indicating that these samples may have been collected from wells that produce groundwater from a bedrock formation. Groundwater from the well in the Terraces Area has a sodium-chloride type (and total dissolved solids [TDS] >5,000 milligrams per liter [mg/L]), which is representative of older groundwater. Given the relatively unique water type of this well in the Terraces Area, the geochemistry suggests this area has a low degree of hydraulically connectivity with the remainder of the UVRGB.

Groundwater Quality

The UVRGB has historically maintained generally good water quality. The Regional Water Quality Control Board's Basin Plan also establishes groundwater quality "objectives" as "the allowable limits or levels of water quality constituents or characteristics which are established for the reasonable protection of beneficial uses of water or the prevention of nuisance within a specific area" (RWQCB-LA, 2019). The groundwater quality objectives are shown in the Table 3.1-02.

Figures 3.1-27 and 3.1-28 show median concentrations for nitrate (as N) calculated over data available from 1975 to 2019 (long-term) and data available from 2008 to 2019 (recent), respectively. Chemographs for select wells with good temporal data coverage are shown for each hydrogeologic area. Wells with median nitrate higher than the water quality objective (10 mg/L as N) are shown in red and labeled. Nitrate concentrations in the Mira Monte/Meiners Oaks Area tend to be the highest, with several wells showing historical and recent nitrates above the water quality objective. Some wells in the Robles Area also show elevated nitrate levels, though these have typically been below the water quality objective. Some of these wells (e.g., 04N23W16C08S) show higher nitrate concentrations during the recent drought (2012-2016), when there was less recharge from fresher quality surface water. Elevated nitrate concentrations in groundwater have been found in areas of Tico Road and Mira Monte, as well as the northern portion of the Robles Area, where several sources including equestrian facilities, fertilizing operations, and septic systems may contribute to the nutrient loading in these areas (DBSA, 2010b). Nitrate concentrations in the Kennedy, Santa Ana, and Casitas Springs areas tend to be low and well below the water quality objective. Note that there is sparse data available in recent years in the Santa Ana Area.

Previous investigations have reported that TDS concentrations from public supply wells within the Basin range from about from 500 to 1240 mg/L, with an average of about 700 mg/L (DWR, 2003). Figures 3.1-29 and 3.1-30 show median concentrations for TDS calculated for the long-term (s-2019) and recent (2008-2019) period of record, respectively. A few wells have median TDS concentrations above the water quality objective, with several wells showing concentrations just below to the water quality objective with a few exceedances in the past. TDS concentrations appear to increase during extended dry periods when there is less recharge of fresher quality surface water.

Figures 3.1-31 and 3.1-32 show median concentrations for sulfate calculated for the long-term (1969-2019) and recent (2008-2019) period of record, respectively. Most wells were below the water quality objective, though several wells had concentrations just below the water quality objective. In general, the lowest observed concentrations are in the Mira Monte/Meiners Oaks Area. Since bedrock contributions are the primary source of sulfates in the water, the relatively lower concentrations in the Mira Monte/Meiners Oaks Area are indicative of older water that has not flowed over or through (fractured) bedrock.

Figures 3.1-33 and 3.1-34 show median concentrations for chloride calculated for the long-term (1975-2019) and recent (2008–2019) period of record, respectively. With one exception, chloride concentrations

Ventura River would improve the understanding and refine the modeling of streamflows and surface-water/groundwater interactions within the UVRGB.

Imported Water [§354.14(d)(6)]

No data gaps or significant uncertainties were identified.

Regional Geology and Structural Setting [§354.14(b)(1), (d)(2)]

No data gaps or significant uncertainties were identified.

Soil Characteristics [§354.14(d)(3)]

No data gaps or significant uncertainties were identified.

Vertical and Lateral Extent [§354.14(b)(2),(b)(3), (c)]

No significant data gaps or uncertainties were identified with respect to the lateral or vertical extent of the Basin.

Groundwater Flow Barriers [§354.14(b)(4)(C) and (c)]

No significant data gaps or uncertainties were identified with respect to lateral groundwater flow barriers in the Basin.

Formation Names and Hydraulic Properties [§354.14(b)(4)(A), (b)(4)(B)]

As noted in Section 3.1.3.1, a few aquifer tests have been reported in the literature. The best available information for aquifer and aquitard hydraulic properties in the UVRGB is from the calibrated numerical flow model (Appendix H). Use of model-derived hydraulic properties values is considered appropriate and, therefore, the lack of aquifer tests results is not considered a significant data gap or uncertainty at this time. Going forward, UVRGA will work with well owners in the Basin to conduct aquifer tests when such opportunities arise, such as when new or replacement wells are constructed. Additional wells and aquifer tests closer to the Ventura River will help refine the estimates of hydraulic properties within the Ventura River floodplain.

Groundwater Recharge and Discharge Areas [§354.14(d)(4)]

The primary locations of groundwater recharge and discharge are adequately identified in the GSP and are not a data gap. It is acknowledged that there is considerable variability in the extents of the recharge and discharge areas over time.

Water Quality [§354.14(b)(4)(D)]

The northern ⅔ of the Mira Monte/Meiners Oaks Area has sparse groundwater quality data. However, there is very little groundwater production in this Area (and much of the area has shallow our outcropping bedrock), so this is not considered to be a significant data gap or uncertainty in the HCM.

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GAVIN NEWSOM, Governor
CHARLTON H. BONHAM, Director

October 5, 2021

Via Electronic Mail and Online Submission

Mr. Bryan Bondy, PG, CHG
Executive Director
Upper Ventura River Groundwater Agency
c/o Meiners Oaks Water District
202 W. El Roblar Dr.
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BBondy@uvrgroundwater.org

Subject: Comments on the Upper Ventura River Groundwater Agency Draft Groundwater Sustainability Plan

Dear Mr. Bondy:

The California Department of Fish and Wildlife (CDFW) appreciates the opportunity to provide comments on the Upper Ventura River Groundwater Agency's (UVRGA) Draft Groundwater Sustainability Plan (Draft GSP) prepared pursuant to the Sustainable Groundwater Management Act (SGMA).

As trustee agency for the State's fish and wildlife resources, CDFW has jurisdiction over the conservation, protection, and management of fish, wildlife, native plants, and the habitat necessary for biologically sustainable populations of such species. (Fish & Game Code §§ 711.7 and 1802.)

Development and implementation of groundwater sustainability plans (GSPs) under SGMA represents a new era of California groundwater management. CDFW has an interest in the sustainable management of groundwater, as many sensitive ecosystems, species, and public trust resources depend on groundwater and interconnected surface waters (ISWs), including ecosystems on CDFW-owned and managed lands within SGMA-regulated basins.

SGMA and its implementing regulations afford ecosystems and species specific statutory and regulatory consideration, including the following as pertinent to GSPs:

- GSPs must **consider impacts to groundwater dependent ecosystems** (GDEs) (Water Code § 10727.4(l); see also 23 CCR § 354.16(g));
- GSPs must consider the interests of all beneficial uses and users of groundwater, including environmental users of groundwater (Water Code § 10723.2) and GSPs must **identify and consider potential effects on all beneficial uses and users of groundwater** (23 CCR §§ 354.10(a), 354.26(b)(3), 354.28(b)(4), 354.34(b)(2), and 354.34(f)(3));
- GSPs must **establish sustainable management criteria that avoid undesirable results** within 20 years of the applicable statutory deadline, including **depletions of interconnected surface water that have significant and unreasonable adverse impacts on beneficial uses of the surface water** (23 CCR § 354.22 *et seq*. and Water

Code §§ 10721(x)(6) and 10727.2(b)) and describe monitoring networks that can identify adverse impacts to beneficial uses of interconnected surface waters (23 CCR § 354.34(c)(6)(D)); and

- GSPs must **account for groundwater extraction for all water use sectors,** including managed wetlands, managed recharge, and native vegetation (23 CCR §§ 351(al) and 354.18(b)(3)).

Furthermore, the Public Trust Doctrine imposes a related but distinct obligation to consider how groundwater management affects public trust resources, including navigable surface waters and fisheries. Groundwater hydrologically connected to surface waters is also subject to the Public Trust Doctrine to the extent that groundwater extractions or diversions affect or may affect public trust uses. (*Environmental Law Foundation v. State Water Resources Control Board* (2018), 26 Cal. App. 5th 844; *National Audubon Society v. Superior Court* (1983), 33 Cal. 3d 419.) The groundwater sustainability agency (GSA) has "an affirmative duty to take the public trust into account in the planning and allocation of water resources, and to protect public trust uses whenever feasible." (*National Audubon Society*, *supra*, 33 Cal. 3d at 446.) Accordingly, groundwater plans should consider potential impacts to and appropriate protections for ISWs and their tributaries, and ISWs that support fisheries, including the level of groundwater contribution to those waters.

Individually and collectively, the SGMA statutes and regulations, and Public Trust Doctrine considerations, necessitate that groundwater planning carefully consider and protect environmental beneficial uses and users of groundwater, including fish and wildlife and their habitats, GDEs, and ISWs.

COMMENT OVERVIEW

CDFW supports ecosystem preservation and enhancement in compliance with SGMA and its implementing regulations based on CDFW expertise and best available information and science. The Upper Ventura River Valley Basin (Basin) is rated as a medium priority basin under SGMA with 18.5 priority points. The Basin is adjacent to the Ojai Valley basin, which is rated as high priority with 22.5 priority points. The Basin is upstream of the Lower Ventura River Basin, which is rated as very low priority with zero priority points. These three basins are located within the larger Ventura River watershed. CDFW offers the following comments and recommendations below to assist the Upper Ventura River Groundwater Agency (UVRGA) in identifying and evaluating impacts on biological resources, including GDEs within the adjacent groundwater basins. Additional suggestions are included for UVRGA's consideration during revisions of the Draft GSP.

COMMENTS AND RECOMMENDATIONS

23

Comment #1: Data Gaps Exist in the Hydrologic Conceptual Model (HCM) (Introduction to Sustainable Management Criteria of the UVRGA-Draft GSP, Section 4.1, starting on p. 92)

Issue: CDFW appreciates the efforts the UVRGA undertook to analyze the Basin's geologic and hydrogeologic characteristics. CDFW also appreciates UVRGA's proposed plans to utilize the updated HCM to fill in the data gaps and deficiencies identified in the Draft GSP. However, CDFW's understanding is that the Draft GSP does not account for the wide range of hydraulic connectivity and transmissivity values across the Basin, nor does it set forth a reasonable pathway to address gaps in the data sets for these values. For example, the draft plans of the

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HCM for Sections 3.1 and 3.2 stated that some of the aquifer information was obtained from available driller logs and short-term pumping tests, which are not likely to provide a complete and accurate data set for assessing aquifer parameters.

Recommendation #1: Accurate hydrogeologic modeling requires an accurate and complete data set. CDFW recommends that the GSA expand the area in which it is assessing hydraulic connectivity and transmissivity values to ensure the model contains representative conditions across the Basin. Furthermore, the GSA should consider well data with adequate construction and accurate aquifer testing information in its analysis to ensure accurate characterization of hydrogeologic conditions. The Draft GSP should also provide specific model details such as hydraulic connectivity and transmissivity values across the Basin to evaluate the accuracy of the results.

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Comment #2: The GSP Does Not Consider All Riparian Groundwater Dependent Ecosystems in the Basin (Riparian Groundwater Dependent Ecosystems, Section 3.2.7.2.1 of the UVRGA-Draft GSP, starting on p. 66 and Appendix O)

Issue: Page 66 of the Draft GSP states, *"As summarized in the Riparian GDE Assessment Memo (Appendix O), the basin was subdivided into eight areas to screen and evaluate potential riparian GDEs."* The Draft GSP then provides a summary of the areas screened out in Appendix O. This portion of the Draft GSP contains a thorough identification of ecosystems that potentially rely on groundwater, also known as "indicators of groundwater dependent ecosystems" (iGDEs), identifying eight areas within the Basin that were mapped as containing iGDEs. However, the Draft GSP concludes that only two of these mapped areas are GDEs subject to SGMA requirements and only provides for monitoring of groundwater levels and vegetative health in these two areas. Regarding the excluded areas, the biologists on the UVRGA GSP Development Team concluded that *"…dominant species are unlikely to be groundwater dependent based on their plant biology, known locations of occurrence in other regions, and comparison of rooting depth with groundwater level data and model generated water table contours"* (p. 66). The GSA concludes that iGDEs containing coast live oaks in the Mira Monte/Meiners Oaks and Terrace Areas do not qualify as GDEs *"…due to the lack of alluvial groundwater where trees are located. The Coast Live Oaks in these areas are sustained by shallow perched groundwater, bedrock groundwater, or surface water in the associated drainages. In other words, pumping in the UVRGB cannot impact these trees"* (p. 67).

Hydrologic connectivity considerations include connected surface waters, disconnected surface waters, and transition surface waters. CDFW believes that shallow perched groundwater, bedrock groundwater, and surface water can still be connected to groundwater and hydrologic connectivity cannot be ruled out without further analysis. A recent publication by The Nature Conservancy notes that, *"If pumping is concentrated in deeper aquifers, SGMA still requires GSAs to sustainably manage groundwater resources in shallow aquifers, such as perched aquifers, that support springs, surface water, domestic wells, and GDEs…This is because vertical groundwater gradients across aquifers may result in pumping from deeper aquifers to cause adverse impacts onto beneficial users reliant on shallow aquifers or interconnected surface water."* (TNC 2019.)

If hydrologic connectivity exists between a terrestrial or aquatic ecosystem and groundwater, then that ecosystem is a potential GDE and must be identified in a GSP. (23 CCR § 354.16 (g).) Therefore, hydrologic connectivity between surface water and groundwater, as well as groundwater accessibility to terrestrial vegetation, must be evaluated carefully. Accurate

24 identification and consideration of GDEs is also essential to assess whether the GSA has complied with the requirement to avoid significant and unreasonable adverse impacts to beneficial uses of surface water, including aquatic ecosystems reliant on interconnected surface water. (Water Code § 10721(x)(6).)

Recommendation #2(a): CDFW recommends the final GSP provide a more detailed assessment of the eight areas within the Basin that were mapped as iGDEs to determine whether they qualify as GDEs. Conclusions regarding the presence of GDEs needs to be well-supported. CDFW also recommends considering best available GDEs-related data and information when conducting this analysis. Specifically, the GSA should consider the best scientific data on depth to groundwater in its analysis of ISWs, USGS data on mapped springs/seeps, and a comparison of recent groundwater level contours to vegetation root zones. CDFW believes the shallow perched aquifer and shallow alluvial aquifer, although rarely used for water supply, likely support GDEs and should be analyzed further in the Draft GSP. Groundwater within the shallow perched and alluvial aquifers is likely critical to supporting "ecological communities or species" within the Basin. (23 CCR § 351(m).) CDFW recommends using Normalized Difference Vegetation Index (NDVI) and Normalized Difference Moisture
24 Index (NDMI) to assess habitat health for all eight iGDE areas on an annual basis.

Recommendation #2(b): If the GSA's revised analysis indicates that additional iGDEs qualify as GDEs under SGMA, the Draft GSP's sustainable management criteria should be revised to facilitate appropriate and timely monitoring and management response actions for all beneficial users within or supported by these GDEs. These GDEs should be monitored for groundwater levels and vegetative health to account for and mitigate potential adverse impacts to these GDEs from new production wells or expanded production from existing wells. The Draft GSP states that in non-drought periods, the Basin can fill up on the *"order of two out of every three years and significant surface water base flow is sustained by rising groundwater in the southern part of the basin"* (p. 31). This "flashy" behavior can provide recharge for the shallow alluvial aquifer and perched zones that may support GDEs. Considering this interconnection, GDEs should be carefully monitored, and groundwater pumping should be responsibly managed to avoid damaging consequences to GDEs.

25 **Recommendation #2(c):** CDFW does not recommend relying solely on soils information to assess the presence of GDEs. For example, the presence of sandy, dry, and friable soils does not mean that existing plant species do not rely on groundwater for some portion of their life cycle. Capillary fringe associated with root networks from native plants could be accessing groundwater from deeper depths.

Recommendation #2(d): CDFW recommends the final GSP develop sustainable management criteria for all areas of ISWs and GDEs within the Upper Ventura River Basin GSP.

26 **Comment #4: The GSP Minimum Thresholds and Measurable Objectives for Interconnected Surface Waters Depletion Do Not Account for the Best Available Science**

Issue: The Draft GSP relies on the Hopkins Study (2013) and Padre Study (2012) to establish minimum thresholds and measurable objectives for the depletion of ISWs in the Foster Park Habitat Area (Page – ES-xiv, Draft GSP.) The Draft GSP indicates these two studies represent the *"best available science for establishing significant and unreasonable interconnected surface water depletion effects in the Foster Park Habitat Area"* because they *"identify flow conditions that may indicate the onset of potential significant and unreasonable effects applicable under*

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SGMA" and are *"based on direct observations of site-specific flow and habitat conditions in the Foster Park area."* The Draft GSP indicates that CDFW's Draft Instream Flow Recommendations (2021) (Draft Recommendations) and National Marine Fisheries Service (NMFS) Draft Biological Opinion for Foster Park Wellfield (2007) (Foster Park Draft BO) are not on point for this analysis because they do not identify a threshold for significant and unreasonable effects based on groundwater pumping, but rather contain "*surface flow recommendations or requirements to maintain optimal habitat conditions for steelhead*." (p. 129.)

CDFW believes that the Draft GSP mischaracterizes CDFW's Draft Recommendations and the Foster Park Draft BO as protecting only "optimal" conditions for steelhead. CDFW also disagrees that the Draft Recommendations and Foster Park Draft BO are not relevant to determining appropriate sustainability criteria to avoid unreasonable adverse impacts to beneficial users of ISWs. The CDFW Draft Recommendations were designed to protect the federal Endangered Species Act (FESA) listed Southern California steelhead (*Oncorhynchus mykiss;* Steelhead) passage and habitat for spawning and rearing, as well as supporting ecological function in the lower Ventura River. CDFW's Lower Ventura Draft Recommendations were largely based on direct measurements and modeling of site-specific flow and habitat conditions, particularly in the summer months. Groundwater pumping has the potential to draw down surface flows, which may lead to inadequate depths for Steelhead passage or reduced habitat for steelhead spawning and rearing. This draw-down may constitute a significant and unreasonable effect on beneficial users, including Steelhead.

Recommendation #4(a): CDFW recommends that the Draft GSP utilize the best available information and science to develop appropriate minimum thresholds and measurable objectives for ISW depletion. Specifically, CDFW recommends that the UVRGA account for CDFW's Draft Recommendations and any subsequent updates to this document. CDFW's Draft Recommendations encompass the areas identified in the Draft GSP as Casitas Springs Area (known as Ventura Reaches 3 & 4 in CDFW's Draft Recommendations). CDFW's Draft Recommendations represent the best available science regarding flows needed to support a range of life stage needs for Steelhead, including the following:

- Passage and habitat during the spawning season from December to May
- Low-flow habitat from June to October
- Fall pulse flows in October through December and varying peak flows from January through May.

Thus, the Draft Recommendations should be used to inform the development of sustainable management criteria needed to avoid ISW depletions that may have significant and unreasonable effects on Steelhead and other beneficial users, as required under SGMA.

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Recommendation #4(b): The Foster Park Draft BO recommends a minimum maintenance flow of 11-12 cfs at the Foster Park gage (USGS 1118500) to allow for improved growth and survival of juvenile Steelhead. Although the Foster Park Draft BO has not yet been imposed as a binding regulatory requirement in the Ventura River, its scientific information can still be relevant to understanding current environmental circumstances and conditions. CDFW recommends that the final GSP consider NMFS's recommended minimum maintenance flow of 11-12 cfs at the Foster Park gage when establishing thresholds to avoid significant and unreasonable ISW depletions.

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Comment #5: Evaluation of Multiple Minimum Thresholds

Issue: According to UVRGA, the Evaluation of Multiple Minimum Thresholds (23 CCR §354.26(c)) is not applicable because only one minimum threshold is established for the ISW depletions sustainability indicator. CDFW disagrees with this conclusion. Because multiple areas within the Basin have ISWs, it is appropriate to have more than one minimum threshold for the ISW sustainability indicator. Areas of ISWs that overlap with GDEs support various fish and wildlife resources. The Upper Ventura River is designated critical habitat for Steelhead and contains important Steelhead spawning and rearing habitat in Southern California. Species including Steelhead, the FESA-listed and California Endangered Species Act (CESA) listed least Bell's vireo (*Vireo bellii pusillus*), and the FESA- and CESA-listed southwestern willow flycatcher (*Empidonax traillii extimus*) utilize the various habitats identified in the draft GSP as wetland and riverine features.

Steelhead have a range of life cycle needs that require multiple minimum thresholds. Excessively high-water temperatures in the spring, summer, and early fall reduce available juvenile Steelhead rearing habitat. Low flows in the fall and winter can delay adult Steelhead passage to critical spawning areas. Steelhead also need passage flows during the spawning season of December-May, ecological baseflows for the low flow months of June-October, and Steelhead habitat optimum flows for the transition month of November. Multiple minimums thresholds throughout the year are needed to provide monthly flows to support Steelhead.

Recommendation #5(a): CDFW proposes that the final GSP incorporate Recommendations #4(a) and #4(b).

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Recommendation #5(b): The NMFS 2007 BO for the Robles Diversion Fish Passage Facility (Robles Diversion BO) states that during the fish passage augmentation season (January 1-June 30), bypass flows of at least 30 cfs are required at the Robles Diversion. The Robles Diversion BO also states that "the minimum flow rate providing successful steelhead migration through the lower river is 50 cfs. Therefore, downstream released flows at the diversion must be maintained at or above 50 cfs during the first 10 days of each migratory storm event (i.e., storms generating flows 150 cfs or greater, as measured at the Robles Diversion)" (p. 7). To augment these stream flows, "storm events during the months of January through June are considered potential migration events if the resulting peak discharge rate (a) exceeds 149 cfs as measured at the Robles Diversion, and (b) results in at least double the flow of any of the three days preceding the storm peak" (p. 6). Steelhead take is not anticipated with the minimum 30-50 cfs recommended by NMFS. CDFW recommends the GSA consider NMFS's recommendation of minimum flows of 30-50 cfs at the Robles Diversion Facility when developing minimum thresholds and measurable objectives to avoid ISW depletions that would have significant and unreasonable adverse impacts on Steelhead and other beneficial users of surface water.

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Recommendation #5(c): On August 31, 2021, the State Water Resources Control Board (SWRCB) released a Preliminary Draft version of the Groundwater-Surface Water Model of the Ventura River Watershed. This integrated groundwater-surface water model quantifies the relationship between surface flow, subsurface flow, and instream flow requirements in the Ventura River, including areas within the Basin. CDFW recommends incorporating the model's data and simulation results into the final GSP.

ADDITIONAL COMMENTS AND RECOMMENDATIONS

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Comment #6: Additional Sensitive Species and Habitats: Southwestern pond turtle (*Actinemys pallida*) was designated as a California Species of Special Concern (SSC) in 1994 and is known to occur throughout the Ventura River watershed, especially in the Casitas Springs area. Southwestern pond turtle's preferred habitat is permanent ponds, lakes, streams, or permanent pools along intermittent streams associated with standing and slow-moving water. A potentially important limiting factor for the southwestern pond turtle is the relationship between water level and flow in off-channel water bodies, which can both be affected by groundwater pumping.

California red legged frog (*Rana draytonii*) is FESA-listed and is considered a California SSC. It is rarely encountered far from permanent water. Tadpoles require water for at least three or four months while completing their aquatic development. Adults eat both aquatic and terrestrial invertebrates, and the tadpoles graze along rocky stream bottoms. Groundwater pumping that impairs streamflow could have negative impacts on California red-legged frog populations in the Confluence Aquatic Habitat Area and the northernmost portion of the Kennedy Area in the Draft GSP.

Other wildlife resources designated as SSCs that could be substantially adversely affected by declining water levels include: coast horned lizard (*Phrynosoma blainvillii*); coast patch-nosed snake (*Salvadora hexalepis virgultea*); California legless lizard (*Anniella spp.*); two-striped gartersnake (*Thamnophis hammondii*); burrowing owl (*Athene cunicularia*).

Proper management of both shallow and deep groundwater pumping combined with reduced surface water pumping and diverting would ensure that beneficial users in the Basin are not negatively impacted. Unsustainable use of groundwater can impact the shallow aquifers and ISWs on which species and GDEs rely, potentially resulting in adverse impacts to fish and wildlife. Determining the relationship between groundwater levels and surface water flows in the Basin will inform how the groundwater levels may be associated with the health and abundance of riparian vegetation. Poorly managed groundwater pumping and ISW flows have the potential to reduce the abundance and quality of riparian vegetation, reducing the amount of shade provided by the vegetation, and ultimately leading to increased water temperatures in the Basin.

Additionally, shallow groundwater levels near interconnected surface waters should be monitored to ensure that groundwater use is not depleting ISWs and adversely affecting fish and wildlife resources in the Basin.

Recommendation #6(a): CDFW proposes that the final GSP incorporate Recommendation 2(a), 2(b), 2(c), and 2(d) to ensure these species would have their habitats protected into the future. CDFW believes shallow perched aquifers, intermittent surface flows and shallow alluvial aquifers, although rarely used for consumptive water supply, are extremely important to the ecological communities or species that depend on groundwater emerging from all aquifers or from groundwater occurring near the surface within the Basin.

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Recommendation #6(b): CDFW recommends that the UVRGA commit to Arundo *(Arundo donax)* removal in the Upper Ventura River within the Basin to improve groundwater supply and enhance habitat quality for nesting birds. Arundo removal is one example of a project and management action to minimize groundwater overdraft. If groundwater depletion results in reduced streamflow due to ISWs, the nesting and foraging success of the SSC yellow warbler

32 (*Dendroica petechia*), the SSC yellow breasted chat (*Icteria virens*), least Bell's vireo, southwestern willow flycatcher, and other bird species may be diminished due to reduced nesting habitat and food availability.

CONCLUSION

33 CDFW appreciates the opportunity to provide input on the Draft GSP for you to consider as it continues to revise the document. As set forth above, the Draft GSP does not yet comply with the aspects of SGMA statutes and regulations related to fish and wildlife beneficial uses and users of groundwater and interconnected surface waters. CDFW has concerns about data gaps in the HCM, identification and consideration of riparian GDEs, and consideration of CDFW's draft flow recommendations released in February 2021 for the Lower Ventura River. CDFW recommends the UVRGA plan for and engage in responsible groundwater management that minimizes or avoids these impacts to the maximum extent feasible as required under applicable provisions of SGMA and the Public Trust Doctrine, and that the UVRGA address the above comments to avoid a potential 'incomplete' or 'inadequate' GSP determination, as assessed by the Department of Water Resources, for the following reasons derived from regulatory criteria for GSP evaluation:

1. The assumptions, criteria, findings, and objectives, including the sustainability goal, undesirable results, minimum thresholds, measurable objectives, and interim milestones are not reasonable and/or not supported by the best available information and best available science. (CCR § 355.4(b)(1).) (See Comments # 1, 2, 3, 4, and 5);

2. The Draft GSP does not identify reasonable measures and schedules to eliminate data gaps (CCR § 355.4(b)(2).) (See Comments # 1, 2, and 3);

3. The sustainable management criteria and projects and management actions are not commensurate with the level of understanding of the basin setting, based on the level of uncertainty, as reflected in the Draft GSP. (CCR § 355.4(b)(3).) (See Comments # 3, 4 and 5); and,

4. The interests of the beneficial uses that are potentially affected by the use of groundwater in the basin, have not been considered. (CCR § 355.4(b)(4).) (See all comments);

CDFW appreciates the opportunity to provide comments. Additionally, CDFW appreciates UVRGA's continued coordination while UVRGA develops a final GSP. If you have any questions or comments regarding this letter, please contact Steve Slack, Environmental Scientist, at Steven.Slack@wildlife.ca.gov.

Sincerely,

DocuSigned by:
B6E58CFE24724F5...

Erinn Wilson-Olgin
Environmental Program Manager I
South Coast Region

Enclosures (Literature Cited)

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October 8, 2021

Upper Ventura River Groundwater Agency
Meiners Oaks Water District
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Submitted via email: bbondy@uvrgroundwater.org

Re: Public Comment Letter for Upper Ventura River Valley Basin Draft GSP

Dear Bryan Bondy,

On behalf of the above-listed organizations, we appreciate the opportunity to comment on the Draft Groundwater Sustainability Plan (GSP) for the Upper Ventura River Valley Basin being prepared under the Sustainable Groundwater Management Act (SGMA). Our organizations are deeply engaged in and committed to the successful implementation of SGMA because we understand that groundwater is critical for the resilience of California's water portfolio, particularly in light of changing climate. Under the requirements of SGMA, Groundwater Sustainability Agencies (GSAs) must consider the interests of all beneficial uses and users of groundwater, such as domestic well owners, environmental users, surface water users, federal government, California Native American tribes and disadvantaged communities (Water Code 10723.2).

As stakeholder representatives for beneficial users of groundwater, our GSP review focuses on how well disadvantaged communities, drinking water users, tribes, climate change, and the environment were addressed in the GSP. While we appreciate that some basins have consulted us directly via focus groups, workshops, and working groups, we are providing public comment letters to all GSAs as a means to engage in the development of 2022 GSPs across the state. Recognizing that GSPs are complicated and resource intensive to develop, the intention of this letter is to provide constructive stakeholder feedback that can improve the GSP prior to submission to the State.

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Based on our review, we have significant concerns regarding the treatment of key beneficial users in the Draft GSP and consider the GSP to be **insufficient** under SGMA. We highlight the following findings:

1. Beneficial uses and users **are not sufficiently** considered in GSP development.
    a. Human Right to Water considerations **are not sufficiently** incorporated.
    b. Public trust resources **are not sufficiently** considered.
    c. Impacts of Minimum Thresholds, Measurable Objectives and Undesirable Results on beneficial uses and users **are not sufficiently** analyzed.

34

2. Climate change **is not sufficiently** considered.
3. Data gaps **are not sufficiently** identified and the GSP **needs additional plans** to eliminate them.
4. Projects and Management Actions **do not sufficiently consider** potential impacts or benefits to beneficial uses and users.

Our specific comments related to the deficiencies of the Upper Ventura River Valley Basin Draft GSP along with recommendations on how to reconcile them, are provided in detail in **Attachment A.**

Please refer to the enclosed list of attachments for additional technical recommendations:

Attachment A	GSP Specific Comments
Attachment B	SGMA Tools to address DAC, drinking water, and environmental beneficial uses and users
Attachment C	Freshwater species located in the basin
Attachment D	The Nature Conservancy's "Identifying GDEs under SGMA: Best Practices for using the NC Dataset"
Attachment E	Maps of representative monitoring points in relation to key beneficial users

Thank you for fully considering our comments as you finalize your GSP.

Best Regards,

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Water Policy Analyst
Clean Water Action/Clean Water Fund

J. Pablo Ortiz-Partida, Ph.D.
Western States Climate and Water Scientist
Union of Concerned Scientists

Samantha Arthur
Working Lands Program Director
Audubon California

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Melissa M. Rohde
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Attachment A

Specific Comments on the Upper Ventura River Valley Basin Groundwater Sustainability Plan

1. Consideration of Beneficial Uses and Users in GSP development

Consideration of beneficial uses and users in GSP development is contingent upon adequate identification and engagement of the appropriate stakeholders. The (A) identification, (B) engagement, and (C) consideration of disadvantaged communities, drinking water users, tribes, groundwater dependent ecosystems, streams, wetlands, and freshwater species are essential for ensuring the GSP integrates existing state policies on the Human Right to Water and the Public Trust Doctrine.

A. Identification of Key Beneficial Uses and Users

35 **Disadvantaged Communities and Drinking Water Users**

The identification of Disadvantaged Communities (DACs) and drinking water users is **insufficient**. We note the following deficiencies with the identification of these key beneficial users.

- The GSP identifies the community of Casitas Springs as a DAC. The GSP, however, does not show the DAC boundaries on a map or provide the population of the DAC area.
- Appendix E includes the Barbareño-Ventureño Band of Mission Indians as part of the GSA's interested parties list and states that "portions of the Barbareño-Ventureño Band of Mission Indians are located within the UVR Basin." A map of these lands, however, is not provided.
- The GSP fails to provide a density map or location map of domestic wells and their depths (such as minimum well depth, average well depth, or depth range) within the basin.
- The GSP fails to identify the population dependent on groundwater as their source of drinking water in the basin. Specifics are not provided on how much the DAC community relies on a particular water supply (e.g., what percentage is supplied by groundwater).

These missing elements are required for the GSA to fully understand the specific interests and water demands of these beneficial users, and to support the development of sustainable management criteria and projects and management actions that are protective of these users.

RECOMMENDATIONS

- Provide a map of the boundaries of the recognized DAC in the basin. Provide the population of the DAC.
- Provide a map of tribal lands within the basin.
- Include a map showing domestic well locations and average well depth across the basin.
- Identify the sources of drinking water for DAC members, including an estimate of how many people rely on groundwater (e.g., domestic wells, state small water systems, and public water systems).

36

Interconnected Surface Waters

The identification of Interconnected Surface Waters (ISWs) is **insufficient**, due to lack of supporting information provided for the ISW analysis. Based on the ISW section of the GSP (Section 3.2.6) and UVRGB Numerical Model documentation (Appendix H), it appears that a comprehensive analysis of ISWs in the basin was performed. The ISW section of the GSP lacked a clear summary of the locations of groundwater wells and their screen depths used in the analysis, and description of temporal (seasonal and interannual) variability of the data used to calibrate the model. This information should be provided in the GSP to support the conclusions presented.

Figure 3.2-11 (Surface Water Bodies – Hydrologic Conditions) labels sections of the Ventura River as: (1) Losing Reach with Intermittent Groundwater- Surface Water Interconnection, (2) Losing Reach with Generally Disconnected Groundwater- Surface Water, (3) Variably Losing or Gaining Reach with Intermittent Groundwater- Surface Water Interconnection, and (4) Gaining Reach with Generally Interconnected Groundwater - Surface Water. We recommend that these labels are clarified in the text so it is more clear which stream segments are retained as ISWs or potential ISWs in the GSP.

RECOMMENDATIONS
• Describe the legend labels used on Figure 3.2-11 in the GSP text to make clear which stream segments are retained as ISWs or potential ISWs in the GSP. • Further describe the groundwater elevation data and stream flow data used in the ISW analysis. Ensure depth-to-groundwater data from multiple seasons and water year types (e.g., wet, dry, average, drought) are used to determine the range of depth and capture the variability in environmental conditions inherent in California's climate. • Overlay the stream reaches shown on Figure 3.2-11 with depth-to-groundwater contour maps to illustrate groundwater depths and the groundwater gradient near the stream reaches. Show the location of groundwater wells used in the analysis. • For the depth-to-groundwater contour maps, use the best practices presented in Attachment D. Specifically, ensure that the first step is contouring groundwater elevations, and then subtracting this layer from land surface elevations from a Digital Elevation Model (DEM) to estimate depth-to-groundwater contours across the landscape. This will provide accurate contours of depth to groundwater along streams and other land surface depressions where GDEs are commonly found. • Describe data gaps for the ISW analysis in the ISW section, in addition to the discussion in Sections 3.1.4 (Data Gaps and Uncertainty). On Figure 3.2-11, include reaches with data gaps as potential ISWs.

37

Groundwater Dependent Ecosystems

The identification of Groundwater Dependent Ecosystems (GDEs) is **insufficient**. The GSP took initial steps to identify and map GDEs using the Natural Communities Commonly Associated with Groundwater dataset (NC dataset) and other sources. However, we found that mapped features in the NC dataset were improperly disregarded, as described below.

37

- NC dataset polygons were incorrectly removed based on the assumption that they are supported by the shallow, perched water table. However, shallow aquifers that have the potential to support well development, support ecosystems, or provide baseflow to streams are principal aquifers[1], even if the majority of the basin's pumping is occurring in deeper principal aquifers. If there are no data to characterize groundwater conditions in the shallow principal aquifer, then the GDE should be retained as a potential GDE and data gaps reconciled in the Monitoring Network section of the GSP.
- NC dataset polygons were incorrectly removed in areas adjacent to irrigated fields due to the presence of surface water. However, this removal criteria is flawed since GDEs, in addition to groundwater, can rely on multiple water sources – including shallow groundwater receiving inputs from irrigation return flow from nearby irrigated fields – simultaneously and at different temporal/spatial scales. NC dataset polygons adjacent to irrigated land can still potentially be reliant on shallow groundwater aquifers, and therefore should not be removed solely based on their proximity to irrigated fields.

We commend the GSA for using depth-to-groundwater data from multiple seasons and water year types to determine the range of depth to groundwater for the GDE analysis. The GSP states that water years 2005, 2010, and 2015 were selected to represent wet, average, and dry precipitation conditions, respectively. We also commend the GSA for including the complete inventory of flora and fauna species and habitat types in the basin's GDEs. Appendices O and P include figures, tables, and descriptions of flora and fauna and a list of special status species with potential to occur in the Upper Ventura River Valley Basin.

RECOMMENDATIONS

- Describe a systematic approach for analyzing the basin's GDEs. For example, provide a map of the NC Dataset. On the map, label polygons retained, removed, or added to/from the NC dataset (include the removal reason if polygons are not considered potential GDEs, or include the data source if polygons are added). Discuss how local groundwater data was used to verify whether polygons in the NC Dataset are supported by groundwater in an aquifer. Refer to Attachment D of this letter for best practices for using local groundwater data to verify whether polygons in the NC Dataset are supported by groundwater in an aquifer.

- Refer to Attachment B for more information on TNC's plant rooting depth database. Deeper thresholds are necessary for plants that have reported maximum root depths that exceed the averaged 30-ft threshold, such as valley oak (*Quercus lobata*). We recommend that the reported max rooting depth for these deeper-rooted plants be used. For example, a depth-to-groundwater threshold of 80 feet should be used instead of the 30-ft threshold, when verifying whether valley oak polygons from the NC Dataset are connected to groundwater. It is important to re-emphasize that actual rooting depth data are limited and will depend on the plant species and site-specific conditions such as soil and aquifer types, and availability to other water sources.

- Provide depth-to-groundwater contour maps, noting the best practices presented in Attachment D. Specifically, ensure that the first step is contouring groundwater elevations, and then subtracting this layer from land surface elevations from a digital elevation model (DEM) to estimate depth-to-groundwater contours across the landscape.

[1] "'Principal aquifers' refer to aquifers or aquifer systems that store, transmit, and yield significant or economic quantities of groundwater to wells, springs, or surface water systems." [23 CCR §351(aa)]

37

- If insufficient data are available to describe groundwater conditions within or near polygons from the NC dataset, include those polygons as "Potential GDEs" in the GSP until data gaps are reconciled in the monitoring network.

38

Native Vegetation and Managed Wetlands

Native vegetation and managed wetlands are water use sectors that are required[2,3] to be included in the water budget. The integration of native vegetation into the water budget is **sufficient**. We commend the GSA for including the groundwater demands of this ecosystem in the historical, current and projected water budgets. Managed wetlands are not mentioned in the GSP, so it is not known whether or not they are present in the basin.

RECOMMENDATION

- State whether or not there are managed wetlands in the basin. If there are, ensure that their groundwater demands are included as separate line items in the historical, current, and projected water budgets.

B. Engaging Stakeholders

39

Stakeholder Engagement during GSP development

Stakeholder engagement during GSP development is **insufficient**. SGMA's requirement for public notice and engagement of stakeholders is not fully met by the description in the Stakeholder Engagement Plan of the GSP (Appendix E).

The GSP describes outreach to DAC members and environmental stakeholders in the basin. Outreach to these members includes representation of DAC and environmental stakeholders on the GSA's Board of Directors, reserving seats on the Stakeholder Advisory Committee for domestic well owners, newsletters and emails to the interested parties list, social media posts, telephone communications with stakeholders, updates given to the Ventura River Watershed Council, public notices, newspaper articles, and direct outreach to DAC members of the Casitas Springs community. An Ad Hoc Stakeholder Engagement Committee was also formed throughout the GSP process to actively seek input across stakeholders. However, we note the following deficiency with the overall stakeholder engagement process. While tribal stakeholders are mentioned, there is no documentation of tribal consultation to ensure participation in GSP development and implementation processes.

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[2] "'Water use sector' refers to categories of water demand based on the general land uses to which the water is applied, including urban, industrial, agricultural, managed wetlands, managed recharge, and native vegetation." [23 CCR §351(al)]

[3] "The water budget shall quantify the following, either through direct measurements or estimates based on data: (3) Outflows from the groundwater system by water use sector, including evapotranspiration, groundwater extraction, groundwater discharge to surface water sources, and subsurface groundwater outflow." [23 CCR §354.18]

39

RECOMMENDATION
• In the Stakeholder Engagement Plan, describe active and targeted consultation with tribal governments within the basin during the remainder of the GSP development process and throughout the GSP implementation phase. Refer to Attachment B for guidance on how to consult with tribal governments.

C. Considering Beneficial Uses and Users When Establishing Sustainable Management Criteria and Analyzing Impacts on Beneficial Uses and Users

40

The consideration of beneficial uses and users when establishing sustainable management criteria (SMC) is **insufficient**. The consideration of potential impacts on all beneficial users of groundwater in the basin are required when defining undesirable results[4] and establishing minimum thresholds[5,6]

Disadvantaged Communities and Drinking Water Users

For chronic lowering of groundwater levels, the GSP mentions impacts to drinking water users when defining undesirable results. The GSP does not, however, analyze direct and indirect impacts on DACs or tribes when defining undesirable results, or evaluate the cumulative or indirect impacts of proposed minimum thresholds on these stakeholders.

The GSP starts the degraded water quality SMC section of the GSP with the statement (p. 112): "Significant changes to the degraded water quality SMC are expected before GSP Adoption." The GSP identifies constituents of concern (COCs) in the basin as the following: nitrate, TDS, sulfate, chloride, and boron. The GSP states (p. 116): "The minimum thresholds [Table 4.7-01] were selected be consistent with protection of human health (MCL for nitrate), the Upper Consumer Acceptance Levels (TDS and sulfate), and concentrations that are considered to represent toxicity thresholds for agricultural beneficial uses (chloride and boron)."

The GSP only includes a very general discussion of impacts to drinking water users when defining undesirable results and evaluating the cumulative or indirect impacts of proposed minimum thresholds. The GSP does not, however, mention or discuss direct and indirect impacts on DACs or tribes when defining undesirable results for degraded water quality, nor does it evaluate the cumulative or indirect impacts of proposed minimum thresholds on these stakeholders.

[4] "The description of undesirable results shall include [...] 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." [23 CCR §354.26(b)(3)]
[5] "The description of minimum thresholds shall include [...] how minimum thresholds may affect the interests of beneficial uses and users of groundwater or land uses and property interests." [23 CCR §354.28(b)(4)]
[6] "The description of minimum thresholds shall include [...] 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 the basis for the difference." [23 CCR §354.28(b)(5)]

41 **RECOMMENDATIONS**

Chronic Lowering of Groundwater Levels

- Describe direct and indirect impacts on DACs, drinking water users, and tribes when describing undesirable results for chronic lowering of groundwater levels.

- Consider and evaluate the impacts of selected minimum thresholds and measurable objectives on DACs, drinking water users, and tribes within the basin. Further describe the impact of passing the minimum threshold for these users. For example, provide the number of domestic wells that would be de-watered at the minimum threshold.

42 **Degraded Water Quality**

- Provide an updated Section 4.7 (Degraded Water Quality) for public comment before GSP adoption.

- Describe direct and indirect impacts on DACs, drinking water users, and tribes when defining undesirable results for degraded water quality. For specific guidance on how to consider these users, refer to "Guide to Protecting Water Quality Under the Sustainable Groundwater Management Act."[7]

- Evaluate the cumulative or indirect impacts of proposed minimum thresholds for degraded water quality on DACs, drinking water users, and tribes.

<u>Groundwater Dependent Ecosystems and Interconnected Surface Waters</u>

For the chronic lowering of groundwater level SMC, the GSP states (p. 99): "Details concerning the analysis are provided in the Draft Riparian GDE Assessment Memo (Appendix O). In summary, it was concluded that riparian plant communities have experienced stress during periods of low groundwater levels historically, such as the 2012-2016 drought. However, the available data show that the riparian GDEs rebound following drought periods without a noticeable change in the predominant plant species. It was concluded that if groundwater levels were to remain chronically low for an extended period (beyond that seen in the historic dataset), pumping within the basin could exacerbate the stress on these communities and could potentially cause permanent or prolonged impacts to the riparian GDEs, which may be significant and unreasonable." The GSP sets the minimum thresholds to the historical low groundwater levels at the representative groundwater level monitoring sites. The GSP states (p. 102): "Modeling projections for the GSP suggest that the proposed minimum thresholds may be occasionally exceeded at some monitoring locations (Appendix Q). However, the criterion for undesirable
43 results is not predicted to be triggered during the 50-year GSP implementation period." Despite acknowledging the impacts of drought-level groundwater elevations on GDEs, the GSP appears to disregard these impacts when setting the minimum thresholds to the historical low groundwater levels at the representative monitoring sites.

44 Two aquatic habitat areas were identified for consideration in the development of depletion of interconnected surface water SMC, Confluence Aquatic Habitat Area and Foster Park Aquatic Habitat Area. The GSP states (p. 131): "[T]here is insufficient information to assess whether depletion effects in the Confluence Aquatic Habitat Area are significant and unreasonable. SMC for the Confluence Aquatic Habitat Area cannot not be evaluated until these data gaps have been

[7] Guide to Protecting Water Quality under the Sustainable Groundwater Management Act https://d3n8a8pro7vhmx.cloudfront.net/communitywatercenter/pages/293/attachments/original/1559328858/Guide_to_Protecting_Drinking_Water_Quality_Under_the_Sustainable_Groundwater_Management_Act.pdf?1559328858.

44 addressed. The Confluence Aquatic Habitat Area will be revisited prior to the first five-year GSP assessment after addressing the data gaps." However, preliminary SMC should be established now (instead of at the five-year update) using the best available science to avoid significant and unreasonable effects on surface water beneficial users in the basin.

RECOMMENDATIONS

43
- Reevaluate the minimum thresholds for impacts to GDEs for the chronic lowering of groundwater level SMC. Set minimum thresholds to levels that avoid 'significant and unreasonable' effects on beneficial users. Potential impacts on environmental beneficial uses and users need to be considered when defining undesirable results[8] in the basin. Defining undesirable results is the crucial first step before the minimum thresholds[9] can be determined.

44
- Establish preliminary SMC for depletion of interconnected surface water for the Confluence Aquatic Habitat Area, instead of waiting for the five-year GSP update.

2. Climate Change

45 The SGMA statute identifies climate change as a significant threat to groundwater resources and one that must be examined and incorporated in the GSPs. The GSP Regulations[10] require integration of climate change into the projected water budget to ensure that projects and management actions sufficiently account for the range of potential climate futures.

The integration of climate change into the projected water budget is **insufficient**. The GSP does incorporate climate change into the projected water budget using DWR change factors for 2030 and 2070. However, the GSP does not consider multiple climate scenarios (e.g., the 2070 extremely wet and extremely dry climate scenarios) in the projected water budget. The GSP should clearly and transparently incorporate the extremely wet and dry scenarios provided by DWR into projected water budgets or select more appropriate extreme scenarios for their basins. While these extreme scenarios may have a lower likelihood of occurring, their consequences could be significant, therefore they should be included in groundwater planning.

We acknowledge and commend the inclusion of climate change into key inputs (e.g., precipitation, evaporation, and surface water flow) of the projected water budget. The sustainable yield is calculated based on the projected pumping with climate change incorporated. However, If the water budgets are incomplete, including the omission of extremely wet and dry scenarios, then there is increased uncertainty in virtually every subsequent calculation used to plan for projects, derive measurable objectives, and set minimum thresholds. Plans that do not adequately include climate change projections may underestimate future impacts on vulnerable beneficial users of groundwater such as ecosystems, DACs, and domestic well owners.

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[8] "The description of undesirable results shall include [...] 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". [23 CCR §354.26(b)(3)]

[9] The description of minimum thresholds shall include [...] how minimum thresholds may affect the interests of beneficial uses and users of groundwater or land uses and property interests." [23 CCR §354.28(b)(4)]

[10] "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." [23 CCR §354.18(e)]

45

RECOMMENDATIONS

- Integrate climate change, including extremely wet and dry scenarios, into all elements of the projected water budget to form the basis for development of sustainable management criteria and projects and management actions.
- Incorporate climate change scenarios into projects and management actions.

46

3. Data Gaps

The consideration of beneficial users when establishing monitoring networks is **insufficient**, due to lack of specific plans to increase the Representative Monitoring Sites (RMSs) in the monitoring network that represent groundwater quality around DACs and domestic wells in the basin.

The GSP states (p. 161): "No representative monitoring sites have been identified for the degraded water quality sustainability indicator. However, it is noted for clarification that four well groups have been established to address the four sets of closely spaced wells in the groundwater quality monitoring network (Table 5.6-01 and Figure 5.6-01). These sets of closely spaced wells are grouped (i.e., treated as a single well) for the purposes of implementing the measurable objectives and minimum thresholds for the degraded water quality sustainability indicator, as discussed in Section 4.7.1." The GSP does not explain how the use of a well group to represent a RMS will satisfy the reporting requirements of SGMA, however.

Figure 5.6-01 (Existing and Planned Water Quality Monitoring Network) shows that no monitoring wells are located across portions of the basin near DACs and domestic wells (see maps provided in Attachment E). Beneficial users of groundwater may remain unprotected by the GSP without adequate monitoring and identification of data gaps in the shallow aquifer. The Plan therefore fails to meet SGMA's requirements for the monitoring network[11].

47

The GSP provides discussion of data gaps for GDEs and ISWs in Section 5.3.4 of the GSP (Assessment and Improvement of Monitoring Network) and provides planned monitoring well locations on Figure 5.3-01 (Existing and Planned Groundwater Level Monitoring Wells). The GSP could be improved by describing the aquatic GDE monitoring programs for the Foster Park and Confluence Aquatic Habitat Areas (p. 159) and how they will be used to assess the potential for significant and unreasonable impacts to GDEs and ISWs due to groundwater conditions in the basin.

46

RECOMMENDATIONS

- Provide maps that overlay monitoring well locations with the locations of DACs and domestic wells to clearly identify potentially impacted areas. Increase the number of representative monitoring sites (RMSs) in the shallow aquifer across the basin for the groundwater quality condition indicator. Prioritize proximity to DACs and drinking water users when identifying new RMSs.
- Choose single wells for water quality RMSs, instead of using well groups. If well groups are used, explain how the reporting requirements of SGMA will be met.

[11] "The monitoring network objectives shall be implemented to accomplish the following: [...] (2) Monitor impacts to the beneficial uses or users of groundwater." [23 CCR §354.34(b)(2)]

47

- Further describe the biological monitoring that can be used to assess the potential for significant and unreasonable impacts to GDEs or ISWs due to groundwater conditions in the basin. The aquatic GDE monitoring programs for the Foster Park and Confluence Aquatic Habitat Areas are mentioned on p. 159 but no further details are provided.

48

4. Addressing Beneficial Users in Projects and Management Actions

The consideration of beneficial users when developing projects and management actions is **insufficient**, due to the failure to identify benefits or impacts of identified projects and management actions to beneficial users of groundwater such as DACs and tribes.

The GSP includes two projects and management actions with explicit benefits to the environment (Foster Park Protocols to Address Direct Depletion of Interconnected Surface Water and Actions to Address Indirect Depletion of Interconnected Surface Water). The only other project included in the GSP is a Domestic Well Survey to collect more information about domestic wells in the basin. The GSP does not discuss the manner in which DACs and tribes may be benefitted or impacted by projects and management actions identified in the GSP, nor does the GSP discuss the potential water quality impacts from groundwater management in the basin. Potential project and management actions may not protect these beneficial users. Groundwater sustainability under SGMA is defined not just by sustainable yield, but by the avoidance of undesirable results for *all* beneficial users.

RECOMMENDATIONS

- For DACs and domestic well owners, include a drinking water well impact mitigation program to proactively monitor and protect drinking water wells through GSP implementation. Refer to Attachment B for specific recommendations on how to implement a drinking water well mitigation program.

- For DACs, domestic well owners, and tribes, include a discussion of whether potential impacts to water quality from projects and management actions could occur and how the GSA plans to mitigate such impacts.

- Recharge ponds, reservoirs, and facilities for managed stormwater recharge can be designed as multiple-benefit projects to include elements that act functionally as wetlands and provide a benefit for wildlife and aquatic species. For guidance on how to integrate multi-benefit recharge projects into your GSP, refer to the “Multi-Benefit Recharge Project Methodology Guidance Document”[12].

- Develop management actions that incorporate climate and water delivery uncertainties to address future water demand and prevent future undesirable results.

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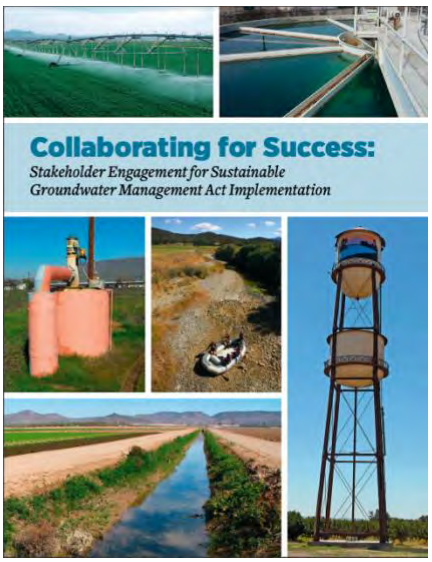
[12] The Nature Conservancy. 2021. Multi-Benefit Recharge Project Methodology for Inclusion in Groundwater Sustainability Plans. Sacramento. Available at: https://groundwaterresourcehub.org/sgma-tools/multi-benefit-recharge-project-methodology-guidance/

Attachment B

SGMA Tools to address DAC, drinking water, and environmental beneficial uses and users

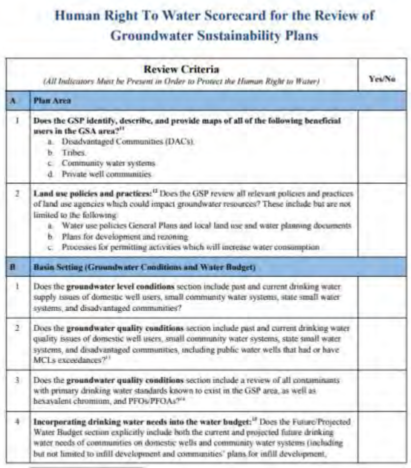
Stakeholder Engagement and Outreach



Clean Water Action, Community Water Center and Union of Concerned Scientists developed a guidance document called Collaborating for success: Stakeholder engagement for Sustainable Groundwater Management Act Implementation. It provides details on how to conduct targeted and broad outreach and engagement during Groundwater Sustainability Plan (GSP) development and implementation. Conducting a targeted outreach involves:

- Developing a robust Stakeholder Communication and Engagement plan that includes outreach at frequented locations (schools, farmers markets, religious settings, events) across the plan area to increase the involvement and participation of disadvantaged communities, drinking water users and the environmental stakeholders.
- Providing translation services during meetings and technical assistance to enable easy participation for non-English speaking stakeholders.
- GSP should adequately describe the process for requesting input from beneficial users and provide details on how input is incorporated into the GSP.

The Human Right to Water

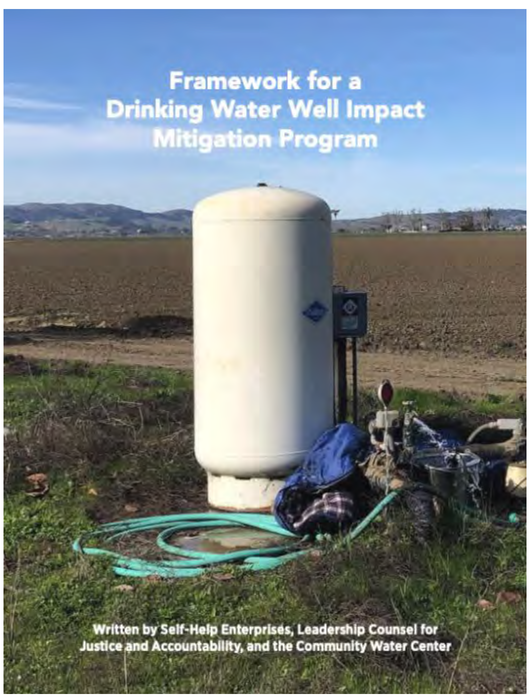


Human Right To Water Scorecard for the Review of Groundwater Sustainability Plans

	Review Criteria *(All Indicators Must be Present in Order to Protect the Human Right to Water)*	Yes/No
A	**Plan Area**	
1	**Does the GSP identify, describe, and provide maps of all of the following beneficial users in the GSA area?**[11] a. Disadvantaged Communities (DACs). b. Tribes. c. Community water systems d. Private well communities	
2	**Land use policies and practices:**[12] Does the GSP review all relevant policies and practices of land use agencies which could impact groundwater resources? These include but are not limited to the following: a. Water use policies General Plans and local land use and water planning documents b. Plans for development and rezoning c. Processes for permitting activities which will increase water consumption	
B	**Basin Setting (Groundwater Conditions and Water Budget)**	
1	Does the **groundwater level conditions** section include past and current drinking water supply issues of domestic well users, small community water systems, state small water systems, and disadvantaged communities?	
2	Does the **groundwater quality conditions** section include past and current drinking water quality issues of domestic well users, small community water systems, state small water systems, and disadvantaged communities, including public water wells that had or have MCLs exceedances?[13]	
3	Does the **groundwater quality conditions** section include a review of all contaminants with primary drinking water standards known to exist in the GSP area, as well as hexavalent chromium, and PFOs/PFOAs?[14]	
4	**Incorporating drinking water needs into the water budget:**[15] Does the Future/Projected Water Budget section explicitly include both the current and projected future drinking water needs of communities on domestic wells and community water systems (including but not limited to infill development and communities' plans for infill development,	

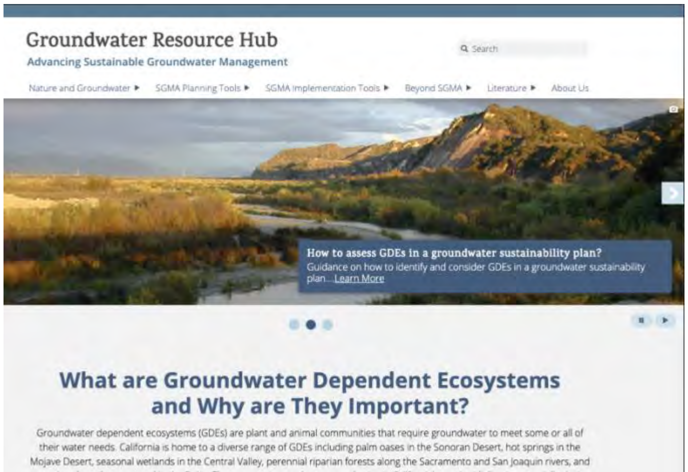
The Human Right to Water Scorecard was developed by Community Water Center, Leadership Counsel for Justice and Accountability and Self Help Enterprises to aid Groundwater Sustainability Agencies (GSAs) in prioritizing drinking water needs in SGMA. The scorecard identifies elements that must exist in GSPs to adequately protect the Human Right to Drinking water.

Drinking Water Well Impact Mitigation Framework



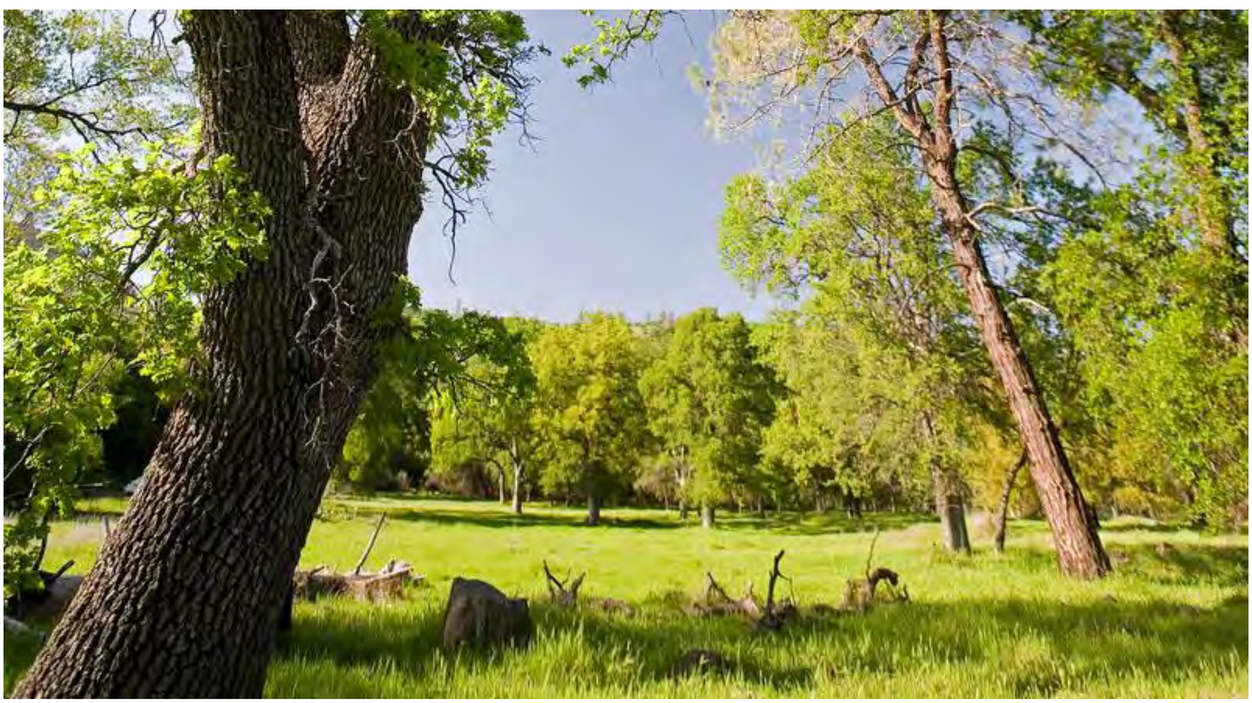
The Drinking Water Well Impact Mitigation Framework was developed by Community Water Center, Leadership Counsel for Justice and Accountability and Self Help Enterprises to aid GSAs in the development and implementation of their GSPs. The framework provides a clear roadmap for how a GSA can best structure its data gathering, monitoring network and management actions to proactively monitor and protect drinking water wells and mitigate impacts should they occur.

Groundwater Resource Hub



The Nature Conservancy has developed a suite of tools based on best available science to help GSAs, consultants, and stakeholders efficiently incorporate nature into GSPs. These tools and resources are available online at GroundwaterResourceHub.org. The Nature Conservancy's tools and resources are intended to reduce costs, shorten timelines, and increase benefits for both people and nature.

Rooting Depth Database



The Plant Rooting Depth Database provides information that can help assess whether groundwater-dependent vegetation are accessing groundwater. Actual rooting depths will depend on the plant species and site-specific conditions, such as soil type and availability of other water sources. Site-specific knowledge of depth to groundwater combined with rooting depths will help provide an understanding of the potential groundwater levels are needed to sustain GDEs.

How to use the database

The maximum rooting depth information in the Plant Rooting Depth Database is useful when verifying whether vegetation in the Natural Communities Commonly Associated with Groundwater (NC Dataset) are connected to groundwater. A 30 ft depth-to-groundwater threshold, which is based on averaged global rooting depth data for phreatophytes[1], is relevant for most plants identified in the NC Dataset since most plants have a max rooting depth of less than 30 feet. However, it is important to note that deeper thresholds are necessary for other plants that have reported maximum root depths that exceed the averaged 30 feet threshold, such as valley oak (*Quercus lobata*), Euphrates poplar (*Populus euphratica*), salt cedar (*Tamarix spp.*), and shadescale (*Atriplex confertifolia*). The Nature Conservancy advises that the reported max rooting depth for these deeper-rooted plants be used. For example, a depth-to groundwater threshold of 80 feet should be used instead of the 30 ft threshold, when verifying whether valley oak polygons from the NC Dataset are connected to groundwater. It is important to re-emphasize that actual rooting depth data are limited and will depend on the plant species and site-specific conditions such as soil and aquifer types, and availability to other water sources.

The Plant Rooting Depth Database is an Excel workbook composed of four worksheets:

1. California phreatophyte rooting depth data (included in the NC Dataset)
2. Global phreatophyte rooting depth data
3. Metadata
4. References

How the database was compiled

The Plant Rooting Depth Database is a compilation of rooting depth information for the groundwater-dependent plant species identified in the NC Dataset. Rooting depth data were compiled from published scientific literature and expert opinion through a crowdsourcing campaign. As more information becomes available, the database of rooting depths will be updated. Please Contact Us if you have additional rooting depth data for California phreatophytes.

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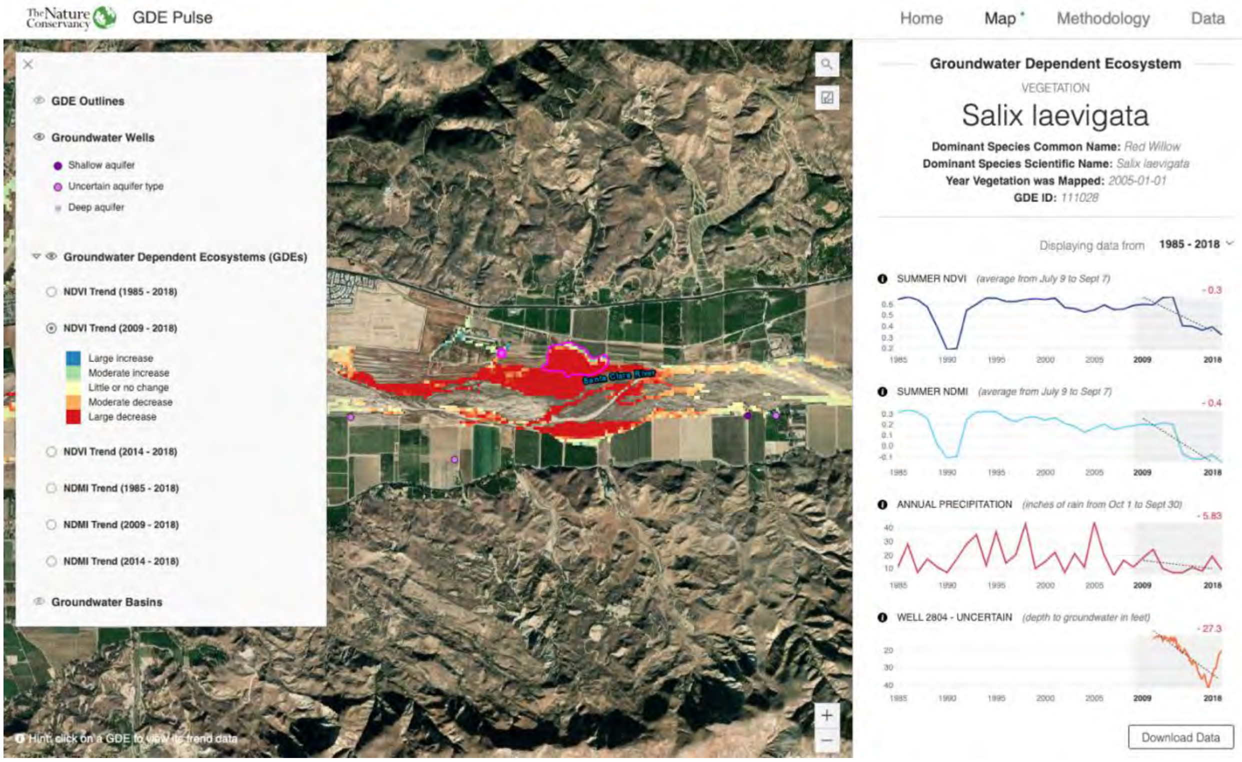
[1] Canadell, J., Jackson, R.B., Ehleringer, J.B. et al. 1996. Maximum rooting depth of vegetation types at the global scale. Oecologia 108, 583–595. https://doi.org/10.1007/BF00329030

GDE Pulse



[GDE Pulse](#) is a free online tool that allows Groundwater Sustainability Agencies to assess changes in groundwater dependent ecosystem (GDE) health using satellite, rainfall, and groundwater data. Remote sensing data from satellites has been used to monitor the health of vegetation all over the planet. GDE pulse has compiled 35 years of satellite imagery from NASA's Landsat mission for every polygon in the Natural Communities Commonly Associated with Groundwater Dataset. The following datasets are available for downloading:

Normalized Difference Vegetation Index (NDVI) is a satellite-derived index that represents the greenness of vegetation. Healthy green vegetation tends to have a higher NDVI, while dead leaves have a lower NDVI. We calculated the average NDVI during the driest part of the year (July - Sept) to estimate vegetation health when the plants are most likely dependent on groundwater.

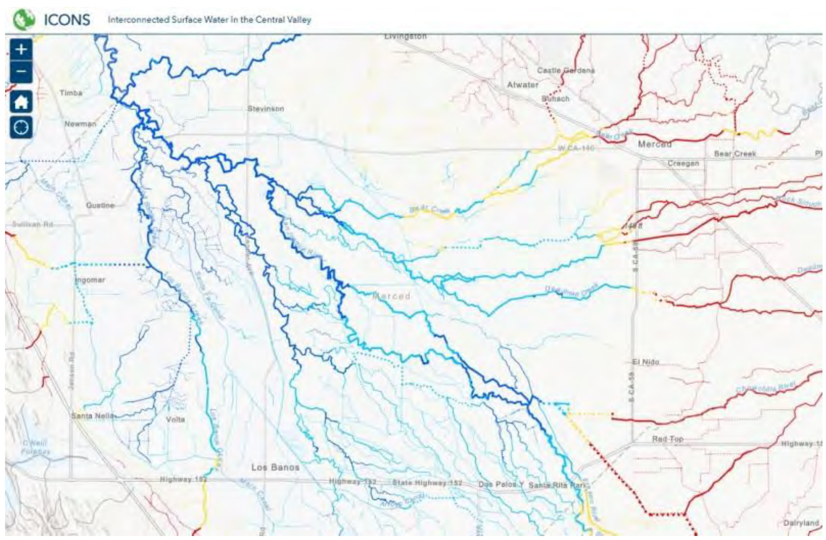
Normalized Difference Moisture Index (NDMI) is a satellite-derived index that represents water content in vegetation. NDMI is derived from the Near-Infrared (NIR) and Short-Wave Infrared (SWIR) channels. Vegetation with adequate access to water tends to have higher NDMI, while vegetation that is water stressed tends to have lower NDMI. We calculated the average NDVI during the driest part of the year (July–September) to estimate vegetation health when the plants are most likely dependent on groundwater.

Annual Precipitation is the total precipitation for the water year (October 1st – September 30th) from the PRISM dataset. The amount of local precipitation can affect vegetation with more precipitation generally leading to higher NDVI and NDMI.

Depth to Groundwater measurements provide an indication of the groundwater levels and changes over time for the surrounding area. We used groundwater well measurements from nearby (<1km) wells to estimate the depth to groundwater below the GDE based on the average elevation of the GDE (using a digital elevation model) minus the measured groundwater surface elevation.

ICONOS Mapper

Interconnected Surface Water in the Central Valley



ICONS maps the likely presence of interconnected surface water (ISW) in the Central Valley using depth to groundwater data. Using data from 2011-2018, the ISW dataset represents the likely connection between surface water and groundwater for rivers and streams in California's Central Valley. It includes information on the mean, maximum, and minimum depth to groundwater for each stream segment over the years with available data, as well as the likely presence of ISW based on the minimum depth to groundwater. The Nature Conservancy developed this database, with guidance and input from expert academics, consultants, and state agencies.

We developed this dataset using groundwater elevation data available online from the California Department of Water Resources (DWR). DWR only provides this data for the Central Valley. For GSAs outside of the valley, who have groundwater well measurements, we recommend following our methods to determine likely ISW in your region. The Nature Conservancy's ISW dataset should be used as a first step in reviewing ISW and should be supplemented with local or more recent groundwater depth data.

Attachment C

Freshwater Species Located in the Ventura River Valley - Upper Ventura River Subbasin

To assist in identifying the beneficial users of surface water necessary to assess the undesirable result “depletion of interconnected surface waters”, Attachment C provides a list of freshwater species located in the Ventura River Valley - Upper Ventura River Subbasin. To produce the freshwater species list, we used ArcGIS to select features within the California Freshwater Species Database version 2.0.9 within the basin boundary. This database contains information on ~4,000 vertebrates, macroinvertebrates and vascular plants that depend on fresh water for at least one stage of their life cycle. The methods used to compile the California Freshwater Species Database can be found in Howard et al. 2015. The spatial database contains locality observations and/or distribution information from ~400 data sources. The database is housed in the California Department of Fish and Wildlife’s BIOS as well as on The Nature Conservancy’s science website.

Scientific Name	Common Name	Legal Protected Status		
		Federal	State	Other
BIRDS				
Actitis macularius	Spotted Sandpiper			
Agelaius tricolor	Tricolored Blackbird	Bird of Conservation Concern	Special Concern	BSSC - First priority
Anas acuta	Northern Pintail			
Anas americana	American Wigeon			
Anas crecca	Green-winged Teal			
Anas cyanoptera	Cinnamon Teal			
Anas discors	Blue-winged Teal			
Anas platyrhynchos	Mallard			
Anas strepera	Gadwall			
Anser albifrons	Greater White-fronted Goose			
Ardea alba	Great Egret			
Ardea herodias	Great Blue Heron			
Aythya collaris	Ring-necked Duck			
Botaurus lentiginosus	American Bittern			
Bucephala albeola	Bufflehead			
Butorides virescens	Green Heron			
Calidris minutilla	Least Sandpiper			
Cistothorus palustris palustris	Marsh Wren			
Egretta thula	Snowy Egret			
Empidonax traillii	Willow Flycatcher	Bird of Conservation Concern	Endangered	
Fulica americana	American Coot			
Gallinago delicata	Wilson's Snipe			
Haliaeetus leucocephalus	Bald Eagle	Bird of Conservation Concern	Endangered	
Himantopus mexicanus	Black-necked Stilt			
Ixobrychus exilis hesperis	Western Least Bittern		Special Concern	BSSC - Second priority

Limnodromus scolopaceus	Long-billed Dowitcher			
Lophodytes cucullatus	Hooded Merganser			
Megaceryle alcyon	Belted Kingfisher			
Mergus merganser	Common Merganser			
Mergus serrator	Red-breasted Merganser			
Numenius phaeopus	Whimbrel			
Nycticorax nycticorax	Black-crowned Night-Heron			
Oxyura jamaicensis	Ruddy Duck			
Piranga rubra	Summer Tanager		Special Concern	BSSC - First priority
Plegadis chihi	White-faced Ibis		Watch list	
Podiceps nigricollis	Eared Grebe			
Podilymbus podiceps	Pied-billed Grebe			
Porzana carolina	Sora			
Rallus limicola	Virginia Rail			
Setophaga petechia	Yellow Warbler			BSSC - Second priority
Tachycineta bicolor	Tree Swallow			
Tringa melanoleuca	Greater Yellowlegs			
Tringa solitaria	Solitary Sandpiper			
Xanthocephalus xanthocephalus	Yellow-headed Blackbird		Special Concern	BSSC - Third priority
CRUSTACEANS				
Gammarus spp.	Gammarus spp.			
Hyalella spp.	Hyalella spp.			
FISHES				
Oncorhynchus mykiss irideus	Coastal rainbow trout			Least Concern - Moyle 2013
Oncorhynchus mykiss - Southern CA	Southern California steelhead	Endangered	Special Concern	Endangered - Moyle 2013
HERPS				
Actinemys marmorata marmorata	Western Pond Turtle		Special Concern	ARSSC
Anaxyrus boreas boreas	Boreal Toad			
Pseudacris cadaverina	California Treefrog			ARSSC
Rana boylii	Foothill Yellow-legged Frog	Under Review in the Candidate or Petition Process	Special Concern	ARSSC
Rana draytonii	California Red-legged Frog	Threatened	Special Concern	ARSSC
Spea hammondii	Western Spadefoot	Under Review in the Candidate or Petition Process	Special Concern	ARSSC

Thamnophis hammondii hammondii	Two-striped Gartersnake		Special Concern	ARSSC
Thamnophis sirtalis sirtalis	Common Gartersnake			
Pseudacris regilla	Northern Pacific Chorus Frog			
INSECTS AND OTHER INVERTS				
Ablabesmyia spp.	Ablabesmyia spp.			
Ambrysus spp.	Ambrysus spp.			
Apedilum spp.	Apedilum spp.			
Argia lugens	Sooty Dancer			
Argia spp.	Argia spp.			
Argia vivida	Vivid Dancer			
Baetidae fam.	Baetidae fam.			
Baetis adonis	A Mayfly			
Baetis spp.	Baetis spp.			
Brechmorhoga mendax	Pale-faced Clubskimmer			
Caenis bajaensis	A Mayfly			
Caenis spp.	Caenis spp.			
Callibaetis spp.	Callibaetis spp.			
Centroptilum spp.	Centroptilum spp.			
Cheumatopsyche spp.	Cheumatopsyche spp.			
Chironomidae fam.	Chironomidae fam.			
Chironomus spp.	Chironomus spp.			
Cloeodes spp.	Cloeodes spp.			
Coenagrionidae fam.	Coenagrionidae fam.			
Corisella decolor				Not on any status lists
Corixidae fam.	Corixidae fam.			
Cricotopus bicinctus				Not on any status lists
Cricotopus spp.	Cricotopus spp.			
Cricotopus trifascia				Not on any status lists
Cryptochironomus spp.	Cryptochironomus spp.			
Dicrotendipes spp.	Dicrotendipes spp.			
Dytiscidae fam.	Dytiscidae fam.			
Endochironomus spp.	Endochironomus spp.			
Ephemerellidae fam.	Ephemerellidae fam.			
Eukiefferiella spp.	Eukiefferiella spp.			
Fallceon quilleri	A Mayfly			
Fallceon spp.	Fallceon spp.			
Gomphidae fam.	Gomphidae fam.			

Hetaerina americana	American Rubyspot			
Hydrobius spp.	Hydrobius spp.			
Hydropsyche spp.	Hydropsyche spp.			
Hydroptila spp.	Hydroptila spp.			
Hydroptilidae fam.	Hydroptilidae fam.			
Labrundinia spp.	Labrundinia spp.			
Laccobius spp.	Laccobius spp.			
Larsia spp.	Larsia spp.			
Micrasema spp.	Micrasema spp.			
Microcylloepus spp.	Microcylloepus spp.			
Micropsectra spp.	Micropsectra spp.			
Microtendipes pedellus				Not on any status lists
Microtendipes spp.	Microtendipes spp.			
Microvelia spp.	Microvelia spp.			
Mideopsis spp.	Mideopsis spp.			
Nanocladius spp.	Nanocladius spp.			
Naucoridae fam.	Naucoridae fam.			
Nectopsyche spp.	Nectopsyche spp.			
Neoclypeodytes spp.	Neoclypeodytes spp.			
Nilothauma spp.	Nilothauma spp.			
Ochrotrichia spp.	Ochrotrichia spp.			
Ochthebius spp.	Ochthebius spp.			
Oecetis spp.	Oecetis spp.			
Ordobrevia nubifera				Not on any status lists
Oxyethira spp.	Oxyethira spp.			
Paltothemis lineatipes	Red Rock Skimmer			
Paracladopelma spp.	Paracladopelma spp.			
Paraleptophlebia spp.	Paraleptophlebia spp.			
Parametriocnemus spp.	Parametriocnemus spp.			
Paratanytarsus spp.	Paratanytarsus spp.			
Pentaneura spp.	Pentaneura spp.			
Petrophila spp.	Petrophila spp.			
Phaenopsectra spp.	Phaenopsectra spp.			
Polycentropus spp.	Polycentropus spp.			
Polypedilum spp.	Polypedilum spp.			
Procladius spp.	Procladius spp.			
Psectrocladius spp.	Psectrocladius spp.			
Psectrotanypus spp.	Psectrotanypus spp.			
Pseudochironomus spp.	Pseudochironomus spp.			
Rheotanytarsus spp.	Rheotanytarsus spp.			
Rhyacophila spp.	Rhyacophila spp.			

Sialis spp.	Sialis spp.			
Sigara mckinstryi	A Water Boatman			Not on any status lists
Sigara spp.	Sigara spp.			
Simulium spp.	Simulium spp.			
Sperchon spp.	Sperchon spp.			
Tanytarsus spp.	Tanytarsus spp.			
Thienemannimyia spp.	Thienemannimyia spp.			
Tinodes spp.	Tinodes spp.			
Trichocorixa calva				Not on any status lists
Tricorythodes explicatus	A Mayfly			
Tricorythodes spp.	Tricorythodes spp.			
Tropisternus spp.	Tropisternus spp.			
Veliidae fam.	Veliidae fam.			
Zavrelimyia spp.	Zavrelimyia spp.			
MOLLUSKS				
Anodonta californiensis	California Floater		Special	
Gyraulus spp.	Gyraulus spp.			
Menetus opercularis	Button Sprite			CS
Physa spp.	Physa spp.			
Pisidium spp.	Pisidium spp.			
PLANTS				
Cotula coronopifolia	NA			
Eleocharis macrostachya	Creeping Spikerush			
Lythrum californicum	California Loosestrife			
Mimulus cardinalis	Scarlet Monkeyflower			
Persicaria lapathifolia				Not on any status lists
Rorippa palustris palustris	Bog Yellowcress			
Schoenoplectus californicus	California Bulrush			
Stuckenia pectinata				Not on any status lists
Typha domingensis	Southern Cattail			
Typha latifolia	Broadleaf Cattail			
Veronica anagallis-aquatica	NA			

Attachment D

July 2019

IDENTIFYING GDEs UNDER SGMA
Best Practices for using the NC Dataset

The Sustainable Groundwater Management Act (SGMA) requires that groundwater dependent ecosystems (GDEs) be identified in Groundwater Sustainability Plans (GSPs). As a starting point, the Department of Water Resources (DWR) is providing the Natural Communities Commonly Associated with Groundwater Dataset (NC Dataset) online[1] to help Groundwater Sustainability Agencies (GSAs), consultants, and stakeholders identify GDEs within individual groundwater basins. To apply information from the NC Dataset to local areas, GSAs should combine it with the best available science on local hydrology, geology, and groundwater levels to verify whether polygons in the NC dataset are likely supported by groundwater in an aquifer (Figure 1)[2]. This document highlights six best practices for using local groundwater data to confirm whether mapped features in the NC dataset are supported by groundwater.

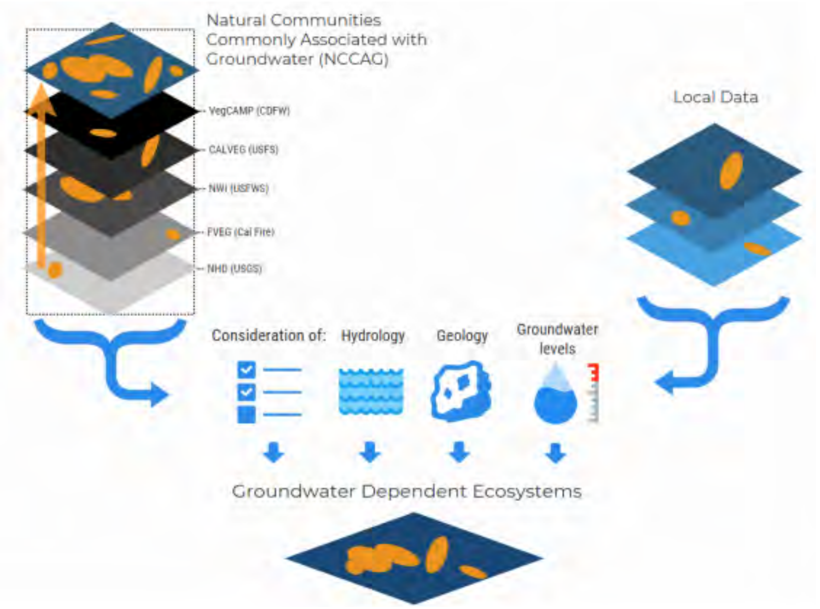


Figure 1. Considerations for GDE identification.
Source: DWR[2]

[1] NC Dataset Online Viewer: https://gis.water.ca.gov/app/NCDatasetViewer/
[2] California Department of Water Resources (DWR). 2018. Summary of the "Natural Communities Commonly Associated with Groundwater" Dataset and Online Web Viewer. Available at: https://water.ca.gov/-/media/DWR-Website/Web-Pages/Programs/Groundwater-Management/Data-and-Tools/Files/Statewide-Reports/Natural-Communities-Dataset-Summary-Document.pdf

The NC Dataset identifies vegetation and wetland features that are good indicators of a GDE. The dataset is comprised of 48 publicly available state and federal datasets that map vegetation, wetlands, springs, and seeps commonly associated with groundwater in California[3]. It was developed through a collaboration between DWR, the Department of Fish and Wildlife, and The Nature Conservancy (TNC). TNC has also provided detailed guidance on identifying GDEs from the NC dataset[4] on the Groundwater Resource Hub[5], a website dedicated to GDEs.

BEST PRACTICE #1. Establishing a Connection to Groundwater

Groundwater basins can be comprised of one continuous aquifer (Figure 2a) or multiple aquifers stacked on top of each other (Figure 2b). In unconfined aquifers (Figure 2a), using the depth-to-groundwater and the rooting depth of the vegetation is a reasonable method to infer groundwater dependence for GDEs. If groundwater is well below the rooting (and capillary) zone of the plants and any wetland features, the ecosystem is considered disconnected and groundwater management is not likely to affect the ecosystem (Figure 2d). However, it is important to consider local conditions (e.g., soil type, groundwater flow gradients, and aquifer parameters) and to review groundwater depth data from multiple seasons and water year types (wet and dry) because intermittent periods of high groundwater levels can replenish perched clay lenses that serve as the water source for GDEs (Figure 2c). Maintaining these natural groundwater fluctuations are important to sustaining GDE health.

Basins with a stacked series of aquifers (Figure 2b) may have varying levels of pumping across aquifers in the basin, depending on the production capacity or water quality associated with each aquifer. If pumping is concentrated in deeper aquifers, SGMA still requires GSAs to sustainably manage groundwater resources in shallow aquifers, such as perched aquifers, that support springs, surface water, domestic wells, and GDEs (Figure 2). This is because vertical groundwater gradients across aquifers may result in pumping from deeper aquifers to cause adverse impacts onto beneficial users reliant on shallow aquifers or interconnected surface water. The goal of SGMA is to sustainably manage groundwater resources for current and future social, economic, and environmental benefits. While groundwater pumping may not be currently occurring in a shallower aquifer, use of this water may become more appealing and economically viable in future years as pumping restrictions are placed on the deeper production aquifers in the basin to meet the sustainable yield and criteria. Thus, identifying GDEs in the basin should done irrespective to the amount of current pumping occurring in a particular aquifer, so that future impacts on GDEs due to new production can be avoided. A good rule of thumb to follow is: *if groundwater can be pumped from a well - it's an aquifer*.

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[3] For more details on the mapping methods, refer to: Klausmeyer, K., J. Howard, T. Keeler-Wolf, K. Davis-Fadtke, R. Hull, A. Lyons. 2018. Mapping Indicators of Groundwater Dependent Ecosystems in California: Methods Report. San Francisco, California. Available at: https://groundwaterresourcehub.org/public/uploads/pdfs/iGDE_data_paper_20180423.pdf

[4] "Groundwater Dependent Ecosystems under the Sustainable Groundwater Management Act: Guidance for Preparing Groundwater Sustainability Plans" is available at: https://groundwaterresourcehub.org/gde-tools/gsp-guidance-document/

[5] The Groundwater Resource Hub: www.GroundwaterResourceHub.org

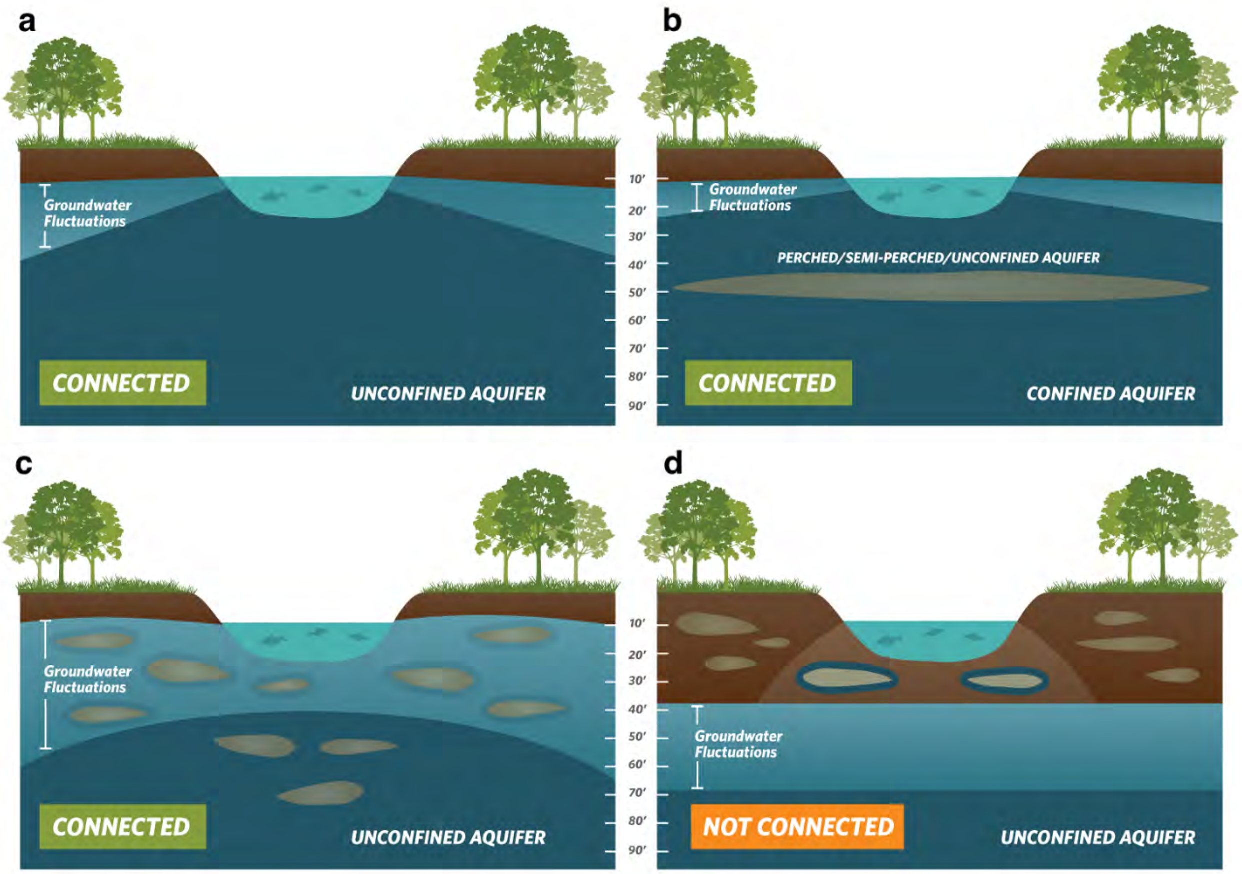

Figure 2. Confirming whether an ecosystem is connected to groundwater. Top: (a) Under the ecosystem is an unconfined aquifer with depth-to-groundwater fluctuating seasonally and interannually within 30 feet from land surface. (b) Depth-to-groundwater in the shallow aquifer is connected to overlying ecosystem. Pumping predominately occurs in the confined aquifer, but pumping is possible in the shallow aquifer. Bottom: (c) Depth-to-groundwater fluctuations are seasonally and interannually large, however, clay layers in the near surface prolong the ecosystem's connection to groundwater. (d) Groundwater is disconnected from surface water, and any water in the vadose (unsaturated) zone is due to direct recharge from precipitation and indirect recharge under the surface water feature. These areas are not connected to groundwater and typically support species that do not require access to groundwater to survive.

BEST PRACTICE #2. Characterize Seasonal and Interannual Groundwater Conditions

SGMA requires GSAs to describe current and historical groundwater conditions when identifying GDEs [23 CCR §354.16(g)]. Relying solely on the SGMA benchmark date (January 1, 2015) or any other single point in time to characterize groundwater conditions (e.g., depth-to-groundwater) is inadequate because managing groundwater conditions with data from one time point fails to capture the seasonal and interannual variability typical of California's climate. DWR's Best Management Practices document on water budgets[6] recommends using 10 years of water supply and water budget information to describe how historical conditions have impacted the operation of the basin within sustainable yield, implying that a baseline[7] could be determined based on data between 2005 and 2015. Using this or a similar time period, depending on data availability, is recommended for determining the depth-to-groundwater.

GDEs depend on groundwater levels being close enough to the land surface to interconnect with surface water systems or plant rooting networks. The most practical approach[8] for a GSA to assess whether polygons in the NC dataset are connected to groundwater is to rely on groundwater elevation data. As detailed in TNC's GDE guidance document[4], one of the key factors to consider when mapping GDEs is to contour depth-to-groundwater in the aquifer that is supporting the ecosystem (see Best Practice #5).

Groundwater levels fluctuate over time and space due to California's Mediterranean climate (dry summers and wet winters), climate change (flood and drought years), and subsurface heterogeneity in the subsurface (Figure 3). Many of California's GDEs have adapted to dealing with intermittent periods of water stress, however if these groundwater conditions are prolonged, adverse impacts to GDEs can result. While depth-to-groundwater levels within 30 feet[4] of the land surface are generally accepted as being a proxy for confirming that polygons in the NC dataset are supported by groundwater, it is highly advised that fluctuations in the groundwater regime be characterized to understand the seasonal and interannual groundwater variability in GDEs. Utilizing groundwater data from one point in time can misrepresent groundwater levels required by GDEs, and inadvertently result in adverse impacts to the GDEs. Time series data on groundwater elevations and depths are available on the SGMA Data Viewer[9]. However, if insufficient data are available to describe groundwater conditions within or near polygons from the NC dataset, include those polygons in the GSP <u>until</u> data gaps are reconciled in the monitoring network (see Best Practice #6).

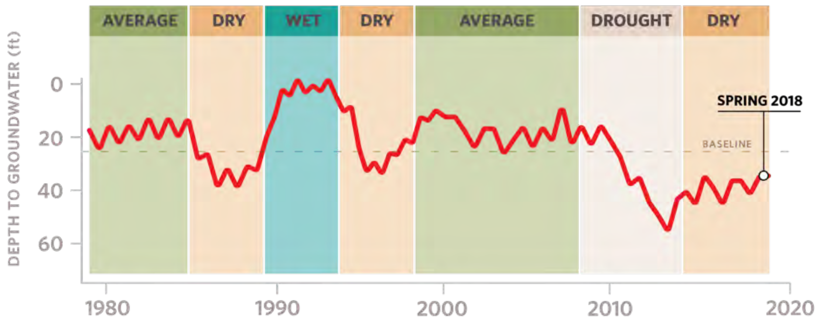

Figure 3. Example seasonality and interannual variability in depth-to-groundwater over time. Selecting one point in time, such as Spring 2018, to characterize groundwater conditions in GDEs fails to capture what groundwater conditions are necessary to maintain the ecosystem status into the future so adverse impacts are avoided.

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[6] DWR. 2016. Water Budget Best Management Practice. Available at: https://water.ca.gov/LegacyFiles/groundwater/sgm/pdfs/BMP_Water_Budget_Final_2016-12-23.pdf

[7] Baseline is defined under the GSP regulations as "historic information used to project future conditions for hydrology, water demand, and availability of surface water and to evaluate potential sustainable management practices of a basin." [23 CCR §351(e)]

[8] Groundwater reliance can also be confirmed via stable isotope analysis and geophysical surveys. For more information see The GDE Assessment Toolbox (Appendix IV, GDE Guidance Document for GSPs[4]).

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

BEST PRACTICE #3. Ecosystems Often Rely on Both Groundwater and Surface Water

GDEs are plants and animals that rely on groundwater for all or some of its water needs, and thus can be supported by multiple water sources. The presence of non-groundwater sources (e.g., surface water, soil moisture in the vadose zone, applied water, treated wastewater effluent, urban stormwater, irrigated return flow) within and around a GDE does not preclude the possibility that it is supported by groundwater, too. SGMA defines GDEs as "ecological communities and species that depend on groundwater emerging from aquifers or on groundwater occurring near the ground surface" [23 CCR §351(m)]. Hence, depth-to-groundwater data should be used to identify whether NC polygons are supported by groundwater and should be considered GDEs. In addition, SGMA requires that significant and undesirable adverse impacts to beneficial users of surface water be avoided. Beneficial users of surface water include environmental users such as plants or animals[10], which therefore must be considered when developing minimum thresholds for depletions of interconnected surface water.

GSAs are only responsible for impacts to GDEs resulting from groundwater conditions in the basin, so if adverse impacts to GDEs result from the diversion of applied water, treated wastewater, or irrigation return flow away from the GDE, then those impacts will be evaluated by other permitting requirements (e.g., CEQA) and may not be the responsibility of the GSA. However, if adverse impacts occur to the GDE due to changing groundwater conditions resulting from pumping or groundwater management activities, then the GSA would be responsible (Figure 4).

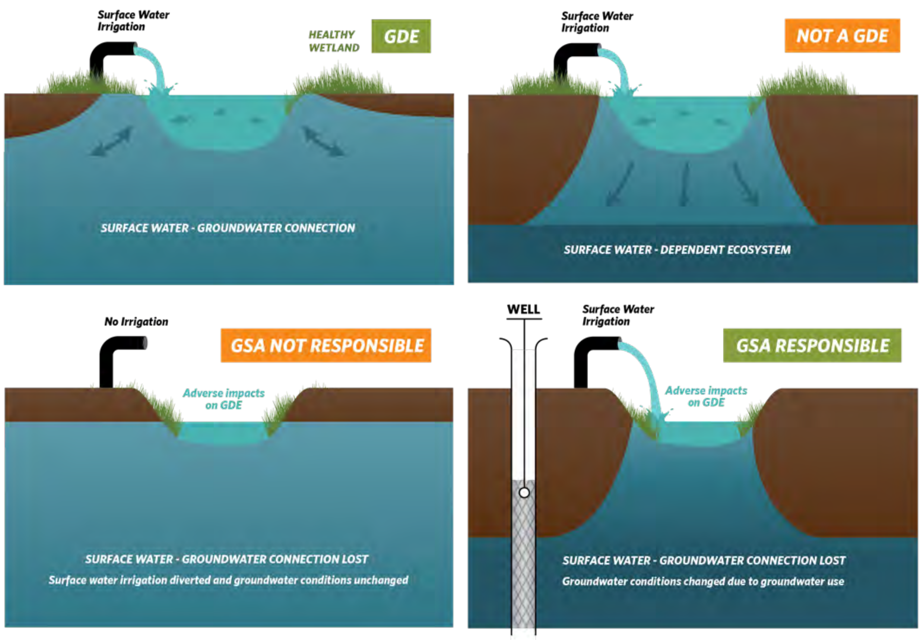

Figure 4. Ecosystems often depend on multiple sources of water. Top: (Left) Surface water and groundwater are interconnected, meaning that the GDE is supported by both groundwater and surface water. (Right) Ecosystems that are only reliant on non-groundwater sources are not groundwater-dependent. Bottom: (Left) An ecosystem that was once dependent on an interconnected surface water, but loses access to groundwater solely due to surface water diversions may not be the GSA's responsibility. (Right) Groundwater dependent ecosystems once dependent on an interconnected surface water system, but loses that access due to groundwater pumping is the GSA's responsibility.

[10] For a list of environmental beneficial users of surface water by basin, visit: https://groundwaterresourcehub.org/gde-tools/environmental-surface-water-beneficiaries/

BEST PRACTICE #4. Select Representative Groundwater Wells

Identifying GDEs in a basin requires that groundwater conditions are characterized to confirm whether polygons in the NC dataset are supported by the underlying aquifer. To do this, proximate groundwater wells should be identified to characterize groundwater conditions (Figure 5). When selecting representative wells, it is particularly important to consider the subsurface heterogeneity around NC polygons, especially near surface water features where groundwater and surface water interactions occur around heterogeneous stratigraphic units or aquitards formed by fluvial deposits. The following selection criteria can help ensure groundwater levels are representative of conditions within the GDE area:

- Choose wells that are within 5 kilometers (3.1 miles) of each NC Dataset polygons because they are more likely to reflect the local conditions relevant to the ecosystem. If there are no wells within 5km of the center of a NC dataset polygon, then there is insufficient information to remove the polygon based on groundwater depth. Instead, it should be retained as a potential GDE until there are sufficient data to determine whether or not the NC Dataset polygon is supported by groundwater.

- Choose wells that are screened within the surficial unconfined aquifer and capable of measuring the true water table.

- Avoid relying on wells that have insufficient information on the screened well depth interval for excluding GDEs because they could be providing data on the wrong aquifer. This type of well data should not be used to remove any NC polygons.

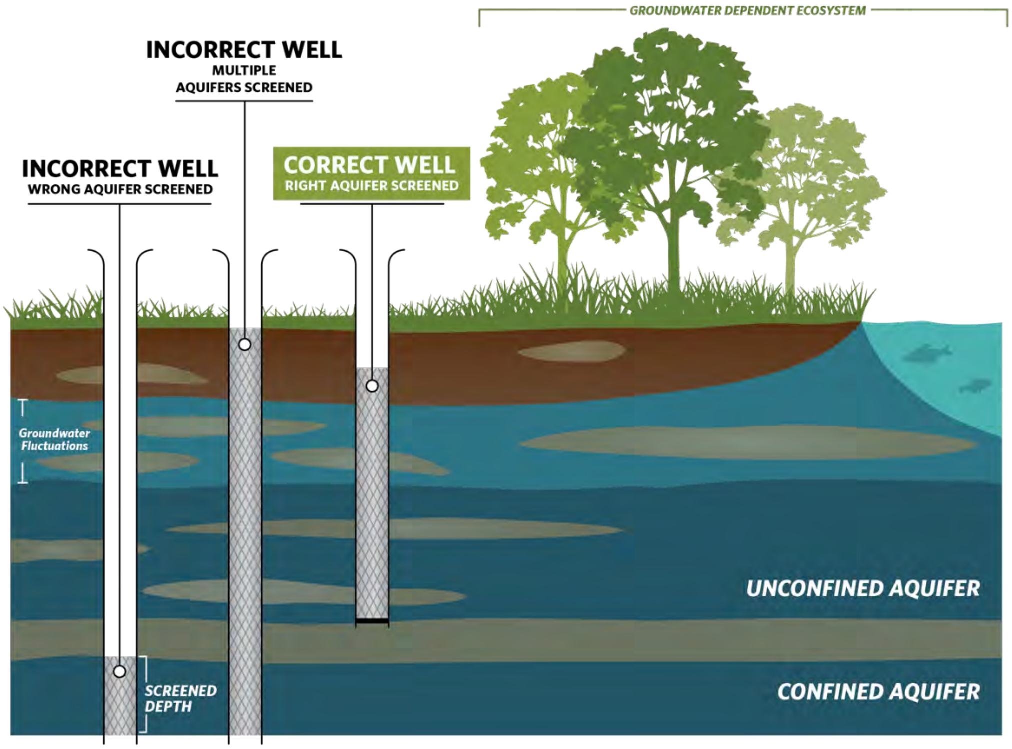

Figure 5. Selecting representative wells to characterize groundwater conditions near GDEs.

BEST PRACTICE #5. Contouring Groundwater Elevations

The common practice to contour depth-to-groundwater over a large area by interpolating measurements at monitoring wells is unsuitable for assessing whether an ecosystem is supported by groundwater. This practice causes errors when the land surface contains features like stream and wetland depressions because it assumes the land surface is constant across the landscape and depth-to-groundwater is constant below these low-lying areas (Figure 6a). A more accurate approach is to interpolate groundwater elevations at monitoring wells to get groundwater elevation contours across the landscape. This layer can then be subtracted from land surface elevations from a Digital Elevation Model (DEM)[11] to estimate depth-to-groundwater contours across the landscape (Figure b; Figure 7). This will provide a much more accurate contours of depth-to-groundwater along streams and other land surface depressions where GDEs are commonly found.

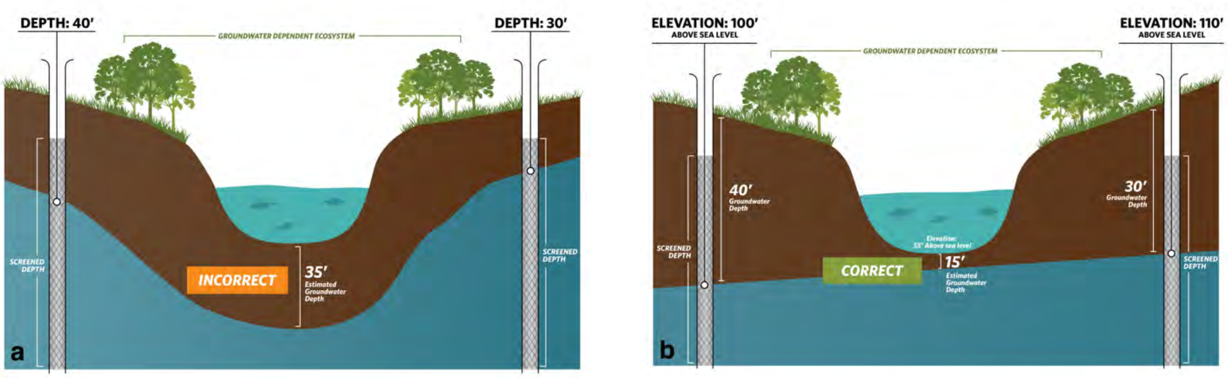

Figure 6. Contouring depth-to-groundwater around surface water features and GDEs. (a) Groundwater level interpolation using depth-to-groundwater data from monitoring wells. (b) Groundwater level interpolation using groundwater elevation data from monitoring wells and DEM data.

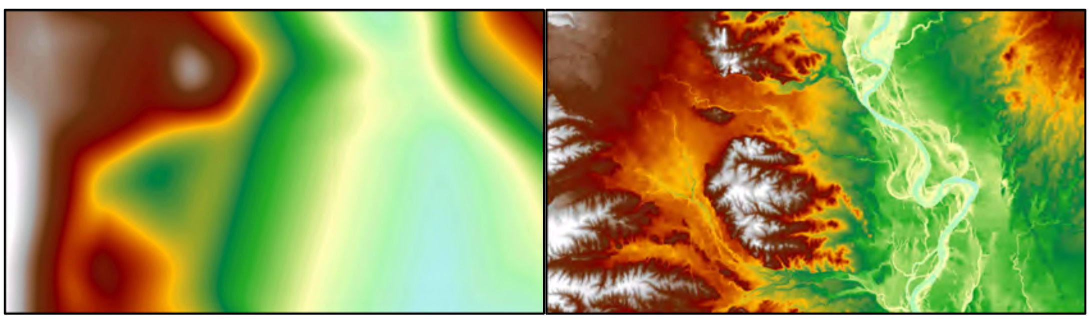

Figure 7. Depth-to-groundwater contours in Northern California. (Left) Contours were interpolated using depth-to-groundwater measurements determined at each well. (Right) Contours were determined by interpolating groundwater elevation measurements at each well and superimposing ground surface elevation from DEM spatial data to generate depth-to-groundwater contours. The image on the right shows a more accurate depth-to-groundwater estimate because it takes the local topography and elevation changes into account.

[11] USGS Digital Elevation Model data products are described at: https://www.usgs.gov/core-science-systems/ngp/3dep/about-3dep-products-services and can be downloaded at: https://iewer.nationalmap.gov/basic/

BEST PRACTICE #6. Best Available Science

Adaptive management is embedded within SGMA and provides a process to work toward sustainability over time by beginning with the best available information to make initial decisions, monitoring the results of those decisions, and using the data collected through monitoring programs to revise decisions in the future. In many situations, the hydrologic connection of NC dataset polygons will not initially be clearly understood if site-specific groundwater monitoring data are not available. If sufficient data are not available in time for the 2020/2022 plan, The Nature Conservancy strongly advises that questionable polygons from the NC dataset be included in the GSP until data gaps are reconciled in the monitoring network. Erring on the side of caution will help minimize inadvertent impacts to GDEs as a result of groundwater use and management actions during SGMA implementation.

KEY DEFINITIONS

Groundwater basin is an aquifer or stacked series of aquifers with reasonably well-defined boundaries in a lateral direction, based on features that significantly impede groundwater flow, and a definable bottom. *23 CCR §341(g)(1)*

Groundwater dependent ecosystem (GDE) are ecological communities or species that depend on groundwater emerging from aquifers or on groundwater occurring near the ground surface. *23 CCR §351(m)*

Interconnected surface water (ISW) 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. *23 CCR §351(o)*

Principal aquifers are 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)*

ABOUT US

The Nature Conservancy is a science-based nonprofit organization whose mission is *to conserve the lands and waters on which all life depends*. To support successful SGMA implementation that meets the future needs of people, the economy, and the environment, TNC has developed tools and resources (www.groundwaterresourcehub.org) intended to reduce costs, shorten timelines, and increase benefits for both people and nature.

Attachment E

Maps of representative monitoring sites in relation to key beneficial users

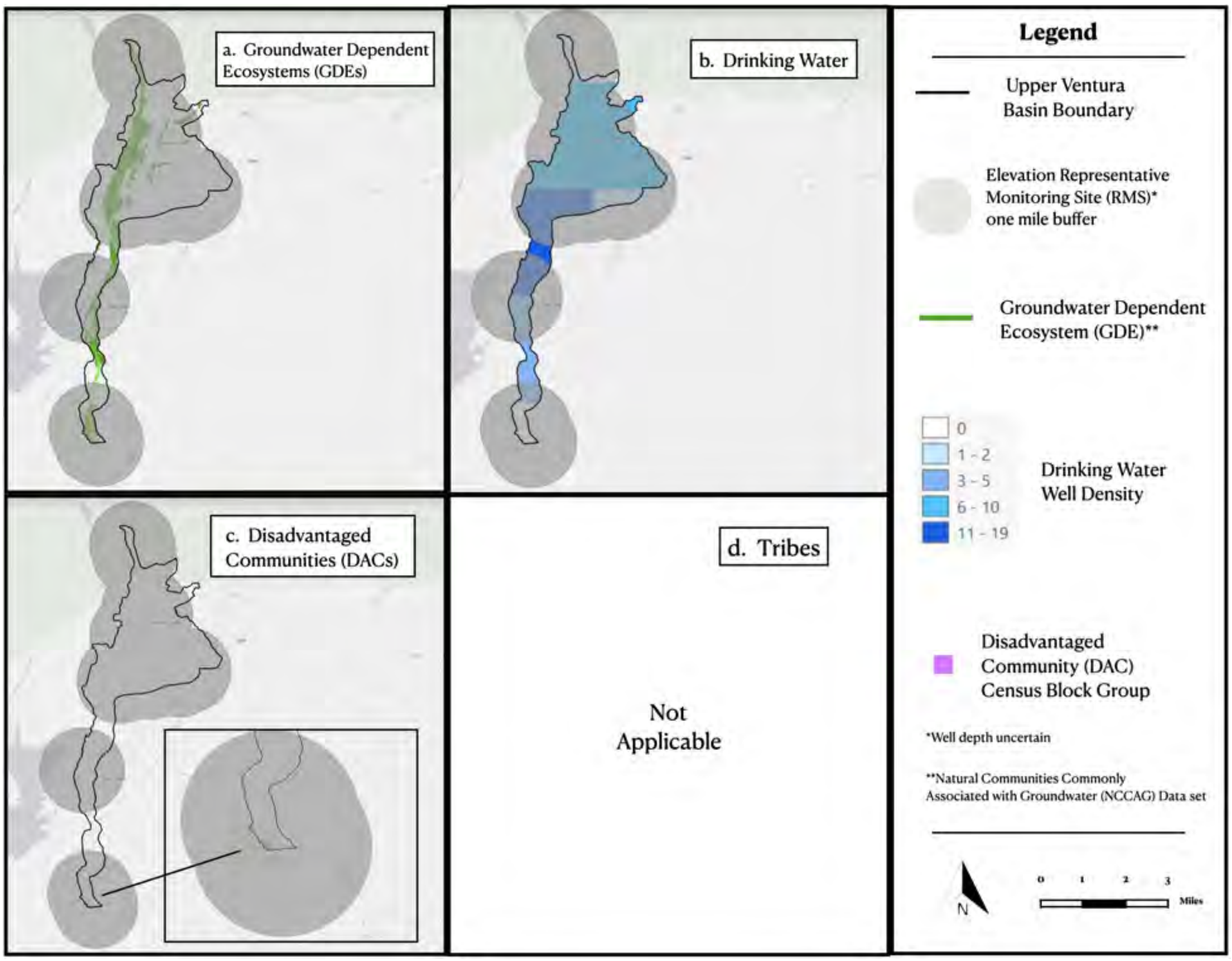

Figure 1. Groundwater elevation representative monitoring sites in relation to key beneficial users: a) Groundwater Dependent Ecosystems (GDEs), b) Drinking Water users, c) Disadvantaged Communities (DACs), and d) Tribes.

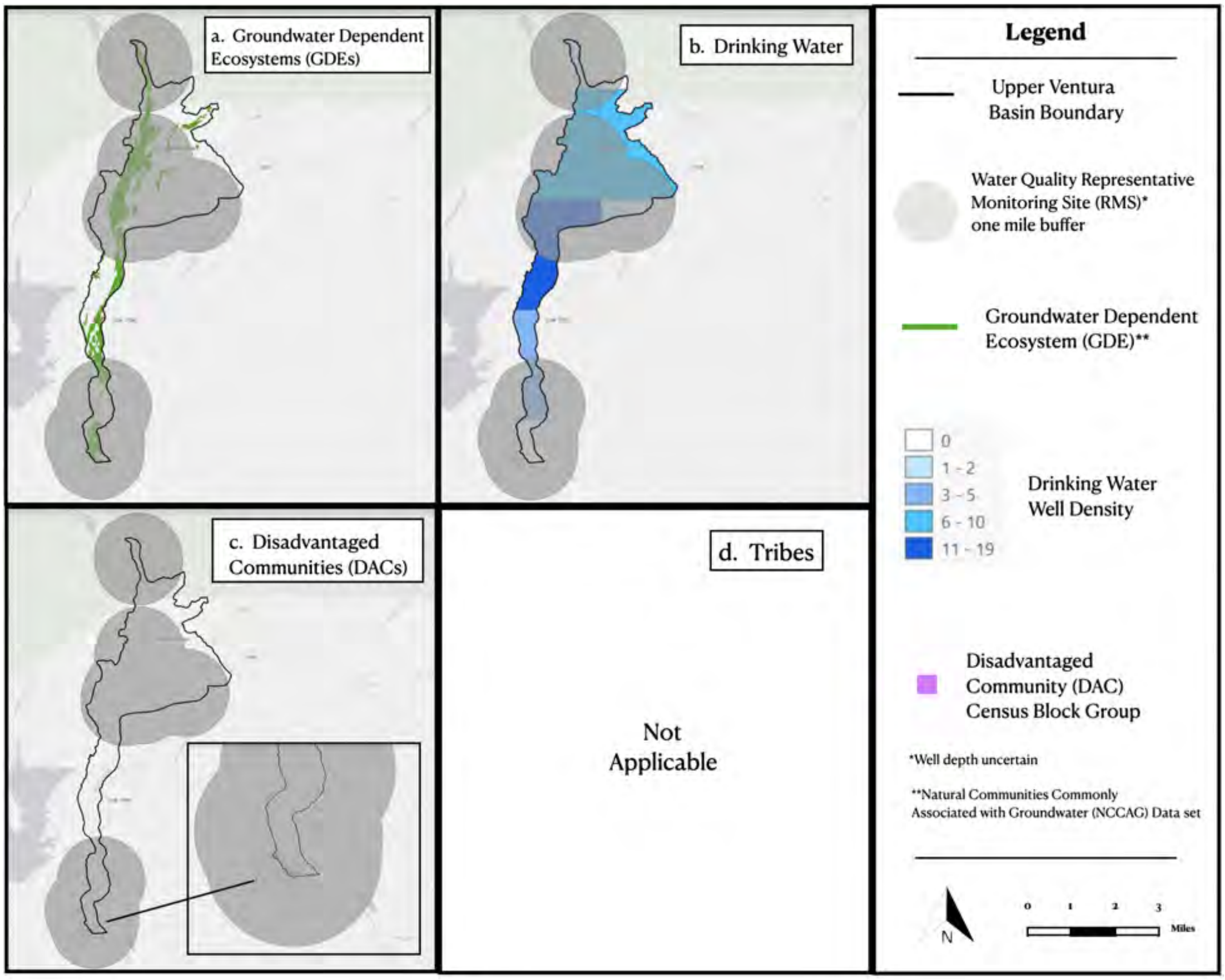

Figure 2. Groundwater quality representative monitoring sites in relation to key beneficial users: a) Groundwater Dependent Ecosystems (GDEs), b) Drinking Water users, c) Disadvantaged Communities (DACs), and d) Tribes.

October 8, 2021

Upper Ventura River Groundwater Agency
Attn: Mr. Bryan Bondy
202 W. El Roblar Dr.
Ojai, CA 93023

Subject: Public Comment Draft Upper Ventura River Valley Basin Groundwater Sustainability Plan

Dear Mr. Bondy:

Ventura County Public Works Agency, Watershed Protection (VCPWA-WP), appreciates the opportunity to review the Upper Ventura River Basin Groundwater Agency (UVRBGA) *Public Comment Draft Upper Ventura River Valley Basin Groundwater Sustainability Plant* (Draft) dated August 2021. Following are our comments:

49 On page ES-xi, a table such as Table 3.3.03 would be helpful to summarize demands and supplies and to provide a usage order of magnitude. It would also be helpful to provide a brief discussion of climate change assumptions (order of magnitude / %changes in precipitation / ET, etc.).

50 On page ES-xii, table ES-01, an explanation should be provided as to why the surface water historical total in/out (48,025-AFY) is lower than the current/projected in out (86,241/96,474-AFY).

51 On page ES-xiv, the well on which the groundwater levels in the hydrograph shown in Fig. ES-11 should be identified.

52 On Page ES-xxii, the Municipal and Industrial (M&I) and Agricultural (Ag) water use efficiency and Casitas Municipal Water District (CMWD) proposed projects to bridge the 5,160-AFY yield gap should be added as described in Section 6.

53 Section 2.2.1 lists the source types of water for municipal and industrial, agricultural, and domestic uses. Are there any significant stream, channel or surface water diversions contributing to water supplies (aside from the Robles Diversion and the privately owned

53	agricultural diversion mentioned in Sections 3.1.1.2 and 4.9.1)? The Draft only lists diversions reported by the State Water Resources Control Board (SWRCB).
54	Section 2.2.2.2 should be revised to reflect that the CMWD's 2020 Urban Water Management Plan update was completed and formally adopted.
55	In Section 2.2.2.2, have there been any recent updates to the Regional Water Quality Control Board (RWQCB) total maximum daily loads (TMDLs) for the Ventura River and its tributaries? If so, these updates should be referenced in the text.
56	In Section 2.2.3.2, it may be useful to state that that the California Well Standards Bulletins are undergoing a technical advisory committee review at the time of the GSP was prepared.
57	A statement should be included in Section 2.3.1 that CMWD's Mira Monte well pumps less than 1% of the water supplied by CMWD.
58	In Sections 3.1, 3.1.3.1.3 and 3.1.3.2, despite the lower hydraulic conductivity of the Ojai Conglomerate, could this formation potentially connect any portions of the water-bearing alluvial sediments of the Upper Ventura River Valley Basin and the Ojai Valley Basin? If so, the Ojai Valley Basin could act as a source of groundwater recharge in Section 3.1.3.2.
59	In general, there are references throughout the text to the groundwater model in Appendix H. It would be helpful to include a summary of the model in GSP text.
60	Section 3.1.1.3 states that water is not imported to the Ventura River Watershed. It may be appropriate to note the planned CMWD interconnect project with Carpinteria Valley Water.
61	Sections 3.1.3.3, 3.2.4 and 4.7 discuss the elevated concentrations of nitrates in the Mira Monte/Meiners Oaks Area. It should be noted that Ventura County discretionary planning reviews consider the RWQCB Basin Plan groundwater quality objectives and groundwater beneficial uses as pertains to potential development and proposed projects.
62	On page 70, last paragraph, climate change is anticipated to change the timing and duration of precipitation events and could influence the year-to-year surface and groundwater budgets. It is suggested to rephrase or acknowledge what is anticipated from climate change, but note that there is a large level of uncertainty.
63	On page 77 and Table 3.3-03 – While estimated Municipal and Industrial (M&I) demands have decreased over time, Agricultural (Ag) demands have stayed constant and therefore start to represent a larger portion of total demand. Discussion should be included about how this is addressed in the future water demands.

64 Table 3.3-03 shows annual Ag demands at 505 AFY, while Table 3.3-06 has a more specific Ag pumping demand. Is the difference due to Ag surface water deliveries? This should be clarified.

65 On page 78 – Reliability of Historic Surface Water Deliveries, information should be added on how CMWD estimates planned deliveries. Regarding the following text: “The surface water supply was deemed reliable because demands were less than projected for much of the historical period and the surface water supply was less than the safe yield of the reservoir, as it was understood at the time” and “the reservoir safe yield has been re-assessed to be 10,660 AF/yr for Lake Casitas (now called “safe demand”), as discussed in Sections 3.3.2 and 3.3.3.2.”

1. The first sentence above is not necessarily accurate since not all of Lake Casitas water is delivered to the Upper Ventura River (UVR). If the other CMWD demands increase, UVR deliveries could potentially decrease.
2. Did the “Safe Demand” estimate incorporate the climate change effects as outlined in this Draft? What is the estimated portion to be delivered to the UVR if the supply is limited to the “Safe Demand”?

66 On page 79, second paragraph, clarify if stream outflows from individual streams make up 83% of the total groundwater model domain inflows.

67 On page 82 – Average 2006-2016 ”M&I GW Supplies” of 845 AFY in Table 3.3-03 “Estimated Historical Demands and Supplies in the UVRGB by Category and Source” are much less than the average 2006-2016 “M&I Pumping” of 4,707 AFY in Table 3.3-06 “UVRGB Groundwater Inflows and Outflows by Water Year, Historical and Current Period.” Is this due to M&I exports out of the basin? If so, there should be a note on Table 3.3-03 similar to the note on Ag groundwater exports. Otherwise, this discrepancy needs to be explained.

68 On pages 87-88, per Table 3.3-03, are M&I demands appropriately estimated, given the likelihood of multiple-dry year conditions?

69 On page 88, in the last paragraph, there is a significant gap between the CMWD safe demand and project demand. What portion of the gap applies to UVR? Is the schedule to close this gap within the next 10 years overly optimistic?

70 Page 90 relates the conclusions from Baseline vs Climate Change. What is the frequency of ENSO/PDO events? Can it be stated that the size of the basin and its responsiveness to changes in precipitation/runoff such that the higher rain fall events of ENSO/PDO rapidly refill the basin?

71 On page 102, top paragraph, the statement “Modeling projections for the GSP suggest that the proposed minimum thresholds may be occasionally exceeded at some monitoring

71 locations (Appendix Q). However, the criterion for undesirable results is not predicted to be triggered during the 50-year GSP implementation period" seems contradictory and potentially weakens the selection of MTs.

72 On page 115, second Paragraph, "…and UVRGA determines that exceedances are caused by groundwater pumping." The criteria for making this determination should be identified.

73 Section 4.7.2.4 discusses the increased costs for treatment of groundwater to meet water quality objectives for municipal beneficial users. This is an important issue, especially within the Meiners Oaks Water District's pumping areas.

74 On page 132, top paragraph, consider using groundwater levels for measuring this SCM (in addition to flows). Measurement may be implied with the addition of new wells, but it is not sufficiently described in this section.

75 On page 142, Section 5.3, additional detail would be helpful regarding the spatial and temporal extent of the monitoring network. Although the GSP network may meet the DWR BMP guidance for well density, the Miramonte/Meiners Oaks area is lacking in monitoring locations. This could be a data gap with an additional well be needing to be identified in this area.

76 Does the Draft address amending the Plan at the five-year assessment to reflect any revisions or modifications made to the RWQCB Water Quality Objectives (Section 5.2)? The Draft discusses potential modification to monitoring networks if there are significant changes in pumping patterns or groundwater quality.

77 Section 6.2 states the UVRGA will attempt to survey domestic well owners in the Basin. The survey will be designed to collect information from the well owners about well status, construction, usage, etc. VCPWA-WP oversees compliance with the County Well Ordinance (No. 4468). UVRGA should notify VCPWA-WP if a well is surveyed and does not comply with the County Well Ordinance.

78 No mention is made of the CMWD proposed projects to increase water conservation and new water supply to bridge the 5,160 AFY gap in the loss of yield from Lake Casitas. The magnitude of impact of the 5,160-AFY to the UVR should also be documented.

79 The Draft does not discuss any anticipated effects on the Basin from the future removal of the Matilija Dam. It might be beneficial to discuss the impacts to the Basin after execution and completion of the project, likely to occur during the 20-year measurable objectives achievement period (Section 7.1.6).

If you should have any questions, please contact James Maxwell at james.maxwell@ventura.org or (805) 654-5164, or me at kim.loeb@ventura.org or (805) 650-4083.

Sincerely,

Kimball R. Loeb, PG, CEG, CHG
Manager, Groundwater Resources Section
Water Resources Division

C: Jeff Pratt, Director, Ventura County Public Works
Glenn Shephard, Director, Ventura County Public Works, Watershed Protection
Arne Anselm, Deputy Director, Ventura County Public Works, Water Resources

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Bryan Bondy

From: Upper Ventura River Groundwater Agency <sward@uvrgroundwater.org>
Sent: Friday, October 8, 2021 4:24 PM
To: Summer Ward
Subject: GSP Comment/Question

GSP Comment/Question Form	
Last Name:	Pitterle
First Name:	Benjamin
Email Address:	ben@sbck.org
Confirm Email Address:	ben@sbck.org
Phone:	
Mailing Address:	Santa Barbara Channelkeeper
GSP Section for Comment/Question: 80	4.4 Chronic Downing of Groundwater Levels
GSP Comment/Question:	Chronic Lowering of Groundwater Levels The GSP used the lowest recorded historical groundwater level outlier as the groundwater level and storage minimum threshold. The stated purpose of establishing this threshold is to prevent significant and unreasonable effects that include causing municipal, domestic, or agricultural beneficial users to be unable to meet basic water supply needs with groundwater or alternative supplies, or permanent or prolonged impacts to riparian GDEs. We note that the ability to pump groundwater from the Robles reach is routinely disrupted during drought for many water rights holders in the basin including the existing municipal water districts. These purveyors rely significantly if not entirely during drought years on alternative supply from Lake Casitas. Lake Casitas is currently critically reduced in capacity. In light of these circumstances and the risk of increased frequency of drought due to climate change, we find the selection of the lowest recorded historical groundwater level in appropriate as a minimum threshold to prevent undesirable effects to water supplies related to chronic lowering of groundwater levels.
Would you like to join the UVRGA Official Interested Parties List?:	Yes

Santa Barbara Channelkeeper Comments (10-8-2021)

Beneficial Uses:

This email was built and sent using Visual Form Builder.

Bryan Bondy

From: Upper Ventura River Groundwater Agency <sward@uvrgroundwater.org>
Sent: Friday, October 8, 2021 4:21 PM
To: Summer Ward
Subject: GSP Comment/Question

GSP Comment/Question Form	
Last Name:	Pitterle
First Name:	Benjamin
Email Address:	ben@sbck.org
Confirm Email Address:	ben@sbck.org
Phone:	
Mailing Address:	Santa Barbara Channelkeeper 714 Bond Avenue Santa Barbara, CA 93103
GSP Section for Comment/Question: 81	4.9 Depletions of Interconnected Service Water
GSP Comment/Question:	Foster Park Flow Protocols The “Foster Park Flow Protocols” are not based on the best available science. Santa Barbara Channelkeeper negotiated the protocols with the City of Ventura as a means to provide “life support” for the lower reaches until a final outcome is reached with the Ventura River Watershed Adjudication. The State Water Board’s groundwater and surface water model was not available when the protocols were developed. The California Department of Fish and Wildlife’s instream flow recommendations for the Ventura River were not available when the protocols were developed. Based on current implementation of the protocols in 2021, extractions at Foster Park continued to take place even though river flows in the reach dropped below 2 CFS for prolonged periods of time. 2 CFS was identified by the City of Ventura’s own 2013 Hydrology Study as a critical threshold below which is detrimental to critical habitat conditions. The “Foster Park Flow Protocols” do not have the endorsement of State and Federal resource agencies. For these reasons, the GSP should not rely on long-term implementation of the “Foster Park Flow Protocols” to ensure that undesirable results do not occur.

Would you like to join the UVRGA Official Interested Parties List?: Yes

Beneficial Uses:

This email was built and sent using Visual Form Builder.

Bryan Bondy

From: Upper Ventura River Groundwater Agency <sward@uvrgroundwater.org>
Sent: Friday, October 8, 2021 4:13 PM
To: Summer Ward
Subject: GSP Comment/Question

GSP Comment/Question Form

Last Name:	Pitterle
First Name:	Benjamin
Email Address:	ben@sbck.org
Confirm Email Address:	ben@sbck.org
Phone:	
Mailing Address:	Santa Barbara Channelkeeper 714 Bond Avenue Santa Barbara, CA 93103 United States of America
GSP Section for Comment/Question:	82 4.9 Depletions of Interconnected Service Water
GSP Comment/Question:	GDE Analysis The GSP has not adequately demonstrated that permanent and prolonged impacts to GDEs have not already occurred in the Robles reach due to historic groundwater extractions. Rather, the GSP essentially asserts that the Robles reach is not a GDE because certain riparian vegetation communities were not identified in the GSA's recent analysis. Significant groundwater extractions, however, have been occurring for many decades. Such extractions and any related depletions of surface water would likely have significant impact on any riparian vegetation that may have been present during the period analyzed during GSP development. 83 Channelkeeper echoes comments submitted by the Surfrider Foundation, Ventura Chapter as they related to the GDE analysis included in the draft GSP. These comments are reiterated below: "The Riparian Groundwater Dependent Ecosystems Assessment Report characterizes the Robles reach as a "Losing reach with generally disconnected groundwater- surface water." This categorization eliminates the majority of this Groundwater Dependent Ecosystem from consideration under SGMA by assuming that it is

83 “disconnected” and thus has too great a depth to groundwater to support riparian habitat. Other reaches are similarly
dismissed. The analysis presented relies heavily on the Nature Conservancy “Natural Communities (NC) Dataset,” using
84 vegetation communities to eliminate GDE polygons from the Upper Ventura River Groundwater Basin. The NC dataset is
a statewide geographic computer database that maps vegetation types in all potential GDEs throughout the State of
California. The large geographic scope of this map does not accurately represent current on-the-ground conditions, and
more robust ground truthing should be undertaken. Even the aerial photos presented tell a different story than is
acknowledged in the narrative. Unfortunately, the UVRGSA analysis does not fully implement the Best Practices for
85 using the NC Dataset guidance provided by the Nature Conservancy, which presents six best practices for using local
groundwater data to confirm whether mapped features in the NC dataset are supported by groundwater. (Best Practices
for using the NC Dataset, TNC July 2019) According to this guidance: While depth-to-groundwater levels within 30 feet of
the land surface are generally accepted as being a proxy for confirming that polygons in the NC dataset are supported by
groundwater, it is highly advised that fluctuations in the groundwater regime be characterized to understand the
seasonal and interannual groundwater variability in GDEs. (see Best Practice #2.) one of the key factors to consider when
mapping GDEs is to contour depth-to-groundwater in the aquifer that is supporting the ecosystem (see Best Practice #5).
The GIS Spatial Analysis of Maximum Rooting Depth and Groundwater Level presented in the Riparian GDE document
does not present such contour depth-to-groundwater mapping or account for temporal variability. Furthermore, TNC
86 guidance acknowledges that; In many situations, the hydrologic connection of NC dataset polygons will not initially be
clearly understood if site-specific groundwater monitoring data are not available. If sufficient data are not available in
time for the 2020/2022 plan, The Nature Conservancy strongly advises that questionable polygons from the NC dataset
be included in the GSP until data gaps are reconciled in the monitoring network. Erring on the side of caution will help
minimize inadvertent impacts to GDEs as a result of groundwater use and management actions during SGMA
implementation. Many of California’s GDEs have adapted to dealing with intermittent periods of water stress, however
if these groundwater conditions are prolonged, adverse impacts to GDEs can result. Therefore, it is likely that the NC
vegetation mapping is representative of conditions in which groundwater levels have been frequently and repeatedly
pumped beyond the reach of riparian tree roots. Meanwhile, field observations over the past few wetter years show
that the riparian vegetation has rebounded, illustrating how the ecosystem responds with the variation in water years.
Receding groundwater levels and corresponding loss of surface flows due to pumping during the current drought will
likely reverse this recent trend, with the potential loss of the many young sycamores and other riparian vegetation.
87 Determining Groundwater/Surface water interactions TNC guidance for determining GDEs recognizes the importance of
surface flows; In addition, SGMA requires that significant and undesirable adverse impacts to beneficial users of surface
water be avoided. Beneficial users of surface water include environmental users such as plants or animals, which
therefore must be considered when developing minimum thresholds for depletions of interconnected surface water.
The Model Results and SMC Implications Presentation (March 25, 2021) reaches the conclusion that: • Basin water
budget is dominated by streamflow percolation into the Basin and groundwater discharge to Ventura River • GW
pumping averages only ~10% of the GW Budget As low as 4% in wet years Up to 31% in dry years • Basin GW levels
will be lower in dry seasons, but Basin will still re-fill in normal to wet years The conclusion that there is no impact from
pumping based on the fact that the basin rapidly refills in the wet season points to the likelihood that the surface water
is in fact “connected” to groundwater during these periods. Moreover, the fact that pumping represents up to 31% of

87 the budget in critical dry years raises the question of how groundwater extractions impact surface flows and groundwater levels.

88 The Model Results identify four areas of concentrated pumping, three of which directly impact groundwater levels in the "Robles Reach." This reach is the area with the most storage in the basin, and should be considered as the "primary sub-basin" for water supply. The three areas of concentrated pumping in this reach are likely to affect conditions throughout the basin.

89 The analyses and graphs presented in the Model Results do not provide information on the spacial and temporal surface flow conditions as they relate to groundwater levels. Because the downstream reaches are largely dependent on surface and groundwater flows out of this sub-basin, further analysis is needed to more clearly define the relationship between groundwater levels and surface flows. The analyses should, at a minimum, determine threshold groundwater levels at which surface flows are diminished or eliminated, both in the reach being monitored and downstream. This relationship was established decades ago in the Ventura River Conjunctive Use Report (1978) which states that; Flows in the live stretch are affected by both the rate of recharge of the upper part of the Ventura River groundwater basin and by the rate of groundwater extraction from wells in the river. Investigations published in the Conjunctive Use Report identified groundwater elevation thresholds in the upper basin at which flows in the live reach will cease; when the water level in well 4N23Wl6C4 falls below Elevation 495, surface flow in much of the live stretch stops although some pools remain. A flow of 1 cfs or more in the live stretch corresponds with a water level in this well of greater than about Elevation 507.

90 Groundwater levels also affect surface flows in the Robles Reach, which frequently dries up despite constant inflows. Unfortunately, the Aquatic GDE Impact Analysis is quick to dismiss the effect of groundwater elevation on surface flows; No monitoring is recommended at either of the critical riffle aquatic GDEs or the Robles Habitat Area, as impacts from pumping in these areas were determined to be minimal or non-existent. This conclusion is inconsistent with the guidance provided in Monitoring Networks and Identification of Data Gaps BMP (DWR 2016) which states: 23 CCR §354.34(c))(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. DWR guidance provides detailed information on developing a monitoring network to accurately assess these concerns."

91 Confluence Area GDE The Draft GSP accurately identifies the Confluence Area as a GDE. The GSP, however, falls short in its determination that more years of study are necessary to determine if surface flow depletions caused by upstream pumping are significant and unreasonable. The confluence area is critical habitat for federally endangered Southern California steelhead trout. Steelhead have been observed over-summering in pools within this reach by state and local resource agencies. Surface water habitat and water quality conditions degrade significantly (to the point of complete dewatering) in this reach due to depletions of interconnected groundwater in the Robles reaches. The numeric model utilized to determine the effect of pumping on surface flows in the Confluence Area is not based on the best available science, which includes the State Water Resource Control Board's Groundwater and Surface Water model, currently well under development.

92 "Direct" Depletions of Surface Water The GSP defines the

92 terms “direct” and “indirect” depletion with regard to depletion of interconnected surface waters. Direct depletion is defined as surface water depletion caused by a cone of depression from pumping wells near the Ventura River. The GSP, however, then continues to identify only the Foster Park Well field as a facility causing direct depletion. Multiple, major water extraction facilities are located in the Robles reach of the Upper Ventura River Basin. These facilities utilize wells located in direct proximity of the Ventura River. Pumping from these wells has the potential to create a cone of depression that could deplete surface flows. The Robles Reach historically receives perennial inflows from the upper Ventura River and its Matilija Creek and North Fork Matilija Creek tributaries. These inflows persist even during prolonged periods of drought. The GSP has not provided adequate evidence to support its assertion that most groundwater in the basin “naturally” drains out of the basin at a rate greater than inflows. In any case, pumping from wells located within the basin and within immediate proximity of the Ventura River clearly have the capacity to produce cone of depression effects that can reduce and eliminate surface flows earlier than may naturally occur absent pumping. Such reduction in flows could have significant effects on riparian habitat and aquatic communities within the Robles Reach and downstream.

Would you like to join the UVRGA Official Interested Parties List?: Yes

Beneficial Uses:

This email was built and sent using Visual Form Builder.

October 13, 2021

Brian Bondy, Executive Director
Upper Ventura River Groundwater Sustainability Agency

Sent via email to bbondy@uvrgroundwater.org

Subject: Comments on the UVRGSA Draft Groundwater Sustainability Plan

Dear Mr. Bondy:

Thank you in advance for accepting these comments and allowing for Casitas' Board of Directors review prior to submittal to the Upper Ventura River Groundwater Sustainability Agency (UVRGSA). Casitas Municipal Water District (Casitas) has the following comments on the UVRGSA's Draft Groundwater Sustainability Plan (Draft GSP) published August 2021. In general, the comments are clarifications and updates to descriptive text relating to water supplies and facilities managed by Casitas.

Page ES-iv, and Pages 9-10

Please revise the language to be based on most recent planning documents as follows.

> *Current Draft GSP Language:*
> *CMWD operates Lake Casitas, which provides approximately ⅔ of the water supply in the Basin. CMWD operates Lake Casitas pursuant to its combined 2015 Urban Water Management Plan (UWMP) and Agricultural Water Management Plan (2020 update of UWMP in progress).*
>
> *CMWD is also currently working on a Comprehensive Water Resources Plan (draft as of June 2020) that identifies the safe demand for its water supplies and identifies projects to address the gap between supply and demand for implementation over the next 10 years. Implementation of this plan is expected to address CMWD's anticipated supply gap, thereby preventing increased reliance on groundwater supply which would otherwise potentially impact UVRGB operational flexibility.*
>
> *Revised Language:*
> *CMWD operates Lake Casitas, which provides approximately ⅔ of the water supply in the Basin. CMWD's 2020 Urban Water Management Plan (UWMP) is a long-term planning document comparing supplies and demands over the next 20 years. The 2020 UWMP outlines reliability of existing and planned water sources, demand management measures, progress toward meeting the State's demand reduction goals, and water shortage contingency plans. During droughts, Casitas manages its supplies with its Water*

Efficiency and Allocation Program (WEAP), which uses a water allocation system to manage demands based on water supply conditions.

Page 33-34

Please revise the language as follows, reflecting that the dry reach begins upstream of the Robles Diversion based on Casitas' observations and mapping shown in Figure 3.2-12 of the Draft GSP.

Current Draft GSP Language:
Just past the Robles Diversion (at Gage 607) the Ventura River has very low flows (and is often dry) in the summer and early fall months. These dry conditions are typical in the Robles and Santa Ana Areas, except during stormflows in much of the Ventura River. In general, flows are generally highest in the months of January to March and are generally lowest August through October.

Revised Language:
Beginning just upstream of the Robles Diversion and at Gage 607 (located just past the Robles diversion), the Ventura River has very low flows (and is often dry) in the summer and early fall months. These dry conditions are typical in the Robles and Santa Ana Areas, except during stormflows in much of the Ventura River. In general, flows are generally highest in the months of January to March and are generally lowest August through October.

Page 35

Please revise the language as follows:

Current Draft GSP Language:
Casitas Reservoir is the largest reservoir within the watershed. The Casitas Dam was constructed in 1959 by the United States Bureau of Reclamation (USBR), providing a maximum storage capacity of 254,000 AF (Entrix, 2001) with a long-term average demand of 17,500 AF (VRWC, 2015). Water is diverted from the Ventura River via the Robles Diversion and delivered to the reservoir through the Robles Diversion Canal, a concrete-lined 5.4-mile canal (EDAW, 1978). The diversion works consist of a cutoff wall, forebay basin, spillway, fish passage structures, and diversion canal to Casitas Reservoir (CMWD, 2005). Typically, a little less than half of the reservoir supply comes from the Ventura River. Runoff from Coyote and Santa Ana sub-watersheds provides the remainder of its supply (Entrix, 2001). Diversions from Ventura River to Casitas Reservoir are typically from January to March when the river flows are sufficient to meet certain operational regulatory requirements designed to address upstream steelhead migration impediments between the diversion works and just north of the Santa Ana Boulevard bridge. The diversion system has a nominal capacity of 500 cfs (CMWD, 2021). Environmental considerations and physical operating conditions govern operation of the diversion structure under different hydrologic situations. The Biological Opinion (BO) from the National Marine Fisheries Service (adopted in 2004) modified previous requirements for passage of flows for fish habitat. This was further modified during the recent drought to allow increased diversions to the Lake when storage levels in the Lake are low (CMWD,

2021). Within the Migration Period (Jan. 1st to June 30th) outlined in the BO, available flows above 30 cfs up to 500 cfs can be diverted down the Robles Canal, with flows at or below 30 cfs, bypassing the diversion structure and flowing downstream. Additional diversion rules are applied to maintain flows during and after stormflow events within the fish migration season. Outside of the migration period (July 1 to December 31), available flows over 20 cfs up to 500 cfs can be diverted down the Robles Canal.

Water from the Lake Casitas Reservoir is the primary water supply for many users in the Basin. Lake Casitas' water is also blended with poorer quality groundwater to improve water quality and extend supplies (VRWC, 2015). The reservoir is carefully managed to maintain supplies during a dry period equivalent to the historical 21-year dry period from 1945 to 1965, the longest dry period on record. While the lake has not yet been put to a "21-year dry period test," it has been a reliable source of water in many multi-year dry periods when numerous wells were dry and there was little flow in the Ventura River (VRWC, 2015).

Revised Language:

Lake Casitas is the largest storage reservoir within the watershed. Casitas Dam was constructed in 1959 by the United States Bureau of Reclamation (USBR), with a current maximum storage capacity of 238,000 AF. Water is diverted from the Ventura River via the Robles Diversion and delivered to the reservoir through the Robles Diversion Canal, a concrete-lined 5.4-mile canal (EDAW, 1978). The diversion works consist of a cutoff wall, forebay basin, spillway, fish passage structures, and diversion canal to Lake Casitas (CMWD, 2005). Typically, a little less than half of the reservoir supply comes from the Ventura River. Runoff from Coyote and Santa Ana sub-watersheds provides the remainder of its supply (Entrix, 2001). Diversions from Ventura River to Lake Casitas are typically from January to March when the river flows are sufficient to meet certain operational regulatory requirements designed to address upstream steelhead migration impediments between the diversion works and just north of the Santa Ana Boulevard bridge. The diversion system has a nominal capacity of 500 cfs (CMWD, 2021). Environmental considerations and physical operating conditions govern operation of the diversion structure under different hydrologic situations. The Biological Opinion (BO) from the National Marine Fisheries Service (adopted in 2004) modified previous requirements for passage of flows for fish habitat. This was further modified during the recent drought to allow increased diversions to Lake Casitas when storage levels are low (CMWD, 2021). Within the steelhead migration season (Jan. 1st to June 30th) outlined in the BO, available flows above 30 cfs up to 500 cfs can be diverted down the Robles Canal, with flows at or below 30 cfs, bypassing the diversion structure and flowing downstream. Additional release rules are applied to maintain flows during and after stormflow events with downstream releases of up to 171 cfs.. Outside of the migration season (July 1 to December 31), available flows over 20 cfs up to 500 cfs can be diverted down the Robles Canal.

Water from the Lake Casitas Reservoir is the primary water supply for many users in the Basin. Lake Casitas' water is also blended with poorer quality groundwater to improve water quality and extend supplies (VRWC, 2015). The reservoir is carefully managed to maintain supplies during a an extended dry period, and planned operations are based on hydrologic modeling that incorporates a historic 21-year dry period, future climate change *impacts, and the National Marine Fisheries Service 2003 non-jeopardy Steelhead Trout Biological Opinion for the Robles Diversion and Fish Passage Facility. Lake Casitas has been a reliable source of water in many multi-year dry periods when numerous wells were dry and there was little flow in the Ventura River (VRWC, 2015).*

Page 52

Regarding the language below describing availability of gage 607 data, please note that the data is now available through 2020 on Casitas' website: https://www.casitaswater.org/for-customers/fisheries-program.

> *Streamflow data along the Ventura River are available at the 607 gage (located just downgradient of the Robles Diversion) and the Foster Park station (gage 608). While continuous and recent streamflow data is available from the Foster Park station, data from gage 607 was not available past 2017 due to delays in reporting by CMWD. This is not considered a significant data gap or uncertainty. These data will be incorporated into the modeling when CMWD publishes.*

Page 64

Please revise the language as follows, reflecting that the dry reach begins upstream of the Robles Diversion based on Casitas' observations and mapping shown in Figure 3.2-12 of the Draft GSP.

> *Draft GSP Language:*
> *The Ventura River within the Robles Area is mostly dry south of the Robles Diversion, except under stormflow conditions, when flows in the Ventura River exceed the infiltration rate along the riverbed.*
>
> *Revised Language:*
> *The Ventura River within the Robles Area is mostly dry starting just upstream of the Robles Diversion, except under stormflow conditions, when flows in the Ventura River exceed the infiltration rate along the riverbed.*

Page 78

Please revise the language as follows:

> *Draft GSP Language:*
> *A 2004 Water Supply and Use Report (CMWD, 2004) quantified the safe yield for the reservoir to be 20,540 AF/yr based on a 21-year critically dry period – down from the original 28,000 AF/yr safe yield planned by the USBR in 1954. The 20,540 AF/yr safe yield was used in the 2005, 2010, and 2015 urban water management plans. As the drought beginning in 2012 progressed, demands decreased due to voluntary and mandatory conservation measures implemented by CMWD and its retail purveyors. These measures were implemented proactively to extend the supplies of Lake Casitas. More recently, the reservoir safe yield has been re-assessed to be 10,660 AF/yr for Lake Casitas (now called "safe demand"), as discussed in Sections 3.3.2 and 3.3.3.2.*

Revised Language:
A 2004 Water Supply and Use Report (CMWD, 2004) quantified the safe yield for the reservoir to be 20,540 AF/yr based on a 21-year critically dry period – down from the original 28,000 AF/yr safe yield planned by the USBR in 1954. The 20,540 AF/yr safe yield was used in the 2005, 2010, and 2015 urban water management plans. As the drought beginning in 2012 progressed, demands decreased due to voluntary and mandatory conservation measures implemented by CMWD and its retail purveyors. These measures were implemented proactively to extend the supplies of Lake Casitas.

More recently, the Lake Casitas yield model was updated to include:

- *Extended hydrologic period of record of 1945-2018 (from previous of 1945-1999)*
- *Incorporated results of recent Lake Casitas bathymetric survey – reduced maximum storage capacity from 254,000 AF to 237,761 AF*
- *Added function to compute reservoir spills*
- *Incorporated Robles Diversion operations based on 2003 Biological Opinion requirements and 2018 Critical Drought Protection Measures*
- *Reduced modeled Robles diversions based on a diversion efficiency of 70 percent, consistent with operational data since the Fish Passage Facility was constructed*
- *Improved method of calculating monthly net evaporation loss*

On April 21, 2021, the Board of Director adopted a planned Casitas System operational yield of 15,010 AF/yr. The new operational yield is based on the updated modeling results, a -4.3 percent climate change adjustment based on the anticipated changes to precipitation, and a -15 percent supply safety factor to account for uncertainty in modeling assumptions. This updated yield was incorporated into CMWD's 2020 Urban Water Management Plan.

Page 82
Please revise the language as follows:

Draft GSP Language:
The current safe yield (also referred to as "safe demand") for Lake Casitas is 10,660 AF/yr. Average CMWD deliveries for the current period are close to the 10,660 AF/yr safe demand. Consistent with the historical evaluation (Section 3.3.1.1), the surface water supply was deemed reliable because demands were less than projected for much of the historical period and the surface water supply was less than the safe yield of the reservoir, as it was understood at the time.

Revised Language
The current operational yield for the Casitas System is 15,010 AF/yr. Average CMWD deliveries for the current period (2017 through 2019) were approximately 11,000 AF/yr. Consistent with the historical evaluation (Section 3.3.1.1), the surface water supply was deemed reliable for purposes of this GSP because water demands were less than projected for much of the historical period and water demands has stayed within the planned operational yield of the reservoir.

Page 88
Please revise the language as follows:

> *Draft GSP Language:*
> *As discussed in Section 3.3.2, Lake Casitas current "safe demand" is estimated to be 10,660 AF/yr (CWRP report). The CMWD CWRP indicates a 5,160 AF supply gap between the reservoir safe demand and projected demands for the overall CMWD service area. However, CMWD's draft CWRP includes projects planned for implementation over the next decade to bridge the gap between "safe demand" and projected demands for Lake Casitas surface water supplies. This includes conservation measures to reduce future demands and projects to generate new water supplies. As such, with the planned future projects and conservation measures in CMWD's CWRP, surface-water deliveries to UVRGB are anticipated to be reliable through the 20-year GSP implementation period.*
>
> *Revised Language*
> *As discussed in Section 3.3.2, the current operational yield of the Casitas System is estimated to be 15,010 AF/yr (CMWD 2020 UWMP). The CMWD 2020 UWMP is a water supply planning document that projects demands and supplies over the next 20 years. This includes demand management measures as well as projects to generate additional water supplies. For purposes of this analysis, with the planned supplies and conservation measures in CMWD's 2020 UWMP, long-term surface-water deliveries to UVRGB are anticipated to be reliable through the 20-year GSP implementation.*

If there are any questions in this regard, please do not hesitate to contact me at mflood@casitaswater.com or 805.649.2251, Ext. 111.

Sincerely,

Michael Flood
General Manager

c:

NMFS Comments

UNITED STATES DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
NATIONAL MARINE FISHERIES SERVICE
West Coast Region
501 West Ocean Boulevard, Suite 4200
Long Beach, California 90802-4213

December 8, 2021

Bryan Bondy
Executive Director
Upper Ventura River Groundwater Sustainability Agency
C/O Meiners Oaks Water District
202 W. El Roblar Drive
Ojai, CA 93023

Re: Draft Upper Ventura River Groundwater Agency Groundwater Sustainability Plan (August 2021)

Dear Mr. Bondy:

Enclosed with this letter are NOAA's National Marine Fisheries Service's (NMFS) comments on the Draft Upper Ventura River Groundwater Sustainability Plan (Draft GSP) prepared by the Upper Ventura River Groundwater Agency.

The Draft GSP was developed pursuant to, and intended to meet, requirements of the California Sustainable Groundwater Management Act (SGMA). The SMGA includes specific requirements to identify and consider adverse impacts on all recognized beneficial uses of groundwater and related interconnected surface waters, including Groundwater Dependent Ecosystems (GDE). (See Cal. Water Code §§ 10720.1, 10721, 10727.2.)

As explained more fully in the enclosure, the Draft GSP does not, but should, adequately address the recognized instream beneficial uses of the Upper Ventura Rive Groundwater Basin, as well as other GDE, potentially affected by the management of groundwater within the subject basin. Additionally, the Draft GSP should also recognize the important relationship between the extensive groundwater extractions and water diversion and storage within the basin (including the Robles and Foster Park diversion facilities) and its potential adverse effects on the amount and extent of surface flows and other water dependent habitat features utilized by the federally listed endangered southern California steelhead (*Oncorhynchus mykiss*). 94

The revised Draft GSP should be re-circulated to give NMFS, and other interested parties, an opportunity to review the revisions before the Draft GSP is finalized.

NMFS appreciates the opportunity to comment on the Draft GSP. If you have a question regarding this letter or enclosure, please contact Mr. Mark H. Capelli in our Santa Barbara Office (805) 963-6478 or mark.capelli@noaa.gov, or Mr. Andres Ticlavilca in our Santa Rosa Office (707) 575-6-54 or andres.ticlavilca@noaa.gov.

Sincerely,

Anthony P. Spina
Chief, Southern California Branch
California Coastal Office

cc:
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Christopher Diel, USFWS, Ventura Field Office
Chris Dellith, USFWS, Ventura Field Office

NOAA's National Marine Fisheries Service's Comments on Draft Upper Ventura River Groundwater Agency Groundwater Sustainability Plan (2021)

December 8, 2021

Overview

NOAA's National Marine Fisheries Service (NMFS) provides the following comments on the Draft Upper Ventura River Groundwater Sustainability Plan (Draft GSP), with a focus on its relevance to the federally listed endangered southern California steelhead (*Oncorhynchus mykiss*). Prior to presenting these comments, NMFS first provides background information on the endangered steelhead and their closely resident cohort, which utilize and reside in the Ventura River watershed, including the reach of the mainstem of the Ventura River underlain by the Upper Ventura River Groundwater Basin (hereafter "Basin"). That background information includes the status of the species, life history and habitat requirements, and actions that are essential for recovery of the species. This information is essential for understanding the potential implications of implementing the Draft GSP for the endangered steelhead. Our general and specific comments on the Draft GSP are presented in subsequent sections.

Status of Steelhead, Life History and Habitat Requirements, and Recovery Needs

Status of steelhead and habitat for the species in the Ventura River Watershed

NMFS listed southern California steelhead, including the populations in the Ventura River watershed (which includes the Basin), as endangered in 1997 (62 FR 43937), and reaffirmed the endangered listing in 2006 (71 FR 5248).

NMFS designated critical habitat for southern California steelhead in 2005 (70 FR 52488). Within the Basin, this designation includes the mainstem of the Ventura River, but also the lower Ventura River and the Ventura River Estuary (See Figures 1 and 2).

Critical habitat for endangered steelhead includes: 1) freshwater spawning habitat with water quality and quantity conditions and substrate that support spawning, incubation, and larval development; 2) freshwater rearing sites with water quality and floodplain connectivity to form and maintain physical habitat conditions that support juvenile growth and mobility, and natural cover such as shade, submerged and overhanging vegetation that provide forage and refugia opportunities; and 3) freshwater migration corridors free of anthropogenic passage impediments that promote adult and juvenile mobility and survival.

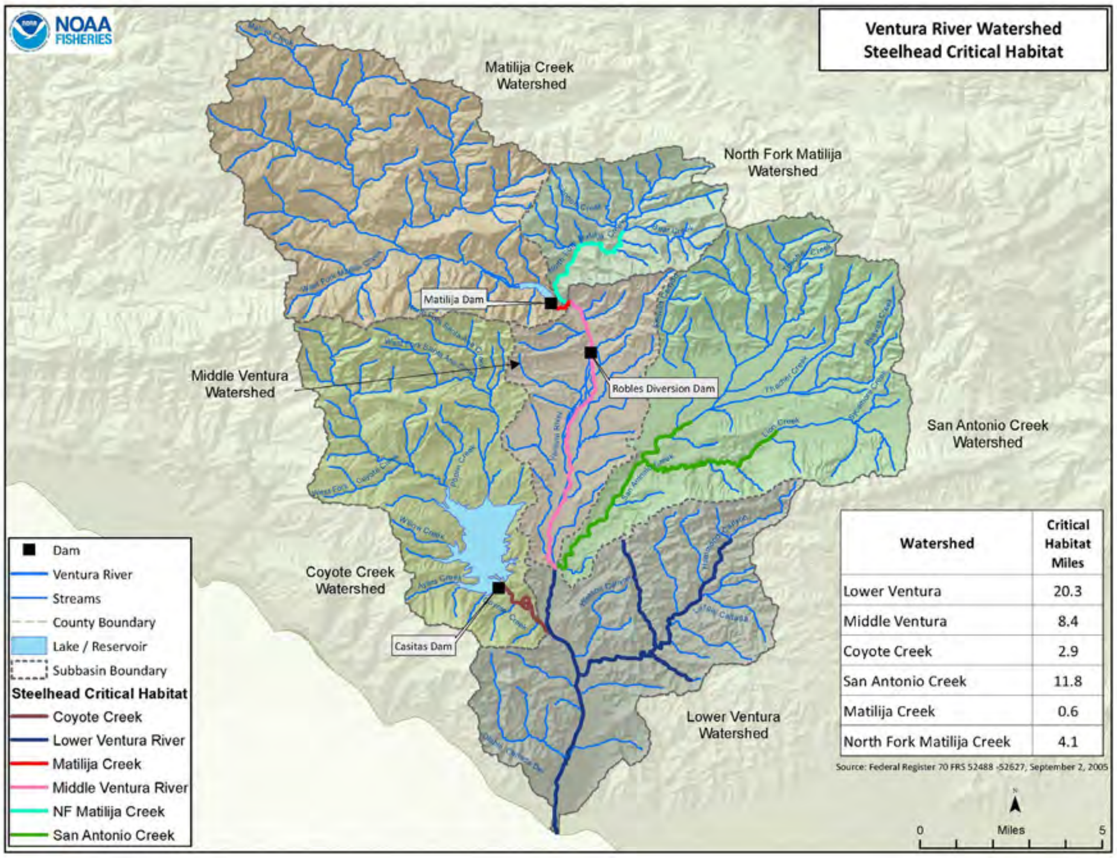

Figure 1. Ventura River Watershed Steelhead Critical Habitat. Dotted line depicts the boundaries of the Upper Ventura River Groundwater Basin.

Of particular relevance to the GSP are the existing and projected groundwater withdrawals from the Basin and their effects on instream beneficial uses of the interconnected surface water of the Ventura River and its tributaries (*e.g.*, Coyote Creek, San Antonio Creek, Matilija Creek, and North Fork Matilija Creek), including the use by adult and rearing juvenile steelhead, as well as other Groundwater Dependent Ecosystems (GDE).

NMFS Southern California Steelhead Recovery Plan (2012) noted:

> "Baseflows in some river reaches can be influenced significantly by groundwater stored and transported through faults and fractured rock formations. Many rivers and streams naturally exhibit interrupted baseflow patterns (alternating channel reaches with and without perennial surface flow) controlled by geologic formations, and a strongly seasonal precipitation pattern characteristic of a Mediterranean climate. Water temperatures are generally highest during summer months, but can be locally controlled by springs, seeps, and rising groundwater, creating micro-aquatic conditions suitable for salmonids [citation omitted]" p. 2-16.

NMFS' Southern California Steelhead Recovery Plan (2012) also noted:

> "Groundwater is an important source of surface flows during dry periods in many southern California watersheds. Groundwater can therefore contribute to sustaining suitable oversummering juvenile rearing conditions in mainstem and tributary habitats. Surface flows can be maintained as a result of the intersection of a high groundwater table or through the transmission of water through geologic fault systems." p. 5-4.

Habitat for this species has been adversely affected by loss and modification of physical or biological features (substrate, water quality and quantity, water temperature channel morphology and complexity, passage conditions, riparian vegetation, introduction of non-native invasive species, *etc*.) through activities such as surface-water diversions and groundwater extractions (See "Current DPS-Level Threats Assessment", pp. 4-1 – 4-11, and "Threats and Threat Sources", pp. 9-14 – 9-17, in NMFS 2012; also, NMFS 2016). Thus many of the physical and biological features of designated critical habitats have been significantly degraded (and in some cases lost) to the detriment of the biological needs of steelhead. These habitat modifications have hindered the ability of designated critical habitat to provide for the survival and ultimately recovery of this species.

NMFS has also modeled and mapped potential intrinsic potential spawning and rearing habitat in the Ventura River watershed. Intrinsic potential habitat was identified as part of NMFS' recovery planning process for the endangered Southern California DPS of Steelhead (See Figure 2). This method uses observed associations between fish distribution and the quantitative values of environmental parameters such as stream gradient, summer mean discharge and air temperature, valley width to mean discharge, and the presence of alluvial deposits – habitat features that are critical to steelhead spawning and rearing (Boughton and Goslin 2006).

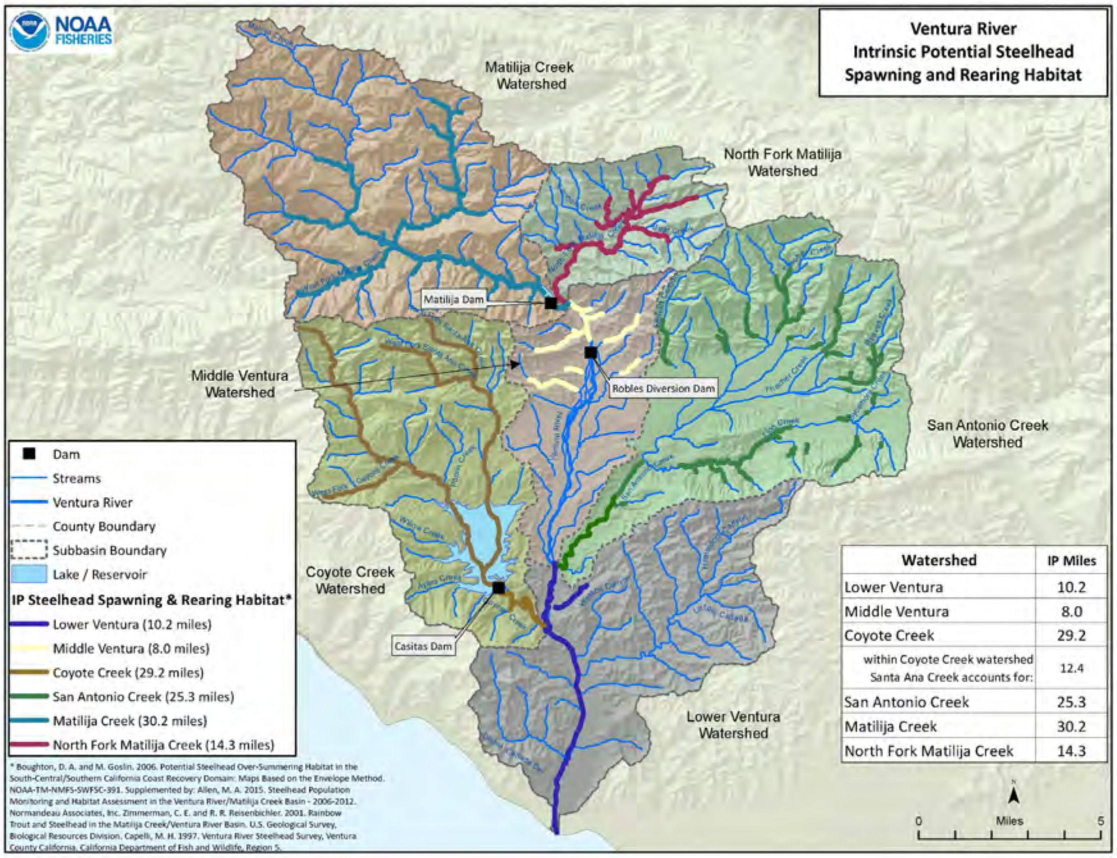

Figure 2. Ventura River Watershed Intrinsic Potential Steelhead Spawning and Rearing Habitat. Dotted line depicts the boundaries of the Upper Ventura River Groundwater Basin.

Steelhead life history and habitat requirements

Adult steelhead spend a majority of their adult life in the marine environment. However, the reproductive and early development stages of this species' life history occurs in the freshwater environment (migration to and from spawning areas, spawning, incubation of eggs and the rearing of juveniles), including in the main stem and tributaries such as those in the Ventura River watershed. Many of the natural variables (such as seasonal surface flow patterns, water quality, including water temperature) are significantly impacted by the artificial modification of these freshwater habitats. This includes both surface and sub-surface extractions that lower the water table and can, in turn, affect the timing, duration, and magnitude of surface flows essential for steelhead migration, spawning and rearing. Juvenile steelhead must have access to perennial stream reaches (including coastal estuaries) with tolerable water temperature for growth and survival (See, for example, Boughton *et al*. 2009). Surface diversions in combination with lowered groundwater tables during the dry season can *indirectly* affect rearing individuals by reducing vegetative cover, and *directly* by reducing or eliminating the summertime surface flows (or pool depths) in parts of the watershed. These conditions have been and are being exacerbated by global climate change (Beighley *et al*. 2008, Feng *et al*. 2019, Gudmundsson *et al*. 2021).

Recovery needs of endangered steelhead

Among other federally mandated responsibilities, NMFS administers the U.S. Endangered Species Act for the protection and conservation of endangered steelhead utilizing the Ventura River Watershed. As part of this responsibility, NMFS developed the Southern California Steelhead Recovery Plan (NMFS 2012)[1]. Through a comprehensive analysis of systemic threats to this species, diversion of surface-flow and groundwater extractions were identified as "very high" threats to the long-term survival of endangered steelhead in the Ventura River (NMFS 2012, pp. 9-1 through 9-17).

To address the identified threats to endangered steelhead in the Ventura River Watershed, NMFS' Southern California Steelhead Recovery Plan identifies a number of recovery actions targeting surface diversions and groundwater extraction (NMFS 2012, p. 8-6, Table 9-7, p. 9-42). These include:

VenR-SCS-4.2 Develop and implement a water management plan to identify the appropriate diversion rates for all surface water diversions that will maintain surface flow necessary to support all *O. mykiss* life history stages, including adult and juvenile *O. mykiss* migration, and suitable spawning, incubation, and rearing habitat.

VenR-SCS-6.1 Conduct groundwater extraction analysis and assessment. Conduct hydrological analysis to identify groundwater extraction rates, effects on the natural stream pattern (timing, duration and magnitude) of surface flows in the mainstem and tributaries, *and the estuary*, and effects on all *O. mykiss* life history stages, including adult and juvenile *O. mykiss* migration, spawning, incubation, and rearing habitats. (emphasis added)

VenR-SCS-6.2 Develop and implement groundwater monitoring and management program. Develop and implement groundwater monitoring program to guide management of groundwater extractions to ensure surface flows provide essential support for all *O. mykiss* life history stages, including adult and juvenile *O. mykiss* spawning, incubation and rearing habitats.

GSPs developed under SGMA provide an important mechanism for implementing these recovery actions for the Ventura River watershed. The GSP for the Basin is an essential mechanism for implementing specific steelhead recovery actions for the Ventura River.

[1] National Marine Fisheries Service. 2012. Southern California Coast Steelhead Recovery Plan. West Coast Region, California Coastal Area Office, Long Beach, California; see also, Keir Associates and National Marine Fisheries Service. 2008, Hunt & Associates Biological Consulting Services 2008.

General Comments on Groundwater Withdrawals and the Draft GSP

Improperly withdrawing groundwater is of concern because the natural process of groundwater inputs to surface flows and water surface elevations can buffer daily water temperature fluctuations (Heath 1983, Brunke and Gosne1997, Barlow and Leake 2012, Hebert 2016). Artificially reducing the groundwater inputs can expand or shrink the amount of fish habitat and feeding opportunities for rearing juvenile steelhead (Fetter 1997, Sophocleous 2002, Glasser *et al.* 2007, Croyle 2009,), and reduce opportunities for juveniles to successfully emigrate to the estuary and the ocean (Bond 2006, Hayes *et al.* 2011). Low summer baseflow, likely caused by both surface water diversions and pumping hydraulically connected groundwater, is noted as a significant stress to steelhead survival in the Ventura and tributaries (See, for example, Table 9-2, p. 9-15 in NMFS 2012).

Management of the groundwater resources within the Ventura River watershed has affected the water resources and other related natural resources throughout the Ventura River watershed. For example, extraction of groundwater from the Basin has lowered groundwater levels causing the lowering, and truncation (by both delaying the onset and hastening the cessation) of surface flows that support the habitat characteristics and condition for endangered steelhead, as well as other aquatic species in the Ventura River watershed (Hunt & Associates Biological Consulting Services 2008, Kier Associates and National Marine Fisheries Service 2008).

The development and operation of groundwater supply facilities throughout the Basin are integral in the management of the water resources of the Ventura River. Facilities such as Robles Diversion and Foster Park Diversion (along with Matilija and Casitas dams) have profoundly altered the natural surface flow and groundwater recharge patterns in the Ventura River watershed, from the headwaters to the Pacific Ocean (*e.g.*, NMFS 2003, 2007). Unless the Draft GSP is revised to reflect the operation of these integral components of the groundwater management program for the Ventura River, the future adopted GSP is unlikely to meet the requirement of SGMA to effectively provide for the protection of habitats, including those recognized instream beneficial uses that are dependent on groundwater such as fish migration, spawning and rearing, as well as other GDE within the Basin. 95

When analyzing impacts on steelhead or other aquatic organisms resulting from groundwater and related streamflow diversions, identifying flow levels that effectively support essential life functions of this organism is critical (Barlow and Leake 2012). Specifically, it is essential to determine what flows adequately supports steelhead migration during the winter and spring, and juvenile rearing year round. Without an understanding of these hydrologic/biotic relationships, a GSP cannot ensure that significant and unreasonable adverse impacts from groundwater depletion (and in the case of the Ventura River, the integrally related surface water diversion/groundwater extraction program) are avoided (Heath 1983, California Department of Water Resources 2016, Belin 2018, CDFW 2019). 96

Specific Comments on the Draft GSP

The following comments on the Executive Summary of the Draft GSP are arranged by page and paragraph number; additional comments on individual Draft GSP elements are presented subsequently.

Executive Summary

Introduction

ES-2 Beneficial Uses

Pages ES-iii-iv

The Draft Plan states:

> "The beneficial uses of groundwater extracted from the Basin include municipal, industrial, and agricultural water supply." p. ES-iii

The listed beneficial uses extracted from the boundaries of the Basin include only out-of-stream beneficial uses, and largely ignores the instream beneficial uses, including those 97
linked to GDE. The Draft GSP should be revised to explicitly acknowledge the instream beneficial uses supported by the Basin, including the GDE associated with the upper Ventura River, as well as those affected by groundwater extraction from the Basin, including the lower Ventura River and the Ventura River Estuary. The recognized instream beneficial uses for the portion of the upper Ventura River within the Basin include: warm freshwater habitat, cold freshwater habitat, wildlife habitat, habitat for rare, threatened and endangered species, fish migration, and wetland habitat. Ventura River Estuary instream beneficial uses include: estuarine habitat, marine habitat, wildlife habitat, habitat for rare, threatened and endangered species, fish migration, spawning habitat, and wetland habitat.[2]

The Draft GSP recognized only two GDE areas within the Basin: 1) Confluence Aquatic Habitat Area, and 2) Foster Park Aquatic Habitat Area. This recognition of GDE underrepresents the known function and value of the river reach within the Basin for 98
adult and juvenile endangered southern California steelhead. Steelhead use the entire reach of the Ventura River within the Basin for completing their life-cycle. See Figures 1 and 2 for a depiction of the designated steelhead critical habitat and intrinsic potential habitat within the Ventura River watershed, including the Basin B. See additional comments below regarding the GDE areas identified in the Basin.

ES-3 Regional Water Management Framework
Page ES-iv 99
Casitas Municipal Water District Water Supply Management

[2] Table 2. Beneficial Use of Inland Surface Waters, California Regional Water Quality Control Board, Los Angeles Region (2014). p. 2-6

It should also be recognized that the Casitas Municipal Water District (CMWS) manages the Matilija Dam conjunctively with the Robles Diversion and Casitas Dam. 99

ES-4 Basin Setting and Groundwater Conditions

The Draft GSP notes that:

> "Groundwater extractions are secondary to spring discharge to the Ventura River except during dry periods when spring flows decrease substantially due to low Ventura River stream flow entering the northern end of the Basin" p. vii

The Ventura River watershed encompasses a system of connected groundwater and surface water that may become disconnected when groundwater levels are very low during drought *and* heavy groundwater extractions (or surface diversions), but this condition is anomalous, and does not represent the natural functioning of the system under unimpaired conditions. The SWRCB groundwater-surface flow study of the Ventura River (which includes the tributary groundwater basins) clearly demonstrates the connections between groundwater levels and surface flow (SWRCB 2021).

The regulations governing SGMA do not stipulate that the provisions of SGMA cover only "principal aquifers" as the Draft GSP appears to presume. The regulations define interconnected surface water as "surface water that is hydraulically connected at any point by a continuous saturated zone to the underlying aquifer and the overlying surface water . . ." (23 CCR Section 351(0). Significantly, "continuous" refers specifically to hydrologic connection, not a continuous temporal connection. 100

The Draft GSP does not adequately recognize the potential role of groundwater in the Basin, including the lower Ventura River and Ventura River Estuary, for ensuring suitable surface water in habitat for supporting different life-history phases of steelhead. Further, because groundwater-management activities within the Ventura River watershed involve the CMCD diversion operations at the Robles Diversion, the relationship between these diversion activities and groundwater elevations along the affected portion of the Ventura River (and estuary) should be addressed in the revised Draft GSP.

See additional comments below on interconnected groundwater and surface flows water surface elevations in Confluence Aquatic Habitat Area GDE and Foster Park Aquatic Habitat Area GDE within the Basin.

ES-4 Water Budget

Pages ES-x-xiii

The Draft GSP notes that: 101

> "It was concluded that these factors [*i.e.*, land use changes and population growth] are not anticipated to have a material impact on future water

> demand and the water budgets for the Basin because of land use policies and ordinances that greatly limit the potential for material growth in the basin" p. ES-x

This statement is misleading because it is does not recognize that groundwater resources of the Basin are used outside the Basin; for example, a substantial amount of groundwater extracted from the City of Ventura's groundwater wells in the vicinity of the Foster Park Aquatic Habitat Area GDE are used outside of the Basin to support development in eastern of Ventura, the fastest growing portion of the City of Ventura. The revised Draft GSP should acknowledge that future land use development and population growth outside of the Basin has the potential to affect the groundwater budget within the Basin. 101

Overdraft Assessment

Pages xi-xii

The Draft GSP concludes that:

> "The water budget results do not indicate an overdraft condition in the Basin currently or in the future. Groundwater level have not been observed to decline over a period of years without fully recovering. Numerical model result for the project water budge indicate that groundwater levels will continue to fully recovery following droughts." p. xii

Several aspects of this statement are problematic. First, the years of record used for this assement include extensive periods of drought, and represent a groundwater/surface water system substantially impacted by past and currently unregulated groundwater extractions. Therefore, it is not surprising that an overdraft condition was not indicated. 102

Second, relying on an assessment that is influenced by an extensive drought period and unregulated groundwater pumping is not likely to inform a proper environmental baseline for determining the true effects of a proposed groundwater-withdrawal program on GDE, including those supporting endangered steelhead.

Third, using a degraded environmental baseline as the comparative barometer has the potential to perpetuate a degraded environmental baseline into the future.

Fourth, the assessment appears to relate primarily to providing groundwater for traditional out-of-stream beneficial uses such a municipal and industrial supply, not instream beneficial uses, including use of ground and related surface waters by the federally endangered southern California steelhead, as well as other GDE.

We would also note while more frequent and prolonged depression groundwater levels can sometimes be offset with water storage systems, or temporary water conservation use, to ensure out-of-stream uses of water demands, GDEs do not function in the same way. Even though a groundwater basin may "fully recover" its groundwater levels, the species depending upon an adequate supply of water do not respond or recovery in the same way as the physical system can. The revised GSP should recommend this fundamental difference in the role of groundwater supplies in supporting out-of-stream and instream beneficial uses, and the related GDE. 102

Sustainable Yield

Pages xii-xiii

The Draft GSP concludes:

> "In summary the concept of a sustainable yield over a long-term average period is not relevant to management of the UVRGB." P. xii 103

While expression of groundwater conditions in term of long-term averages conditions may have limited utility (particularly with respect to GDE) in a highly variable rainfall and run-off pattern, a long-term water budget is relevant. See comments above regarding the overdraft assessment.

ES-6 Sustainable Management Criteria

Pages ES-xiii-x

The sustainable criteria are expressed explicitly and in terms of groundwater levels, storage water quality and depletion of interconnected surface waters, and do not clearly relate to the habitat conditions necessary to support steelhead during incubation and rearing phases of their life-cycle. 104

Chronic Lowering of Groundwater Levels and Reduction of Groundwater Storage

Page xiv-xv

While the Draft GSP recognizes potential significant and unreasonable effects from groundwater extractions, the minimum thresholds identified to address this is are based on historical low groundwater levels in the representative groundwater level monitoring wells. Using this standard, which includes significant periods of drought and unregulated groundwater extraction, is not likely to provide long-term protection for all the recognized beneficial uses of the Basin. Specifically, the exceedances caused by groundwater extraction and the related measurable objectives for groundwater storage do not adequately recognize the needs of the federally endangered southern California steelhead, or other GDE. The proposed standards appear aimed at seasonally refilling the Basin for the purposes of protecting existing groundwater extractions for traditional out-of-stream beneficial uses, and not for the protection of GDE. See additional comments below. 105

Degraded Water Quality

Page xvi-xvii 106

The Draft GSP does adequately recognize the important relationship between groundwater levels and the surface flows (particularly base flows) or water quality parameters (such as temperature, dissolved oxygen, *etc*.) that contribute to the maintenance of GDE within the Basin (including the lower Ventura River and the Ventura River Estuary). 106

Depletions of Interconnected Surface Water

Page xvii-xix

As noted above, the Draft GSP recognized only two GDE areas within the Basin: 1) Confluence Aquatic Habitat Area and 2) Foster Park Aquatic Habitat Area. This limited recognition of the actual extent of GDE within the Basin does not accurately reflect the use of the river reach within the Basin by endangered southern California steelhead. Steelhead use the entire reach of the Ventura River within the Basin in completing their life-cycle. See Figures 1 and 2 for a depiction of the designated critical habitat and intrinsic potential habitat within the Ventura River watershed, including the Basin. 107

The Draft GSP indicates that the sustainable management criteria for interconnected surface waters in the Foster Park Aquatic Habitat Area GDE relied on a field study performed by Hopkins (2013). This study, which the Draft GSP characterized as "the best available science for the Foster Park Aquatic Habitat Area", identified a flow of 2 cfs measured at the USGS Foster Park gauge (1118500) as adequate to prevent significant and unreasonable effects on steelhead. This claim warrants a couple of comments:

First, the base flows are difficult to accurately measure in alluvial river settings that are characterized by shifting channel, and where and groundwater and hyporheic flows constitute an important component of the surface flow conditions. We would note in this regard that there are reported discrepancies between the Hopkins and USGS gauge measurements, as well the City of Ventura's gauge measurements, and those done by other groups such as Santa Barbara Channel Keeper as part of their water quality monitoring pursuant to the State Water Board's Quality Assurance Plan (USGS Station 11118500 Ventura R NR Ventura nwis.waterdata.usgs.gov/nwis, Foster Park gauge reporting website https://www.picovale.com. 108

Second, NMFS has conducted an analysis of the effects of the groundwater extractions of the City of Ventura's well field in the Foster Park area and concluded that the groundwater extractions would have significant effects of rearing steelhead in wet, average and dry hydrologic conditions, and has identified a minimum flow (11-12 cfs) that is considerably larger than that proposed in the Hopkins study (NMFS 2007).

In its analysis, NMFS noted that the rate of pumping during wet years analyzed groundwater extractions from the Foster Park well field varied between 1 cfs and 20 cfs, and most commonly ranged between 9 to 12 cfs. These well pumping rates reduced surface flow in the Foster Park area by more than 50%, from about 15 cfs to less than 5 cfs in during the summer or fall in 1992, 1993, and 2001 when juvenile rearing would be expected to utilize the habitat. During average hydrologic conditions, the maximum and minimum flows in the lower Ventura River were reduced by well field withdrawals. The range of well field withdrawals during average rainfall years was also from about 2 cfs to 20 cfs, and ranged between 8 and 10 cfs. The reduction of surface flows from the Foster Park well field operations would result in extremely low surface flow levels (< 2 cfs), and would occur earlier in the year, compared to wet hydrologic conditions. Flow records during average rainfall years show that flows dropped to levels at or near zero due to the Foster Park well field extractions during the summer and fall rearing period in almost all average rainfall year (NMFS 2007, pp. 24-25). 108

Based on this analysis, and an assement of the effects of groundwater extractions in the Foster Park area, NMFS identified a limit on groundwater extractions that would prevent a reduction of surface flow in the Foster Park area below 11 to 12 cfs (measured at the USGS Foster Park gauge 11118500), a level significantly higher that that identified by Hopkins, and adopted by the Draft GSP.

ES-7 Monitoring Networks

Pages x-xii

The proposed monitoring is aimed primarily at addressing the limited Sustainable Management Criteria for only two GDE. There is little in the monitoring program that specifically addresses the potential effects of groundwater extractions on other GDE, including, but not limited to, the upper reaches of Basin, as well as the lower Ventura River and the Ventura River Estuary. As noted above, the Draft GSP recognized only two GDE areas within the Basin: 1) Confluence Aquatic Habitat Area and 2) Foster Park Aquatic Habitat Area. This limited recognition of GDE does not accurately affect the use of the reaches of the Ventura River within the Basin made by the endangered southern California steelhead, as well as other reaches and which may affected by groundwater extractions from the Basin. 109

ES-8 Projects and Management Actions

Page xxii-xxiii

Regarding the Foster Park Protocols, see comments above. 110

The Draft GSP should also recognize the potential changes to water supply operations associated with the Matilija Dam Removal and Ecosystem Restoration Project (*e.g.*, the retro-fitting of the Robles Diversion and fish passage facilities).

Draft Upper Ventura River Valley Basin GSP

1.0 Introduction to Plan Contents [Article 5 §354]

The following comments are addressed to the specific sections and provisions of the Draft GSP, arranged by the Draft GSP section headings.

2.2. Description of the Plan Area [§354.8]

Page 8

In addition to the agencies listed, we would note that a considerable amount land area is owned and managed by the Ojai Valley Land Conservancy (including land within the Confluence Aquatic Habitat Area GDE). 111

2.2.2.2 Existing Water Resource Management Programs [§354.8(c) and (d)]

Pages 9-11

One of the largest and most significant water-resource-management programs within the Ventura River watershed, the CMWD's water development program, consists of the combined facilities of the Robles Divers (and conjunctively operated Matilija Dam) and Casitas Dam and Reservoir This program and its related facilities should be included in this section because it affects the natural recharge to the other groundwater basins in upper lower Ventura River, as well as the lower Ventura River basin and the Ventura River Estuary (NMFS 2003). 112

2.2.2.3 Conjunctive Use Programs [§354.8(e)]

Page 12

The City of Ventura's water supply includes groundwater extractions (as well as surface diversions) and this fact should be noted in the revised GSP. See comment above. 113

2.2.3.1 Land Use/General Plans [**§354.8(f)(1),(f)(2), and (f)(3)])]**

Pages 13-20

The Draft GSP should also include NMFS' Southern California Steelhead Recovery Plan (2012) which includes essential actions for the recovery of this species that pertain to existing land-use and water management policies. See comments above regarding the relevant policies from NMFS' Southern California Steelhead Recovery Plan. 114

2.3 Notice and Communication [§354.10]

Pages 22-24

The Draft GSP is focused on out-of-stream users of the Basin and does not adequately recognize the public trust natural resources that may be affected by the extractions of groundwater from the Basin. The GSP is therefore be of interest to state and federal natural resource regulatory agencies such as NMFS, U.,S. Fish and Wildlife Service, and the California Department of Fish and Wildlife, and the California Department of Parks and Recreation (which owns a portion of the Ventura River Estuary). 115

2.3.1 Beneficial Uses and Users [§354.10(a)]

Pages 23-26 116

See comments above regarding instream beneficial uses within the Ventura River watershed, including the Basin. 116

3.0 Basin Setting [Article 5, SubArticle 2]

3.1. Hydrogeologic Conception Model [§354.14]

Pages 30-52

HCM Overview – Key Features of the UVRGB

Page 30

I In addition to the older alluvium that is generally elevated above the groundwater table directly underlying the alluvial aquifer between the banks of the Ventura River, a large, perhaps a majority of the groundwater collected in the alluvium originates from the up-slope portions of the watershed. In effect, the area of the percolation lens that feeds the Basin is more extensive than the two areas identified in the Draft GSP (*i.e.*, alluvial aquifer and the older alluvium). Significantly, not all the wells in the upper Ventura River are located and drilled into the shallow aquifer directly underlying the river channel that is most directly recharged by surface flows in the Ventura River. The GSP should explicitly address these groundwater extractions from the Basin. 117

3.1.2.2 Surface Water Bodies [§354.14(5)]

Page 33

In addition to groundwater discharge, hyporheic flows are an important component of surface flows, particularly base flows. These conditions create an interrupted surface flow regime during a large portion of the year in the middle reaches of the Ventura River (from approximately the Robles Diversion down to the confluence of San Antonio Creek), and can be significantly affected by groundwater extractions, particularly from shallow wells. 118

Page 34

Springs along the Ventura River are generally associated with east-west trending faults that run perpendicular to the mainstem. These faults have been mapped, though the production of the springs associated with them have not been measured (Ventura River Watershed Council 2015). 119

Page 35

Water from Casitas Reservoir is also used in the west end of the City of Ventura that lies outside the Basin (Ventura River Watershed Council 2015). See comment above.

3.1.3.2 Groundwater Recharge and Discharge Areas [§354.14(d)(4)]

Pages 46-47

See comments above regarding the extent of the groundwater recharge area in the Ventura River watershed. 120

3.1.4 Data Gaps and Uncertainty [§354.1(b)(5)]

Surface Water Bodies

Page 52

One of the largest data gaps is the rate of surface flow under base flow conditions, including the diurnal changes. Because of their relatively small size and dependence on groundwater and hyporheic flows and groundwater levels, these flows measured in a way that records their seasonal and diurnal fluctuations, and should be a major focus of current and future modeling efforts. 121

3.1.4.4 Primary Beneficial Uses [§354.14(b)(4)(E)]

Pages 50-52

See comments above regarding beneficial uses of the groundwater resource of the Basin, and interconnected surface waters. 122

3.2 Groundwater Conditions [§354.16]

Pages 54-69

The Draft GSP notes that:

> "Vertical gradients may exist between the alluvium and the bedrock, but no paired wells screened in the bedrock and alluvial exist to estimate this gradient." p. 55

The Draft GSP does not, but should, provide details regarding the well construction showing the intervals of the well through which groundwater enters the wells. In addition, the revised GSP should clarify whether "sanitary plugs" are installed in the wells that retard or prevent flow through shallow and deep aquifers. See comment above regarding the assertion that "No data gaps or significant uncertainties were identified." 123

3.2.1 Groundwater Elevations [§354.16(a)]

Page 55-56

The Draft GSP acknowledges that: 124

> "The Basin groundwater level and storage trends closely mimic surface water flows, with groundwater levels and storage exhibiting large and rapid fluctuation relative to the total started thickness and total

groundwater storage – more so than perhaps any other groundwater basin in the State." p 56

We would note that base surface flows closely mimic groundwater levels, making the management of groundwater extraction particularly importance in the maintenance of GDE, including habitat for the endangered southern California steelhead. 124

3.2.2 Change in Storage [§354.16(b)]

Page 57

See comments above regarding groundwater elevations 125

3.2.3 Seawater Intrusion [§354.16(c)]

Page 58

The Draft GSP notes that:

> "The UVRGB is an inland groundwater basin, with no connection to the ocean." p. 62

The analysis appears to be focused on the effects of seawater intrusion on the Basin, but does not address the effects of groundwater extraction from the Basin on the lower Ventura River or the estuary. The GSP should address the issue of reducing groundwater levels underlying the lower reaches that are hydrologically connected to the Basin. 126

3.3.4 Groundwater Quality Impacts [§354.16(d)]

Pages 58-60

See comments above regarding water quality. 127

3.2.6 Interconnected Surface Water Systems [§354.16(f)]

Pages 63-65

See comments above regarding interconnected surface waters. 128

3.2.7 Groundwater-Dependent Ecosystems [§354.16(g)]

Pages 66-69

The Draft GSP relies heavily on the Nature Conservancy's (TNC) guidance for GDE analysis (TNC 2019, 2020). According to this guidance, GDE are defined on their dependence on groundwater for all or a portion of their water needs. The method used by TNC in identifying GDE is based on statewide data on "vegetation known to use 129 groundwater", and therefore does not adequately reflect the uses made of groundwater by other biological resources, such as seasonal migration of fishes, or other organisms such as invertebrates that have differing life-cycles and environmental requirements than plants (TNC 2019, 2020).

In addition to supplying water to the root zone of plants, groundwater can also contribute to surface flows, influencing the timing, duration, and magnitude of surface flows, particularly base flows. These base flows provide essential support to aquatic invertebrates, avian fauna, and fish species, including native resident and anadromous fishes. In addition, groundwater that only seasonally supports surface flows can contribute to the life-cycle of migratory fishes, such as steelhead, that can make use of intermittent flows for both migration, spawning and rearing (Erman and Hawthorne 1976, Boughton *et al*. 2006, 2009). 129

The methodology used in the Draft GSP focuses almost exclusively on vegetation known to use groundwater and, therefore, ignores the seasonal variation in the groundwater levels in the reach of the Ventura River underlain by the Basin that can periodically (seasonally, or intra-annually) exhibit surface flows by affecting their timing magnitude, and duration.

As a result, the Draft GSP only identified 5 potential GDE and included only two for further consideration in the formulation of sustainable management criteria: 1) Confluence Aquatic Habitat Area and 2) Foster Park Aquatic Habitat Area. This limited view of the GDE does not accurately reflect the use of the river reach within the Basin by endangered southern California steelhead. Steelhead use the entire reach of the Ventura River within the Basin for completing their life-cycle. The GSP should be revised to recognize the role that groundwater plays in supporting base flows that support other GDE, including those used by steelhead. 130

3.3 Water Budget [§354.18]

Pages 70-75

See comments above regarding the water budget for the Basin. 131

3.3.1 Historical Water Budget [§354.18(c)(2) (B)]

Pages 76-82

The Draft GSP notes that:

> "The SGMA Regulations require that the historical surface water and groundwater budget be based on a minimum of 10 years of historical data." p. 79

132

The Draft GSP does not refer to or account for the effects of the operation of the CMWD's Robles Diversion on the Upper Ventura River, which supplies on average 45% of the total amount of water diverted and stored in the Casitas reservoir acre-feet per year from the main stem of the Ventura River (NMFS 2003, Ventura River Watershed Council 2015). This diversion operation affects recharge to all of the Ventura River groundwater basins, not just the Basin, including the shallow alluvial aquifer and the other deeper aquifers within Basin. These operations have the potential to impact endangered adult and juvenile steelhead in the upper Ventura River and estuary (NMFS 2003, 2007). The Draft GSP should therefore include as part of its water-budget analysis the operations of the Robles Diversion. Specifically, the relationship of groundwater management activities (including both recharge and groundwater extraction activities) and the effects of the related Robles Diversion on surface flows below the diversion and the maintenance of surface flows supported by groundwater should be explicitly addressed a in the revised GSP. 132

3.3.2 Current Water Budget [§354.18(c)(1)]

Pages 84-86

As noted above, the Draft GSP does not refer to or account for the effects of the operation of the CMWD's Robles Diversion on the upper Ventura River, but should as part of its current water budget. See comments above regarding the CMWD's Robles Diversion. 133

3.3.3 Projected Water Budget

Pages 84-91

As noted above, the Draft GSP does not refer to or account for the effects of the operation of the CMWD's Robles Diversion on the upper Ventura River, but should be included as part of its projected water budget. See comments above regarding the CMWD's Robles Diversion. 134

3.3.4.1 Overdraft Assessment

Page 91

The Draft GSP notes that:

> "The water budget result do not indicate an overdraft condition in the Basin currently or in the future. . . . Numerical model results for the projected water budge indicate the groundwater level will continue to fully recovery following droughts." p. 91 135

As noted above, this analysis does not take into account the effects of either the protracted drought or the past unregulated extraction of groundwater, or the differing effects of temporary drawn of the groundwater table on traditional out-of-stream beneficial uses and instream beneficial uses of the waters of the Ventura River watershed.

4.0 Sustainable Management Criteria [Article 5, SubArticle 3]

Pages 98-136

See comments below on individual sub-sections of the Draft GSP.

4.2 Sustainability Goal [§354.24]

Pages 90-100

The Draft GSP states, in part, that:

> "The goal of this Groundwater Sustainability Plan (GSP) is to sustainably manage the groundwater resources of the Upper Ventura River Basin for the benefit of current and anticipated future beneficial users of groundwater, including the environment and the welfare of the general public who rely directly or indirectly on groundwater. Sustainable groundwater management will ensure the long-term reliability of the Upper Ventura River Basin groundwater resources by avoiding undesirable results pursuant to the Sustainable Groundwater Management Act (SGMA) no later than 20 years from Plan adoption and through implementation of a data-driven and performance-based adaptive management framework." p. 94

Nothing in the language of the goal specifically refers to the protection of instream beneficial uses associated with the GDE of the Basin, such as the upper Ventura River or the downstream reaches of the Ventura River, including the Ventura River Estuary. This appears to be the result, in part, of not fully recognizing interconnected surface waters or GDE within the boundaries of the Basin. However, as noted above, the Basin contains interconnected surface water and GDE beyond the two that are identified for sustainable management criteria. See comments above, and Figures 1 and 2, regarding the extent of steelhead habitat within the Ventura River watershed, including within the boundaries of the Basin. 136

4.4. Chronic Lowering of Groundwater Levels

Pages 97-106

See comments above regarding groundwater Basin dynamics. 137

Evaluation of Potential Effects on Beneficial Uses and Users, Land Uses, and Property Interests [§354.26(b)(3)]

Pages 98-99

The discussion in this section is focused on out-of-stream beneficial uses of the groundwater resources of the Basin., It does not directly address the instream beneficial uses of interest to state and federal natural resource regulatory agencies such as NMFS, U.S. Fish and Wildlife Service, and the California Department of Fish and Wildlife, and the California Department of Parks and Recreation. These would include, but are not limited to, the GDE associated with the upper Ventura River, lower Ventura and the Ventura River Estuary. 138

The causes that could lead to undesirable results should include the operations of CMWD's Robles Diversion on the upper Ventura River. See comments above, particularly regarding GDE. 138

4.4.2 Minimum Thresholds [§354.28]

Pages 101-103

None of the minimum thresholds in the Draft GSP addresses specifically the endangered southern California steelhead (other than the Foster Park Aquatic Habitat Area GDE). As noted, this standard is not supported by the best available science. This is a significant omission from the Draft GSP that should be addressed in the revised Draft GSP for the Basin. 139

4.4.2.4 Impact of Minimum Thresholds on Beneficial Uses and Users [§354.28(b)(4)]

Page 102

See comments above regarding the interest of state and federal natural resource regulatory agencies such as NMFS, U.S. Fish and Wildlife Service, and the California Department of Fish and Wildlife, and the California Department of Parks and Recreation (which owns a portion of the Ventura River Estuary). 140

4.4.2.6 Current Standards Relevant to Sustainability Indicator [§354.28(b)(5)]

Page 104

The Draft GSP states that:

> "UVRG is unaware of any federal, state, or local standards for chronic lowering of groundwater levels." p. 104 141

While there is no general numeric standards for chronic lowering of groundwater levels, this statement fails to recognize the over-arching standards established by SGMA, particularly those intended to protect GDE.

4.4.2.7 Measurement of Minimum Thresholds [§354.28(b)(6)]

Page 104

The Draft GSP indicates that:

> "Groundwater elevations will be directly measured to determine their relation to minimum thresholds. Groundwater level monitoring will be conducted in accordance with the monitoring plan outlined in Section 5." p. 111 142

The groundwater-monitoring plan only provides for annual monitoring. A more appropriate approach would be to monitor seasonally to account for the strong effect of seasonal changes in hydrologic and hydraulic conditions that are of significant to GDE, including, but not limited to, those associated with the Basin. For example, monitoring towards the end of summer or beginning of fall, as well as the beginning of spring each year could help inform groundwater and other natural resource managers of the effects of both recharge (natural and artificial) as well as groundwater pumping patterns on GDE within the Basin.

Without shallow groundwater wells that would provide specific data on the relationship between groundwater levels and surface flows, a reliable assessment of the effects of extracting groundwater from these areas on GDE is not possible. This is a significant data gap that could be addressed by the installation of shallow groundwater wells (or piezometers) to better describe these relationships. 142

Additionally, data gathered from groundwater well monitoring should be correlated with stream flow in the upper Ventura River. This can and should be accomplished by added a stream flow gauges capable of monitoring base flows in the upper Ventura.

4.4.3.3 Measurable Objectives and Interim Milestones [§354.30(a),(b),(d),(g) and §354(g)(3)]

Page 105-106

4.4.3.1 Description of Measurable Objectives

Page 103-106

The Draft GSP indicates that:

> "The chronic lowering of groundwater levels measurable objectives were developed by applying the concept of providing a reasonable margin of operational flexibility under adverse conditions." p. 105 143

This strategy is more suitable for managing traditional out-of-stream beneficial uses that instream beneficial uses associated with GDE, including river flows for the endangered southern California steelhead. See additional comments above.

4.5 Reduction of Groundwater Storage

4.5.1 Undesirable Results [§354.26]

Evaluation of Potential Effects on Beneficial Uses and Users, Land Uses, and Property Interests [§354.26(b)(3)]

The Draft GSP states that:

> "The evaluation of potential effects on beneficial uses and users, and property interests for the reduction of groundwater storage sustainability indicate is the 144

same as for chronic lowering of groundwater levels and depletions of interconnected surface water sustainability criteria and its incorporated by reference" p. 108

As noted previously, the Draft GSP should be revised to explicitly acknowledge all the instream beneficial uses supported by the Basin. The recognized instream beneficial uses for the portion of the upper Ventura River include: warm freshwater habitat, cold freshwater habitat, wildlife habitat, habitat for rare, threatened and endangered species, fish migration, and wetland habitat. See comments above, and Figures 1 and 2, regarding the extent of steelhead habitats within the Ventura River Watershed, including the Basin. 144

Criteria Used to Define Undesirable Results [§354.26(b)(2)]

The Draft GSP states that:

> "The criteria used to define undesirable results for the reduction of groundwater storage sustainability indicator are based on the qualitative description of undesirable results, which is causing other sustainability indicators to have undesirable results. As explained in Section 4.5.2, groundwater levels will be used as a proxy for the reduction of groundwater storage sustainability indicator minimum thresholds. Based on the foregoing, the combination of minimum threshold exceedances that is deemed to cause significant and unreasonable effects in the basin for the reduction of groundwater storage sustainability indicator is the same as the combinations deemed to cause undesirable results for the chronic lowering of the groundwater levels sustainability indicator (Table 4.1-01)." p. 108 145

While groundwater levels are an important indicator of the general condition of the Basin, there are other more meaningful metrics specifically aimed at informing management of the Basin for the protection of instream beneficial uses associated with GDE (*e.g.*, base flow rates, pool depth, stream with, depth across riffles, etc.) Specifically, the current approach is based on criteria that do not, but should, address whether there may be significant stream flow depletion or lowered water surface elevation (from a biological perspective) caused by groundwater pumping within the Basin.

4.5.2.3 Relationships Between Minimum Thresholds and Sustainability Indicators [§354.28(b)(2)]

The Draft GSP indicates that:

> "The relationships between the minimum thresholds for the reduction of groundwater storage sustainability indicator and other sustainability indicators are the same as the potential effects of the minimum thresholds for the chronic lowering of groundwater levels on the other sustainability indicators . . ." p. 110 146

This approach and analysis may be appropriate when considering groundwater supplies for out-of-stream beneficial uses for which there may be alternatives. However, it does not take into account the adverse effects of periodic reduction of groundwater on GDE, including the use by migrating, spawning or rearing steelhead. The effects of periodic groundwater reductions on out-of-stream beneficial uses (*e.g.*, domestic or agricultural water supplies) may be addressed with alternative water sources. However, instream uses such as GDE are more vulnerable to periodic groundwater reductions, because there is generally no alternative water source to sustain the GDE, and even a short-term depletion or limitation of stream flow or water surface elevation can be lethal to aquatic species. 146

4.5.2.5 Impact of Minimum Thresholds on Beneficial Uses and Users [§354.28(b)(4)]

Page 110 147

See comment above regarding the relationship between Minimum Thresholds and Sustainability Indicators.

4.5.2.6 Current Standards Relevant to Sustainability Indicator [§354.28(b)(5)]

Page 110 148

As noted above, while there are no numeric standards, this statement does not appear to recognize the standards that that are established by SGMA, particularly regarding GDE.

4.5.2.7 Measurement of Minimum Thresholds [§354.28(b)(6)]

Page 111 149

See the comments above regarding “Minimum Thresholds”, “Criteria Used to Define Undesirable Results” and “Relationship Between Minimum Thresholds and Sustainability Indicators.”

4.5.3 Measurable Objectives and Interim Milestones [§354.30(a),(b),(c),(d),(e),(g)]

Page 111 150

See the comments above regarding “Minimum Thresholds”, “Criteria Used to Define Undesirable Results” and “Relationship Between Minimum Thresholds and Sustainability Indicators.”

4.6 Seawater Intrusion

Page 112 151

See comment above regarding the seawater intrusion.

Criteria Used to Define Undesirable Results [§354.26(b)(2)]

Page 114 152

See the comments above regarding “Minimum Thresholds”, “Criteria Used to Define Undesirable Results” and “Relationship Between Minimum Thresholds and Sustainability Indicators.” 152

4.7.2 Minimum Thresholds [§354.28]

4.6.2.1 Information and Criteria to Define Minimum Thresholds [§354.28(a), (b)(1),(c)(3)(A),(c)(3)(B), and (e)]

Page 115

See the comments above regarding “Minimum Thresholds”, “Criteria Used to Define Undesirable Results” and “Relationship Between Minimum Thresholds and Sustainability Indicators.” 153

4.7.2.3 Relationships Between Minimum Thresholds and Sustainability Indicators [§354.28(b)(3)]

Page 119

As noted above, the groundwater extraction from the Basin can affect recharge of the groundwater basin underlying the lower Ventura River and Ventura River Estuary. 154

4.7.2.3 Minimum Thresholds in Relation to Adjacent Basins [§354.28(b)(3)]

Page 119

See comment above. 155

4.7.2.4 Impact of Minimum Thresholds on Beneficial Uses and Users [§354.28(b)(4)]

Page 120

See the comments above regarding “Minimum Thresholds”, “Criteria Used to Define Undesirable Results” and “Relationship Between Minimum Thresholds and Sustainability Indicators.” 156

4.7.2.5 Current Standards Relevant to Sustainability Indicator [§354.28(b)(5)]

Page 120

As noted, the Draft GSP does not appear to recognize the broad standards that that are established by SGMA. 157

4.6.2.6 Measurement of Minimum Thresholds [§354.28(b)(6)]

Page 121 158

See the comments above regarding "Minimum Thresholds", "Criteria Used to Define Undesirable Results" and "Relationship Between Minimum Thresholds and Sustainability Indicators." 158

4.7.3 Measurable Objectives and Interim Milestones [§354.30(a),(b),(c),(d),(e),(g)]

Page 121

See the comments above regarding "Minimum Thresholds", "Criteria Used to Define Undesirable Results" and "Relationship Between Minimum Thresholds and Sustainability Indicators." 159

4.9 Depletion of Interconnected Surface Water

Pages 123-124

See comments above regarding interconnected surface water and GDE. 160

Process and Criteria for Defining Undesirable Results [§354.26(a)]

Page 124

See comments above regarding the interest of state and federal natural resource regulatory agencies such as NMFS, U.S. Fish and Wildlife Service, and the California Department of Fish and Wildlife, and the California Department of Parks and Recreation (which owns a portion of the Ventura River Estuary). 161

Evaluation of Potential Effects on Beneficial Uses and Users, Land Uses, and Property Interests [§354.26(b)(3)]

Page 125

As noted previously, the Draft GSP should be revised to explicitly acknowledge the instream beneficial uses supported by the Basin, including the GDE associated with the upper reaches and middle of Ventura River. See comment above regarding "Process and Criteria for Defining Undesirable Results." 162

Effects on Surface Water Diversions

Page 126

See the discussion above regarding the City of Ventura's Foster Park well field and the CMWD's Robles Diversion. 163

Effects on Aquatic GDEs

Page 127 164

The Draft GSP only identified 5 potential GDE and included only two for further consideration in the formulation of sustainable management criteria: 1) Confluence Aquatic Habitat Area and 2) Foster Park Aquatic Habitat Area. This limited recognition of GDE does not accurately reflect the use of the river reach within the Basin by endangered steelhead. Steelhead use the entire reach of the Ventura River within the Basin for completing their life-cycle. See Figures 1 and 2 for a depiction of the designated critical habitat and intrinsic potential habitat within the Ventura River watershed, including the Basin. 164

Confluence Habitat Area

Page 127

The Draft GSP's assertion that because the Basin has 20 years to achieve sustainable management, there is ample time available to implement appropriate management of the groundwater levels associated with the Confluence Habitat Area does not appropriately recognize the endangered status of the steelhead that utilize and occupy the Ventura River, including the area the Confluence Habitat Area. This statement reflects the same perspective that was expressed in the assertion that the periodic depletion of the Basin is acceptable or reasonable because the Basin has the ability to refill rapidly. As noted above, instream beneficial uses such as GDE are more vulnerable to periodic groundwater reductions, because there is generally no alternative water source to sustain the GDE during periodic periods of groundwater depletion. Even a short-term depletion or limitation of stream flow or water surface elevation can be lethal to aquatic species. 165

Foster Park Habitat Area

Page 128 166

See the discussion above regarding the City of Ventura's Foster Park well field, as well as the discussion below under Section 6.0., Project and Management Actions.

4.9.2 Minimum Thresholds [§354.28]

Page 131

See the comments above regarding "Minimum Thresholds", "Criteria Used to Define Undesirable Results" and "Relationship Between Minimum Thresholds and Sustainability Indicators." 167

4.10 Measurable Objectives and Interim Milestones for Additional Plan Elements [§354.30(f)]

Page 136

The Draft GSP indicates that "No additional plan elements that have measurable objectives are include in the GSP". P. 136. 168

See the comments above regarding the Confluence Habitat Area, Foster Park Habitat Area, and other GDE within the Basin, which are not adequately addressed. 168

5.0 Monitoring Networks [Article 5, SubArticle 4]

Pages 137-154

As noted above, the monitoring proposed is aimed at addressing the limited Sustainable Management Criteria. There is nothing identified in the monitoring program that addresses the potential effects of groundwater extractions on GDE (with the exceptions of the Confluence Habitat Area and the Foster Park Habitat Area) within the Basin. Shallow groundwater wells within the alluvial overlaying the Basin would provide specific data on relationship between groundwater levels and surface flows. This appears to be a significant data gap that should be addressed by the installation of shallow groundwater wells (or piezometers) to better described these relationships. 169

6.0 Projects and Management Actions [Article 5, SubArticle 5]

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6.3 Foster Park Protocols to Address Direct Depletion of Interconnected Surface Water[§354.44)b)(1)(d)]

It should be recognized that NMFS was not a party to the settlement agreement between Santa Barbara Channel Keep and the State Water Recourses Control Board and the City of San Buenaventura, and has not reviewed or endorsed that settlement agreement which uses a different (lower) minimum flow standard recommended by NMFS for the operation of the City's Foster Park well field. See the comments above regarding the City of Ventura's Foster Park Well Field. 170

7.0 GSP Implementation

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See comment above regarding "Projects and Management Actions". 171

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Appendix H

UVRGB Numerical Model Construction and Calibration Documentation

TECHNICAL MEMORANDUM

To: The Upper Ventura River Groundwater Agency (UVRGA)

From: Abhishek Singh, PhD, PE; Nathan Hatch; Erick Fox; Steven Humphrey; INTERA Incorporated
Bryan Bondy, PG, CHG; Bondy Groundwater Consulting, Incorporated

Date: November 17, 2021

Re: **Upper Ventura River Basin Numerical Model Construction, Calibration, and Predictive Modeling Documentation**

1.0 INTRODUCTION

This technical memorandum provides the documentation for the numerical model constructed and calibrated for development of the groundwater sustainability plan (GSP) for the Upper Ventura River Groundwater Basin (UVRGB). The numerical model is referred to as the Upper Ventura River Groundwater Model (UVRGM).

The Sustainable Groundwater Management Act (SGMA) requires all groundwater and surface water models used for a GSP to meet the following standards (CCR 352.4(f)):

(1) The model shall include publicly available supporting documentation.

(2) The model shall be based on field or laboratory measurements, or equivalent methods that justify the selected values, and calibrated against site specific field data.

(3) Groundwater and surface water models developed in support of a Plan after the effective date of these regulations shall consist of public domain opensource software.

The UVRGM addresses the above-listed SGMA requirements. This memorandum provides the required supporting documentation. The model utilizes publicly available Unites States Geologic Survey (USGS) public-domain code MODFLOW and was developed using best available science and data for the UVRGB, including basin-specific groundwater field data such as geologic/lithologic data, geophysical data, streamflow, and groundwater levels. The UVRGM simulates key surface-water and groundwater processes within the UVRGB and simulates three-dimensional, transient groundwater levels and flows within the Basin. The model was calibrated to available historical (2005 – 2019) groundwater levels and streamflow data and exceeds industry calibration standards. The model development and calibration process followed ASTM International (ASTM) standards D5447[1] and D5891[2].

The calibrated UVRGM was used to assess historical (2005 – 2019) groundwater levels, flows and depletions of surface water from the Ventura River and develop the historical water budget for the GSP. In addition, climate change datasets (provided by California Department of Water Resources (DWR) for SGMA planning purposes) and projections for future water use and pumping were incorporated into the model to develop predictive scenarios to assess the future water levels, river flows and depletions, and groundwater budget, as required by SGMA and the GSP Emergency Regulations.

2.0 BASIN SETTING AND HYDROGEOLOGY

Key figures from GSP Sections 3.1 and 3.2 are included here for reference. **Figures 2.1a** and **2.1b** show the surface geology and major fault systems within and surrounding the UVRGB (USGS, 2005, 2015). The UVRGB has been delineated into six hydrogeologic areas based on the hydrogeology, stratigraphy, and primary recharge and discharge processes, as shown in **Figure 2.2** (discussed in detail in GSP Section 3.1 and 3.2). **Figure 2.3** shows Ventura River flow conditions and areas with salient surface-water/groundwater interactions (discussed in detail in GSP Section 3.1 and 3.2).

3.0 MODEL DESIGN

MODFLOW-NWT (Niswonger et al., 2011) was selected as the numerical code for the UVRGM. MODFLOW is a finite-difference groundwater-flow code that solves the three-dimensional form of the continuity equation that governs flow through saturated porous media. The benefits of using MODFLOW include (1) MODFLOW incorporates the necessary physics of groundwater flow, which are the basis for the conceptual model (described in Sections 3 to 5 of this report); (2) MODFLOW is the most widely accepted groundwater flow code in use today; (3) MODFLOW was written and is supported by the USGS and is public domain; (4) MODFLOW is well documented (Harbaugh et al., 2000); (5) MODFLOW has a large user group; and (6) there are several mature graphical user interface programs written for use with MODFLOW.

MODFLOW-NWT is a Newton-Raphson formulation for MODFLOW-2005 (Harbaugh, 2005), which improves the solution of the unconfined groundwater-flow systems. MODFLOW-NWT treats nonlinearities of cell drying and rewetting by use of a continuous function of groundwater head (even under unsaturated conditions), rather than the discrete approach of drying and rewetting used by earlier versions of MODFLOW. Unlike older versions of MODFLOW that either inactivated unsaturated cells or used rewetting functions (that can introduce mass-balance errors and numerical instabilities), MODFLOW-NWT uses the "Upstream-Weighting" (UPW) package to calculate intercell conductance, hydraulic heads, and flow in (but not out of) unsaturated cells. MODFLOW-NWT was selected to simulate unconfined groundwater flow conditions. The solver used for the model was the Orthomin/stabilized conjugate-gradient χMD solver. Default values for solver settings, corresponding to

[1]ASTM D5447: Standard Guide for Application of a Numerical Groundwater Flow Model to a Site-Specific Problem
[2]ASTM D5981: Standard Guide for Calibrating a Groundwater Flow Model Application

"complex" models (see Niswonger et al., 2011, for details) were chosen for this model. Head- and flux-convergence tolerance were set at 0.1 ft and 5000 cubic feet per day (ft^3/day), respectively.

The MODFLOW datasets were developed to be compatible with Groundwater Vistas for Windows Version 8.04 (Rumbaugh and Rumbaugh, 2017). Groundwater Vistas was used to visualize model properties and results. Changes to static model properties (such as hydraulic conductivities and storage coefficients) were made in Groundwater Vistas. Spatio-temporal input packages (Stream Flow River (SFR), Well (WEL), Recharge (RCH), and EVapoTranspiration (EVT)) were created and modified using Python scripts outside Groundwater Vistas. Since the model utilizes input packages created outside Groundwater Vistas, it was run outside Groundwater Vistas using the Windows Command Prompt and the MODFLOW-NWT executable.

4.0 MODEL DOMAIN AND BOUNDARY CONDITIONS

Figure 4.1 shows the lateral model domain and the active (where groundwater levels and flow are simulated) areas within the model domain. Different colors show where one or both layers were active (see **Section 5.0** for details on model layering). The original basin boundary of the UVRGB was delineated in Bulletin 118 in 2003 (DWR, 2003). The boundary was modified (Kear, 2016) and approved by DWR in 2016. In general, the active model boundary corresponds to the 2016 DWR Basin boundary with a few exceptions described below. In select areas where the alluvium is very thin (10 feet [ft] or less), the model layers were inactivated which allows numerical convergence since thin cells that go dry can cause convergence issues with MODFLOW-NWT. This was done in the north-east edge of the Mira Monte/Meiners Oaks Area, where the Sespe and Coldwater Sandstone Bedrock units are shallow and outcrop along the edges of the basin. Select cells with thin and elevated alluvium (which goes dry during low water level conditions) along the periphery of the Ventura River floodplain were also inactivated to allow for improved convergence. The southern extent of the active model domain was extended south (shown by the dashed line in **Figure 4.1**) of the 2016 DWR Basin boundary to a mapped bedrock outcrop along the river, where groundwater underflows would be minimal (due to minimal alluvium thickness where bedrock outcrops).

The vertical extent of the model was defined based on the bottom and thickness of the younger and older alluvium (and Ojai Conglomerate in the Mira Monte/Meiners Oaks Area) within the UVRGB. Preliminary estimates of alluvium thickness within the UVRGB were obtained from a regional modeling study for the Ventura River Watershed being performed pursuant to the California Water Action Plan (Ventura River Instream Flow Program) (DBSA, 2020). Note, the alluvium includes the older alluvium, where present beneath younger alluvium, and the Ojai Conglomerate is the bedrock formation in the Mira Monte/Meiners Oaks Area. Model calibration and available data indicate that the Ojai Conglomerate has much lower permeability than the alluvial units. The alluvium bottom (and corresponding top of bedrock) mapping was revised and refined by incorporating high resolution ground surface elevation (Light Detection and Ranging - LIDAR) data and additional subsurface data from well construction records and studies. These studies include those by Fugro (2002, 2015), hydrogeologic investigations and studies (Hopkins, 2007; VCFCD, 1971; Entrix, 2001), published cross-sections (Fugro, 2002; Entrix, 2001), and basin-specific surface geology information (USGS, 2005, 2015). INTERA reviewed, analyzed, and identified the bedrock elevation from the well construction records and published cross-sections. The prior alluvium bottom and thickness (DBSA, 2020) were validated against and revised, where necessary, to match selected well logs and cross-sections. **Figure 4.2** shows the regional alluvium bottom received from the Ventura River Instream Flow Program modeling study (DBSA, 2020) along with the well logs and cross-sections where the alluvium bottom was validated or revised. **Figure 4.3** shows the bottom of the alluvium (top of bedrock), which forms the effective base of the groundwater model.

The UVRGB is surrounded by bedrock outcrops in the north, west, and south. In the east, the basin is separated from the Ojai Basin with a recognized groundwater and surface water divide. As such, no-flow boundaries were specified along the UVRGB boundaries in the model. Model boundary conditions within the active domain include groundwater recharge from and discharge to the Ventura River; recharge from precipitation and return flows; groundwater losses to evapotranspiration; and groundwater extractions. Groundwater recharge from percolating precipitation (discussed in **Section 6.1**) and return-flows (discussed in **Section 6.2**) was simulated using the MODFLOW RCH package (Harbaugh et al., 2000; Harbaugh, 2005), which applies a specified rate of recharge for each model stress period. Surface flows were simulated using the MODFLOW SFR2 package (Prudic et al., 2004; Niswonger and Prudic, 2005), which routes surface flows along the river channel and dynamically simulates surface-water/groundwater interactions based on the relative elevations of the Ventura River stage and groundwater table at each reach in the Ventura River (discussed in **Section 7.0**). Groundwater losses to evapotranspiration were simulated for the riparian vegetation within the Ventura River floodplain with the MODFLOW EVT package (Harbaugh et al., 2000; Harbaugh, 2005), which dynamically simulates groundwater uptake by vegetation based on a specified maximum evapotranspiration rate and the elevation of the groundwater table in relation to the rooting depth (discussed in **Section 8.0**). Groundwater pumping was simulated using the MODFLOW WEL package (Harbaugh et al., 2000; Harbaugh, 2005), which applies a specified extraction rate to each model cell with groundwater wells (discussed in **Section 9.0**). Note, that MODFLOW-NWT reduces groundwater extractions for cells as they get desaturated and no extraction is simulated for dry cells (even if groundwater pumping is specified for those cells). This represented a minimal (approximately 2%) difference in simulated and specified extraction rates over the historical simulation period. This is well within the uncertainty of the specified (estimated) pumping volumes in the model. Groundwater losses to surficial drainage was simulated using the MODFLOW DRN package (discussed in **Section 10.0**).

5.0 MODEL DISCRETIZATION

MODFLOW requires a rectilinear grid. **Figure 5.1** shows the model grid used for the UVRGM. The UVRGM grid had a general north-south/east-west orientation, with an origin at 1,951,202.0 ft northing and 6,161,918.4 ft easting in the California State Plane, NAD 1983, Zone 5 coordinate system. The model grid was rotated at an angle of -7.5^{o} to align with the long axis of the Basin. The grid spacing ranged from 50 ft by 100 ft along the Ventura River floodplain to 100 ft by 100 ft in the remainder of the model domain. The model has 505 rows, 213 columns, and 2 layers for a total of 215,130 cells; 47,142 of which are active.

Given the hydrogeology of the UVRGB, the model was split into two layers. **Figure 4.1** shows areas where layer 1 and/or layer 2 are active within the model domain. **Table 5.1** shows the model layer, active cells, and layer type for both model layers. The upper layer represents the younger alluvium within the Ventura River floodplain. The maximum depth of the younger alluvium within the river floodplain was kept at 30 ft (consistent with well logs from near the Ventura River). The older alluvium of the Terrace Area located west of the Ventura River was also included in layer 1 because it is laterally connected to younger alluvium to the south, although this connection is very limited. This area consists of alluvial deposits that are elevated above and separated from the Ventura River floodplain by bedrock and, therefore, have a very limited hydraulic connection with alluvium in other areas of the Basin. Layer 2 underlies layer 1 and represents a mix of young and older alluvium within the floodplain and older alluvium and the Ojai Conglomerate in the east. Layer 2 covers almost the entire UVRGB, except in some parts of the Kennedy Areas where the floodplain alluvium is thinner than 30 ft and the Terraces Area to the west. In these areas only layer 1 was active (**Figure 4.1**). Layer 2 was also inactivated where the alluvium is very thin, for example in the elevated north-east edge of the Mira Monte/Meiners Oaks Area. Layer 1 was treated as "unconfined" and layer 2 was treated as "convertible" (**Table 5.1**), such that unconfined (head-dependent) transmissivities and specific yields were used when groundwater elevations were below the top of the model layer and confined (head independent) transmissivities and storage coefficients were used when groundwater elevations were above the top of the model layer.

Figures 5.2 and **5.3** show the top and bottom of layer 1. The top of the layer is based on high resolution LIDAR elevation data (averaged to the model grid scale). In areas where only layer 1 is active (**Figure 4.1**) the bottom of layer 1 represents the bottom of the alluvium. In areas where both layer 1 and layer 2 are active, the bottom of layer 1 represents the top 30 ft of alluvium, representing the younger alluvium deposited within the river floodplain. **Figure 5.4** shows the top of layer 2. In areas where only layer 2 is active (**Figure 4.1**), this represents the average ground surface elevation (from LIDAR data) at the model grid scale. In areas where both layer 1 and 2 are active, the top of layer 2 corresponds to the bottom of layer 1. The bottom of layer 2 represents the base of alluvium or Ojai Conglomerate (where present) and is shown in **Figure 4.3**. **Figures 5.5** and **5.6** show the thickness of the two model layers.

The historical model simulates (and was calibrated to) surface water and groundwater conditions from January 2005 to Sept 2019. Model stress periods represent time intervals when transient inputs (such as streamflows) and boundary conditions (such as pumping) are held constant. Inputs and boundary conditions can change from one stress-period to another. Daily stress periods were used for the wet winter and early spring months from November to March (when stormflows typically occur in the basin) to account for the highly dynamic and variable surface flow conditions. Monthly stress periods were used for the months from April to October. This led to a total of 2311 stress periods for the historical model. By default, each stress-period used one time-step (with up to 500 iterations to solve for groundwater heads and flows for each time-step). For some model simulations shorter (weekly) time-steps were needed for the monthly stress periods for numerical convergence.

6.0 RECHARGE PACKAGE

Recharge was modeled using the MODFLOW RCH package (Harbaugh et al., 2000; Harbaugh, 2005), which applies a given rate of recharge to the topmost active cell. The recharge components simulated by the RCH package include infiltration of precipitation and return flows from agriculture, municipal and industrial (M&I) applications, pipeline distribution losses, and septic systems. These recharge components are described in the sub-sections below.

6.1 Recharge from Precipitation

Recharge from direct precipitation was estimated using the Basin Characterization Model (BCM[1]), a publicly available model and dataset for the California hydrologic region which includes all basins in the state (Flint and Flint, 2014; Flint et al., 2013). The BCM is a distributed grid-based regional model that calculates the water balance (**Figure 6.1**) for any time step or spatial scale by using climate inputs, precipitation, minimum and maximum air temperature. Potential evapotranspiration is calculated from solar radiation with topographic shading and cloudiness, snow is accumulated, sublimated, and melted (sublimation, snowfall, snowpack, snowmelt), and excess water moves through the soil profile, changing the soil water storage. Changes in soil water are used to calculate actual evapotranspiration, and when subtracted from potential evapotranspiration calculates climatic water deficit. Depending on soil properties and the permeability of underlying bedrock, water may become recharge or runoff. Routing is done via post-processing to estimate baseflow, streamflow, and groundwater recharge (Flint et al., 2013). Inputs to the BCM include (1) a 30-meter (m) digital elevation model (DEM), (2) spatially distributed monthly Parameter-elevation Regressions on Independent Slopes Model (PRISM) precipitation (Daly, 2008), (3) the National Land Cover Database, (4) atmospheric conditions including minimum and maximum air temperature, (5) Soil Survey Geographic (SSURGO) database (USDA NRCS, 2020), and (6) mapped surficial geology. One of the outputs of the BCM is temporally varying (monthly), gridded, in-place recharge, which is the precipitation that infiltrates below the root zone.

The BCMv65 (2014) version contains historical recharge from 1896 – 2010, with an update in 2017 that adds hydrologic data for water years 2011 – 2016. For the historical model, the BCM data were used for monthly recharge from January 2005 to September 2016. To fill in the months beyond the BCM simulation period (October 2016 – September 2019), precipitation records from Ventura County Watershed Protection District’s (VCWPD) station 218 in Meiners Oaks were used to match these months with “analogous” months (months with similar precipitation ranges) within the BCM’s simulation period. The BCM-simulated recharge from the analogous months was applied to the extended monthly period (October 2016 – September 2019). **Figure 6.2** shows the relationship between average monthly precipitation at VCWPD station 218 and BCM recharge. Based on these results, model recharge occurs when the monthly average precipitation is 4 inches or more. As such, months with missing BCM data where the precipitation at station 218 was less than 4 inches were assigned no direct recharge. Where precipitation was 4 inches or more, historical months with similar precipitation were identified. Additionally, consideration was given to also matching the precipitation in the month preceding the missing month, to ensure that antecedent moisture conditions were accounted for in analogous months used to fill the missing period. **Table 6.1** shows the missing months and the corresponding analogous months from the BCM simulation period used to estimate recharge for those months. The table also shows precipitation for both sets of months. Only months with more than 4 inches of rain are shown, as months with less than 4 inches of rain had 0 recharge. Once the missing months were estimated, monthly recharge from BCM was applied to the corresponding stress periods in the UVRGM. Since BCM

[1]https://ca.water.usgs.gov/projects/reg_hydro/basin-characterization-model.html

is a monthly model, recharge was kept constant within a month, but could vary from one month to another.

Figures 6.3a – 6.3d shows BCM recharge for several example months. Higher recharge is seen in wet months and years (for example, January 2005) and little to no recharge is seen in dry months and years (for example, January 2015 which was during the 2012 – 2016 drought).

6.2 Return Flows

Recharge from return flows was categorized into four different terms: (1) M&I landscape irrigation, (2) pipeline distribution losses, (3) septic systems, and (4) agricultural. Each of these components is described below.

6.2.1 Recharge from M&I Return Flows

M&I return flows were conceptualized as landscape irrigation in excess of plant needs that is assumed to percolate to the water table. It was assumed that 50% of delivered M&I water is for outdoor use, 20% of which is lost to return flows. This is consistent with return flow assumptions for other nearby basins in similar settings (UWCD, 2018). The three water service providers in the area are Casitas Municipal Water District (CMWD), Ventura River Water District (VRWD), and Meiners Oaks Water District (MOWD). **Figure 6.4** shows the service area for each district within the UVRGB. The total volume of M&I water for each water district was assumed to be equal to each water service provider's residential usage and was applied evenly over the respective water service provider area with no overlap between different water districts. Total water use data for VRWD and MOWD[1] from 2005 to 2019 was provided by the districts. Water use for each district within UVRGB was estimated based on the proportion of the service area of the district inside the UVRGB boundary and the total service area. The water use within the UVRGB for each water district was divided by the service area within UVRGB to come up with a water use per unit area. M&I return flow factor (20% of 50% of total M&I use) was applied to the water use per unit area rate, which was applied uniformly across the district's service area. A slightly modified approach was taken for CMWD that has a very large service area much of which is outside UVRGB. Given the large service area, it was difficult to estimate a CMWD's water deliveries within the UVRGB boundary. As such, the per area M&I usage rate (and corresponding return flow) estimated for VRWD was also applied to the CMWD service area. M&I return flows were kept constant within a year but varied from year to year.

6.2.2 Recharge from Water Distribution System Leakage Return Flows

Distribution losses that contribute to return flows are conceptualized as the water that is lost in distribution from central water supply locations on its way to endpoints such as residential or industrial facilities due to leaks in pipes. A similar approach was applied as was done for M&I return flows. Water deliveries for each district within the UVRGB were kept the same as for the M&I return flow calculation (**Section 6.2.1**). Distribution system losses were assumed to be 4% (consistent with CMWD UWMP

[1] Note, MOWD services both M&I and agricultural customers in the UVRGB; however, for this calculation MOWD's total water use rate was utilized to estimate M&I return flows. M&I and Agricultural deliveries for MOWD may be separated out in the next revision of this model.

[CMWD, 2021]) of water use and applied over the entire service area. Distribution losses were kept constant within a year but varied from year to year.

6.2.3 Recharge from Septic System Return Flows

Septic return flows are conceptualized as water that is lost from septic tanks due to leaks. The water use per area calculated for M&I return flows (**Section 6.2.1**) was assumed to apply to areas with septic tanks. It was assumed that 50% of the total water use was for indoor use, and thus flowed to into septic tanks. Septic return flows were only applied to parcels of land that were known to use septic tanks (VCWPD GIS data received from UVRGA in February 2020). Septic return flows were calculated as the total indoor water usage using a constant per area rate for each water district. **Figure 6.5** shows the parcels within UVRGB where septic return flows were applied as part of the recharge package. Several agricultural parcels were also on septic systems; hence, the figure shows parcels where both septic and agricultural (discussed in the next section) return flows were applied. Septic return flows were kept constant within a year but varied from year to year.

6.2.4 Recharge from Agricultural Return Flows

Agricultural return flows were conceptualized as irrigation in excess of plant needs that is assumed to percolate to the water table. They were estimated by assuming a constant 2 acre-feet/acre/year for all cropland in the basin (UVRGA, 2020). This constant 2 acre-feet/acre/year is meant to represent average crop demand in the region and is informed by UVRGA Board Members' survey of groundwater extractions within the UVRGB (UVRGA, 2020). 20% of the assumed constant crop demand is assumed to be lost to return flows consistent with return flow assumptions for other nearby basins in similar settings (UWCD, 2018). Agricultural land-use was determined using the Agricultural Commissioner's maps of crops in the area which was also subsequently refined by inspection of aerial imagery. **Figure 6.5** shows the parcels within UVRGB where agricultural return flows were applied as part of the recharge package. Several agricultural parcels were also on septic systems; hence, the figure shows parcels where both agricultural and septic return flows were applied. Since, a constant 2 acre-feet/acre/year was assumed for agricultural demand, agricultural return flows stayed constant over the simulation period.

Figure 6.6 shows the total return flows (sum of M&I, distribution losses, septic, and agricultural return flows) for an example model stress-period (January 2019).

6.2.5 Total Recharge

Total recharge is the sum of recharge from direct precipitation and total contributions from return flows. Note, both precipitation-based recharge and return flows vary over time, hence different stress periods can have different total recharge. **Table 6.2** shows the annual recharge components for each water year in the UVRGM simulation period.

7.0 STREAMFLOW PACKAGE

The MODFLOW streamflow routing (SFR2) package (Prudic et al., 2004; Niswonger and Prudic, 2005) was selected to simulate the complex interaction between surface water and groundwater along the

Ventura River. The SFR2 package uses the continuity (conservation of mass) equation to route surface water flow through one or more simulated rivers, streams, canals, or ditches. Streams are divided into segments, and segments are divided into reaches where reaches are specified for an individual model cell. Each reach can have different physical properties (such as length, elevation, slope, streambed thickness, streambed conductivity). Reach properties can be spatially varying but cannot change from one stress-period to another. A stream segment represents a set of reaches that can have different time-variant inputs and properties. For each stream segment, SFR2 allows for inflows, outflows, diversions, tributary contributions, and other gains/losses (such as direct precipitation gains or evapotranspiration losses) to be specified for each stress-period. SFR2 also allows for several approaches (such as Manning Coefficients, rating curves, 8-point cross-section, or a lookup table) to define time-varying flow-width and flow-depth relationships for each segment. Different options may be used for different segments of the stream and may change from one stress period to another.

SFR2 routes the surface water inflows and outflows from one reach to the next (downstream reach), including tributary contributions and apportioning diversion flows based on the diversion rules specified. For each reach SFR2 uses the flow-width/flow-depth relationship (for the given segment) to calculate the channel width and stage. The channel width is used in the calculation of riverbed conductance, which also accounts for the riverbed thickness and conductivity. Groundwater gains and losses are iteratively calculated based on the riverbed conductance and the relative elevations of the stream stage and groundwater elevations – when groundwater elevations are higher than the stage, then the river reach gains groundwater proportional to the riverbed conductance and the difference between the groundwater table and stage; when groundwater elevations are below the stage but above the river bottom then the river reach loses surface water to groundwater proportional to the riverbed conductance and the difference between the stage and the groundwater table; when the groundwater elevation is below the river bottom then the river reach loses surface water to groundwater at a constant rate proportional to the riverbed conductance (i.e. the groundwater table is disconnected from the river and surface water losses are independent of the water table elevations). **Figure 7.1** shows different surface-water/groundwater interaction scenarios and the relationship between flow, river stage, groundwater elevations. Recharge from or discharge to the stream is dependent on the difference between the hydraulic head in the river and the underlying aquifer as well as the riverbed conductance, based on the following equations:

$$Q = \frac{KA}{T}(H_{GW} - H_{Riv}) \qquad \text{if } H_{GW} > R_{BOT} \qquad \text{[Equation 1]}$$

$$Q = \frac{KA}{T}(H_{GW} - R_{BOT}) \qquad \text{if } H_{GW} < R_{BOT} \qquad \text{[Equation 2]}$$

Where H_{GW} is the groundwater head, H_{Riv} is the head in the river, K is the riverbed conductivity, A is the surface area of the riverbed, and T is the thickness of the riverbed. The surface area of the riverbed (A) is based on the length and width of the river channel and can change based on flows and the flow-width relationship. The term KA/T is also referred to as the riverbed conductance.

LIDAR data were used to delineate primary and secondary braids of the Ventura River for input into the SFR2 package. Aerial imagery was used to validate the results. Segments define hydrologically consistent units for which inflows/outflows, and flow-stage-width relationships can be specified. The Ventura River was divided into 43 segments based on streambed and channel characteristics as assessed from aerial imagery. **Figure 7.2** shows the 43 different stream segments discretized along the Ventura River. These included secondary braids, which were delineated based on GIS analysis and areal imagery. The flow-stage-width relationships were uniform for every stream segment with 11 points at which the different flow-stage-width is specified (**Figure 7.3**). These relationships were adjusted during model calibration to match observed and simulated streamflows (at gage 607 and 608) and groundwater levels in wells near the Ventura River (**Section 13**).

Each segment was divided into multiple reaches, with each reach corresponding to the model grid cell intersecting the segment. LIDAR data was used to determine the elevation, channel length, and slope for each reach element. **Figure 7.4** shows elevations along a north-south cross-section of the Ventura River.

The streambed riverbed conductance (KA/T in equations 1 and 2) values were calibrated by adjusting the riverbed conductivity (K) for different river reaches to match simulated and observed streamflows (at gage 607 and 608) and groundwater levels at wells near the Ventura River (**Section 13**). Note, that the conductance is also dynamically adjusted by the model as flow conditions (and the corresponding channel width) changes. As such, riverbed conductance can vary for different reaches and different simulation times (based on flows in the Ventura River). **Figure 7.5a** and **7.5b** show the riverbed conductance for river reach elements for a representative wet (February 2010) and dry conditions (September 2010).

Inflows to the SFR2 package consisted of gaged inflows from Matilija Creek (gage 602/602A) and the North Fork Matilija Creek (gage 604), inflows from San Antonio Creek (gage 605/605A) as shown on **Figure 7.2**. Runoff from the River catchment area within the UVRGB and flows ungaged tributaries (Coyote Creek, Cozy Dell Canyon & McDonald Canyon, Happy Valley Drain, Live Oak Creek, Mirror Lake Drain, Oak View Drain, Rice Canyon & Wills Canyon, and Kennedy Canyon) were also included in the SFR2 package, as shown on **Figure 7.6**. Tributary/runoff contributions were calculated using the modified Curve Number approach (USDA, 1986; Hawkins et al., 2002), which accounts for drainage characteristics for the catchment as well as antecedent moisture conditions (Ward et al., 2004). A representative curve number for the contributing catchment was used based on the land-use and soil-type for each contributing catchment. Flow accumulation analysis in ArcGIS was used to calculate the contributing area for each catchment. **Table 7.1** shows the Curve Number and area for each of the contributing catchment. The curve numbers were adjusted for dry or wet antecedent conditions (Ward et al., 2004) based on the average precipitation of the preceding three months. Baseflow was added to tributary flows by using a simple exponential decay function to estimate flows after stormflow events. Runoff occurring in the subbasin area of the main channel was distributed over the length of the channel without any baseflow contribution. **Figure 7.6** shows the tributary flows for each of the tributaries.

Two diversions were simulated from the Ventura River: (1) outflows from the Robles Diversion; and (2) outflows from a private agricultural diversion in the Kennedy Area (**Figure 7.2**). Flows were removed downstream of river segment 4 (**Figure 7.2**) to simulate outflows from the Robles Diversion, which feed Casitas Reservoir. Daily data for the Robles Diversion were available from October 1993 through September 2017. Monthly data was available from CMWD to fill in the remaining simulation period (October 2017 to September 2019). The monthly data was converted to a daily frequency by dividing up the total monthly diversions among the number of days diversions were known to occur for a given month proportional to relative flows in the stream for that period (i.e., more diversions were apportioned to days with higher inflows).

Diversion amounts for the private agricultural diversion in the Kennedy Area were based on data available from the State Water Resources Control Board electronic Water Rights Information Management System (eWRIMS[1]) website for the years 2010 - 2019. Annual data was available from 2005 to 2009 from UVRGA. For the pre-2010 model years (when monthly diversion data was not available), the annual diversion data was distributed to monthly volumes based on the average monthly ratios from the 2010 – 2019 period of record. Note, this diversion withdraws water from a subsurface sump (infiltration gallery) adjacent to the Ventura River. As such, diversions represent a mix of surface flows and subsurface underflows. To model this dynamic, diversions were simulated as a surface-flow diversion downstream of segment 2 (**Figure 7.2**) in the SFR2 package from December through April (when flows in the Ventura River are high) and as extractions using the WEL package in the groundwater model cell from May through November (when flows in the river are generally low and underflows likely represent a more significant proportion of the diversions).

The Ventura River is characterized by flows in multiple braided channels. Flows were split equally between the two braids and then aggregated where the braids converged. The Robles Diversion includes a cut-off wall, such that flows overtopping the cut-off wall spill into a secondary channel (segment 6 in **Figure 7.2**). Records of overtopping events during the simulation period (2005 – 2019) were not available. Inspection of areal imagery from 2005 to 2019, did not reveal any periods when flows overtopped the cut-off wall. The highest observed flow at gage 607, which is on the primary channel and upstream of the confluence with the secondary channel, during the simulation period was 10,000 cubic feet per second (cfs). Hence, a threshold of 10,000 cfs was specified as the flow threshold for the secondary channel. Flows higher than 10,000 cfs would be diverted into the secondary channel, while all flows lower than 10,000 cfs would flow into the primary channel (segment 5).

8.0 EVAPOTRANSPIRATION FROM RIPARIAN VEGETATION

Plants can uptake and transpire water from the unsaturated zone (above the water table) and the groundwater table (if roots extend to the groundwater table). Surficial evapotranspiration (ET) was accounted for in the BCM model which calculates recharge, after accounting for surface ET losses. The groundwater table is relatively deep in the Mira Monte/Meiners Oaks area, and hence, most of the vegetation here is not expected to be transpiring water directly from the deeper groundwater table. Vegetation in the riparian zone (Ventura River floodplain), may be connected to the groundwater table depending on rooting depth and the water table elevation. Hence, groundwater ET was calculated for riparian vegetation along the Ventura River (i.e., within the Kennedy, Robles, Santa Ana, and Casitas Springs Areas). Groundwater losses to evapotranspiration from riparian vegetation were modeled using the Evapotranspiration (ET), or EVT, package from MODFLOW (Harbaugh et al., 2000; Harbaugh, 2005).

The Nature Conservancy (TNC) provides mapping of natural communities commonly associated with groundwater (NCCAG) dataset. These NCCAG were further evaluated and screened based on known

[1] https://www.waterboards.ca.gov/waterrights/water_issues/programs/ewrims/

ecological and hydrologic conditions in the UVRGB to identify basin specific potential GDEs (See GSP Appendices O and P for details). **Figure 8.1** shows the riparian vegetation in the UVRGB, which could uptake groundwater based on root depth and water table elevation. The riparian vegetation consists of native plants and trees and are divided into six vegetation classes: Coast Live Oak, Riparian Mixed Hardwood, Riversidean Alluvial Scrub, Scalebroom, Wetlands, and Willow Shrub. Riparian vegetation also includes the invasive species *Arundo donax* (Arundo), a significant source of riparian transpiration in the UVRGB. Mapping of Arundo was sourced from surveys done in 2007, 2011, 2015, and 2019 (**Figures 8.2a – 8.2d**) and was made available for the modeling by Rincon Consultants. In total, counting Arundo, seven vegetation groups were included in the EVT package in the UVRGB.

The EVT package requires three main inputs: an ET surface, a maximum ET rate, and an ET extinction depth. **Figure 8.3** shows the relationship between the ET rate, the ET surface, the extinction depth, and the groundwater table. The EVT package scales actual ET between the maximum ET rate and 0, depending on the relative water table elevation with respect to the extinction depth. Groundwater ET is maximum when the water table is at or above the ET surface and 0 if the water table is at or below the extinction depth. Hence, the ET surface represents the surface at which maximum transpiration occurs and the ET extinction depth represents the depth below the ET surface at which evapotranspiration declines to 0. The relative elevation from the extinction depth up until the ET surface is linearly proportional to the rate at which is ET losses are simulated. ET surface was set at the average surface elevation (based on LIDAR data) for the area within each model grid cell that had native vegetation coverage.

The ET rate is known to be dependent on vegetation characteristics (plant type, crop coefficients, rooting depth, vegetation density) and environmental factors (temperature, relative humidity, wind, and soil moisture availability). Vegetation characteristics for the various native riparian vegetation and Arundo were provided by Rincon Consultants in the form of maximum rooting depth, crop coefficients (Kc), and spatial density terms for each vegetation class in each hydrogeologic area (with the Robles and Santa Ana Areas further split into north and south) and different seasons (**Table 8.1**).

The extinction depth for any given model cell was determined using a spatial average (based on relative spatial density) of each vegetation group's maximum rooting depth (**Table 8.1**). **Figure 8.4** shows the effective rooting depths for all EVT cells in the model.

The spatial coverage of the native vegetation was kept constant over the simulation period (2005 to 2009). However, the spatial coverage of Arundo (GIS data received from Rincon Consultants) changed every four years based on the surveys completed since 2007. ET parameters were calculated for each vegetation class in each model grid cell. The effective ET parameters for a given model grid were then calculated as a weighted average based on the relative spatial density for all native vegetation classes in a given hydrogeologic zone (**Table 8.1**). ET values from native vegetation and Arundo were added for each model grid cell based on the relative density of Arundo and native vegetation in each model grid cell. **Figure 8.5** shows the effective crop coefficient for all EVT cells in the model for an example time period (January 2019). Note, that crop coefficients vary seasonally as vegetation can go dormant during the dry summer and fall months (**Table 8.1**).

The maximum ET rate was determined from nearby evaporation pan data. There are two evaporation pans operated by Casitas Municipal Water District – one at the recreation center at higher elevation, and another near the Casitas Reservoir at a lower elevation. The average pan evaporation rate from these two stations was multiplied by a scaling factor, 1.04, to convert to a reference ET rate (BCMAFF, 2001). The pan evaporation data was available from October 1993 to January 2017. For missing periods, the respective month for an average year was substituted. To determine the maximum ET rate, the reference ET was multiplied by a spatially averaged Kc and spatial density for the respective vegetation class in a given hydrogeological zone. ET rates were kept constant within a month but could vary from month to month, to account for seasonal variability in ET. **Figure 8.6** shows the reference ET rates over the simulation period (2005 – 2019).

Note, high ET rates and extinction depths in some thin and elevated cells along the edges of the model domain led to numerical convergence problems due to the cells drying from excessive ET losses. ET was removed from these cells to facilitate numerical convergence. Plants in these areas probably sustained by other water sources.

9.0 MODEL PUMPING

Groundwater pumping was modeled using the WEL package (Harbaugh et al., 2000; Harbaugh, 2005). 133 wells are known to extract groundwater from the basin, along with the Foster Park Subsurface Intake which extracts groundwater near the Ventura River. Four agencies pump groundwater at 18 locations from the basin for M&I use: CMWD, MOWD, VRWD, and the City of San Buenaventura (City of Ventura or the City). Two private mutual water companies (MWCs) pump from the basin for domestic use, along with 92 wells which pump for on-site domestic use. Water for agricultural use is extracted at 23 sites. **Figure 9.1** shows the groundwater wells in the UVRGB by average extraction rates, water use type, and M&I well owner.

Pumping records were available for the four M&I agencies and for four agricultural wells. Water extraction for the remainder of the agricultural wells, the domestic MWCs, and de minimis users was estimated for 2017 according to the Groundwater Extraction Estimates Technical Memorandum presented to the UVRGA board on June 30, 2020, and information provided by the UVRGA Ad Hoc Stakeholder Engagement Committee that was developed through interviews with certain well owners (UVRGA, 2020). **Figure 9.2** shows the data availability for different well types in the UVRGB. Because the model uses both daily and monthly stress periods, the pumping records and estimated pumping volumes were converted to model units of cubic feet per day (cfd) and applied to each (daily or monthly) stress-period. Data originally at the daily scale was simply aggregated for each month; data originally at the monthly scale was spread evenly to each day.

Monthly records for the entire model period were available for CMWD and MOWD. Daily records for the entire period were available for VRWD. City records were available at monthly intervals from 2005-2009, and daily data were available for 2010-2019. These records were reviewed, data gaps filled, and outliers removed when compiling the pumping data for the model. The M&I records were resampled to daily and monthly time steps as needed for the groundwater model.

Annual pumping records for four agricultural wells and two MWCs were made available by UVRGA. 2017 estimates for agricultural and MWC wells without historic pumping records were included in the Groundwater Extraction Estimates Technical Memorandum (UVRGA, 2020). Pumping for other (non-

2017) years was calculated by scaling the 2017 pumping estimate based on the ratio of the annual precipitation (VCWPD gage 20B) to 2017 precipitation for a given year. Pumping was inversely correlated with precipitation, such that years with higher than 2017 precipitation had lower pumping, and vice-versa. The annual scaling of pumping was done to ensure the minimum and maximum scaled pumping were within a range of ±30% of 2017 pumping (i.e., the year with the lowest annual precipitation would have 30% more pumping than the 2017 estimate; and the year with highest annual precipitation would have 30% less pumping than 2017). To bring annual agricultural pumping estimates to a monthly timestep, a monthly scaling function was used to linearly increase pumping from 0 in January (when much of the agricultural water demand is met by precipitation) to a maximum constant value from June to November (when most of the agricultural water demand is met by groundwater extractions) and then reducing linearly to 0 in January of the following year. Scaling factors were used such that the total annual pumping volumes were maintained. **Table 9.1** shows the agricultural monthly distribution factors.

Pumping by the domestic MWC and de minimis private wells were estimated for 2017 in the Groundwater Extraction Estimates Technical Memorandum (UVRGA, 2020), and these same estimates were used for all the years of the model period.

As discussed in Section 7.0, the agricultural diversion in the Kennedy Area was modeled using the SFR2 package from December to April and with the WEL package from May to November.

Figure 9.3 shows the monthly pumping volumes by category for the UVRGM.

10.0 DRAINS

During initial calibration, rising water levels were observed in the eastern Mira Monte/Meiners Oaks Area. These were contrary to observed groundwater levels in the area. There are also known surface drainage features in the area. Hence, drain cells were specified to allow for high groundwater to outflow to surface drainage features. Drain cells elevations were based on ground-surface elevations and observed groundwater levels. **Figure 10.1** shows the locations of the drain cells.

11.0 INITIAL HEADS

The model requires initial heads (groundwater levels) to be specified for January 2005 (beginning of the model simulation period). Observed groundwater levels from spring 2005 were interpolated to define the initial heads for the model. These were iteratively run through the model and adjusted to match observed and simulated water levels for spring 2005. Initial heads are shown in **Figure 11.1**.

12.0 MODEL HYDRAULIC PROPERTIES

Hydraulic properties for the model include hydraulic conductivity, specific yield, and specific storage for both model layers. Based on the hydrogeologic conceptual model (**Section 2.0**), the younger alluvium in the river floodplain is stream-channel deposits of sand and gravel, which has high permeability and specific yield. The younger alluvium is deposited over older more consolidated alluvium, which can vary in depth and extent depending on how the river has incised and deposited sediments. Layer 1 represents the predominantly younger floodplain deposits. Hence, a high conductivity range of 100 to 5000 ft/d was used for this layer, consistent with the material description from well logs (i.e., predominantly boulders, cobbles, gravels, and sands). Layer 1 also includes the Terraces Area and consists of elevated thin older alluvium along the western periphery of the floodplain. Hydraulic conductivity in these areas was kept lower at 10 – 50 ft/d. Layer 2 represents a mix of younger and older alluvium within the river floodplain, and older more consolidated alluvium and the Ojai Conglomerate bedrock unit in the Mira Monte/Meiners Oaks Area. As such, higher hydraulic conductivities (100 to 5000 ft/d) were maintained for layer 2 in the river floodplain. In the Santa Ana and Casitas Springs Area, Layer 2 was predominantly younger alluvium with conductivities in the 1000 – 5000 ft/d range. In the Mira Monte/Meiners Oaks Area, layer 2 represents older consolidated alluvium and the Ojai Conglomerate bedrock unit. A hydraulic conductivity value of 1 ft/d was used in areas where the Ojai Conglomerate outcrops. Hydraulic conductivity ranged from 5 – 10 ft/d in other parts of the Mira Monte/Meiners Oaks Area. **Figures 12.1a and 12.1b** show the calibrated hydraulic conductivities for each of the model layers.

The subsurface dam along the Ventura River in Foster Park was modeled as a linear hydraulic flow barrier (HFB) spanning across the river floodplain. HFBs reduce the effective hydraulic conductivity between model grid cells. The HFB was specified for both layers and delineated based on published cross-sections and engineering drawings (Fugro, 2002). **Figure 12.2** shows the location of the HFBs used for the subsurface dam. A uniform hydraulic conductivity of $1x10^{-5}$ ft/d was used for the HFB cells.

Similar to hydraulic conductivities, specific yield values were specified based on the hydrogeology of different parts of the basin and calibration to observed water levels. Layer 1, representing younger alluvium in the river floodplain had a relatively higher specific yield of 0.2. Layer 2, representing a mix of younger and older alluvium in the river floodplain, had specific yield values ranging from 0.1 to 0.2. Specific yield in the Mira Monte/Meiners Oaks area, where layer 2 represents older consolidated alluvium and bedrock units ranged from 0.1 to 0.15. A uniform specific storage of 0.001 was used for layer 2 across the model area. Note, that specific storage is only used when the groundwater level is above the top of the model layer (i.e., during confined conditions). Hence, the specific storage value for layer 2 was only operative in the river floodplain during high water level conditions (when the groundwater table is in layer 2 and above the top of layer 2). Since there is only one active layer (Layer 2) in the Mira Monte/Meiners Oaks Area, and the groundwater table is always below the top of the model layer, specific storage was not used in this part of the model domain. **Figures 12.3a, 12.3b, and 12.4** show the storage properties for the two model layers.

13.0 MODEL CALIBRATION

Model calibration entailed adjusting model hydraulic parameters via trial and error to match simulated and observed groundwater levels and streamflow over the historical period from January 2005 to September 2019. Model parameters adjusted during calibration included: spatially varying hydraulic conductivities for both layers; specific yields for both layers; riverbed conductance (specified in the SFR2 package); river flow-stage and flow-width relationships; and HFB conductivities. During initial testing of the model, simulated groundwater levels were seen to be “flooding” above ground surface in the area where the bedrock outcrops near the Ventura River in the Robles area (**Figures 2.1a and 2.1b**) narrowing the river floodplain, thus restricting groundwater flows. Bedrock elevations were lowered in this area by to reduce flooding and allow groundwater to flow more easily through the narrows. This is an area with no well logs to define bedrock elevations within the river floodplain, hence there is uncertainty with respect to the bedrock surface in this area.

Observed groundwater elevations were available from 48 groundwater wells in the Basin. **Figure 13.1** shows the wells with water level records used for model calibration. Of these, several (31) were clusters of shallow environmental monitoring wells located in the north-east portion of the Mira Monte/Meiners Oaks area. The remaining 17 wells were located across the Basin, within or at the edge of the river floodplain.

Example wells with observed and simulated hydrographs are shown in **Figures 13.2a** to **13.2g.** Note, groundwater heads during storm flows tends to spike because of the way the SFR2 package calculates the stage in the river. Storm flows in the Ventura River typically flow across several braids that may, in turn, be incised by the storm flows. The SFR2 package maintains all the flow in the primary and secondary braids (as defined in the SFR2 package) and does not have the ability to spread the water across multiple braids as flows increase. The result is that during a storm event the stage in the river can build up, as all the water is restricted within the channel. High stage during the storm flows translates to higher heads in the groundwater table in areas where groundwater is connected to the river. Hence, groundwater heads are also seen to "spike" during these storm events. These spikes are intermittent and quickly dissipate once the storm flows pass through the basin, and groundwater returns to average conditions. As such, the groundwater elevation "spikes" during storm events are modeling artifacts and should not be seen as indicative of actual groundwater levels in the basin. Thus, this numerical phenomenon does not impact to overall model calibration and utility. Groundwater heads in the north-eastern Robles Area and northern Mira Monte/Meiners Oaks Area (wells 04N23W04J01S and 04N23W09B01S shown in **Figures 13.2c** and **13.2d**) are underpredicted during the drought years, with the lowest simulated groundwater levels approximately 40 ft lower than observed. This is likely because these wells are partially screened in consolidated or bedrock units that the model is not intended to simulate.

Figure 13.3 shows a scatter plot for observed and simulated water levels for all wells used for model calibration. As can be seen from the figure, the observed and simulated water levels are strongly correlated, indicating a good level of model calibration. **Table 13.1** shows model calibration statistics for observed versus simulated groundwater levels. The mean absolute error (MAE) and root mean square error (RMSE) - measures of model error - are approximately 6.5 and 9 ft, respectively. The scaled MAE/RMSE (ratio of the model error metric to the range of observed water levels) is 1.1% and 1.5%, respectively. This is significantly less than the industry calibration standard of 10% scaled MAE or RMSE (Spitz and Moreno, 1996; Rumbaugh and Rumbaugh, 2017). Based on the match between the observed and simulated groundwater hydrographs at key wells, the strong correlation between observed and simulated water levels, and the low scaled MAE and RMSE statistics, the groundwater model is well calibrated using industry standards.

Observed streamflow records are available at gage 607 (near the Robles Diversion) and the Foster Park gage 608. **Figures 13.4a** and **13.4b** show observed versus simulated streamflow at gage 607 and 608. Overall, the model captures observed stormflows and baseflows in the Ventura River at these two locations. The high flows during the historically wet years (2005, 2006, and 2011) are well captured. The low (often little to no) flows during the drought years are also simulated within a few cfs of observed flows. The model simulates the near 0 flows at the 607 gage in late summer and fall for most years. Based on the match between observed and simulated flows at the Foster Park gage, the model has an accuracy of 1-2 cfs in simulating low flows in late summer and fall.

Note, surface flows are highly variable and impacted by upstream and (ungaged) tributary flows. The model routes flow from the gaged data (602, 604, and 605/605A) and estimates contributions from ungaged tributaries. Hence, gage errors or uncertainties in estimated ungaged flows propagate to model streamflow results. The gage data at 607 and 608 also show anomalous trends (for example, relatively high flows at the Foster Park 608 gage in the winter of 2013 when there was little to no precipitation in the Basin).

In addition to observed groundwater and surface-water data, the model was also qualitatively calibrated to River flow mapping conducted by CMWD (**Figure 13.5). Figure 13.6** shows winter and fall simulated flow conditions in Ventura River. Simulated flows are in good agreement with observed flow conditions. Both observed and simulated conditions show the Ventura River mostly flowing north of the Robles Diversion (in the Kennedy Area). River flows were predominantly dry between the Robles Diversion and the Confluence with San Antonio Creek during summer and fall, and for most of the drought years (2012 – 2016), except during stormflow events. Simulated and observed flows in the Ventura River are typically wet south of the San Antonio Confluence, especially in the Foster Park area. Similar to mapped flows, the Ventura River was simulated as flowing from the Robles Diversion to the San Antonio Confluence during peak flow conditions (winter of 2005, 2006, 2010, and 2011). The Ventura River typically has very low flows in the Casitas Springs Area in summer and fall. However, the model does not have the requisite resolution to accurately simulate very low (< 1 cfs) flows. This is likely the reason why the simulated flow conditions in the Casitas Springs Area do not match the CMWD mapping in a few summer/fall months (e.g., 2009). In general, the monthly stress periods used from April to October limits the ability of the model to simulate transient summer stormflows as well as very low flow conditions in late summer and fall, observed in the southern portion of the Ventura River.

14.0 MODEL RESULTS

Groundwater levels at select wells within or near the Ventura River floodplain are shown in **Figures 13.2a** - **13.2g.** Streamflow at gage 607 and 608 is shown in **Figures 13.4a** and **13.4b.** Simulated water level contours for representative high and low water level conditions are shown in **Figures 14.1a – 14.1d.** The predominant flow of groundwater is from north to south along the general topographical gradient. Due to the high permeability of the younger alluvium in the Ventura River floodplain, stormflows in the Ventura River percolate and travel very rapidly through the floodplain. The water level hydrographs in **Figures 13.2a – 13.2g** indicate highly transient groundwater levels that go down during the drier summer and fall months (and drought years) but quickly rebound once the Ventura River receives stormflows in the wetter winter and spring months.

Figures 14.2 and **14.3** show the simulated annual groundwater and surface-water budgets for the historical model. **Tables 14.1** and **14.2** show the values for the different water budget terms for each water year. As can be seen from the water budget, surface-water/groundwater interactions (as shown by percolation to groundwater from losing river reaches and groundwater discharge to gaining river reaches) dominates the groundwater budget. Precipitation-based recharge can be highly variable ranging from more than 2,000 acre-feet/year to effectively zero for the drought years. Pumping represents the major groundwater outflow component from the UVRGB, with an average of approximately 4,900 acre-feet/year of groundwater extractions. Riparian ET ranges from 1,800 acre-feet/year to approximately 700 acre-feet/year, with the lowest ET during drought years. Groundwater storage in the basin is highly variable and driven primarily by hydrologic conditions in the basin. There is a small net negative change in average storage over the historical simulation period. This is ostensibly due to the simulation period, with 8 out of the 16 water years being dry years (including the 2012 – 2016 drought).

Zonal budget analysis was undertaken to calculate groundwater underflows from one hydrogeologic area to the other. **Figure 14.4** shows the average monthly underflows for the hydrogeologic areas (note that the Robles and Santa Ana Areas were further split into north and south sub-areas). The zonal budget analysis shows that much of the groundwater flows north to south within the River floodplain with minimal groundwater exchange between the floodplain and Mira Monte/Meiners Oaks Area or the Terraces Area (in the West) and the floodplain.

15.0 PREDICTIVE MODEL

The calibrated historical model was used as the basis to develop predictive model simulations to assess future surface and groundwater budgets, groundwater elevations, and surface flows in the River for the GSP. Three future scenarios were developed for this purpose – a baseline scenario consisting of a repeat of the last 50 years of historical hydrology (water years 1970 to 2019); a 2030 scenario consisting of the last 50 years of historical hydrology (water years 1970 – 2019) altered based on near-term climate change factors (provided by DWR for SGMA planning purposes); and a 2070 scenario consisting of the last 50 years of historical hydrology (water years 1970 – 2019) altered based on long-term climate change factors (provided by DWR for SGMA planning purposes). DWR climate change factors and methodology (DWR, 2018) were used to scale the baseline hydrology to future climate-change impacted conditions. DWR climate change factors were available from 1915 to 2011. Climate change factors were compiled for the predictive simulation period from 1969 to 2011. Climate change factors for the remaining 2012-2019 were determined by finding analogous years (based on monthly precipitation patterns) from the 1949 – 2011 period of record for the climate change dataset. **Figures 15.1a** and **15.1b** show the 2030 and 2070 precipitation and ET change factors used for the predictive models. On average, precipitation goes down by approximately 0.2% and 5% for the 2030 and 2070 scenarios, respectively. On average ET goes up by 4% and 9% for the 2030 and 2070 scenarios, respectively.

Each future model scenario, incorporated future anthropogenic factors such as pumping and return flows, accounting for impacts from climate change, as needed. **Table 15.1a** summarizes key model inputs and assumptions for the predictive model scenarios. **Table 15.1b** summarizes future water use assumptions that were the basis for pumping and return flows for the predictive scenarios. Additional details for key model inputs and boundary conditions are discussed in the following sub-sections.

15.1 Predictive Recharge

Similar to the historical model, the predictive recharge package consisted of precipitation-based recharge and return flows.

15.1.1 Recharge from Precipitation

For the UVRGA predictive model, recharge from precipitation was estimated based on BCM values (Flint and Flint, 2014; Flint et al., 2013). Recharge for the baseline hydrology (water years 1970 - 2019) were taken from the BCM monthly recharge dataset from October 1969 – September 2019 (with missing 2016 – 2019 BCM months filled in using the analogous months approach, as discussed in **Section 6.1**). For the climate change scenarios, the recharge values are multiplied by the monthly precipitation climate change factor provided by DWR (2018). Recharge was divided by the monthly ET change factors to account for higher temperatures (and less recharge) in the future.

15.1.2 Return Flows

For the predictive model, the M&I water usage (to estimate M&I return flows) was calculated based on the Ventura River Water District's per area water usage rates. During dry years, the water usage applied was kept equivalent to the average Ventura River Water District residential usage from 2015-2020 (which included drought conservation during drought conditions). For the non-dry years, the applied water usage was made equivalent to 85% of the average demand from 1985-2009. The M&I return flow factors were kept the same as for the historical model (50% assumed outdoor with 20% of outdoor water use contributing to M&I return flows). Distribution losses and septic return flows were tied to M&I water use, with similar return flow factors as for the historical model (4% for distribution losses and all of indoor water use for septic return flows, respectively). Agricultural water-use was assumed to be the same as for historical conditions (2 acre-feet/acre of agricultural parcel area) with a 20% return flow factor.

All irrigation water usage (inclusive of agricultural and outdoor M&I return flows) was scaled by the average climate change scenario ET factor for the respective scenario, to represent increased water demands (and applied water) due to higher temperatures in the future. For the 2030 scenario, the constant applied ET factor was 1.0424, and for the 2070 scenario, the constant applied ET factor was 1.089.

15.2 Predictive Streamflow and Diversions

The SFR2 package segment relationships as well as data for reaches and flow-stage-width relationships were all kept the same as for the historical model. Inflows and diversions, however, were modeled differently.

Daily historic flow records from the baseline period (October 1969 to Sept 2019) were adjusted to 2030 and 2070 future conditions using the annual and monthly streamflow change factors for the Ventura River watershed (designated HUC8_18070101 by DWR), using the methodology for application of time series change factor data described in DWR (2018) guidance. Note, the DWR streamflow change factors change the volume and the timing of streamflow using annual and monthly change factors. The methodology was applied to the daily flow data using the same methods as recommended for monthly data. Similar to the precipitation factors, streamflow change factors for water years 2012-2019 were selecting from analogous years from the 1949 - 2011 period (with available streamflow change factors) based on matching gaged streamflow (North Fork Matilija Creek, Matilija Creek, and San Antonio Creek) for the 2012 – 2019 water years with observed streamflow from the 1949 – 2011 period. **Figure 15.2** shows the streamflow change factors for the 2030 and 2070 scenarios used for the UVRGB predictive model. On average, the streamflow decreases by 11% and 17% for the 2030 and 2070 scenarios, respectively.

Runoff and tributary inflows were calculated similar to the historic model using the curve number approach (**Section 7.0**) but based on climate-change impacted precipitation from gage 20B.

Future Robles Diversions were calculated based on diversion facility operating rules included in the National Marine Fisheries Service biological opinion rules, which were programmed into an algorithm to simulate diversion volumes based on future (climate-change impacted) inflows from gages 602 and 604. The diversion rules were validated against historical daily diversion data (made available by CMWD).

Future estimates for the agricultural diversion in the Kennedy Area were also provided by UVRGA for drought and non-drought conditions. Drought and non-drought classifications for future water years were determined based on percentiles of annual precipitation. Water years with annual precipitation lower than the 33rd percentile of the annual precipitation record were classified as drought years and the remaining years were classified as non-drought years. Agricultural diversions in the Kennedy area were split between the SFR2 and the WEL package in the same way as for the historical model (**Section 7.0**).

15.3 Predictive Pumping

Pumping for the predictive scenarios was based on a memo presented to the UVRGA board on December 10, 2020, as modified by Board member input during and following that meeting (**Table 15.1a**). Daily and monthly time series were developed for all wells under baseline, 2030, and 2070 climate change scenarios as follows:

M&I Pumping:

- City of Ventura future M&I pumping estimates were provided for drought and non-drought years (**Table 15.1a**) (Ventura Water, 2021; pers. comm. with city staff). In addition, the City provided estimates for reduced pumping for the third and subsequent consecutive years of drought. The City provided a monthly percentage allocation for future non-drought years. For drought years, pumping was evenly distributed from February to July. **Table 15.2** shows the monthly factors used for City pumping for drought and non-drought years.
- M&I estimates were available for the other agency's total pumping amount at the annual scale. Future estimates of drought and non-drought pumping were also provided for the other three M&I pumpers (CMWD, MOWD, and VRWD) by UVRGA (**Table 15.1a**). Historical pumping records were used to distribute pumping across days/months and different M&I wells for a given Agency. For example, VRWD's future non-drought annual pumping estimate is 950 acre-feet/year. VRWD Well 1 accounted for an average of approximately 39% of annual VRWD pumping under non-drought conditions in the historical model. On each January 1st of historical non-drought years, Well 1

pumped an average of 0.1215% of its annual production. Therefore, in the predictive model Well 1 was assigned approximately 0.45 acre-feet/day of pumping on January 1st during non-drought years.

- To distribute the total agency pumping to individual wells, each well's share of total pumping during the historical model was calculated for both drought and non-drought conditions. **Table 15.3** gives the well-specific ratios for the M&I wells used to distribute the total agency pumping across each Agency well. These ratios were then applied to the predictive model.
- Note, that drought and non-drought classifications for each year (used to estimate M&I pumping) were based on the precipitation for the given future (baseline, 2030, 2070) scenario. Hence, based on the projected precipitation for a given year and scenario, years could be classified as drought or non-drought differently for future scenarios.

Agricultural Pumping:

- Future baseline agricultural pumping was assumed to be the same as historical agricultural pumping. For all agricultural wells except those belonging to the Rancho Matilija Mutual Water Company (RMMWC), 2017 pumping estimates were scaled by precipitation using the same method that was used in the historical model. Precipitation scaling factors were calculated for each of the three scenarios based on future (climate-change impacted) precipitation. **Tables 15.4a to 15.4c** show the precipitation-based scaling factors for agricultural pumping for the baseline, 2030, and 2070 scenarios. For all agricultural groundwater extractions, an additional ET factor was applied for the 2030 and 2070 climate change scenarios. For each scenario, the average ET factor for the analogous historical model period was used as a scaling factor to represent increased evaporative demand.
- Drought and non-drought estimates for pumping were provided for the RMMWC wells by UVRGA. These were associated with future years based on the projected precipitation for future years.

Domestic MWCs and domestic well pumping were held constant at the 2017 levels for all years and all three future scenarios.

Tables 15.5a to **15.5c** show the annual future pumping estimates by water use category for each of the three future scenarios.

15.4 Predictive Evapotranspiration

For the predictive climate change scenarios, the reference ET was multiplied by the corresponding monthly ET factor from the DWR climate change dataset. The predictive model used the same calibrated areal coverage of active EVT model cells. Native and Arundo vegetation coverage were kept the same as 2019 over the entire predictive timeframe. For each climate change scenarios, monthly maximum ET rate was scaled by the respective monthly ET change factor from the corresponding DWR climate change dataset.

15.5 Predictive Model Results

Future groundwater levels, streamflow, and water budgets were simulated for each of the predictive scenarios (baseline, 2030, and 2070). **Figures 15.3a – 15.3g** show future water levels for the baseline, 2030, and 2070 scenarios for select groundwater wells (**Figure 13.1**). Future water levels for all three scenarios are very similar to each other, indicating the climate change does not have a significant influence on future groundwater levels in the basin. In general, future groundwater level trends are similar to historical groundwater levels and within the uncertainty of the model inputs and predictions. Note, the predictive groundwater levels also “spike” during storm events due to the way the river stage is calculated in the SFR2 package. These spikes are intermittent and quickly dissipate once the storm flows pass through the basin, and groundwater returns to average conditions. As such, the groundwater elevation “spikes” during storm events are modeling artifacts and should not be seen as indicative of actual groundwater levels in the basin. **Figures 15.4a** and **15.5a** show streamflow at gage 607 and Foster Park gage (608), respectively, for each of the three future scenarios. **Figures 15.4b** and **15.5b** show the difference in streamflow between baseline and 2030 and 2070 scenarios for each of the two gage locations. As can be seen from **Figures 15.4b** and **15.5b**, both stormflows and baseflows tends to be slightly lower under the 2030 and 2070 scenarios.

Figures 15.6a – 15.6c show the groundwater budget for the baseline, 2030, and 2070 scenarios. **Tables 15.6a – 15.6c** show groundwater budget components for each of the scenarios. **Figures 15.7a – 15.7c** show the surface water budget for the three future scenarios, with **Tables 15.7a – 15.7c** showing the surface water budget components. Both the surface water and groundwater budgets are similar across the three scenarios, with slightly lower total recharge for the climate change scenarios. However, basin storage is seen to be stable for all predictive scenarios, with groundwater storage (levels) declining during dry years but rebounding with subsequent wet months/years.

16.0 MODEL LIMITATIONS

While the model represents the best available basin-specific predictive tool, there remain some numerical and data limitations must be understood as they relate to limitations of the model’s ability to simulate the hydrologic conditions in the UVRGB:

- Surface water and groundwater flows are strongly influenced by bedrock elevations and geology. The model incorporates all available lithologic data from UVRGB groundwater wells and surface geology and geologic cross-sections from published literature. However, there is sparse geologic/lithologic data within the Ventura River floodplain. Additional geologic/lithologic data near the Ventura River in these areas would improve the understanding of bedrock topography and increase confidence in surface water and groundwater predictions in the area.
- Streamflows were available from gages 602, 604, and 605/605A where flows enter the basin from Matilija Creek, North Fork Matilija Creek, and San Antonio Creek, respectively. However, the River receives flows from several ungaged tributaries. Tributary contributions were estimated using a Curve Number approach. Additional gages on contributing tributaries would validate/refine these estimates. Furthermore, streamflow data is available downstream of the Robles Diversion (gage 607) and at Foster Park (gage 608). Modeled streamflow was calibrated to observed streamflow at these two gages. However, no streamflow gage data is available along the Ventura River between the two gages. Additional streamflow data along the Ventura River between gages 607 and 608 would allow for more refined simulation and calibration of streamflow conditions along these sections of the Ventura River. The Ventura Watershed

numerical model being developed by the SWRCB as part of the Ventura River Instream Flow Program may be used to update estimates of ungagged runoff and tributary flow in the future (DBSA, 2020).

- Some anomalous flow conditions were observed in the streamflow records. Validation of historical streamflow records would improve confidence in the model inflows, surface water calibration, and streamflow predictions.
- Groundwater elevations from wells within the Ventura River floodplain were used to calibrate groundwater levels and surface water/groundwater interactions along the Ventura River. Few groundwater observations are available in much of the Robles and Santa Ana Areas. Additional groundwater levels near the Ventura River in this part of the Basin would improve understanding and refine model results for surface water/groundwater conditions in the Robles and Santa Ana Areas.
- The model underpredicted drought groundwater levels in a few wells in the north part of the Robles and Mira Monte/Meiners Oaks Areas. This was likely due to these wells being screened in and influenced by flow in fractured bedrock units. The model does not simulate contributions from the fractured bedrock. Including this in the future would allow for improved model predictions of drought groundwater levels in this area.
- The groundwater model used daily stress periods for winter and spring conditions (November through March) and monthly stress periods for late spring to fall (April to October). Monthly stress periods from April to October limit the ability of the model to simulate spring and summer stormflow and baseflow conditions. A future update of the model could potentially incorporate year-round daily stress periods.
- The model poses significant uncertainty when simulating very low flows in the summer and fall, especially in the Casitas Springs Area. Based on streamflow calibration results, the model has an uncertainty of 1-2 cfs in simulating low flow conditions (< 5 cfs) typical of summer and fall in the Ventura River. Note, this uncertainty is driven both by the resolution of the model and the uncertainty and gaps in the available data to calibrate the model. The model was used to assess streamflow depletions by running the model with and without pumping (UVRGA GSP Section 3.2.6, 4.9.1, and Appendix N). The depletions are dependent on the pumping and the degree of surface water/groundwater connectivity within the Ventura River floodplain. Since the same model is used for both the “pumping” and “no pumping” simulations, the relative impact of pumping on streamflow depletions can still be reliably evaluated with the model. In other words, while there is 1-2 cfs of uncertainty in simulating the magnitude of low flows, there is less uncertainty in simulating the relative difference (due to impact from pumping) in the flow conditions. Thus, the model is an appropriate tool for estimating streamflow depletion due to groundwater pumping.

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FIGURES

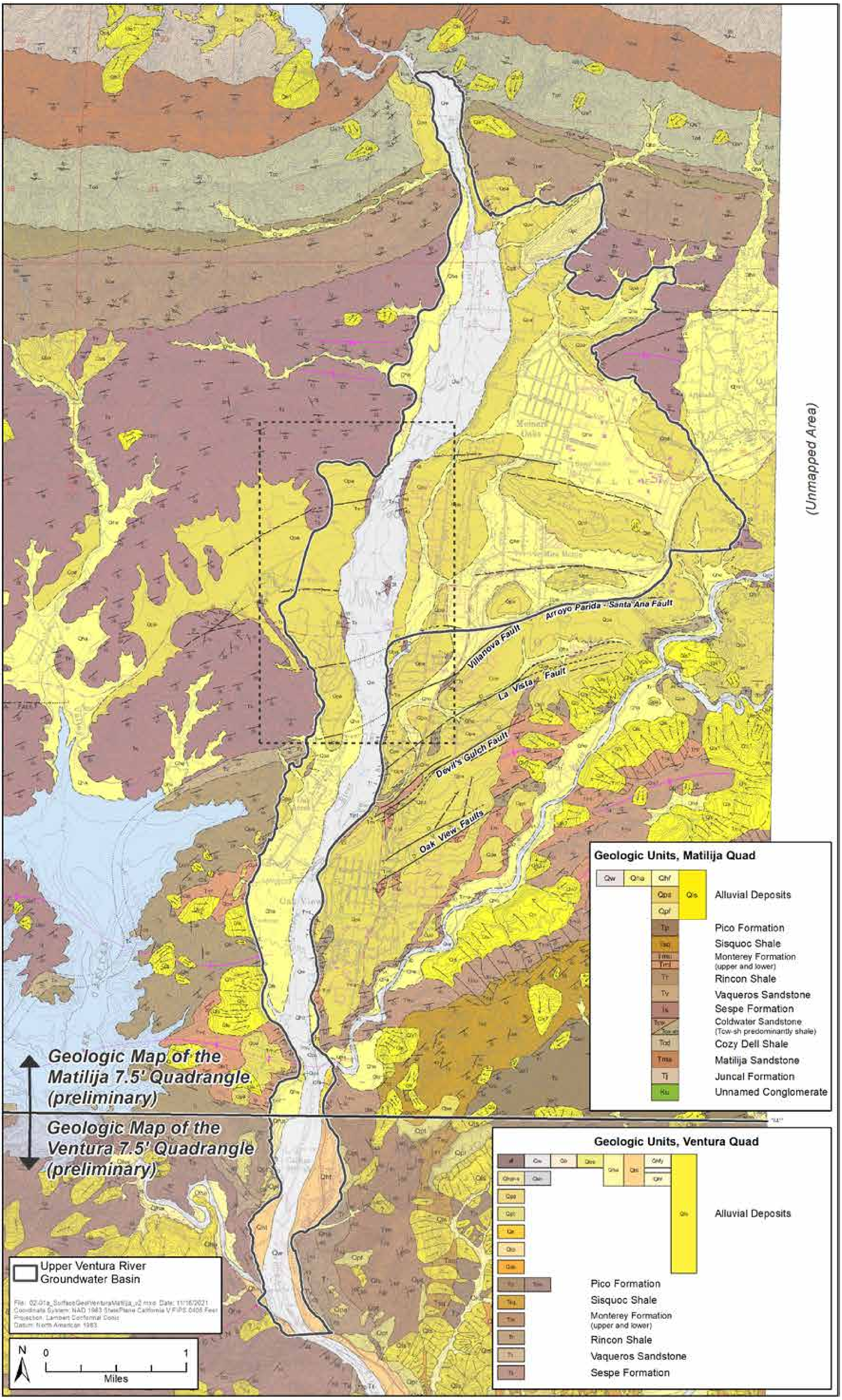


Figure 2.1a. Regional Surface Geologic Map (Ventura & Matilija).

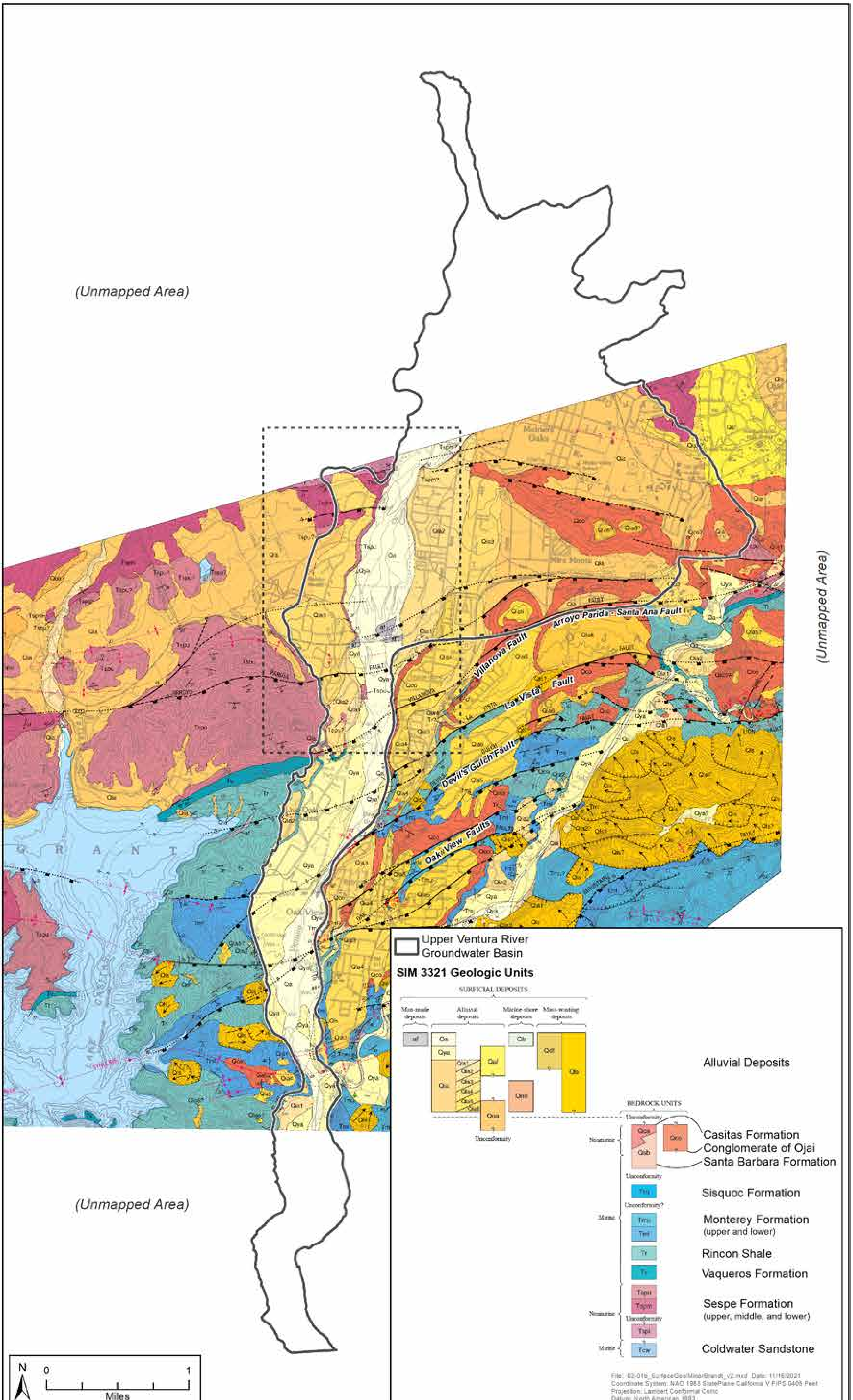


Figure 2.1b. Regional Surface Geologic Map (Minor & Brandt).

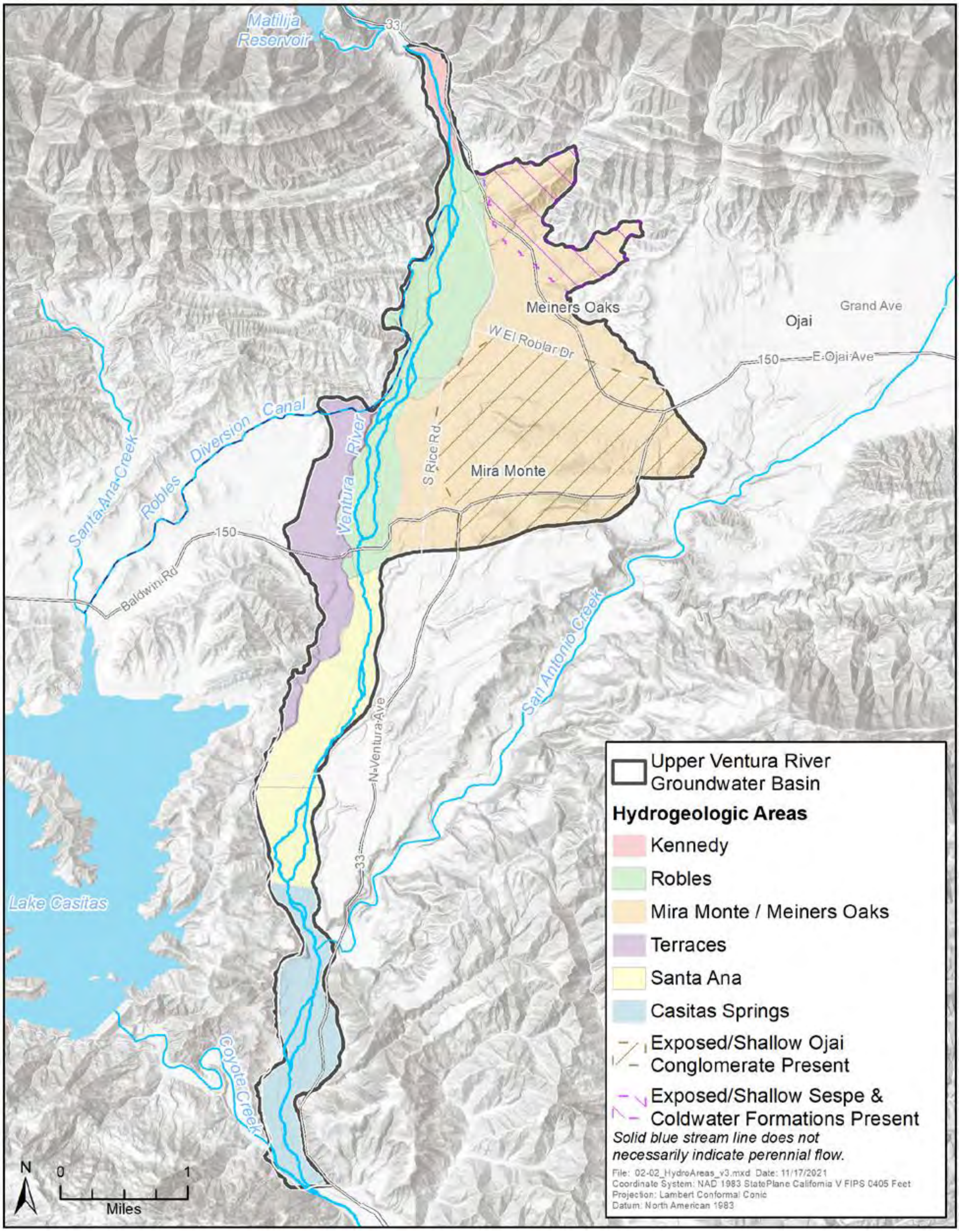


Figure 2.2. Hydrogeologic Areas within the UVRGB.

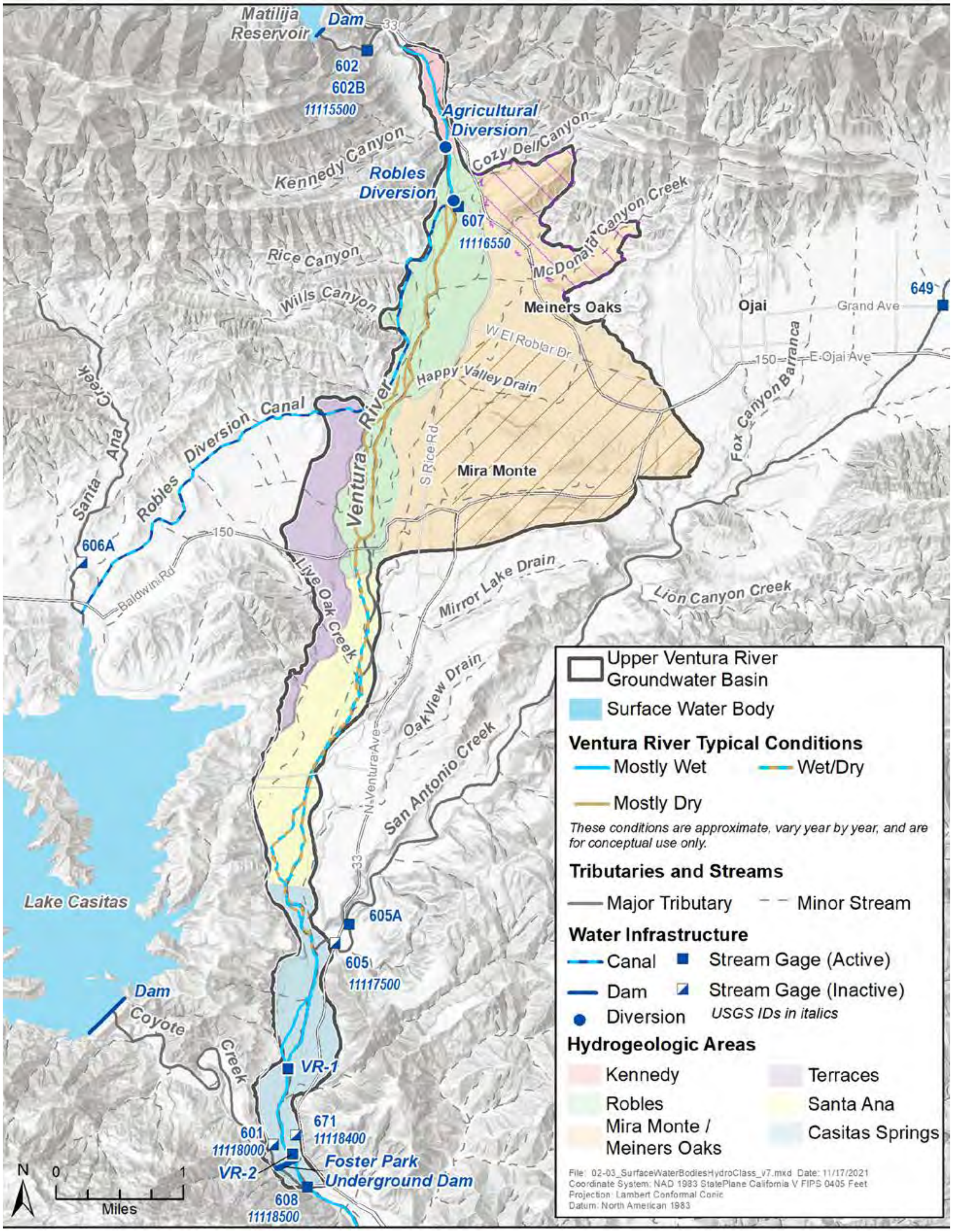


Figure 2.3. Surface Water Bodies – Hydrologic Conditions.

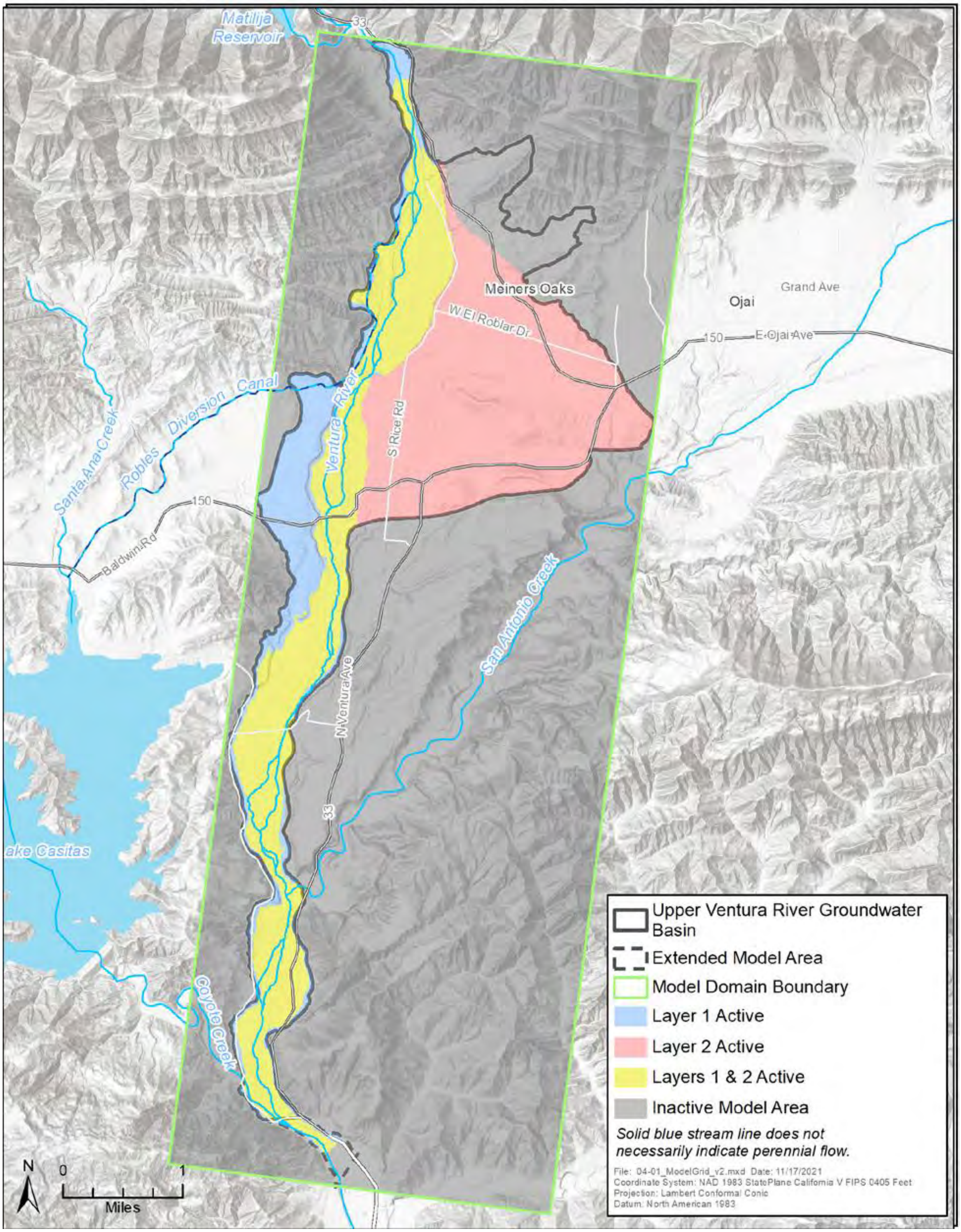


Figure 4.1. Model Layers (Active/Inactive).

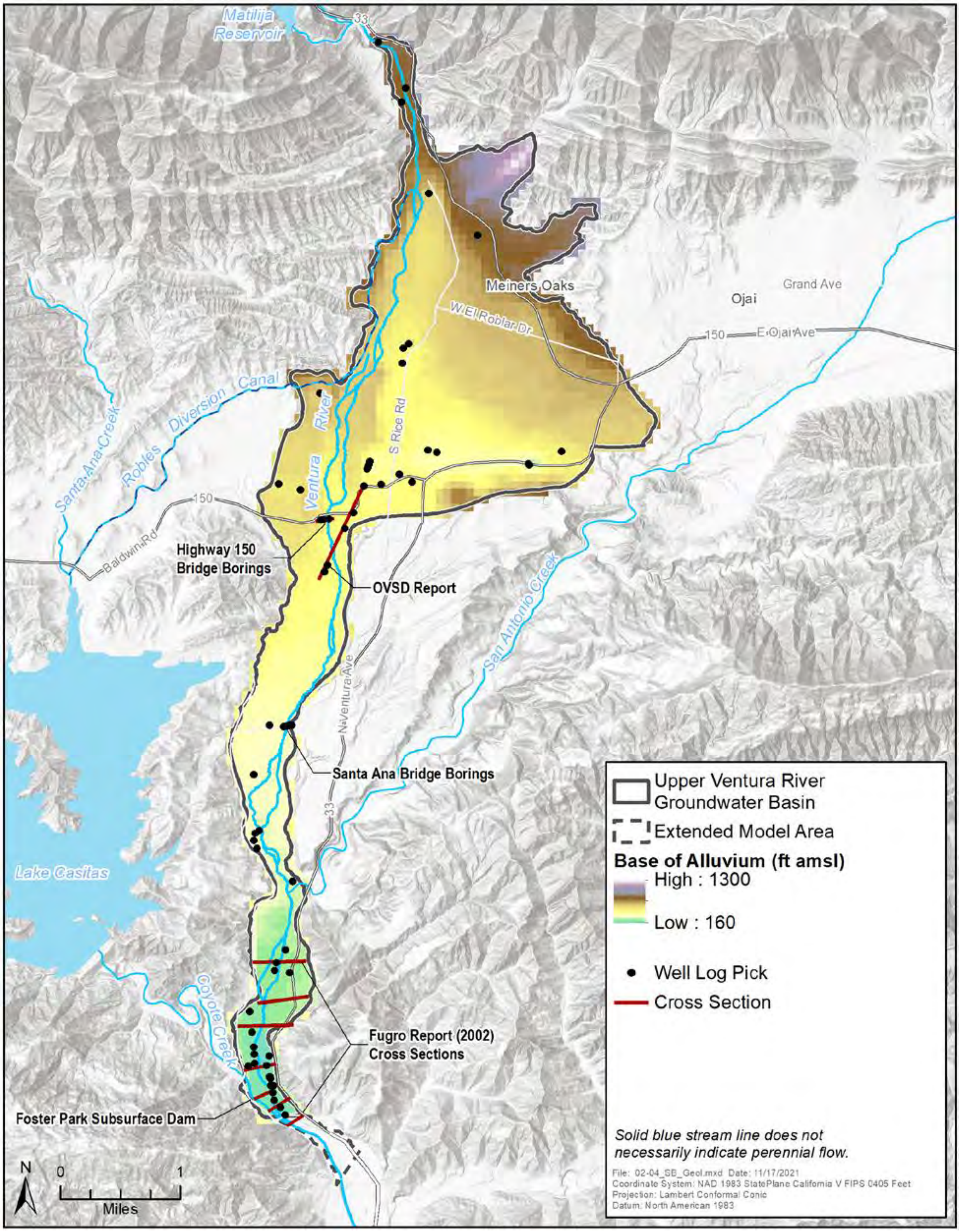


Figure 4.2. Original Bedrock Elevations from the Ventura River Instream Flow Program Modeling Study (DBSA, 2020) and Locations of Well Logs and Cross-sections Used to Refine Bedrock Elevations.

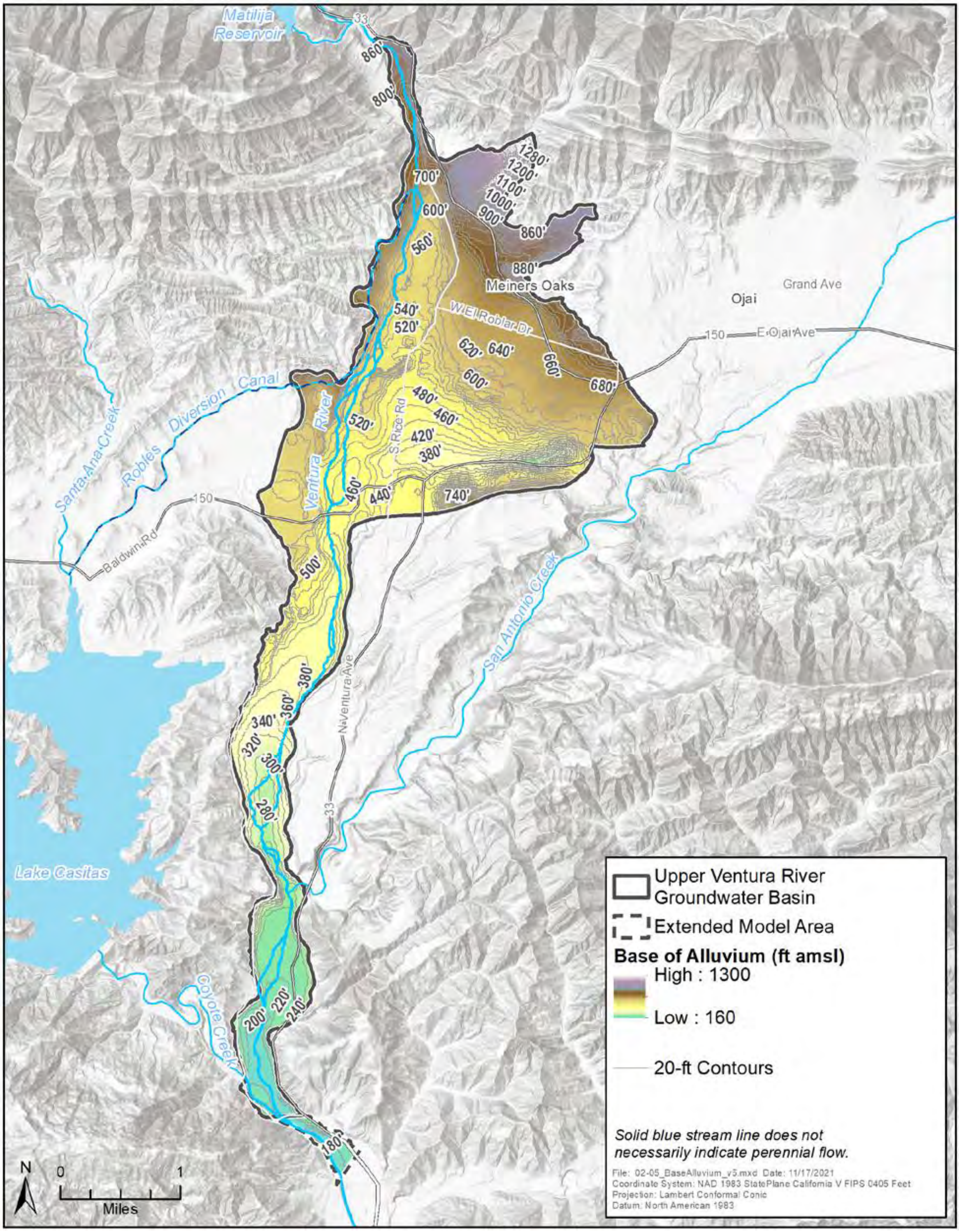


Figure 4.3. Bottom of the Basin Elevation Map

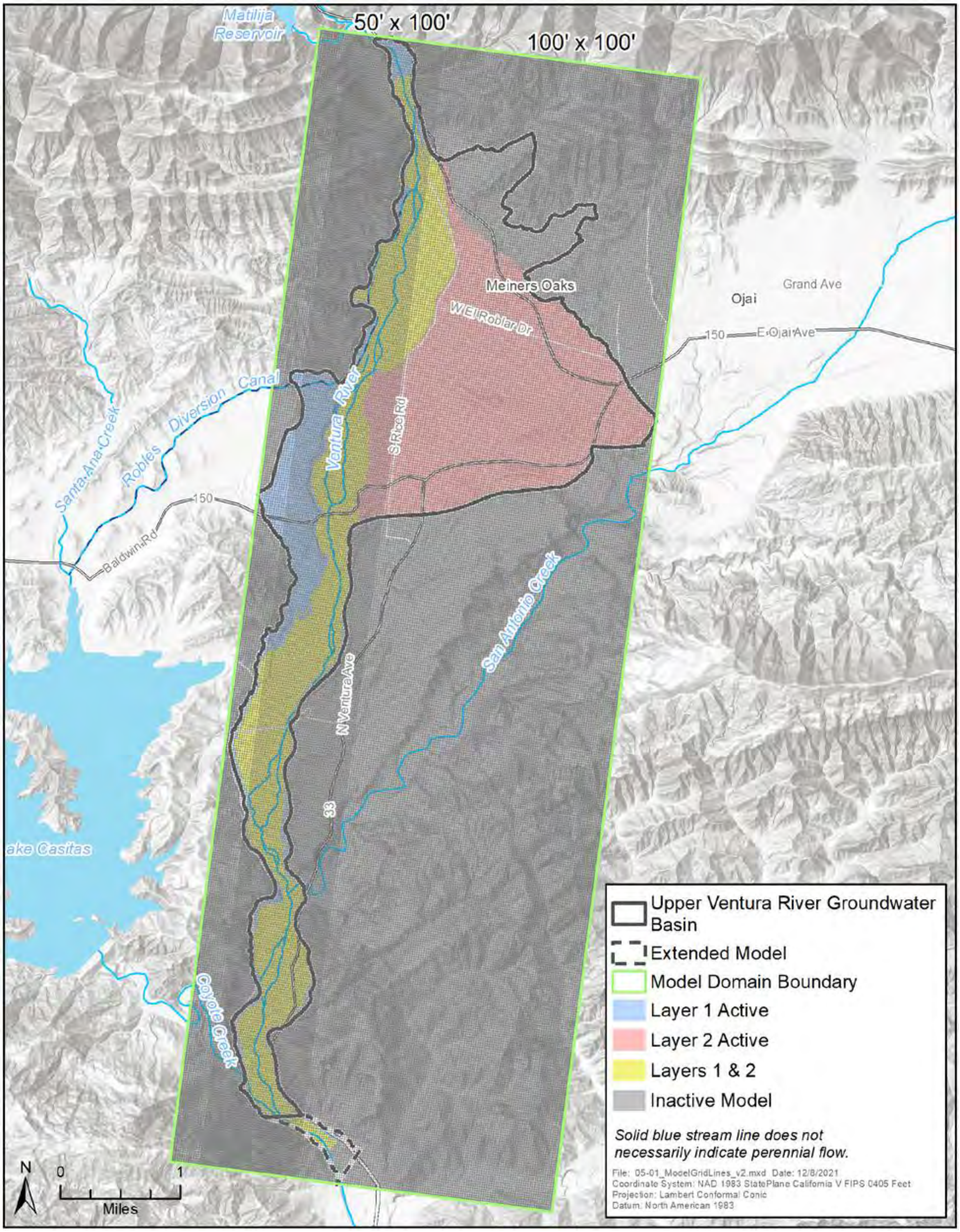


Figure 5.1. Model Grid.

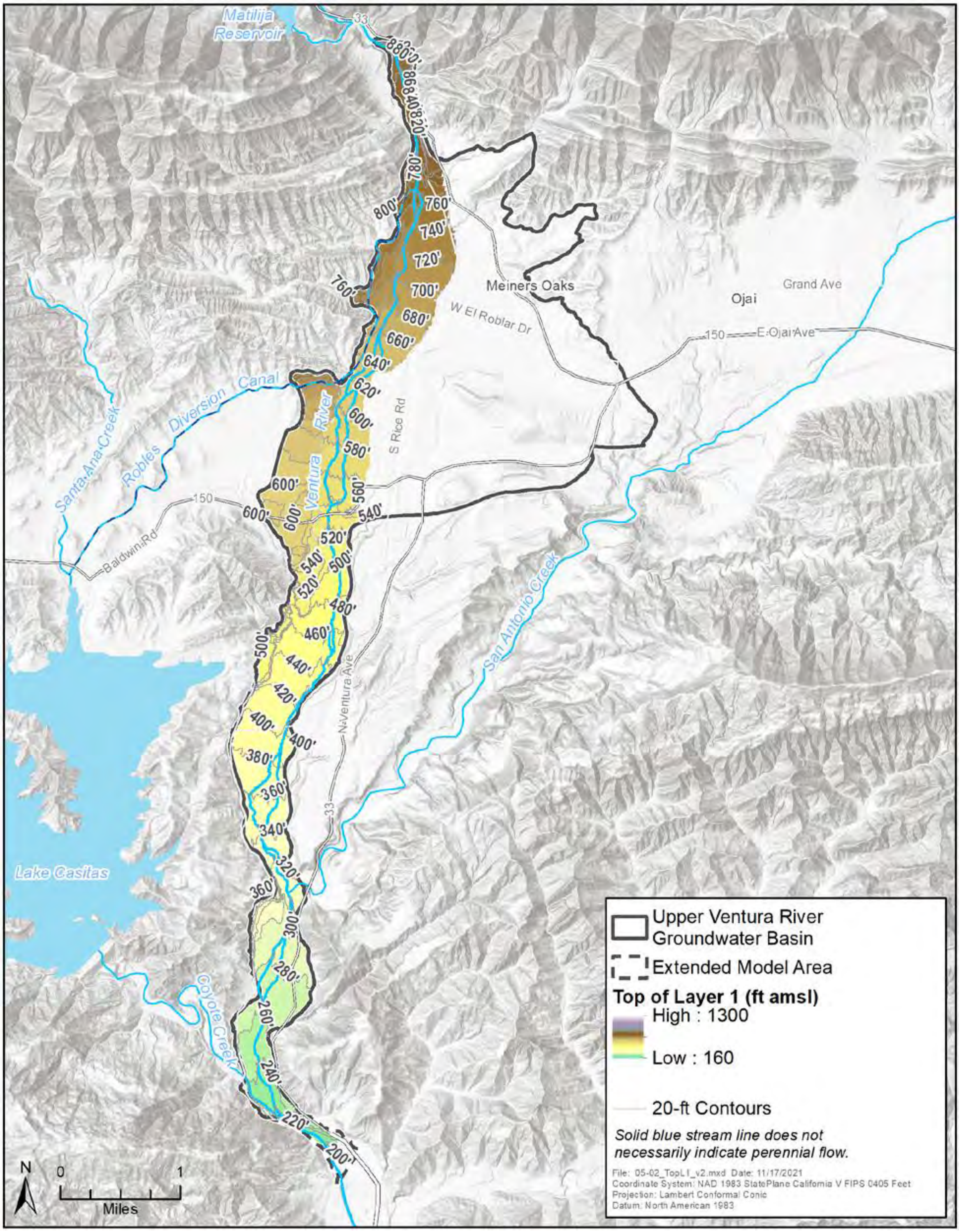


Figure 5.2. Top of Model Layer 1.

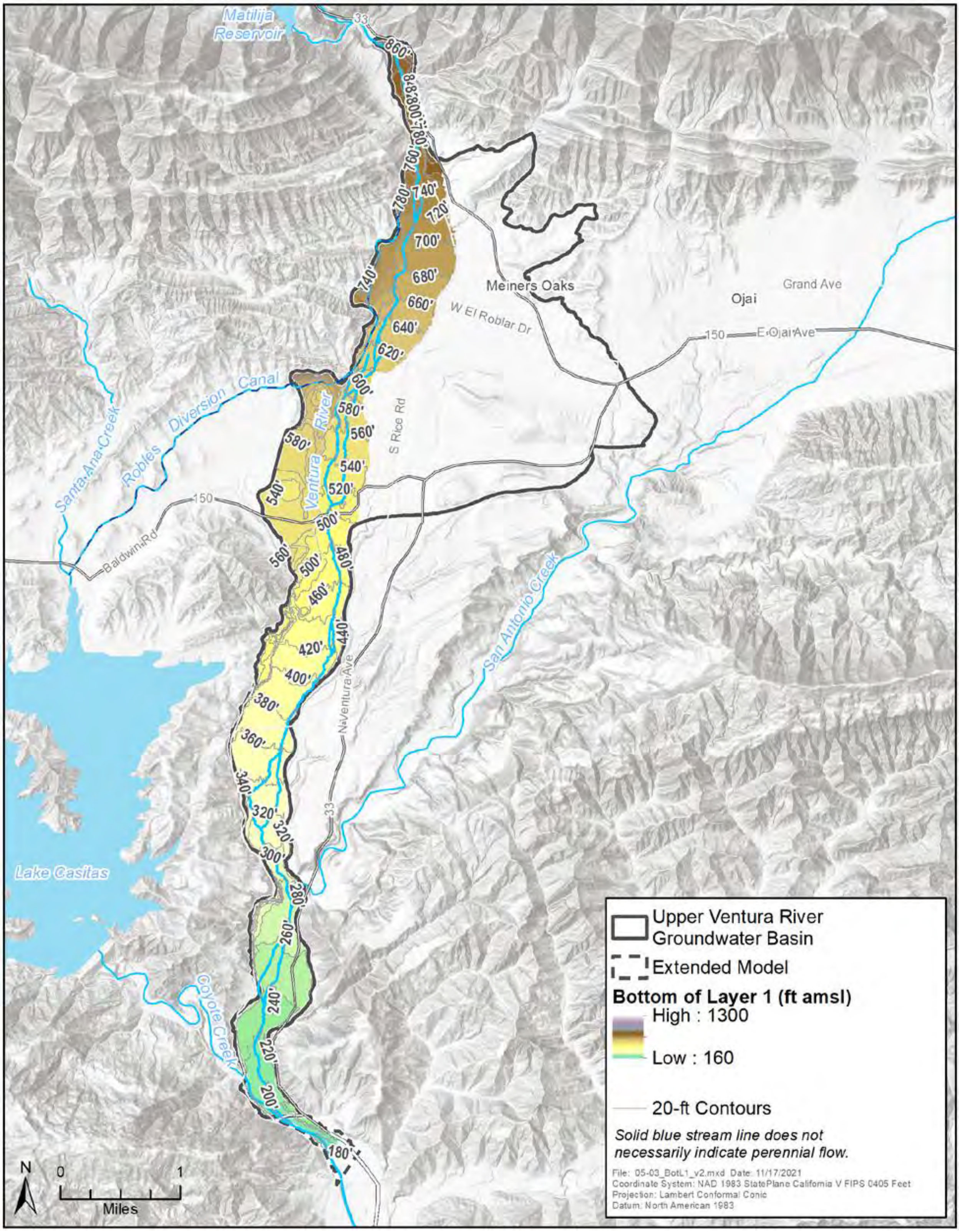


Figure 5.3. Base of Model Layer 1.

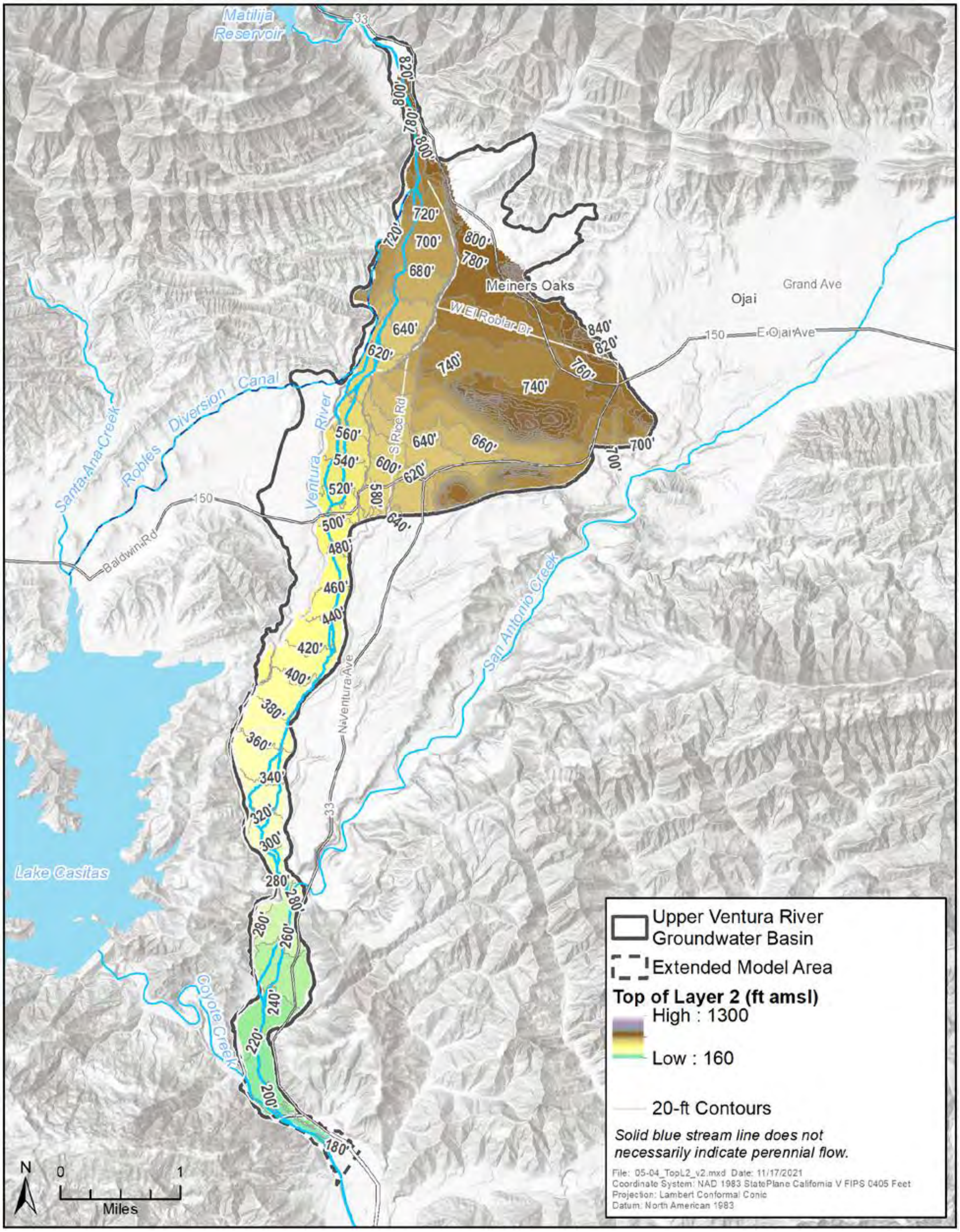


Figure 5.4. Top of Model Layer 2.

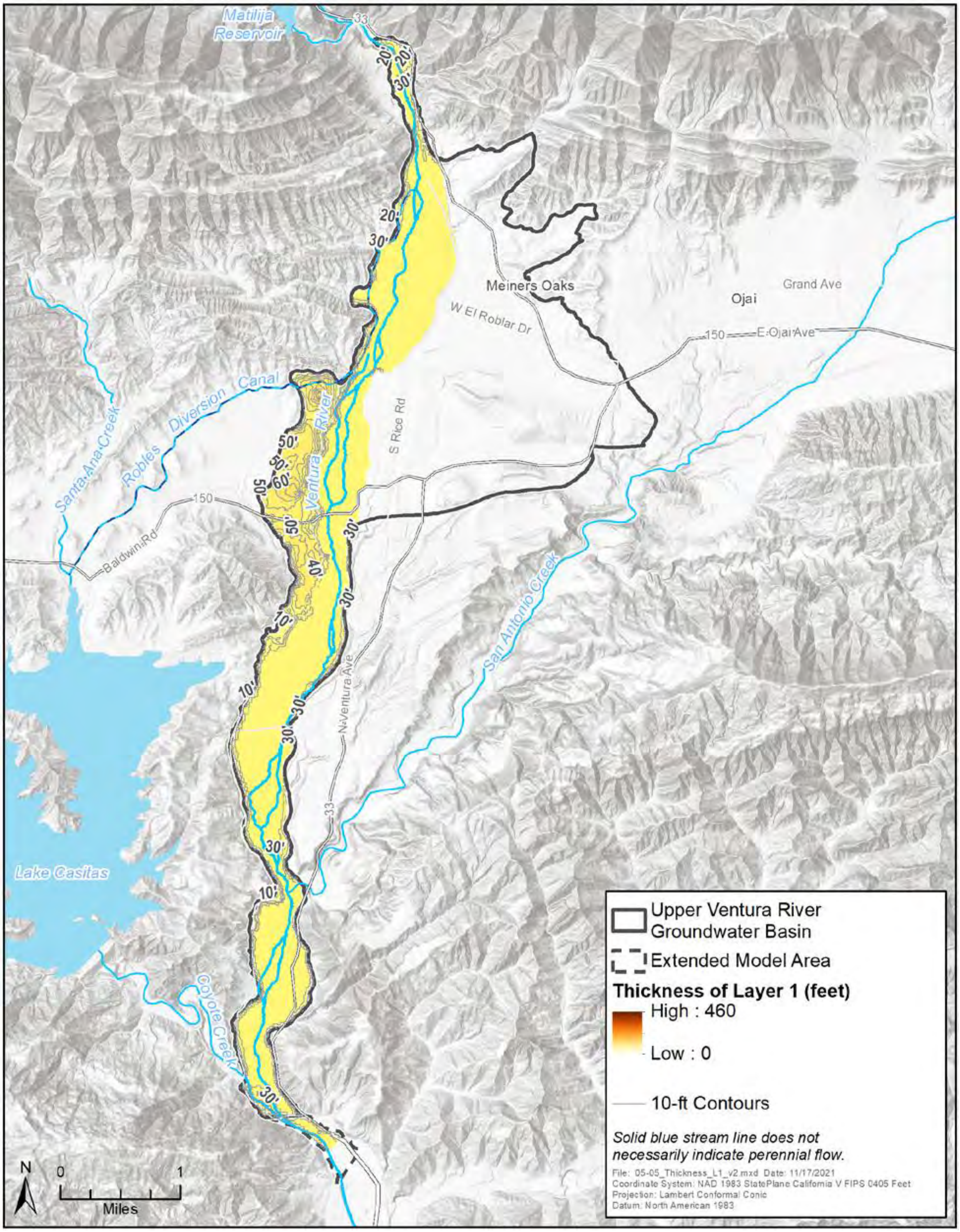


Figure 5.5. Model Layer 1 Thickness.

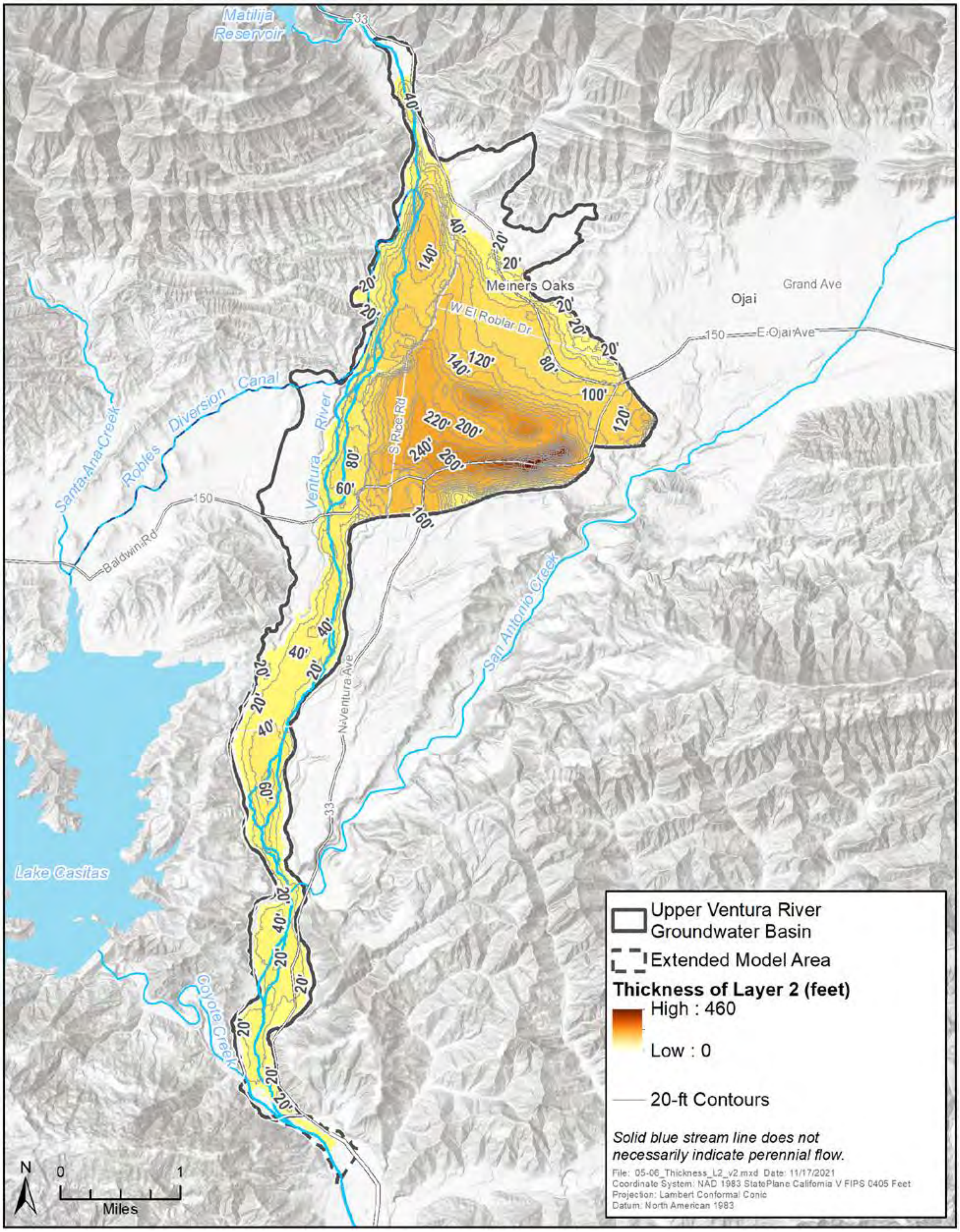


Figure 5.6. Model Layer 2 Thickness.

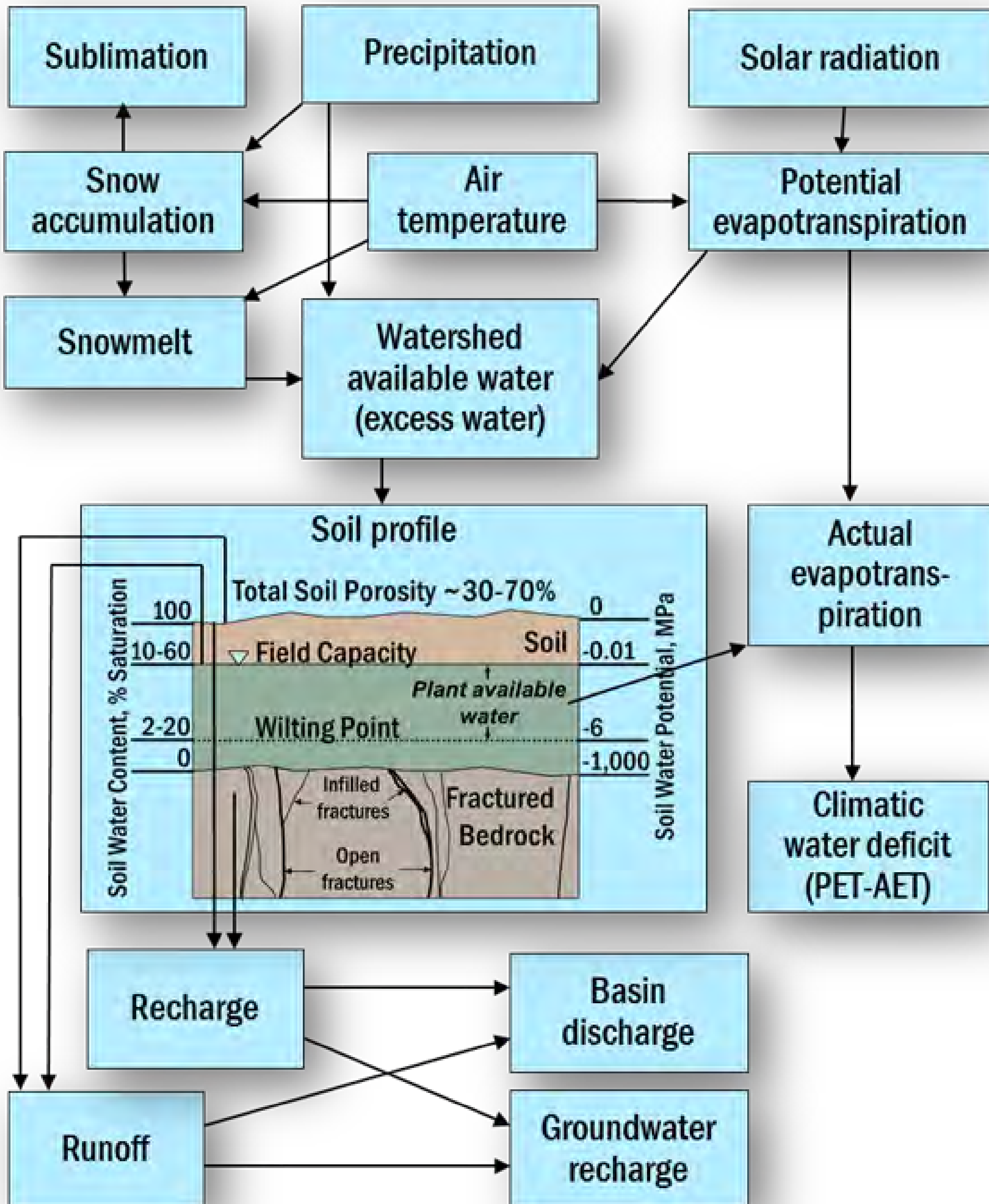


Figure 6.1. Schematic[1] of Components and Processes Simulated by the Basin Characterization Model (BCM) (from Flint and Flint, 2012; Thorne and others, 2012).

[1]Taken from https://ca.water.usgs.gov/projects/reg_hydro/basin-characterization-model.html

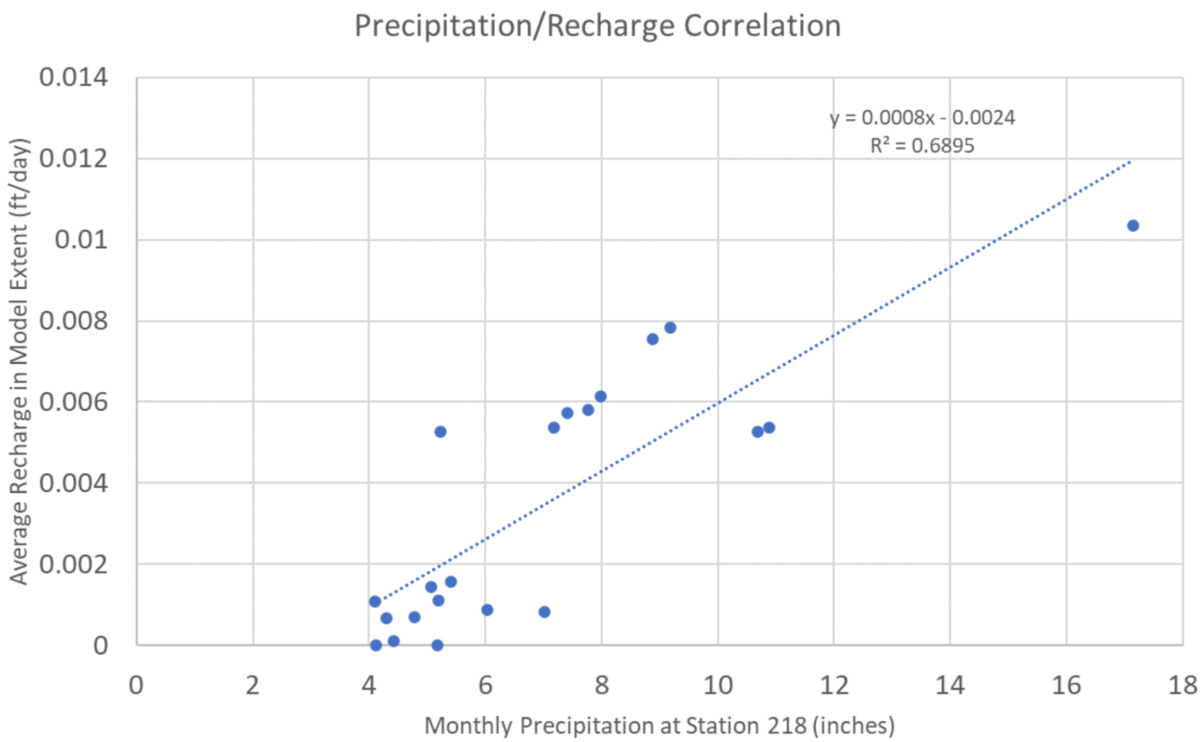


Figure 6.2. Relationship of Precipitation to BCM Recharge.

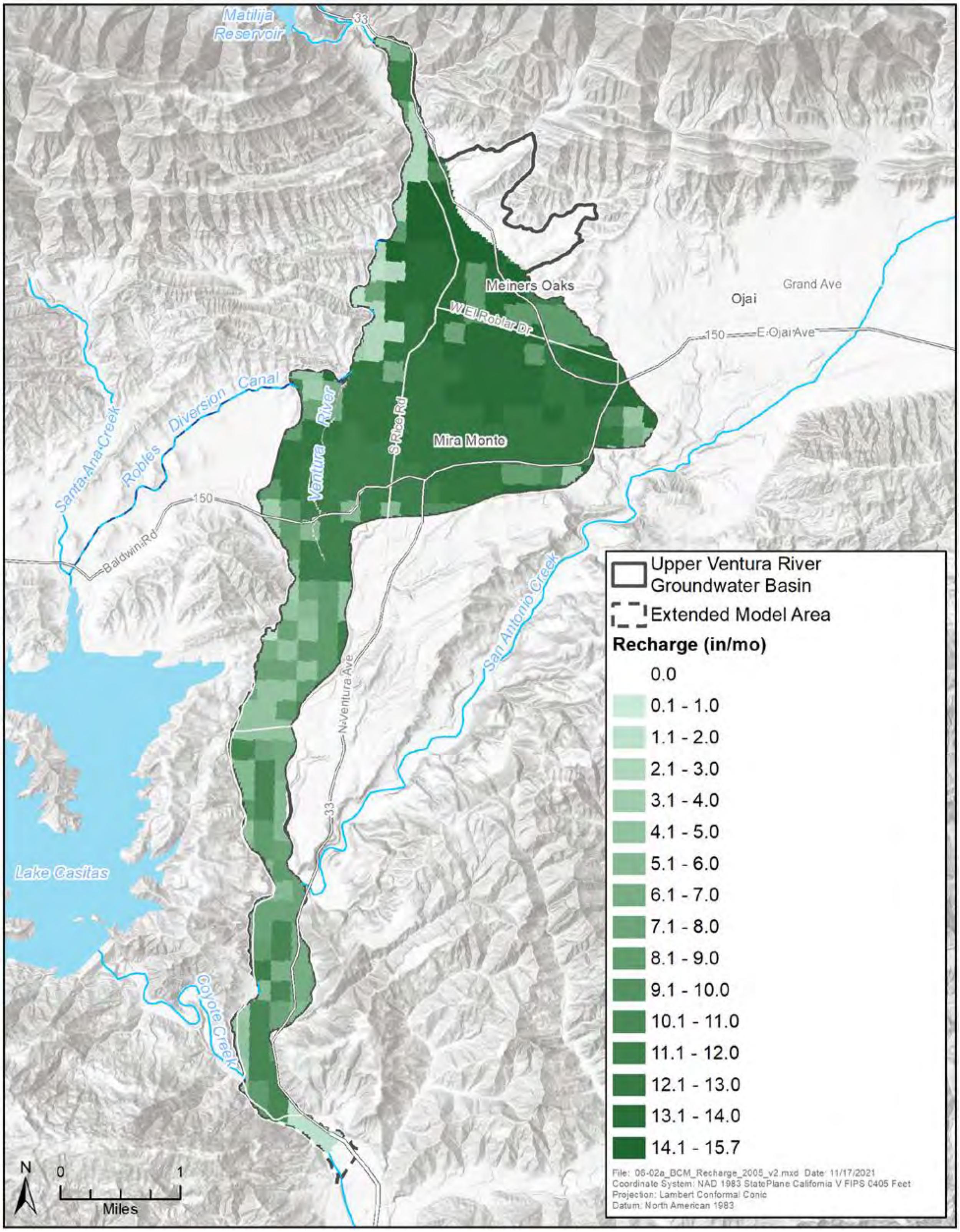


Figure 6.3a. BCM Recharge, January 2005.

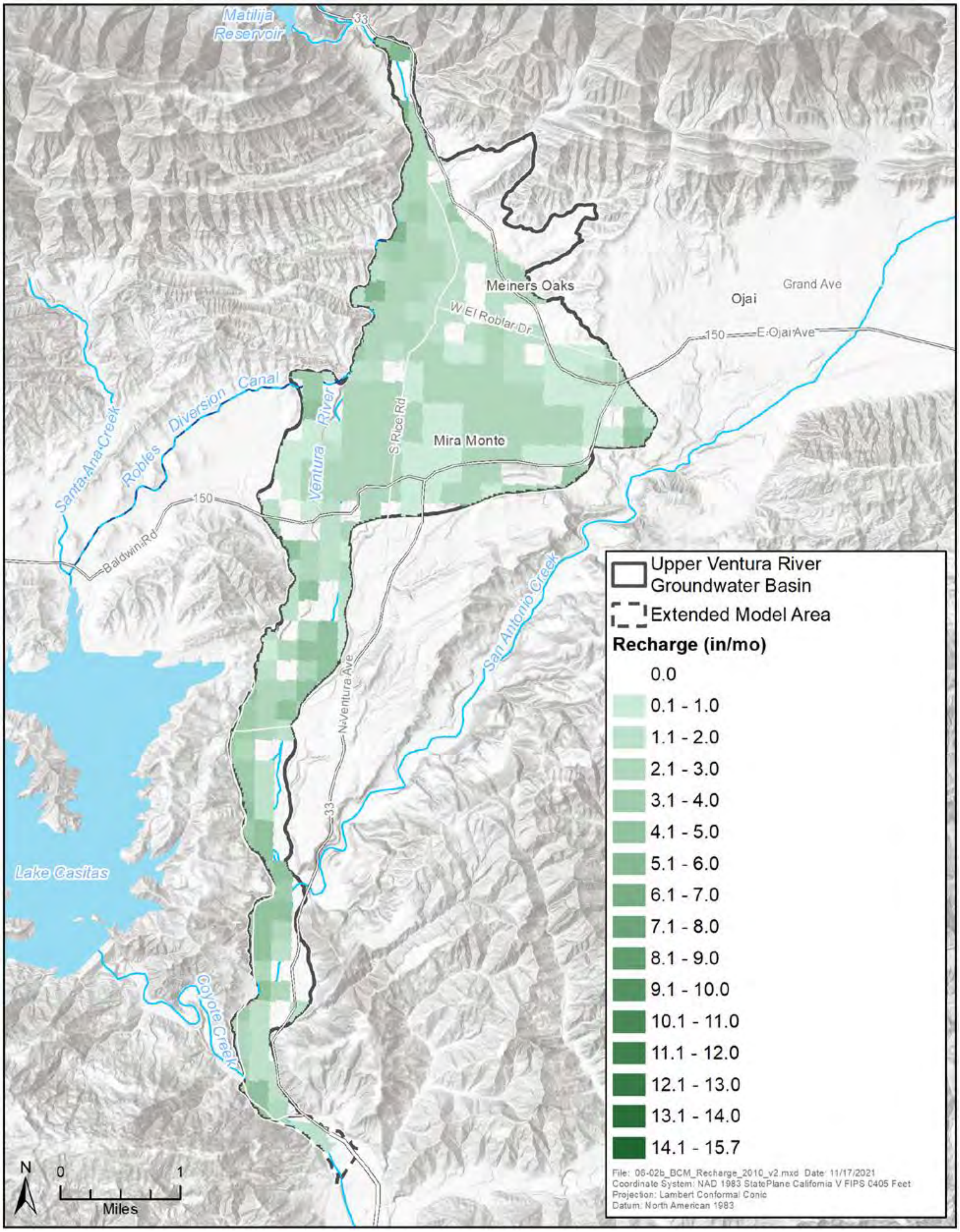


Figure 6.3b. BCM Recharge, January 2010.

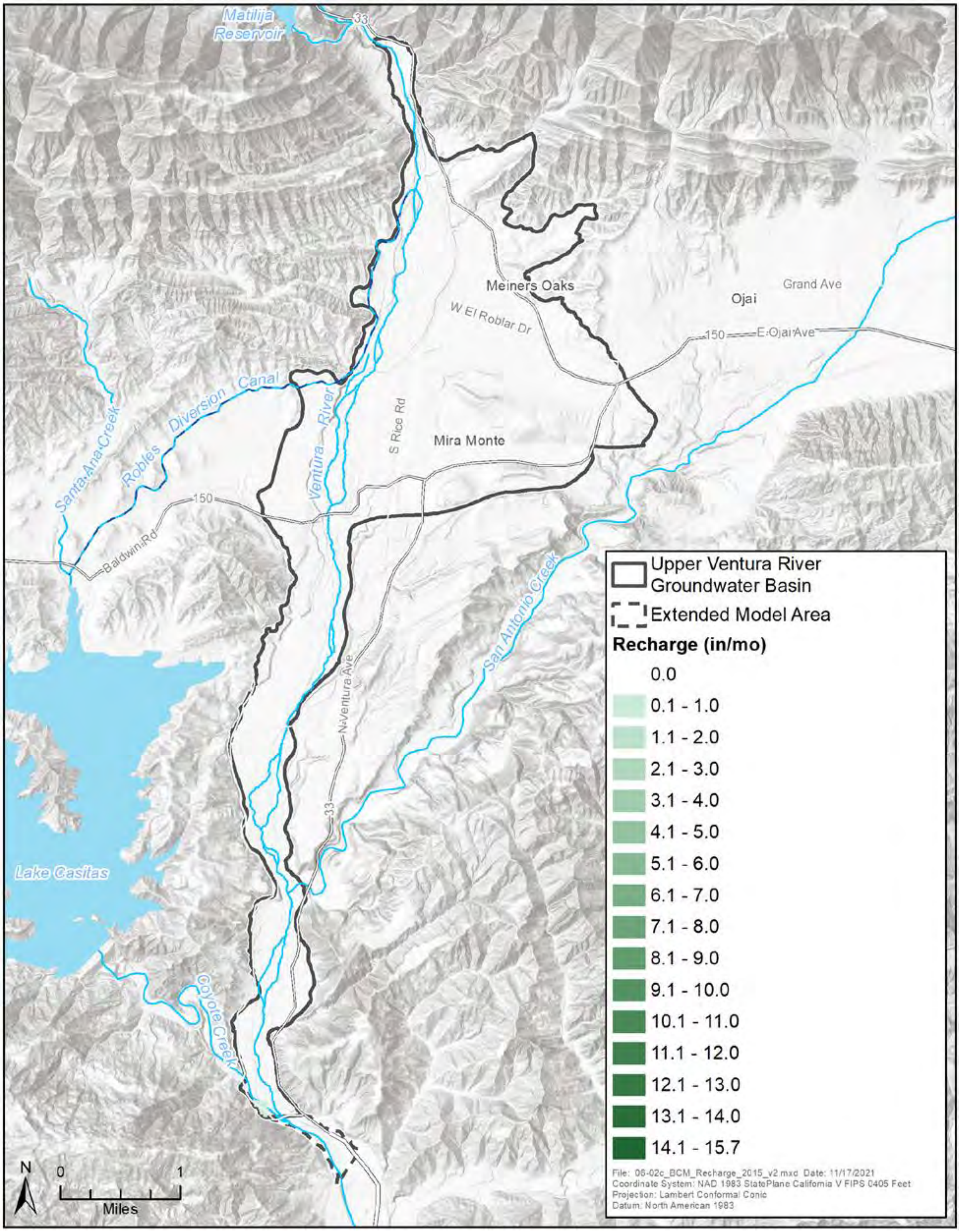


Figure 6.3c. BCM Recharge, January 2015.

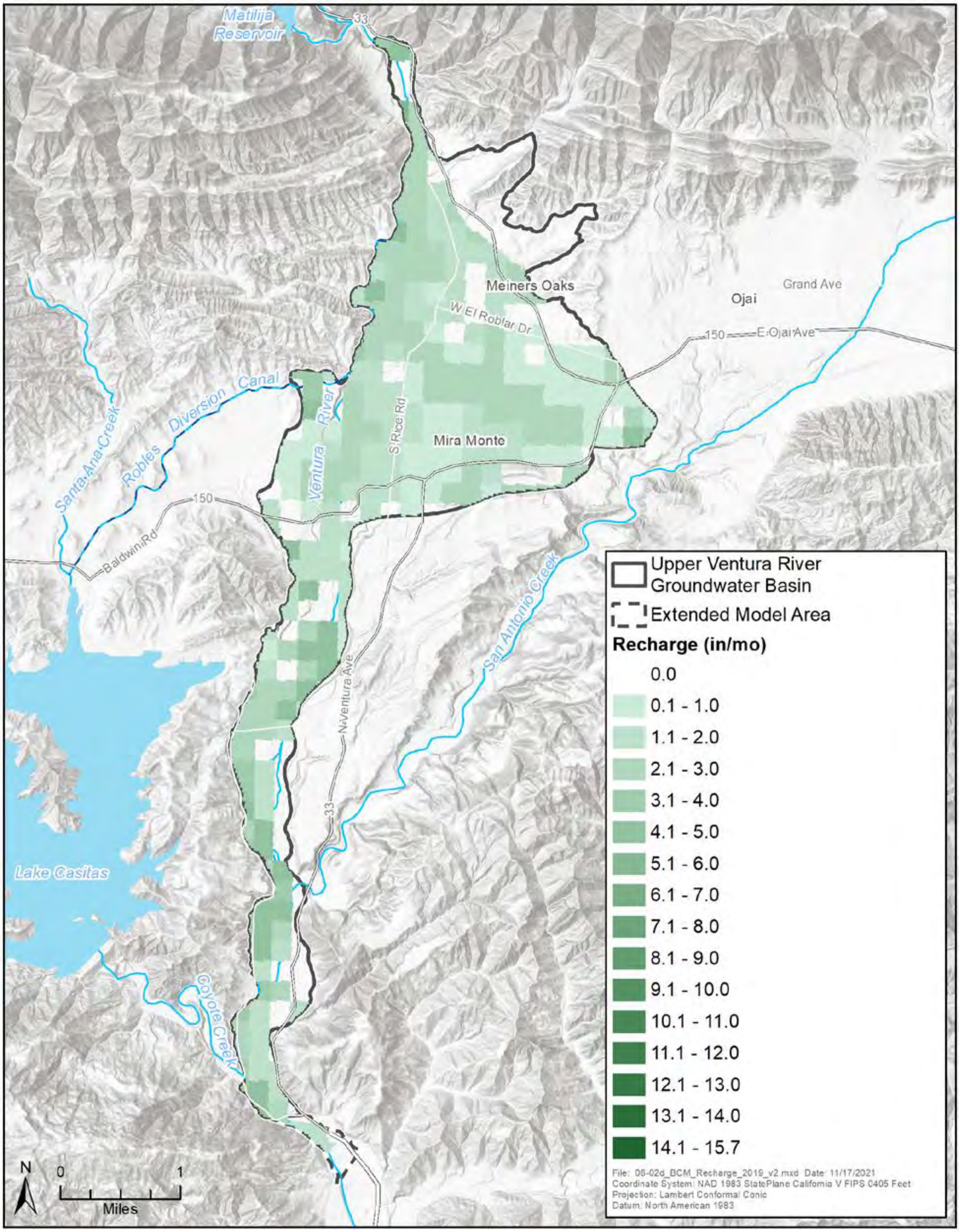


Figure 6.3d. BCM Recharge, January 2019.

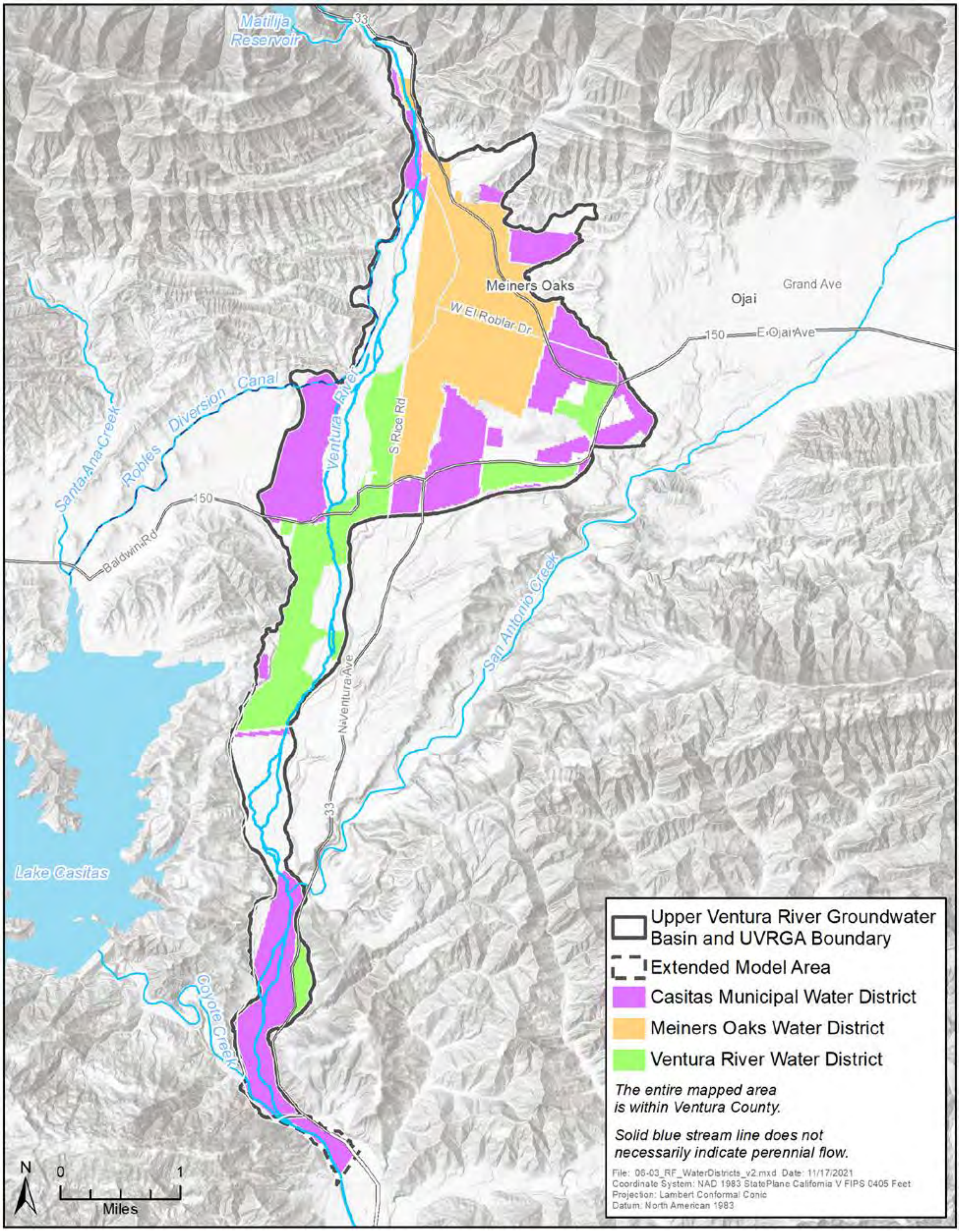


Figure 6.4. Water District Coverage used for M&I Return Flows.

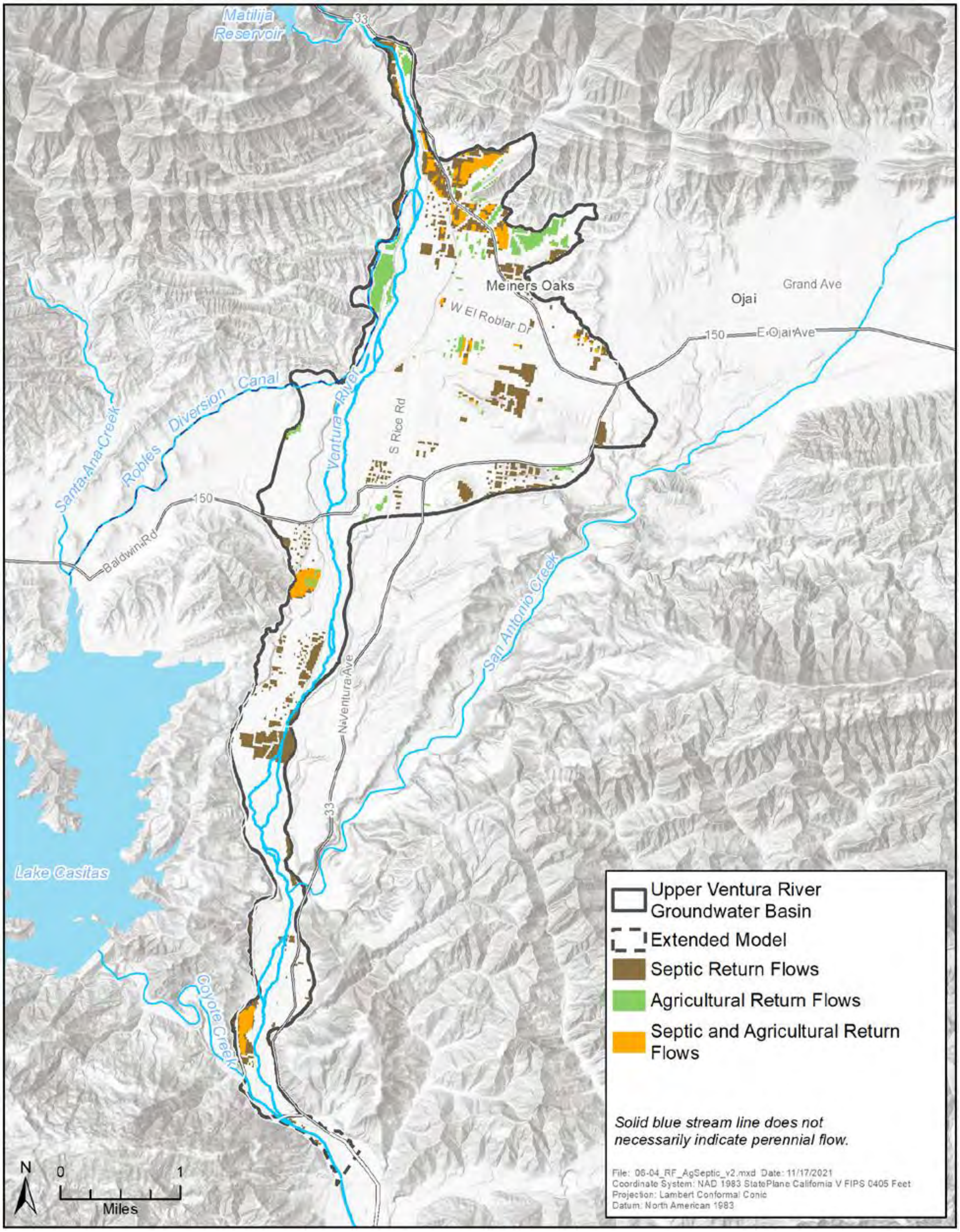


Figure 6.5. Ag Coverage and Septic Parcels used for Ag and Septic Return Flows.

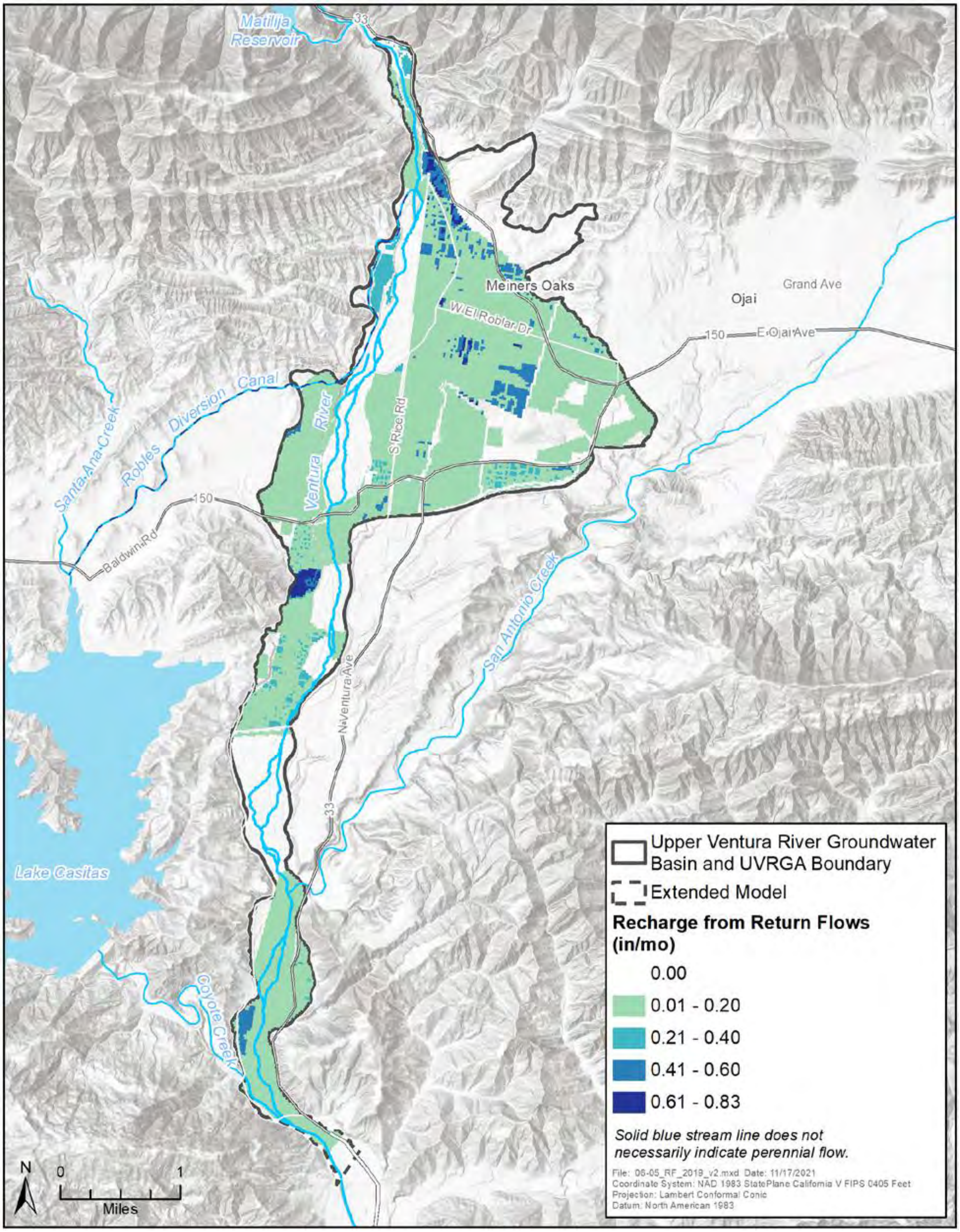


Figure 6.6. Total Return Flows for Example Historical Period (January 2019).

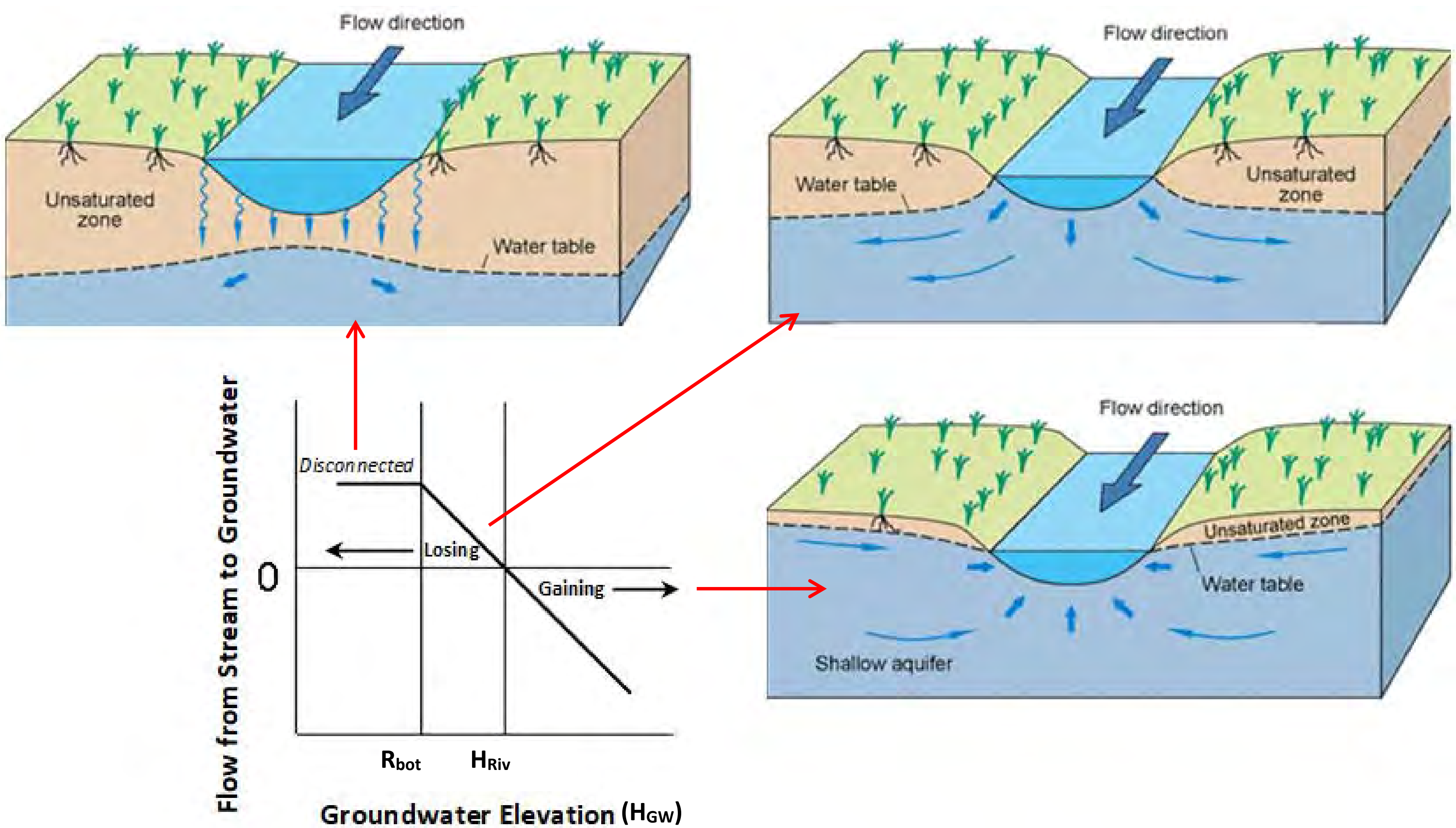


Figure 7.1. Surface-water/Groundwater Interaction Scenarios and the Relationship between Flow, Stage, and Groundwater Elevations.

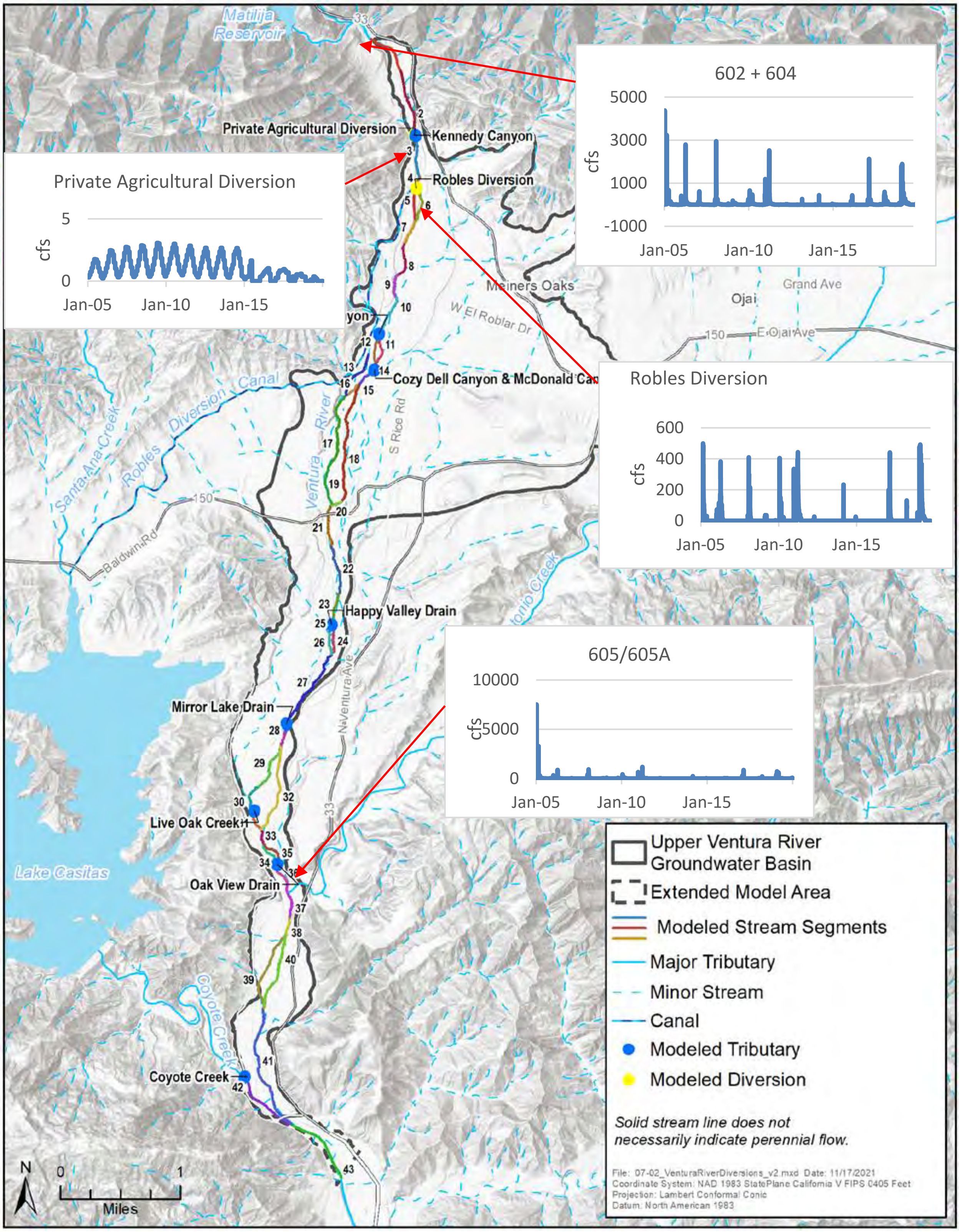
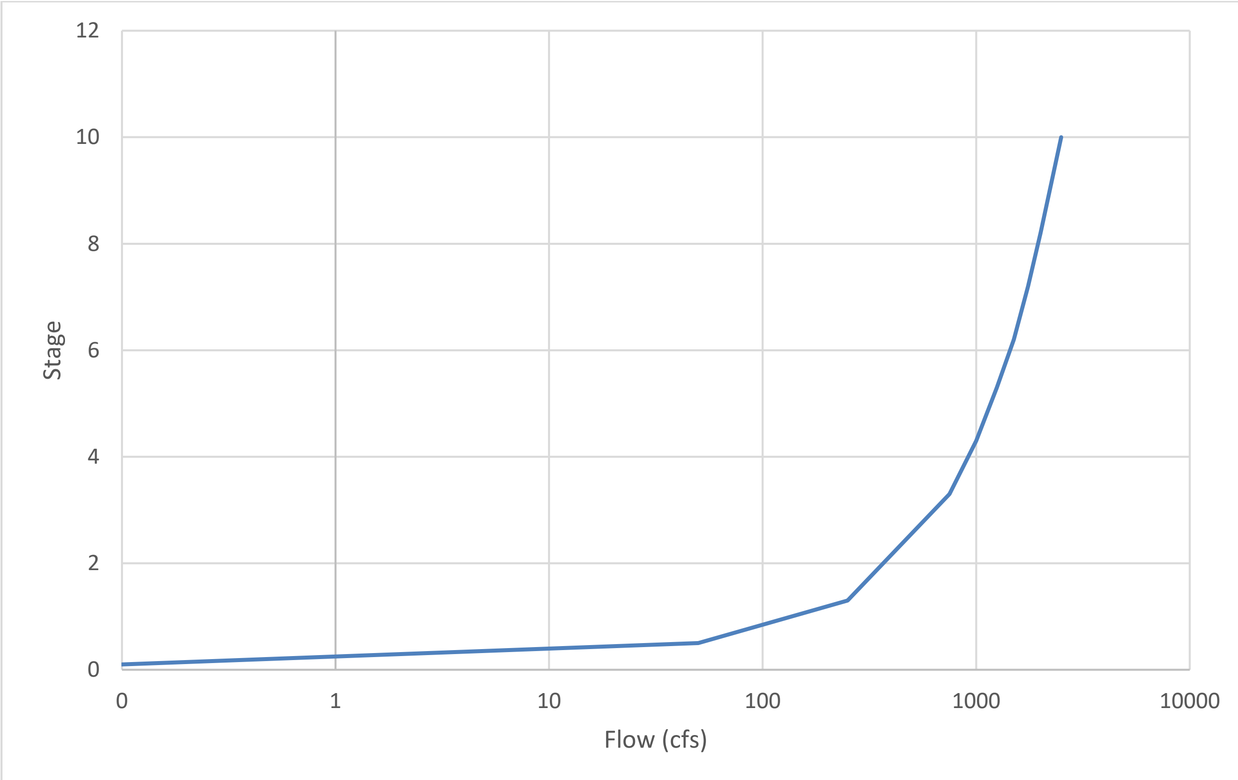


Figure 7.2. Map of Upper Ventura River by Segment with Diversion/Tributary and Hydrographs for Matilija Inflows and Diversions.



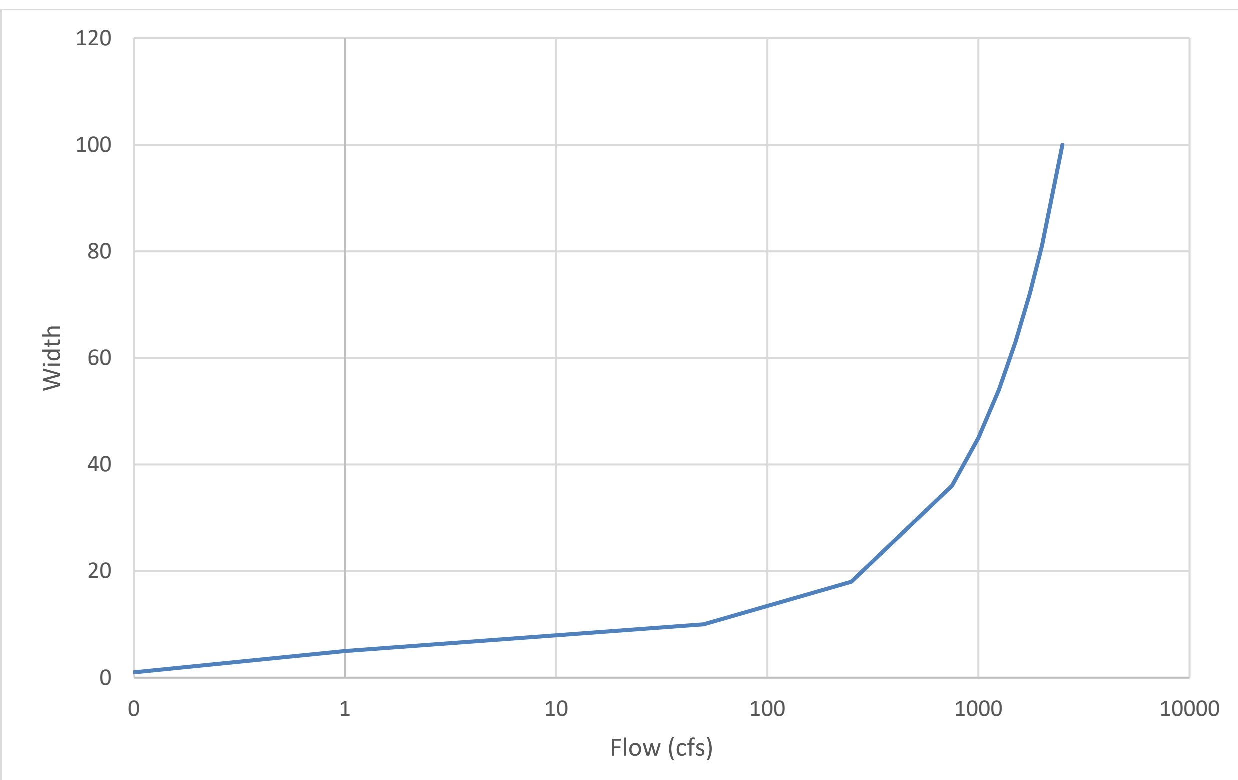


Figure 7.3. Flow-stage-width relationships for the Ventura River.

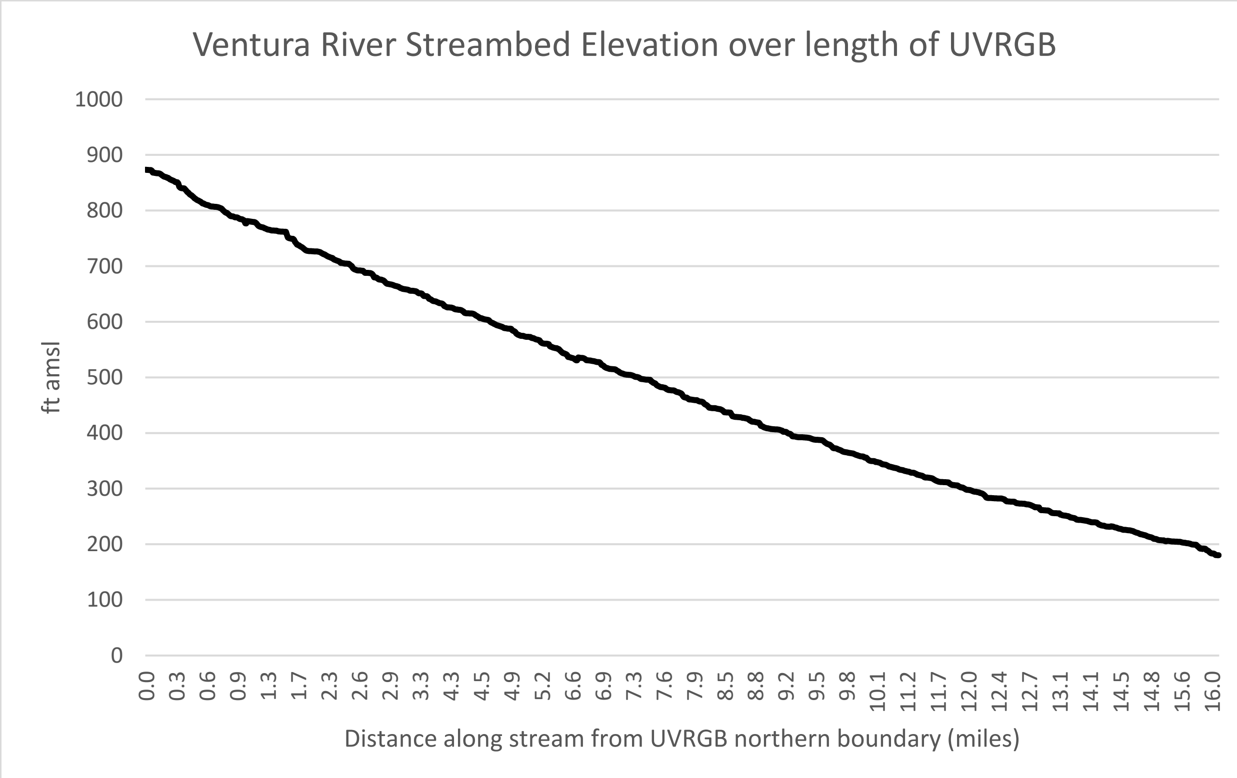


Figure 7.4. Upper Ventura Streambed Elevations Cross-Section.

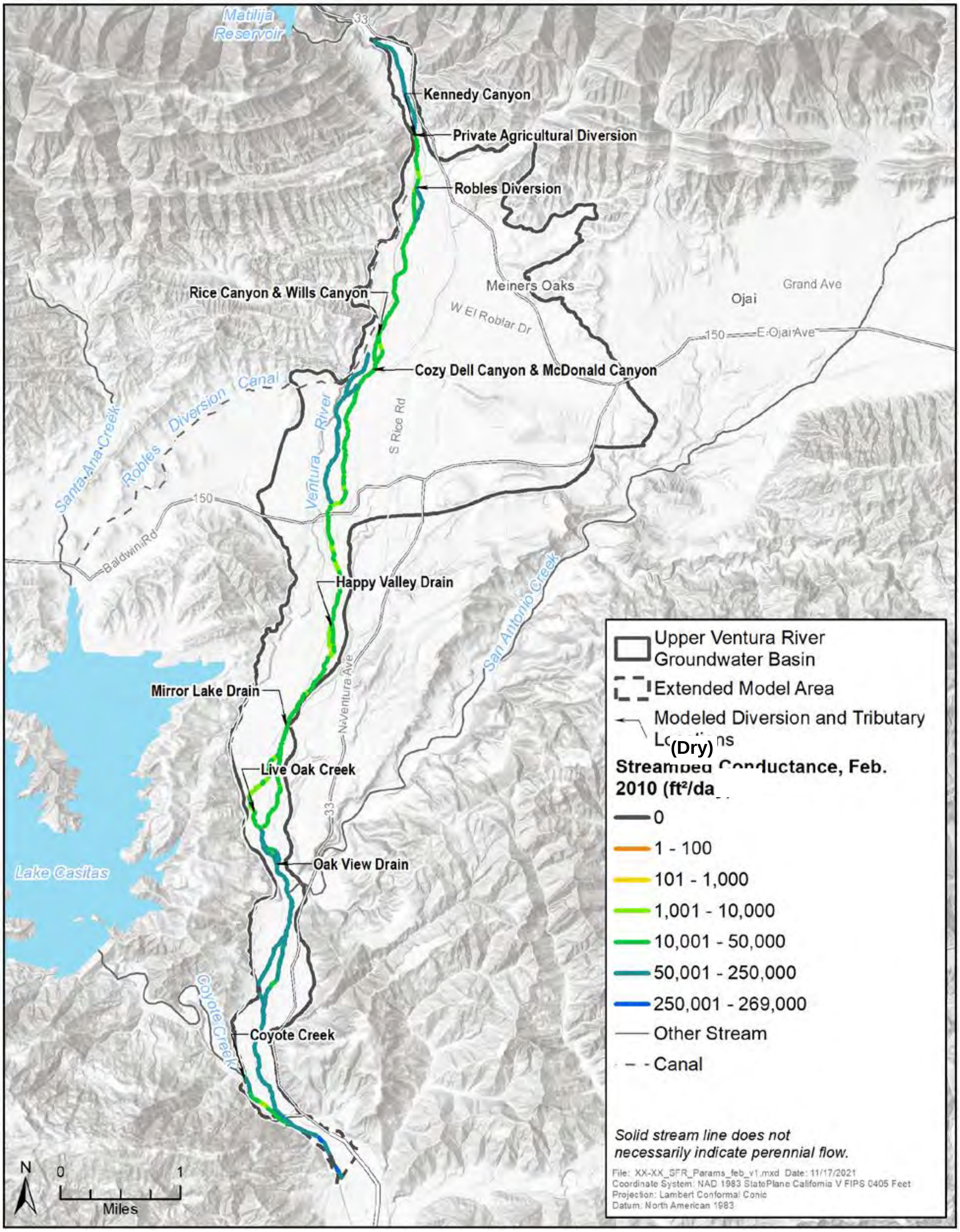


Figure 7.5a. Streambed Conductance, February 2010.

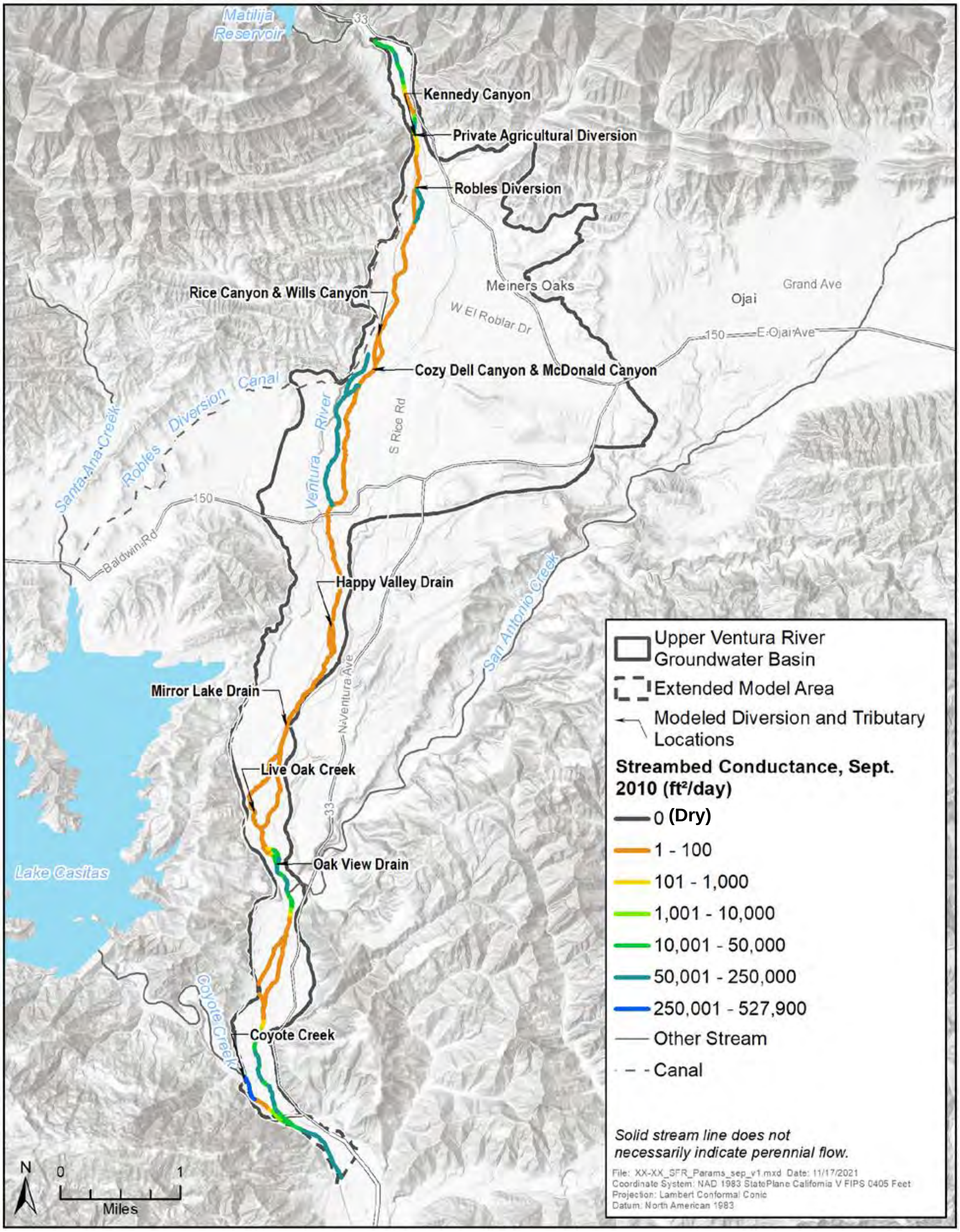


Figure 7.5b. Streambed Conductance, September 2010.

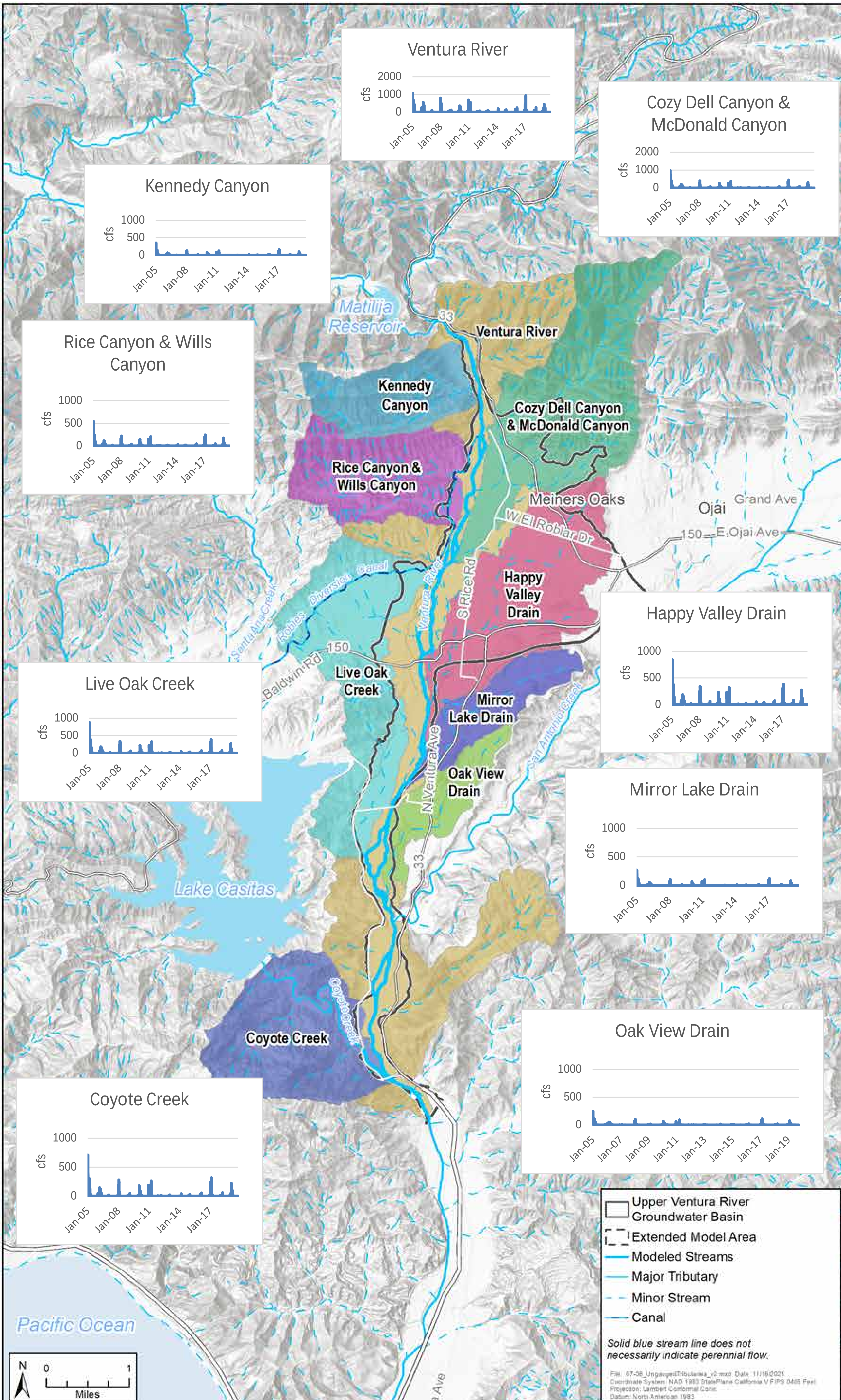


Figure 7.6. Map of Basin Areas for Ungauged Tributaries with Hydrographs for Each Tributary.

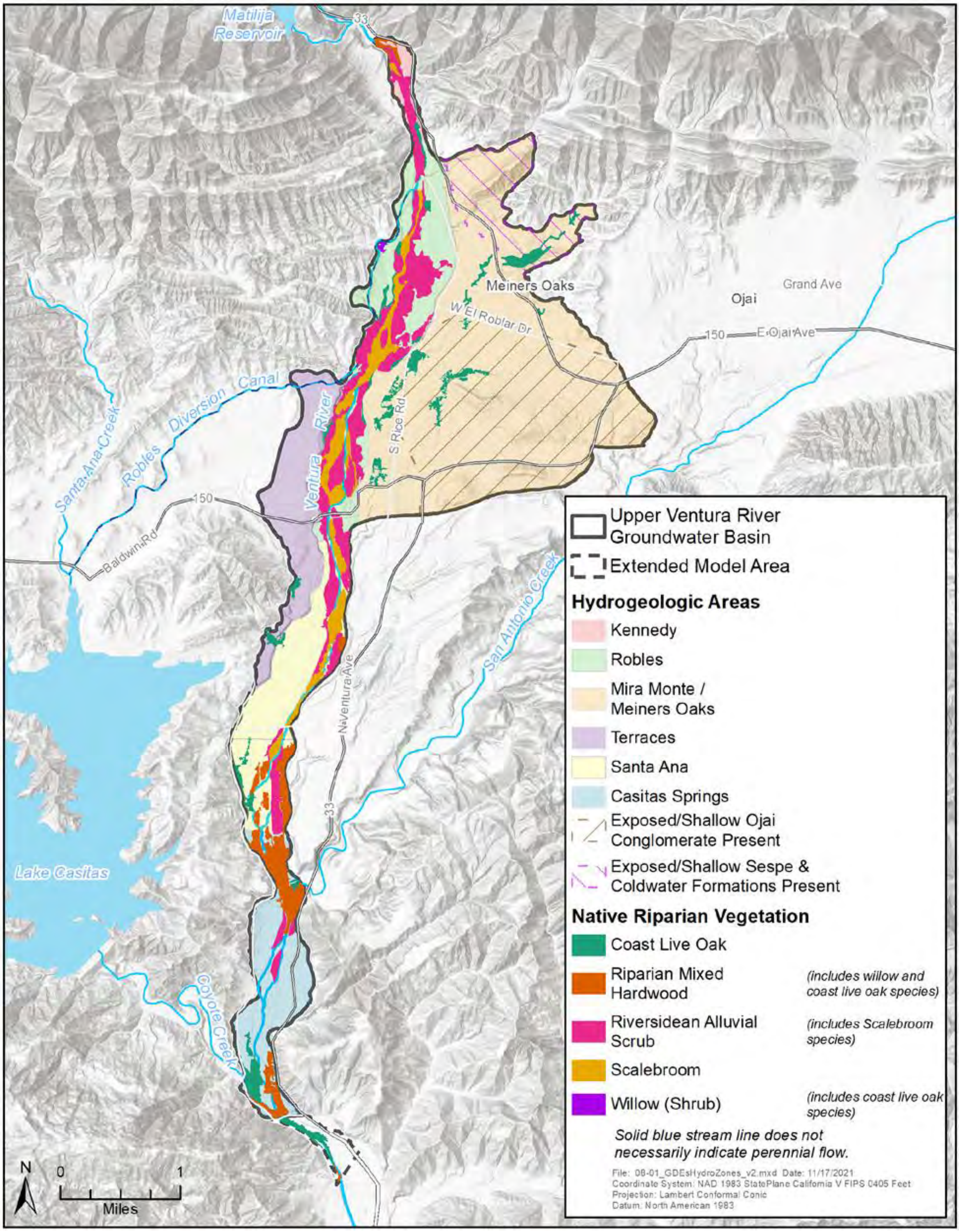


Figure 8.1. Native Riparian Vegetation and Hydrogeologic Areas.

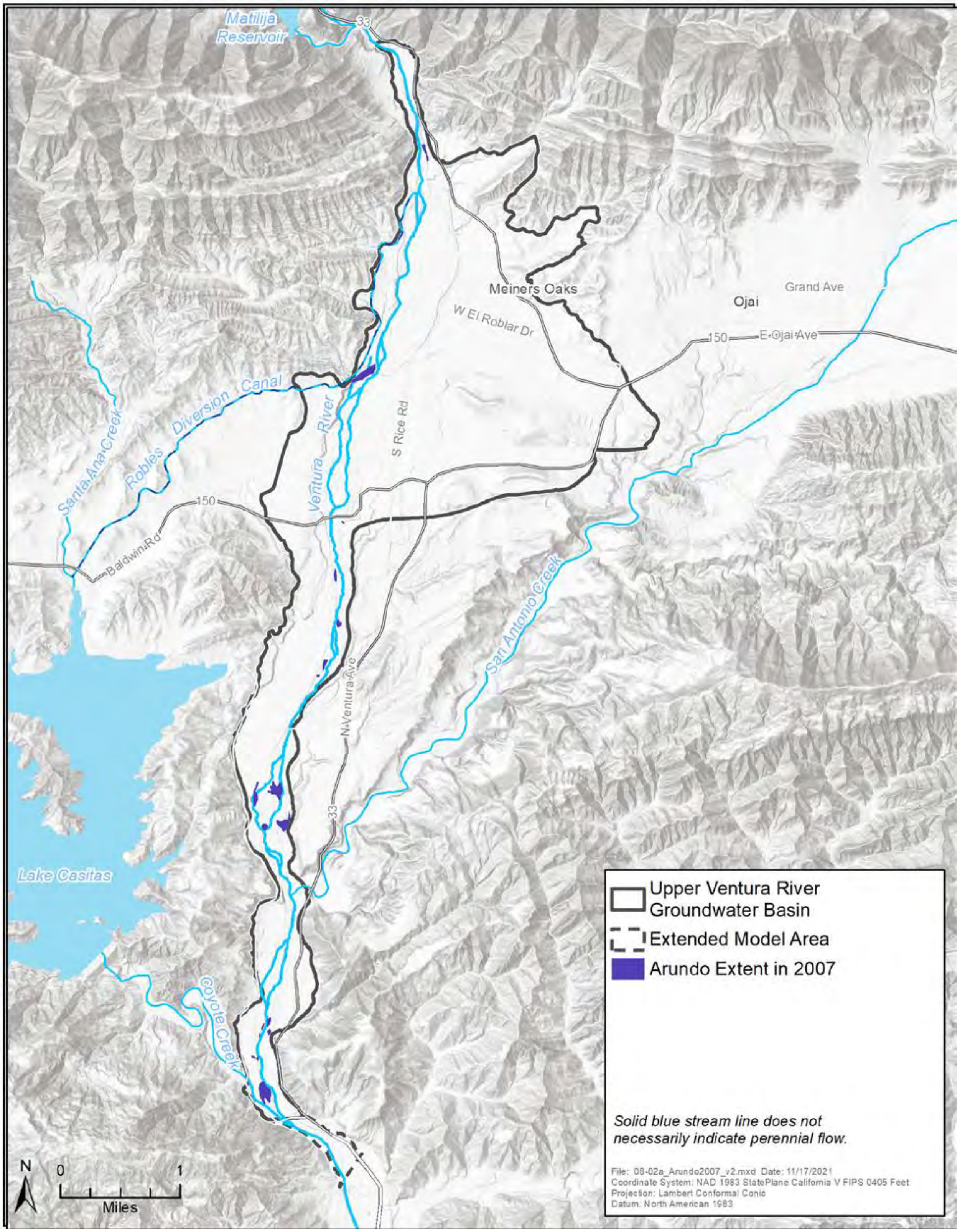


Figure 8.**2**a. Arundo, 2007.

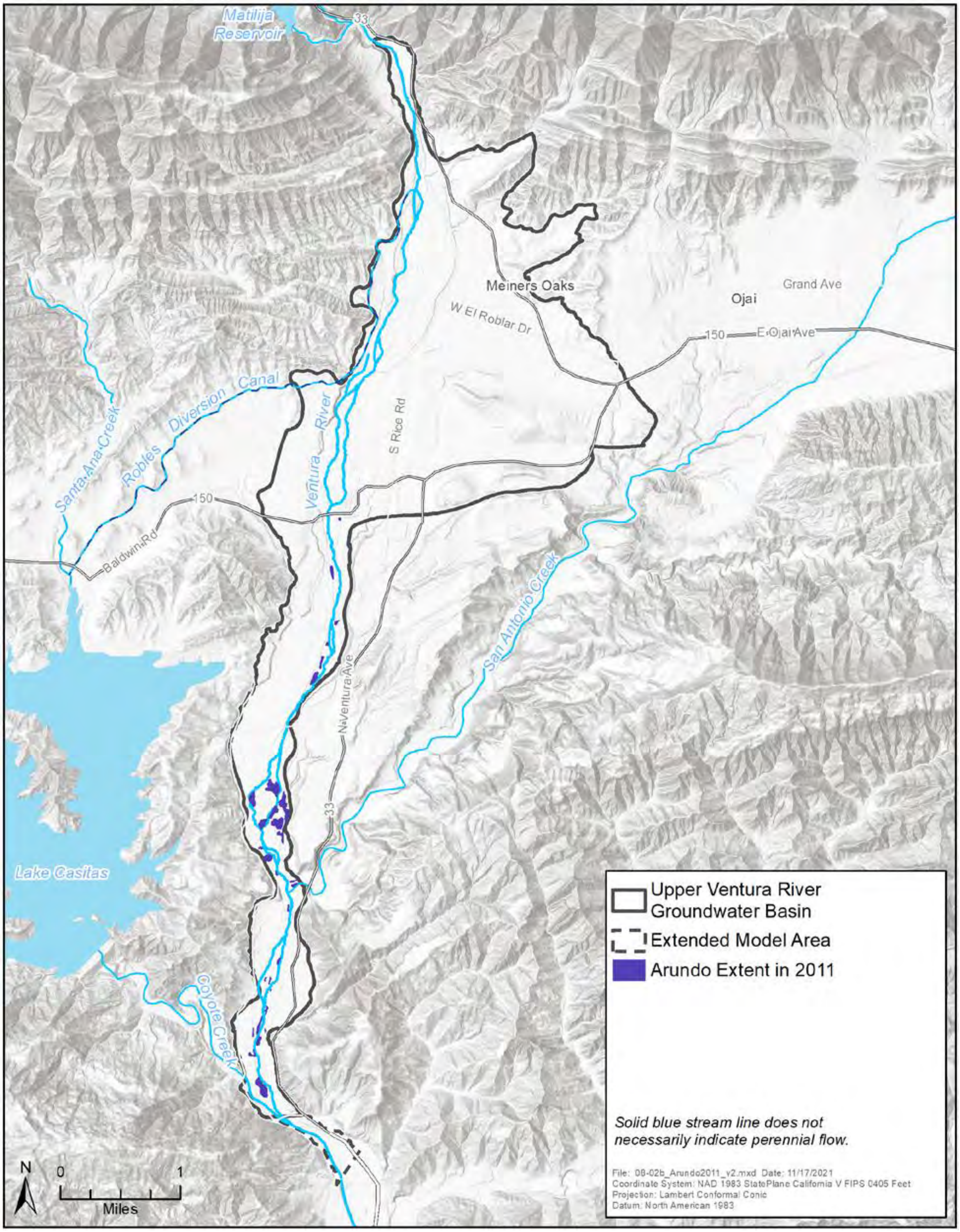


Figure 8.**2**b. Arundo, 2011.

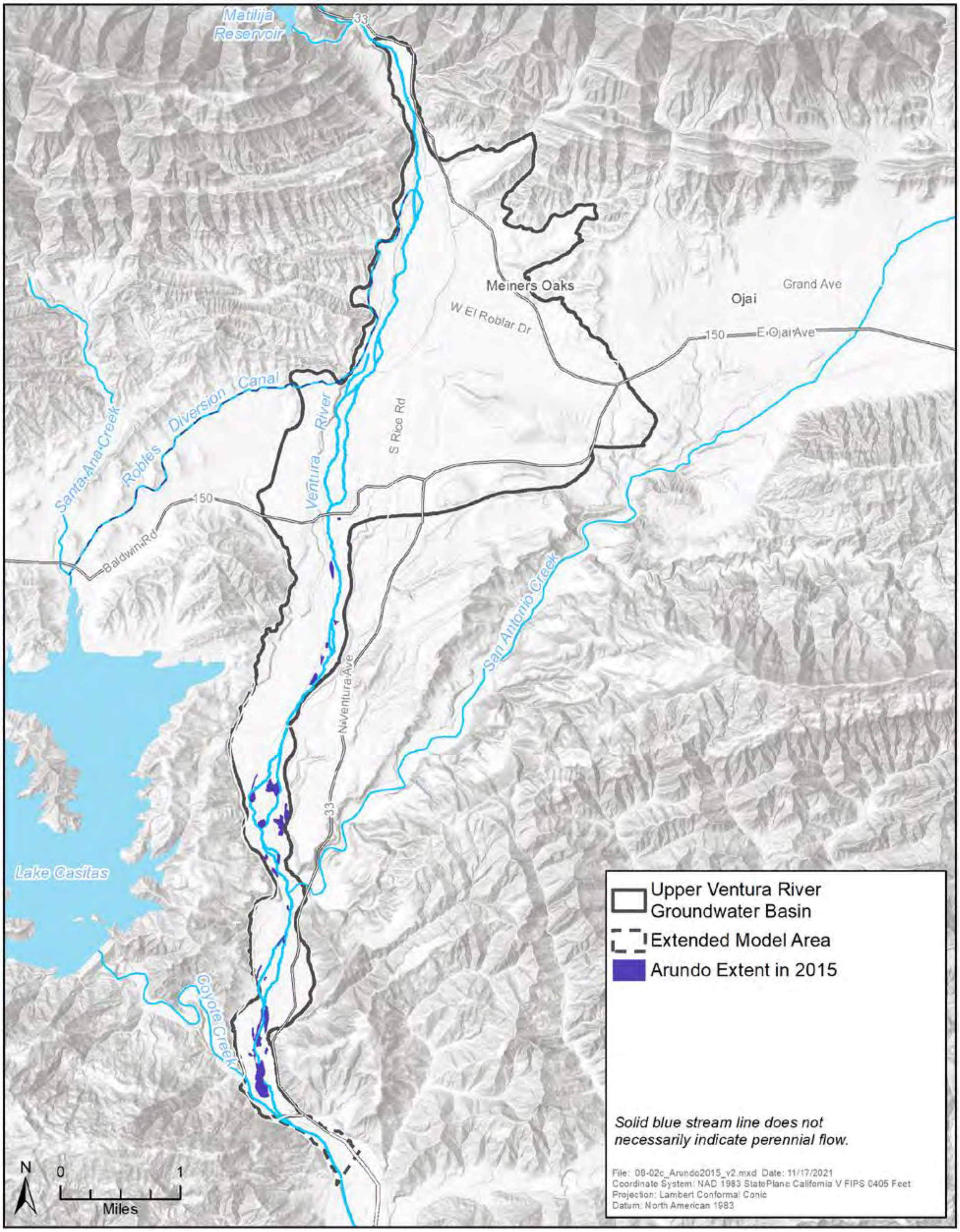


Figure 8.**2**c. Arundo, 2015.

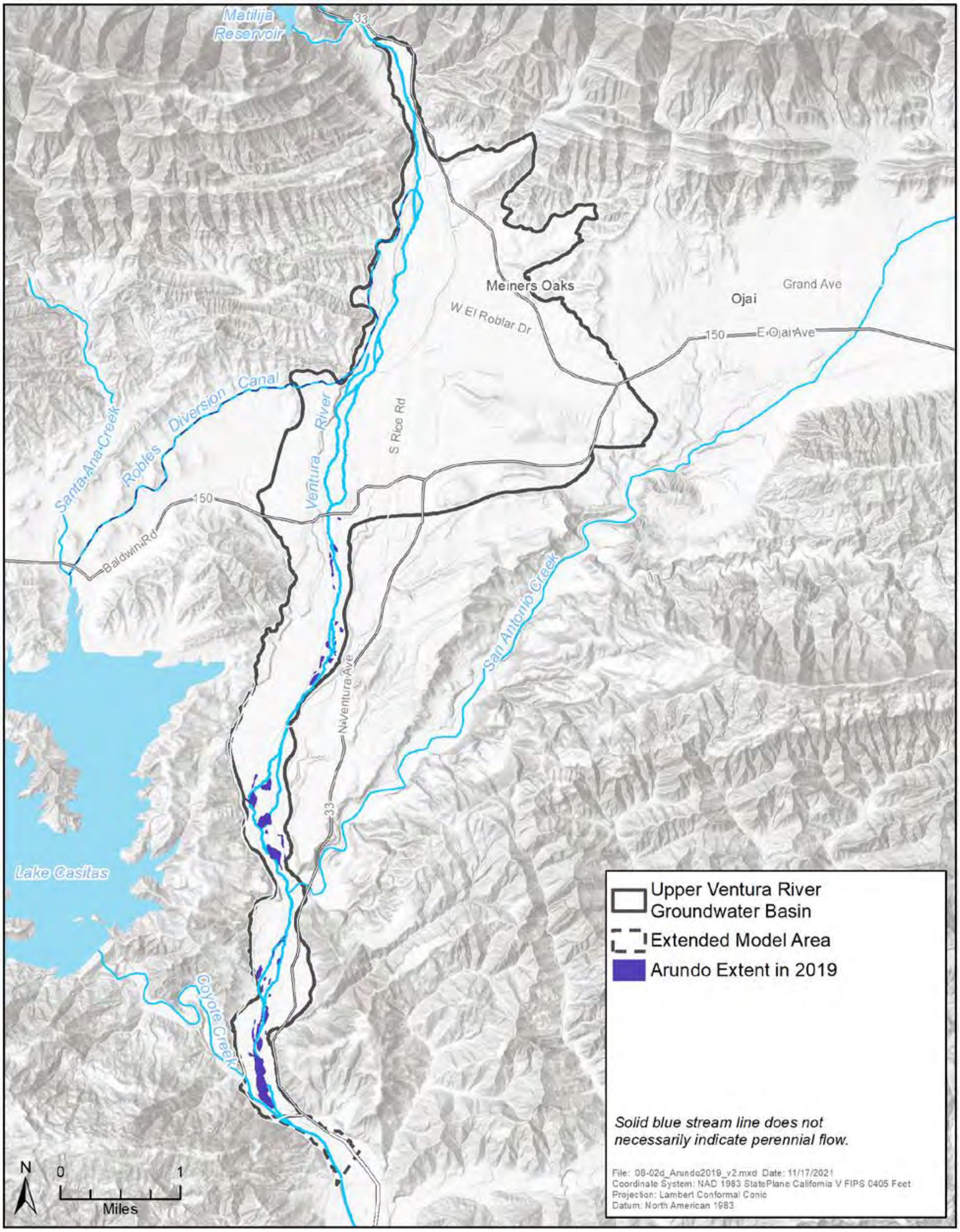


Figure 8.**2**d. Arundo, 2019.

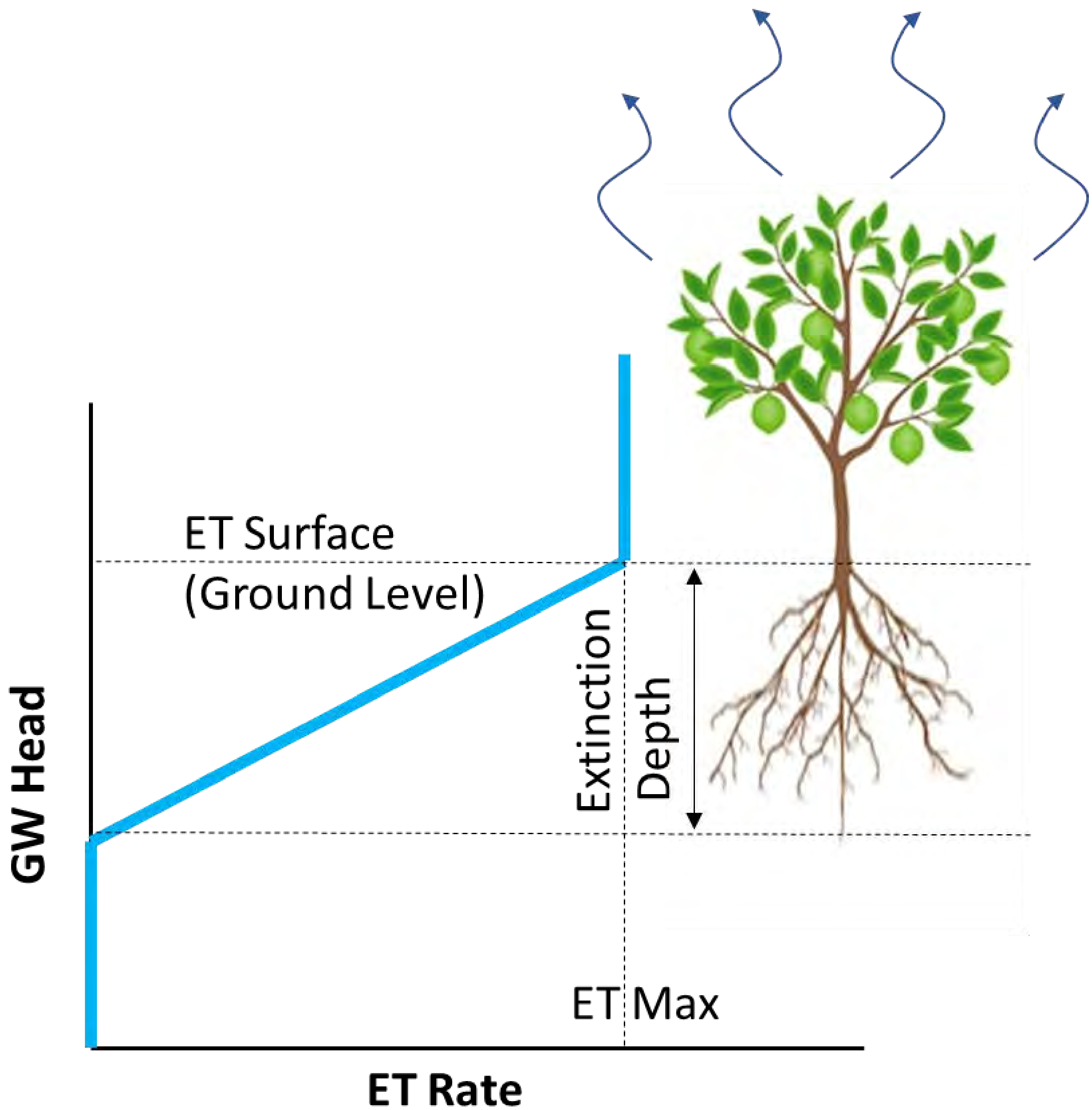


Figure 8.3. Schematic Showing Relationship between Groundwater Table, ET Rate, ET Extinction Depth, and ET Surface.

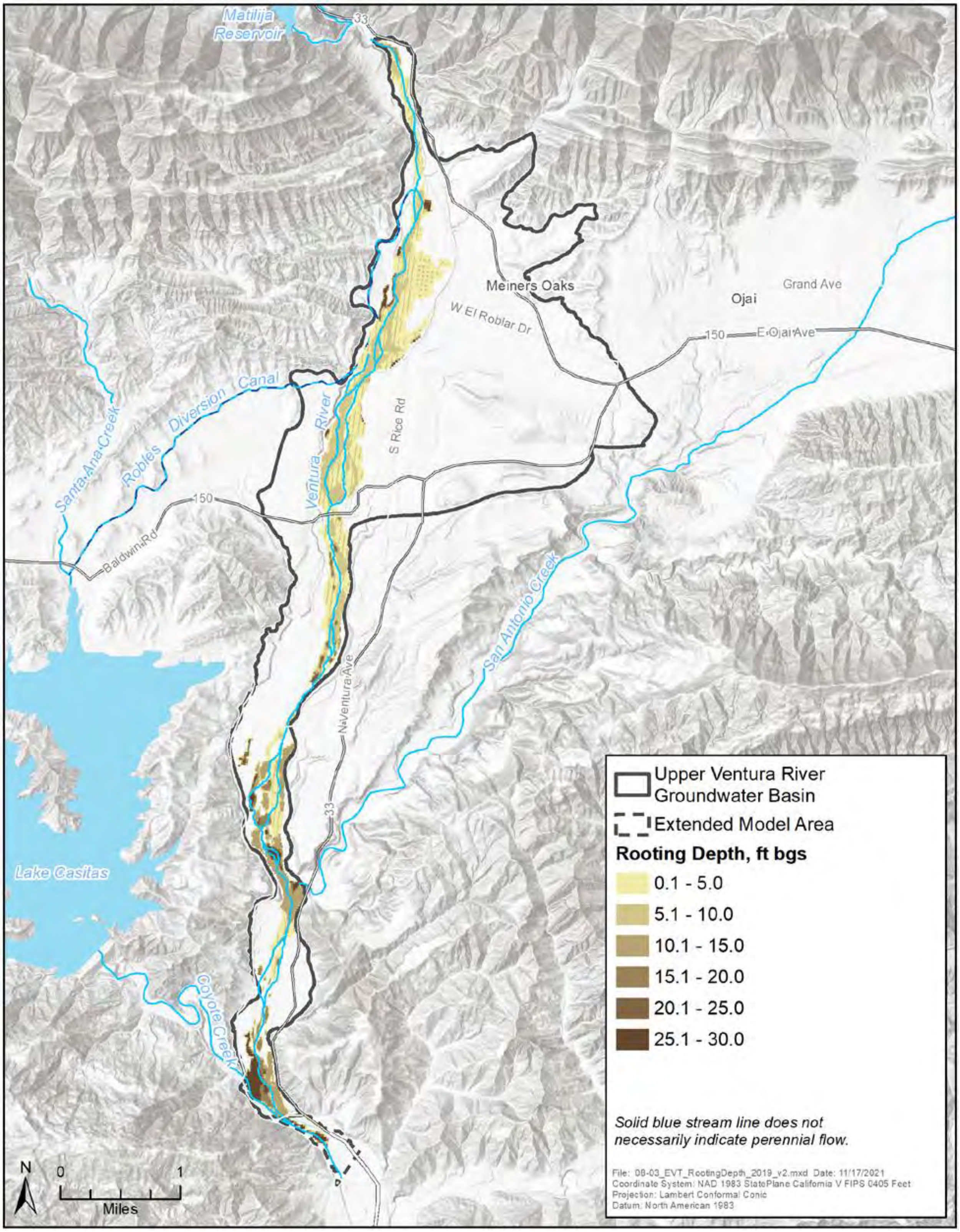


Figure 8.4. Modeled Rooting Depth for Example Historical Period (January 2019).

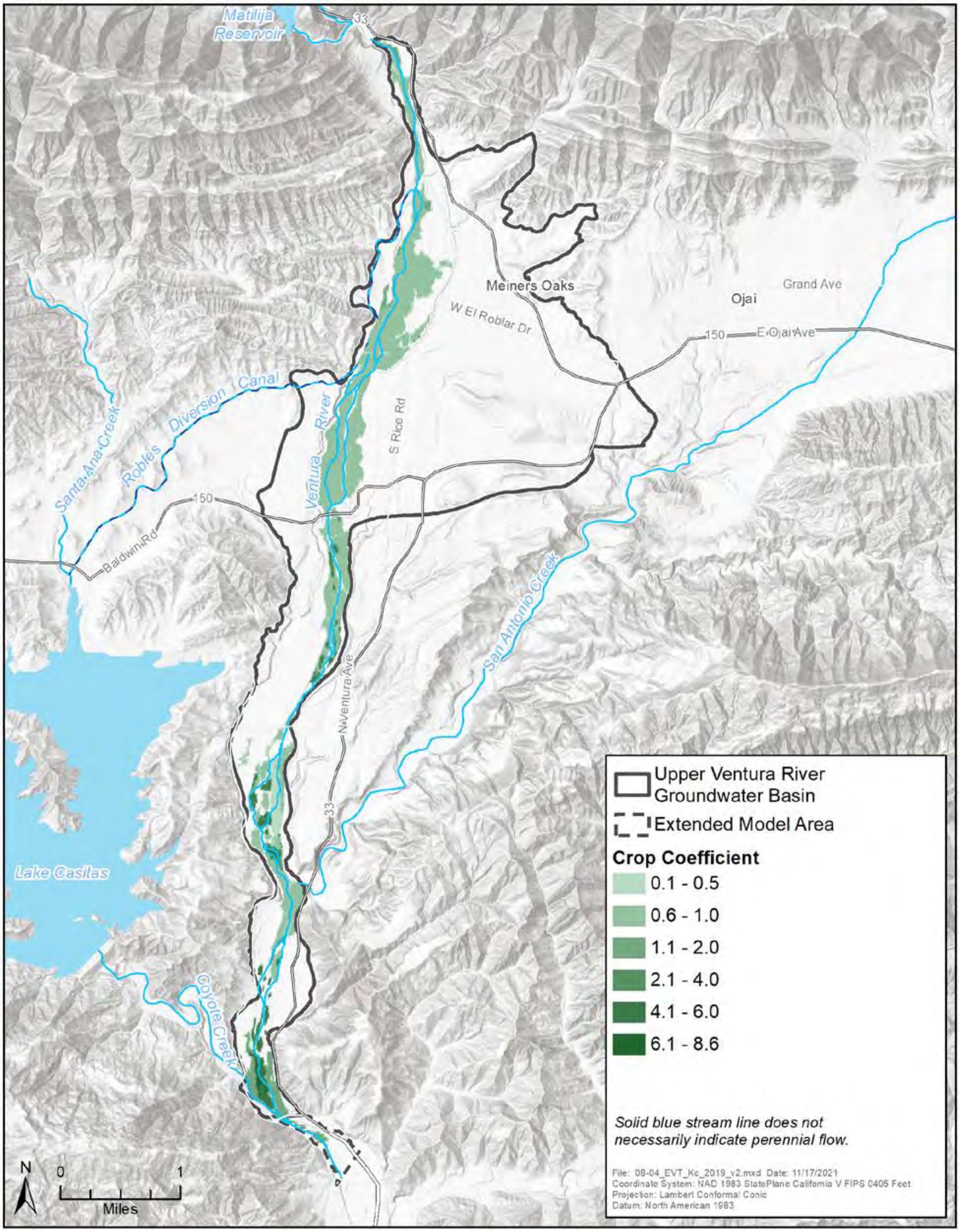


Figure 8.5. Modeled Crop Coefficient for Representative Historical Period (January 2019).

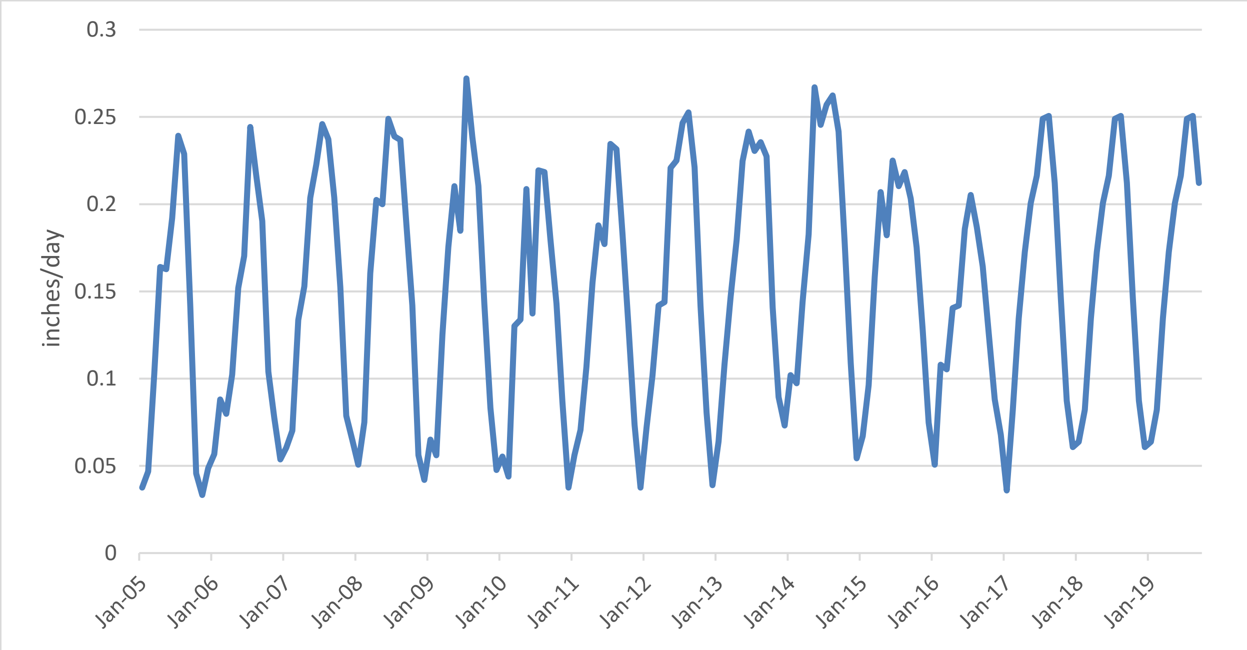


Figure 8.6. Reference ET Time-Series for Historical Period.

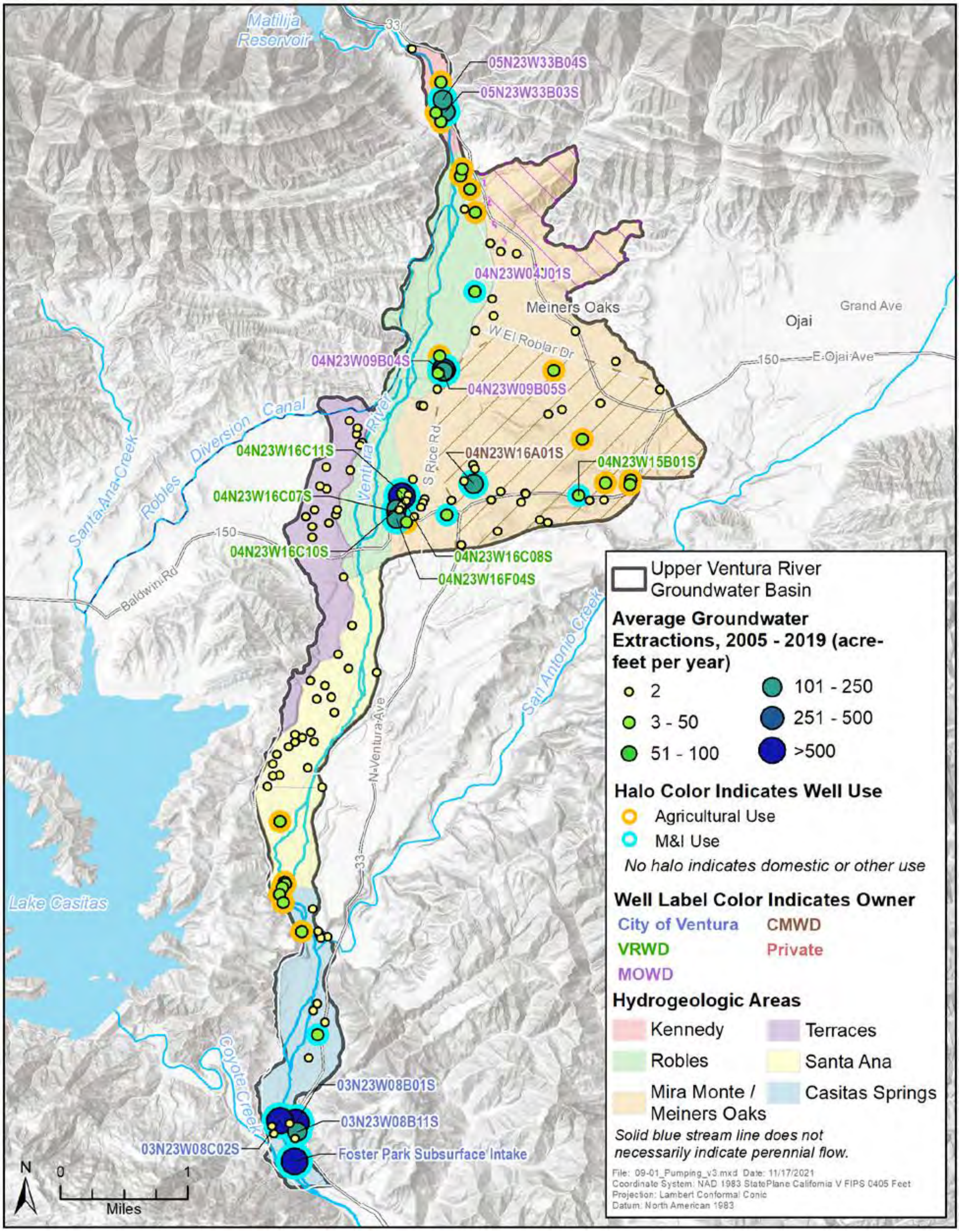


Figure 9.1. Pumping Wells with General Rates.

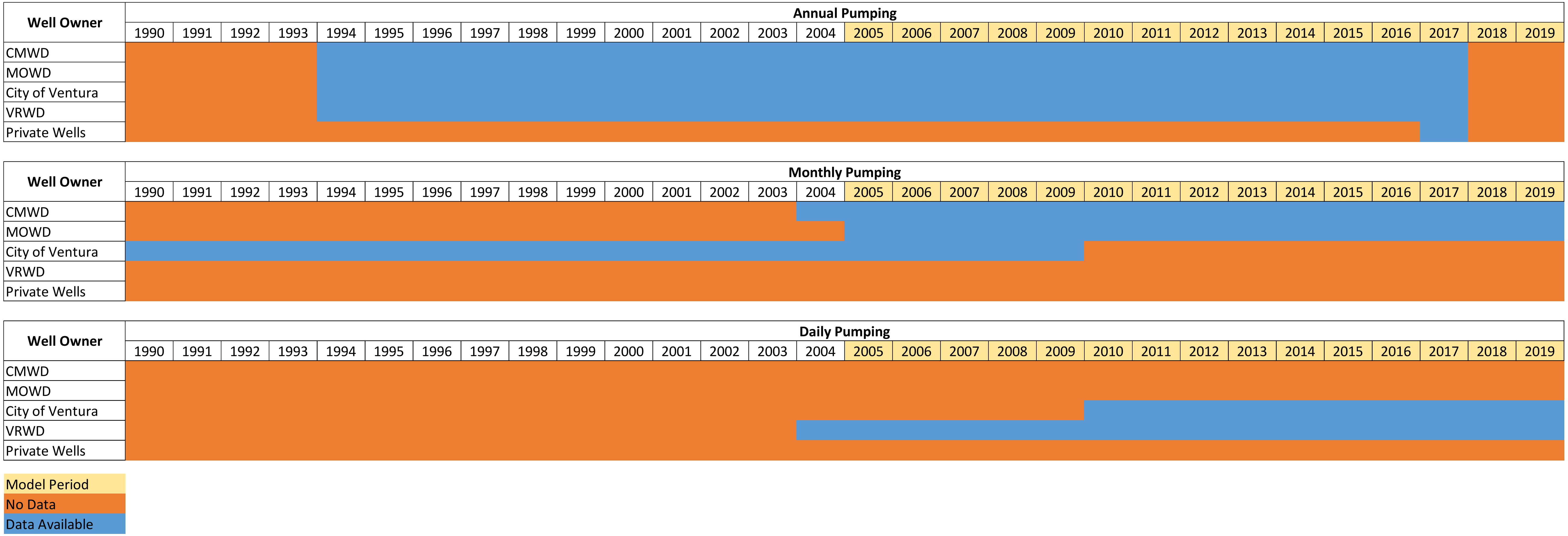


Figure 9.2. Pumping Data Availability.

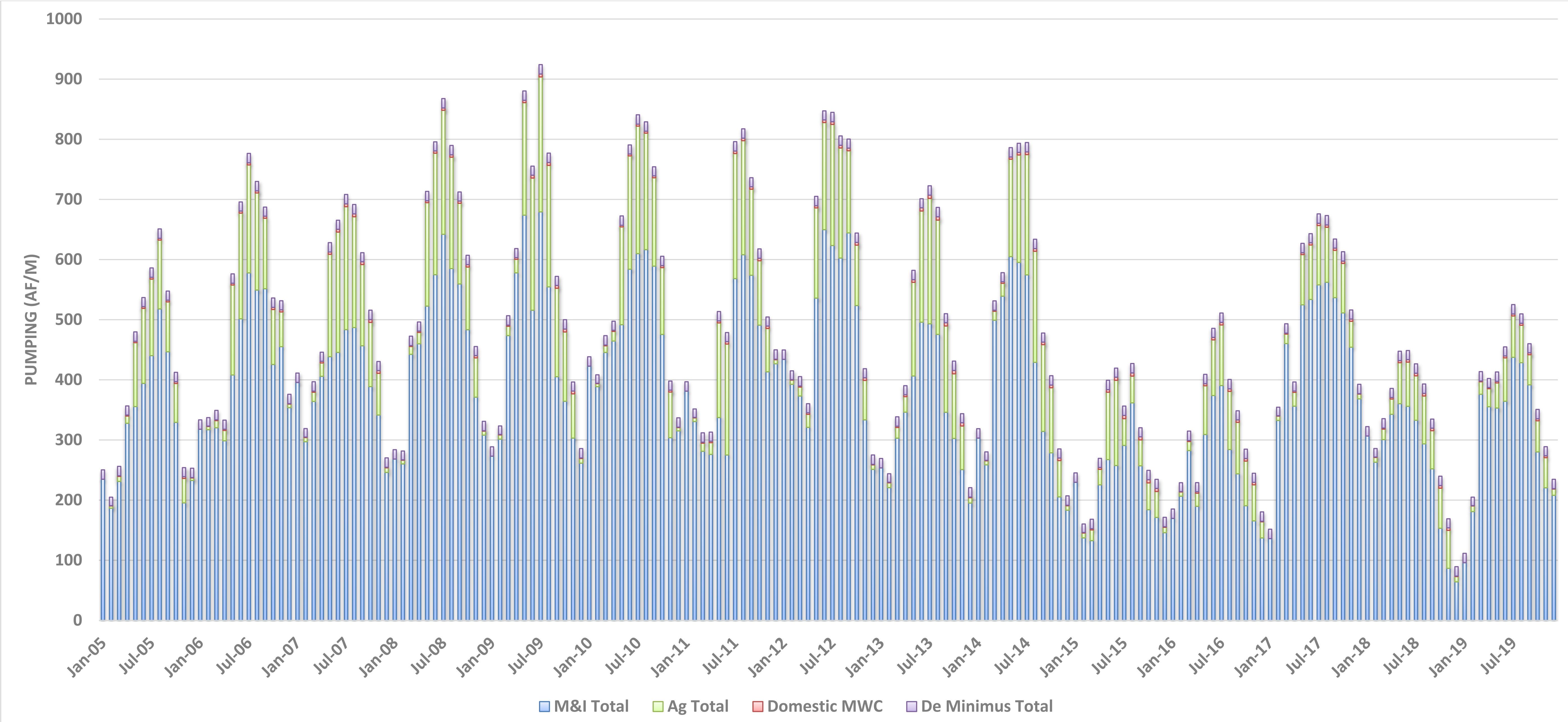


Figure 9.3. Modeled Historical Pumping by Category.

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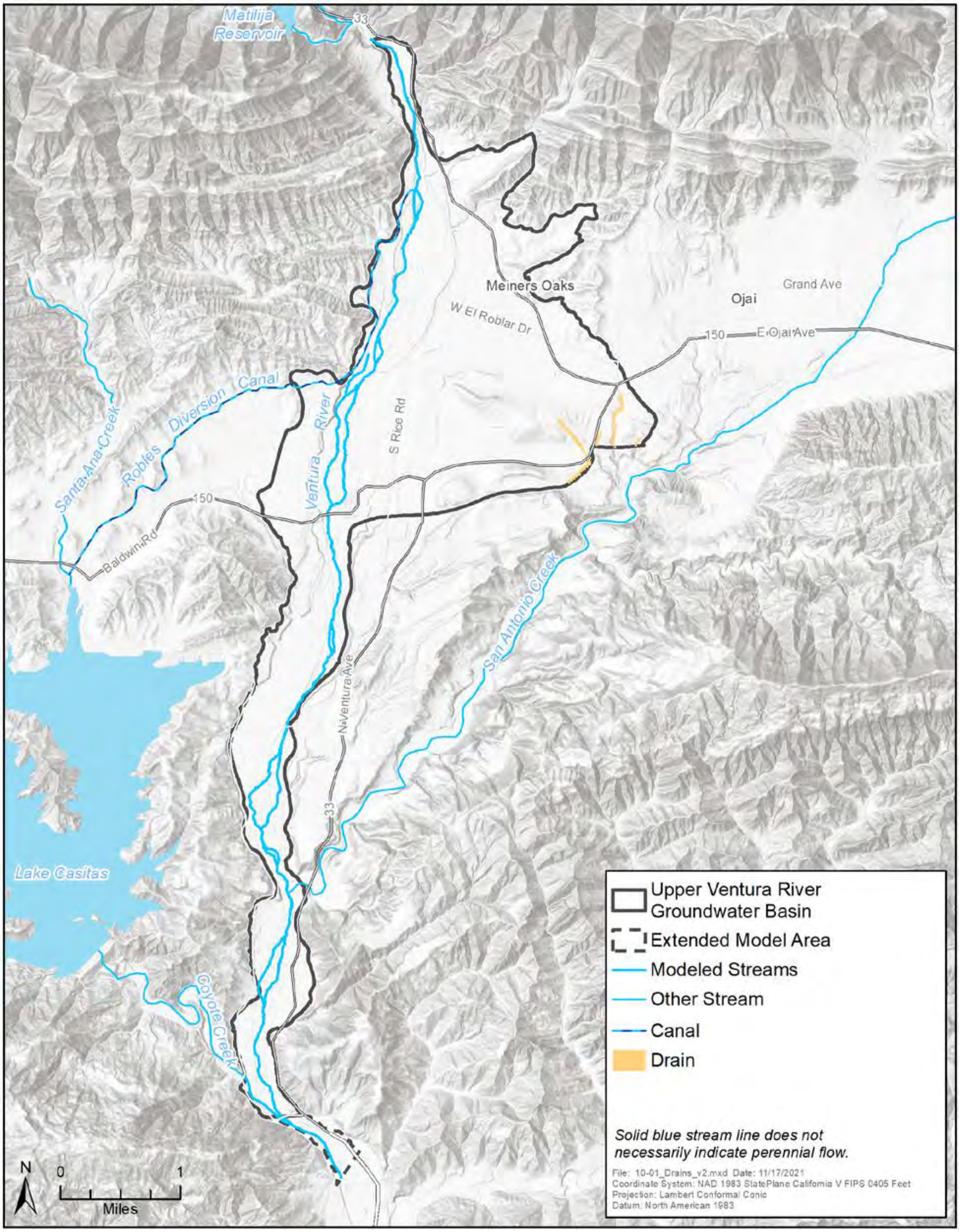


Figure 10.1. Drain Locations.

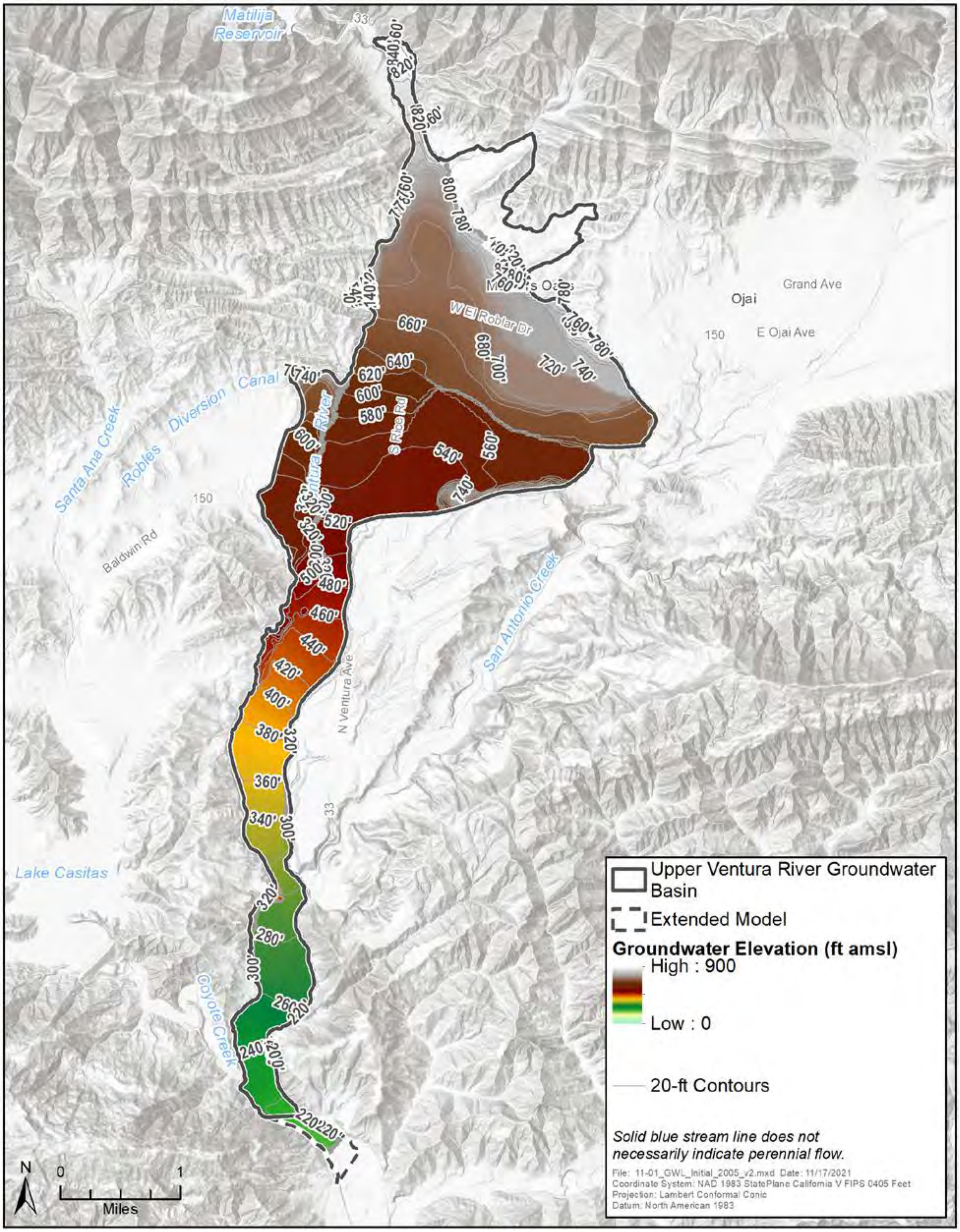


Figure 11.1. Water Level Contours, Initial Head, January 2005.

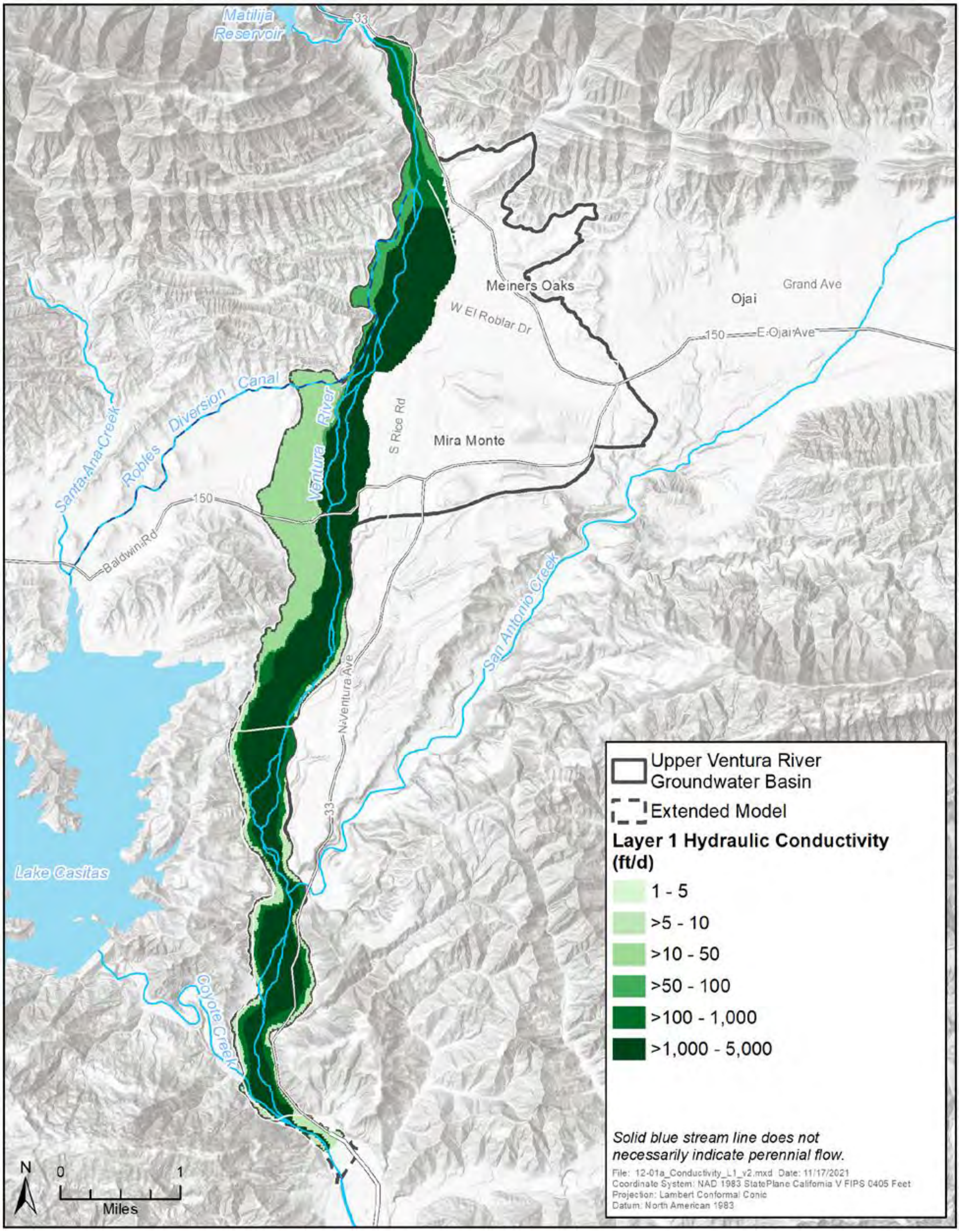


Figure 12.1a. Layer 1 Hydraulic Conductivity.

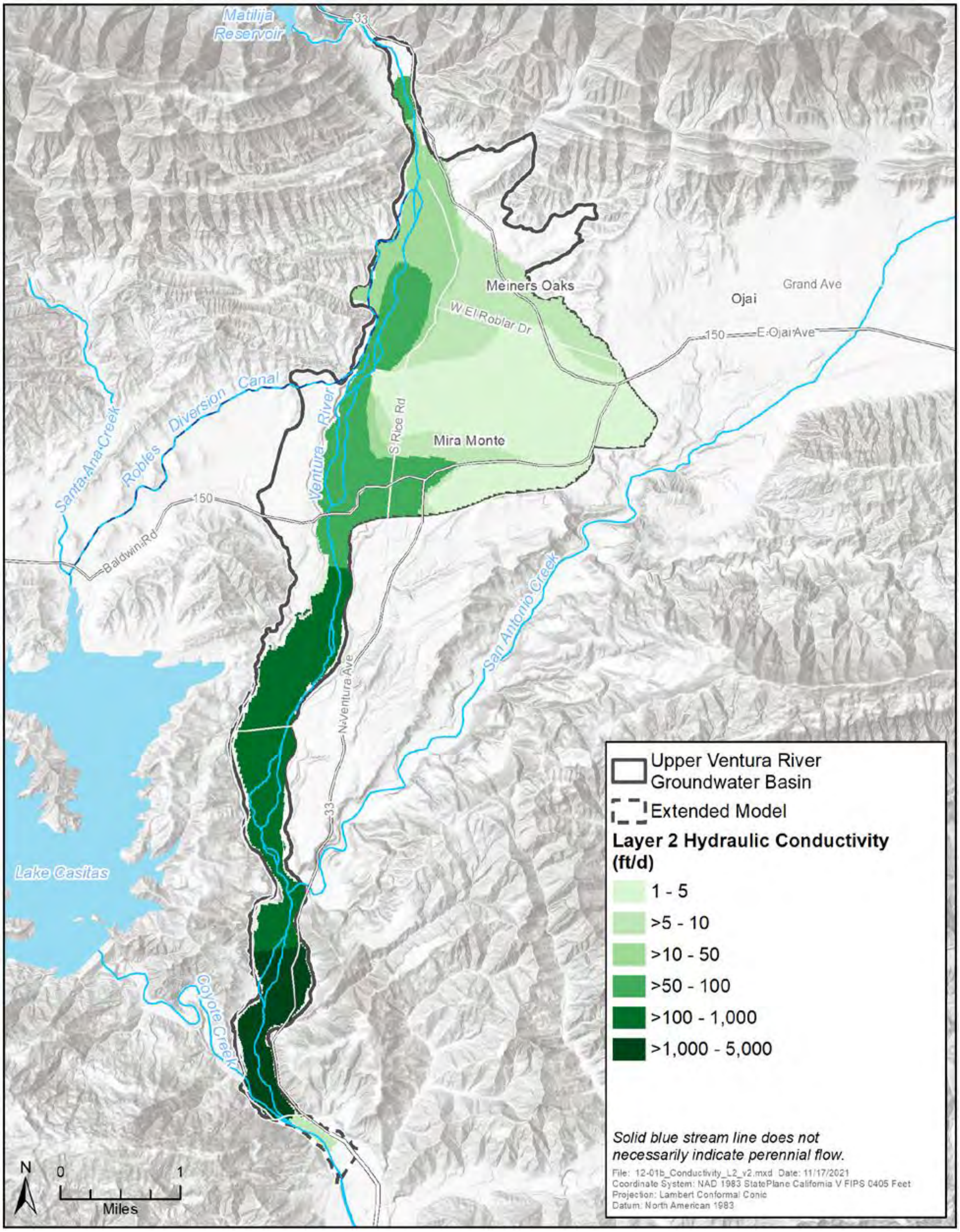


Figure 12.1b. Layer 2 Hydraulic Conductivity.

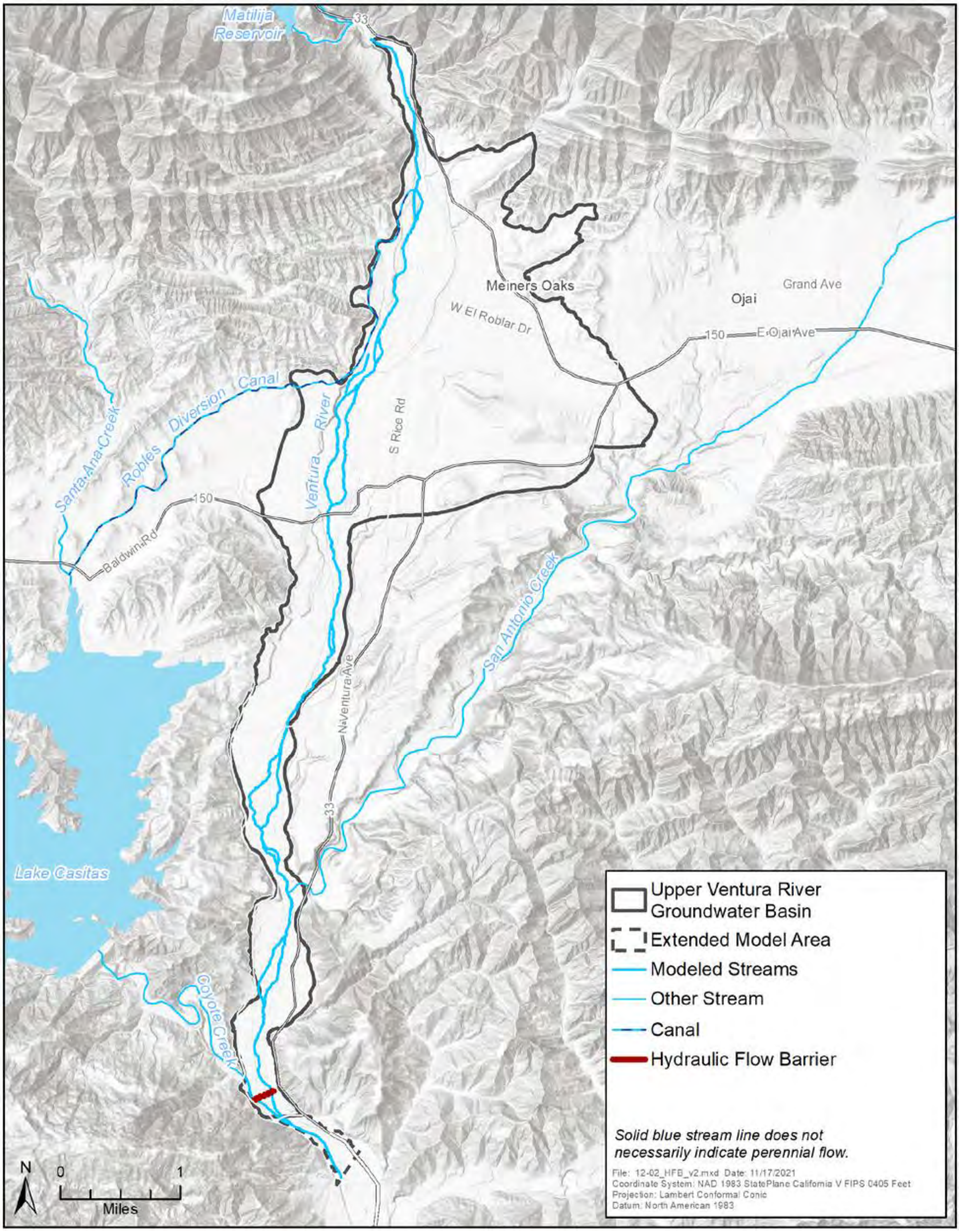


Figure 12.2. Hydraulic Flow Barriers (HFBs) for Subsurface Dam.

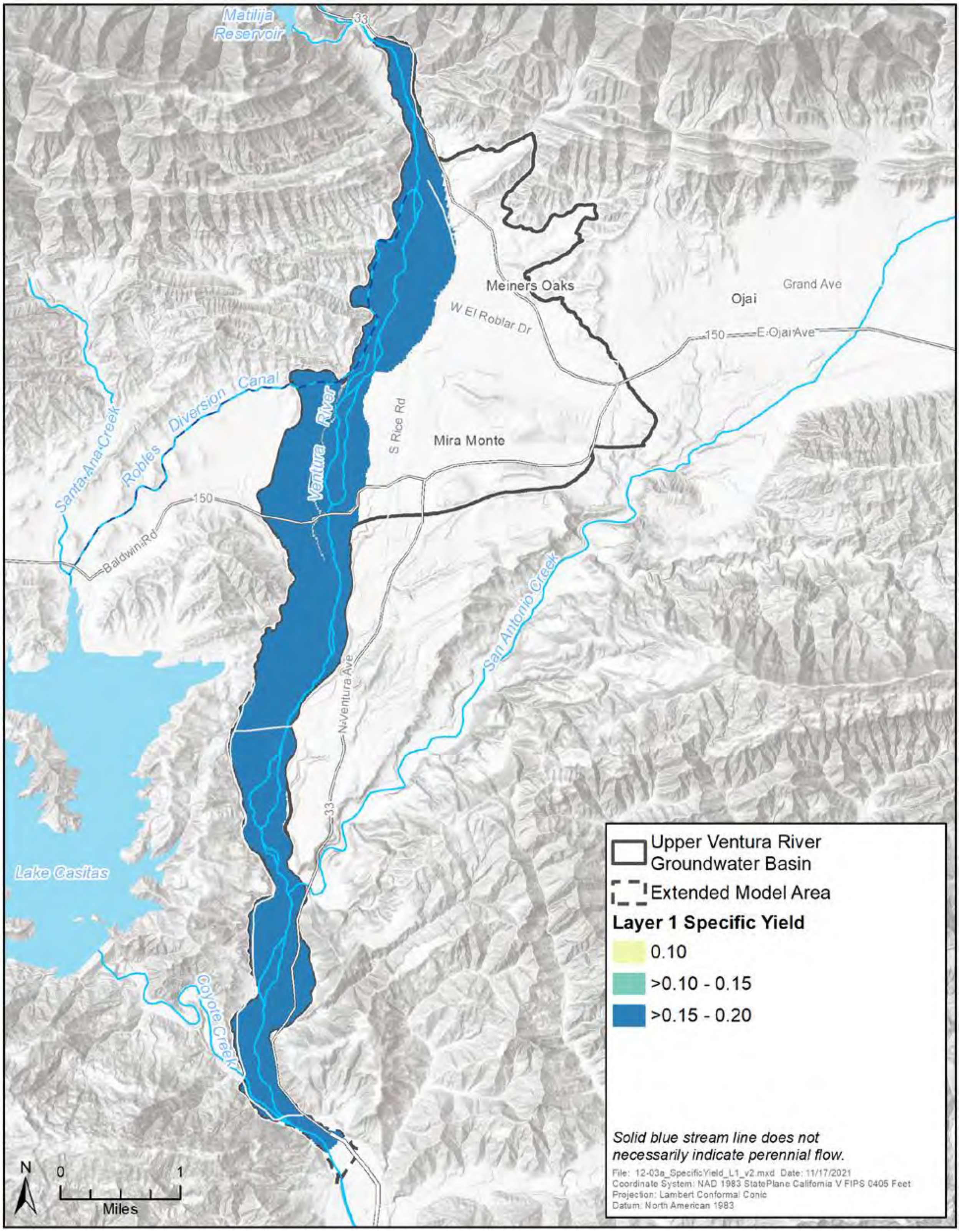


Figure 12.3a. Layer 1 Specific Yield.

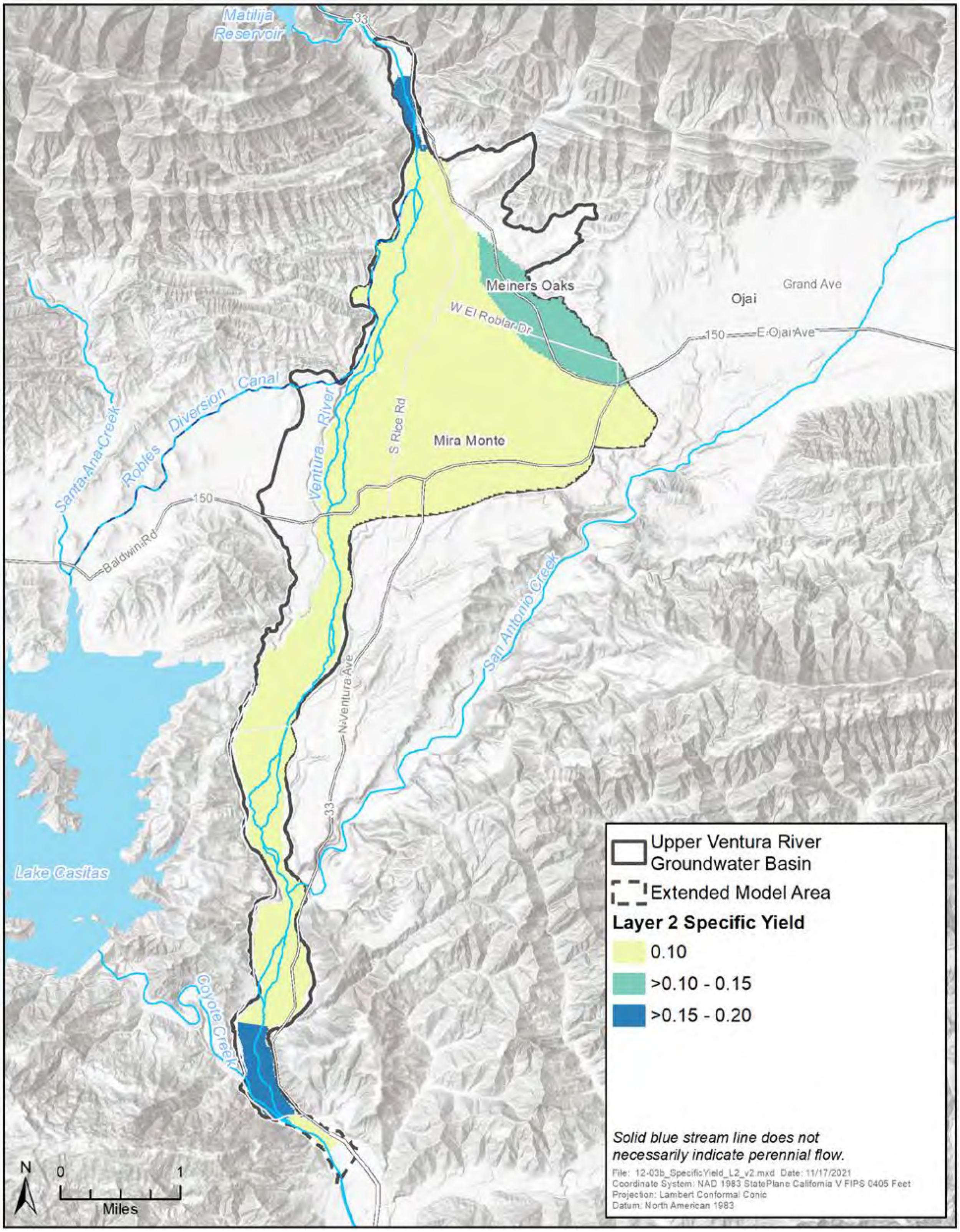


Figure 12.3b. Layer 2 Specific Yield.

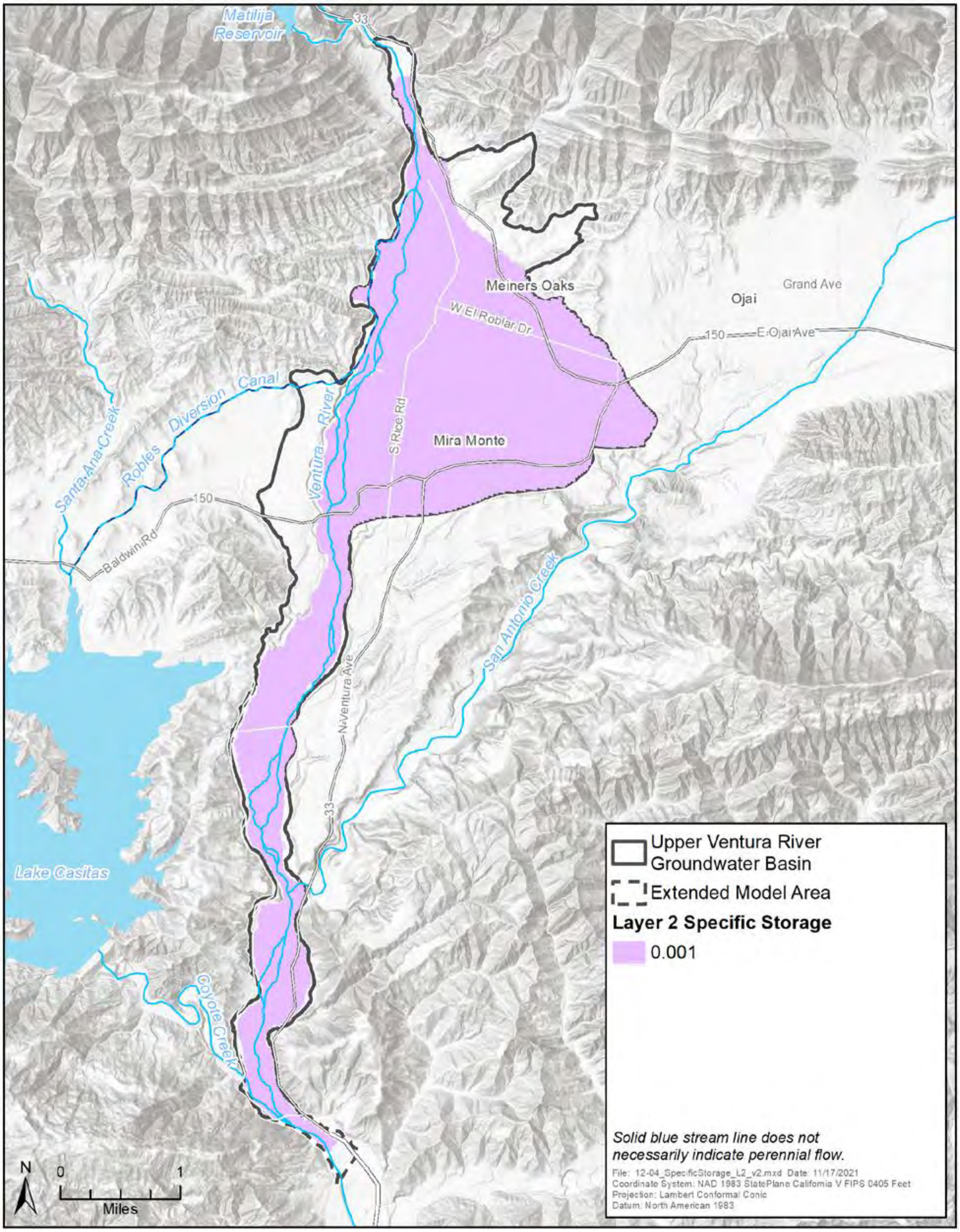


Figure 12.4. Layer 2 Specific Storage.

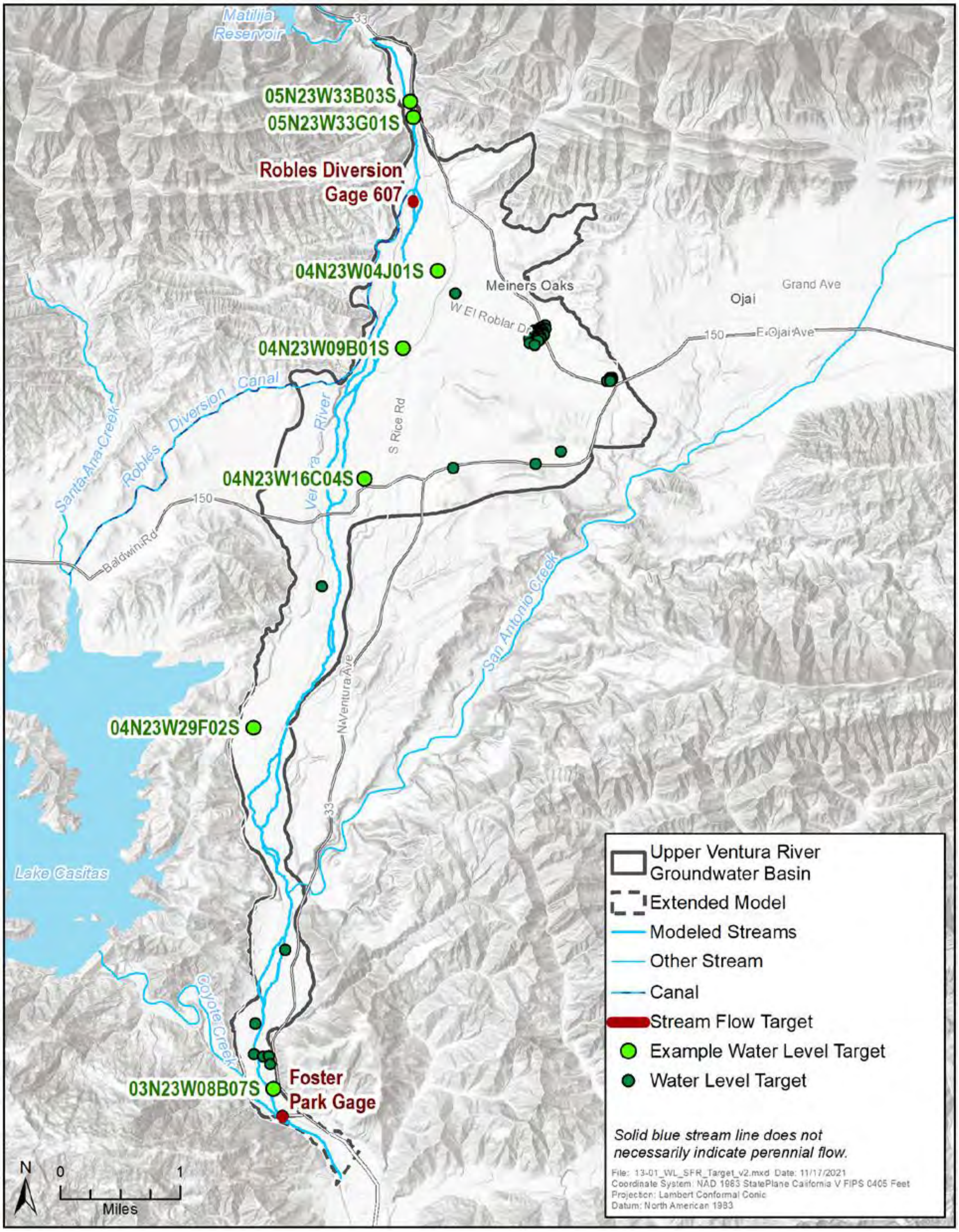


Figure 13.1. Groundwater Level and Stream Flow Targets.

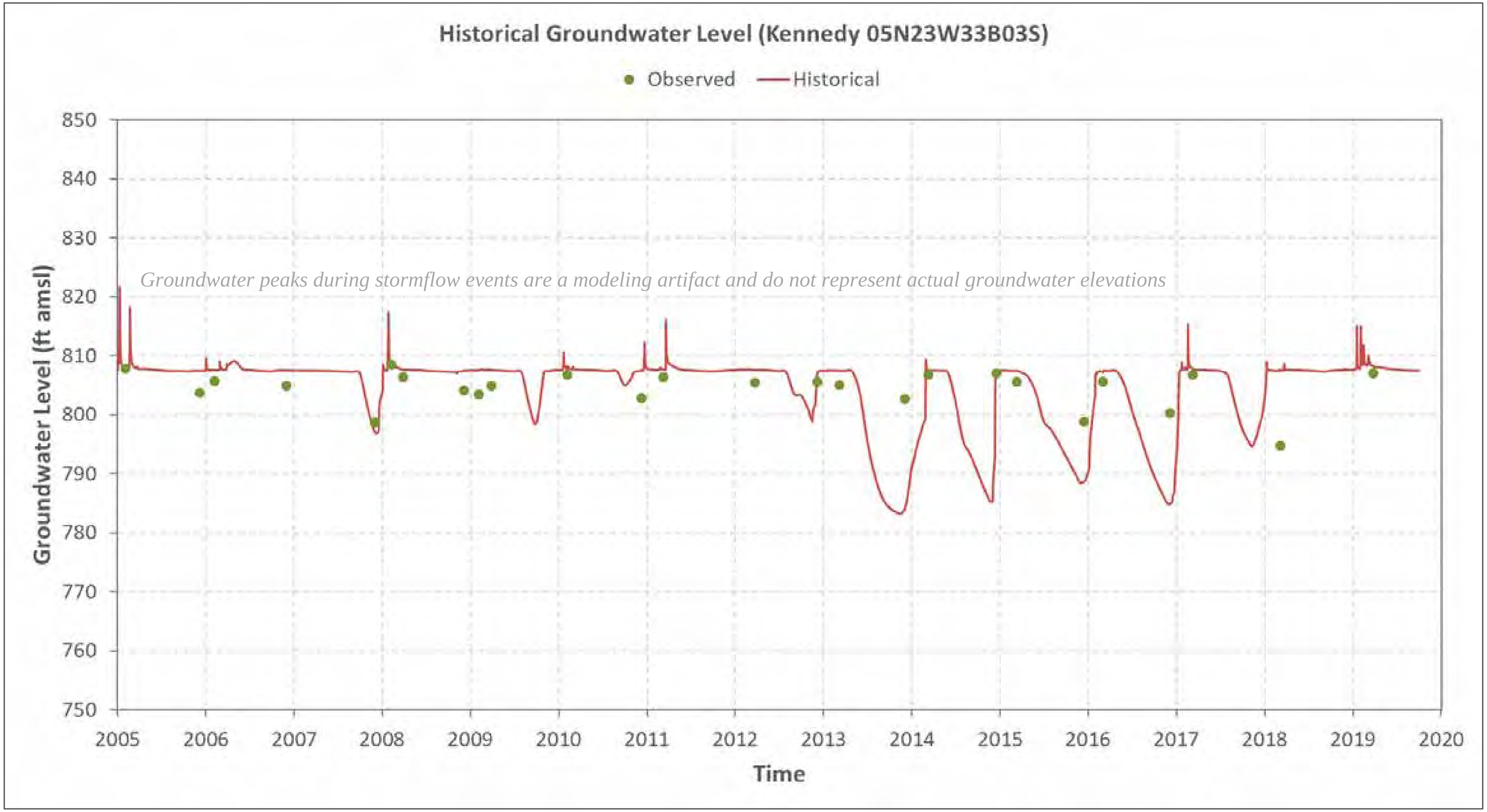


Figure 13.2a. GWL hydrograph (Historical) – Kennedy 05N23W33B03S.

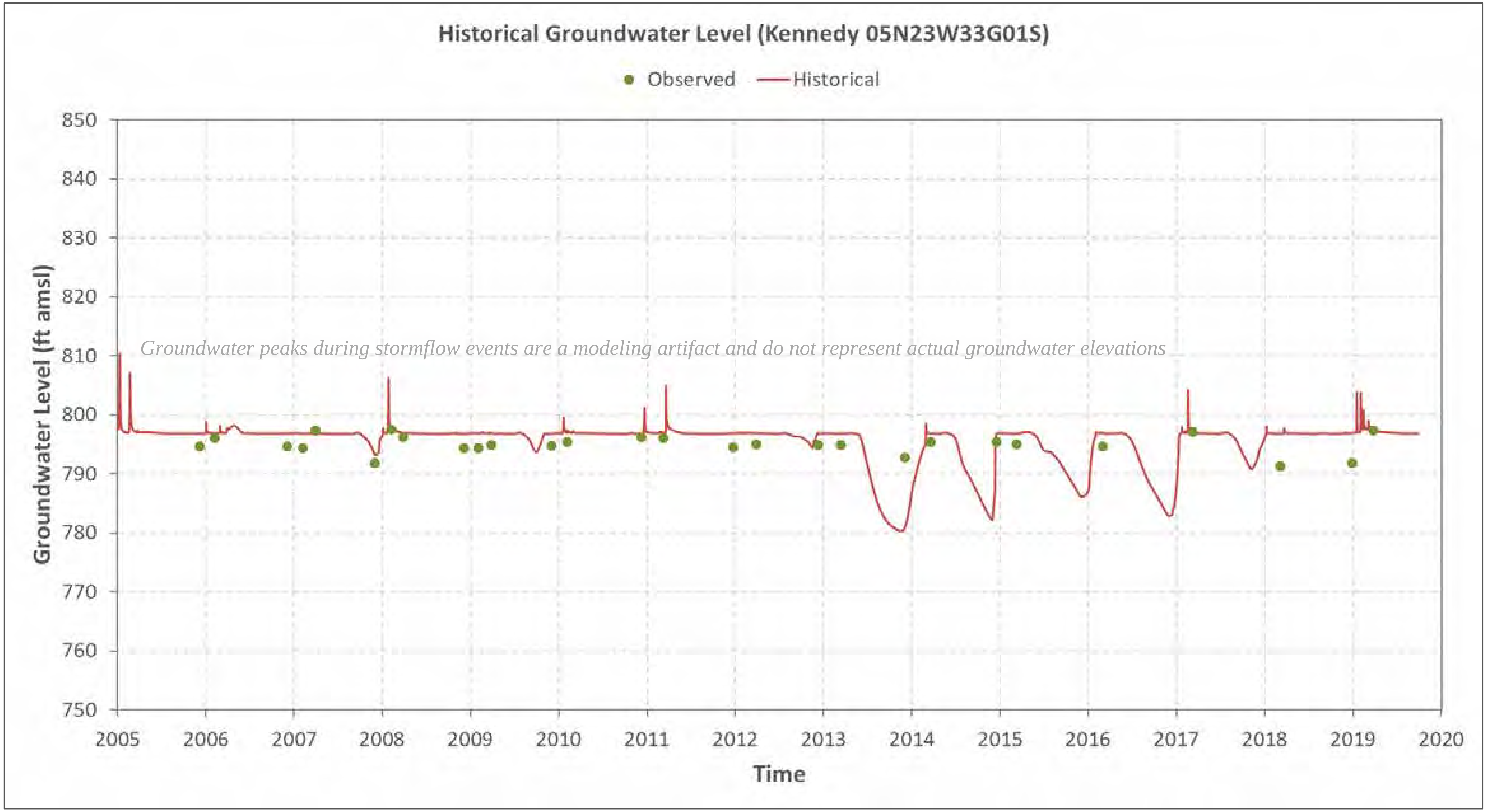


Figure 13.2b. GWL hydrograph (Historical) – Kennedy 05N23W33G01S.

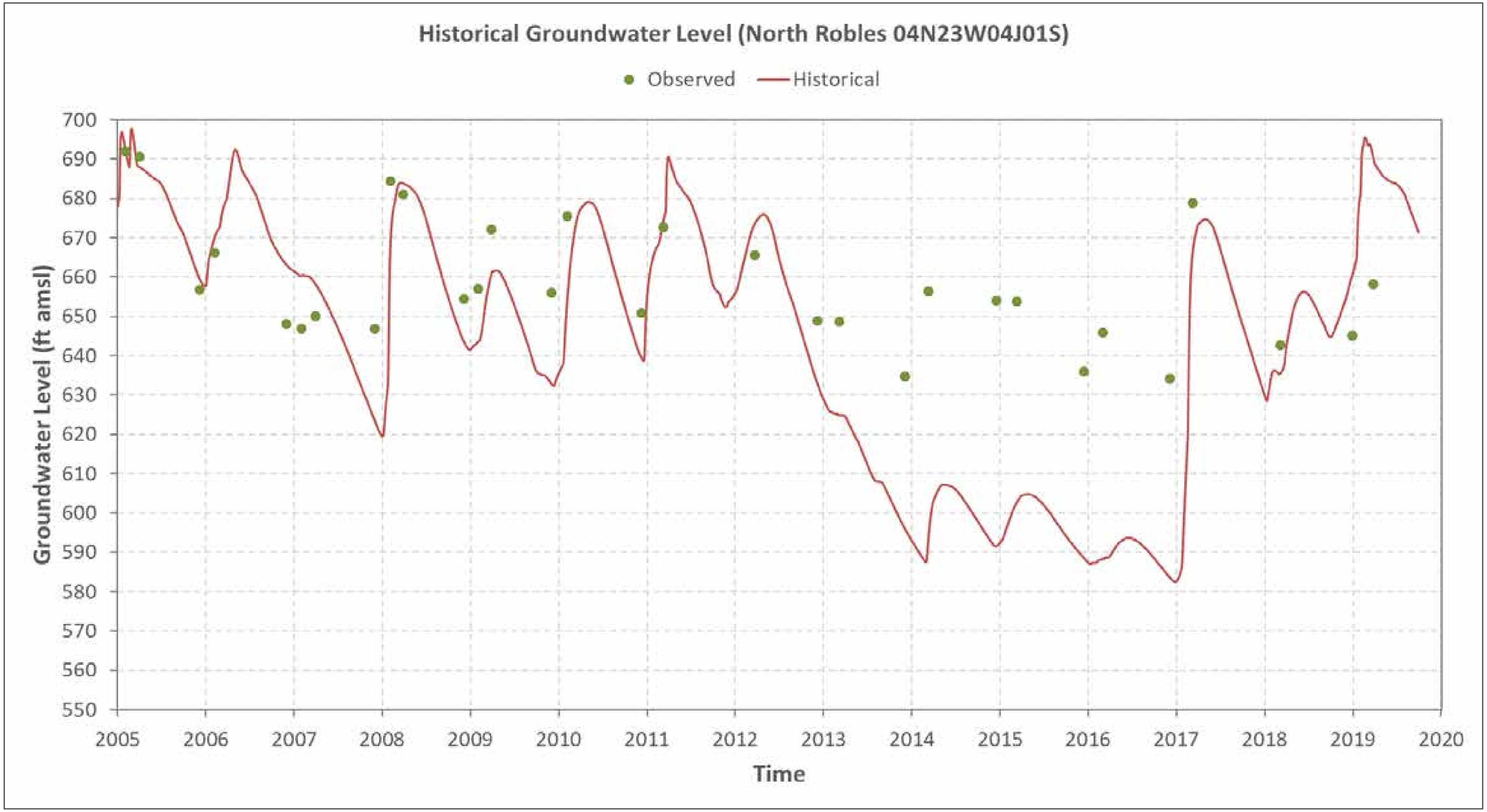


Figure 13.2c. GWL hydrograph (Historical) – North Robles 04N23W04J01S.

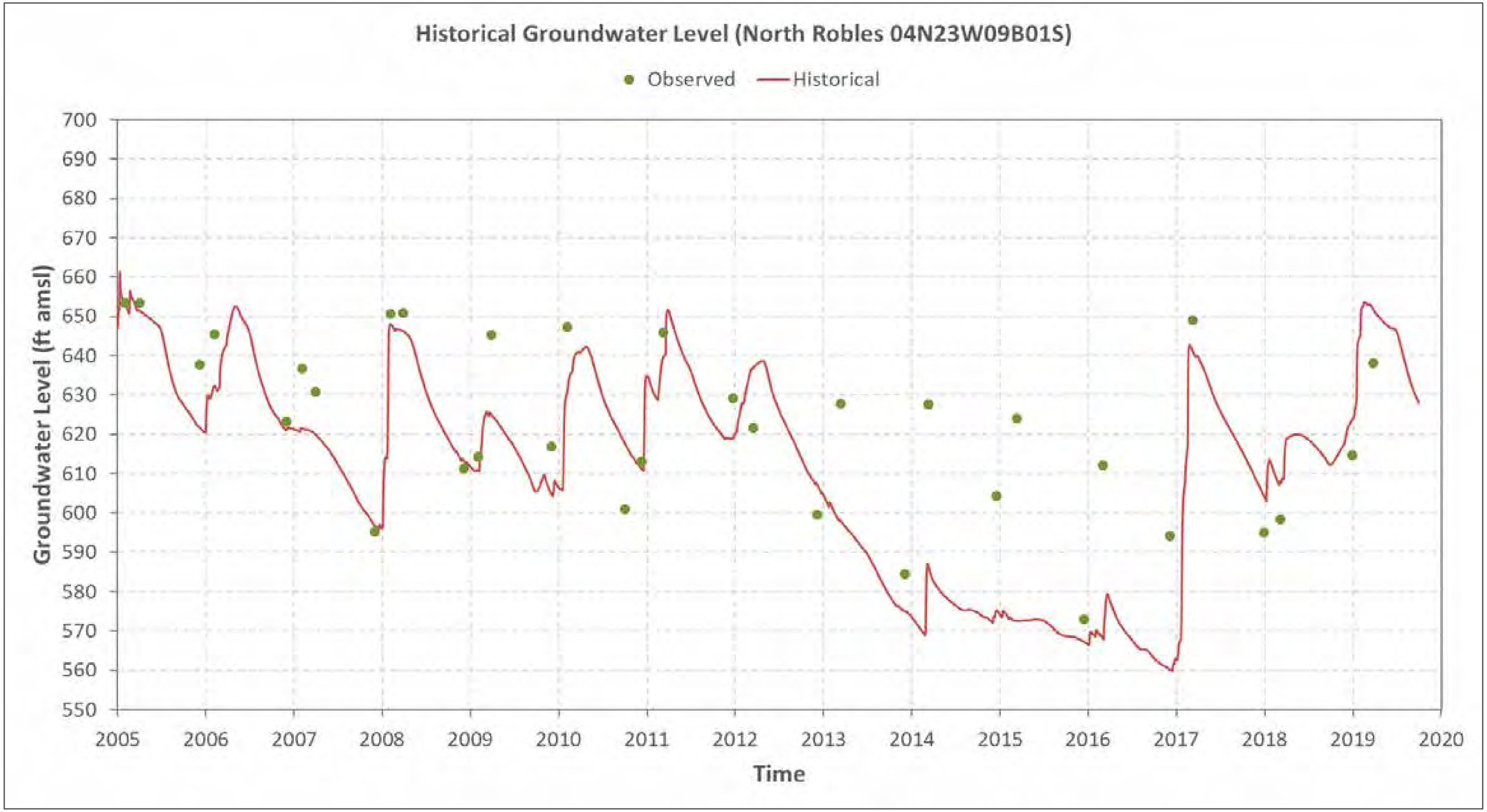


Figure 13.2d. GWL hydrograph (Historical) – North Robles 04N23W09B01S.

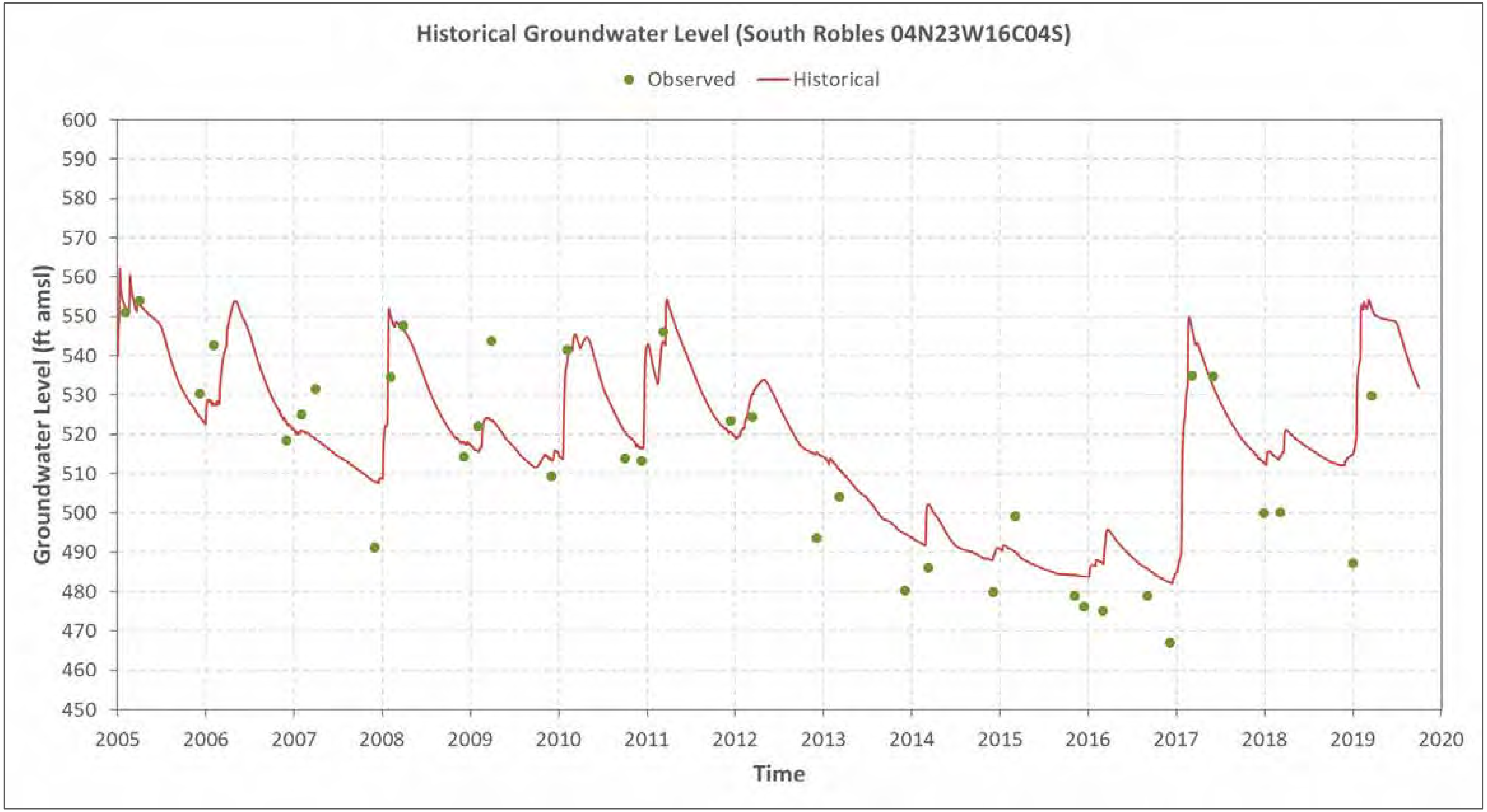


Figure 13.2e. GWL hydrograph (Historical) – South Robles 04N23W16C04S.

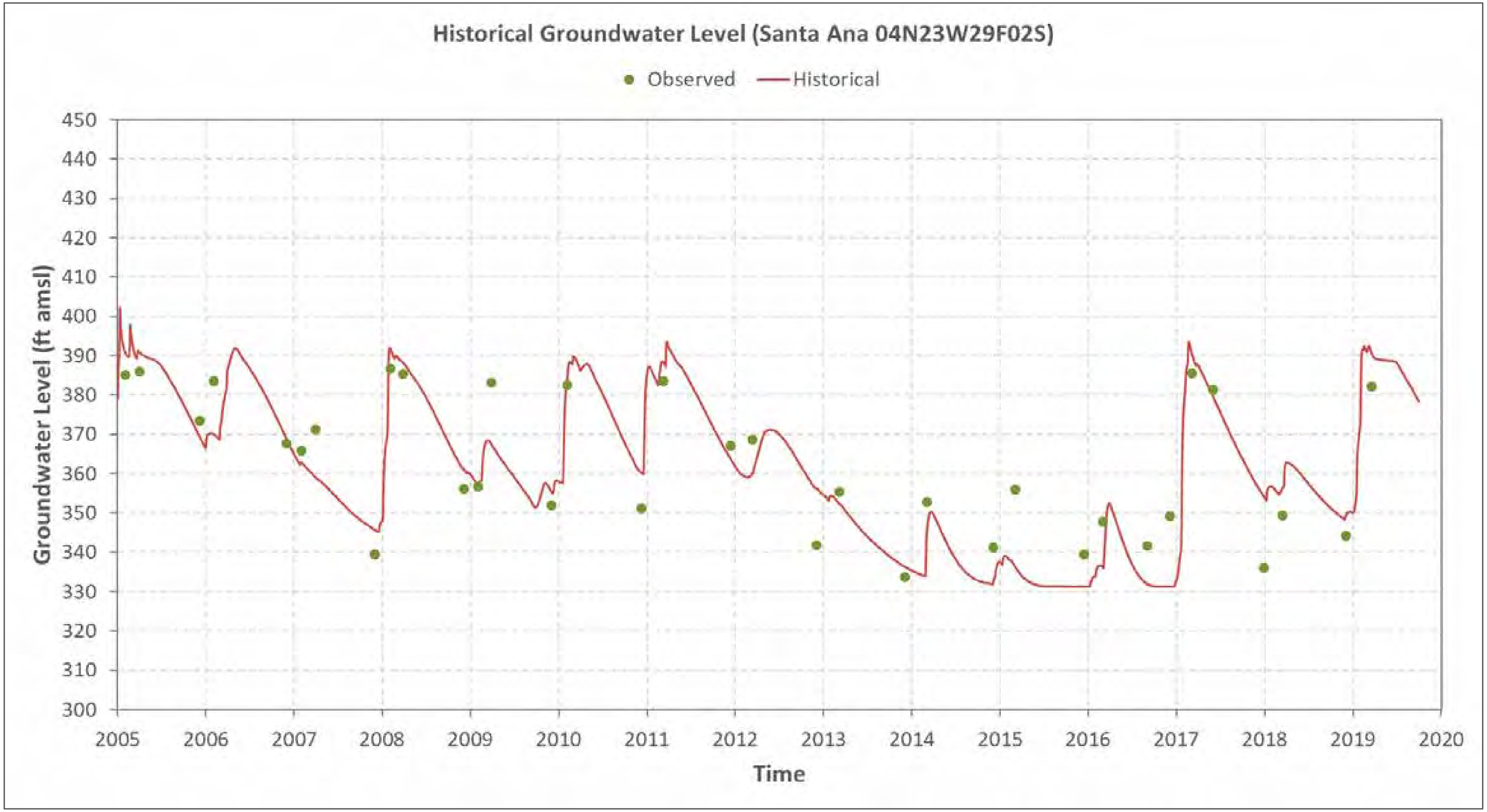


Figure 13.2f. GWL hydrograph (Historical) – Santa Ana 04N23W29F02S.

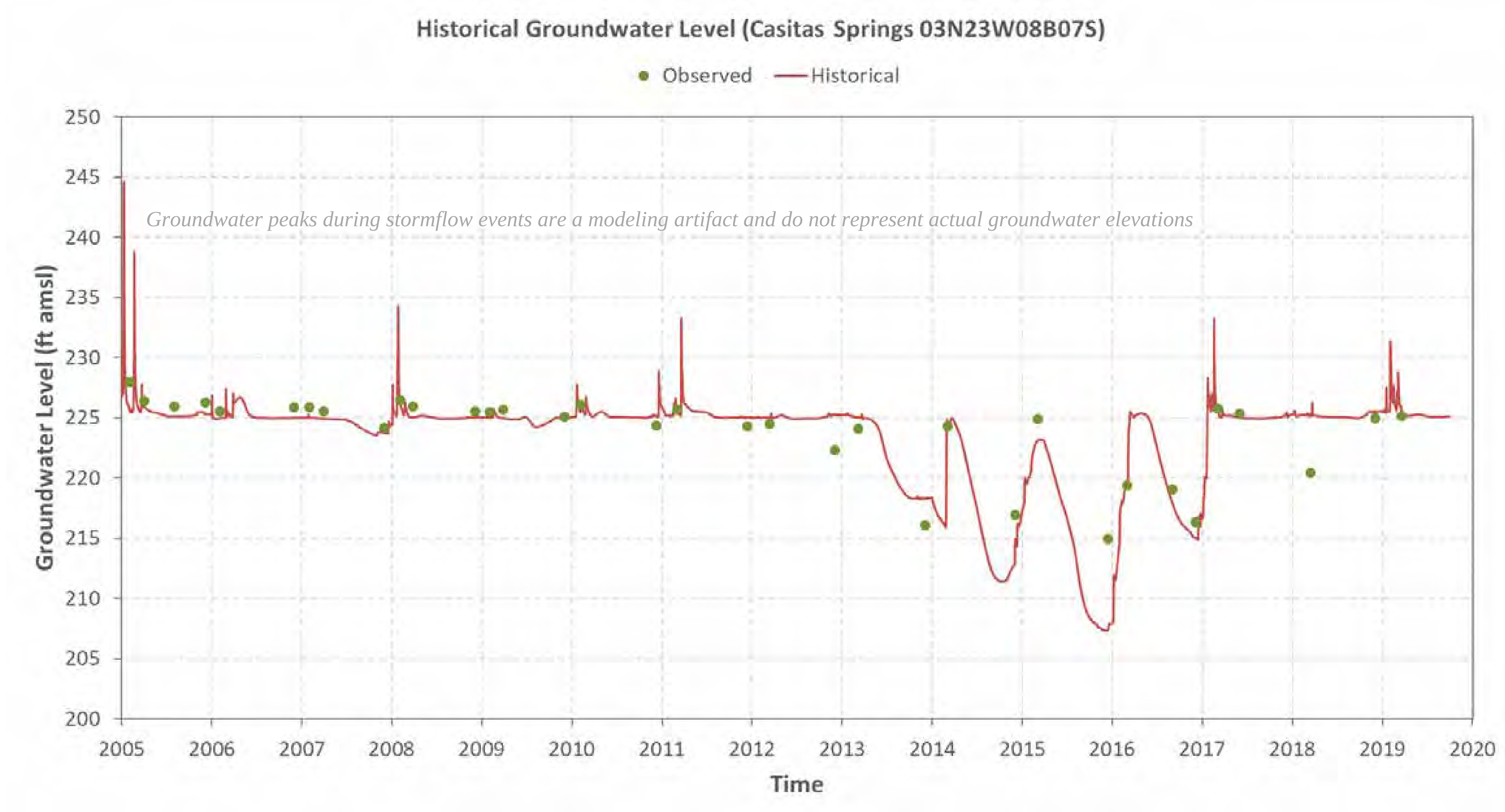


Figure 13.2g. GWL hydrograph (Historical) – Casitas Springs 03N23W08B07S

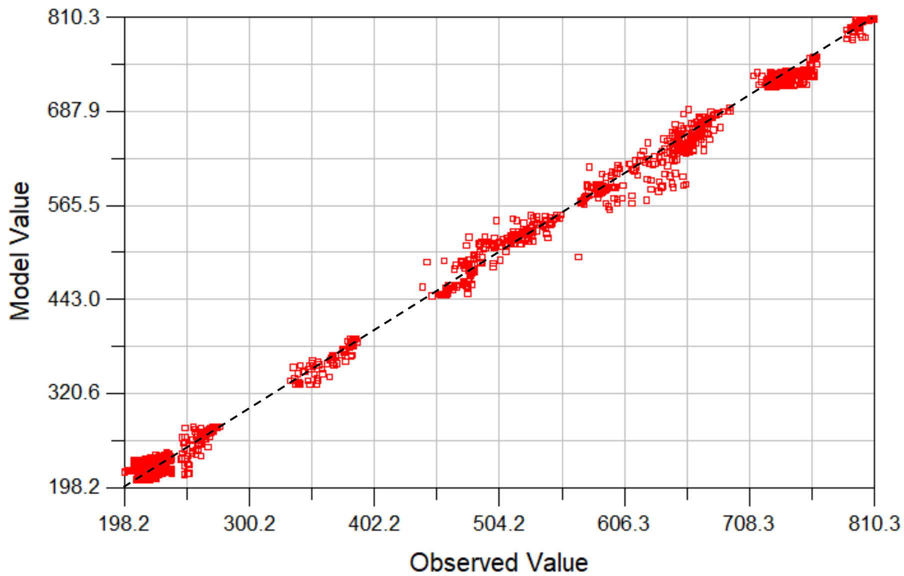


Figure 13.3. Observed and Simulated Groundwater Levels.

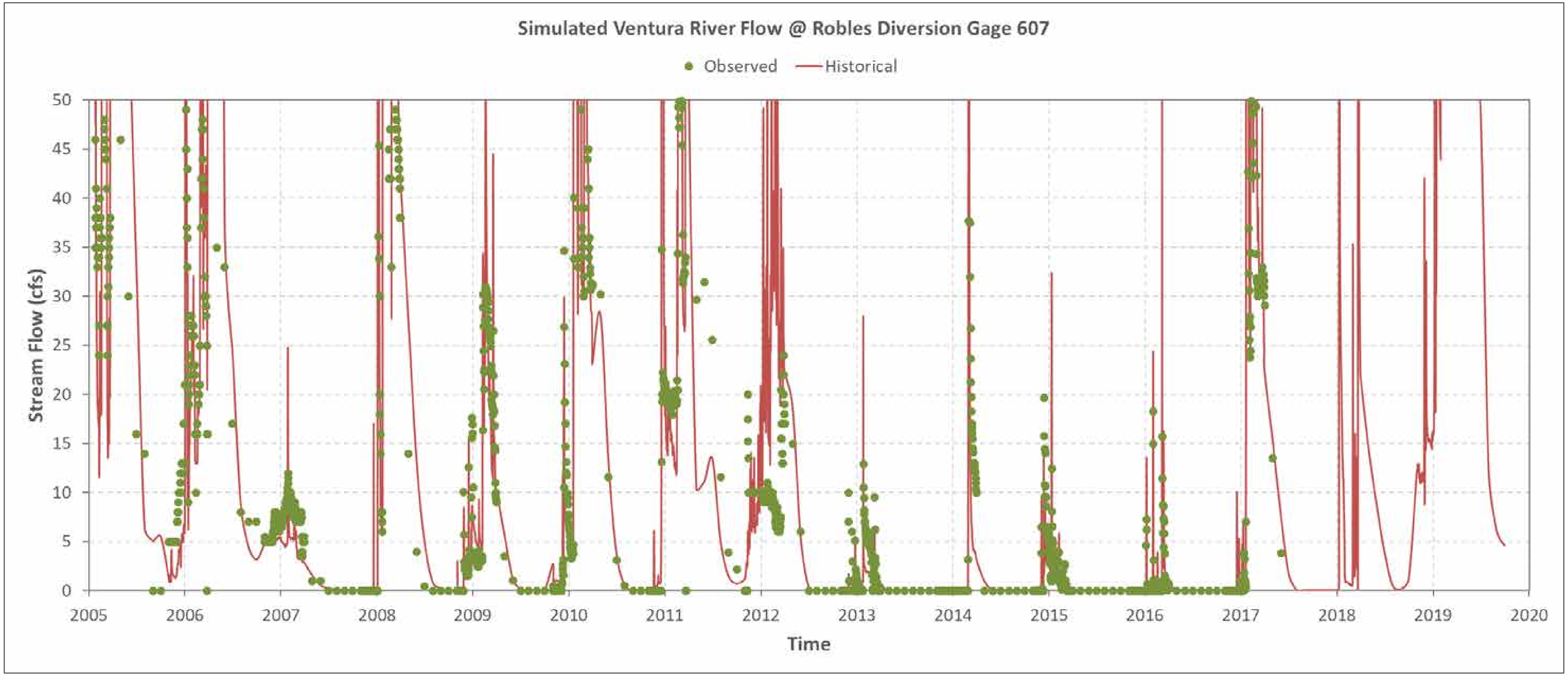


Figure 13.4a. Streamflow hydrograph (Historical) – Robles Diversion Gage 607.

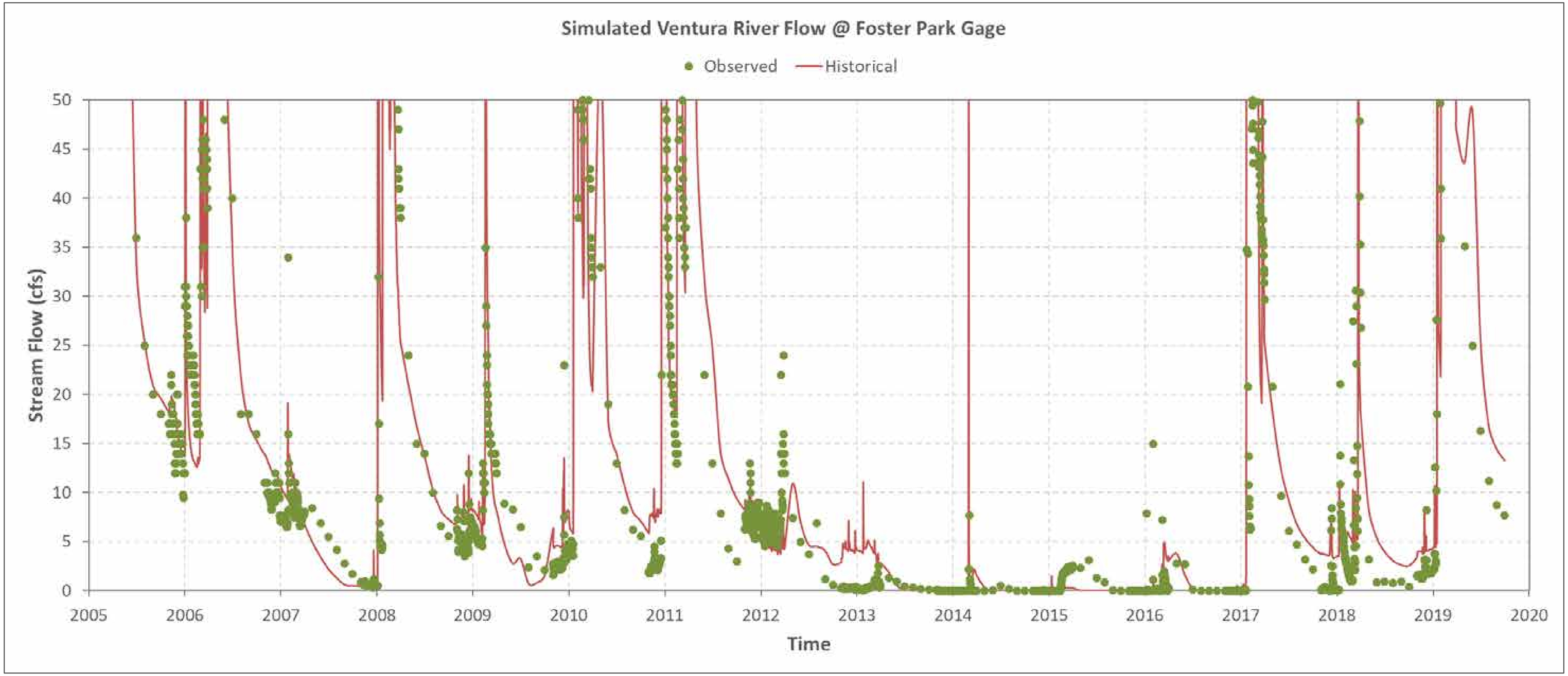


Figure 13.4b. Streamflow hydrograph (Historical) – Foster Park Gage.

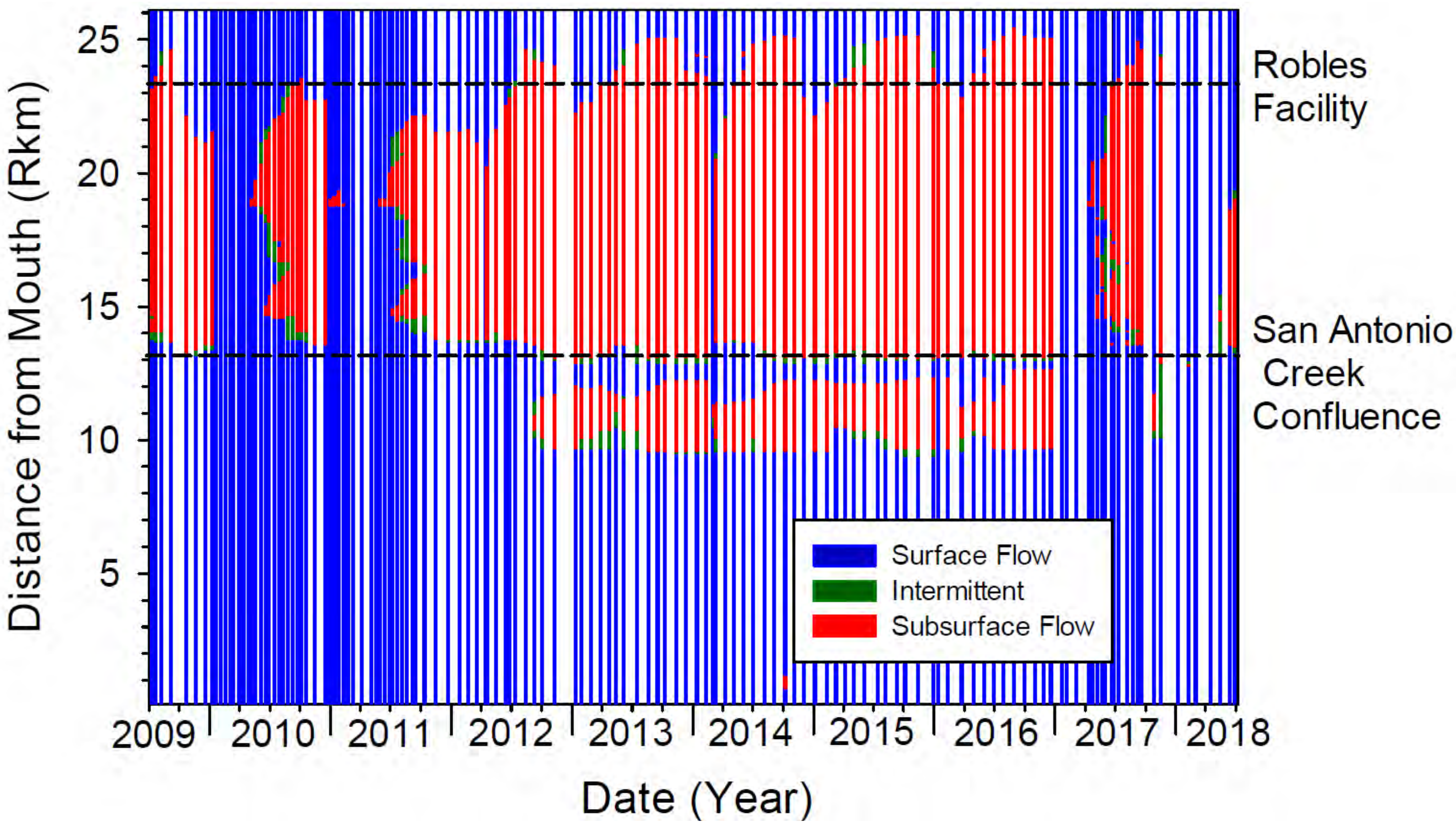
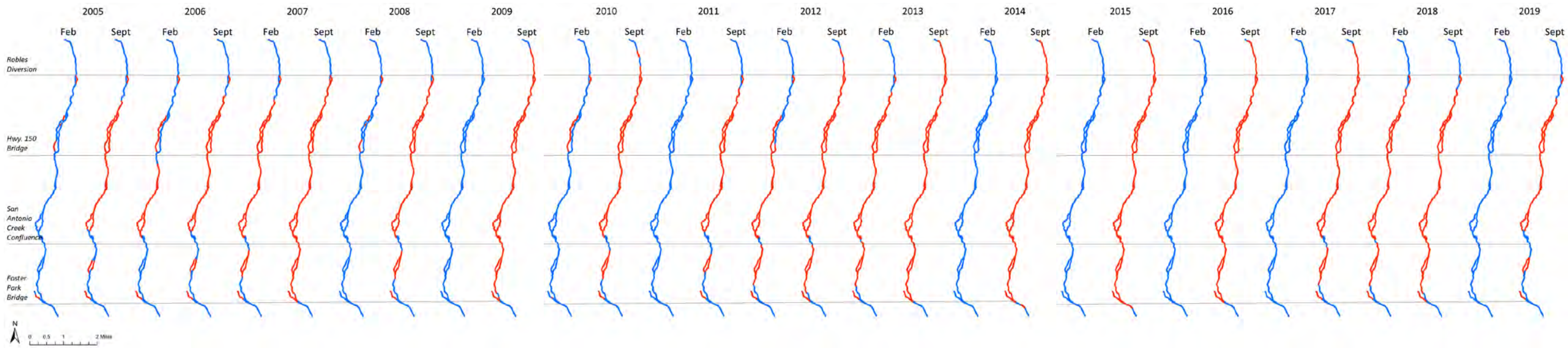


Figure 13.5. Mapping of Ventura River Flow Conditions Based on Surface Flow Monitoring from 2009 to 2018.



Please see text for discussion of model resolution at very low flow conditions, which impacts the mapping displayed in this figure.

Figure 13.6. Modeled SFR Flow Condition (February and September, 2005 – 2019). Blue Indicates Flows Greater than 0.01 cfs; Red Indicates Flows Less than 0.01 cfs.

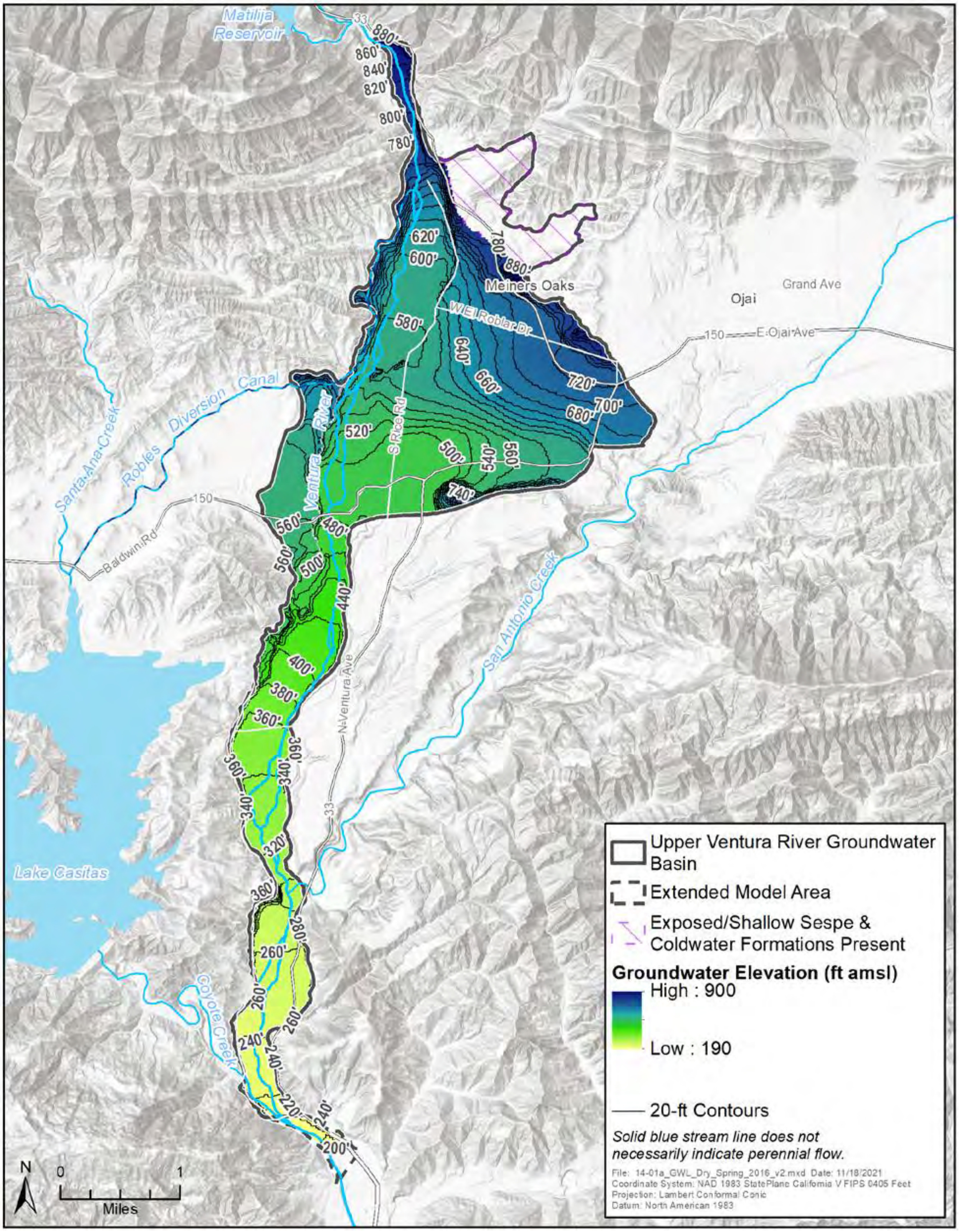


Figure 14.1a. Water Level Contours, Spring 2016.

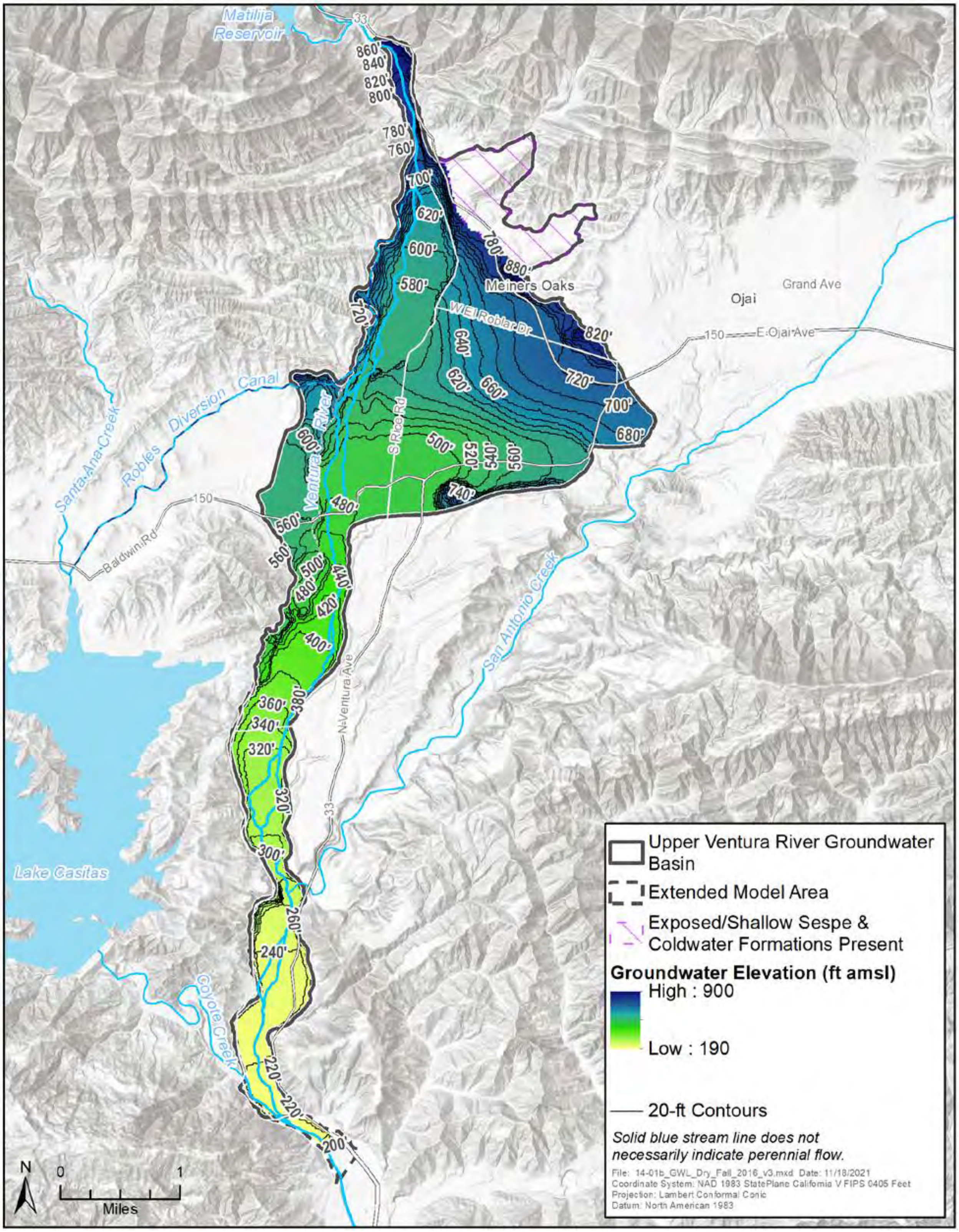


Figure 14.1b. Water Level Contours, Fall 2016.

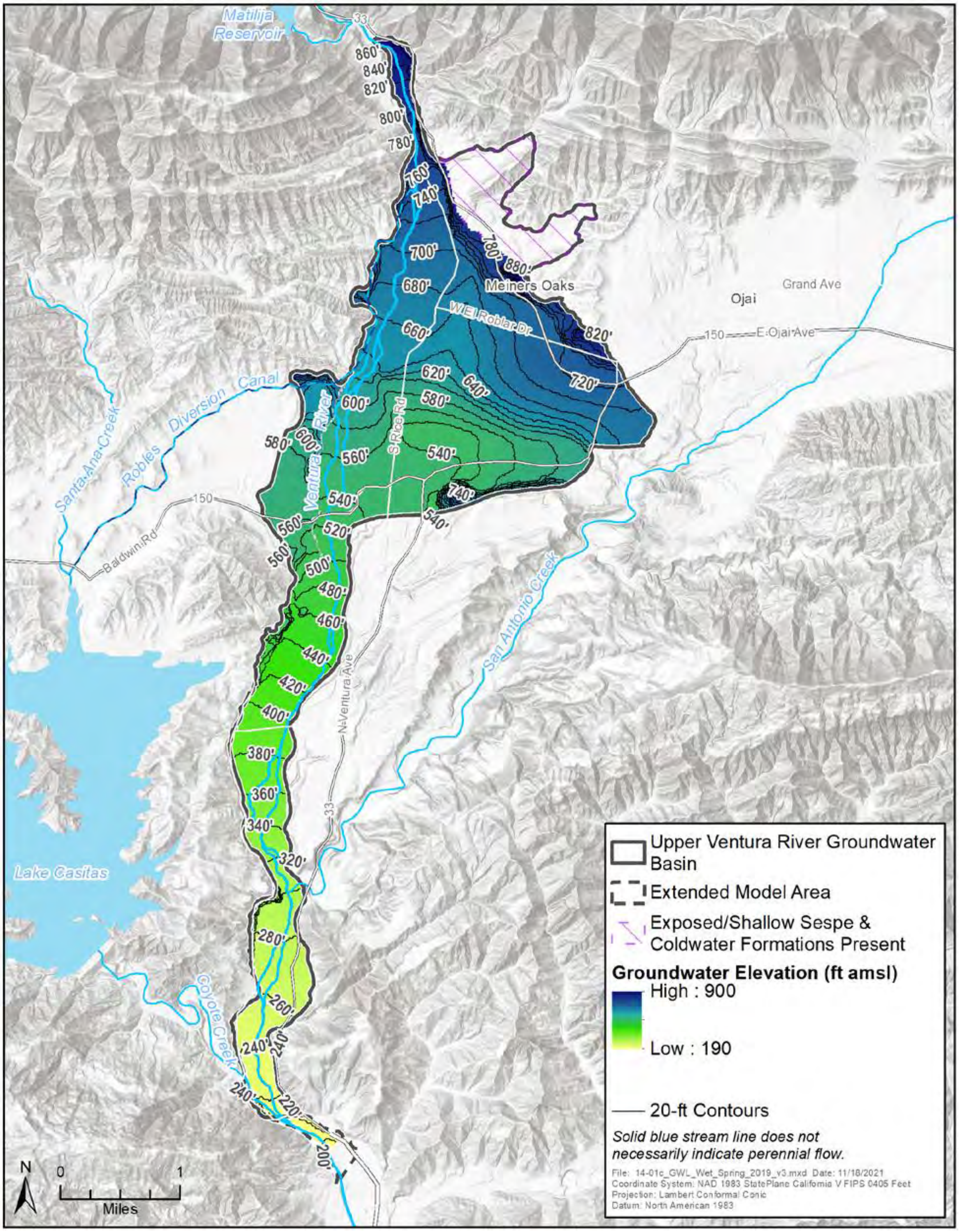


Figure 14.1c. Water Level Contours, Spring 2019.

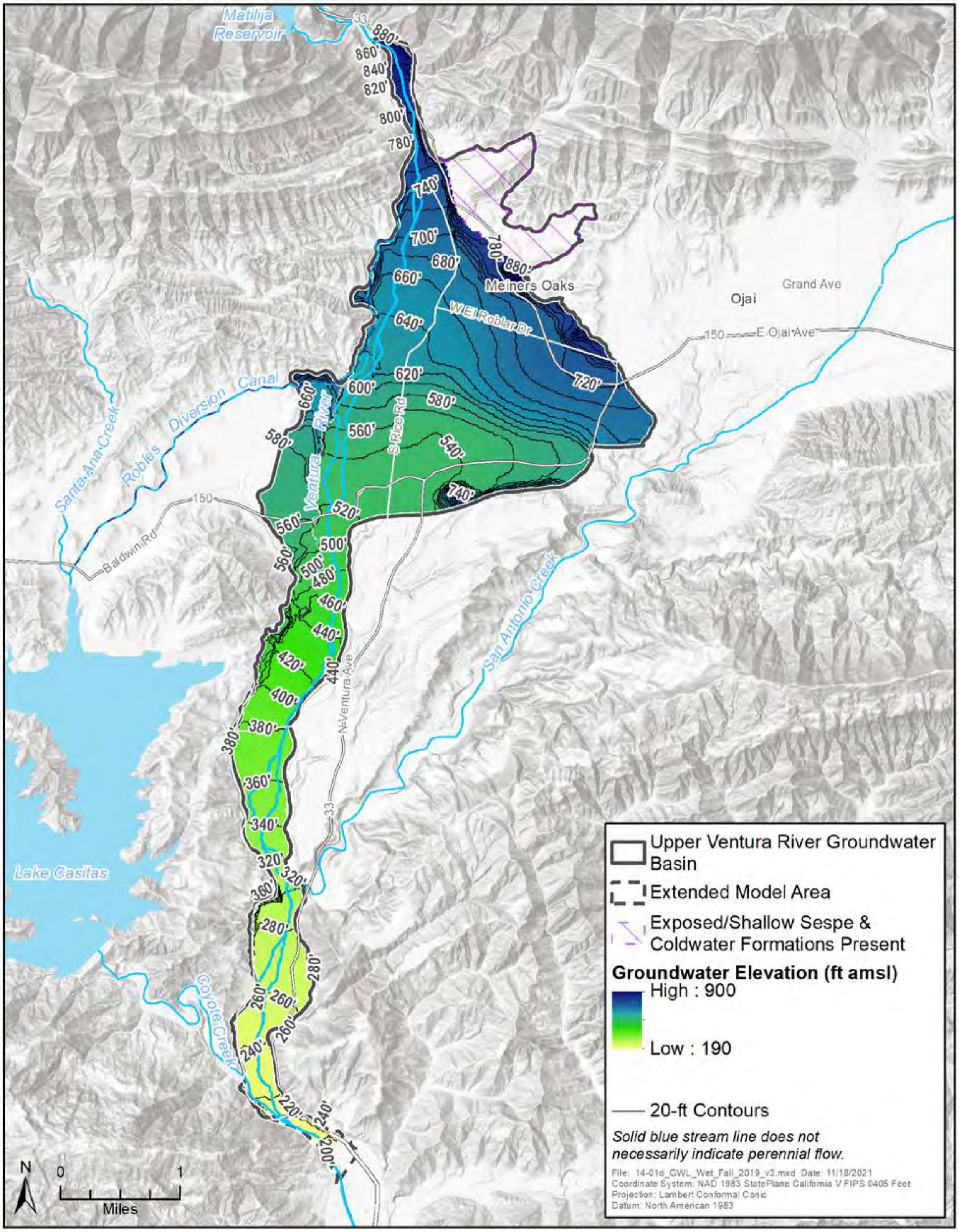


Figure 14.1d. Water Level Contours, Fall 2019.

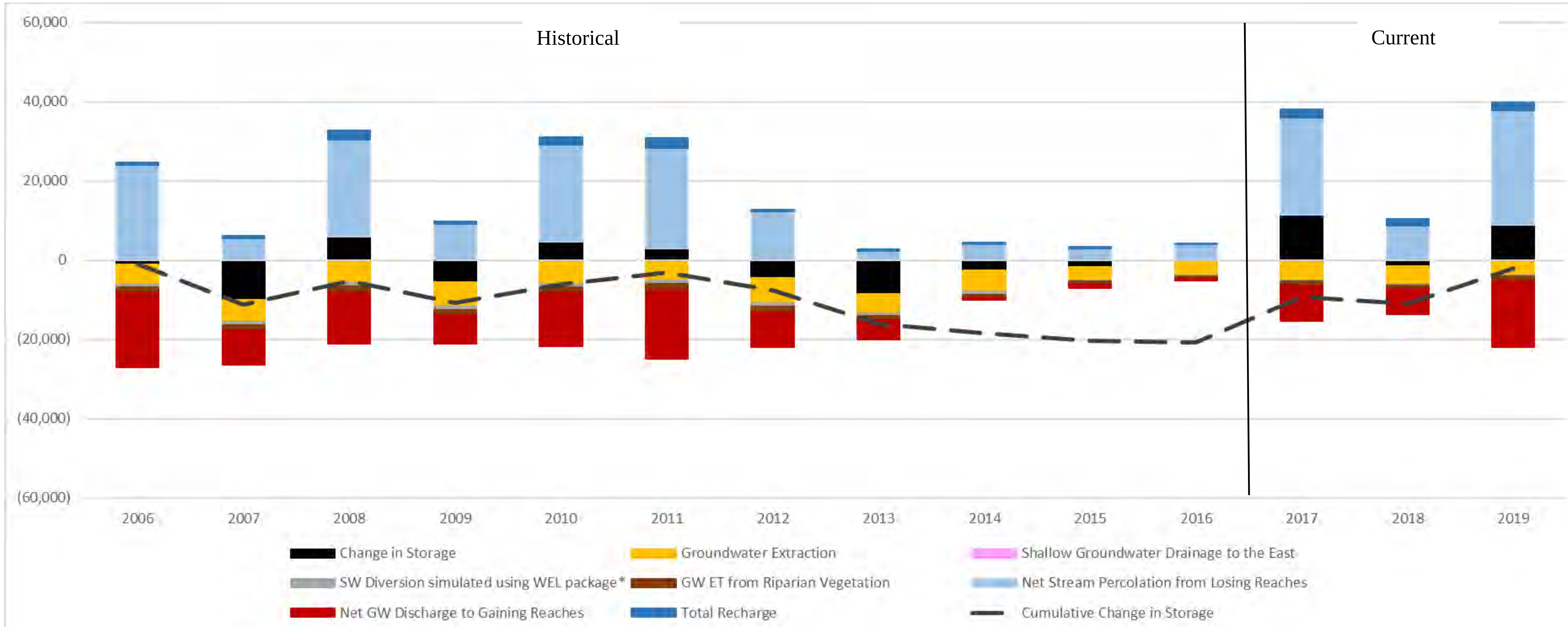


Figure 14.2. Historical and Current Groundwater Inflows and Outflows to/from UVRGB Basin (acre-feet per year).

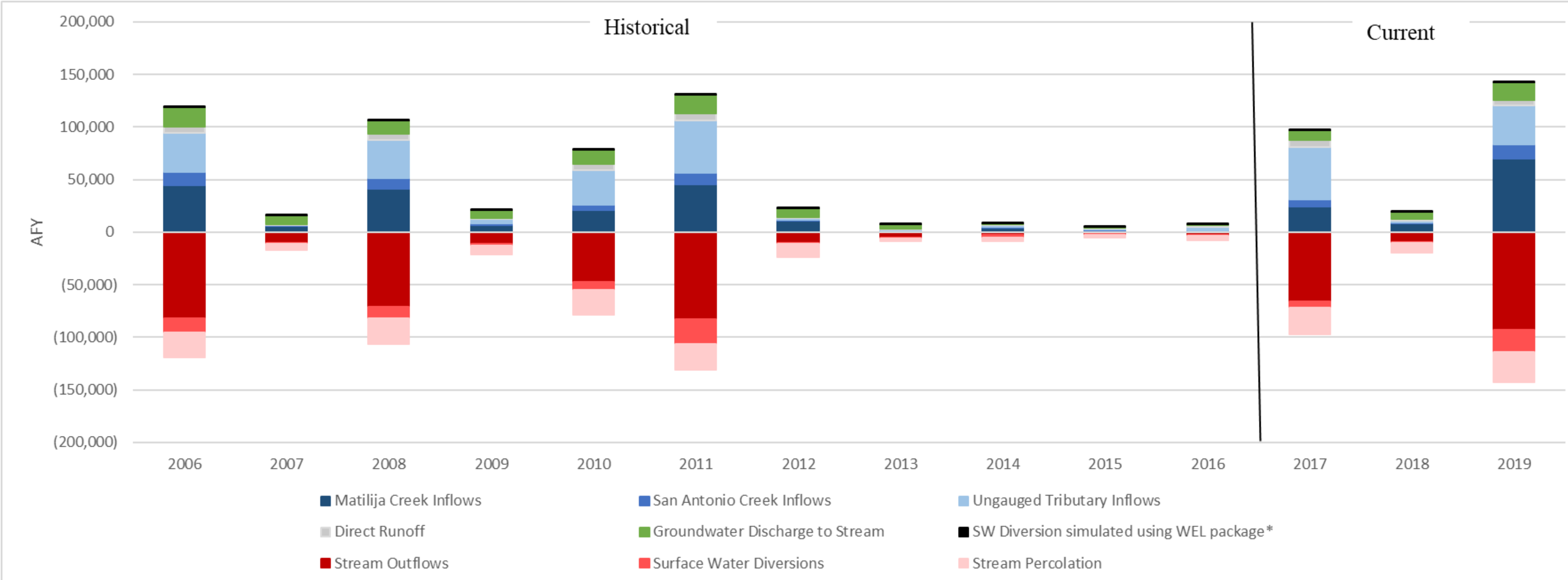


Figure 14.3. Historical and Current Surface Water Inflows and Outflows to/from UVRGB Basin (acre-feet per year).

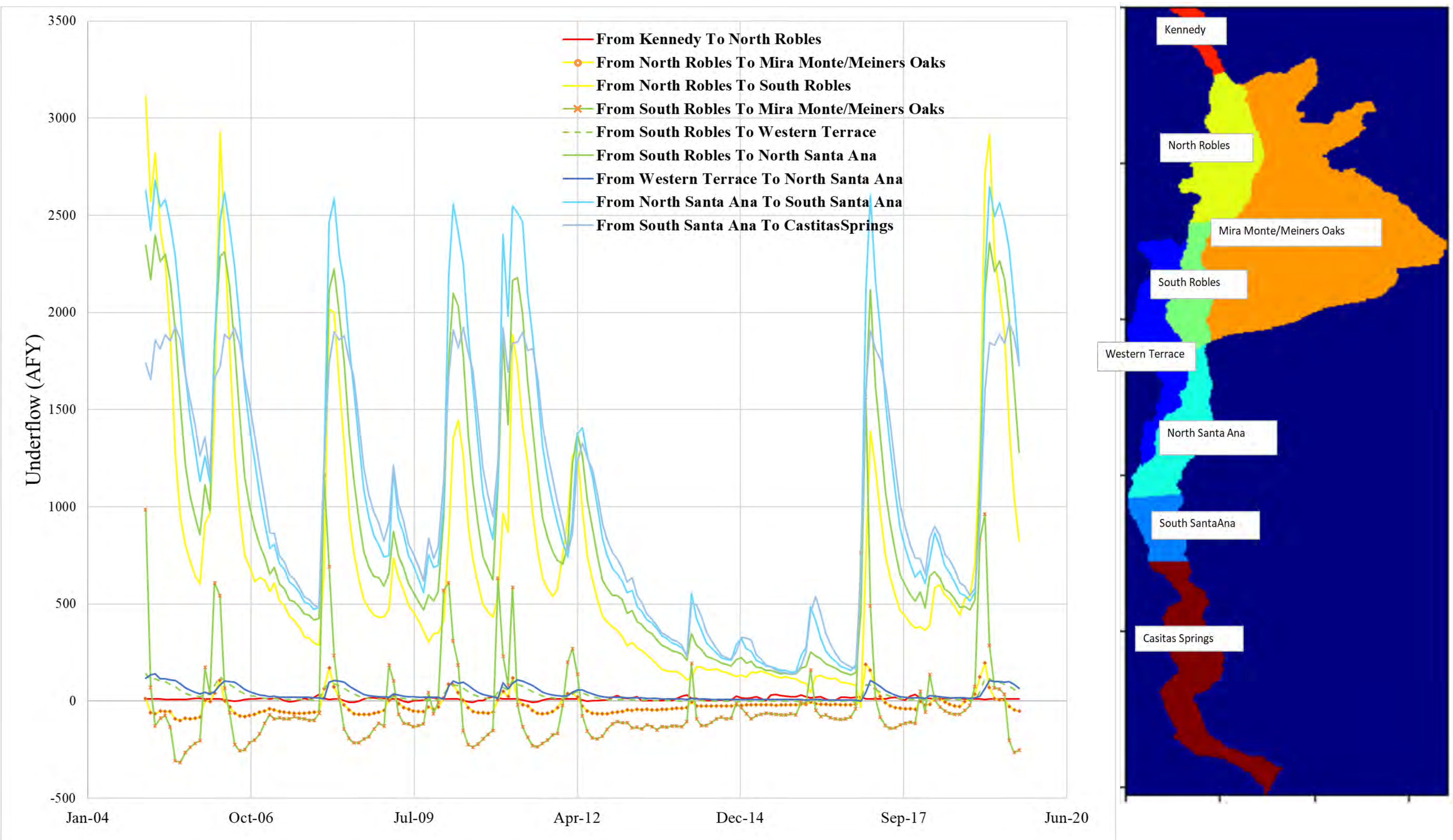


Figure 14.4. Underflows from and within Hydrogeologic Areas.

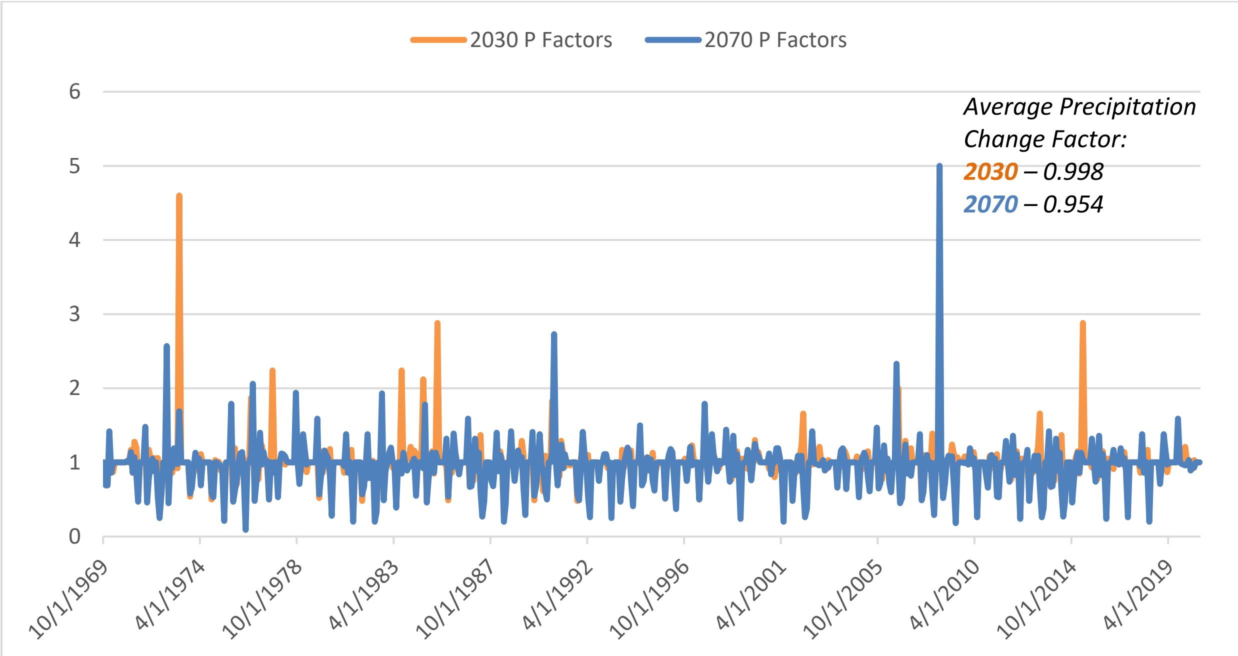


Figure 15.1a. Monthly Precipitation Scaling Factors for Climate Change Scenarios.

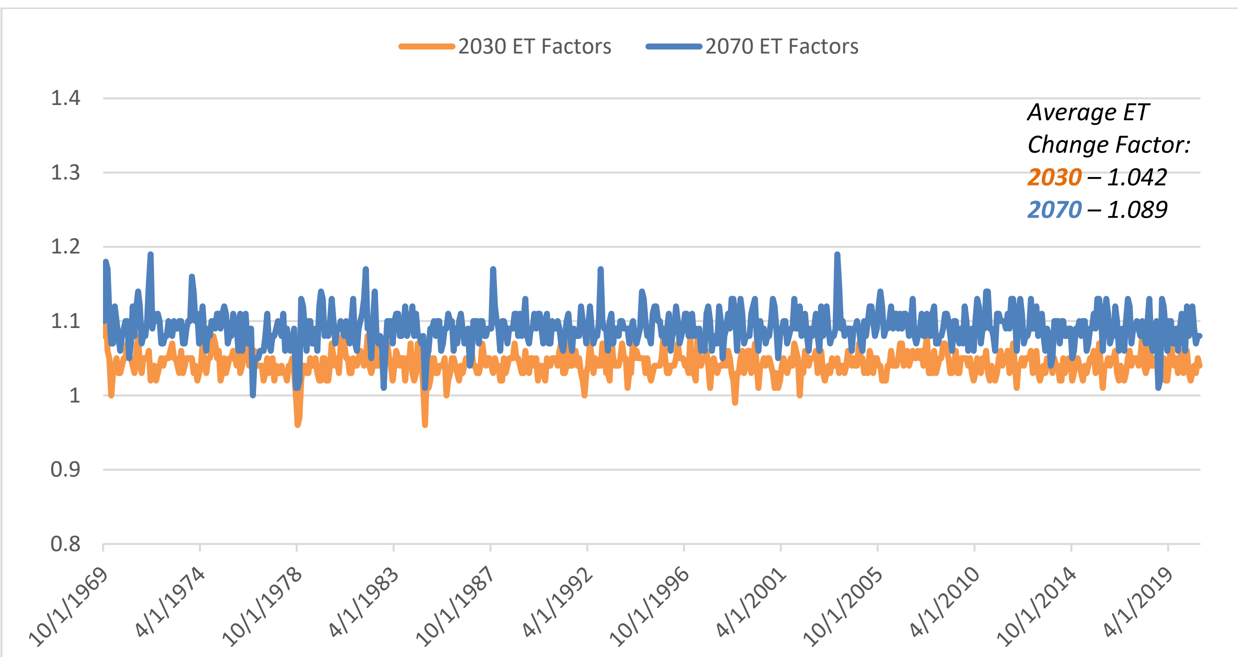


Figure 15.1b. Monthly Evapotranspiration Scaling Factors for Climate Change Scenarios.

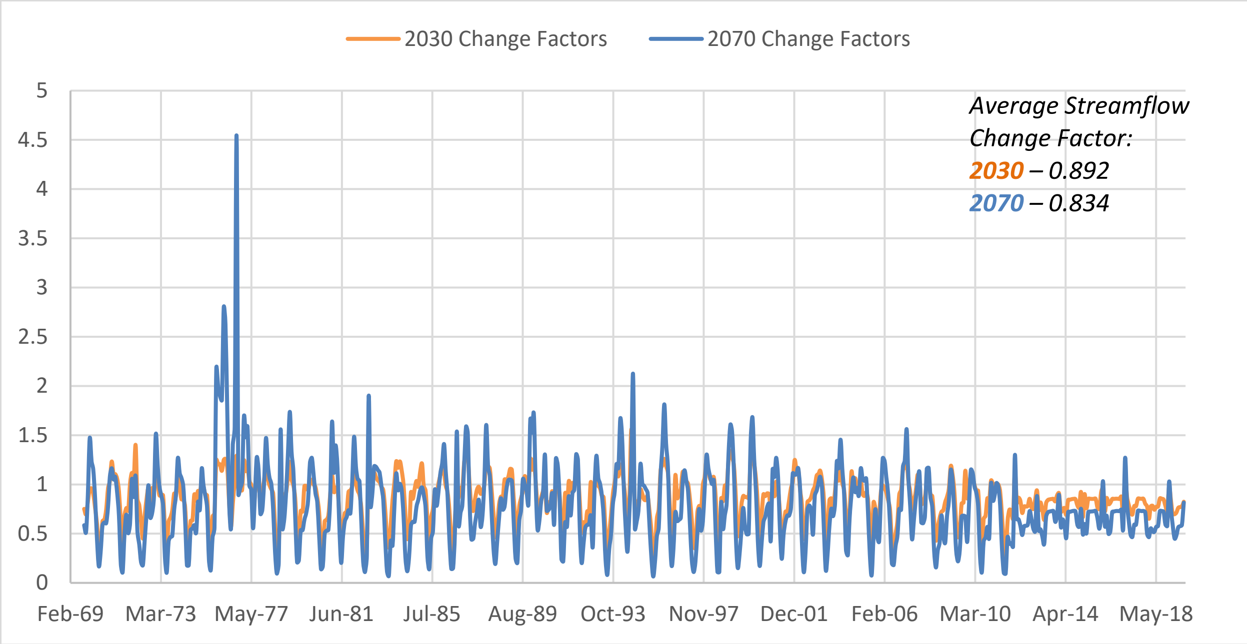


Figure 15.2. Streamflow Change Factors for Climate Change Scenarios.

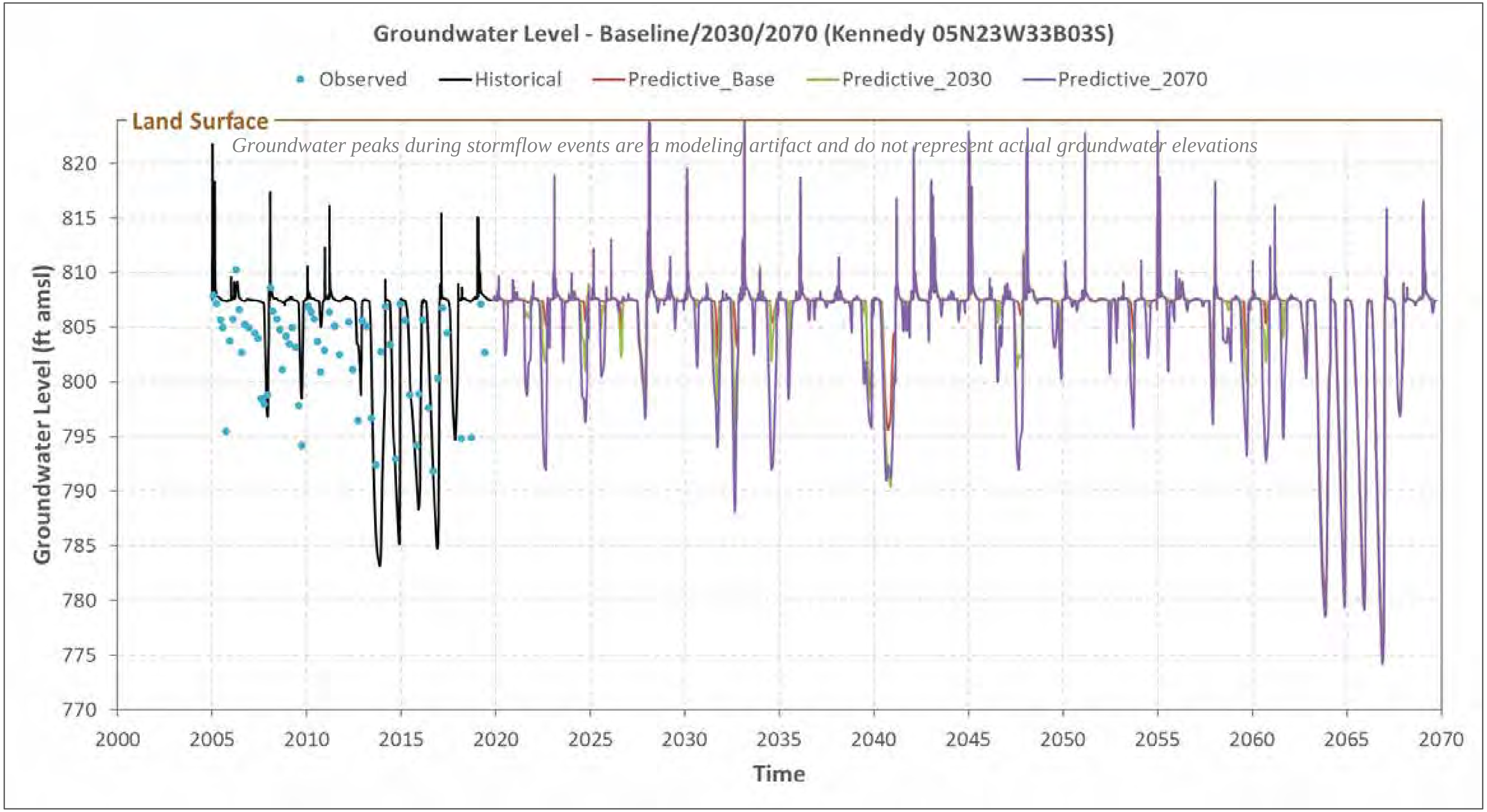


Figure 15.3a. GWL hydrograph (Baseline, 2030, 2070) – Kennedy 05N23W33B03S.

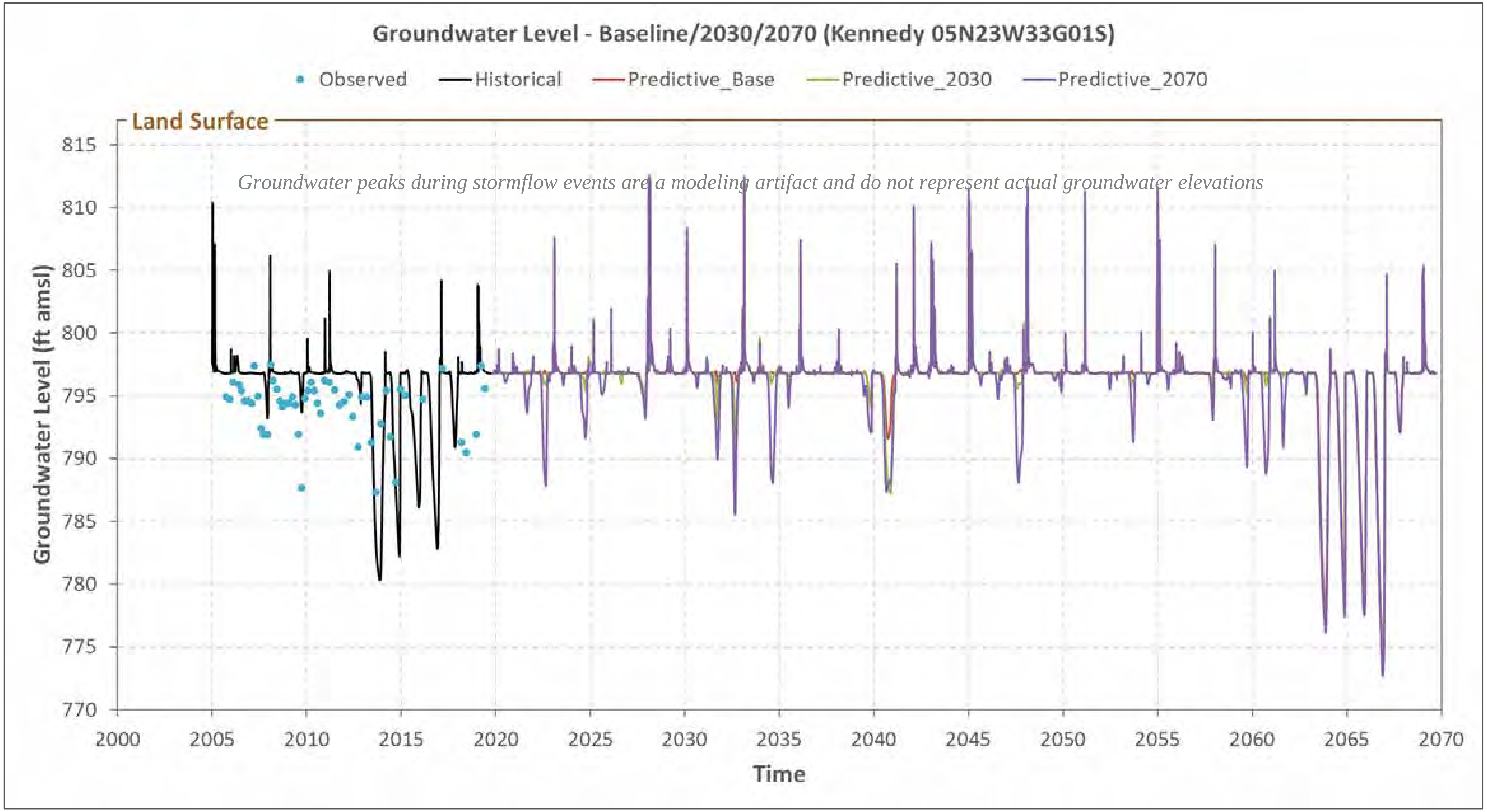


Figure 15.3b. GWL hydrograph (Baseline, 2030, 2070) – Kennedy 05N23W33G01S.

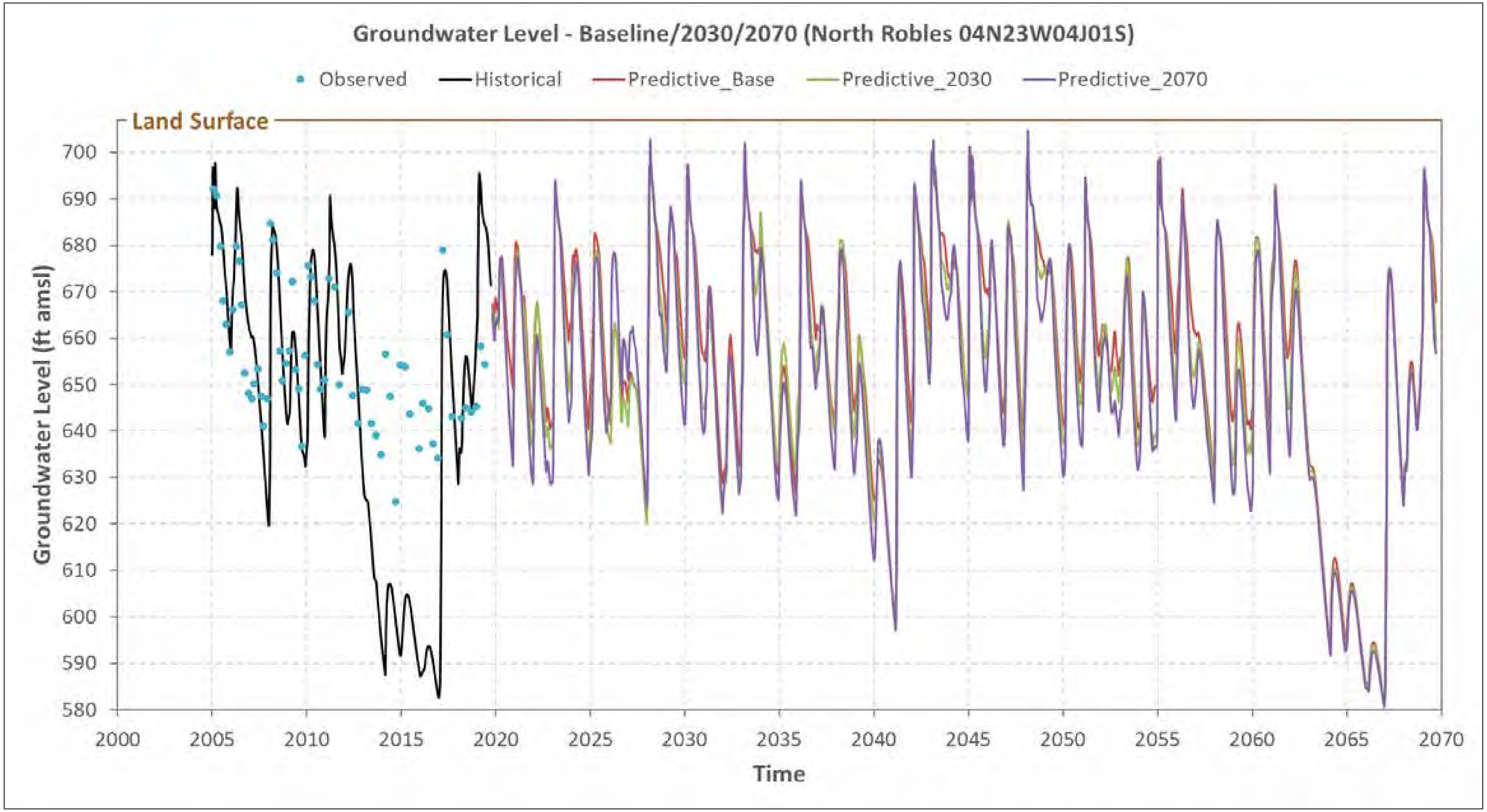


Figure 15.3c. GWL hydrograph (Baseline, 2030, 2070) – North Robles 04N23W04J01S.

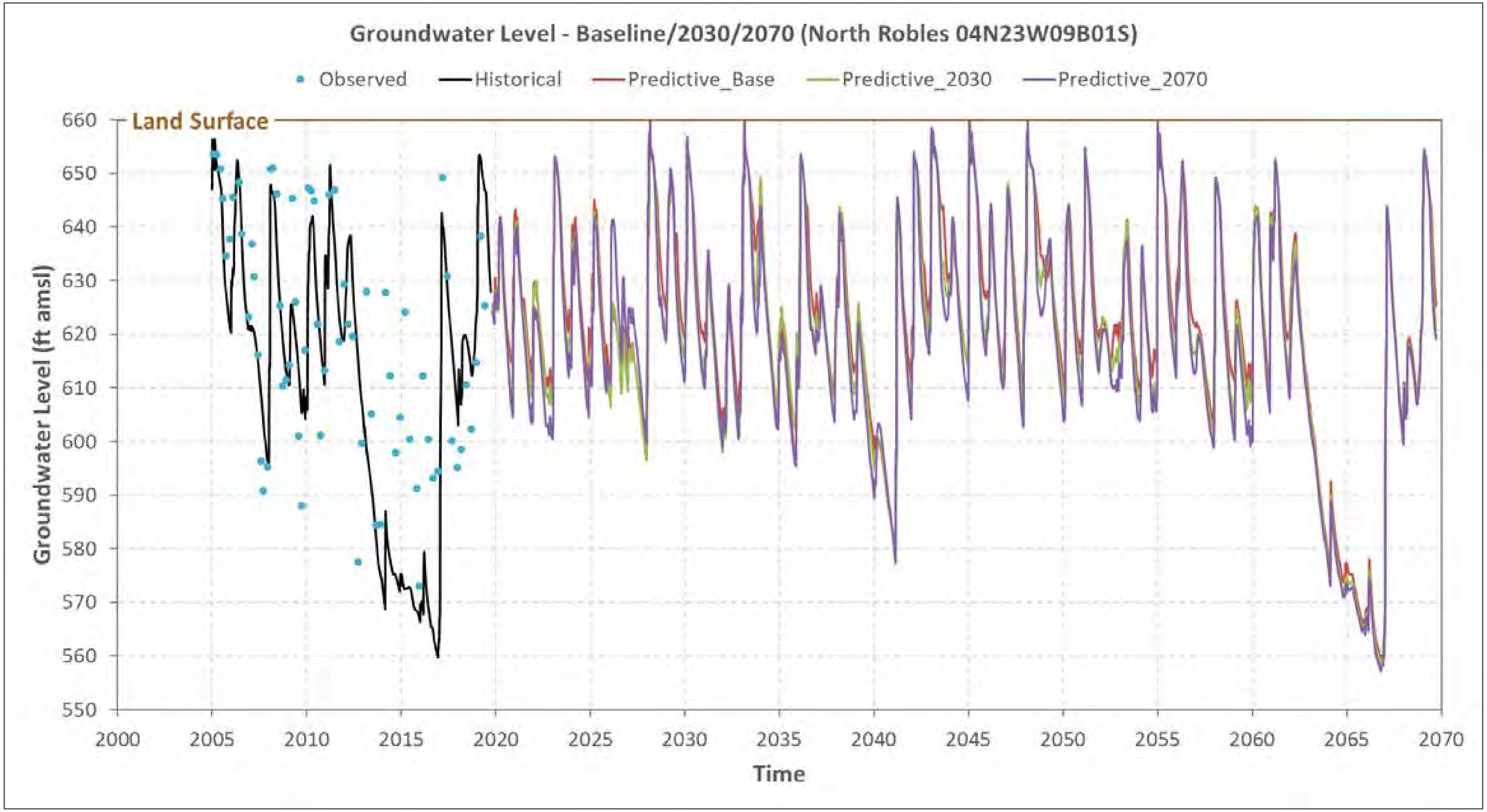


Figure 15.3d. GWL hydrograph (Baseline, 2030, 2070) – North Robles 04N23W09B01S.

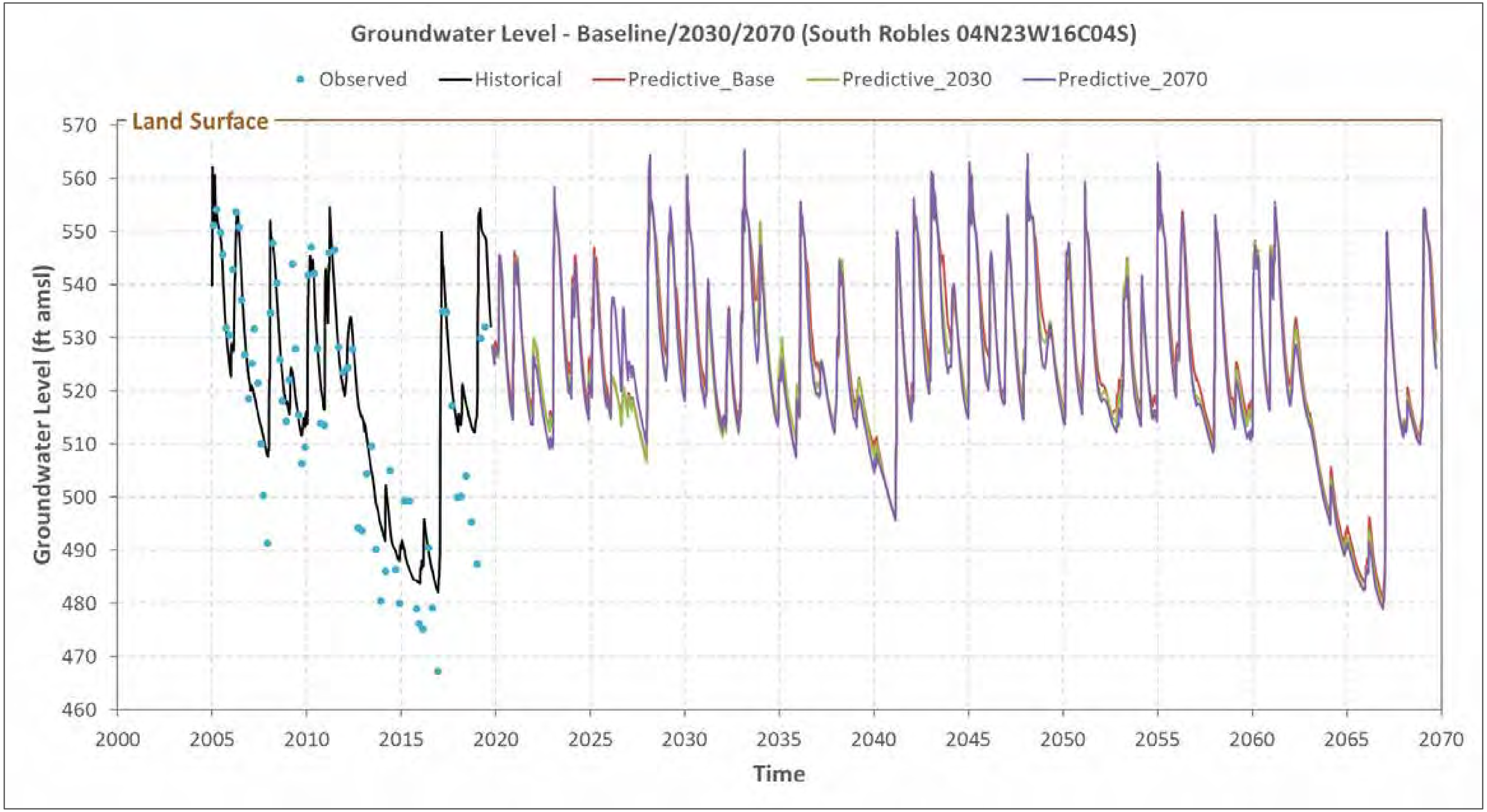


Figure 15.3e. GWL hydrograph (Baseline, 2030, 2070) – South Robles 04N23W16C04S.

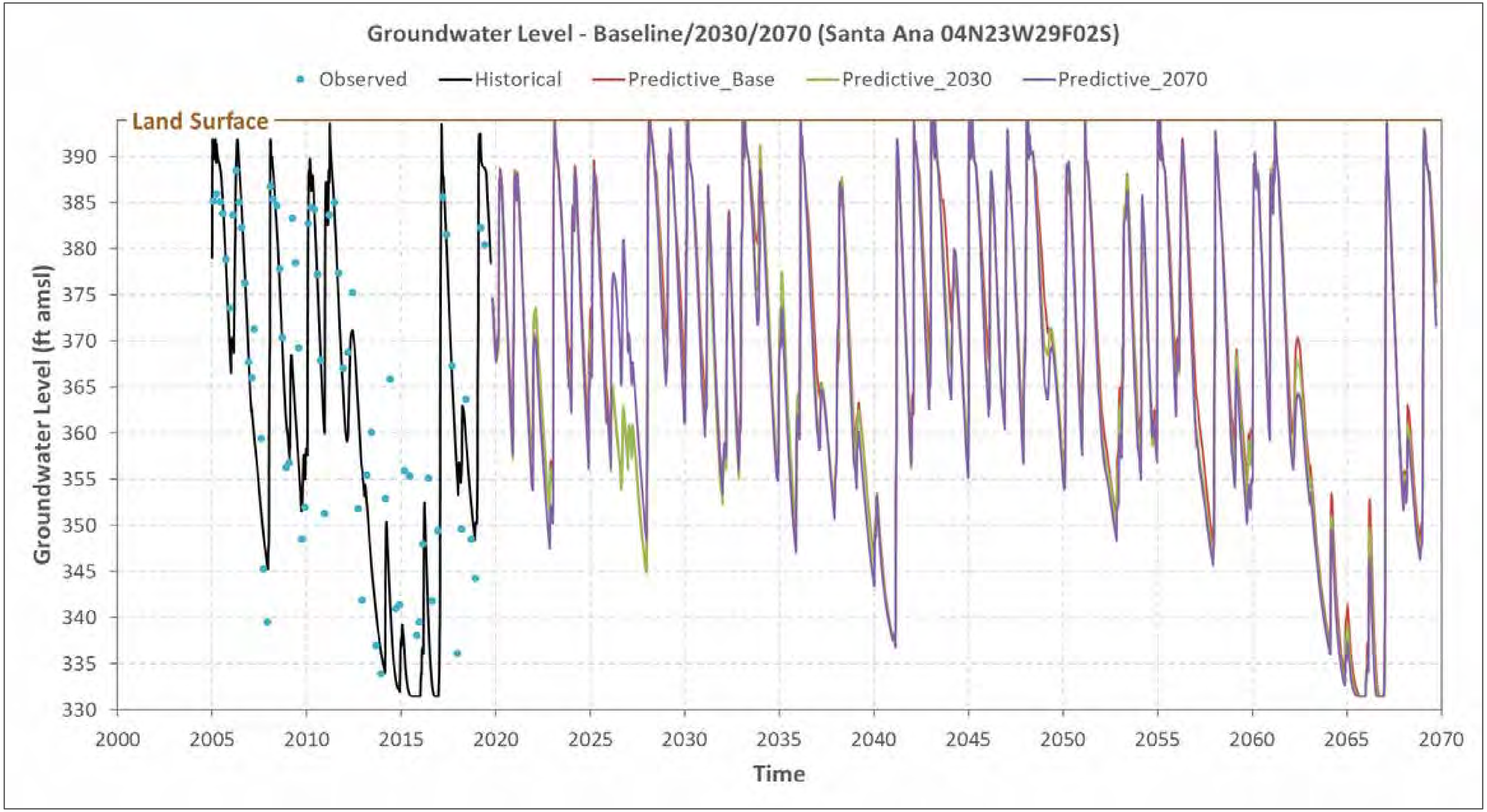


Figure 15.3f. GWL hydrograph (Baseline, 2030, 2070) – Santa Ana 04N23W29F02S.

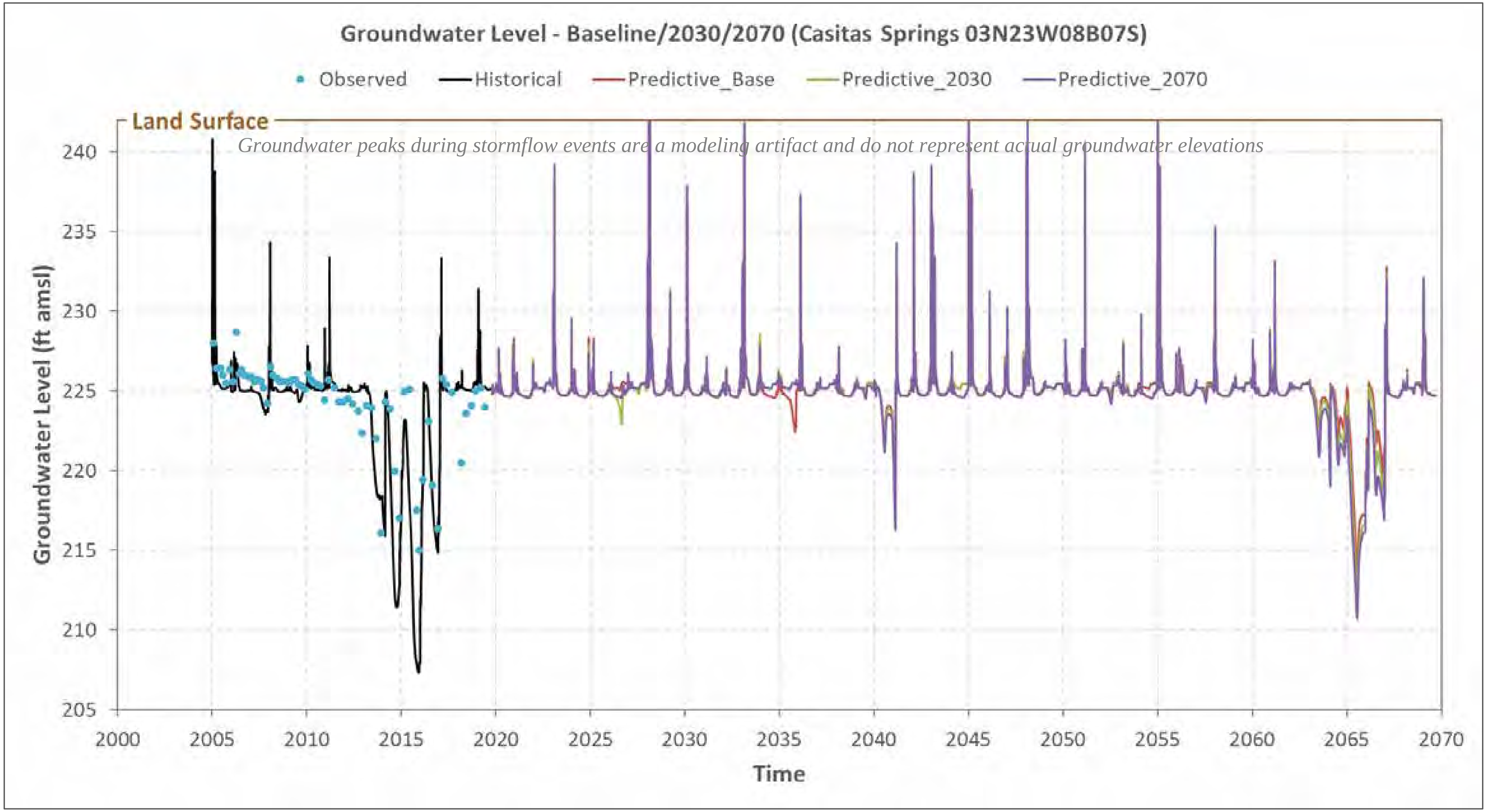


Figure 15.3g. GWL hydrograph (Baseline, 2030, 2070) – Casitas Springs 03N23W08B07S.

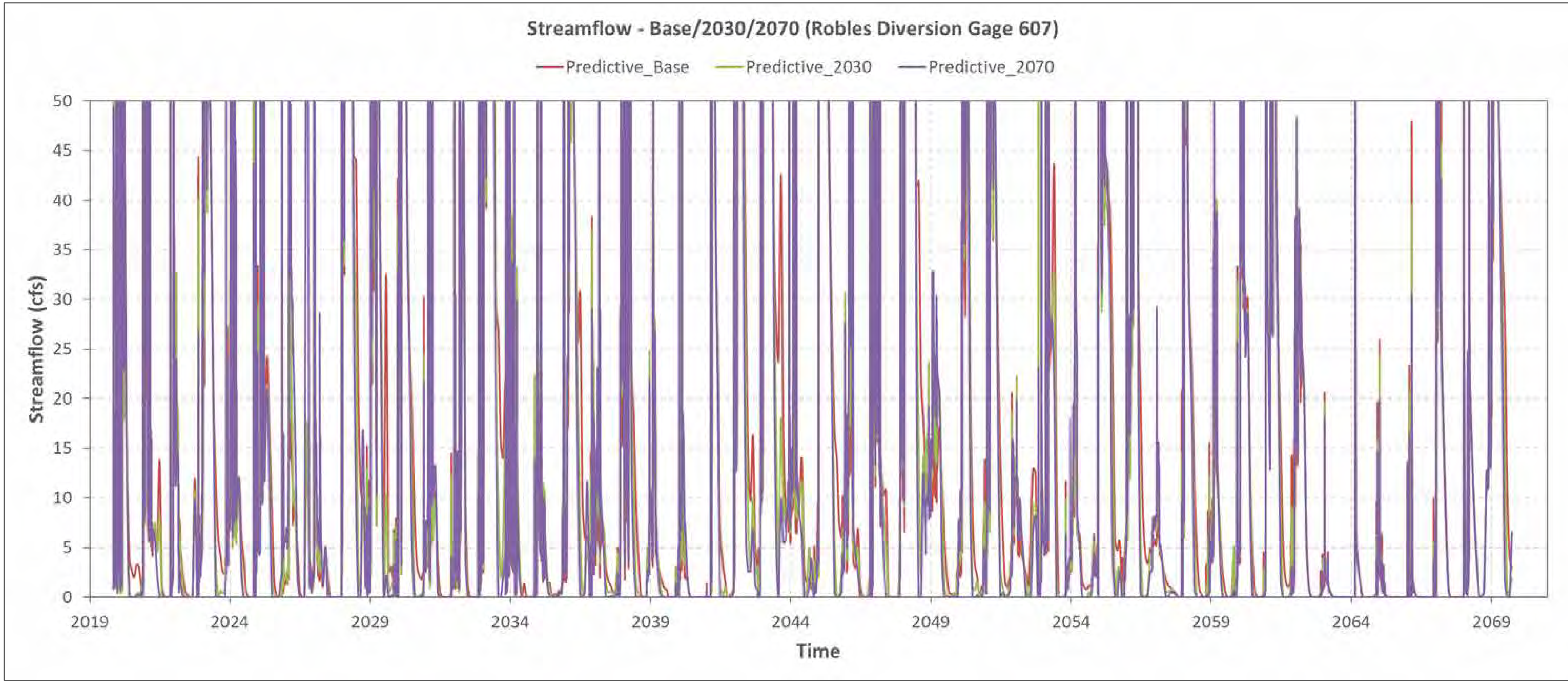


Figure 15.4a. Streamflow hydrograph (Baseline, 2030, 2070) – Robles Diversion Gage 607.

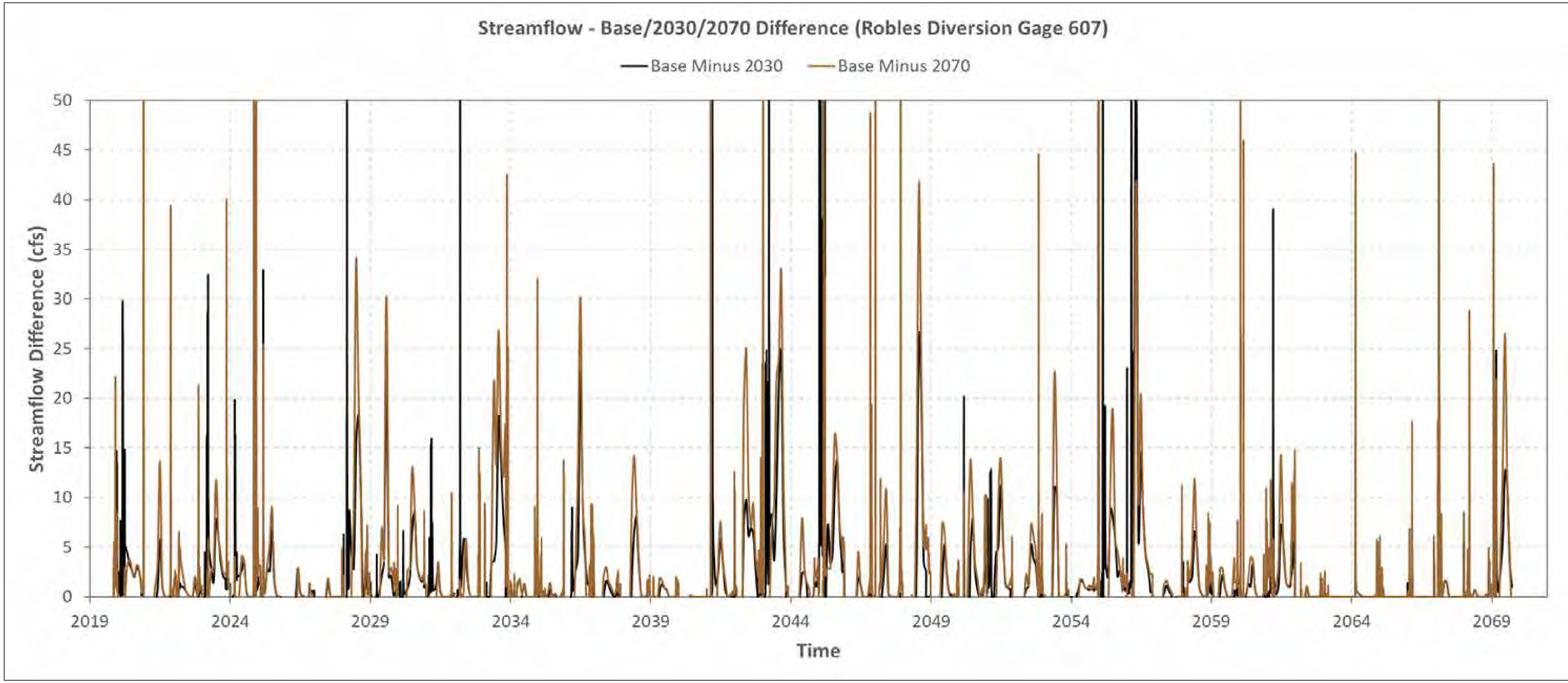


Figure 15.4b. Streamflow hydrograph difference (Baseline, 2030, 2070) – Robles Diversion Gage 607.

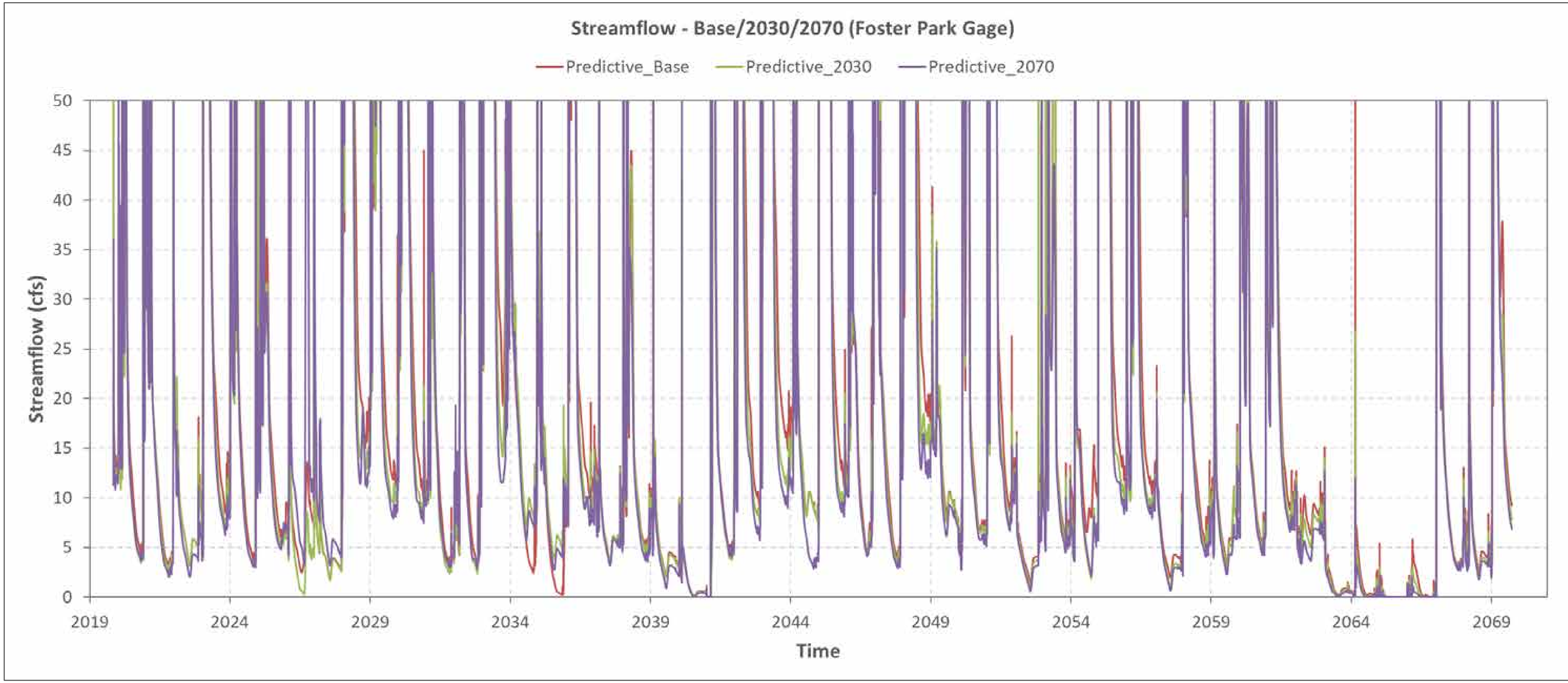


Figure 15.5a. Streamflow hydrograph (Baseline, 2030, 2070) – Foster Park Gage.

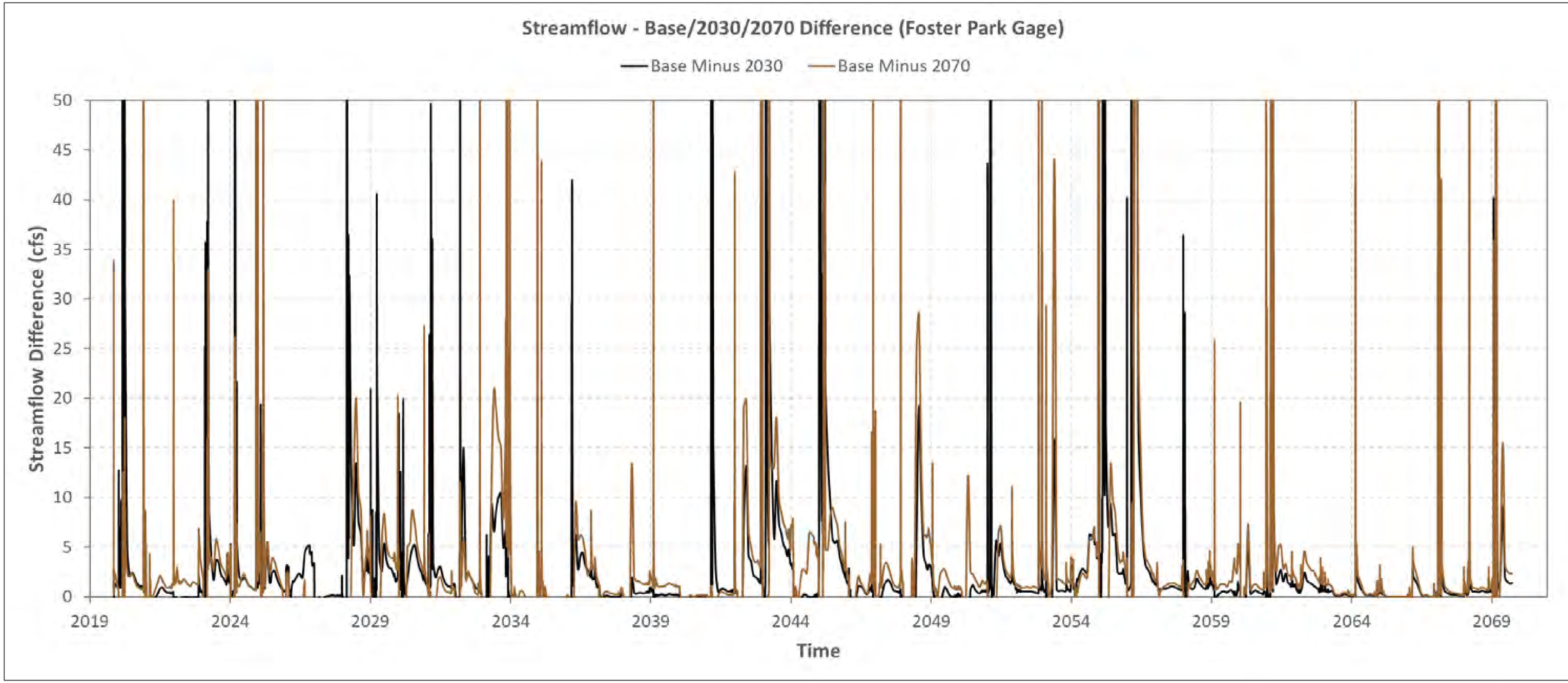


Figure 15.5b. Streamflow hydrograph difference (Baseline, 2030, 2070) – Foster Park Gage.

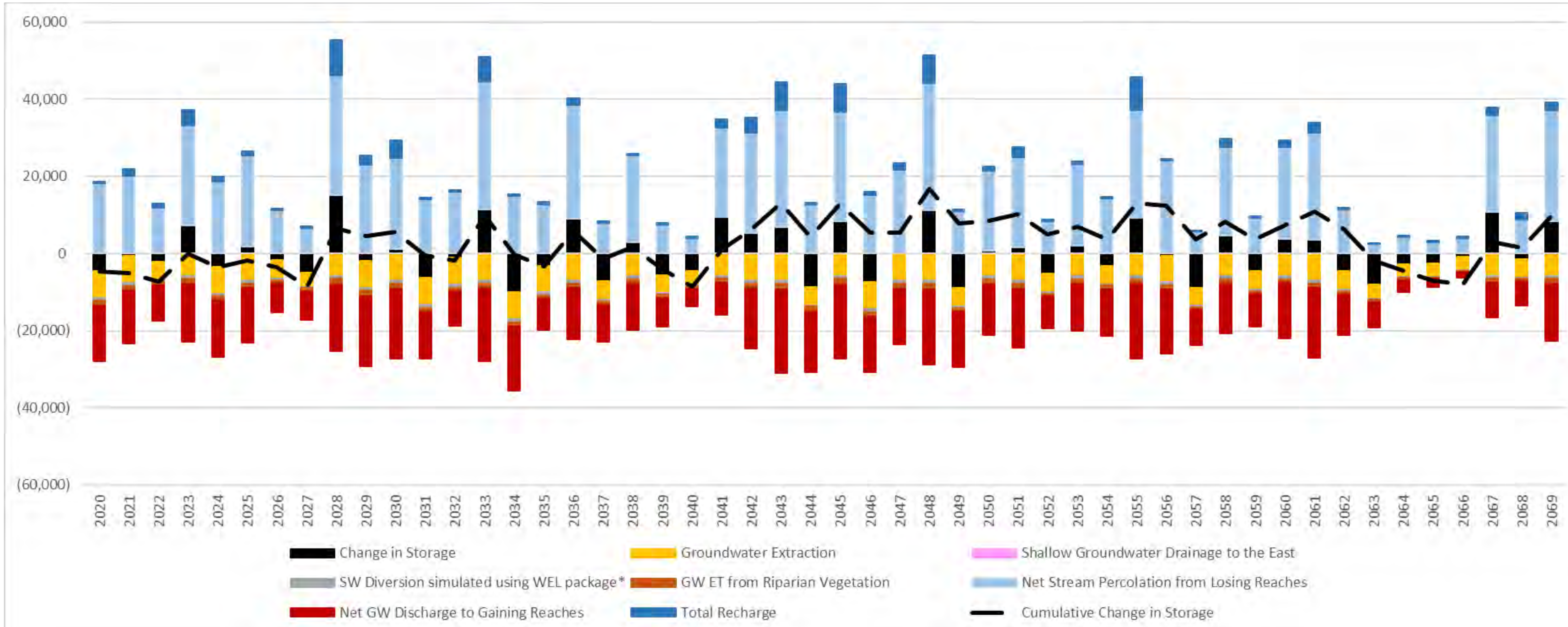


Figure 15.6a. Baseline Projected Annual Groundwater Inflows (positive values) and Outflows (negative values) to/from UVRGB (acre-feet per year).

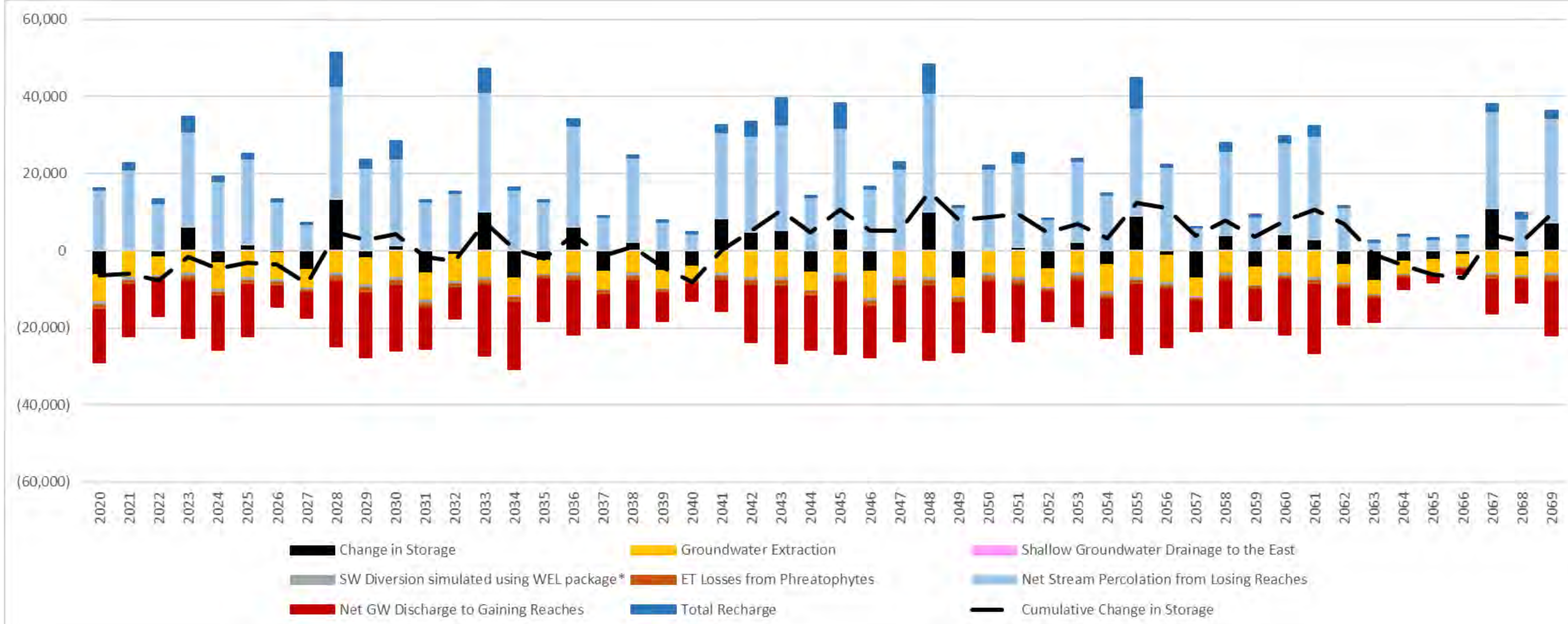


Figure 15.6b Projected Groundwater Budget Components Under the 2030 Climate Change Scenario.

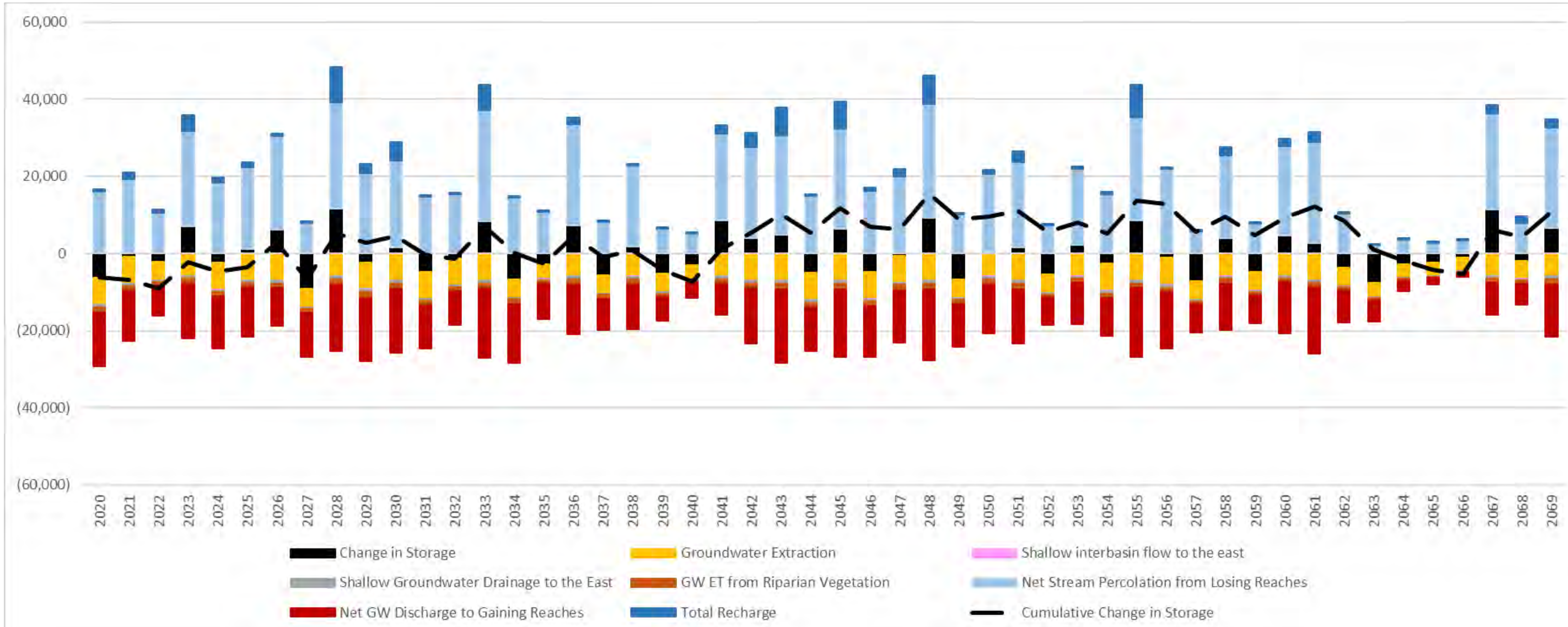


Figure 15.6c. Projected Groundwater Budget Components Under the 2070 Climate Change Scenario.

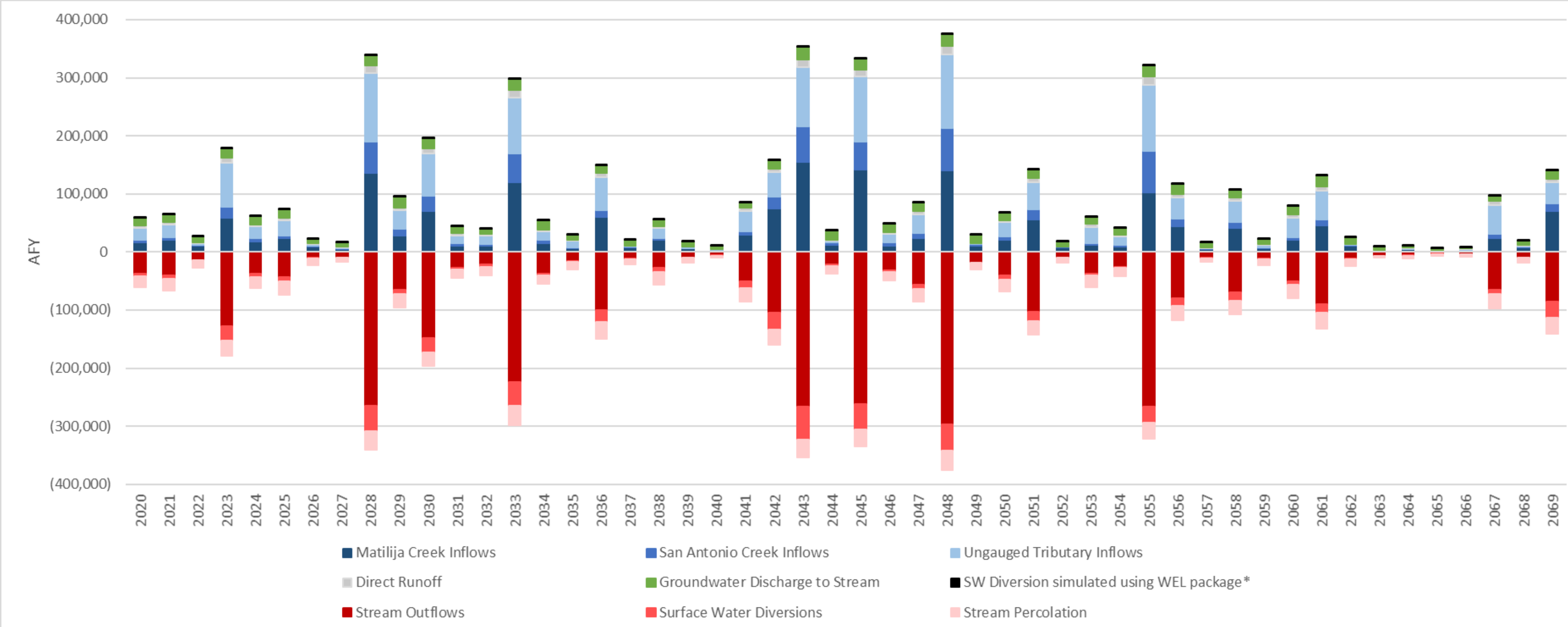


Figure 15.7a. Baseline Projected Annual Surface Water Inflows (positive values) and Outflows (negative values) to/from UVRGB (acre-feet per year).

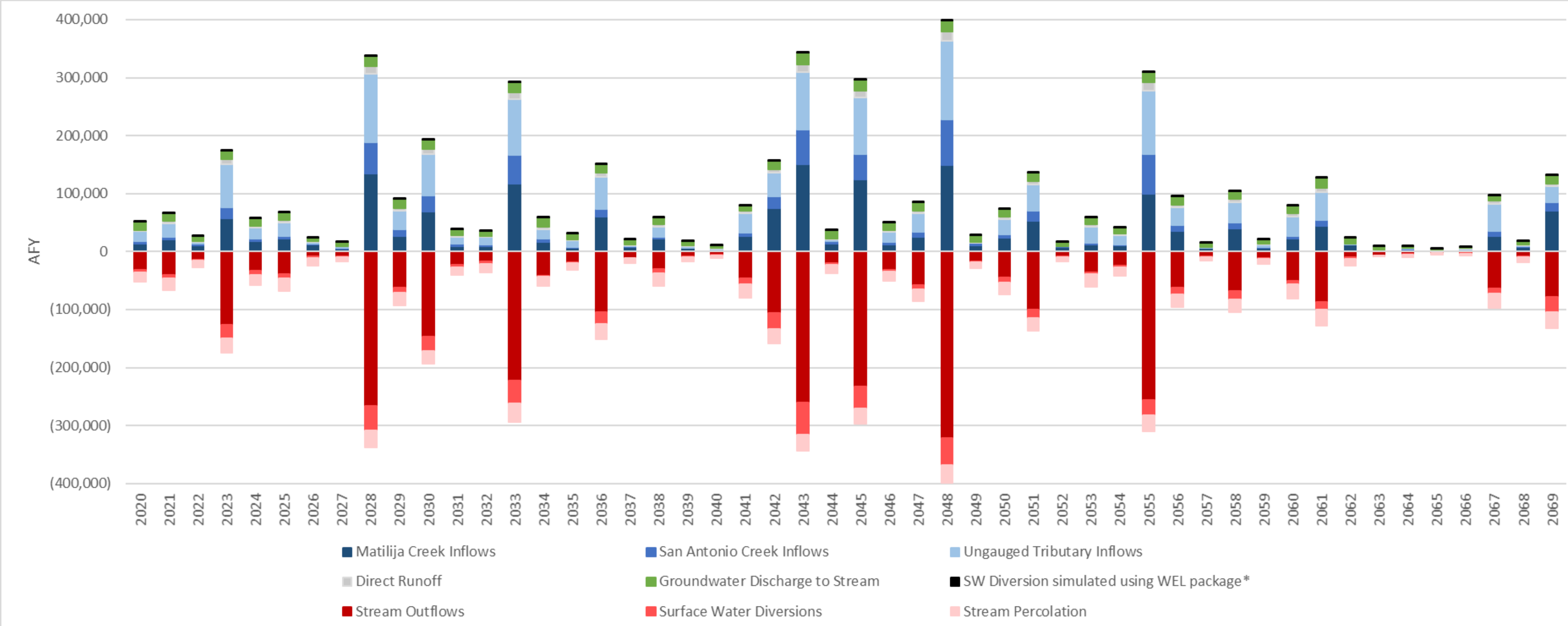


Figure 15.7b. Projected Surface Water Budget Components Under the 2030 Climate Change Scenario.

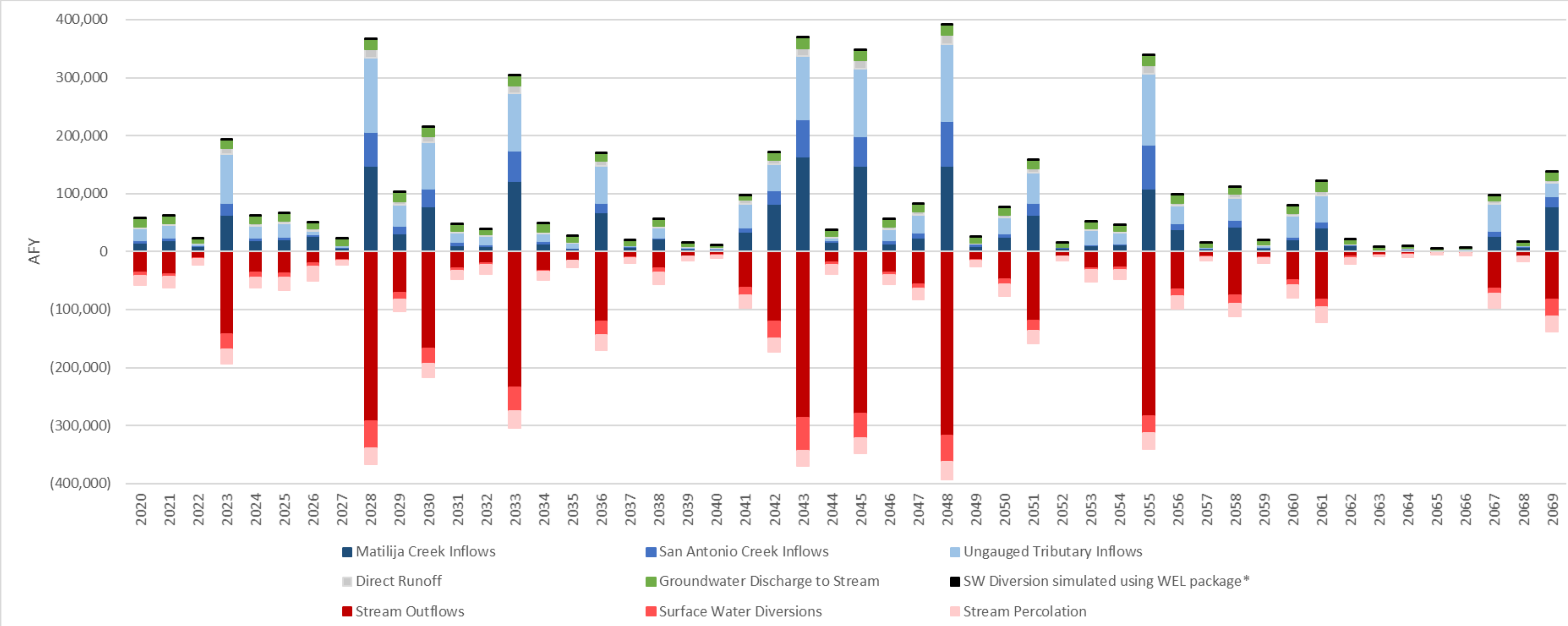


Figure 15.7c. Projected Surface Water Budget Components Under the 2070 Climate Change Scenario.

TABLES

Table 5.1. UVRGM Layers and Active Cells

Model Layer	Stratigraphic Unit(s)	Active Cells	Layer Type
1	Young Alluvium	21,234	Unconfined
2	Mixed/Older Alluvium/Ojai Conglomerate (where present)	25,908	Convertible

Table 6.1. Representative Months for Missing BCM Recharge

Missing Month*	Missing Month Precipitation (in)	Analogous Month	Analogous Month Precipitation (in)
01/2017	10.68	12/2010	10.89
02/2017	9.18	01/2010	7.99
03/2018	7.77	03/2011	7.18
01/2019	7.42	01/2010	7.99
02/2019	8.88	01/2010	7.99
03/2019	4.10	02/2006	5.40
12/2019	6.04	12/2014	4.78

**Months will less than 4 in of rain were assumed to have 0 groundwater recharge consistent with BCM results*

Table 6.2. Annual BCM Recharge and Return Flows

Water Year	Precipitation-Based Recharge	Agricultural Return Flows	M&I Return Flows	Distribution Losses	Septic Return Flows	Total Recharge
2006	152	62	242	97	125	678
2007	0	62	271	108	140	581
2008	1744	62	262	105	135	2308
2009	44	62	245	98	126	575
2010	1478	62	220	88	113	1961
2011	2215	62	206	82	106	2671
2012	0	62	213	85	110	471
2013	5	62	209	84	109	468
2014	0	62	199	80	102	443
2015	42	62	175	70	90	438
2016	6	62	148	59	76	352
2017	1724	62	139	55	72	2052
2018	1309	62	149	59	76	1655
2019	1570	62	143	57	73	1905
Average	*735*	*62*	*202*	*81*	*104*	*1183*

Table 7.1. Curve Number Values and Contributing Areas for each Tributary Sub-Basin

Sub-Basin	Curve Number	Area (acres)
Kennedy Canyon	76.6	1007
Rice Canyon & Wills Canyon	83.2	1380
Cozy Dell Canyon & McDonald Canyon	81.7	2577
Happy Valley Drain	84.0	2121
Mirror Lake Drain	80.7	715
Live Oak Creek	81.9	2279
Oak View Drain	82.6	631
Coyote Creek	81.4	1862
Ventura River	77.3	4988

Table 8.1. Max Rooting Depth, Seasonal Kc, and Spatial Density by Vegetation Group and Hydrogeological Zone

		Season					
Hydrogeological Area	**Vegetation Class**	**Max Rooting Depth (ft)**	**Spring Kc**	**Summer Kc**	**Fall Kc**	**Winter Kc**	**Spatial Density**
Kennedy	Coast Live Oak	30	0.59	0.30	0.36	1.06	2.25
Kennedy	Riparian Mixed Hardwood	13.7	0.90	1.20	1.20	0.85	1.14
Kennedy	Riversidean Alluvial Scrub	5	0.45	0.60	0.45	0.35	1.00
Kennedy	Scalebroom	6	0.45	0.60	0.45	0.35	0.75
Kennedy	Wetland	3	1.05	1.15	0.80	0.75	1.00
Robles (North)	Coast Live Oak	30	0.59	0.30	0.36	1.06	2.00
Robles (North)	Riversidean Alluvial Scrub	5	0.45	0.60	0.45	0.35	1.2
Robles (North)	Scalebroom	6	0.45	0.60	0.45	0.35	1.00
Robles (North)	Wetland	3	1.05	1.15	0.80	0.75	1.00
Robles (North)	Willow_Shrub	30	0.59	0.30	0.36	1.06	1.00
Robles (South)	Coast Live Oak	30	0.59	0.30	0.36	1.06	1.50
Robles (South)	Riversidean Alluvial Scrub	5	0.45	0.60	0.45	0.35	1.20
Robles (South)	Scalebroom	6	0.45	0.60	0.45	0.35	1.00
Robles (South)	Wetland	3	1.05	1.15	0.80	0.75	1.00
Robles (South)	Arundo	16	5.00	5.474	3.81	3.57	0.74
Mira Monte/ Meiners Oaks	Coast Live Oak	30	0.59	0.30	0.36	1.06	2.00
Santa Ana (North)	Riparian Mixed Hardwood	13.7	0.90	1.20	1.20	0.85	1.00
Santa Ana (North)	Riversidean Alluvial Scrub	5	0.45	0.60	0.45	0.35	1.40
Santa Ana (North)	Scalebroom	6	0.45	0.60	0.45	0.35	1.25
Santa Ana (North)	Wetland	3	1.05	1.15	0.80	0.75	1.00
Santa Ana (North)	Arundo	16	5.00	5.47	3.81	3.57	0.63
Santa Ana (South)	Coast Live Oak	30	0.59	0.30	0.36	1.06	1.00
Santa Ana (South)	Riparian Mixed Hardwood	13.7	0.90	1.20	1.20	0.85	0.57
Santa Ana (South)	Riversidean Alluvial Scrub	5	0.45	0.60	0.45	0.35	0.80
Santa Ana (South)	Wetland	3	1.05	1.15	0.80	0.75	1.00
Santa Ana (South)	Arundo	16	5.00	5.47	3.81	3.57	0.74
Casitas Springs	Coast Live Oak	30	0.59	0.30	0.36	1.06	2.25
Casitas Springs	Riparian Mixed Hardwood	13.7	0.90	1.20	1.20	0.85	1.14
Casitas Springs	Riversidean Alluvial Scrub	5	0.45	0.60	0.45	0.35	1.40
Casitas Springs	Wetland	3	1.05	1.15	0.80	0.75	1.00

		Season					
Hydrogeological Area	**Vegetation Class**	**Max Rooting Depth (ft)**	**Spring Kc**	**Summer Kc**	**Fall Kc**	**Winter Kc**	**Spatial Density**
Casitas Springs	Arundo	16	5.00	5.47	3.81	3.57	0.95
Terraces	Coast Live Oak	30	0.59	0.30	0.36	1.06	2.00
Notes:							
Spring: March-May; *Summer: June-August;* *Fall: September-November;* *Winter: December-February*							

Table 9.1. Agricultural Monthly Distribution Factors

Month	Scale Factor
January	0.00000
February	0.02439
March	0.04878
April	0.07317
May	0.09756
June	0.12195
July	0.12195
August	0.12195
September	0.12195
October	0.12195
November	0.12195
December	0.02439
Total	1.00000

Table 13.1. Calibration Statistics (Groundwater Levels)

Calibration Metric	Value
Mean Error	-0.95
Mean Absolute Error (MAE)	6.46
Root Mean Square Error (RMSE)	8.93
Number of Observations	5,284
Range of Observations	612.12
Scaled MAE[1]	0.011
Scaled RMSE[1]	0.015

[1]10% scaled MAE/RMSE is the industry calibration standard (Spitz and Moreno, 1996; Rumbaugh and Rumabugh, 2005)

Table 14.1. Simulated Historical Groundwater Budget

Water Year	Year Type	Precipitation-Based Recharge	Agricultural Return Flows	M&I Return Flows	Septic Return Flows	Distribution losses Return Flows	Net Stream Percolation from Losing Reaches	Net GW Discharge to Gaining Reaches	Shallow Groundwater Drainage to the East	SW Diversion simulated using WEL package	M&I Pumping	Agricultural Pumping	Domestic Pumping	GW ET from Riparian Vegetation	Inflows	Outflows	Change in Storage	Cumulative Change in Storage
2006	Wet	152	62	242	125	97	24,048	(18,642)	(5)	(708)	(4,600)	(215)	(194)	(1,525)	24,726	(25,889)	(1,090)	(1,090)
2007	Dry	0	62	271	140	108	5,509	(8,632)	(3)	(804)	(5,009)	(283)	(196)	(1,359)	6,090	(16,286)	(10,115)	(11,205)
2008	Normal	1,744	62	262	135	105	24,526	(12,588)	(5)	(846)	(5,292)	(266)	(197)	(1,802)	26,834	(20,996)	5,930	(5,274)
2009	Dry	44	62	245	126	98	9,096	(7,178)	(6)	(903)	(5,618)	(290)	(197)	(1,275)	9,670	(15,466)	(5,523)	(10,798)
2010	Wet	1,478	62	220	113	88	24,365	(13,492)	(9)	(886)	(5,542)	(240)	(193)	(1,399)	26,325	(21,763)	4,673	(6,125)
2011	Wet	2,215	62	206	106	82	25,145	(17,267)	(14)	(856)	(4,727)	(252)	(197)	(1,538)	27,816	(24,851)	3,045	(3,080)
2012	Dry	0	62	213	110	85	12,246	(8,768)	(13)	(785)	(5,908)	(284)	(199)	(1,439)	12,717	(17,398)	(4,490)	(7,569)
2013	Dry	5	62	209	109	84	2,225	(5,015)	(12)	(765)	(4,449)	(310)	(196)	(944)	2,693	(11,690)	(8,439)	(16,008)
2014	Dry	0	62	199	102	80	4,041	(573)	(11)	(787)	(4,867)	(266)	(183)	(809)	4,484	(7,497)	(2,532)	(18,540)
2015	Dry	42	62	175	90	70	2,904	(1,056)	(11)	(271)	(2,815)	(294)	(170)	(678)	3,343	(5,296)	(1,808)	(20,348)
2016	Dry	6	62	148	76	59	3,955	(397)	(11)	(207)	(2,944)	(338)	(166)	(662)	4,307	(4,725)	(354)	(20,702)
2017	Wet	1,724	62	116	71	76	24,609	(9,055)	(15)	(256)	(4,494)	(367)	(184)	(1,001)	26,658	(15,372)	11,363	(9,339)
2018	Dry	1,309	62	121	74	78	8,665	(6,363)	(15)	(199)	(4,142)	(335)	(192)	(767)	10,309	(12,012)	(1,592)	(10,931)
2019	Wet	1,570	62	119	73	77	28,938	(16,696)	(18)	(93)	(3,288)	(395)	(192)	(1,314)	30,838	(21,996)	8,939	(1,992)
Average (2006 – 2019)		735	62	196	104	85	14,305	(8,980)	(11)	(598)	(4,550)	(295)	(190)	(1,179)	15,486	(15,803)	(142)	

All values are in acre-feet.

Table 14.2. Simulated Historical Surface Water Budget

Water Year	Year Type	Matilija Creek Inflows	San Antonio Creek Inflows	Ungauged Tributary Inflows	Direct Runoff	Groundwater Discharge to Stream	SW Diversion simulated using WEL package	Stream Outflows	Surface Water Diversions	Stream Percolation	Inflows	Outflows
2006	Wet	44,605	12,527	37,128	5,833	18,642	708	(82,387)	(13,009)	(24,048)	119,444	(119,444)
2007	Dry	5,381	1,270	297	309	8,632	804	(10,120)	(1,064)	(5,509)	16,694	(16,694)
2008	Normal	40,874	10,332	36,188	5,871	12,588	846	(71,136)	(11,036)	(24,526)	106,698	(106,698)
2009	Dry	6,829	1,416	4,032	1,182	7,178	903	(10,759)	(1,685)	(9,096)	21,540	(21,540)
2010	Wet	21,348	4,544	33,228	5,525	13,492	886	(46,999)	(7,660)	(24,365)	79,024	(79,024)
2011	Wet	45,682	10,580	49,632	7,243	17,267	856	(82,672)	(23,443)	(25,145)	131,260	(131,260)
2012	Dry	11,029	901	1,298	742	8,768	785	(10,172)	(1,105)	(12,246)	23,524	(23,524)
2013	Dry	1,817	110	470	478	5,015	765	(5,443)	(987)	(2,225)	8,655	(8,655)
2014	Dry	4,188	685	1,474	1,131	573	787	(2,845)	(1,952)	(4,041)	8,839	(8,839)
2015	Dry	1,978	153	964	843	1,056	271	(1,933)	(427)	(2,904)	5,265	(5,265)
2016	Dry	1,138	501	3,512	1,574	397	207	(3,047)	(327)	(3,955)	7,329	(7,329)
2017	Wet	23,963	7,152	49,881	6,540	9,055	256	(65,770)	(6,468)	(24,609)	96,847	(96,847)
2018	Dry	8,027	1,306	1,842	1,427	6,363	199	(9,621)	(877)	(8,665)	19,164	(19,164)
2019	Wet	69,779	13,801	36,595	5,748	16,696	93	(92,791)	(20,983)	(28,938)	142,711	(142,711)
Average (2006 – 2019)		20,474	4,663	18,324	3,175	8,980	598	(35,407)	(6,502)	(14,305)	56,214	(56,214)

All values are in acre-feet.

Table 15.1a. Predictive Model Scenario Assumptions

Scenario	Simulation Period (Water Year)	Hydrology	Land-Use	(Natural) Areal Recharge	(Natural) Stream Recharge	Managed Recharge	Return Flows (Ag)	Return Flows (M&I)	Pumping/Diversions within UVRGA				
									Groundwater ET (Riparian)	M&I	AG & RMMWC	Dom and Domestic MWCs	Robles Diversion
Baseline (Future with no Climate Change)	50 yrs: 1970 - 2019	Historical Conditions	No change expected due to SOAR (Future = current)	Based on Historical Precip/ET	Based on Historical Hydrology	None	Identify Ag parcels based on areal imagery, Assume 2 AFY/acre applied water, 20% of applied water is return flow	Estimate outdoor water use using VRWD as proxy for all res/comm. land in Basin. Assume 50% of water deliveries are outdoor use. Assume 20% of applied outdoor water is return flow	Based on Historical ET	Non-Drought Extraction (AFY): CMWD: 188 MOWD: 924* VRWD: 950* Ventura: 4,200 * = changed by board 12/10/20 Drought Extraction (AFY): CMWD: 45 MOWD: 487 VRWD: 863 Ventura: 1,573 Three or More Consecutive Years of Drought Extraction (AFY): Ventura: 1,298 CMWD, MOWD, VRWD: same as Drought Extraction above.	Ag Wells Except RMMWC: Scale 2017 pumping estimates by precip. RMMWC Sump (33G03): Drought: 309 AFY (ave 15-18) Non-Drought: 1,034 AFY (ave 05-14) Well 8 (04Q01): most recent year 49 AFY, apply during dry part of year Well 5 (09B01): most recent year 136 AFY, apply during dry part of year	Same as historical period	Develop diversion algorithm based on National Marine Fisheries Service biological opinion rules[2] and CMWD CWRP[3]. Use predictive inflows (combined flows from 602 and 604) for River flow conditions.
2030s Climate Change	50 yrs: 1970 - 2019	Historical impacted by 2030s CC Factors	No change expected due to SOAR (Future = current)	Historical impacted by 2030 CC Precip/ET	Historical impacted by 2030 CC Streamflow	None	Baseline adjusted for increased irrigation demand for 2030 CC	Baseline adjusted for increased outdoor water use for 2030 CC	Based on 2030s CC ET	Same as Baseline	Baseline adjusted for increased irrigation demand for 2030 CC* based on average annual ET change factor (one value)	Same as Baseline	Same as Baseline
2070s Climate Change	50 yrs: 1970 - 2019	Historical impacted by 2070s CC Factors	No change expected due to SOAR (Future = current)	Historical impacted by 2070 CC Precip/ET	Historical impacted by 2070 CC Streamflow	None	Baseline adjusted for increased irrigation demand for 2070 CC	Baseline adjusted for increased outdoor water use for 2070 CC	Based on 2070s CC ET	Same as Baseline	Baseline adjusted for increased irrigation demand for 2070 CC	Same as Baseline	Same as Baseline

[2]https://www.casitaswater.org/home/showpublisheddocument?id=1825
[3]https://www.casitaswater.org/home/showpublisheddocument?id=2553

Table 15.1b. Future Water Usage Assumptions

Return Flows Assumptions		
Scenario	**Ag**	**M&I**
Baseline	Aerial coverage estimated from Ag Commissioner data - same as historical model. 2 acre-ft/year/acre assumed applied water for all crop areas	Water Service Areas for M&I application same as historical model Per-area water usage rates taken from VRWD data (dry years used average of 2015-2019 water usage; wet years used 85% of average of 2005-2009 water usage)
2030	Aerial coverage same as baseline Water usage adjusted by constant average 2030 ET factor	Coverage same as baseline Outdoor M&I water usage increased by average 2030 ET factor
2070	Aerial coverage same as baseline Water usage adjusted by constant average 2070 ET factor	Coverage same as baseline Outdoor M&I water usage increased by average 2070 ET factor

Table 15.2. Monthly Distribution of City of Ventura Pumping

Month	Non-Drought Year	Drought Year	3rd and Subsequent Drought Year
1	0.0384	0.0000	0.0000
2	0.0663	0.1667	0.1667
3	0.0917	0.1667	0.1667
4	0.0947	0.1667	0.1667
5	0.1021	0.1667	0.1667
6	0.0991	0.1667	0.1667
7	0.0977	0.1667	0.1667
8	0.0985	0.0000	0.0000
9	0.0925	0.0000	0.0000
10	0.0903	0.0000	0.0000
11	0.0745	0.0000	0.0000
12	0.0543	0.0000	0.0000

Table 15.3. Distribution of Predictive M&I Pumping Based on Historical Pumping Distributions

Well ID	Agency	Well Name	Well Distribution Factor (Drought)	Well Distribution Factor (Non-Drought)
04N23W16A01S	CMWD	Mira Monte Well #3	1.000	1.000
05N23W33B03S	MOWD	Well 1	0.302	0.238
05N23W33B04S	MOWD	Well 2	0.167	0.1478
04N23W09B05S	MOWD	Well 4	0.232	0.385
04N23W09B04S	MOWD	Well 7	0.298	0.205
04N23W04J01S	MOWD	Well 8	0.001	0.024
04N23W16C08S	VRWD	Well 1	0.766	0.392
04N23W16C07S	VRWD	Well 2	0.025	0.178
04N23W16F04S	VRWD	Well 3	0.133	0.233
04N23W16C10S	VRWD	Well 4	0.074	0.181
04N23W15B01S	VRWD	Well 5	0.000	0.015
04N23W16C11S	VRWD	Well 7	0.001	0.000
03N23W08B01S	City of Ventura	Nye Well #7	0.275	0.237
03N23W08C02S	City of Ventura	Nye Well #8	0.396	0.149
03N23W08B11S	City of Ventura	Nye Well #11	0.041	0.035
Foster Park Subsurface Intake	City of Ventura	Foster Park Subsurface Intake	0.288	0.578
03N23W08B05S	City of Ventura	Nye Well #1	0.000	0.001
03N23W08B02S	City of Ventura	Nye Well #2	0.000	0.001

Table 15.4a. Agricultural Pumping Precipitation Scaling Factors for Baseline

Year	Scaling Factor	Normalized Ratio	Ratio to 2017	Annual Precip. (in/year)
1967	0.97	1.04	1.15	32.62
1968	1.22	0.82	0.55	15.52
1969	0.81	1.23	1.68	47.72
1970	1.17	0.85	0.65	18.48
1971	1.16	0.86	0.68	19.15
1972	1.31	0.76	0.40	11.26
1973	0.95	1.05	1.20	34.10
1974	1.18	0.84	0.62	17.71
1975	1.11	0.90	0.77	21.90
1976	1.23	0.81	0.54	15.20
1977	1.33	0.75	0.37	10.60
1978	0.80	1.25	1.74	49.44
1979	1.09	0.92	0.84	23.72
1980	0.95	1.05	1.19	33.83
1981	1.22	0.82	0.56	15.77
1982	1.15	0.87	0.70	19.95
1983	0.83	1.20	1.60	45.49
1984	1.22	0.82	0.55	15.69
1985	1.23	0.81	0.54	15.24
1986	0.96	1.04	1.16	32.78
1987	1.36	0.73	0.32	9.03
1988	1.18	0.85	0.64	18.10
1989	1.30	0.77	0.42	12.03
1990	1.37	0.73	0.31	8.74
1991	1.14	0.88	0.71	20.19
1992	1.04	0.96	0.96	27.12
1993	0.85	1.18	1.54	43.73
1994	1.26	0.79	0.49	13.76
1995	0.83	1.20	1.60	45.45
1996	1.20	0.84	0.60	17.09
1997	1.09	0.92	0.83	23.47
1998	0.77	1.30	1.88	53.29
1999	1.33	0.75	0.38	10.66
2000	1.15	0.87	0.70	19.73
2001	1.04	0.96	0.95	26.98
2002	1.40	0.72	0.27	7.73
2003	1.08	0.92	0.84	23.95
2004	1.23	0.81	0.54	15.22
2005	0.81	1.24	1.70	48.25
2006	1.07	0.94	0.88	24.96
2007	1.43	0.70	0.23	6.43

Year	Scaling Factor	Normalized Ratio	Ratio to 2017	Annual Precip. (in/year)
2008	1.08	0.92	0.84	23.80
2009	1.27	0.78	0.46	13.02
2010	1.05	0.95	0.91	25.92
2011	1.00	1.00	1.05	29.71
2012	1.31	0.77	0.41	11.59
2013	1.37	0.73	0.31	8.79
2014	1.36	0.73	0.32	9.08
2015	1.33	0.75	0.36	10.32
2016	1.31	0.77	0.41	11.51
2017	1.02	0.98	1.00	28.35
2018	1.32	0.76	0.39	11.13
2019	1.03	0.97	0.96	27.28

Table 15.4b. Agricultural Pumping Precipitation Scaling Factors for 2030

Year	Scaling Factor	Normalized Ratio	Ratio to 2017	Annual Precip. (in/year)
1967	1.01	0.99	1.09	30.79
1968	1.22	0.82	0.59	16.64
1969	0.86	1.17	1.59	44.82
1970	1.20	0.83	0.62	17.63
1971	1.15	0.87	0.74	20.91
1972	1.36	0.74	0.36	10.04
1973	0.98	1.02	1.17	33.12
1974	1.21	0.82	0.61	17.12
1975	1.19	0.84	0.64	18.16
1976	1.21	0.82	0.61	17.10
1977	1.32	0.76	0.42	11.88
1978	0.82	1.22	1.73	48.92
1979	1.10	0.91	0.86	24.23
1980	0.97	1.03	1.20	33.89
1981	1.26	0.80	0.52	14.79
1982	1.17	0.86	0.70	19.78
1983	0.83	1.20	1.69	47.58
1984	1.26	0.79	0.51	14.39
1985	1.26	0.79	0.52	14.60
1986	0.98	1.02	1.16	32.61
1987	1.36	0.74	0.35	9.94
1988	1.18	0.85	0.67	18.82
1989	1.30	0.77	0.44	12.53
1990	1.38	0.72	0.32	8.94
1991	1.16	0.86	0.72	20.22
1992	1.06	0.95	0.95	26.94
1993	0.88	1.14	1.50	42.32
1994	1.27	0.79	0.51	14.26
1995	0.88	1.13	1.49	41.99
1996	1.20	0.83	0.63	17.84
1997	1.10	0.91	0.84	23.64
1998	0.77	1.30	1.97	55.54
1999	1.32	0.76	0.41	11.69
2000	1.14	0.88	0.75	21.20
2001	1.08	0.93	0.90	25.50
2002	1.40	0.72	0.29	8.29
2003	1.12	0.89	0.81	22.74
2004	1.24	0.81	0.56	15.67
2005	0.87	1.15	1.54	43.53
2006	1.12	0.89	0.79	22.42
2007	1.43	0.70	0.25	7.03

Year	Scaling Factor	Normalized Ratio	Ratio to 2017	Annual Precip. (in/year)
2008	1.11	0.90	0.84	23.60
2009	1.28	0.78	0.48	13.58
2010	1.07	0.94	0.93	26.23
2011	1.07	0.94	0.93	26.25
2012	1.32	0.76	0.42	11.77
2013	1.40	0.72	0.29	8.30
2014	1.37	0.73	0.33	9.35
2015	1.36	0.74	0.35	9.92
2016	1.29	0.77	0.46	13.04
2017	1.04	0.96	1.00	28.22
2018	1.35	0.74	0.37	10.44
2019	1.09	0.92	0.88	24.90

Table 15.4c. Agricultural Pumping Precipitation Scaling Factors for 2070

Year	Scaling Factor	Normalized Ratio	Ratio to 2017	Annual Precip. (in/year)
1967	1.00	1.00	1.06	31.74
1968	1.25	0.80	0.49	14.72
1969	0.82	1.21	1.65	49.51
1970	1.17	0.85	0.65	19.52
1971	1.21	0.82	0.57	16.97
1972	1.34	0.75	0.35	10.59
1973	0.96	1.04	1.16	34.90
1974	1.20	0.84	0.60	17.86
1975	1.18	0.84	0.62	18.67
1976	1.12	0.89	0.76	22.82
1977	1.30	0.77	0.42	12.45
1978	0.79	1.27	1.82	54.48
1979	1.07	0.93	0.87	26.13
1980	0.94	1.06	1.22	36.61
1981	1.21	0.82	0.56	16.91
1982	1.13	0.88	0.73	21.77
1983	0.84	1.19	1.59	47.56
1984	1.28	0.78	0.45	13.56
1985	1.25	0.80	0.49	14.68
1986	0.97	1.03	1.15	34.32
1987	1.36	0.73	0.32	9.44
1988	1.18	0.85	0.63	18.98
1989	1.32	0.76	0.38	11.50
1990	1.36	0.74	0.32	9.55
1991	1.13	0.88	0.74	22.03
1992	1.03	0.97	0.97	28.92
1993	0.85	1.17	1.53	45.93
1994	1.25	0.80	0.50	15.00
1995	0.85	1.18	1.55	46.54
1996	1.18	0.85	0.62	18.73
1997	1.09	0.92	0.82	24.62
1998	0.77	1.30	1.90	56.83
1999	1.32	0.76	0.38	11.33
2000	1.13	0.88	0.73	21.89
2001	1.04	0.96	0.94	28.23
2002	1.41	0.71	0.25	7.50
2003	1.13	0.88	0.73	21.81
2004	1.24	0.81	0.52	15.69
2005	0.84	1.20	1.61	48.15
2006	1.12	0.89	0.75	22.51
2007	1.43	0.70	0.22	6.53

Year	Scaling Factor	Normalized Ratio	Ratio to 2017	Annual Precip. (in/year)
2008	1.08	0.92	0.84	25.30
2009	1.28	0.78	0.44	13.13
2010	1.07	0.94	0.89	26.56
2011	1.04	0.97	0.96	28.79
2012	1.33	0.75	0.37	10.98
2013	1.40	0.71	0.25	7.64
2014	1.38	0.73	0.29	8.67
2015	1.35	0.74	0.34	10.17
2016	1.28	0.78	0.44	13.24
2017	1.02	0.98	1.00	29.96
2018	1.30	0.77	0.41	12.16
2019	1.05	0.95	0.93	27.80

Table 15.5a. Predictive Pumping Volumes by Category for Baseline

Water Year	De Minimus (AF)	Domestic MWCs (AF)	M&I (AF)	Ag (AF)
1970	162	31	6261	468
1971	161	31	6262	491
1972	157	31	4053	520
1973	162	31	5177	461
1974	162	31	6262	480
1975	160	31	6262	484
1976	156	31	4053	501
1977	153	31	2967	527
1978	165	31	5177	431
1979	164	31	6262	451
1980	166	31	6262	446
1981	161	31	6262	486
1982	156	31	6262	489
1983	165	31	6262	426
1984	161	31	6262	477
1985	155	31	6262	508
1986	159	31	6262	458
1987	159	31	4053	516
1988	160	31	5177	508
1989	154	31	4053	518
1990	147	31	2967	534
1991	154	31	5177	495
1992	163	31	6262	466
1993	168	31	6262	423
1994	162	31	4053	488
1995	166	31	5177	435
1996	163	31	6262	475
1997	162	31	6262	479
1998	166	31	6262	410
1999	163	31	4053	495
2000	160	31	5177	500
2001	162	31	6262	467
2002	157	31	4053	527
2003	160	31	5177	491
2004	158	31	4053	499
2005	166	31	5177	429
2006	163	31	6262	448
2007	157	31	4053	536
2008	160	31	5177	495
2009	156	31	4053	507
2010	160	31	5177	478

Water Year	De Minimus (AF)	Domestic MWCs (AF)	M&I (AF)	Ag (AF)
2011	162	31	6262	453
2012	161	31	4053	507
2013	151	31	2967	535
2014	144	31	2692	503
2015	131	31	2692	489
2016	126	31	2692	479
2017	147	31	5177	448
2018	154	31	4053	508
2019	159	31	5177	478

Table 15.5b. Predictive Pumping Volumes by Category for 2030

Water Year	De Minimus (AF)	Domestic MWCs (AF)	M&I (AF)	Ag (AF)
1970	161	31	6261	497
1971	160	31	6262	511
1972	158	31	4053	547
1973	162	31	5177	490
1974	161	31	6262	506
1975	160	31	6262	519
1976	155	31	6262	523
1977	152	31	4053	545
1978	165	31	5177	452
1979	164	31	6262	474
1980	165	31	6262	469
1981	158	31	6262	513
1982	155	31	6262	514
1983	165	31	6262	445
1984	161	31	4053	508
1985	156	31	2967	539
1986	159	31	5177	484
1987	157	31	4053	538
1988	160	31	5177	531
1989	154	31	4053	540
1990	147	31	2967	558
1991	153	31	5177	513
1992	162	31	6262	491
1993	168	31	6262	448
1994	162	31	4053	512
1995	165	31	5177	464
1996	162	31	6262	497
1997	161	31	6262	501
1998	166	31	6262	427
1999	163	31	4053	515
2000	159	31	5177	520
2001	162	31	6262	494
2002	155	31	4053	553
2003	158	31	5177	519
2004	158	31	6262	523
2005	166	31	6262	459
2006	162	31	6262	483
2007	154	31	4053	562
2008	160	31	5177	519
2009	155	31	4053	528
2010	160	31	5177	500

Water Year	De Minimus (AF)	Domestic MWCs (AF)	M&I (AF)	Ag (AF)
2011	162	31	6262	484
2012	159	31	4053	536
2013	150	31	2967	564
2014	143	31	2692	527
2015	127	31	2692	514
2016	125	31	2692	496
2017	147	31	5177	468
2018	153	31	4053	538
2019	159	31	5177	511

Table 15.5c. Predictive Pumping Volumes by Category for 2070

Year	De Minimus (AF)	Domestic MWCs (AF)	M&I (AF)	Ag (AF)
1969	165	31	6261	510
1970	164	31	6262	544
1971	160	31	4053	568
1972	165	31	5177	506
1973	164	31	6262	524
1974	164	31	6262	536
1975	163	31	6262	526
1976	162	31	4053	559
1977	169	31	5177	463
1978	168	31	6262	487
1979	169	31	6262	481
1980	163	31	6262	526
1981	160	31	6262	526
1982	169	31	6262	463
1983	165	31	4053	529
1984	159	31	2967	557
1985	163	31	5177	502
1986	160	31	4053	562
1987	163	31	5177	552
1988	156	31	4053	560
1989	151	31	2967	578
1990	157	31	5177	526
1991	166	31	6262	504
1992	171	31	6262	461
1993	166	31	6262	530
1994	170	31	6262	476
1995	166	31	6262	512
1996	164	31	6262	518
1997	170	31	6262	445
1998	166	31	4053	538
1999	163	31	5177	540
2000	166	31	6262	508
2001	158	31	4053	577
2002	161	31	5177	545
2003	162	31	6262	543
2004	170	31	6262	473
2005	166	31	6262	501
2006	158	31	4053	588
2007	164	31	5177	536
2008	157	31	4053	547
2009	163	31	5177	521

Year	De Minimus (AF)	Domestic MWCs (AF)	M&I (AF)	Ag (AF)
2010	166	31	6262	497
2011	161	31	4053	558
2012	154	31	2967	581
2013	147	31	2692	551
2014	129	31	2692	534
2015	127	31	2692	515
2016	150	31	5177	483
2017	157	31	4053	551
2018	163	31	5177	522
2019	165	31	6261	510

Table 15.6a. Simulated Future Groundwater Budget (Baseline Conditions)

Water Year	Year Type	Precipitation-Based Recharge	Agricultural Return Flows	M&I Return Flows	Septic Return Flows	Distribution losses Return Flows	Net Stream Percolation from Losing Reaches	Net GW Discharge to Gaining Reaches	Shallow Groundwater Drainage to the East	SW Diversion simulated using WEL package	M&I Pumping	Agricultural Pumping	Domestic Pumping	GW ET from Riparian Vegetation	Inflows	Outflows	Change in Storage	Cumulative Change in Storage
2020	Normal	53	62	201	102	80	18,203	(14,334)	(13)	(784)	(6,261)	(468)	(193)	(1,294)	18,700	(23,347)	(4,548)	(4,548)
2021	Normal	1,336	62	201	102	80	20,213	(13,795)	(15)	(784)	(6,262)	(491)	(192)	(1,159)	21,994	(22,699)	(607)	(5,154)
2022	Dry	670	62	177	90	71	11,868	(9,160)	(15)	(302)	(4,053)	(520)	(188)	(946)	12,938	(15,185)	(2,139)	(7,294)
2023	Wet	3,590	62	193	98	77	26,002	(15,081)	(19)	(716)	(5,177)	(461)	(193)	(1,225)	30,021	(22,873)	7,244	(50)
2024	Normal	888	62	201	102	80	18,707	(14,646)	(20)	(784)	(6,262)	(480)	(193)	(1,135)	20,039	(23,521)	(3,383)	(3,432)
2025	Normal	782	62	201	102	80	23,604	(14,371)	(19)	(784)	(6,262)	(484)	(191)	(1,100)	24,831	(23,212)	1,729	(1,703)
2026	Dry	66	62	177	90	71	11,130	(7,523)	(17)	(302)	(4,053)	(501)	(187)	(892)	11,596	(13,475)	(1,777)	(3,480)
2027	Dry	30	62	169	86	68	6,556	(7,376)	(14)	(234)	(2,967)	(527)	(184)	(793)	6,970	(12,096)	(5,012)	(8,492)
2028	Wet	8,713	62	193	98	77	31,183	(17,358)	(34)	(716)	(5,177)	(431)	(196)	(1,443)	40,325	(25,355)	15,062	6,570
2029	Normal	1,887	62	201	102	80	23,025	(18,290)	(37)	(784)	(6,262)	(451)	(195)	(1,356)	25,356	(27,376)	(1,922)	4,648
2030	Wet	4,233	62	201	102	81	23,588	(18,163)	(46)	(784)	(6,262)	(446)	(198)	(1,361)	28,267	(27,260)	1,097	5,744
2031	Normal	69	62	201	102	80	13,958	(12,069)	(37)	(784)	(6,262)	(486)	(192)	(1,117)	14,472	(20,947)	(6,320)	(575)
2032	Normal	60	62	201	102	80	15,940	(9,017)	(31)	(784)	(6,262)	(489)	(187)	(939)	16,445	(17,710)	(1,111)	(1,687)
2033	Wet	5,935	62	201	102	80	33,073	(18,954)	(51)	(784)	(6,262)	(426)	(196)	(1,349)	39,452	(28,023)	11,517	9,830
2034	Normal	75	62	201	102	81	14,870	(16,633)	(42)	(784)	(6,262)	(477)	(192)	(1,184)	15,391	(25,576)	(9,996)	(167)
2035	Normal	87	62	201	102	80	12,791	(7,943)	(35)	(784)	(6,262)	(508)	(186)	(893)	13,322	(16,611)	(3,127)	(3,293)
2036	Wet	1,258	62	201	102	80	29,514	(13,203)	(36)	(784)	(6,262)	(458)	(190)	(1,249)	31,216	(22,183)	9,133	5,840
2037	Dry	0	62	177	90	71	7,972	(9,713)	(31)	(302)	(4,053)	(516)	(190)	(900)	8,371	(15,705)	(7,229)	(1,389)
2038	Normal	55	62	193	98	77	22,357	(12,134)	(27)	(716)	(5,177)	(508)	(191)	(1,179)	22,842	(19,932)	3,016	1,627
2039	Dry	36	62	177	90	71	7,400	(7,557)	(23)	(302)	(4,053)	(518)	(185)	(844)	7,835	(13,483)	(5,546)	(3,919)
2040	Dry	16	62	169	86	68	3,997	(4,564)	(21)	(234)	(2,967)	(534)	(178)	(620)	4,396	(9,118)	(4,613)	(8,532)
2041	Normal	1,658	62	193	98	77	23,217	(8,273)	(23)	(716)	(5,177)	(495)	(185)	(1,051)	25,304	(15,920)	9,495	962
2042	Wet	3,474	62	201	102	81	25,963	(15,553)	(31)	(784)	(6,262)	(466)	(194)	(1,322)	29,883	(24,613)	5,367	6,329
2043	Wet	6,739	62	201	102	80	30,548	(21,776)	(54)	(784)	(6,262)	(423)	(199)	(1,525)	37,732	(31,023)	6,801	13,130
2044	Dry	88	62	177	90	71	12,657	(15,742)	(41)	(302)	(4,053)	(488)	(193)	(1,137)	13,145	(21,957)	(8,698)	4,432
2045	Wet	6,751	62	193	98	77	28,389	(19,160)	(66)	(716)	(5,177)	(435)	(197)	(1,512)	35,569	(27,264)	8,397	12,829
2046	Normal	287	62	201	102	81	15,199	(14,384)	(54)	(784)	(6,262)	(475)	(194)	(1,253)	15,932	(23,407)	(7,380)	5,449
2047	Normal	1,307	62	201	102	80	21,742	(14,511)	(53)	(784)	(6,262)	(479)	(193)	(1,292)	23,494	(23,575)	26	5,475
2048	Wet	6,722	62	201	102	80	32,900	(19,646)	(87)	(784)	(6,262)	(410)	(197)	(1,492)	40,067	(28,878)	11,278	16,754
2049	Dry	1	62	177	90	71	11,049	(14,316)	(64)	(302)	(4,053)	(495)	(194)	(1,068)	11,449	(20,492)	(8,935)	7,819
2050	Normal	597	62	193	98	77	20,738	(13,178)	(57)	(716)	(5,177)	(500)	(191)	(1,284)	21,765	(21,103)	766	8,585
2051	Wet	2,185	62	201	102	80	23,379	(15,319)	(62)	(784)	(6,262)	(467)	(193)	(1,346)	26,009	(24,434)	1,671	10,256
2052	Dry	0	62	177	90	71	8,425	(8,314)	(50)	(302)	(4,053)	(527)	(188)	(756)	8,824	(14,190)	(5,256)	5,000
2053	Normal	260	62	193	98	77	21,285	(12,453)	(44)	(716)	(5,177)	(491)	(191)	(1,083)	21,974	(20,155)	1,945	6,945
2054	Dry	104	62	177	90	71	14,300	(12,043)	(39)	(302)	(4,053)	(499)	(189)	(1,020)	14,804	(18,145)	(3,248)	3,698
2055	Wet	7,991	62	193	98	77	28,030	(19,511)	(81)	(716)	(5,177)	(429)	(197)	(1,115)	36,451	(27,226)	9,314	13,012
2056	Wet	152	62	201	102	80	24,059	(16,550)	(60)	(784)	(6,262)	(448)	(194)	(1,002)	24,655	(25,300)	(552)	12,459
2057	Dry	0	62	177	90	71	5,679	(9,118)	(48)	(302)	(4,053)	(536)	(188)	(730)	6,078	(14,974)	(8,788)	3,672
2058	Normal	1,744	62	193	98	77	22,971	(12,935)	(50)	(716)	(5,177)	(495)	(191)	(1,123)	25,145	(20,688)	4,564	8,236
2059	Dry	44	62	177	90	71	9,279	(8,555)	(41)	(302)	(4,053)	(507)	(187)	(790)	9,721	(14,436)	(4,605)	3,631
2060	Wet	1,478	62	193	98	77	23,742	(14,380)	(43)	(716)	(5,177)	(478)	(191)	(973)	25,649	(21,959)	3,787	7,418
2061	Wet	2,215	62	201	102	80	27,834	(18,164)	(47)	(784)	(6,262)	(453)	(193)	(1,139)	30,493	(27,044)	3,539	10,958
2062	Dry	0	62	177	90	71	11,493	(10,563)	(39)	(302)	(4,053)	(507)	(192)	(918)	11,893	(16,575)	(4,572)	6,385
2063	Dry	5	62	169	86	68	2,380	(6,457)	(33)	(234)	(2,967)	(535)	(182)	(601)	2,768	(11,010)	(8,099)	(1,714)
2064	Dry	0	62	169	86	68	4,178	(3,153)	(28)	(234)	(2,692)	(503)	(175)	(566)	4,561	(7,353)	(2,704)	(4,418)
2065	Dry	42	62	169	86	68	2,989	(2,206)	(25)	(234)	(2,692)	(489)	(162)	(294)	3,414	(6,102)	(2,618)	(7,035)
2066	Dry	6	62	169	86	68	4,006	(1,407)	(22)	(234)	(2,692)	(479)	(157)	(365)	4,397	(5,358)	(876)	(7,911)
2067	Wet	1,724	62	193	98	77	24,973	(8,996)	(26)	(716)	(5,177)	(448)	(178)	(948)	27,127	(16,489)	10,851	2,940
2068	Dry	1,309	62	177	90	71	8,857	(6,282)	(25)	(302)	(4,053)	(508)	(185)	(759)	10,565	(12,114)	(1,421)	1,519
2069	Wet	1,570	62	193	98	77	28,880	(14,802)	(28)	(716)	(5,177)	(478)	(190)	(1,258)	30,880	(22,650)	8,331	9,849
Average (2020-2069)		1,566	62	189	96	76	17,902	(12,393)	(38)	(586)	(5,060)	(482)	(189)	(1,054)	19,891	(19,802)	197	2,944

All values are in acre-feet.

Table 15.6b. Groundwater Budget Table for 2030

Water Year	Year Type	Precipitation-Based Recharge	Agricultural Return Flows	M&I Return Flows	Septic Return Flows	Distribution losses Return Flows	Net Stream Percolation from Losing Reaches	Net GW Discharge to Gaining Reaches	Shallow Groundwater Drainage to the East	SW Diversion simulated using WEL package	M&I Pumping	Agricultural Pumping	Domestic Pumping	GW ET from Riparian Vegetation	Inflows	Outflows	Change in Storage	Cumulative Change in Storage
2020	Normal	46	64	209	102	80	15,737	(13,609)	(13)	(817)	(6,261)	(497)	(192)	(1,303)	16,238	(22,692)	(6,299)	(6,299)
2021	Normal	1,295	64	209	102	80	20,698	(13,270)	(15)	(817)	(6,262)	(511)	(191)	(1,201)	22,448	(22,267)	365	(5,935)
2022	Dry	690	64	185	90	71	12,347	(9,171)	(15)	(315)	(4,053)	(547)	(189)	(989)	13,447	(15,278)	(1,720)	(7,654)
2023	Wet	3,432	64	201	98	77	24,830	(14,750)	(19)	(747)	(5,177)	(490)	(193)	(1,257)	28,702	(22,632)	6,161	(1,493)
2024	Normal	819	64	209	102	80	17,971	(13,681)	(20)	(817)	(6,262)	(506)	(192)	(1,143)	19,246	(22,621)	(3,106)	(4,599)
2025	Normal	695	64	209	102	80	22,416	(13,260)	(19)	(817)	(6,262)	(519)	(191)	(1,104)	23,567	(22,172)	1,583	(3,016)
2026	Normal	69	64	210	102	81	12,781	(5,431)	(16)	(817)	(6,262)	(523)	(186)	(909)	13,307	(14,145)	(538)	(3,554)
2027	Dry	34	64	184	90	71	6,947	(6,572)	(14)	(315)	(4,053)	(545)	(183)	(819)	7,390	(12,501)	(4,998)	(8,552)
2028	Wet	8,377	64	201	98	77	29,308	(16,815)	(33)	(747)	(5,177)	(452)	(196)	(1,440)	38,125	(24,859)	13,361	4,809
2029	Wet	1,798	64	209	102	80	21,485	(16,634)	(35)	(817)	(6,262)	(474)	(195)	(1,351)	23,739	(25,769)	(1,936)	2,873
2030	Wet	4,142	64	210	102	81	22,639	(16,823)	(43)	(817)	(6,262)	(469)	(196)	(1,379)	27,238	(25,990)	1,358	4,231
2031	Normal	61	64	209	102	80	12,776	(10,610)	(35)	(817)	(6,262)	(513)	(189)	(1,117)	13,292	(19,544)	(5,895)	(1,664)
2032	Normal	53	64	209	102	80	14,955	(8,023)	(29)	(817)	(6,262)	(514)	(186)	(945)	15,463	(16,777)	(960)	(2,624)
2033	Wet	5,747	64	209	102	80	31,054	(18,097)	(48)	(817)	(6,262)	(445)	(196)	(1,356)	37,257	(27,221)	10,124	7,500
2034	Dry	78	64	185	90	71	15,897	(17,246)	(40)	(315)	(4,053)	(508)	(192)	(1,227)	16,385	(23,582)	(7,091)	409
2035	Dry	91	64	176	86	68	12,684	(10,823)	(34)	(244)	(2,967)	(539)	(187)	(974)	13,168	(15,768)	(2,493)	(2,084)
2036	Wet	1,216	64	201	98	77	26,296	(13,993)	(34)	(747)	(5,177)	(484)	(190)	(1,262)	27,952	(21,887)	6,163	4,079
2037	Dry	0	64	184	90	71	8,722	(8,551)	(29)	(315)	(4,053)	(538)	(188)	(931)	9,131	(14,606)	(5,367)	(1,288)
2038	Normal	56	64	201	98	77	21,835	(12,184)	(25)	(747)	(5,177)	(531)	(191)	(1,230)	22,332	(20,084)	2,354	1,066
2039	Dry	35	64	184	90	71	7,397	(7,129)	(22)	(315)	(4,053)	(540)	(185)	(866)	7,841	(13,111)	(5,160)	(4,094)
2040	Dry	15	64	176	86	68	4,375	(4,426)	(20)	(244)	(2,967)	(558)	(178)	(636)	4,784	(9,030)	(4,130)	(8,224)
2041	Normal	1,514	64	201	98	77	22,106	(7,951)	(22)	(747)	(5,177)	(513)	(184)	(1,079)	24,059	(15,673)	8,482	259
2042	Wet	3,373	64	210	102	81	24,779	(14,652)	(29)	(817)	(6,262)	(491)	(193)	(1,332)	28,609	(23,777)	4,927	5,185
2043	Wet	6,471	64	209	102	80	27,462	(20,015)	(50)	(817)	(6,262)	(448)	(199)	(1,482)	34,389	(29,274)	5,210	10,395
2044	Dry	93	64	184	90	71	13,861	(13,788)	(39)	(315)	(4,053)	(512)	(193)	(1,169)	14,363	(20,070)	(5,601)	4,795
2045	Wet	5,991	64	201	98	77	26,061	(18,611)	(57)	(747)	(5,177)	(464)	(196)	(1,523)	32,492	(26,776)	5,806	10,601
2046	Normal	292	64	210	102	81	15,985	(13,207)	(48)	(817)	(6,262)	(497)	(194)	(1,299)	16,735	(22,326)	(5,414)	5,187
2047	Normal	1,252	64	209	102	80	21,263	(14,229)	(47)	(817)	(6,262)	(501)	(192)	(1,337)	22,970	(23,386)	(53)	5,134
2048	Wet	7,117	64	209	102	80	30,801	(19,075)	(80)	(817)	(6,262)	(427)	(197)	(1,494)	38,374	(28,353)	10,111	15,245
2049	Dry	2	64	184	90	71	11,327	(12,850)	(60)	(315)	(4,053)	(515)	(194)	(1,093)	11,738	(19,079)	(7,222)	8,023
2050	Normal	592	64	201	98	77	20,598	(13,105)	(52)	(747)	(5,177)	(520)	(190)	(1,344)	21,631	(21,135)	606	8,629
2051	Wet	2,181	64	209	102	80	21,857	(14,433)	(57)	(817)	(6,262)	(494)	(193)	(1,352)	24,494	(23,610)	980	9,609
2052	Dry	0	64	184	90	71	8,073	(7,511)	(47)	(315)	(4,053)	(553)	(186)	(760)	8,482	(13,426)	(4,830)	4,779
2053	Normal	262	64	201	98	77	20,972	(11,893)	(42)	(747)	(5,177)	(519)	(189)	(1,108)	21,674	(19,676)	2,268	7,047
2054	Normal	106	64	210	102	81	14,450	(10,051)	(37)	(817)	(6,262)	(523)	(189)	(1,050)	15,013	(18,929)	(3,736)	3,311
2055	Wet	7,395	64	209	102	80	27,961	(17,846)	(72)	(817)	(6,262)	(459)	(197)	(1,130)	35,811	(26,783)	9,125	12,436
2056	Normal	138	64	209	102	80	21,725	(14,923)	(54)	(817)	(6,262)	(483)	(193)	(984)	22,319	(23,716)	(1,296)	11,141
2057	Dry	0	64	184	90	71	5,867	(7,743)	(44)	(315)	(4,053)	(562)	(185)	(716)	6,276	(13,618)	(7,228)	3,912
2058	Normal	1,631	64	201	98	77	21,902	(12,286)	(46)	(747)	(5,177)	(519)	(191)	(1,144)	23,975	(20,109)	3,978	7,891
2059	Dry	44	64	184	90	71	8,912	(7,840)	(38)	(315)	(4,053)	(528)	(186)	(799)	9,365	(13,759)	(4,287)	3,603
2060	Wet	1,443	64	201	98	77	23,760	(14,037)	(40)	(747)	(5,177)	(500)	(191)	(1,003)	25,643	(21,695)	4,188	7,792
2061	Wet	2,132	64	209	102	80	26,866	(17,741)	(44)	(817)	(6,262)	(484)	(193)	(1,168)	29,454	(26,710)	2,890	10,681
2062	Dry	0	64	185	90	71	11,226	(9,384)	(36)	(315)	(4,053)	(536)	(190)	(920)	11,636	(15,435)	(3,688)	6,994
2063	Dry	4	64	176	86	68	2,261	(6,060)	(30)	(244)	(2,967)	(564)	(181)	(597)	2,659	(10,644)	(7,835)	(841)
2064	Dry	0	64	176	86	68	3,786	(2,913)	(26)	(244)	(2,692)	(527)	(174)	(540)	4,179	(7,117)	(2,846)	(3,687)
2065	Dry	43	64	176	86	68	2,856	(1,905)	(23)	(244)	(2,692)	(514)	(158)	(264)	3,292	(5,801)	(2,431)	(6,118)
2066	Dry	7	64	176	86	68	3,652	(1,117)	(21)	(244)	(2,692)	(496)	(156)	(337)	4,053	(5,064)	(927)	(7,045)
2067	Wet	1,691	64	201	98	77	24,996	(8,718)	(25)	(747)	(5,177)	(468)	(178)	(977)	27,127	(16,289)	11,076	4,031
2068	Dry	1,106	64	184	90	71	8,361	(5,888)	(23)	(315)	(4,053)	(538)	(184)	(769)	9,876	(11,770)	(1,764)	2,267
2069	Wet	1,681	64	201	98	77	27,071	(14,162)	(27)	(747)	(5,177)	(511)	(190)	(1,264)	29,193	(22,077)	7,219	9,486
Average (2020-2069)		1,506	64	197	96	76	17,279	(11,701)	(35)	(611)	(5,060)	(507)	(188)	(1,069)	19,219	(19,172)	190	2,493

All values are in acre-feet.

Table 15.6c. Groundwater Budget Table for 2070

Water Year	Year Type	Precipitation-Based Recharge	Agricultural Return Flows	M&I Return Flows	Septic Return Flows	Distribution losses Return Flows	Net Stream Percolation from Losing Reaches	Net GW Discharge to Gaining Reaches	Shallow Groundwater Drainage to the East	SW Diversion simulated using WEL package	M&I Pumping	Agricultural Pumping	Domestic Pumping	GW ET from Riparian Vegetation	Inflows	Outflows	Change in Storage	Cumulative Change in Storage
2020	Normal	47	67	219	102	80	16,140	(13,904)	(13)	(687)	(6,261)	(510)	(196)	(1,392)	16,655	(22,963)	(6,201)	(6,201)
2021	Normal	1,269	67	219	102	80	19,411	(13,082)	(15)	(632)	(6,262)	(544)	(195)	(1,236)	21,149	(21,966)	(706)	(6,907)
2022	Dry	546	67	193	90	71	10,525	(7,701)	(14)	(323)	(4,053)	(568)	(191)	(957)	11,492	(13,807)	(2,197)	(9,104)
2023	Wet	3,683	67	210	98	77	24,792	(14,164)	(19)	(692)	(5,177)	(506)	(196)	(1,296)	28,927	(22,051)	6,978	(2,125)
2024	Normal	912	67	219	102	80	18,346	(13,552)	(20)	(534)	(6,262)	(524)	(195)	(1,201)	19,726	(22,288)	(2,446)	(4,571)
2025	Normal	693	67	219	102	80	21,354	(12,768)	(19)	(616)	(6,262)	(536)	(195)	(1,140)	22,515	(21,537)	1,091	(3,480)
2026	Normal	67	67	219	102	81	24,341	(9,841)	(17)	(792)	(6,262)	(526)	(194)	(1,162)	24,877	(18,795)	6,193	2,713
2027	Dry	40	67	193	90	71	7,882	(11,533)	(14)	(329)	(4,053)	(559)	(193)	(988)	8,343	(17,671)	(9,215)	(6,503)
2028	Wet	8,841	67	210	98	77	27,495	(17,192)	(35)	(733)	(5,177)	(463)	(200)	(1,476)	36,788	(25,276)	11,612	5,109
2029	Wet	1,916	67	219	102	80	20,860	(16,398)	(37)	(795)	(6,262)	(487)	(199)	(1,407)	23,244	(25,587)	(2,244)	2,865
2030	Wet	4,297	67	219	102	81	22,437	(16,505)	(47)	(716)	(6,262)	(481)	(200)	(1,443)	27,204	(25,655)	1,646	4,511
2031	Normal	68	67	219	102	80	14,656	(11,277)	(37)	(512)	(6,262)	(526)	(194)	(1,202)	15,192	(20,010)	(4,709)	(199)
2032	Normal	59	67	219	102	80	15,313	(8,679)	(31)	(485)	(6,262)	(526)	(191)	(1,005)	15,840	(17,181)	(1,232)	(1,430)
2033	Wet	6,003	67	219	102	80	28,944	(17,972)	(52)	(790)	(6,262)	(463)	(200)	(1,382)	35,415	(27,122)	8,388	6,958
2034	Dry	65	67	193	90	71	14,461	(15,372)	(43)	(326)	(4,053)	(529)	(196)	(1,212)	14,948	(21,732)	(6,671)	287
2035	Dry	79	67	184	86	68	10,750	(9,262)	(36)	(255)	(2,967)	(557)	(190)	(950)	11,234	(14,217)	(2,866)	(2,579)
2036	Wet	1,265	67	210	98	77	26,350	(13,034)	(36)	(724)	(5,177)	(502)	(194)	(1,297)	28,067	(20,965)	7,207	4,628
2037	Dry	0	67	193	90	71	8,131	(8,124)	(31)	(329)	(4,053)	(562)	(191)	(949)	8,552	(14,239)	(5,574)	(946)
2038	Normal	59	67	211	98	77	20,877	(11,673)	(27)	(758)	(5,177)	(552)	(194)	(1,249)	21,389	(19,631)	1,874	928
2039	Dry	31	67	193	90	71	6,444	(6,245)	(24)	(329)	(4,053)	(560)	(187)	(845)	6,895	(12,243)	(5,231)	(4,303)
2040	Dry	16	67	184	86	68	5,086	(3,967)	(21)	(254)	(2,967)	(578)	(182)	(648)	5,506	(8,618)	(2,992)	(7,296)
2041	Normal	1,703	67	210	98	77	22,490	(8,108)	(24)	(700)	(5,177)	(526)	(188)	(1,144)	24,646	(15,867)	8,616	1,321
2042	Wet	3,436	67	219	102	81	23,459	(14,189)	(32)	(854)	(6,262)	(504)	(197)	(1,357)	27,365	(23,396)	4,077	5,398
2043	Wet	6,849	67	219	102	80	25,846	(19,133)	(55)	(805)	(6,262)	(461)	(202)	(1,513)	33,163	(28,431)	4,832	10,230
2044	Normal	97	67	219	102	80	14,907	(11,472)	(42)	(791)	(6,262)	(530)	(197)	(1,199)	15,472	(20,492)	(4,904)	5,326
2045	Wet	6,653	67	219	102	80	25,982	(17,424)	(67)	(779)	(6,262)	(476)	(201)	(1,602)	33,104	(26,811)	6,397	11,723
2046	Normal	319	67	219	102	81	16,300	(13,054)	(55)	(591)	(6,262)	(512)	(197)	(1,354)	17,088	(22,026)	(4,831)	6,892
2047	Normal	1,444	67	219	102	80	19,953	(13,705)	(55)	(470)	(6,262)	(518)	(195)	(1,357)	21,865	(22,562)	(591)	6,302
2048	Wet	6,979	67	219	102	80	29,416	(18,329)	(90)	(825)	(6,262)	(445)	(201)	(1,517)	36,864	(27,669)	9,289	15,591
2049	Dry	2	67	193	90	71	10,209	(11,136)	(66)	(329)	(4,053)	(538)	(197)	(1,109)	10,631	(17,427)	(6,680)	8,911
2050	Normal	625	67	211	98	77	20,086	(12,613)	(58)	(737)	(5,177)	(540)	(194)	(1,375)	21,165	(20,696)	580	9,491
2051	Wet	2,376	67	219	102	80	22,048	(14,111)	(65)	(854)	(6,262)	(508)	(197)	(1,413)	24,892	(23,410)	1,577	11,067
2052	Dry	0	67	193	90	71	7,237	(7,172)	(52)	(329)	(4,053)	(577)	(189)	(761)	7,658	(13,133)	(5,346)	5,721
2053	Normal	231	67	210	98	77	19,779	(10,782)	(46)	(501)	(5,177)	(545)	(192)	(1,114)	20,462	(18,356)	2,220	7,941
2054	Normal	112	67	219	102	81	15,467	(9,999)	(40)	(652)	(6,262)	(543)	(193)	(1,115)	16,048	(18,804)	(2,644)	5,297
2055	Wet	8,071	67	219	102	80	26,711	(17,850)	(83)	(765)	(6,262)	(473)	(201)	(1,176)	35,250	(26,811)	8,542	13,839
2056	Normal	141	67	219	102	80	21,847	(14,778)	(61)	(808)	(6,262)	(501)	(197)	(1,040)	22,456	(23,647)	(1,082)	12,756
2057	Dry	0	67	193	90	71	5,741	(7,430)	(49)	(329)	(4,053)	(588)	(189)	(722)	6,161	(13,359)	(7,079)	5,678
2058	Normal	1,728	67	211	98	77	21,426	(12,095)	(52)	(558)	(5,177)	(536)	(195)	(1,187)	23,608	(19,799)	3,924	9,601
2059	Dry	42	67	193	90	71	7,727	(7,207)	(43)	(329)	(4,053)	(547)	(188)	(791)	8,189	(13,159)	(4,848)	4,754
2060	Wet	1,490	67	210	98	77	23,199	(13,192)	(44)	(484)	(5,177)	(521)	(194)	(1,027)	25,141	(20,639)	4,616	9,370
2061	Wet	2,159	67	219	102	80	26,061	(17,191)	(48)	(569)	(6,262)	(497)	(197)	(1,209)	28,688	(25,974)	2,777	12,146
2062	Dry	0	67	193	90	71	10,297	(8,311)	(40)	(329)	(4,053)	(558)	(192)	(916)	10,718	(14,398)	(3,568)	8,578
2063	Dry	4	67	184	86	68	2,148	(5,613)	(33)	(226)	(2,967)	(581)	(185)	(589)	2,556	(10,194)	(7,528)	1,050
2064	Dry	0	67	184	86	68	3,652	(2,717)	(29)	(250)	(2,692)	(551)	(178)	(532)	4,056	(6,949)	(2,798)	(1,747)
2065	Dry	38	67	184	86	68	2,679	(1,703)	(26)	(255)	(2,692)	(534)	(160)	(242)	3,122	(5,612)	(2,420)	(4,167)
2066	Dry	7	67	184	86	68	3,315	(938)	(23)	(238)	(2,692)	(515)	(158)	(308)	3,728	(4,874)	(1,073)	(5,240)
2067	Wet	1,733	67	210	98	77	25,055	(8,484)	(27)	(623)	(5,177)	(483)	(181)	(1,017)	27,240	(15,992)	11,330	6,090
2068	Dry	1,236	67	193	90	71	7,994	(5,654)	(26)	(313)	(4,053)	(551)	(188)	(779)	9,650	(11,563)	(1,796)	4,294
2069	Wet	1,784	67	210	98	77	25,978	(13,702)	(30)	(732)	(5,177)	(522)	(194)	(1,278)	28,213	(21,635)	6,682	10,976
Average (2020-2069)		1,584	67	207	96	76	17,032	(11,407)	(39)	(553)	(5,126)	(525)	(192)	(1,104)	19,063	(18,945)	220	3,431

All values are in acre-feet.

Table 15.7a. Surface Water Budget Table for Baseline

Water Year	Year Type	Matilija Creek Inflows	San Antonio Creek Inflows	Ungauged Tributary Inflows	Direct Runoff	Groundwater Discharge to Stream	SW Diversion simulated using WEL package*	Stream Outflows	Surface Water Diversions	Stream Percolation	Inflows	Outflows
2020	Normal	16,204	4,901	20,731	3,309	14,334	784	(36,778)	(5,281)	(18,203)	60,263	(60,263)
2021	Normal	20,172	5,513	21,826	3,831	13,795	784	(40,950)	(4,758)	(20,213)	65,922	(65,922)
2022	Dry	10,721	1,972	2,936	1,471	9,160	302	(13,704)	(991)	(11,868)	26,562	(26,562)
2023	Wet	58,273	19,145	76,065	9,250	15,081	716	(127,755)	(24,774)	(26,002)	178,531	(178,530)
2024	Normal	18,448	4,852	20,292	3,597	14,646	784	(36,880)	(7,033)	(18,707)	62,620	(62,620)
2025	Normal	23,653	5,105	25,328	5,020	14,371	784	(42,794)	(7,863)	(23,604)	74,261	(74,261)
2026	Dry	9,920	1,250	2,295	1,751	7,523	302	(9,917)	(1,995)	(11,130)	23,041	(23,041)
2027	Dry	4,812	861	2,254	853	7,376	234	(9,103)	(733)	(6,556)	16,391	(16,391)
2028	Wet	135,574	53,947	118,373	13,993	17,358	716	(265,227)	(43,550)	(31,183)	339,960	(339,960)
2029	Normal	27,908	11,499	32,825	4,680	18,290	784	(64,600)	(8,361)	(23,025)	95,986	(95,986)
2030	Wet	69,751	27,305	71,787	9,079	18,163	784	(148,703)	(24,580)	(23,588)	196,871	(196,871)
2031	Normal	10,101	4,507	14,162	3,116	12,069	784	(27,190)	(3,591)	(13,958)	44,739	(44,739)
2032	Normal	9,938	3,232	15,187	2,836	9,017	784	(21,348)	(3,705)	(15,940)	40,993	(40,993)
2033	Wet	119,319	50,110	96,700	12,272	18,954	784	(224,425)	(40,641)	(33,073)	298,139	(298,139)
2034	Normal	15,729	5,401	14,100	2,895	16,633	784	(37,437)	(3,235)	(14,870)	55,542	(55,542)
2035	Normal	6,624	1,745	10,651	2,198	7,943	784	(15,254)	(1,900)	(12,791)	29,945	(29,945)
2036	Wet	59,645	12,835	55,898	7,942	13,203	784	(99,495)	(21,299)	(29,514)	150,308	(150,308)
2037	Dry	7,640	1,400	1,053	807	9,713	302	(11,630)	(1,313)	(7,972)	20,915	(20,915)
2038	Normal	21,551	2,233	17,186	2,965	12,134	716	(27,509)	(6,919)	(22,357)	56,785	(56,785)
2039	Dry	5,877	736	2,091	1,205	7,557	302	(9,340)	(1,028)	(7,400)	17,768	(17,768)
2040	Dry	2,947	298	1,273	986	4,564	234	(5,753)	(553)	(3,997)	10,303	(10,303)
2041	Normal	29,307	6,685	34,865	5,282	8,273	716	(50,701)	(11,211)	(23,217)	85,129	(85,129)
2042	Wet	75,028	20,511	41,257	6,084	15,553	784	(104,696)	(28,556)	(25,963)	159,215	(159,215)
2043	Wet	155,396	61,083	101,824	12,555	21,776	784	(265,965)	(56,905)	(30,548)	353,418	(353,418)
2044	Dry	12,745	3,312	3,480	1,709	15,742	302	(21,512)	(3,123)	(12,657)	37,292	(37,292)
2045	Wet	141,479	48,603	111,416	12,861	19,160	716	(262,549)	(43,298)	(28,389)	334,236	(334,236)
2046	Normal	11,173	4,722	15,347	3,294	14,384	784	(31,266)	(3,239)	(15,199)	49,705	(49,705)
2047	Normal	24,488	8,752	31,175	5,481	14,511	784	(56,893)	(6,556)	(21,742)	85,191	(85,191)

Water Year	Year Type	Matilija Creek Inflows	San Antonio Creek Inflows	Ungauged Tributary Inflows	Direct Runoff	Groundwater Discharge to Stream	SW Diversion simulated using WEL package*	Stream Outflows	Surface Water Diversions	Stream Percolation	Inflows	Outflows
2048	Wet	140,192	73,503	125,957	15,216	19,646	784	(297,523)	(44,875)	(32,900)	375,299	(375,299)
2049	Dry	10,126	3,943	978	489	14,316	302	(18,351)	(754)	(11,049)	30,154	(30,154)
2050	Normal	21,113	5,406	24,519	3,817	13,178	716	(40,810)	(7,203)	(20,738)	68,750	(68,750)
2051	Wet	55,372	18,402	46,454	6,559	15,319	784	(103,666)	(15,845)	(23,379)	142,890	(142,890)
2052	Dry	7,996	1,099	356	387	8,314	302	(9,335)	(695)	(8,425)	18,455	(18,455)
2053	Normal	12,304	2,790	27,936	5,065	12,453	716	(36,850)	(3,130)	(21,285)	61,265	(61,265)
2054	Dry	9,699	1,847	15,097	2,615	12,043	302	(25,443)	(1,861)	(14,300)	41,604	(41,604)
2055	Wet	102,614	71,059	114,060	14,233	19,511	716	(266,449)	(27,713)	(28,030)	322,193	(322,193)
2056	Wet	44,605	12,527	37,128	5,833	16,550	784	(79,511)	(13,858)	(24,059)	117,428	(117,428)
2057	Dry	5,381	1,270	297	309	9,118	302	(10,305)	(695)	(5,679)	16,678	(16,678)
2058	Normal	40,874	10,332	36,188	5,871	12,935	716	(70,210)	(13,735)	(22,971)	106,916	(106,916)
2059	Dry	6,829	1,416	4,032	1,182	8,555	302	(11,840)	(1,198)	(9,279)	22,317	(22,317)
2060	Wet	21,348	4,544	33,228	5,525	14,380	716	(49,880)	(6,120)	(23,742)	79,742	(79,742)
2061	Wet	45,676	10,580	49,632	7,243	18,164	784	(90,301)	(13,945)	(27,834)	132,080	(132,080)
2062	Dry	11,037	901	1,298	742	10,563	302	(11,659)	(1,692)	(11,493)	24,843	(24,843)
2063	Dry	1,820	110	470	478	6,457	234	(6,645)	(544)	(2,380)	9,569	(9,569)
2064	Dry	4,188	685	1,474	1,131	3,153	234	(5,250)	(1,439)	(4,178)	10,866	(10,866)
2065	Dry	1,978	153	964	843	2,206	234	(2,847)	(542)	(2,989)	6,378	(6,378)
2066	Dry	1,139	501	3,512	1,574	1,407	234	(3,830)	(531)	(4,006)	8,367	(8,367)
2067	Wet	23,961	7,152	49,881	6,540	8,996	716	(65,319)	(6,953)	(24,973)	97,246	(97,246)
2068	Dry	8,001	1,306	1,842	1,427	6,282	302	(9,254)	(1,049)	(8,857)	19,160	(19,160)
2069	Wet	69,788	13,801	36,595	5,748	14,802	716	(85,355)	(27,214)	(28,880)	141,450	(141,450)
Average (2020-2069)		35,009	12,317	31,486	4,683	12,393	586	(67,400)	(11,172)	(17,902)	96,474	(96,474)

All values are in acre-feet.

Table 15.7b. Surface Water Budget Table for 2030

Water Year	Year Type	Matilija Creek Inflows	San Antonio Creek Inflows	Ungauged Tributary Inflows	Direct Runoff	Groundwater Discharge to Stream	SW Diversion simulated using WEL package*	Stream Outflows	Surface Water Diversions	Stream Percolation	Inflows	Outflows
2020	Normal	13,258	3,981	17,672	2,534	13,609	817	(31,293)	(4,843)	(15,737)	51,872	(51,872)
2021	Normal	20,390	5,572	22,516	3,869	13,270	817	(40,894)	(4,843)	(20,698)	66,435	(66,435)
2022	Dry	11,285	2,076	3,184	1,543	9,171	315	(14,145)	(1,082)	(12,347)	27,574	(27,574)
2023	Wet	56,879	18,687	74,765	8,978	14,750	747	(125,722)	(24,254)	(24,830)	174,806	(174,806)
2024	Normal	17,471	4,595	18,498	3,410	13,681	817	(33,187)	(7,313)	(17,971)	58,472	(58,472)
2025	Normal	21,707	4,685	23,674	4,588	13,260	817	(38,651)	(7,663)	(22,416)	68,731	(68,731)
2026	Normal	11,833	1,491	2,739	2,082	5,431	817	(7,948)	(3,665)	(12,781)	24,394	(24,394)
2027	Dry	5,220	934	2,451	916	6,572	315	(8,437)	(1,023)	(6,947)	16,407	(16,407)
2028	Wet	134,937	53,694	117,735	13,927	16,815	747	(265,590)	(42,957)	(29,308)	337,855	(337,855)
2029	Wet	27,115	11,172	31,910	4,521	16,634	817	(61,938)	(8,747)	(21,485)	92,170	(92,170)
2030	Wet	69,130	27,062	71,264	8,969	16,823	817	(147,111)	(24,315)	(22,639)	194,065	(194,065)
2031	Normal	8,968	4,002	12,519	2,773	10,610	817	(23,308)	(3,605)	(12,776)	39,690	(39,690)
2032	Normal	8,813	2,866	12,954	2,550	8,023	817	(17,646)	(3,423)	(14,955)	36,024	(36,024)
2033	Wet	117,722	49,439	95,324	12,076	18,097	817	(222,420)	(40,002)	(31,054)	293,476	(293,476)
2034	Dry	16,909	5,806	16,286	3,047	17,246	315	(41,129)	(2,584)	(15,897)	59,610	(59,610)
2035	Dry	6,480	1,707	10,579	2,127	10,823	244	(18,611)	(665)	(12,684)	31,960	(31,960)
2036	Wet	59,927	12,896	55,791	7,926	13,993	747	(103,881)	(21,102)	(26,296)	151,279	(151,279)
2037	Dry	8,177	1,498	1,132	856	8,551	315	(10,669)	(1,138)	(8,722)	20,529	(20,529)
2038	Normal	22,737	2,356	18,183	3,102	12,184	747	(30,202)	(7,272)	(21,835)	59,308	(59,308)
2039	Dry	6,049	757	2,153	1,230	7,129	315	(8,983)	(1,254)	(7,397)	17,634	(17,634)
2040	Dry	3,279	331	1,419	1,097	4,426	244	(5,824)	(598)	(4,375)	10,797	(10,797)
2041	Normal	26,958	6,149	32,586	4,836	7,951	747	(46,600)	(10,520)	(22,106)	79,226	(79,226)
2042	Wet	74,728	20,429	41,226	6,031	14,652	817	(105,340)	(27,764)	(24,779)	157,884	(157,884)
2043	Wet	151,219	59,442	99,464	12,205	20,015	817	(260,844)	(54,856)	(27,462)	343,161	(343,161)
2044	Dry	13,735	3,569	3,689	1,828	13,788	315	(20,042)	(3,022)	(13,861)	36,925	(36,925)
2045	Wet	124,752	42,857	98,148	11,333	18,611	747	(232,577)	(37,809)	(26,061)	296,448	(296,448)
2046	Normal	12,047	5,091	16,422	3,526	13,207	817	(31,653)	(3,473)	(15,985)	51,111	(51,111)
2047	Normal	24,879	8,892	31,784	5,549	14,229	817	(58,289)	(6,599)	(21,263)	86,151	(86,151)

Water Year	Year Type	Matilija Creek Inflows	San Antonio Creek Inflows	Ungauged Tributary Inflows	Direct Runoff	Groundwater Discharge to Stream	SW Diversion simulated using WEL package*	Stream Outflows	Surface Water Diversions	Stream Percolation	Inflows	Outflows
2048	Wet	149,849	78,566	134,899	16,232	19,075	817	(321,863)	(46,773)	(30,801)	399,438	(399,438)
2049	Dry	10,428	4,060	990	504	12,850	315	(16,955)	(865)	(11,327)	29,147	(29,147)
2050	Normal	23,452	6,005	26,843	4,278	13,105	747	(45,334)	(8,497)	(20,598)	74,429	(74,429)
2051	Wet	52,877	17,573	44,624	6,221	14,433	817	(99,429)	(15,260)	(21,857)	136,546	(136,546)
2052	Dry	7,652	1,052	341	370	7,511	315	(8,445)	(724)	(8,073)	17,242	(17,242)
2053	Normal	12,072	2,737	27,725	4,992	11,893	747	(35,409)	(3,785)	(20,972)	60,165	(60,165)
2054	Normal	10,249	1,952	15,990	2,741	10,051	817	(24,023)	(3,328)	(14,450)	41,801	(41,801)
2055	Wet	99,011	68,564	110,385	13,731	17,846	817	(255,971)	(26,421)	(27,961)	310,354	(310,354)
2056	Normal	36,146	10,151	29,305	4,746	14,923	817	(62,859)	(11,506)	(21,725)	96,089	(96,089)
2057	Dry	5,568	1,315	308	320	7,743	315	(8,977)	(724)	(5,867)	15,568	(15,568)
2058	Normal	39,941	10,096	35,524	5,724	12,286	747	(68,605)	(13,810)	(21,902)	104,317	(104,317)
2059	Dry	6,763	1,403	4,182	1,138	7,840	315	(11,226)	(1,504)	(8,912)	21,641	(21,641)
2060	Wet	21,742	4,628	33,758	5,618	14,037	747	(50,269)	(6,501)	(23,760)	80,530	(80,530)
2061	Wet	44,136	10,223	47,767	6,991	17,741	817	(87,007)	(13,803)	(26,866)	127,676	(127,676)
2062	Dry	11,662	878	1,043	600	9,384	315	(10,320)	(2,337)	(11,226)	23,883	(23,883)
2063	Dry	1,823	114	387	379	6,060	244	(6,179)	(567)	(2,261)	9,008	(9,008)
2064	Dry	4,004	647	1,036	795	2,913	244	(4,415)	(1,438)	(3,786)	9,639	(9,639)
2065	Dry	2,026	161	755	650	1,905	244	(2,319)	(565)	(2,856)	5,741	(5,741)
2066	Dry	1,191	554	2,889	1,299	1,117	244	(3,088)	(554)	(3,652)	7,293	(7,293)
2067	Wet	26,831	8,637	46,073	6,008	8,718	747	(63,580)	(8,437)	(24,996)	97,013	(97,013)
2068	Dry	7,869	1,288	1,367	1,058	5,888	315	(8,357)	(1,068)	(8,361)	17,786	(17,786)
2069	Wet	69,939	14,586	28,041	4,546	14,162	747	(78,625)	(26,324)	(27,071)	132,021	(132,020)
Average (2020-2069)		34,437	12,145	30,606	4,527	11,701	611	(65,724)	(11,024)	(17,279)	94,026	(94,026)

All values are in acre-feet.

Table 15.7c. Surface Water Budget Table for 2070

Water Year	Year Type	Matilija Creek Inflows	San Antonio Creek Inflows	Ungauged Tributary Inflows	Direct Runoff	Groundwater Discharge to Stream	SW Diversion simulated using WEL package*	Stream Outflows	Surface Water Diversions	Stream Percolation	Inflows	Outflows
2020	Normal	15,317	4,580	20,279	3,011	13,904	854	(35,674)	(6,131)	(16,140)	57,944	(57,944)
2021	Normal	18,702	5,111	21,592	3,524	13,082	854	(38,904)	(4,549)	(19,411)	62,864	(62,864)
2022	Dry	9,597	1,765	2,620	1,310	7,701	329	(11,811)	(988)	(10,525)	23,323	(23,323)
2023	Wet	63,225	20,772	84,398	9,870	14,164	780	(142,105)	(26,311)	(24,792)	193,208	(193,208)
2024	Normal	18,951	4,985	20,438	3,677	13,552	854	(35,495)	(8,616)	(18,346)	62,457	(62,457)
2025	Normal	20,689	4,465	23,507	4,346	12,768	854	(37,485)	(7,791)	(21,354)	66,630	(66,630)
2026	Normal	25,994	3,276	6,049	4,423	9,841	854	(19,938)	(6,158)	(24,341)	50,437	(50,437)
2027	Dry	6,147	1,100	2,917	1,065	11,533	329	(13,931)	(1,279)	(7,882)	23,092	(23,092)
2028	Wet	146,975	58,484	128,600	15,154	17,192	780	(293,173)	(46,515)	(27,495)	367,184	(367,184)
2029	Wet	31,299	12,897	36,957	5,178	16,398	854	(71,427)	(11,295)	(20,860)	103,582	(103,582)
2030	Wet	77,878	30,487	80,397	10,044	16,505	854	(167,833)	(25,895)	(22,437)	216,165	(216,165)
2031	Normal	11,369	5,073	16,146	3,494	11,277	854	(29,288)	(4,269)	(14,656)	48,212	(48,212)
2032	Normal	9,516	3,094	13,987	2,755	8,679	854	(19,844)	(3,728)	(15,313)	38,885	(38,885)
2033	Wet	122,106	51,280	99,764	12,457	17,972	854	(233,636)	(41,853)	(28,944)	304,433	(304,433)
2034	Dry	13,116	4,504	13,608	2,310	15,372	329	(32,785)	(1,992)	(14,461)	49,239	(49,239)
2035	Dry	5,269	1,388	8,617	1,731	9,262	255	(15,103)	(669)	(10,750)	26,522	(26,522)
2036	Wet	68,192	14,674	64,834	8,881	13,034	780	(120,564)	(23,480)	(26,350)	170,395	(170,395)
2037	Dry	7,772	1,424	1,082	801	8,124	329	(10,223)	(1,178)	(8,131)	19,533	(19,533)
2038	Normal	21,914	2,270	17,056	3,003	11,673	780	(28,218)	(7,603)	(20,877)	56,697	(56,697)
2039	Dry	5,227	654	1,857	1,061	6,245	329	(7,740)	(1,189)	(6,444)	15,373	(15,373)
2040	Dry	3,900	394	1,688	1,292	3,967	255	(5,749)	(663)	(5,086)	11,497	(11,497)
2041	Normal	33,596	7,663	41,420	5,982	8,108	780	(61,848)	(13,210)	(22,490)	97,548	(97,548)
2042	Wet	82,495	22,552	45,858	6,563	14,189	854	(120,329)	(28,723)	(23,459)	172,511	(172,511)
2043	Wet	163,589	64,304	108,669	13,151	19,133	854	(286,758)	(57,095)	(25,846)	369,700	(369,700)
2044	Normal	15,818	4,110	4,127	2,076	11,472	854	(18,444)	(5,105)	(14,907)	38,457	(38,457)
2045	Wet	148,331	50,957	116,640	13,443	17,424	854	(278,804)	(42,863)	(25,982)	347,649	(347,649)
2046	Normal	14,065	5,944	18,872	4,045	13,054	854	(35,957)	(4,578)	(16,300)	56,835	(56,835)
2047	Normal	23,524	8,408	31,331	5,178	13,705	854	(55,971)	(7,075)	(19,953)	82,999	(82,999)

Water Year	Year Type	Matilija Creek Inflows	San Antonio Creek Inflows	Ungauged Tributary Inflows	Direct Runoff	Groundwater Discharge to Stream	SW Diversion simulated using WEL package*	Stream Outflows	Surface Water Diversions	Stream Percolation	Inflows	Outflows
2048	Wet	147,129	77,139	133,148	15,864	18,329	854	(317,800)	(45,247)	(29,416)	392,463	(392,463)
2049	Dry	9,464	3,685	849	460	11,136	329	(14,784)	(929)	(10,209)	25,922	(25,922)
2050	Normal	24,913	6,379	27,391	4,622	12,613	780	(47,044)	(9,567)	(20,086)	76,698	(76,698)
2051	Wet	62,537	20,783	53,207	7,306	14,111	854	(119,020)	(17,732)	(22,048)	158,799	(158,799)
2052	Dry	6,851	942	304	337	7,172	329	(7,942)	(756)	(7,237)	15,936	(15,936)
2053	Normal	10,110	2,292	23,860	4,194	10,782	780	(28,894)	(3,345)	(19,779)	52,018	(52,018)
2054	Normal	11,919	2,270	18,748	3,146	9,999	854	(27,455)	(4,015)	(15,467)	46,936	(46,936)
2055	Wet	108,576	75,188	122,751	14,955	17,850	854	(284,463)	(29,000)	(26,711)	340,174	(340,174)
2056	Normal	38,167	10,719	29,734	5,028	14,778	854	(65,184)	(12,249)	(21,847)	99,279	(99,279)
2057	Dry	5,451	1,287	300	315	7,430	329	(8,616)	(756)	(5,741)	15,113	(15,113)
2058	Normal	43,293	10,943	38,783	6,172	12,095	780	(75,719)	(14,921)	(21,426)	112,066	(112,066)
2059	Dry	5,846	1,212	3,765	958	7,207	329	(10,106)	(1,485)	(7,727)	19,318	(19,318)
2060	Wet	21,313	4,537	35,107	5,435	13,192	780	(49,632)	(7,533)	(23,199)	80,364	(80,364)
2061	Wet	42,002	9,729	45,642	6,620	17,191	854	(82,744)	(13,233)	(26,061)	122,038	(122,038)
2062	Dry	11,100	783	725	426	8,311	329	(9,009)	(2,369)	(10,297)	21,675	(21,675)
2063	Dry	1,823	114	314	290	5,613	255	(5,669)	(593)	(2,148)	8,410	(8,410)
2064	Dry	4,004	647	850	647	2,717	255	(4,006)	(1,462)	(3,652)	9,120	(9,120)
2065	Dry	2,026	161	571	487	1,703	255	(1,933)	(591)	(2,679)	5,203	(5,203)
2066	Dry	1,191	554	2,369	1,127	938	255	(2,540)	(578)	(3,315)	6,434	(6,434)
2067	Wet	26,831	8,637	46,156	6,020	8,484	780	(63,338)	(8,514)	(25,055)	96,907	(96,907)
2068	Dry	7,869	1,288	943	728	5,654	329	(7,717)	(1,100)	(7,994)	16,811	(16,811)
2069	Wet	78,001	16,795	24,412	4,068	13,702	780	(82,195)	(29,586)	(25,978)	137,759	(137,759)
Average (2020-2069)		37,100	13,054	32,865	4,781	11,407	650	(70,897)	(11,927)	(17,032)	99,856	(99,856)

All values are in acre-feet.

Appendix I

Time Series Plots of Groundwater Quality with Minimum Thresholds and Measurable Objectives

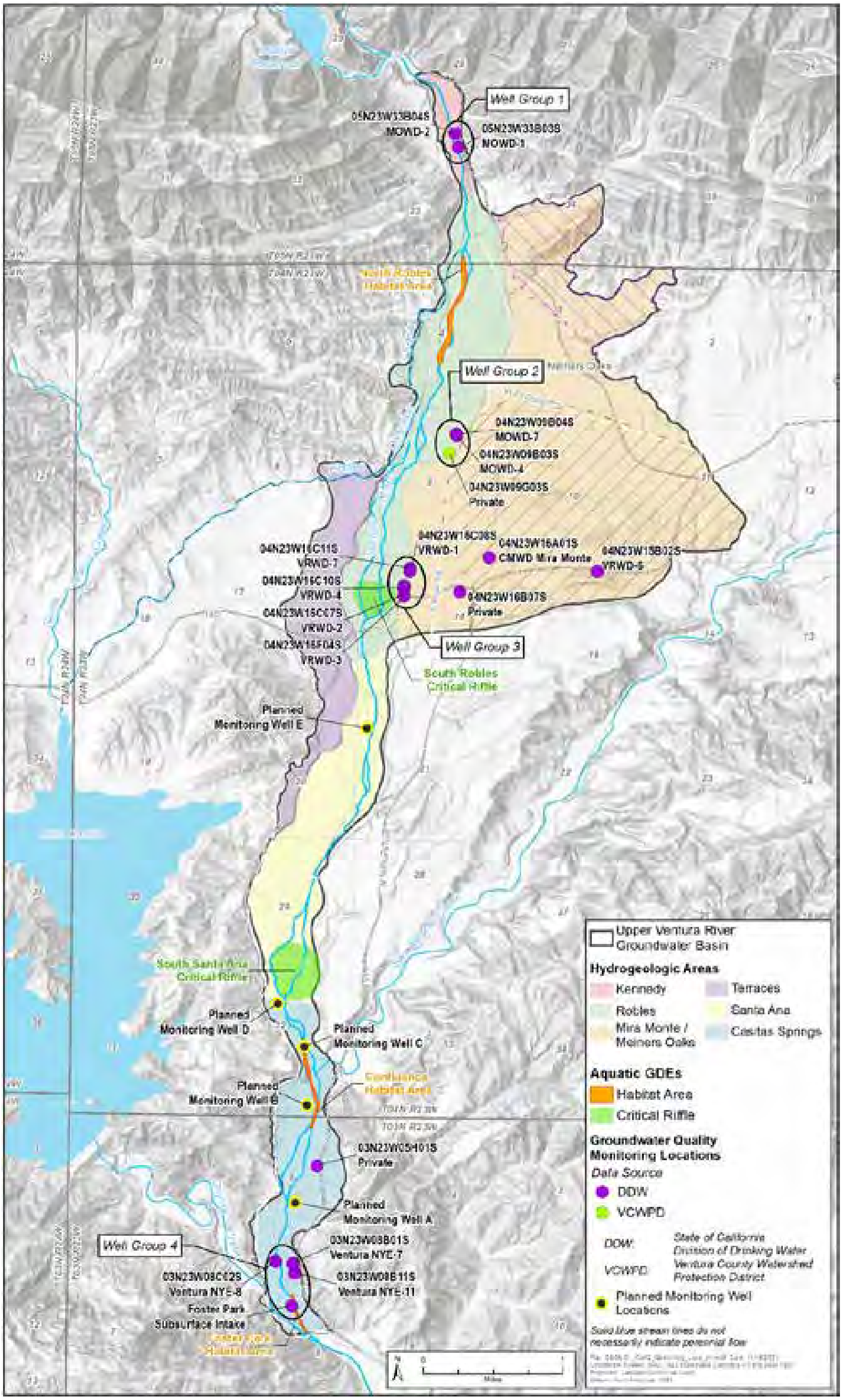


Figure I-01 Representative Monitoring Well Locations for Sustainable Management Criteria.

Table I-01 RWQCB-established WQOs, Minimum Thresholds, and Measurable Objectives for Nitrate.

Constituent	MCL (mg/L)	RWQCB WQO (mg/L)	Range of Average Historical Concentrations for Wells or Well Groups (mg/l)	Planned MT isocontour (mg/L)	MT Rationale	Planned MO isocontour (mg/L)	MO Rationale
Percolating Groundwater Areas (Kennedy, Robles, Mira Monte/Meiners Oaks, and Santa Ana Hydrogeologic Areas)							
Nitrate (as N)	10	10	1.1 – 12.6	10	Prevent significant and unreasonable impact to municipal and domestic beneficial uses of groundwater consistent with the MCL.	7.5	Preserve existing groundwater quality for municipal and domestic beneficial uses.
Areas with Rising Groundwater (Casitas Springs Hydrogeologic Areas)							
Nitrate (as N)	10	5 (Surface Water WQO)	1.1 – 1.4	10	Prevent significant and unreasonable impact to municipal and domestic beneficial uses of groundwater consistent with the MCL.	3	Preserve existing groundwater quality for municipal and domestic beneficial uses. Protect surface water beneficial uses consistent with the RWQCB surface water WQO (MO is lower than surface water WQO).