3480
3500
3520
3540
3560
3580
0
0.01
0.02
0.03
0.04
0.05
0.06
0.07
1950
1955
1960
1965
1970
1975
1980
1985
1990
1995
2000
2005
2010
2015
2020



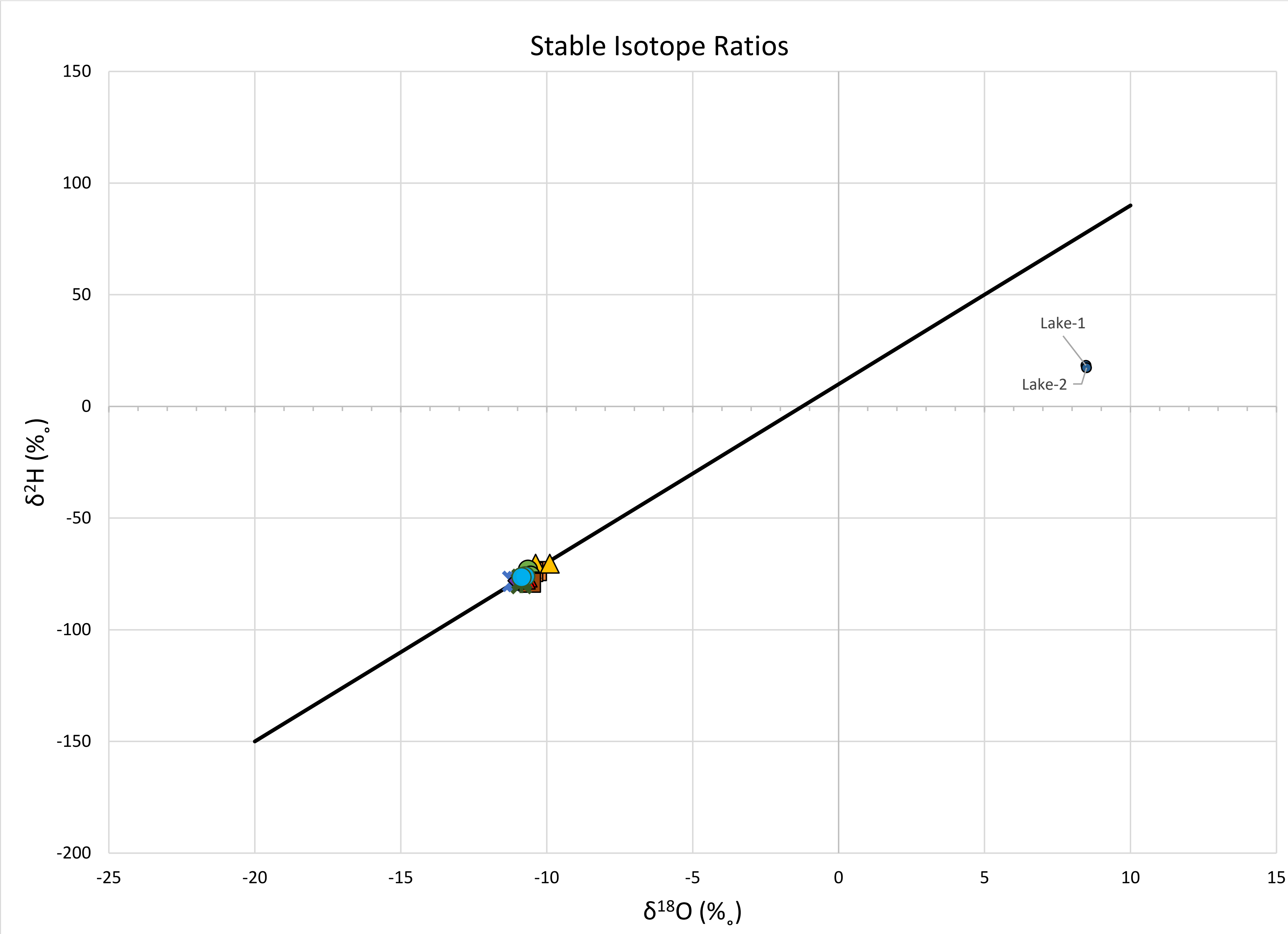
TRC-PW81
Uranium
Uranium MCL
Groundwater Elevation (ft msl)
Uranium concentration (mg/L)
-100
-50
0
50
100
0
0.01
0.02
0.03
0.04
0.05
0.06
0.07
1950
1955
1960
1965
1970
1975
1980
1985
1990
1995
2000
2005
2010
2015
2020



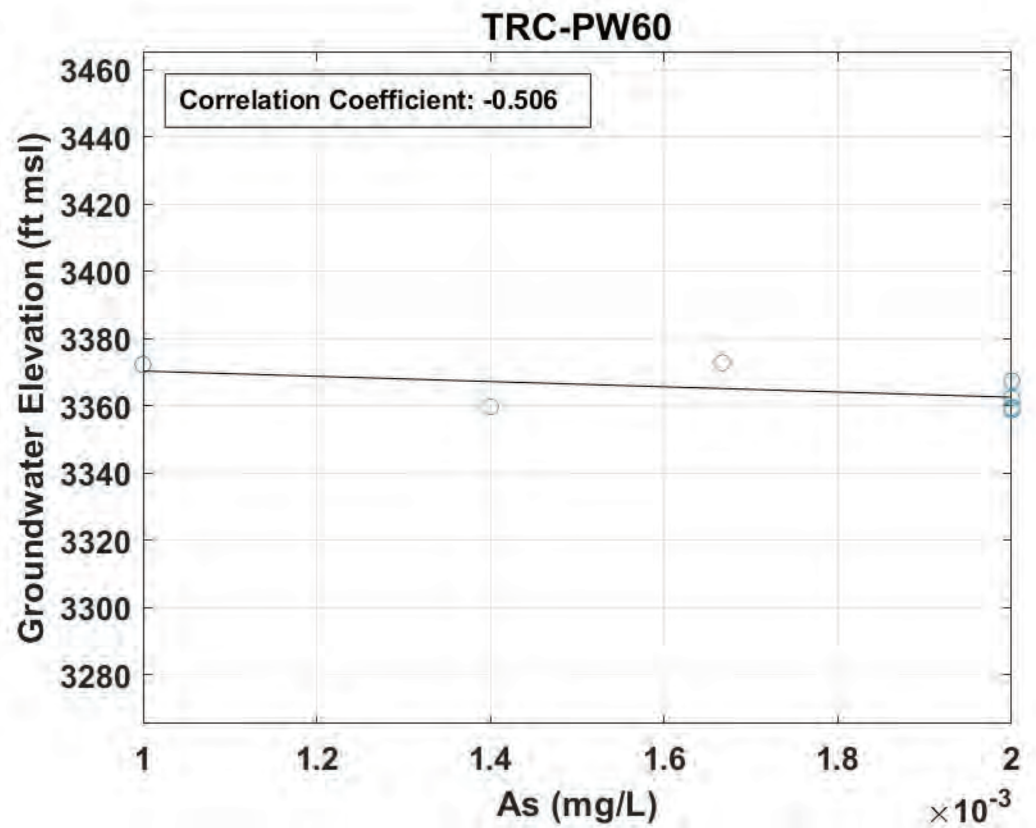
TRC-PW88
GWE
Uranium
Uranium MCL
Groundwater Elevation (ft msl)
Uranium concentration (mg/L)
3560
3540
3520
3500
3480
3460
3440
3420
3400
3380
0.07
0.06
0.05
0.04
0.03
0.02
0.01
0
1950
1955
1960
1965
1970
1975
1980
1985
1990
1995
2000
2005
2010
2015
2020



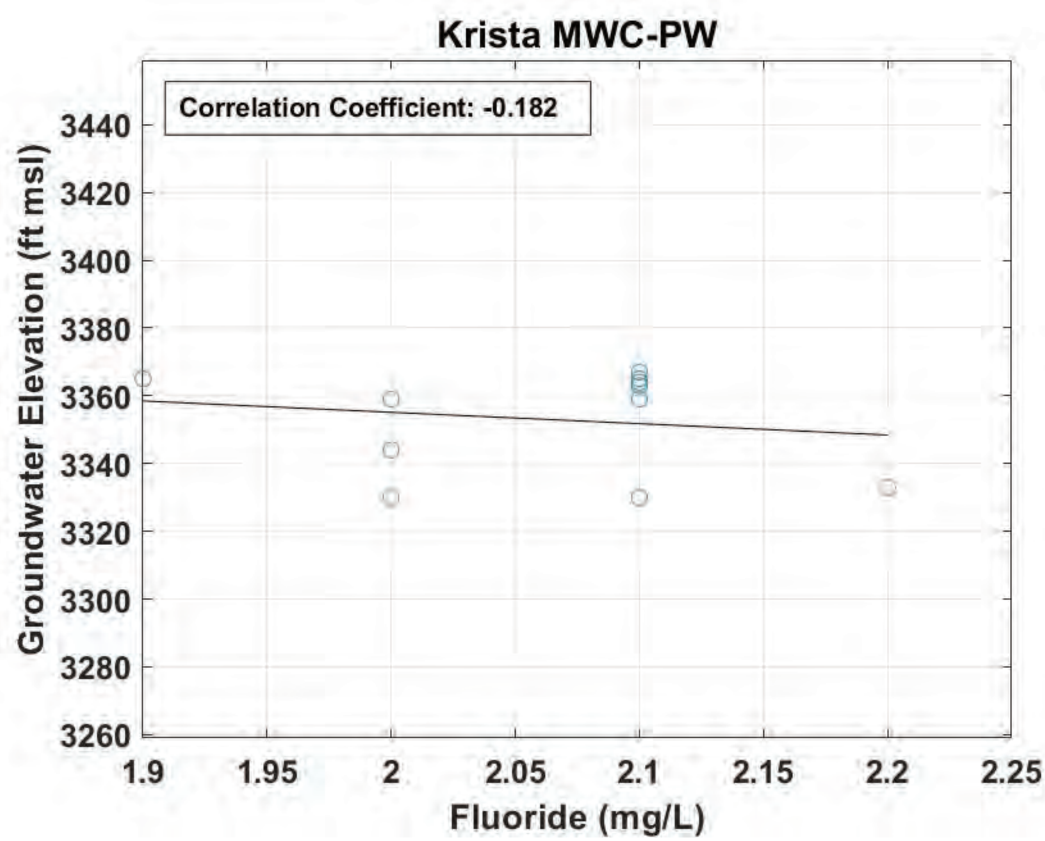
Stable Isotope Ratios
-66
-68
-70
-72
-74
-76
-78
-80
-82
δ2H (‰)
-11.5
-11.3
-11.1
-10.9
-10.7
-10.5
-10.3
-10.1
-9.9
-9.7
-9.5
δ18O (‰)
MW2-1
MW2-2
PW88-1
GV-1
GV-2
PW81-1
PW80-1
PW88-2
PW81-2
MW5-1
CR-2
MW6D-1
PW80-2
CR-1
MW5-2
MW3-1
MW22D-1
MW3-2
MW22D-2
MW6D-2



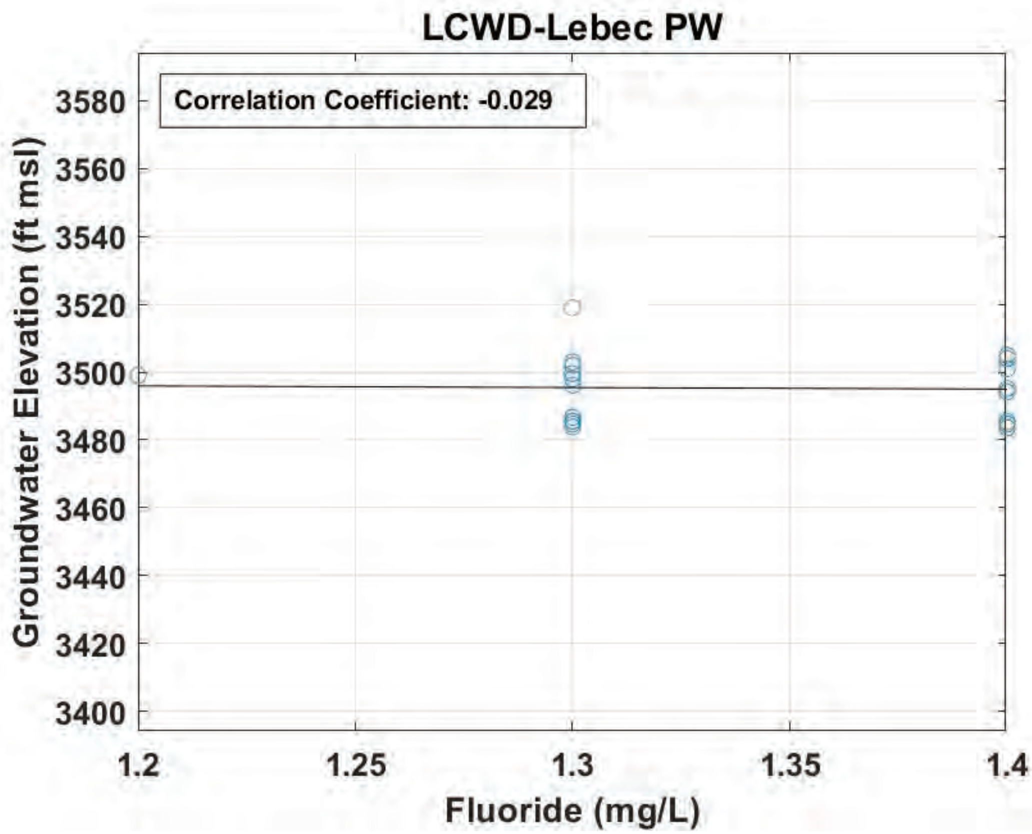
Stable Isotope Ratios
150
100
50
0
-50
-100
-150
-200
-25
-20
-15
-10
-5
0
5
10
15
δ²H (%ₒ)
δ¹⁸O (%ₒ)
Lake-1
Lake-2

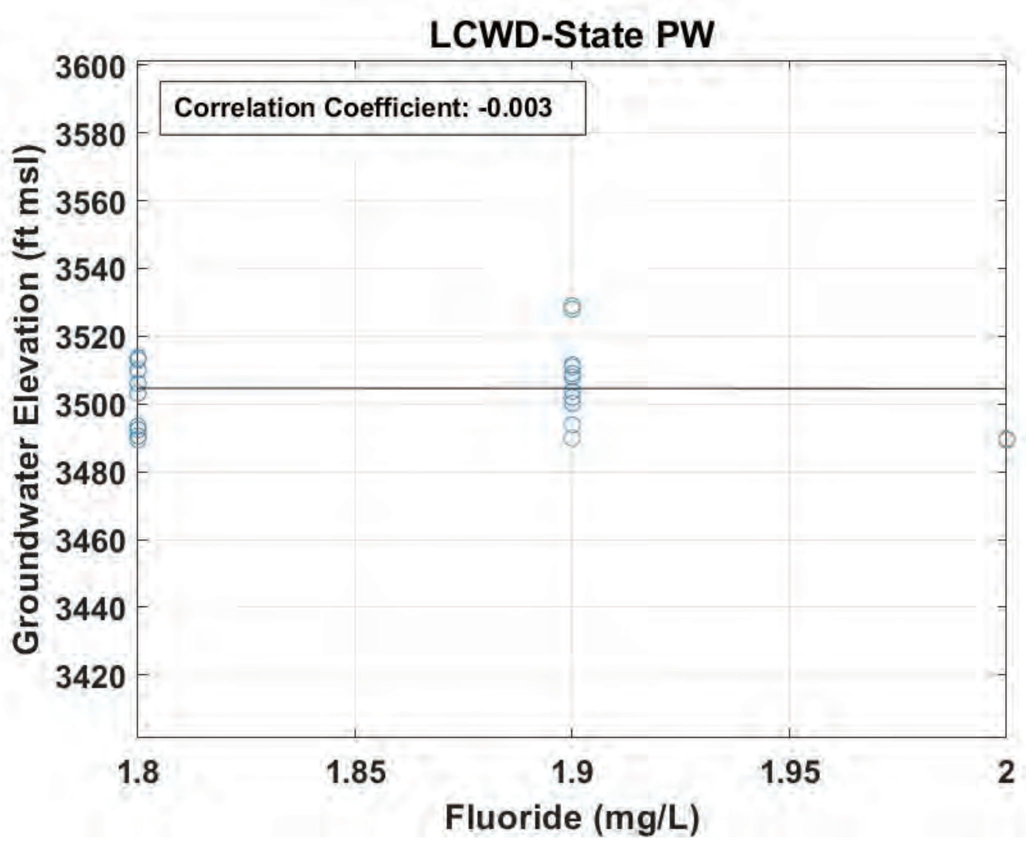


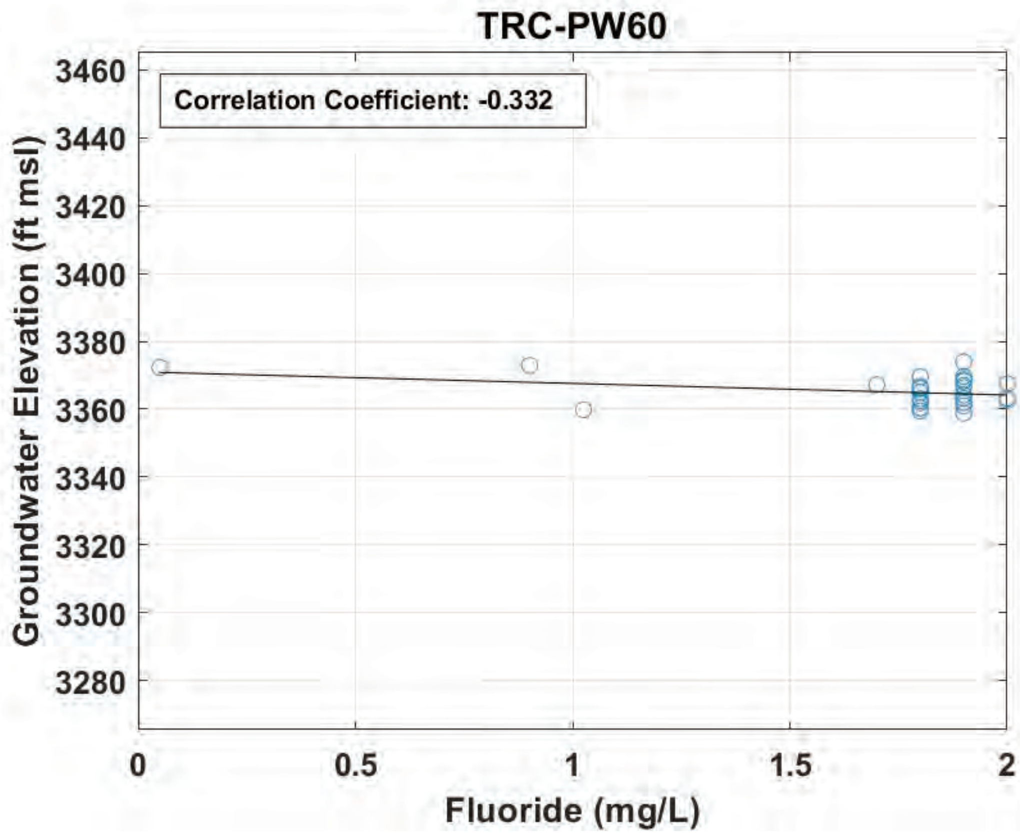
TRC-PW60
Correlation Coefficient: -0.506
Groundwater Elevation (ft msl)
3460
3440
3420
3400
3380
3360
3340
3320
3300
3280
1
1.2
1.4
1.6
1.8
2
As (mg/L)
×10^-3



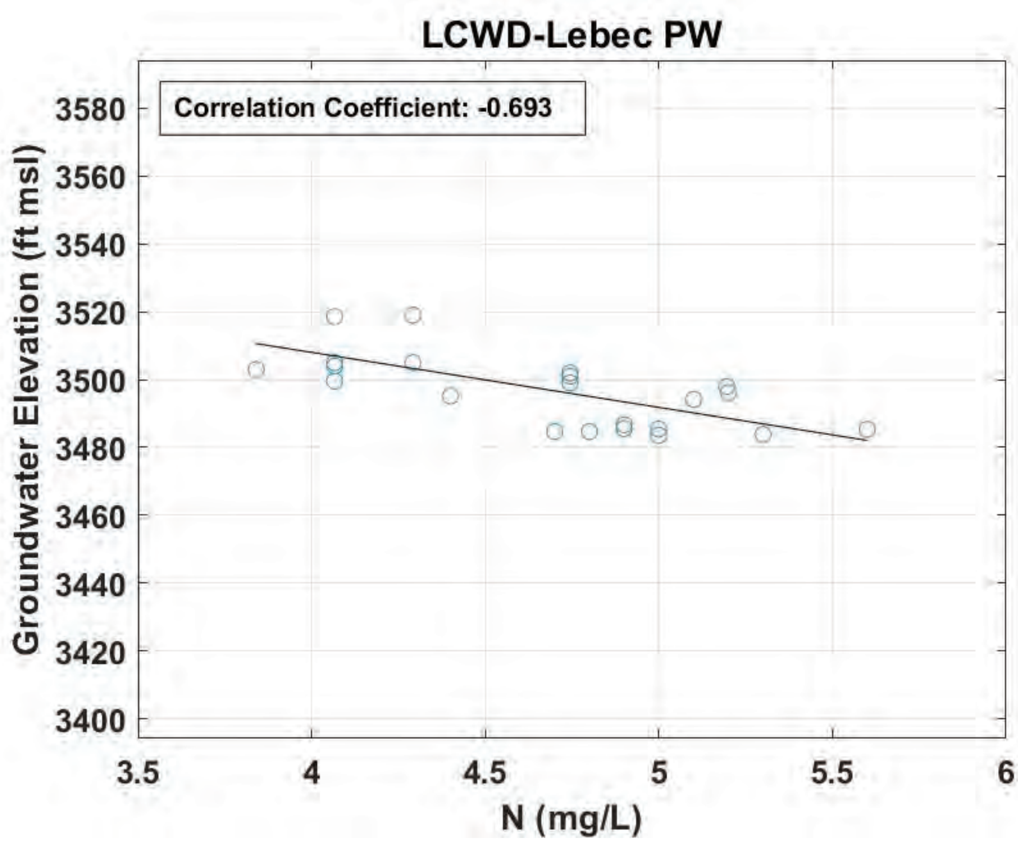
Krista MWC-PW
Correlation Coefficient: -0.182
Groundwater Elevation (ft msl)
3440
3420
3400
3380
3360
3340
3320
3300
3280
3260
1.9
1.95
2
2.05
2.1
2.15
2.2
2.25
Fluoride (mg/L)


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)

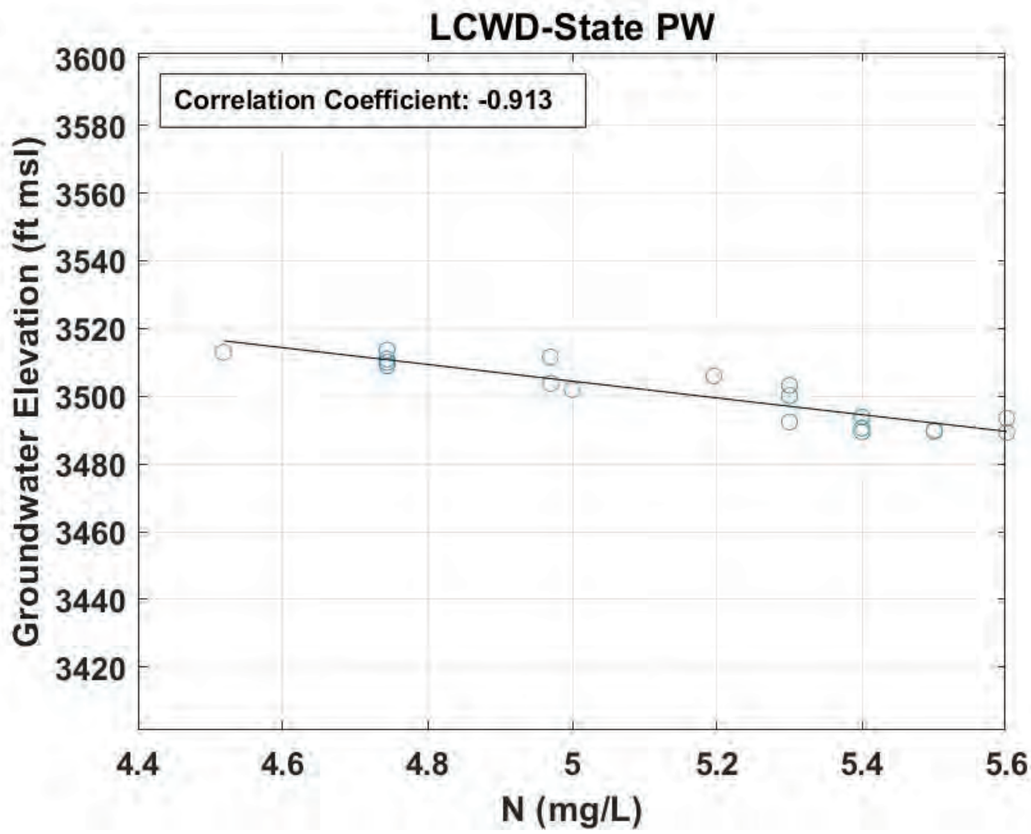

LCWD-State PW
Correlation Coefficient: -0.003
Groundwater Elevation (ft msl)
3600
3580
3560
3540
3520
3500
3480
3460
3440
3420
1.8
1.85
1.9
1.95
2
Fluoride (mg/L)



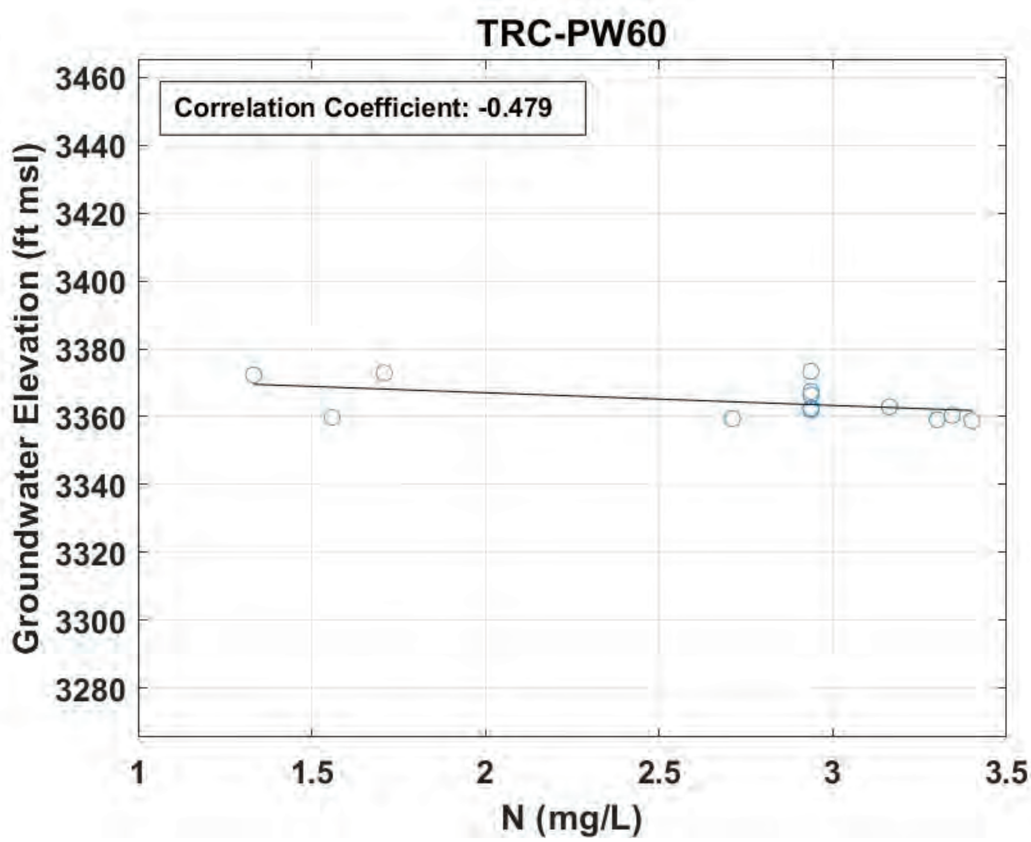
TRC-PW60
Correlation Coefficient: -0.332
Groundwater Elevation (ft msl)
3460
3440
3420
3400
3380
3360
3340
3320
3300
3280
0
0.5
1
1.5
2
Fluoride (mg/L)



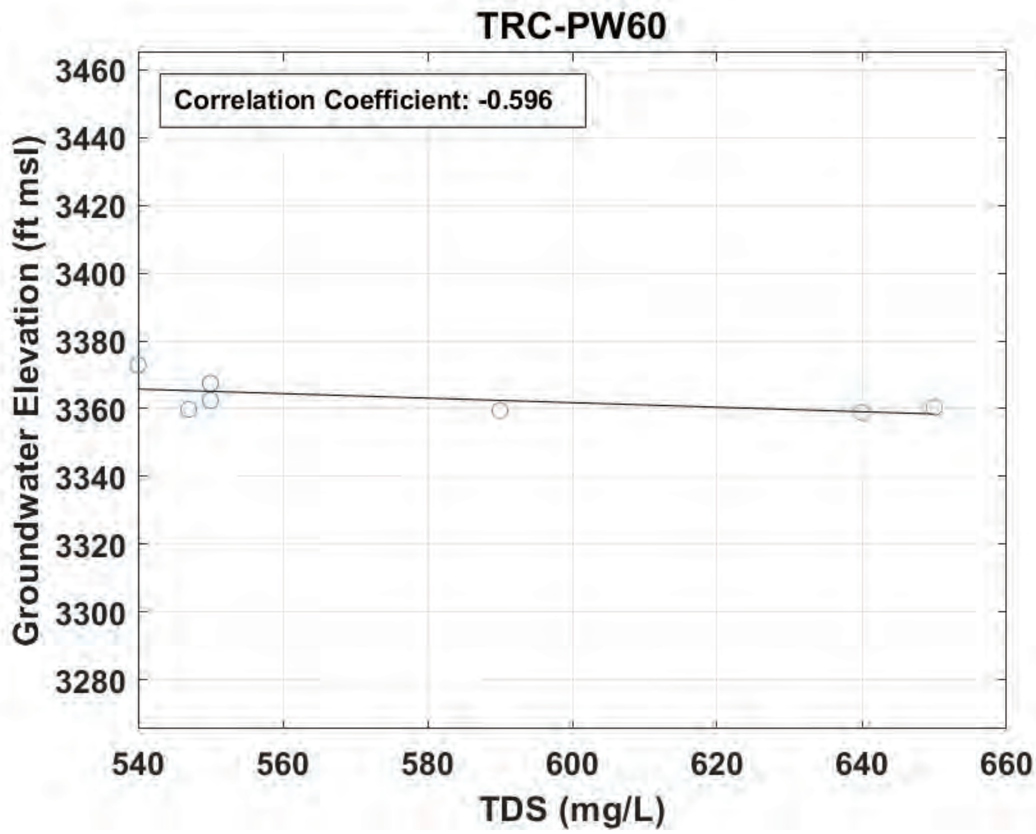
LCWD-Lebec PW
Correlation Coefficient: -0.693
Groundwater Elevation (ft msl)
3580
3560
3540
3520
3500
3480
3460
3440
3420
3400
3.5
4
4.5
5
5.5
6
N (mg/L)

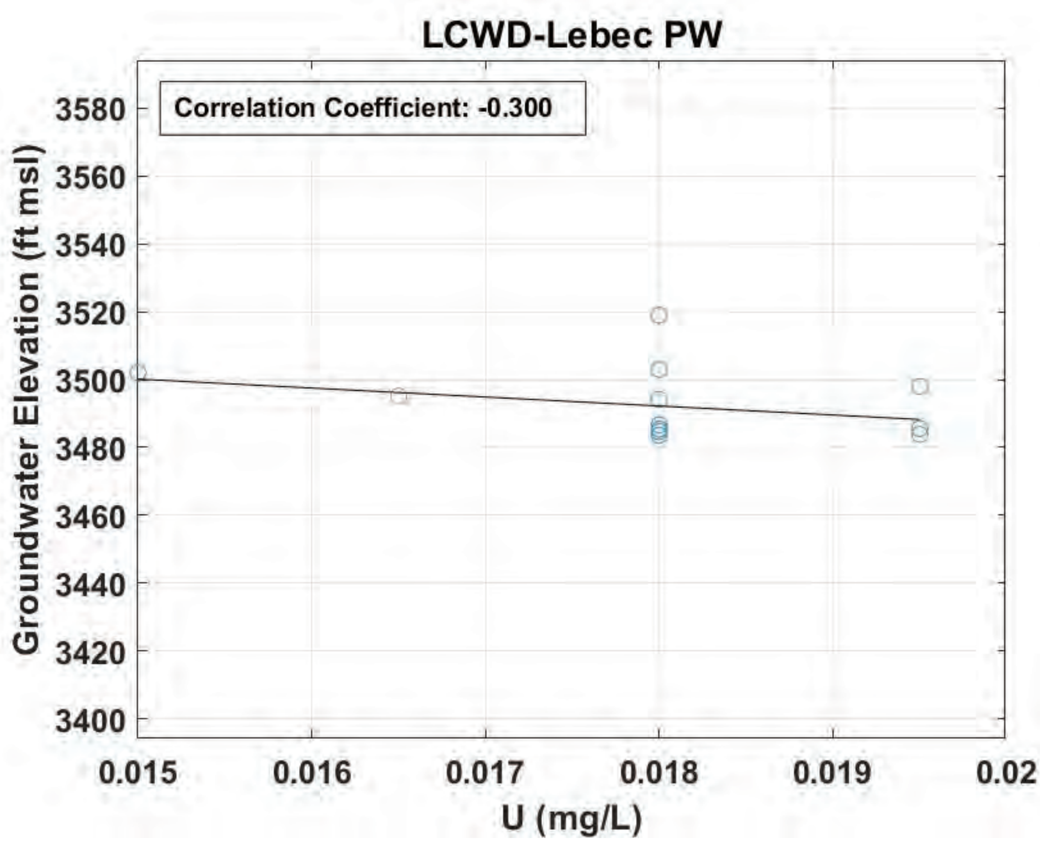


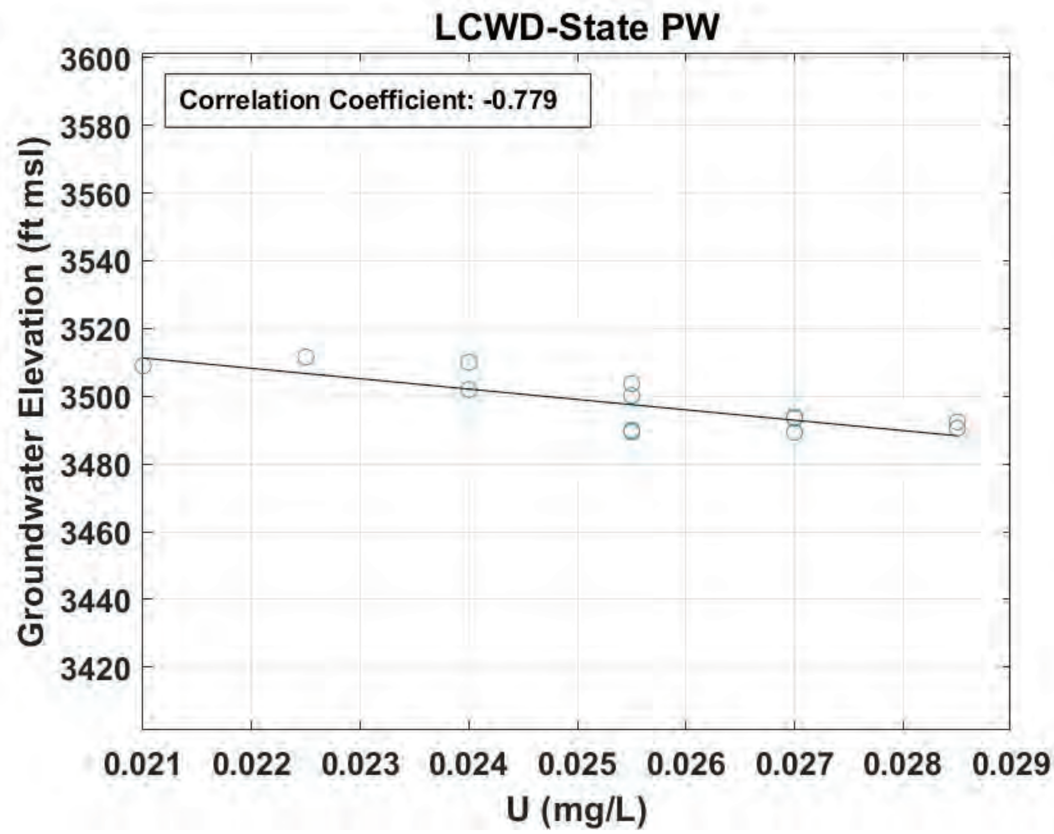
LCWD-State PW
Correlation Coefficient: -0.913
Groundwater Elevation (ft msl)
3600
3580
3560
3540
3520
3500
3480
3460
3440
3420
4.4
4.6
4.8
5
5.2
5.4
5.6
N (mg/L)



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)

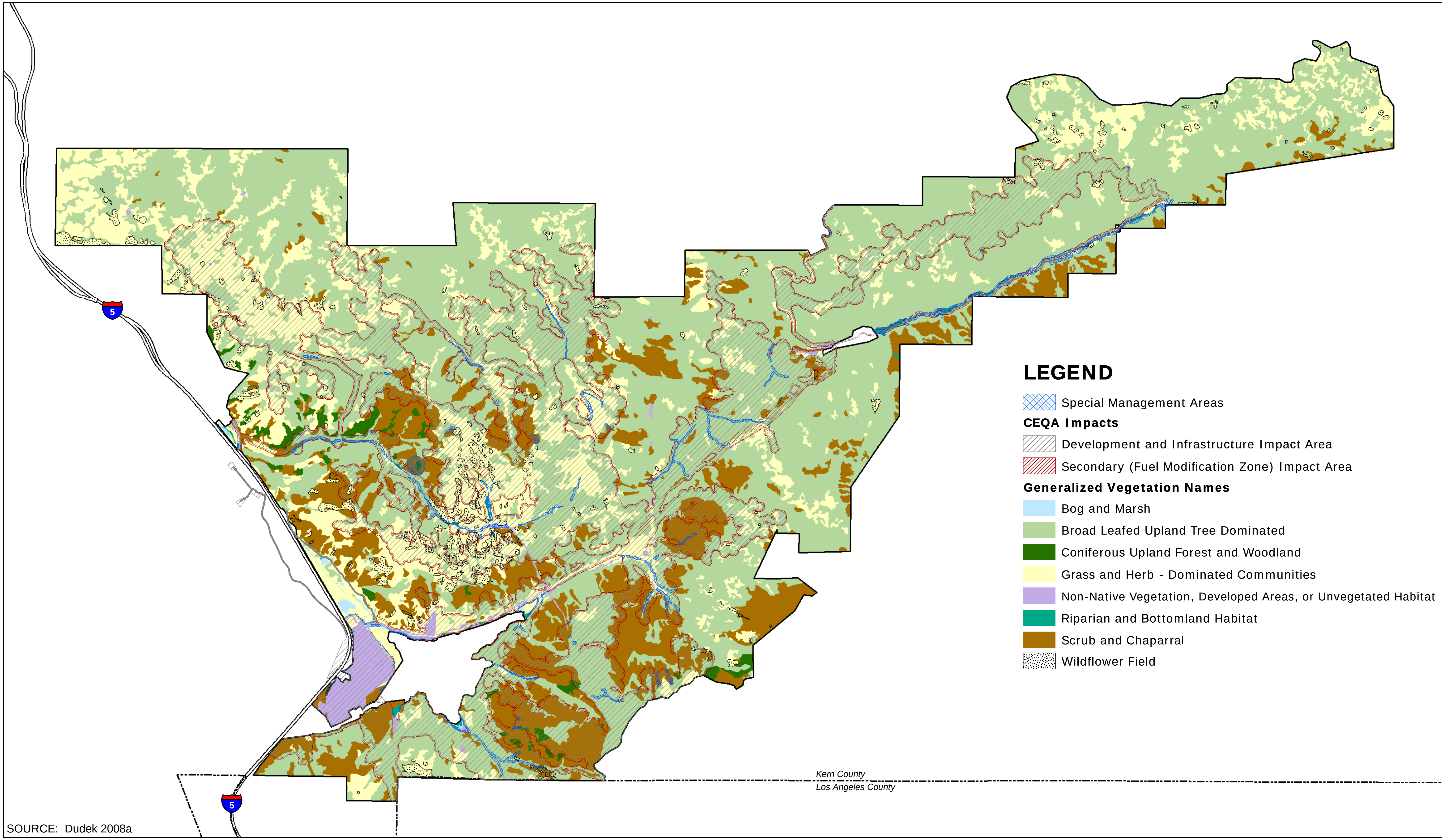
Appendix F

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

May 2009

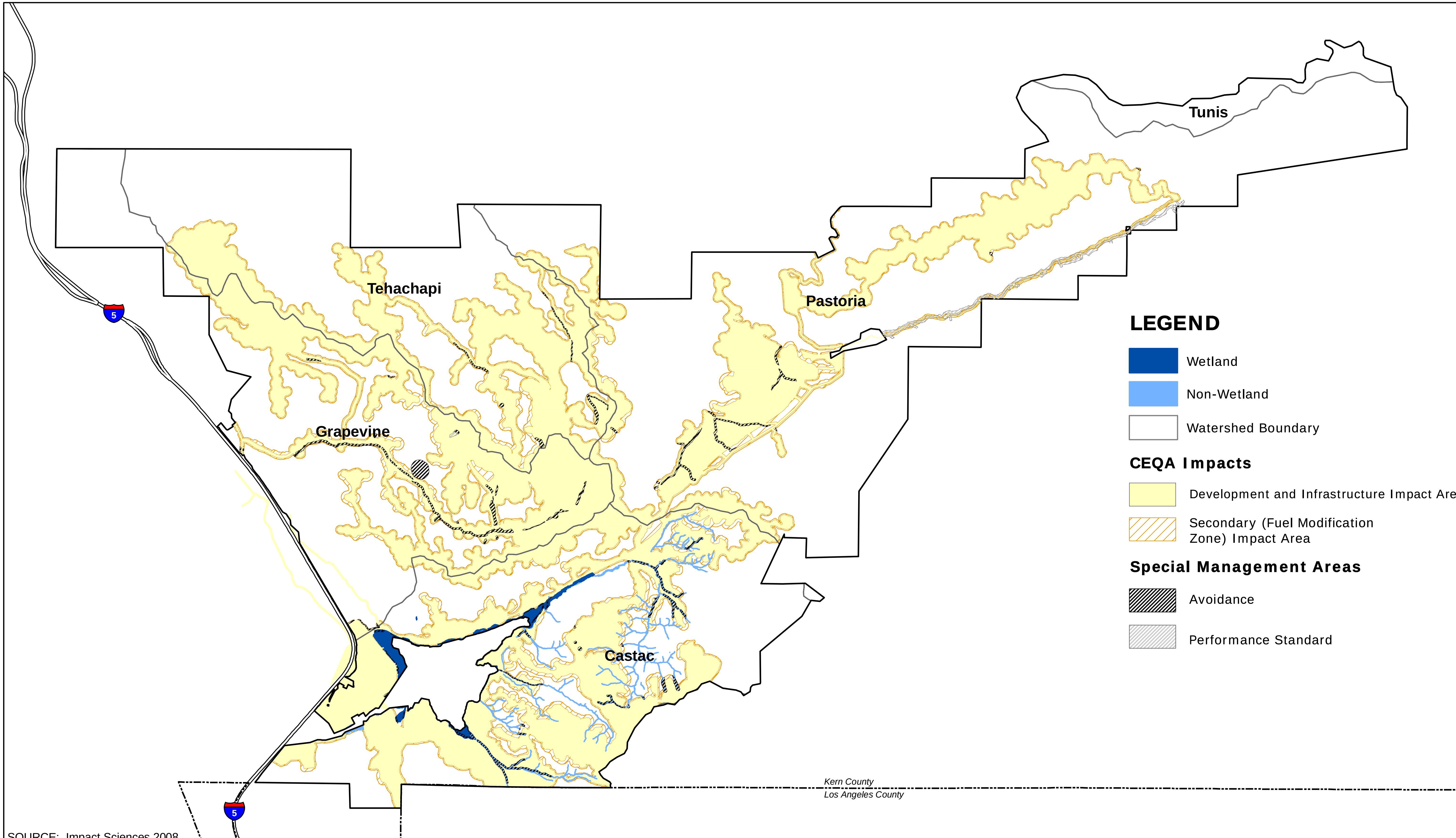


Figure 4.4-5
U.S. ARMY CORPS OF ENGINEERS JURISDICTIONAL AREAS

Tejon Mountain Village EIR

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

May 2009

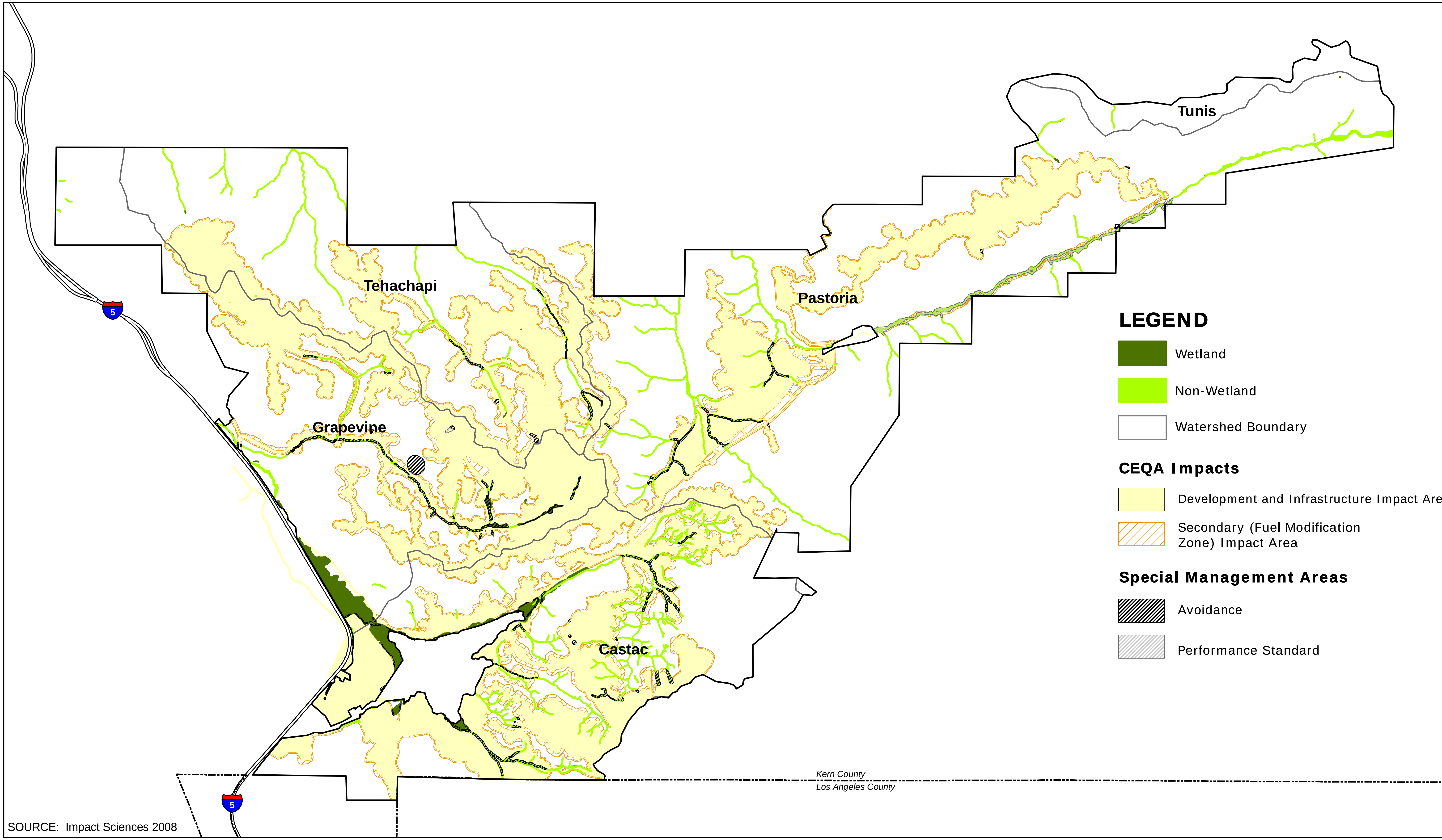
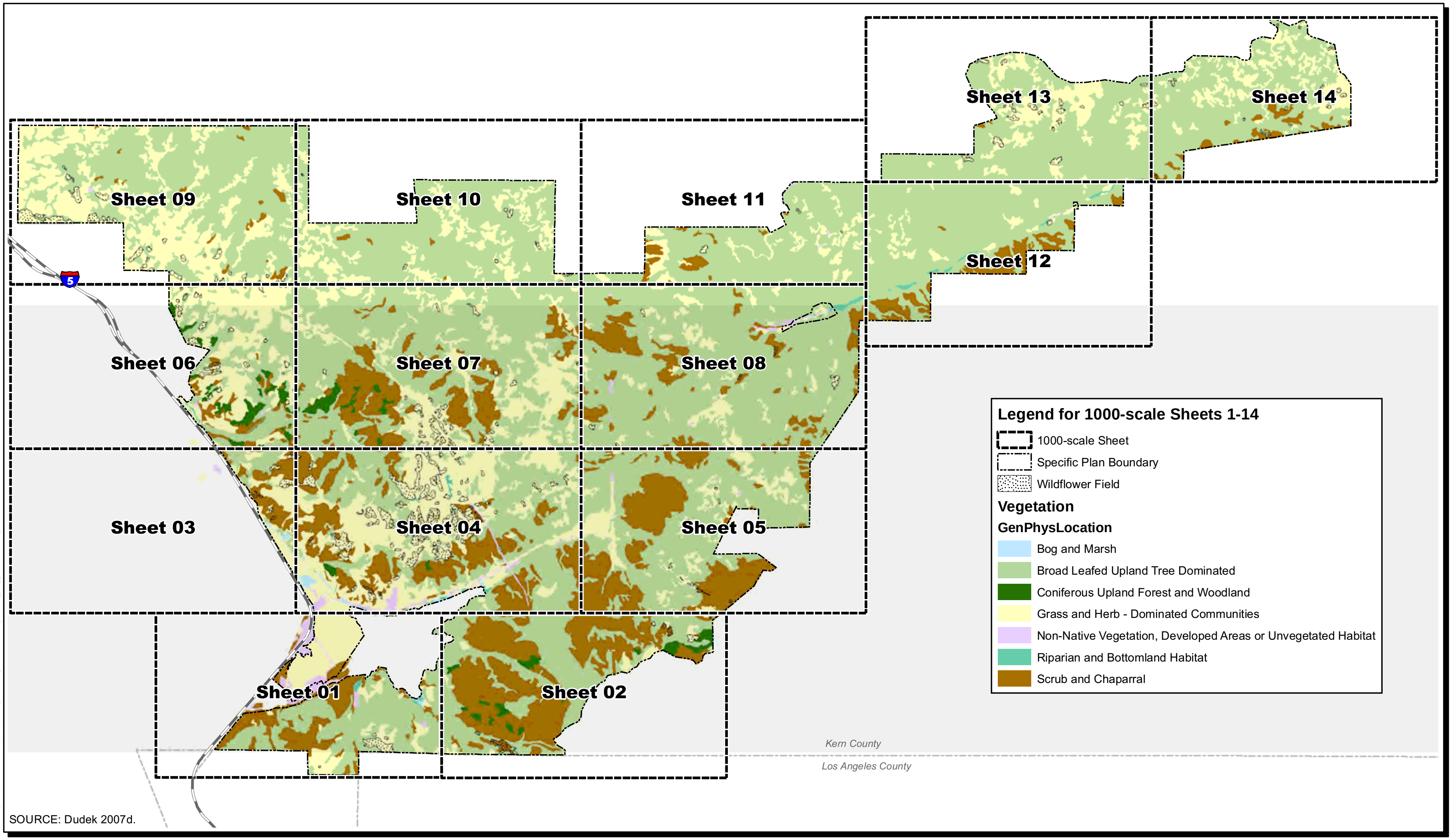


Figure 4.4-6
CALIFORNIA DEPARTMENT OF FISH & GAME JURISDICTIONAL AREAS

Tejon Mountain Village EIR

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

May 2009



Feet
0 5,000

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

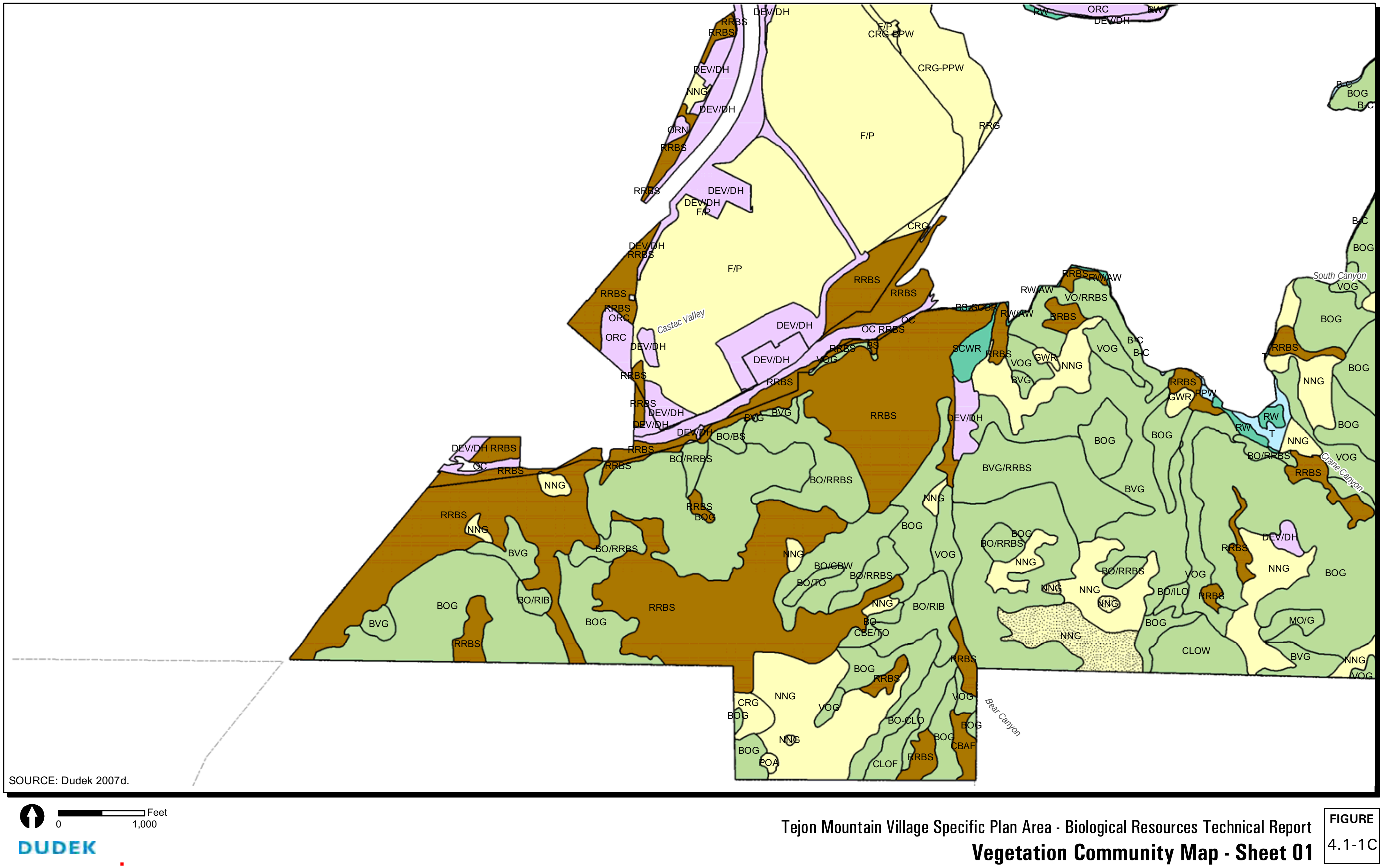
- B-C, Bulrush - Cattail
- BBM, Bigberry Manzanita
- BLC, Broad-Leafed Cattail
- BLMM, Birchleaf Mountain-Mahogany
- BLMM-CBW, Birchleaf Mountain-Mahogany - California Buckwheat
- BO/ILO, Blue Oak / Interior Live Oak
- BO/ILO-WC, Blue Oak / Interior Live Oak - Wedgeleaf Ceanothus
- BO/TO, Blue Oak / 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

DUDEK

Tejon Mountain Village Specific Plan Area - Biological Resources Technical Report

Legend for Vegetation Map Codes and Vegetation Communities/Stand Types

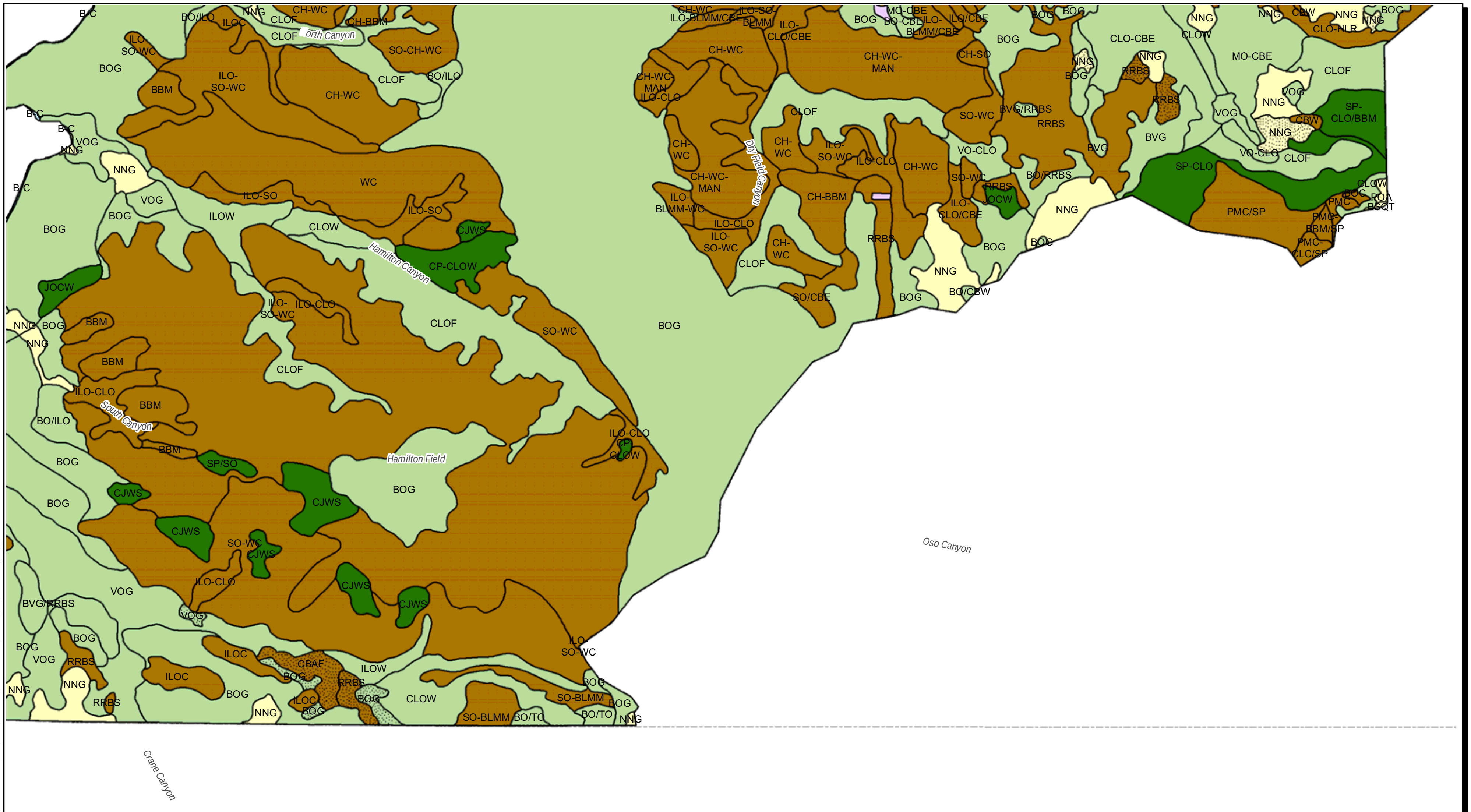
FIGURE 4.1-1B



Tejon Mountain Village Specific Plan Area - Biological Resources Technical Report

Vegetation Community Map - Sheet 01

FIGURE 4.1-1C



SOURCE: Dudek 2007d.

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.

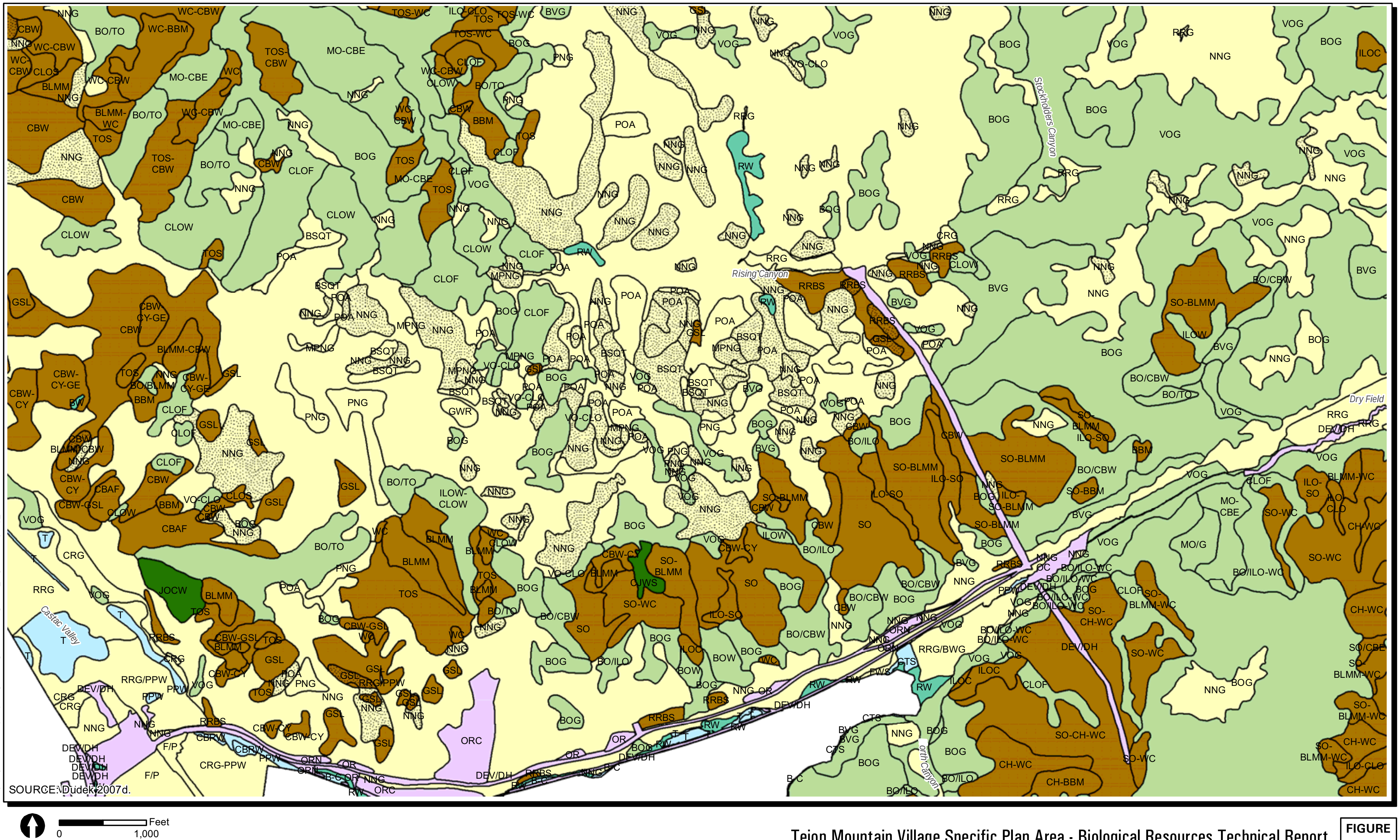
Feet
0 1,000

DUDEK

Tejon Mountain Village Specific Plan Area - Biological Resources Technical Report

Vegetation Community Map - Sheet 03

FIGURE 4.1-1E

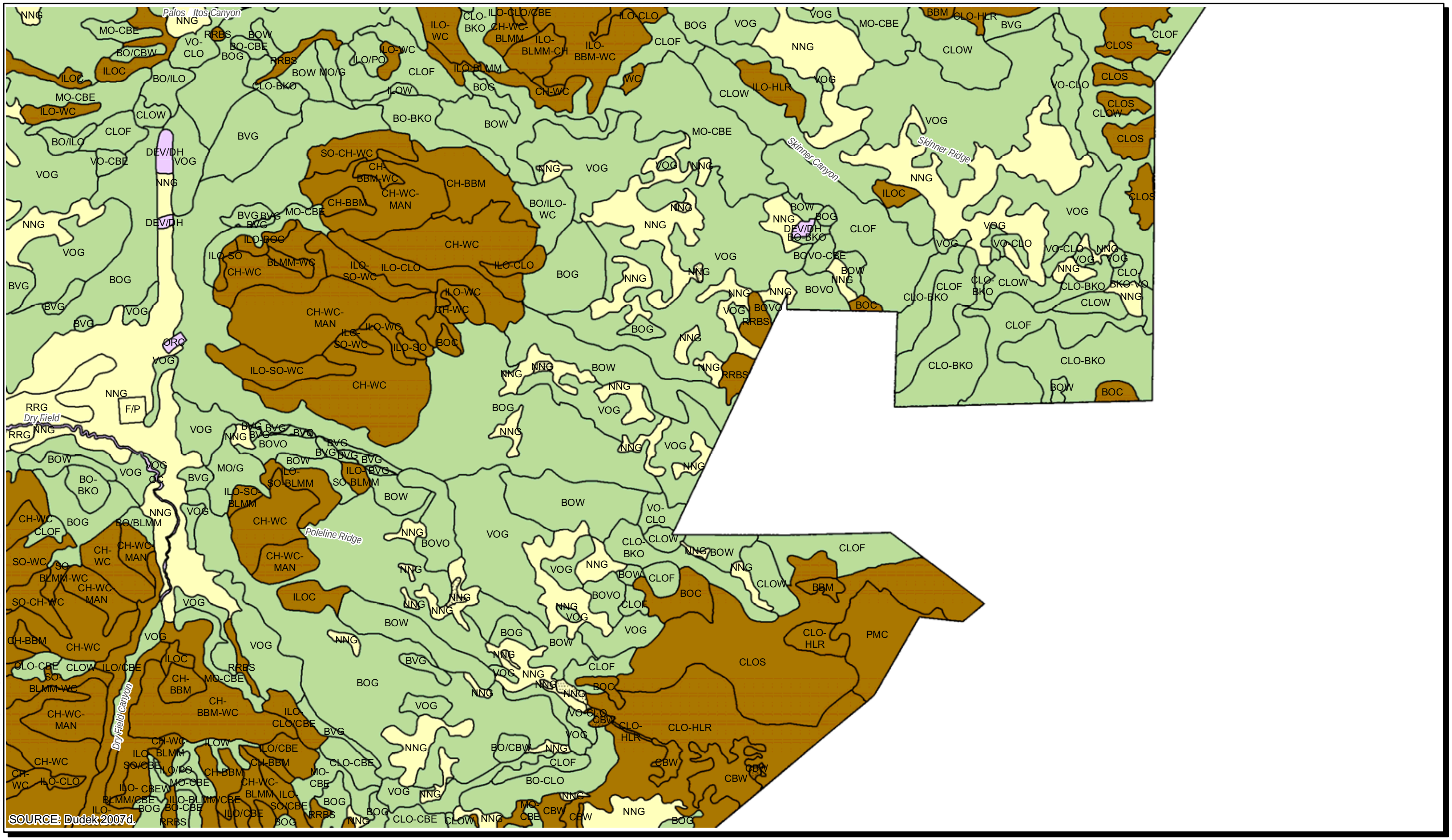


DUDEK

Tejon Mountain Village Specific Plan Area - Biological Resources Technical Report

Vegetation Community Map - Sheet 04

FIGURE 4.1-1F



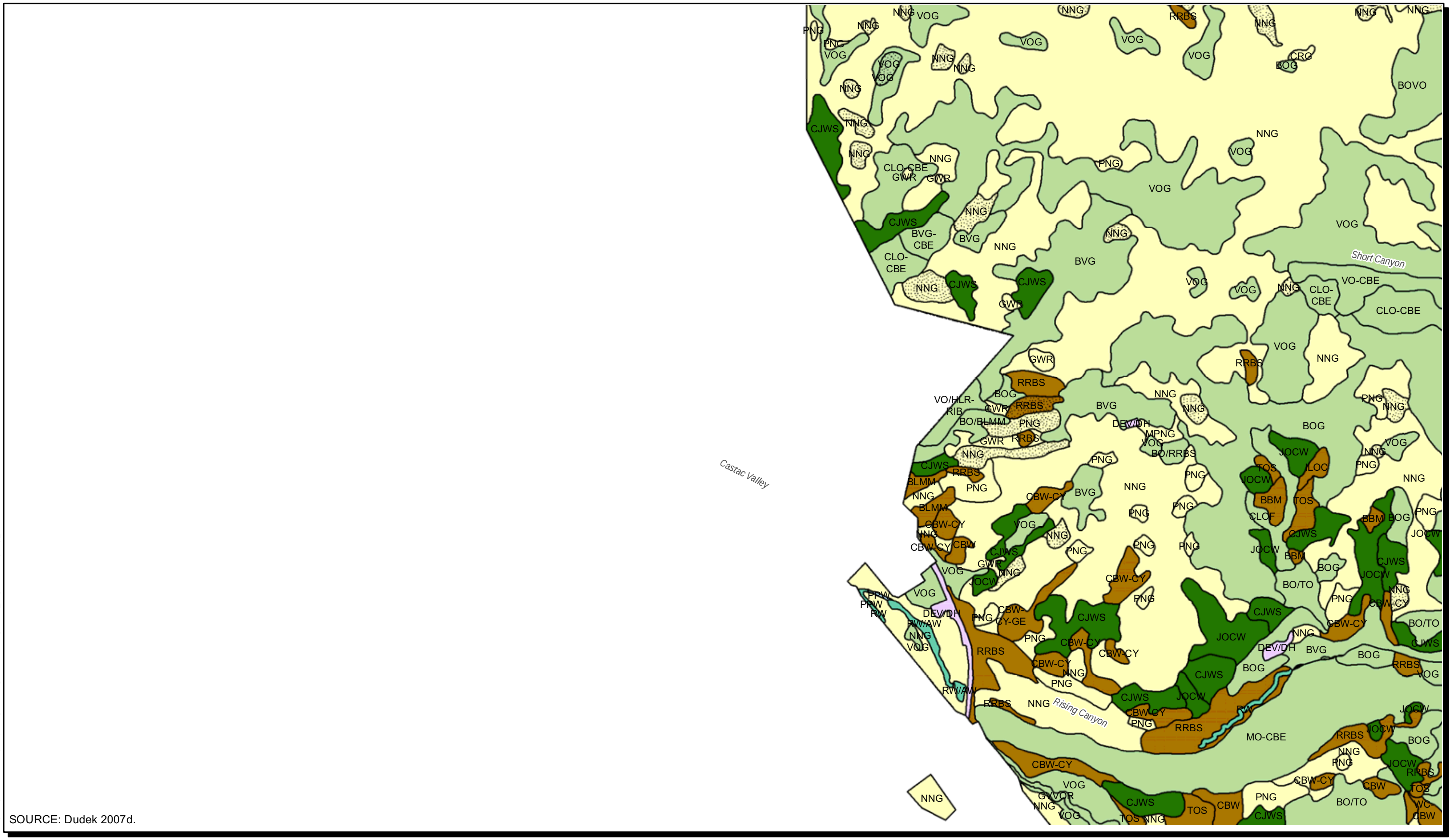
Feet
0 1,000

DUDEK

Tejon Mountain Village Specific Plan Area - Biological Resources Technical Report

Vegetation Community Map - Sheet 05

FIGURE 4.1-1G



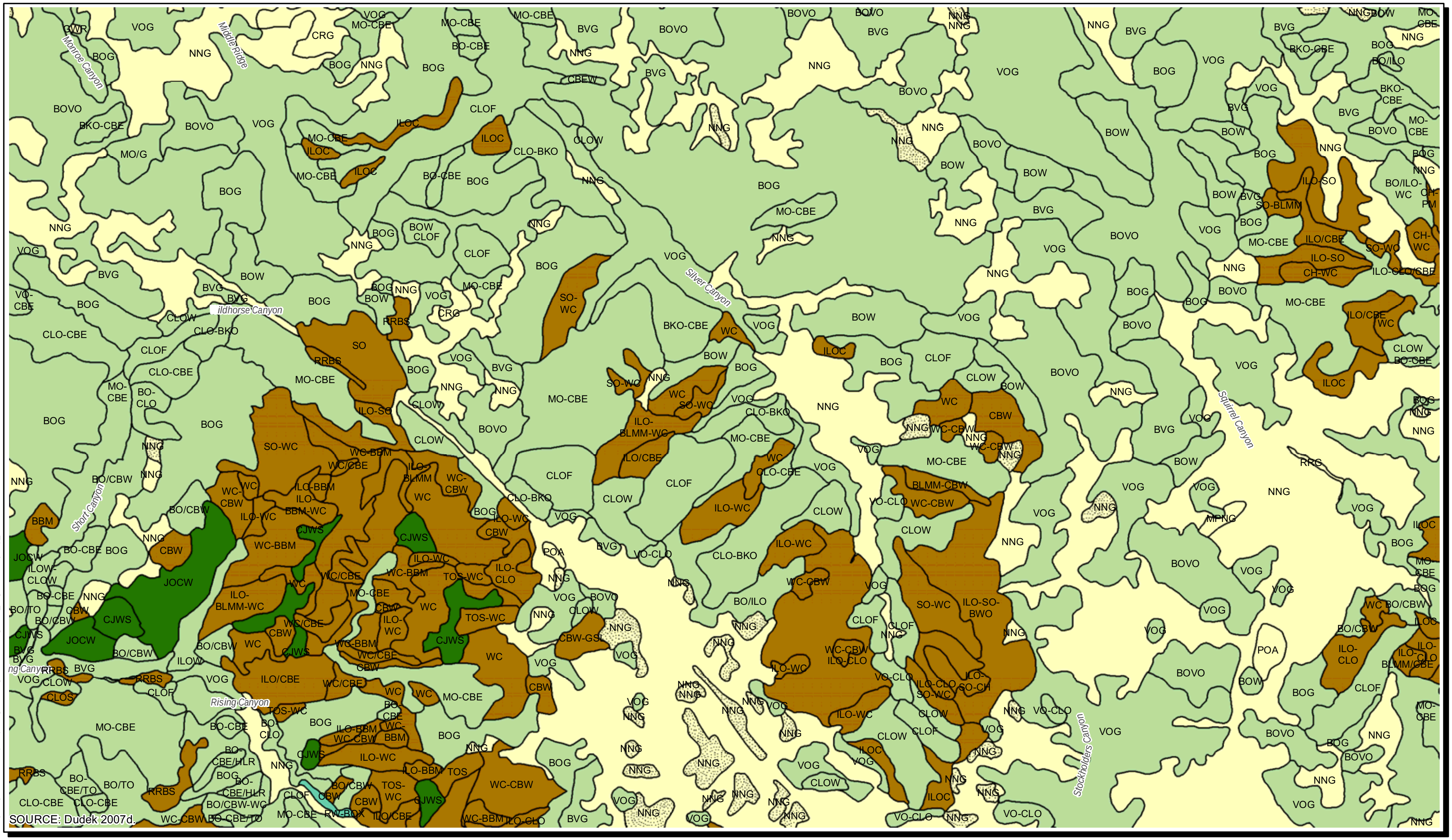
Feet
0 1,000

DUDEK

Tejon Mountain Village Specific Plan Area - Biological Resources Technical Report

Vegetation Community Map - Sheet 06

FIGURE 4.1-1H



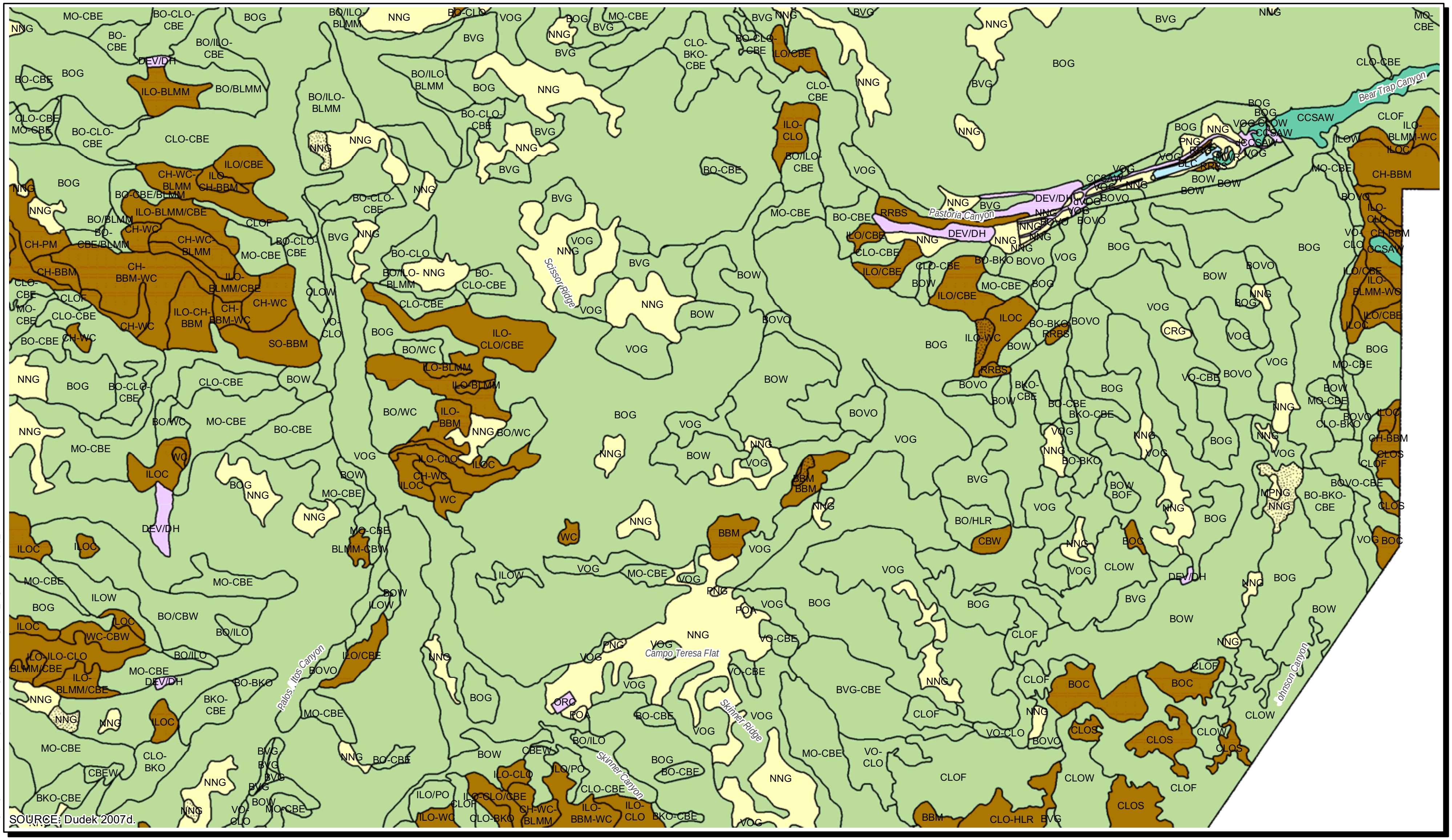
Feet
0 1,000

DUDEK

Tejon Mountain Village Specific Plan Area - Biological Resources Technical Report

Vegetation Community Map - Sheet 07

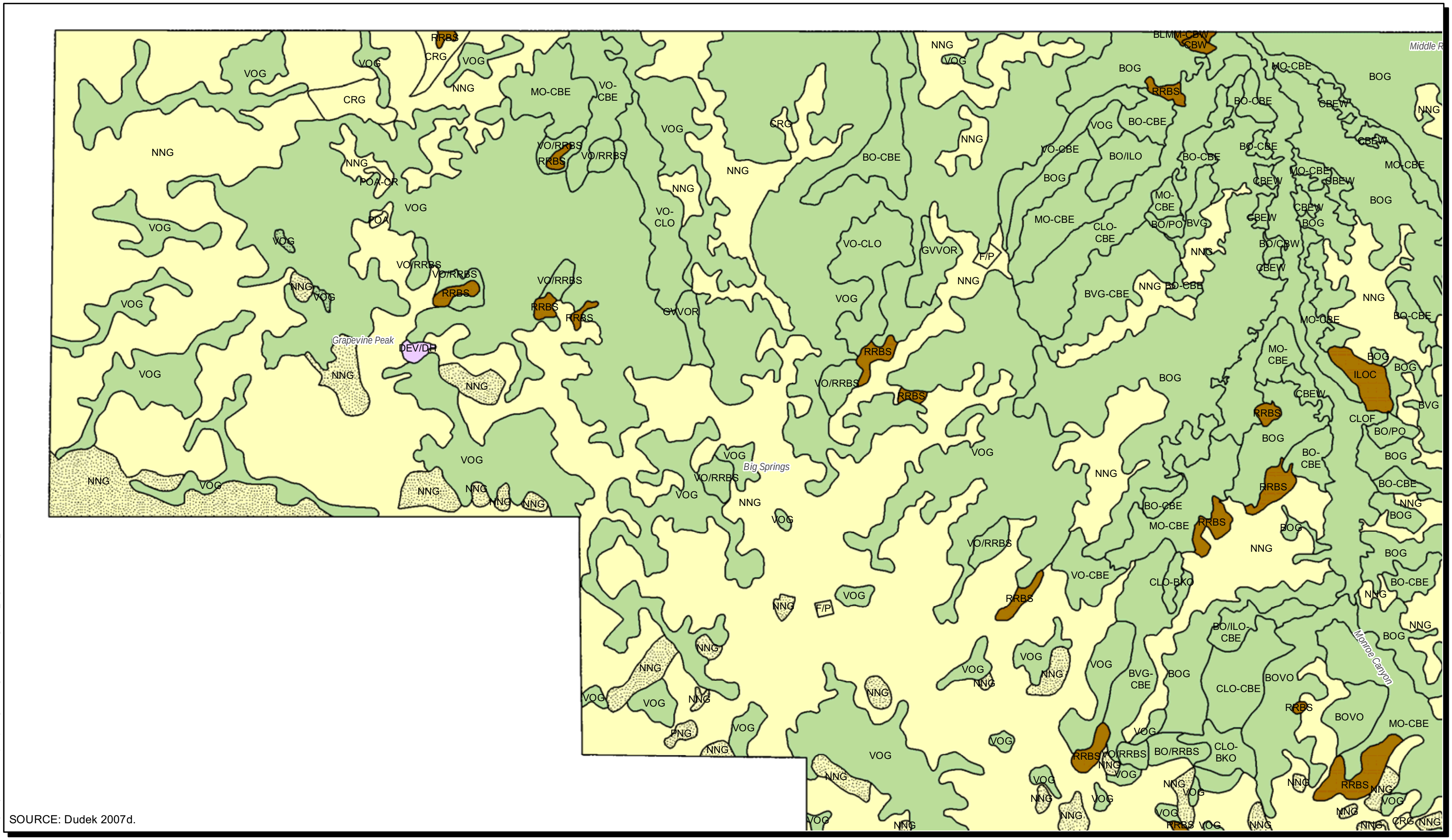
FIGURE 4.1-1I



Tejon Mountain Village Specific Plan Area - Biological Resources Technical Report

Vegetation Community Map - Sheet 08

FIGURE 4.1-1J



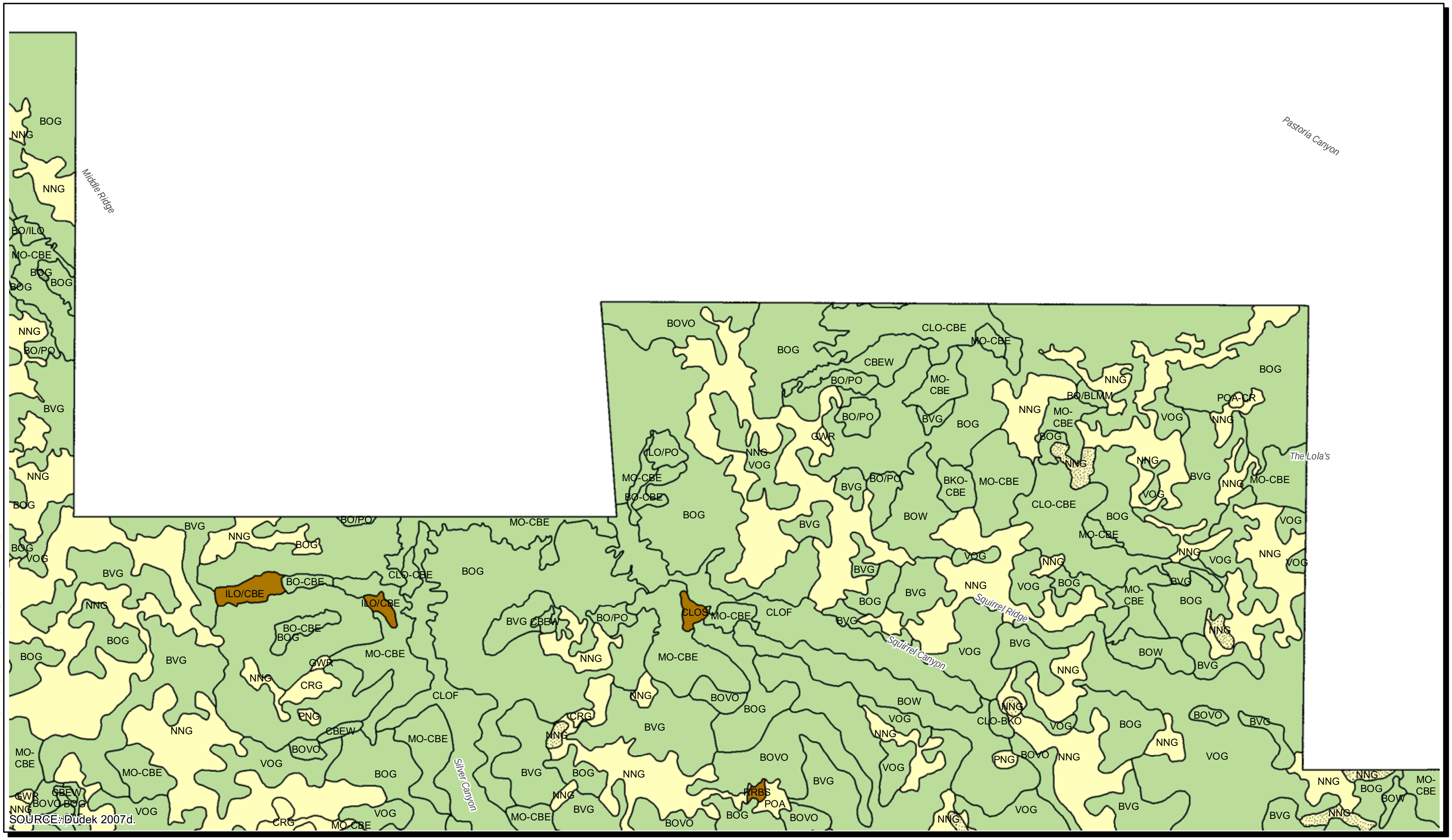
Feet
0 1,000

DUDEK

Tejon Mountain Village Specific Plan Area - Biological Resources Technical Report

Vegetation Community Map - Sheet 09

FIGURE
4.1-1K

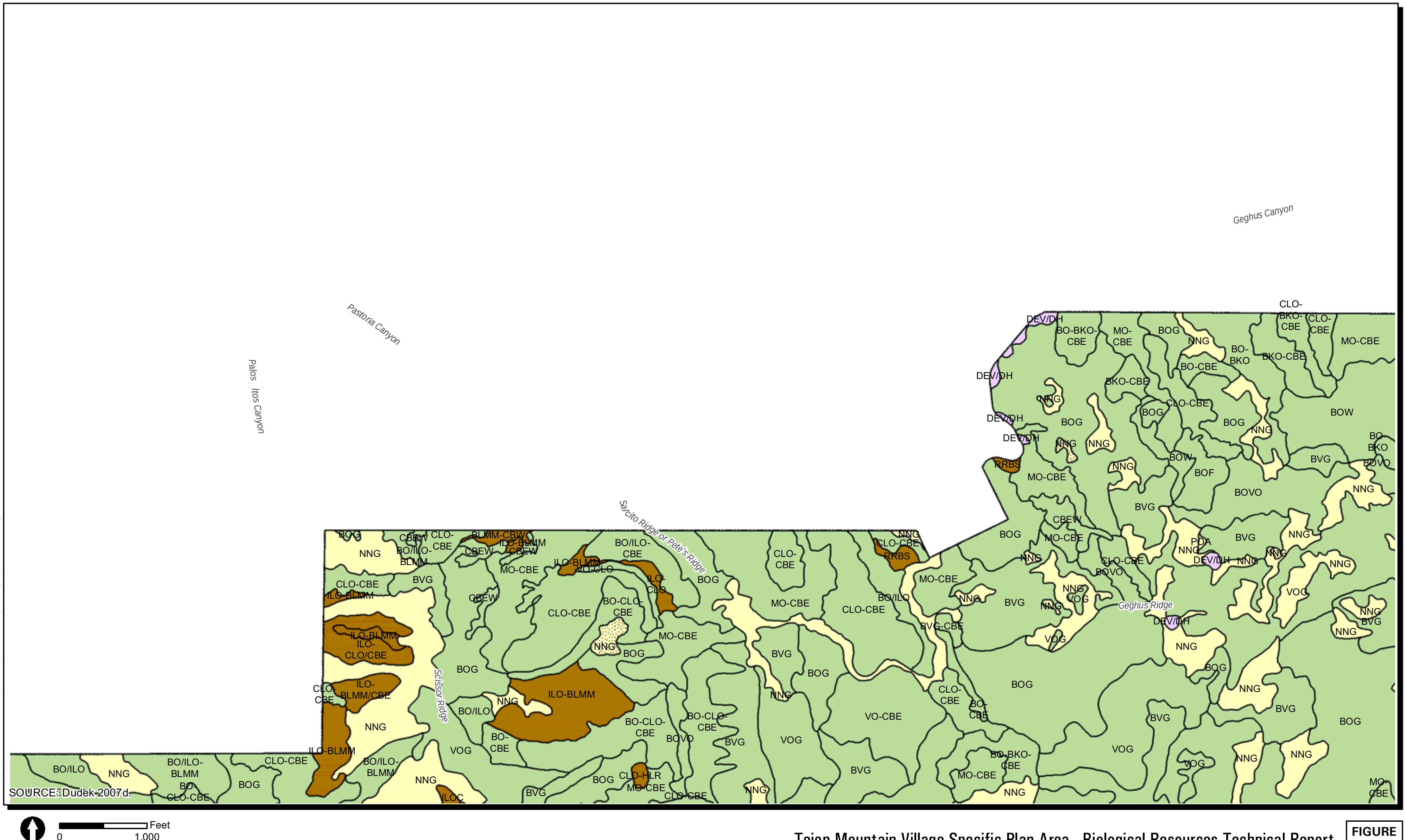


DUDEK

Tejon Mountain Village Specific Plan Area - Biological Resources Technical Report

Vegetation Community Map - Sheet 10

FIGURE 4.1-1L

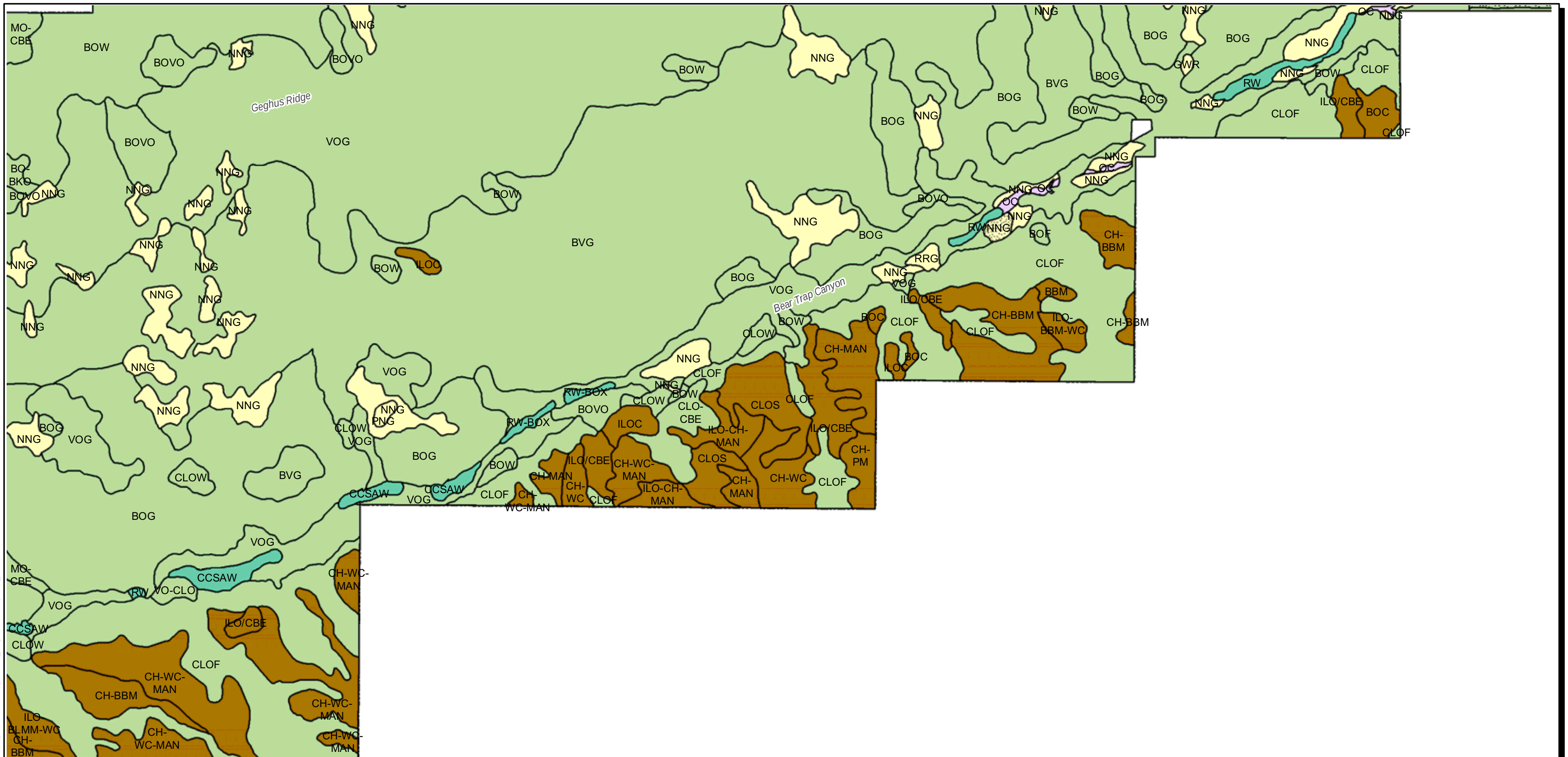


DUDEK

Tejon Mountain Village Specific Plan Area - Biological Resources Technical Report

Vegetation Community Map - Sheet 11

FIGURE 4.1-1M



SOURCE: Dudek 2007d.

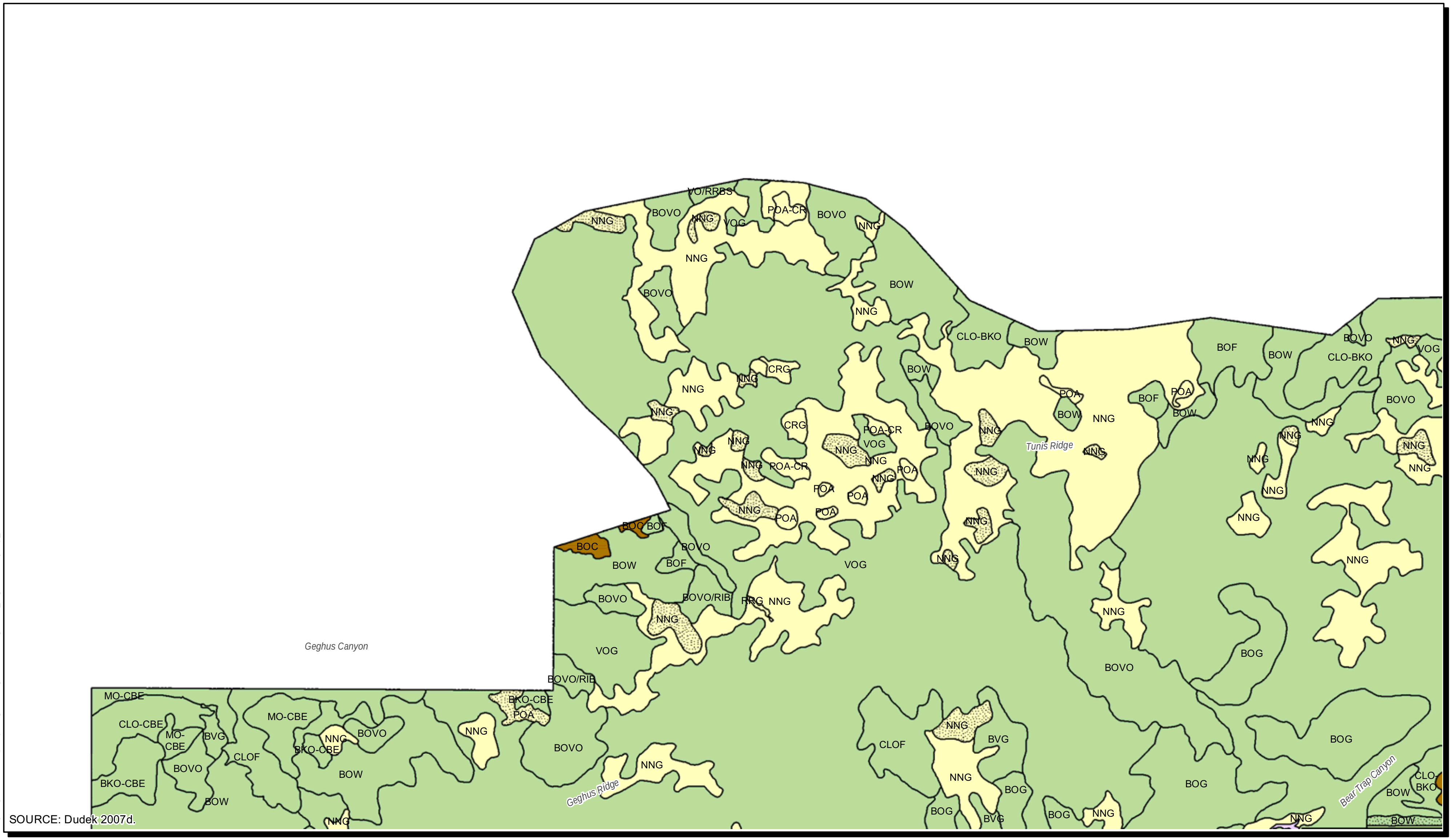
Feet
0 1,000

DUDEK

Tejon Mountain Village Specific Plan Area - Biological Resources Technical Report

Vegetation Community Map - Sheet 12

FIGURE
4.1-1N



SOURCE: Dudek 2007d.

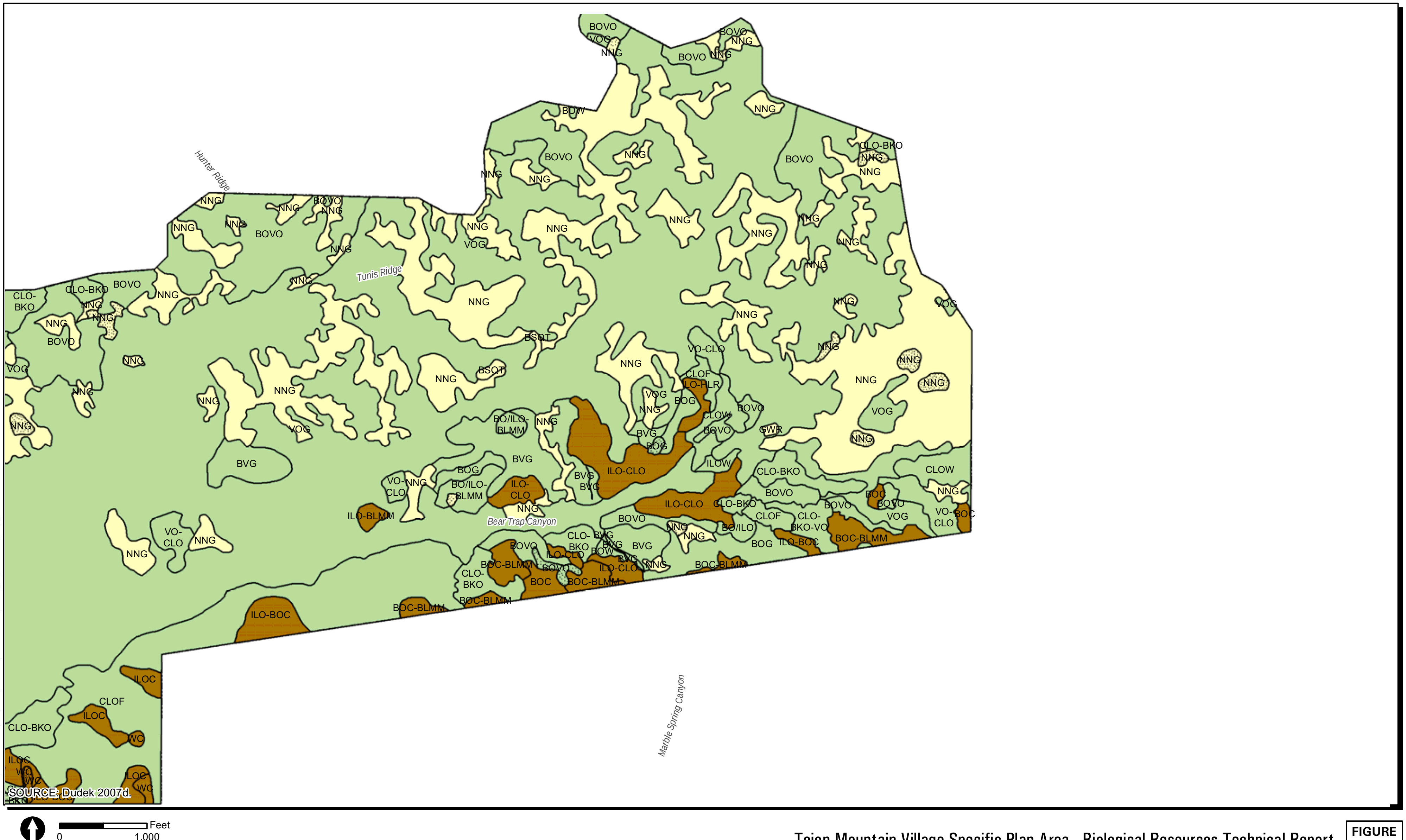
0 1,000 Feet

DUDEK

Tejon Mountain Village Specific Plan Area - Biological Resources Technical Report

Vegetation Community Map - Sheet 13

FIGURE 4.1-10

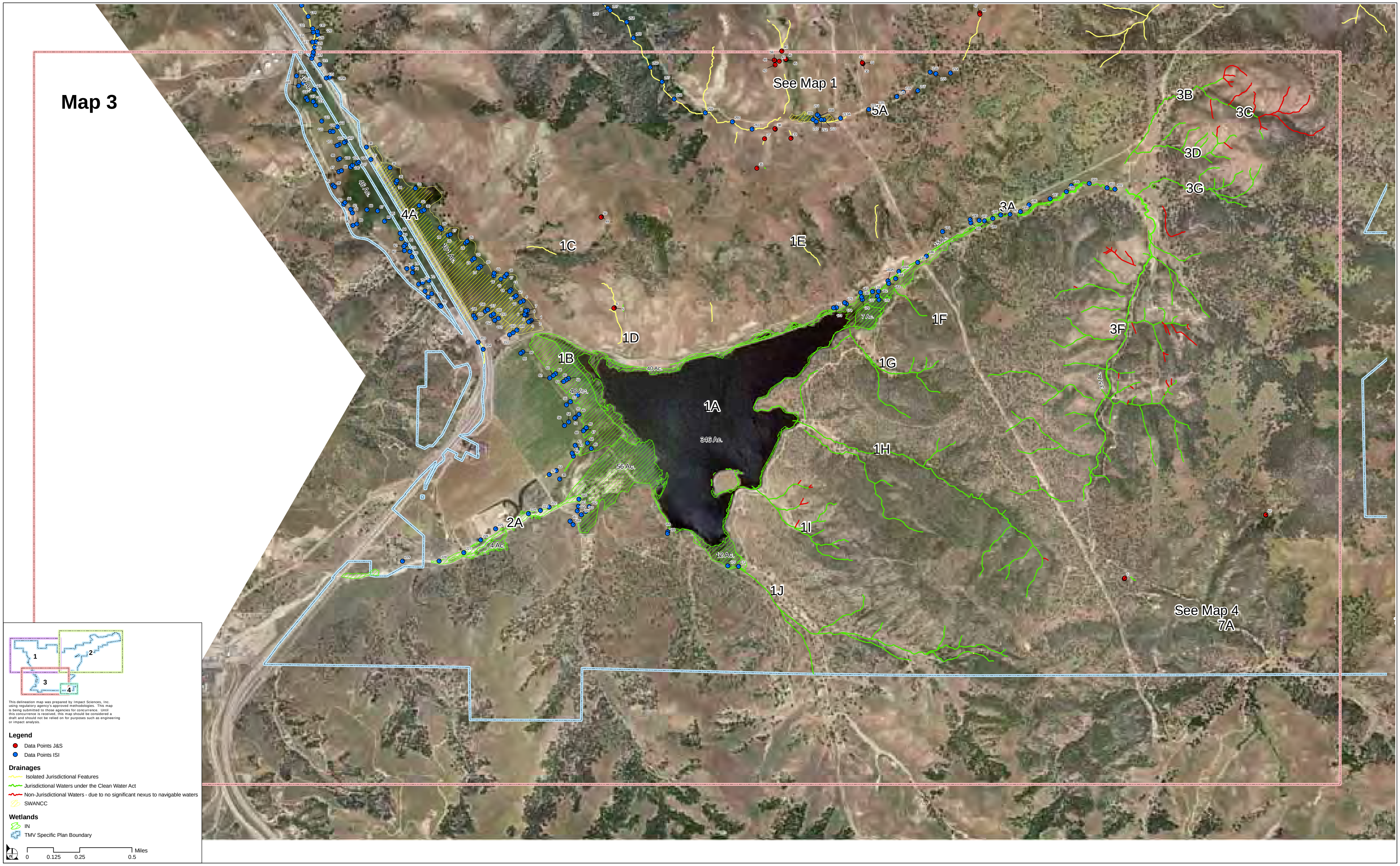


DUDEK

Tejon Mountain Village Specific Plan Area - Biological Resources Technical Report

Vegetation Community Map - Sheet 14

FIGURE 4.1-1P



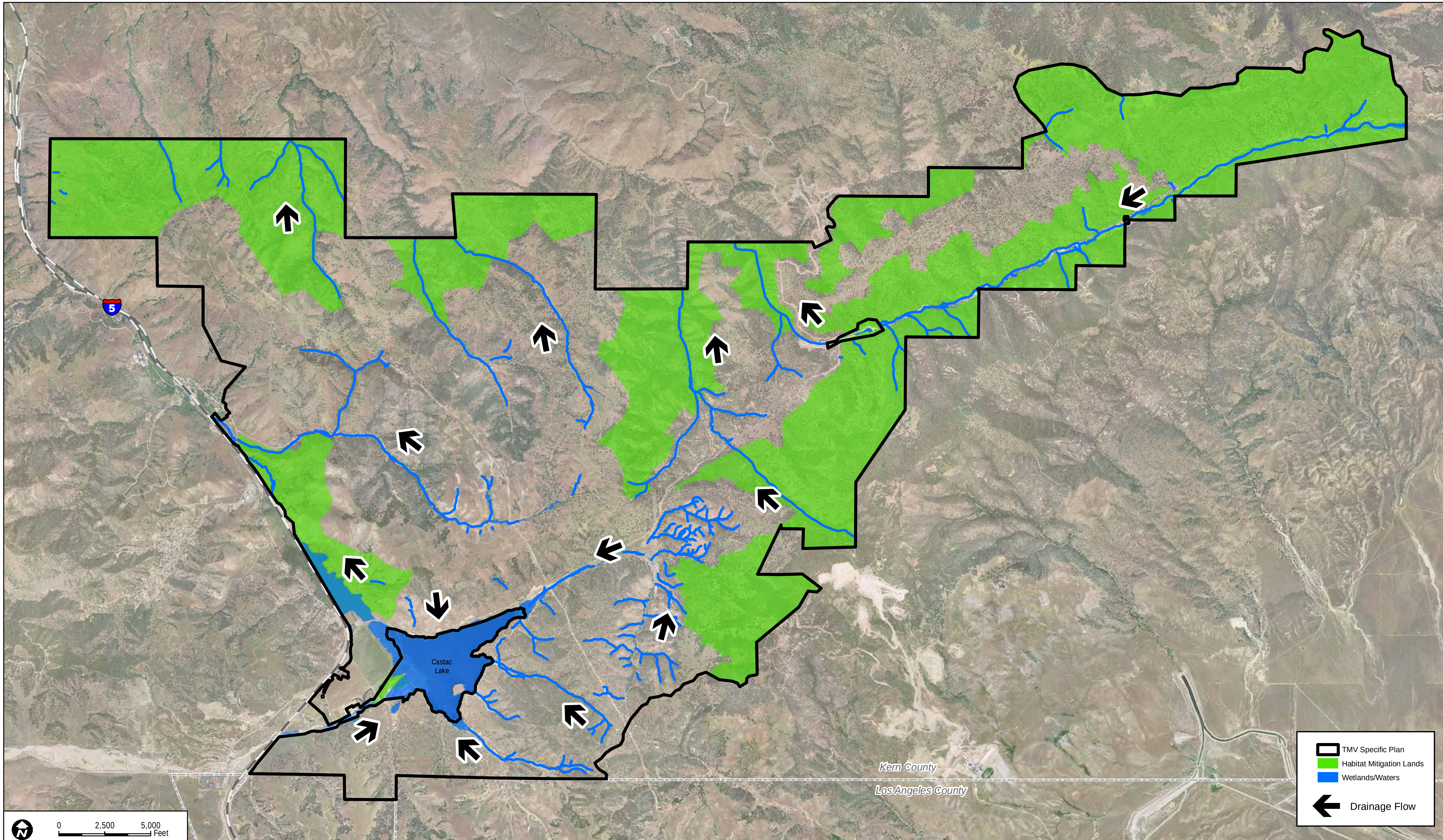
SOURCE: Impact Sciences, Inc. - November 2007

FIGURE 6

Castac Lake and Adjacent Wetlands

317-028•08/08

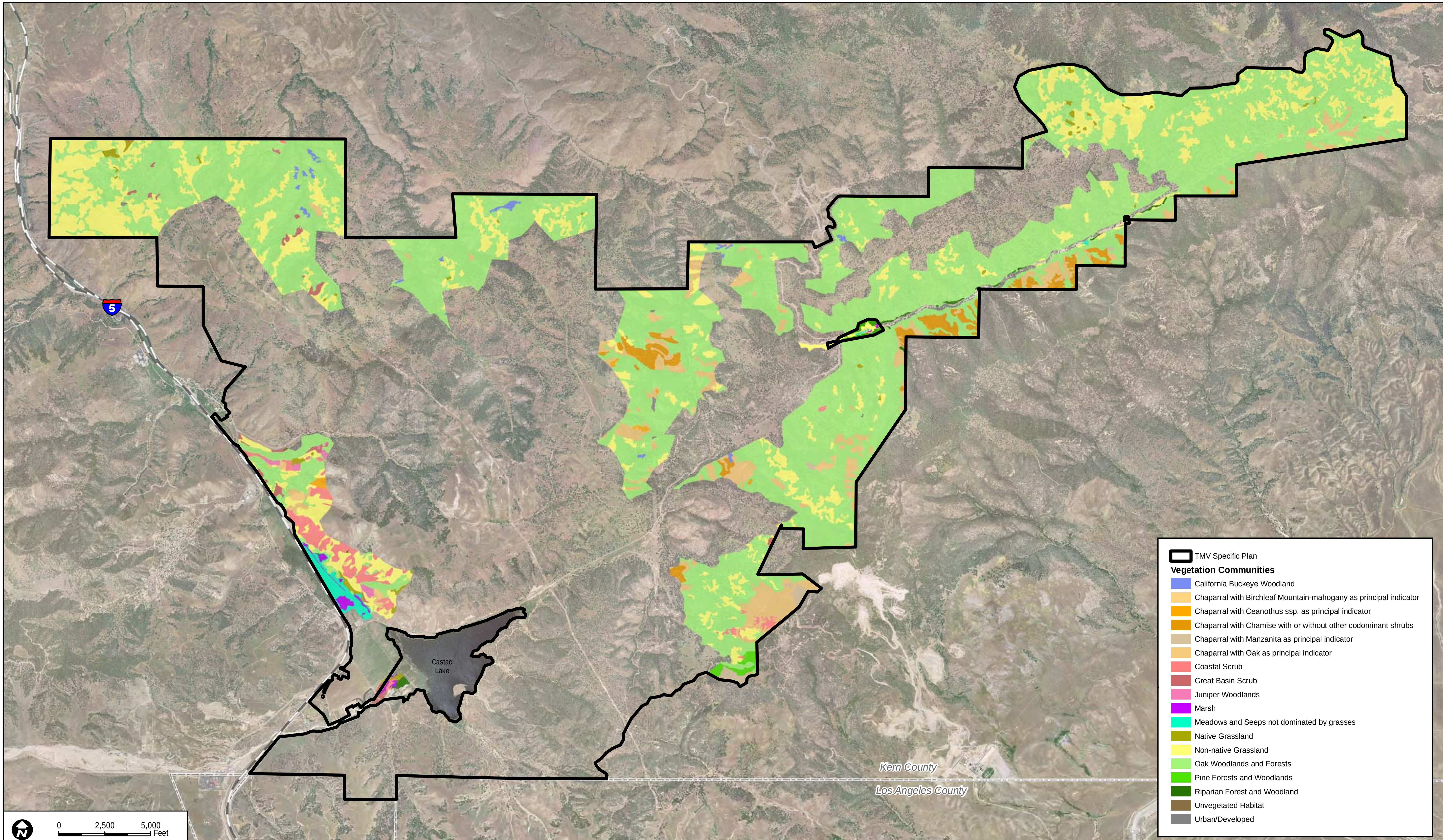
FILE: \\Prometheus\GIS-Data\317-025_Tejon\Mxd\Jurisdiction\Figures_073108\Figure6TejonLakeAdjacentWatersheds_24x36_073108.mxd



SOURCE: TRC 2007

FIGURE 2-9

Drainage Direction on Habitat Mitigation Lands



SOURCE: TRC 2007

FIGURE 3-1

Vegetation Communities on Habitat Mitigation Lands

Tejon Mountain Village - Habitat Management Plan

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
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
+ 0.02
1985
2018
SUMMER NDMI
- 0.02
1985
2018
ANNUAL PRECIPITATION
- 3.45
1985
2018
Download Data
Learn how to interpret these charts

NDMI Trend (1985-2018)

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)
1985
2018
SUMMER NDMI (average from July 9 to Sept 7)
1985
2018
ANNUAL PRECIPITATION
1985
2018
Download Data
Learn how to interpret these charts
Learn more about the downloadable data

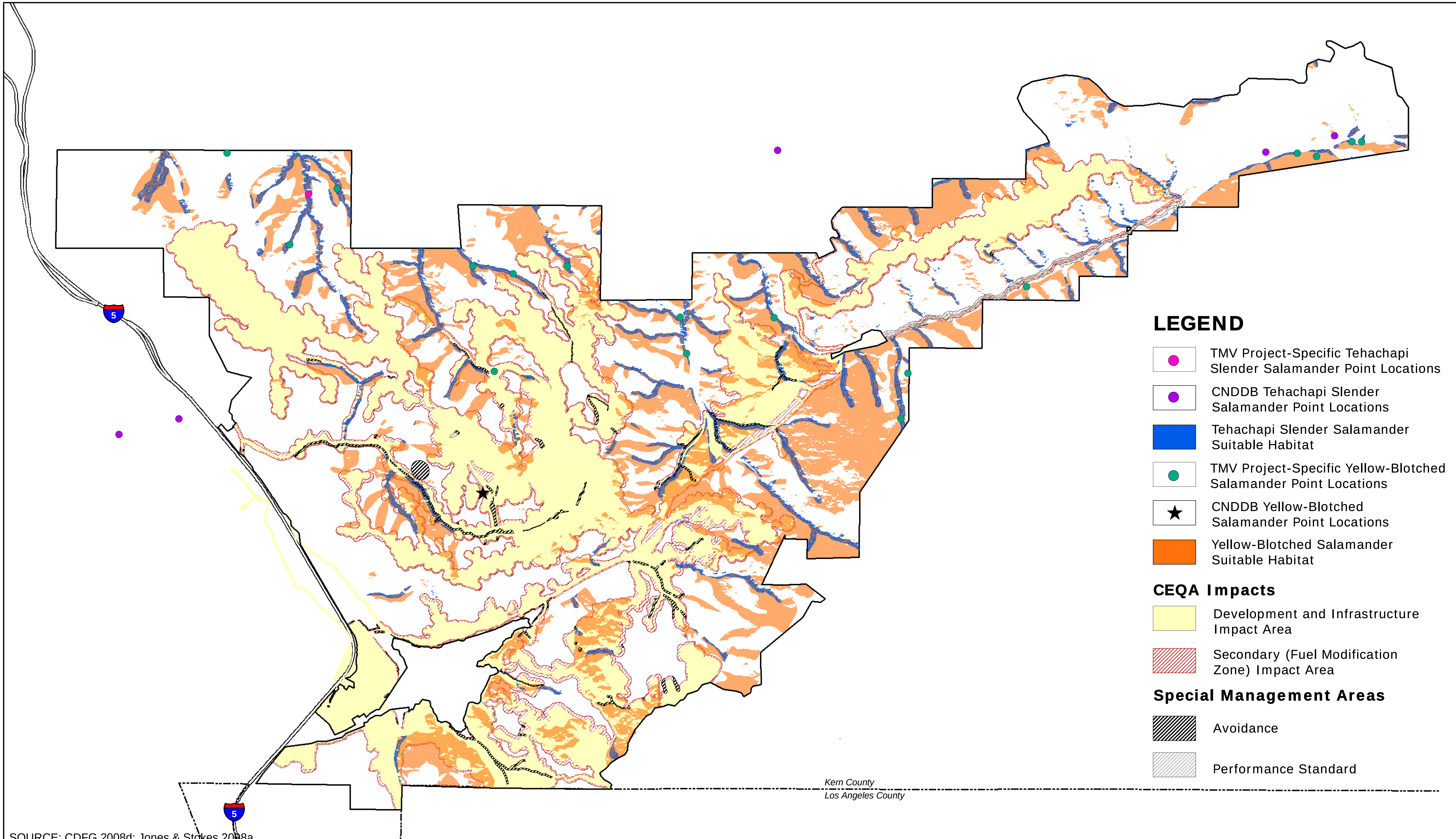
Appendix G

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

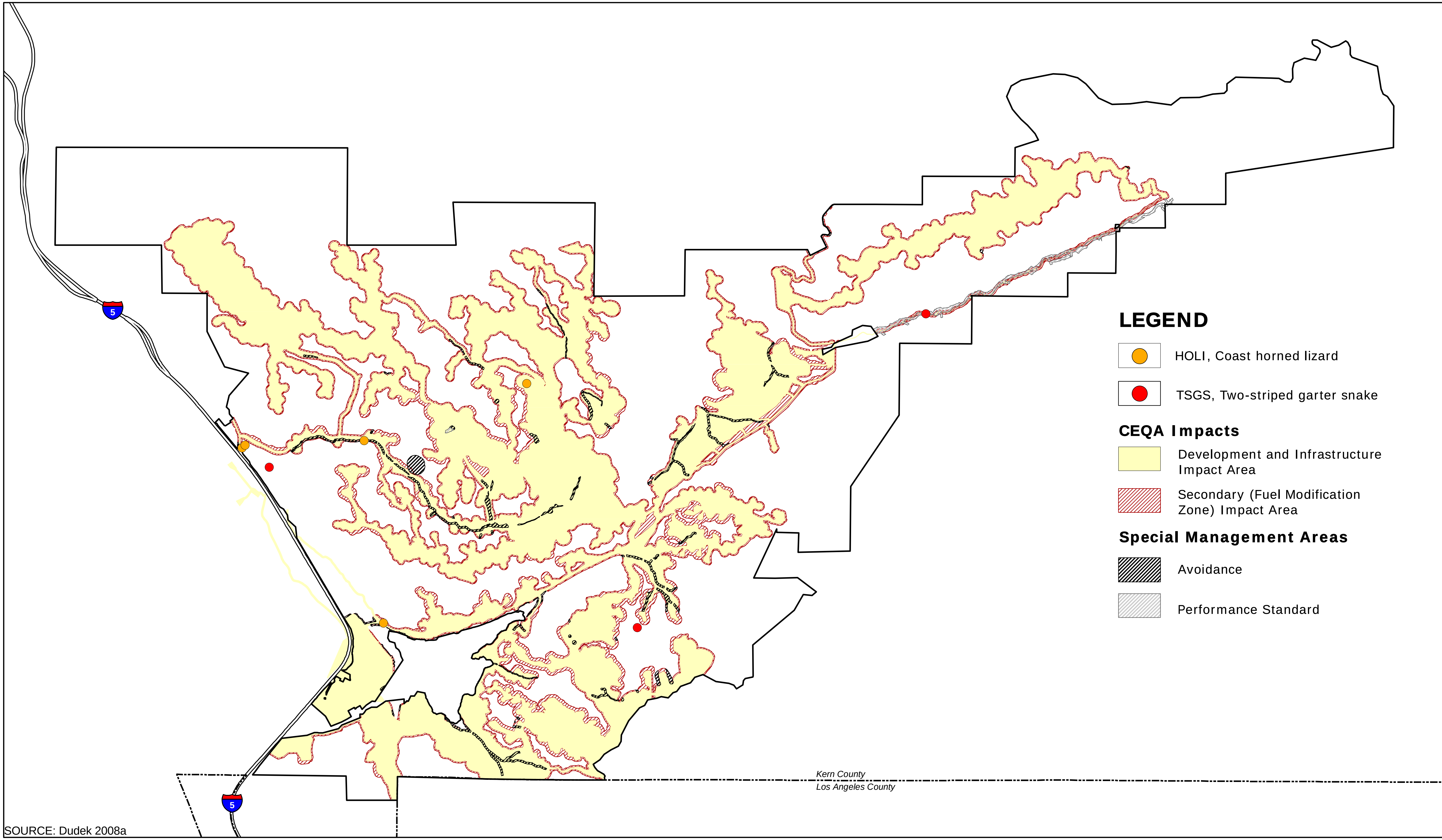


Tejon Mountain Village
EIR

Figure 4.4-8
SPECIAL STATUS SALAMANDERS

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

May 2009



Tejon Mountain Village

EIR

Figure 4.4-9

SPECIAL-STATUS REPTILES

May 2009

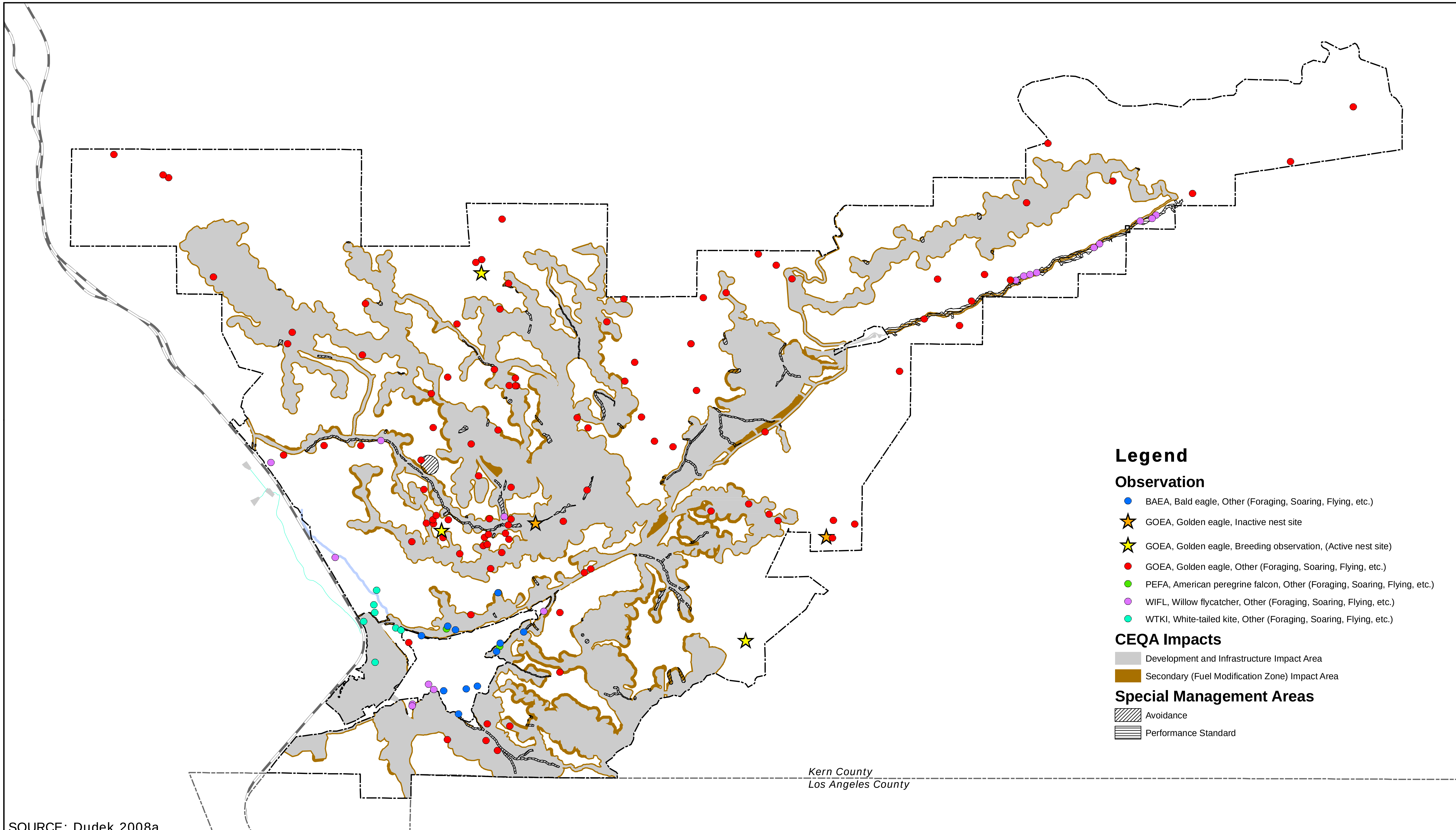


Figure 4.4-10

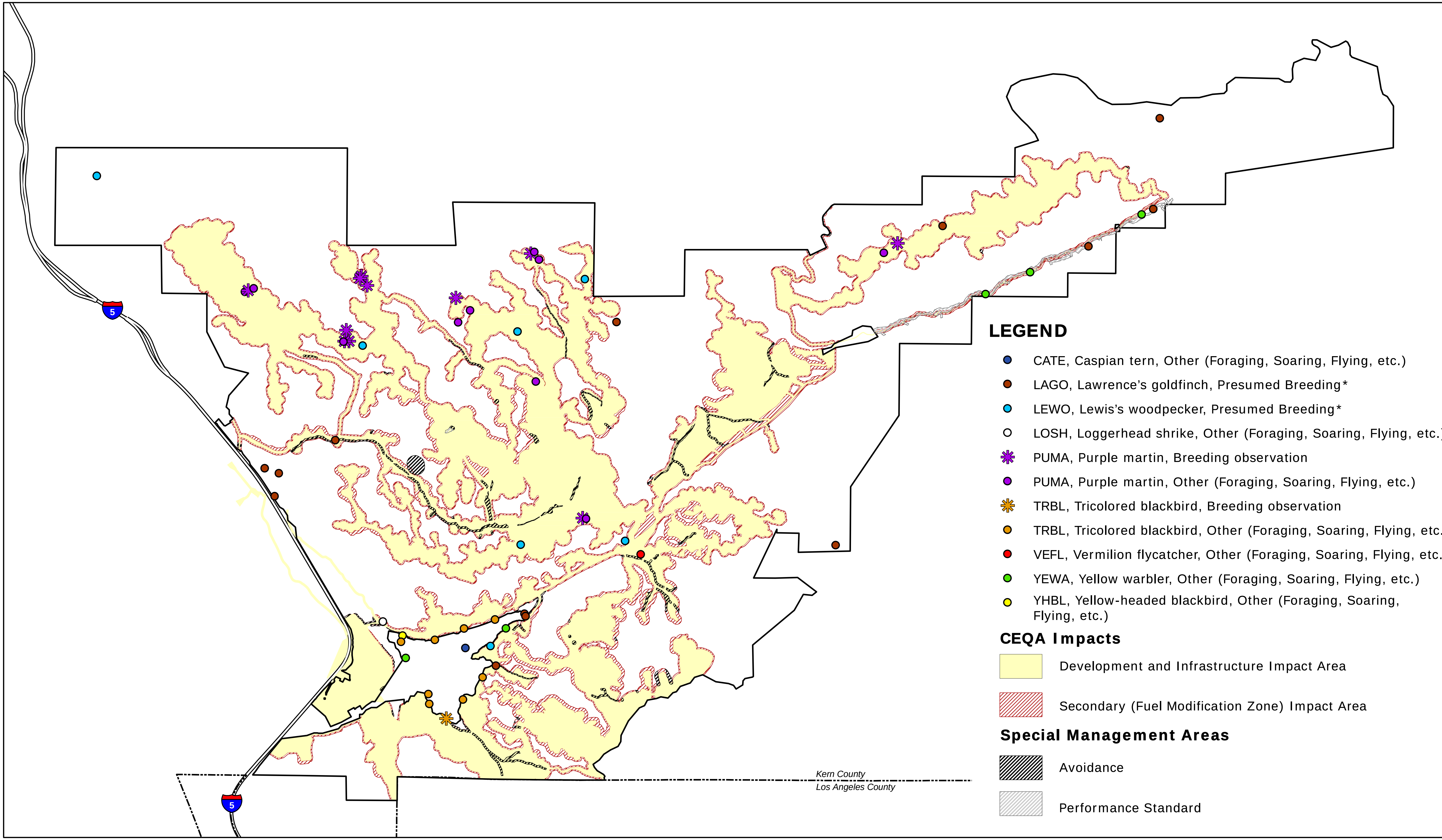
Tejon Mountain Village

EIR

FEDERALLY LISTED, STATE LISTED OR FULLY PROTECTED BIRDS

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

May 2009



Tejon Mountain Village

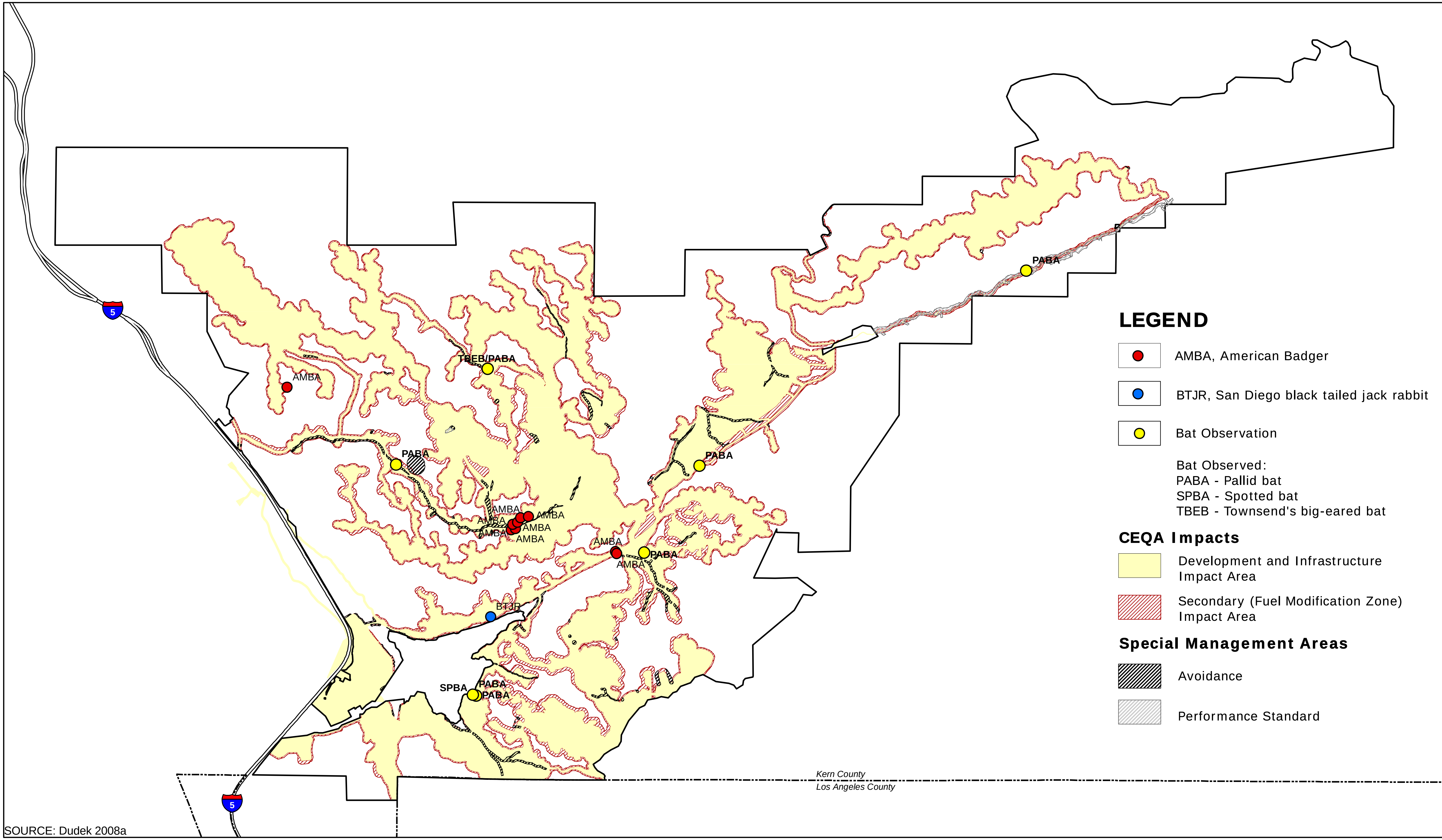
EIR

Figure 4.4-11

OTHER SPECIAL STATUS BIRDS

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

May 2009



Tejon Mountain Village
EIR

Figure 4.4-12
SPECIAL-STATUS MAMMALS

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

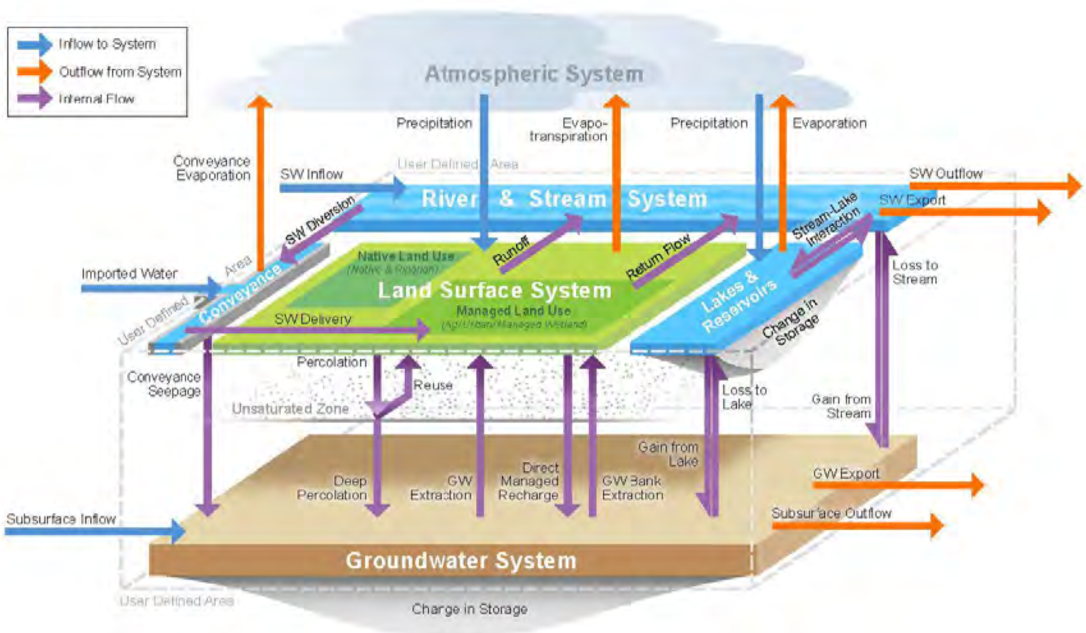
APPENDIX H
Spreadsheet Water Budget Model Overview

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 should not be directly edited 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

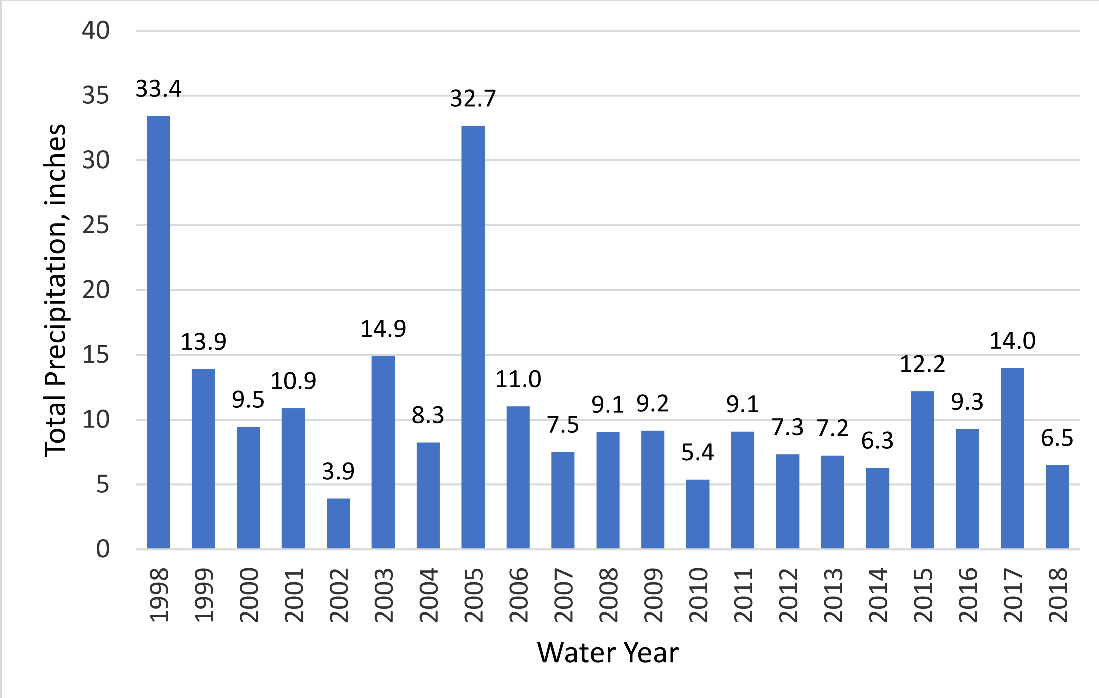
3.1 Atmospheric Domain

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

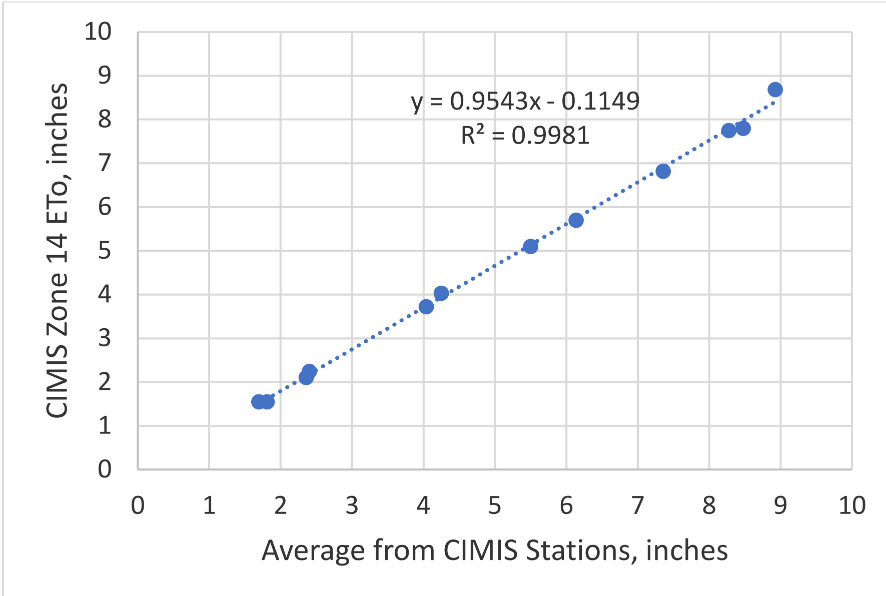


3.1.2 Reference Evapotranspiration

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

---

[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.

---

[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.

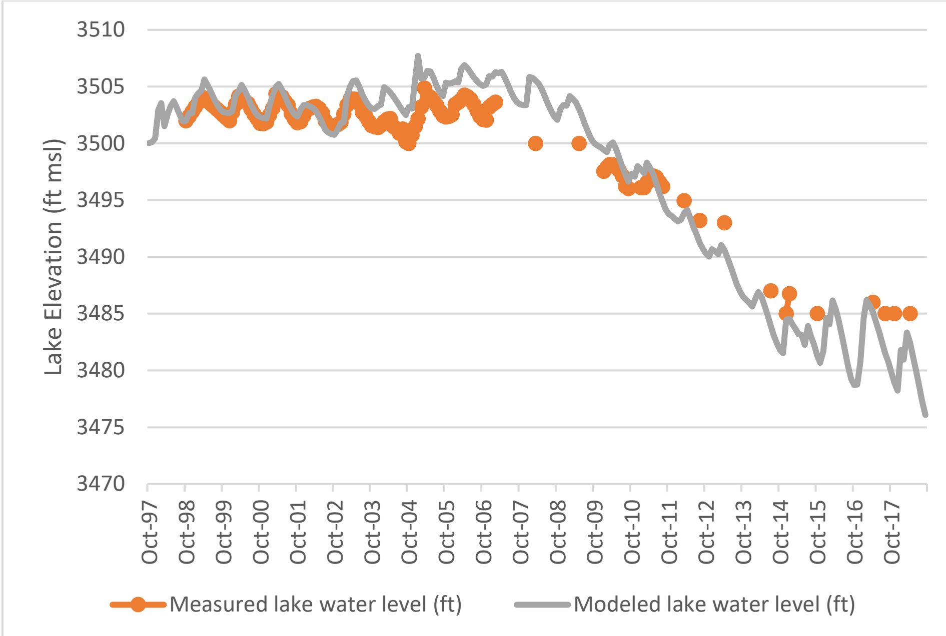
- The Grapevine Creek surface water outflow (baseflow) rate was set to be a multiple of the groundwater outflow rate, discussed below in "Groundwater Outflow". Through calibration, the surface water baseflow was estimated to be 50% of the groundwater outflow.
- The fraction of other streamflow that leaves 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.

---

[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.

---

[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.

---

[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.

---

[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.

---

[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.

---

[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

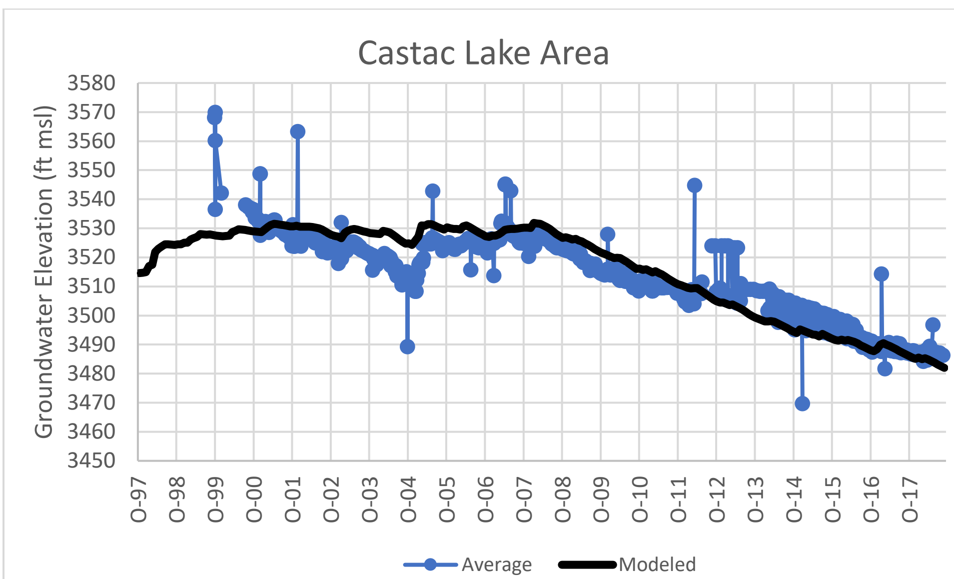


Table H-2. Average Water Level Change between Water Years 2009-2018 for the Castac Lake and Dryfield Canyon portions of the Basin

	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

---

[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

[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. Groundwater Inflows and Outflows

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%

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

<u>Notes:</u>
[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%.

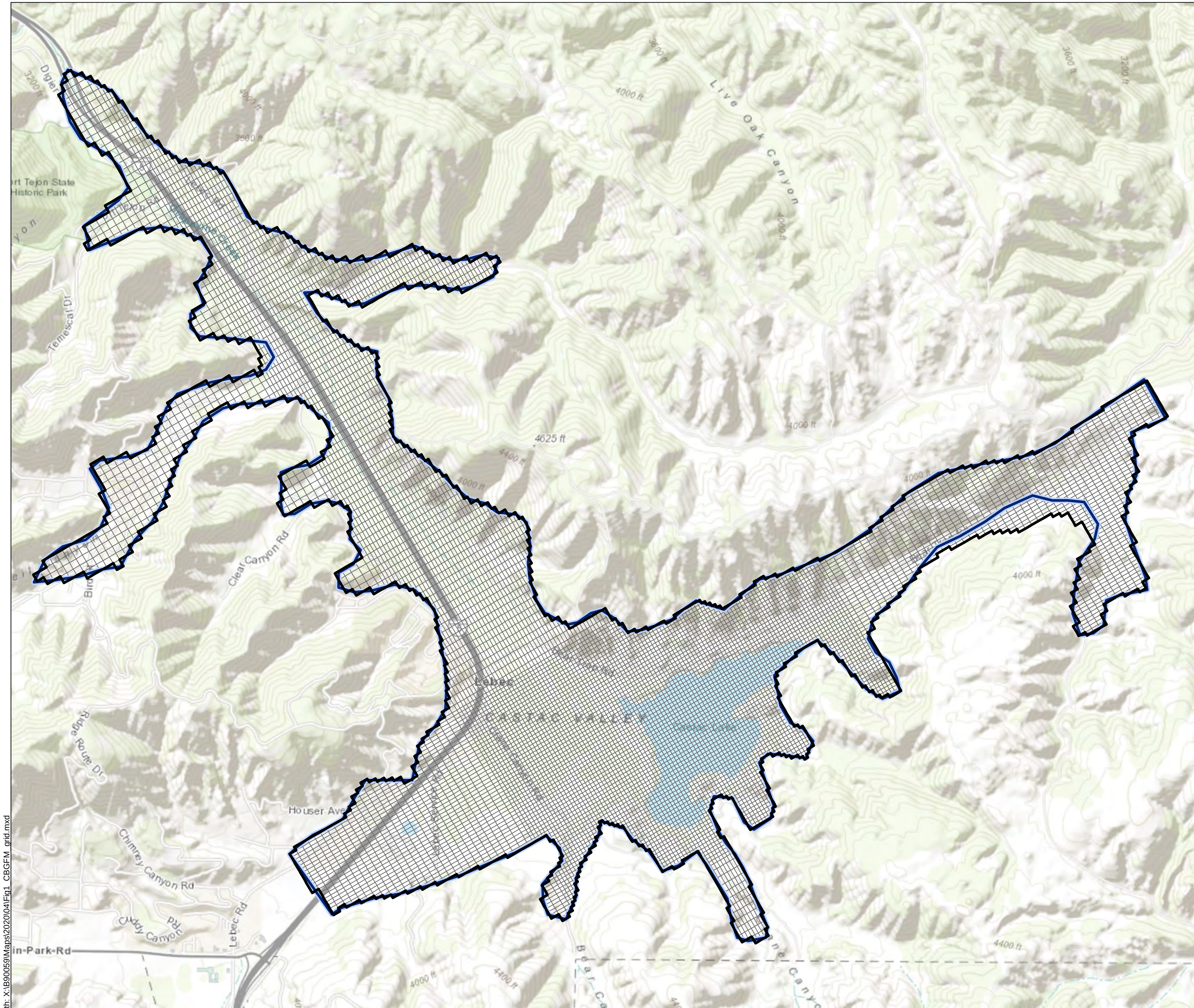
5.3. Model Limitations and Suggested Future Refinements

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.

N

0 0.5 1

(Scale in Miles)

DRAFT

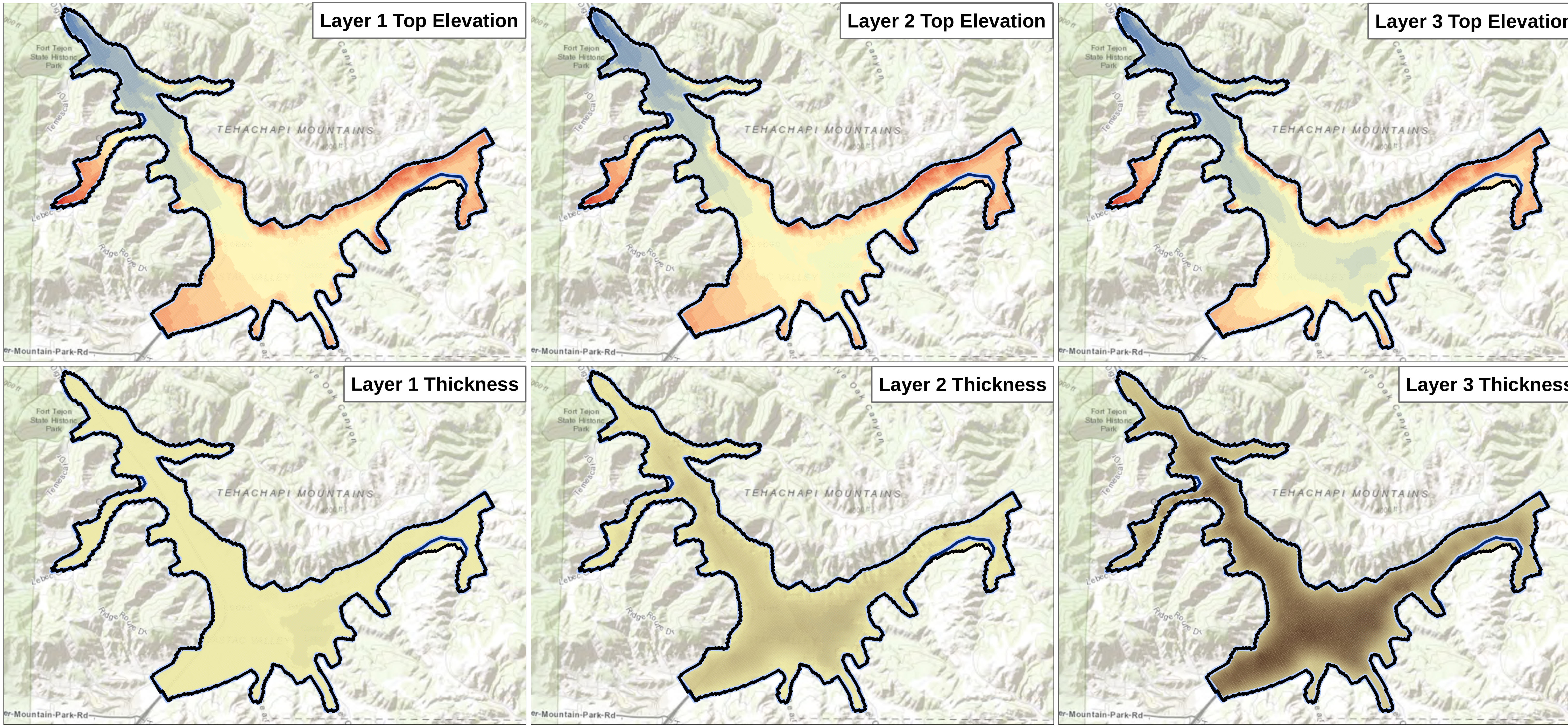
Active CBGFM Grid

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

eki environment & water

Figure 1

Path: X:\B90059\Maps\2020\04\Fig1_CBGFM_grid.mxd



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

Path: X:\B90059\Maps\2020\04\Fig2_CBGFM_elev_thk.mxd

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.

N

0 1 2

(Scale in Miles)

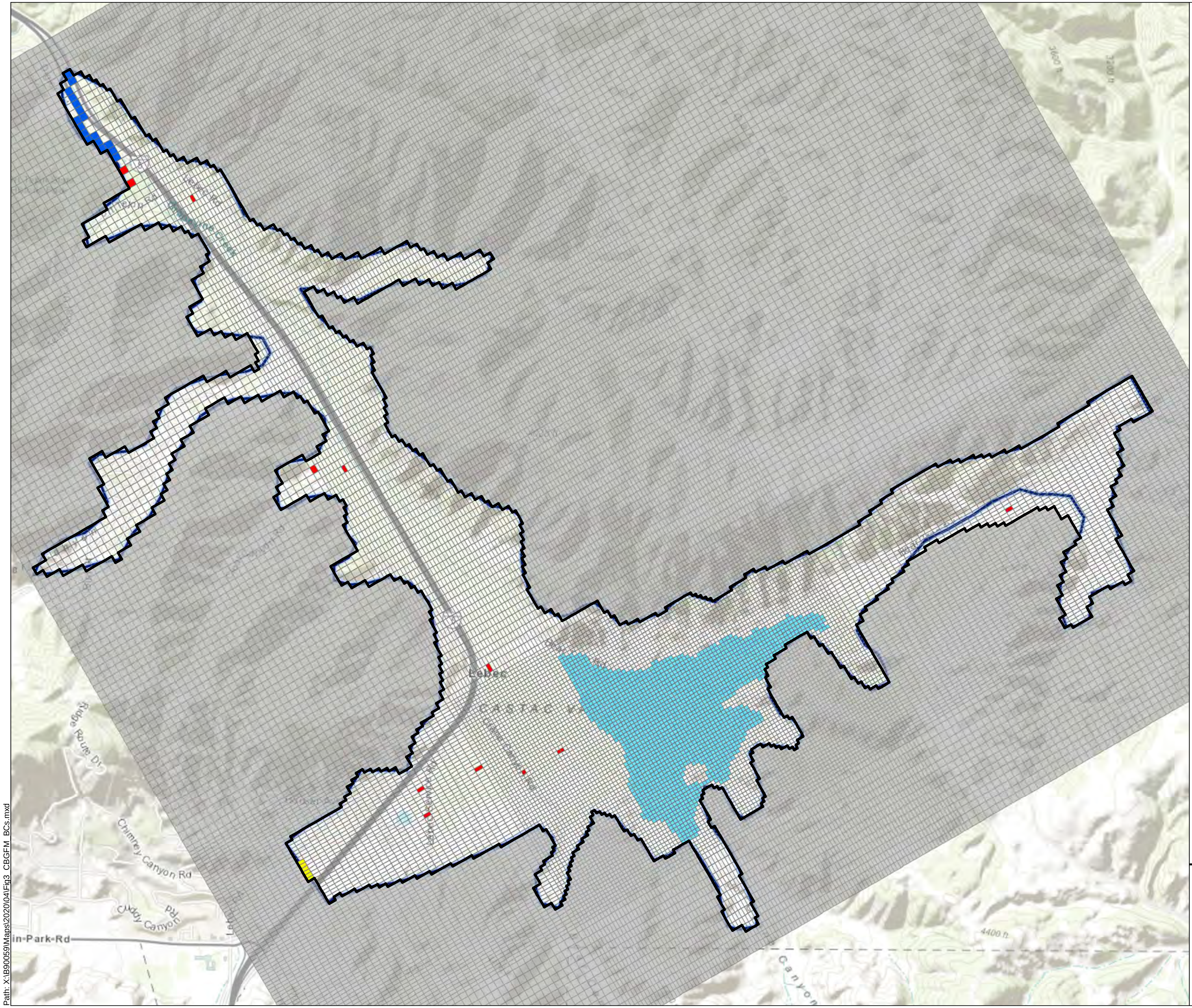
DRAFT

CBGFM Layer Elevations and Thicknesses

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

eki environment & water

Figure 2



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.

N

0 0.5 1
(Scale in Miles)

DRAFT

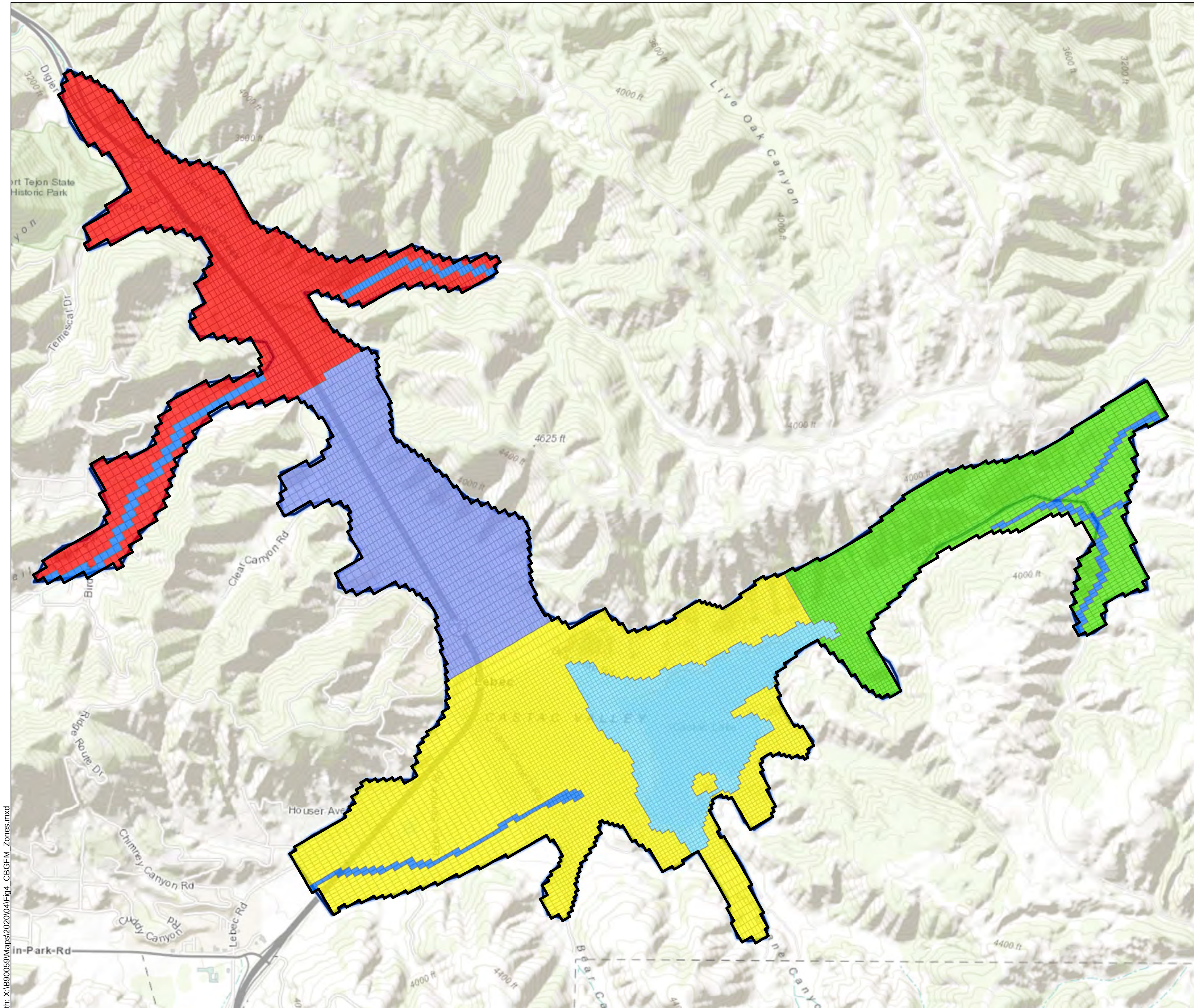
CBGFM Boundary Conditions

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

eki environment & water

Figure 3

Path: X:\B90059\Maps\2020\04\Fig3_CBGFM_BCs.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

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

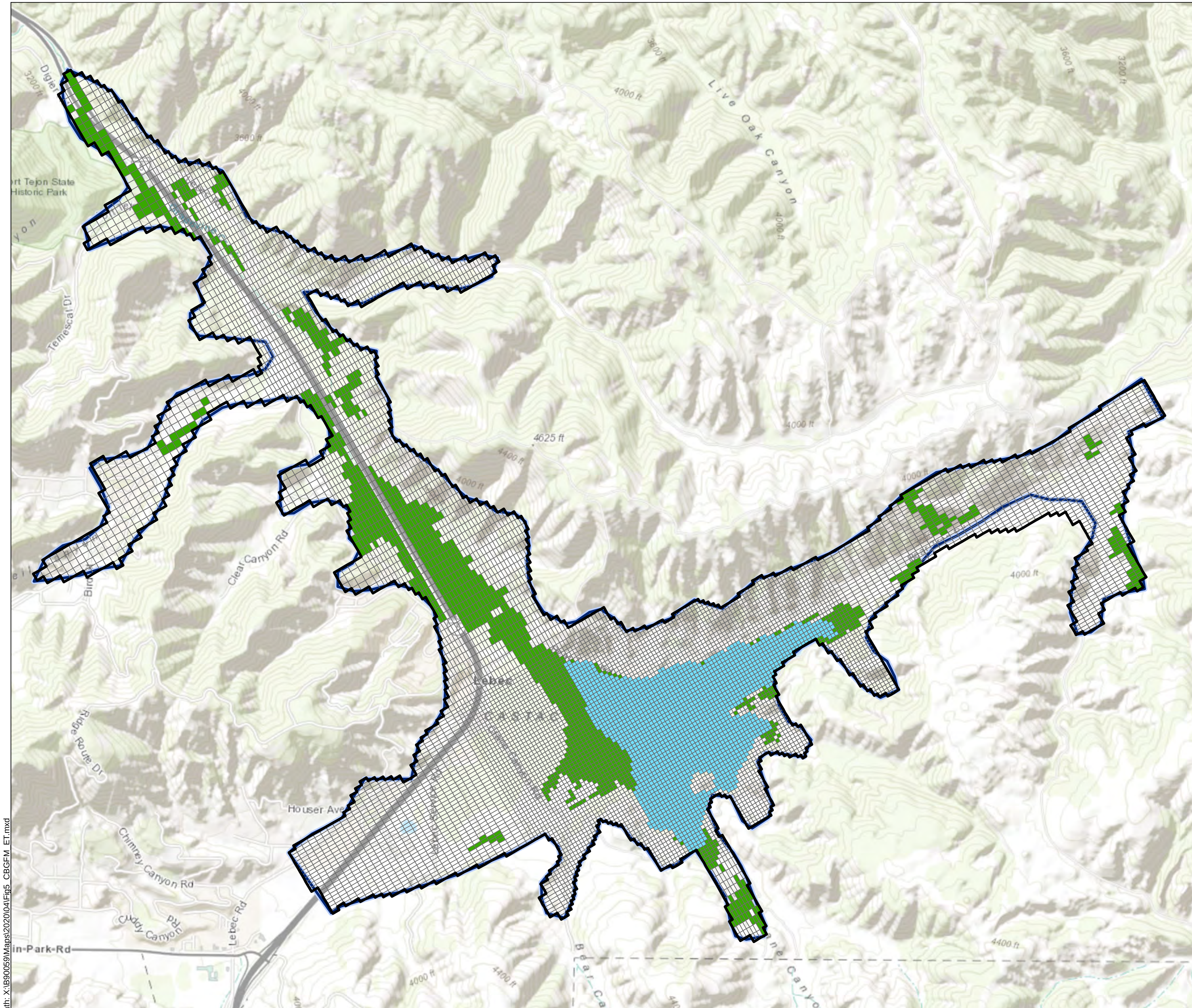
CBGFM Physiographic Zones

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

eki environment & water

Figure 4

Path: X:\B90059\Maps\2020\04\Fig4_CBGFM_Zones.mxd



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

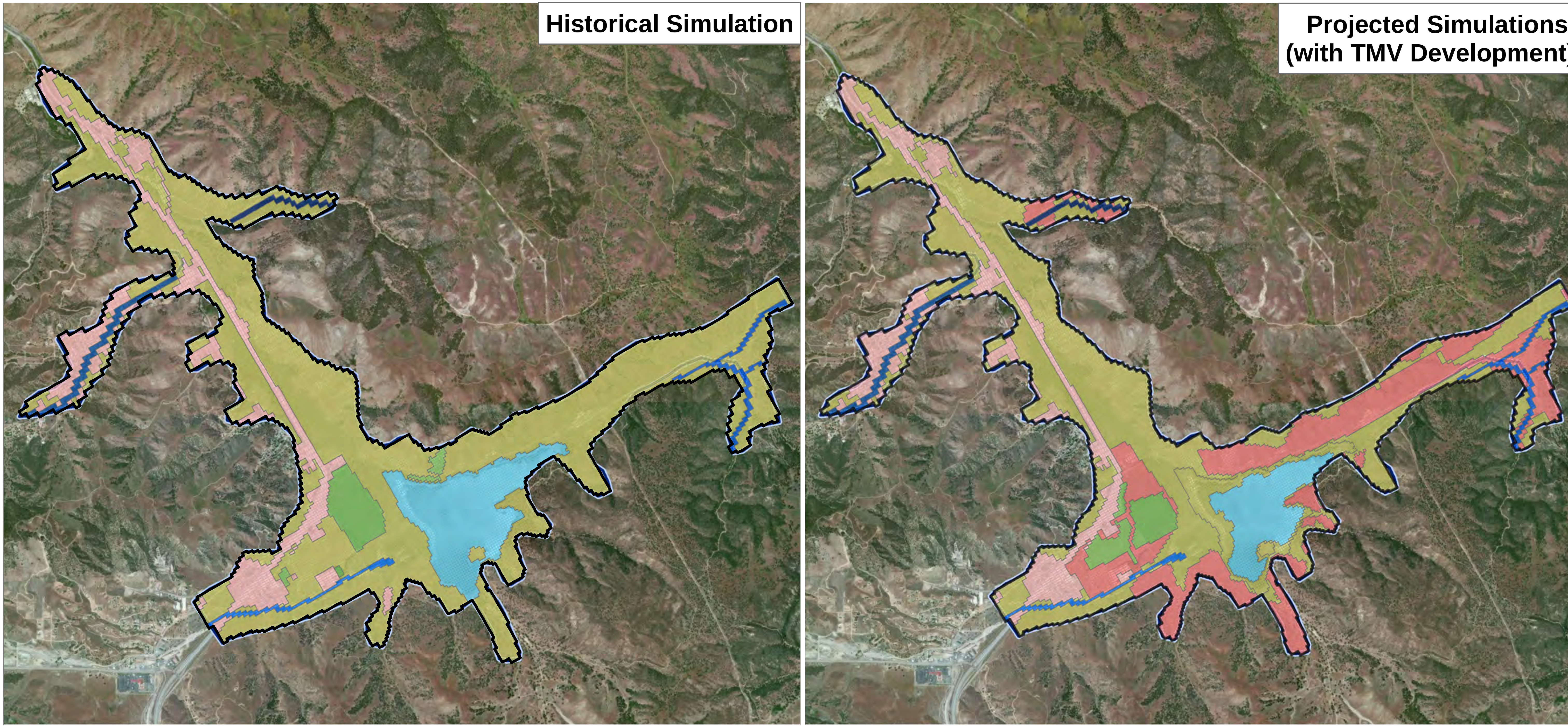
CBGFM Evapotranspiration Cells

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

eki environment & water

Figure 5

Path: X:\B90059\Maps\2020\04\Fig5_CBGFM_ET.mxd



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)

DRAFT

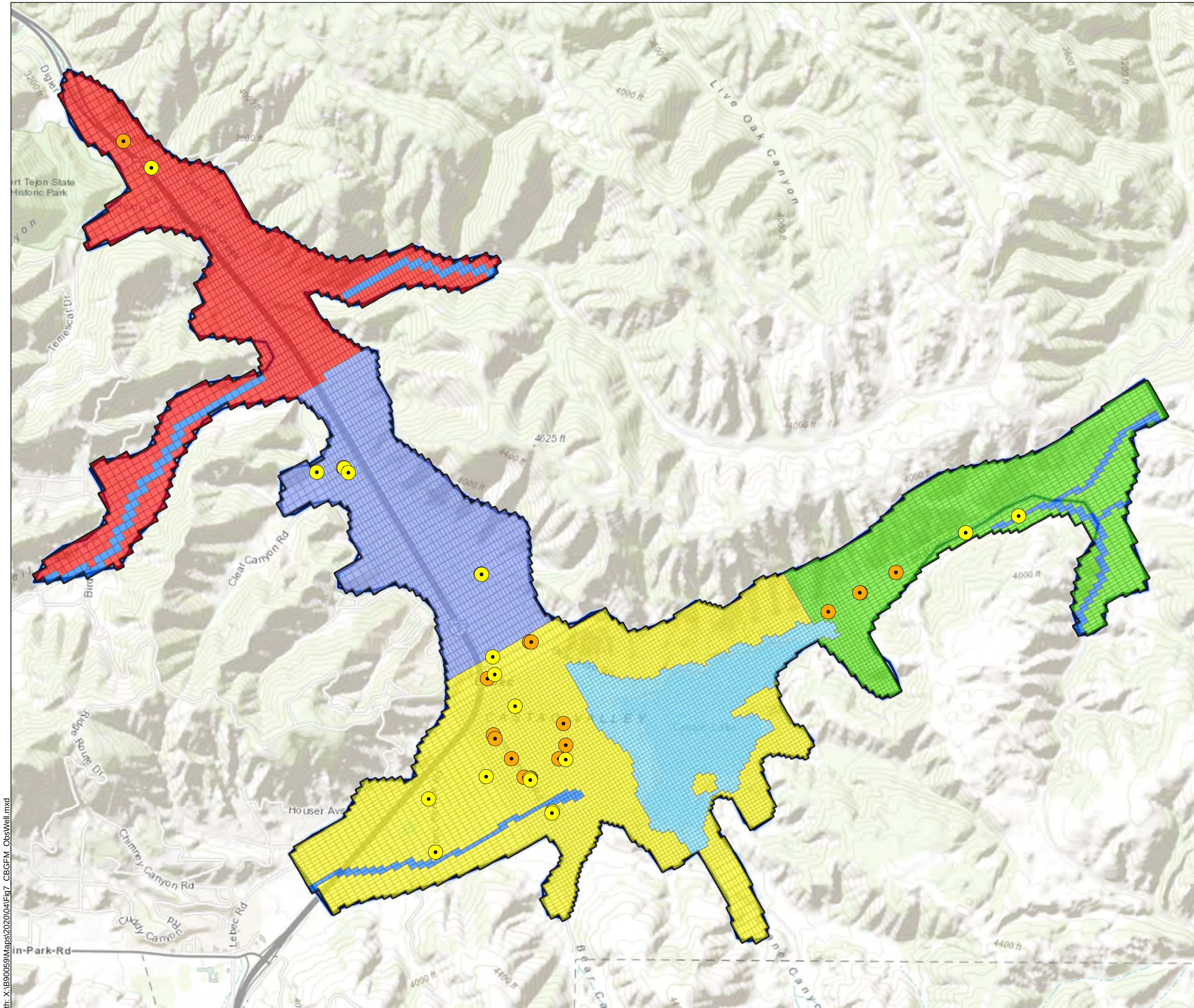
CBGFM Land Use and Recharge Areas

eki environment & water

Tejon-Castac Water District
April 2020
B90059.00

Figure 6

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



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

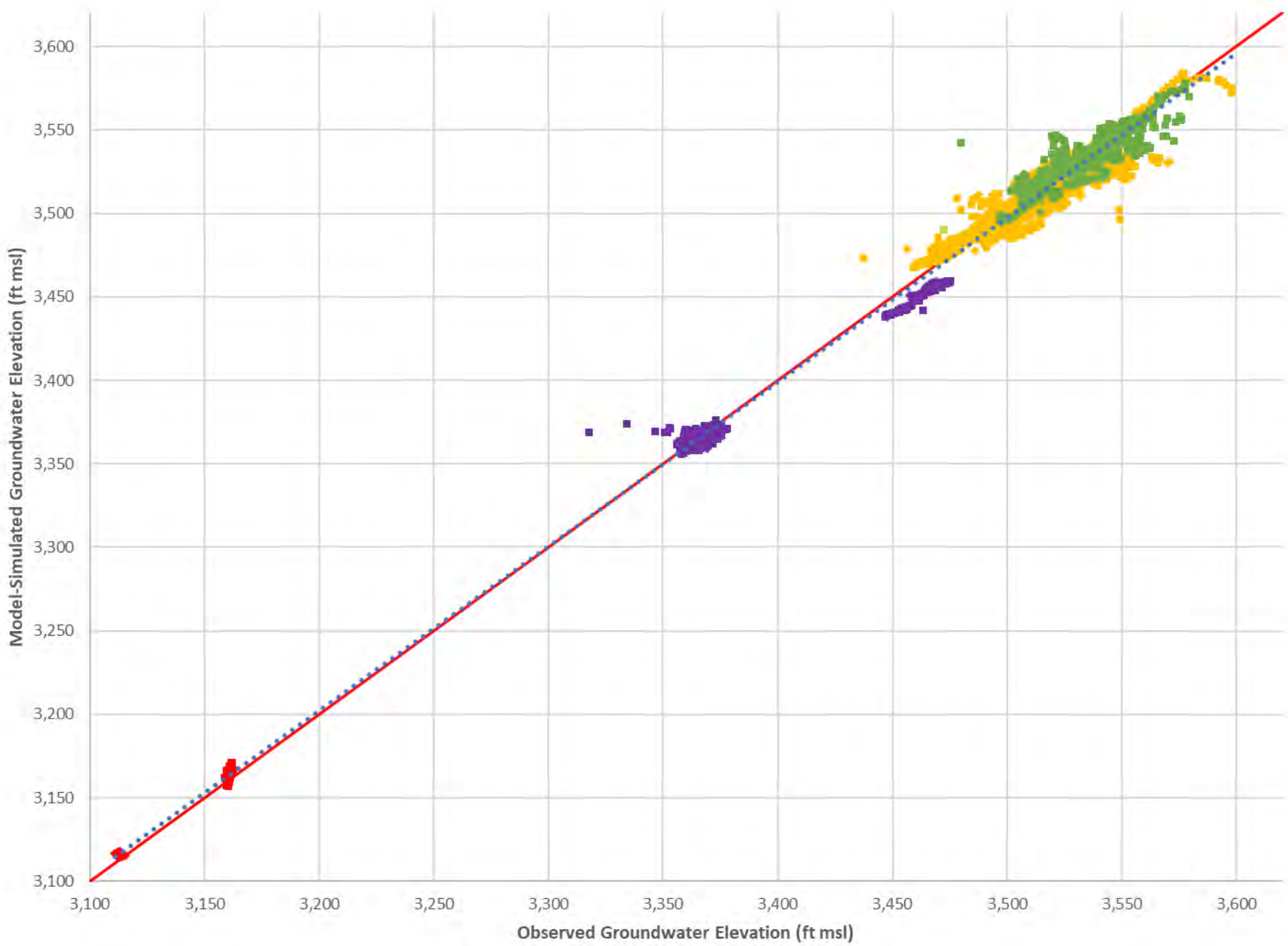
April 2020

B90059.00

eki environment & water

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

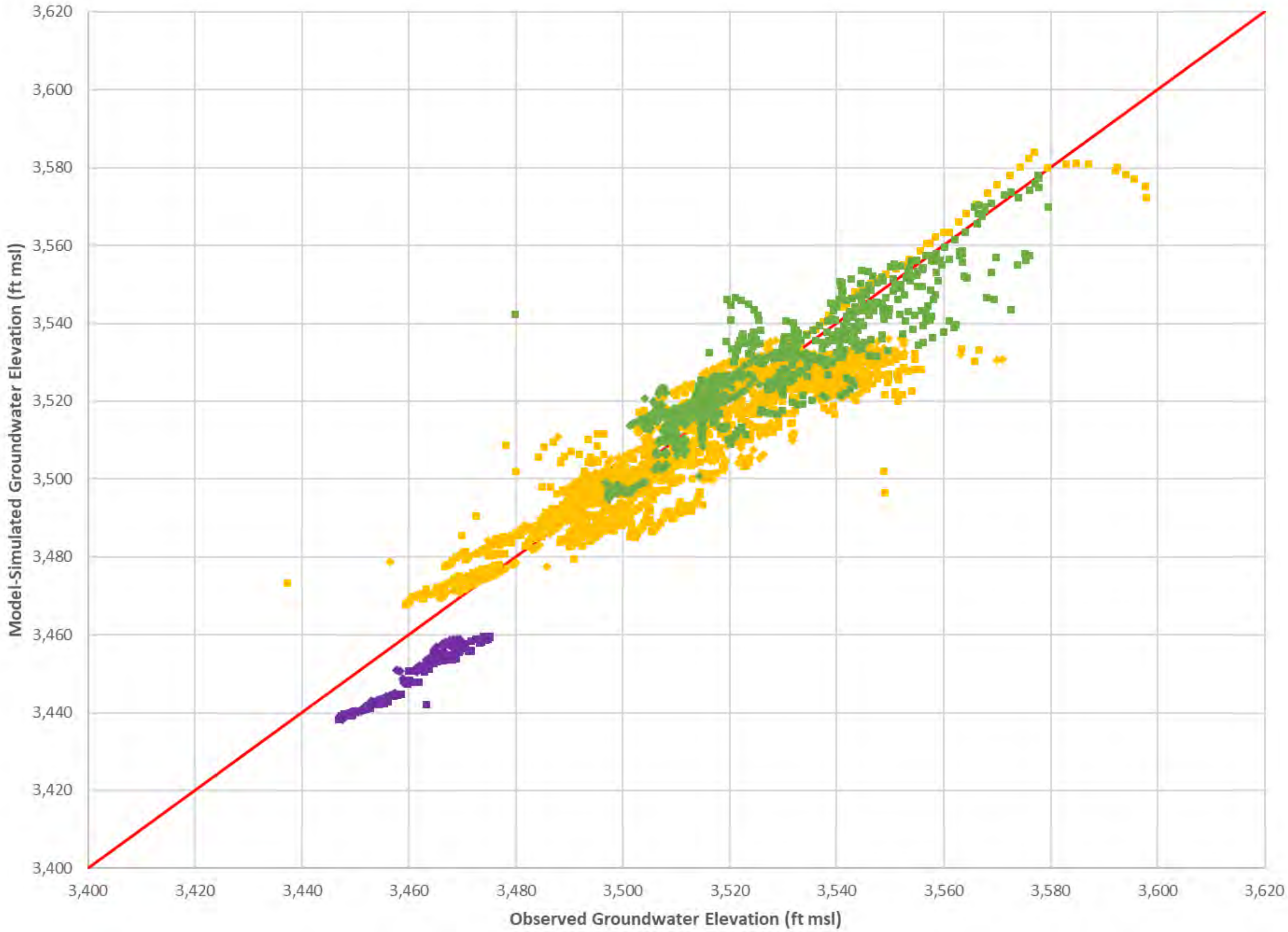
1. Model-simulated groundwater elevations are from the calibrated historical CBGFM.
2. Model-simulated groundwater elevations with zero residual will fall on the 1:1 line.

eki environment & water

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

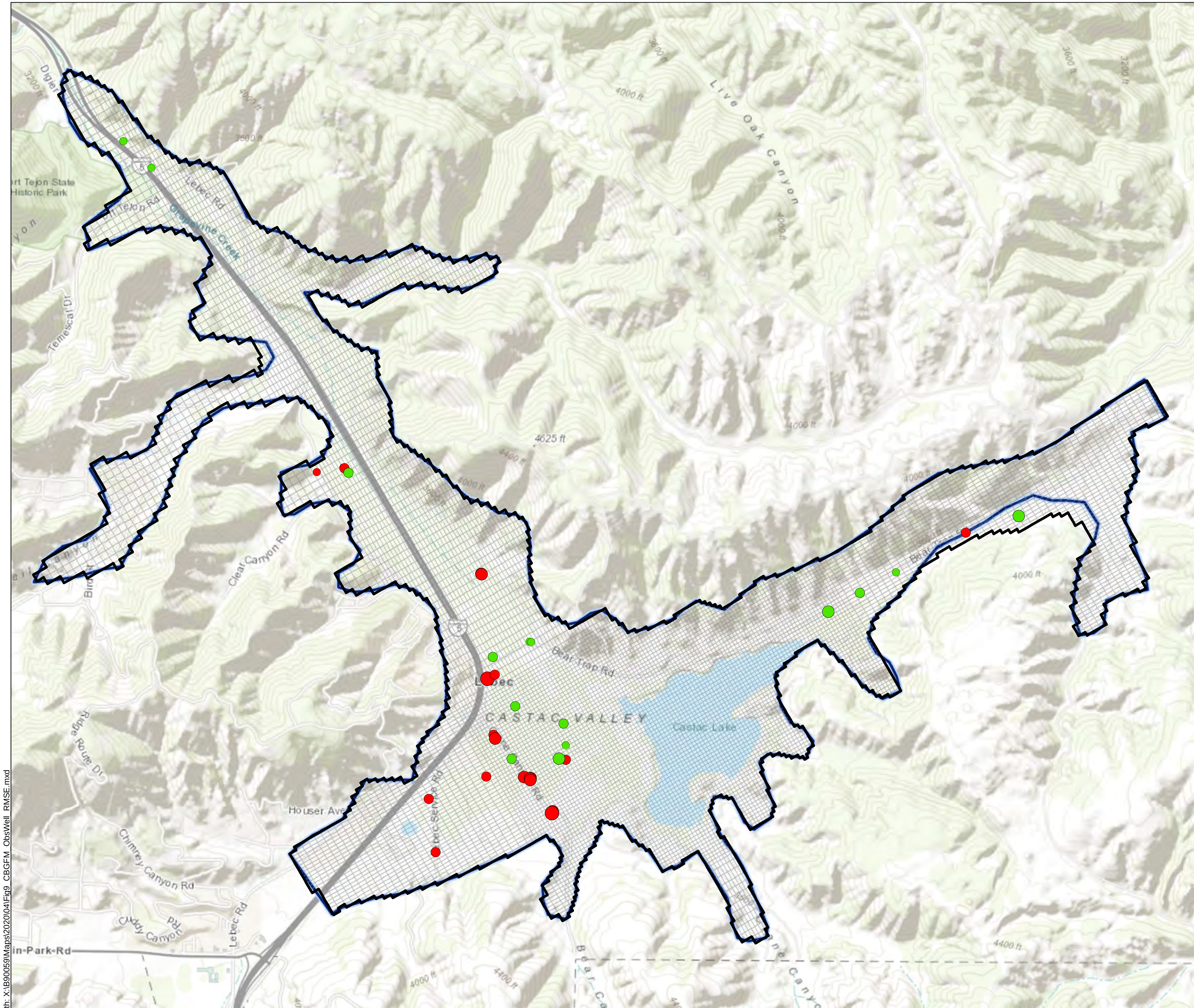
1. Model-simulated groundwater elevations are from the calibrated historical CBGFM.
2. Model-simulated groundwater elevations with zero residual will fall on the 1:1 line.

eki environment & water

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

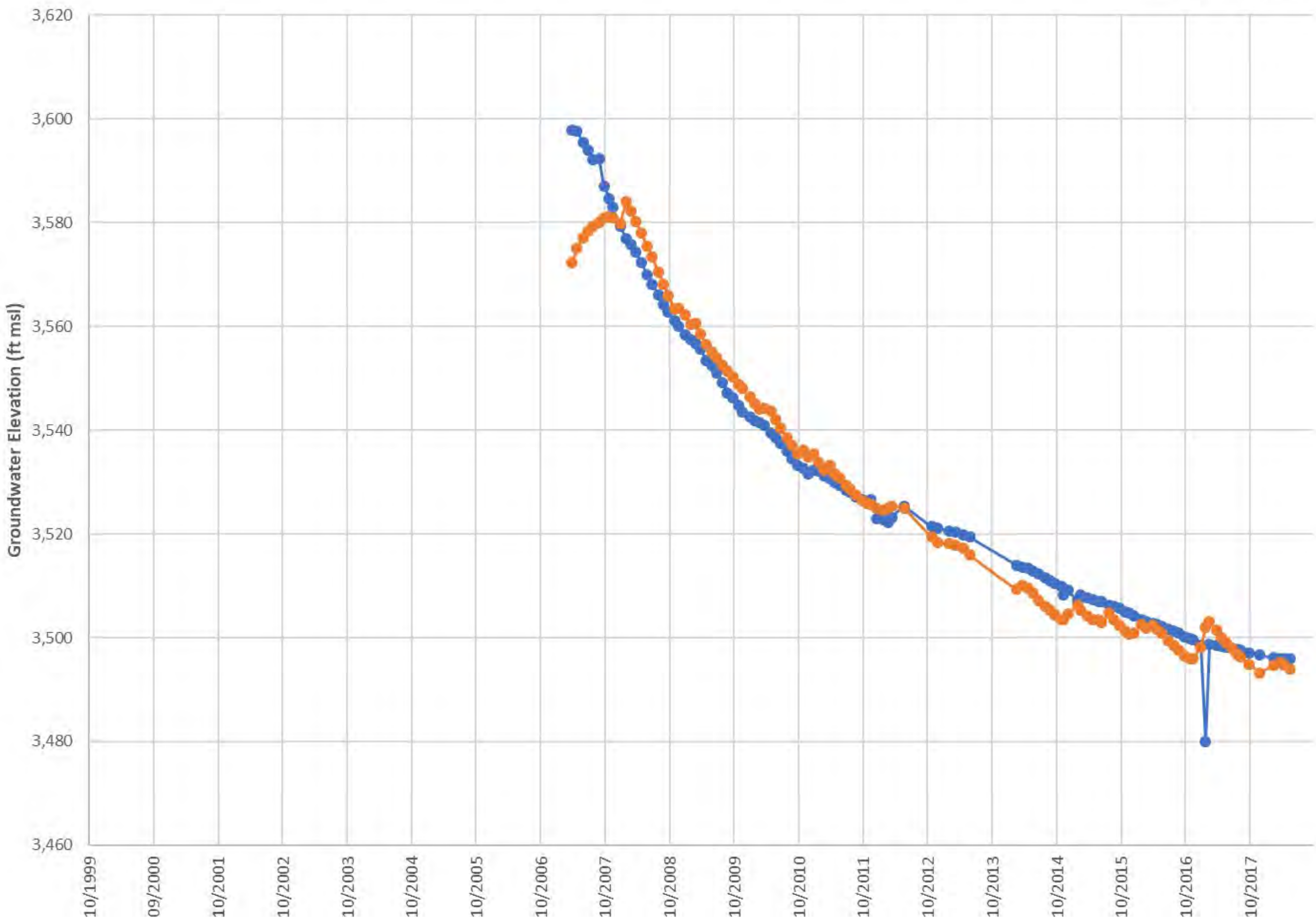
April 2020

B90059.00

Figure 9

eki environment & water

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

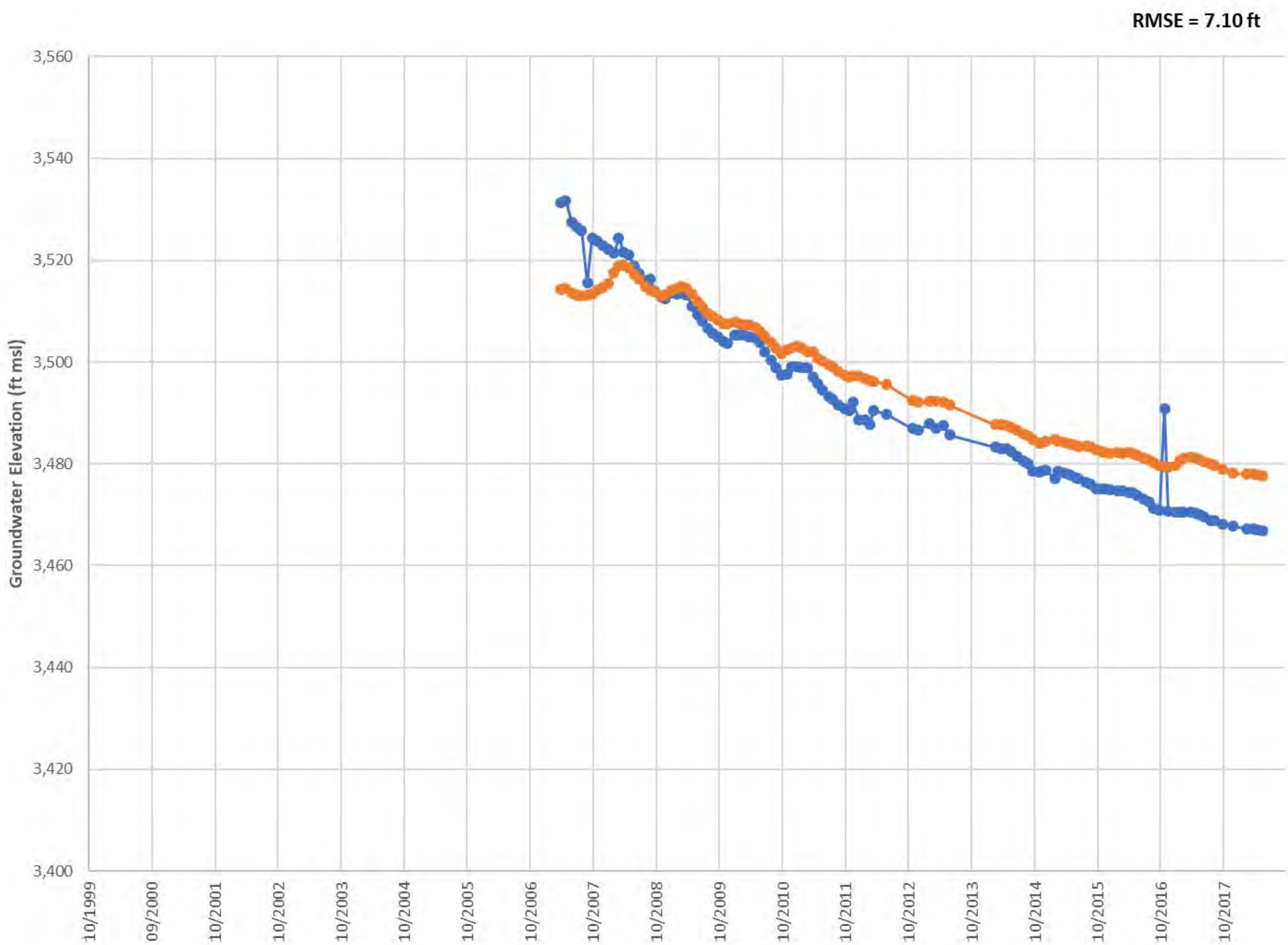
1. Model-simulated groundwater elevations are from the calibrated historical CBGFM.
2. RMSE is a quantitative measure of the closeness of fit, and is calculated as the square root of the average squared residuals between observed and model-simulated groundwater elevations.

eki environment & water

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

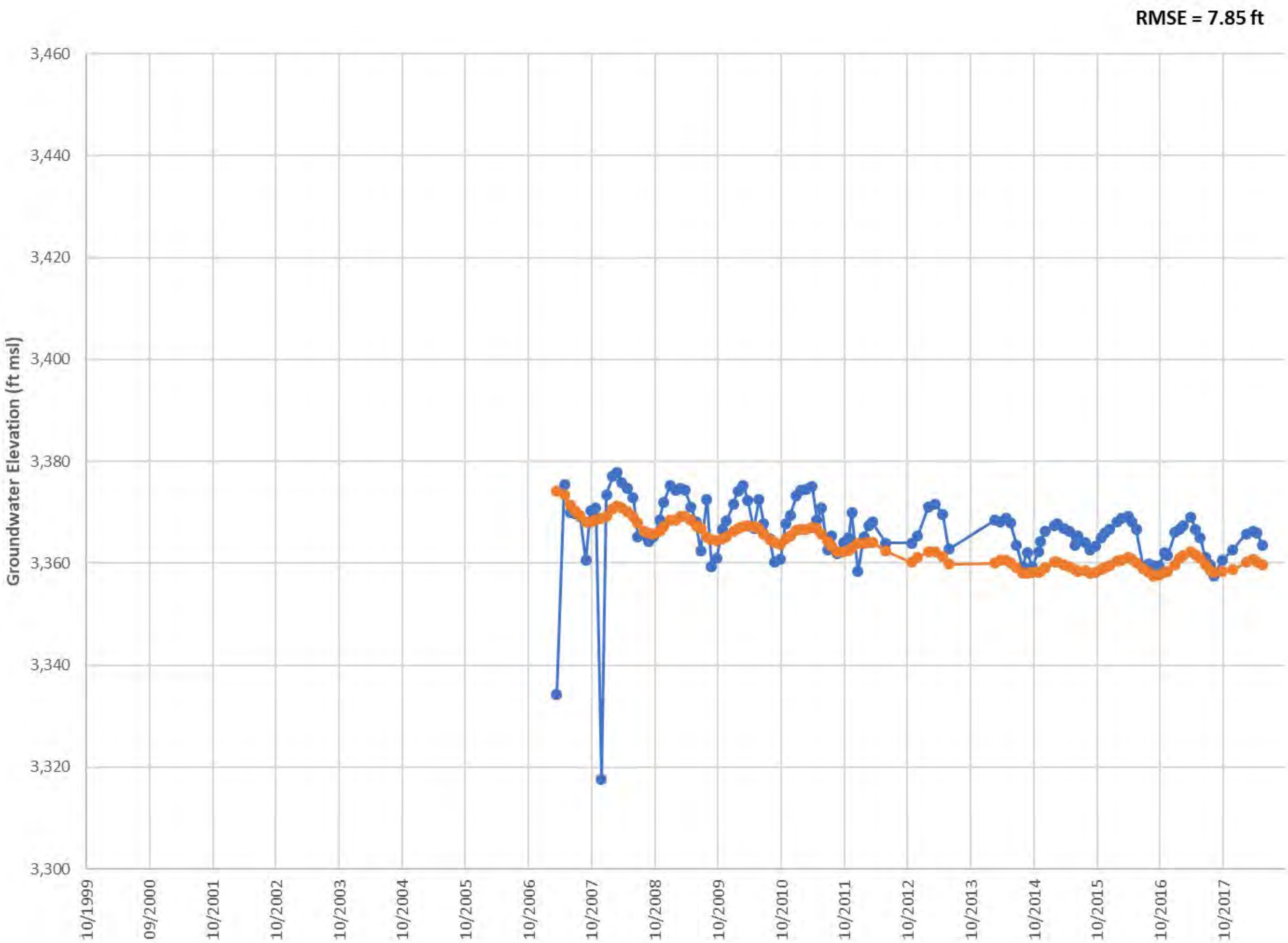
1. Model-simulated groundwater elevations are from the calibrated historical CBGFM.
2. RMSE is a quantitative measure of the closeness of fit, and is calculated as the square root of the average squared residuals between observed and model-simulated groundwater elevations.

eki environment & water

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

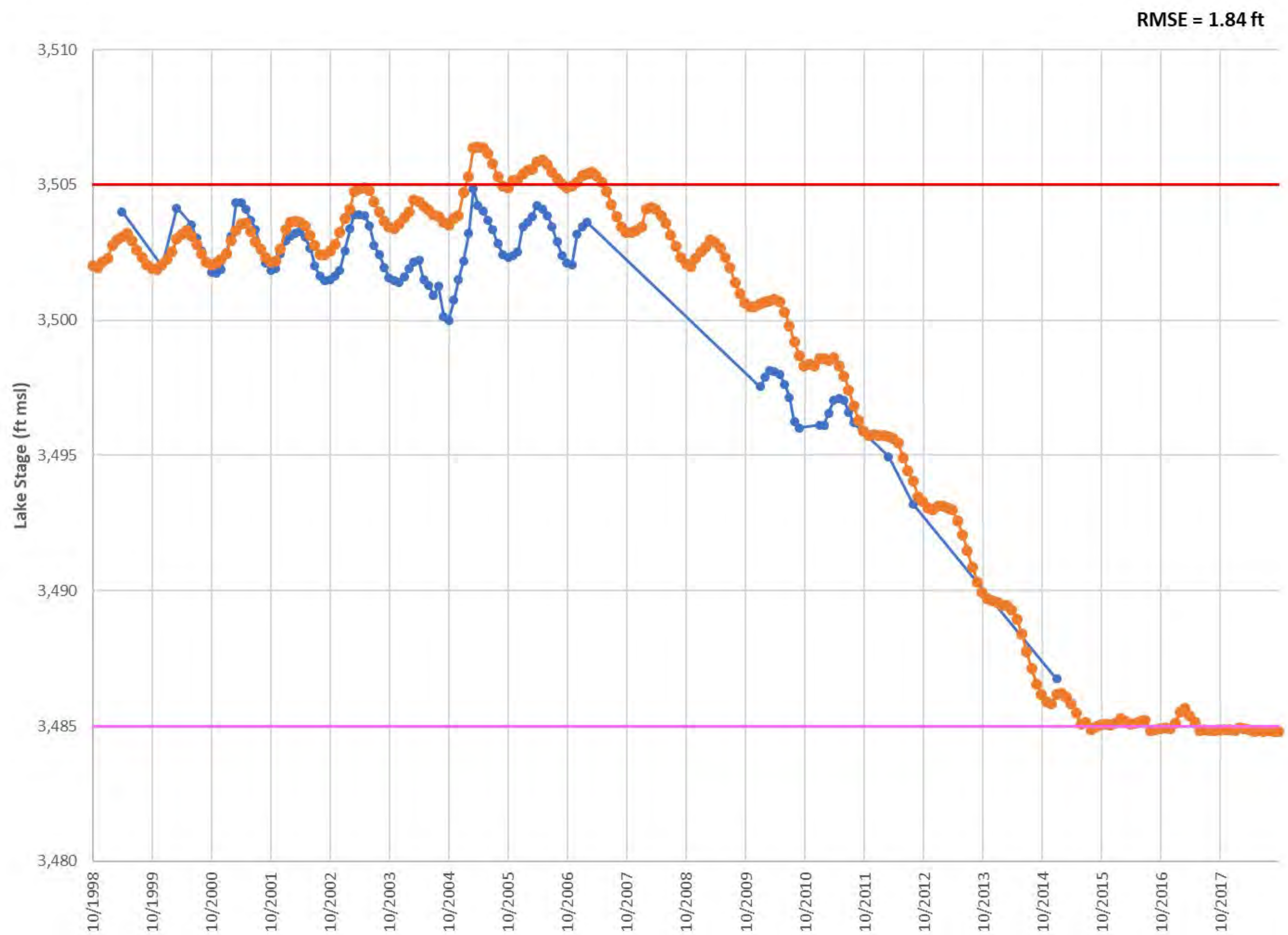
1. Model-simulated groundwater elevations are from the calibrated historical CBGFM.
2. RMSE is a quantitative measure of the closeness of fit, and is calculated as the square root of the average squared residuals between observed and model-simulated groundwater elevations.

eki environment & water

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

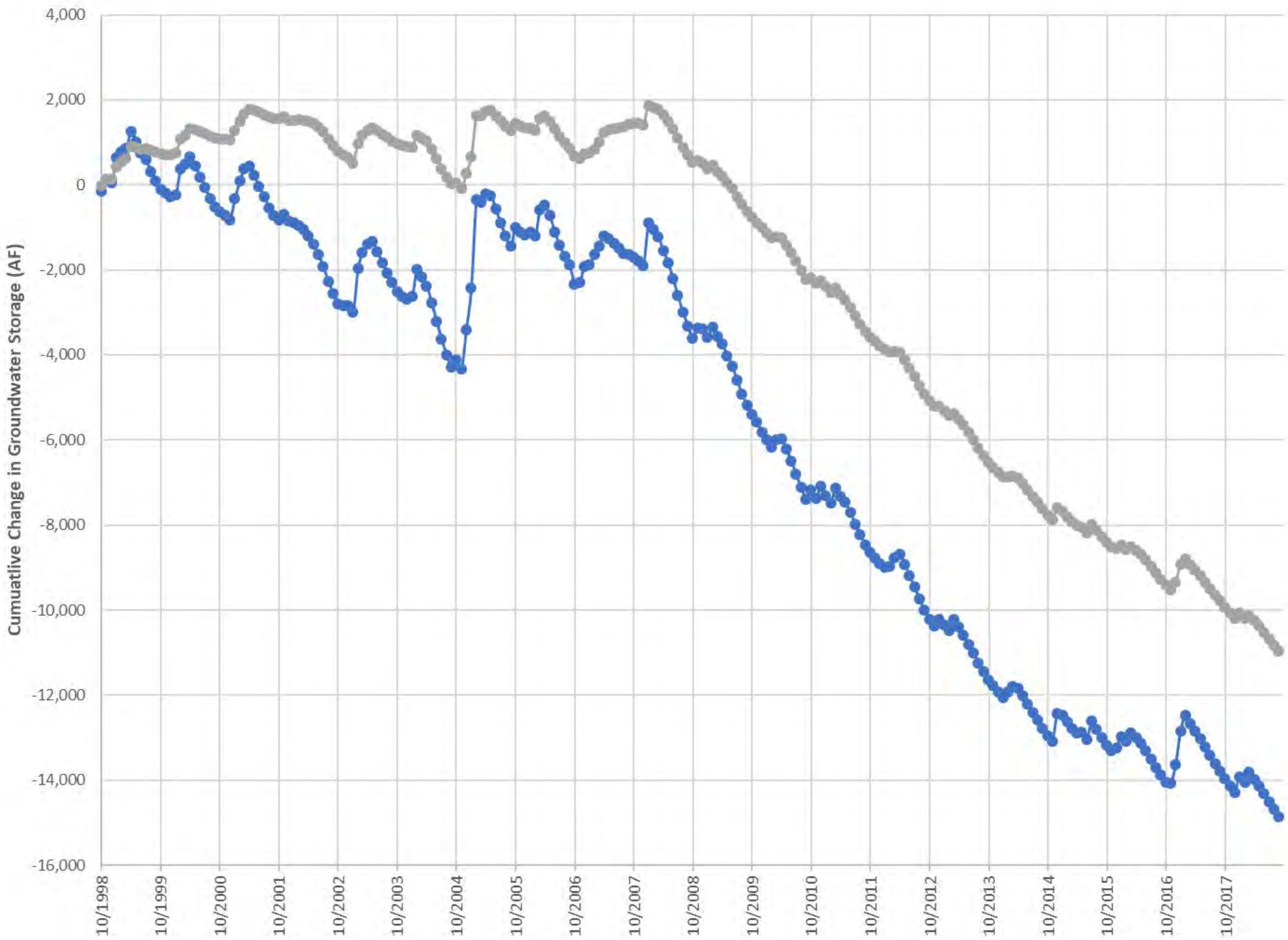
1. Model-simulated Castac Lake stages are from the calibrated historical CBGFM.
2. RMSE is a quantitative measure of the closeness of fit, and is calculated as the square root of the average squared residuals between observed and model-simulated lake stages.

eki environment & water

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

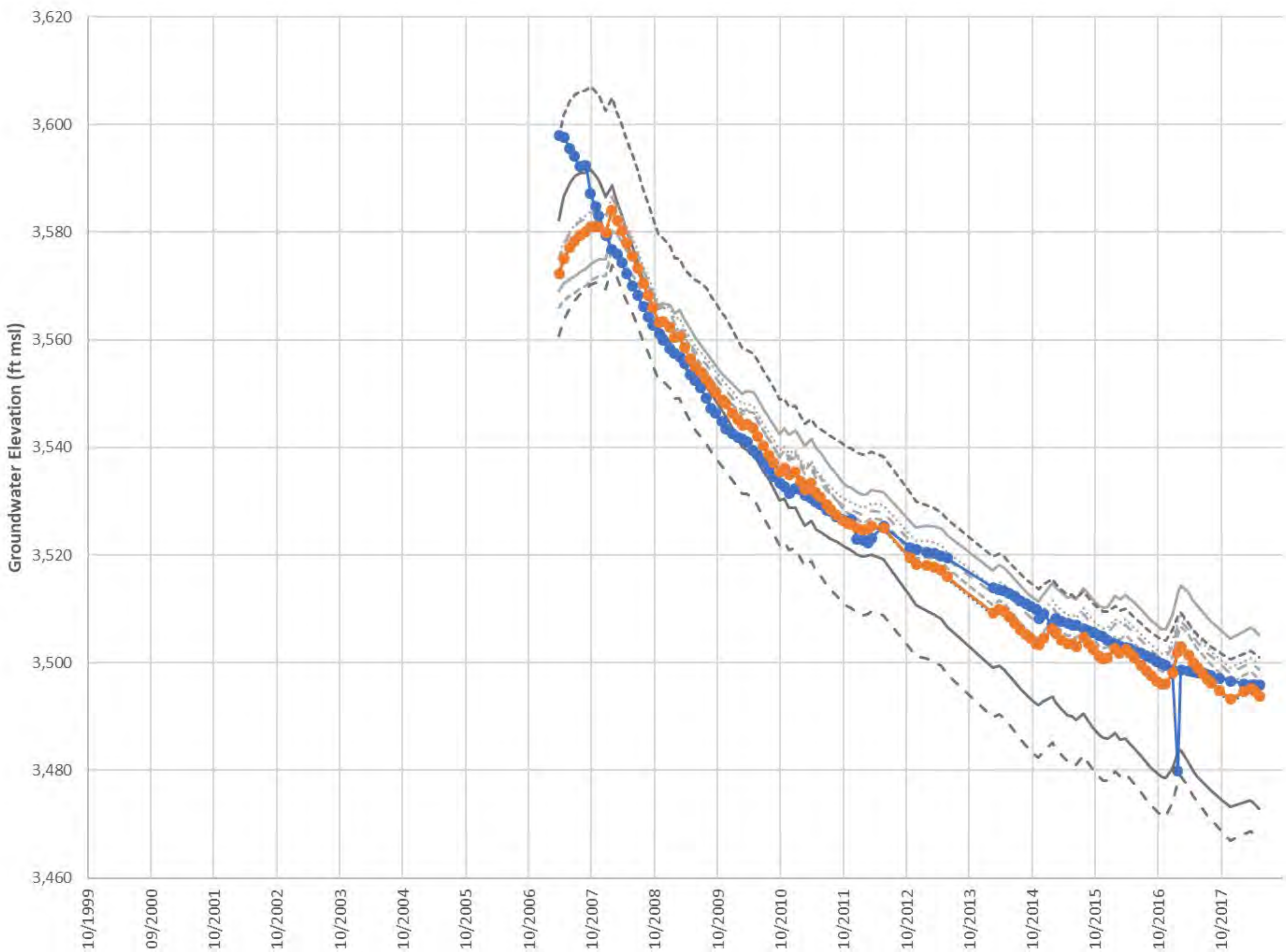
1. CBGFM simulated change in groundwater storage values are from the calibrated historical CBGFM.

eki environment & water

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

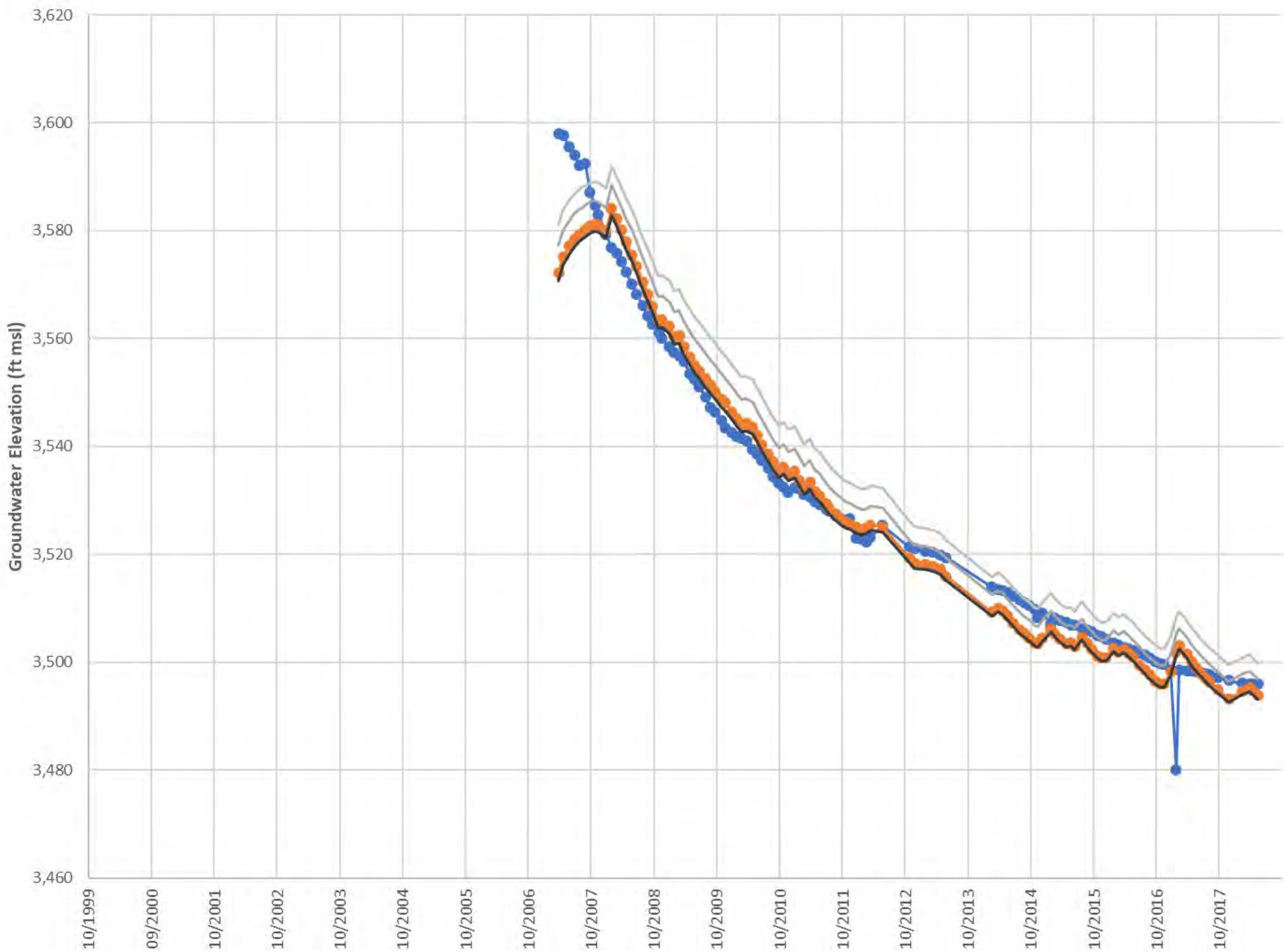
1. See Attachment B for complete results of sensitivity analyses.

eki environment & water

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

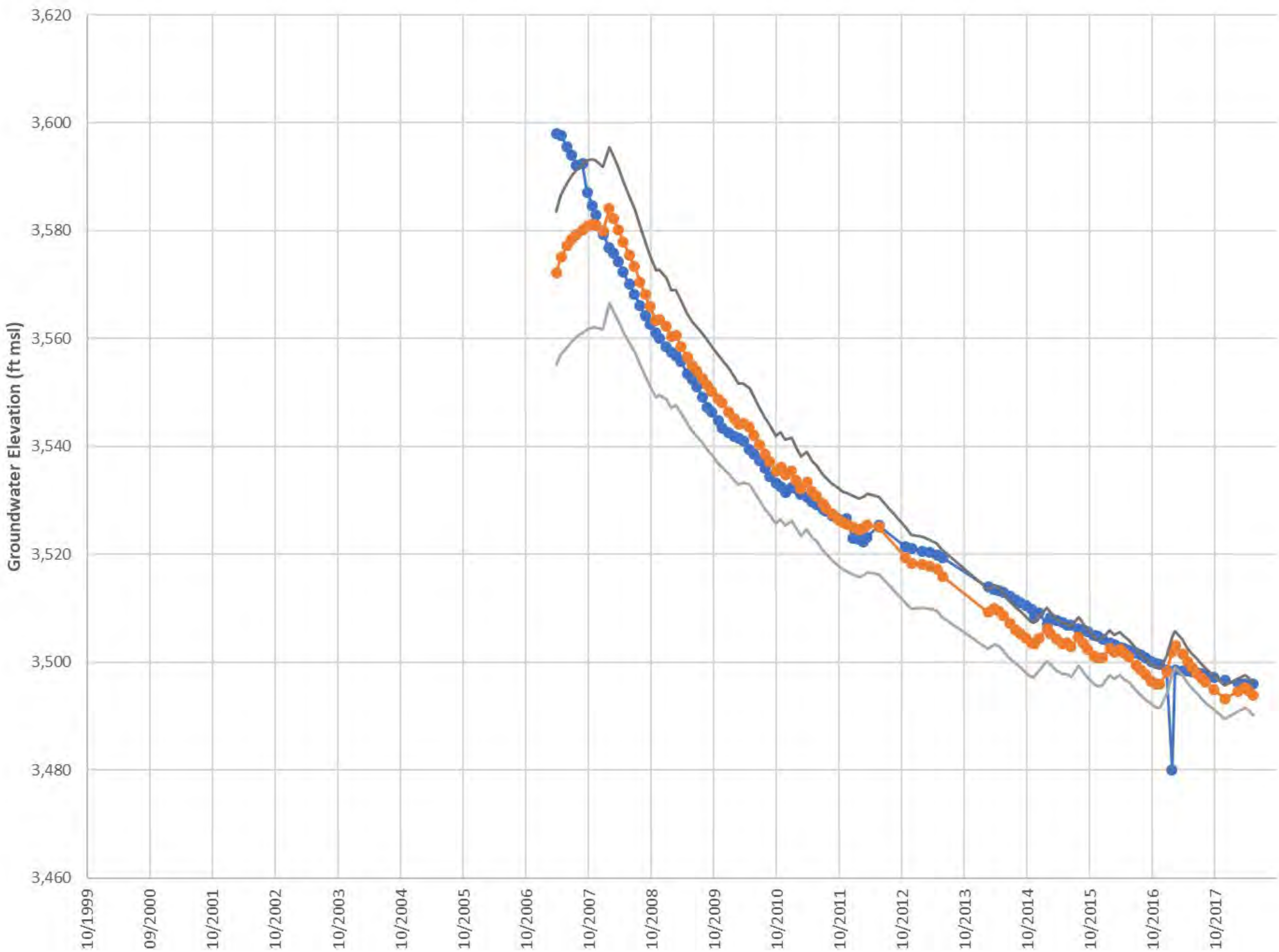
1. See Attachment B for complete results of sensitivity analyses.

eki environment & water

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

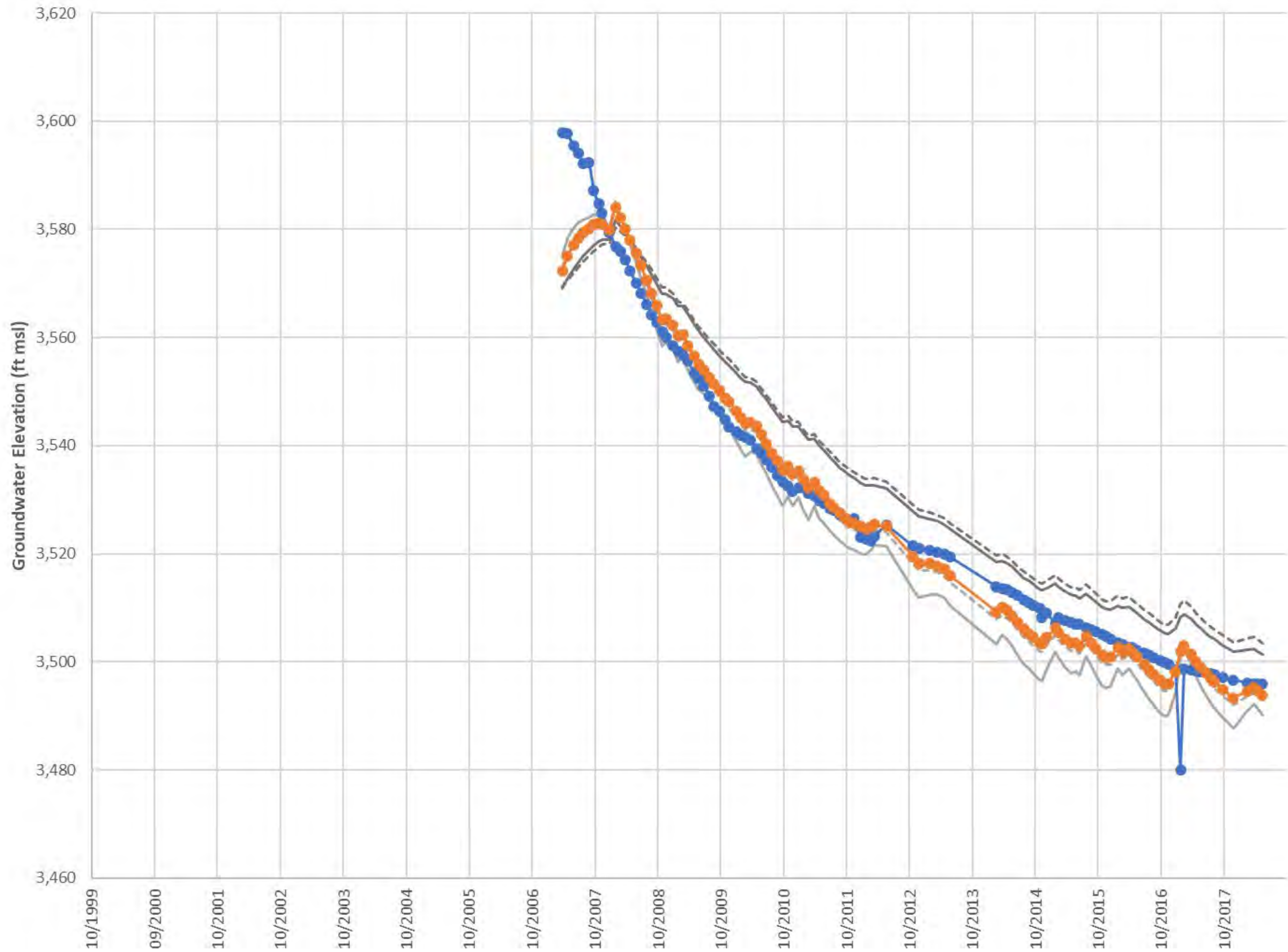
1. See Attachment B for complete results of sensitivity analyses.

eki environment & water

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

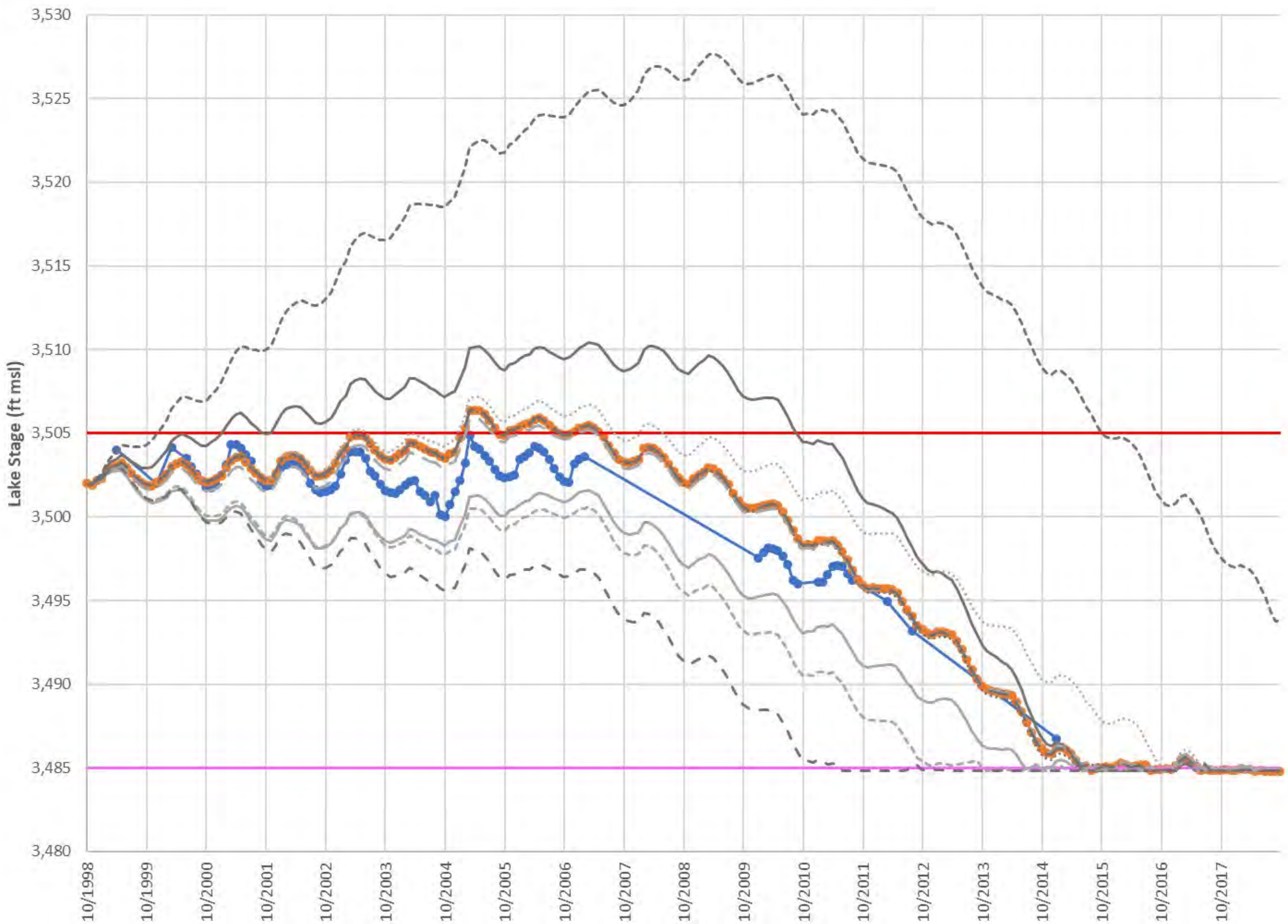
1. See Attachment B for complete results of sensitivity analyses.

eki environment & water

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

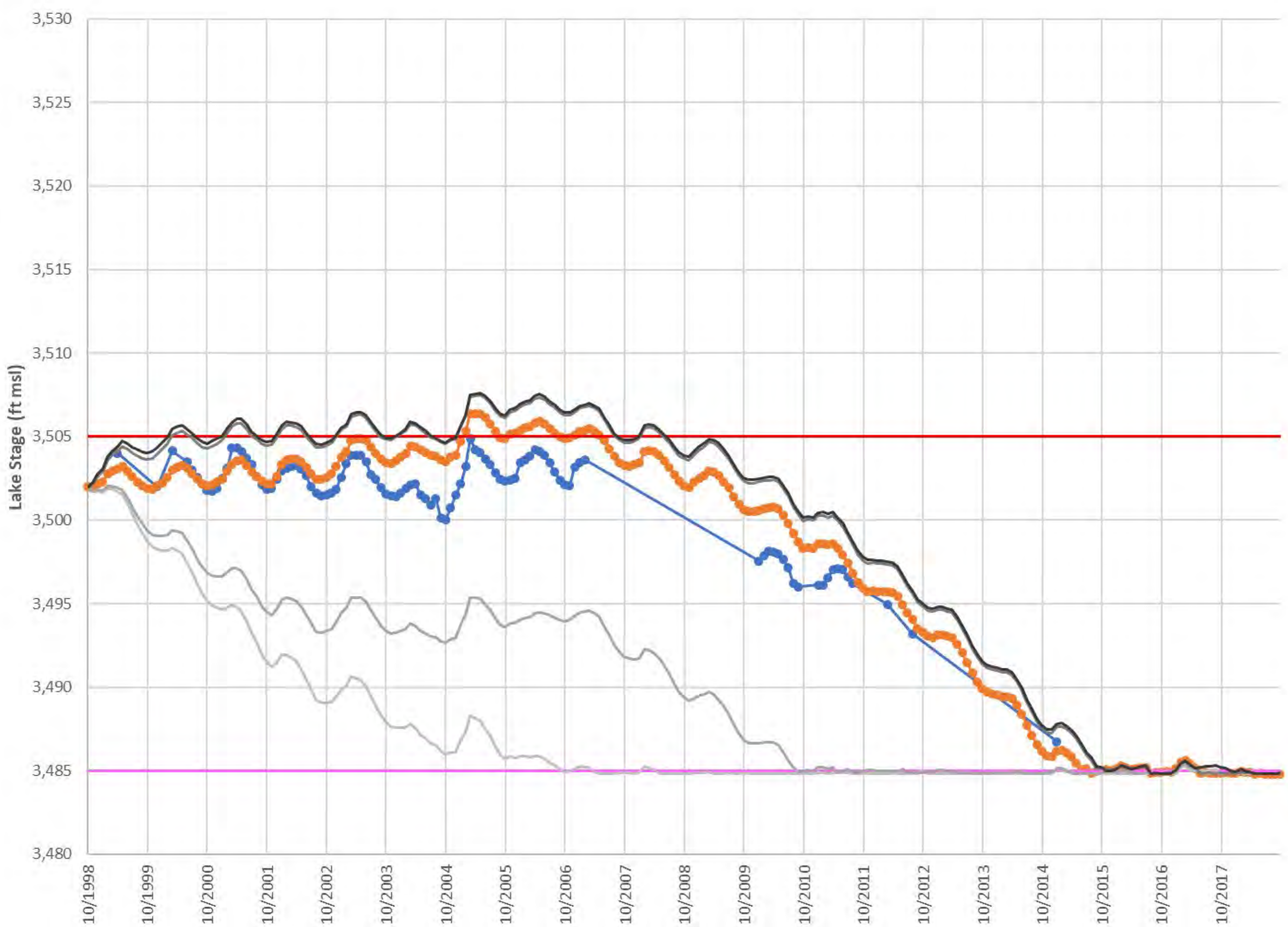
1. See Attachment B for complete results of sensitivity analyses.

eki environment & water

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

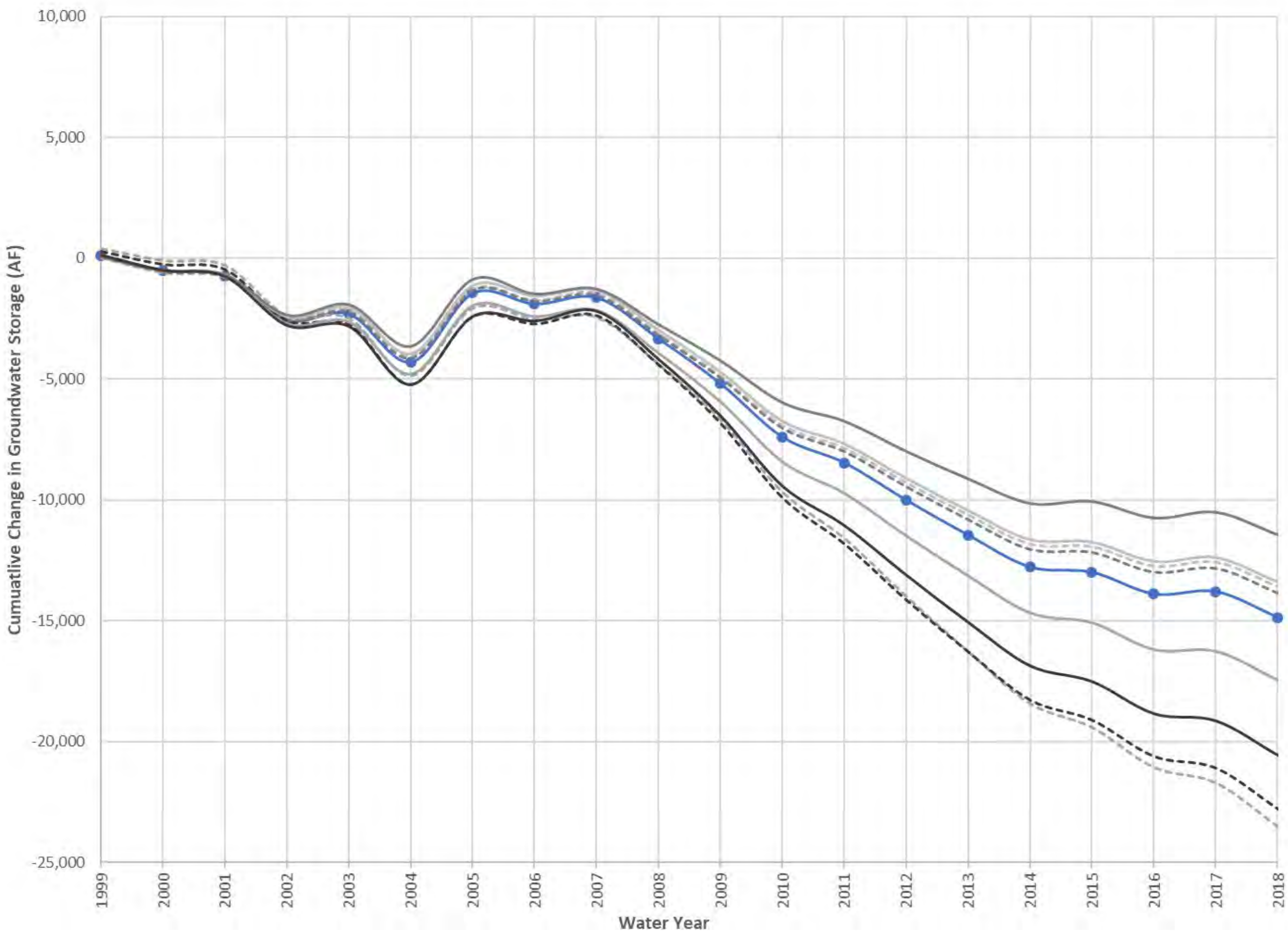
1. See Attachment B for complete results of sensitivity analyses.

eki environment & water

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

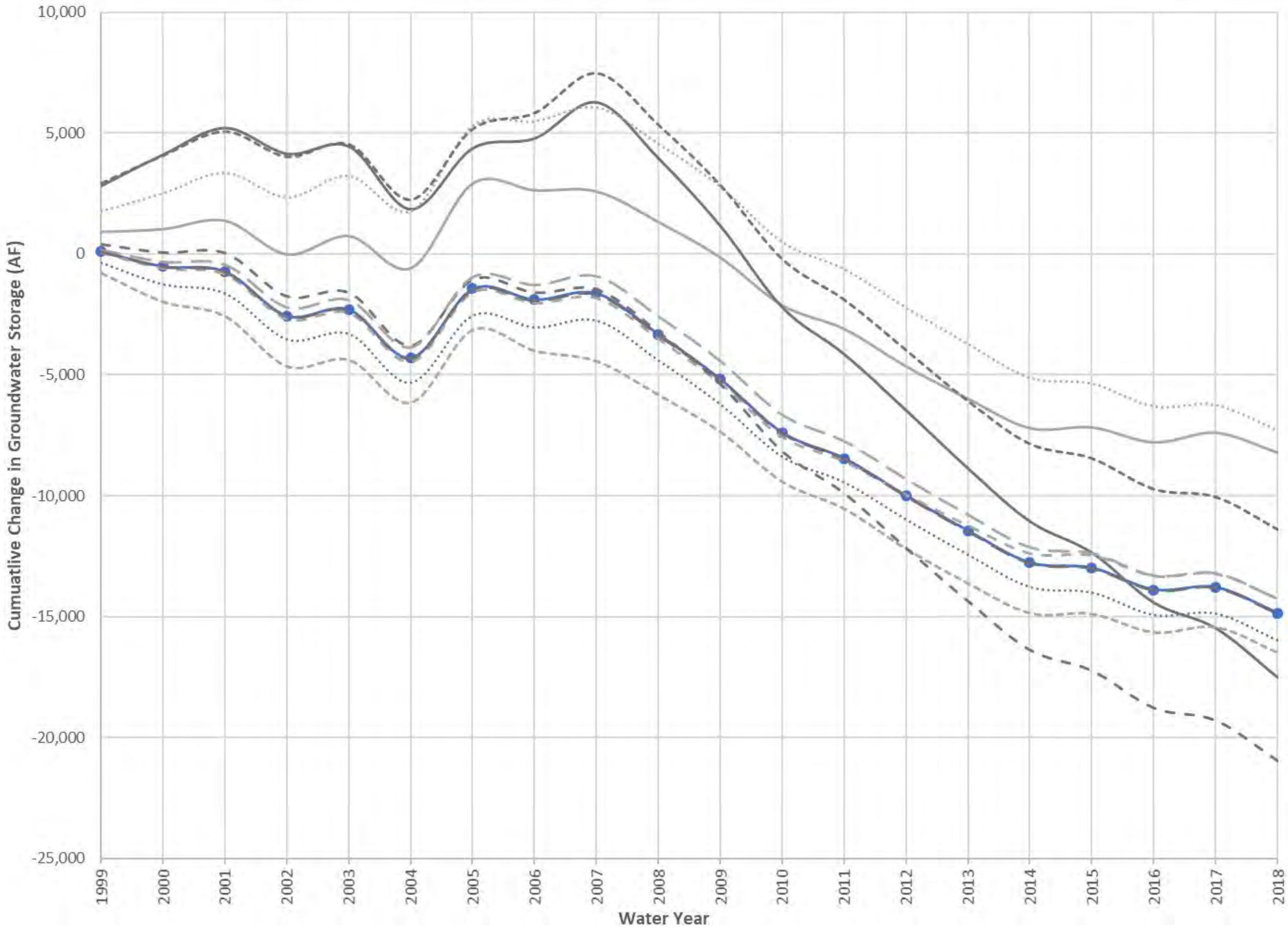
1. See Attachment B for complete results of sensitivity analyses.

eki environment & water

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

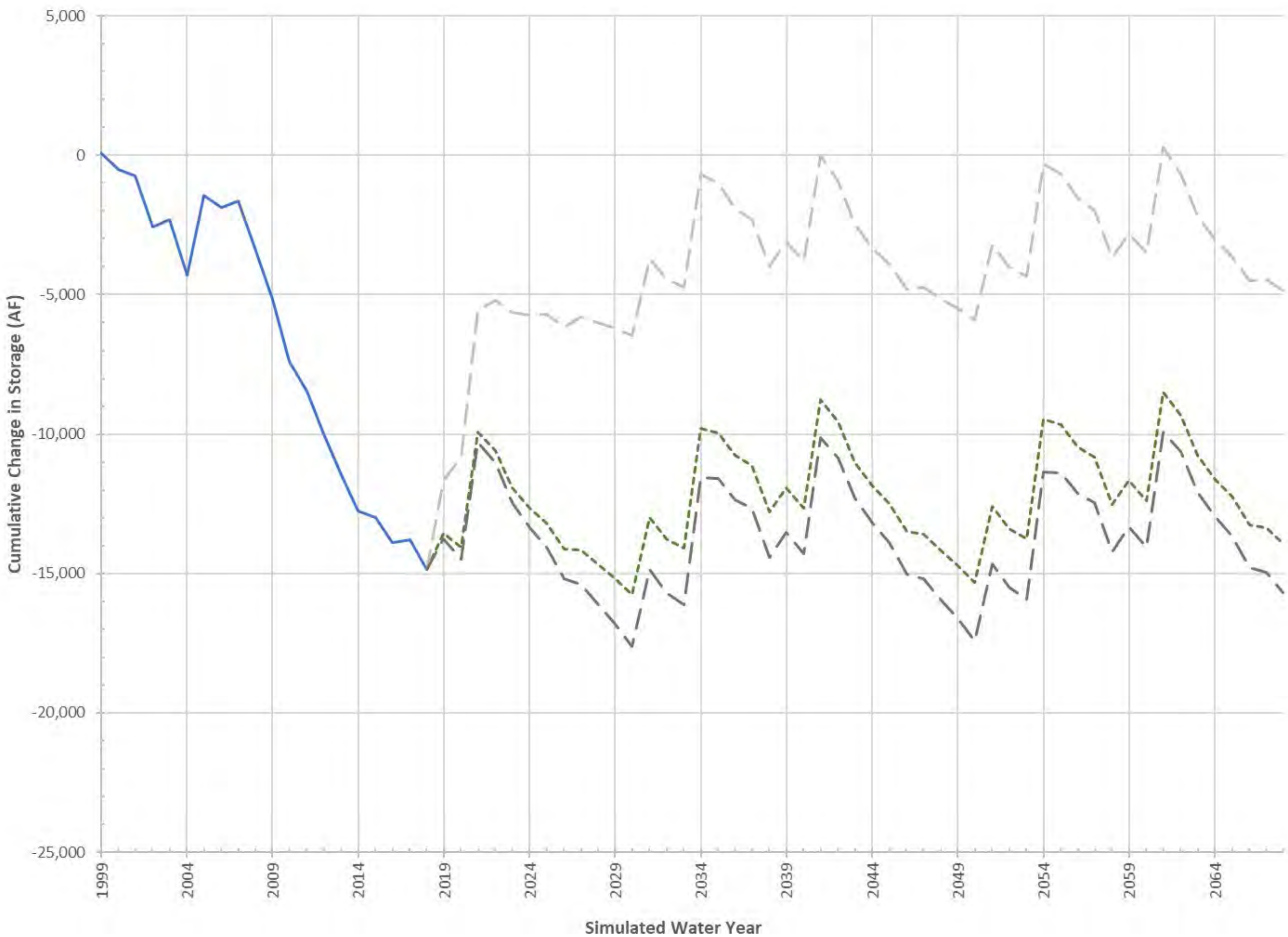
1. See Attachment B for complete results of sensitivity analyses.

eki environment & water

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.

eki environment & water

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

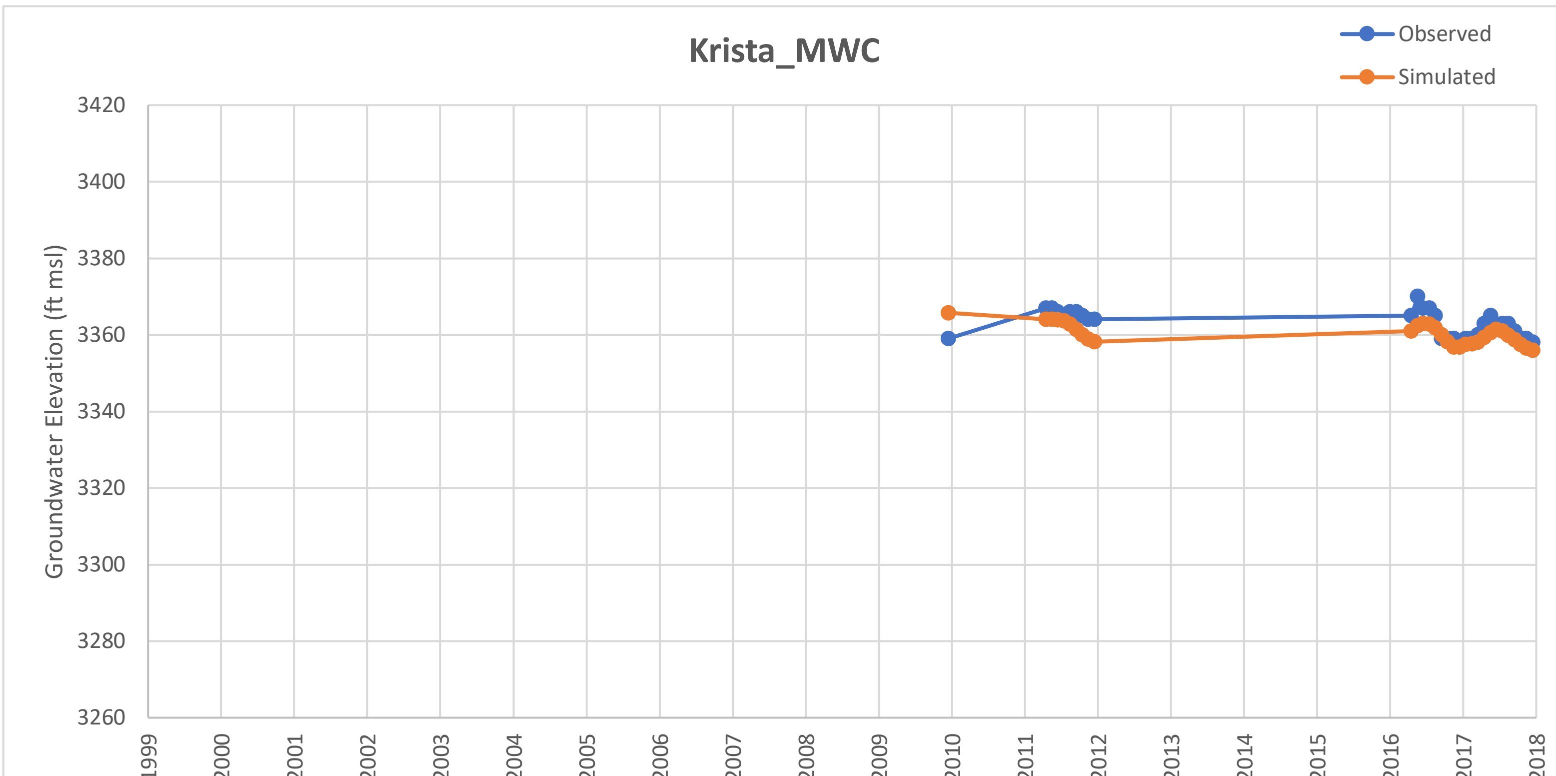
Tejon-Castac Water District
Kern County, California
April 2020
EKI B90059.00

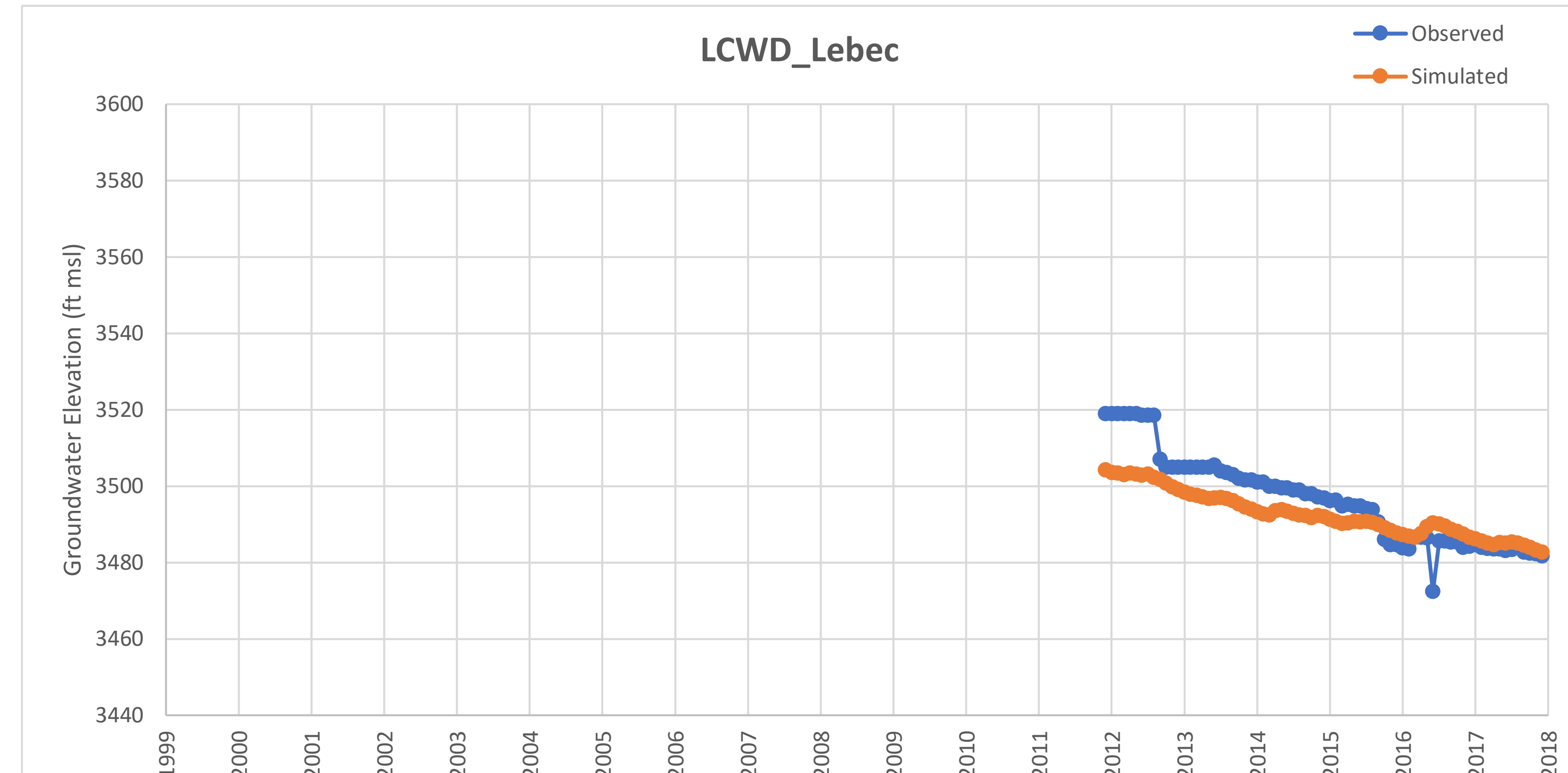
Figure 16

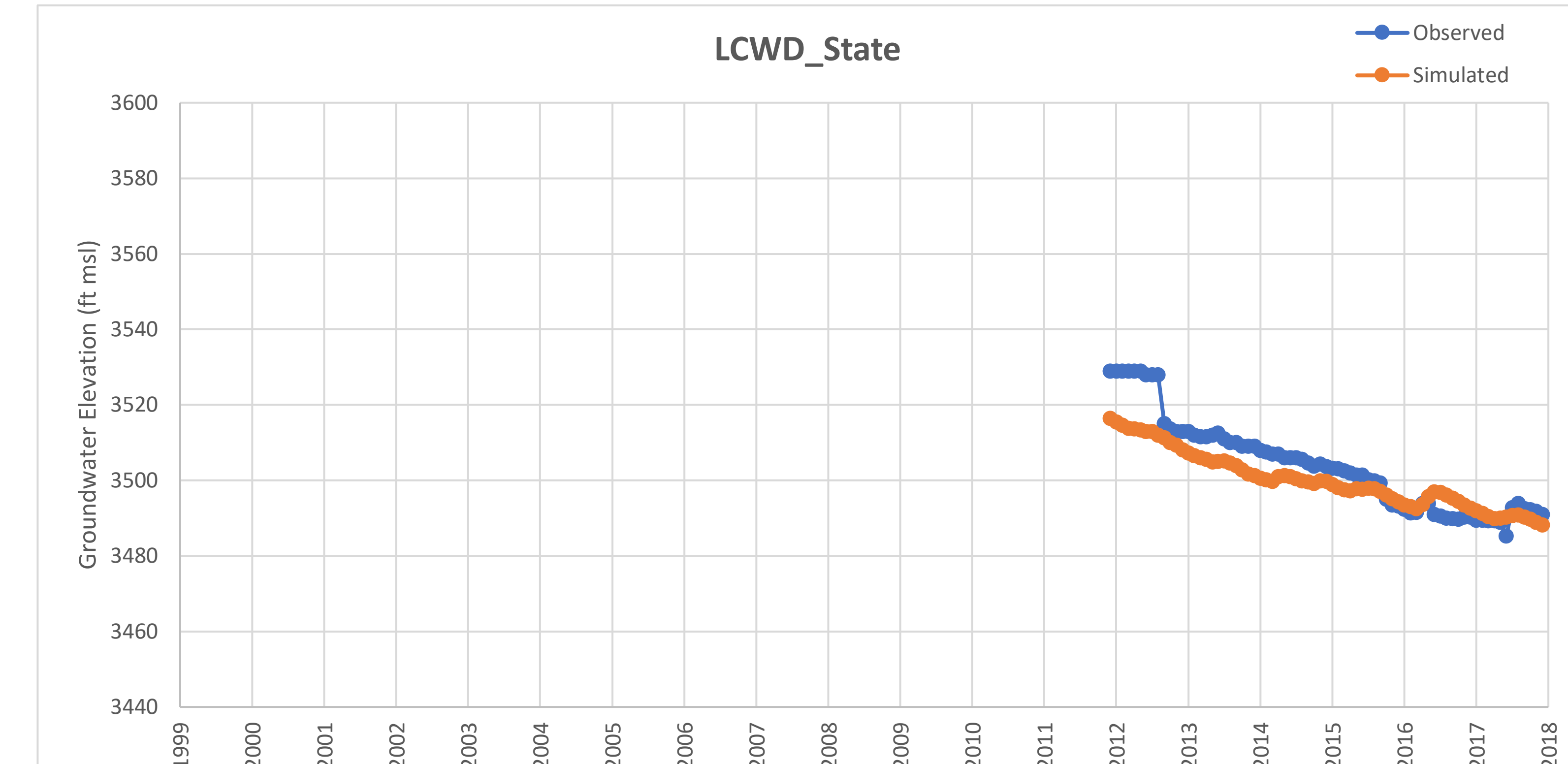
ATTACHMENT A

CBGFM HISTORICAL MODEL CALIBRATION HYDROGRAPHS

CBGFM CALIBRATION HYDROGRAPHS



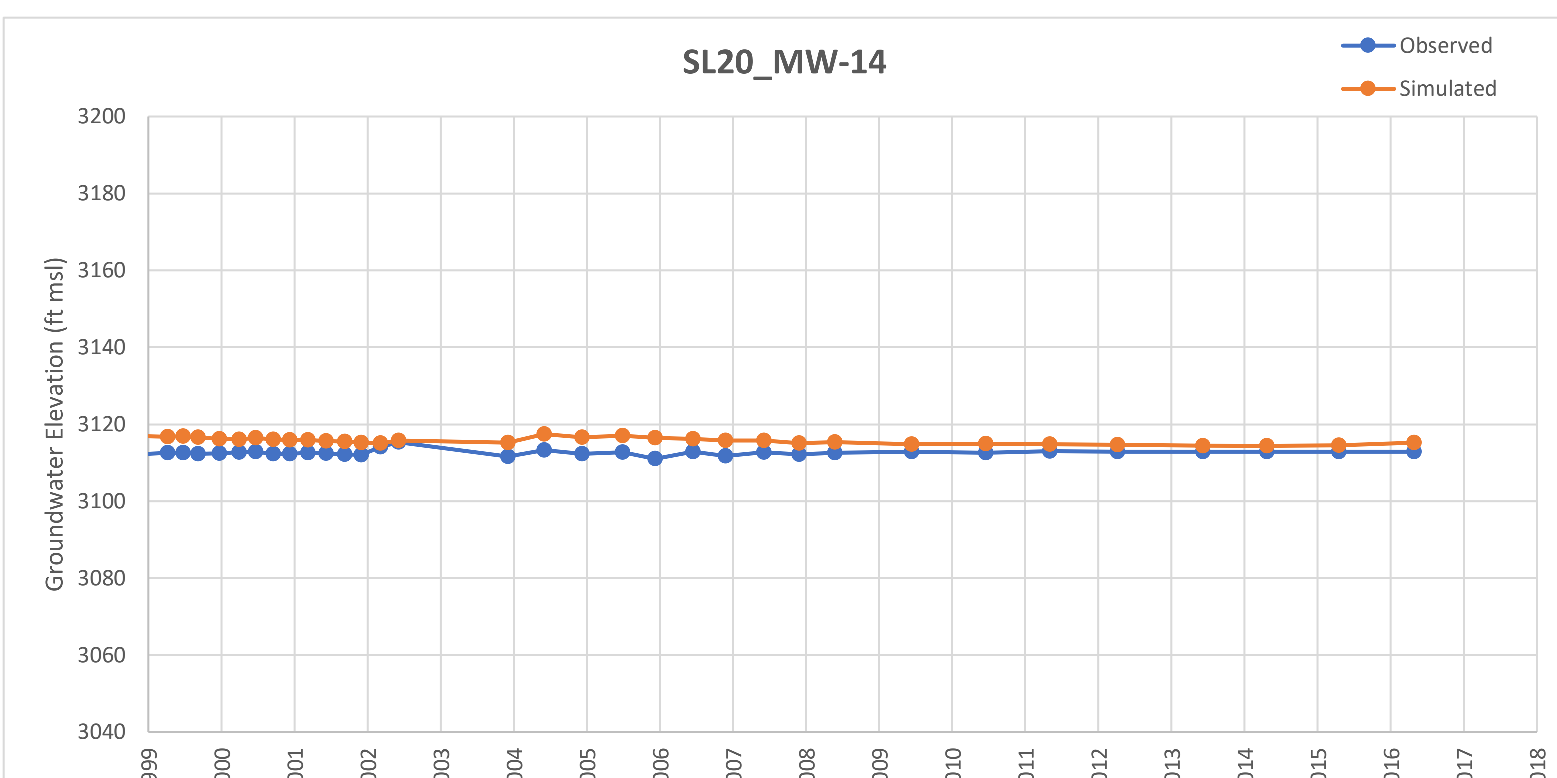


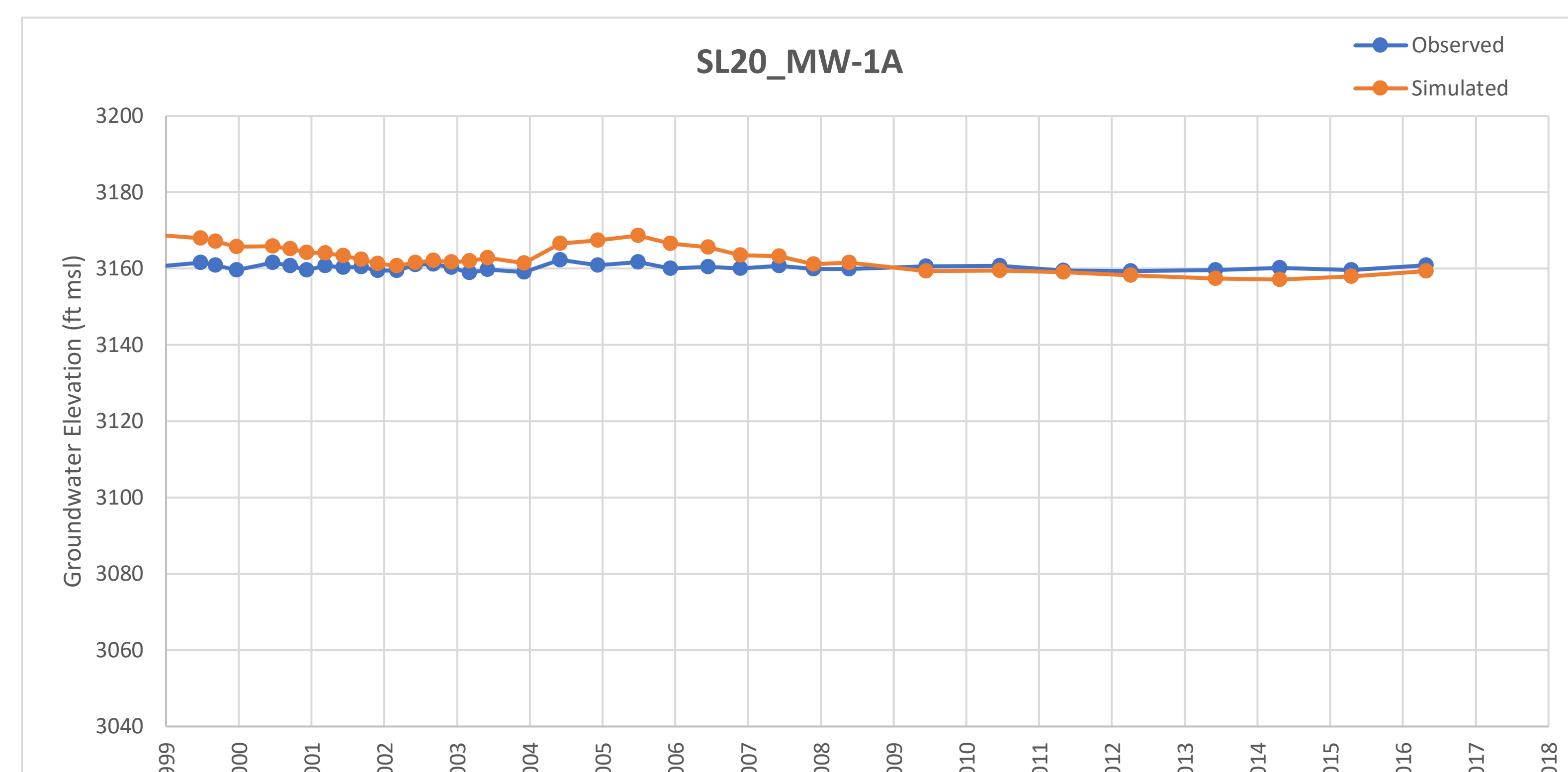


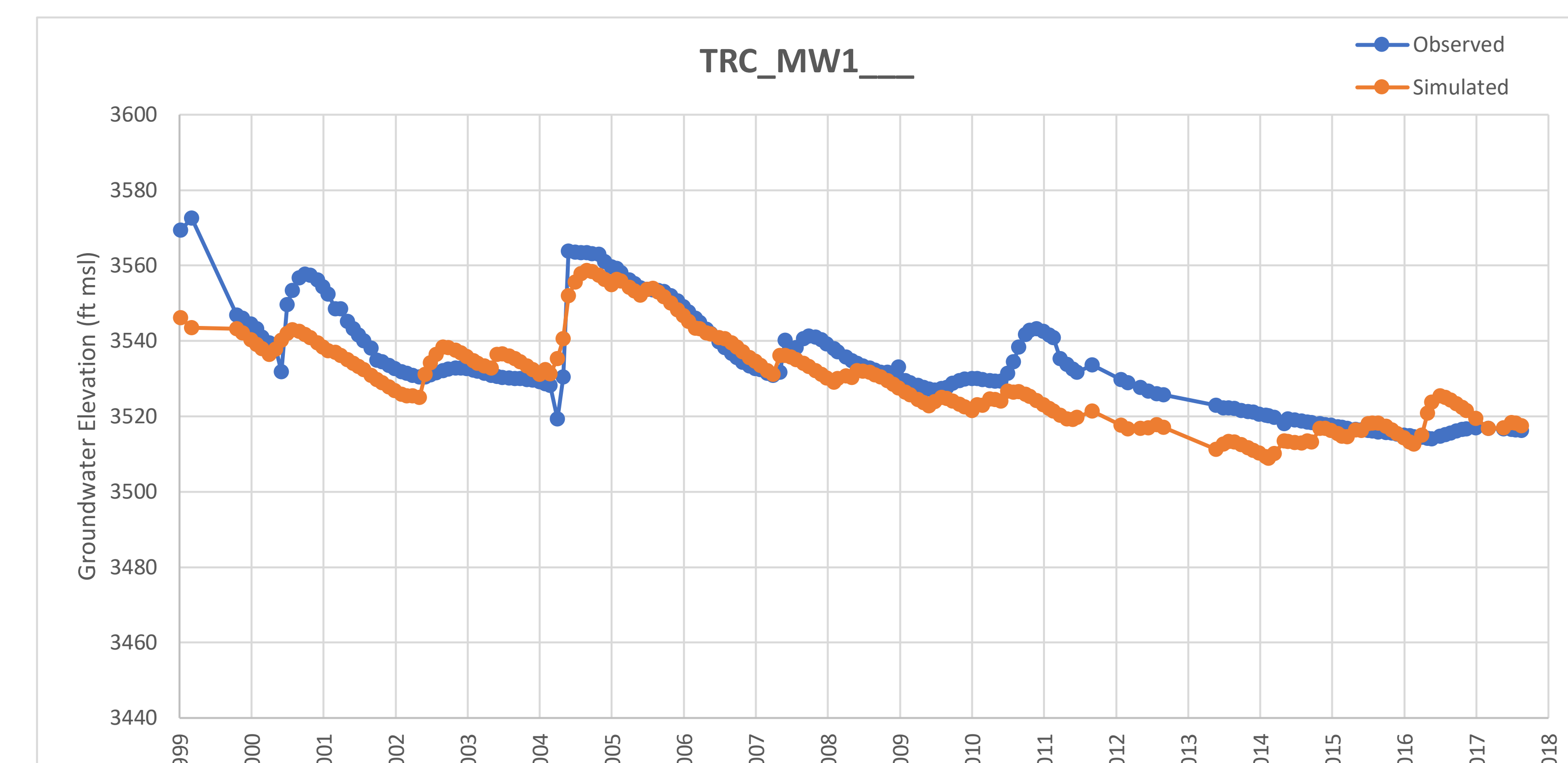
RMSE 3.51 ft | well: **Krista_MWC**
Min -7.6 | area: GVC S
Max 6.8 | layer: 3
Average -2.5 | cells: 9:39
Median -2.5

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





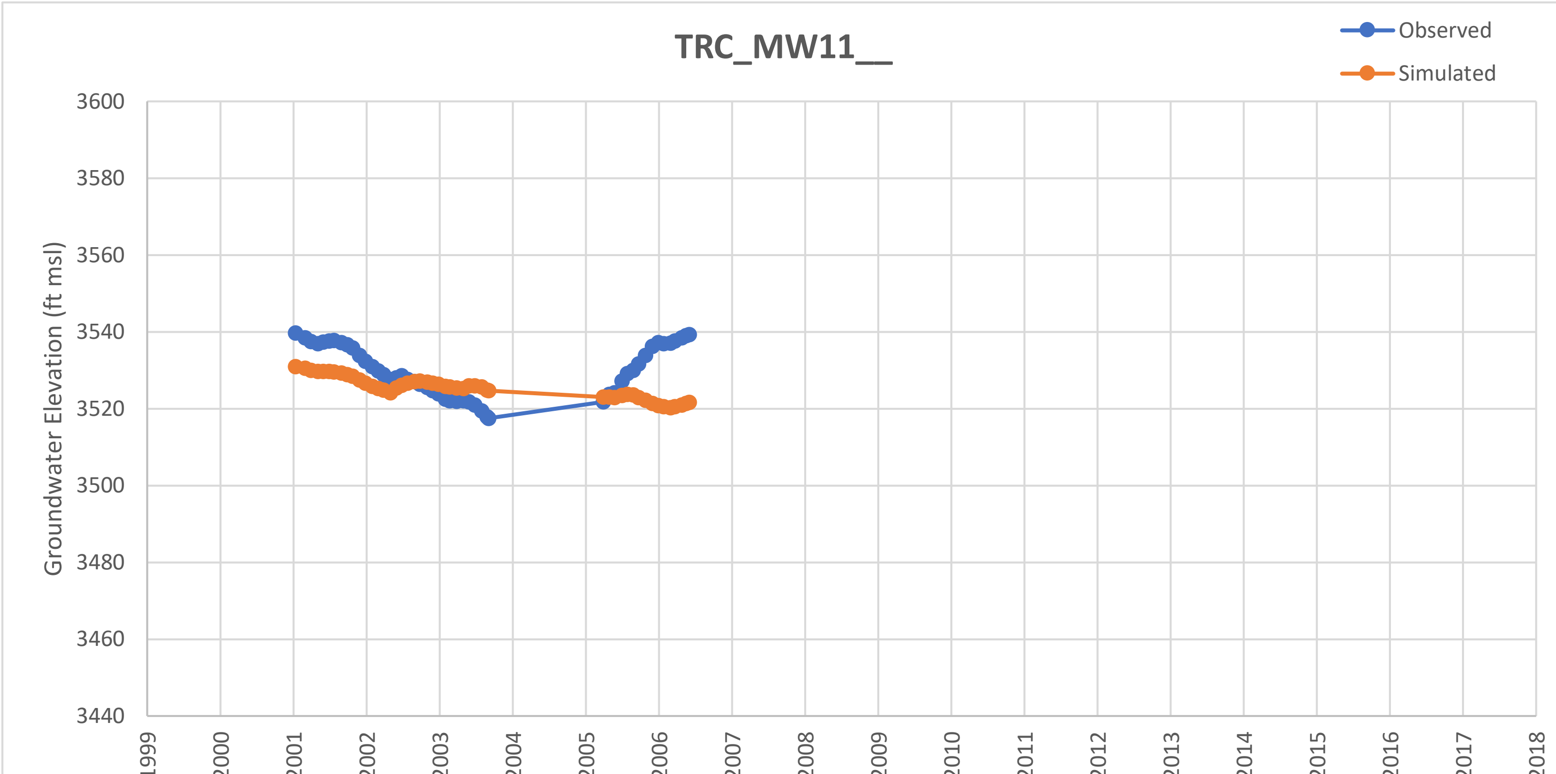


RMSE 3.47 ft | well: **SL20_MW-14**
Min 0.4 | area: GVC N
Max 5.4 | layer: 2
Average 3.3 | cells: 186:221
Median 3.4

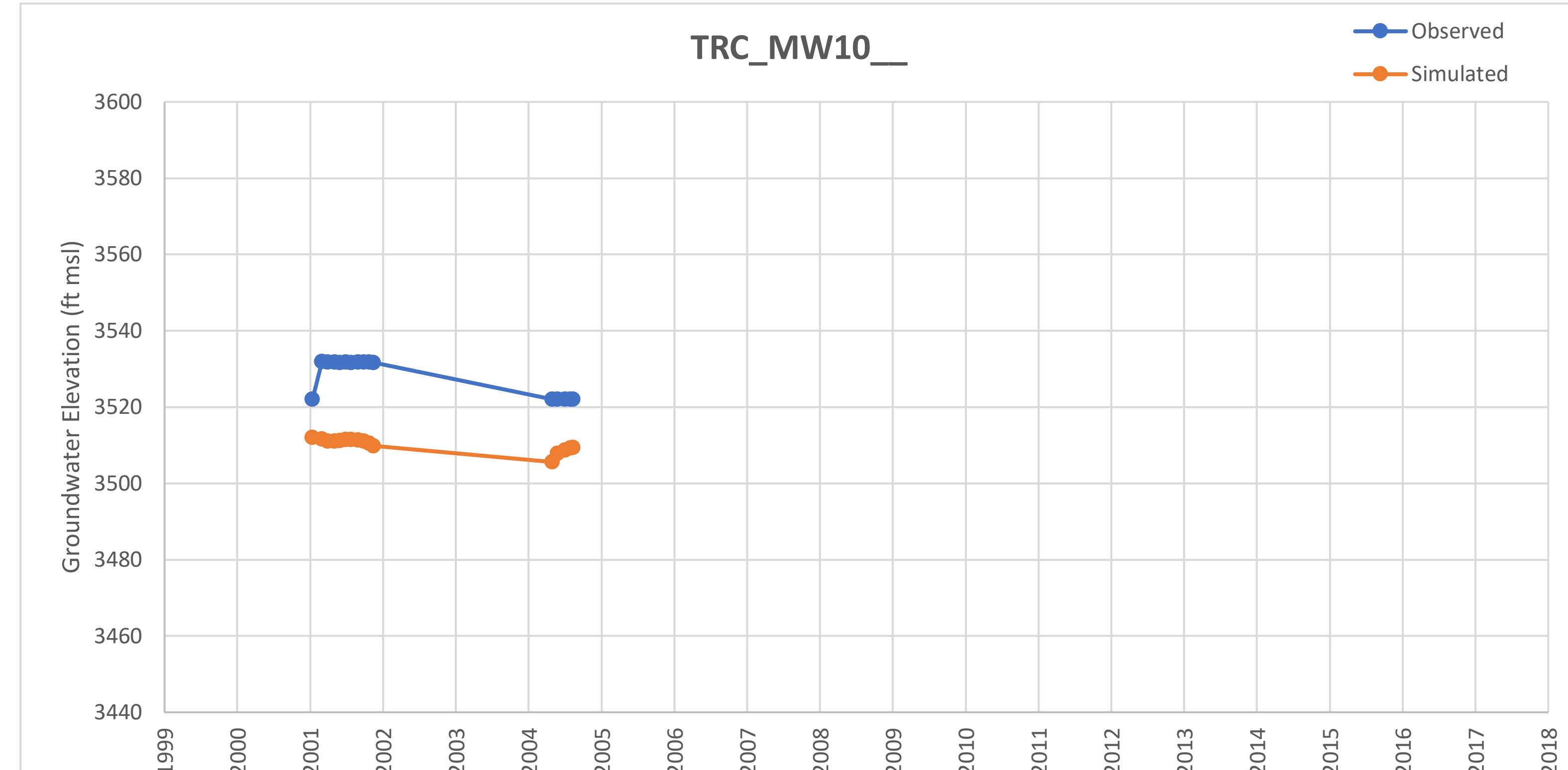
(no dry) RMSE 3.47 ft
Min 0.4
Max 5.4
Average 3.3
Median 3.4

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

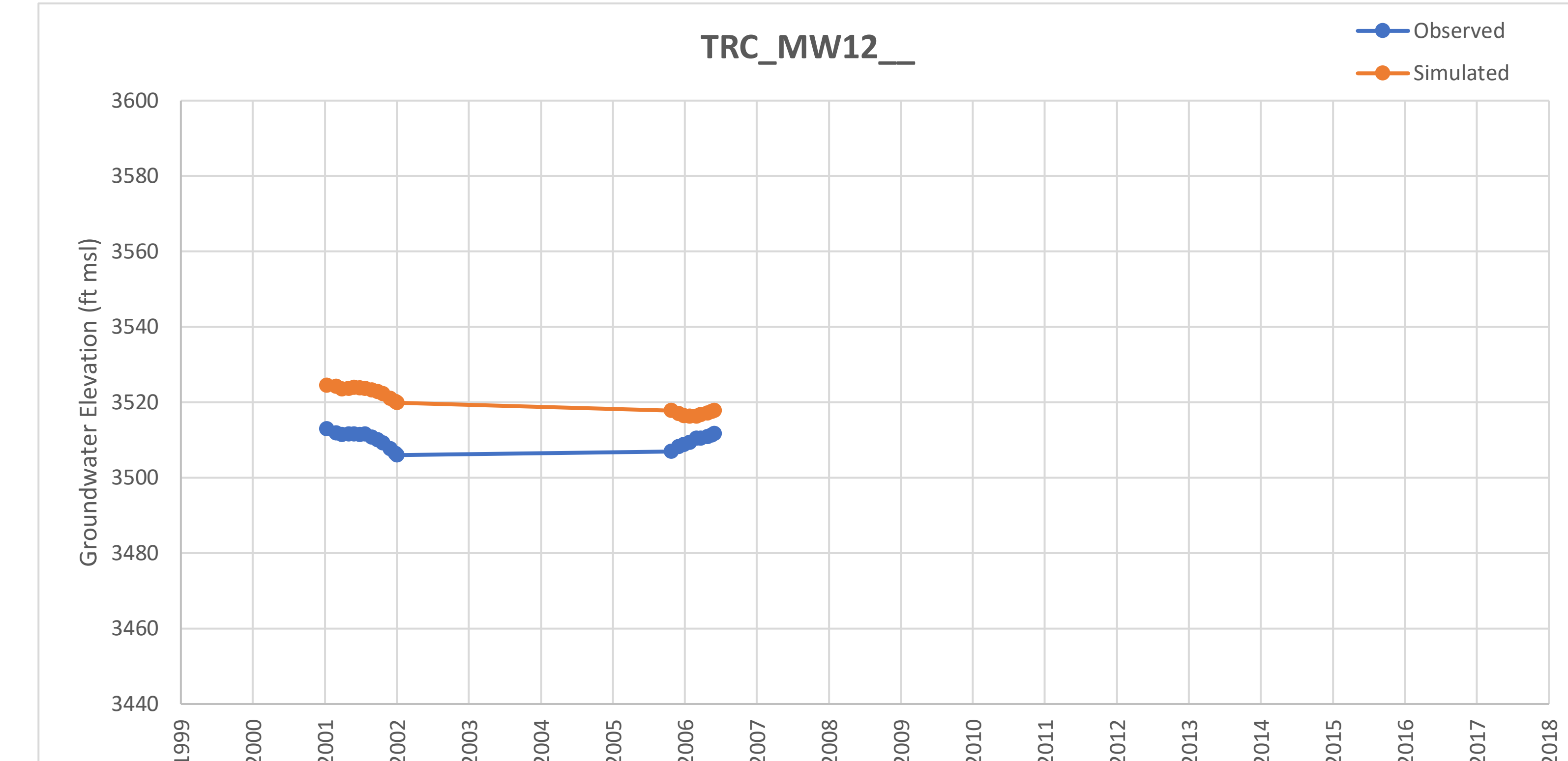
RMSE 7.92 ft | well: **TRC_MW1___**
Min -29.1 | area: Dryfield
Max 16.0 | layer: 3
Average -3.8 | cells: 259:458
Median -3.2



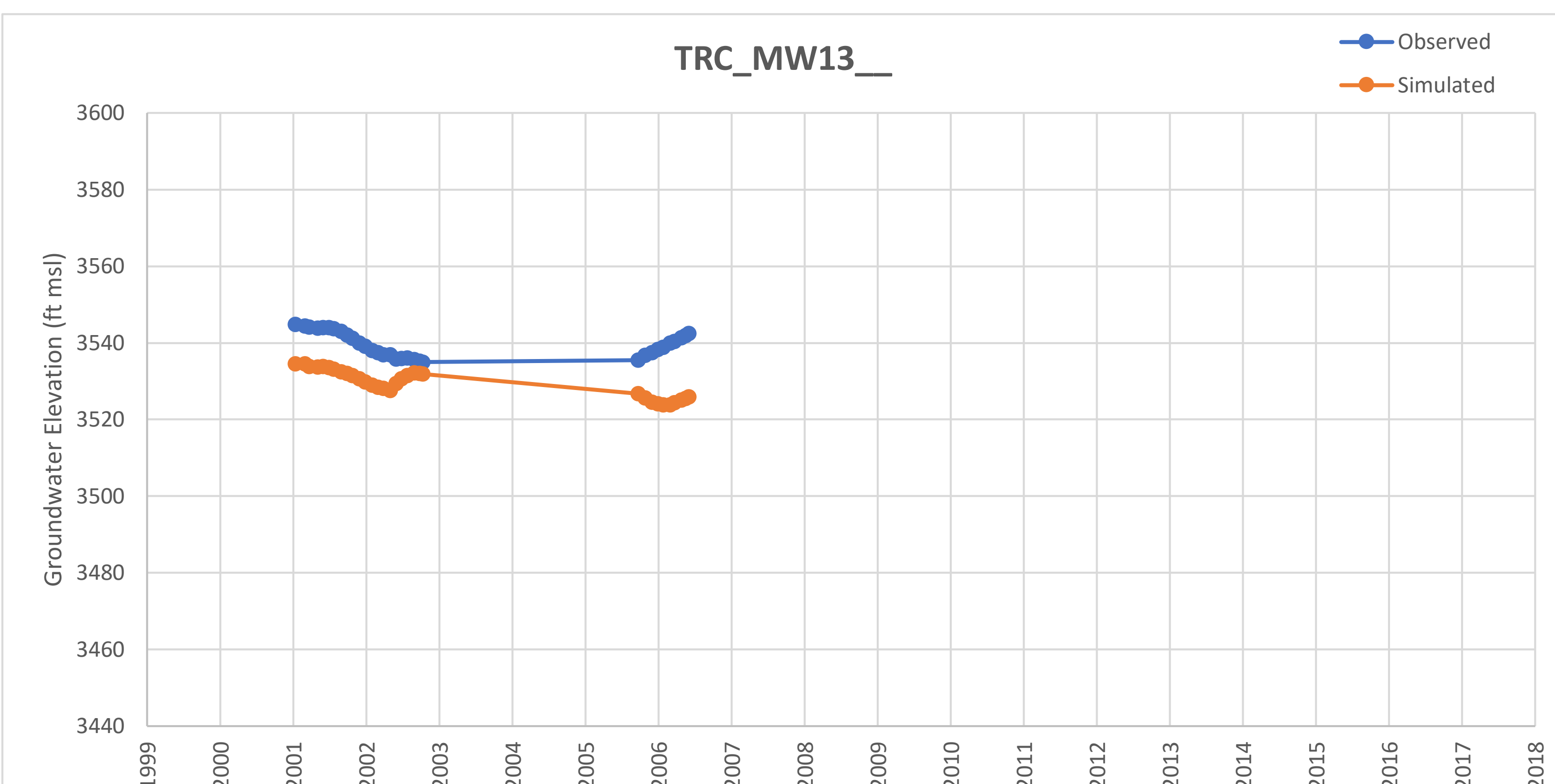
RMSE	8.54	ft	well:	TRC_MW11__
Min	-17.7		area:	Main
Max	7.2		layer:	2
Average	-4.8		cells:	459:507
Median	-5.2			



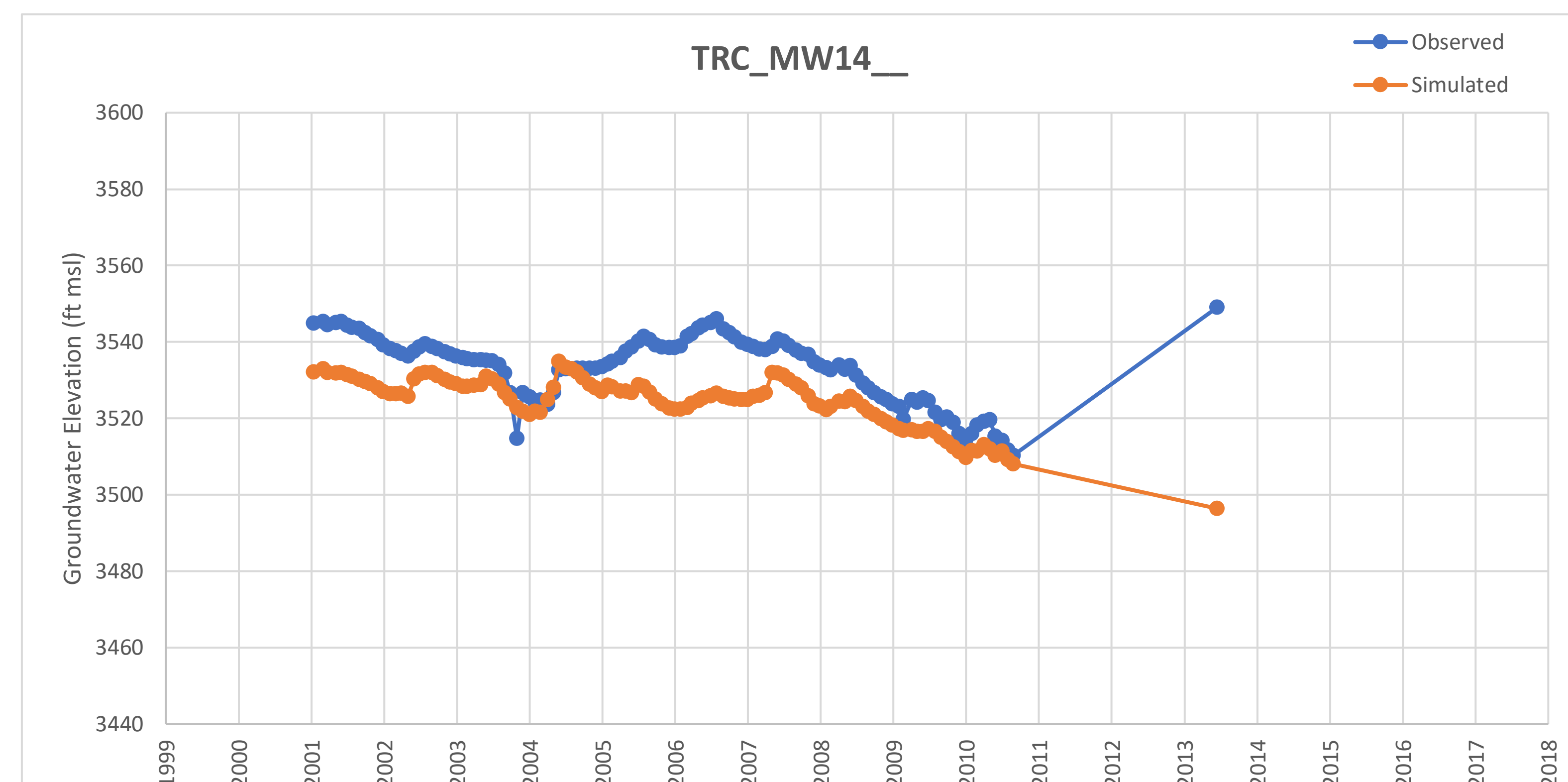
RMSE	18.27	ft	well:	TRC_MW10__
Min	-21.9		area:	Main
Max	-10.0		layer:	2
Average	-17.9		cells:	508:523
Median	-20.3			



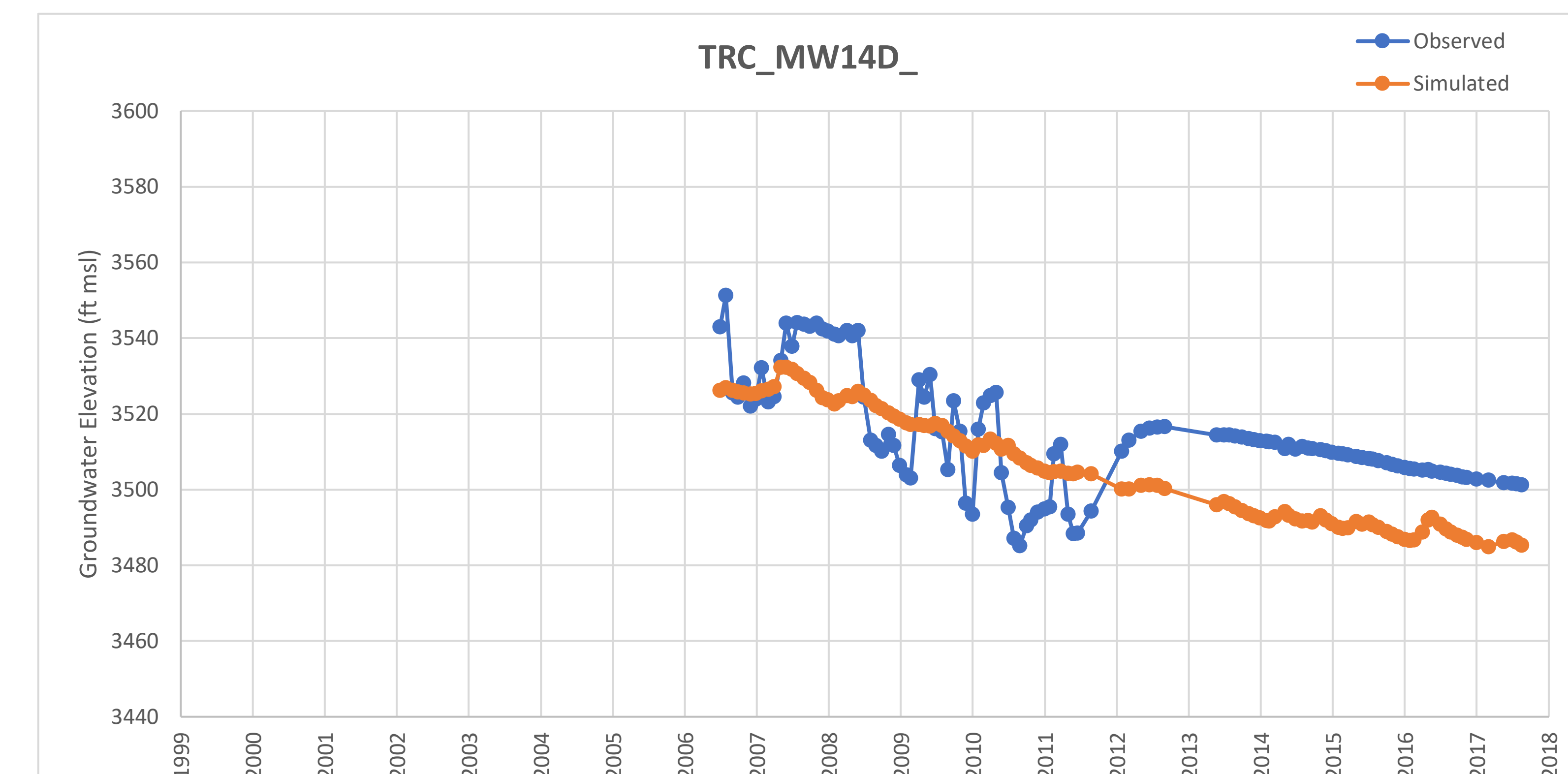
RMSE	10.82	ft	well:	TRC_MW12__
Min	5.9		area:	Main
Max	13.9		layer:	2
Average	10.4		cells:	524:545
Median	12.1			



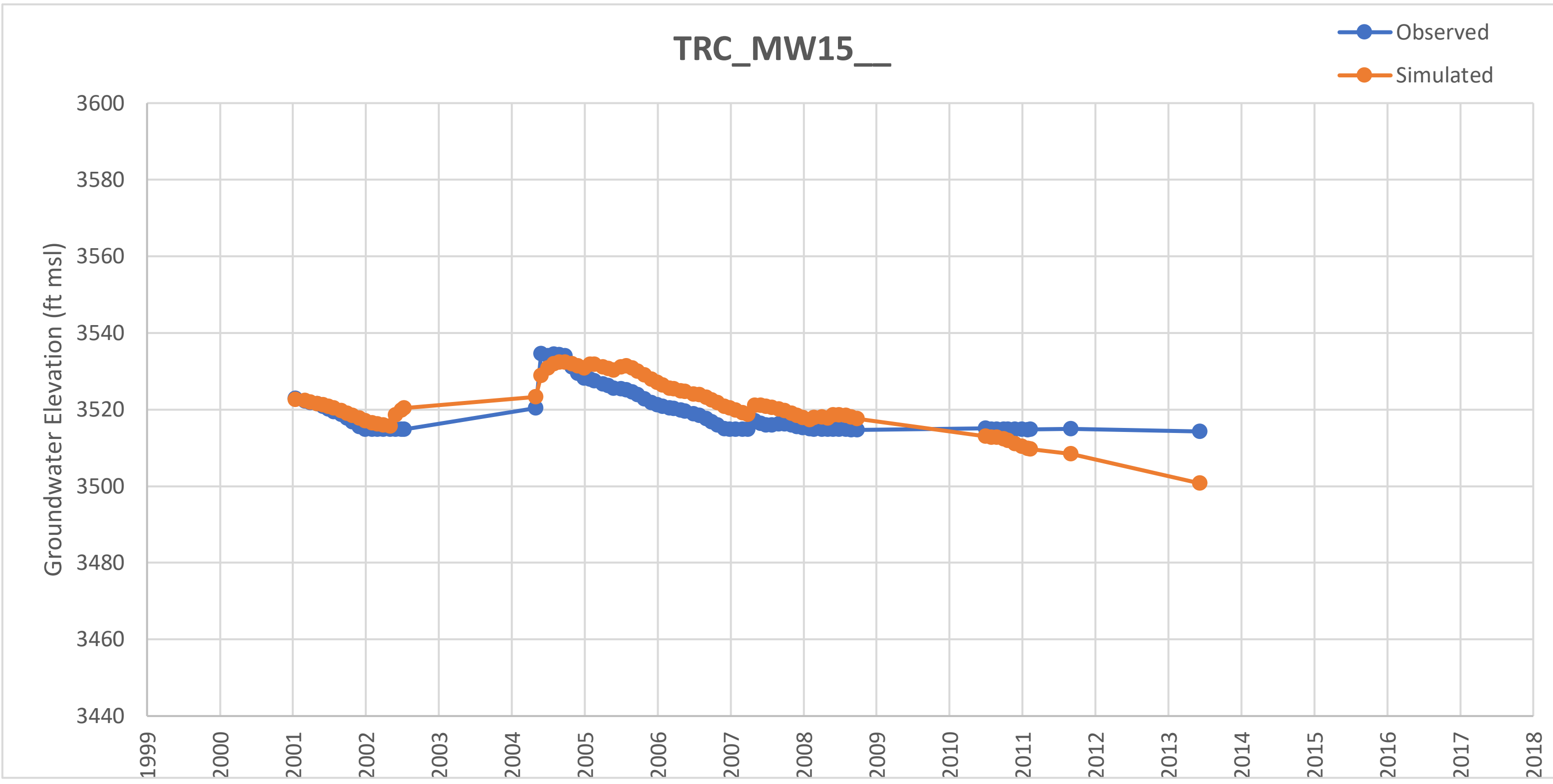
RMSE	10.88	ft	well:	TRC_MW13__
Min	-16.5		area:	Main
Max	-3.1		layer:	2
Average	-10.2		cells:	546:577
Median	-10.1			



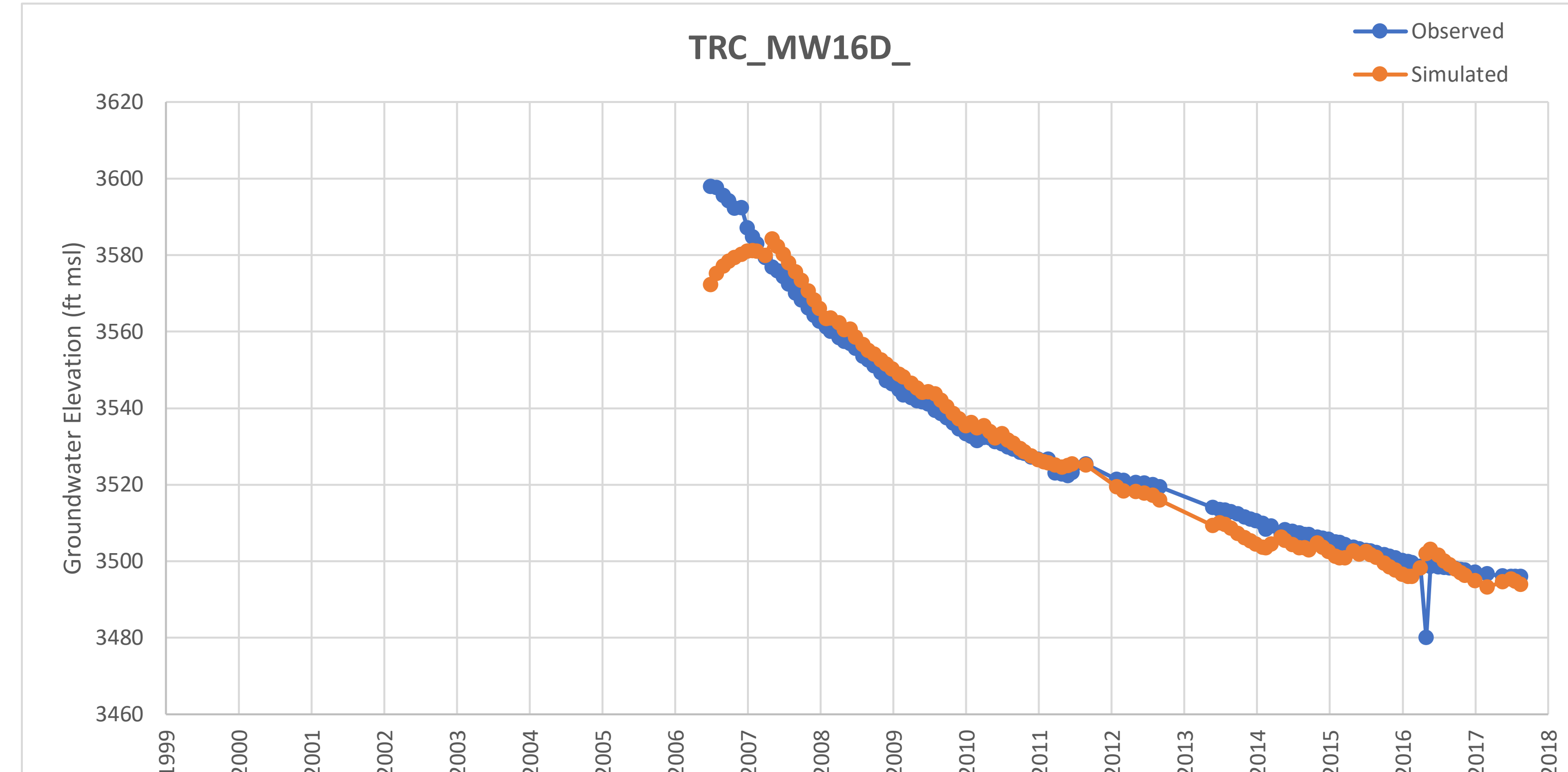
RMSE	11.05	ft	well:	TRC_MW14__
Min	-52.6		area:	Main
Max	7.9		layer:	3
Average	-9.0		cells:	578:694
Median	-7.7			



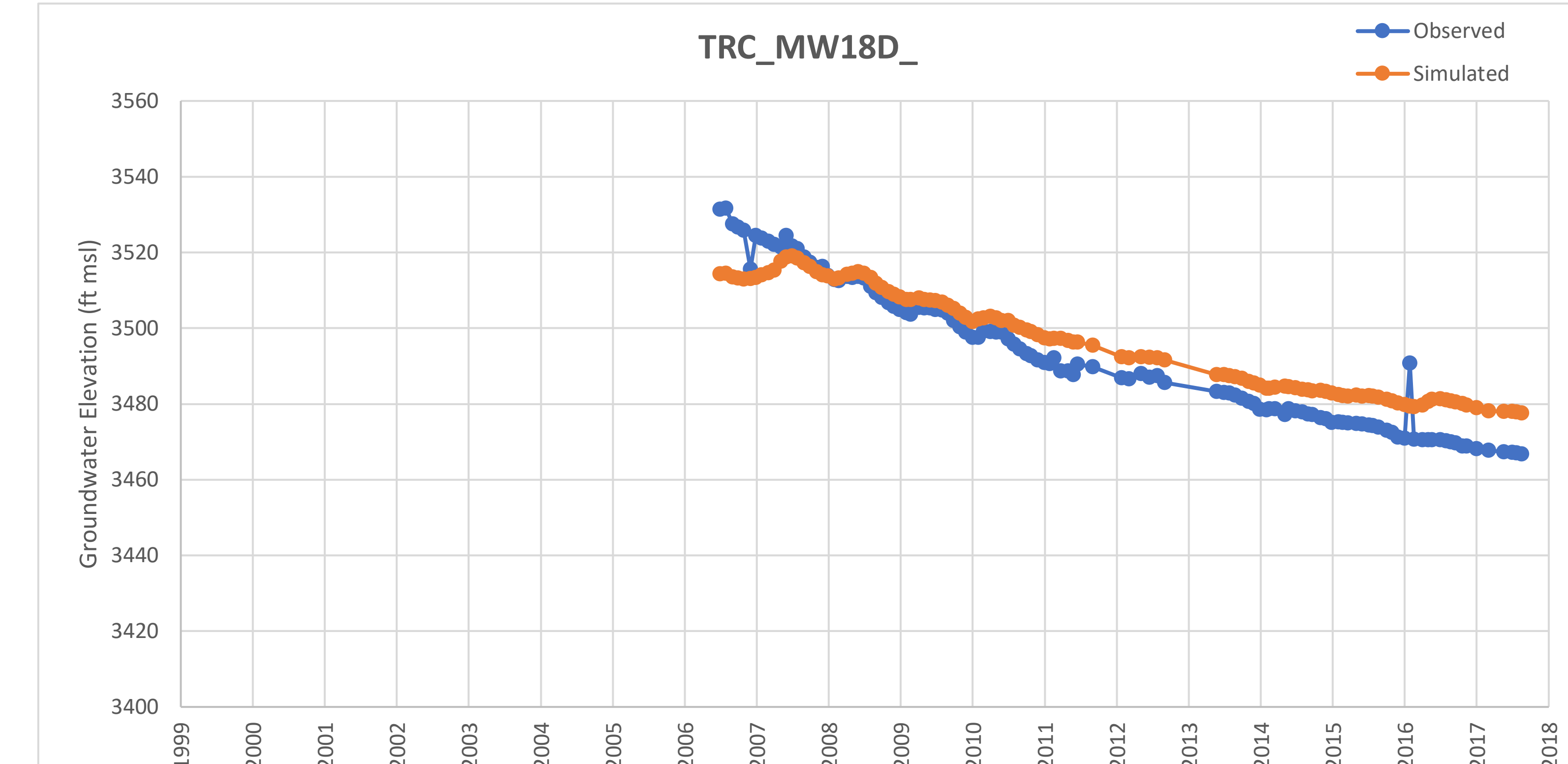
RMSE	15.00	ft	well:	TRC_MW14D_
Min	-24.4		area:	Main
Max	23.2		layer:	3
Average	-8.3		cells:	695:811
Median	-14.8			



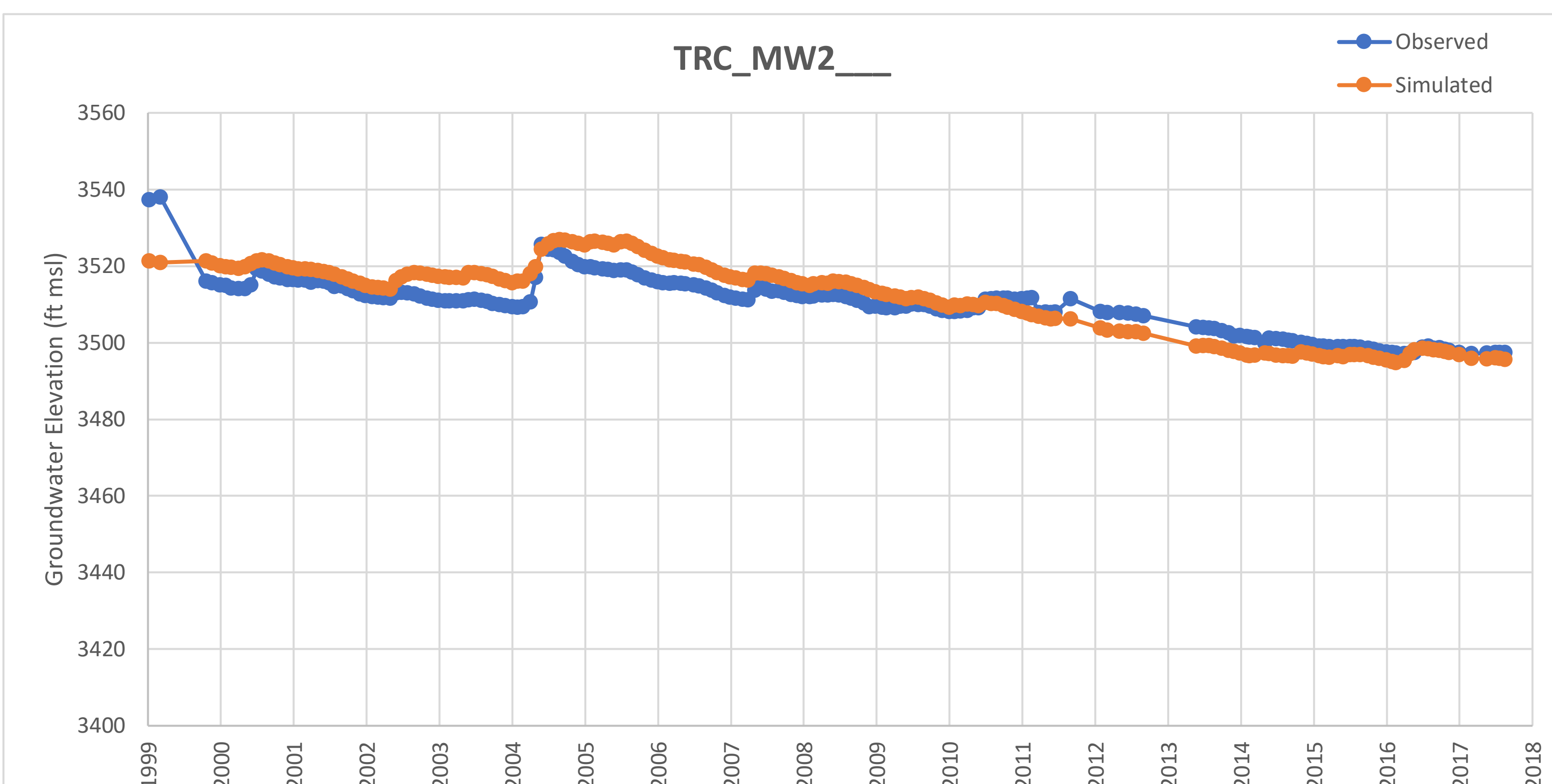
RMSE	4.23	ft	well:	TRC_MW15__
Min	-13.5		area:	Dryfield
Max	6.2		layer:	2
Average	2.1		cells:	812:895
Median	3.0			



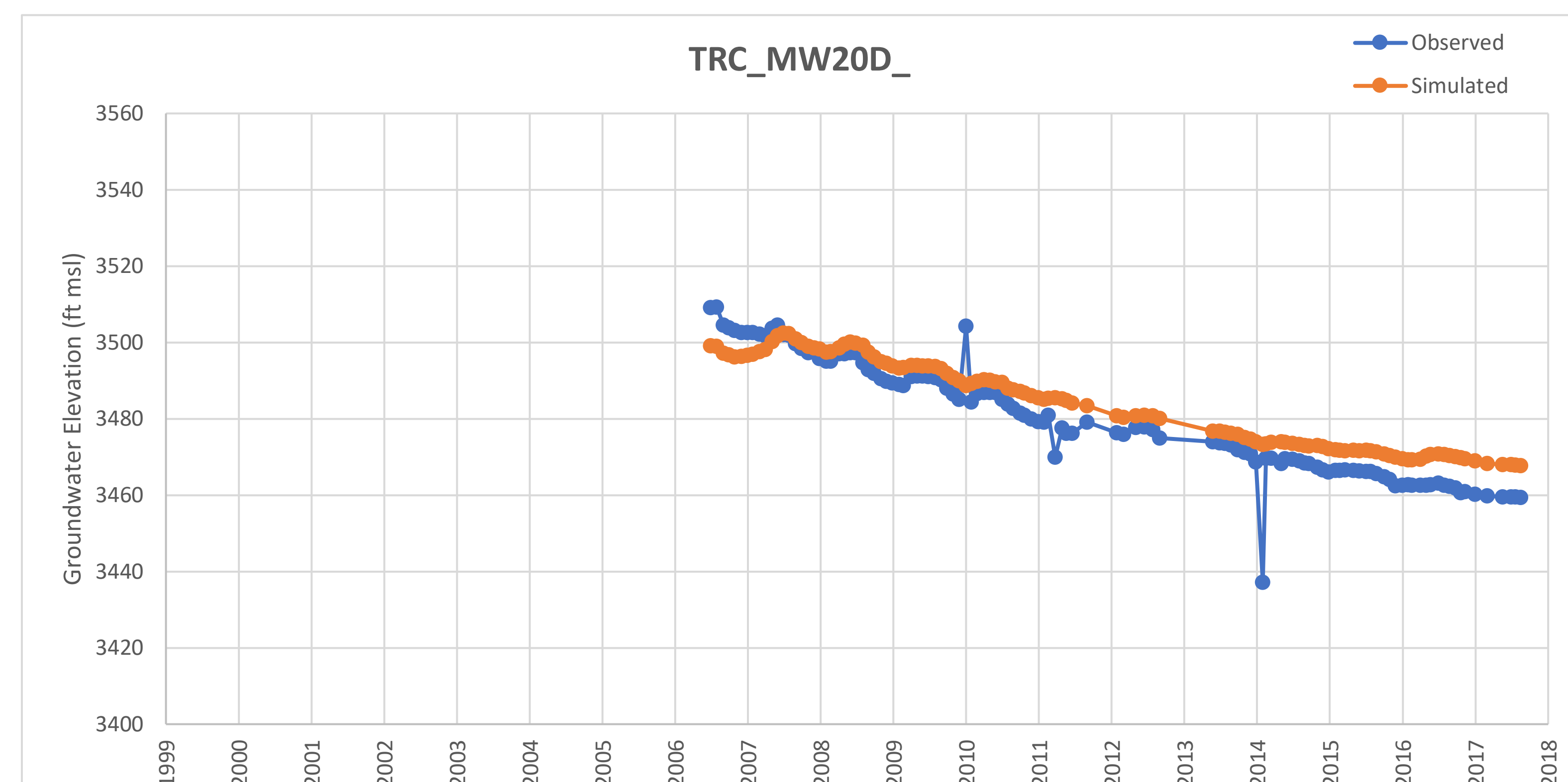
RMSE	5.69	ft	well:	TRC_MW16D_
Min	-25.7		area:	Main
Max	22.0		layer:	3
Average	-0.7		cells:	896:1012
Median	-0.3			



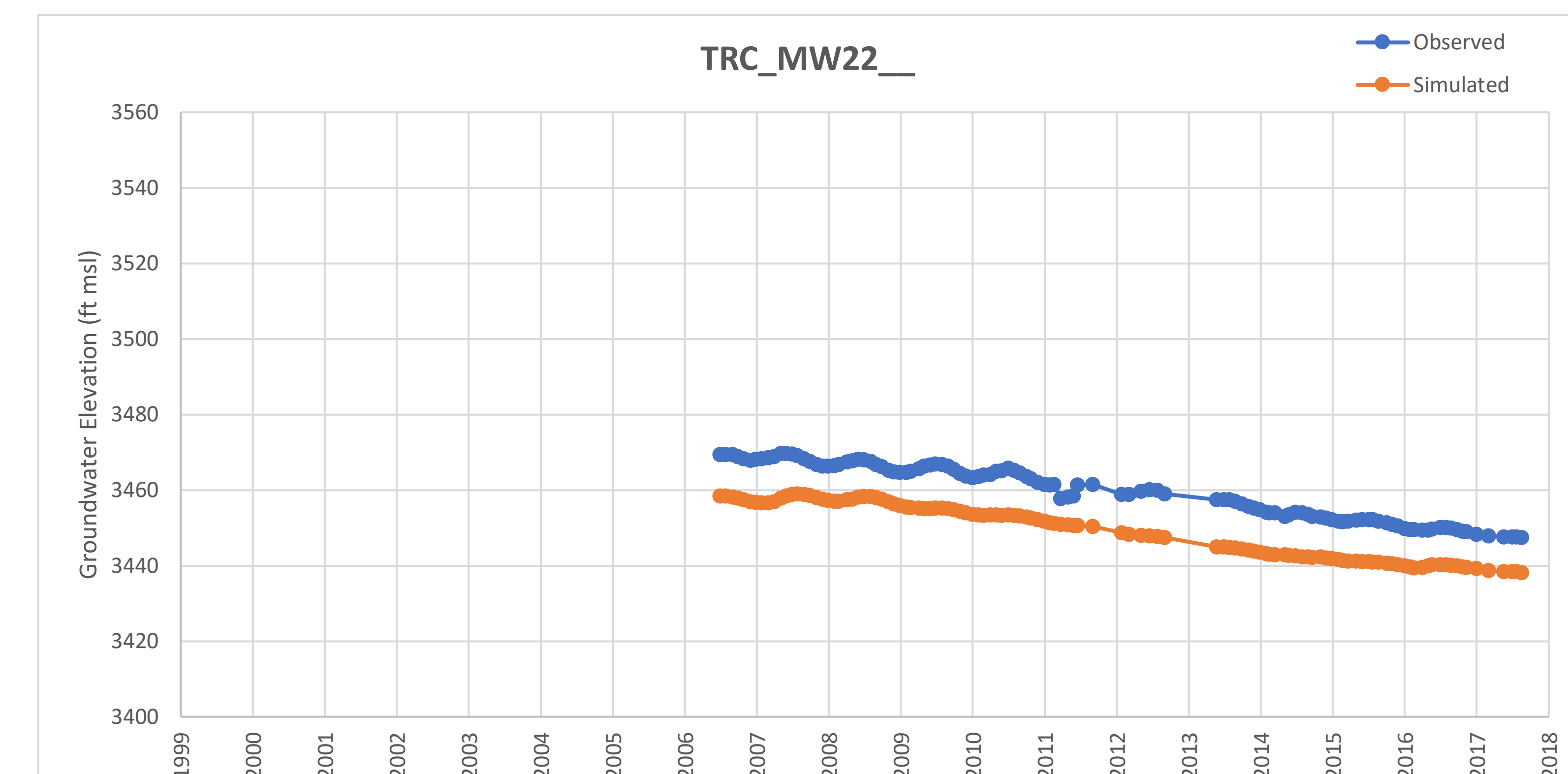
RMSE	7.10	ft	well:	TRC_MW18D_
Min	-17.2		area:	Main
Max	11.2		layer:	3
Average	3.7		cells:	1013:1129
Median	5.2			



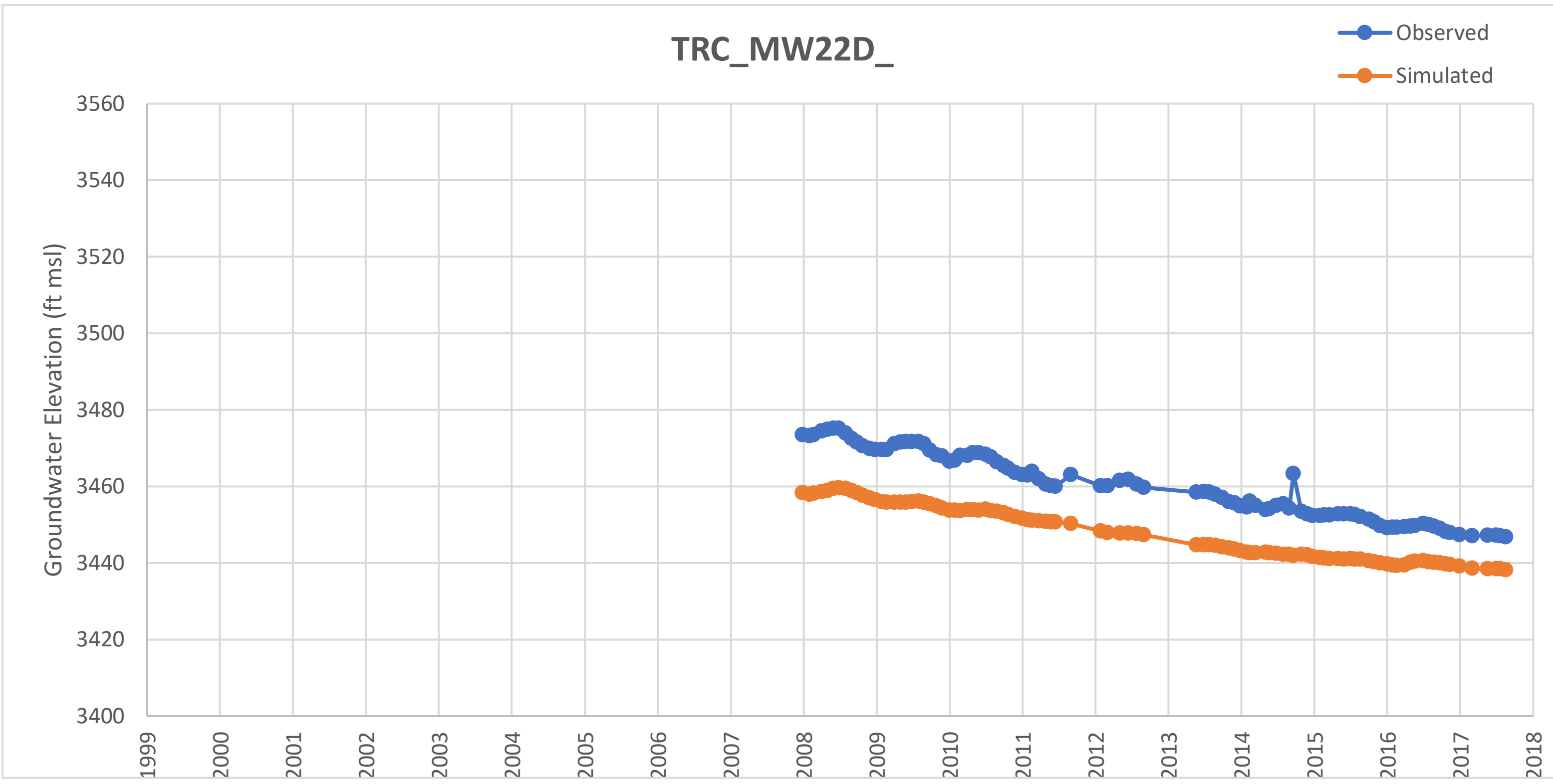
RMSE	4.52	ft	well:	TRC_MW2___
Min	-17.0		area:	Dryfield
Max	7.5		layer:	2
Average	1.7		cells:	1130:1328
Median	2.6			



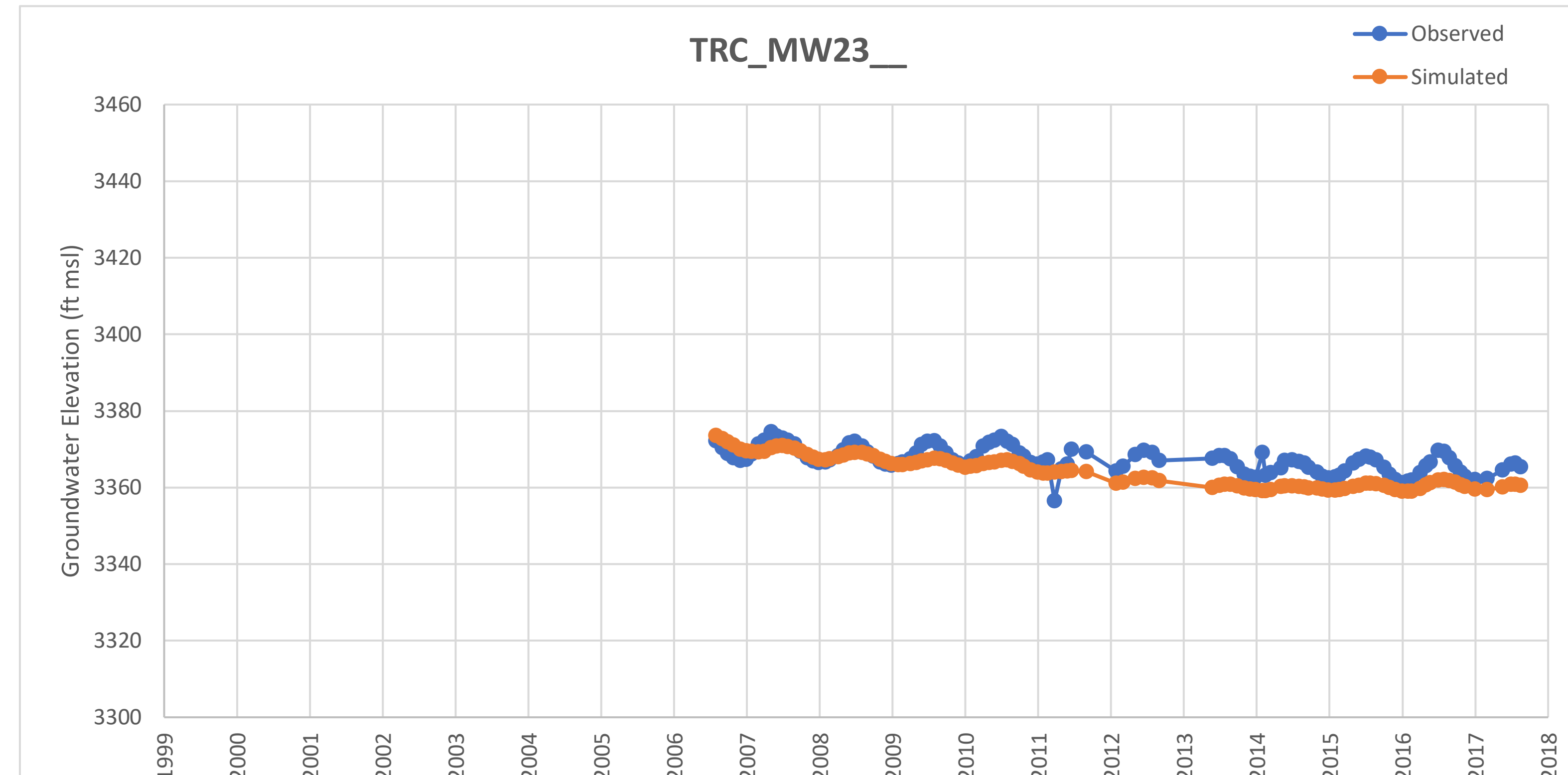
RMSE	6.63	ft	well:	TRC_MW20D_
Min	-15.5		area:	Main
Max	36.1		layer:	3
Average	3.9		cells:	1329:1445
Median	4.4			



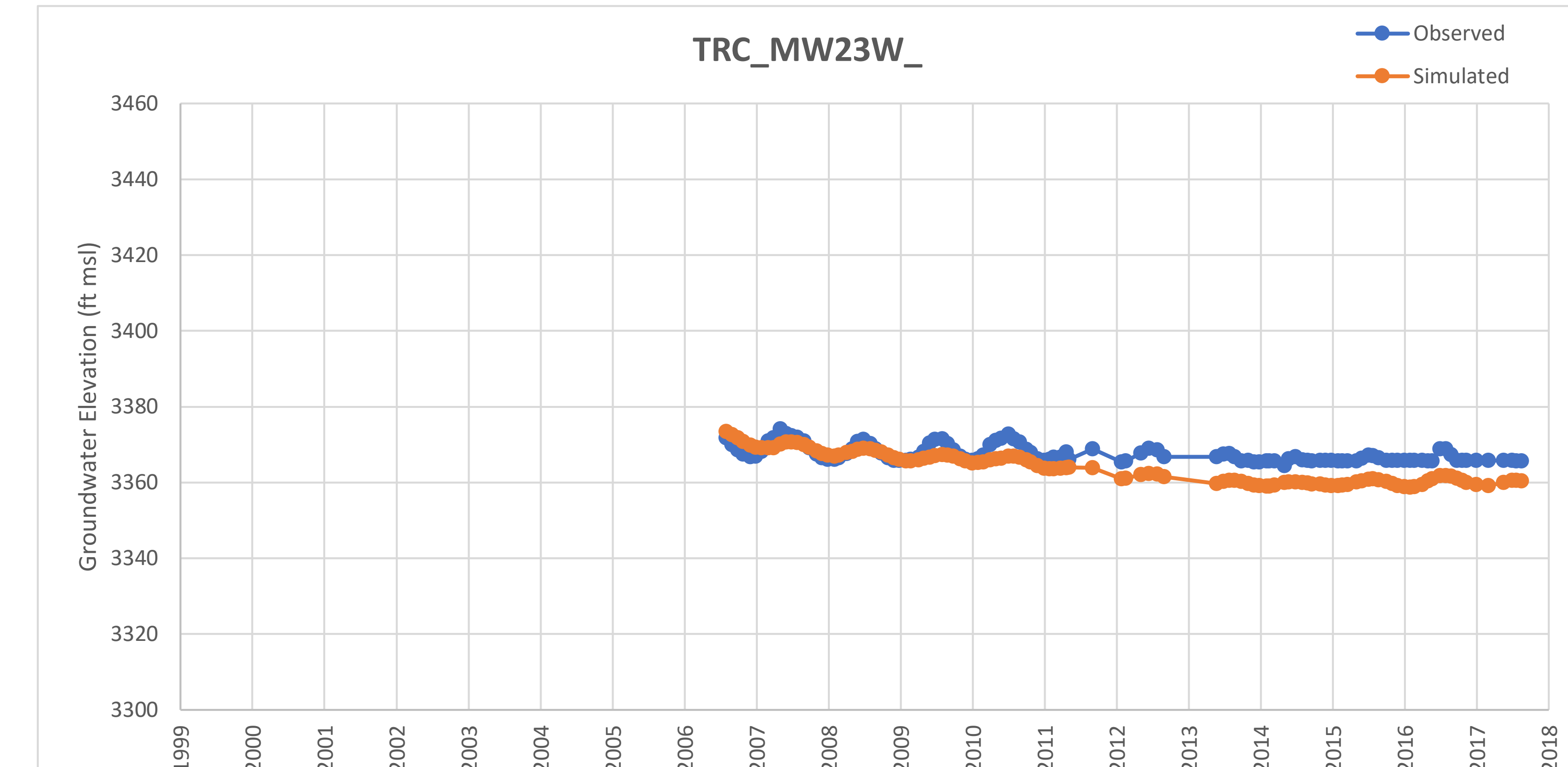
RMSE	10.48	ft	well:	TRC_MW22__
Min	-12.6		area:	Main
Max	-6.7		layer:	2
Average	-10.4		cells:	1446:1562
Median	-10.5			



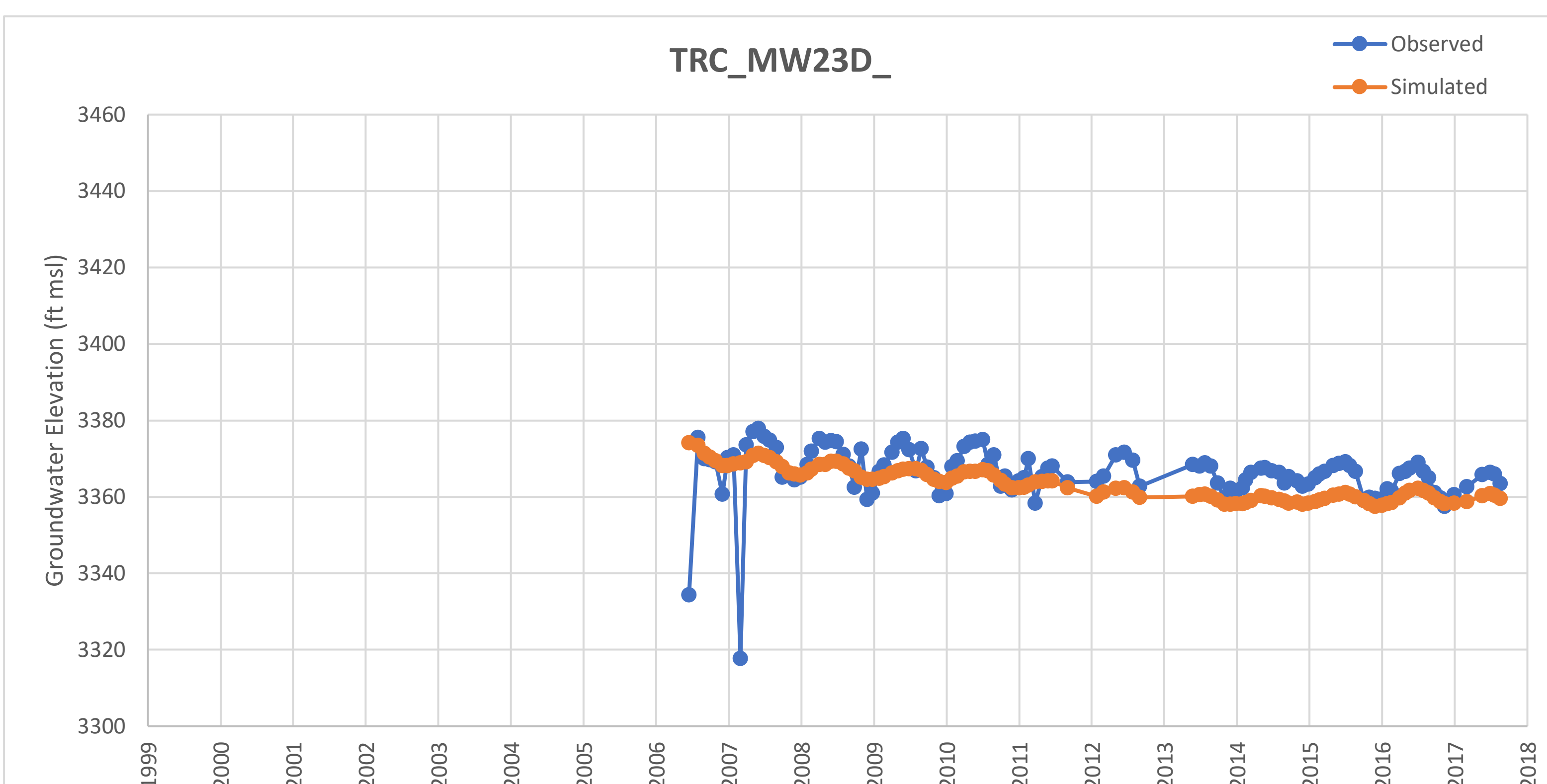
RMSE	12.54 ft		well:	TRC_MW22D_
Min	-21.3		area:	Main
Max	-8.3		layer:	3
Average	-12.3		cells:	1563:1661
Median	-12.3			



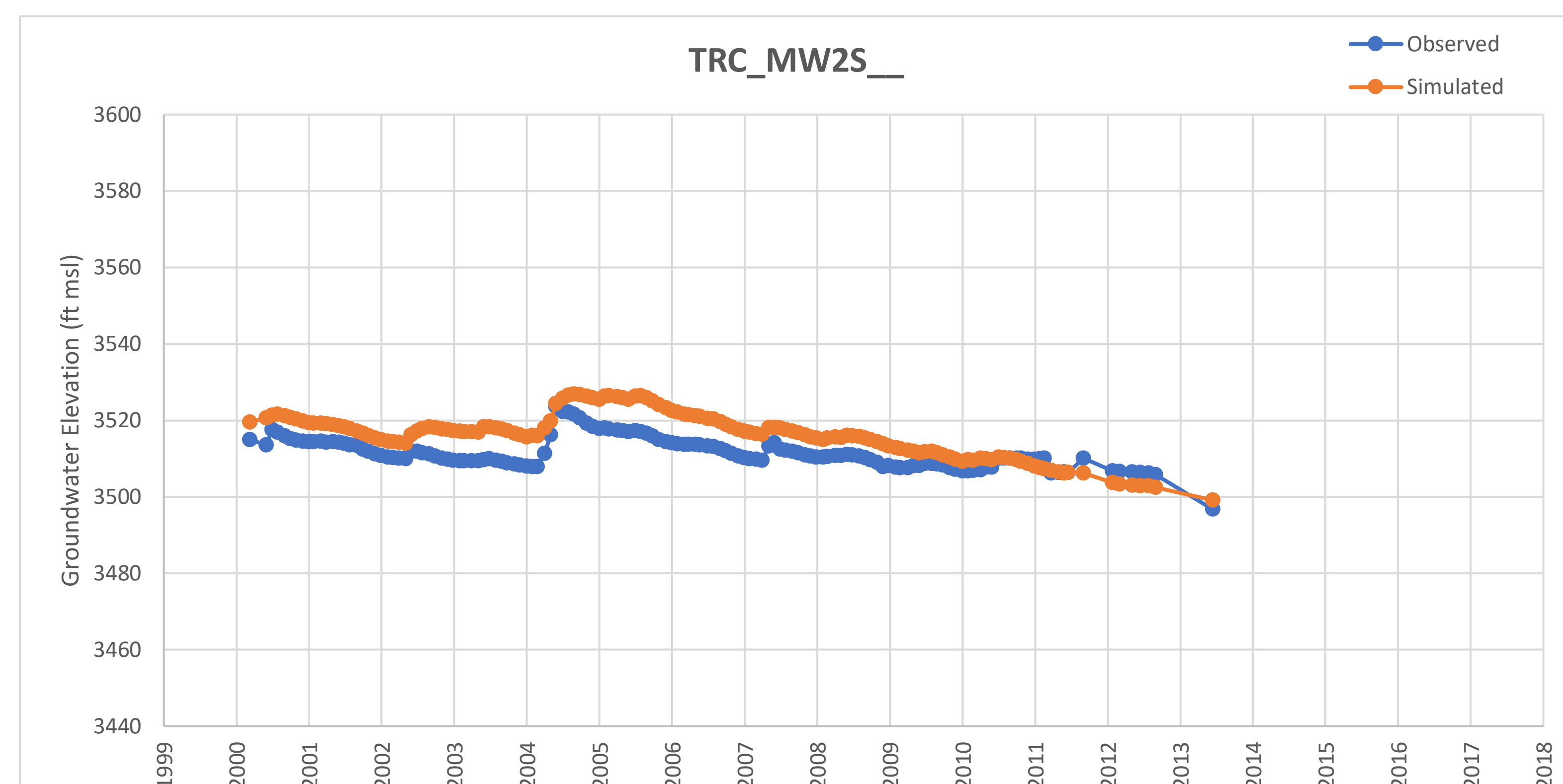
RMSE	4.25 ft		well:	TRC_MW23__
Min	-10.0		area:	GVC S
Max	7.4		layer:	2
Average	-3.1		cells:	1662:1777
Median	-3.3			



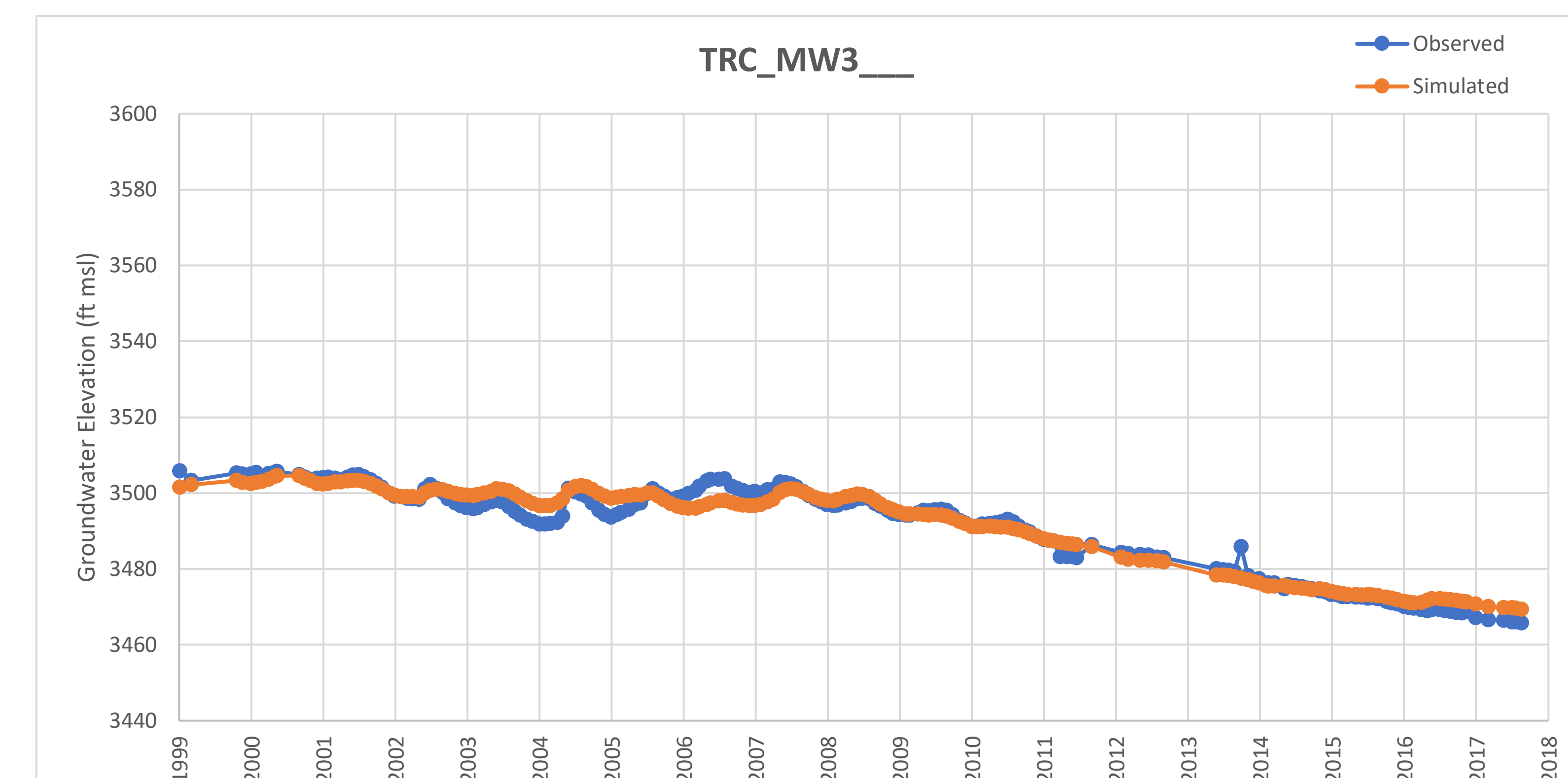
RMSE	4.62 ft		well:	TRC_MW23W_
Min	-7.2		area:	GVC S
Max	3.4		layer:	2
Average	-3.6		cells:	1778:1892
Median	-4.6			



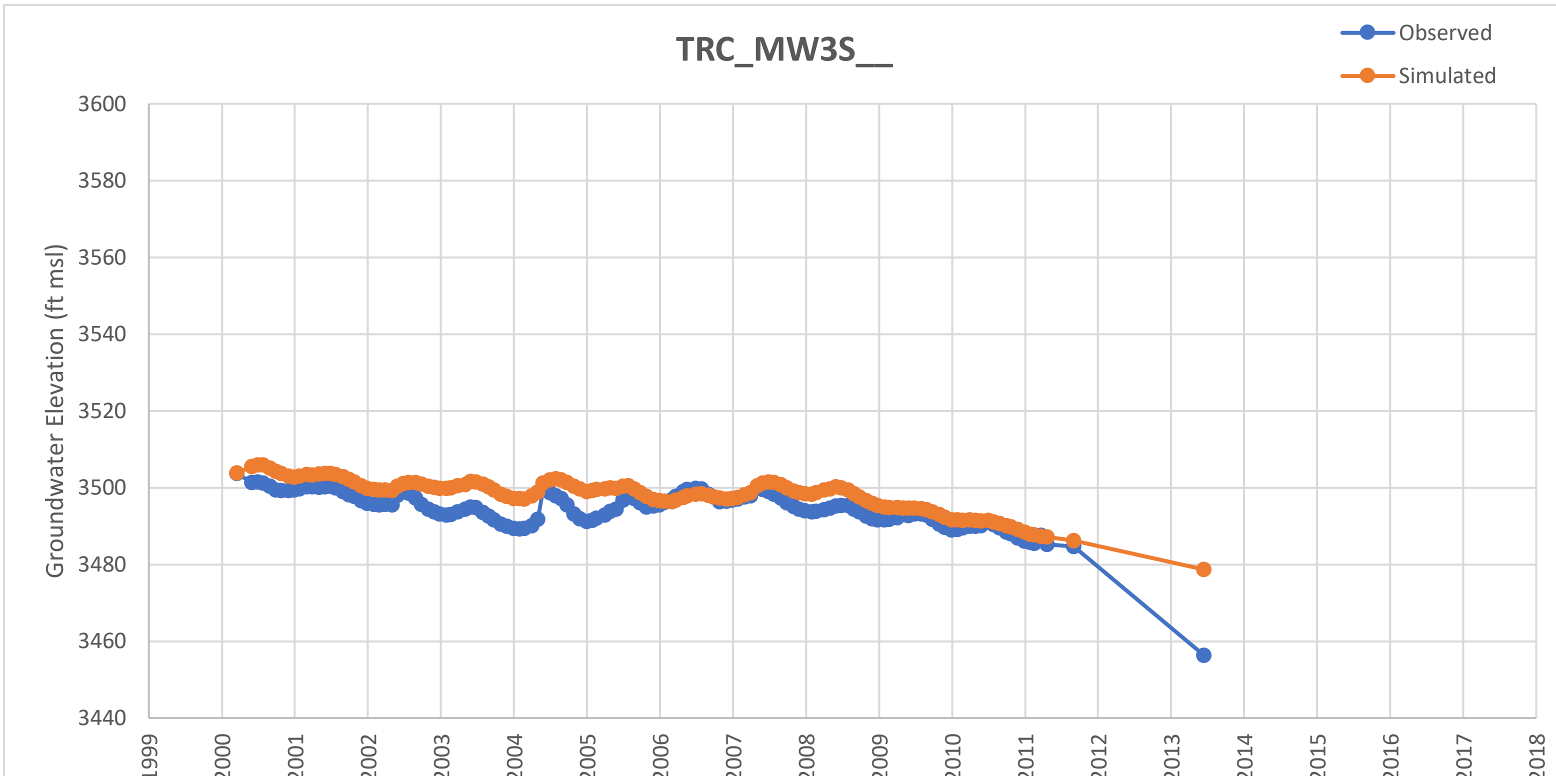
RMSE	7.85 ft		well:	TRC_MW23D_
Min	-9.4		area:	GVC S
Max	51.3		layer:	3
Average	-2.9		cells:	1893:2009
Median	-4.2			



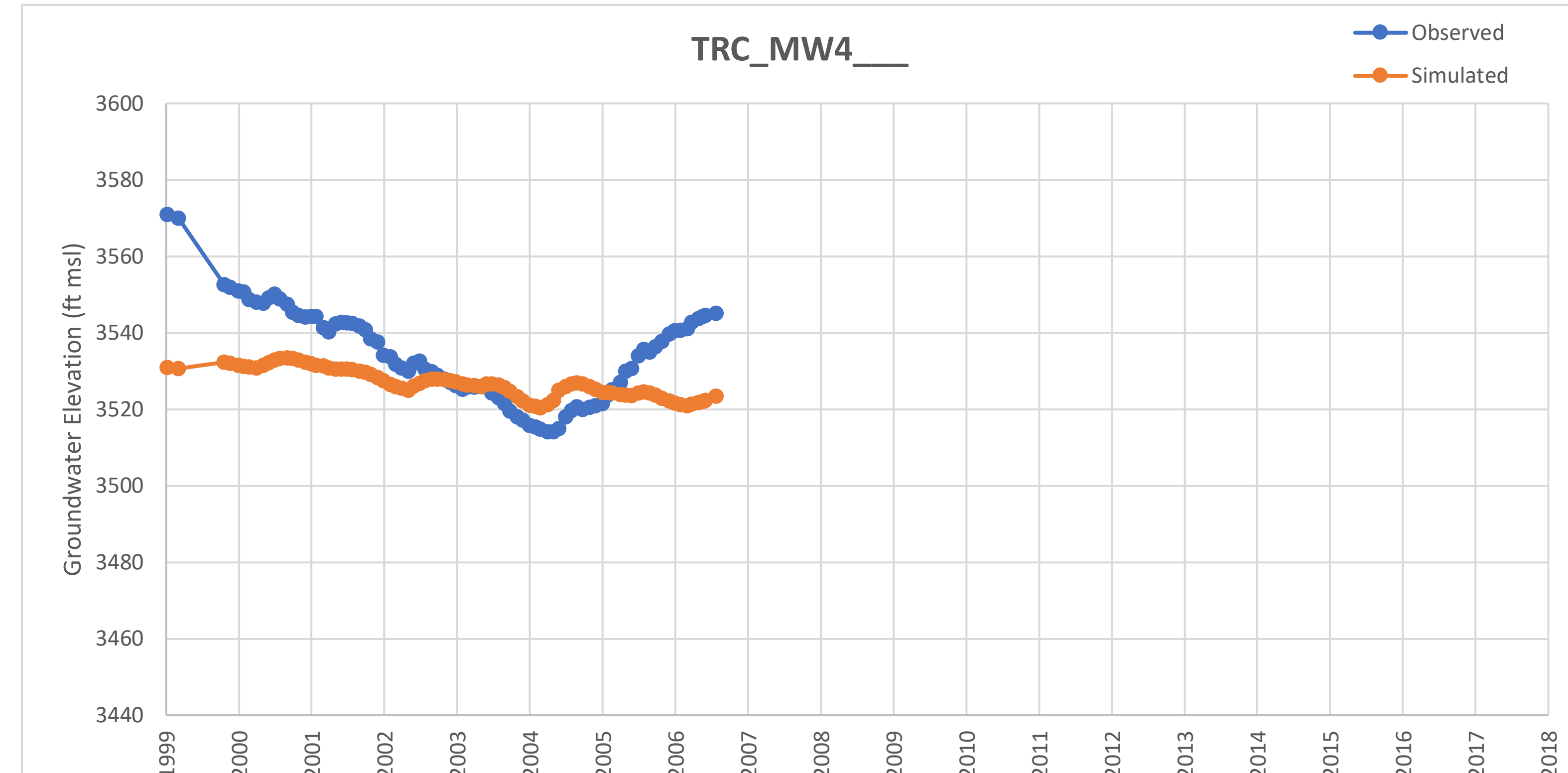
RMSE	5.73 ft		well:	TRC_MW2S__
Min	-3.9		area:	Dryfield
Max	9.3		layer:	2
Average	4.8		cells:	2010:2152
Median	5.1			



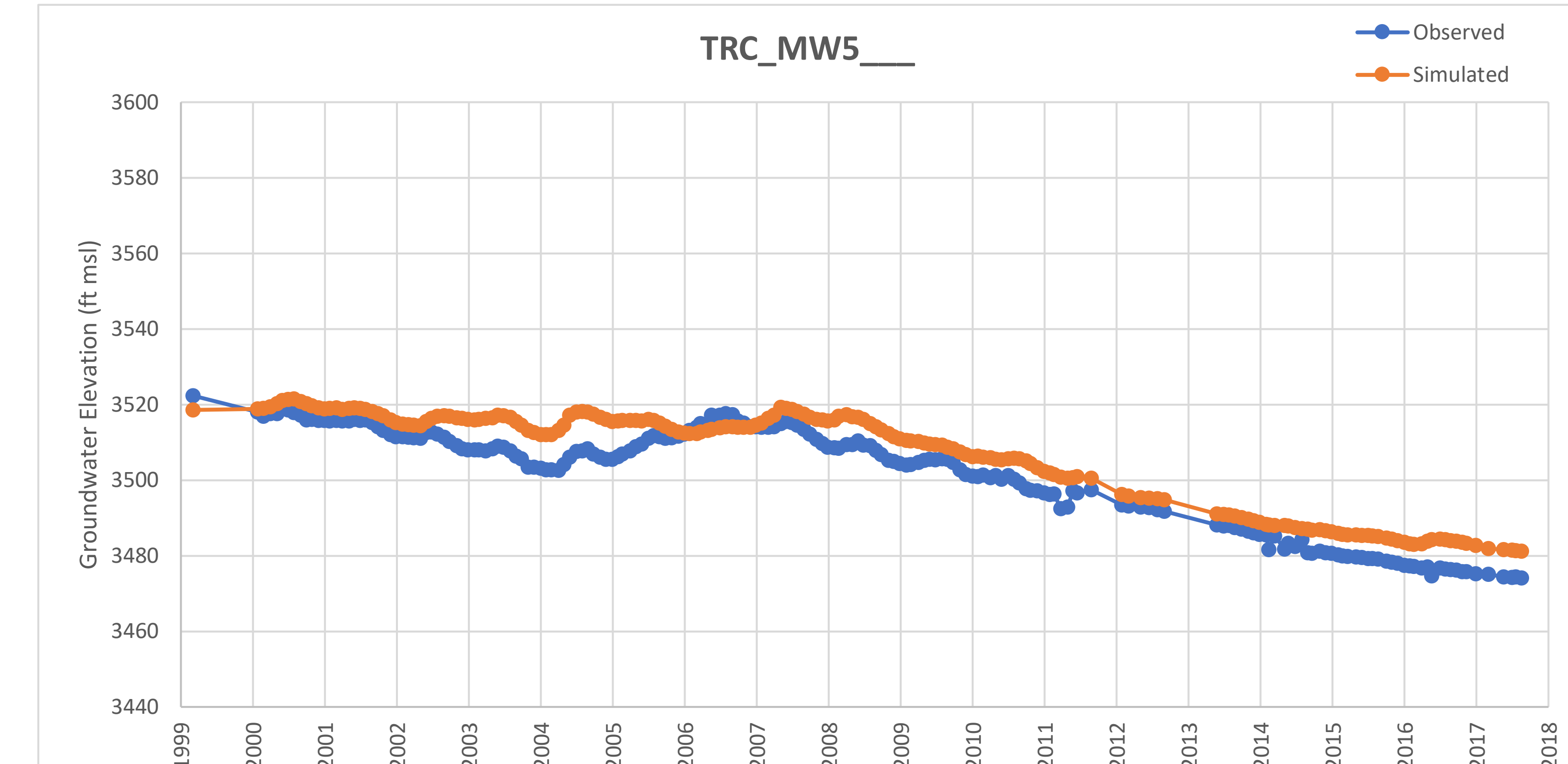
RMSE	2.50 ft	well:	TRC_MW3___	(no dry)	RMSE	2.50 ft
Min	-8.3	area:	Main		Min	-8.3
Max	5.1	layer:	2		Max	5.1
Average	0.2	cells:	2153:2349		Average	0.2
Median	0.0				Median	0.0



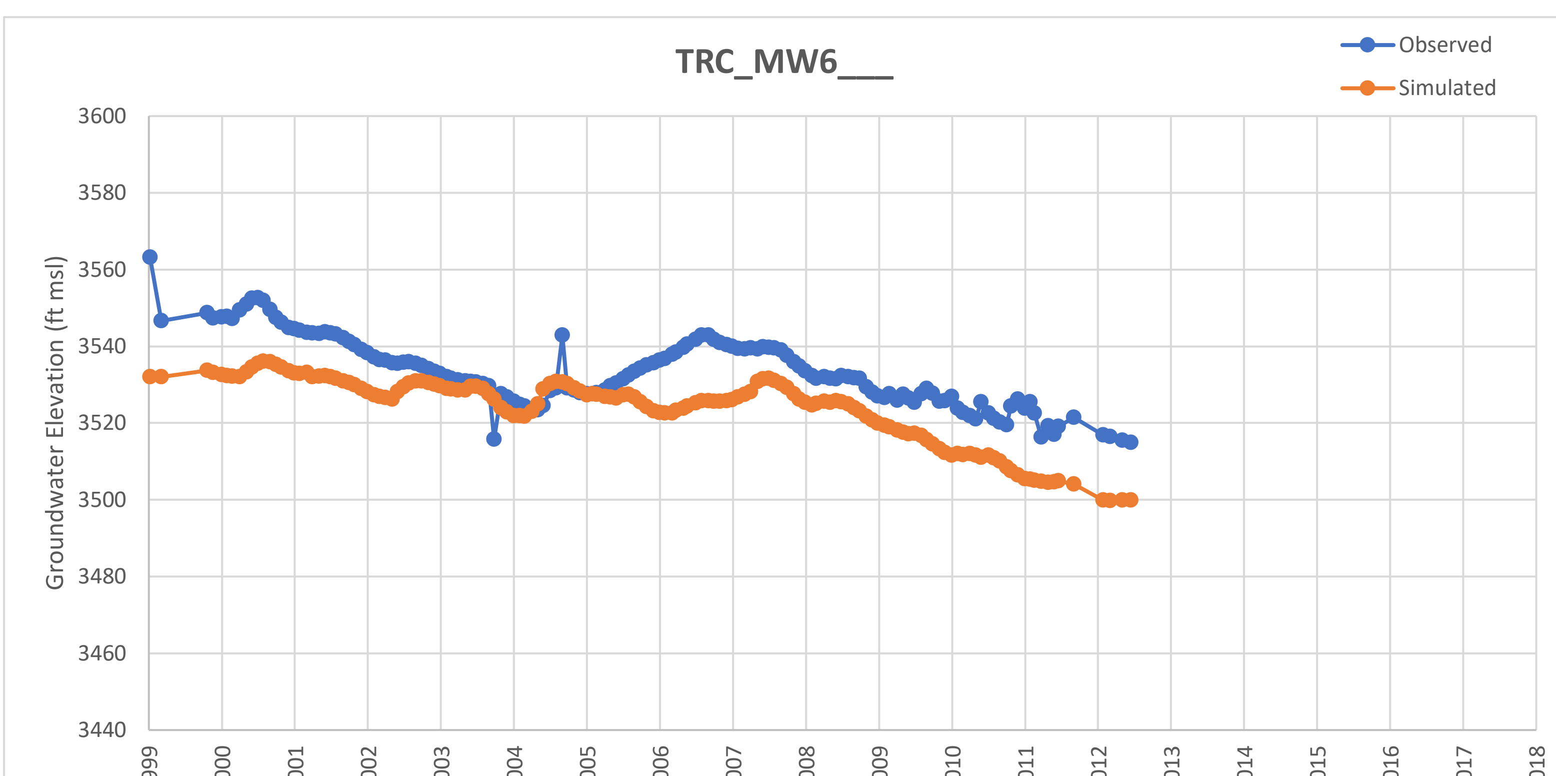
RMSE	4.63	ft	well:	TRC_MW3S__
Min	-1.7		area:	Main
Max	22.3		layer:	2
Average	3.6		cells:	2350:2484
Median	3.5			



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			



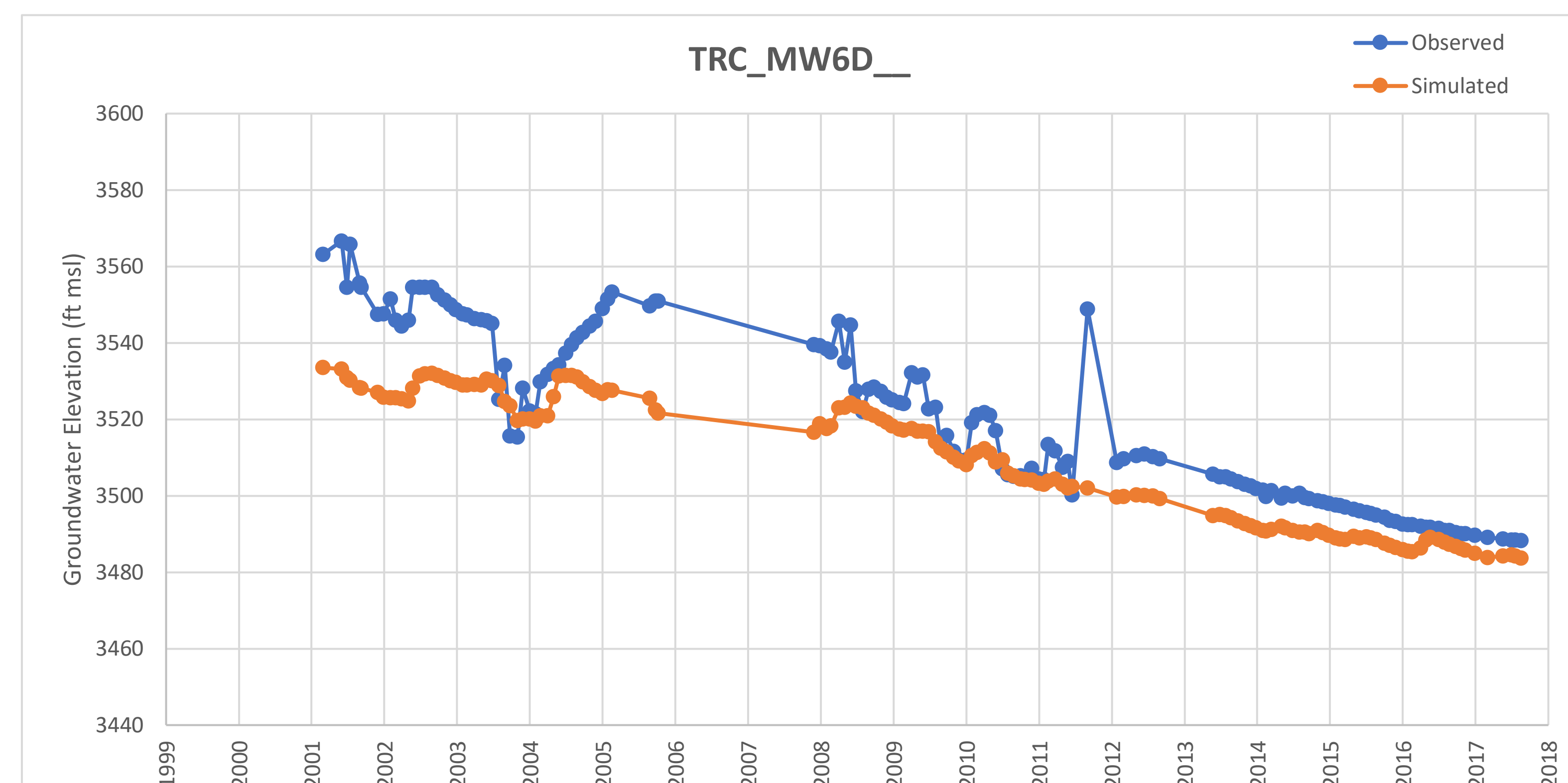
RMSE	5.86	ft	well:	TRC_MW5___
Min	-3.8		area:	Main
Max	11.1		layer:	2
Average	5.0		cells:	2569:2763
Median	5.4			



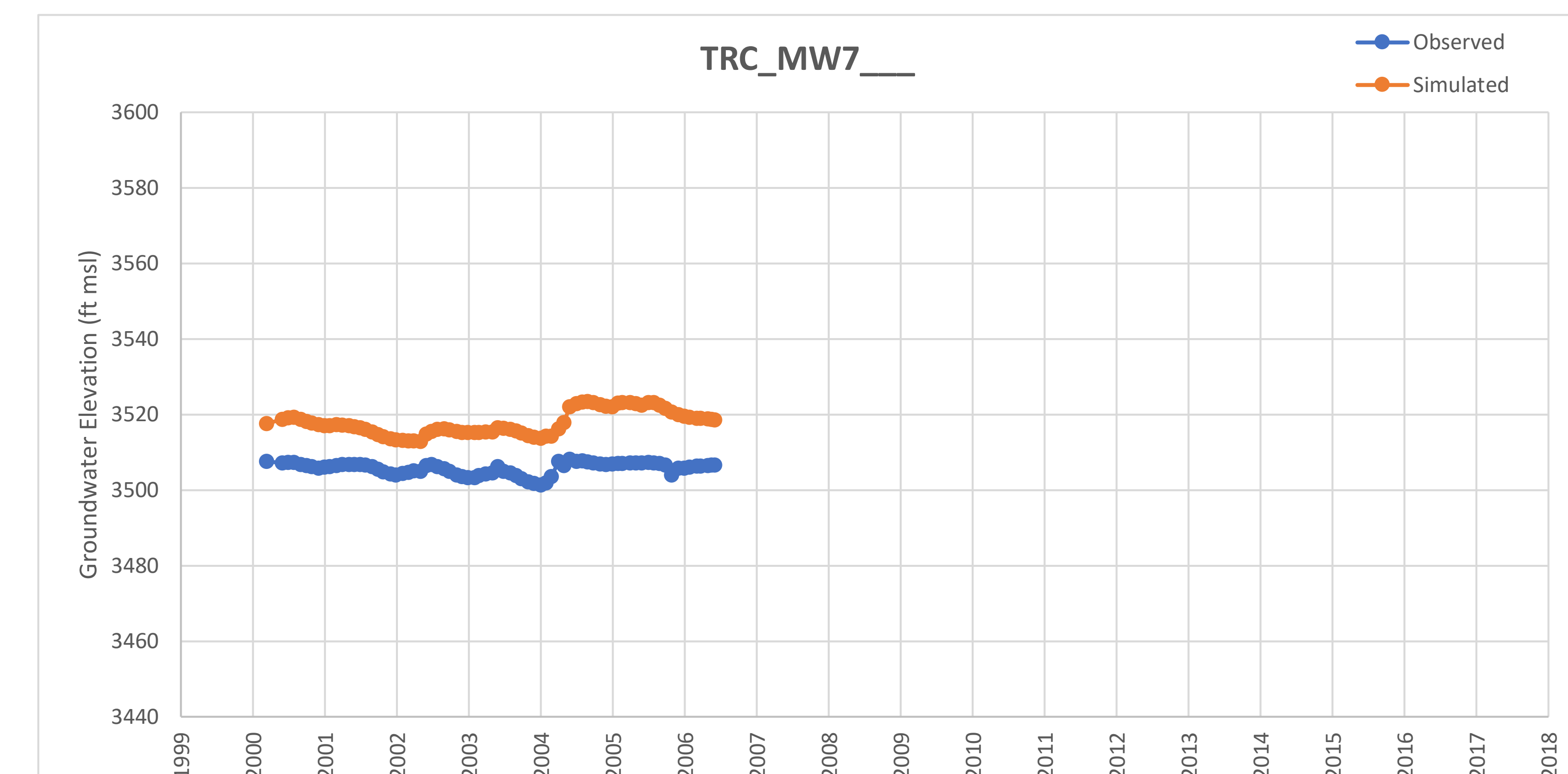
RMSE	11.18	ft	well:	TRC_MW6___
Min	-31.1		area:	Main
Max	10.5		layer:	2
Average	-9.5		cells:	2764:2911
Median	-10.1			

(no dry)

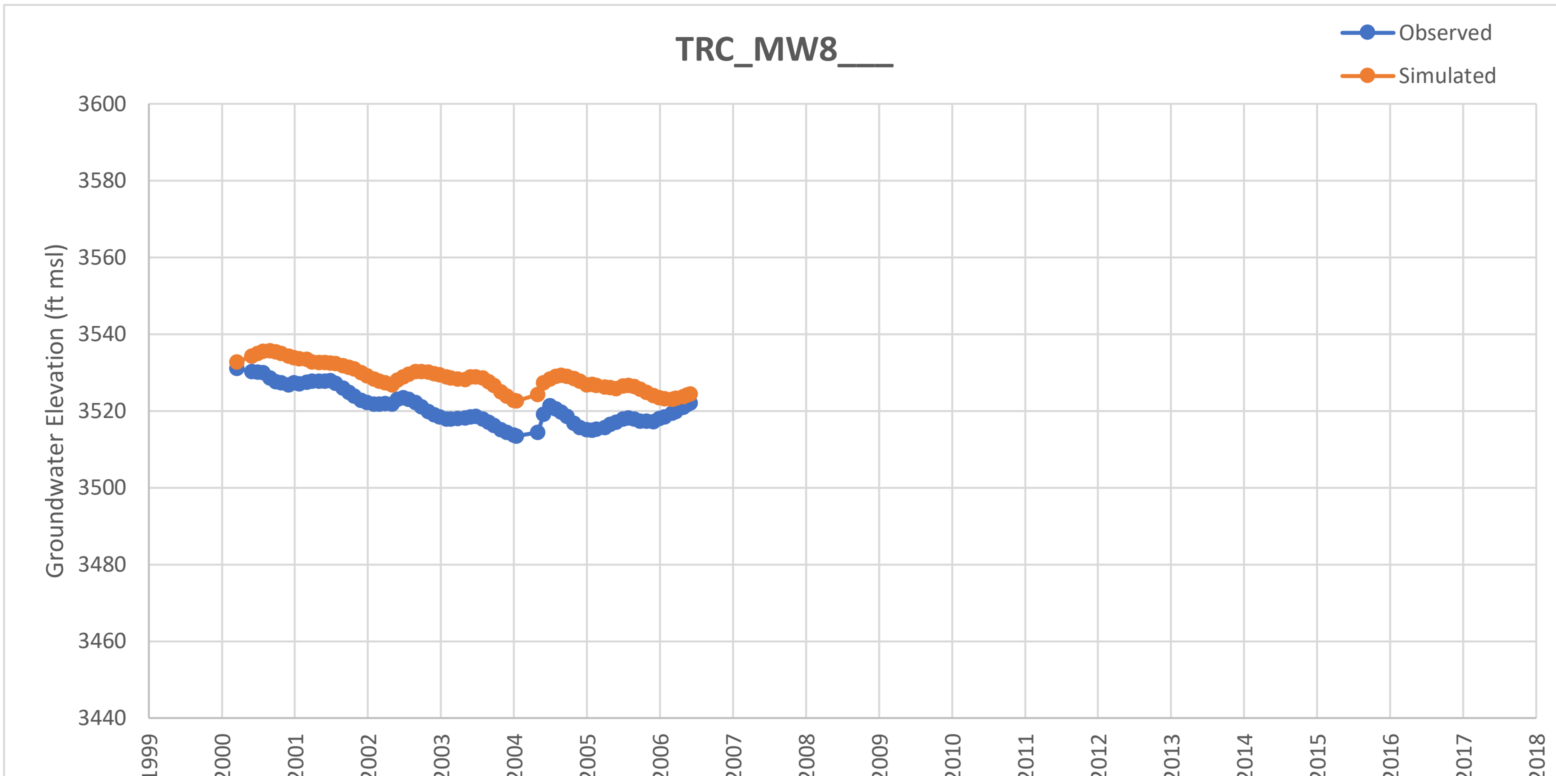
RMSE	11.18	ft
Min	-31.1	
Max	10.5	
Average	-9.5	
Median	-10.1	



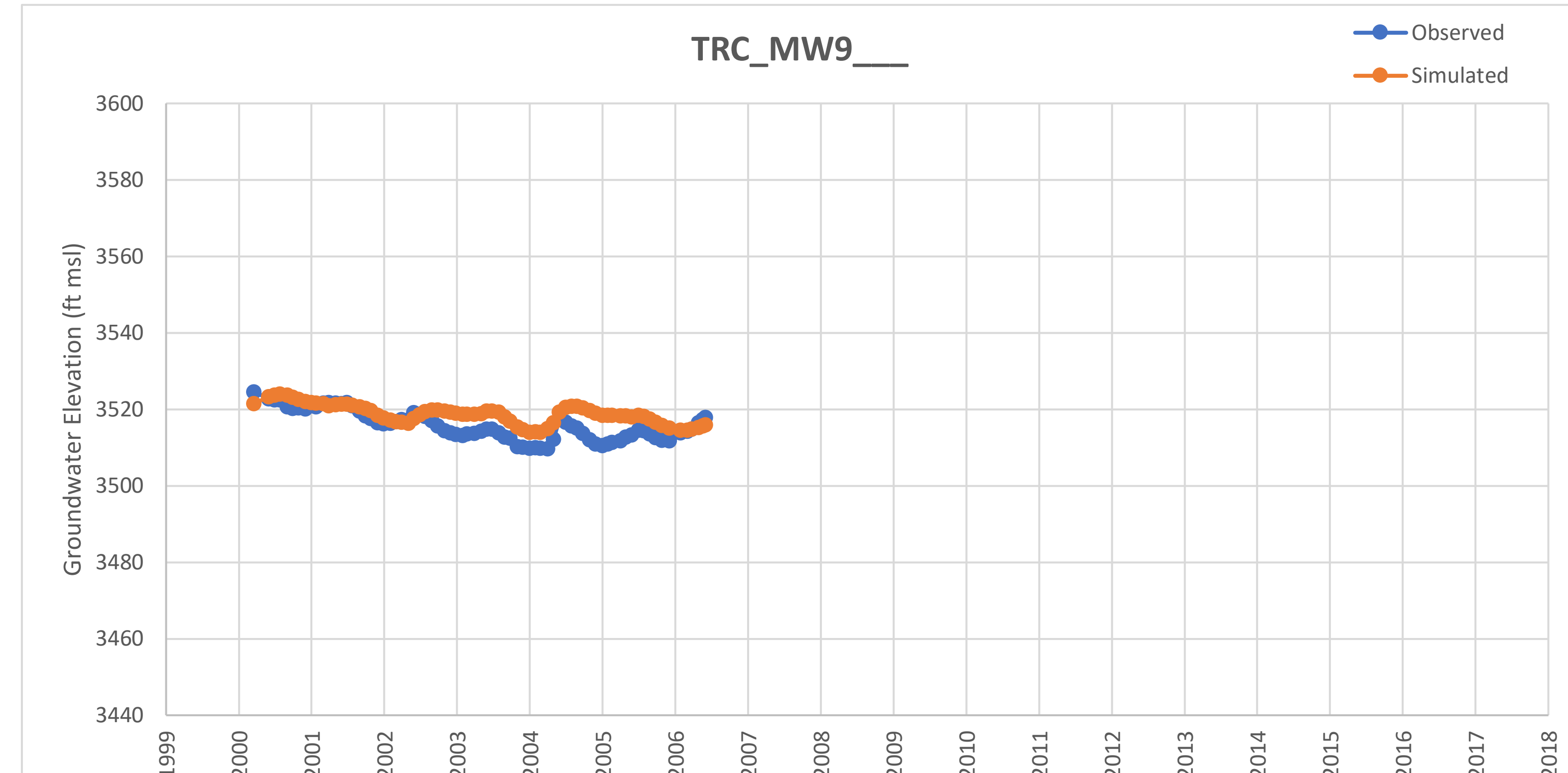
RMSE	14.03	ft	well:	TRC_MW6D__
Min	-46.8		area:	Main
Max	8.0		layer:	3
Average	-11.0		cells:	2912:3060
Median	-9.0			



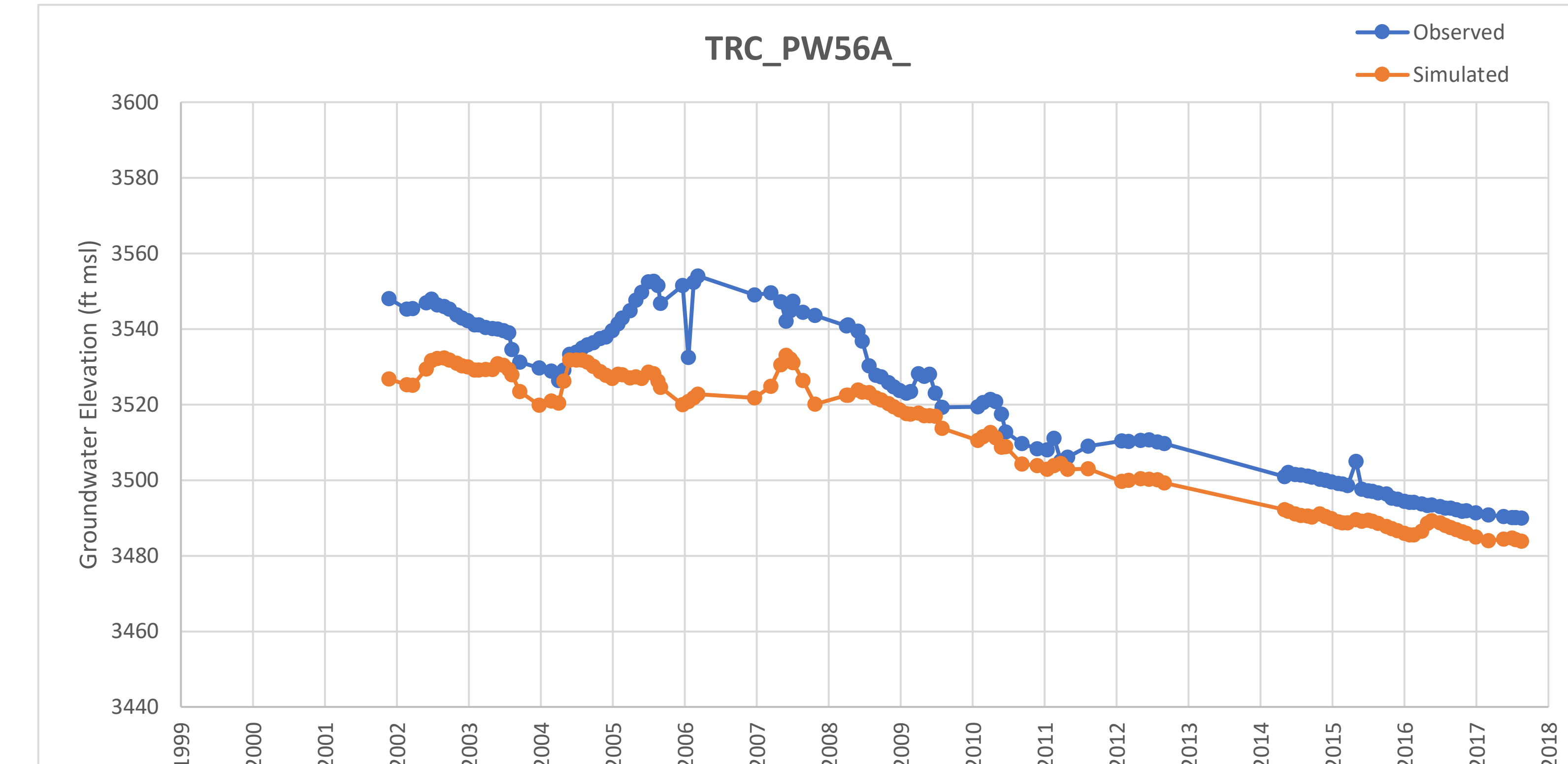
RMSE	12.28	ft	well:	TRC_MW7___
Min	7.9		area:	Dryfield
Max	16.7		layer:	2
Average	12.0		cells:	3061:3135
Median	11.7			



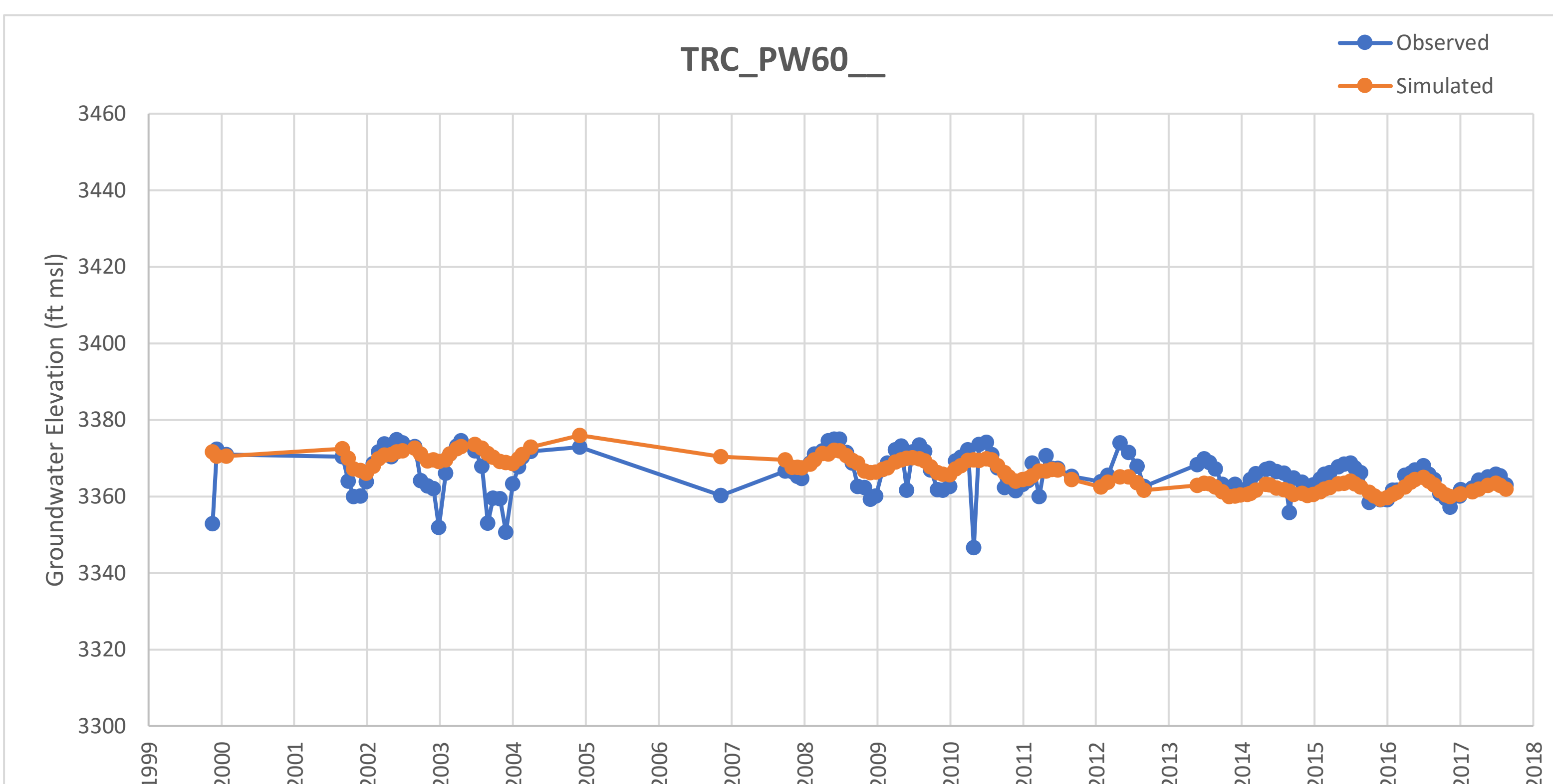
RMSE	8.10	ft	well:	**TRC_MW8___**
Min	1.7		area:	Main
Max	12.0		layer:	2
Average	7.7		cells:	3136:3208
Median	7.7			



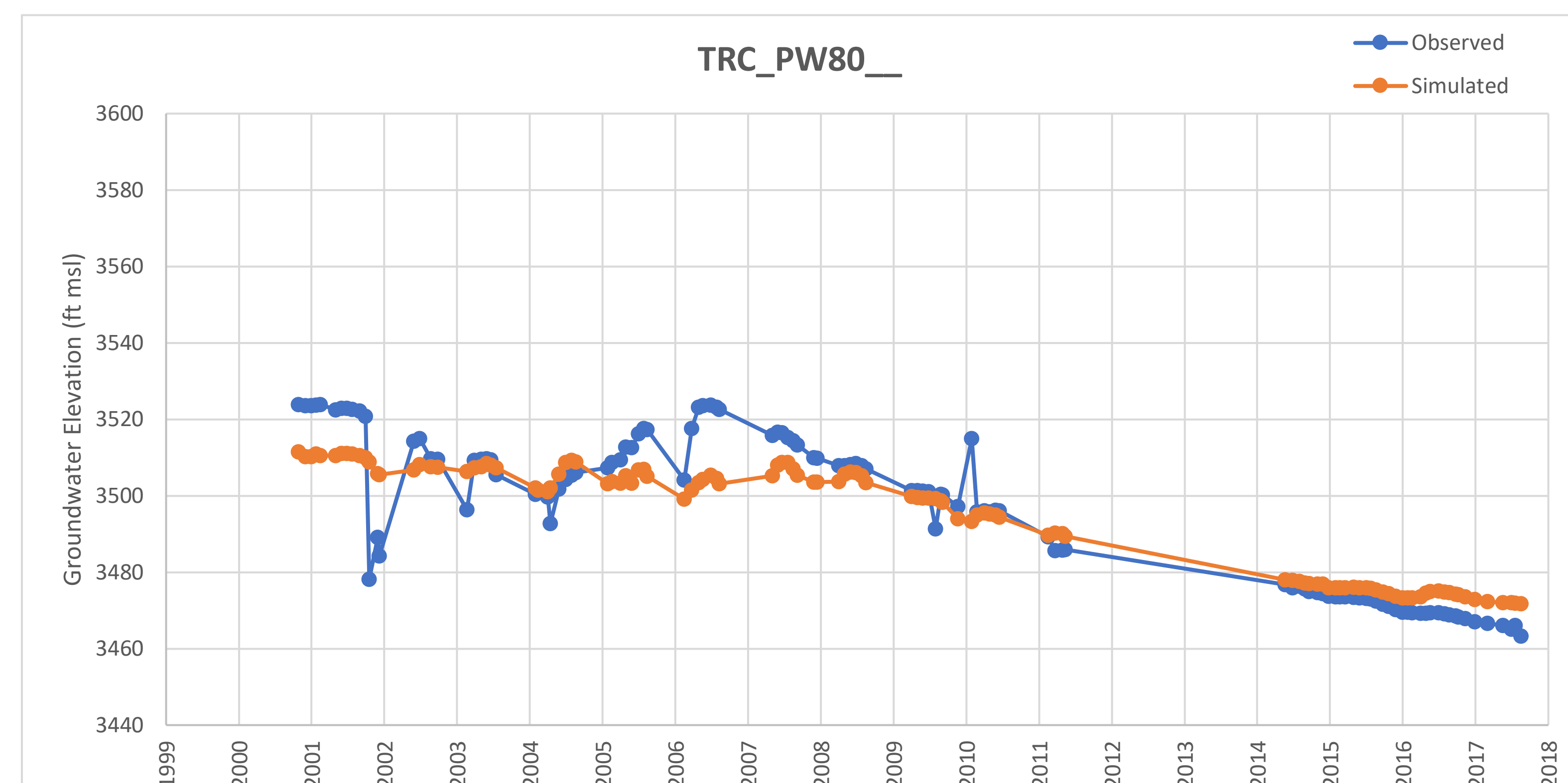
RMSE	3.95	ft	well:	**TRC_MW9___**
Min	-3.1		area:	Main
Max	8.1		layer:	2
Average	2.9		cells:	3209:3282
Median	3.5			



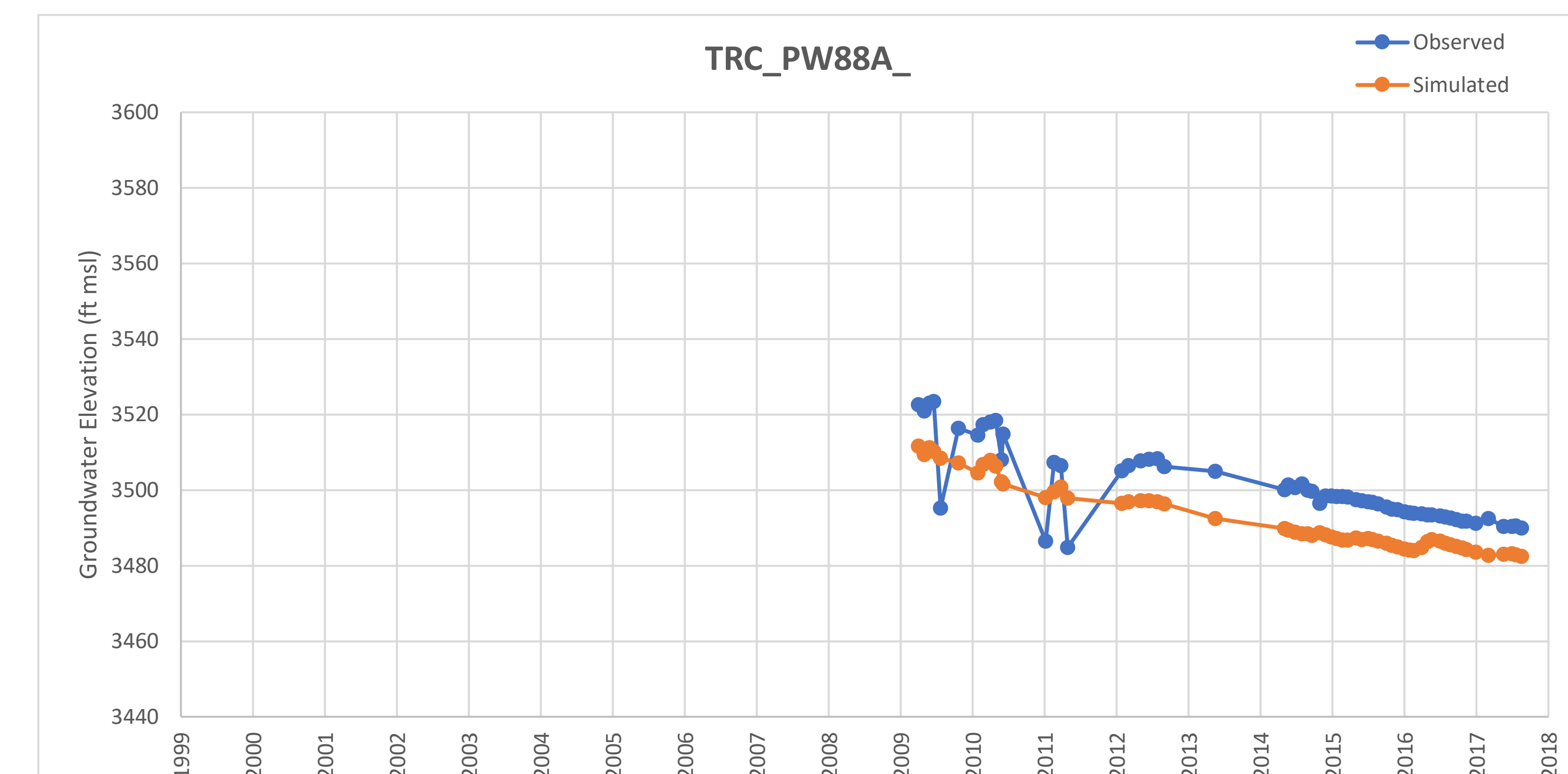
RMSE	12.56	ft	well:	**TRC_PW56A_**
Min	-31.6		area:	Main
Max	-0.6		layer:	3
Average	-10.9		cells:	3283:3409
Median	-9.5			



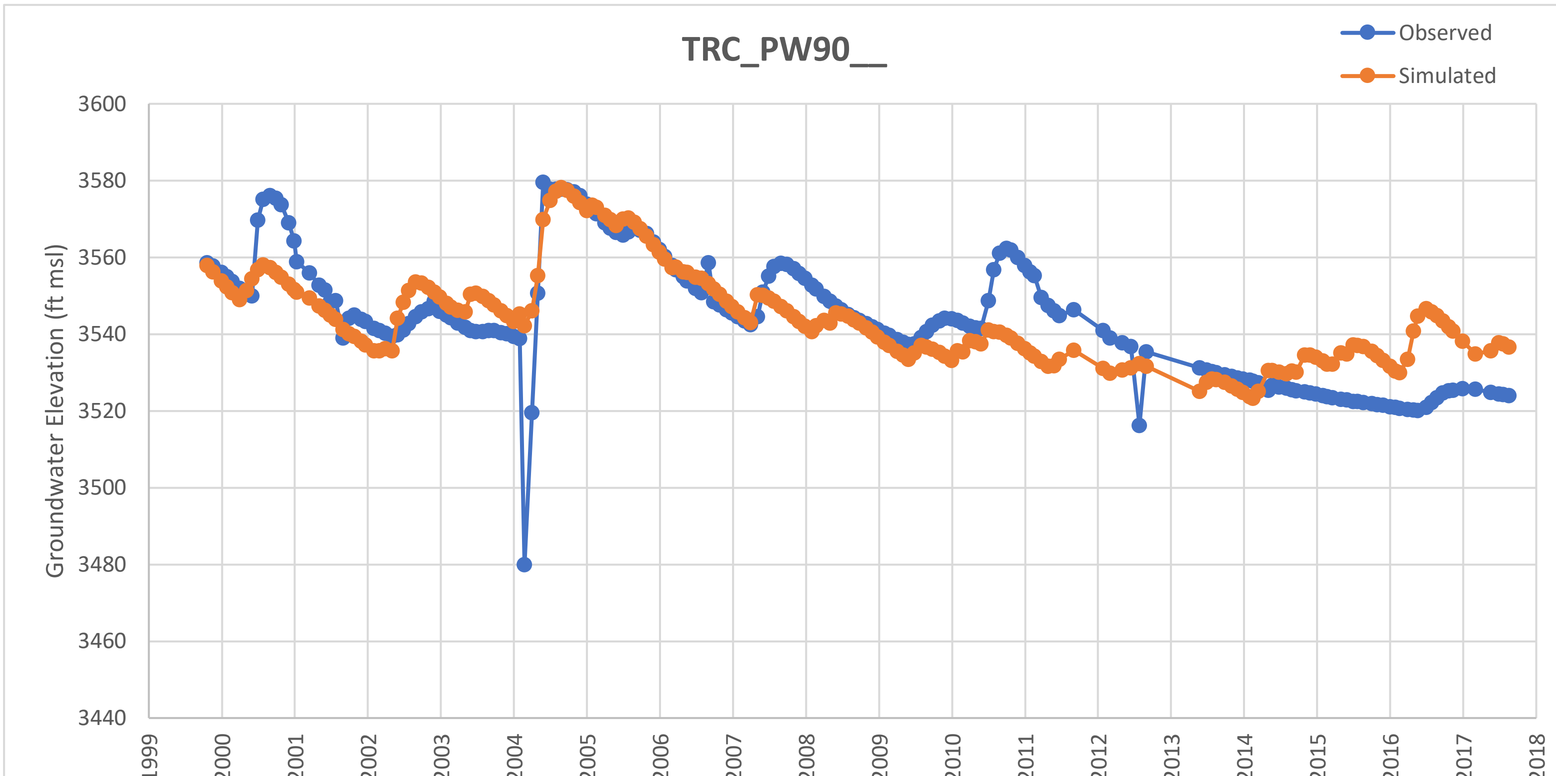
RMSE	5.18	ft	well:	**TRC_PW60__**
Min	-8.8		area:	GVC S
Max	22.9		layer:	3
Average	0.4		cells:	3410:3549
Median	-1.0			



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
□ 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 ($): 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: ____________

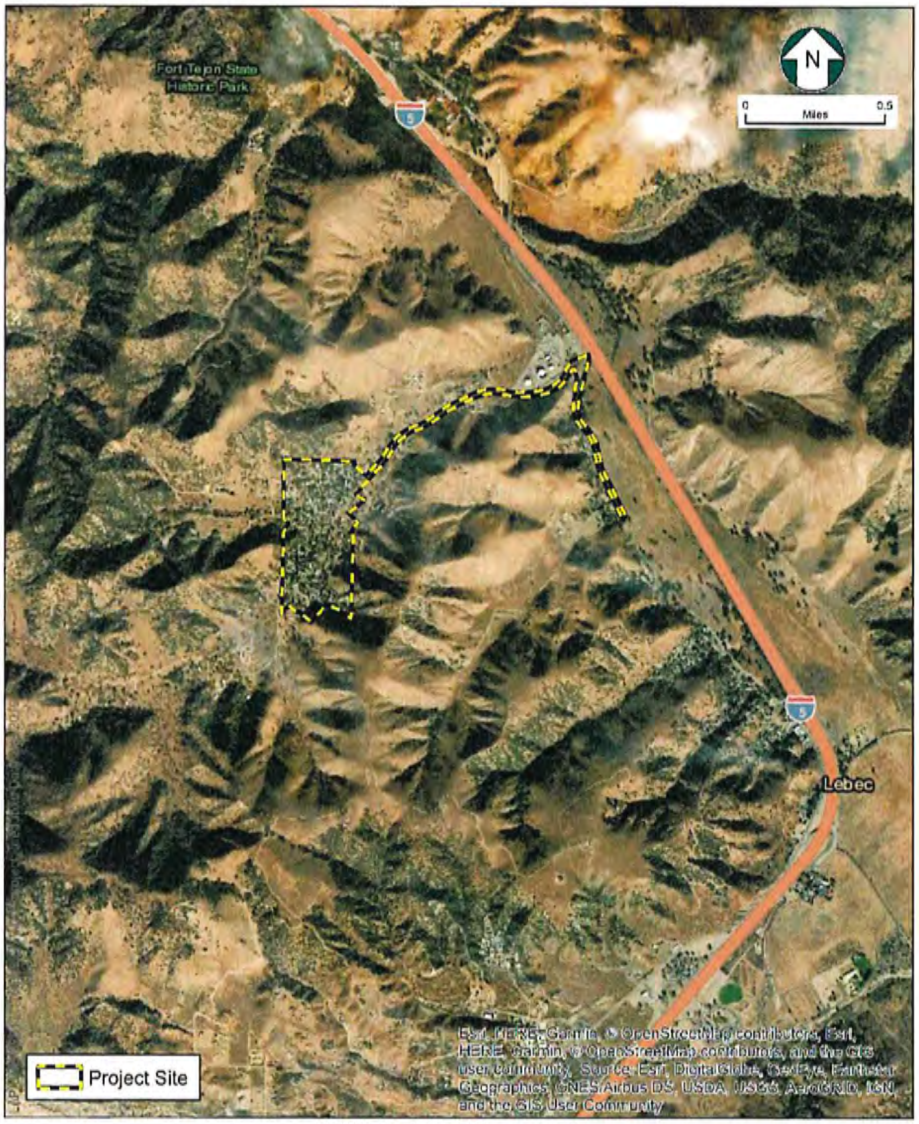
ADDITIONAL DETAILS (as necessary):

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:

5080 California Avenue, Suite 220
Bakersfield, CA 93309
Contact: Cathy Williams, P.E.
Phone: (661) 616-2600

June 2019

Project #170228

Table of Contents

Appendices

List of Figures

List of Tables

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.

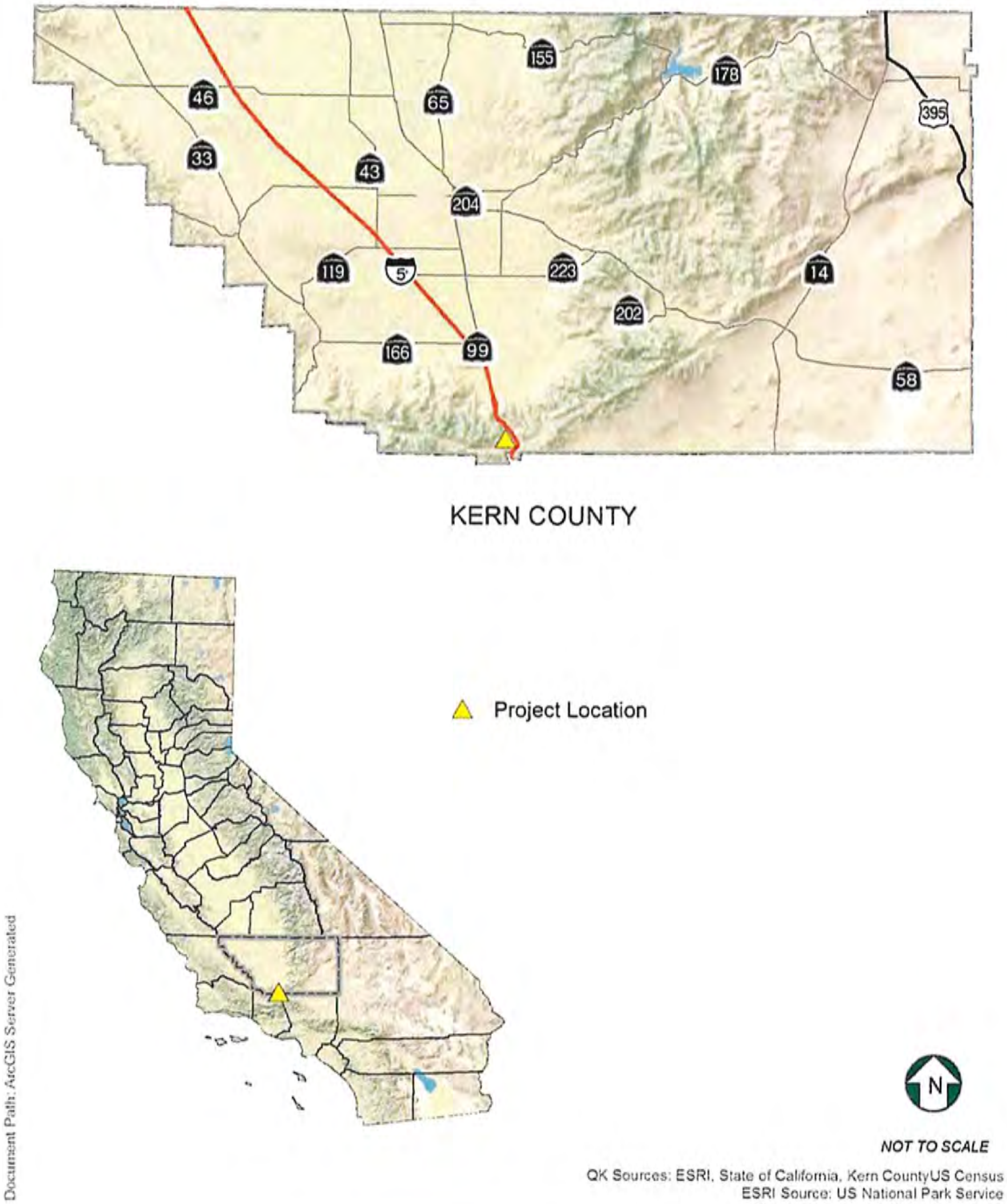


Figure 2-1
Regional Location

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.

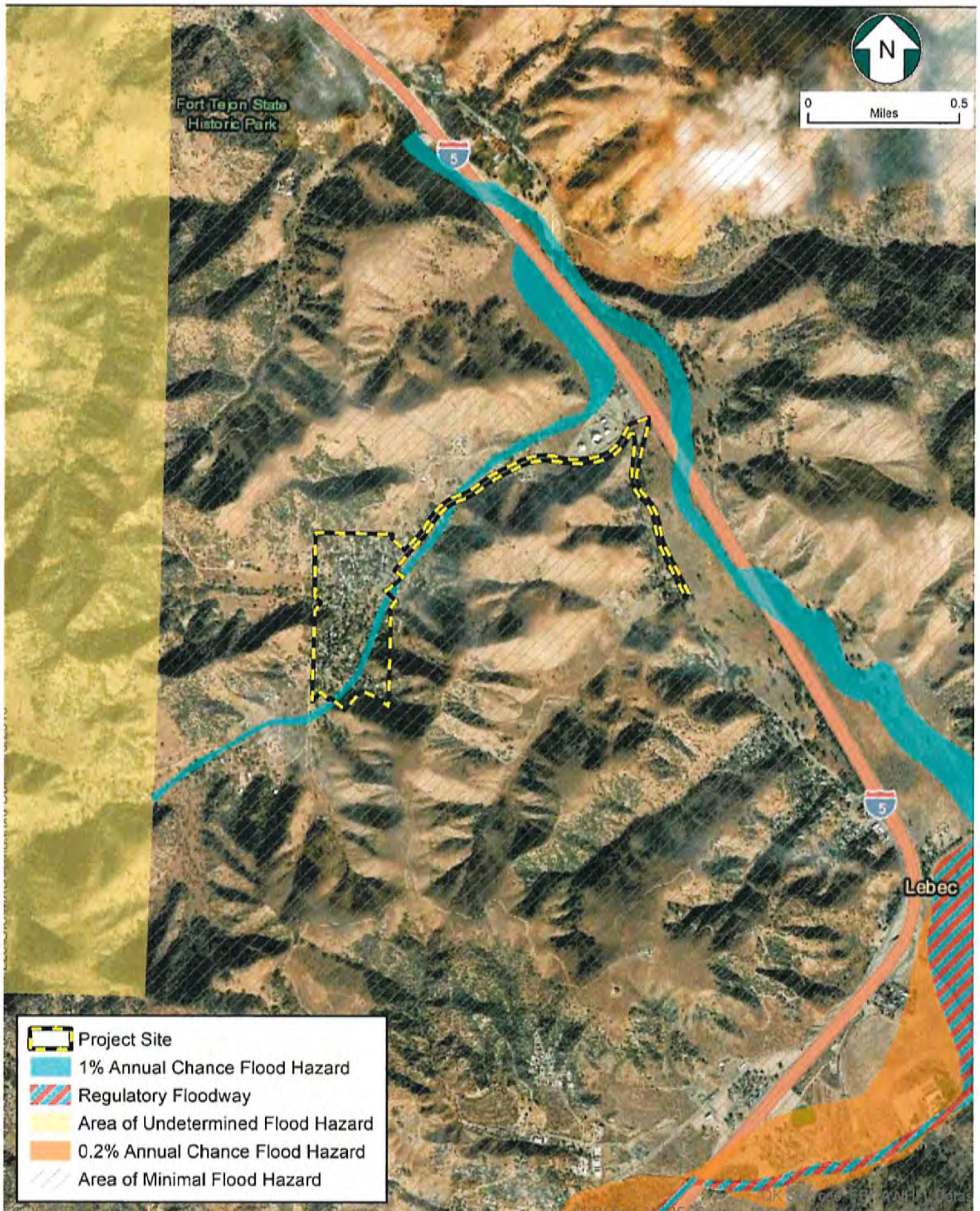


Figure 2-3
FEMA Flood Insurance Rate Map

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.

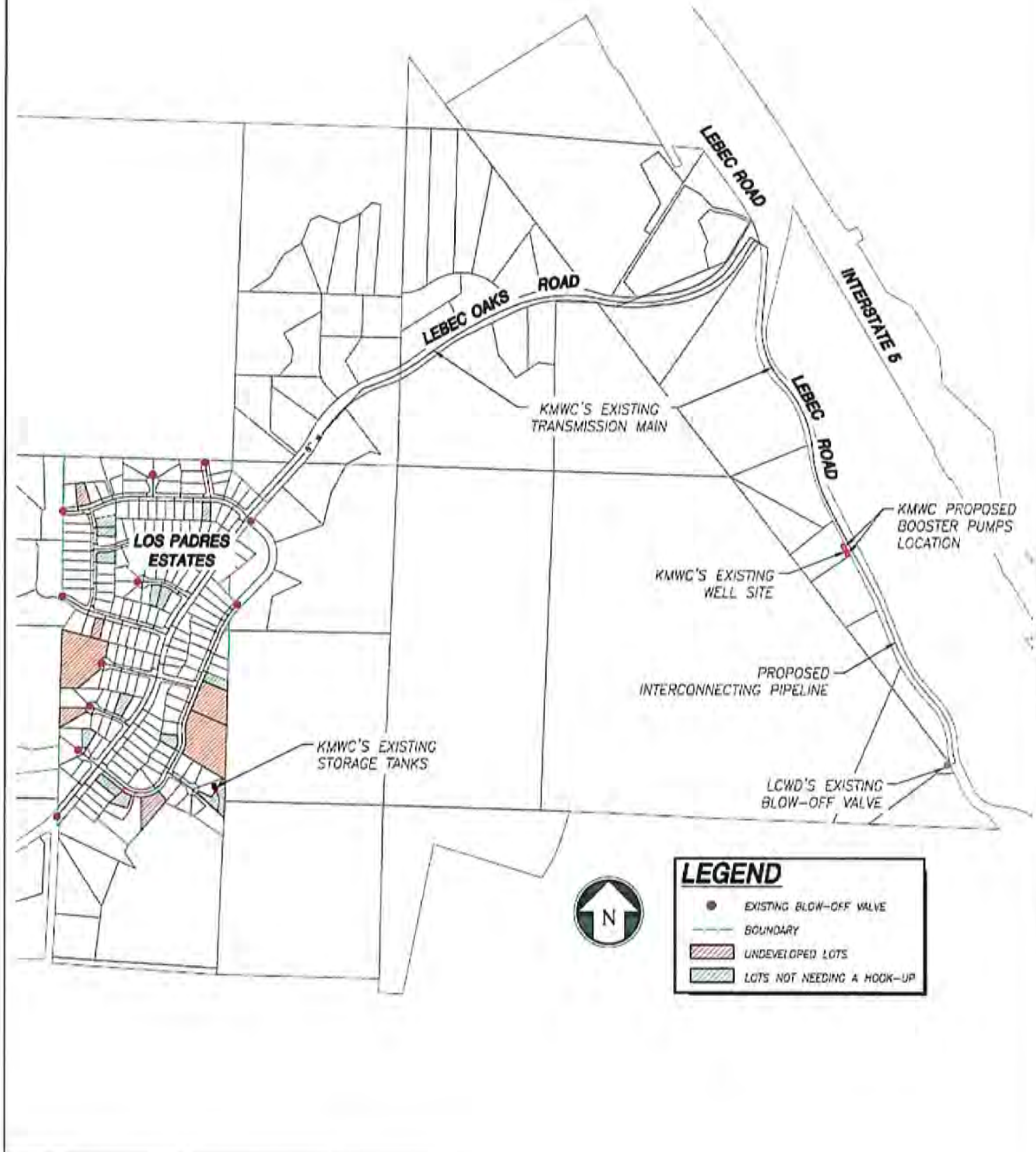


Figure 3-1
Alternative I: Consolidation with LCWD Project Area

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.

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

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.

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

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.

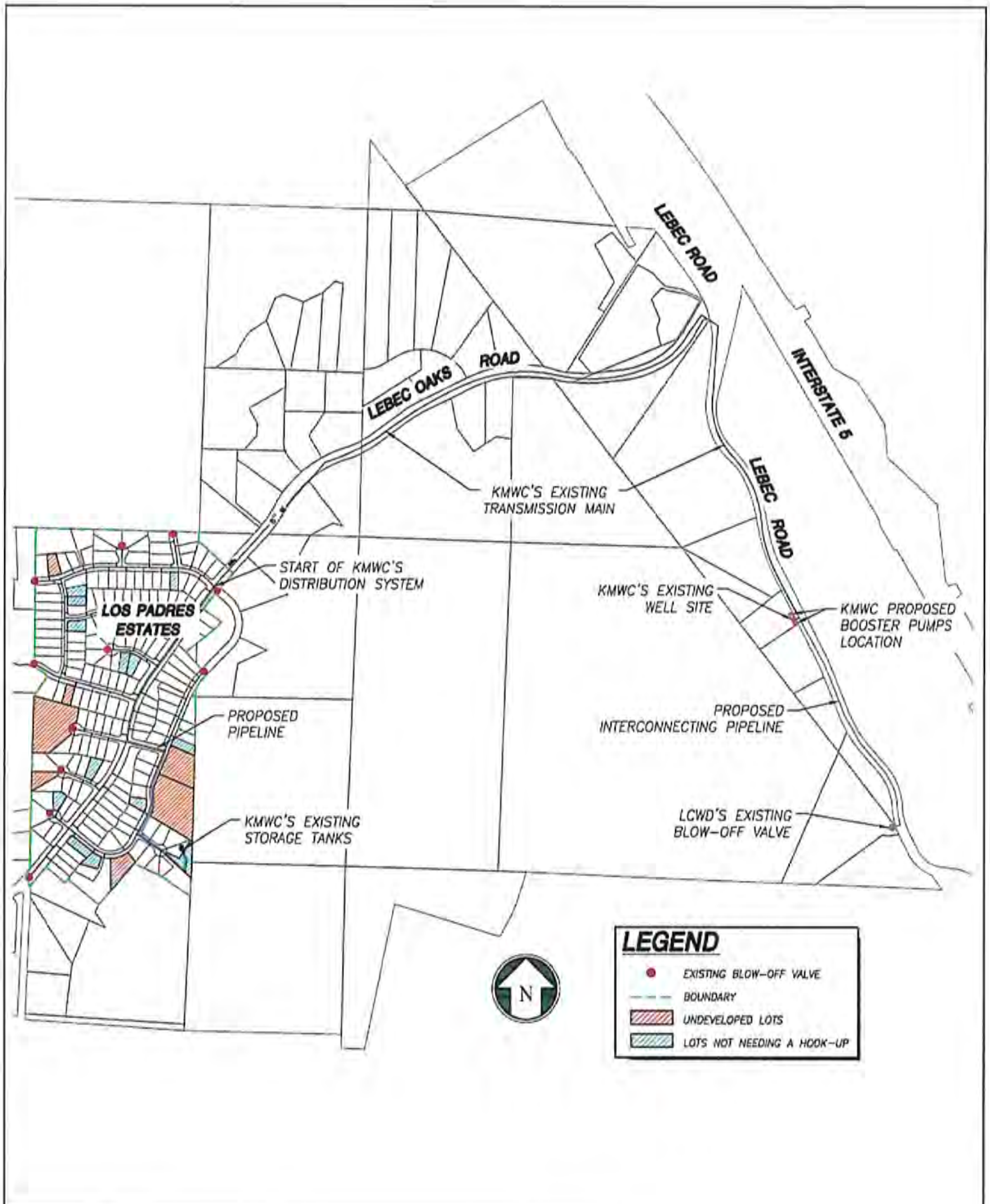


Figure 3-2
Alternative II: Blending with LCWD Project Area

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.

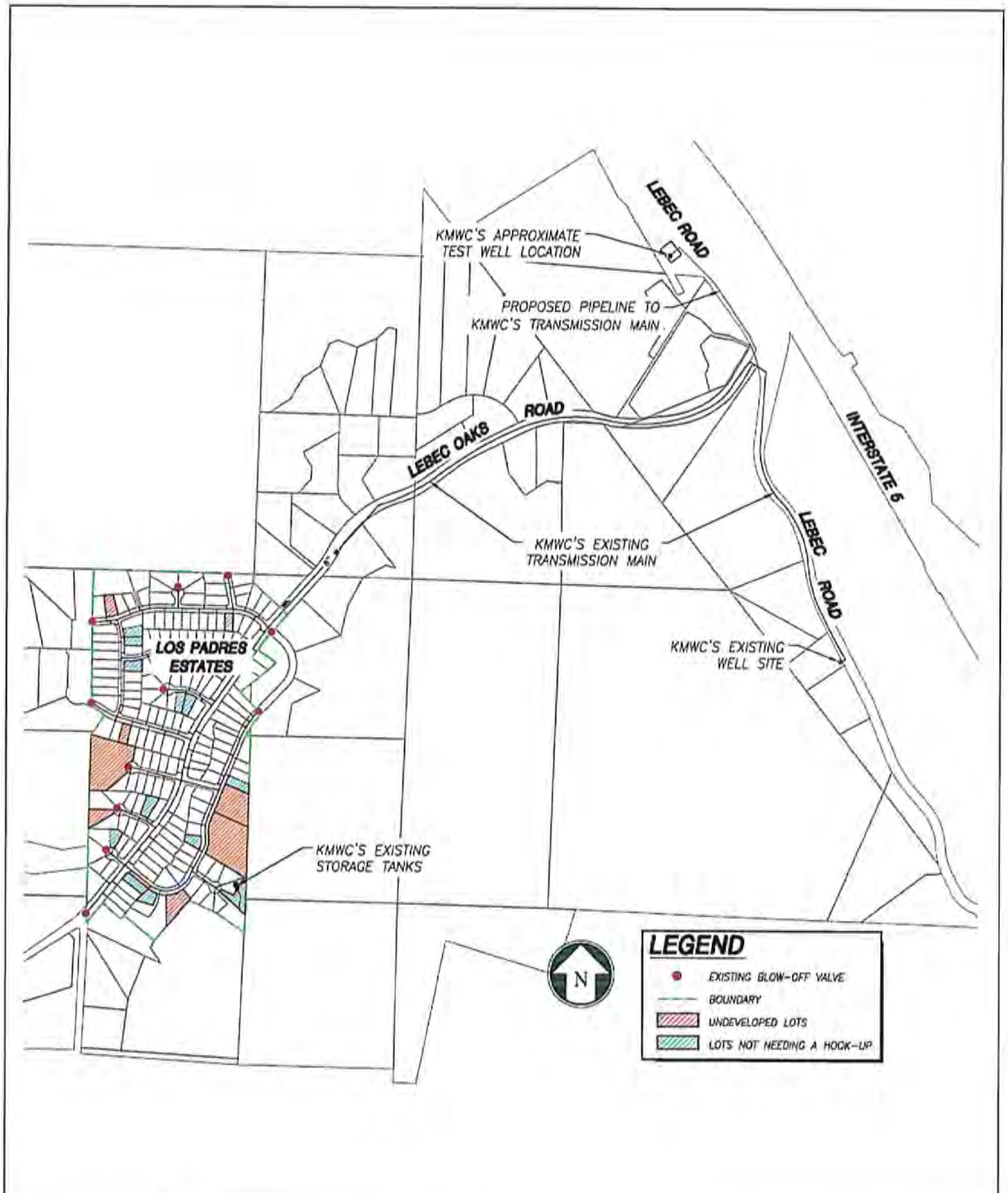


Figure 3-3
Alternative III: New Supply Well Project Area

Table 3-2
Depth Sampling Results for KMWC Test Well

Constituent	Depth		
	Airlift	Airlift	Pumped
	162- 167 (ft)	188- 193 (ft)	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.

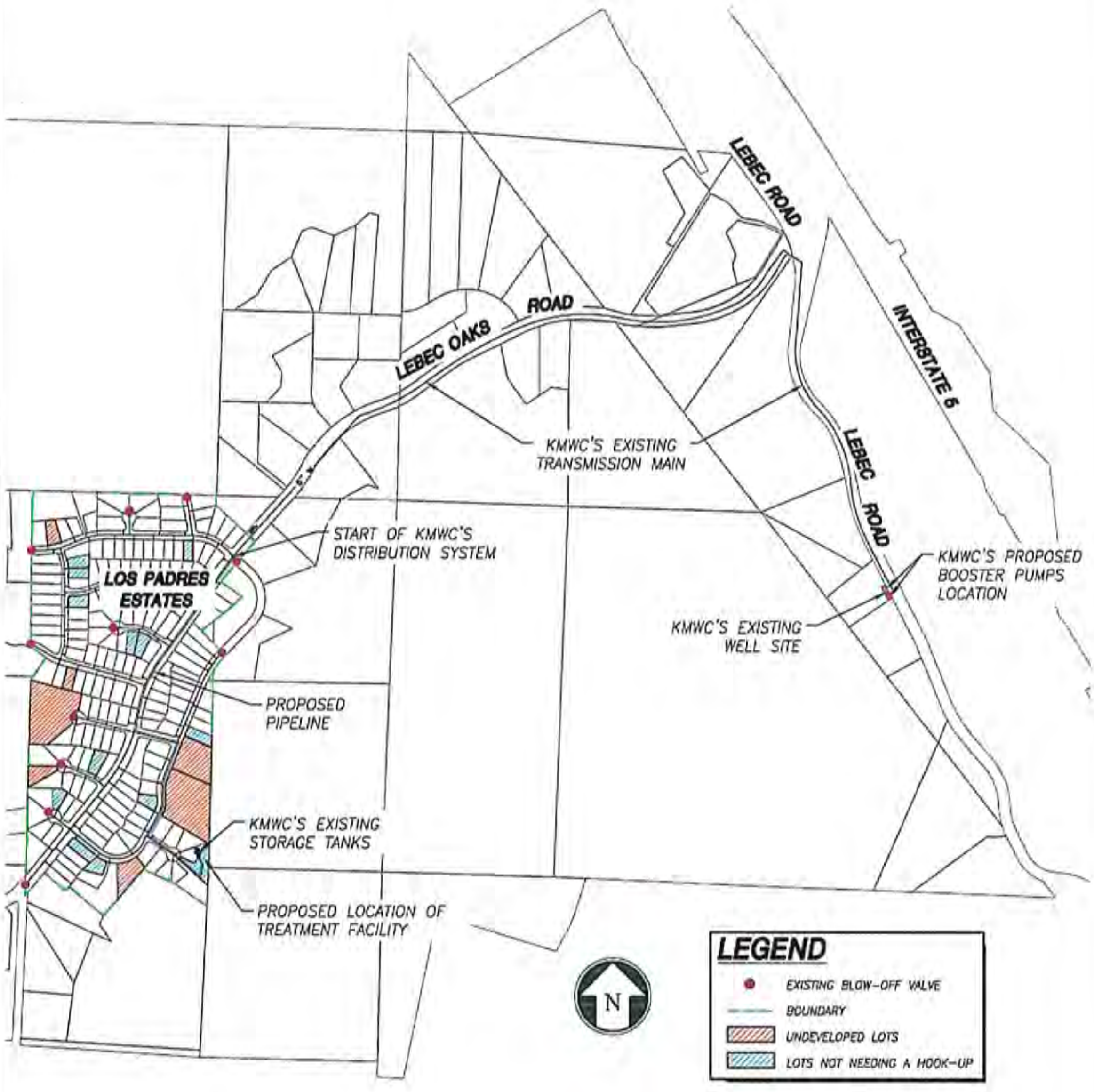


Figure 3-4
Alternative IV: Treatment Facility Project Area

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.

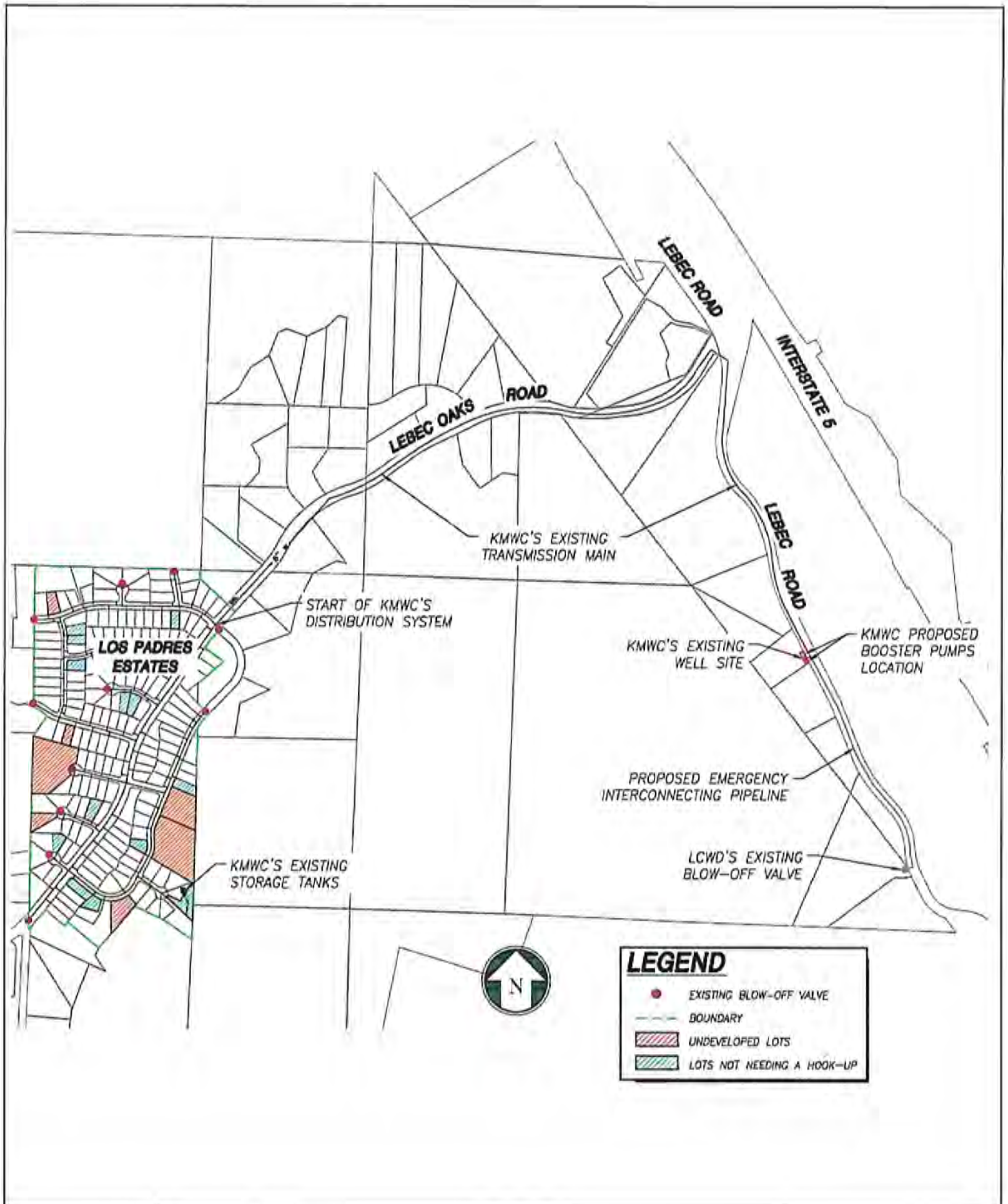


Figure 3-5
Alternative V: Emergency Interconnect with LCWD Project Area

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.

Bibliography

Blending Water Systematically. (2017, October). Retrieved from Burkert-USA: https://www.burkert-usa.com/en/content/download/222294/6046640/version/5/file/Water-Blending.pdf

Extension. (2010, December). Retrieved from Drinking Water Treatment- Activated Alumina: https://articles.extension.org/pages/31568/drinking-water-treatment-activated-alumina

Fluoride Removal by Activated Alumina. (2005). Retrieved from Tramfloc, Inc.: http://www.tramfloc.com/tf133.html

Gerhart, D. J. (2011, October 25). *News and Events*. Retrieved from UW Health: https://www.uwhealth.org/news/dr-jacqueline-gerhart-theres-good-and-bad-to-using-reverse-osmosis-water-systems/36710

Groundwater Blending Optimization. (2017). Retrieved from Real Tech Inc.: https://realtechwater.com/applications/drinking-water/blending-optimization/

How to Remove Fluoride From Water? (2019). Retrieved from ESP Water Products: https://www.espwaterproducts.com/how-to-remove-fluoride-from-water/

Industrial Reverse Osmosis Systems. (2009). Retrieved from Nanacreede Engineering Company: https://www.necoindustrialwater.com/water-treatment-equipment/reverse-osmosis-water-system/

Kiparsky, M., Nylen, N. G., & Pannu, C. (2018, May 02). *Learning From California's Experience with Small Water System Consolidations*. Retrieved from https://www.law.berkeley.edu/wp-content/uploads/2018/05/SmallWaterSystemConsolidation_2018-05-02.pdf

Reverse Osmosis Water Exposed. (2019). Retrieved from AquaLiv: https://www.aqualiv.com/reverse-osmosis-water-filter-health

Schmidt, K. (2018, November 21). Krista MWC TW-1.

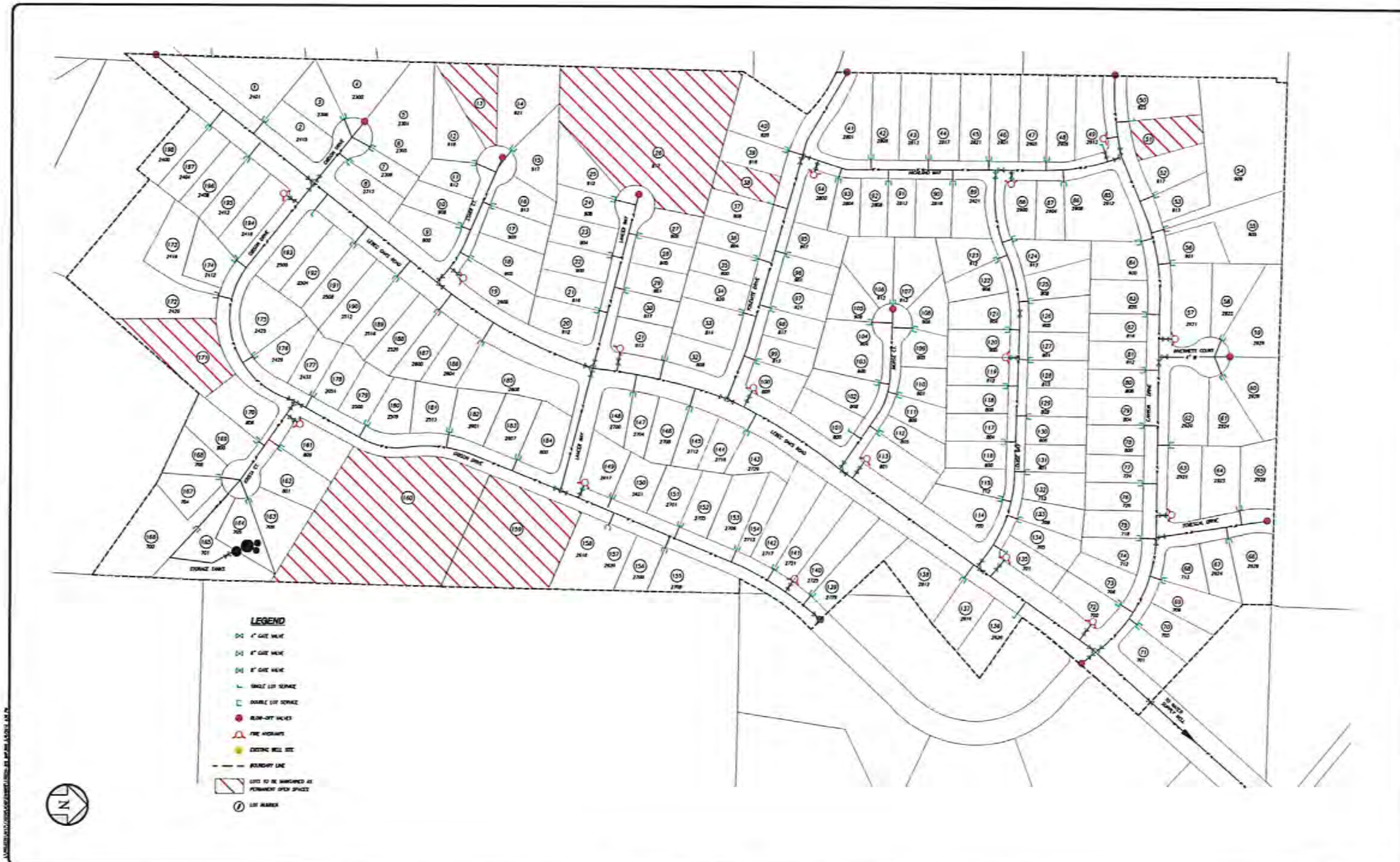
United States Environmental Protection Agency. (2016, November 2). Retrieved from EPA: https://www.epa.gov/dwreginfo/variances-and-exemptions

Water System Partnerships and Voluntary Consolidation. (2019). Retrieved from State Water Resources Control Board: https://www.waterboards.ca.gov/drinking_water/certlic/drinkingwater/waterpartnership.html

What is Activated Alumina? (2017). Retrieved from Interra Global Corp: https://www.interraglobal.com/what-is-activated-alumina/

APPENDIX A

Water System Map of Los Padres Estates



SYSTEM MAP EXHIBIT

LOS PADRES ESTATES

KRISTA MUTUAL WATER COMPANY

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, SB 200, 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 Permi & 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:	**BASIN/MANAGEMENT AREA** (if any):
6	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).