Calaveras County Mokelumne River Long-Term Water Needs Study

Prepared for:

Calaveras County Water District
Calaveras Public Utility District

October 2017

ECORP Consulting, Inc.
ENVIRONMENTAL CONSULTANTS

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Calaveras County, California

Prepared For:

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and
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1.0 INTRODUCTION

The purpose of the Calaveras County Mokelumne River Long-Term Water Needs Study is to guide both Calaveras County Water District (CCWD) and Calaveras Public Utility District (CPUD) in pursuing two objectives: 1) supplying the requested information to the Secretary of the Natural Resources Agency (Secretary) for a report to the legislature on the suitability of portions of the Mokelumne River for state designation as “Wild and Scenic”, as required by Assembly Bill (AB) 142 (Bigelow, 2015), and, 2) the necessary investigation to provide a long-term planning document to assist the Districts in meeting their future water supply objectives. AB 142 requires the Secretary to study and submit to the Governor and the Legislature a report that analyzes the suitability or non-suitability of the proposed designation of the segments of the Mokelumne River as Wild and Scenic. This report provides information about anticipated water supply needs for both Districts in support of the Wild and Scenic Studies required by AB 142. It should be noted that the Districts have the implicit obligation to plan for the ability to serve all the present and future inhabitants within their service boundaries and support the Calaveras County Government within their planning authorities under the County General Plan; for CCWD those boundaries include all of Calaveras County not already being served by a water agency.

The following segments of the North Fork and main stem Mokelumne River are designated for potential addition to the Wild and Scenic system:

a. The North Fork Mokelumne River from 0.50 miles downstream of the Salt Springs 97-006 Dam to 0.50 miles upstream of the Tiger Creek Powerhouse.

b. The North Fork Mokelumne River from 1,000 feet downstream of the Tiger Creek Afterbay 97-105 Dam to State Highway Route 26.

c. The North Fork Mokelumne River from 400 feet downstream of the small reregulating dam at the outlet of the West Point Powerhouse to the confluence of the North and Middle Forks of the Mokelumne River.

d. The main stem of the Mokelumne River from the confluence of the North and Middle Forks to 300 feet upstream of the Electra Powerhouse.

e. The main stem of the Mokelumne River from 300 feet downstream of the small reregulating dam downstream of the Electra Powerhouse to the Pardee Reservoir flood surcharge pool at 580 feet elevation above mean sea level (msl).

The Districts’ current Mokelumne River Basin supplies originate from Bear Creek (a tributary to the Middle Fork of the Mokelumne River), Middle Fork Mokelumne River, Licking Fork Mokelumne River, and South Fork Mokelumne River. The Districts have limited their analysis within this study to the evaluation of potential changes to existing conditions in these segments of the river due to reasonably foreseeable land use and water supply demand forecasts within the County of Calaveras. Changes in diversions from these sources could only affect proposed sections (d) and (e) of the Mokelumne River.

2.0 BACKGROUND

The Districts' multiple service areas are independent and geographically distinct; with widely varying demographics, land use, climate, and water supply infrastructure. Their respective service areas range in elevation from about 200 feet msl near Wallace on the Eastern side of the San Joaquin Valley floor, to an elevation of about 7,200 feet msl at the upper reaches of the Middle Fork Mokelumne Watershed near the Sierra Nevada Crest.

Due to its specific location within California and the associated topography, Calaveras County has a remarkably varied climate. Hot, dry summers and temperate winters prevail in the western foothills, with temperatures ranging from the mid-30s to the high 90s in degrees Fahrenheit (°F), routinely exceeding 100°F during the summer. Mild summers and cold winters characterize the mountainous eastern portion of the County, with temperatures ranging from the low 20s to the mid-80s °F. The project location for the purposes of this study includes the mainstem Mokelumne River and tributary watersheds within Calaveras County and areas planned to be served by the Districts.

2.1 Calaveras Public Utility District

CPUD was formed in 1934 by an election held under the California Public Utilities Code. Mokelumne Hill and San Andreas voters approved the formation of a public utility district to provide water to their area due to growing concern about future water needs in both towns. At the time of the election CPUD did not own any facilities as a result of a failed attempt to apply for federal funding in 1934. It was not until after acquiring funding from a federal grant and a bond measure passed in December 1938, CPUD was able to purchase the Mokelumne River Power and Water Company. With the purchase came existing water rights to the Middle Fork and South Fork Mokelumne Rivers with a priority date of 1852, canals, ditches, flumes and reservoirs which formed the backbone of the water supply system. In 1973, the District added the Jeff Davis Water Treatment Plant and reservoir, storage tanks, pipelines and associated improvements. The communities of Mokelumne Hill, San Andreas, Paloma, and portions of Glencoe and Rail Road Flat are served by this system.

2.2 Calaveras County Water District

CCWD was organized under the laws of the State of California as a public agency for the purpose of developing and administering the water resources in Calaveras County. Therefore, CCWD is a political subdivision of the State of California and is governed by the California Constitution and the California Government and Water Codes. CCWD was formed to preserve and develop water resources and to provide water to the citizens of Calaveras County. CCWD currently serves the communities of West Point, Wilseyville, and Bummerville located in the northeastern portion of Calaveras County with surface water supplies from the Mokelumne River. These communities are served primarily by Bear Creek, a tributary to the Middle Fork Mokelumne, with supplemental supplies provided by diversions off the Middle Fork Mokelumne River under contract with CPUD. CCWD also supplies water to areas of Wallace using groundwater supplies from the Eastern San Joaquin Groundwater Subbasin (ESJGS), which has been listed as "critically overdrafted" for more than 35 years by the Department of Water Resources (DWR). Future expansion includes serving the communities of Wallace, Burson and Valley Springs to reduce reliance on unreliable groundwater supplies, improve the conditions of the "critically overdrafted" ESJGS, and improve redundancy considerations due to unreliable water quantity and quality from the Calaveras River. Figure 1 illustrates existing areas currently served by Mokelumne River. Figure 2 illustrates existing and potential Mokelumne River service areas.

2.3 California Wild and Scenic Rivers Act and Future Suitability Study

The California Wild and Scenic Rivers Act (Act) was passed by the State Legislature in 1972, following the passage of the Federal Wild and Scenic Rivers Act by Congress in 1968. Summarily, the Act created a state Wild and Scenic classification system and the necessary administrative considerations, in addition to dedicating several specified reaches of multiple rivers throughout California as "wild and scenic." The specific provisions relating to the Act are contained in Public Resources Code § 5093.50 *et seq.* PRC § 5093.50 states as follows:

> "It is the policy of the State of California that certain rivers which possess extraordinary scenic, recreational, fishery, or wildlife values shall be preserved in their free-flowing state, together with their immediate environments, for the benefit and enjoyment of the people of the state. The Legislature declares that such use of these rivers is the highest and most beneficial use and is a reasonable and beneficial use of water within the meaning of Section 2 of Article X of the California Constitution. It is the purpose of this chapter to create a California Wild and Scenic Rivers System to be administered in accordance with the provisions of this chapter."

Of notable interest to the Districts within the context of the development of this study is that Section 5093.55 further prohibits construction of "...any dam, reservoir, diversion, or other water impoundment facility ..." on any Wild and Scenic designated river and segment thereof, and continues "... nor may a water diversion facility be constructed on the river and segment unless and until the secretary determines that the facility is needed to supply domestic water to the residents of the county or counties through which the river and segment flows, and unless and until the secretary determines that the facility will not adversely affect the free-flowing condition and natural character of the river and segment." The Districts are acutely aware that there will reasonably be future additional water supply needs within Calaveras County, moreover, the additional storage and diversions to support those needs. It is likely that any new project in the upper reaches of Amador and Calaveras County to supply future demands for these counties will affect the "free-flowing and natural character" of the watershed within the lower reaches of Mokelumne River.

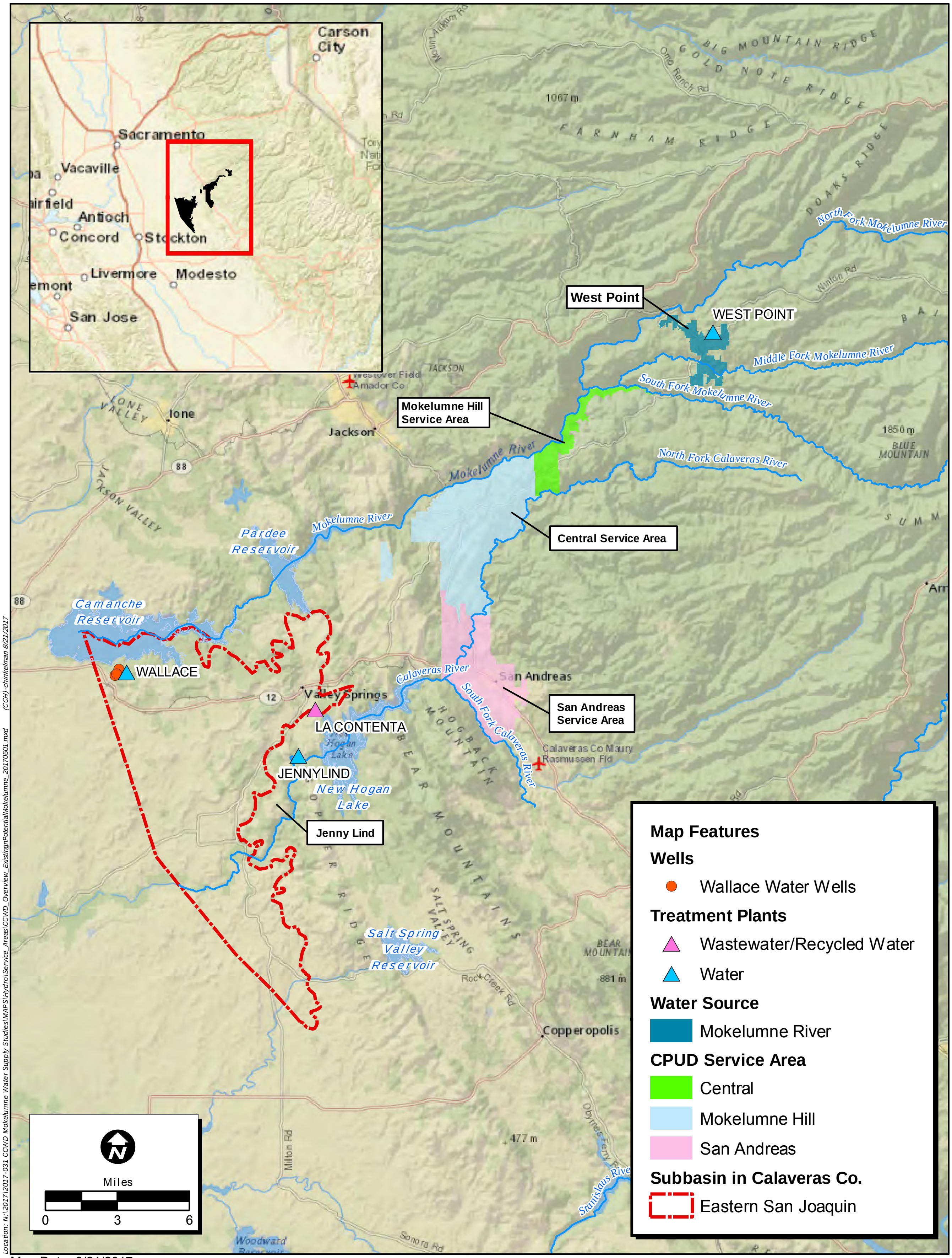

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Figure 1. CCWD & CPUD Service Areas Currently Served by Mokelumne River

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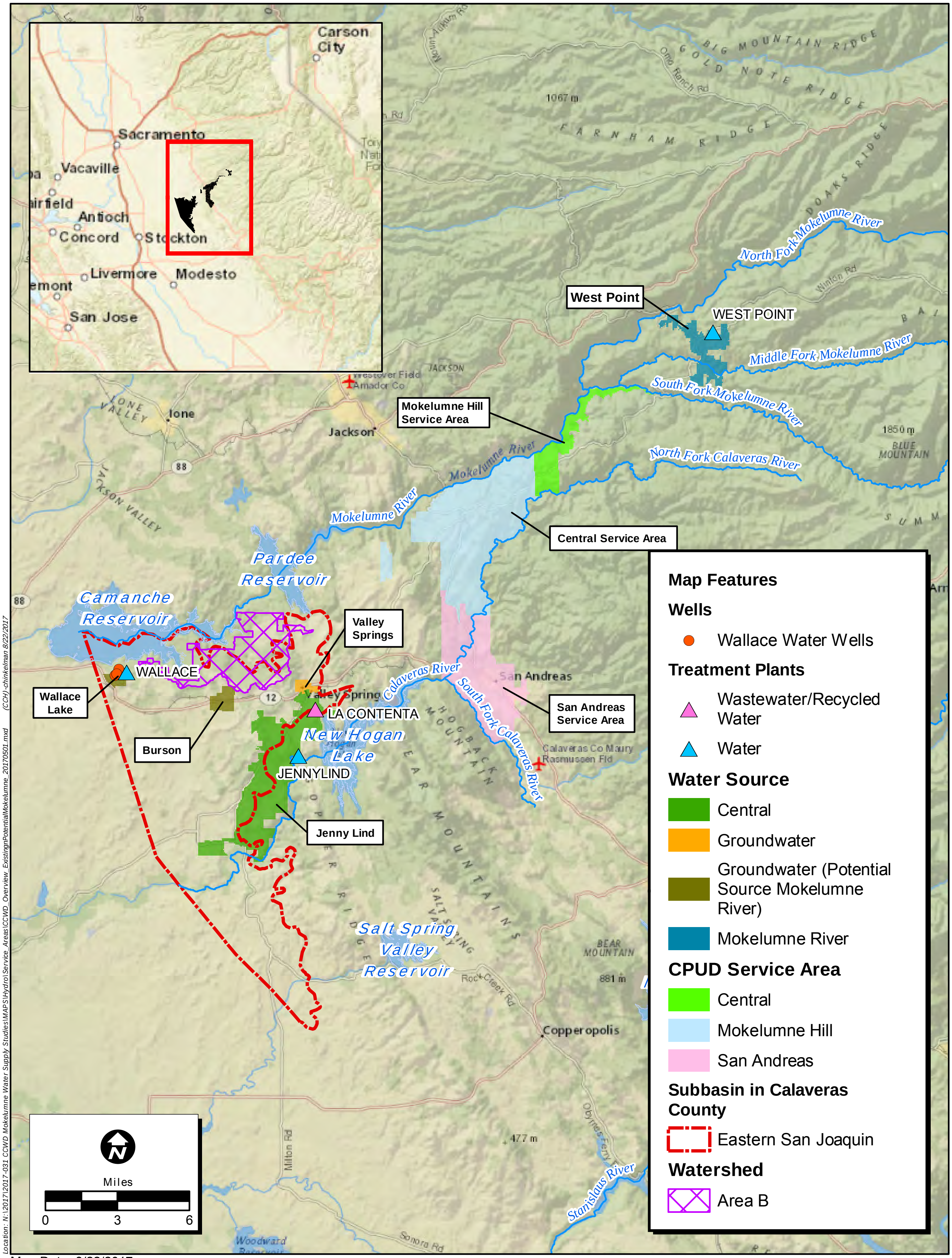

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Figure 2. Existing & Potential Mokelumne Service Areas

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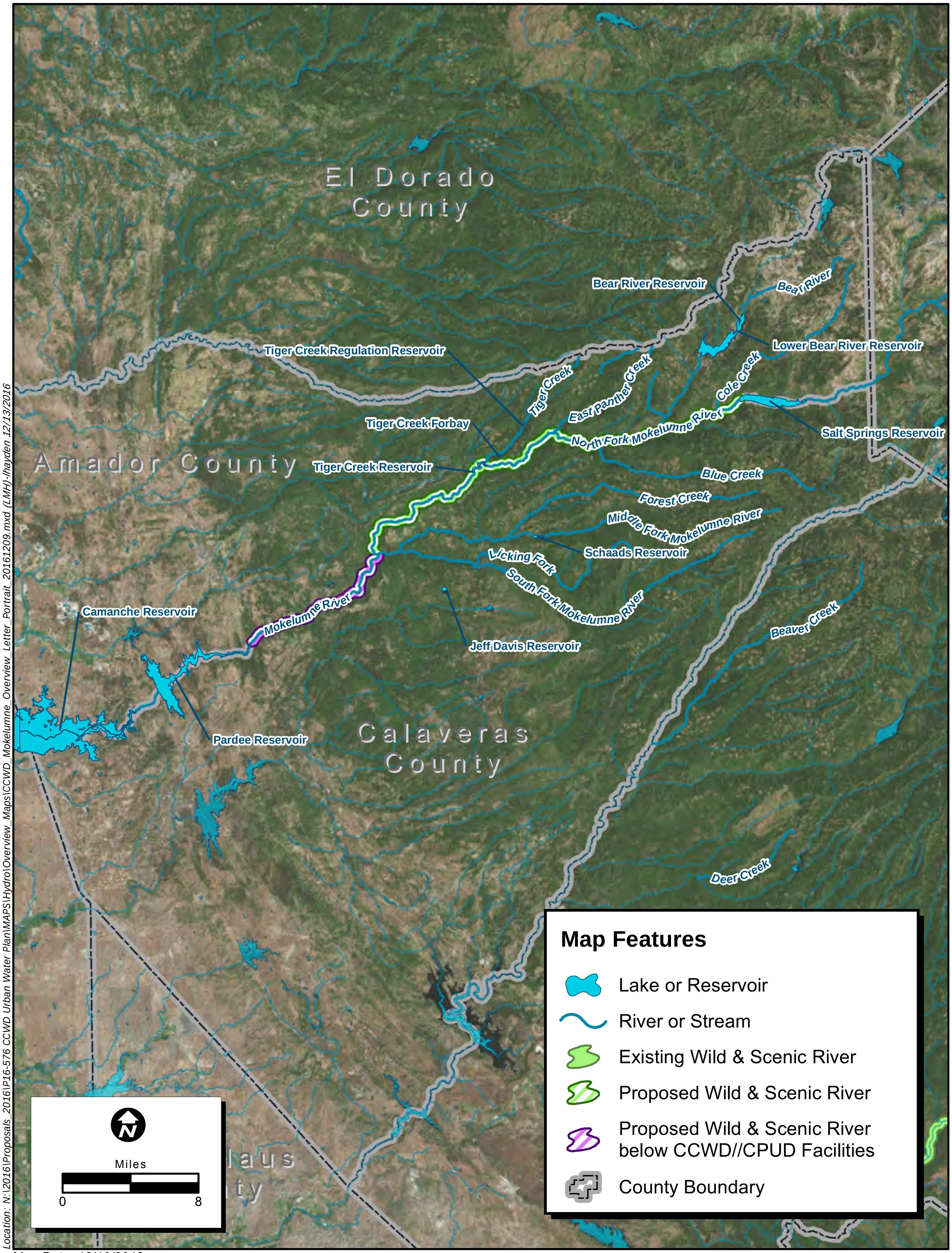
AB 142 (Bigelow) was passed by the Legislature in 2015, and signed by the Governor on October 9, 2015. The bill, among other things, required the secretary" (Secretary of the Natural Resources Agency) prepare a report analyzing the suitability or nonsuitability of a proposed designation of the Mokelumne River, its tributaries, or segments thereof as additions to the system, to consider the potential effects of the proposed designation on future water requirements, as specified, and the effects of climate change on river values and current and projected water supplies, and to consider other factors. This report would be submitted to the State Legislature and Governor and requires the Secretary provide a clear recommendation on the suitability or nonsuitability for adding the specified reaches to the State Wild and Scenic system. (On June 17, 2017 the Districts received correspondence from staff at the California Natural Resources Agency requesting additional information of local value for their preparation of the report. In the letter, the staff and consultant Project Manager states that they are "…seeking any relevant existing information on existing and future Mokelumne River water supplies and water uses; regional climate change; and Mokelumne River geologic, water and water quality, scenic, recreational, fish, botanical, wildlife, cultural and historic, and/or scientific, ecological, or educational resources, especially those that may be deemed to be extraordinary."

The Districts provided an index of studies and reports that have been completed over a span of more than 60 years related to the Mokelumne River within Calaveras County in partial fulfillment of the California Natural Resources Agency's request. The analysis and study in this report provides the California Natural Resources Agency with an evaluation to meet their informational needs consistent with AB 142, specific to the effects of the reasonably foreseeable demands and supply requirements for the Districts within Calaveras County on the proposed reaches of the Mokelumne River to be evaluated in the Wild and Scenic suitability report. For this study, the Districts have chosen to only evaluate the impacts of potential changes in hydrology in the proposed sections (d) and (e) of the Mokelumne River as shown in Figure 3.



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Map Date: 12/13/2016
Photo Source: ESRI Aerial Basemap, accessed Dec. 2016

Figure 3. Proposed Designated Section of the Mokelumne River as Wild and Scenic

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3.0 CONSUMPTIVE DEMANDS

The primary focus of this effort is to identify long-term water supply needs from the Mokelumne River and its tributaries to meet the projected demands of Calaveras County. The methods used reflect the conservation measures employed by both Districts.

CCWD views conservation as an integral part of their water resource stewardship responsibility. As such, the District signed the California Urban Water Conservation Council Memorandum of Understanding in 1991 and implemented many of the Demand Management Measures (DMMs), even prior to the MOU, such as leak detection and repair, 100-percent metered service, metered rates, public information programs, and water waste prohibitions. CCWD has worked to expand its water conservation program to achieve the largest water savings, and appropriately manages a tiered rate structure to promote water conservation while ensuring water use equity. However, due to the rural nature of the County; diversity in climate, soils, elevation, and geography; and relatively small and dispersed rural population with a large fraction of low income housing; CCWD is reaching a point where DMM affordability is decreasing. Nevertheless, the District is exploring cost-effective options to meet DMM requirements and the state's 20 x 2020 (Senate Bill X7-7) requirements.

One of the CCWD's most effective efforts in 2015 was the formation of "Calaveras Conserves," a countywide conservation group that includes every major water supplier in the County. This eight member group, which includes CPUD, collaborated to create a website, www.calaverasconserves.com, where county residents can find mandatory water conservation restrictions for every water district in Calaveras County in one place. Additionally, members pooled funds to make hundreds of road signs that read "Use Water Wisely," which were placed in prominent locations throughout the County to promote conservation. This group continues to meet quarterly and is an excellent platform for water purveyors to collaborate and work together toward achieving common goals.

CPUD is also using public outreach to encourage conservation. However, CPUD's status and approach is slightly different than CCWD. According to the CPUD's December 2013 Sphere of influence Update, CPUD provided water services to approximately 1,985 water connections in 2009. Senate Bill X7-7 which requires a 20 percent reduction in use by the year 2020, is only applicable to agencies with 3000 connections or more. Although CPUD is exempt from meeting the 20 X 2020 goals, they are actively engaged in conservation programs. In addition to Calaveras Conserves, CPUD Board of Directors passed Resolution 2015-6 which enacted a mandatory water conservation plan. This ordinance establishes Permanent Water Conservation Requirements intended to alter behavior related to water use efficiency for non-shortage conditions and further establishes three levels of water supply shortage response actions to be implemented during times of declared water shortage emergency, with increasing restrictions on water use in response to worsening drought or emergency conditions and decreasing supplies.

This section describes the methods used for each projecting demands in the Districts' services areas. Projected demands reflect the Districts' commitment to conservation.

3.1 CCWD Demands

CCWD's 2015 Urban Water Management Plan Update (UWMP) was used as a reference to determine future Mokelumne River demands. The UWMP presents the results of three approaches used to calculate future level demands. Approach 1 is the Historical Connections Growth Projection which assumes that future demands would increase at the same rate as historical growth in the number of new residential connections. Approach 2 is the Land Use Based Projections which are based on Calaveras County's expected build out according to the County's General Plan as well as approved Community Plans and Special Plans. Approach 3 is the Department of Finance Population Projections, which project growth by applying percent growth for Calaveras County to the baseline demand averaged from 2009-2013 in each service area for all customer classes apart from agriculture. As stated in the UWMP, projections developed using the population-based approach fall between the projections developed with the other two approaches, and are anticipated to be the most representative of future growth in the District. For this analysis, the municipal and industrial demands were derived from the population projections where applicable. In the agricultural areas of Calaveras County, the Draft General Plan was used to estimate projected demands.

West Point/Wilseyville/Bummerville

CCWD currently serves the West Point, Bummerville, and Wilseyville areas (West Point service area) with water supplies originating in the Middle Fork Mokelumne River Basin. The West Point service area is shown in Figure 4. These areas are served by diversions from Bear Creek or from the Middle Fork Mokelumne. There are currently approximately 590 retail connections served (as of 2015). Current surface water demand in this area is 194 acre feet (AF). Using the population growth demand projections method outlined in the UWMP, the future level demands were calculated and are presented in the table below. The projections utilize a baseline water use representative of the averages from 2009-2013 to better represent water use under normal conditions.

There is a small community east of West Point served by the Lili Valley Water Company. The water company operates two wells to supply approximately 70 connections. The demands are relatively small totaling 20 – 30,000 gallons per month (0.09 AF) for a maximum of about 11 AF per year and could be served by extending a treated water pipeline from the West Point system. The Lili Valley demands were not modeled in this study and are not represented in the results, but should be considered in future planning efforts. Alternately, Lili Valley Water Company may want to independently develop their own surface water supplies.

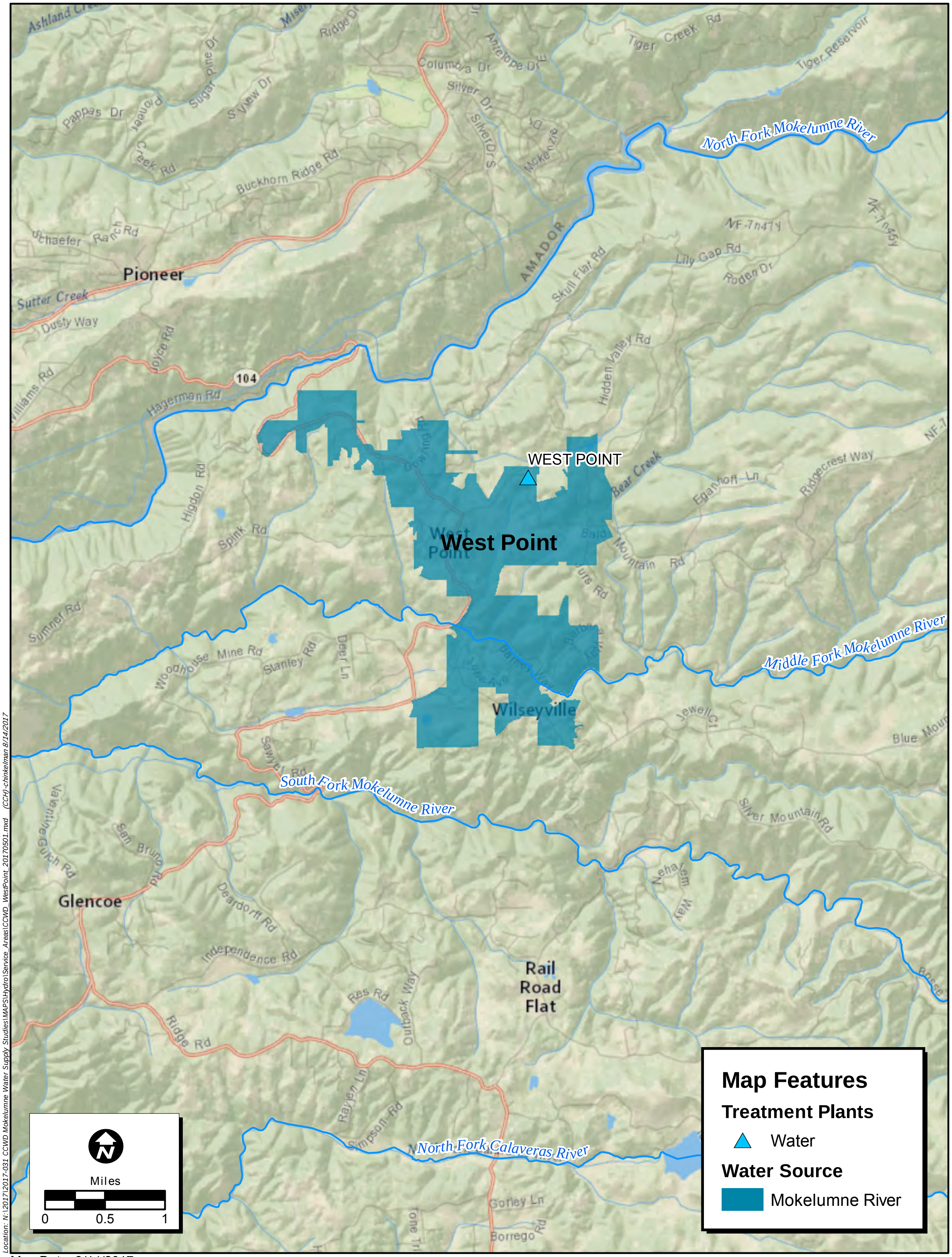

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Figure 4.

West Point/Wilseyville/Bummerville Service Area

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CCWD and CPUD are considering a joint use facility known as the Middle Fork Ditch Pipeline to serve anticipated demands. Although the initial purpose of the pipeline was to deliver raw water supplies to Jeff Davis Reservoir, the pipeline alignment travels through existing parcels that could be served by the pipeline. A proposed Middle Fork Ditch Pipeline service Area was developed by selecting existing parcels located adjacent or in close proximity to the proposed Middle Fork Ditch Pipeline Alignment. See Figure 4, Attachment B for details. Projected demands in the Middle Fork Ditch Pipeline service area were estimated by applying the Calaveras County base land use designations from the Draft Calaveras County General Plan update (2016). To each parcel in the proposed service area, water demands by land use designations were applied according to the 2015 Calaveras County Water District Urban Water Management Plan. See Appendix B for details. For the purposes of this study, the pipeline was assumed to be operational by 2030. Table 1, below, shows the demand projections for West Point and Middle Fork Pipeline service areas.

Table 1. West Point / Wilseyville / Bummerville Demand Projections

Annual Projected Surface Water Demand AF/YR	Current (2015)	2030	2070	2100 (Projected)
West Point Service Area	194[1]	224	282	327
Future Suggested Middle Fork Ditch Pipeline Service Area	0	2,468	3,690	4,988
Total	194	1,104	3,510	5,315

Notes:

1 Lili Valley Water Company's (LVWC) 11 acre foot demand currently served by groundwater were not modeled in this study, but may be considered in future planning efforts.

Western Calaveras County

The majority of western Calaveras County is currently reliant on groundwater supplies. Growth projections in this area are far greater than in the higher elevations. Anticipated growth includes agricultural and municipal development in an area that overlies the critically overdrafted Eastern San Joaquin Groundwater Subbasin (ESJS). An approximately 70 square-mile area of the ESJGS overlies the western edge of Calaveras County as defined in the California Department of Water Resources (DWR) Bulletin 118. Bulletin 118, first published in 1975 and updated several times thereafter is a comprehensive document that gives a multi-faceted overview of the groundwater resources in California. Bulletin 118 also defines the boundaries and describes the hydrologic characteristics of groundwater basins for statewide planning purposes.

The State of California enacted legislation in 2014 known as the Sustainable Groundwater Management Act (SGMA) which empowers local agencies to adopt groundwater management plans that are tailored to the resources and needs of their communities. CCWD and Valley Springs Public Utility District pump water for municipal use from the ESJGS, which has been categorized by the California Department of Water Resources (DWR) as a "critically overdrafted" since DWR issued Bulletin 118-80 in January 1980. CCWD serves many administrative functions over that portion of the basin through the establishment of the Assembly Bill No. 3030 approved Groundwater Management Plan and its role as the recognized California Statewide Groundwater Elevation Monitoring entity for the region.

A suite of comprehensive groundwater management objectives will be necessary to provide a buffer against drought and climate change, and contribute to reliable water supplies, as mandated by SGMA. Figure 5 illustrates the Bulletin 118 groundwater basins and subbasins that have been characterized as being in a state of "critical overdraft" in California. The ESJGS is the northernmost "critically overdrafted" subbasin on the map. The Wallace, Burson, and Valley Springs area overlies a portion of the basin, and CCWD must seriously evaluate the use of currently unused Mokelumne River consumptive state-filed "area of origin water rights" to assist in the groundwater stabilization of the basin. CCWD has joined with Calaveras County, Rock Creek Water District, and Stanislaus County, through a Memorandum of Understanding, to form the Eastside San Joaquin Groundwater Sustainability Agency pursuant to SGMA requirements.

Because DWR has identified the ESJGS as significantly overdrafted, the subbasin must have a Groundwater Sustainability Plan completed and approved by the local agencies by January 31, 2020. As required by SGMA, the planning and implementation horizon for the GSP is 50 years, with "sustainability" being achieved within 20 years of adoption of the plan. CCWD must reasonably plan for the use of Mokelumne River surface water supplies for these areas in lieu of groundwater supplies as an opportunity to allow the subbasin to recharge naturally, or risk irreversible detrimental effects associated with the continued unsustainable overdraft of the groundwater basin. Figure 6 shows the proximity of these areas to the Mokelumne River.

Figure 5. Critically Overdrafted Groundwater Basins, January 2016

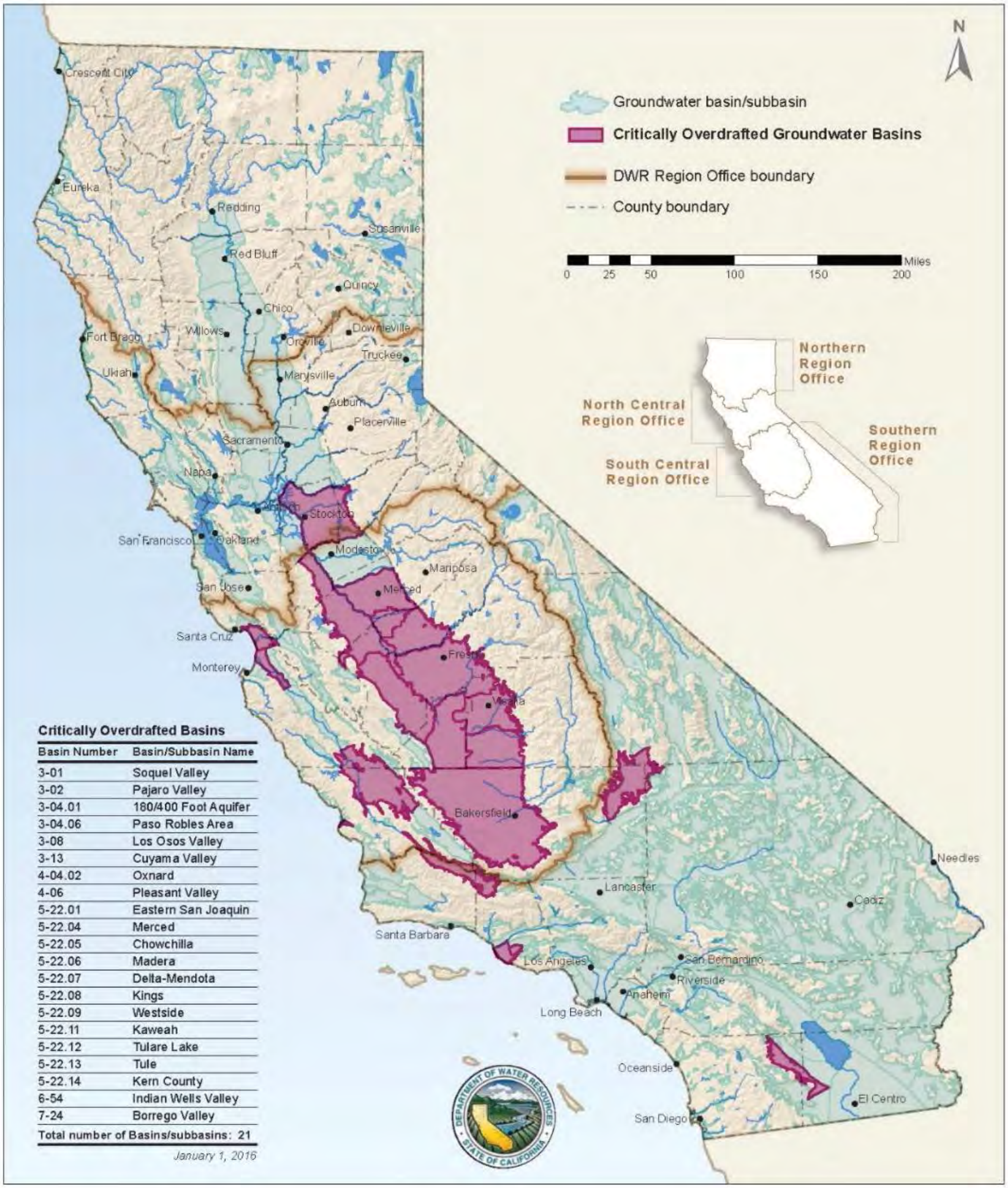

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Figure 6.
Eastern San Joaquin GW Basin within Calaveras County
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Area A / Area B / (Wallace/Burson) / Camanche Area South Shore

For the purposes of this study, the draft 2016 Calaveras County General Plan was used to identify designated land use types in the areas of western Calaveras County that could reasonably be served by the Mokelumne River. A Technical Memorandum identifying the potential demands for Mokelumne River supplies in western Calaveras County was prepared by KASL Engineers using the Draft Calaveras County General Plan (Attachment A). The assumptions are further detailed in the Technical Memorandum which assessed the potential demands for Mokelumne River Water Supplies in Western Calaveras County. The areas analyzed for potential demands include the areas of Wallace, Burson and their vicinities, and the surrounding agricultural areas labeled as Area A and Area B (Figure 7) in the Technical Memorandum in Attachment A.

Area A is the area of western Calaveras County between the Mokelumne River watershed and the Calaveras River Watershed and encompasses 12,926 acres. Over 90% of the land in Area A is zoned as agricultural. Area B lies within the Mokelumne River Watershed south of the East Bay Municipal Utility District and encompasses 6,303 acres. Over 90% of the land in this area is zoned agricultural. Although a majority portion of these areas are zoned as agricultural in the Draft Calaveras County Plan, it is generally understood that not all of these parcels will be fully developed into productive agricultural lands due to a variety of suitability factors. However, the Districts are proceeding with the best available information in this analysis of reasonably foreseeable potential uses of water in Calaveras County.

CCWD conducted the first Phase of an evaluation of potential agricultural lands in western Calaveras County in 2011, completed by Provost & Pritchard. The Provost & Pritchard study utilized a variety of screening factors to assess areas that are actually suitable for potential agriculture in western Calaveras County. For the purposes of this evaluation of Long-Term Water Needs from the Mokelumne River, Areas A and B were defined, then the 2016 Draft County General Plan Update zoning was applied. The Provost & Pritchard 2011 methodology was used to further screen out the unsuitable agricultural lands. The screening criteria from the Provost & Pritchard study includes parcel size, slope, soil depth, surface rockiness, soil stoniness, existing cover, and irrigated land suitability. Once the screening criteria and methodology from the Provost & Pritchard study was applied to the total agricultural areas identified in the 2016 Draft Calaveras County General Plan, this significantly reduced total agricultural and corresponding water demand associated with the agricultural lands to a more reasonable estimate for future growth.

Wallace and Burson are primarily within Area A and are currently dependent upon groundwater supplies (Figure 8). The Wallace Lake Estates development utilizes two 200-gallon-per-minute wells that generate a blended water supply of groundwater from the ESJGS. CCWD also owns a third well that was drilled for anticipated future demands and use but never fully developed or permitted for municipal drinking water use. The groundwater from these wells is high in iron and manganese, which causes several treatment and well management challenges. Future treatment of these water supplies may become challenging, as the cost per unit of treatment has increased over time. According to the UWMP, the Wallace area includes plans for expansion of a large subdivision.

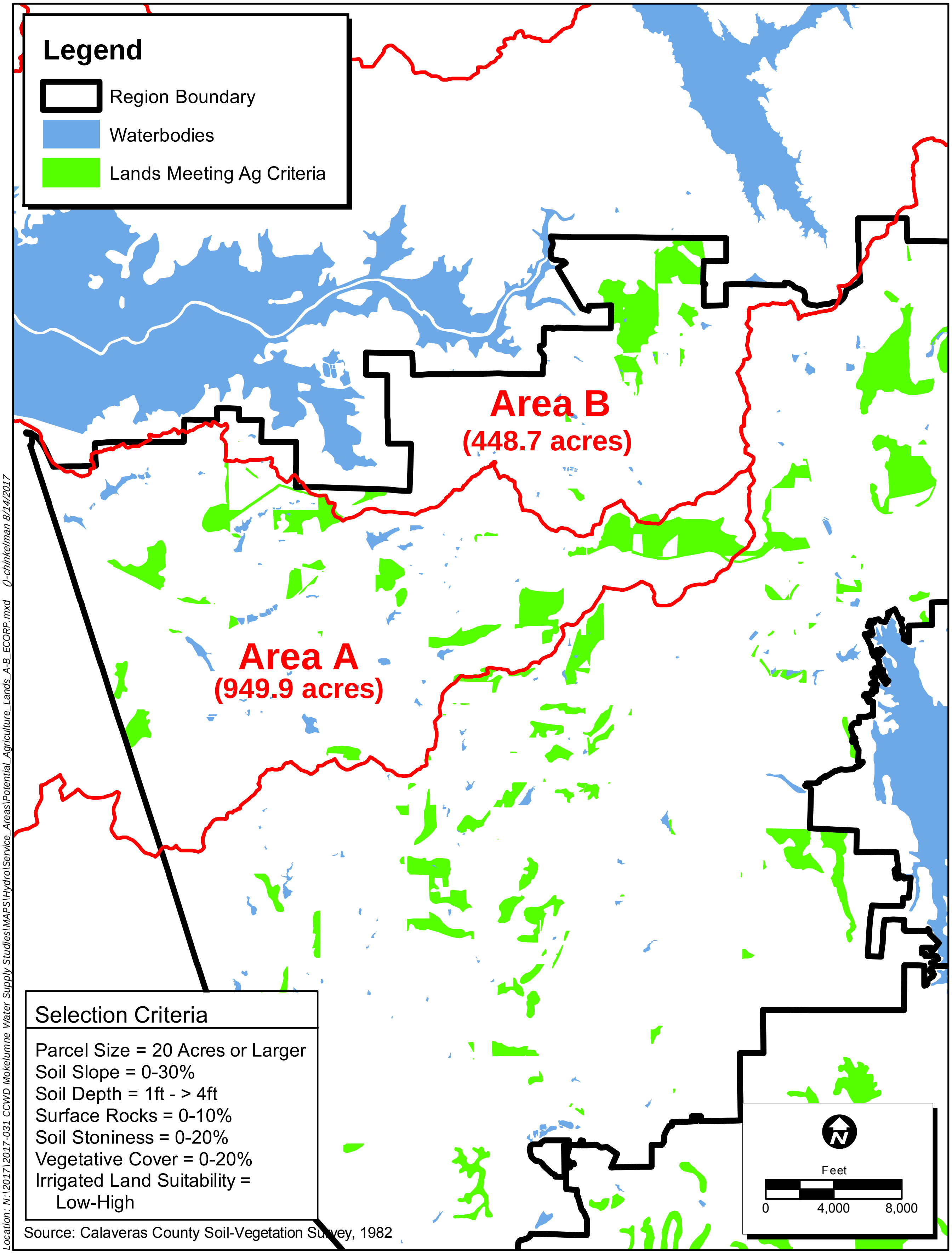

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Figure 7.
Potential Suitable Agriculture Lands in Area A and Area B
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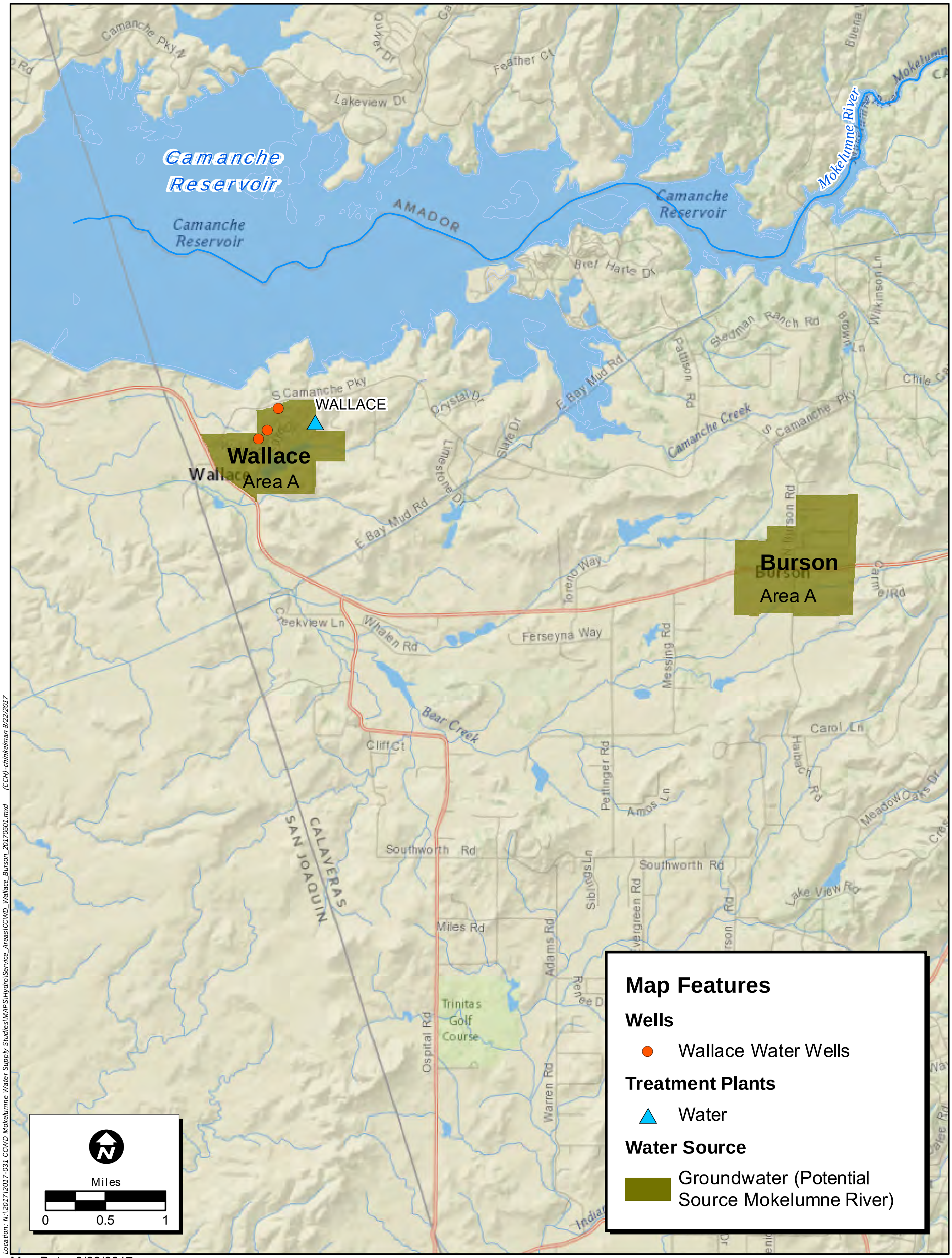

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Figure 8.
Wallace and Burson Service Area
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The long-term reliability of groundwater supply is problematic given that this area overlies the critically overdrafted ESJGS. In 1989, CCWD authorized a study in response to complaints of poor water quality and diminishing supplies from existing wells by property owners within the Lancha Plana area. The Lancha Plana area is located south of Camanche Reservoir and includes the Burson area. Again in 2001, residents requested assistance from the District to alleviate the hardship of failing wells or poor quality groundwater supplies. In order to address potential health and safety concerns, CCWD set up a program to allow residents to fill individual containers with potable water at the Jenny Lind Water Treatment Plant to transport water as a short-term solution. CCWD also drilled an exploratory well to determine if the water was suitable for treatment, but the reconnaissance showed that background levels of arsenic, iron and manganese would require additional treatment that was not cost feasible for the residents of the community. Issues of groundwater quantity and quality have been an ongoing problem in this area for decades. Current demand in this area is 45 AF annually.

Camanche Area South Shore (CASS) is located on a peninsula on the east side of the Lake Camanche just south of the main stem Mokelumne River. CASS is currently served by East Bay Municipal Utility District (EBMUD), however a joint study known as the Camanche Area Regional Water Supply Project (CARWSP) was developed in partnership with CCWD, Amador Water Agency and EBMUD to serve the water needs of areas around Lake Camanche including CASS. The projected demands for CASS are taken from the CARWSP report and presented below.

Projected surface water demands for these areas are listed in Table 2.

Table 2. Area A/Area B/ Wallace/Burson/ Camanche South Shore Projected Demand

Annual Projected Surface Water Demand AF/YR	2015 (Current)	2030	2070	2100 (Projected)
Wallace / Burson[1]	0	878	1300	1741
Camanche Area South Shore	113	123	123	123
Area A General Plan	0	7,081	25,947	40,090
Area A Modified by P&P Report	0	4,892	17,954	27,758
Area B General Plan	0	3,372	12,378	19,139
Area B Modified by P&P Report	0	2,053	7,528	11,634

Notes:

1 Wallace / Burson demands are located in Area A, but for this analysis will be met in addition to Area B demands.

The in-depth analysis of Area A and Area B resulted in refinements to provide Mokelumne River supplies by proximity and need. Because Area B is within the Mokelumne River watershed, this study assumes that its projected demands will be met by Mokelumne River supplies. Area B demands modified by the Provost & Pritchard Report appear to be the most likely projected demands in western Calaveras County. The Draft General Plan indicates Area A demands will largely be agricultural and can be served by CCWD's Calaveras River supplies with the exception of the Wallace and Burson areas. A portion of the Wallace service area lies within Area B with the majority in Area A. Burson is entirely within Area A. Because of their proximity to the Mokelumne River and the need for higher quality surface supplies, this study assumes future demands in the Wallace and Burson areas will be met by Mokelumne River supplies.

Valley Springs

The area of Central Valley Springs is also utilizing groundwater supplies and overlies the ESJGS. Central Valley Springs, or Valley Springs "proper" is served by the Valley Springs Public Utility District (VSPUD). VSPUD has two wells and three storage tanks with a combined storage of 500,000 gallons. Because VSPUD overlies the ESJGS, it suffers from many of the same problems as Area A and Area B. The first historical water system that served Valley Springs included a reservoir that was supplied by an aqueduct that carried water from a diversion on the Mokelumne River. Parts of the aqueduct can still be seen along Paloma Road. In addition, CCWD constructed an emergency intertie in 1988 to serve Valley Springs from the Jenny Lind Water Treatment Plant due to some unforeseen reliability issues with groundwater supplies. VSPUD has since made some investments in groundwater well upgrades that addressed many of those recurring problems, but reliably meeting projected demands or emergency fire flow demands will be problematic without redundant surface supplies. VSPUD calls upon this backup supply on very rare occasions, usually when there is a fire within its service area.

Current demands in Valley Springs are about 105 AF/YR. *The Valley Springs Public Utility District Effluent Management and Wastewater Treatment Project Initial Study/Mitigated Negative Declaration* dated May 2015 prepared by Stantec anticipated growth at 1.5% per year. Applying a 1.5% growth rate to the 2015 demand of 105 AF per year, anticipated demands are shown in Table 3 below.

Table 3. Valley Springs Projected Surface Water Demand

Annual Projected Surface Water Demand AF/YR	2015 (Current)	2030	2070	2100 (Projected)
Valley Springs	0	131	238	372

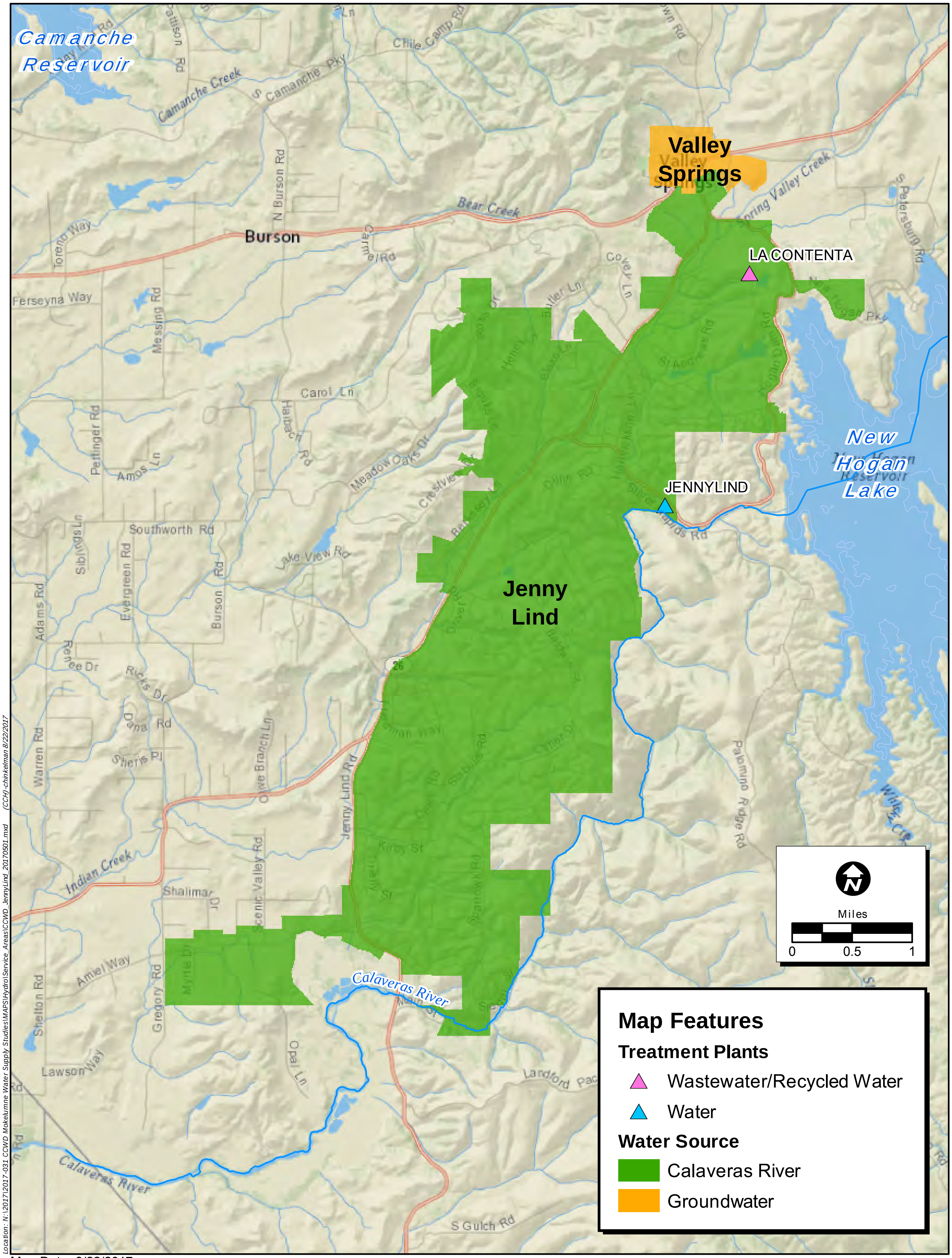
Jenny Lind / La Contenta

The Jenny Lind/ La Contenta area (Figure 9) currently receives surface water from a non-Central Valley Project contract with the United States Bureau of Reclamation (USBR) for supplies from New Hogan Reservoir on the mainstem Calaveras River. The diversion point for the Jenny Lind Water Treatment Plant is in the lower Calaveras River, approximately one mile downstream of New Hogan Dam and has an existing capacity of about six million gallons per day with 3,756 municipal connections in 2015. CCWD's New Hogan supplies are used to serve water to retail customers and raw water supplies to agricultural customers and a golf course. Current total demands from CCWD supplies are 3,333 AF/YR, with a treated water demand of approximately 1,935 AF. Projected demands for the Jenny Lind / La Contenta area are listed in Table 4, below.

Table 4. Jenny Lind/La Contenta Projected Demand

Annual Projected Surface Water Demand AF/YR	2015 (Current)	2030	2070	2100 (Projected)
Jenny Lind/La Contenta M&I	1,935	2,113	2,220	2,301

Water quality on the Calaveras River can unpredictably vary, especially during times of prolonged drought. A baseline water quality program study was completed in 2005 under a CALFED Bay-Delta Program grant.



Location: N:\2017\2017-031 CCWD Mokelumne Water Supply Studies\MAPS\Hydro\Service_Areas\CCWD_JennyLind_20170501.mxd (CCH)-chinkelman 8/22/2017

Map Date: 8/22/2017
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Figure 9.
Jenny Lind/La Contenta/Valley Springs
2017-031 Calaveras County Water District

The study found that potential impacts to the water quality in the Calaveras River are mostly naturally occurring; including increased sediments from runoff, manganese from runoff and low reservoir levels, nutrient loading, and coliform bacteria. Water quality in this region is also impacted by high levels of iron, manganese, nitrates, nutrients and other constituents associated with agricultural production. This water supply is suitable for agriculture, but municipal users would benefit from the higher quality of Mokelumne River for treatability reasons, either as a supplemental or a redundant water supply. Influent turbidity levels coming into the Plant have been measured above 200 NTU on many occasions. This study assumes that the municipal demands will be met by Mokelumne River diversions in the future. Agricultural demands will continue to be met by diversions from the Calaveras River.

Groundwater Recharge/Augmentation

CCWD serves many administrative functions over that portion of the basin through the establishment of the Assembly Bill No. 3030 approved Groundwater Management Plan and its role as the recognized California Statewide Groundwater Elevation Monitoring entity for the region. As such, CCWD is actively participating in regional efforts through the newly created Eastside San Joaquin Groundwater Sustainability Agency and the eventual submission of a Groundwater Sustainability Plan (GSP) to the California Department of Water Resources for the Eastern San Joaquin Groundwater subbasin necessary to meet SGMA requirements by January 1, 2020. The District acknowledges this key role with regard to stewardship of the County's surface water supplies, which must be holistically evaluated to support regional planning efforts mandated by SGMA legislation.

CCWD has previously investigated, through several studies, the hydrogeology of the western end of the County and also identified areas that may provide favorable groundwater recharge opportunities. In 2013, the District undertook a study to identify specific recharge opportunities within its portions of the Eastern San Joaquin subbasin; this Technical Memorandum was titled *Groundwater Characteristics and Recharge Implications Near Lake Camanche and Valley Springs, California* (Dunn Environmental 2013). The study found that existing geologic conditions in the Study Area do not generally favor deep percolation of surface water for recharge. However, small target areas could be investigated further where Tertiary age sands and gravels persist in the subsurface to support expectations for feasible managed aquifer recharge on a local scale. Surface water conjunctive use options could be investigated to assess potential for aquifer storage and recovery via direct supply well injection. Additional alternative recharge projects, such as injection wells, may be viable. Stored water injected into high yield areas could be explored. Where such areas are identified, diverting surface water to groundwater injection wells may prove a viable coordinated effort for the subbasin and local groundwater users.

Based on these efforts, the District is currently evaluating the most effective methods to conjunctively manage its water resources within the County, including the use of its permitted surface water rights for groundwater recharge. The District continues to study the groundwater basin in the Camanche/Valley Springs area to determine potential management methods to improve the basin and/or its potential for conjunctive use to meet future water supply needs within the region. Currently, the District does not include groundwater in its projected supplies due to the general availability of surface water to meet current service area needs. The District will likely be an important partner in ultimately achieving the sustainability goals required by SGMA by using its permitted rights to address overdraft in the basin. It is anticipated that, through these efforts, CCWD will be required to participate in some form of groundwater recharge program to achieve long-term sustainability of the basin, which could increase future demands. However, SGMA is being implemented in a parallel planning process to this study and the District's future demands associated with groundwater recharge are currently unknown.

3.2 CPUD Demands

Currently, CPUD's treated water demands come from the Licking Fork and South Fork of the Mokelumne River. From the South Fork Mokelumne, water is pumped to the 1,740 AF Jeff Davis Reservoir located near Rail Road Flat. CPUD meets all of its treated water demands from the Jeff Davis Water Treatment Plant. The Treatment plant has a current capacity to treat up to 6 million gallons per day with room for expansion of up to 12 million gallons per day. CPUD's current service areas include Mokelumne Hill, San Andreas, and portions of Rail Road Flat, Glencoe, and Paloma.

Anticipated future demand in CPUD's service area is much greater than existing facilities can meet. The District completed studies in 1988, 2001 and again in 2014, to evaluate the feasibility of piping their pre-1914 water from their storage Schaads Reservoir, located on the Middle Fork of the Mokelumne River to supplement Jeff Davis Reservoir, now served by CPUD's South Fork Mokelumne River Pump Station diversion. Details of the proposed Middle Fork Pipeline are discussed in Appendix B, *Technical Memorandum: Potential Demand for Mokelumne River Water Supplies Along Proposed Route of Middle Fork Ditch Pipeline*.

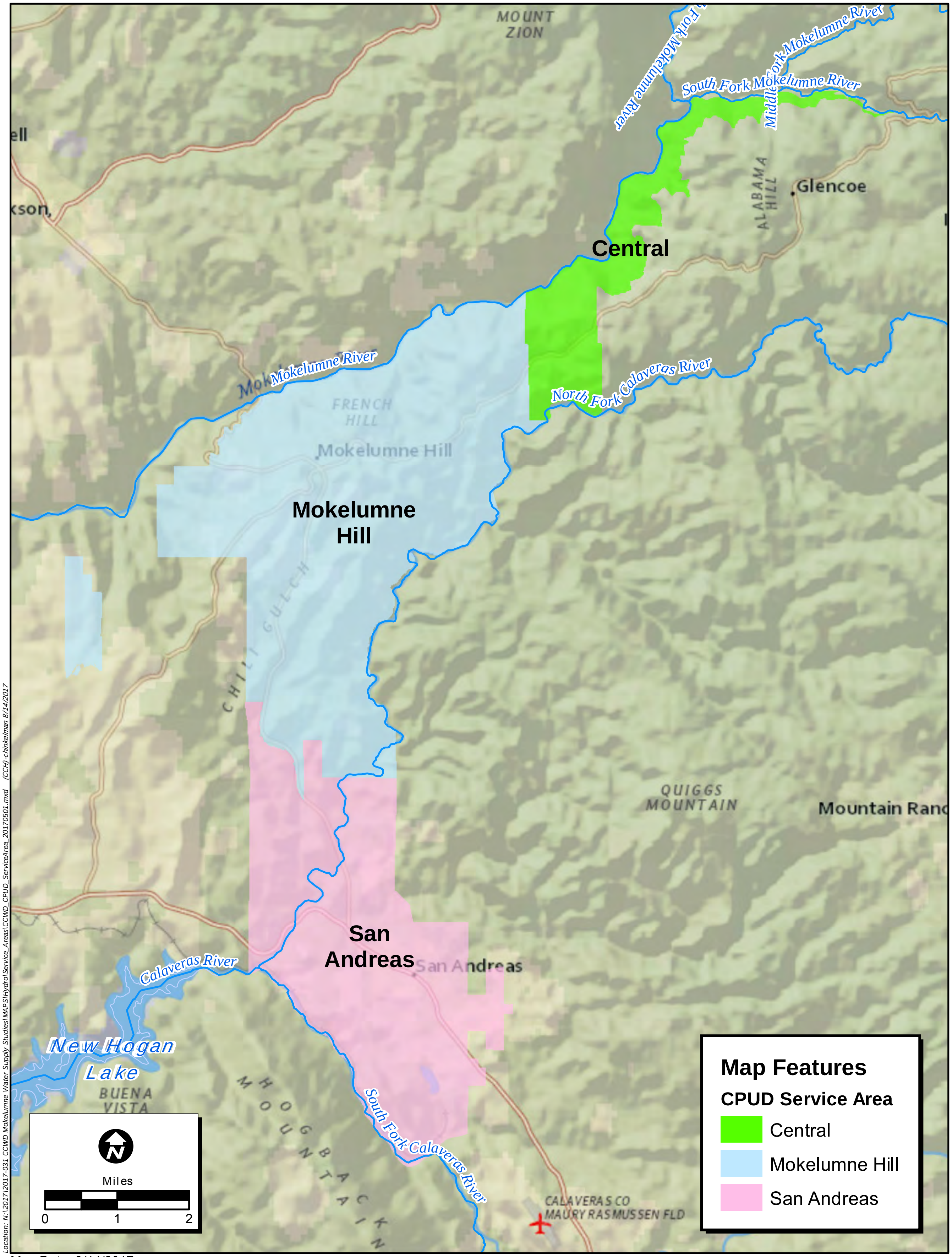
As a result of the recent 2011 – 2015 California drought, the State Water Resources Control Board (SWRCB) was forced to conduct an unprecedented review of water rights and supplies held by the state's water resources managers. As a result of this determination a moratorium on new connections in CPUD's service areas was issued in October 2014. In response, CPUD supplied the SWRCB with a comprehensive compilation of its existing pre- and post-1914 water rights, which resulted in the SWRCB lifting the moratorium in March 2016. Although the moratorium was lifted, supplemental supplies will be needed for anticipated growth and to meet future severe drought conditions. The proposed Middle Fork Ditch pipeline would augment the current supplies by providing pre-1914 stored water supplies from Schaads Reservoir and direct diversions from the Middle Fork Mokelumne River to Jeff Davis Reservoir.

Jeff Davis Water Treatment Plant (Existing) Service Areas

Currently, treated water demands at the Jeff Davis WTP are approximately 1,542 AF/YR. Annual water demands supplied by the Jeff Davis WTP have increased approximately 1% per year over the last 20 years. To account for reservoir percolation and evaporation losses and for losses in the South Fork Pump Station discharge pipeline, it is reasonable to assume an annual delivery from the South Fork (or future Middle Fork) supply which is 25% greater than the annual treated water demand at the Jeff Davis WTP. Extending the growth rate with these assumptions through 2100 results in a demand of 4,491 AF/YR. Projected demands for these areas are shown below in Table 5.

Table 5. Projected CPUD Consumptive Surface Water Demands

Annual Projected Surface Water Demand AF/YR	2015 (Current)	2030	2070	2100 (Projected)
Jeff Davis WTP Demands	1,928	2,238	3,332	4,491



Location: N:\2017\2017-031 CCWD Mokelumne Water Supply Studies\MAPS\Hydro\Service_Areas\CCWD_CPUD_ServiceArea_20170501.mxd (CCH)-chinkelman 8/14/2017

Map Date: 8/14/2017
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Figure 10.
CPUD Service Area
2017-031 Calaveras County Water District

4.0 WATER SUPPLY / EXISTING WATER RIGHTS

4.1 CCWD Water Rights

Approximately 150 years ago, the communities of West Point, Bummerville and Wilseyville began initially as mining camps, and later developed into logging communities. Originally, all three areas were served with water routed through a series of mining ditches, which were owned or operated in conjunction with these activities. The decline of these industries, critical to the area economy, brought about CCWD purchase of the water and conveyance systems.

The West Point water system was purchased in 1954 by CCWD from the West Point Ditch Company. The predecessor to Sierra Pacific Logging Company owned and built the Wilseyville System and sold it to CCWD in 1964. The Bummerville system was connected to the West Point System in 1959. The existing water system serves 570 customers, including a local Native American Reservation. The current facilities include: two raw water reservoirs, Wilson Dam and Reservoir (currently no storage, water passes through) and Regulating Reservoir; two raw water diversion facilities, Bear Creek (gravity) and Middle Fork Mokelumne (pumped); one water treatment plant, West Point; two treated water pump stations, Bummerville and Upper Wilseyville; and the associated distribution and storage system, raw pump station, Mokelumne River intake, and the raw booster pump station near Bummerville. The Mokelumne River intake pump station is for emergency or backup use should the Bear Creek diversion fail or provide insufficient flow.

Permit 15452

Permit 15452 was issued to Calaveras County Water District on September 7, 1967 pursuant to Application 5648D. This permit allows CCWD to divert up to 4 cfs from January 1 to December 31 of each year and store up to 150 AF/YR at Regulating Reservoir to be collected from about December 1 of each year to about May 30 of the succeeding year. Maximum use of this right is 1,830 AF. The Bear Creek supply is currently used to serve the West Point/Wilseyville/Bummerville area. The quantity of water granted to CCWD by this permit is a part of the 27,000 AF reserved for Calaveras County under the 1927 filing by the State Department of Finance. The purpose of use for permit 15452 is municipal, irrigation and stockwatering. Table 6 summarizes the water rights held by CCWD and CPUD.

Table 4. Water Rights Summary

Application (Permit)			Point of Diversion		Direct Diversion		Storage		Use Limit
Number	Priority Date	Purpose of Use	Location	Stream	Amount (cfs)	Season	Amount (AFA)	Season of Diversion	(AFA)
A005648[1]	7/30/1927	Irrigation Municipal Stockwatering				1/1 – 12/31			18,514
Calaveras County Water District									
		Irrigation Municipal Stockwatering	Wilson Dam	Bear Creek			45		
A005648D (P15452)	9/7/1967 (7/30/1927)	Irrigation Municipal Stockwatering	Bear Creek Diversion & Regulating Reservoir	Bear Creek	4	1/1 - 12/31	150	12/1- 5/31	1,830
Calaveras Public Utility District									
S010773	1852	Domestic Irrigation Stockwatering Power	Below Schaads Reservoir	Middle Fork Mokelumne	2.5	1/1 – 12/31	1,800[2]	1/1 – 12/31	
S025267	1852	Domestic Irrigation Stockwatering Power		South Fork Mokelumne	7.35			1/1 – 12/31	
A005648F (P16338)	12/13/1971 (7/30/1927)	Domestic Municipal Incidental Power Industrial		Middle Fork Mokelumne South Fork Mokelumne	12.5		2,130	1/1 – 12/31	6,656[3]

Notes:

1 Decision 858 allows the Districts to take up to 27,000 AF for development of West Point and the Mokelumne Service Area. This water is held in reserve for the Districts for Mokelumne River supplies needed to serve future development within Calaveras County. The use limit of 18,514 AF represents the remaining supply held in reserve for the Districts.

2 The May 8, 1940 agreement between CPUD and EBMUD gives CPUD the permission to use a portion of the 12.5 cfs direct diversion to store up to 1,800 AF per year at Schaads Reservoir. This 12.5 cfs diversion right may be combined with storage withdrawals to divert a maximum of 15 cfs. The Agreement also states that CPUD's rights in excess of those amounts will be junior and subordinate to EBMUD's rights.

3 Application 005648F states that the safe yield developed under this permit, together with all other prior rights of permittee, shall not exceed 6,656 AF/YR and shall be a part of the 27,000 acre-feet per annum reserved for use in Calaveras County pursuant to the release from priority of Applications 5647 and 5648 by the State Water Board to East Bay Municipal Utility District dated March 5, 1959, and as set forth in the agreements between Calaveras Public Utility District and East Bay Municipal Utility District dated May 8, 1940 and January 13, 1970.

4.2 CPUD Water Rights

CPUD was formed on January 16, 1934 by special election. On March 13, the newly formed CPUD acquired the Mokelumne River Power and Water Company, which constructed and owned several pre-1914 ditches and associated water rights.

A portion of the Mokelumne River Power and Water Company diversion rights have since been converted to storage rights allowing CPUD to store water at Schaads Reservoir, located on the Middle Fork Mokelumne River. The following provides a history of water rights and agreement supporting CPUD operations.

May 8, 1940 Agreement

The May 8, 1940 Agreement between CPUD and EBMUD is a formal recognition of CPUD's Pre-1914 rights by EBMUD. EBMUD recognized that CPUD has pre-1914 rights to divert from the South Fork of the Mokelumne River as augmented by diversions from the Middle and Licking Forks of the Mokelumne River, not to exceed 12.5 cfs for industrial, domestic, mining, and agriculture. Per the May 8, 1940 Agreement with East Bay Municipal Utility District, CPUD has the right to use a portion of the 12.5 cfs for diversion to storage at Schaads Reservoir not to exceed 1,800 AF/YR. Water in storage may later be released to augment flow available for diversion.

March 5, 1959 Release from Priority

On March 5, 1959, the Department of Water Resources issued a Release from Priority of the State Applications Nos. 5647 and 5648, filed July 30, 1927 in favor of East Bay Municipal Utility District's (EBMUD) Applications 13156 and 15201. The Release from Priority is subject to a reservation for use within Calaveras County for waters of the Mokelumne River and its tributaries covered by Applications Nos. 5647 and 5648 a quantity of water for direct diversion to beneficial use of 27,000 AF for Calaveras County.

January 13, 1970 Agreement

On January 13, 1970 CPUD entered into an agreement with EBMUD for partial assignment of the State filed applications 5647 and 5648 water sufficient to construct and operate the proposed Jeff Davis Project. At the time, CPUD and EBMUD anticipated that with existing facilities, prior pre 1914 rights and the new storage of at least 1,750 AF per annum will produce a safe yield of 6,656 AF per annum. CPUD agreed that the 6,656 AF would be a part of the 27,000 AF reserved for Calaveras County under the State Filing. Per the 1970 Agreement, CPUD filed an application with the State Water Board resulting in Permit 16338 in support of the Jeff Davis Project.

Permit 16338

Permit 16338 granted to CPUD a quantity of water that can be beneficially used and shall not exceed 2,130 AF per year by storage at Jeff Davis Reservoir to be collected from January 1 to December 31 of each year. The maximum rate of diversion to offstream storage shall not exceed 15 cubic feet per second. The safe yield developed under this permit, together with all other prior rights of CPUD, shall not exceed 6,656 AF/YR and shall be a part of the 27,000 AF/YR reserved for use in Calaveras County pursuant to the release from priority of Application 5647 and 5648 by the State Water Board to EBMUD dated March 5 1959, and as set forth in the agreements between CPUD and EBMUD dated May 8, 1940 and January 13, 1970. Decision 858 also discusses the partial assignment of Application 5647 and 5648. This supply is currently used to serve the CPUD service areas.

CPUD / CCWD Agreement

As a supplemental supply to CCWD's Bear Creek Diversion, CPUD has entered into an agreement with CCWD to provide 200 AF per year diverted at the Middle Fork Pump Station. The supply is currently used to serve the West Point/Wilseyville/Bummerville area.

5.0 SIMULATION MODELING

Simulation modeling was performed to identify the flow impacts in Wild and Scenic Reaches (d) and (e) due to CCWD and CPUD operations required to meet anticipated surface water demands in Calaveras County, and to identify potential infrastructure improvements to meet those demands. A series of studies were designed and performed to evaluate the Districts' water rights permits and agreements, climate change hydrology, existing facilities, and projected demands in an effort to develop a conceptual expansion plan to meet anticipated demands. The study results will provide the Natural Resources Agency and their consultant, GEI, with an indication of potential changes to flows for their evaluation of suitability or non-suitability of the proposed designation of sections (d) and (e) of the Mokelumne River as Wild and Scenic. Contained in this section is a summary of the modeling assumptions used, a brief description of each modeling study, and a presentation of the pertinent results. Attachment D contains a more detailed description of the modeling assumptions.

5.1 Modeling Assumptions

Hydrology

The simulation model includes three hydrology datasets. The basis for these datasets is the historic hydrology which occurred from 1934 – 2016 recorded from multiple stream gages on the upper and lower Mokelumne River. Statistical methods are used to estimate flow where records are missing. Attachment D contains a more detailed description of development of the hydrology.

Climate change adjusted hydrology was developed using the data products from the California Water Commission's dataset for Water Storage Investment Program applications. These data products include the results from statewide Variable Infiltration Capacity (VIC) watershed runoff models preformed with historical meteorology and climate change adjusted meteorology using climate change assumptions centered at the year 2030 and 2070. These VIC models are better suited to be used in a comparative manner rather than predictive, and for this reason a ratio is taken of climate change adjusted VIC model output to historic meteorology VIC model output. These ratios are applied to historical hydrology for the 1934 – 2011 period to estimate the climate change adjusted hydrology. For the 2012 – 2016 period, ECORP selected similar years from the 1934 – 2011 record and applied climate change factors from those similar years to 2012 – 2016 historic unimpaired flow data. The hydrology dataset was developed for the upper Mokelumne River watershed and is consistent with Commission methods on a daily time step.

Figure 11. Average Monthly Flows at the confluence of the Middle Fork and South Fork Mokelumne River

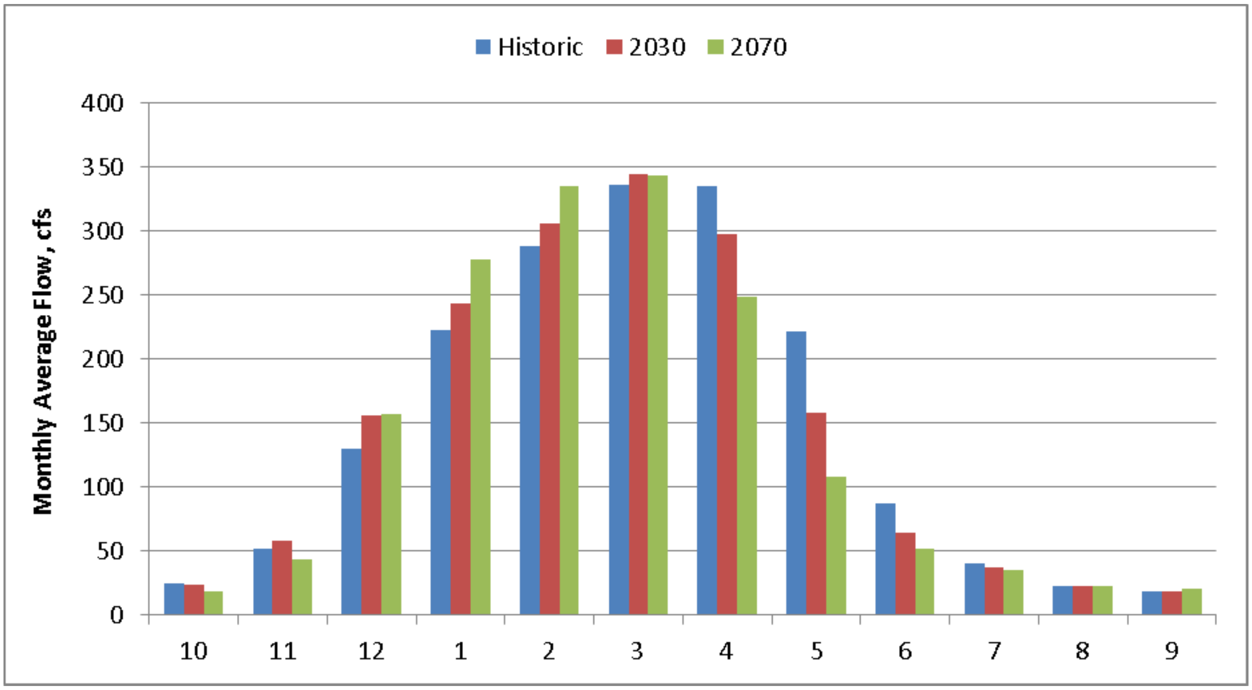


Figure 11 illustrates the Historic unimpaired flow compared to the 2030 and 2070 levels of climate change hydrology. Annual volumes are roughly 10% lower than historic hydrology and there is a shift in runoff patterns such that the peak occurs in February or March rather than the historic March or April peak runoff.

Facilities

The existing facilities included in the modeling are listed by owner.

CPUD owns and operates:

- Schaads Reservoir (1,700 AF)
- South Fork Mokelumne Pump Station
- Jeff Davis Reservoir and Water Treatment Plant

CCWD owns and operates:

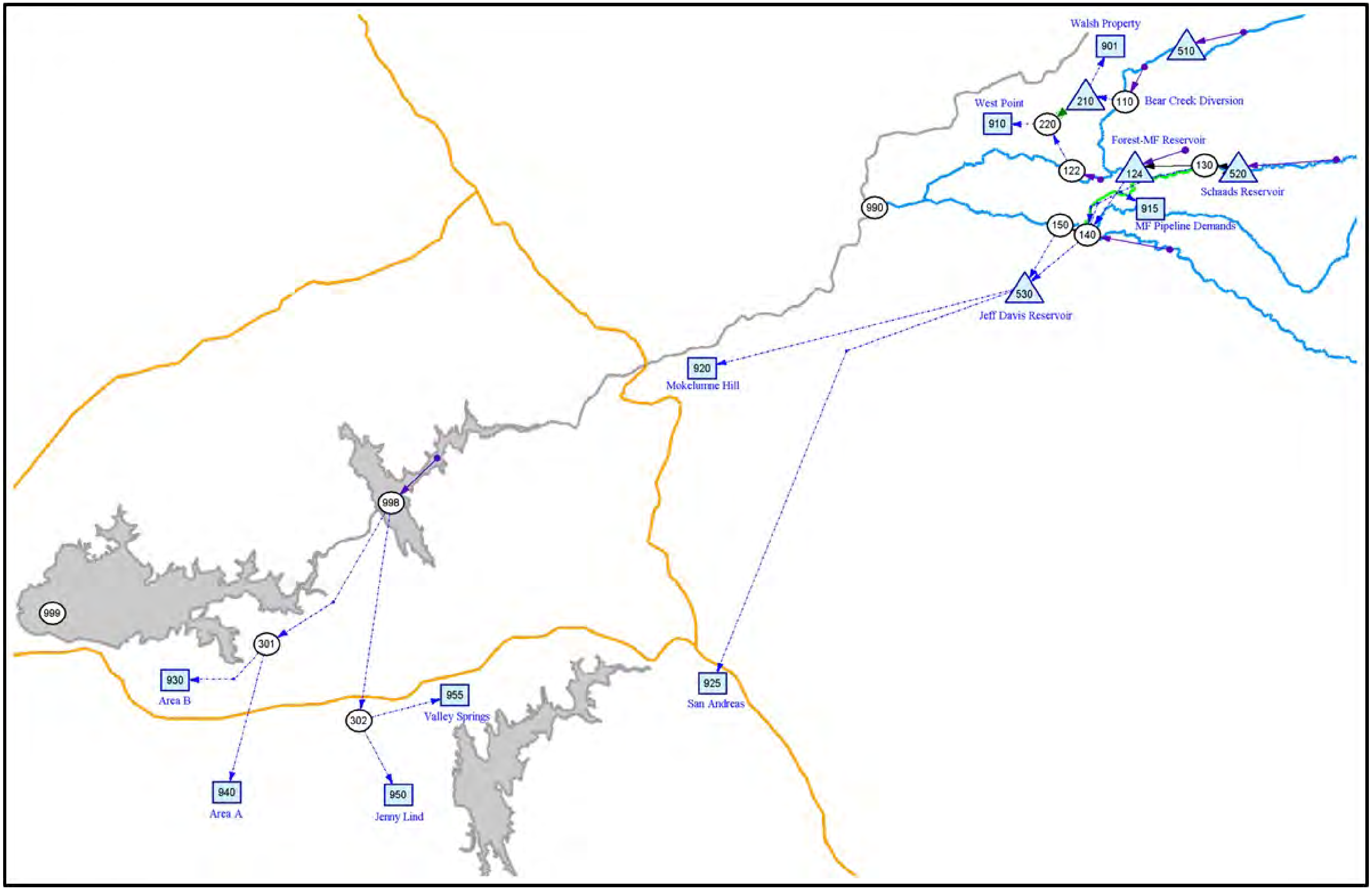
- Wilson Dam (0 AF, currently water passes through)
- Bear Creek Diversion Dam
- Regulating Reservoir (50 AF)
- West Point Water Treatment Plant
- Middle Fork Mokelumne Pumping Station (0.44 cfs capacity)

Proposed improved or new facilities include:

- Schaads Reservoir (1,950 AF)
- Wilson Dam (50 AF)
- Regulating Reservoir (150 AF)
- Middle Fork Mokelumne Pumping Station (1.5 cfs capacity)
- Forest-Middle Fork Dam and Reservoir (8,000 AF or 12,000 AF)
- Middle Fork Ditch Pipeline (25 cfs capacity)

Figure 12 illustrates the model schematic. The schematic uses nodes and arcs to represent the system. Nodes are points of interest in the system. Arcs convey water from one node to another. In this schematic, triangles represent reservoirs, circles represent junctions and rectangles represent consumptive demand areas. Conveyance can be in the form of a natural channel, penstock, or pipeline. This schematic uses a natural stream trace for natural conveyance and a dashed or a green line for man-made conveyance. The green line is used to highlight the proposed Middle Fork Ditch Pipeline.

Figure 12. Model Schematic



Consumptive Demands

The following table summarizes the demands in areas within Calaveras County that are projected to be served by Mokelumne River water. The studies prepared for this analysis use the 2015 (Current) demands and the 2100 (Projected) demands to represent anticipated changes in flow due to CCWD and CPUD operations in proposed sections (d) and (e). Table 7 provides a summary of the projected Mokelumne River demands.

Table 5. Demand Summary

Annual Projected Surface Water Demand AF/YR	2015 (Current)	2030	2070	2100 (Projected)
West Point Service Area	194[1,2]	224	282	327
Future Suggested Middle Fork Ditch Pipeline Service Area	0	2,468	3,690	4,988
Wallace and Burson	0	878	1,300	1,741
Area B Modified by P&P Report[3]	113	2,176	7,650	11,757
Valley Springs	0	131	238	372
Jenny Lind/La Contenta M&I Only	0	2,113	2,220	2,301
Jeff Davis WTP Demands	1,928	2,238	3,332	4,491
Total Projected Demands	2,235	10,228	18,712	26,067

Notes:

1 As a supplemental supply to CCWD's Bear Creek Diversion, CPUD has entered into an agreement with CCWD to provide 200 AF per year diverted at the Middle Fork Pump Station.

2 Lili Valley Water Company (LLWC) has a maximum annual demand of 11 acre feet currently served by two wells. LLWC may want to develop a surface water supply in the future, but was not considered in this study.

3 Area B includes demands from the Camanche Area South Shore derived from the Draft CARWSP report.

5.2 Alternatives

The studies performed in this analysis were designed to provide an estimate of the changes in flow due to projected demands. The analysis includes two baseline studies and three alternatives. Each of the studies are described below.

Baseline: The purpose of the Baseline Study is to represent current conditions in the system. The flow, storage and deliveries made in this study will be used as the basis for measuring changes in the system due to increased demands and new facilities needed to meet the projected demands. Key assumptions made for this study include:

- Historic Hydrology
- Existing Facilities
- 2015 (Current) Demands

Baseline 2070: The Baseline 2070 study includes the existing facilities and the 2015 (Current) demands, but uses a year 2070 climate change hydrology rather than the historic hydrology. When compared to the Baseline Study, this study was used to determine changes in flow in sections (d) and (e) due to differences in **hydrology** (Historic vs 2070 climate change). When compared to the Alternative studies, this study was used to determine changes in flow in sections (d) and (e) due to differences in **projected CCWD and CPUD operations**, which includes increased demands and new facilities. Key assumptions made for this study include:

- 2070 Climate Change Hydrology

- Existing Facilities
- 2015 (Current) Demands

Alternative 1: The Alternative 1 study builds on the Baseline 2070 study by adding projected demands and the Middle Fork Ditch Pipeline (MFDP). The purpose of this study is to identify the water supply benefits of the proposed MFDP. The proposed MFDP can carry up to 25 cfs from Schaads Reservoir to Jeff Davis Reservoir and can deliver water along the MFDP route. Attachment B describes the MFDP in more detail. Key assumptions made for this study include:

- 2070 Climate Change Hydrology
- Existing Facilities
- Middle Fork Ditch Pipeline
- Projected Demands
- Deliveries to Area B would be dependent upon CCWD reaching an agreement with EBMUD to directly divert from or divert from a CCWD storage account within EBMUD facilities. Deliveries to western Calaveras County are assumed to be made by leaving the water in the Mokelumne River and diverting at EBMUD's facilities. This approach minimizes impacts to the river and relies on the CCWD's ability to reach agreement with EBMUD to directly divert and divert from storage at Pardee or Lake Camanche.

Alternative 2: Alternative 2 builds upon Alternative 1 by adding an expanded Schaads Reservoir, a restored/rehabilitated Wilson Dam, an enlarged Regulating Reservoir, a capacity increase at the Middle Fork Pump Station, and a proposed 8,000 AF Forest-Middle Fork Dam approximately 700 feet below the confluence of Forest Creek and the Middle Fork Mokelumne. Key assumptions made for this study include:

- 2070 Climate Change Hydrology
- Expand Schaads Reservoir by 250 AF
- Restore/rehabilitate Wilson Dam and Reservoir to 50 AF
- Enlarge Regulating Reservoir to 150 AF
- Increase Capacity of Middle Fork Pumping Station and Pipeline to 1.5 cfs
- Build Middle Fork Ditch Pipeline with 25 cfs capacity
- 8,000 AF Forest-Middle Fork Reservoir with Pump Station
- Projected Demands
- Deliveries to Area B would be dependent upon CCWD reaching an agreement with EBMUD to directly divert from or divert from a CCWD storage account within EBMUD facilities. Determining the quantity of storage needed is beyond the scope of work for this effort. However, in the driest water year on record (1977), Area B received a delivery of 10,938 AF with the support of storage withdrawals from the 8,000 AF Forest-Middle Fork Reservoir.

The Forest-Middle Fork Dam and Reservoir has been studied several times since August 1959 when Tudor Engineering Company first developed the idea for CCWD to serve the West Point area. The Tudor report was called *Mokelumne River Development Plan and Report*. CPUD published *Reconnaissance Report of Alternate Water Sources* prepared by, Clair A. Hill and Associates in September 1961. The CPUD report included a 20,000 AF storage facility at the Forest Creek site that would produce a yield of approximately 14,800 AF. During May 1974, CCWD published the *Calaveras County Water Master Plan*, prepared by Tudor Engineering Company. The Master Plan included an 11,000 AF Forest-Middle Fork Reservoir. The latest study of the Forest-Middle Fork Dam was in January 1996 as part of the County Water Master Plan, Making Effective Use of Supplies, prepared by Borcalli & Associates, Inc. for CCWD. This version of the reservoir was 12,000 AF with and estimated yield of 5,900 AF. The Middle Fork Reservoir is included in a study has a minimum flow requirement of three cfs. Water stored at Schaads Reservoir is passed to the Forest – Middle Fork Reservoir for hydropower generation. See Attachment D - Simulations Modeling Tech Memo for detailed assumptions.

<u>Alternative 3</u>: Alternative 3 is a variation of Alternative 2 making use of a larger 12,000 AF Forest-Middle Fork Reservoir without the multiple smaller storage expansion projects (restored / rehabilitated Wilson Dam, enlarged Regulating Reservoir, expanded Schaads Reservoir). As in Alternative 2, the Forest-Middle Fork Reservoir assumes a three cfs minimum flow requirement below the reservoir. The purpose of this study is to identify a water supply project that would meet all of the projected demands. Key assumptions made for this study include:

- 2070 Climate Change Hydrology
- Increase Capacity of Middle Fork Pumping Station and Pipeline to 1.5 cfs
- 12,000 AF Forest-Middle Fork Reservoir with Pump Station
- Build Middle Fork Ditch Pipeline with 25 cfs capacity
- Projected Demands
- Deliveries to Area B would be dependent upon CCWD reaching an agreement with EBMUD to directly divert from or divert from a CCWD storage account within EBMUD facilities.

<u>Alternative 4</u>**:** Alternative 4 was designed to take advantage of the CPUD's existing infrastructure. This alternative builds on Alternative 3, using a 12,000 AF Forest – Middle Fork Reservoir and assumes an extension of a pipeline that currently provides the Paloma area with treated water from the Jeff Davis WTP. The pipeline could be extended to serve Valley Springs and Jenny Lind/La Contenta area. Key assumptions made for this study include:

- 2070 Climate Change Hydrology
- Increase Capacity of Middle Fork Pumping Station and Pipeline to 1.5 cfs
- 12,000 AF Forest-Middle Fork Reservoir with Pump Station
- Build Middle Fork Ditch Pipeline with 25 cfs capacity
- Projected Demands

Deliveries to Area B would be dependent upon CCWD reaching an agreement with EBMUD to directly divert from or divert from a CCWD storage account within EBMUD facilities. Treated water deliveries to Valley Springs, Jenny Lind and La Contenta would be made by extending CPUD's pipeline from Paloma.

Table 8, below, summarizes the features in each study.

Table 6. Study Matrix

Features	Baseline	Baseline 2070	Alternative 1	Alternative 2	Alternative 3	Alternative 4
Historic Hydrology	✓					
2070 Climate Change Hydrology		✓	✓	✓	✓	✓
1,700 AF Schaads Reservoir	✓	✓	✓		✓	✓
1,950 AF Schaads Reservoir				✓		
Existing Wilson Dam	✓	✓	✓		✓	✓
50 AF Wilson Dam				✓		
Existing Regulating Reservoir	✓	✓	✓		✓	✓
150 AF Regulating Reservoir				✓		
0.44 cfs Middle Fork Pump Station	✓	✓	✓			
1.5 cfs Middle Fork Pump Station				✓	✓	✓
Middle Fork Ditch Pipeline			✓	✓	✓	✓
8,000 AF Forest-Middle Fork Reservoir				✓		
12,000 AF Forest-Middle Fork Reservoir					✓	✓
Existing Demands	✓	✓				
Projected Demands			✓	✓	✓	✓
Diversion Agreement with EBMUD			✓	✓	✓	✓
Delivery to Valley Springs/Jenny Lind via Jeff Davis WTP						✓

5.3 Results

Results of studies with existing facilities and projected demands indicate that additional storage and conveyance will be needed to meet projected demands. For studies assuming a future level of development, the model adds the proposed Forest-Middle Fork Dam and Reservoir and Middle Fork Ditch Pipeline to provide the necessary water supply and conveyance to meet the anticipated future demands in the West Point, Mokelumne Hill, and San Andreas areas of Calaveras County. The future level of development also assumes that CCWD and EBMUD would enter into an agreement to allow CCWD to use existing Camanche and Pardee storage capacity to support deliveries in western Calaveras County. To support the use of the new facilities, the model assumes that CCWD and CPUD will apply for and be granted partial assignment of the water rights filed by the California Department of Finance on July 30, 1927 held in reserve for use in Calaveras County. These rights were assigned application number A005648 and total 27,000 AF. The remaining supply held in reserve for Calaveras County is 18,514 AF and could be used to support new storage projects.

The following is a summary of the results of the simulation modeling.

Baseline. The Baseline study represents current operations and provides a basis from which to measure impacts. This study is used to evaluate the performance of the system with current demands, existing facilities and existing operations. The historic hydrology from 1934-2016 is used because it contains a range hydrologic variability from very wet to critically dry years. Future hydrology will most likely fall within variability contained in the historic hydrologic record.

Figure 13. Baseline Deliveries

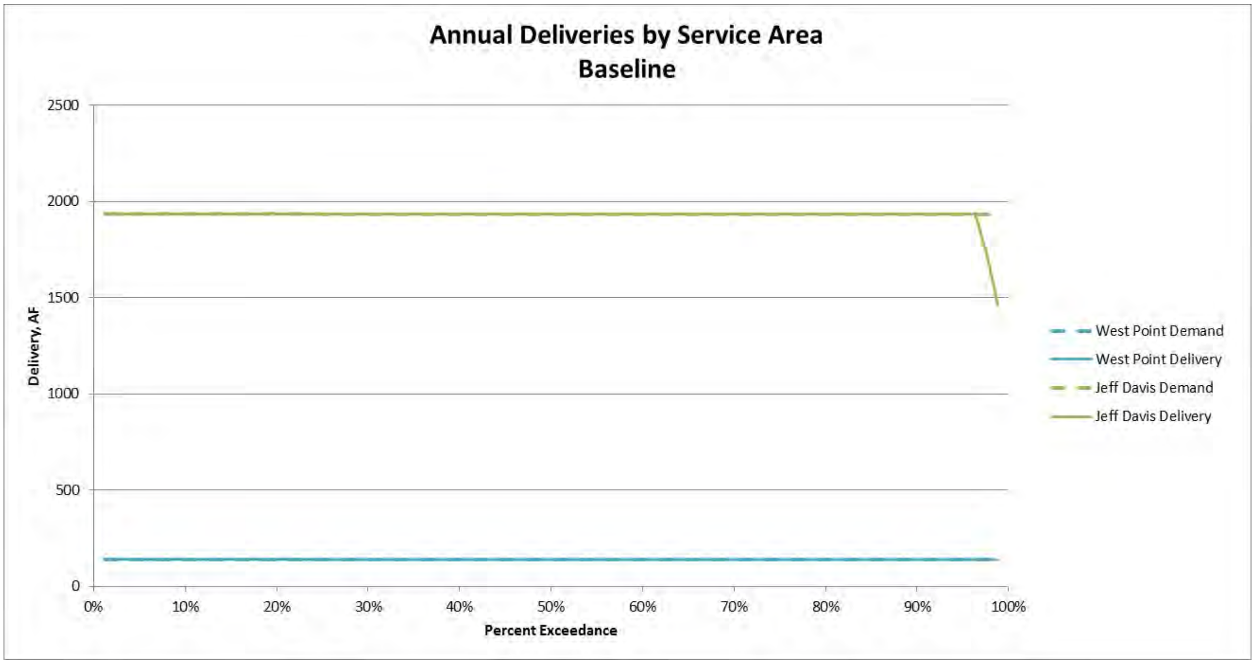


Figure 13, above illustrates annual deliveries to West Point and Jeff Davis WTP. For each service area there is a demand trace, denoted by a dashed line and a delivery trace denoted by a solid line. Shortages will show as a divergence in the two traces. The deliveries are ranked from the highest annual delivery shown on the left side of the figure to the lowest annual delivery shown at the right side of the figure. Results indicate that the existing facilities and water supply can meet the West Point Service Area demands in all years within the historic hydrologic record. However, the model suggests Jeff Davis WTP would experience a water supply shortage in the very driest years.

<u>Baseline 2070</u>. The Baseline 2070 study duplicates the Baseline study with one exception. The hydrologic record for this study represents a theoretical climate change hydrology expected in 2070. Results from the Baseline 2070 study show that the 2070 climate change hydrology causes additional impacts to deliveries to Jeff Davis WTP.

Figure 14. Baseline 2070 Deliveries

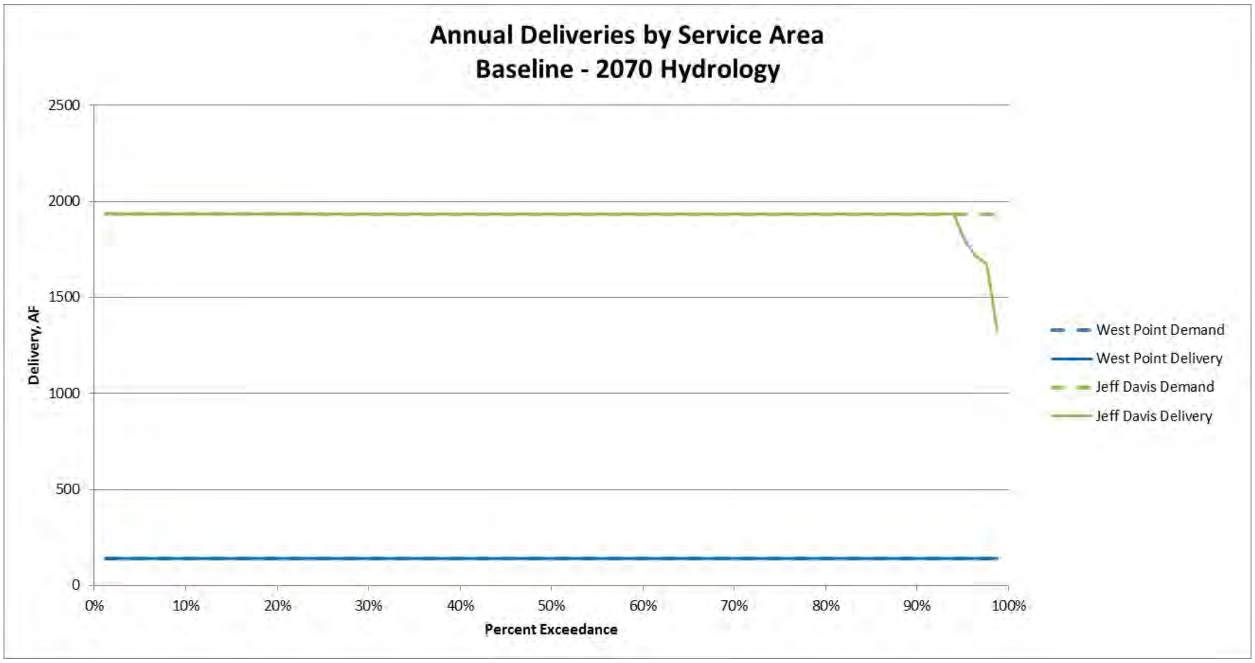


Figure 14 illustrates that existing facilities and 2070 water supply can meet the West Point Service Area demands in all years. The 2070 climate change hydrology exacerbates the water supply deficiencies at Jeff Davis WTP in the very driest years.

Figure 15. Incremental Change in Sections (d) and (e), Baseline - Baseline 2070

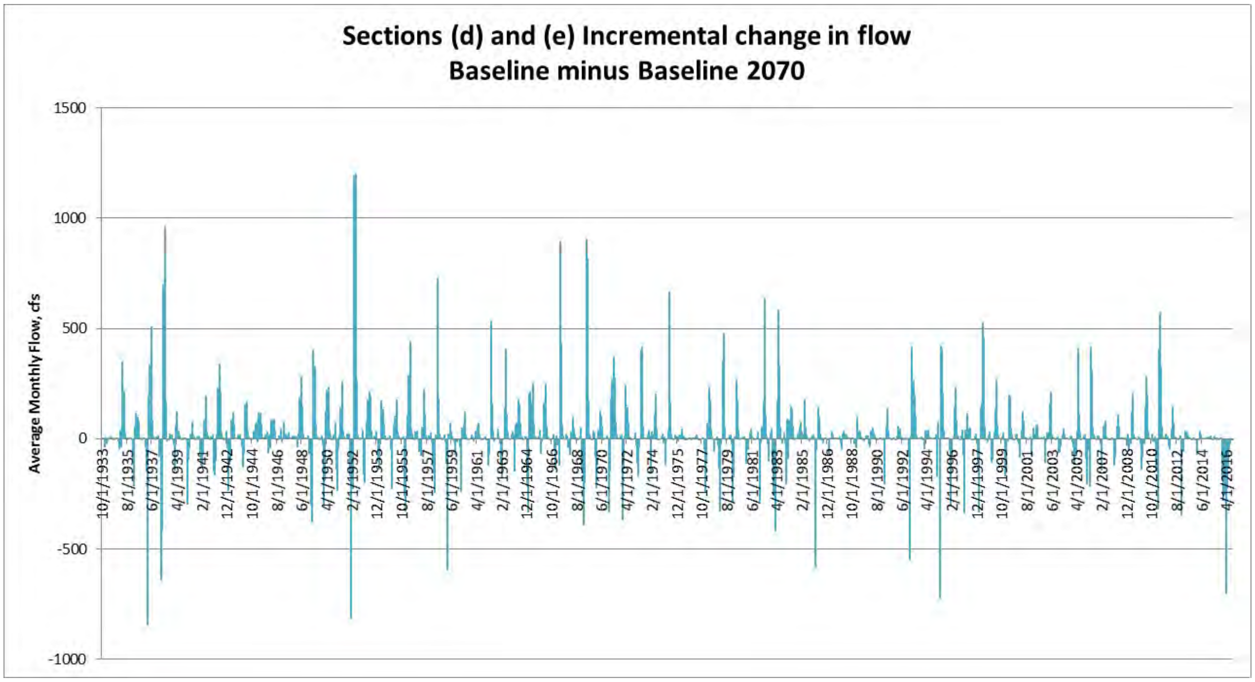


Figure 15 illustrates the incremental change due to the climate change hydrology. The differences shown in Figure 15 reflect a shift in the climate change runoff patterns and illustrates a need for the system to modify operations.

Alternative 1. Alternative 1 adds the projected demands, the Middle Fork Ditch Pipeline from Schaads Reservoir to Jeff Davis Reservoir, and the assumption that CCWD will reach a diversion agreement with EBMUD to the Baseline 2070 study. Figure 16 illustrates the key annual projected deliveries made in Alternative 1. Results indicate western Calaveras County demands can be met by diverting water at EBMUD's facilities without additional storage. The results also indicate multiple shortages in the higher elevation service areas and that additional storage in the higher country will be necessary to meet projected demands.

Figure 16. Alternative 1 Deliveries

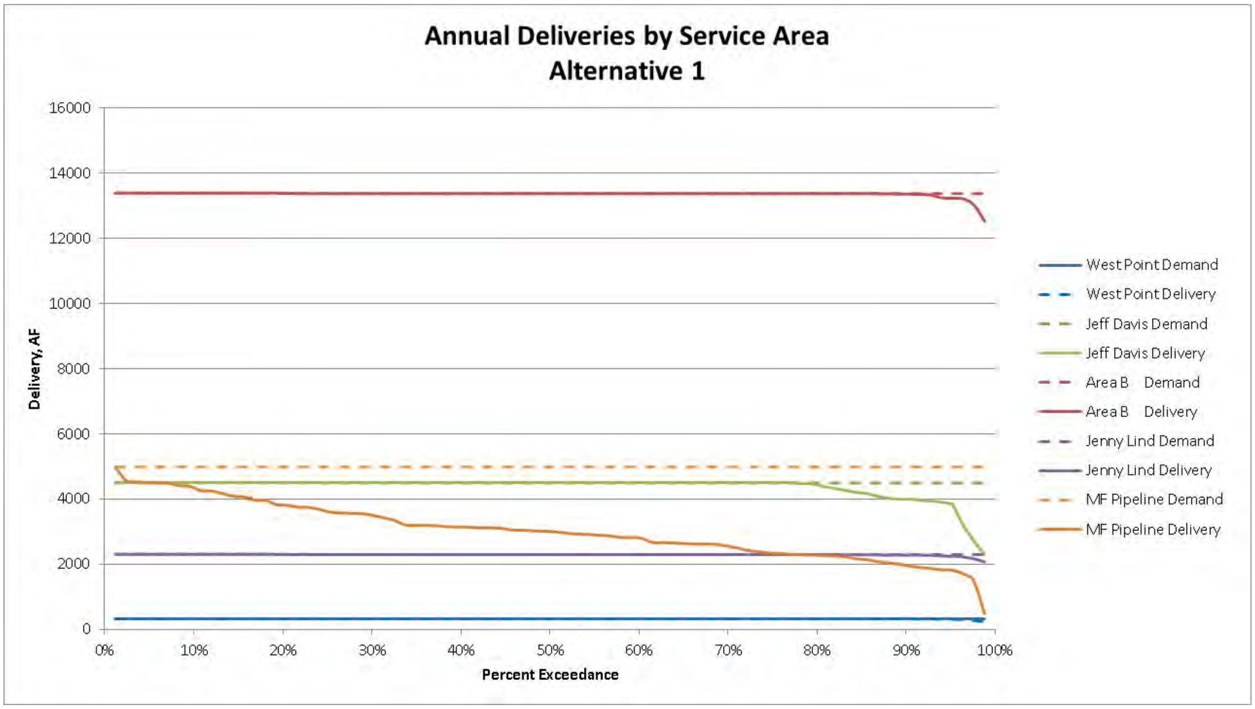


Figure 16 illustrates that the addition of the Middle Fork Ditch Pipeline alone is not enough to meet the projected demands. The results indicate that additional storage may be needed as well.

Figure 17. Incremental Change in Sections (d) and (e), Alternative 1 - Baseline 2070

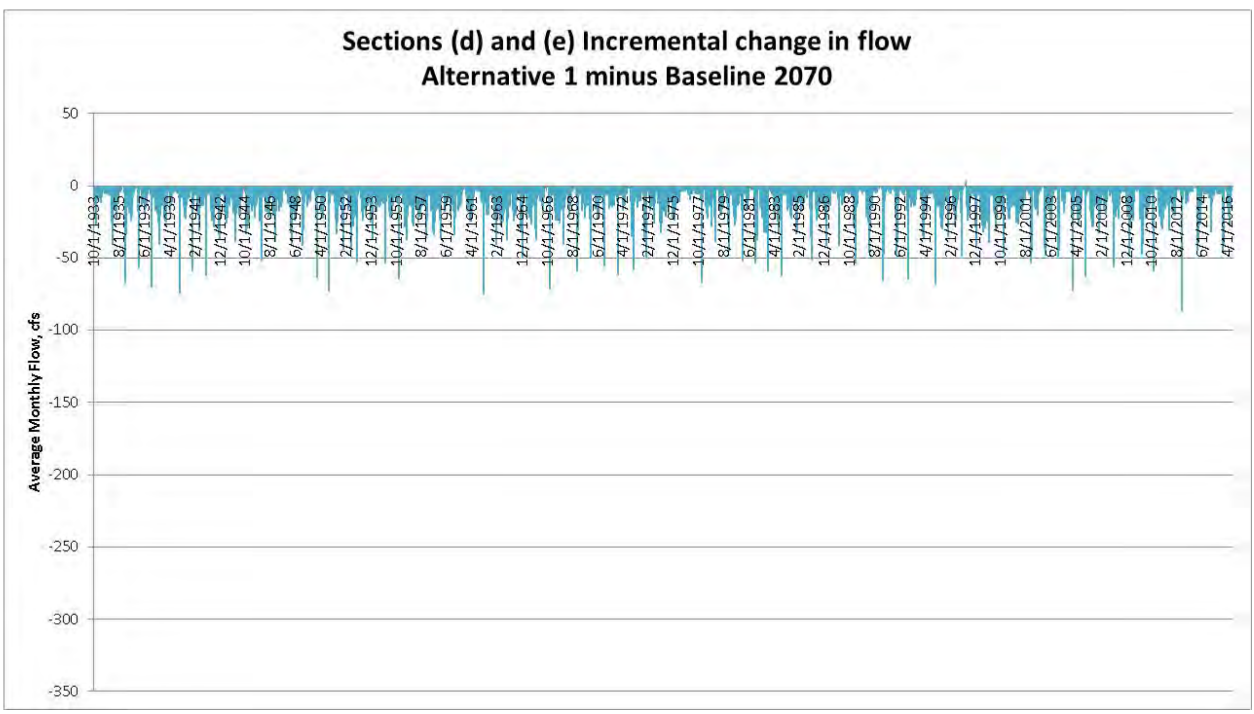


Figure 17 represents the average monthly incremental flow difference between Alternative 1 and the Baseline 2070 study. The differences are due to additional diversions to meet projected demands in the higher elevation service areas. Western Calaveras County demands were met by diversions below Sections (d) and (e). In this alternative, the diversion come from Lake Pardee, but could potentially come from Pardee Lake, Lake Camanche or the Mokelumne Aqueduct. Changes due to CCWD and CPUD operations in Sections (d) and (e) flow range from 0 to approximately 75 cfs at projected levels.

Alternative 2. Alternative 2 adds storage increases to Wilson Dam, Regulating Dam, Schaads Dam, a new 8,000 AF Forest-Middle Fork Dam, and a capacity increase to the Middle Fork Pumping Station to the Alternative 1 study. Figure 18 illustrates the key annual projected deliveries made in Alternative 2. Results indicate that the storage added in this alternative improve the water supply to meet projected demands in all but the very driest years.

Figure 18. Alternative 2 Deliveries

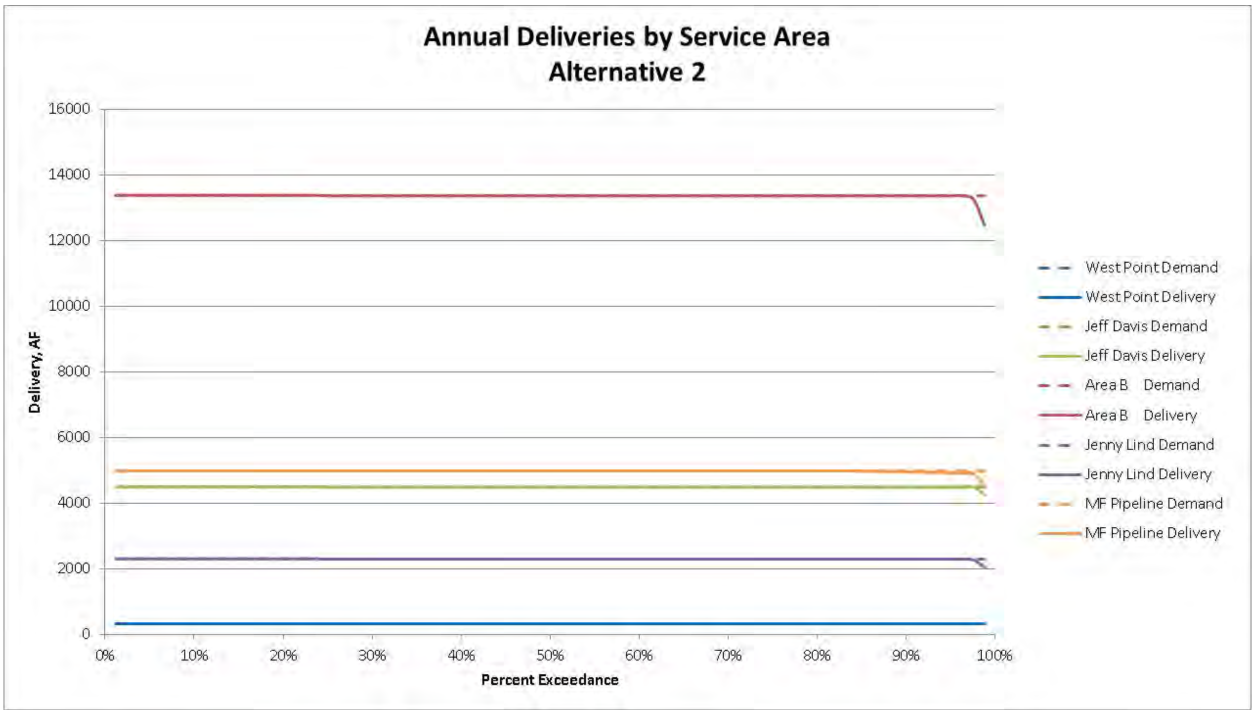


Figure 18 illustrates that the additional storage projects along with the Middle Fork Ditch Pipeline provides full deliveries except in the very driest years.

Figure 19. Incremental Change in Sections (d) and (e), Alternative 2 - Baseline 2070

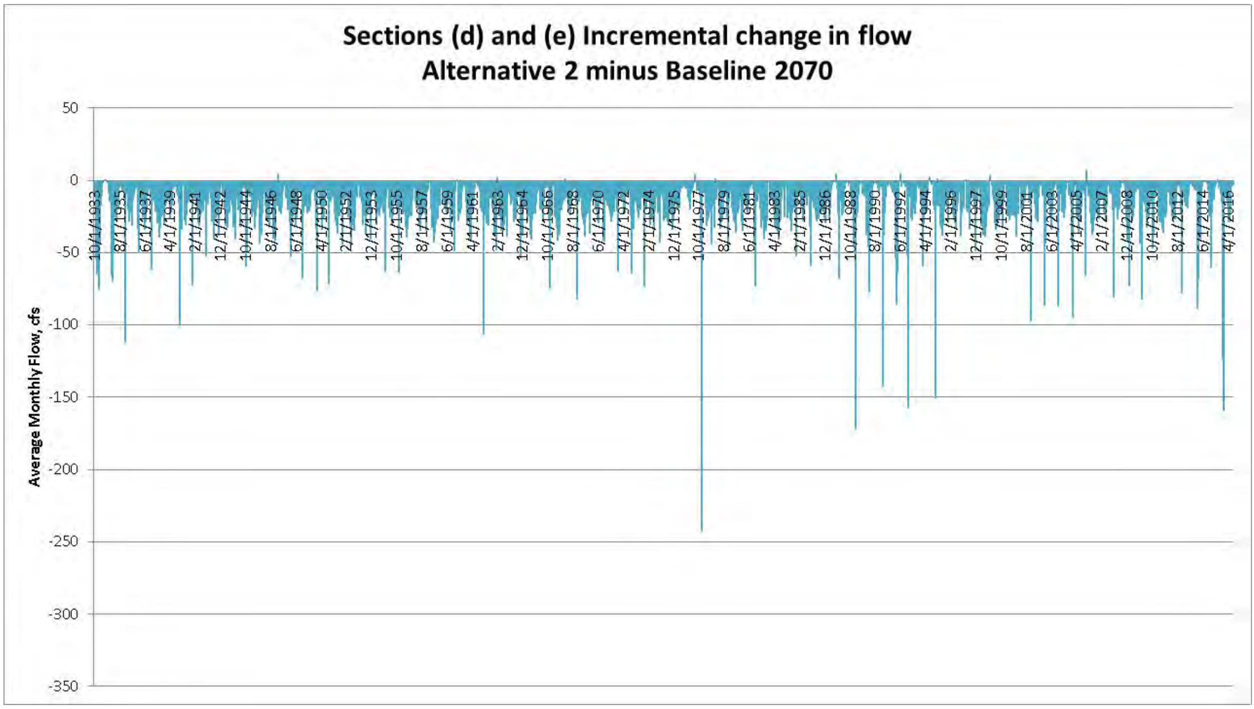


Figure 19 represents the average monthly incremental flow difference between Alternative 2 and the Baseline 2070 study. The differences are due to additional diversions to meet projected demands in the higher elevation service areas. Western Calaveras County demands were met by diversions below Sections (d) and (e). In this alternative, the diversion come from Lake Pardee, but could potentially come from Pardee Lake, Lake Camanche or the Mokelumne Aqueduct. Changes due to CCWD and CPUD upstream operations in Sections (d) and (e) flow range from 0 to approximately 250 cfs at projected demand levels.

Alternative 3. Alternative 3 was designed to take the same approach as Alternative 2 by adding storage to the higher elevations, but uses a 12,000 AF Forest-Middle Fork Dam and Reservoir instead of the multiple smaller storage increases with the 8,000 AF Forest-Middle Fork Dam and Reservoir. Figure 20 indicates that the Alternative 3 approach provides enough water supply to make full deliveries in even the driest years.

Figure 20. Alternative 3 Deliveries

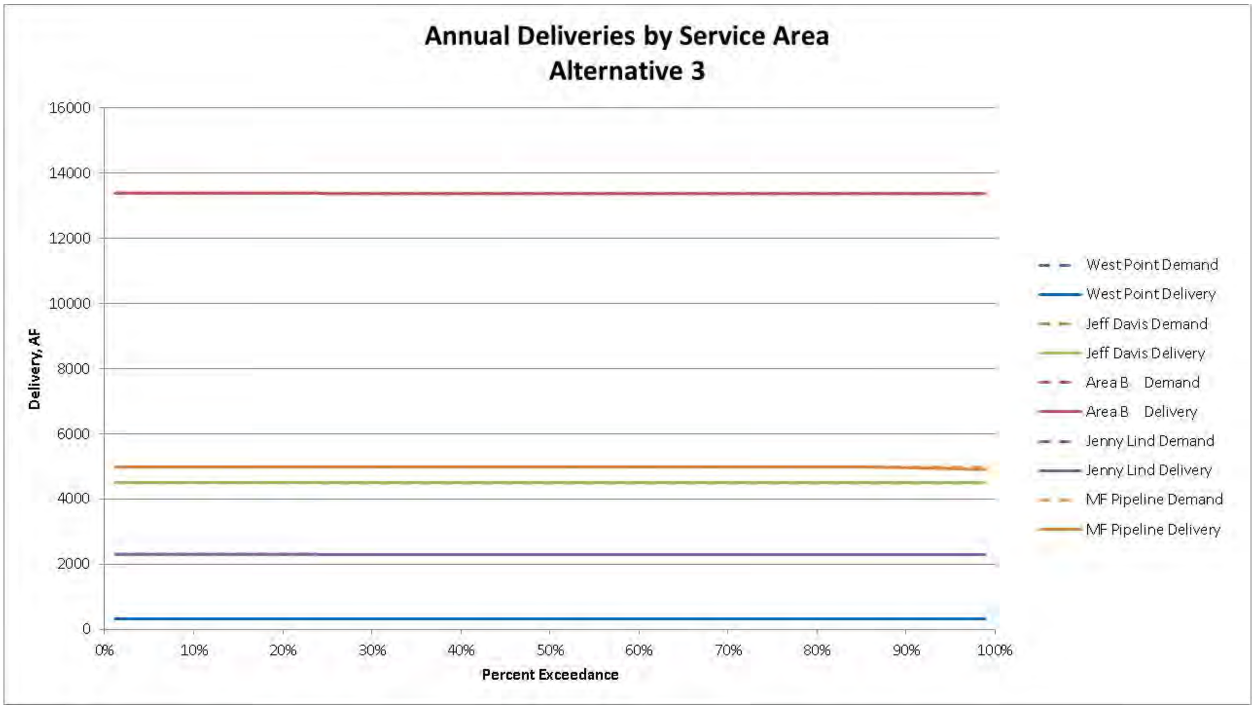


Figure 21. Incremental Change in Sections (d) and (e), Alternative 3 - Baseline 2070

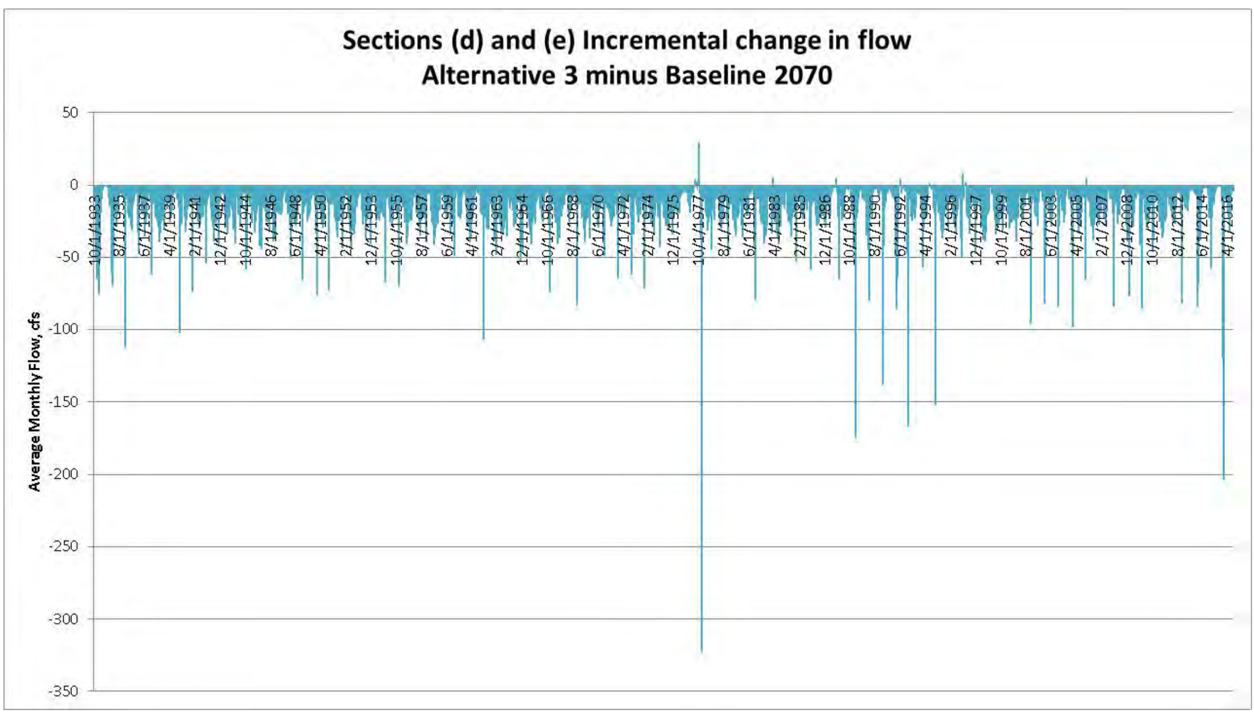


Figure 21 shows that the additional upstream storage results in larger incremental impacts to Sections (d) and (e). In some of the drier years, the larger reservoir provides additional flows in Sections (d) and (e).

Alternative 4. Alternative 4 was designed to take advantage of the CPUD's existing infrastructure. This alternative builds on Alternative 3, using a 12,000 AF Forest – Middle Fork Reservoir and assumes an extension of a pipeline that currently provides the Paloma area with treated water from the Jeff Davis WTP. The pipeline could be extended to serve Valley Springs and Jenny Lind/La Contenta area.

Figure 22. Alternative 4 Deliveries

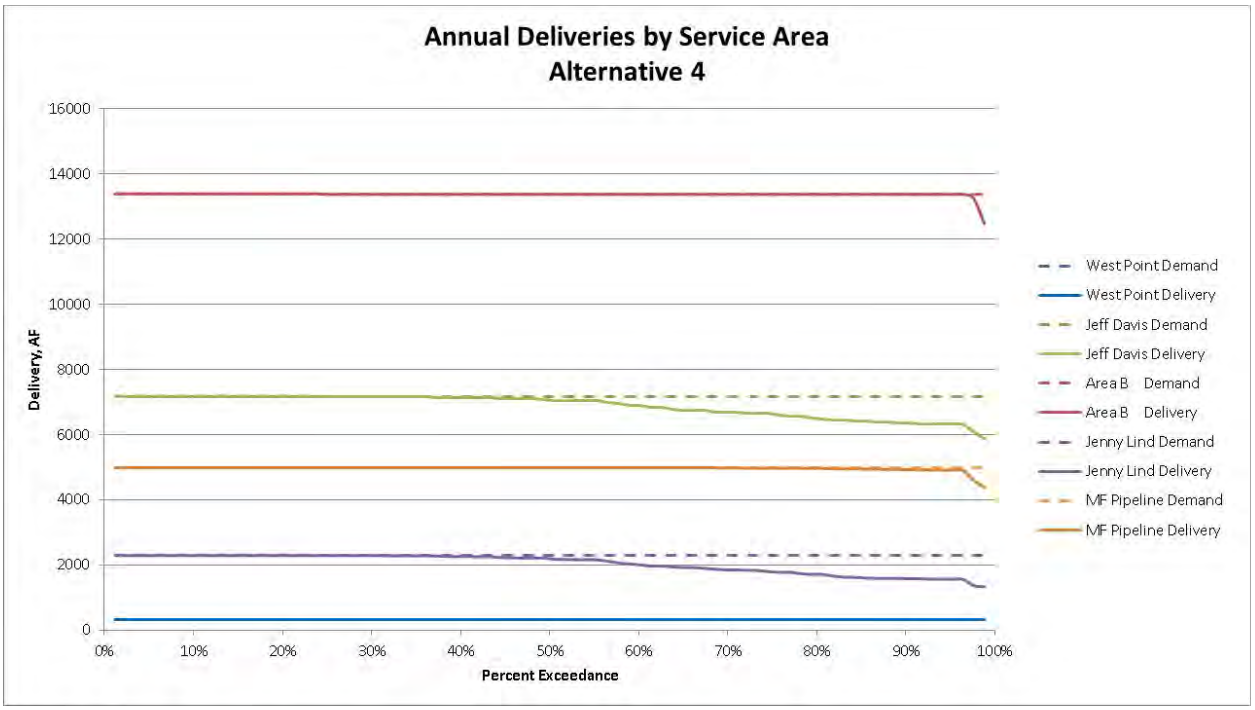


Figure 22 indicates that the moving water through Jeff Davis WTP rather than down the Mokelumne River to meet the Valley Springs and Jenny Lind/La Contenta demands results in a reduction in supply reliability. This indicates that accretion flows below the Forest – Middle Fork Reservoir are needed to meet the western Calaveras County demands.

Figure 23 - Incremental Change in Sections (d) and (e), Alternative 4 - Baseline 2070

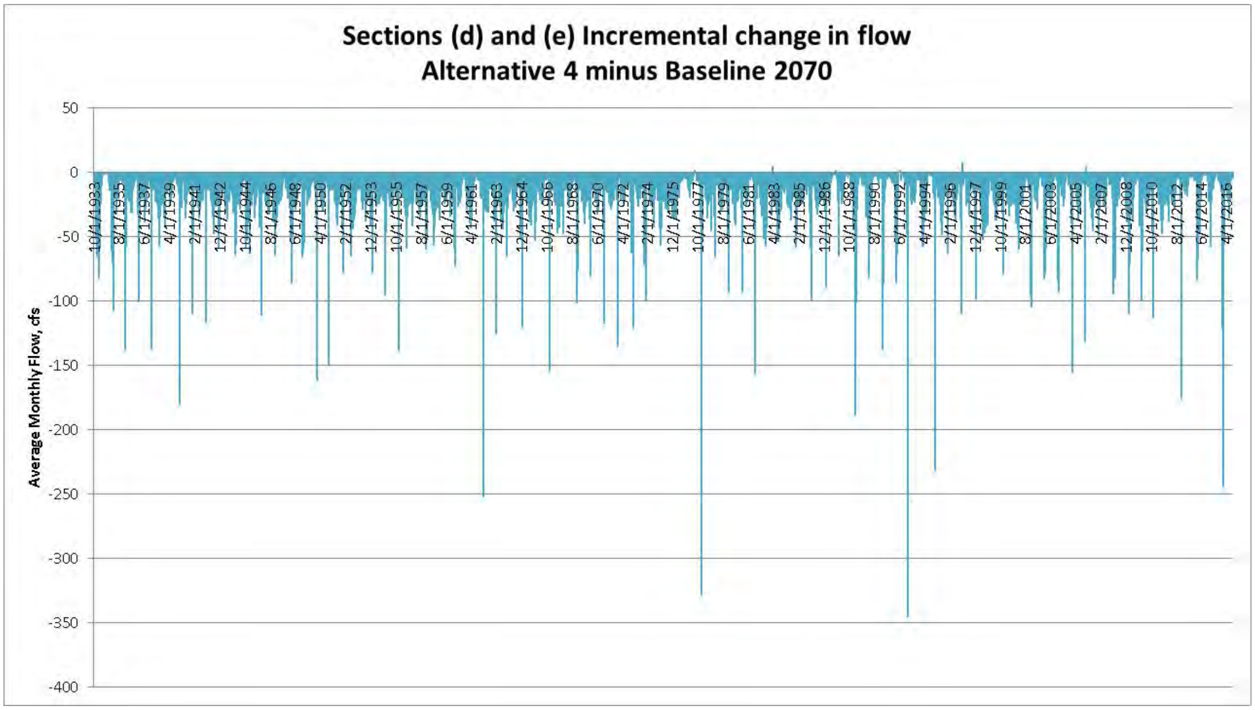


Figure 23 confirms that moving water through Jeff Davis WTP increases the magnitude of incremental impacts to Sections (d) and (e) when compared to Alternatives 2 and 3.

6.0 CONCLUSIONS

Demand within the Districts' service areas is anticipated to increase to almost 26,000 AF annually. The anticipated increases are within the Area of Origin rights held in reserve for Calaveras County. In 1927, the California Department of Finance filed a number of applications to reserve unappropriated water for future development according to statewide plans. Application 005648 holds 27,000 AF from the waters of the Mokelumne River and its tributaries to serve anticipated growth within Calaveras County. Both CCWD and CPUD have obtained partial assignment of Application 005648 to serve areas within Calaveras County. As demands increase over time, the Districts will need to call upon those rights to supplement existing supplies. Currently, there is approximately 18,514 AF remaining in the Area of Origin reservation for Calaveras County.

The Sustainable Groundwater Management Act requires local public agencies to form Groundwater Sustainability Agencies responsible for the development of Groundwater Sustainability Plans. Because western Calaveras County overlies the Eastern San Joaquin Groundwater Basin, CCWD joined the Eastern San Joaquin Groundwater Sustainability Agency. As a potential element of the Groundwater Sustainability Plan, CCWD is exploring the possibility of replacing the groundwater supplies of Wallace, Burson, and Valley Springs with a surface water supply from the Mokelumne River.

In addition to claiming the water rights held in reserve, the Districts will need to invest in infrastructure projects to meet the anticipated demand. The location of the projected demand influences the type of projects.

To meet the anticipated demands, the Districts are considering multiple projects listed below:

- Middle Fork Ditch Pipeline
- Middle Fork Pump Station Capacity Increase
- Wilson Dam Restoration to 50 AF
- Regulating Reservoir Expansion to 150 AF
- Schaads Reservoir Expansion
- Forest-Middle Fork Dam and Reservoir
- In addition to these projects, the Districts will need to negotiate with EBMUD for a diversion and storage agreement at Lake Camanche or Pardee Lake to meet demands in Area B, Valley Springs and the Jenny Lind/ La Contenta area.

The facility improvements included in Alternatives 2 and 3 provide reasonable solutions to meeting the anticipated projected demands. The selected storage and conveyance projects evaluated in these study alternatives utilized the best available information from previously completed plans, reports, and reconnaissance studies. The ultimate solution to meeting the future demands of the Districts will require focused environmental analysis, feasibility studies and cost evaluations as part of responsible due diligence to provide economical use of water on behalf of the District's ratepayers and the citizens of Calaveras County.

Further, the alternatives presented assume some operational coordination at EBMUD's Pardee Lake and Lake Camanche. Alternately, the Districts may need to pursue a larger upper elevation reservoir than those evaluated in this study to support western Calaveras County demands if coordination can't be achieved. The incremental flow impacts in Sections (d) and (e) as a result of a larger reservoir would be in terms of pattern changes that would provide more flow to support deliveries in the summer months and less flow in the winter months due to refilling the larger reservoir. There should not be any significant change in volume.

These upstream storage projects have the potential to affect the free-flowing and natural characteristics of the river. If a Wild and Scenic designation were established in these reaches, the Districts may be affected even in baseline conditions with their ability to supply water in a prolonged drought.

7.0 REFERENCES

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LIST OF ATTACHMENTS

ATTACHMENT A

KASL Technical Memorandum: Potential Demands for Mokelumne River Water Supplies in Western Calaveras County

CALAVERAS COUNTY
MOKELUMNE RIVER
LONG-TERM WATER NEEDS STUDY

TECHNICAL MEMORANDUM. POTENTIAL DEMANDS FOR MOKELUMNE RIVER WATER SUPPLIES IN WESTERN CALAVERAS COUNTY

INTRODUCTION

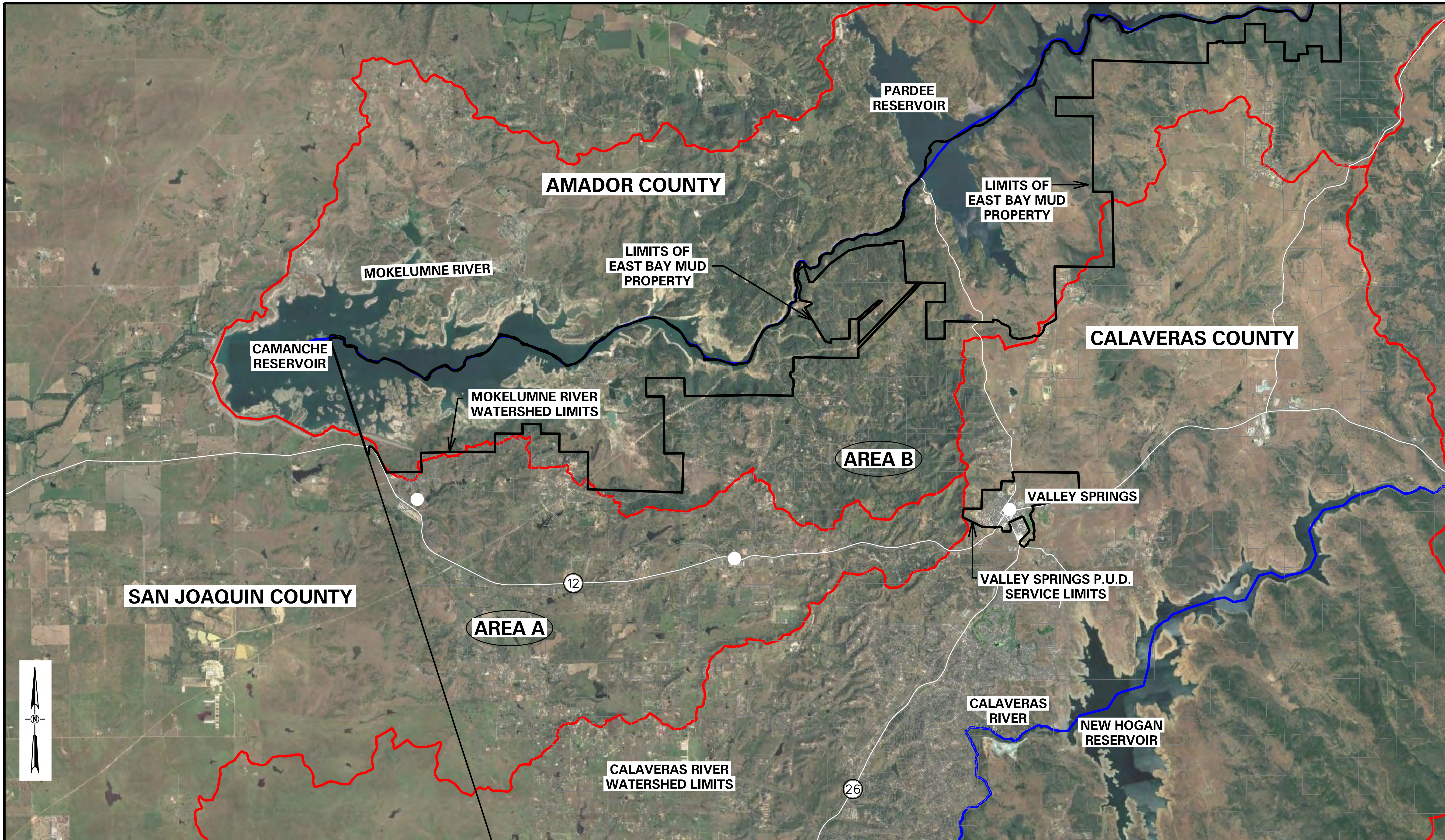
The service boundaries for the Calaveras County Water District are contiguous with the boundaries of Calaveras County. The Jenny Lind Area is now supplied by the Calaveras River and the treatment, storage and distribution facilities of CCWD's Jenny Lind water systems. The Copper Cove area is supplied by the Stanislaus River and CCWD's potable water systems that serve customers in this area. In the lower Calaveras River area there are also a few customers who receive raw water for irrigation. Currently, the Western Calaveras County communities of Wallace, Wallace Lake Estates and Burson and the surrounding agricultural lands are served by groundwater wells. Groundwater resources located in this area are part of the Eastern San Joaquin Groundwater Subbasin (ESJ Subbasin) which is critically overdrafted. In this Technical Memorandum (TM) projected water demands are estimated for Western Calaveras County areas which could reasonably be supplied by the Mokelumne River.

WESTERN CALAVERAS COUNTY EXISTING WATERSHED AREAS AND SERVICE AREAS

In **Figure 1** is presented existing watershed limits in Western Calaveras County. These include the Mokelumne River watershed areas and the Calaveras River watershed and the area that lies between these two watershed limits. The area of Western Calaveras County lying between the Mokelumne River watershed and the Calaveras River watershed is identified in Figure 1 as “Area A”. This area encompasses some 12,926 acres and is largely zoned A1, General Agricultural, AP, Agricultural Preserve, RA, Residential Agricultural or RR, Rural Residential. These agricultural land uses encompass over 90% of the land area within “Area A”.

The area within Western Calaveras County that lies within the Mokelumne River Watershed, but outside the limits of the East Bay MUD property or the Valley Springs Public Utility District service area, is identified as “Area B” in Figure 1 and encompasses some 6,303 acres. A1, AP, RA and RR designated land uses within “Area B” also comprises over 90% of the total land uses within this area.

As shown in Figure 1, to the east of “Area A” & “Area B”, is the CCWD Jenny Lind Service Area and the area served by the Valley Springs Public Utility District. This area is largely developed with low to medium density residential and commercial land uses. North of “Area B” is Camanche Reservoir, land owned by EBMUD and the Amador County limits. To the south of Area A is land located within the Calaveras River watershed. For the purpose of this TM it is reasonable to assume that land within the Calaveras River watershed would continue to be served by Calaveras River supplies. Land to the west of “Area A” lies within San Joaquin County and is not part of this Study.



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WESTERN CALAVERAS COUNTY
WATERSHED AND SERVICE AREAS

FIGURE 1

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Groundwater Conditions in the Eastern San Joaquin Groundwater Basin

The Eastern San Joaquin (ESJ) Subbasin includes eastern San Joaquin County and the westerly portions of Calaveras County, In response to ever increasing groundwater demands in this basin, the Northeastern San Joaquin County Groundwater Banking Authority completed an ESJ Groundwater Basin Groundwater Management Plan. As part of this management plan, historic groundwater levels were graphed for the period between 1948 and 2002. Groundwater surface elevations for the two wells closest to Western Calaveras County are presented in **Figure 2,** (Hydrograph Well “C”) and **Figure 3** (Hydrograph Well “F”). As shown in both of these hydrographs, static groundwater levels in the Western Calaveras County Study Area have steadily decreased during the past ± 60 years and have dropped at a rate of 1.4 to 1.5 feet per year. To reverse this long trend in groundwater overdraft, groundwater management options include the introduction of surface water during wet years, supplying surplus surface water to help recover declining groundwater levels, transferring surface water from out of basin areas, construction of new, or expansion of existing, reservoirs and other effective conjunctive use programs that would utilize carryover storage from surface water resources to reverse depressed groundwater trends. Calaveras County Water District has participated in the ESJ Groundwater Subbasin studies and it is understood that, as an active participant in regional efforts to establish one or more Groundwater Sustainability Agencies (GSA) and a Groundwater Sustainable Plan (GSP), CCWD will be required to participate in some form of groundwater recharge program or achieve long-term sustainability by replacing a portion of the existing groundwater demands with surface water. Groundwater recharge in Western Calaveras County is included in the 2015 Urban Water Management Plan prepared for the Calaveras County Water District.

Western Calaveras County Existing Land Uses

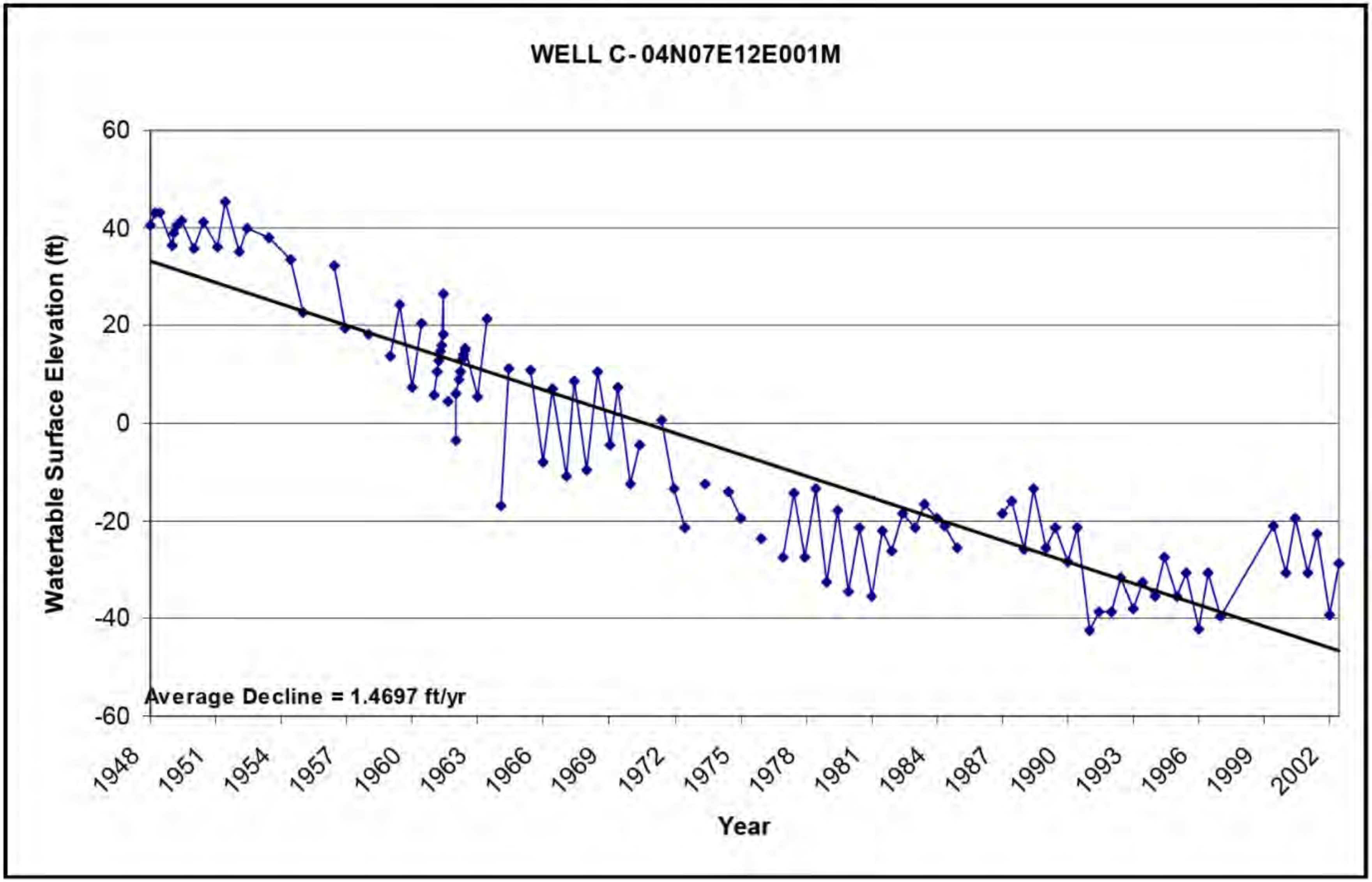
Existing parcels within “Area A” and “Area B” of this Western Calaveras County Water Demand TM are shown in **Figure 4** and are listed in **Table 1** which follows this TM. As shown in Figure 4. There are a few parcels itemized in Table 1 which are over 100 acres but the majority of parcels are small, rural, “ranchettes”, 1 to 10 acres in size.

With the small parcel sizes in “Area A” and “Area B” of Western Calaveras County large scale agricultural usage is not present. There are isolated orchards (fruit trees and nut trees) and there are a few property owners that have made application for cannabis cultivation. Both “Area A” and “Area B” land uses consist mostly of low density, residential dwellings, outbuildings and pasture lands for horses, sheep, goats and cattle. Vineyards are located in San Joaquin County, nearby, but none were found in the Western Calaveras County study areas.

Western Calaveras County Projected Water Demands

Projected water demands for “Area A” and “Area B” residential and commercial land uses can be estimated from the 2015 Calaveras County Urban Water Management Plan.

For agricultural land uses, studies conducted by the Department of Water Resources (DWR) were used to estimate evapotranspiration and precipitation typical of Western Calaveras



Source: California Department of Water Data Library at http://well.water.ca.gov/
Eastern San Joaquin Groundwater Basin Groundwater Management Plan

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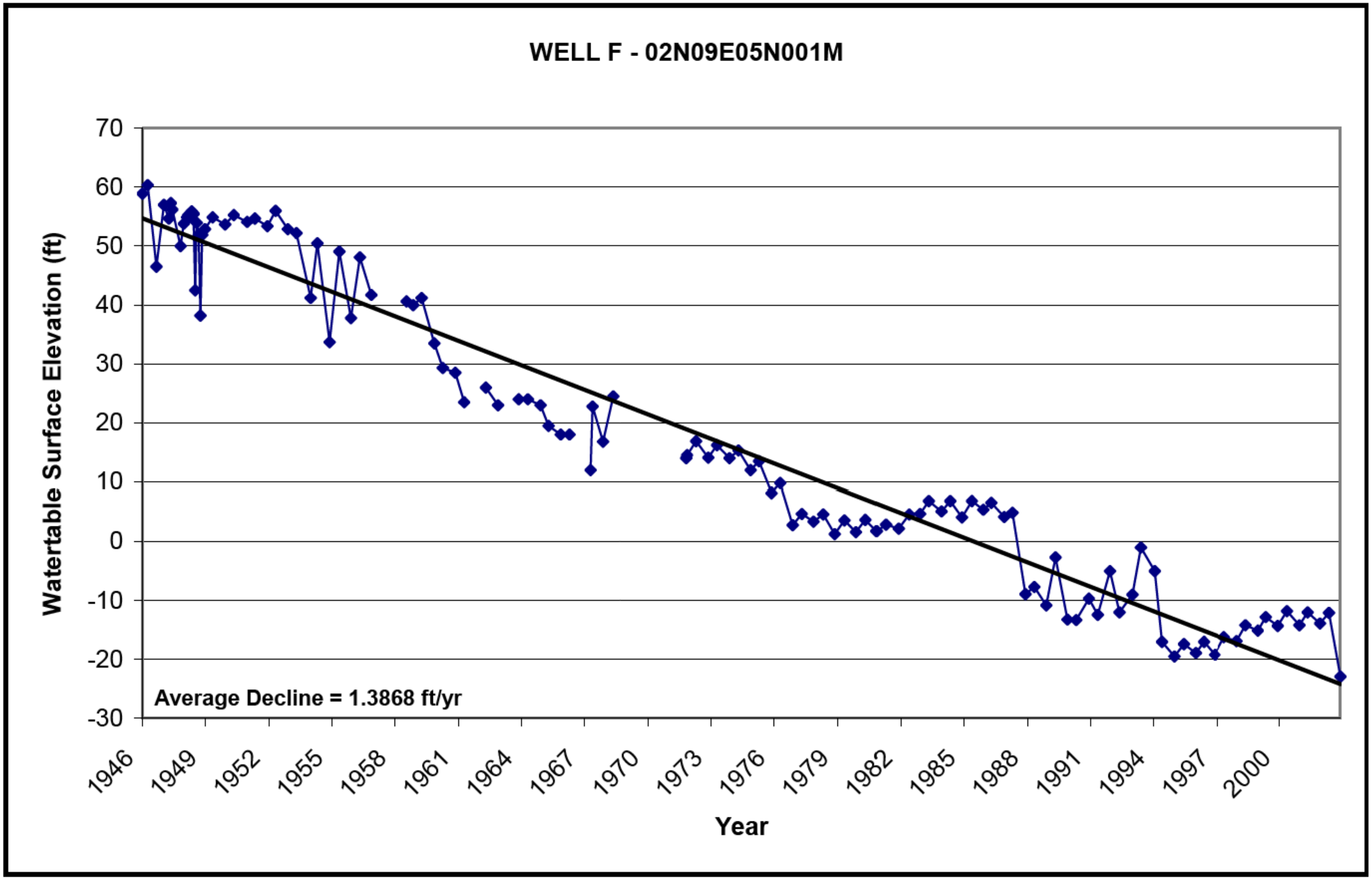
GROUND WATER LEVELS, WESTERN CALAVERAS COUNTY (1 OF 2)

FIGURE 2



Source: California Department of Water Data Library at http://well.water.ca.gov/
Eastern San Joaquin Groundwater Basin Groundwater Management Plan

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GROUND WATER LEVELS, WESTERN CALAVERAS COUNTY (2 OF 2)

FIGURE 3

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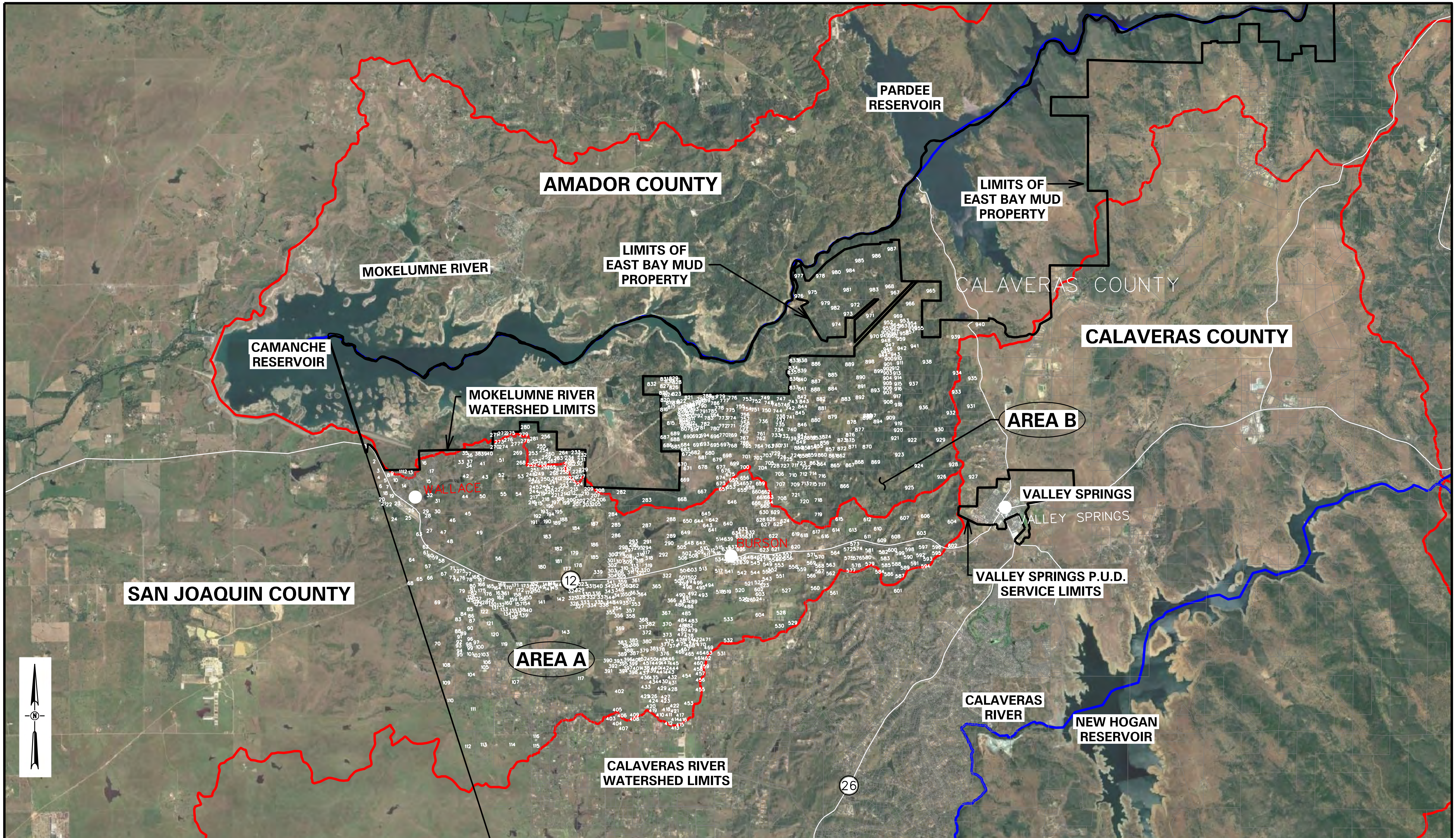

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POTENTIAL WESTERN CALAVERAS COUNTY AREAS SERVED BY LOWER MOKELUMNE RIVER

FIGURE 4

County. In **Table 2** is presented, average year, “reference” evapotranspiration and average year rainfall values typical of Western Calaveras County. Using this data, the normal year water demand for agricultural crops is estimated at 37.2 inches or approximately 3.1 acre ft. / acre annually.

The reference evapotranspiration (ETo) values presented in Table 2 can be adjusted by a crop coefficient, Kc, for various crops, ground conditions and surfaces. For pastureland, for example, values of Kc vary from 0.80 (humid conditions) to 1.0 (dry windy conditions). For alfalfa, Kc varies from 0.85 to 1.05. For various type of evergreen plant species, Kc varies from 1.05 to 1.20. For evergreen trees, Kc ranges from 1.10 to 1.30. For the purpose of this Study and for the predominant pasture – alfalfa type crops that are present in “Area A” and “Area B” of Western Calaveras County, it is reasonable to apply a Kc factor of 1.0 to the ETo values presented in Table 2. Annual water demands of 3.1 acre ft. / acre are, therefore, used in this determination of agricultural water uses in Western Calaveras County. This value compares favorably with other Calaveras County water use studies. In their 2011 study of water demands for agricultural development in Calaveras County, Provost & Pritchard estimated that crops typical of Western Calaveras County have water requirements ranging from 2.5 to over 3.5 acre ft. / acre. Allowing for irrigation system inefficiencies, an average irrigation demand value of 3.5 acre ft. / acre was used in the 2011 Agricultural Water Demand Study. Vineyards in the Calaveras – Amador – Eldorado County areas using highly efficient drip irrigation methods typically require 250 gallons of water per vine per year or approximately 1.4 acre feet / acre. Other methods of vineyard irrigation require up to 400 gallons of water per vine per year or approximately 2.2 acre feet / acre. Similarly, for cannabis cultivation, water demands of ± 2.2 to 2.6 acre ft. / acre annually were reported to the Calaveras County Water Needs Study Team by the Calaveras Cannabis Alliance.

A summary of potential water demands in Western Calaveras County “Area A” and “Area B” is presented in Table 3. This demand includes both potable (residential, commercial type demands) and raw water (irrigation) demands. It is understood that an assessment district or an irrigation district would need to be formed to develop the supply and conveyance system needed to serve Western Calaveras County agricultural uses with Mokelumne River Water.

As summarized in **Table 3**, the potential residential and irrigation water discussed in “Area A” is estimated at 43,653 acre feet / year, average year conditions and is estimated at 19,138 acre feet / year, average year conditions for “Area B”.

JENNY LIND SERVICE AREA

As previously discussed, water demands in the Jenny Lind Service Area are currently supplied by the Calaveras River and CCWD’s Jenny Lind water treatment, storage and distribution system. When considering long term needs, it would be physically possible to supply the Jenny Lind Service Area from the Mokelumne River. The Mokelumne River watershed is considerably larger than the watershed that feeds the Calaveras River and extends into higher, snow melt elevations. These factors increase the reliability of the Mokelumne River supply to serve residential water demands.

TABLE 2
Average Year Evapotranspiration - Precipitation (ETo-P)
Data for Western Calaveras County

Month	Average Evapotranspiration ETo[1]		Average Precipitation P	ETo-P	
	(Isoline Map; DWR Bull.113-3)		(DWR California Rainfall Data)		
	mm/day	inch/mo	inch/mo	inch/mo	
Jan.	1.0	1.22	6.02	-4.8	
Feb.	1.4	1.54	5.52	-3.88	
Mar.	2.4	2.93	5.03	-2.10	
Apr.	4.0	4.72	2.67	2.05	Included in Annual Demand
May	5.2	6.14	1.49	4.65	Included in Annual Demand
June	6.3	7.44	0.35	7.09	Included in Annual Demand
July	7.0	8.54	0.02	8.52	Included in Annual Demand
Aug.	5.8	7.08	0.06	7.02	Included in Annual Demand
Sept.	4.8	5.67	0.56	6.52	Included in Annual Demand
Oct.	2.7	3.30	1.96	1.34	Included in Annual Demand
Nov.	1.2	1.42	3.96	-2.54	
Dec.	0.7	0.85	5.49	-4.64	
Total Avg. Annual	**42.5**	**50.85**	**33.13**	**37.19 inch/year (April - October)** **~ 3.10 Ac-Ft/AC-Year**	

(1) ETo = Reference Evapotranspiration

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Table 3
Potential Residential and Irrigation Water Demands, Area A and B, Western Calaveras County

Area A Zones			
Land Use	Area (Acres)	Water Demand Future. (AF/Ac-yr)	Water use Future(AF/yr)
A1	4,890	3.10	15,159
AP	3,619	3.10	11,219
RA	2,154	3.25	7,001
RR	1,826	3.40	6,208
U	394	1.20	473
COMM	109	2.40	262
MANU	65	2.40	156
PS	51	1.00	51
REC	69	2.5	173
RES - LOW	500	1.20	600
RES - MED	44	3.64	160
LOSES	13,721	0.16	2,195
Total	**13,721**		**43,656**

Area B Zones			
Land Use	Area (Acres)	Water Demand Future. (AF/Ac-yr)	Water use Future(AF/yr)
A1	4,034	3.10	12,505
AP	320	3.10	992
RA	353	3.25	1,147
RR	687	3.40	2,336
U	148	1.20	178
COMM	5	2.40	12
MANU	410	2.40	984
PS	-	1.00	-
REC	12	2.5	30
RES - LOW	-	1.20	-
RES - MED	-	3.64	-
LOSES	5,969	0.16	955
Total	**5,969**		**19,139**

A1= General Agriculture

AP= Agriculture Preserve

RA=Residential Agriculture

RR=Residential Rural

U=Unclassified

COMM=Commercial

MANU=Manufacturing

PS=Public Service

REC=Recreation

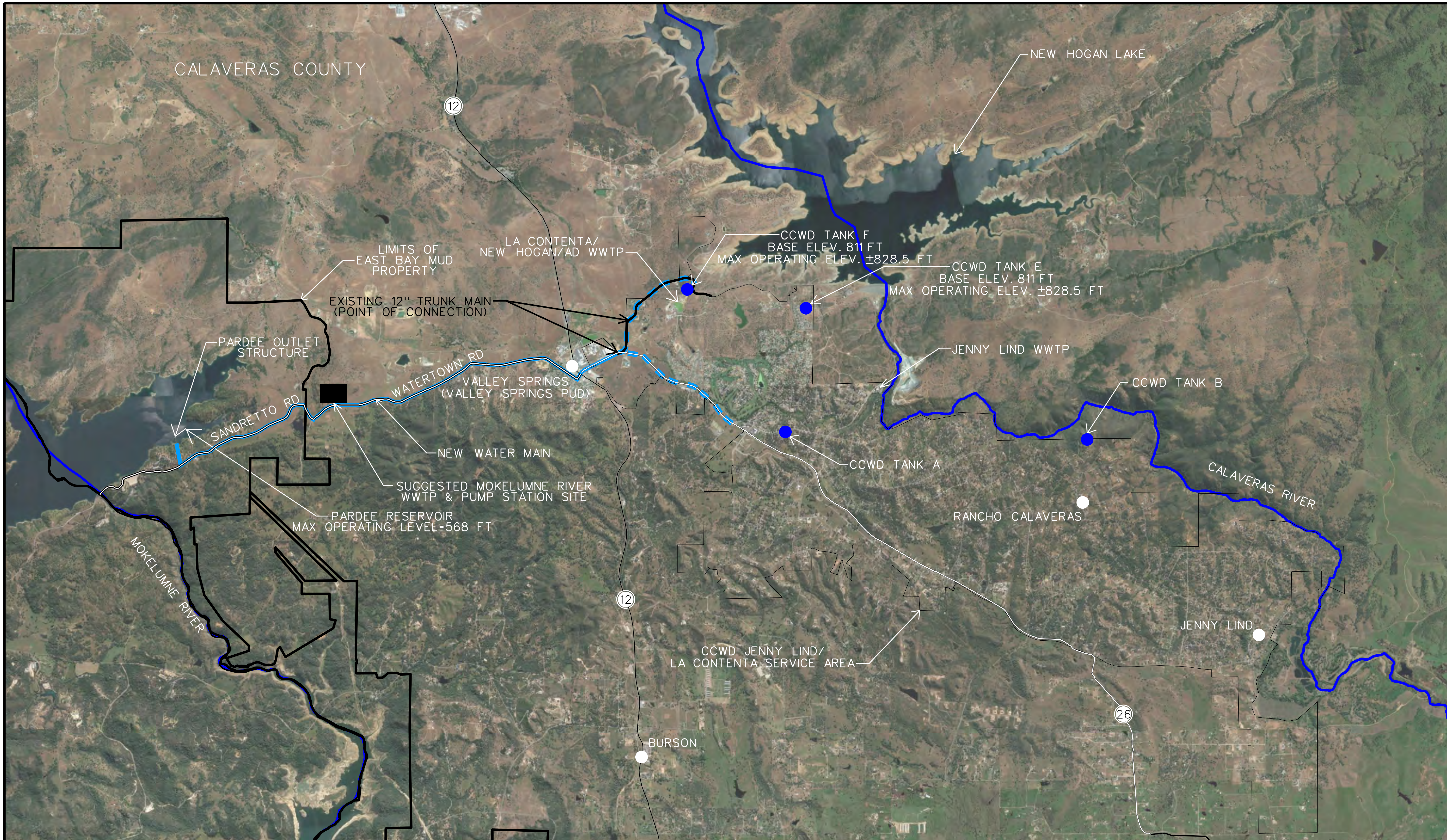
RES-LOW=Low Density Residential

RES-MED=Medium Density Residential

LOSES=Loses in the Water System

In **Figure 5** is presented an overview of Pardee Reservoir, the lower Mokelumne River, New Hogan Lake, the Calaveras River and the CCWD Jenny Lind / La Contenta Service Area.

With the close proximity of the Pardee Reservoir outlet structure to the Jenny Lind / La Contenta Service Area, an outlet pipeline could be constructed along Sandretto Road to Watertown Road. A new water treatment plant and pump station could then be constructed along Watertown Road between the limits of the East Bay MUD Property and the Valley Springs PUD service area. The new pipeline could then be extended south of Valley Springs to the existing trunk (12 inch diameter) mains of the Jenny Lind / La Contenta Service Area located near New Hogan Dam Road and State Route 26. From this point Mokelumne River supply could extend to Tank E, Tank F and Tank A of the Jenny Lind / La Contenta system. The existing pumps located at Tank A could then lift the treated Mokelumne River supply to Tank B and to the rest of the Jenny Lind / La Contenta Service Area. Master planning of the Jenny Lind area was recently completed by Peterson – Brustad Inc. Projected, year 2040, potable and raw water use for the Jenny Lind Service Area are estimated at 6,664 acre feet in the Peterson-Brustad report. If these demands were served by the Mokelumne River rather than by the Calaveras River, it is reasonable to expect that Calaveras River water, which now supplies Jenny Lind could be made available to meet agricultural demands in Western Calaveras County Areas such as the “Area A” land lying between the Mokelumne River and Calaveras River watersheds.



CONSULTING KASL ENGINEERS

POSSIBLE EXPANSION OF MOKELUMNE RIVER SUPPLES TO JENNY LIND/LA CONTENTA SERVICE AREA

FIGURE 5

Table 1.
Western Calaveras County Land Uses

Area A					
Parcel	APN	Land Use	Area (SF)	Area (Acres)	Cannabis Permit App.
1	48018062	A1	145,767	3.35	
2	48018063	A1	1,167,644	26.81	
3	48018053	A1	74,745	1.72	
4	48018002	A1	638,045	14.65	
5	48018005	COMM	250,429	5.75	
6	48018144	U	139,000	3.19	
7	48018066	RR	117,935	2.71	
8	48018165	COMM	86,459	1.98	
9	48018164	COMM	259,381	5.95	
10	48061016	COMM	477,671	10.97	
11	48061001	REC	41,692	0.96	
12	48061002	REC	102,505	2.35	
13	48061003	REC	175,558	4.03	
14	48061010	REC	1,042,720	23.94	
15	48061011	REC	1,632,693	37.48	
16	48061013	U	1,122,309	25.76	
17	Wallace Lake Estates	RES	1,625,949	37.33	
18	48018145	MANU	544,806	12.51	
19	48019057	MANU	605,489	13.90	
20	48019045	RR	44,465	1.02	
21	48019046	RR	112,585	2.58	
22	48019031	AP	48,019,031	1,102.37	
23	48019049	U	73,220	1.68	
24	48018160	AP	3,420,908	78.53	
25	48020007	AP	1,139,967	26.17	
26	48020012	MANU	493,571	11.33	
27	Mokelumne Oaks Sub Division	RES	1,772,946	40.70	
28	48020011	A1	251,124	5.77	
29	48020010	A1	197,088	4.52	
30	48018181	RES	1,704,335	39.13	
31	48061025	RES	5,458,050	125.30	
32	48061024	RES	1,371,654	31.49	
33	48018168	RA	664,600	15.26	
34	48018163	RA	253,355	5.82	
35	48018169	RA	208,763	4.79	
36	48018156	RA	366,671	8.42	
37	48018162	RA	206,804	4.75	
38	48018175	RA	215,772	4.95	

Table 1. (Cont.)

39	48018176	RA	215,645	4.95	
40	48018177	RA	214,971	4.94	
41	48018178	RA	1,033,212	23.72	
42	48018159	A1	1,784,136	40.96	
43	48018096	A1	1,725,378	39.61	
44	48018102	A1	1,804,000	41.41	
45	48018080	A1	3,252,213	74.66	
46	48018146	A1	1,119,506	25.70	
47	48018147	A1	1,430,471	32.84	
48	48018148	A1	1,458,837	33.49	
49	48018133	A1	7,310,981	167.84	
50	48018101	A1	1,852,547	42.53	
51	48018092	A1	1,679,312	38.55	
52	48018097	A1	1,782,813	40.93	
53	48018098	A1	1,776,512	40.78	
54	48018099	A1	1,783,834	40.95	
55	48018100	A1	1,879,662	43.15	
56	48018036	A1	14,947,024	343.14	
57	48018073	A1	709,340	16.28	
58	48018180	RR	481,916	11.06	
59	48018179	RR	217,395	4.99	
60	48018115	RA	169,308	3.89	
61	48018114	RA	214,710	4.93	
62	48018188	A1	192,395	4.42	
63	48018189	A1	199,310	4.58	
64	48018161	AP	4,046,137	92.89	
65	48018039	AP	263,191	6.04	
66	48018074	RA	832,633	19.11	
67	48018075	RA	861,882	19.79	
68	48021005	A1	84,229	1.93	
69	48021068	AP	9,888,254	227.00	
70	48021069	AP	3,644,545	83.67	
71	48018137	RR	261,609	6.01	
72	48018138	RR	196,773	4.52	
73	48018139	RR	212,187	4.87	
74	48018140	RR	213,116	4.89	
75	48018122	RR	209,286	4.80	
76	48018125	RR	202,340	4.65	
77	48018123	RR	247,518	5.68	
78	48018124	RR	218,278	5.01	
79	48042046	RR	1,614,097	37.05	
80	48042047	RR	302,903	6.95	
81	48042048	RR	133,979	3.08	
82	48042045	RR	322,250	7.40	
83	48042040	RR	504,081	11.57	
84	48042041	RR	542,718	12.46	
85	48042079	RR	698,289	16.03	

Table 1. (Cont.)

86	48042051	RR	211,404	4.85	
87	48042052	RR	299,839	6.88	
88	48078001	RA	217,709	5.00	
89	48078002	RA	230,827	5.30	
90	48078003	RA	774,328	17.78	
91	48078004	RA	215,185	4.94	
92	48078005	RA	223,234	5.12	
93	48079001	RA	237,095	5.44	
94	48079002	RA	225,209	5.17	
95	48079003	RA	283,597	6.51	
96	48078006	RA	207,558	4.76	
97	48078007	RA	202,394	4.65	
98	48079006	RA	233,836	5.37	
99	48079005	RA	252,110	5.79	
100	48079007	RA	266,089	6.11	
101	48079010	RA	223,413	5.13	
102	48079011	RA	247,535	5.68	
103	48079012	RA	303,113	6.96	
104	48021111	RA	5,815,035	133.50	
105	48021113	RA	205,081	4.71	
106	48021112	RA	202,042	4.64	
107	Southworth Estates	RA	36,578,342	839.73	
108	48021102	A1	1,922,627	44.14	
109	48021103	A1	1,384,025	31.77	
110	48021015	U	1,182,936	27.16	
111	48021039	AP	6,911,305	158.66	
112	50001109	AP	14,240,184	326.91	
113	50001107	AP	2,609,750	59.91	
114	50001108	AP	7,237,678	166.16	
115	50048014	U	424,261	9.74	
116	50048001	U	458,084	10.52	
117	48021011	A1	8,860,129	203.40	
118	48021118	A1	940,748	21.60	
119	48042066	A1	858,462	19.71	
120	48042065	A1	2,539,405	58.30	
121	48042081	A1	2,010,000	46.14	
122	48042080	A1	2,509,645	57.61	
123	48042037	A1	94,643	2.17	
124	48042031	A1	116,062	2.66	**X**
125	48042030	A1	78,469	1.80	**X**
126	48042028	A1	93,060	2.14	
127	48042029	A1	135,105	3.10	
128	48042036	A1	214,648	4.93	
129	48042013	A1	244,746	5.62	
130	48042014	A1	206,156	4.73	
131	48042015	A1	227,564	5.22	

Table 1. (Cont.)

132	48042016	A1	211,613	4.86	
133	48042017	A1	205,968	4.73	
134	48042018	A1	242,951	5.58	
135	48042019	A1	250,663	5.75	
136	48042020	A1	180,058	4.13	
137	48042021	A1	223,762	5.14	
138	48042022	A1	199,498	4.58	
139	48042023	A1	254,939	5.85	
140	48042024	A1	208,074	4.78	
141	48021141	A1	2,316,274	53.17	
142	48021142	A1	1,656,029	38.02	
143	48021010	AP	17,106,770	392.72	
144	48023003	COMM	172,645	3.96	
145	48023002	A1	71,021	1.63	
146	48023001	A1	80,099	1.84	
147	48022006	COMM	111,091	2.55	
148	48022005	A1	90,519	2.08	
149	48022004	A1	345,666	7.94	
150	48022008	A1	229,194	5.26	
151	48022007	A1	103,563	2.38	
152	48022002	A1	38,915	0.89	
153	48022001	A1	52,889	1.21	
154	48042088	RA	205,665	4.72	
155	48042087	RA	237,341	5.45	
156	48042074	RA	196,779	4.52	
157	48042073	RA	215,279	4.94	
158	48042004	A1	221,364	5.08	
159	48042005	A1	196,780	4.52	
160	48042006	A1	435,115	9.99	
161	48042050	RR	228,370	5.24	
162	48042049	RR	204,549	4.70	
163	48042008	A1	191,916	4.41	
164	48042009	A1	204,251	4.69	
165	48042010	A1	413,618	9.50	
166	48042011	A1	293,668	6.74	
167	48018104	A1	236,841	5.44	
168	48018103	A1	207,015	4.75	
169	48042068	RR	241,444	5.54	
170	48042075	RR	205,564	4.72	
171	48042071	RR	303,998	6.98	
172	48042076	RR	160,711	3.69	
173	48042077	RR	296,243	6.80	
174	48042078	RR	252,386	5.79	
175	48042085	RR	241,329	5.54	
176	48042086	RR	232,522	5.34	
177	48018027	MANU	356,374	8.18	
178	48018187	RA	3,723,080	85.47	

Table 1. (Cont.)

179	48018190	RA	919,103	21.10	
180	48018030	RA	3,638,640	83.53	**X**
181	48018191	A1	2,030,694	46.62	
182	48018031	A1	839,062	19.26	**X**
183	48018032	RA	3,509,267	80.56	**X**
184	48018049	A1	824,950	18.94	
185	48018024	A1	801,348	18.40	
186	48018023	A1	1,682,566	38.63	
187	48018022	A1	4,534,923	104.11	**X**
188	48046007	RR	279,473	6.42	
189	48046006	RR	426,801	9.80	
190	48046005	RR	240,528	5.52	
191	48046001	RR	376,416	8.64	
192	48046002	RR	390,888	8.97	
193	48046003	RR	374,541	8.60	
194	48046004	RR	318,267	7.31	
195	48047006	RR	224,548	5.15	
196	48047005	RR	238,368	5.47	**X**
197	48047004	RR	240,118	5.51	
198	48047003	RR	268,471	6.16	
199	48047002	RR	226,856	5.21	
200	48048012	RR	220,814	5.07	**X**
201	48048011	RR	225,572	5.18	
202	48048010	RR	233,595	5.36	
203	48048009	RR	219,410	5.04	
204	48048008	RR	232,501	5.34	
205	48048007	RR	220,310	5.06	
206	48048005	RR	249,074	5.72	
207	48048006	RR	186,246	4.28	
208	48018128	RR	293,135	6.73	
209	48018127	RR	261,000	5.99	
210	48048004	RR	229,415	5.27	
211	48048003	RR	222,881	5.12	
212	48048002	RR	210,153	4.82	
213	48048001	RR	216,767	4.98	
214	48047001	RR	215,490	4.95	
215	48045005	RR	244,964	5.62	
216	48045004	RR	177,724	4.08	
217	48045003	RR	213,710	4.91	
218	48045006	RR	233,119	5.35	
219	48045007	RR	217,715	5.00	
220	48045010	RR	259,710	5.96	
221	48045011	RR	182,725	4.19	
222	48045012	RR	225,880	5.19	
223	48045013	RR	214,184	4.92	
224	48018126	RR	237,465	5.45	
225	48043018	RR	214,963	4.93	

Table 1. (Cont.)

226	48043017	RR	193,750	4.45	
227	48043016	RR	236,157	5.42	
228	48043015	RR	230,283	5.29	
229	48043014	RR	216,750	4.98	
230	48043013	RR	238,521	5.48	
231	48043012	RR	215,499	4.95	
232	48043011	RR	224,999	5.17	
233	48043010	RR	270,590	6.21	
234	48043009	RR	226,185	5.19	
235	48043024	RR	204,762	4.70	
236	48043023	RR	208,989	4.80	
237	48043022	RR	199,725	4.59	
238	48043021	RR	206,538	4.74	
239	48043019	RR	207,116	4.75	
240	48043020	RR	203,748	4.68	
241	48044008	RR	231,480	5.31	
242	48045009	RR	208,266	4.78	
243	48045008	RR	234,151	5.38	
244	48045002	RR	222,764	5.11	
245	48045001	RR	242,207	5.56	
246	48044006	RR	211,562	4.86	
247	48044005	RR	212,844	4.89	
248	48044004	RR	234,168	5.38	
249	48044003	RR	233,311	5.36	
250	48044007	RR	230,607	5.29	
251	48044002	RR	251,000	5.76	
252	48044001	RR	201,476	4.63	
253	48018120	RR	420,443	9.65	
254	48018166	RR	295,007	6.77	
255	48018167	RR	240,467	5.52	
256	48018149	RR	1,345,492	30.89	
257	48043001	RR	189,060	4.34	
258	48043002	RR	245,484	5.64	
259	48043004	RR	213,138	4.89	
260	48043005	RR	217,242	4.99	
261	48043003	RR	208,815	4.79	
262	48043006	RR	231,673	5.32	
263	48043007	RR	231,307	5.31	
264	48043008	RR	484,131	11.11	
265	48018151	RA	526,515	12.09	
266	48018153	RA	268,069	6.15	
267	48018152	RA	206,228	4.73	
268	48018183	RA	884,522	20.31	
269	48018182	RA	852,791	19.58	**X**
270	48018107	A1	226,054	5.19	
271	48018055	A1	190,805	4.38	
272	48018056	A1	133,756	3.07	

Table 1. (Cont.)

273	48018108	A1	247,865	5.69	
274	48018109	A1	294,369	6.76	
275	48018057	A1	97,885	2.25	
276	48018110	A1	355,253	8.16	
277	48018012	A1	559,092	12.84	
278	48018014	A1	337,860	7.76	
279	48018013	A1	437,910	10.05	**X**
280	48018044	A1	446,360	10.25	**X**
281	48018015	A1	1,248,321	28.66	**X**
282	48017001	A1	1,534,247	35.22	
283	48017003	A1	4,709,574	108.12	
284	48017108	A1	1,761,660	40.44	
285	48017109	A1	893,310	20.51	
286	48017088	A1	1,808,972	41.53	
287	48017092	AP	6,749,385	154.95	
288	48017093	A1	1,391,556	31.95	
289	48017103	A1	735,673	16.89	
290	48017098	A1	160,425	3.68	
291	48055036	RR	149,981	3.44	
292	48017112	A1	3,430,180	78.75	
293	48055035	RR	53,632	1.23	
294	48055011	RR	437,701	10.05	
295	48055010	RR	221,067	5.08	
296	48055009	RR	215,241	4.94	
297	48055008	RR	227,956	5.23	
298	48077001	RR	252,405	5.79	
299	48055006	RR	241,856	5.55	
300	48055005	RR	232,469	5.34	
301	48077002	RR	223,345	5.13	
302	48055003	RR	241,404	5.54	
303	48055002	RR	240,835	5.53	
304	48077006	RR	219,588	5.04	
305	48077007	RR	217,120	4.98	
306	48055019	RR	233,432	5.36	
307	48077004	RR	256,611	5.89	
308	48077003	RR	227,232	5.22	
309	48077005	RR	242,819	5.57	
310	48055020	RR	263,863	6.06	
311	48055038	RR	263,535	6.05	
312	48055037	RR	207,939	4.77	
313	48055027	RR	187,790	4.31	
314	48055026	RR	291,585	6.69	
315	48055015	RR	261,585	6.01	
316	48055014	RR	247,521	5.68	
317	48055013	RR	227,181	5.22	
318	48077010	RR	235,359	5.40	
319	48055039	RR	219,307	5.03	

Table 1. (Cont.)

320	48077012	RR	228,854	5.25	
321	48077011	RR	200,716	4.61	
322	48017113	AP	1,300,697	29.86	
323	48080002	RR	635,610	14.59	
324	48080003	RR	211,448	4.85	
325	48080005	RR	219,007	5.03	
326	48080007	RR	250,499	5.75	
327	48080008	RR	213,003	4.89	
328	48080006	RR	291,573	6.69	
329	48080004	RR	250,908	5.76	
330	48080010	RR	201,411	4.62	
331	48080001	RR	248,471	5.70	
332	48080011	RR	254,707	5.85	
333	48080009	RR	194,334	4.46	
334	48080012	RR	281,970	6.47	
335	48080014	RR	210,534	4.83	
336	48080013	RR	220,531	5.06	
337	48080016	RR	232,091	5.33	
338	48080015	RR	231,082	5.30	
339	48018025	A1	1,463,816	33.60	**X**
340	48021009	A1	693,754	15.93	
341	48080033	RR	259,488	5.96	
342	48080034	RR	229,728	5.27	
343	48080019	RR	290,803	6.68	
344	48080020	RR	192,902	4.43	
345	48080035	RR	286,217	6.57	
346	48080036	RR	229,899	5.28	
347	48080021	RR	229,352	5.27	
348	48080025	RR	262,246	6.02	
349	48080024	RR	287,693	6.60	
350	48080022	RR	250,406	5.75	
351	48080023	RR	421,529	9.68	
352	48080031	RR	238,086	5.47	
353	48080032	RR	262,437	6.02	
354	48080026	RR	239,455	5.50	
355	48080027	RR	474,367	10.89	
356	48080028	RR	247,091	5.67	
357	48080030	RR	459,134	10.54	
358	48080029	RR	474,121	10.88	
359	48024002	A1	87,293	2.00	
360	48024003	A1	342,679	7.87	
361	48024005	A1	140,615	3.23	
362	48024004	A1	355,095	8.15	**X**
363	48024007	A1	260,475	5.98	
364	48024006	A1	242,395	5.56	
365	48025279	A1	5,519,204	126.70	
366	48025301	RA	886,770	20.36	**X**

Table 1. (Cont.)

367	48025008	A1	948,980	21.79	
368	48025009	A1	86,575	1.99	
369	48025010	A1	4,923,984	113.04	
370	48025118	A1	1,342,758	30.83	
371	48025117	A1	121,073	2.78	
372	48025120	A1	858,036	19.70	
373	48025119	A1	407,165	9.35	
374	48025020	A1	474,384	10.89	
375	48025181	A1	418,398	9.61	**X**
376	48025139	A1	224,558	5.16	
377	48025138	A1	233,325	5.36	
378	48025017	A1	421,228	9.67	
379	48025015	A1	735,730	16.89	
380	48025013	A1	886,951	20.36	
381	48025016	A1	80,786	1.85	
382	48025116	MANU	747,385	17.16	
383	48025236	RA	215,755	4.95	
384	48025237	RA	203,882	4.68	
385	48025240	RA	220,133	5.05	
386	48025241	RA	218,118	5.01	
387	48025242	RA	392,478	9.01	
388	48025243	RA	229,032	5.26	
389	48025244	RA	210,523	4.83	
390	48025106	U	330,218	7.58	
391	48025068	RR	322,270	7.40	
392	48025114	RA	390,052	8.95	
393	48025115	RA	446,891	10.26	
394	48025108	U	224,351	5.15	
395	48025058	U	229,162	5.26	
396	48025057	U	220,166	5.05	
397	48025109	U	216,051	4.96	
398	48025110	U	212,142	4.87	
399	48025056	U	213,947	4.91	
400	48025055	U	199,907	4.59	
401	48025111	U	203,991	4.68	
402	48025061	A1	6,062,536	139.18	
403	48035021	RR	1,104,331	25.35	
404	48035024	RA	242,762	5.57	
405	48025061	U	6,062,536	139.18	
406	48035025	RA	213,483	4.90	
407	48035026	RA	690,773	15.86	
408	48086001	RR	263,116	6.04	
409	48086002	RR	261,296	6.00	
410	48035029	RR	209,333	4.81	
411	48035020	RR	297,631	6.83	
412	48035028	RR	303,340	6.96	
413	48035036	RR	284,678	6.54	

Table 1. (Cont.)

414	48035035	RR	233,945	5.37	
415	48025184	RA	207,843	4.77	
416	48025212	RA	200,799	4.61	
417	48025211	RA	221,729	5.09	
418	48035013	U	605,442	13.90	
419	48035017	U	423,799	9.73	
420	48035016	U	422,500	9.70	
421	48035034	RR	251,601	5.78	
422	48025290	RR	237,906	5.46	
423	48025128	RR	298,277	6.85	
424	48025126	RR	445,014	10.22	
425	48025287	RR	231,149	5.31	
426	48025288	RR	238,306	5.47	
427	48025127	RR	328,587	7.54	
428	48025292	RR	617,495	14.18	
429	48025239	RR	421,440	9.68	**X**
430	48025238	RR	488,097	11.21	
431	48025291	RR	274,279	6.30	**X**
432	48025277	RR	213,554	4.90	**X**
433	48025129	RA	598,606	13.74	
434	48025090	U	217,714	5.00	
435	48025089	U	248,301	5.70	
436	48025088	RA	236,899	5.44	
437	48025197	RA	202,755	4.65	
438	48025196	U	205,937	4.73	
439	48025092	U	221,314	5.08	
440	48025097	U	215,886	4.96	
441	48025080	U	205,710	4.72	
442	48025081	U	183,968	4.22	
443	48025270	RA	237,416	5.45	
444	48025077	U	243,608	5.59	
445	48025076	U	240,064	5.51	
446	48025269	RA	214,763	4.93	
447	48025070	U	191,049	4.39	
448	48025079	U	209,930	4.82	
449	48025096	U	206,106	4.73	
450	48025095	U	223,676	5.13	
451	48025195	RA	186,213	4.27	
452	48025194	RA	203,091	4.66	
453	48025038	A1	5,243,276	120.37	
454	48025041	A1	3,460,267	79.44	
455	48025039	U	437,338	10.04	
456	48025040	U	455,612	10.46	
457	48072004	RA	196,466	4.51	
458	48072003	RA	226,729	5.21	
459	48072006	RA	345,231	7.93	
460	48072002	RA	220,365	5.06	

Table 1. (Cont.)

461	48072001	RA	212,102	4.87	
462	48072008	RA	233,158	5.35	
463	48085003	RA	234,779	5.39	
464	48085004	RA	212,824	4.89	
465	48081005	RA	292,948	6.73	
466	48081008	RA	202,964	4.66	
467	48081009	RA	225,328	5.17	
468	48081002	RA	300,191	6.89	
469	48085002	RA	301,232	6.92	
470	48085001	RA	209,507	4.81	
471	48081011	RA	278,696	6.40	
472	48081010	RA	221,258	5.08	
473	48081003	RA	276,296	6.34	
474	48081002	RA	300,191	6.89	
475	48025256	RA	201,198	4.62	
476	48025164	RA	202,432	4.65	
477	48025220	RA	227,925	5.23	
478	48025221	RA	223,788	5.14	
479	48025222	RA	210,840	4.84	
480	48025219	RA	206,883	4.75	
481	48025224	RA	213,557	4.90	
482	48025225	RA	219,674	5.04	
483	48025226	RA	195,688	4.49	
484	48025223	RA	216,712	4.98	
485	48025191	RA	812,439	18.65	
486	48025257	RA	212,093	4.87	
487	48025258	RA	196,961	4.52	
488	48025259	RA	203,580	4.67	
489	48025260	RA	226,026	5.19	
490	48025263	RA	243,118	5.58	
491	48025264	RA	223,531	5.13	
492	48025265	RA	255,457	5.86	
493	48025201	RA	883,800	20.29	
494	48025268	RA	386,726	8.88	
495	48025267	RA	296,048	6.80	
496	48025266	RA	232,596	5.34	
497	48025286	RA	217,815	5.00	
498	48025285	RA	398,587	9.15	
499	48025284	RA	220,379	5.06	
500	48025283	RA	219,839	5.05	
501	48017075	RA	204,425	4.69	
502	48017085	RA	207,976	4.77	
503	48017083	RA	406,649	9.34	
504	48017074	RA	472,739	10.85	
505	48017057	A1	742,138	17.04	
506	48017037	A1	205,001	4.71	
507	48017038	A1	420,492	9.65	

Table 1. (Cont.)

508	48017039	A1	399,335	9.17	
509	48017023	A1	362,172	8.31	
510	48017079	A1	356,510	8.18	
511	48017080	A1	75,475	1.73	
512	48017105	A1	431,549	9.91	
513	48017110	A1	2,004,167	46.01	
514	48017045	A1	395,146	9.07	
515	48017046	A1	373,324	8.57	
516	48017048	A1	68,316	1.57	
517	48017111	A1	902,612	20.72	
518	48025145	A1	879,757	20.20	
519	48025146	A1	792,599	18.20	
520	48026016	A1	1,557,888	35.76	
521	48026002	A1	47,784	1.10	
522	48026004	A1	115,667	2.66	
523	48026013	A1	337,000	7.74	
524	48026010	A1	400,706	9.20	
525	48026017	A1	68,885	1.58	
526	48026006	A1	40,370	0.93	
527	48025261	A1	2,421,572	55.59	
528	48025262	A1	4,192,130	96.24	
529	48025234	A1	1,888,969	43.37	
530	48025148	A1	1,675,279	38.46	
531	48025137	A1	808,792	18.57	
532	48025251	A1	1,707,498	39.20	
533	48025249	AP	11,043,707	253.53	
534	48017094	COMM	392,778	9.02	
535	48017069	COMM	206,529	4.74	
536	48016008	COMM	162,642	3.73	
537	48016009	MANU	92,280	2.12	
538	48016002	COMM	85,081	1.95	
539	48016003	COMM	133,159	3.06	
540	48016010	RES	233,023	5.35	
541	48017060	RES	863,142	19.82	
542	48017032	RES	1,642,050	37.70	
543	48011015	COMM	237,092	5.44	
544	48011034	COMM	788,279	18.10	
545	48011033	COMM	443,879	10.19	
546	48011032	COMM	88,960	2.04	
547	48011025	COMM	221,700	5.09	
548	48011026	COMM	221,404	5.08	
549	48011013	COMM	281,520	6.46	
550	48011014	A1	217,105	4.98	
551	48011021	A1	1,477,706	33.92	**X**
552	48011011	A1	59,091	1.36	
553	48011020	A1	320,754	7.36	
554	48012007	A1	593,620	13.63	

Table 1. (Cont.)

555	48012001	A1	86,756	1.99	
556	48012006	A1	29,180	0.67	
557	48012004	A1	48,227	1.11	
558	48011005	A1	1,434,997	32.94	
559	48011006	A1	1,265,543	29.05	
560	48025005	A1	1,899,103	43.60	
561	73042120	A1	1,743,716	40.03	
562	46001152	A1	1,103,434	25.33	
563	46001151	A1	923,954	21.21	
564	46004013	A1	911,695	20.93	X
565	48012002	COMM	118,901	2.73	
566	48011019	RR	785,402	18.03	
567	48011030	RR	627,052	14.40	
568	48011031	RR	215,398	4.94	
569	48011029	RR	234,789	5.39	
570	48011017	RR	642,495	14.75	
571	48011028	RR	391,033	8.98	
572	46004007	RES	433,013	9.94	
573	46003017	RES	73,099	1.68	
574	46004008	RES	379,802	8.72	
575	46004009	RES	428,071	9.83	
576	46004010	RES	414,349	9.51	
577	46030013	RR	560,692	12.87	
578	46030014	RR	431,126	9.90	
579	46031003	RR	538,413	12.36	
580	46031002	RR	489,790	11.24	
581	46031001	RR	703,888	16.16	
582	46031016	RR	583,232	13.39	
583	46031005	RR	438,445	10.07	
584	46030011	RR	435,974	10.01	
585	46031006	RR	436,215	10.01	
586	46030012	RR	649,956	14.92	
587	46032001	RR	903,747	20.75	
588	46031011	RR	446,542	10.25	
589	46031012	RR	435,823	10.01	
590	46031013	RR	490,503	11.26	
591	46031014	RR	478,264	10.98	
592	46033011	RR	441,219	10.13	
593	46033010	RR	528,208	12.13	
594	46033008	RR	754,912	17.33	
595	46033009	RR	516,438	11.86	
596	46033002	RR	509,882	11.71	
597	46033001	RR	437,999	10.06	
598	46031010	RR	436,110	10.01	
599	46031008	RR	441,502	10.14	X
600	46031007	RR	471,372	10.82	
601	73042038	A1	3,566,499	81.88	

Table 1. (Cont.)

602	46001123	AP	499,345	11.46	
603	46001092	AP	2,970,381	68.19	
604	46001102	A1	6,267,119	143.87	
606	46001053	A1	2,624,900	60.26	
607	46001017	A1	935,890	21.49	
608	46001147	A1	829,312	19.04	
609	46001146	A1	882,982	20.27	
610	46001145	A1	945,579	21.71	**X**
611	46001144	A1	667,793	15.33	
612	46001014	AP	15,346,171	352.30	
613	46003014	AP	1,184,520	27.19	
614	46003001	A1	1,214,997	27.89	
615	46001016	A1	1,710,423	39.27	
616	48009005	A1	145,871	3.35	
617	48009023	RR	1,337,455	30.70	
618	48009025	RR	1,771,229	40.66	
619	48009024	RR	1,895,177	43.51	
620	48009009	RR	303,721	6.97	
621	48011010	RR	432,084	9.92	
622	Camanche Estates	RR	3,530,574	81.05	
623	48013004	RES	454,006	10.42	
624	48009002	A1	1,001,244	22.99	
625	48009039	A1	291,710	6.70	
626	48009038	A1	270,934	6.22	
627	48009021	A1	282,831	6.49	
628	48009020	A1	217,780	5.00	
629	48009016	A1	567,420	13.03	
630	48009014	A1	485,143	11.14	
631	48014008	RES	317,717	7.29	
632	48014002	RES	71,208	1.63	
633	48014010	RES	400,080	9.18	
634	48014009	RES	227,773	5.23	
635	48014007	RES	532,299	12.22	
636	48015016	RES	306,787	7.04	
637	48017082	RES	338,178	7.76	
638	48017043	RES	207,298	4.76	
639	48017081	RES	369,631	8.49	
640	48017007	RES	5,104,371	117.18	
641	48017008	A1	439,545	10.09	
642	48017028	A1	330,232	7.58	
643	48017041	A1	202,162	4.64	
644	48017029	A1	192,733	4.42	
645	48017040	A1	1,045,953	24.01	
646	48003191	A1	3,093,869	71.03	
647	48017070	A1	193,270	4.44	

Table 1. (Cont.)

648	48017055	RR	457,733	10.51	
649	48017020	RR	1,081,766	24.83	
650	48017005	U	1,681,899	38.61	
651	48053012	RA	316,250	7.26	
652	48053008	RA	236,367	5.43	
653	48053007	RA	236,753	5.44	
654	48053009	RA	247,335	5.68	
655	48053010	RA	338,970	7.78	
656	48037041	RA	366,144	8.41	
657	48037043	RA	225,838	5.18	
658	48037044	RA	205,161	4.71	
659	48039001	RA	1,727,280	39.65	
660	48082001	RA	252,276	5.79	
661	48082002	RA	224,749	5.16	
662	48082003	RA	277,994	6.38	
663	48082004	RA	262,612	6.03	
664	48082005	RA	325,254	7.47	
665	48082006	RA	195,403	4.49	
666	48082007	RA	196,840	4.52	

Total	**13,720**

Area B					
Parcel	**APN**	**Land Use**	**Area (SF)**	**Area (Acres)**	**Permit App.**
667	48003189	AP	6,130,098	140.73	
668	48003190	MANU	121,091	2.78	
669	48003017	MANU	1,219,998	28.01	
670	48037026	A1	272,424	6.25	
671	48037048	A1	474,316	10.89	
672	48037016	A1	345,193	7.92	
673	48053005	RA	216,069	4.96	
674	48053004	RA	242,658	5.57	
675	48053003	RA	228,268	5.24	**X**
676	48053002	RA	199,351	4.58	
677	48053001	RA	244,780	5.62	
678	48037024	RA	1,155,653	26.53	
679	48037040	RA	421,149	9.67	
680	48037039	RA	430,963	9.89	
681	48037038	RA	276,526	6.35	**X**
682	48037037	RA	221,380	5.08	
683	48037046	RA	217,191	4.99	
684	48037045	RA	380,514	8.74	
685	48037014	A1	488,960	11.23	
686	48037015	A1	491,030	11.27	
687	48037001	A1	478,096	10.98	
688	48037036	A1	230,489	5.29	

Table 1. (Cont.)

689	48037035	A1	235,371	5.40	
690	48037034	A1	552,810	12.69	
691	48037032	A1	305,953	7.02	
692	48037031	A1	323,888	7.44	
693	48037013	A1	476,664	10.94	
694	48037005	A1	463,878	10.65	
695	48037012	A1	517,707	11.89	
696	48037006	A1	491,084	11.27	
697	48037011	A1	491,243	11.28	
698	48037018	A1	901,929	20.71	
699	48037020	A1	633,774	14.55	
700	48037021	A1	796,391	18.28	
701	48037019	A1	1,097,168	25.19	
702	48034012	A1	679,126	15.59	
703	48034010	A1	532,540	12.23	
704	48034011	A1	242,854	5.58	
705	48034009	A1	242,047	5.56	
706	48039015	A1	900,841	20.68	
707	48039016	A1	906,533	20.81	
708	48039013	A1	1,830,552	42.02	
709	48039010	A1	441,907	10.14	**X**
710	48039003	A1	443,021	10.17	
711	48034004	A1	430,736	9.89	
712	48039004	A1	463,244	10.63	
713	48039009	A1	417,401	9.58	
714	48039005	A1	446,169	10.24	**X**
715	48039008	A1	435,018	9.99	
716	48039006	A1	400,788	9.20	**X**
717	48039007	A1	386,982	8.88	
718	48039011	A1	1,582,041	36.32	
719	48009004	A1	1,553,414	35.66	
720	48039020	RA	846,383	19.43	
721	48039019	RA	892,468	20.49	
722	48034029	RA	212,740	4.88	
723	48034028	RA	216,235	4.96	
724	48034001	RA	433,630	9.95	
725	48034033	RA	253,626	5.82	
726	48034032	RA	251,091	5.76	
727	48034005	RA	435,429	10.00	
728	48034007	RA	473,306	10.87	
729	48034008	RA	260,487	5.98	
730	48034014	RR	426,434	9.79	
731	48034016	RR	418,291	9.60	
732	48034017	RR	395,810	9.09	
733	48034015	RR	422,477	9.70	
734	48040020	RR	402,400	9.24	
735	48040019	RR	418,425	9.61	

Table 1. (Cont.)

736	48040021	RR	1,520,650	34.91	
737	48040018	RR	406,145	9.32	
738	48040017	RR	402,219	9.23	
739	48034018	A1	441,513	10.14	
740	48040014	A1	265,827	6.10	
741	48040029	RR	234,311	5.38	
742	48040028	RR	218,069	5.01	
743	48040027	RR	428,320	9.83	
744	48040024	A1	431,530	9.91	
745	48040030	RA	348,512	8.00	
746	48040031	RA	270,001	6.20	
747	48040022	A1	600,179	13.78	
748	48040003	A1	272,001	6.24	
749	48040002	A1	335,937	7.71	
750	48040004	A1	406,577	9.33	
751	48040005	A1	316,041	7.26	
752	48040001	A1	633,812	14.55	
753	48038012	A1	872,322	20.03	
754	48038013	A1	200,439	4.60	
755	48038014	A1	376,638	8.65	
756	48038041	A1	420,482	9.65	
757	48038017	A1	437,079	10.03	
758	48038018	A1	374,911	8.61	
759	48038019	A1	438,451	10.07	
760	48037027	A1	483,947	11.11	
761	48034021	A1	428,583	9.84	
762	48034022	A1	444,243	10.20	
763	48034031	A1	402,934	9.25	
764	48034030	A1	439,957	10.10	
765	48037030	A1	467,996	10.74	
766	48037029	A1	430,736	9.89	
767	48037028	A1	457,000	10.49	
768	48037010	A1	435,481	10.00	
769	48037008	A1	436,008	10.01	
770	48037007	A1	477,284	10.96	**X**
771	48038039	A1	413,716	9.50	
772	48038038	A1	426,894	9.80	
773	48038036	A1	449,466	10.32	
774	48038037	A1	448,851	10.30	
775	48038015	A1	573,480	13.17	
776	48038011	A1	474,985	10.90	
777	48038042	A1	254,017	5.83	
778	48038043	A1	258,273	5.93	
779	48038008	A1	208,751	4.79	
780	48038021	RR	369,291	8.48	
781	48038026	RR	651,416	14.95	
782	48038025	RR	196,504	4.51	

Table 1. (Cont.)

783	48038024	RR	352,108	8.08	
784	48038022	RR	185,951	4.27	
785	48038023	RR	259,992	5.97	
786	48038007	RR	305,440	7.01	
787	48038006	RR	240,387	5.52	
788	48032012	RR	122,789	2.82	
789	48032011	RR	169,394	3.89	
790	48038029	RR	338,235	7.76	
791	48038028	RR	317,005	7.28	
792	48038027	RR	300,813	6.91	
793	48038030	RR	194,775	4.47	
794	48032010	RR	76,721	1.76	
795	48032009	RR	69,663	1.60	
796	48032008	RR	82,529	1.89	**X**
797	48032007	RR	99,199	2.28	
798	48032006	RR	81,267	1.87	
799	48032005	RR	71,268	1.64	
800	48032004	RR	95,199	2.19	
801	48032002	RR	64,276	1.48	
802	48032001	RR	86,319	1.98	
803	48033001	RR	100,183	2.30	
804	48033002	RR	79,087	1.82	
805	48033003	RR	85,691	1.97	
806	48033004	RR	171,311	3.93	
807	48033005	RR	229,658	5.27	
808	48032003	RR	98,049	2.25	
809	48033011	RR	92,190	2.12	
810	48033010	RR	96,685	2.22	
811	48033009	RR	95,918	2.20	
812	48033008	RR	79,501	1.83	
813	48033007	RR	93,576	2.15	
814	48033006	RR	68,042	1.56	
815	48038035	RR	1,972,257	45.28	
816	48038046	REC	281,495	6.46	
817	48038047	REC	239,294	5.49	
818	48038031	REC	223,356	5.13	
819	48038045	RR	157,244	3.61	
820	48038044	RR	299,617	6.88	
821	48038005	A1	419,586	9.63	
822	48038004	A1	90,955	2.09	**X**
823	48038003	A1	485,452	11.14	
824	48038002	A1	172,166	3.95	**X**
825	48038001	A1	280,831	6.45	**X**
826	48036006	RR	316,222	7.26	
827	48036008	RR	395,483	9.08	
828	48036005	A1	273,972	6.29	
829	48036004	A1	142,551	3.27	

Table 1. (Cont.)

830	48036003	A1	130,667	3.00	
831	48036007	A1	186,366	4.28	
832	48036001	A1	1,637,182	37.58	
833	48041001	A1	388,191	8.91	
834	48041016	A1	191,529	4.40	
835	48041017	A1	318,194	7.30	
836	48041007	A1	372,742	8.56	
837	48041015	A1	366,857	8.42	
838	48041002	A1	451,309	10.36	
839	48041004	A1	451,698	10.37	
840	48041008	A1	410,306	9.42	
841	48041011	A1	471,032	10.81	
842	48040009	A1	244,599	5.62	
843	48040010	A1	225,828	5.18	
844	48040011	A1	246,039	5.65	
845	48040012	A1	682,634	15.67	
846	48040013	A1	854,348	19.61	
847	48034025	A1	202,401	4.65	
848	48034026	A1	219,764	5.05	
849	48034027	A1	246,378	5.66	
850	48034034	RR	274,997	6.31	
851	48034035	RR	211,345	4.85	
852	46002023	RR	307,845	7.07	
853	46002024	RR	218,052	5.01	
854	46002020	RR	304,385	6.99	
855	46002021	RR	330,504	7.59	
856	46002022	RR	330,478	7.59	
857	46002029	RR	531,978	12.21	
858	48034002	A1	448,080	10.29	
859	46002025	RR	345,949	7.94	
860	46002028	RR	407,323	9.35	
861	46002030	RR	369,988	8.49	
862	46002037	RR	519,823	11.93	
863	46002026	RR	454,918	10.44	
864	46002027	RR	432,019	9.92	
865	46002038	RR	863,385	19.82	
866	46001015	MANU	7,088,052	162.72	**X**
867	46002009	A1	468,209	10.75	
868	46002036	A1	1,206,141	27.69	
869	46001054	A1	2,209,494	50.72	
870	46001001	A1	426,336	9.79	
871	46002007	A1	1,537,096	35.29	
872	46002016	A1	282,126	6.48	
873	46002015	A1	650,393	14.93	
874	46002033	A1	683,148	15.68	
875	46002035	RA	217,330	4.99	
876	46002034	RA	238,695	5.48	

Table 1. (Cont.)

877	48007006	A1	374,938	8.61	
878	48002090	A1	1,671,915	38.38	
879	48002089	A1	2,591,300	59.49	
880	48040015	A1	2,716,198	62.36	
881	48040026	A1	382,777	8.79	
882	48040025	A1	353,545	8.12	
883	48002036	A1	3,138,019	72.04	
884	48002078	A1	1,353,281	31.07	
885	48002091	A1	1,709,753	39.25	
886	48041003	A1	1,683,101	38.64	**X**
887	48041009	A1	800,610	18.38	
888	48041010	RR	894,495	20.53	
889	48002092	A1	4,764,597	109.38	
890	48002079	RA	187,215	4.30	
891	48002080	RA	922,733	21.18	
892	48002070	RA	809,720	18.59	
893	48002064	A1	3,044,706	69.90	
894	48007004	A1	994,175	22.82	
895	48007002	A1	78,624	1.80	
896	48007001	A1	45,113	1.04	
897	48007003	A1	40,209	0.92	
898	48002058	RR	1,081,699	24.83	
899	48002059	RR	602,233	13.83	
900	48030018	RR	166,064	3.81	
901	48030014	RR	221,337	5.08	
902	48030013	RR	208,266	4.78	
903	48030012	RR	201,563	4.63	
904	48030011	RR	224,195	5.15	
905	48030010	RR	259,391	5.95	
906	48030009	RR	175,933	4.04	
907	48030008	RR	254,945	5.85	
908	48031005	RR	631,311	14.49	**X**
909	48031004	RR	1,000,689	22.97	
910	48030001	RR	221,309	5.08	
911	48030002	RR	224,767	5.16	
912	48030003	RR	209,335	4.81	
913	48030004	RR	147,838	3.39	**X**
914	48030005	RR	278,784	6.40	
915	48030006	RR	260,197	5.97	
916	48030007	RR	228,699	5.25	
917	48031001	RR	416,346	9.56	
918	48031002	RR	631,762	14.50	
919	48031007	RR	511,234	11.74	
920	48031009	RR	125,583	2.88	
921	46001136	A1	1,415,890	32.50	
922	46001124	A1	5,992,836	137.58	
923	46001055	A1	344,120	7.90	

Table 1. (Cont.)

924	46001127	A1	4,144,221	95.14	
925	46001013	A1	3,150,881	72.33	
926	46001128	A1	3,211,890	73.74	
927	46001012	A1	7,667,690	176.03	
928	46001126	A1	2,285,153	52.46	
929	46001003	MANU	3,693,932	84.80	
930	48002073	A1	1,698,108	38.98	
931	48002072	RES	3,867,971	88.80	
932	48002028	A1	250,719	5.76	
933	48002026	A1	2,116,187	48.58	**X**
934	48002027	A1	1,014,178	23.28	
935	48002068	MANU	5,734,759	131.65	
936	48002071	A1	8,619,472	197.88	
937	48002048	A1	1,832,421	42.07	
938	48002032	A1	5,506,788	126.42	
939	48002015	A1	8,791,684	201.83	
940	48002017	U	85,256	1.96	
941	48006002	U	1,653,594	37.96	
942	48006003	U	836,234	19.20	
943	48006013	U	172,527	3.96	
944	48006005	U	63,001	1.45	
945	48006006	U	147,128	3.38	
946	48006007	U	74,517	1.71	
947	48006008	U	163,340	3.75	
948	48006009	U	258,930	5.94	
949	48004039	U	56,190	1.29	
950	48004031	U	81,966	1.88	
951	48004019	U	131,944	3.03	
952	48004001	U	428,953	9.85	
953	48004005	U	396,334	9.10	
954	48004042	U	296,811	6.81	
955	48004044	U	267,833	6.15	
956	48004043	U	216,914	4.98	
957	48004007	U	449,934	10.33	
958	48004008	U	201,172	4.62	
959	48006010	U	74,625	1.71	
960	48004034	U	147,149	3.38	
961	48004014	U	39,901	0.92	
962	48004030	U	42,984	0.99	
963	48004004	U	65,983	1.51	
964	48004024	U	85,647	1.97	
965	48002016	AP	1,795,654	41.22	
966	48002041	AP	4,013,006	92.13	
967	48002013	AP	1,794,548	41.20	
968	48002011	AP	185,188	4.25	
969	48002042	A1	235,824	5.41	
970	48002007	A1	1,836,069	42.15	

Table 1. (Cont.)

971	48002006	A1	2,950,846	67.74	
972	48002005	A1	1,473,180	33.82	
973	48002003	A1	184,824	4.24	
974	48002009	A1	2,029,881	46.60	
975	48002002	A1	6,066,502	139.27	
976	48002001	A1	94,133	2.16	
977	16031001	A1	602,425	13.83	
978	16031007	A1	865,730	19.87	
979	48002045	A1	519,953	11.94	
980	16031006	A1	2,358,491	54.14	
981	48002004	A1	3,379,658	77.59	
982	48002046	A1	1,508,344	34.63	
983	48002047	A1	1,688,926	38.77	
984	16031003	A1	935,804	21.48	
985	16031004	A1	2,282,201	52.39	
986	16031008	A1	5,604,363	128.66	
987	16031005	A1	1,599,292	36.71	

Total	**5,968**

ATTACHMENT B

KASL Technical Memorandum: Potential Demand for Mokelumne River Water Supplies Along Proposed Route of Middle Fork Ditch Pipeline

CALAVERAS COUNTY
MOKELUMNE RIVER
LONG TERM WATER NEEDS STUDY

TECHNICAL MEMORANDUM: POTENTIAL DEMAND FOR MOKELUMNE RIVER WATER SUPPLIES ALONG PROPOSED ROUTE OF MIDDLE FORK DITCH PIPELINE

INTRODUCTION

The following Technical Memorandum (TM) is prepared as an element of the Mokelumne River Long Term Water Needs Study being conducted for the Calaveras County Water District (CCWD) and the Calaveras Public Utility District (CPUD). The purpose of this TM is to assess long term water needs from the Middle Fork of the Mokelumne River, specifically associated with potential agricultural and domestic demands from a future planned Middle Fork Ditch Pipeline. The format of this TM follows the format of a similar TM prepared for CCWD and CPUD to estimate long term water needs for Mokelumne River Water in western Calaveras County.

MIDDLE FORK DITCH PIPELINE

In 1988, in 2001 and, again, in 2014, the CPUD evaluated the feasibility of piping water from their storage facility at Schaads Reservoir, located on the Middle Fork of the Mokelumne River, ("Middle Fork") to Jeff Davis Reservoir, now served by CPUD's South Fork Mokelumne River Pump Station and an existing 20 inch diameter pump discharge pipeline. Jeff Davis Reservoir is CPUD's supply for the Jeff Davis Water Treatment Plant. Treated water from this facility is delivered to CPUD customers in San Andreas, Railroad Flat and Mokelumne Hill and to other Calaveras County locations. The Middle Fork Ditch Pipeline proposal is particularly attractive because it has been determined, through previous feasibility studies, that Middle Fork water can be transferred, via a gravity pipeline, to the Jeff Davis Reservoir beginning at Schaads Reservoir with connection either to the existing penstock exposed near the existing Schaads Hydroelectric Plant or the existing reservoir drain pipe. Connection to the existing penstock would reduce the Middle Fork Ditch Pipeline length by approximately 525 feet and avoid construction along the toe of the Schaads embankment. Beginning at Schaads Reservoir, the Middle Fork Ditch Pipeline would be placed west along the existing unpaved road used by CPUD to access Schaads Reservoir, then across Schaads Road and then continue west approximately 1000 feet through a private campground area and along the south side of the Middle Fork until intercepting an existing Middle Fork Ditch diversion structure, then continuing west, a distance of approximately 16,000 feet along the historic Middle Fork Ditch, then, along unpaved and paved roadways, including Jewel Court, Blue Mountain Road, Noble Road and Railroad Flat Road and then within CPUD's access road and easement to the District's South Fork Pump Station. From this location, there would be sufficient hydraulic head to deliver Middle Fork Water to Jeff Davis Reservoir without pumping using the existing 20 inch diameter South Fork pump discharge pipeline. During months when there is sufficient supplies available from the Middle Fork, the Middle Fork Ditch Pipeline Project would not only eliminate pumping costs at the South Fork Pump Station but could also deliver sufficient flow and head to operate a 1 megawatt (MW) hydroelectric facility. There is approximately 700 feet of head available between Schaads operating levels and the floor of a future hydroelectric plant which would be constructed adjacent to the South Fork Pump Station. In the most recent (2014) Feasibility Study, a 30 inch diameter Middle Fork Ditch Pipeline is recommended capable of delivering, by gravity, 25 cubic feet per second (cfs) of Middle Fork water. The most recent Feasibility Study is based on providing up to 5 cfs of supply to Jeff Davis Reservoir with the remaining 20 cfs delivered through a proposed 1 MW hydroelectric facility on the South Fork.

Several Middle Fork Ditch pipeline alignments have been evaluated. The currently recommended alignment is presented in **Figure 1.0** (overview) followed by more detailed alignments shown in Figures **1.1 through 1.5.** A hydraulic profile of the Middle Fork Ditch Pipeline along the route proposed in Figures 1.1 through 1.5 is presented in **Figure 2**. Typical pipeline sections along the Middle Fork Ditch and along existing unpaved and paved roadways in the Project area are presented in **Figure 3**.

EXISTING CONDITIONS, LAND USES AND POTENTIAL WATER DEMANDS FROM THE MIDDLE FORK DITCH PIPELINE

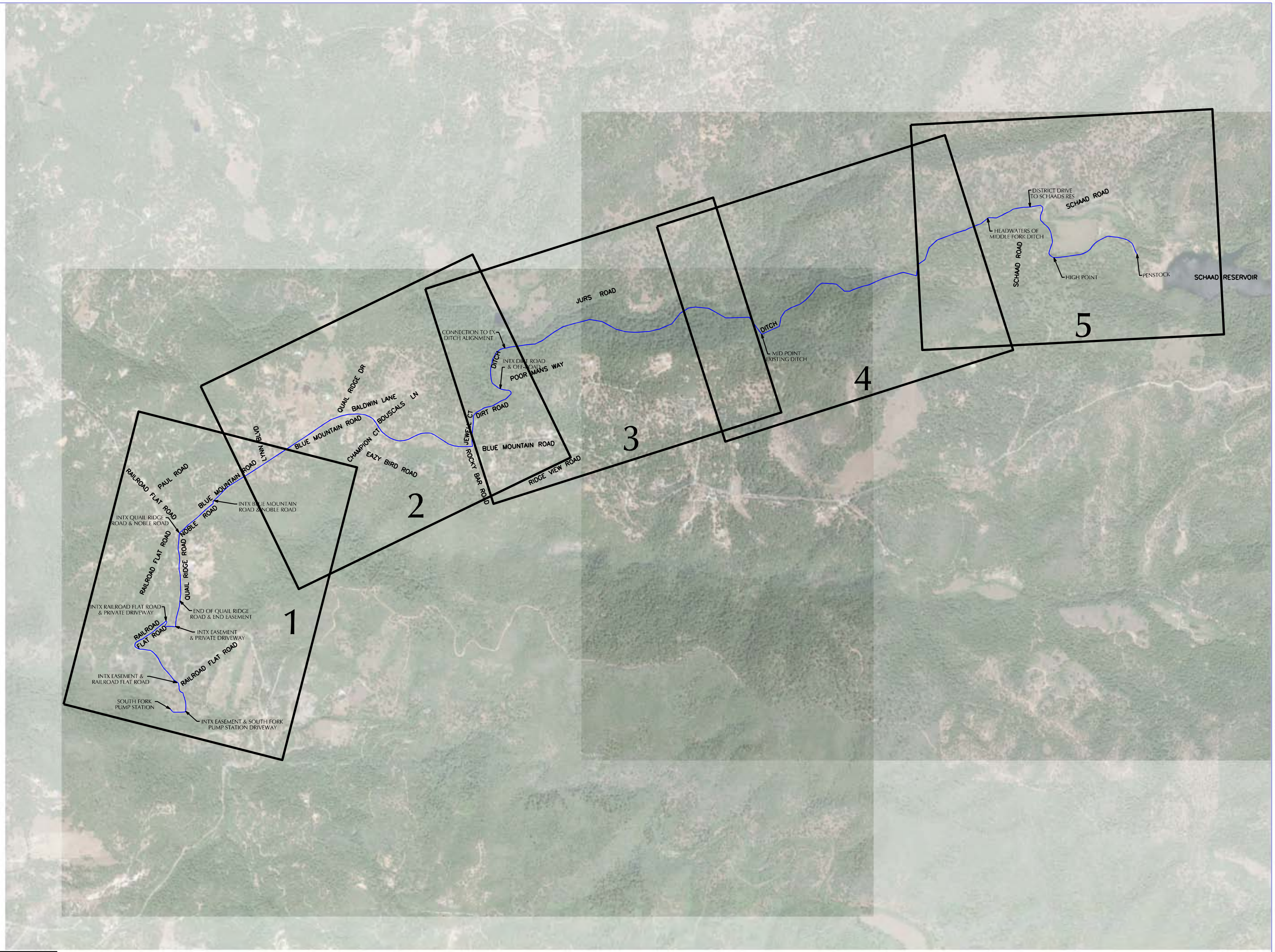
Schaads Reservoir and Middle Fork Mokelumne River Flows

Schaads Reservoir contains 1800 acre-feet of storage at a maximum pool elevation of 2907. Upstream of Schaads the contributing Middle Fork Mokelumne River watershed encompasses some 18,200 acres. Only limited local stream flow date is available immediately upstream or downstream of Schaads. The closest USGS Gauging Station is located approximately 7 ½ miles downstream, near West Point, at the State Highway 26 crossing of the Middle Fork (USGS Station 1131700). In **Table 1** is presented the mean of monthly flows recorded at this gauging stations for the period of 1912-2016. Also presented are maximum and minimum Middle Fork flows as measured at the West Point Gauging Station.

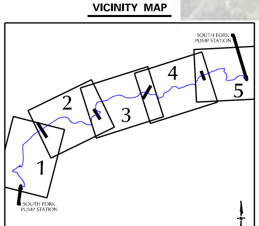
TABLE 1
MIDDLE FORK MOKELUMNE RIVER STREAM FLOW MEASUREMENTS(1)

Month	Mean Monthly Stream Flow Measurements (cfs)	Mean of Maximum Monthly Stream Flow Measurements (cfs)	Mean of Minimum Monthly Stream Flow Measurements (cfs)
October	11	37.5	0.86
November	21	223	2.64
December	50	389	3.33
January	89	680	4.75
February	119	768	5.70
March	141	653	9.06
April	149	765	6.47
May	107	372	4.17
June	43	181	0.95
July	16	71.8	0.22
August	9.3	40.8	0.07
September	7.6	31.1	0.15

(1) Data from USGS, 1131 700 Middle Fork Mokelumne River Gauging Station, State Highway 26, 1912-2016.



VICINITY MAP



LEGEND

SUGGESTED MIDDLE FORK DITCH PIPELINE ALIGNMENT

APPROXIMATE PROPERTY LINE

MOKELUMNE RIVER LONG TERM WATER NEEDS STUDY MIDDLE FORK DITCH PIPELINE

CALAVERAS COUNTY, CA

JUNE 2017

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Fax (916) 722-4595
CIVIL - WATER RESOURCES - SURVEYING

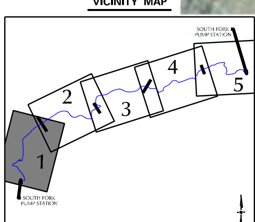
FIGURE NO. 1.0

FILE: S:\2517-01 West Point, Mokelumne River\Study B - Mokelumne River Demands\Study & Technical Memos for MFD Pipeline\Mid Fork Pipeline TM\1.0.dgn
DATE: 8/16/2017

NOT TO SCALE

NORTH

VICINITY MAP



LEGEND

SUGGESTED MIDDLE FORK DITCH PIPELINE ALIGNMENT

APPROXIMATE PROPERTY LINE

MOKELUMNE RIVER LONG TERM WATER NEEDS STUDY MIDDLE FORK DITCH PIPELINE

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FIGURE NO. 1.1

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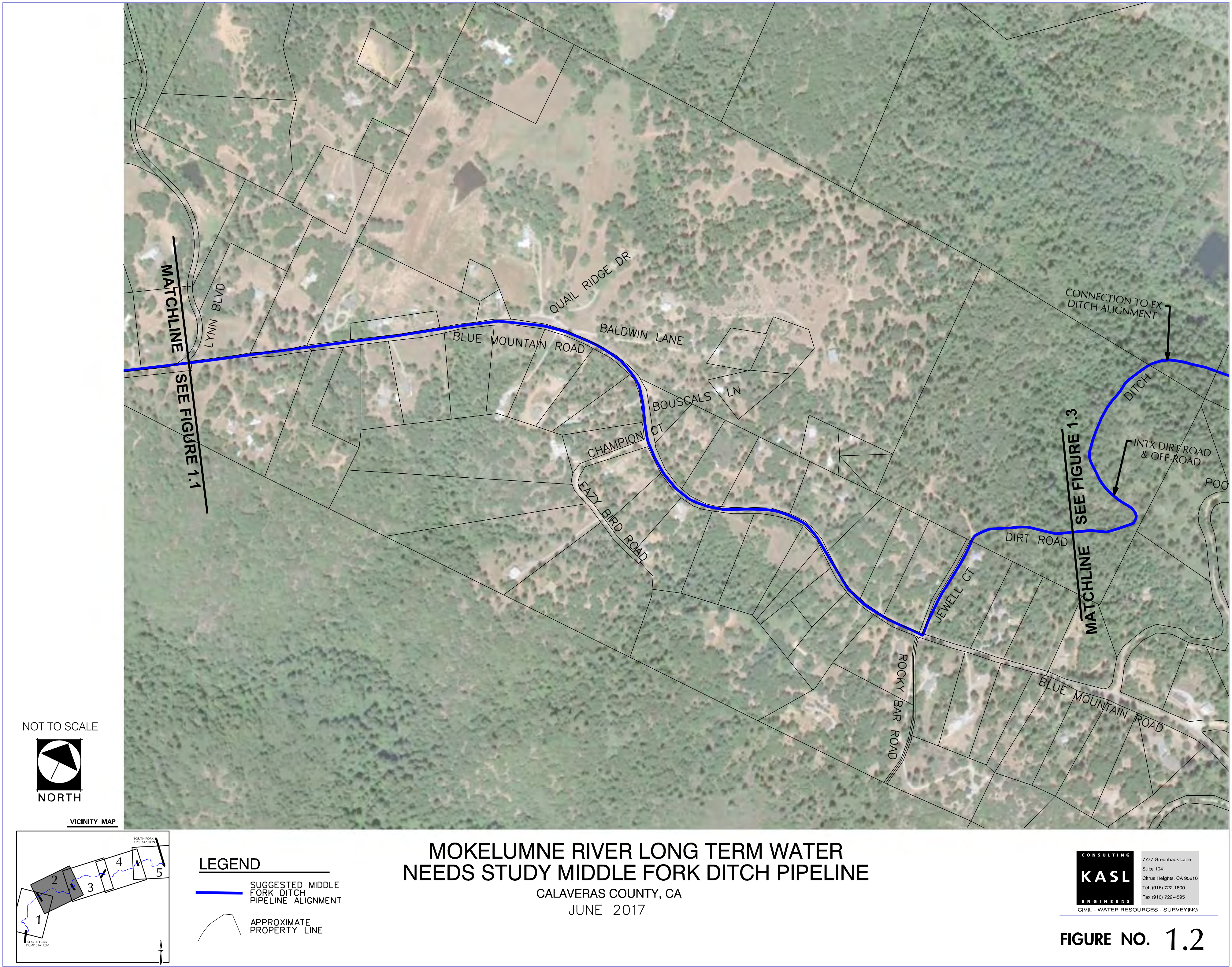

LEGEND

SUGGESTED MIDDLE FORK DITCH PIPELINE ALIGNMENT

APPROXIMATE PROPERTY LINE

MOKELUMNE RIVER LONG TERM WATER NEEDS STUDY MIDDLE FORK DITCH PIPELINE

CALAVERAS COUNTY, CA

JUNE 2017

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FIGURE NO. 1.2

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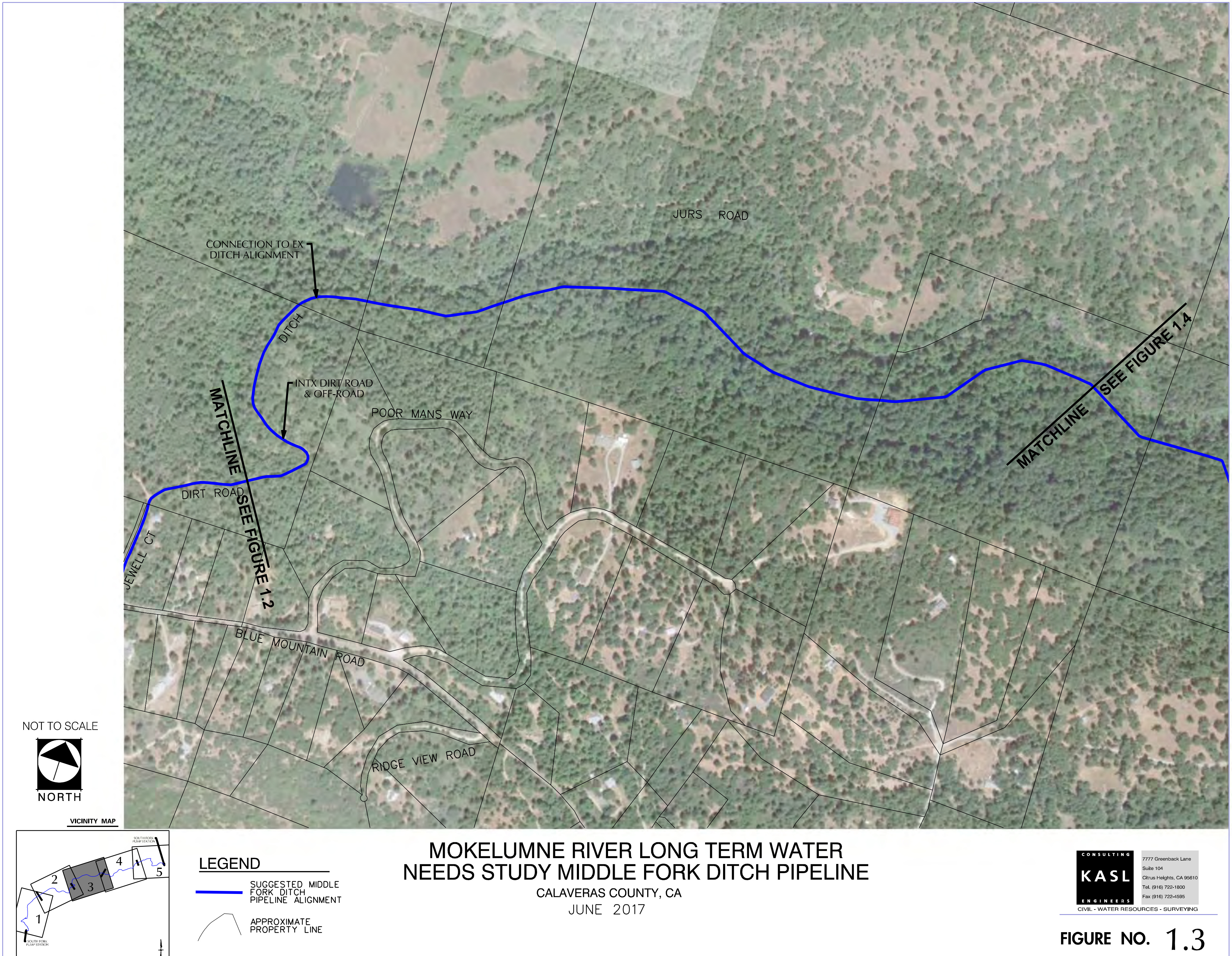

LEGEND

SUGGESTED MIDDLE FORK DITCH PIPELINE ALIGNMENT

APPROXIMATE PROPERTY LINE

MOKELUMNE RIVER LONG TERM WATER NEEDS STUDY MIDDLE FORK DITCH PIPELINE

CALAVERAS COUNTY, CA

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FIGURE NO. 1.3

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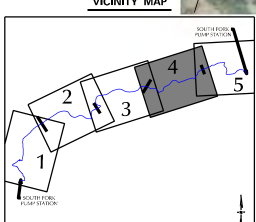
NOT TO SCALE

NORTH

VICINITY MAP



LEGEND

SUGGESTED MIDDLE FORK DITCH PIPELINE ALIGNMENT

APPROXIMATE PROPERTY LINE

MOKELUMNE RIVER LONG TERM WATER NEEDS STUDY MIDDLE FORK DITCH PIPELINE

CALAVERAS COUNTY, CA

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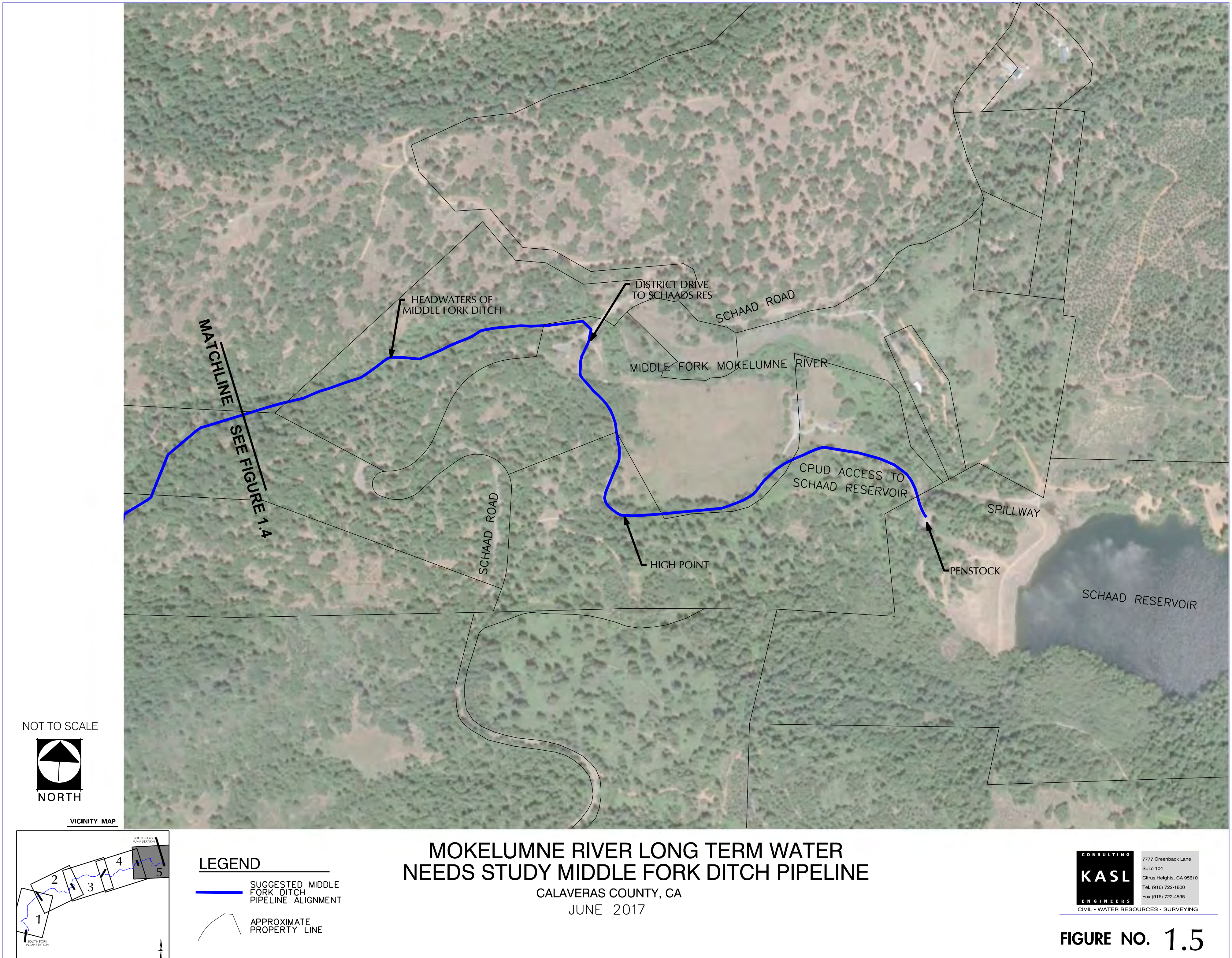
CIVIL - WATER RESOURCES - SURVEYING

FIGURE NO. 1.4



LEGEND

SUGGESTED MIDDLE FORK DITCH PIPELINE ALIGNMENT

APPROXIMATE PROPERTY LINE

MOKELUMNE RIVER LONG TERM WATER NEEDS STUDY MIDDLE FORK DITCH PIPELINE

CALAVERAS COUNTY, CA

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CIVIL - WATER RESOURCES - SURVEYING

FIGURE NO. 1.5

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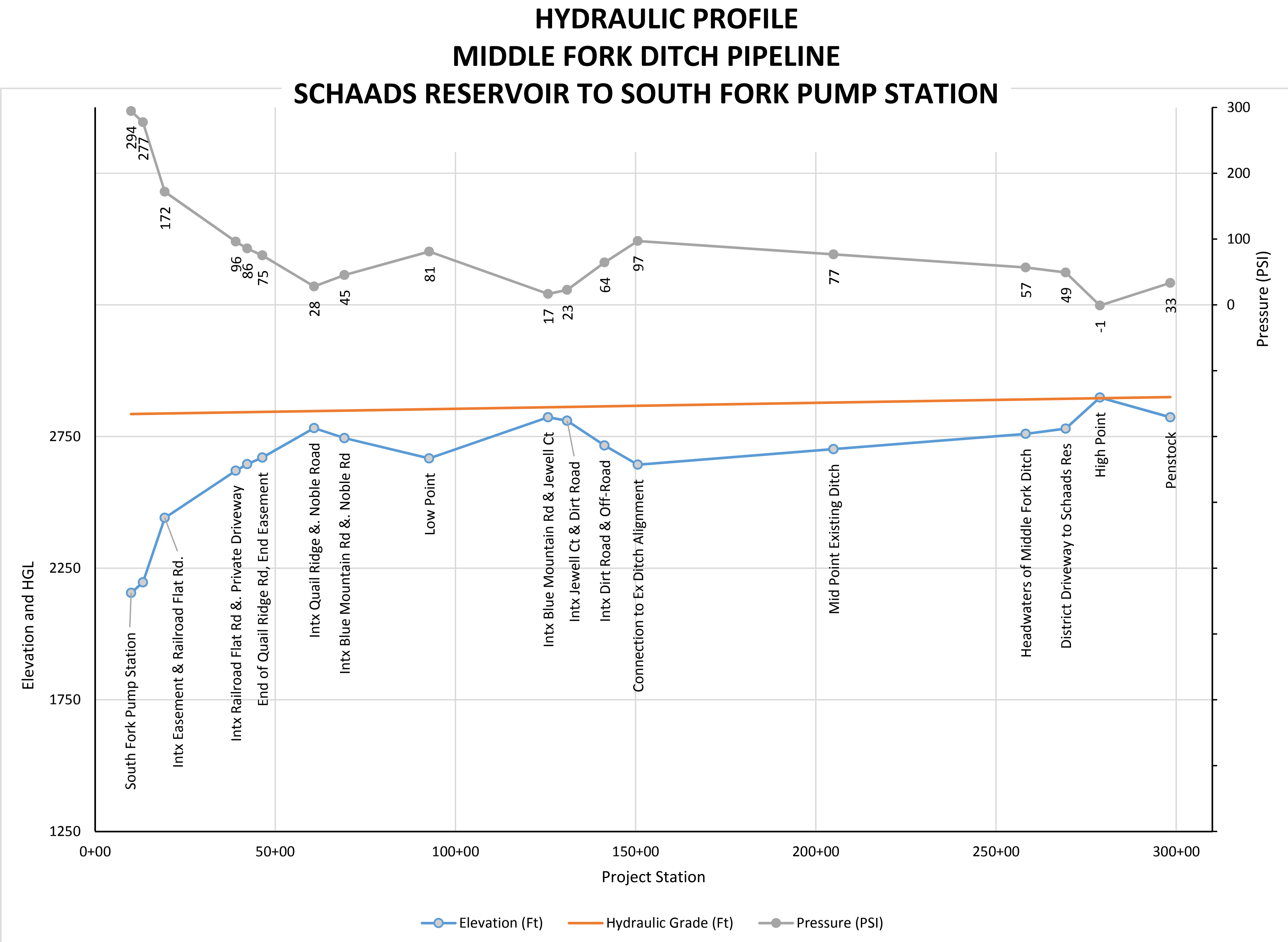
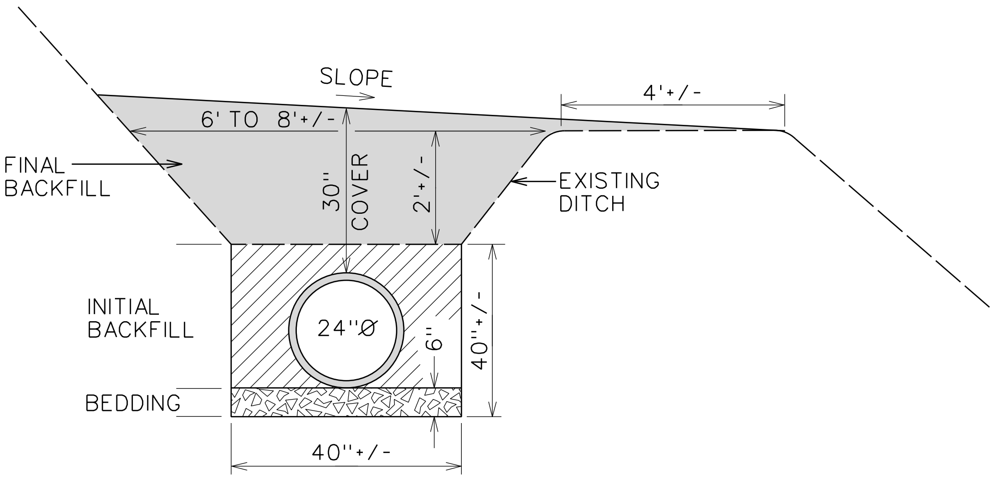
DATE: 8/16/2017



HYDRAULIC PROFILE
MIDDLE FORK DITCH PIPELINE
SCHAADS RESERVOIR TO SOUTH FORK PUMP STATION
Elevation and HGL
Pressure (PSI)
Project Station
0+00
50+00
100+00
150+00
200+00
250+00
300+00
1250
1750
2250
2750
0
100
200
300
294
277
172
96
86
75
28
45
81
17
23
64
97
77
57
49
-1
33
South Fork Pump Station
Intx Easement & Railroad Flat Rd.
Intx Railroad Flat Rd &. Private Driveway
End of Quail Ridge Rd, End Easement
Intx Quail Ridge &. Noble Road
Intx Blue Mountain Rd &. Noble Rd
Low Point
Intx Blue Mountain Rd & Jewell Ct
Intx Jewell Ct & Dirt Road
Intx Dirt Road & Off-Road
Connection to Ex Ditch Alignment
Mid Point Existing Ditch
Headwaters of Middle Fork Ditch
District Driveway to Schaads Res
High Point
Penstock
Elevation (Ft)
Hydraulic Grade (Ft)
Pressure (PSI)

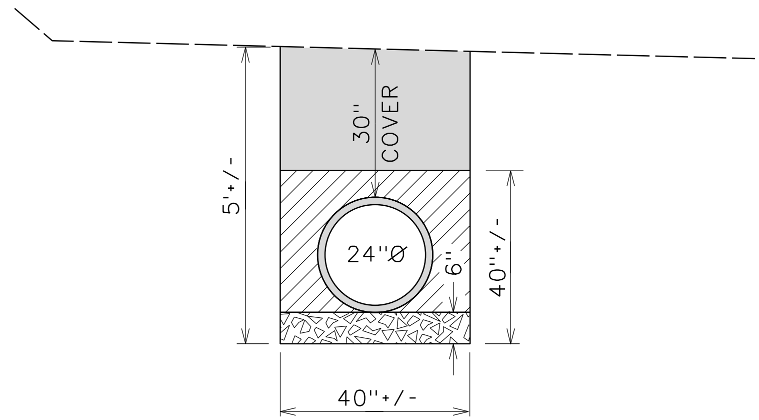
FIGURE 2

TYPICAL TRENCH SECTIONS



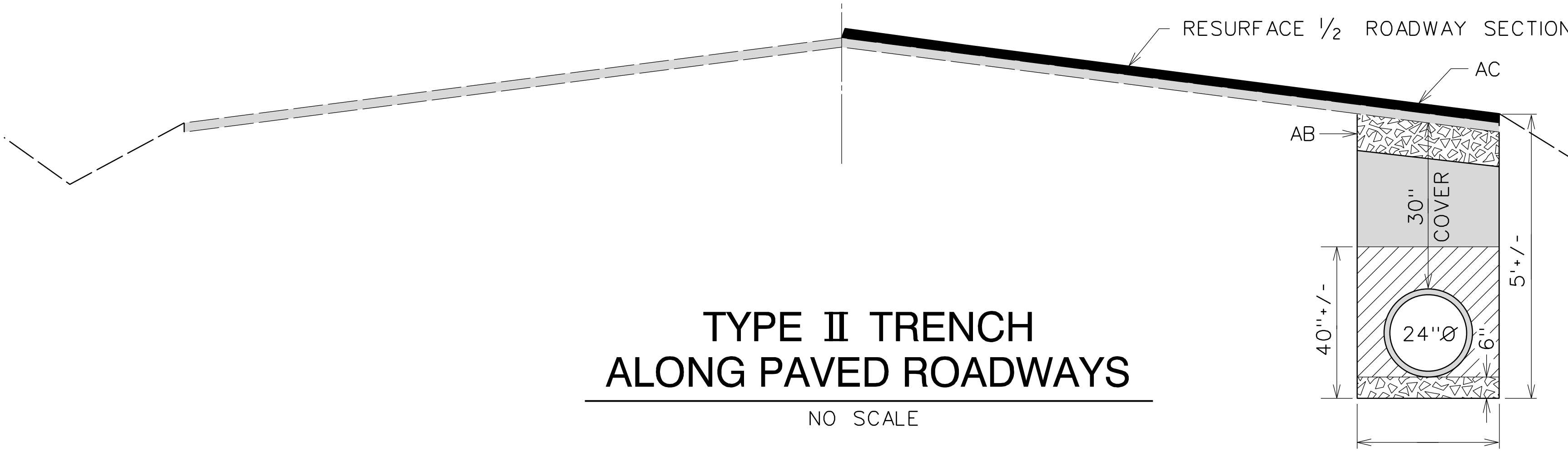
TYPE I TRENCH
ALONG MIDDLE FORK DITCH

NO SCALE



TYPE III TRENCH
ALONG EXISTING DIRT ROADWAYS
AND WITHIN EASEMENT DIRT AREAS

NO SCALE



TYPE II TRENCH
ALONG PAVED ROADWAYS

NO SCALE

CALAVERAS COUNTY MOKELUMNE RIVER LONG TERM WATER
NEEDS STUDY MIDDLE FORK DITCH PIPELINE

FIGURE 3

FILE: S:\2517-01 West Point, Mokelumne River\Study B - Mokelumne River Demands\Study & TechnicalMemos for MFD Pipeline\Mid Fork Pipeline TM\3.0 TRENCH SEC.dgn
DATE: 8/16/2017

Gauging Station 1131700 measures Middle Fork flows from a contributing basin area of approximately 43,800 acres. Since inflow to Schaads is the results of runoff from approximately 18,200 acres, it is reasonable to expect that mean, wet year and dry year inflow rates at Schaads would be approximately 18,200 / 43,800 or approximately 41.6% of the mean, maximum and minimum flows measured at the State Highway 26 USGS gauging station. Using the ratio of contributing watershed areas, estimated mean, maximum and minimum inflow at Schaads is presented in **Table 2.**

TABLE 2

ESTIMATED MIDDLE FORK MOKELUMNE RIVER INFLOW AT SCHAADS

Month	Projected Mean Monthly Stream Flows(1) cfs	Projected Mean of Maximum Year Monthly Stream Flows(1) cfs	Mean of Minimum Year Monthly Stream Flows(1) cfs	Average Inflow Measurements 1967-1978(2) cfs
October	4.6	15.6	0.4	5.3
November	8.7	92.7	1.1	10.6
December	20.8	161.7	1.4	13.0
January	37.0	282.7	2.0	25.3
February	49.5	319.3	2.4	42.3
March	58.6	271.5	3.8	70.1
April	62.0	318.1	2.7	84.8
May	44.5	154.7	1.7	45.7
June	17.9	75.3	0.4	29.1
July	6.7	29.9	0.1	12.1
August	3.9	17.0	.03	8.5
September	3.2	12.9	0.1	6.9

(1) Schaads inflows prorated at $\frac{18,200 \text{ Ac}}{43,776 \text{ Ac}}$ = 41.58% of Watershed

(2) Measurements by EBMUD, compare to Mean Monthly Stream Flows, Column 1

During the period between 1967 – 1978, the East Bay Municipal Utility District (EBMUD) monitored Middle Fork inflows at Schaads. In Table 2 is presented average monthly flows measured by EBMUD for this period. These flows are comparable to the mean monthly inflows estimated for Schaads based on the West Point Gauging Station data and the ratio of contributing watersheds. As shown in Table 2, a good comparison of mean monthly stream inflows is achieved. During the period of 1967-1978, rainfall was at, or above, average for the first 9 years and then below average in 1975 through 1978.

ECORP Consulting has conducted detailed modeling of Middle Fork Mokelumne River inflows and outflows at Schaads Reservoir using a hydrology data set from 1934 to 2016. Results of this modeling are presented in **Table 3**: estimated mean, maximum and minimum inflows at Schaads Reservoir and in **Table 4**; estimated mean, maximum and minimum outflows at Schaads Reservoir.

TABLE 3

ESTIMATED MIDDLE FORK MOKELUMNE RIVER INFLOW AT SCHAADS

Month	Modeled Mean Monthly Stream Flows cfs	Modeled Mean of Maximum Year Monthly Stream Flows cfs	Modeled Mean of Minimum Year Monthly Stream Flows cfs	Average Inflow Measurements 1967-1978 cfs
October	5.3	16.1	0.7	5.3
November	11.2	102.5	2.4	10.6
December	26.8	187.2	2.9	13.0
January	44.7	329.2	3.2	25.3
February	58.1	328.9	3.2	42.3
March	68.9	282.9	6.2	70.1
April	70.5	325.7	4.0	84.8
May	47.6	174.2	4.4	45.7
June	18.9	74.0	2.1	29.1
July	8.6	25.1	0.4	12.1
August	5.0	14.2	0.0	8.5
September	4.1	11.3	0.0	6.9

TABLE 4
MODELED MIDDLE FORK MOKELUMNE RIVER OUTFLOW AT SCHAADS

Month	Modeled Mean Monthly Stream Flows cfs	Modeled Mean of Maximum Year Monthly Stream Flows cfs	Modeled Mean of Minimum Year Monthly Stream Flows cfs
October	4.9	12.5	3.0
November	9.8	100.6	3.0
December	25.0	182.4	3.0
January	43.4	330.4	3.0
February	57.0	327.7	3.0
March	67.9	283.5	5.9
April	70.7	324.7	4.2
May	48.9	176.3	4.8
June	19.9	74.8	3.0
July	8.8	27.5	3.0
August	5.5	14.5	3.0
September	4.5	10.4	3.0

The modeled mean inflow results presented in Table 3 compare favorably with the mean monthly inflows estimated, by KASL, in Table 2 and the average inflow measurements conducted by EBMUD for the period 1967-1978.

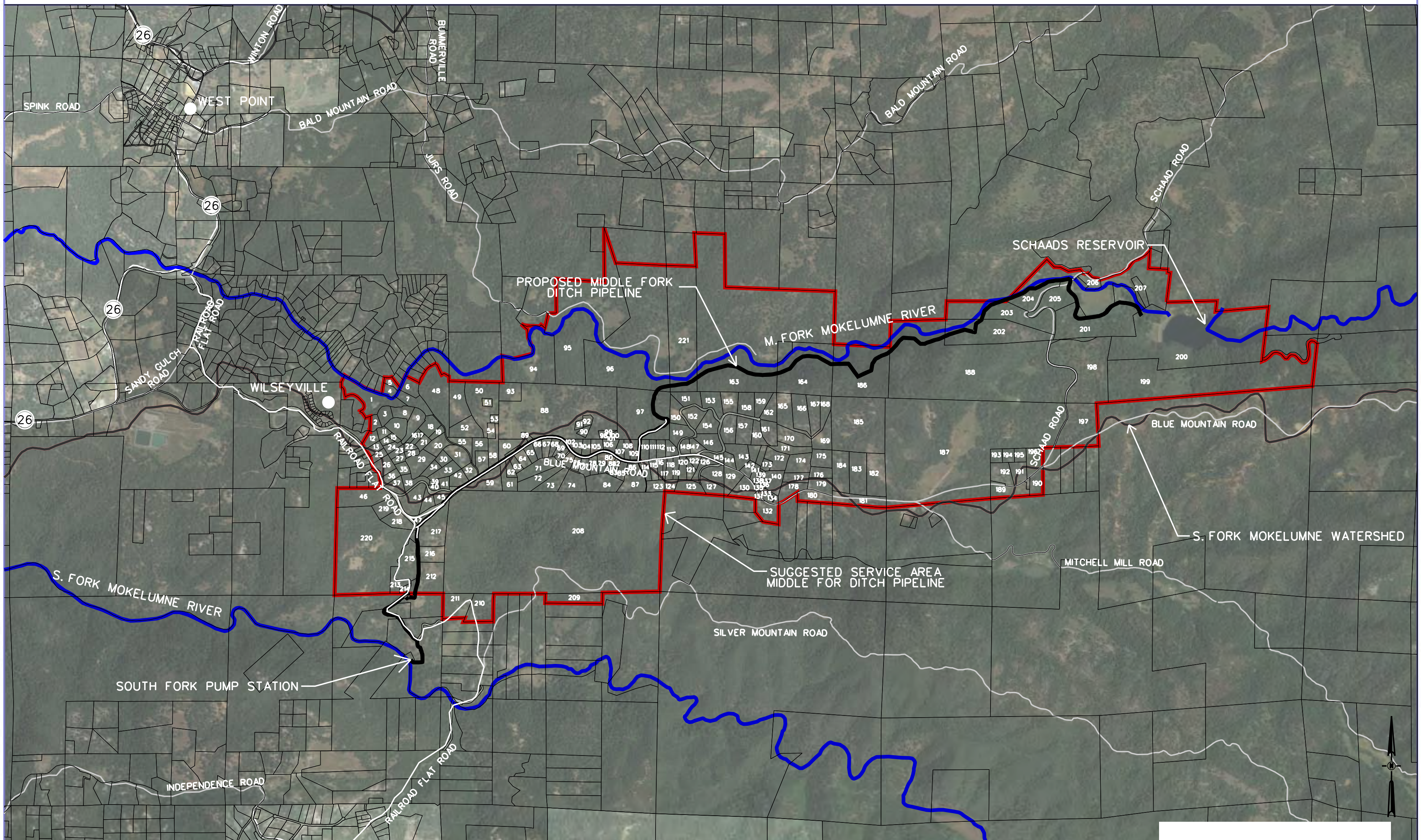
The modeled outflows for Schaads takes into account flows through the existing Schaads Hydroelectric Facility, flows discharged over the Schaads spillway and flows through the Schaads toe drain. The maximum release through the Schaads penstock is 39.5 cfs with a maximum of 18.5 cfs delivered through the first hydro unit and 21 cfs through the second unit. A minimum 3 cfs fish release is required from Schaads as part of CPUD's Federal Energy Regulating Commission (FERC) license. This fish release is made from the Schaads toe drain to insure that the maximum temperature of this release, 19º Celsius as stipulated in the FERC license, is not exceeded. When the fish release is added to the maximum release through the Schaads penstock the total maximum discharge from Schaads through the penstock and drain is 42.5 cfs. When outflows from Schaads exceeds 42.5 cfs the reservoir "spills" at the existing spillway. During our field visit in March 2017, the reservoir level was approximately 12 inches above the spillway elevation.

Long Tem Middle Fork Ditch Pipeline Demands

In **Figure 4** is presented an overview of existing parcels located adjacent, or in close proximity to, the proposed Middle Fork Ditch pipeline alignment. The Assessor's Parcel Numbers, existing Calaveras County base land use designations from the County's updated (2015) General Plan and the acreage of each parcel shown in Figure 4 are presented in **Table 5**. Also noted in Table 5 are parcels where property owners have applied for Cannabis Cultivation permits.

With a few exceptions, almost all of the 221 parcels included in the potential Middle Fork Ditch Pipeline Service Area are less than 10 acres and are typically designated with a base land use zone of "RR", Residential Record, or "RA", Residential Agriculture. There are a few parcels that are designated as "U", Unclassified, "REC", Recreation, "TP, Timber Production and "GF", General Forestry. There is a total land area of 2622 acres included in the suggested Middle Fork Ditch Pipeline Service Area.

In **Table 6** is presented estimated water demands for parcels located within the Middle Fork Ditch Pipeline Service Area. Water Demands by land use designations are based on the 2015 Calaveras County Water District Urban Water Management Plan, an annual water demand of 2.2 to 2.6 acre-ft/acre reported by the Calaveras County Cannabis Water Alliance and an annual demand of approximately 1.4 acre-ft/acre, typical for vineyards in the Calaveras – Amador-Eldorado County areas. From these sources, an annual water use of 2.55 acre-ft/acre was assigned to RA land uses in the Middle Fork Ditch Service Area and an annual demand of 2.70 acre-ft/acre was assigned to land uses within RR zones. No water demands were assigned to Middle Fork Ditch area land designated as "TP", Timber Production or "GF", General Forestry. The Middle Fork Ditch service water demands estimated for RR and RA land uses are lower than demands estimated for RR and RA land uses in Western Calaveras County because rainfall in the Middle Fork Ditch Service Area are greater and average evapotranspiration is lower in the



SUGGESTED MIDDLE FORK DITCH PIPELINE SERVICE AREA

MOKELUMNE RIVER LONG TERM WATER
NEEDS STUDY MIDDLE FORK DITCH PIPELINE
CALAVERAS COUNTY, CA
JUNE 2017

NORTH

SCALE:
NTS

CONSULTING
KASL
ENGINEERS
7777 Greenback Lane
Suite 104
Citrus Heights, CA 95610
Tel. (916) 722-1800
Fax (916) 722-4595
CIVIL - WATER RESOURCES - SURVEYING

FIGURE NO. 4

FILE: S:\2517-01 West Point, Mokelumne River\Study B - Mokelumne River Demands\Study & Technical Memos for MFD Pipeline\Mid Fork Pipeline TM\4.0 - Suggested Middle Fork Ditch Pipeline Service Area.dgn
DATE: 8/16/2017

TABLE 5
MIDDLE FORK DITCH PIPELINE
SERVICE AREA PARCELS

Parcel [(1)]	APN	Land Use [(2)]	Area (SF)	Area (Acres)	Cannabis Permit App.
1	10016003	RR	591,705	13.6	
2	10016017	RR	87,029	2.0	
3	10016016	RR	133,753	3.1	
4	10016027	RR	93,457	2.1	
5	10016026	RR	65,509	1.5	
6	10016010	RR	170,056	3.9	
7	10016011	RR	229,116	5.3	X
8	10016015	RR	147,041	3.4	
9	10016013	RR	227,291	5.2	
10	10016014	RR	206,367	4.7	
11	10017047	RR	75,442	1.7	
12	10017046	RR	115,075	2.6	
13	10017034	RR	87,275	2.0	
14	10017031	RR	41,917	1.0	
15	10017040	RR	48,546	1.1	
16	10017038	RR	43,414	1.0	
17	10017037	RR	43,758	1.0	
18	10017041	RR	174,388	4.0	
19	10017043	RR	61,948	1.4	
20	10017044	RR	200,505	4.6	
21	10017036	RR	81,672	1.9	
22	10017026	RR	54,802	1.3	
23	10017029	RR	69,552	1.6	
24	10017039	RR	78,496	1.8	
25	10017035	RR	78,311	1.8	
26	10017022	RR	166,930	3.8	
27	10017028	RR	63,550	1.5	
28	10017027	RR	52,652	1.2	
29	10017005	RR	294,191	6.8	
30	10017032	RR	100,109	2.3	
31	10017011	RR	231,194	5.3	
32	10017012	RR	111,758	2.6	
33	10017017	RR	181,885	4.2	
34	10017033	RR	103,994	2.4	
35	10017004	RR	87,109	2.0	
36	10017021	RR	100,720	2.3	
37	10017020	RR	134,482	3.1	
38	10017019	RR	144,339	3.3	
39	10017016	RR	28,911	0.7	
40	10017015	RR	37,309	0.9	
41	10017014	RR	71,336	1.6	

TABLE 5 (Cont.)

42	10017013	RR	153,732	3.5	
43	10019016	RA	331,836	7.6	
44	10019017	RA	128,743	3.0	
45	10019015	RA	99,207	2.3	
46	10019034	RA	551,110	12.7	
47	10019007	U	53,220	1.2	
48	10016012	RR	810,061	18.6	
49	10020001	U	450,820	10.3	
50	10020031	U	734,063	16.9	
51	10020004	U	48,834	1.1	
52	10020002	U	319,328	7.3	
53	10020032	U	42,937	1.0	
54	10020033	U	76,411	1.8	
55	10017008	RR	138,481	3.2	
56	10017045	RR	155,268	3.6	
57	10017010	RR	169,247	3.9	
58	10020034	U	203,458	4.7	
59	10020027	U	366,952	8.4	
60	10020012	U	213,541	4.9	
61	10026015	RR	186,269	4.3	
62	10026014	RR	83,074	1.9	**X**
63	10026013	RR	78,685	1.8	
64	10026012	RR	115,292	2.6	
65	10026011	RR	98,136	2.3	
66	10026010	RR	85,856	2.0	
67	10026009	RR	101,932	2.3	
68	10026008	RR	75,670	1.7	
69	10026007	RR	66,974	1.5	
70	10026006	RR	52,444	1.2	
71	10026016	RR	300,798	6.9	
72	10026017	RR	278,380	6.4	
73	10026018	RR	242,406	5.6	**X**
74	10026019	RR	272,125	6.2	
75	10026005	RR	89,038	2.0	
76	10026004	RR	67,904	1.6	
77	10026003	RR	106,084	2.4	
78	10027020	RR	94,673	2.2	**X**
79	10027019	RR	113,855	2.6	**X**
80	10027030	RR	40,384	0.9	
81	10027031	RR	36,384	0.8	
82	10027024	RR	41,132	0.9	
83	10027025	RR	39,537	0.9	
84	10027021	RR	350,085	8.0	
85	10027016	RR	91,086	2.1	
86	10027015	RR	107,331	2.5	
87	10027014	RR	252,141	5.8	
88	10020030	U	3,398,655	78.0	

TABLE 5 (Cont.)

89	10020035	U	25,924	0.6	
90	10020021	U	53,676	1.2	
91	10020007	U	41,689	1.0	
92	10020020	U	60,345	1.4	
93	10020028	U	250,333	5.7	
94	10009027	U	1,273,077	29.2	
95	10009004	U	3,662,917	84.1	
96	10009021	U	4,615,548	106.0	
97	10020026	U	1,615,566	37.1	
98	10020016	U	41,755	1.0	
99	10020017	U	18,866	0.4	
100	10020018	U	27,725	0.6	
101	10020019	U	8,873	0.2	
102	10026021	RR	35,428	0.8	
103	10026001	RR	78,170	1.8	
104	10026002	RR	87,790	2.0	
105	10027001	RR	103,864	2.4	
106	10027002	RR	107,217	2.5	
107	10027003	RR	89,199	2.0	
108	10027004	RR	79,242	1.8	
109	10027005	RR	107,991	2.5	
110	10027006	RR	131,870	3.0	
111	10027007	RR	84,418	1.9	
112	10027008	RR	100,867	2.3	
113	12022001	RR	101,024	2.3	
114	10027012	RR	97,316	2.2	
115	10027011	RR	90,814	2.1	
116	10027010	RR	68,568	1.6	
117	10027009	RR	43,541	1.0	
118	12023001	RR	93,852	2.2	
119	12023002	RR	81,658	1.9	
120	12023003	RR	106,268	2.4	
121	12023011	RR	83,128	1.9	
122	12023012	RR	67,994	1.6	
123	10027013	RR	130,185	3.0	
124	12023010	RR	82,828	1.9	
125	12023009	RR	202,133	4.6	
126	12023006	RR	117,040	2.7	
127	12023008	RR	174,148	4.0	
128	12023007	RR	206,922	4.8	
129	12018027	RR	228,589	5.2	
130	12018028	RR	247,989	5.7	
131	12018026	RR	29,651	0.7	
132	12013058	RR	271,289	6.2	
133	12018022	U	111,036	2.5	
134	12018005	U	11,724	0.3	
135	12018021	U	29,069	0.7	

TABLE 5 (Cont.)

136	12018004	U	7,597	0.2	
137	12018020	U	16,819	0.4	
138	12018006	U	37,241	0.9	
139	12018007	U	17,281	0.4	
140	12018019	U	219,654	5.0	
141	12018024	U	71,391	1.6	
142	12018016	U	91,176	2.1	
143	12018015	U	251,565	5.8	
144	12018001	U	94,017	2.2	
145	12022014	RR	81,346	1.9	
146	12022017	RR	223,442	5.1	
147	12022016	RR	96,192	2.2	
148	12022015	RR	86,468	2.0	
149	12022002	RR	222,844	5.1	
150	12022003	RR	184,678	4.2	
151	12022004	RR	215,574	4.9	
152	12022019	RR	202,713	4.7	
153	12022005	RR	243,663	5.6	
154	12022018	RR	227,784	5.2	
155	12022006	RR	207,324	4.8	
156	12022013	RR	252,125	5.8	
157	12022012	RR	267,846	6.1	
158	12022007	RR	234,249	5.4	
159	12022008	RR	185,704	4.3	
160	12022011	RR	161,932	3.7	
161	12022010	RR	217,453	5.0	
162	12022009	RR	191,066	4.4	
163	10021074	U	7,937,101	182.2	
164	10021137	U	1,618,896	37.2	
165	12024003	RR	359,201	8.2	
166	12024004	RR	352,890	8.1	
167	12024005	RR	278,447	6.4	
168	12024006	RR	184,895	4.2	
169	12024007	RR	265,896	6.1	
170	12024002	RR	302,730	6.9	
171	12024001	RR	192,713	4.4	
172	12025001	RR	234,166	5.4	
173	12018018	U	62,989	1.4	
174	12025002	RR	275,937	6.3	
175	12025007	RR	226,929	5.2	
176	12025006	RR	147,477	3.4	
177	12025003	RR	151,689	3.5	
178	12025004	RR	224,411	5.2	
179	12025005	RR	209,862	4.8	
180	12013036	U	228,821	5.3	
181	12013037	U	376,287	8.6	
182	12013049	RR	495,028	11.4	

TABLE 5 (Cont.)

183	12013048	RR	450,800	10.3	
184	12013047	RR	432,421	9.9	
185	12013046	RR	1,801,387	41.4	
186	10021034	U	1,788,776	41.1	
187	12013005	REC	8,677,125	199.2	
188	10021056	REC	6,795,428	156.0	
189	12020017	U	308,958	7.1	
190	12020009	U	191,241	4.4	
191	12020012	U	205,634	4.7	
192	12020011	U	265,594	6.1	X
193	12020001	U	101,629	2.3	
194	12020002	U	100,361	2.3	
195	12020003	U	100,422	2.3	
196	12020008	U	251,741	5.8	
197	12013007	REC	930,493	21.4	
198	10021039	REC	1,774,394	40.7	
199	10021029	TP	4,126,878	94.7	
200	10021028	U	5,021,062	115.3	
201	10021134	U	1,654,450	38.0	
202	10021144	GF	1,354,362	31.1	
203	10021143	GF	1,206,898	27.7	
204	10021138	GF	920,386	21.1	
205	10021141	REC	2,195,501	50.4	
206	10021133	U	139,725	3.2	
207	10021132	U	130,737	3.0	
208	10019019	U	13,408,787	307.8	
209	12012038	U	356,821	8.2	
210	12012127	U	422,865	9.7	
211	12012126	U	404,592	9.3	
212	10019029	RR	535,930	12.3	
213	10019010	RA	168,549	3.9	
214	10019009	RA	46,017	1.1	
215	10019028	REC	463,534	10.6	
216	10019027	REC	239,000	5.5	
217	10019026	REC	588,506	13.5	
218	10019032	RA	238,975	5.5	
219	10019031	RA	208,245	4.8	
220	10019035	RA	3,137,451	72.0	X
221	10021128	U	2,187,451	50.2	
		Total		**2,622**	**Acres**

(1) See Figure 4, Suggested Middle Fork Ditch Pipeline Service Area.

(2) Base land Use, Calaveras County General Plan Land Use Element, November 2015.

Middle Fork Ditch Service Area than in Western Calaveras County areas. Average annual rainfall in the West Point area is approximately 41 inches per year compared to an average annual rainfall of approximately 33 inches per years reported for San Andreas.

The estimated annual water demands for RA and RR land uses in the Middle Fork Ditch Service Area includes both raw water (irrigation) and potable water demands. Although parcels in the Middle Fork Ditch Service Area are currently not served by a community water supply system, CCWD has indicated that a water treatment plant with capacity of approximately 200 gpm could be constructed along Blue Mountain Road to serve this area if the Middle Fork Ditch Pipeline is constructed along the alignment shown in Figure 1.

As summarized in Table 6, the estimated annual Mokelumne River Water demands for the Middle Fork Ditch Pipeline Service Area is 4,988 acre-ft/year.

TABLE 6
ESTIMATED MOKELUMNE RIVER WATER DEMANDS,
MIDDLE FORK DITCH PIPELINE SERVICE AREA

Land Use (1)	Area (Acres)(2)	Estimated Water Demand Rate (AF/AC-yr)	Estimated Annual Water Demand (AF/yr)
RA	113	2.55	288
RR	555	2.70	1499
U	1282	1.20	1538
Rec	497	2.50	1243
TP	95	0	0
GF	80	0	0
Loses	2622	0.16	420
Totals	**2622 acres**		**4988 AF/year**

(1) RE = Residential Agriculture
RR = Residential Rural
U = Unclassified
REC = Recreation
TP = Timber Production
GF = General Forestry
Loses = Estimated Loses in the Water System

(2) Area totals from Table 5

CPUD Treated Water Demands

The CPUD currently receives treated water supply from the South Fork of the Mokelumne River ("South Fork"). As previously described in this TM, South Fork water is delivered to Jeff Davis Reservoir and the Jeff Davis Water Treatment Plant by the District's South Fork Pump Station and a 20 inch diameter pump discharge pipeline. With the completion of the Middle Fork Ditch Pipeline, water could also be supplied to Jeff Davis Reservoir from the Middle Fork.

Currently, treated water demands at the Jeff Davis Water Treatment Plant (WTP) are approximately 502.5 Million Gallons, annually (± 1542 acre-ft/year). This demand can be adequately supplied by the existing Jeff Davis Water Treatment Plant with a current 6 Million

Gallon per day (MGD) capacity and expansion capability to 12 MGD. Maximum day demands at the Jeff Davis WTP are now approximately 2 MGD.

The South Fork Pump Station was constructed in 1972. It currently has a capacity to deliver approximately 2000 gpm (approximately 2.88 MGD or about 4.5 cfs) from the South Fork supply to the Jeff Davis Reservoir. There are currently two, 400 hp, vertical turbine pumps in service at the South Fork Pump Station with space for a third supply pump.

Annual water demands supplied by the Jeff Davis WTP during the past 20 years have increased by approximately 1% per year. Projecting future demands at a 1% growth rate, and assuming a year 2100 buildout projection, would result in a future treated water demand of approximately 1170 Million Gallons annually or approximately 3592 acre-feet per year. This annual demand could be supplied with the capacity available at the existing Jeff Davis WTP.

In **Table 7** is presented a comparison of annual South Fork Pump Station delivery totals and the annual treated water produced at the Jeff Davis WTP. When the water supplied to Jeff Davis Reservoir is compared to the water produced at the Jeff Davis WTP, a rough determination can be made regarding the typical annual losses due to reservoir evaporation, losses due to reservoir percolation / infiltration and losses from the South Fork pipeline conveyance system.

TABLE 7

ANNUAL WATER SUPPLIED AND WATER TREATED, JEFF DAVIS RESERVOIR

Year	Water Supplied from South Fork Pump Station[1] (Million Gallons)	Water Treated at Jeff Davis WTP (Million Gallons)	Ratio of Water Supplied / Treated Water Produced
1999	448.4	422.6	1.06
2000	434.4	410.1	1.06
2001	520.9	450.1	1.16
2002	468.2	415.2	1.13
2003	557.9	391.0	1.42
2004	604.4	436.9	1.38
2005	459.4	397.2	1.16
2006	442.0	438.4	1.01
2007	593.4	486.3	1.22
2008	374.5	500.7	0.75
2009	487.6	476.0	1.02
2010	424.5	397.3	1.08
2011	278.9	413.1	0.68
2012	303.8	466.4	0.65
2013	327.8	495.0	0.66

(1) Source: CPUD Annual Records

Based on the above records, annual flows delivered to Jeff Davis Reservoir have been as much as 42%, above, and as much as 35% below the treated water produced at the Jeff Davis WTP. To account for reservoir percolation and evaporation losses and to account for losses in the South Fork Pump Station discharge pipeline, it is reasonable to assume an annual delivery from the South Fork (or future Middle Fork) supply which is 25% greater than the annual treated water demand at the Jeff Davis WTP. A projected annual treated water demand from the Mokelumne River supply of 1.25 (1170 Million Gallons) = 1463 Million Gallons, or 1.25 (3592 acre-feet) = 4491 acre-feet per year is, therefore, estimated for CPUD in this Long Term Water Needs Study.

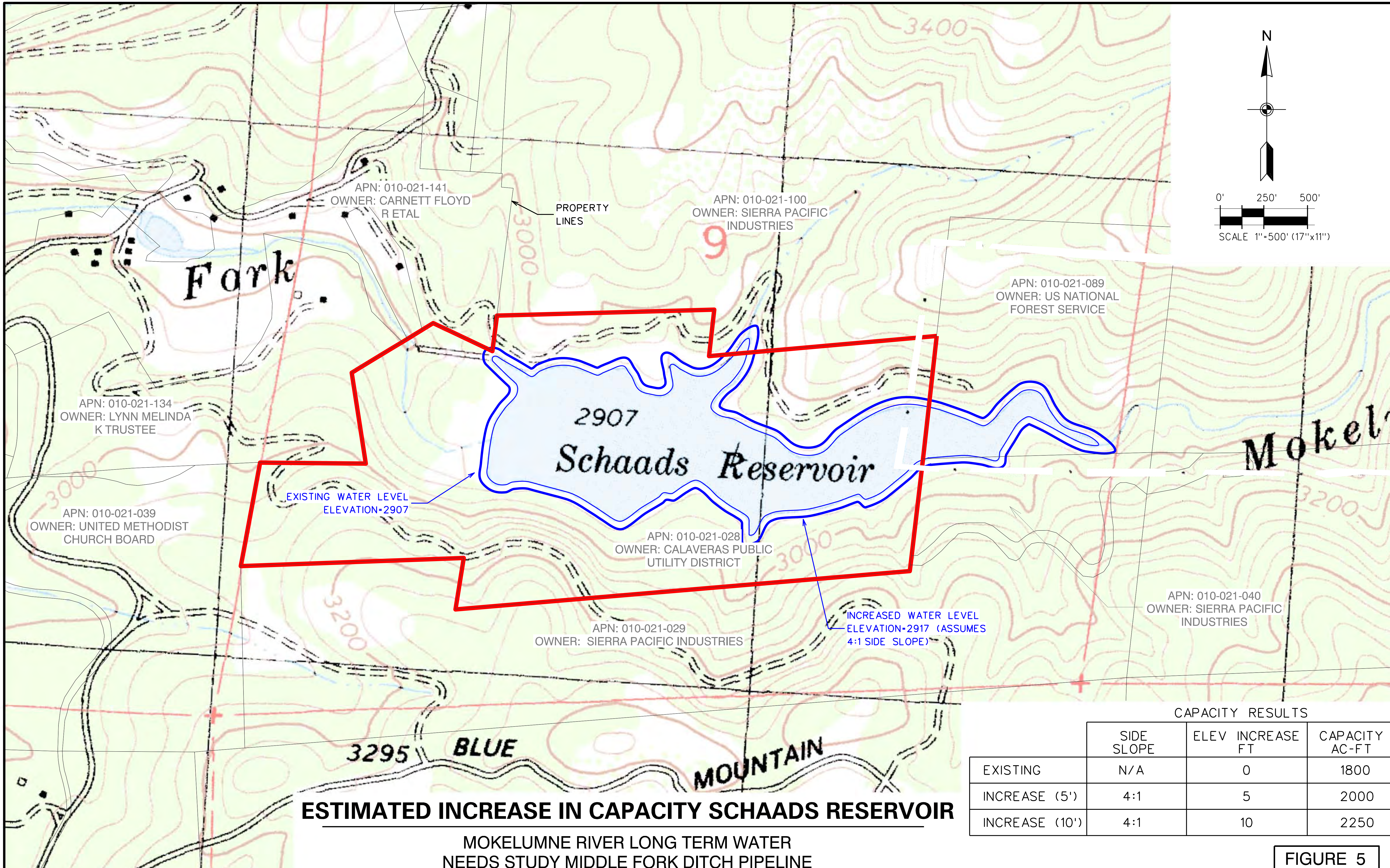
Summary of Middle Fork Ditch Pipeline Demands

As presented herein, long term Middle Fork water demands for the Middle Fork Ditch Pipeline Service Area are estimated at 4988 acre-ft/year. The long term Middle Fork and South Fork water demands at the Jeff Davis WTP are 4491 acre-ft/ year, for a total annual demand of 9479 acre-feet/year.

SCHAADS RESERVOIR

Increased demands to Middle Fork Mokelumne River water will also increase demands in the storage capacity at Schaads Reservoir.

The existing limits of the 1800 ac-foot capacity of Schaads Reservoir are shown in **Figure 5.** While most of the existing reservoir is located within land owned by the CPUD, the easterly reservoir limits and a portion of the northern shoreline are located on adjoining property (U.S. National Forest Service on the east, Sierra Pacific Industries on the north). Assuming an average side slope of approximately 4:1, an increase in the spillway and levee elevation of 5 feet would allow the maximum water surface elevation to increase from elevation 2907 to elevation 2912, and the reservoir capacity to increase to approximately 2000 ac-feet. Increasing the maximum water surface elevation by 10 feet would increase the reservoir storage capacity to approximately 2250 ac-feet.



CAPACITY RESULTS

	SIDE SLOPE	ELEV INCREASE FT	CAPACITY AC-FT
EXISTING	N/A	0	1800
INCREASE (5')	4:1	5	2000
INCREASE (10')	4:1	10	2250

ESTIMATED INCREASE IN CAPACITY SCHAADS RESERVOIR

MOKELUMNE RIVER LONG TERM WATER
NEEDS STUDY MIDDLE FORK DITCH PIPELINE

FIGURE 5

FILE: S:\2517-01 West Point, Mokelumne River\Study B - Mokelumne River Demands\Study & Technical Memos for MFD Pipeline\Mid Fork Pipeline TM\5.0 Shaads Res Potential Increase Capacity.dgn
DATE: 8/16/2017

CALAVERAS COUNTY
MOKELUMNE RIVER
LONG TERM WATER NEEDS STUDY

SUPPLEMENT TO TECHNICAL MEMORANDUM: POTENTIAL DEMAND FOR MOKELUMNE RIVER WATER SUPPLIES ALONG PROPOSED ROUTE OF MIDDLE FORK DITCH PIPELINE WITH FOREST CREEK – MIDDLE FORK RESERVOIR

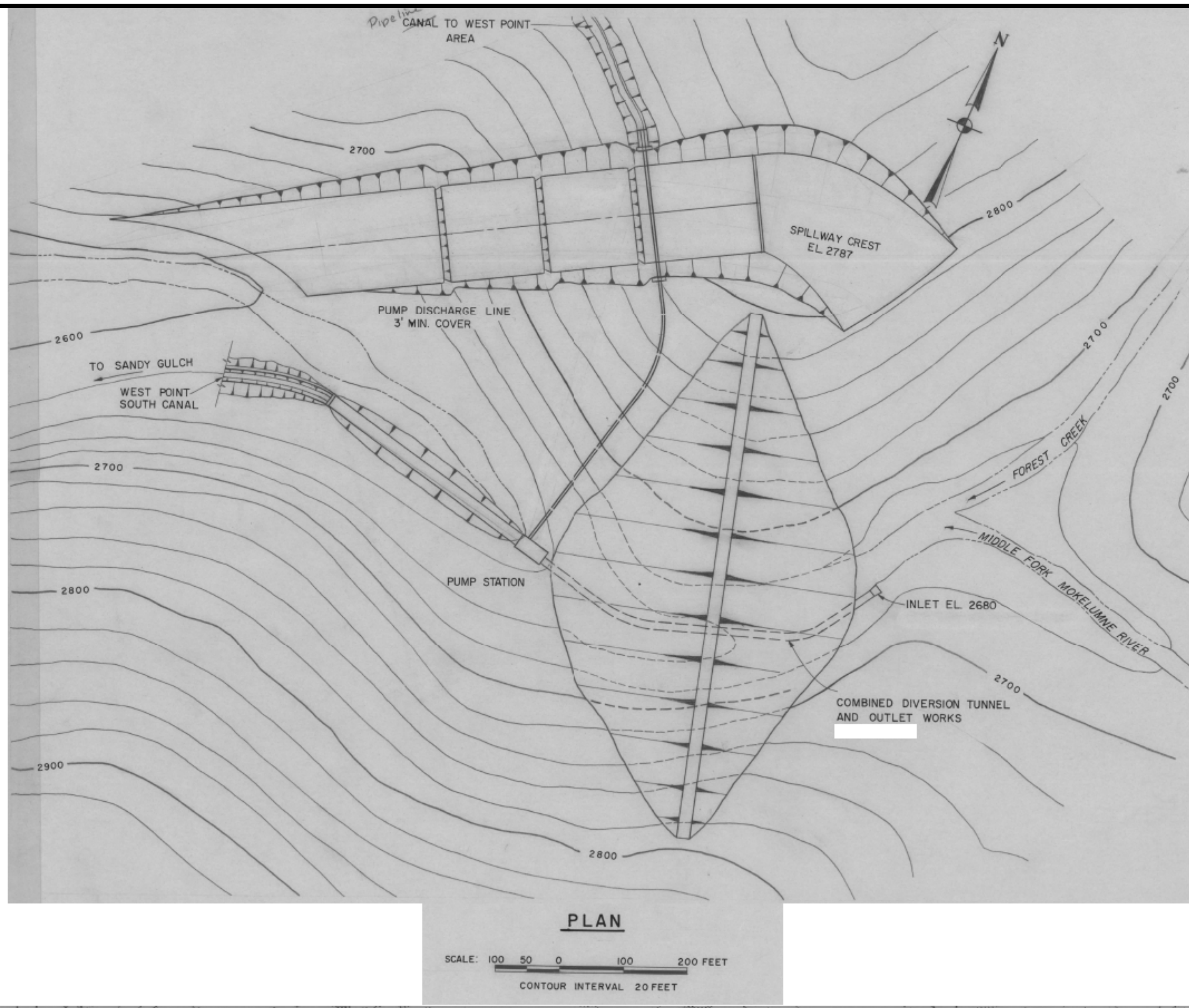
INTRODUCTION

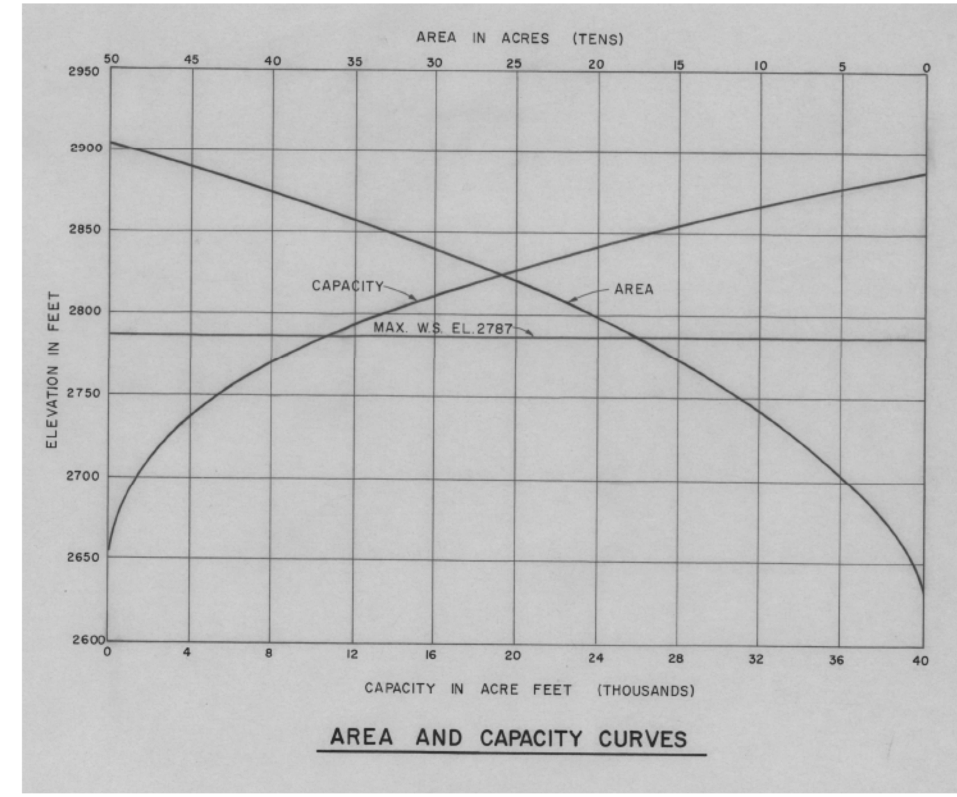
The following is submitted to supplement the Technical Memorandum (TM) prepared for determination of Middle Fork Ditch Pipeline demands. Evaluation of available Mokelumne River supplies and estimated long term CCWD and CPUD demands conducted by ECORP Consulting has resulted in a number of water supply scenarios. Supply alternatives include consideration of the Forest Creek – Middle Fork (Mokelumne) Reservoir. This reservoir project was first considered in the late 1950's and has been reconfigured and reevaluated a number of times since then by both CCWD and CPUD. Forest Creek– Middle Fork Reservoir capacities ranging from 4300 to 14,800 acre-feet have been considered. A reservoir with a capacity of nearly 12,000 acre-feet and a maximum water surface elevation of 2787 is evaluated herein. As shown in **Figure S-1** of this Supplement, the center of the dam for a Forest-Middle Fork Reservoir of this capacity and maximum operating elevation would be located approximately 350 feet downstream of the confluence of Forest Creek and the Middle Fork Mokelumne River. The reservoir pool would extend about 1.0 mile upstream along Forest Creek and approximately 1.5 miles upstream along the Middle Fork Mokelumne to a point approximately 600 feet downstream of Schaads Reservoir. At maximum pool, the Forest Creek – Middle Fork Reservoir would encompass about 180 acres.

IMPACT TO MIDDLE FORK DITCH PIPELINE

In **Figure S.2** is the projected footprint of the ± 12,000 acre-foot capacity Forest Creek – Middle Fork Reservoir, described above, superimposed over the Middle Fork Ditch alignment presented in the previously prepared Middle Fork Ditch Pipeline TM. With completion of a Forest Creek – Middle Fork Reservoir as shown in this Supplement, approximately 7700 lineal feet of the Middle Fork Ditch Pipeline would be inundated or otherwise eliminated. The total ditch pipeline length from Schaads to the South Fork Pump Station has been previously estimated at 28,800 lineal feet.

With connection to Schaads Reservoir penstock the Middle Fork Ditch pipeline could, by gravity, deliver Middle Fork water to the South Fork Mokelumne River Pump Station and to Jeff Davis Reservoir. Gravity delivery could also be made to a 1MW hydroelectric facility constructed adjacent to the South Fork Pump Station. Gravity delivery of Middle Fork Mokelumne River from Schaads to the South Fork Pump Station and to Jeff Davis Reservoir depends on a minimum operating level at Schaads of elevation 2900. The maximum water surface elevation in the Forest Creek – Middle Fork Reservoir is estimated at elevation 2787. To deliver Middle Fork water from





CONCEPT PLAN ±12,000 AC-FOOT CAPACITY
FOREST CREEK MIDDLE FORK RESERVOIR

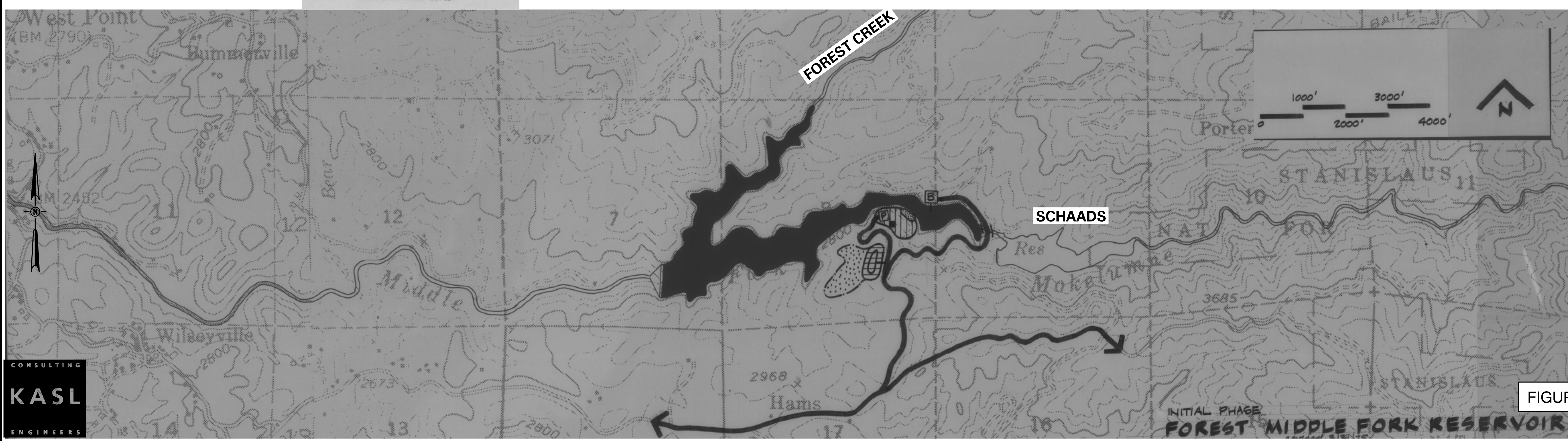


FIGURE S-1

FILE: S:\2517-01 West Point, Mokelumne River\Study B - Mokelumne River Demands\Exhibits\Fig S-1.dgn
DATE: 8/16/2007

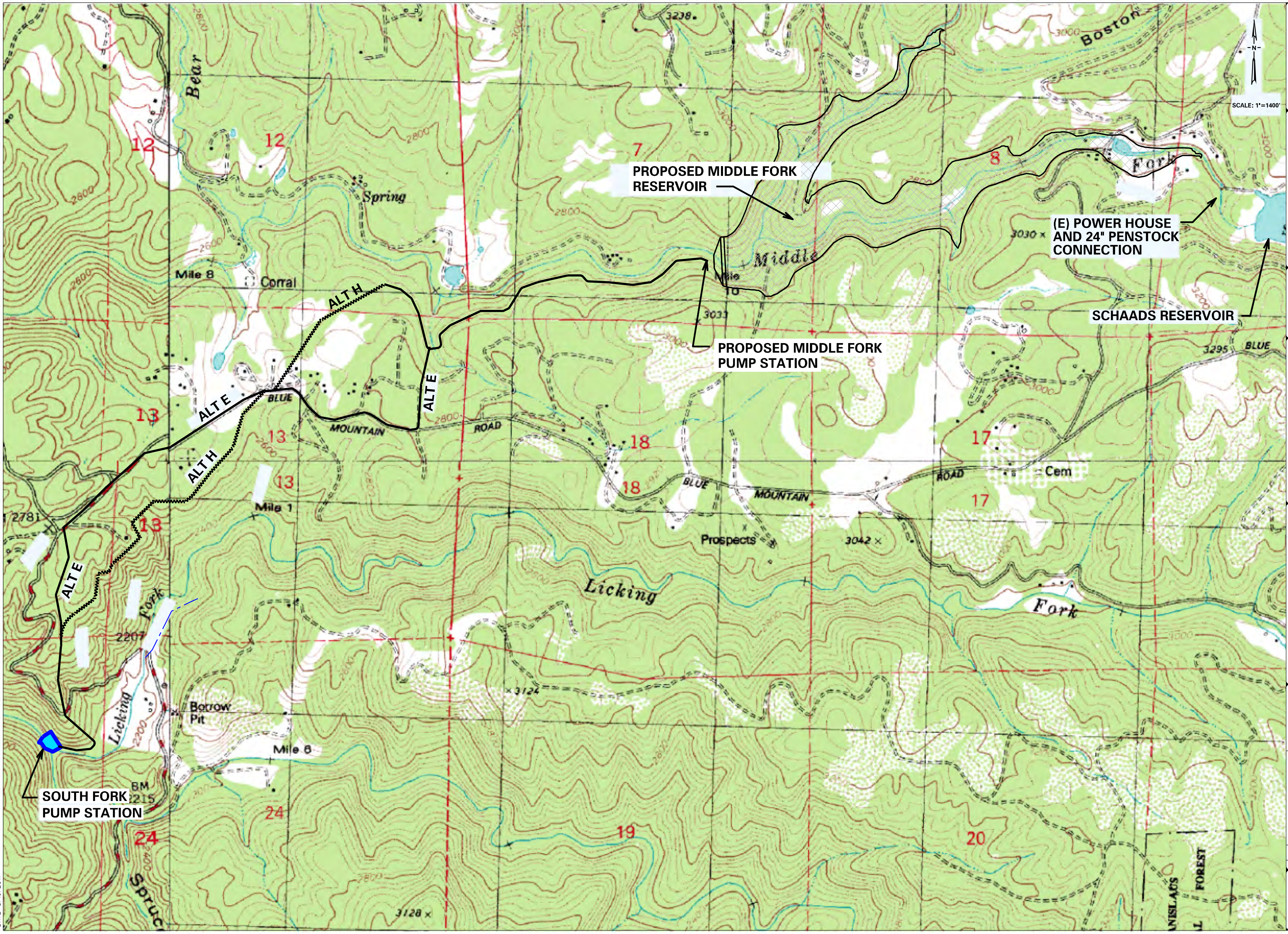


FIGURE 2

RECOMMENDED ALTERNATIVE

CALAVARAS PUBLIC UTILITY DISTRICT

CALAVARAS COUNTY, CALIFORNIA

CONSULTING KASL ENGINEERS

7777 Greenback Lane, Suite 104, Citrus Heights, CA 95610, Tel. (916) 722-1800, Fax (916) 722-4595

CIVIL - WATER RESOURCES - SURVEYING

BENCH MARK :	ELEV :	SCALE 1"=1400'
DESCRIPTION :	DATUM :	JOB. NO. 2517-01
		DATE: AUG. 2017

NO.	DESCRIPTION	COUNTY APPROVAL APPROVED BY	DATE

REVISION

SHEET 2 OF 2

FILE: S:\2517-01 West Point, Mokelumne River\Study B - Mokelumne River Demands\Long Term Water Demands TM\Fig S-2.dgn
DATE: 8/16/2017

FIGURE S-2

HYDRAULIC PROFILE, 24 INCH DIAMETER PIPELINE FORM FOREST CREEK MIDDLE FORK RESERVOIR TO SOUTH FORK PUMP STATION

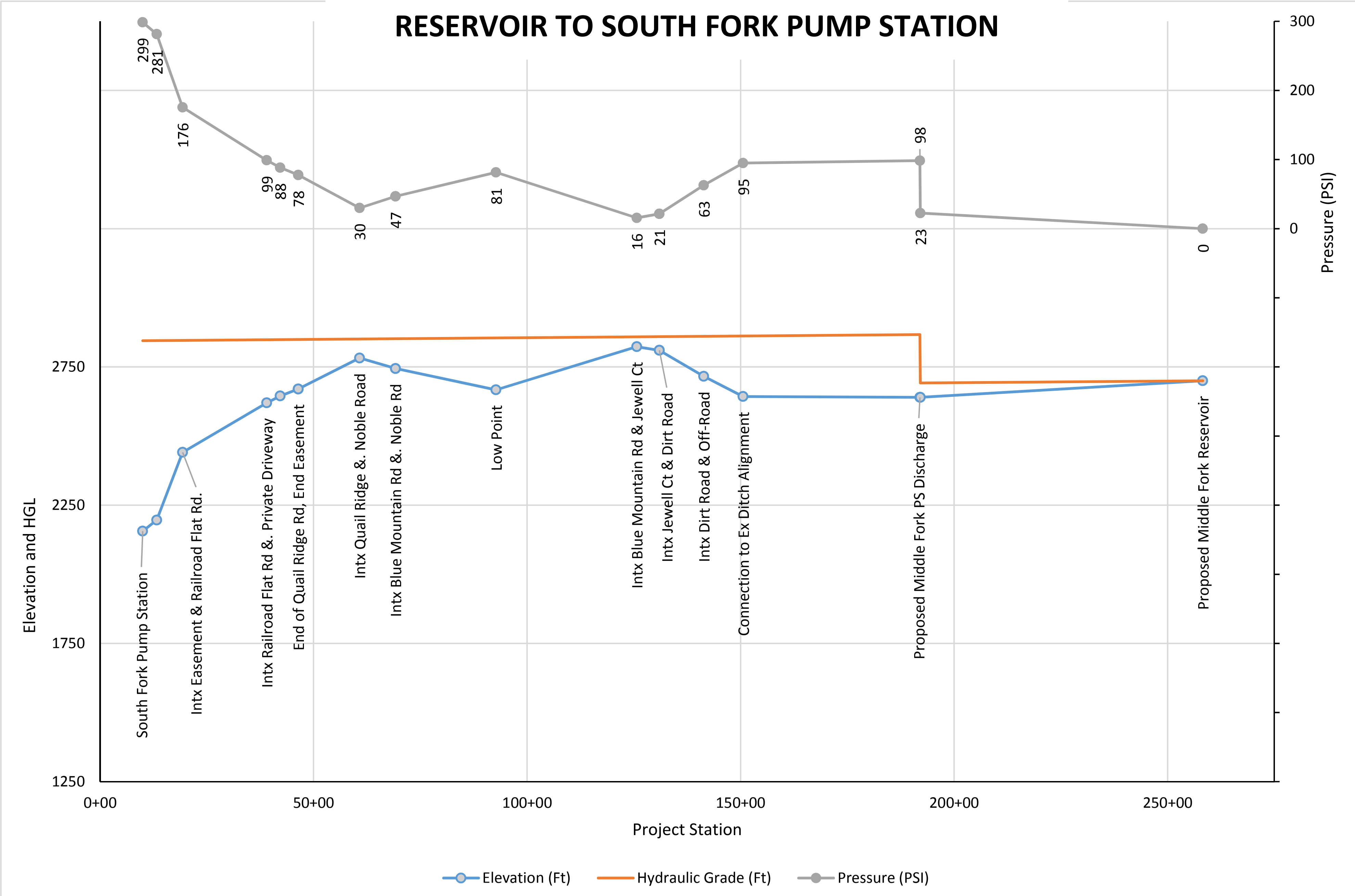


FIGURE S-3

the Forest Creek – Middle Fork Reservoir to the South Fork Pump Station and to Jeff Davis Reservoir via a shortened Middle Fork Ditch Pipeline will require pumping. Since pumping from the Forest – Middle Fork Reservoir to the South Fork Pump Station is required, it is reasonable to assume that sizing the Middle Fork Ditch Pipeline to provide a release through a South Fork hydroelectric facility would not be included in the scope of these improvements. The future CPUD demands at Jeff Davis Reservoir are estimated at approximately 6.2 cfs or approximately 4491 acre-feet, annually. A pipeline from the Forest Creek – Middle Fork Dam to meet this demand together with demands from the Middle Fork Ditch Pipeline service area is, therefore, proposed. The Middle Fork Ditch Pipeline could, therefore, be reduced from 30 inches in diameter to 24 inches in diameter with this scenario. A hydraulic profile of the delivery of Middle Fork water from the Forest Creek – Middle Fork Reservoir to the South Fork pump station is presented in **Figure S-3**. Assuming a 24 inch diameter main and a minimum pool elevation in the Forest Creek Middle Fork Reservoir of 2700, a pump station capable of 175 feet of lift is required.

While pumping from the Forest Creek – Middle Fork Reservoir to the South Fork Pump Station would eliminate the previously suggested South Fork hydroelectric facility, a 12,000 acre-foot capacity the Forest Creek – Middle Fork Reservoir would be sufficient to meet the future, year round and seasonal demands at Jeff Davis. With the head available at the South Fork Pump Station the need to pump from the South Fork to Jeff Davis would be eliminated. Water pumped from the Forest Creek – Middle Fork Reservoir could continue by gravity to Jeff Davis Reservoir via the existing 20 inch diameter South Fork Pipeline.

IMPACT TO WATER DEMANDS FROM THE MIDDLE FORK DITCH PIPELINE

In **Figure S-4,** the footprint of the Forest Creek – Middle Fork Reservoir is superimposed over the Middle Fork Ditch Pipeline service area previously presented in the Middle Fork Ditch Pipeline TM. The Forest Creek – Middle Fork Reservoir would decrease the total potential Middle Fork Ditch Pipeline service area by 84 acres. Revised estimated Middle Fork Ditch Pipeline service area demands are presented in **Table S-1**. The estimated total annual demands would decrease from approximately 4988 acre-feet / year to approximately 4875 acre-feet / year with the Forest Creek – Middle Fork Reservoir.

HYDRAULIC PROFILE, 24 INCH DIAMETER PIPELINE FORM FOREST CREEK MIDDLE FORK RESERVOIR TO SOUTH FORK PUMP STATION

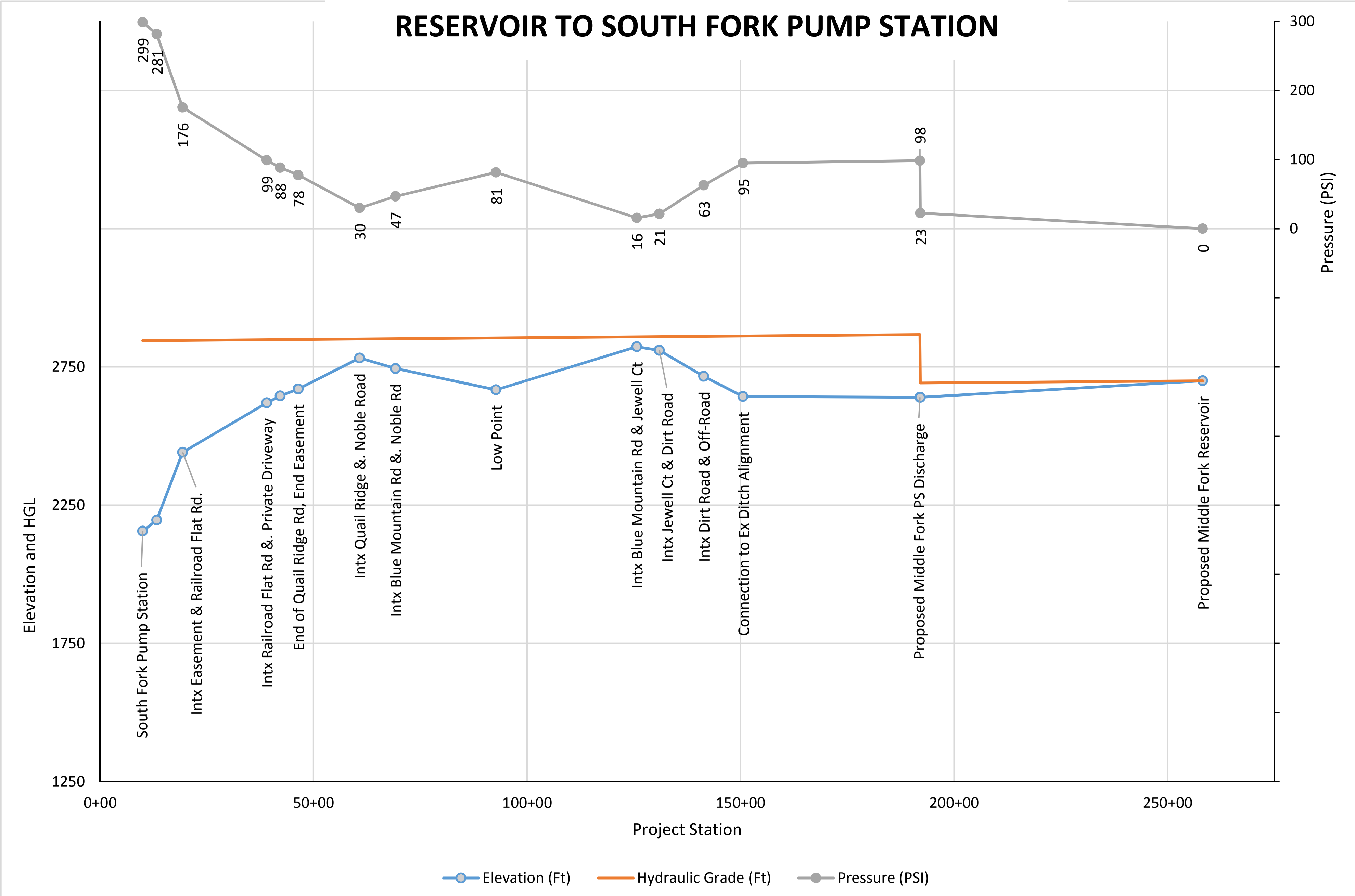
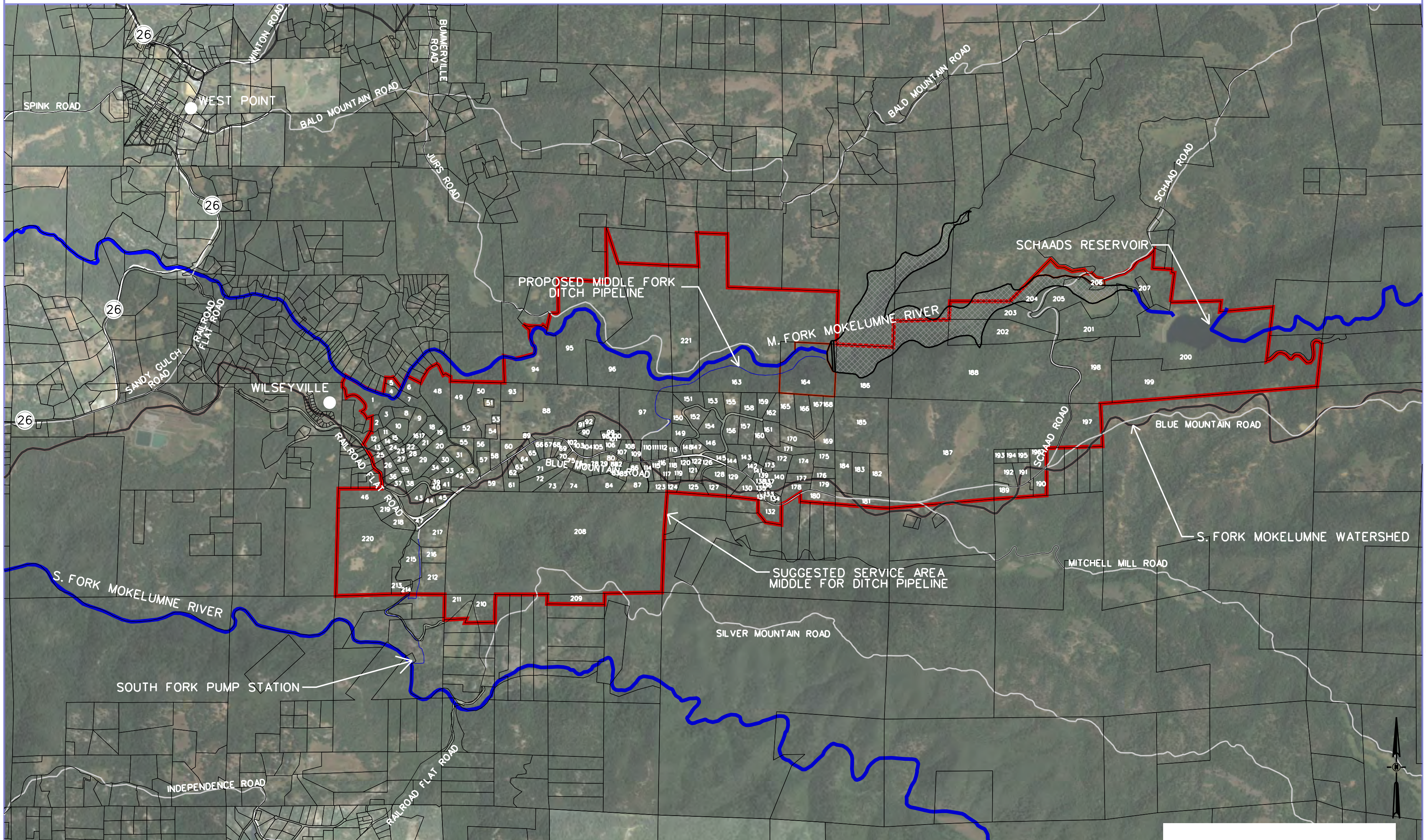


FIGURE S-3



SUGGESTED MIDDLE FORK DITCH PIPELINE SERVICE AREA

MOKELUMNE RIVER LONG TERM WATER NEEDS MIDDLE FORK DITCH PIPELINE
WITH FOREST CREEK MIDDLE FORK RESERVOIR
CALAVERAS COUNTY, CA
AUGUST 2017

NORTH

SCALE:
NTS

KASL CONSULTING ENGINEERS
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FIGURE NO. S-4

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DATE: 8/16/2017

TABLE S-1

ESTIMATED MOKELUMNE RIVER WATER DEMANDS IN THE MIDDLE FORK DITCH PIPELINE SERVICE AREA WITH THE FOREST CREEK – MIDDLE FORK RESERVOIR

Land Use	Area (acres)	Estimated Water Demand Future. (AF/Ac-yr)	Estimated Annual Water Demand (AF/yr)
RA	113	2.55	288
RR	555	2.70	1,499
U	1,258	1.20	1,510
REC	469	2.50	1,173
TP	95	-	-
GF	48	-	-
LOSES	2,538	0.16	406
	2,538		**4,875**

RA = Residential Agriculture
RR = Residential Rural
U = Unclassified
GF = General Forestry
REC = Recreation
TP = Timber Production
LOSES = Loses in the Water System

ATTACHMENT C

Provost & Pritchard. 2011. Technical Memorandum: Evaluating the Potential for Agricultural Development in Calaveras County. 15 June 2011.

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CONSULTING GROUP
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WWW.PPENG.COM

TECHNICAL MEMORANDUM

To: Edwin Pattison
Calaveras County Water District

From: Rick Hanks, Kevin Johansen, Rick Besecker

Subject: Evaluating the Potential for Agricultural Development in Calaveras County

Date: June 15, 2011

PROJECT BACKGROUND

In response to multiple requests by agricultural interests, the Calaveras County Water District (District) desires to evaluate the potential for irrigated agricultural development in Calaveras County and has authorized preparation of this technical memorandum as a first step toward that evaluation. The District is uniquely positioned to potentially develop available water resources and deliver irrigation water that could support agricultural development that would benefit the local and regional economy.

Development of production agriculture in Calaveras County has been discussed for many years and several studies were previously conducted, notably the 1960 Tudor Engineering Company report by Dr. H.S. Nelson titled The Potential Agriculture of Calaveras County. That report concluded that "approximately 93,000 acres of land in Calaveras County and approximately 85,000 acres of land in the Area of Use outside the county are suitable for irrigation; that crops of olives, apples, walnuts, and pasture presently under production in the area studied can be irrigated by Calaveras County water resource developments…".

During the fifty years that have passed since the 1960 Tudor Engineering study, no surface water resources have been developed in Calaveras County to support widespread irrigated agriculture, and much of the lands have been developed for residential and municipal use, rendering them unsuitable for irrigated agriculture. The limited irrigated agriculture that does exist in the County primarily utilizes groundwater. The purpose of this technical memorandum is to report the findings of an updated preliminary evaluation of the potential for agricultural development in western Calaveras County that could potentially be irrigated with surface water.

IRRIGATED AGRICULTURE IN CALIFORNIA—HISTORY AND FUTURE

Prime agricultural land in California is generally located in the interior valleys, where flat, deep, well drained soils are optimal for irrigated agriculture. Historically, the widespread development of irrigated agriculture in most areas of California was limited by the lack of a reliable surface water supply. With the development of the State Water Project (SWP) and the Federal Central Valley Project (CVP), a reliable and relatively inexpensive surface water supply was made available to western portions of the San Joaquin Valley that did not have local water supplies.

In contrast, the District has abundant water rights on the three major river systems within or bordering Calaveras County (the Mokelumne, Calaveras and Stanislaus Rivers), and can provide a reliable water supply to support irrigated agriculture, but the soils in the District are generally sloped, shallow, and have other limitations that render them less than optimal for irrigated agriculture. Development of irrigated agriculture within Calaveras County was contemplated in the early 1970's with the formation of the Western Calaveras Irrigation District, whose purpose was to deliver surface water to portions of northwestern Calaveras County for irrigated agriculture. A bond measure to support development of a water conveyance system was narrowly defeated in 1974. Without a surface water supply, agricultural development never got traction in Calaveras County. With adequate water and prime soils, the inland valleys became the preferred lands for agricultural development.

Presently, farmers in the central and southern San Joaquin Valley have been increasingly burdened by two problems associated with their water supplies: decreasing reliability and increased costs. The following factors have helped create these water supply challenges:

- Pumping restrictions in the south Delta are reducing south-of-Delta average allocations for both the State Water Project (SWP) (to an average of 60%[1] of contracted amounts) and the Federal Central Valley Project (CVP), adversely impacting farms located in the central and western side of the southern San Joaquin Valley.
- The San Joaquin River Restoration Program, which will provide year-round flows down the San Joaquin River, is projected to reduce Friant Division CVP allocations by 12-15%[2], adversely impacting farms located on the east side of the southern San Joaquin Valley.
- The Bay Delta Conservation Plan, which contemplates the construction of new conveyance facilities through the Delta, is projected to cost $7.5-$8.5B[3] over the first five years, and will substantially increase water costs to CVP and SWP south-of-Delta water users.
- The groundwater basins in the southern San Joaquin Valley have been identified by the California Department of Water Resources as being in a critical condition of overdraft[4], and continued pumping to supplement reduced surface supplies will exacerbate the overdraft conditions.

[1] The State Water Project Delivery Reliability Report, DWR 2009.
[2] San Joaquin River Restoration Program Fact Sheet April 2009.
[3] Presentation to BDCP Steering Committee July 15, 2010, http://baydeltaconservationplan.com
[4] California's Groundwater, DWR Bulletin 118-03.

It is expected that these factors will ultimately drive the cost of water beyond the ability of some growers in the southern San Joaquin Valley to economically afford to farm, and some of those growers will inevitably migrate to areas in the state that have better water supply prospects. Since the District has a reliable and available supply of surface water, growers may ultimately look to areas within Calaveras County where they could economically farm.

POTENTIAL IRRIGATED ACRES IN CALAVERAS COUNTY

While portions of the mountainous regions of Calaveras County support some irrigated agriculture, i.e., a number of vineyards have developed in the Murphys area that are primarily irrigated with groundwater, for economic development of irrigated agriculture that utilizes surface water it was felt that the greatest opportunity would be in the western, flatter portion of Calaveras County. Working with District staff, we have initially divided the western portion of the County into three study areas, focusing on the Valley Springs Study Area (Valley Springs) in the northwestern portion of the County, the Salt Springs Study Area (Salt Springs) in the central western portion, and the Copperopolis Study Area (Copperopolis) in the southwestern portion of the County (see Figure 1). These study areas were identified by District staff as having the most suitable soils, terrain, and elevation for potential irrigated agricultural development.

For this initial evaluation, only available information about the land in the County was utilized, no new field information has been developed to date. Discussions were held with the current and former County Farm Advisors and with the Natural Resource Conservation Service (NRCS) to gather local knowledge about the potential for agricultural development and what information is available about the land in the western portion of the County. The NRCS is currently in the process of preparing a soil survey of the area that will be available in a few years, but it is interesting to note that NRCS (or the former Soil Conservation Service) did not previously prepare a Calaveras County soil survey when other soil surveys were prepared for most of the other counties in the State. It was agreed that the best available information for evaluating the potential for irrigated agriculture in the County is the Calaveras County Soil-Vegetation Maps that were created in the mid-1960’s and subsequently updated and published in handbook form by the Calaveras County Farm Advisors Office in 1982. Using the Soil-Vegetation Maps that were digitized by the County, and overlaying the three study area boundaries, the following data layers were analyzed using Geographic Information System (GIS) software and ranked for agricultural suitability:

- Parcel Size
- Slope
- Soil Depth
- Surface Rockiness
- Soil Stoniness
- Existing Cover
- Irrigated Land Suitability

Each of these criteria were analyzed separately and used to reject properties that did not meet the selected criteria based on economic (size) and agronomic characteristics. The properties that remained were ultimately combined to estimate the maximum potential acreage that could reasonably be developed for irrigated agriculture with the development of a surface water supply. The information shown in Tables 2 through 7 below reflect the acreage within each study area that met the criteria shown in the respective table, which were the choices in the Soil-Vegetation Survey dataset.

Note that this evaluation relies heavily on the Soil-Vegetation Survey dataset. Parcel size information is current data that was gathered from the County Assessor's Office, but all other information used in the evaluation was from the Soil-Vegetation Survey. It appears that this is the best and most comprehensive information available, but the survey data ranges between 30 and 45 years old. The scope of this evaluation did not include a provision for "ground truthing" the results, so the selected lands shown on the figures should not be relied on to locate specific parcels. Rather, the lands that met the selected criteria represent generalized locations of potential agricultural development.

Parcel Size

Modern production agriculture typically relies on economies of scale to offset the large fixed costs of initial development and ongoing operation. Examples of these costs include land acquisition, orchard/vineyard development, equipment acquisition, etc. As such, larger parcels are more suited to production agricultural development as these fixed costs can be distributed over more acreage, reducing the unit cost per acre. For this analysis, parcels 20 acres and larger were selected for initial evaluation. Parcels smaller than 20 acres were not selected for this initial evaluation because they were viewed as being too small to economically develop into a production farming unit. Parcels less than 20 acres may be viable and profitable as small-family or "boutique" farms, but for evaluating the potential for production agricultural development it was felt that the focus of this initial evaluation should be on parcels that are 20 acres or larger because parcels smaller than 20 acres may not be able to afford the large capital investment for a large-scale water diversion and conveyance system.

That is not to say that parcels less than 20 acres are not viable for agricultural production, and our understanding is that the County in fact has seen the greatest agricultural growth in the past fifteen years on parcels that are between 5 and 20 acres. If a water supply conveyance system was ultimately developed to serve agricultural land within the County, then parcels that are less than 20 acres that are relatively close to the conveyance system would likely be able to economically connect to water service.

Table 1 summarizes the resulting acreage that remains after parcels of less than 20 acres were rejected. Figure 2 shows the location of the parcels that were rejected based on small parcel size alone.

Table 1. Summary of Selection by Parcel Size.

Parcel Size	Valley Springs Study Area Parcels	Valley Springs Study Area Acres	Salt Springs Study Area Parcels	Salt Springs Study Area Acres	Copperopolis Study Area Parcels	Copperopolis Study Area Acres	Total Parcels	Total Acres	Selection Result
Less than 5 Acres	6,526	8,645	94	121	21	8	6,641	8,774	Rejected
>5 and <20 Acres	1,618	13,132	79	943	5	56	1,702	14,130	Not selected
20 Acres or Greater	471	32,528	421	70,448	50	22,507	942	125,482	Selected
Total	8,615	54,304	594	71,512	76	22,571	9,285	148,387	
Subtotal Selected	471	32,528	421	70,448	50	22,507	942	125,482	

Source: Calaverous County Assessor's office.

Slope of the Ground Surface

Innovations in irrigation technology have allowed agricultural developers to design irrigation systems for lands that are not necessarily level. For this analysis, lands with slopes greater than 30 percent were rejected as being too steep for production agriculture.

Table 2 summarizes the resulting acreage that remains after lands with slopes greater than 30 percent were rejected. Figure 3 shows the location of lands that were rejected based on excessive slope.

Table 2. Summary of Selection by Slope.

Slope	Valley Springs Study Area Acres	Salt Springs Study Area Acres	Copperopolis Study Area Acres	Total Acres	Selection Result
0%	8,097	6,843	872	15,812	Selected
0 - 30%	39,000	55,965	19,120	114,085	Selected
30 - 50%	6,949	8,607	2,538	18,095	Rejected
50 - 70%	257	97	41	395	Rejected
> 70%	0	0	0	0	Rejected
Total	54,304	71,512	22,571	148,387	
Subtotal Selected	47,097	62,808	19,992	129,897	

Source: Calaveras County Soil-Vegetation Handbook (1982), Calaveras County Farm Advisor's Office.

Soil Depth

While plants need a minimum amount of soil depth to flourish and generally the deeper the soil profile the better, shallow soils can often be altered through mechanical means by ripping and deep plowing before planting and through the use of soil amendments. The County Farm Advisor's office has indicated that while many of the soils on the western edge of the county are shallow, their shallowness is principally due to an impermeable layer that is not bedrock, and that most of these soils can be improved by deep ripping through such hardpan layer. For this analysis, lands with soil depths less 1 foot were rejected as being too shallow for agricultural development.

Table 3 summarizes the resulting acreage that remains after lands with soil depths less than 1 foot were rejected. Figure 4 shows the location of lands that were rejected based on shallow soils alone.

Table 3. Summary of Selection by Soil Depth.

Soil Depth	Valley Springs Study Area Acres	Salt Springs Study Area Acres	Copperopolis Study Area Acres	Total Acres	Selection Result
Very Shallow (< 1')	10,611	12,963	7,057	30,631	Rejected
Shallow (1' - 2')	26,535	32,976	7,833	67,345	Selected
Moderately Shallow (2' - 3')	7,819	15,709	6,420	29,947	Selected
Moderately Deep (3' - 4')	971	2,627	388	3,986	Selected
Deep (> 4')	271	395	0	666	Selected
Not Classified	8,097	6,843	872	15,812	Rejected
Total	54,304	71,512	22,571	148,387	
Subtotal Selected	35,596	51,706	14,642	101,944	

Source: Calaveras County Soil-Vegetation Handbook (1982), Calaveras County Farm Advisor's Office.

Rockiness of the Soil

Rockiness, or percentage of surface rock, can be a limiting factor to agricultural development, as exposed rock limits the area that can be planted, and generally indicates shallow soils adjacent to the rocks. For this analysis, lands with rocks covering more than 10 percent of soil surface were rejected as being too rocky for agricultural development.

Table 4 summarizes the resulting acreage that remains after lands with rocks covering more than 10 percent of the soil surface were rejected. Figure 5 shows the location of lands that were rejected based on rockiness alone.

Table 4. Summary of Selection by Rocky Soil Surface.

Percent of Surface Rock	Valley Springs Study Area Acres	Salt Springs Study Area Acres	Copperopolis Study Area Acres	Total Acres	Selection Result
0%	48,473	60,894	18,048	127,416	Selected
2 - 10%	0	404	0	404	Selected
10 - 50%	5,393	9,448	4,519	19,360	Rejected
10 - 25%	108	0	0	109	Rejected
25 - 50%	330	766	3	1,099	Rejected
Total	54,304	71,512	22,571	148,387	
Subtotal Selected	48,473	61,298	18,048	127,820	

Source: Calaveras County Soil-Vegetation Handbook (1982), Calaveras County Farm Advisor's Office.

Stoniness of the Soil

Stony soils, where the coarse fragment in the soil (gravel, cobbles, or stones) makes up 20 percent or more of the soil's volume, can be limiting to agricultural development, as these soils tend to be droughty (have low water holding capacities) and can be damaging to tilling and harvesting equipment. For this analysis, stony soils were rejected as being too limiting for agricultural development.

Table 5 summarizes the resulting acreage that remains after lands with stony soils were rejected. Figure 6 shows the location of lands that were rejected based on stoniness alone.

Table 5. Summary of Selection by Stony Soil Composition.

Soil Type	Valley Springs Study Area Acres	Salt Springs Study Area Acres	Copperopolis Study Area Acres	Total Acres	Selection Result
Not Stony	53,899	70,355	22,571	146,824	Selected
Stony	406	1,157	0	1,562	Rejected
Total	54,304	71,512	22,571	148,387	
Subtotal Selected	53,899	70,355	22,571	146,824	

Source: Calaveras County Soil-Vegetation Handbook (1982), Calaveras County Farm Advisor's Office.

Woody Vegetation

The density of woody vegetation (trees and shrubs) can be a limiting factor to agricultural development, as removal can be both costly and environmentally objectionable. For this analysis, lands that were identified during the Soil-Vegetation Survey as having woody vegetation covering more than 20 percent of soil surface were rejected as being too densely populated for agricultural development.

Table 6 summarizes the resulting acreage that remains after lands with woody vegetation covering more than 20 percent of the soil surface were rejected. Figure 7 shows the location of lands that were rejected based on vegetation density alone.

Table 6. Summary of Selection by Woody Vegetation Cover.

Cover Density (Percent of Ground Covered by Woody Vegetation)	Valley Springs Study Area Acres	Salt Springs Study Area Acres	Copperopolis Study Area Acres	Total Acres	Selection Result
Extremely Open (0 - 5%)	18,061	29,829	6,828	54,718	Selected
Very Open (5 - 20%)	9,188	6,442	4,315	19,944	Selected
Open (20 - 50%)	12,809	19,300	8,969	41,078	Rejected
Semidense (50 - 80%)	5,905	7,783	1,860	15,548	Rejected
Dense (80 - 100%)	4,016	6,793	447	11,256	Rejected
Not Classified	4,325	1,365	152	5,842	Rejected
Total	54,304	71,512	22,571	148,387	
Subtotal	27,249	36,271	11,143	74,663	

Source: Calaveras County Soil-Vegetation Handbook (1982), Calaveras County Farm Advisor's Office.

Irrigated Land Suitability

The irrigated land suitability rating that was generated by the Soil-Vegetation Survey team is based on soil characteristics of depth, surface and subsoil textures, rockiness, and parent material of soils that occur in a natural state on slopes less than 30 percent. For this analysis, lands with irrigated land suitability ratings of less than low were rejected as being too unsuitable for agricultural development.

Table 7 summarizes the resulting acreage that remains after lands with less than low irrigated land suitability were rejected. Figure 8 shows the location of the parcels that were rejected based on irrigated land suitability alone.

Table 7. Summary of Selection by Irrigated Land Suitability.

Irrigated Land Suitability	Valley Springs Study Area Acres	Salt Springs Study Area Acres	Copperopolis Study Area Acres	Total Acres	Selection Result
High	0	0	0	0	Selected
Medium to High	1,424	908	132	2,465	Selected
Medium	7,663	15,813	6,585	30,061	Selected
Low to Medium	6,302	24,955	6,198	37,455	Selected
Low	9,618	12,322	3,920	25,860	Selected
Questionable to Low	2,910	0	0	2,910	Rejected
Unsuited to Low	0	0	695	695	Rejected
Unsuited	5,788	9,259	1,529	16,576	Rejected
Questionable	0	0	0	0	Rejected
Questionable to Unsuited	13,415	3,350	3,196	19,960	Rejected
Not Classified	7,186	4,904	316	12,406	Rejected
Total	54,304	71,512	22,571	148,387	
Subtotal Selected	25,006	53,999	12,915	95,840	

Source: Calaveras County Soil-Vegetation Handbook (1982), Calaveras County Farm Advisor's Office.

Screening Results

Utilizing the screening criteria previously described, parcels were selected that had the potential, given an adequate and economical surface water supply, to be developed into irrigated agriculture based on the information contained in the Soil-Vegetation Survey dataset and current parcel size information. Table 8 summarizes the maximum acreage that could potentially be developed into irrigated agriculture, based on meeting the selection criteria previously discussed. Figure 9 shows the location of the parcels that were selected based on all of those criteria.

Table 8. Summary of Selection by all Criteria.

Suitability for Agricultural Production	Valley Springs Study Area Acres	Salt Springs Study Area Acres	Copperopolis Study Area Acres	Total Acres
Lands not meeting Criteria	50,888	51,699	16,580	119,167
Lands meeting Criteria	3,416	19,813	5,991	29,220
Total Acres	54,304	71,512	22,571	148,387

Source: Calaveras County Soil-Vegetation Handbook (1982), Calaveras County Farm Advisor's Office.

POTENTIAL AGRICULTURAL DEMANDS

The Tudor Engineering report identified apples, walnuts, olives and irrigated pasture as potential index crops for their study. The Calaveras County Agricultural Commissioner's 2009 Annual Crop Report notes that relatively small acreages of those crops are being grown, in addition to some wine grapes and minor crops, including stone fruits, pistachios, and berries, that are grown in the County. Given suitable soils and water supply, it is anticipated that the areas identified in the screening process would be suited to producing all of these crops. Some crops, such as berries, would likely be more boutique size farms rather than large production acreage.

One of the “hot” crops right now is almonds, and almonds in fact are currently being grown in neighboring Stanislaus County south of Highway 4, just west of the County. Also in Stanislaus County just a little further west, Oakdale Irrigation District (OID) is currently experiencing the conversion of land to almonds from rangeland and irrigated pasture on soil that is often fairly shallow with an underlying hardpan. This conversion to almonds is occurring in large part because OID has a reliable water supply and the economics of farming almonds is currently favorable to development. Almonds may be a possibility for the western portion of the County that have suitable temperature ranges. In addition, grapes, olives and stone fruits also have potential to do well on the western edge of the County. Irrigated pasture would supplement the dryland grazing that is prevalent in the County, but the relatively high water cost could prevent that crop from being economically viable.

The crops identified above have water requirements ranging from 2.5 AF/acre to over 3.5 AF/acre. After allowing for irrigation system inefficiencies, leaching requirements, etc., water requirements would likely range between 3.0 and 4.0 AF/acre, and could exceed 4.0 AF/acre. An average irrigation demand value of 3.5 AF/acre was used for this demand study to conservatively estimate potential agricultural water demand. Table 9 summarizes the estimated maximum potential agricultural irrigation demands for each study area with the minimum 20-acre parcel size.

Table 9. Potential Agricultural Demands.

Suitability for Agricultural Production	Valley Springs Study Area	Salt Springs Study Area	Copperopolis Study Area	Total
Lands Meeting Criteria, acres	3,416	19,813	5,991	29,220
Est. Avg. Irrigation Demand, AF/acre	3.5	3.5	3.5	
Total Estimated Demand, AF	11,956	69,346	20,969	102,270

It should be noted from the table above that most of the potential agricultural water demand appears to be in the Salt Springs and Copperopolis area. By contrast, in the 1960 Tudor Engineering Report that estimated there was approximately 93,000 acres within the County that were suitable for irrigation, approximately 25,000 acres appear to fall within the three study areas, with the highest concentration of irrigable acres within the Valley Springs area and very little in the Salt Springs area. Furthermore the land that was proposed to be served by the Western Calaveras Irrigation District was principally in the Valley Springs Study Area. Significant development and parcelization of the Valley Springs area since the mid-1970’s would mean that a lot of the land previously identified as irrigable in the Valley Springs area did not meet the selection criteria for this evaluation, primarily because most of the parcels are now less than 20 acres. One of the uncertainties at this point is why more land in the Salt Springs area wasn't identified as potential irrigable land in the 1960 Tudor Engineering report. Part of the second phase of this analysis (if authorized) would be to ascertain whether the potential irrigable acreage in the Salt Springs and Copperopolis areas identified in this analysis is indeed suitable for production agriculture.

RECOMMENDED NEXT STEPS

If the District is interested in further pursuing the potential for agricultural development in the western portion of the County, there are a number of questions that need to be answered and items that need to be verified. The following next steps are recommended to help the District decide whether to pursue agricultural development and to what degree:

1) This initial analysis utilizes a dataset of information that is 30 to 45 years old and has not been verified. At this time it is unknown how extensive the original field work was in developing the dataset and it is unknown how things have changed in the area. It is recommended that this initial analysis and subsequent results be reviewed with the County Farm Advisors Office and local NRCS office to ascertain whether local knowledge could refine the analysis. The data needs to be field verified or "ground truthed", but most of the land is privately owned and it may be difficult to obtain permission to access the land.
2) While many soil conditions can often be mitigated through mechanical means, the deeper the soils the better. At this time it is not known what a shallow soil depth in the Soil-Vegetation dataset actually means, but agricultural development will be much more economically attractive if a grower does not have to spend significant capital dollars on deep ripping or other soil modifications. The NRCS is in the middle of their soil survey and it is our understanding that they cannot publicly release any information until the soil survey is published in a few years, but it may be possible to have them verify some of these preliminary findings by comparing soil borings that they have available. They may also be able to generally tell us more information about certain areas such as the Salt Springs area.
3) Discussions with local landowners would be helpful to gain their insight on the potential for developing irrigated agriculture in the area. It is interesting to note that the water supply from the private Salt Springs Reservoir apparently is delivered to agricultural land outside Calaveras County rather than used on the land adjacent to or immediately downstream of the reservoir. It would be helpful to learn more about this area and how that water supply was developed.
4) Gather information on land prices and lease rates in the area.
5) Further evaluate the possible crop mix to identify crops that would likely be limited to small boutique acreage versus larger production acreage and the factors that would influence that decision, such as contracts and processing facilities. It may also be possible to research possible effects of the apparent impact of global warming on future cropping patterns Almonds moving onto a

little higher ground may be viable to obtain adequate chilling hours with the apparent impact of global warming.

6) Evaluate the economics of different crops that could be grown in the area, utilizing the crop production cost information developed by the University of California and modifying it for local conditions with expected yield information. The irrigation system types to serve each crop would also need to be included with expected capital repayment costs. A determination needs to be made to estimate how much agriculture could pay for water and infrastructure, while still yielding a reasonable profit to the grower to entice agricultural development.

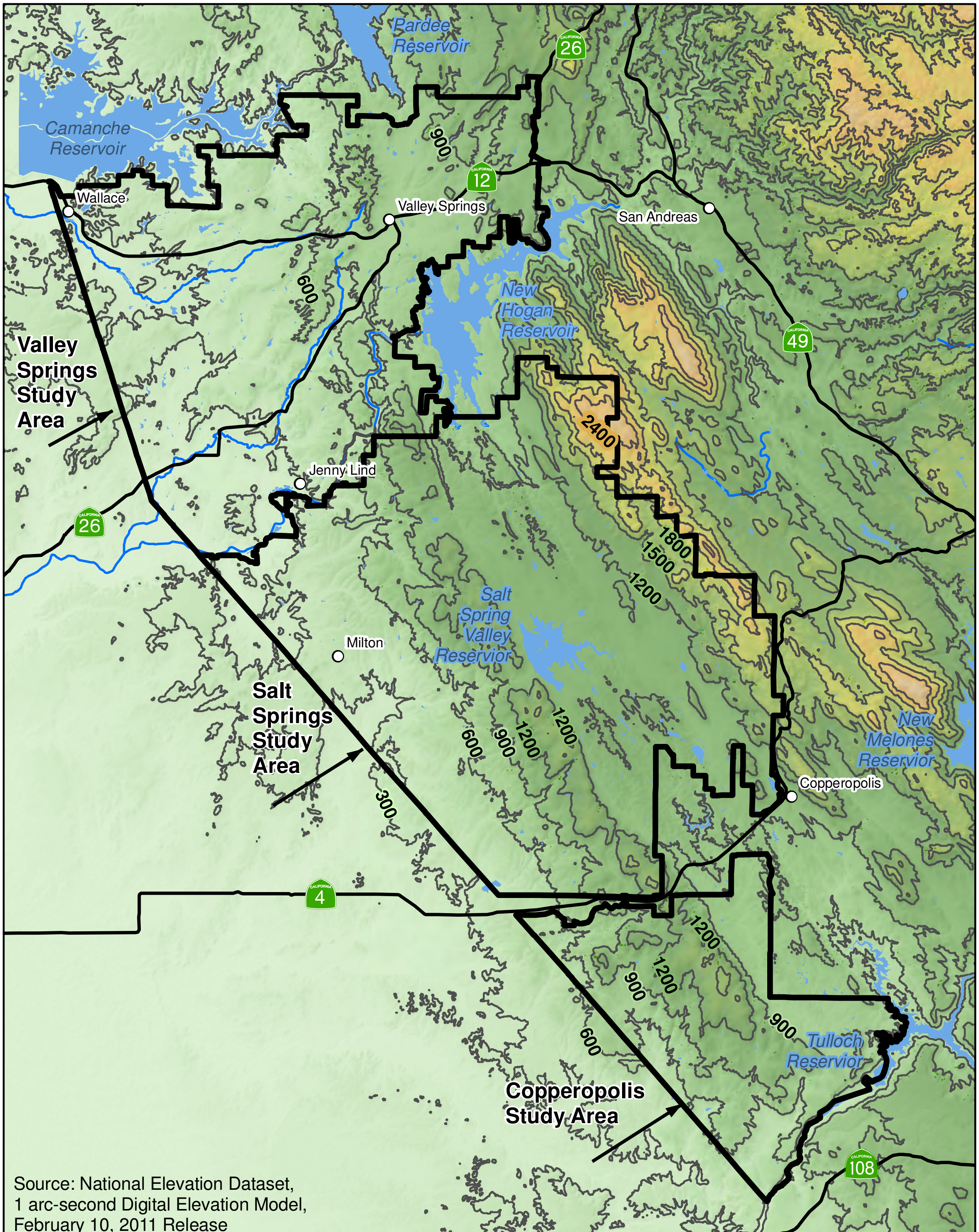
7) Evaluate the community support for developing agriculture. It is anticipated that some opposition to agriculture would be present, either because of changes to the landscape or the perception that urban areas would subsidize agriculture. Irrigated pasture, for instance, may be more acceptable than cropland because it maintains the current grazing and livestock lifestyle, but irrigated pasture may not be economically possible if there was a significant cost for the delivered water.

8) Evaluate the available water supply and possible diversion locations and perform a conceptual evaluation of several water supply conveyance system alternatives, analyzing possible routes and system types (gravity versus pressurized systems) to serve potential agricultural development land to utilize the available District water supply. Topography would need to be reviewed along with the number of landowners that would need to be dealt with along the conveyance route (the fewer the better). Parcels that are smaller than 20-acres could be identified in the vicinity of each potential conveyance route to help identify the total potential irrigated acreage. A conceptual level cost estimate of a potential preferred conveyance system would need to be performed to consider in the economic analysis.

9) The above information could be used to essentially update the 1960 Tudor Engineering Report that would be helpful in discussing the possibility of developing production agriculture with local landowners and outside investors.

SUMMARY

This initial evaluation indicates that there is the potential to use over 100,000 acre-feet of water for agricultural production within the western portion of Calaveras County, realizing that this analysis utilizes a dataset that is 30 to 45 years old. This information needs to be verified and “ground truthed” before committing to plans for agricultural development. Should the District decide to pursue a more in-depth study, the goal of the second phase of this analysis would be to prioritize and address the items noted above under Next Steps and confirm and/or revise the results of this preliminary analysis.



0 1 2 3 4 Miles

N

EST. 1968
PROVOST & PRITCHARD
CONSULTING GROUP
An Employee Owned Company

132 S. 3rd Ave
Oakdale, CA 95361
(209) 845-8700

Elevation (ft)

High : 3500

Low : 150

Figure 1

Topographical Map

Irrigable Acres Suitability Study

Calaveras County Water District

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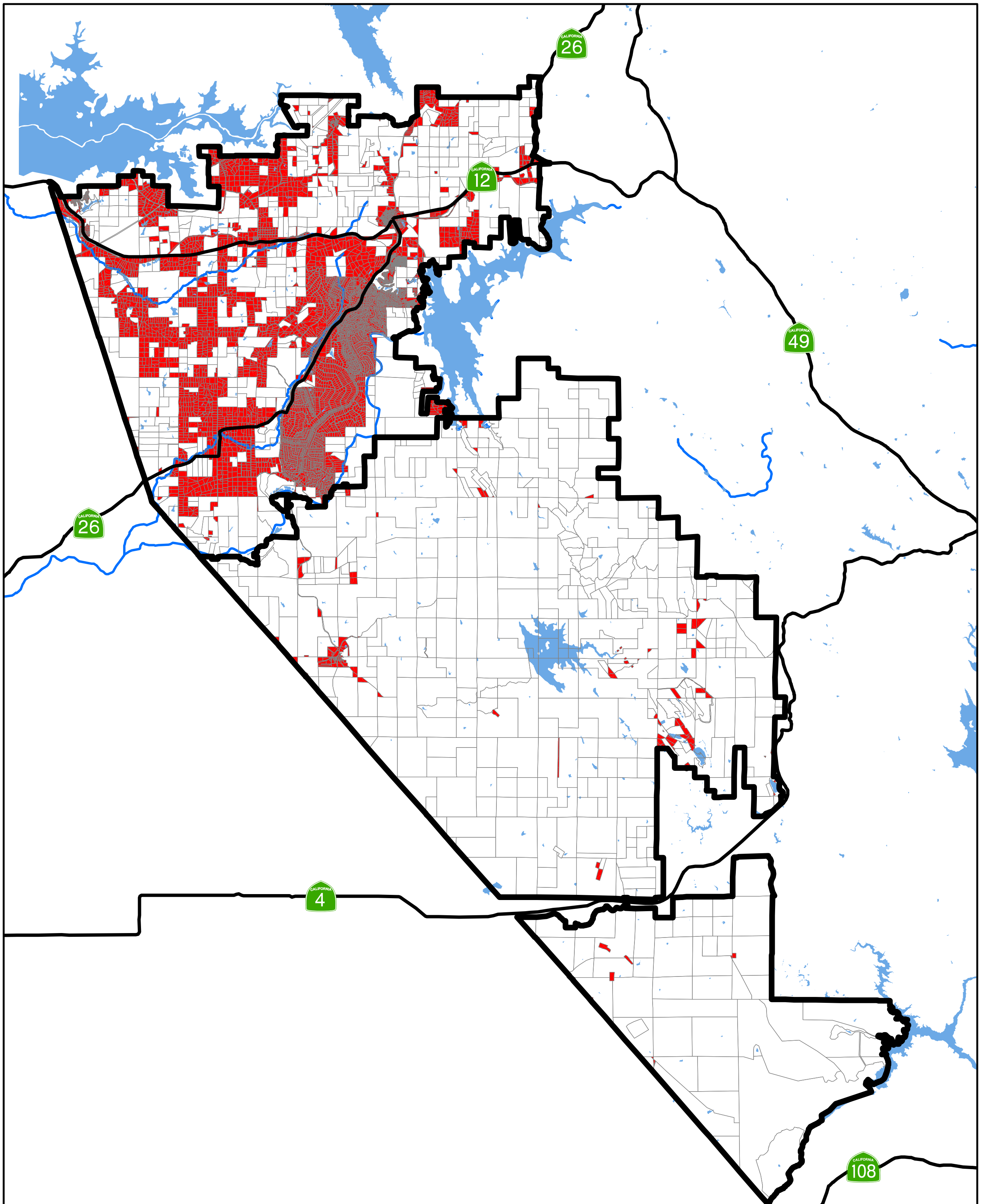

Source: Calaveras County Soil-Vegetation Survey, 1982

0 2 4 Miles

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Legend

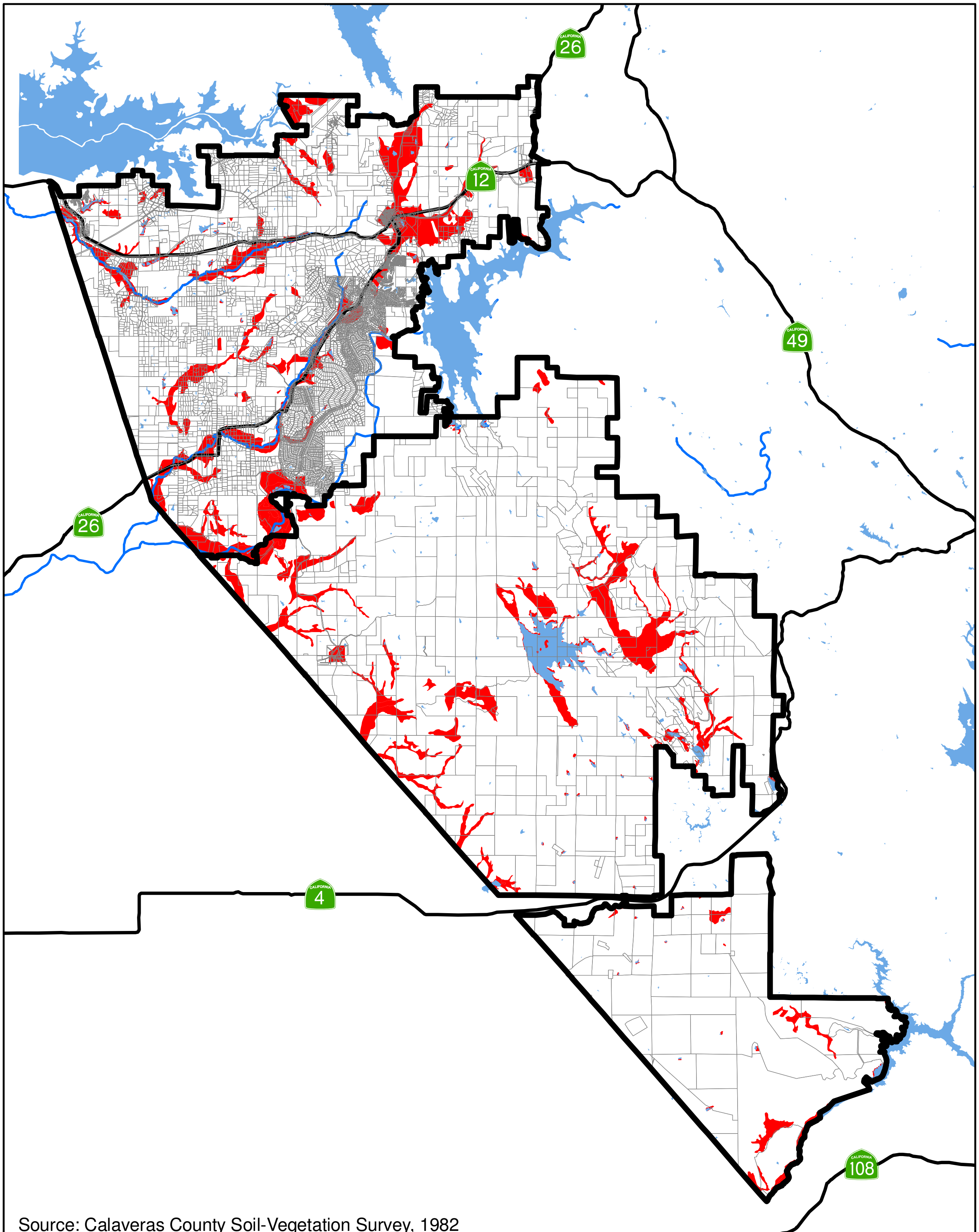
- Parcel Size < 20 acres (22,905 acres)
- Parcel Size >= 20 acres (125,482 acres)

Figure 2

Parcel Size

Irrigable Acres Suitability Study

Calaveras County Water District



0 1 2 3 4 Miles

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Legend

Slope > 30% (18,490 acres)

Slope = 0-30% (129,897 acres)

Figure 3

Soil Slope

Irrigable Acres Suitability Study

Calaveras County Water District

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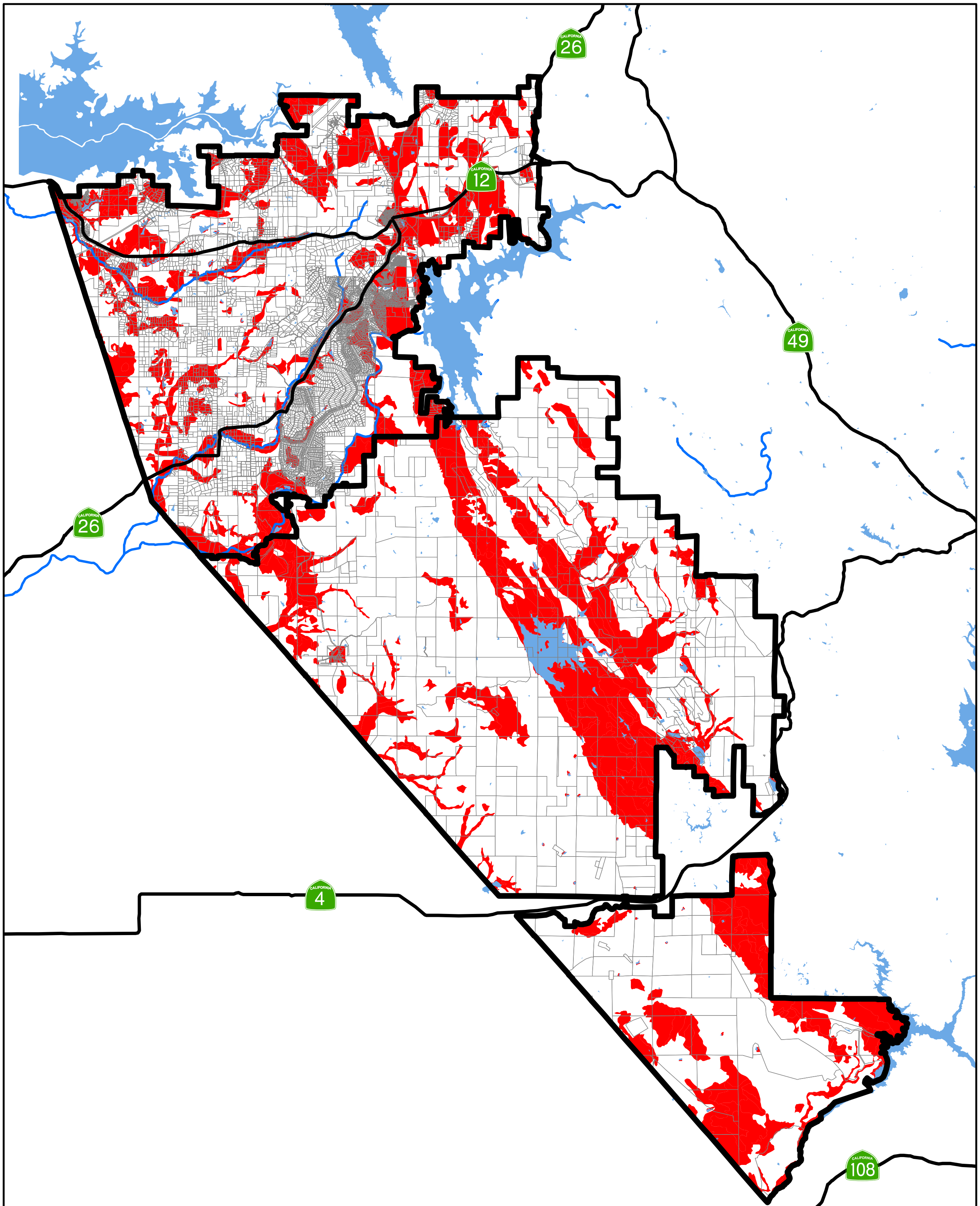

Source: Calaveras County Soil-Vegetation Survey, 1982

0 1 2 3 4 Miles

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Oakdale, CA 95361
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Legend

Depth < 1 foot (46,443 acres)

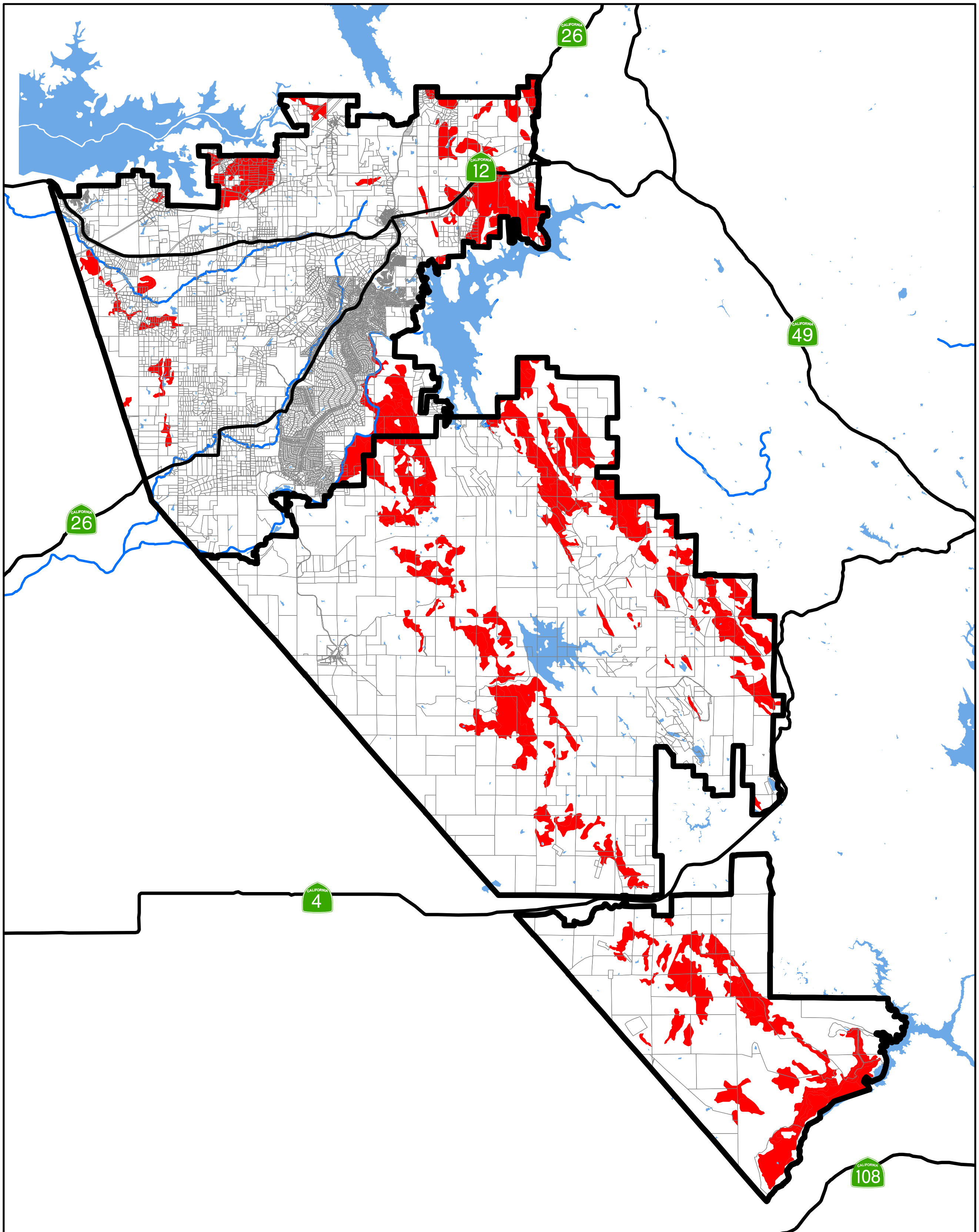
Depth >= 1 foot (101,944 acres)

Figure 4

Soil Depth

Irrigable Acres Suitability Study

Calaveras County Water District



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(209) 845-8700

Legend

Rocks > 10% (20,567 acres)

Rocks = 0-10% (127,820 acres)

Figure 5

Surface Rocks

Irrigable Acres Suitability Study

Calaveras County Water District

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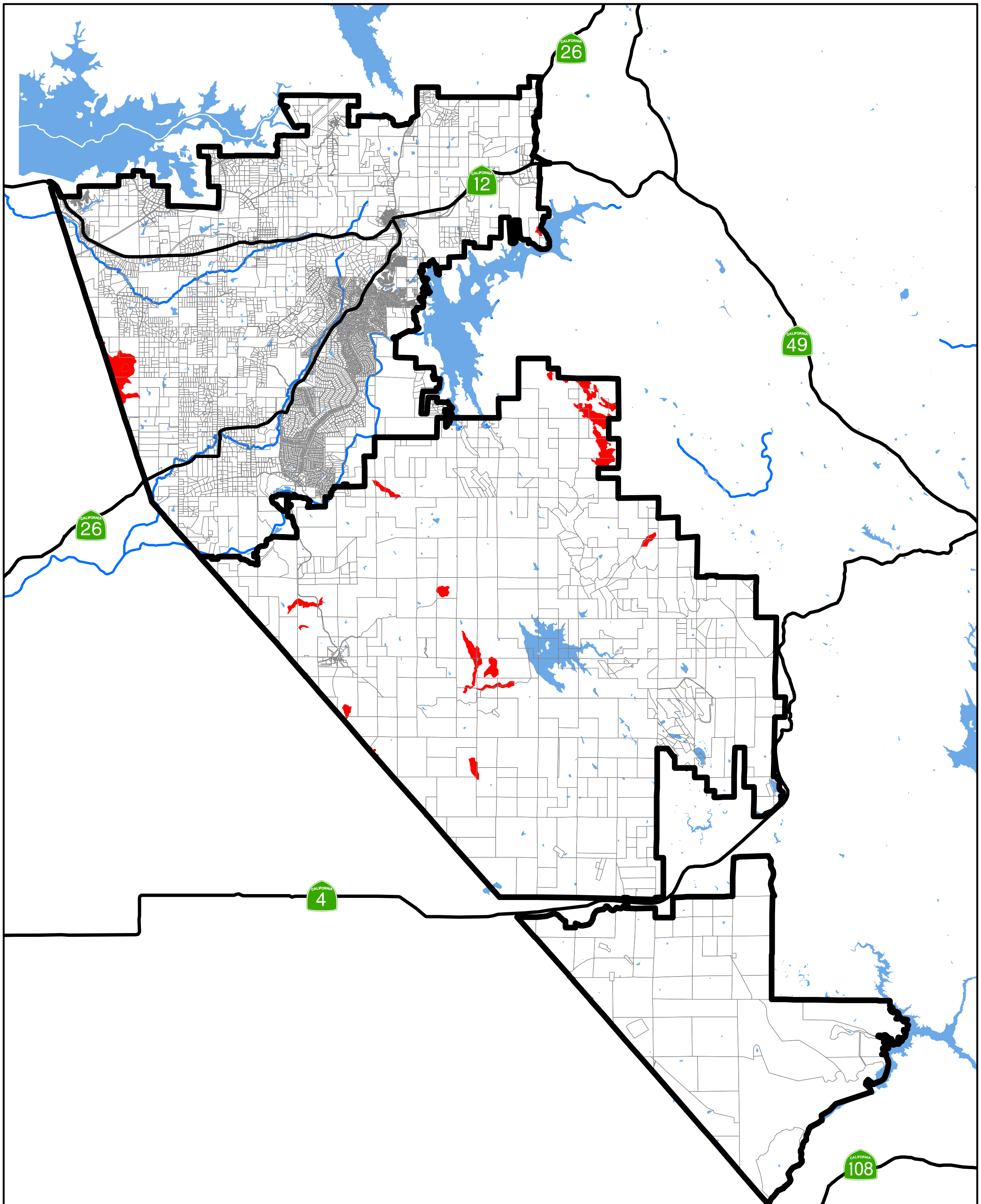

Source: Calaveras County Soil-Vegetation Survey, 1982

0 1 2 3 4 Miles

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Legend

Stoniness > 20% (1,562 acres)

Stoniness = 0-20% (146,825 acres)

Figure 6

Soil Stoniness

Irrigable Acres Suitability Study

Calaveras County Water District

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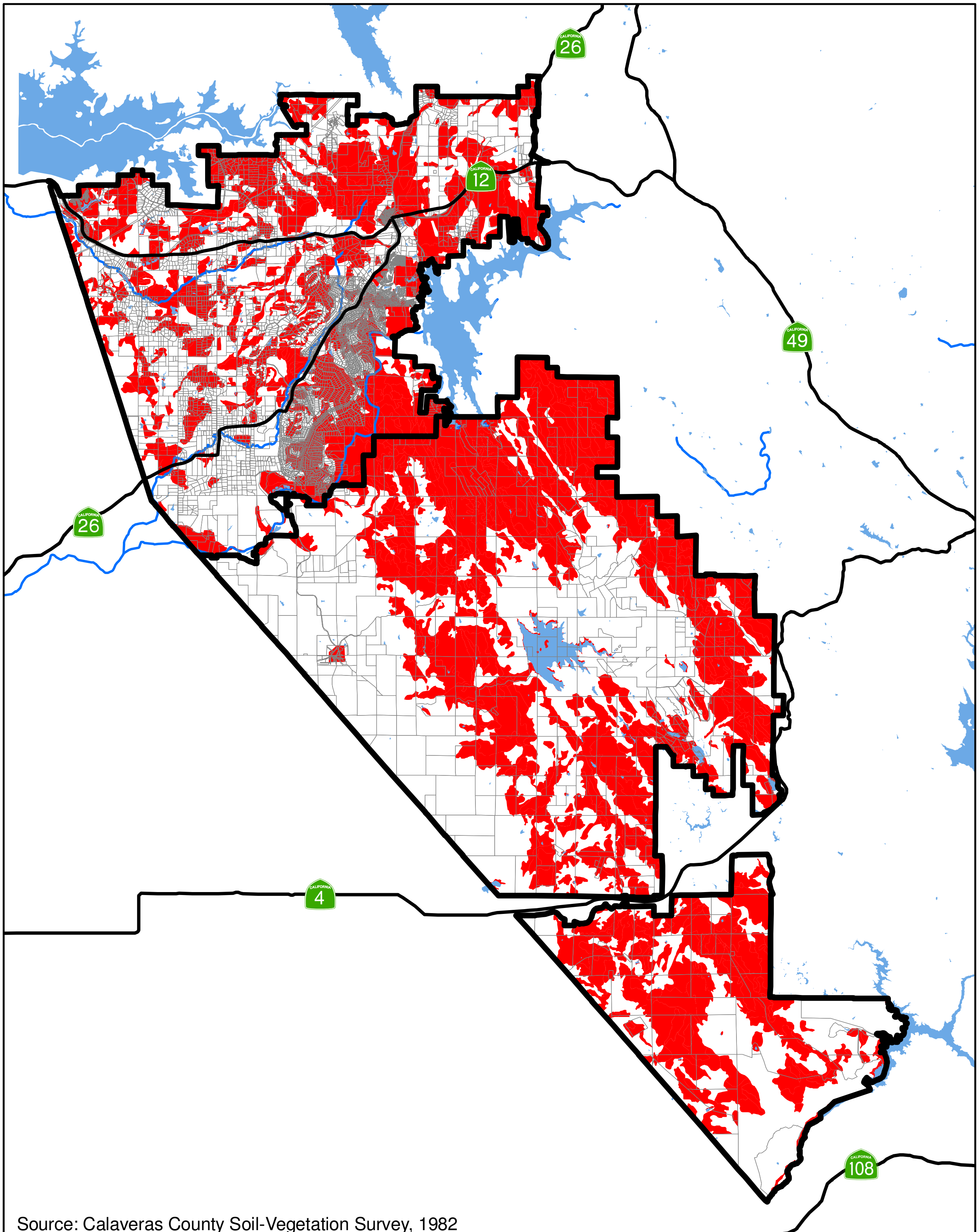

Source: Calaveras County Soil-Vegetation Survey, 1982

0 1 2 3 4 Miles

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Legend

Cover > 20% (73,725 acres)

Cover 0-20% (74,662 acres)

Figure 7

Vegetative Cover

Irrigable Acres Suitability Study

Calaveras County Water District

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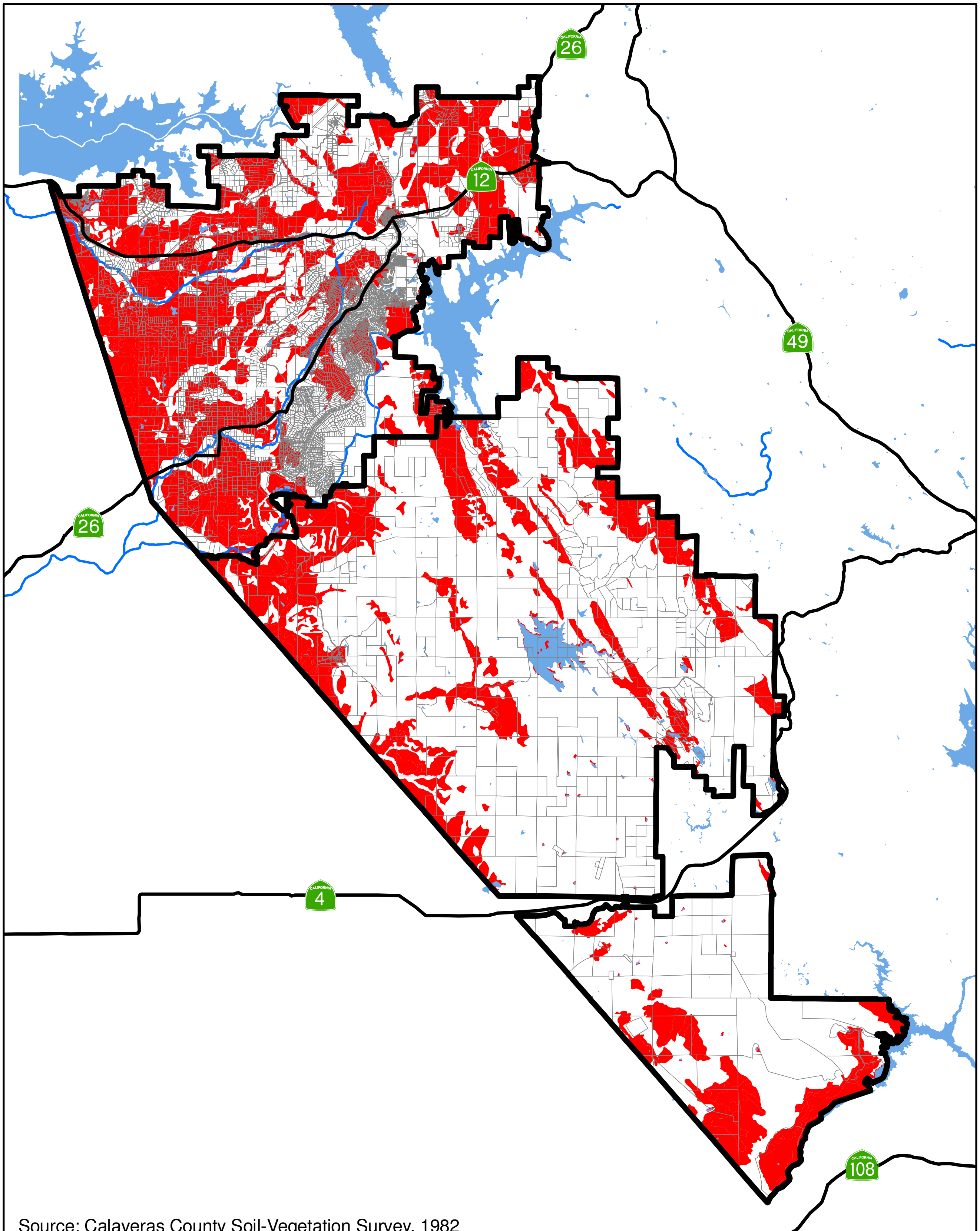

Source: Calaveras County Soil-Vegetation Survey, 1982

0 1 2 3 4 Miles

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Legend

Suitability < Low (52,547 acres)

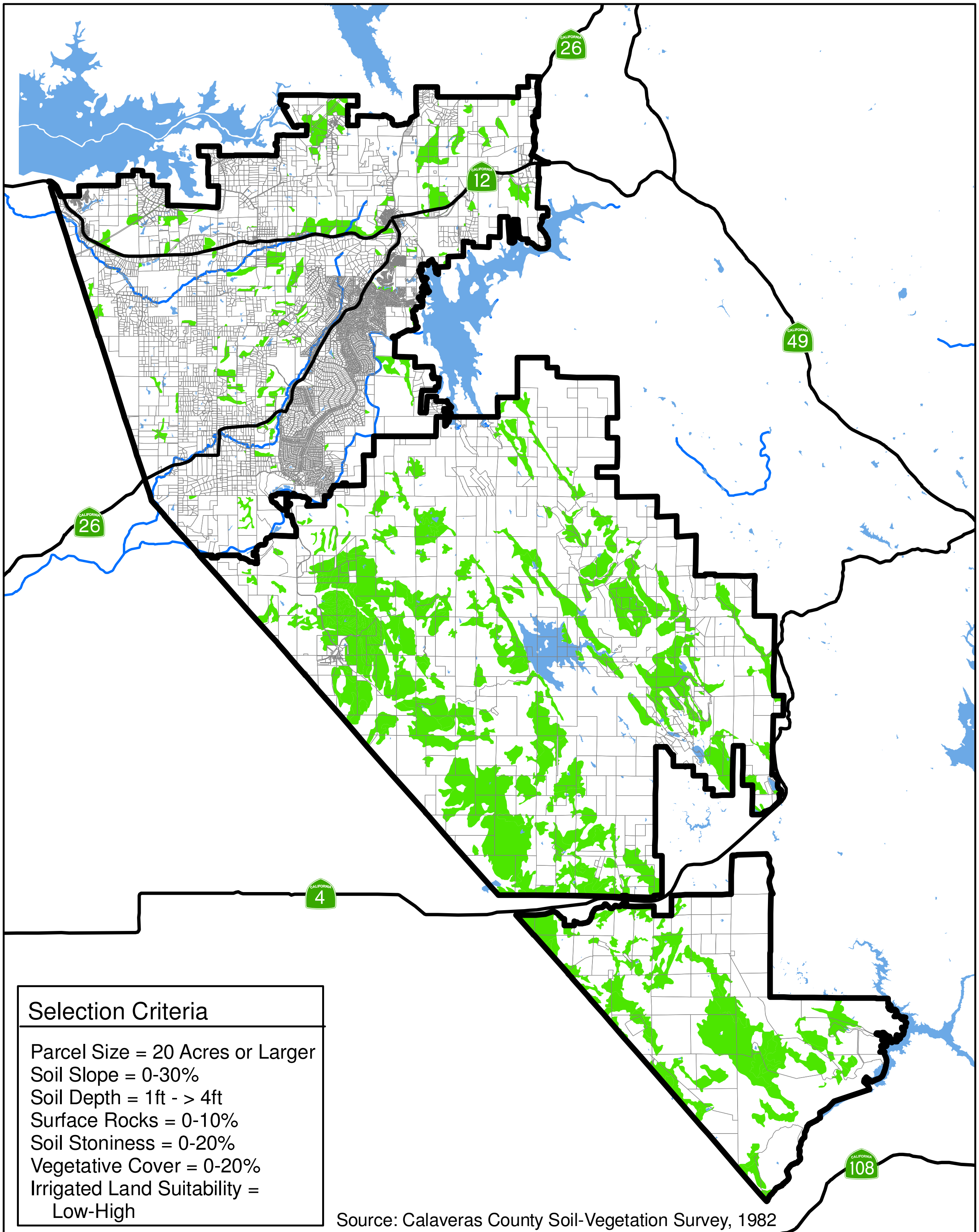
Suitability = Low-High (95,840 acres)

Figure 8

Irrigated Land Suitability

Irrigable Acres Suitability Study

Calaveras County Water District



Legend

Lands Meeting Criteria (29,220 Acres)

Lands not Meeting Criteria (119,168 Acres)

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Oakdale, CA 95361
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Figure 9

Potential Agricultural Lands

Irrigable Acres Suitability Study

Calaveras County Water District

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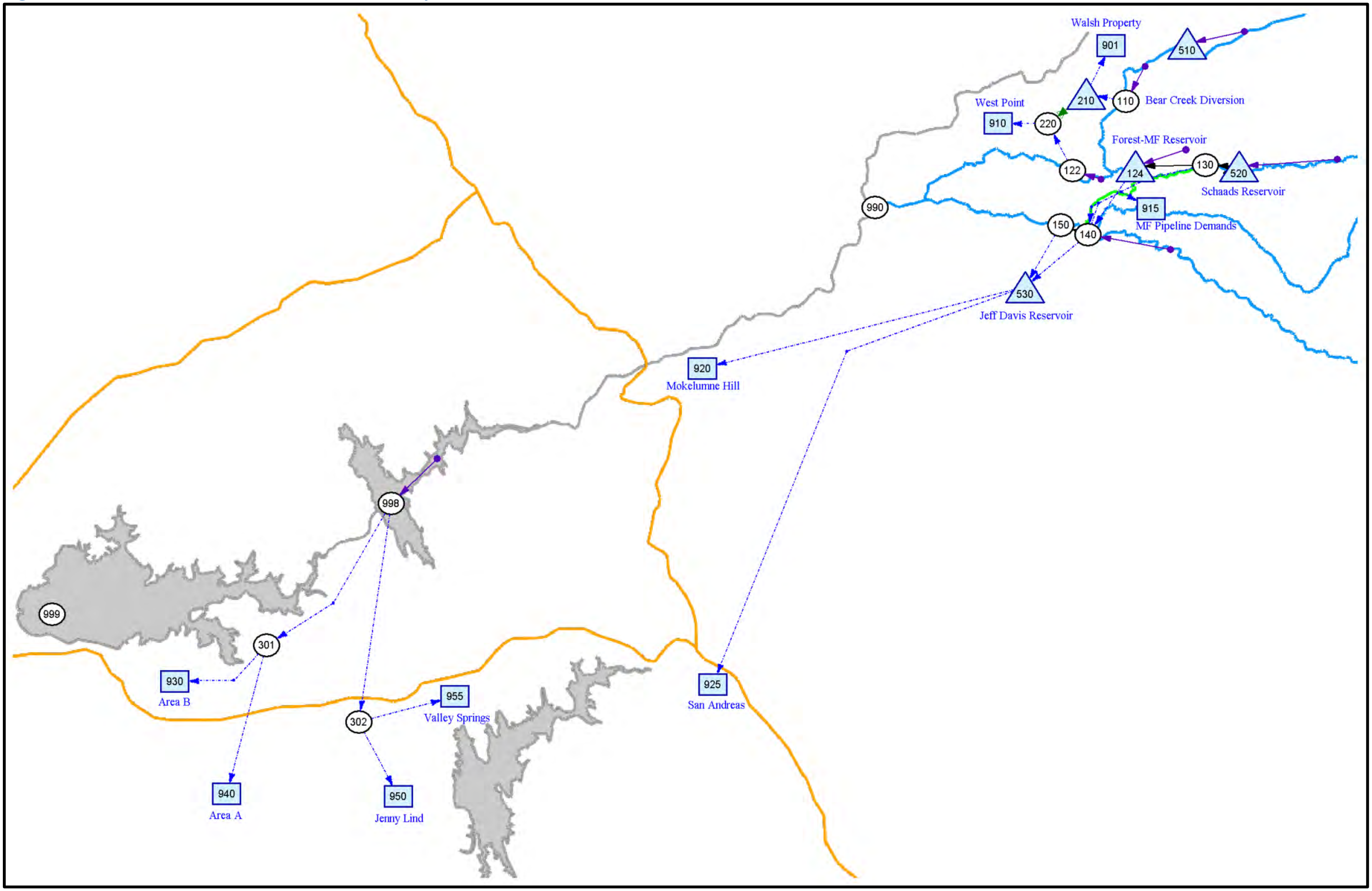
ATTACHMENT D

ECORP Consulting: Mokelumne River Modeling Technical Memorandum, August 2017

Middle and South Forks Mokelumne River Operations Modeling Assumptions

This technical memo describes the operations model for the Middle and South Forks Mokelumne River. The model simulates, on a daily time step, the operations of CCWD's operations on the Mokelumne including the Bear River Diversion Dam, the Middle Fork Mokelumne Diversions, the operation of West Point Water Treatment Plant and its Regulating Reservoir. The model also simulates the operation of CPUD's operations on the Mokelumne including Schaads Reservoir, the South Fork Mokelumne Diversions, the operation of Jeff Davis Water Treatment Plant and Jeff Davis Reservoir. These operations are interconnected, as CPUD sells Schaads storage releases to CCWD to pick up at its Middle Fork diversion. A schematic of the model is shown in Figure 1.

Figure 1 - Middle and South Forks Mokelumne Operations Model Schematic



Hydrology

Hydrology is developed for five inflow points in the Middle and South Forks Mokelumne River, with an additional inflow point at Pardee Reservoir on the mainstem Mokelumne. The inflow points and the watersheds defined by these inflow points are shown in Figure 2. Watershed areas are listed in Table 1. The hydrology is developed for a period of record containing water years 1934 through 2016.

Table 1 - Watershed Areas

Watershed	Watershed Area (Acres)
Wilson Dam	2,794
Bear Creek Diversion Dam	817
Schaads Reservoir	18,204
Forest Creek	13,465
Middle Fork Pump Station	7,560
South Fork Pump Station	43,408

There are four stream gages in the watershed, listed in Table 2. Forest Creek is unimpaired; the Middle Fork Mokelumne is impaired by CCWD diversions in Bear Creek and on the Middle Fork Mokelumne, and is impaired by the operations of Schaads Reservoir and diversions into the South Fork Ditch. The South Fork Mokelumne is impaired by diversions at the South Fork Pumping Plant and flows in the South Fork Ditch.

Table 2 – Stream gages used in Hydrology Development

USGS Streamgage ID	Streamgage Name	Watershed Area (Acres)	Period of Record	Impairment
11317000	Middle Fork Mokelumne at West Point	30,467	1912-Present	Heavily Impaired
11318500	South Fork Mokelumne at West Point	47,947	1934-Present	Light impairment
11316800	Forest Creek near Wilseyville	13,465	1961-Present	None
11319500	Mokelumne River near Mokelumne Hill	348,160	1928-Present	Heavily Impaired

Historical unimpaired runoff from each of the watersheds listed in Table 1 is estimated using a paired-basin approach, with runoff estimated by scaling a reference streamgage by watershed area to estimate each watershed's runoff. For water years 1961 through 2016, Forest Creek is used as the reference streamgage. For water years 1934 through 1960, the South Fork Mokelumne streamgage is used as the reference streamgage. There are no records with which to unimpair historical South Fork streamgage flows, and the flow record is left as-is, with no adjustments.

Figure 2 - Mokelumne River Watersheds

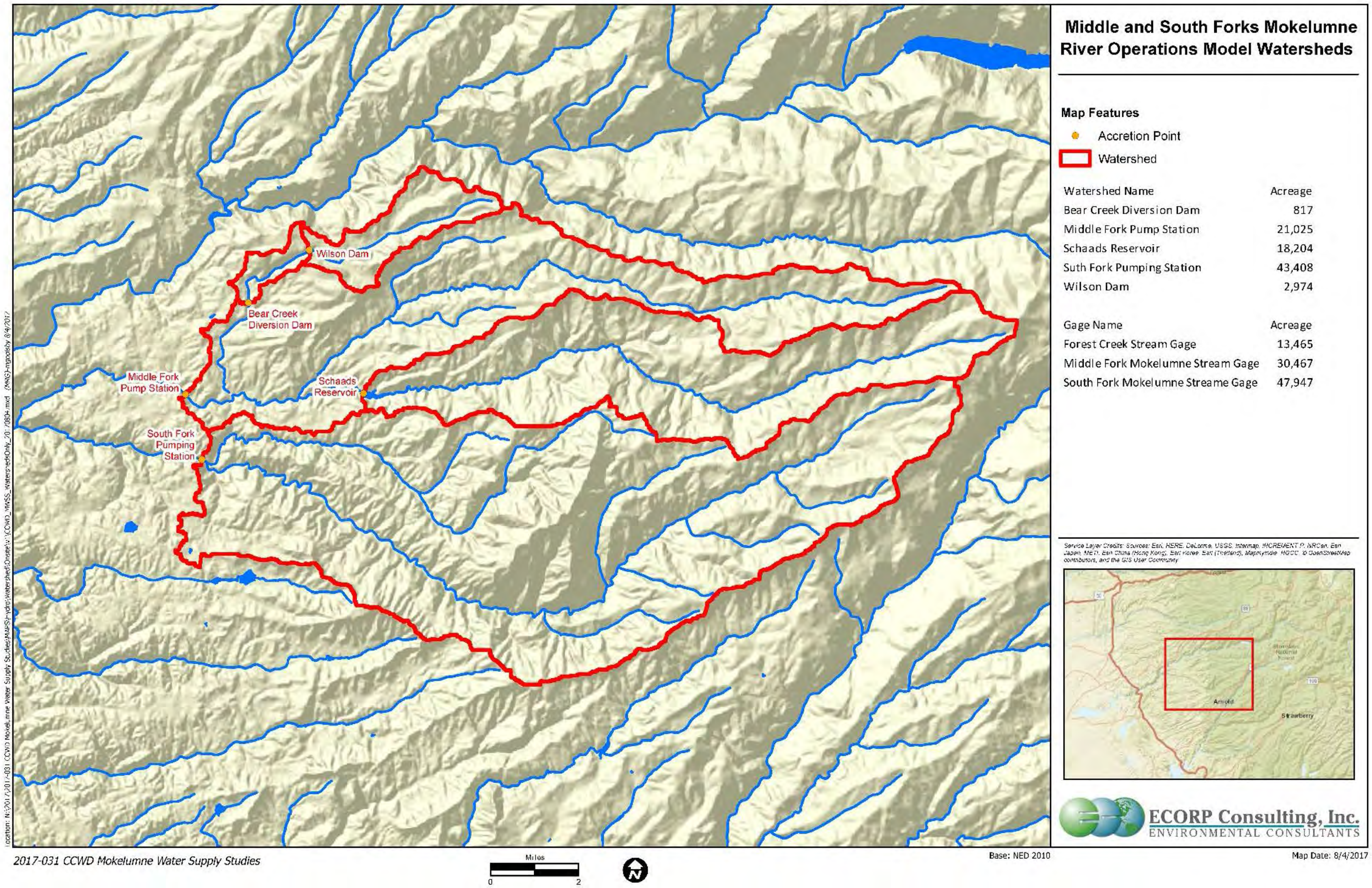
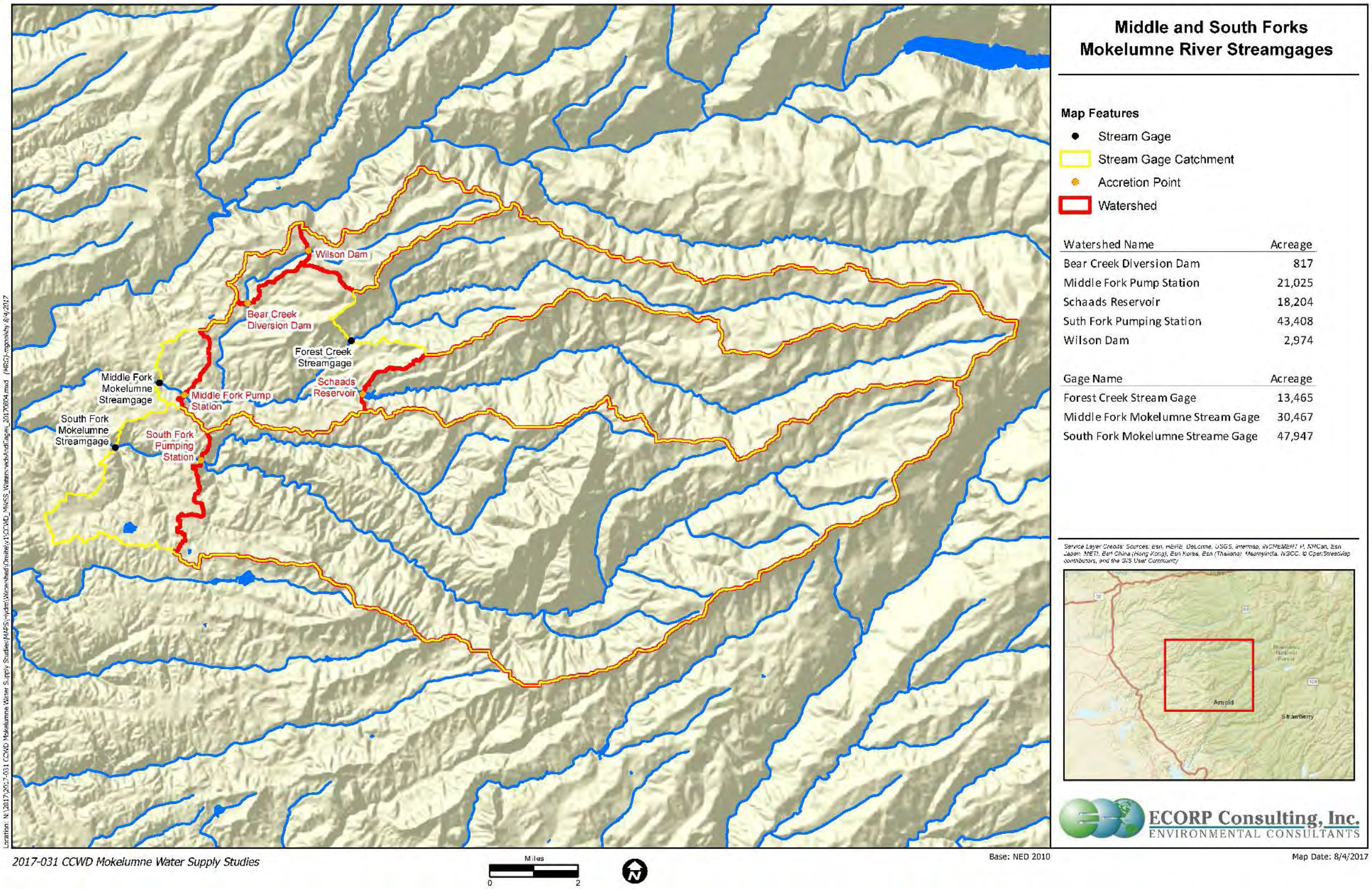


Figure 3 - Mokelumne River Streamgage Watersheds



Historical inflow to Pardee is estimated using a mass balance approach, and this inflow is used as impaired by historical operations on the North Fork Mokelumne. The inflow to Pardee, not including flows in the Middle and South Forks Mokelumne, is estimated as the flow in the mainstem Mokelumne minus the flow at the South Fork streamgage, minus the flow at the Middle Fork streamgage.

A set of streamflows expected under climate change is estimated using climate conditions for California projected at years 2030 and 2070. This is done using the data products published by the California Water Commission (CWC) in 2016 for use in the Water Storage Investment Program applications. These CWC data products contain watershed runoff modeling results for three climate conditions, described in Table 3, in six-kilometer gridded cells across California. The gridded cells are shown with the five project watersheds in Figure 4.

Table 3 - Climate Conditions Descriptions

Condition	Description
Historical	Historical temperature-detrended conditions for a thirty-year period centered on 1995 (1981-2010)
2030 Future Condition	Future condition projected climate for a thirty-year period centered on 2030 (2016-2045)
2070 Future Condition	Future condition projected climate for a thirty-year period centered on 2070 (2056-2085)

Simulated runoff in all 3 conditions is estimated in each project watershed using a weighted sum of the runoff in each grid cell within the watershed, as shown in Equation 1.

Equation 1

$$Q_i = R_k * A_{i,k}$$

, where: Q_i is the flow from watershed i, in units of Acre-Feet, R_k is the Runoff from cell k, converted from mm to feet, and $A_{i,k}$ is the watershed area of watershed i contained within cell k, in Acres.

Monthly watershed runoff modeling results for each watershed is calculated in all 3 climate conditions for 1934 through 2011. Monthly perturbation factors are calculated in each watershed for each future climate condition, as the ratio of future climate watershed runoff modeling results to historical watershed runoff modeling results. These monthly perturbation factors are disaggregated into daily perturbation factors, and these daily perturbation factors are applied to the historical daily inflow hydrology to estimate the daily hydrology under expected climate change conditions at both future climate conditions.

The California Water Commission dataset period of record is 1922 through 2011. To develop climate change adjusted hydrology for water years 2012-2016, similar hydrologic years were selected, listed in Table 4, and the climate change perturbation factors for the similar hydrologic years are used to perturb the historic 2012-2016 streamflows. The average monthly flows at the confluence of the Middle and

South Forks Mokelumne River is shown in Figure 5 at the historical level and both levels of climate change.

Table 4 - Similar Hydrologic Years for water years 2013-2016

Water Year	Selected Similar Hydrologic Year
2012	2001
2013	1994 / 1971*
2014	1987
2015	1977
2016	1971

* 2013 uses 1994 factors in each month except December, which uses 1971.

Figure 4 - CWC Climate Change Runoff Modeling Grid Cells and Project Watersheds

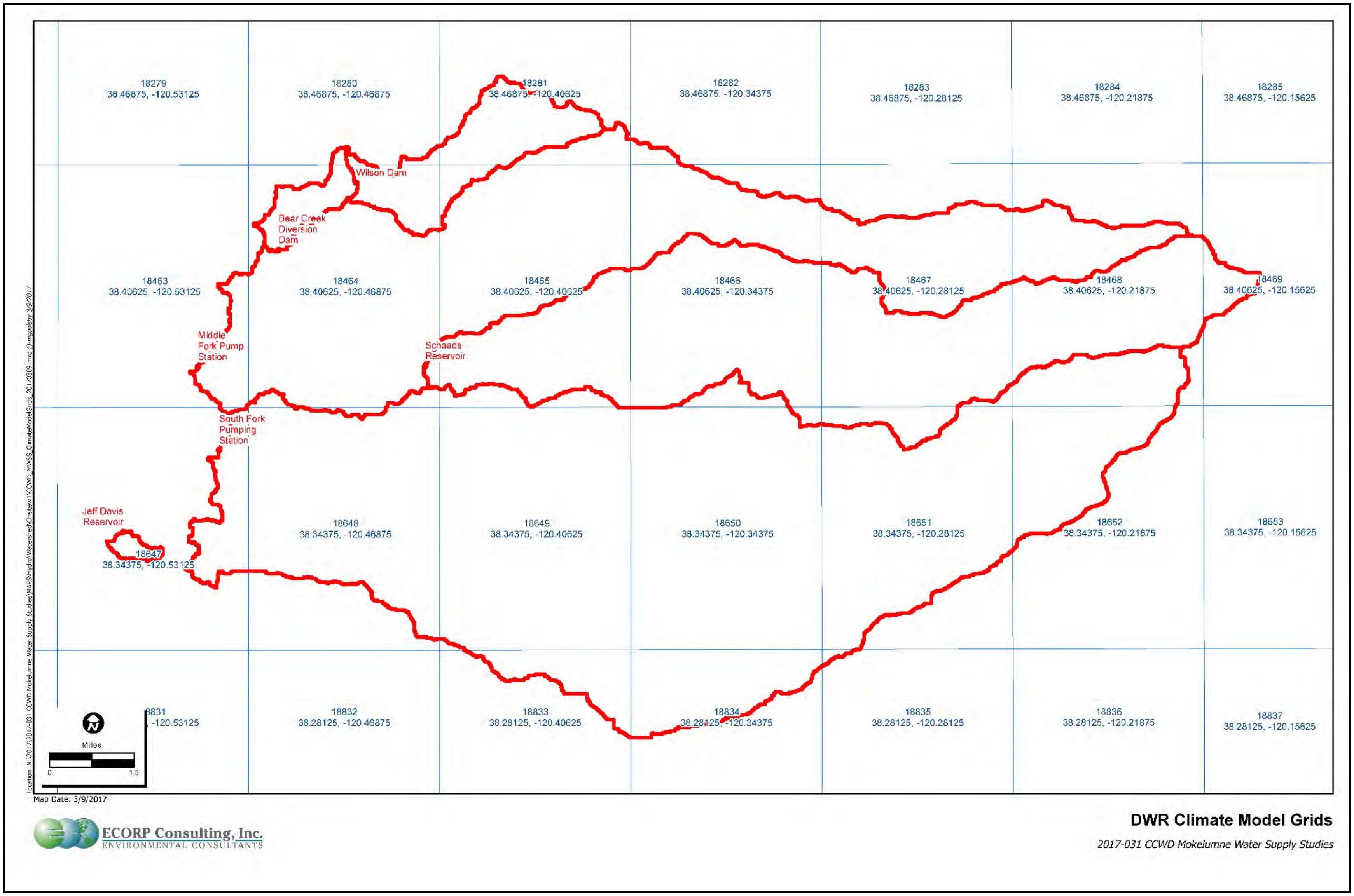
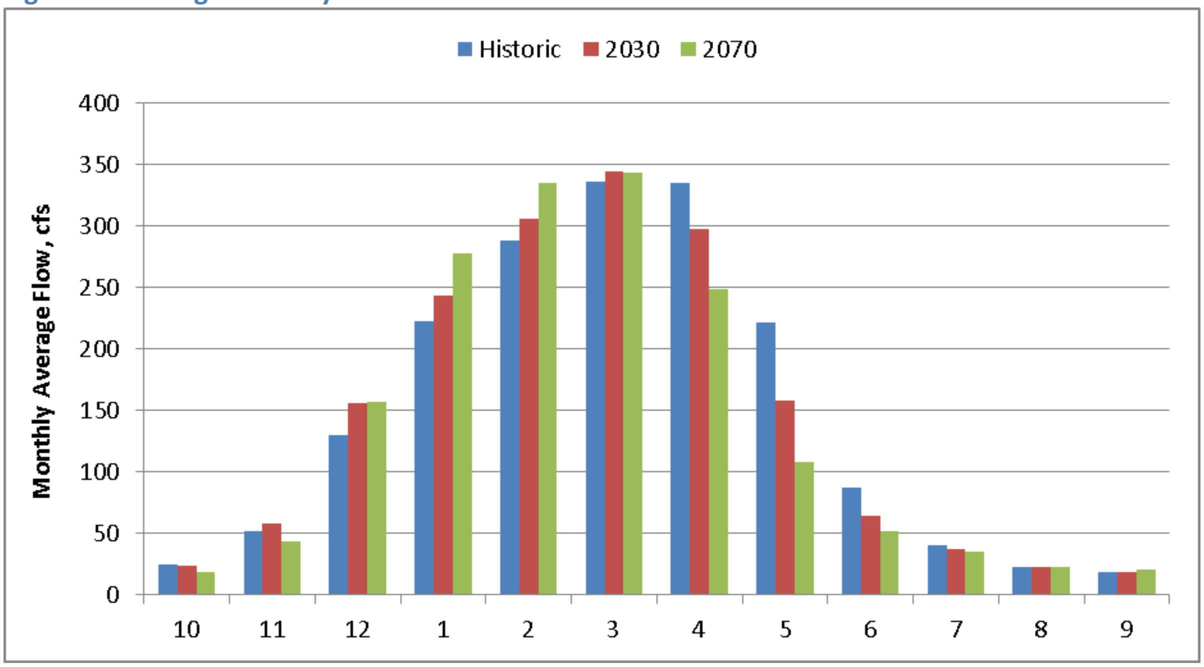


Table 5 - Similar Hydrologic Years for water years 2013-2016

Water Year	Selected Similar Hydrologic Year
2012	2001
2013	1994 / 1971*
2014	1987
2015	1977
2016	1971

* 2013 uses 1994 factors in each month except December, which uses 1971.

Figure 5 - Average Monthly Flows at the confluence of Middle Fork and South Fork Mokelumne River



Water Rights

The model tracks diversions by water right, and does the water rights accounting for all diversion sources. The Model contains following water rights and limitations:

- CPUD Pre-1914 Direct Diversion (S 025267) allows diversions at the South Fork Pumping Plant up to facility capacity, 3300 gpm (7.25 cfs). Maximum past use when the statement was filed is 1,734 AF, but they comment that it will need up to 4,704 at Build-Out.
- CPUD Permit 016338, dated 1927, allows up to 2,130 AF of storage per year, Jan through Dec, in Jeff Davis Reservoir. Maximum rate of diversion to offstream storage is 15 cfs. Permit states that the district cannot yield more than 6,656 AF per year combined with all other rights.
- CCWD Permit 015452 allows diversion to storage and rediversion of Bear Creek water. Allows direct diversion of up to 4 cfs all year and 150 AF of storage December 1 through May 30. Total annual diversion is limited to 1,830 AF per year.

Consumptive Demands

The modeled consumptive demand nodes include:

- Walsh Property – CCWD's water rights permit on Bear Creek is junior to a downstream right holder, referred to here as The Walsh Property. In lieu of taking a direct diversion below CCWD's Bear Creek diversion dam, CCWD provides the Walsh Property with these water rights entitlements directly from Regulating Reservoir.
- West Point WTP – M&I consumptive demands at the intake of the West Point WTP.
- Middle Fork Pipeline – consumptive demands along the alignment of the Middle Fork Pipeline.
- Jeff Davis WTP – M&I consumptive demands at the intake of Jeff Davis Reservoir, including for Mokelumne Hill and San Andreas.
- Jenny Lind – M&I consumptive demands in the Jenny Lind service area.
- Valley Springs – M&I consumptive demand in the Valley Springs service area.
- Area B – A combination of M&I, agricultural, and rural residential consumptive demands located within the Mokelumne River watershed in the area south of Pardee Lake and Lake Camanche.
- Wallace & Burson – surface water replacement for current groundwater pumping in the rural residential neighborhoods of Wallace and Burson. Consumptive demands for Wallace and Burson are included in Area B.

The consumptive demands contained in the model at various levels of development are shown in Table 6. More information on these consumptive demands are found in the Calaveras County Mokelumne River Long-Term Water Needs Study Technical Memorandum.

Table 6 - Model Consumptive Demands

Demand Node	Demand Name	Demand Pattern	Annual Consumptive Demand, Acre Feet			
			Current LoD	2030 LoD	2070 LoD	2100 LoD
901	Walsh Property	25 GPM, May through October	18	18	18	18
910	West Point WTP	West Point Historical[1]	141	242	282	327
915	MF Pipeline	Rural Residential	0	2468	3690	4988
920+925	Jeff Davis WTP	Jeff Davis Historical[2]	1928	2238	3332	4491
950	Jenny Lind	M&I	0	2113	2220	2301
955	Valley Springs	M&I	0	131	238	372
930a	Area B M&I	M&I	0	1142	4186	6469
930b	Area B Agricultural	Agricultural	0	269	985	1523
930c	Area B Rural Res	Rural Residential	0	642	2356	3642
930d	Wallace & Burson	Rural Residential	0	69	90	106

[1] Pattern developed from the average of 2011-2015 usage at West Point WTP.
[2] Pattern developed from the average of 1976-2014 usage at Jeff Davis WTP.

Facility Capacities

Facility	Capacity (given units)	Capacity (cfs)
Bear Creek Diversions	4 cfs	4 cfs
Middle Fork Pumping Plant	200 gpm	0.44 cfs
South Fork Pumping Plant	3300 gpm	7.25 cfs
Jeff Davis WTP	6.0 MGD	11.16 cfs
West Point WTP	1.0 MGD	1.86 cfs
Middle Fork Pipeline	25 cfs	25 cfs

Operations

Wilson Dam

Wilson Dam is modeled with no storage, and passes all inflow.

Bear Creek Diversion Dam

Bear Creek diversions fall into three categories; Direct Diversions to the West Point WTP, diversions to storage in Regulating Reservoir, and diversions that wheel Walsh Property diversions. All diversions, except Walsh Property wheeling, are subject to a 400 AF water right limitation, and diversions to storage in Regulating Reservoir are limited to 150 AF, December through May.

The model imposes a minimum flow requirement below the Bear Creek Diversion Dam of 0.5 cfs. This represents obligations that CCWD has to downstream water right holders regarding flow bypass. The maximum diversion at the Bear Creek Diversion Dam is modeled as 4 cfs.

The general operation of Bear Creek Diversion Dam is to use the winter storms to refill Regulating Reservoir, and once the reservoir is filled, the diversions are equal to demand at the West Point WTP. In the summer, as Bear Creek flows recede, diversions will drop off until the next winter.

Middle Fork Pumping Plant and Diversion Dam

The Middle Fork Pumping Plant is generally used in the summer when there is not adequate hydrology at the Bear Creek Diversion dam to support gravity diversions from Bear Creek. The Middle Fork Pumping Plant is used to redivert the 200 AF water transfer from CPUD to CCWD. The Middle Fork Pumping Plant has a capacity of 0.44 cfs. When the water transfer is initiated, the Middle Fork Pumping plant diverts 0.44 cfs until the annual diversion has reached 200 AF or when there is adequate hydrology to support gravity diversions at Bear Creek Diversion Dam in the fall or winter.

Regulating Reservoir and West Point WTP

Regulating Reservoir is a 50 acre-foot offstream reservoir that is used as a forebay for West Point WTP. Regulating Reservoir is generally filled in the fall and winter, and is kept full throughout the remainder of the winter and through the spring. In the early summer, diversions from Bear Creek are no longer available, and the storage in Regulating Reservoir decreases. When storage reaches 45 acre-feet, the water transfer from CPUD is initiated and Middle Fork Pumping Plant supplies 0.44 cfs for the remainder of the summer. At levels of demand in which summer demands exceed 0.44 cfs, Regulating Reservoir continues to provide supply to supplement Middle Fork Pumping Plant diversions.

Schaads Reservoir

The model contains a minimum instream flow requirement below Schaads Reservoir of 3 cfs or natural inflow, whichever is less. Schaads Reservoir is operated with 3 storage zones: Hydro Operations, Water Supply, and Minimum Pool, as shown in Figure 6. The reservoir never encroaches on the Minimum Pool. The water in the Water Supply zone is used to provide water supply to the Middle Fork Pipeline and water transfers to CCWD. In the Hydro Operations Zone, the reservoir is cycled to generate power through the reservoir's hydro generation units. There are three generations units modeled, described in Table 7, with each operated in an on-off manner, where each unit is operating at full flow or not at all. The model operates each unit as needed to keep storage below the spillway, while not encroaching into the Water Supply zone.

Figure 6 - Schaads Reservoir Storage Zones

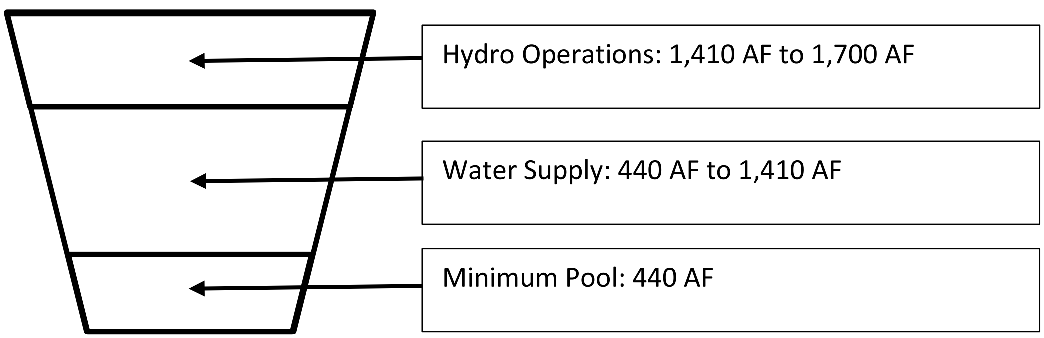


Table 7 - Schaads Reservoir Hydrogeneration Units

Unit	Unit Maximum Throughput (cfs)
1	3
2	16.5
3	21

South Fork Pumping Plant and Diversion Dam

CPUD has an agreement with CDFW, later included in water rights permit 016338, for a minimum instream flow requirement downstream of the South Fork Pumping Plant. The agreement specifies an instream flow requirement of 5 cfs or natural flow on the SF Mokelumne below the South Fork Pumping Plant. This is relaxed to 3 cfs in dry years, defined as an April Runoff forecast less than or equal to 50% of average. This is interpreted as being relaxed to 3 cfs when the Bulletin 120 forecast of April through July natural flow at the "Mokelumne River Total Inflow to Pardee Reservoir" forecast point. This is modeled using the CDEC Full Natural Flow at the station Mokelumne River at Mokelumne Hill as a proxy for Bulletin 120 forecasts.

The South Fork Pumping Plant has a maximum capacity of 7.25 cfs. The model operates the pumping plant to divert all available flow above the minimum instream flow requirement, up to the maximum capacity, when available. When Jeff Davis Reservoir is full, the Pumping Plant diversion is equal to the consumptive demand at Jeff Davis WTP.

Jeff Davis Reservoir and WTP

Jeff Davis Reservoir acts as a regulating Reservoir between the operations of Jeff Davis WTP and the South Fork Pumping Plant. The WTP intakes that day's consumptive demand, and the South Fork Pumping Plant diverts all available diversions, and the storage in Jeff Davis Reservoir is the result of the offset of the two flows. When Jeff Davis Reservoir storage reaches zero, intake to the Jeff Davis WTP is equal to the diversions at the South Fork Pumping Plant, which depending on the study may or may not be augmented with Middle Fork Pipeline deliveries.

Middle Fork Pipeline

The Middle Fork Pipeline is an anticipated future facility that will replace the old Middle Fork Ditch system that conveys water from Schaads Reservoir to the South Fork Mokelumne. In the event of a Middle Fork Reservoir, it is assumed that the Middle Fork Pipeline will also be able to convey diversions from that Reservoir to the South Fork Mokelumne for rediversion at the South Fork Pumping Plant. The pipeline will have a capacity of 25 cfs, with a capacity to move 5 cfs directly to Jeff Davis Reservoir via gravity-siphon.

Pardee Diversions

The model assumes that diversions for Western Calaveras County demands will be diverted at Pardee Reservoir, and that the hydrology at this point is completely available for these diversions. In reality agreements would be reached between parties that are outside the scope of this model, but the model assumes full use of this water as a best case for deliveries and worst case for river flows.

Forest - Middle Fork Reservoir

The proposed Forest - Middle Fork Dam and Reservoir Project is modeled in some studies to evaluate the effect that this project would have on water supplies. This project is modeled in those studies as described in the 1999 constraints analysis [K.S. Dunbar and Associates, 1999] (Dunbar Report); a 12,000 acre-foot reservoir located just downstream of the confluence between the Middle Fork Mokelumne and Forest Creek. In addition to making releases into the Middle Fork Mokelumne for downstream rediversion, the reservoir would be able to be able to divert by pumping up into the Middle Fork Pipeline.

The Elevation-Capacity relationship shown in Table 8 was assumed based on the reservoir parameters described in the Dunbar Report.

Table 8 - Middle Fork Reservoir Elevation-Capacity Relationship

Elevation, Feet	Storage Capacity, Acre-Feet	Pool Surface Area, Acres
2,656	0	0
2,720	1,450	45
2,760	3,935	88

Elevation, Feet	Storage Capacity, Acre-Feet	Pool Surface Area, Acres
2,780	6,040	121
2,800	8,875	163
2,817	12,000	202

The Middle Fork Reservoir would inundate most of the river between Schaads Reservoir and the confluence with Forest Creek. When the Middle Fork Reservoir is included in a study, Middle Fork Reservoir takes on the three cfs minimum flow requirement and Schaads is relieved of its minimum flow requirement.

Evaporation

Evaporation is assumed at Schaads Reservoir and Forest - Middle Fork Reservoir. The evaporation pattern used in the model is the average of measured evaporation at Salt Springs Reservoir, averaged over 1932-1978 as given in CDWR Bulletin 73 [California Department of Water Resources, 1979]. This evaporation pattern is shown in Figure 7.

Figure 7 - Evaporation Pattern

Month	Evaporation (Inches)
1	1.7
2	1.4
3	2.3
4	3.4
5	4.5
6	6.1
7	7.8
8	8.0
9	7.1
10	4.8
11	2.7
12	2.2

Modeling Scenarios

The modeling scenarios that were studied for analysis are listed in Table 9.

Table 9 - Modeling Scenarios

Scenario Name	Hydrology Set	Consumptive Demand Level of Development	Schaads Reservoir	Middle Fork Pipeline	Forest - Middle Fork Reservoir	Regulating Reservoir
Baseline	Historical	Current	Current Configuration	No	None	50 AF
Baseline 2070	2070 Climate Change	Current	Current Configuration	No	None	50 AF
Current Facilities 2030	2030 Climate Change	2030	Current Configuration	Yes	None	50 AF
Current Facilities 2070	2070 Climate Change	2070	Current Configuration	Yes	None	50 AF
Alternative 1	2070 Climate Change	2100	Current Configuration	Yes	None	50 AF
Expanded Schaads 2030	2030 Climate Change	2030	Schaads raised 6’ for 250 AF capacity increase	Yes	None	50 AF
Expanded Schaads 2070	2070 Climate Change	2070	Schaads raised 6’ for 250 AF capacity increase	Yes	None	50 AF
Expanded Schaads 2100	2070 Climate Change	2100	Schaads raised 6’ for 250 AF capacity increase	Yes	None	50 AF
Expanded Regulator 2030	2030 Climate Change	2030	Current Configuration	Yes	None	150 AF
Expanded Regulator 2070	2070 Climate Change	2070	Current Configuration	Yes	None	150 AF
Expanded Regulator 2100	2070 Climate Change	2100	Current Configuration	Yes	None	150 AF
Alternative 2	2070 Climate Change	2100	Schaads raised 6’ for 250 AF capacity increase	Yes	8,000 AF Reservoir	150 AF
Alternative 3	2070 Climate Change	2100	Current Configuration	Yes	12,000 Reservoir as described in operations section.	50 AF

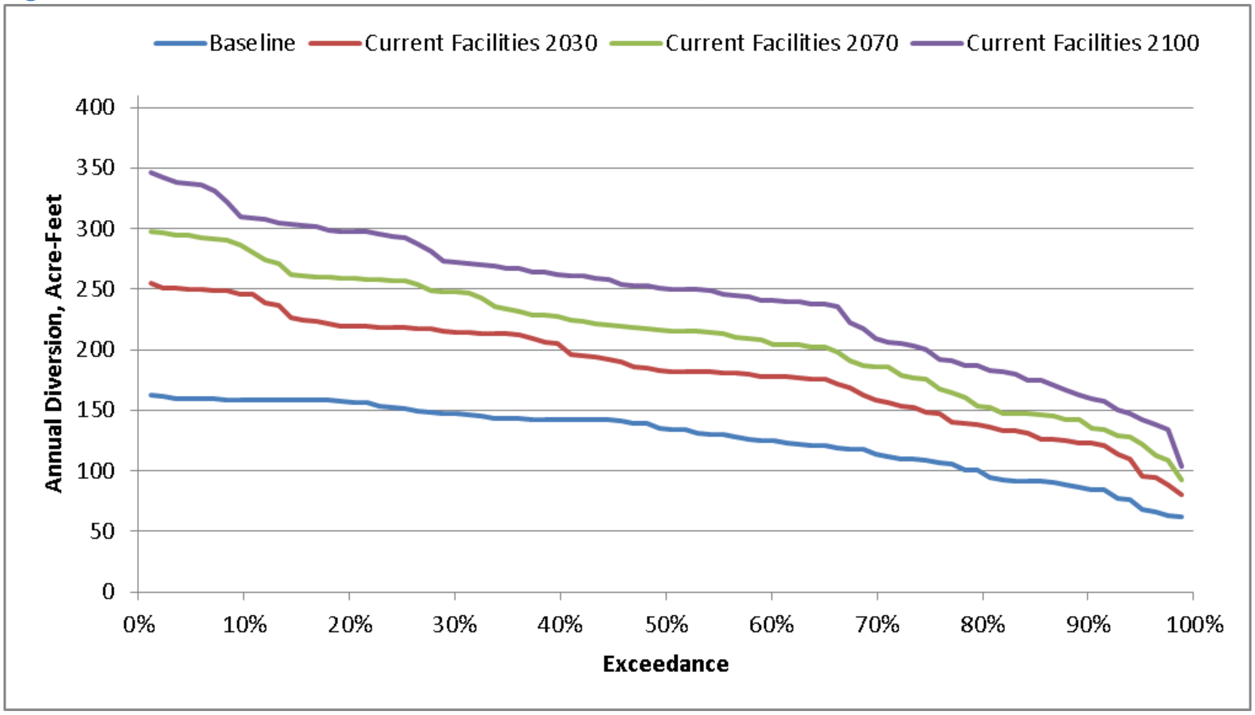
Modeling Results

West Point System

Bear Creek Diversion Dam

Annual diversions at the Bear Creek Diversion Dam are shown in Figure 8. These diversions are well within the 1,830 AF water rights limitation. Bear Creek supplies most of the annual usage at the West Point WTP, so as WTP demand increases through time, the diversions at Bear Creek Diversion Dam will increase by a similar amount. In the driest year, supply is limited by natural hydrology and the annual diversion does not increase with consumptive demand.

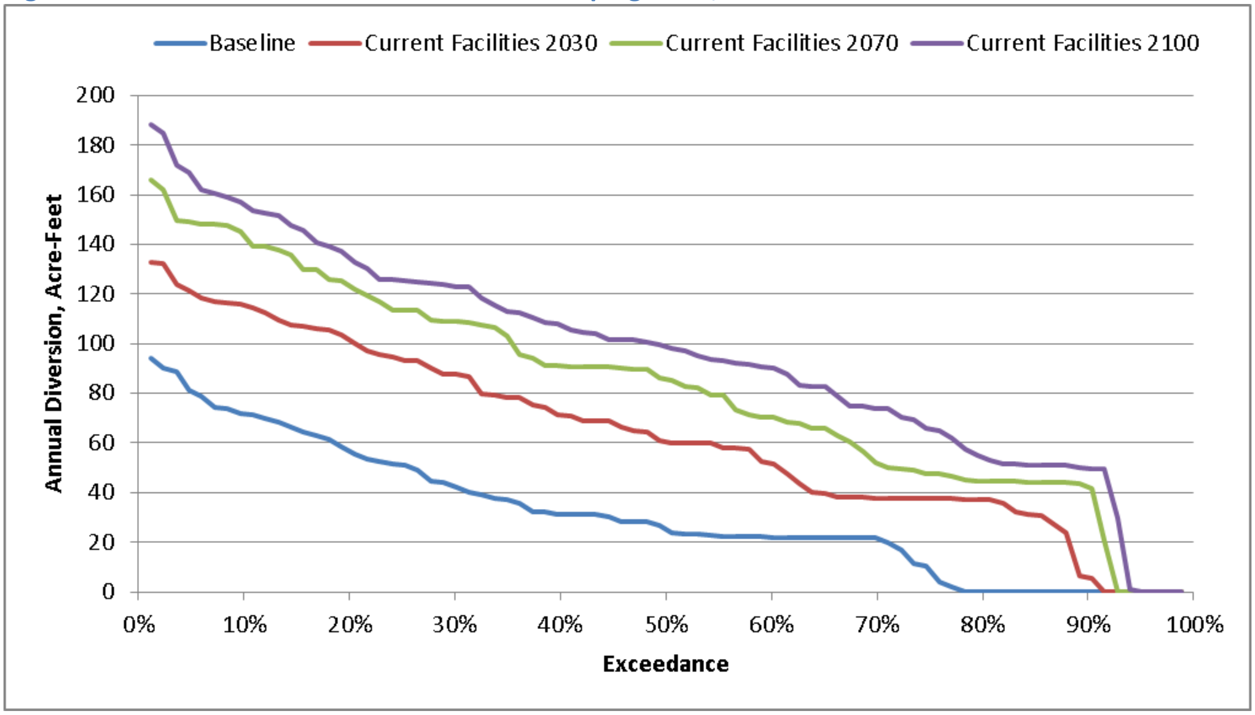
Figure 8 - Annual Diversions at Bear Creek Diversion Dam, 1934-2016



Middle Fork Pumping Plant

Annual diversions at the Middle Fork Pumping Plant are shown in Figure 9.

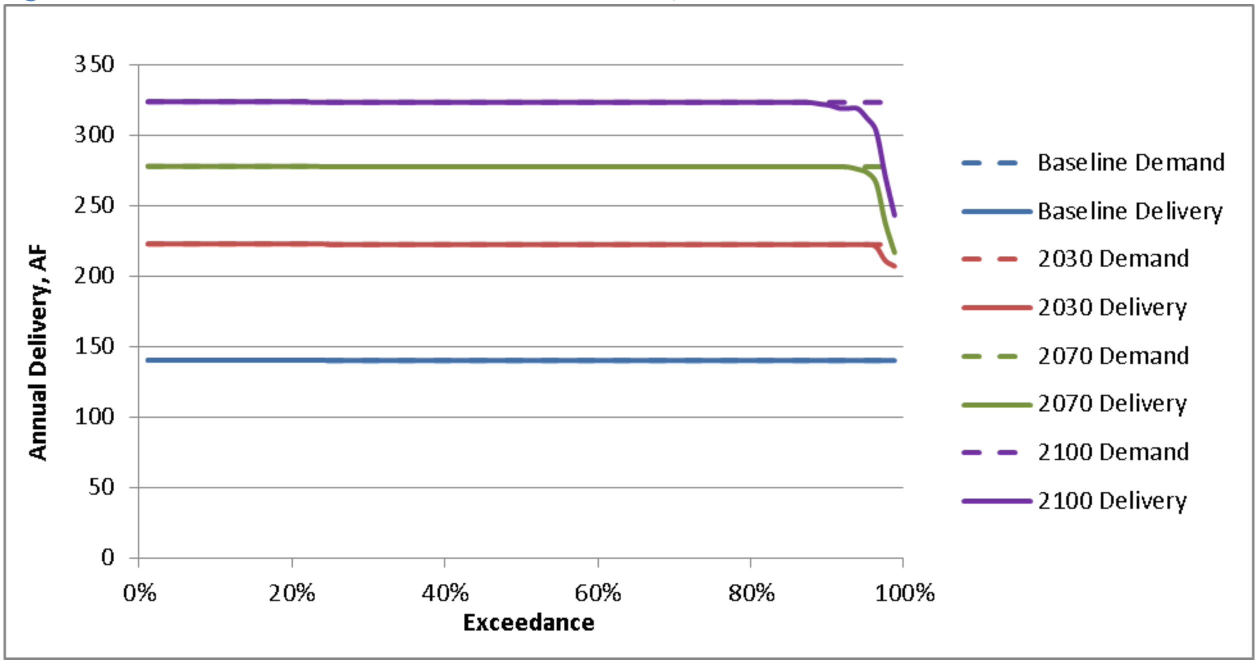
Figure 9 - Annual Diversions at Middle Fork Pumping Plant, 1934-2016



West Point Water Treatment Plant and Regulating Reservoir

Annual usage at West Point WTP with current facilities is shown in Figure 10. The general operations are to use Bear Creek diversions from fall through early summer. In early summer, when Bear Creek hydrology no longer supports diversions, the model will call on the Middle Fork Pumping Plant to redivert releases from Schaads Reservoir. However, full buildout demands at West Point WTP reach 0.7 cfs, greater than the 0.44 cfs diversion capacity at Middle Fork Pumping Plant. This difference between demand and pumping capacity is supplemented with storage at Regulating Reservoir. In dry years, this scenario starts earlier in the summer, and more storage at Regulating Reservoir is used throughout the summer. In very dry years, Regulating Reservoir will run out of storage and is unable to continue supplementing Middle Fork Pumping Plant diversions, resulting in deficits. In the driest years, Schaads Reservoir hits minimum pool and is unable to provide sufficient flows to Middle Fork Pumping Plant, resulting in further deficits.

Figure 10 - West Point Deliveries with Current Facilities, 1934-2016



Future Facility Improvements

One option for future facilities is an expanded Regulating Reservoir, expanding from 50 AF to 150 AF. This option allows Regulating Reservoir to continue to supplement Middle Fork Pumping Plant diversions longer throughout the summer, and avoid deficits in some dry years. The additional storage would be diverted out of Bear Creek throughout the winter and spring. Deliveries to West Point WTP with this option are shown in Figure 11, and diversions from Bear Creek are shown in Figure 12.

Figure 11 - Deliveries to West Point WTP with Expanded Regulating Reservoir, 1934-2016

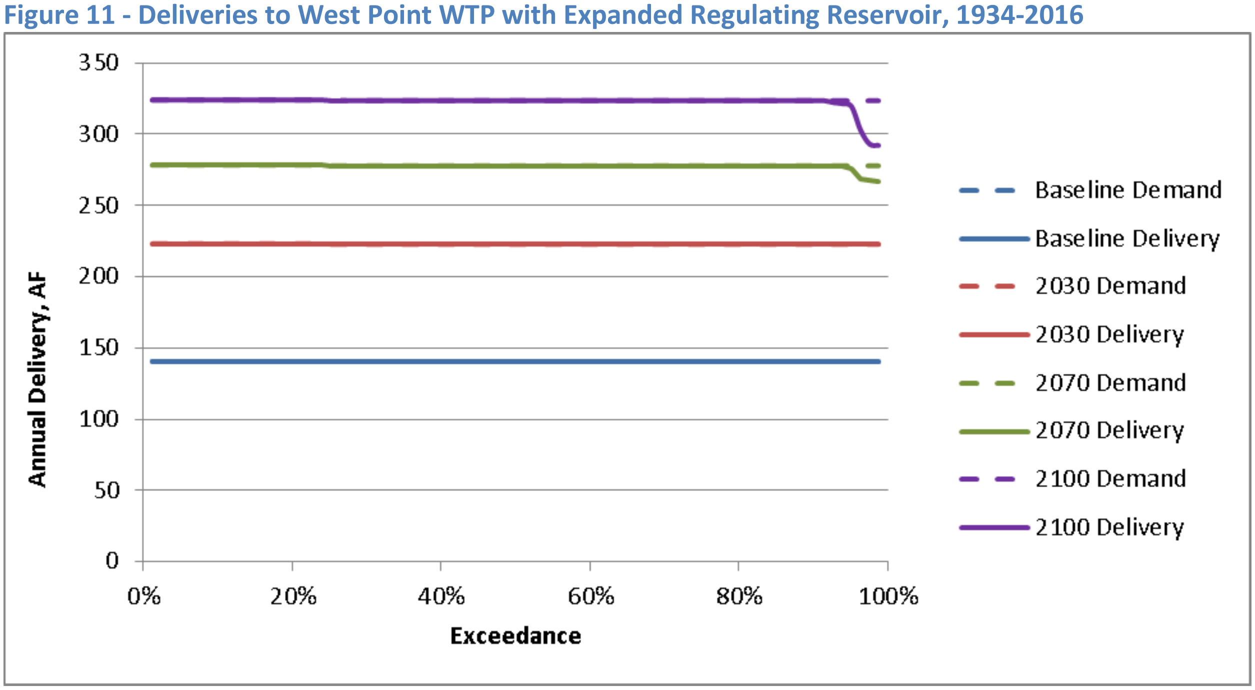
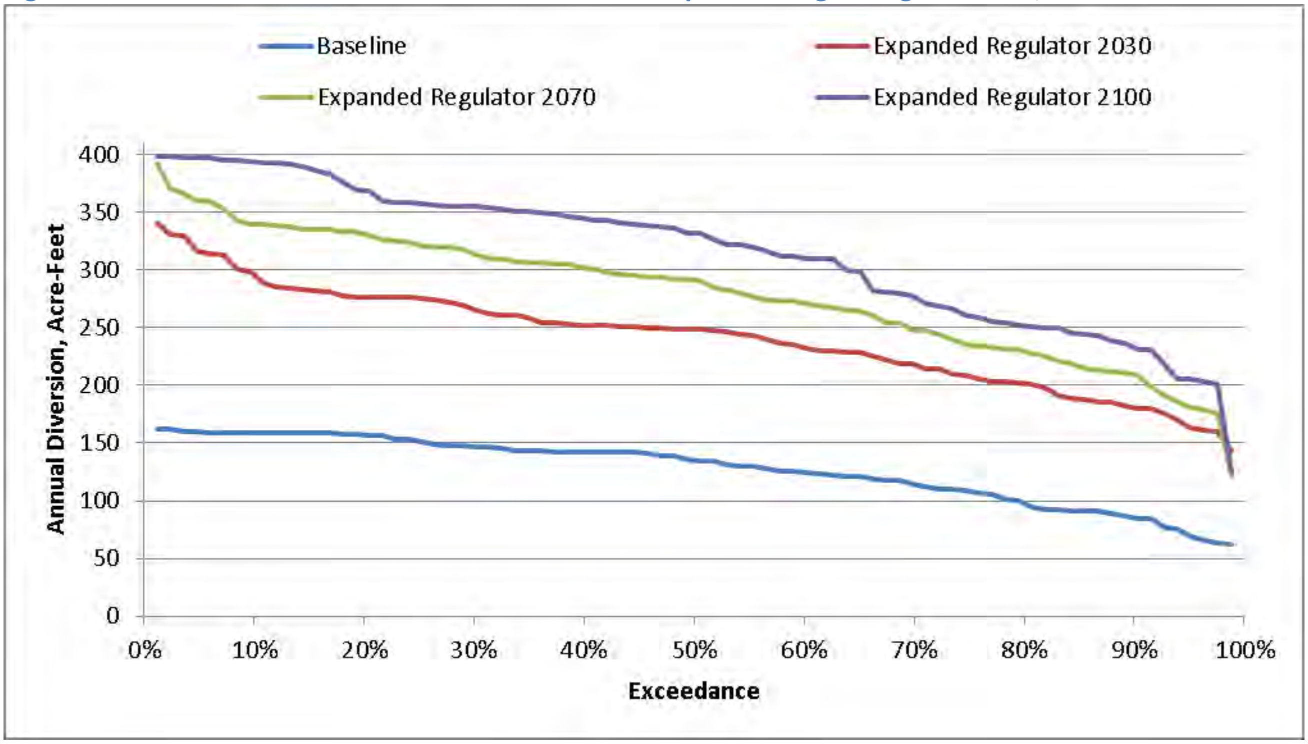
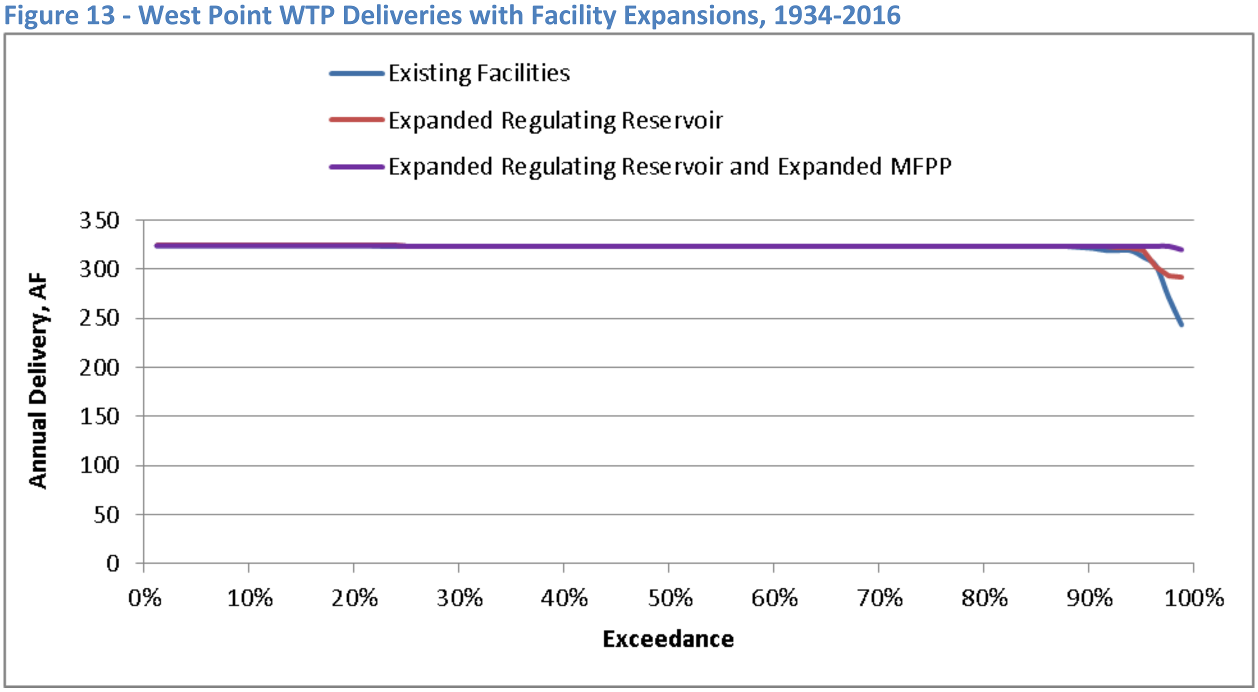


Figure 12 - Bear Creek Diversion Dam Diversions with Expanded Regulating Reservoir, 1934-2016



Another option for future facilities is an expanded Middle Fork Pumping Plant, increasing the capacity from 0.44 cfs to 0.7 cfs. This allows West Point WTP demand to be met fully with diversions from the Middle Fork Pumping Plant throughout the summer. The effect on deliveries at West Point WTP with these expansions, at the 2100 level of demand, is shown in Figure 13.

Figure 13 - West Point WTP Deliveries with Facility Expansions, 1934-2016



Schaads Reservoir and Middle Fork Pipeline

Deliveries along the Middle Fork Pipeline are shown in Figure 14. As seen in the figure, Schaads Reservoir does not have sufficient size to support Middle Fork Pipeline demands at any future demand level. As shown in Figure 15, the demands in the Middle Fork Pipeline cause Schaads Reservoir to reach minimum pool often, and at build out demand level Schaads Reservoir is at minimum pool in almost every year. With Schaads Reservoir reaching minimum pool most summers, Schaads is unable to provide water to Middle Fork Pumping Plant or to the South Fork Mokelumne for diversions into Jeff Davis Reservoir.

Figure 14 - Middle Fork Pipeline Deliveries with Current Facilities, 1934-2016

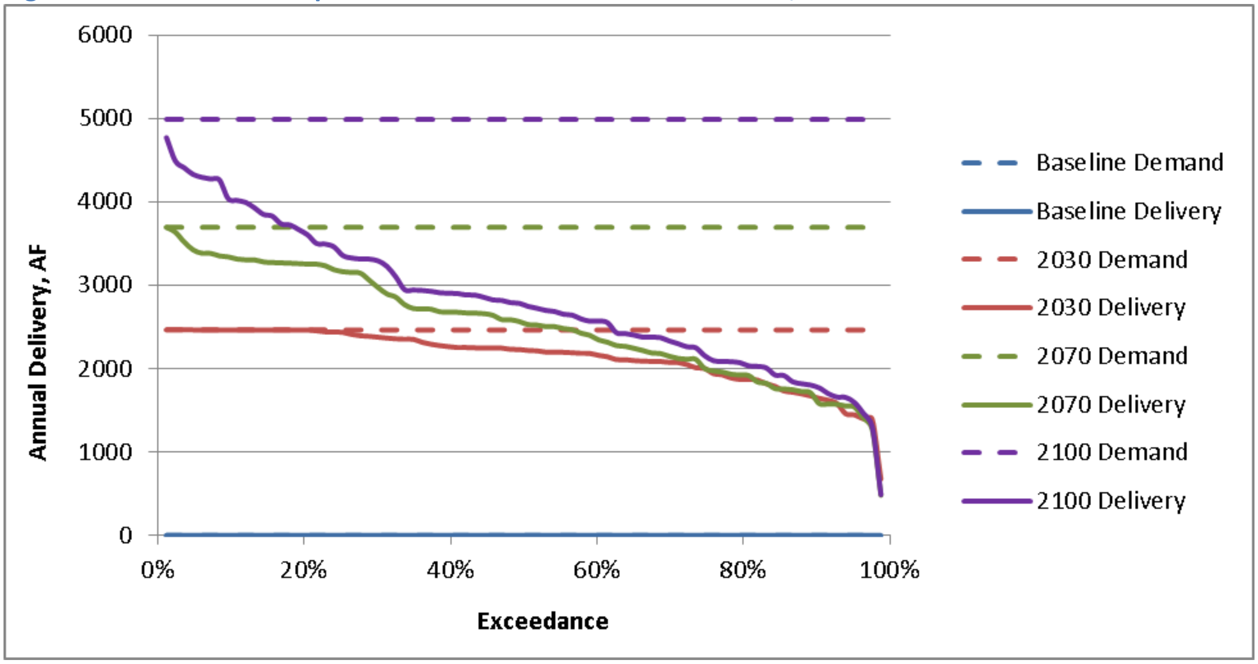
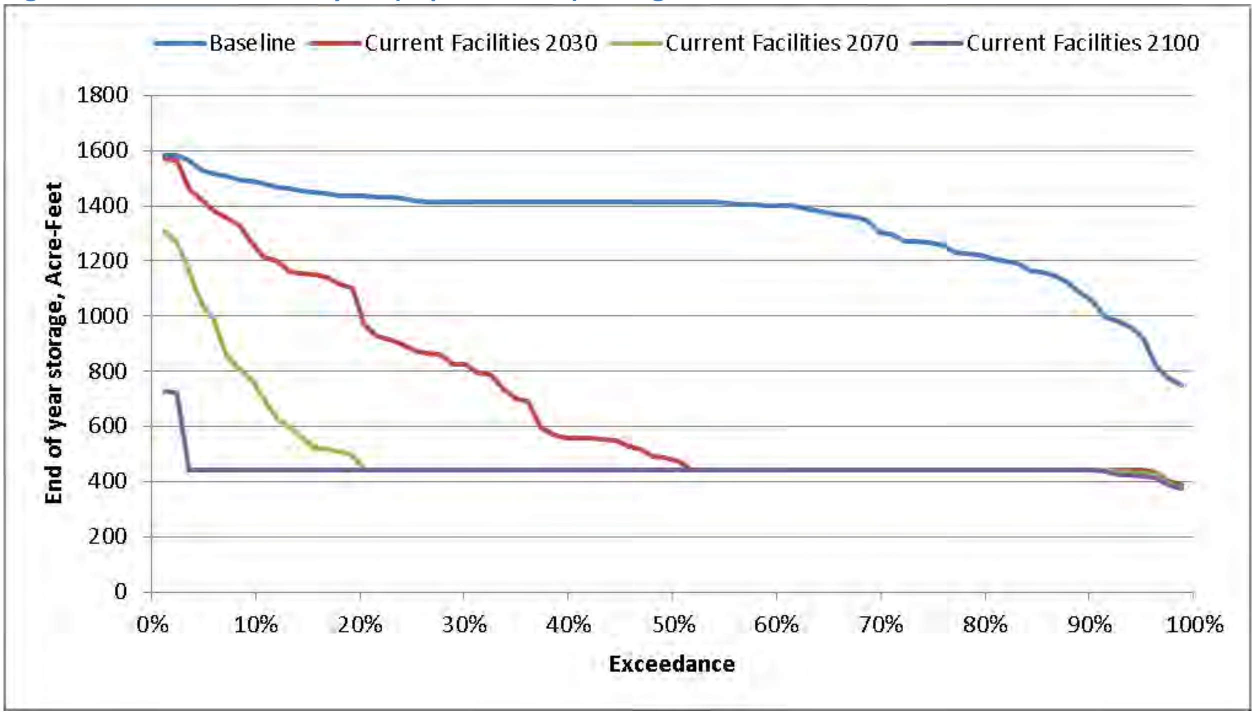


Figure 15 - Schaads End-of-year (September 30) Storage



An option for future facility enhancement is an expanded Schaads Reservoir. This option helps with Schaads storage conditions slightly, as shown in Figure 16, and increases deliveries along the pipeline as shown in Figure 17.

Figure 16 - Schaads End-of-year (September 20) Storage with Expanded Schaads Reservoir

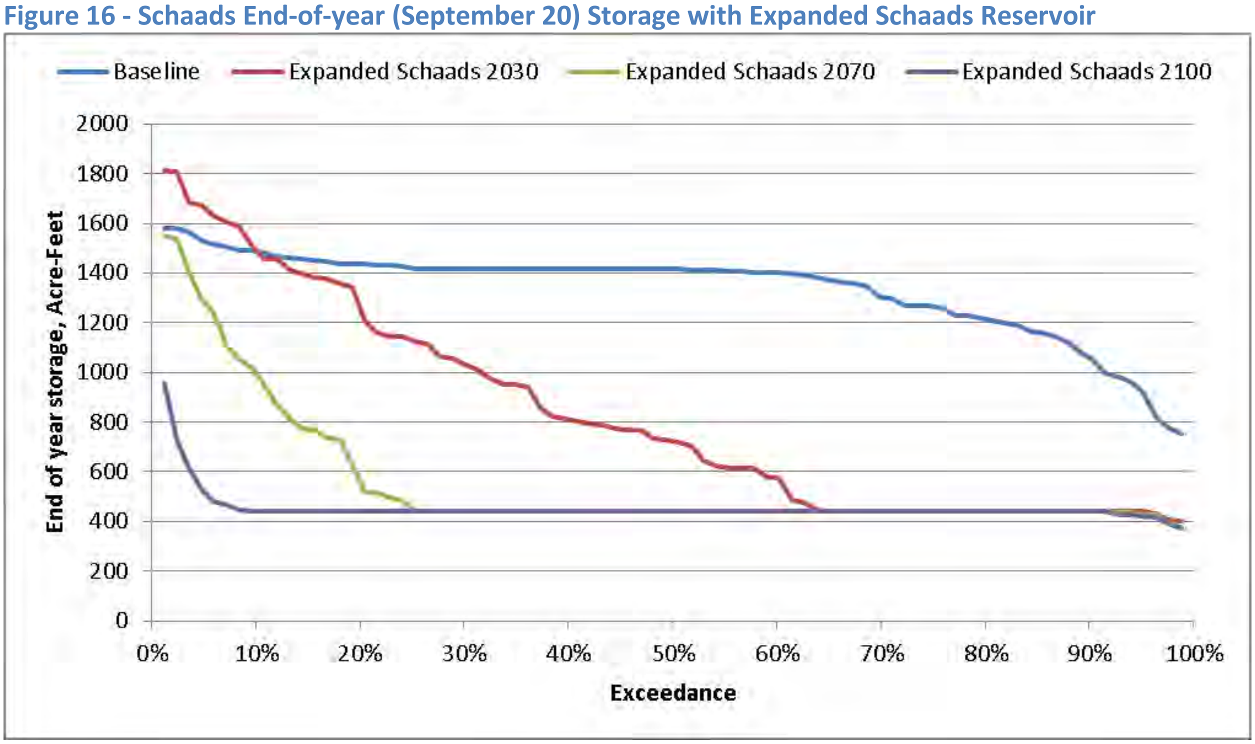
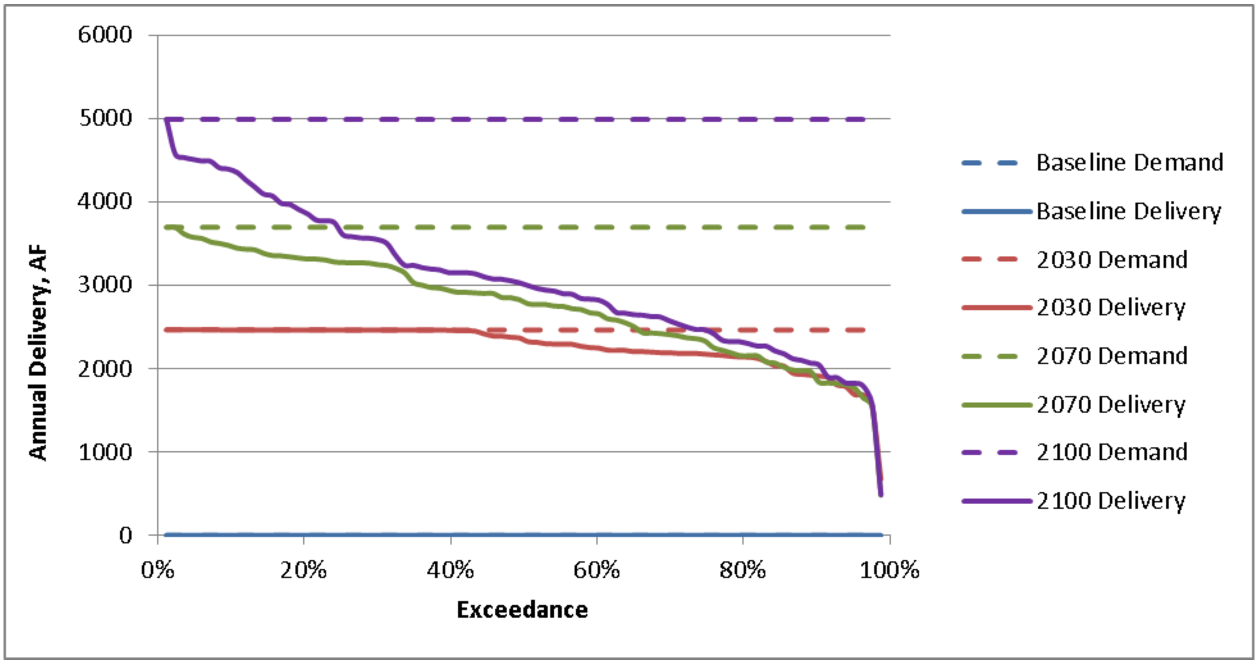


Figure 17 - Middle Fork Pipeline Deliveries with Expanded Schaads Reservoir, 1934-2016



South Fork Pumping Plant and Jeff Davis Reservoir

Annual diversions at the South Fork Pumping Plant with current facilities are shown in Figure 18. Total annual deliveries to Jeff Davis WTP are shown in Figure 19, and end of year storage at Jeff Davis Reservoir is shown in Figure 20. The system generally operates with Jeff Davis Reservoir full, diverting WTP demand at the Pumping Plant. In the summer when flows recede, storage at Jeff Davis Reservoir is used to supplement pumping. In dry years, storage reaches zero, and deficits result. With current facilities, Schaads Reservoir is already at minimum pool and is unable to provide supplementary flows to the South Fork Mokelumne. Increasing the size of Schaads Reservoir tends to provide more deliveries to the Middle Fork Pipeline, but not additional deliveries to Jeff Davis Reservoir.

Figure 18 - Annual Diversions at South Fork Pumping Plant, 1934-2016

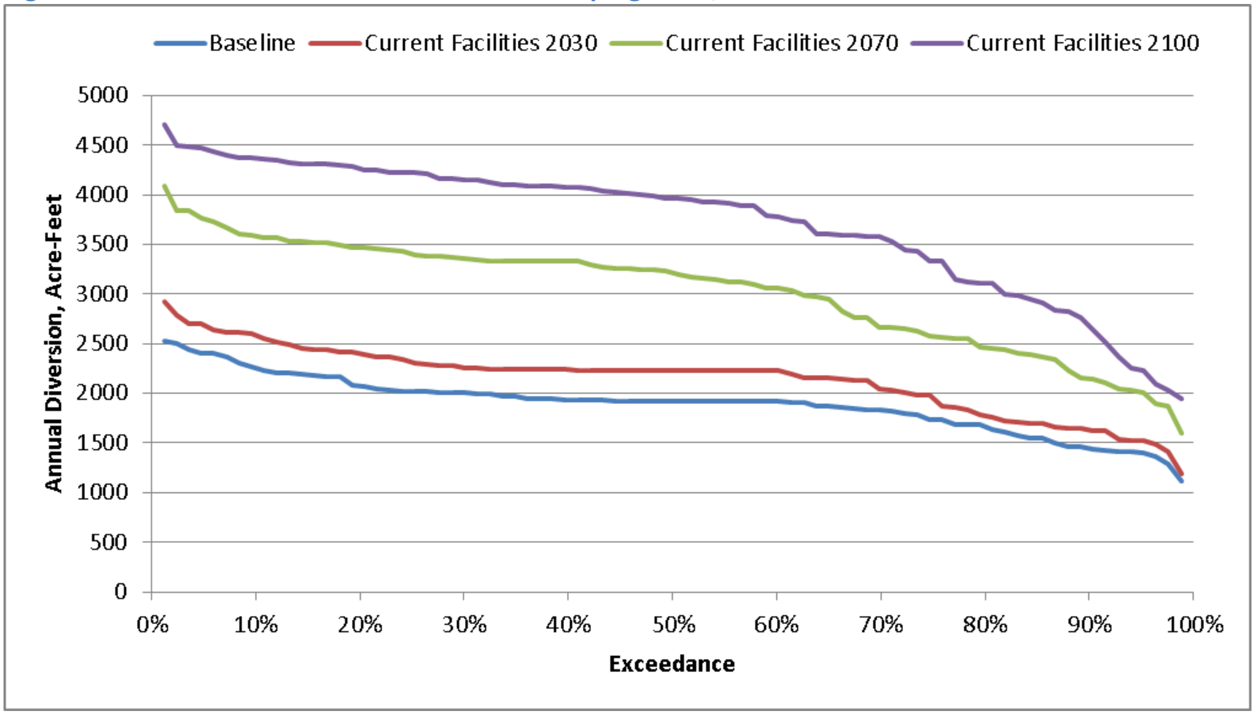


Figure 19 - Jeff Davis WTP Deliveries, 1934-2016

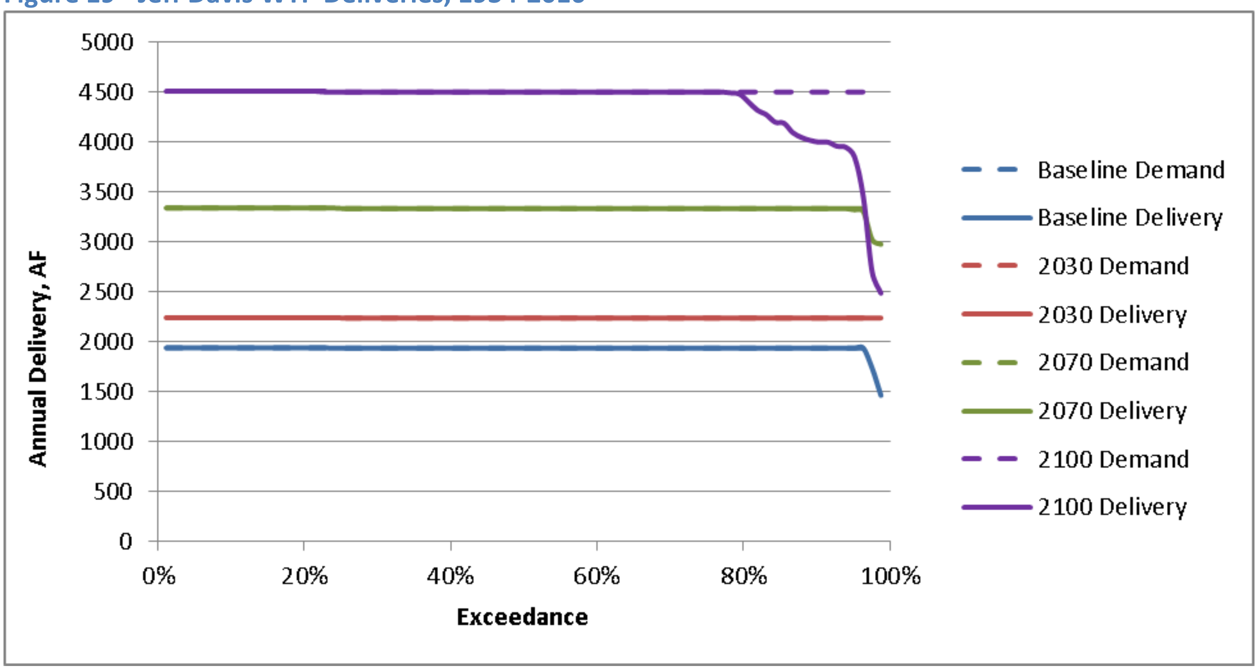
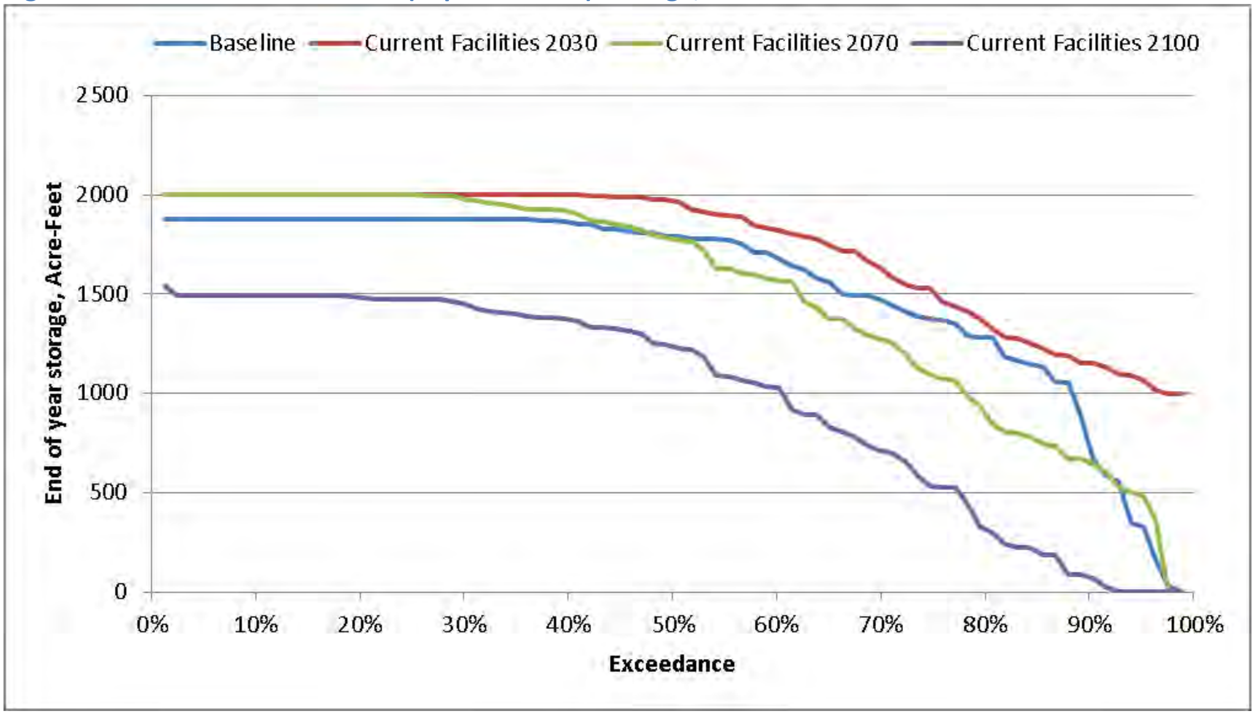


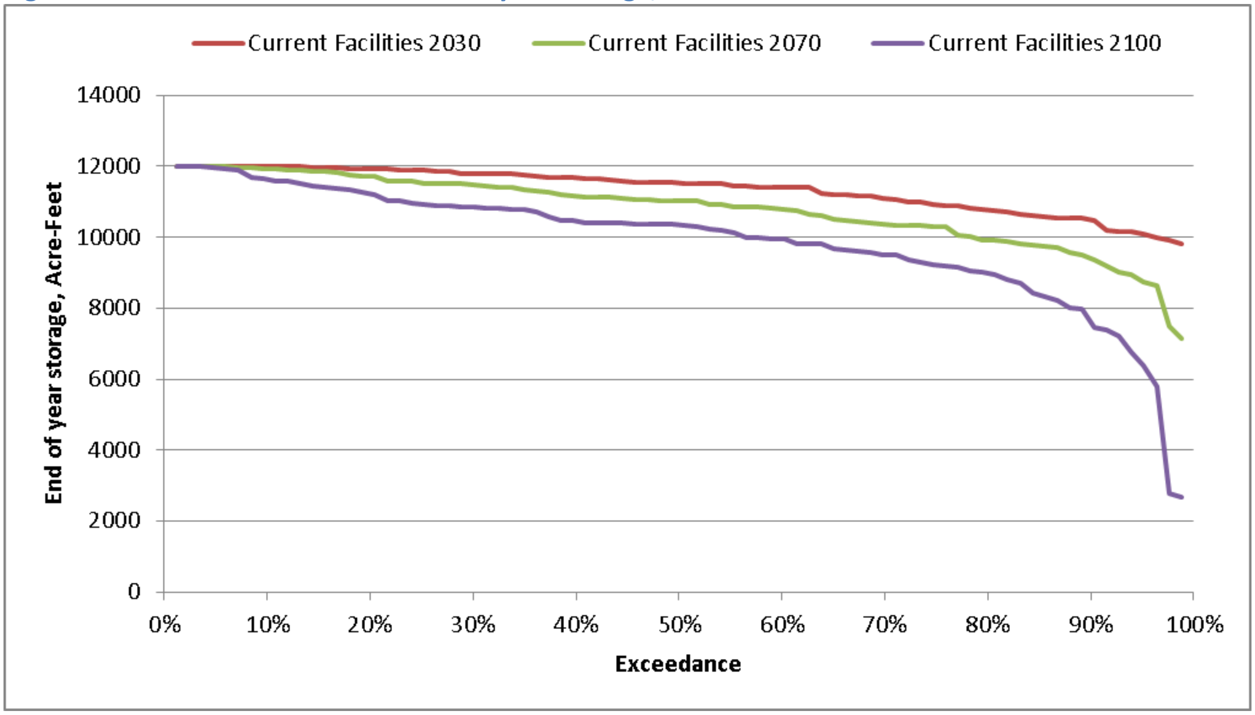
Figure 20 - Jeff Davis End of Year (September 20) Storage, 1934-2016



Middle Fork Reservoir

The Middle Fork Reservoir provides backstop supply for the West Point WTP, Jeff Davis WTP, and Middle Fork Pipeline deliveries (Figure 21). With the inclusion of this reservoir each of these delivery points receive full deliveries in even the driest years at the 2100 level of demand. The reservoir also serves as a backstop to the lower Mokelumne deliveries at Pardee, which divert the natural flow in the river at Pardee.

Figure 21 - Middle Fork Reservoir end of year Storage, 1934-2016



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California Department of Water Resources, Evaporation from Water Sources in California. November 1979.

K.S. Dunbar and Associates, Forest-Middle Fork Dam and Reservoir Project Constraints Analysis. April 1999.

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