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VINA SUBBASIN SURFACE WATER SUPPLY FEASIBILITY ANALYSIS

EVALUATING THE POTENTIAL FOR EXPANDED SURFACE WATER USE
FOR IRRIGATION TO REDUCE GROUNDWATER PUMPING
IN THE VINA SUBBASIN

MARCH 4, 2026

Brad Samuelson, *Managing Member*
209.658.8487
bsamuelson@waterandlandsolutions.com

Chase Hurley, *Managing Member*
209.704.5105
churley@waterandlandsolutions.com



Vina Subbasin Surface Water Supply Feasibility Analysis

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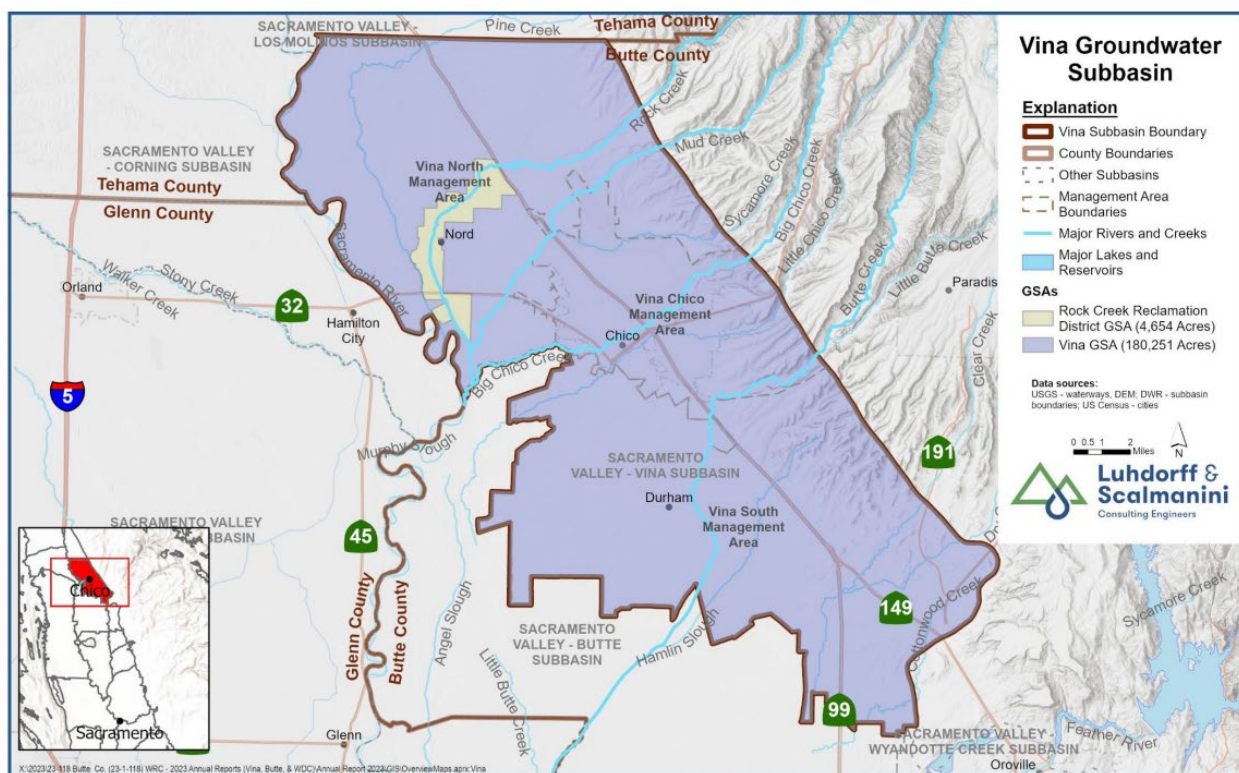
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Preface

The Vina Subbasin

The Vina Subbasin (DWR Basin No. 5-021.57) covers approximately 289 square miles—roughly 185,000 acres—on the western side of Butte County in the northern Sacramento Valley. The subbasin includes the City of Chico, the community of Nord and Durham, and the surrounding rural residential and agricultural lands. Approximately 110,000 people reside in the subbasin, with the majority in Chico.

Figure 1. Vina Groundwater Subbasin.



The Vina Subbasin is predominantly groundwater dependent. Approximately 89 percent of its water supply comes from groundwater, with the remaining 11 percent from surface water. Agricultural irrigation accounts for 91 percent of total water use, supporting orchards, rice, row crops, vineyards, and grazing. Municipal and domestic uses account for the remaining 9 percent.

Groundwater Conditions and the GSP

The Vina GSA and Rock Creek Reclamation District GSA submitted the Vina Subbasin Groundwater Sustainability Plan in January 2022 (2022 GSP), and the Department of Water Resources approved it in July 2023. The GSP estimates the subbasin's sustainable yield at 233,500 acre-feet per year (AFY), based on historical pumping of approximately 243,500 AFY

and an annual storage decrease of approximately 10,000 AFY. County analyses suggest the actual annual deficit may be as high as 20,000 AFY based on longer-term downward trends and observed groundwater levels. Although recent wetter years have stabilized groundwater levels, action is needed to address longer-term downward trends and prepare for the next drought. Under SGMA, the subbasin must achieve sustainability by 2042.

Approach to Sustainability

Closing the gap between current groundwater use and sustainable yield requires a portfolio of actions. No single project will likely be sufficient. Grant funds from the California Department of Water Resources (DWR) Sustainable Management grant program (SGM grant) funded a suite of feasibility studies and pilot projects. The Vina and Rock Creek GSAs and their partners—including Butte County, the City of Chico, Durham Irrigation District, Tuscan Water District, and the Agricultural Groundwater Users of Butte County—are advancing a coordinated strategy across four categories:

Demand Reduction and Conservation

Pilot programs for extended orchard replacement and precision irrigation were investigated with SGM grant funds (to be completed March 2026) to explore approaches for reducing agricultural water demand. Results of the pilot studies will provide information on potential water savings and costs of the programs, but initial estimates indicate that if implemented these approaches could reduce groundwater use by 4,000 to 8,000 AFY at scale.

Groundwater Recharge

The Butte County Recharge Action Plan, adopted by the Board of Supervisors in February 2024, establishes a recharge target of at least 20,000 AFY and prioritizes the Vina Subbasin. The SGM grant funded Recharge Feasibility Analysis identifies potential recharge sites and assessed site feasibility and multi-benefit opportunities. This study will be complete in June 2026.

Increasing Surface Water Supplies

This strategy reduces the reliance on groundwater for water uses in the subbasin by identifying and refining surface water supply projects. This Feasibility Study evaluates opportunities to deliver surface water to farms that currently rely entirely on groundwater, directly offsetting pumping through conjunctive use.

Planning and Partnerships

Interbasin coordination, partnerships with water districts (e.g., Western Canal Water District, Paradise Irrigation District), engagement with state and federal agencies, and collaboration with local entities such as Tuscan Water District enable the other strategies to succeed.

The Challenge of Increasing Surface Water Supplies

The Vina Subbasin lies outside the boundaries of any surface water delivery district. Unlike the neighboring Butte Subbasin, which is served by multiple irrigation districts with established canal systems and water rights, the Vina Subbasin has historically lacked surface water conveyance infrastructure. Building that infrastructure is capital-intensive, and surface water

often costs more than pumping groundwater—at least at current depths—limiting individual landowner incentive to switch without financial support.

However, identifiable opportunities exist. Western Canal Water District holds pre-1914 Feather River water rights totaling 295,000 AFY and operates a canal system along the Vina Subbasin’s southern boundary. Butte County’s State Water Project Table A allocation guarantees a minimum of 3,000 AFY even in the driest years, with current lease agreements expiring in 2031. Paradise Irrigation District (PID) holds surface water rights and supplies the Town of Paradise; however, water demand dropped significantly following the 2018 Camp Fire. PID’s reservoir system discharges directly into Little Butte Creek and Butte Creek which can provide a natural conveyance corridor to Vina Subbasin farms. Past studies, including the 2018 Evaluation of Restoration and Recharge Study and prior PID-Chico intertie evaluations, established the physical and hydrological basis for these concepts.

The regulatory and funding environment has also shifted in favor of action. SGMA provides a legal imperative for surface water development. Proposition 4, approved by California voters in November 2024, authorized \$10 billion in bonds including \$386 million for groundwater management, \$100 million for Integrated Regional Water Management, and \$75 million for regional conveyance projects. Federal WaterSMART programs and corporate water stewardship funding further expand the financial toolkit.

Purpose of This Feasibility Study

In April 2024, the Vina GSA was awarded \$5.5 million through DWR’s SGM Grant Program. Butte County received funds through a subrecipient agreement to implement the Surface Water Supply Project, of which this Feasibility Study is a central deliverable. Two projects were selected for evaluation following a fatal flaw analysis, a 6-1 recommendation by the Butte County Water Commission on April 2, 2025, and Board of Supervisors confirmation on May 27, 2025.

The **South Vina Extension Project** would deliver water from the Feather River or Lake Oroville through Western Canal Water District’s canal system to approximately 2,476 acres of rice land in the southern Vina Subbasin, offsetting an estimated 6,970 AFY of groundwater pumping. The **Ridge to Valley Project** would transfer available PID water through Butte Creek to agricultural diversions in the western portion of the subbasin, offsetting an estimated 1,400 to 3,500 AFY. Together, these projects could offset 8,370 to 10,470 AFY of groundwater extraction—a substantial contribution toward closing the subbasin’s sustainability gap.

This study evaluates water availability, project locations, infrastructure needs, legal and regulatory considerations, groundwater sustainability implications, costs, and funding opportunities. It provides the evidence base for decision-makers to determine whether to advance these projects toward design, permitting, and implementation. The 2042 sustainability deadline demands that we move from planning to action.

Section 1: Introduction

In April 2024, the Vina Groundwater Sustainability Agency (GSA) was awarded \$5.5 million through the Department of Water Resources (DWR) SGM Grant Program to implement PMAs identified in the GSP. The Butte County Department of Water and Resource Conservation (WRC) received funds through a subrecipient agreement with the GSA to implement the Vina Subbasin Surface Water Supply Project (SWSP). The SWSP is a feasibility study that evaluates the potential to expand surface water use in areas within the subbasins for irrigation and reduce groundwater pumping, creating conjunctive use systems for the properties identified. The intent of the Feasibility Study is to identify the opportunities and constraints to increasing surface water use in the subbasin.

Increasing surface water supplies and use within the northwestern portion of Butte County (the Vina Subbasin) has been considered in previous studies led by the WRC. The consultant team evaluated an initial list of projects (Appendix A), that were narrowed down to four for a fatal flaw analysis. The fatal flaws analysis report identified potential challenges that could prevent the four identified projects from being implemented, including an intermediate level of project information to eliminate weaker alternatives and refine the two strongest projects ultimately selected for feasibility studies. On April 2, 2025, the Butte County Water Commission discussed the four projects and voted 6-1 to recommend advancing the South Vina Extension and the Ridge to Valley projects for this Feasibility Study. This recommendation was confirmed by the Butte County Board of Supervisors on May 27, 2025. A staff report from that meeting, including the fatal flaw analysis report, are included in Appendix B.

Section 1.1: Overview of Feasibility Study Projects

Two projects were selected for evaluation in this Feasibility Study:

- 1) South Vina Extension
- 2) Ridge to Valley

Section 1.1.1: South Vina Extension Project

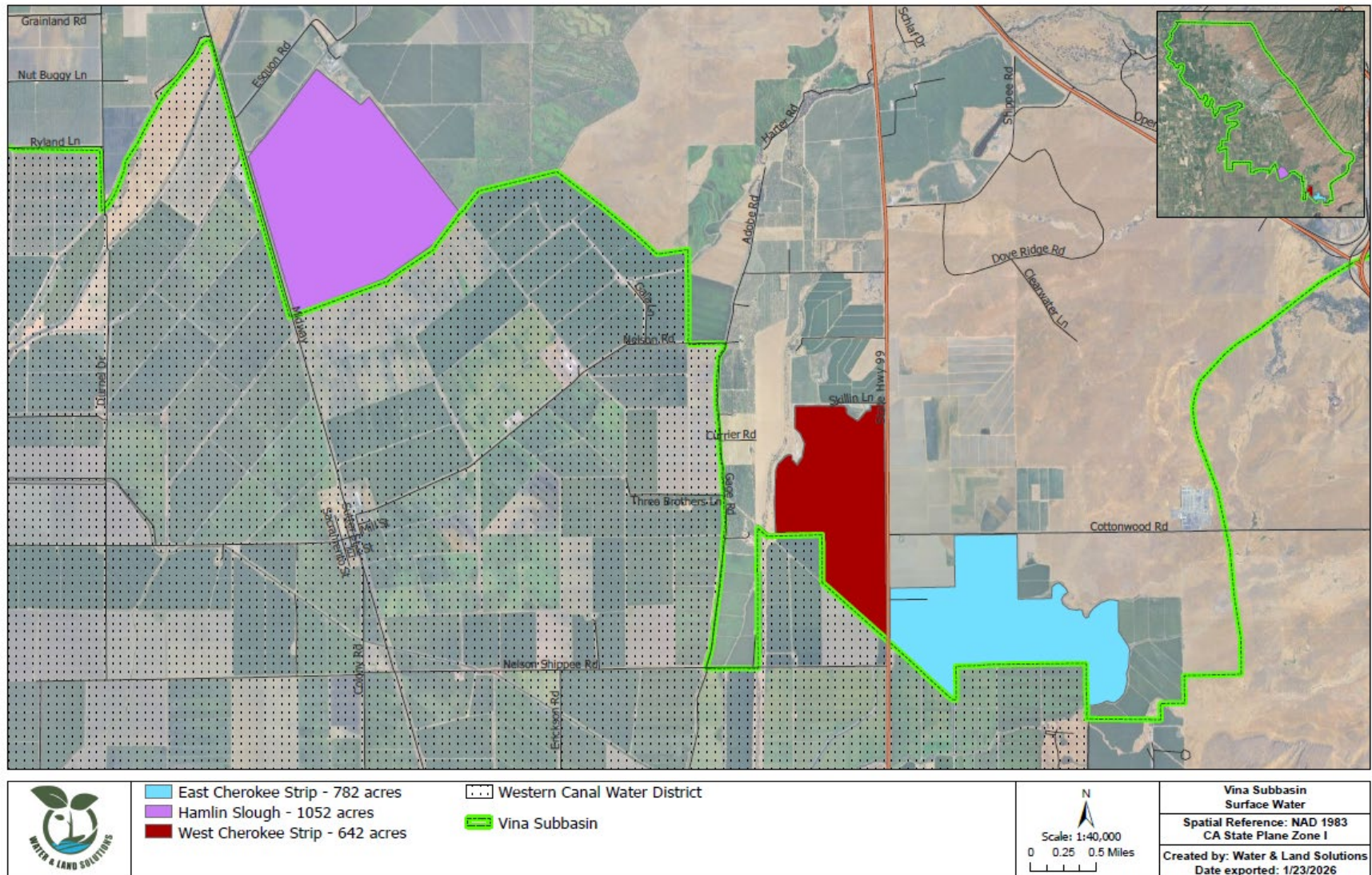
The South Vina Extension, depicted in Figure 2 below, proposes transferring water¹ from water rights held on the Feather River or stored in Lake Oroville through Western Canal

¹ A water transfer is a temporary or long-term change in the point of diversion, place of use, or purpose of use of water due to a transfer, sale, lease, or exchange of water or water rights. Temporary transfers are those lasting one year or less, and long-term transfers are those lasting more than one year. https://water.ca.gov/-/media/DWR-Website/Web-Pages/Programs/California-Water-Plan/Docs/RMS/2016/07_Water_Transfers_July2016.pdf

Water District (WCWD) and new pipelines to target areas in the Vina Subbasin. This approach minimizes the need for extensive new infrastructure by leveraging existing conveyance facilities, significantly reducing capital costs compared to other alternatives for delivering Feather River water that have been previously considered in Butte County.

Project sites were chosen due to their proximity to WCWD boundaries, cropping patterns and existing water usage, existing infrastructure, and contiguous property owners with a willingness to adopt conjunctive use irrigation practices.

Figure 2. Project Area for the South Vina Extension Project.



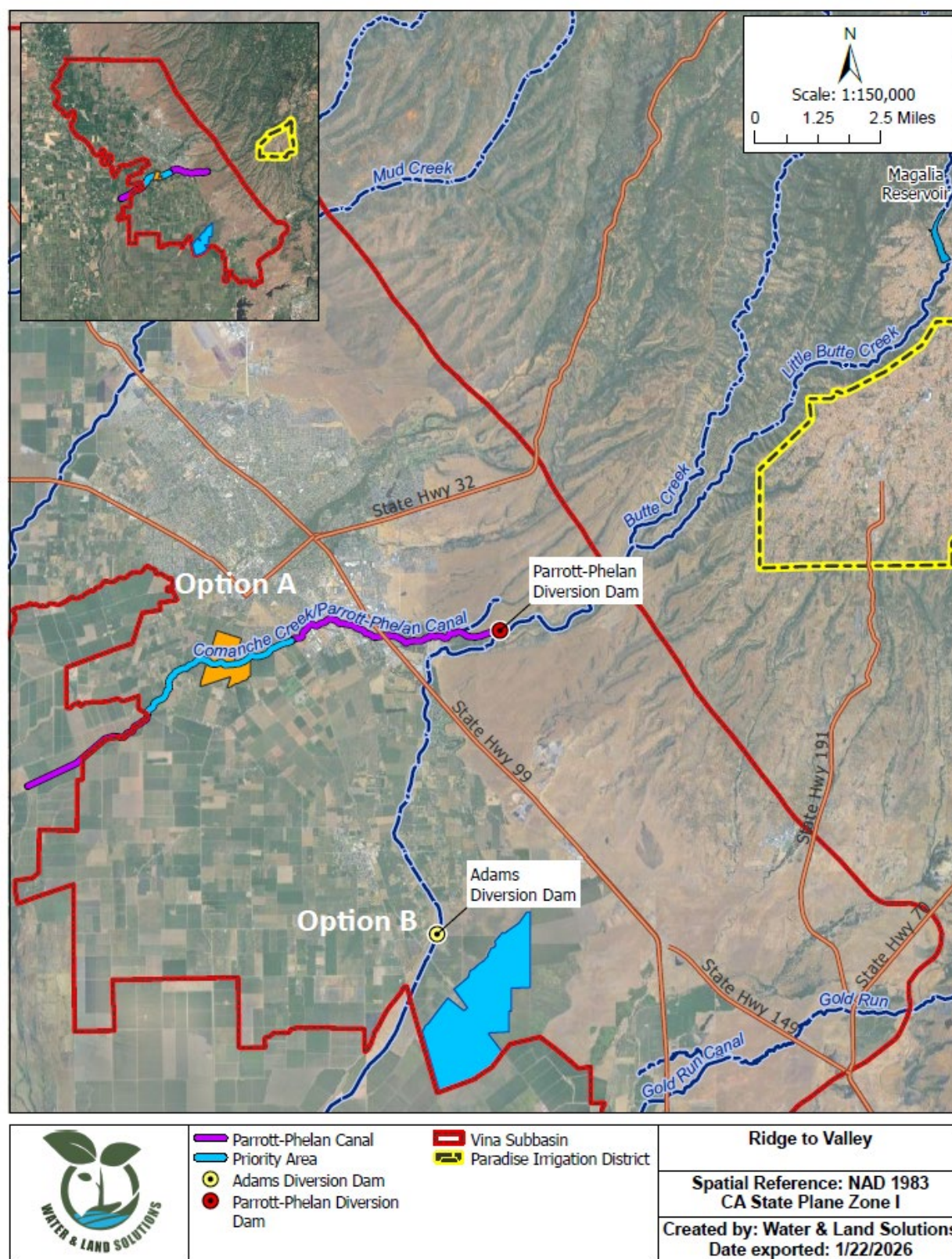
Section 1.1.2: Ridge to Valley Project

The Ridge to Valley Project option refers to a term used by locals to describe the mountain “ridge” east of Chico primarily encompassing the towns of Paradise and Magalia. This project would utilize existing Paradise Irrigation District (PID) water rights and transfer them, on a temporary basis, to groundwater dependent farmers in the Vina Subbasin for conjunctive use direct irrigation. The water would be discharged from PID’s reservoirs into Little Butte Creek to be re-diverted further down Butte Creek, as shown in Figure 3, below.

Project Sites were chosen due to connectivity to Butte Creek, continuity of property with sufficient water demand, existing groundwater dependence, and landowner willingness.

This Feasibility Study evaluates and discusses water availability, potential surface water sources, infrastructure that would need to be improved or constructed, project locations, legal and regulatory implementation considerations, costs for operation and maintenance (O&M), capital costs and cost-benefit analysis, and potential funding opportunities.

Figure 3. Project Area for Ridge to Valley Project.



Section 1.2: Conjunctive Use

The Vina GSA is exploring programs that will facilitate long-term groundwater sustainability, including those that include the acquisition of surface water supplies to promote conjunctive use and/or recharge of the local aquifer. Any water that the Vina GSA acquires in support of these sustainability programs will not uniquely benefit a particular landowner or groundwater right holder, rather, the purpose of such programs will be to increase groundwater storage for the health of the subbasin and for the continued sustainability to support the beneficial use of groundwater. For example, if the Vina GSA were to acquire surface water and provide such supply to landowners to reduce reliance on groundwater, the conjunctive use and resulting groundwater benefit would not accrue to that particular landowner, but for the subbasin as a whole. The Vina GSA understands the limitations of its role, and will not be making determinations of groundwater rights, while expressly reserving its authority to limit extractions, if necessary, to achieve sustainability.

Legal implications of conjunctive use and recharge programs will be further addressed by the Vina GSA outside of this report.

Section 1.3: Groundwater Sustainability Indicators

SGMA requires GSAs to manage for six undesirable results that indicate unsustainable groundwater conditions in a subbasin including: (1) chronic lowering of groundwater levels, (2) reduction of groundwater storage, (3) seawater intrusion, (4) land subsidence, (5) water quality degradation, and (6) depletions of interconnected surface waters.

This report primarily focuses on benefits to groundwater levels, as the 2022 Vina Groundwater Subbasin GSP uses groundwater levels as a proxy for groundwater storage, subsidence, and interconnected surface waters². According to the 2022 GSP, the subbasin's sustainability indicators show the following:

1. The GSP showed a downward trend in groundwater levels³.
2. Declining groundwater levels indicate an overall decline in groundwater storage.
3. While groundwater levels are used as a proxy for subsidence in the GSP, and groundwater levels are trending downward, the GSP notes that available data sources indicate that inelastic subsidence is not significant in the Vina Subbasin⁴.

² **Groundwater Sustainability Plan (GSP 2022) for the Vina Subbasin (5-021.57)**, submitted January 28, 2022; available from California Department of Water Resources SGMA Portal. P. ES-16.

³GSP 2022. P. 84.

⁴ GSP 2022. P. 91.

4. Interconnected surface waters are not well understood in the Vina Subbasin at this time. The GSAs are actively working to address identified data gaps.

With these sustainability indicators in mind, the Project team found that the Projects evaluated in the Feasibility Study could provide benefits to groundwater levels in the Vina Subbasin, and by proxy, benefits to groundwater storage, subsidence, and interconnected surface waters.

The 2022 GSP identifies areas adjacent to Butte Creek as potential groundwater dependent ecosystem locations. Both projects identified in this study include properties near Butte Creek (see Figures 2 and 3), likely resulting in benefits to these GDEs. However, given the data gaps and lack of thorough understanding regarding interconnected surface waters in the subbasin, it is unknown the extent of the benefits these projects may provide to interconnected surface waters. Instead, the project team used groundwater levels as a proxy for this sustainability indicator, as was done in the 2022 GSP.

For both projects, benefits to groundwater levels would be commensurate with the amount of surface water delivered. This would be ensured by agreements with landowners receiving the surface water, who would agree to reduce groundwater pumping by an equal amount to the surface water that is delivered. These agreements are described further in Sections 1.4, 2.5.2, and 3.5.2.

Section 1.4: Governance

Implementation of the projects proposed in this study would require involvement of one or more local agencies and landowners. Agreements will be needed with the water supplier and a project implementer. In the case of the South Vina Extension Project, the water supplier could be either Butte County or WCWD. These options are discussed further in Section 2.1. In the case of the Ridge to Valley Project, the water supplier would be PID. These projects could be implemented in a number of different ways. For example, for both projects the implementer could be either the Vina GSA or Tuscan Water District, whose boundaries encompass both of the projects. Roles and responsibilities of involved parties would be further defined through an MOU or other appropriate legal agreement. Identification of the project implementer is outside of the scope of this Feasibility Study.

After a project implementer is decided on, and agreements are entered into between the supplier and the implementer, individual agreements will also be needed with the implementers and the landowners who will carry out these projects. These landowner agreements are discussed further in Sections 2.5.2 and 3.5.2.

Section 1.5: Funding Opportunities

Grant funding for infrastructure costs can provide one-time funding to offset one-time capital costs and increase the financial feasibility of both the South Vina Extension Project and the Ridge to Valley Project. State and federal grant funding opportunities include California's Prop 4 Bond and federal WaterSMART programs. California voters approved \$10 billion in bonds through Proposition 4 the "Safe Drinking Water, Wildfire Prevention, Drought Preparedness, and Clean Air Bond Act of 2024" in November 2024. Funding for water infrastructure projects is a major component of the bond, including the funding opportunities below that could be useful for Vina Subbasin projects.

- \$386 million for Groundwater management
- \$100 million for Integrated Regional Water Management
- \$75 million for Regional conveyance projects and repairs

A portion of the costs identified in Sections 2.7 and 3.8 could be offset with public funding opportunities. For the South Vina Extension Project, costs eligible for public funding could be as much as \$5,067,200, and \$448,144 for the Ridge to Valley Project. These specific project cost offsets are described further in Sections 2.7 and 3.8.

An increasing number of large corporations have begun funding water supply, water efficiency, and groundwater recharge projects to offset corporate water demands. The GSA could also provide funding, as these conjunctive use projects would benefit groundwater levels for the entire subbasin to comply with SGMA.

Additional funding will also likely be needed to offset the cost of purchasing the water, because public bonds cannot finance the purchase of water. If the cost of water is more expensive than the growers' current cost to pump groundwater, growers are unlikely to utilize surface water that comes at an additional expense without an incentive.

Section 2: South Vina Extension

The South Vina Extension proposes transferring water from water rights held on the Feather River or stored in Lake Oroville through Western Canal Water District's (WCWD) canal system and new pipelines to target areas in the Vina Subbasin.

Section 2.1: Water Source

Section 2.1.1 Western Canal Water District

WCWD holds water rights from Butte Creek and Feather River, totaling 304,300 AF per

year, for 59,000 irrigable acres within the district. WCWD’s Feather River rights are Pre-1914⁵ and entitle the district to 295,000 AF from March – October. The rights, originally acquired by the district in 1984 from Pacific Gas & Electric Company’s “Western Canal” water system, include natural flow and stored water in the upper Feather River watershed. The natural flow may be curtailed up to 50% in any one year or 100% in any series of seven consecutive years. The stored water may not be curtailed⁶. The District’s Butte Creek water rights are subject to the Butte Creek Adjudication and may be curtailed in times of shortage, according to the adjudication’s prioritization. The district’s water rights are summarized below in Table 1.

Table 1. Western Canal Water District Water Rights

SWRCB Permit or Application Number	Priority Date	Source	Quantity	Notes
S000925	Pre-1914	Feather River, natural flow	150,000 AF	Subject to reduction during drought
S000925	Pre-1914	Feather River, upstream storage	145,000 AF	Not subject to reduction during drought, or otherwise
Butte Creek Decree No. 18917	1942	Butte Creek	9,300 AF	Could be curtailed to 0 AF

Acre Feet (AF)

WCWD is one of 11 GSAs in the Butte Subbasin, neighboring the southern portion of the Vina Subbasin. While outside of the Vina Subbasin, WCWD is the closest surface water district to the Vina Subbasin. Water from WCWD could be used for surface water deliveries in Vina Subbasin, subject to availability, as the primary or supplemental source of water supply for the South Vina Extension.

WCWD’s pre-1914 water right and diversion agreement with the California Department of Water Resources (DWR) enables them to deliver water outside their boundary. If WCWD is delivering the water as is contemplated in this Project, then it is considered a water delivery rather than a water transfer and is not subject to water transfer processes or requirements.

WCWD has indicated that the requested amount of 6,970 AF is available in non-cutback

⁵ Pre-1914 appropriative water rights are among California’s most senior water rights. In times of shortage, Pre-1914 water right holders are one of the last to be curtailed.

⁶ Western Canal Water District, *Water Supply Fact Sheet* (2022), <https://static1.squarespace.com/static/56f3336d9f7266fac154ef8b/t/6244e79423718a1316e9767f/1648682900809/Water.Supply.2022.pdf>.

years, when the district's water rights have not been curtailed. Non-cutback years are anticipated to occur 7 in 10 years. In years when WCWD experiences a water shortage—3 in 10 years—water would not be available to lands outside of the District, including these projects in Vina Subbasin. Outside-district deliveries from WCWD are always considered interruptible, and the lands in Vina Subbasin that receive water from WCWD would be expected to continue to maintain and use their groundwater wells as needed at their own expense as they do currently.

Section 2.1.2: Water Source: Butte County Table A

When DWR constructed the State Water Project (SWP) including Lake Oroville in the 1960's, Butte County was allocated a share of the project water, referred to as Table A water. There is a lack of infrastructure to convey this water from Lake Oroville to other portions of Butte County that have a demand for the water. Butte County currently leases that water to various water agencies throughout the state. There has been expressed interest, including in the Butte County Recharge Action Plan⁷, to utilize that water within the county. Butte County's Table A water allocation could be used for this Project and wheeled through WCWD's main canal (Western Canal). All of Butte County is within the SWP Place of Use, which enables any land within the county to legally receive SWP Table A water. When Butte County leases its Table A water to local agencies, Butte County serves as a water wholesaler, and therefore a water transfer is not required.

In 2014, Butte County filed a lawsuit against DWR, claiming Area of Origin (AOO) protections for curtailments to their Table A allocation. A settlement was reached in 2014, in which DWR and intervening parties comprised of water districts that receive SWP water, agreed to a specific allocation structure for Table A water. In years when the South of Delta (SOD) allocation is 0 or 5 percent, Butte County has 3,000 AF available for in-county uses and in years when the SOD allocation is 15 percent or higher, that allocation increases to a minimum of 3,500 AF.⁸

Table 2 below shows SWP water allocations in the years since this settlement was reached in 2014, modifying how Table A allocations to Butte County are calculated. These historical allocations could be compared to a benchmark of approximately 7,000 AF needed for the Vina Subbasin projects. Even in the worst drought years, Butte County receives at least 3,000 AF and lands served by this Project could have at least some surface water available to them. Existing in-county contracts include water wholesales to Del Oro and California Water Service Company, typically totaling 450 AF/year.

⁷ Butte County Department of Water & Resource Conservation, *Butte County Recharge Action Plan* (adopted February 13, 2024), Butte County, <https://ca-buttecounty.civicplus.com/DocumentCenter/View/12687/Butte-County-Recharge-Action-Plan-2024>.

⁸ Butte County Table A Allocation Overview <https://www.buttecounty.net/DocumentCenter/View/4883/Butte-County-Table-A-Allocation-Overview-PDF>

Table 2. SWP Allocations for Butte County Table A under AOO Settlement, 2014-2025

Year	Allocation AF	Percent of 7,000 AF benchmark
2014	3,000	43%
2015	6,000	86%
2016	27,500	>100%
2017	27,500	>100%
2018	17,875	>100%
2019	27,500	>100%
2020	6,000	86%
2021	3,000	43%
2022	3,000	43%
2023	27,500	>100%
2024	19,250	>100%
2025	22,000	>100%

Source: California Department of Water Resources⁹

Butte County currently has Table A Lease Agreements with multiple South of Delta water users for up to 24,000 AF/year of its Table A allocation, subject to annual SWP allocations. Existing agreements with the SOD contractors expire in 2031 and include provisions that Butte County can reduce the existing SOD contracted water due to increases in in-county water use. The agreements allow for changes to be made every 5 years with the next potential reduction to be in place by January 1, 2031 (when they expire), and notice provided by October 1, 2030.¹⁰

If Table A water was delivered to lands in Vina Subbasin via the Western Canal, a wheeling agreement would be needed with WCWD, discussed further in Section 2.4.

Section 2.2: Project Locations

Three properties in Vina Subbasin are evaluated in this Feasibility Study as potential locations for receiving surface water in the South Vina Extension Project (Project), with a total combined acreage of 2,476 acres of rice. Project sites were chosen due to their

⁹ State Water Project Historical Table A Allocations Water Years 1996-2025 <https://water.ca.gov/-/media/DWR-Website/Web-Pages/Programs/State-Water-Project/Management/SWP-Water-Contractors/Files/Historical-SWP-allocations-1996-----2025-w-NOD-tables-042925.pdf>

¹⁰ Butte County – Westside Water Districts Agreement

proximity to WCWD boundaries, cropping patterns and existing water usage, existing infrastructure, and contiguous property ownership with a willingness to adopt conjunctive use. The project team conducted site visits and interviews with landowners, farmers, and WCWD staff to assess the suitability of these properties. The three proposed areas include: Hamlin Slough, which would serve 1,052 acres shown in purple on Figure 2, West Cherokee Strip, which would serve 642 acres shown in red, and East Cherokee Strip, which would serve up to 782 acres shown in blue on Figure 2.¹¹ The total acreage comes to 2,476 acres and is all planted in rice.

Section 2.3: Water Demand and Availability

To serve 2,476 acres of rice with 4 AF of water per acre would require 9,904 AF. This total demand is affected by the following circumstances:

1. Capacity constraints in WCWD's main canal, described further in Section 2.4, from July to early August. a
2. Butte Creek water rights are utilized by the Hamlin Slough property for early season flood up, leaving water demand from mid-June to mid-August only, for this property.
3. Potential additional demand for the Hamlin Slough and West Cherokee Strip properties for fall water for straw decomposition. The East Cherokee Strip property would not take fall water because natural creeks are used to deliver water to this property, which requires the installation of dams that are removed before the fall. It is infeasible to keep the dams in place due to high flow in the creeks during the fall and winter months.

Taking these considerations into account, an estimated **6,970 AF could be delivered each year**, as detailed in Table 3 below. Peak instantaneous demand anticipated for all three properties is 47 cubic feet per second (cfs)¹².

¹¹ See Appendix C for a potential alternative for delivering surface water to Cherokee Strip properties

¹² Peak flow assumption is 2.5 cfs for every 100 acres and maintenance flow assumption is 1.9 cfs for every 100 acres.

Table 3. Water demand for Vina Subbasin projects

Hamlin Slough	Acre feet
Irrigation season demand (39.6 AF for 60 days)	2,377
Minus canal capacity issues (39.6 AF for 30 days)	-1,189
Plus fall water (1 AF/ac)	1,052
Total property demand	2,240
West Cherokee Strip	Acre feet
Irrigation season demand (642 acres x 4 AF/ac)	2,568
Minus canal capacity issues (24.2 AF for 30 days)	-725
Plus fall water (1 AF/ac)	642
Total property demand	2,485
East Cherokee Strip	Acre feet
Irrigation season demand (782 acres x 4 AF/ac)	3,128
Minus canal capacity issues (29.5 AF for 30 days)	-885
Total property demand	2,244
TOTAL Vina Subbasin Demand	6,970

Section 2.4: Delivery and Infrastructure

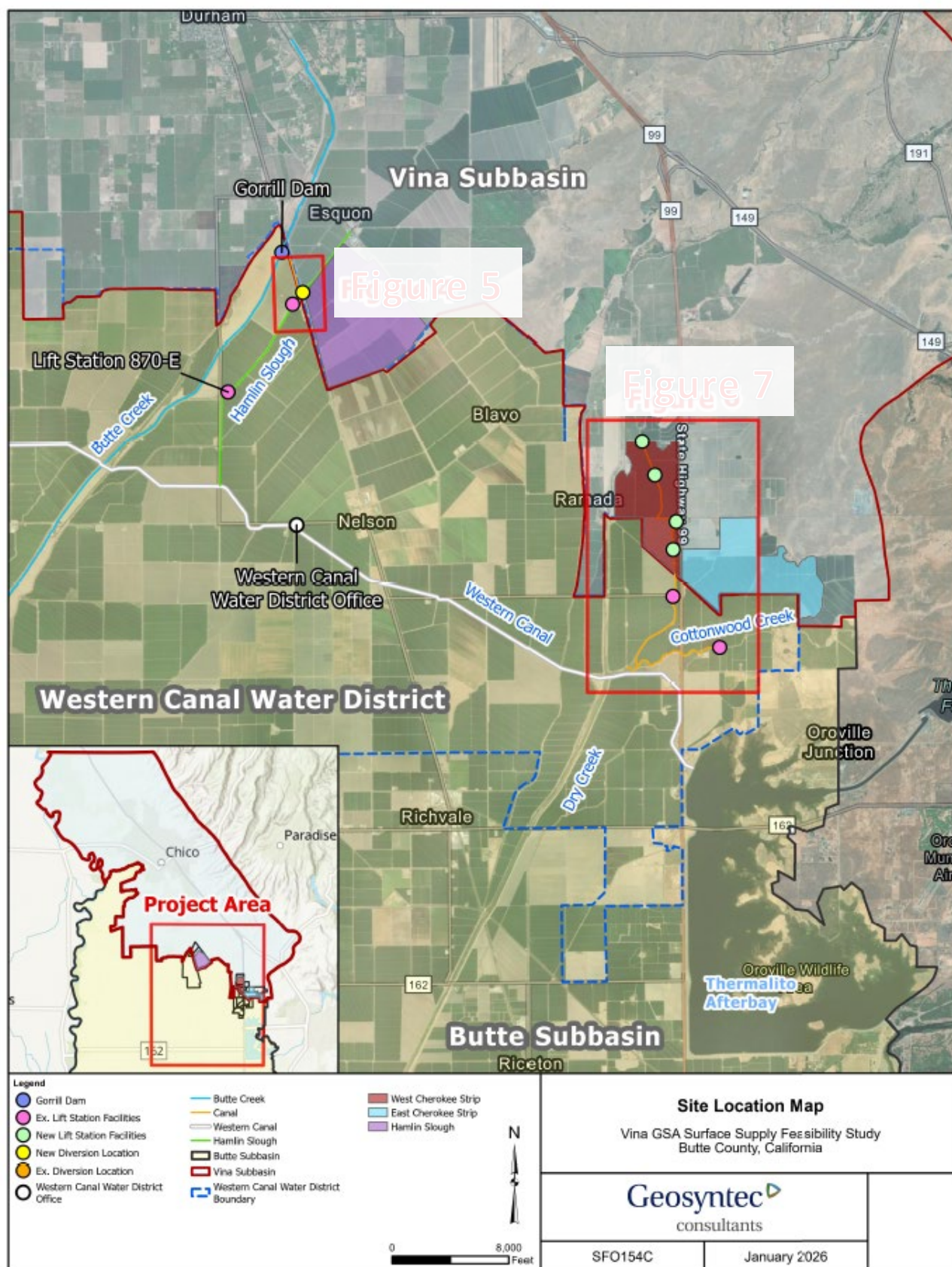
For either water source contemplated by this Project, water would be diverted from Lake Oroville at Thermalito Afterbay at WCWD's existing diversion infrastructure. The water would then be conveyed through WCWD's main canal, the "Western Canal," shown in Figure 4 below. Distribution to individual properties would then rely on a network of existing private canals and new infrastructure described and depicted in this section.

Deliveries to the South Vina properties are currently constrained in July and August by invasive aquatic weeds that limit capacity in the Western Canal. The overgrowth of these weeds limits delivery to existing WCWD customers. Water deliveries for any new customers served by the system would not be prioritized over existing WCWD landowners and customers. District staff are working through more effective methods to eradicate the weeds and improve canal capacity, however at this time, South Vina properties will not be able to reliably get surface water deliveries in July and early August.

New infrastructure would be needed for each of the three properties, including metered deliveries. A technical memorandum prepared by Geosyntec Consultants that details needed infrastructure improvements is included as Appendix C. All infrastructure

discussed below would be paid for by outside-WCWD landowners and/or the Vina GSA in exchange for the benefits the projects provide to the Vina Subbasin as a whole. As described in Section 1.5, third party funding may be available to offset these costs. Cost estimates are provided in Section 2.7 and an overview of the infrastructure improvement areas is shown in Figure 4 below.

Figure 4. Map overview of Vina Subbasin infrastructure



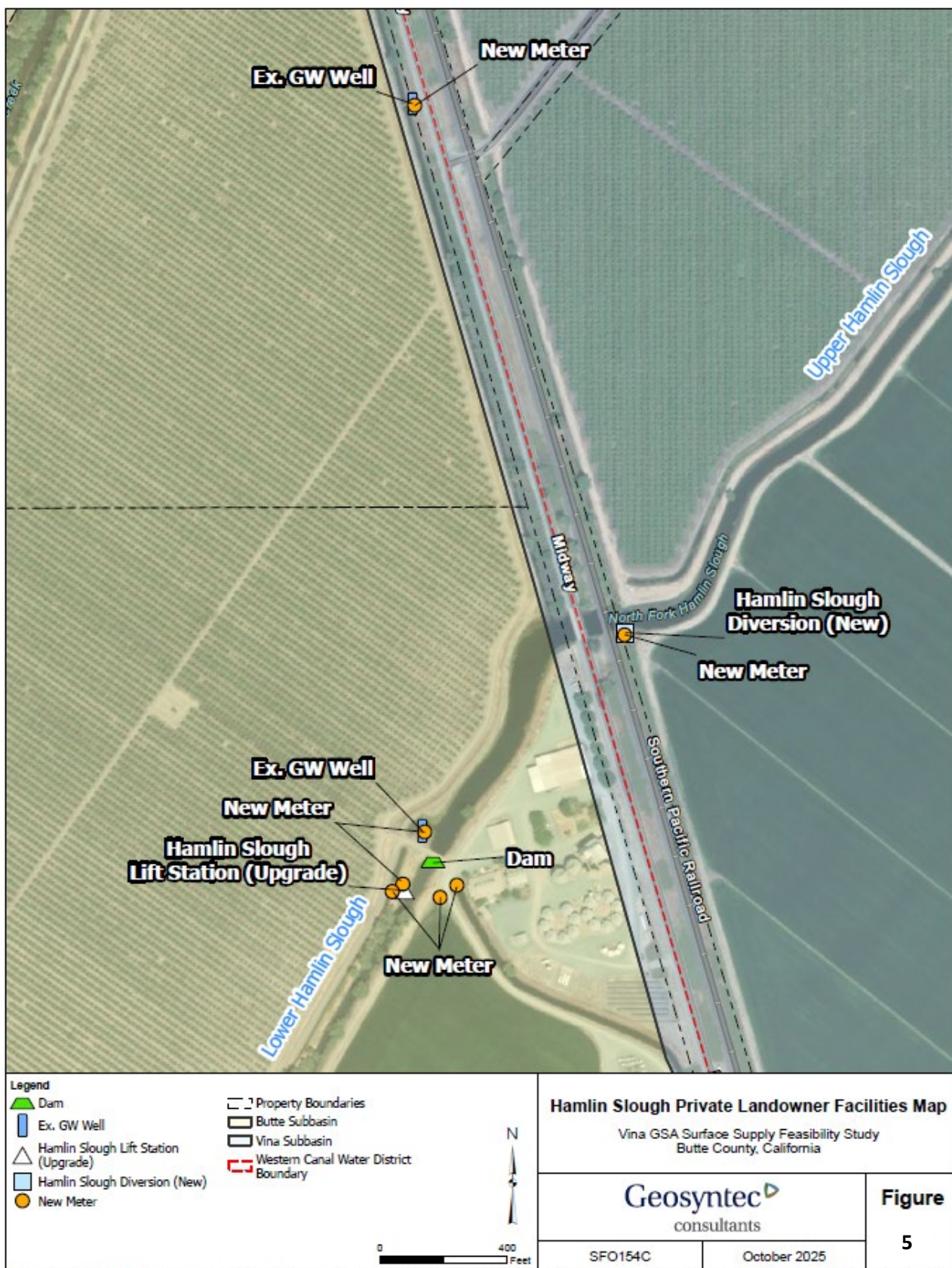
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Section 2.4.1: Hamlin Slough Property

Existing, private water conveyance facilities at a neighboring property would be used to deliver water to the Hamlin Slough property, as shown in Figure 5, with 10,052 acres and 2,240 AF of demand. The existing system includes backing water up into Hamlin Slough, which traverses the Hamlin Slough property. Thus, no improvements are needed to deliver water from WCWD to the edge of the property. In order to further distribute the water, the Hamlin Slough property would need to establish a headwall and gate for gravity diversion into their existing on-farm ditch. Improvements to the current system to convey additional water include an additional lift pump from lower Hamlin to upper Hamlin and 7 new meters to track all water flowing into and out of upper Hamlin Slough.

Butte Creek conditions may limit deliveries in some years. For example, the privately owned water delivery system that would be used to deliver water would not have been able to deliver water to the Hamlin Slough property in 2020 due to low flows, despite WCWD having a full water allocation that year. To ensure that deliveries could be made to the Hamlin Slough property even when Butte Creek is low, improvements to the 870E lift station would be needed. However, given the relative infrequency of such conditions, those improvements were not analyzed in this Feasibility Study.

Figure 5. Map of Hamlin Slough project infrastructure



C:\Users\yaxin.jin\OneDrive - Geosyntec\Desktop\Tasks\Vina Subbasin GIS\Vina Subbasin GIS\Vina Subbasin GIS.aprx\Figure3_HamlinSlough 10/6/2025 12:44 PM (Yaxin.Jin)

Section 2.4.2: Cherokee Strip Properties – Cottonwood Creek

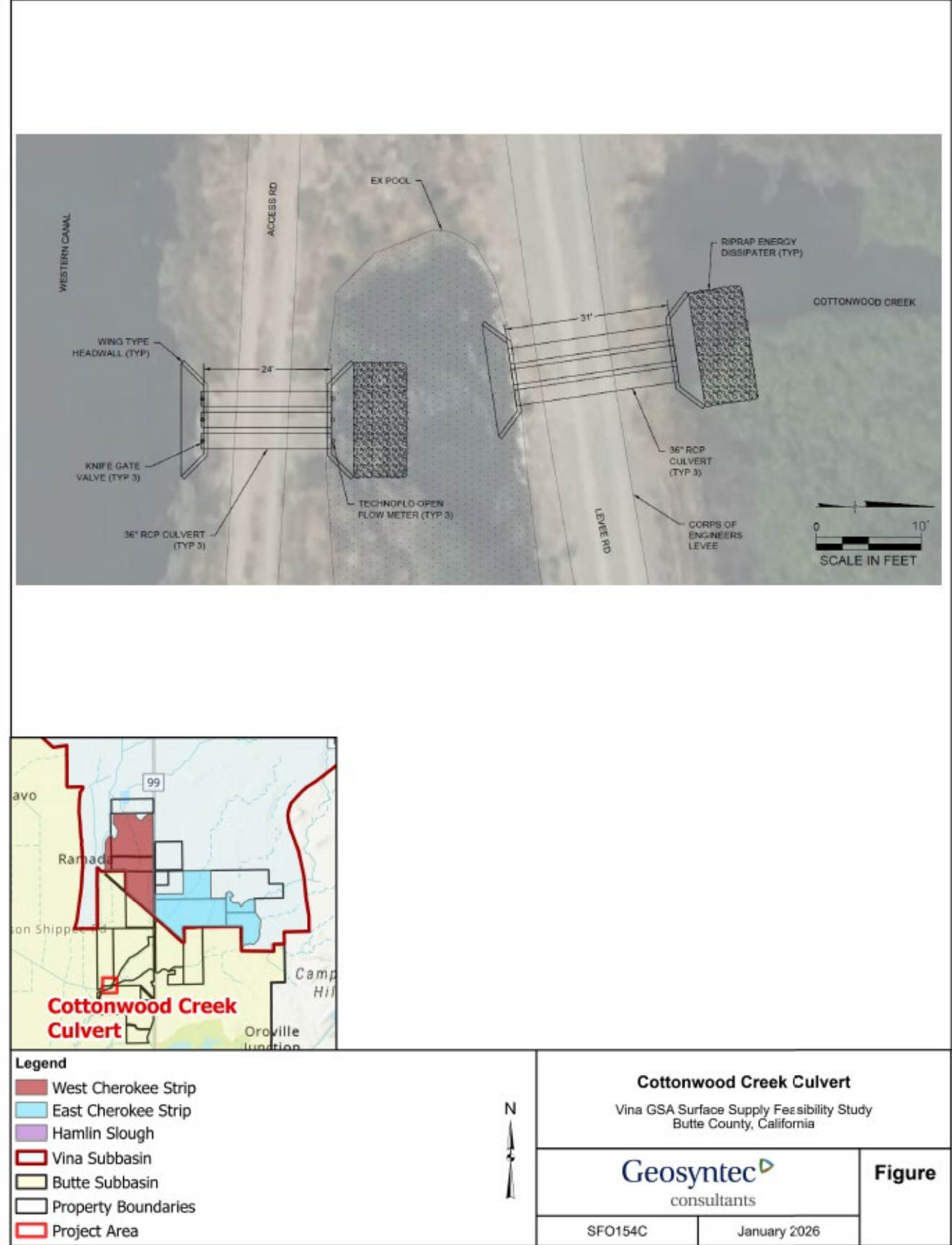
For both the Cherokee Strip properties, West serving 2,485 AF for 642 acres and East serving 2,244 AF for 782 acres, improvements would be needed at the Cottonwood Creek levee. WCWD currently discharges into Cottonwood Creek, and this system serves several existing WCWD landowner properties in the area. As currently constructed, it is a bottleneck upstream of the West and East Cherokee Strip properties. Currently, a 24" and a 30" pipe go through the levee into a privately owned system, which is served by delivery facility 543R. Those two pipes are a bottleneck, and no additional water deliveries could be made to the Cherokee Strip without increasing capacity through the Cottonwood Creek levee. Installation of a third pipe through the levee could also provide benefit to existing WCWD customers.

The Cherokee Strip properties would have a peak demand of up to 36 cfs, which would be met by increasing the two existing pipes to 36" and installing a third 36" pipe, as shown in Figure 6. The improvements would require a California Environmental Quality Act (CEQA) process and additional permits discussed in Section 2.5.

Both Cherokee Strip properties would require additional infrastructure, as discussed below.

Water management for the Cherokee Strip properties includes scheduling deliveries through the de facto water master for the 543R facility deliveries via the Cottonwood Creek system. Both landowners who would receive water through this Project already receive water through the Cottonwood Creek system and are familiar with the process.

Figure 6. Schematic of Cottonwood Creek improvements needed for Cherokee Strip properties



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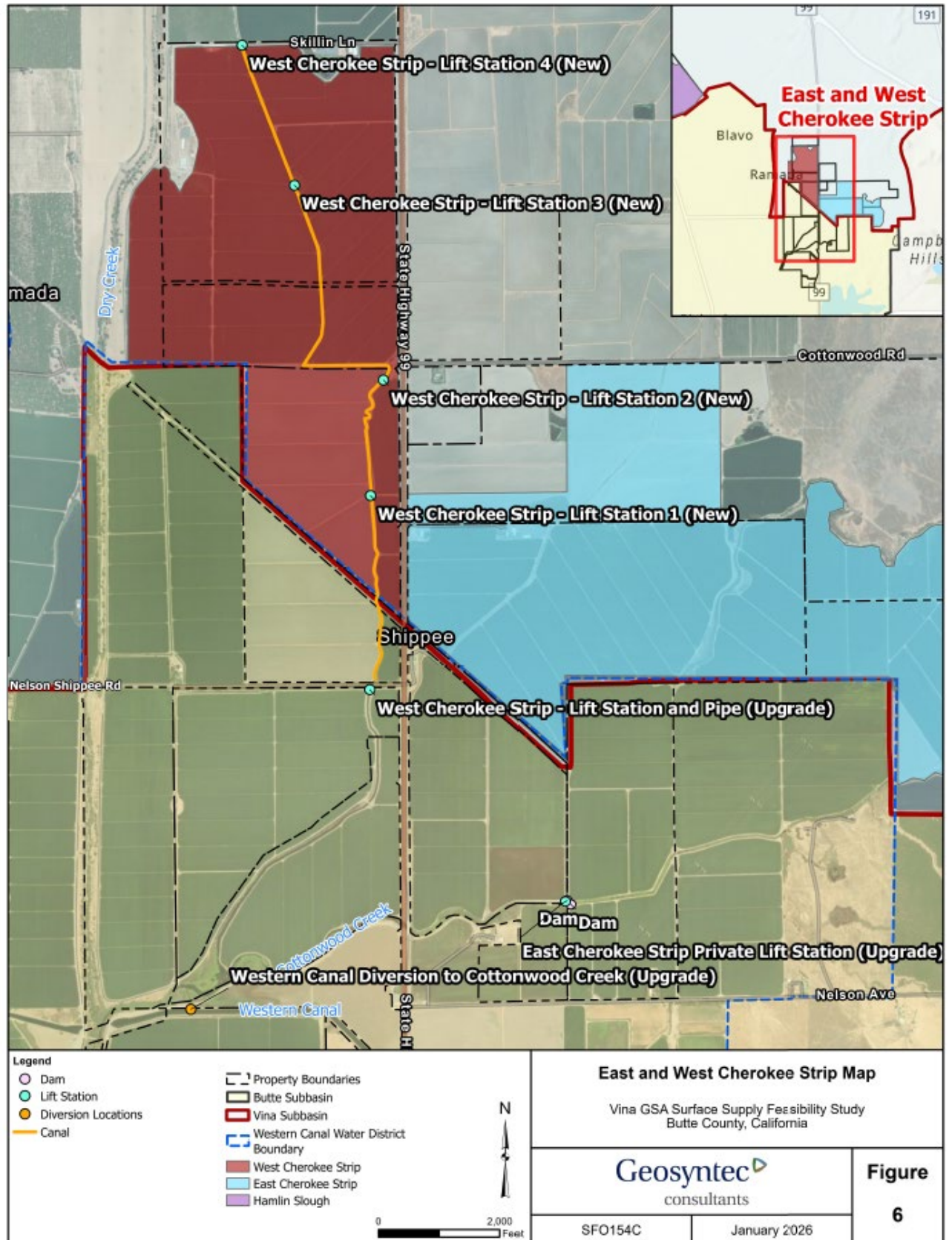
Section 2.4.3: West Cherokee Strip Property

The West Cherokee Strip property, which is 642 acres with 2,485 AF of water demand, is adjacent to lands within WCWD that currently receive water from the District. These lands are served by a pump in a Cottonwood Creek slough and pipe under Nelson Shippee Road, with a current capacity of roughly 7 cfs. To serve the additional 642 acres would require replacing the existing pump with a 20 cfs pump station including a weed screen and 24" iron pipe under Nelson Shippee Road. Up to 4 additional 20 cfs lift pumps would be needed to move the water north to the top of the rice fields, as shown in Figure 7.

Section 2.4.4: East Cherokee Strip Property

For the East Cherokee property, which is 782 acres with 2,244 AF of water demand, a new lift pump is needed at an existing dam on Cottonwood Creek to increase capacity in an existing landowner owned on-farm ditch, as shown in Figure 7. To ensure adequate flows, the cost estimates in Section 2.7 include replacing two existing pumps and installing a new pump, to include pumps with 8, 10, and 15 cfs capacities. A new on-farm reverse grade ditch at the East Cherokee Strip property would be needed to serve 611 acres, which the landowner has indicated they would develop as an in-kind cost share. An additional 171 acres could be served with a new pipeline, which was proposed late into this project and was not included in cost estimates.

Figure 7. Map of West and East Cherokee Strip project infrastructure



F:\Projects\SFO154_Vina GSA Subbasin Grant\SFO154C_Vina GSA Subbasin Grant Component 5\500 Technical\520 GIS Data\Vina Subbasin GIS\Vina Subbasin_v2.aprx\Figure6

Section 2.5: Legal and Regulatory Considerations

Section 2.5.1: Permitting

Improvements to the existing Cottonwood Creek water delivery system would require environmental review and permitting, as detailed in Appendix D. Pursuant to Section 14 of the Rivers and Harbors Appropriations Act of 1899 (33 USC 408) projects that modify federal infrastructure facilities are required to obtain a “Section 408 permit.” Since the Cottonwood Creek levee is a part of the federal Sacramento River Flood Control Project, it will require a Section 408 permit from the U.S. Army Corps of Engineers and an encroachment permit from the Central Valley Flood Protection Board (CVFPB). National Environmental Policy Act (NEPA) compliance would be required prior to a final Section 408 decision from the USACE, and CEQA compliance would also be needed for the Project. The anticipated timeline to obtain all the necessary permits is 18 months. The cost estimate from a consultant team, Environmental Science Associates, is \$199,000 for preparation of all necessary permit applications and project management to obtain the final permits. In addition, another \$10,000-\$15,000 is anticipated for permitting fees to the agencies.

Mitigation would be needed for de-watering approximately 0.10 acres of wetland habitat that could support Giant Garter Snake (GGS). It is recommended that a design approach is chosen that does not negatively affect GGS habitat. Designs completed in 2025 as part of this effort maintain that wetted area and would avoid long-term mitigation requirements (see Appendix C).

Additional permitting may be needed for other aspects of Hamlin Slough or Cottonwood Creek projects, such as California Department of Fish and Wildlife (CDFW) Lake and Streambed Alteration Agreements, CEQA, and California Endangered Species Act coverage, depending on the project design and findings of additional environmental review. A comprehensive biological assessment of the properties that would inform the full scope of necessary permits was outside the scope of this project.

Section 2.5.2: Water Agreements

Water deliveries from WCWD to Vina Subbasin could be provided through a combination of a multi-year memorandum of agreement (MOA) with an annual water service contract for the outside district lands. As discussed in Section 1.4, agreements would be entered into with the water supplier and the project implementer. For example, a 10-year MOA with a 5-year extension could be signed by the project implementer and WCWD before infrastructure improvements are made. Each year during that term, WCWD’s Board of Directors could determine water availability for that season. Presumably, WCWD would not deliver water in years with a water supply deficiency and there may be other years when conditions on Butte Creek or other factors limit deliveries. Such an MOA between WCWD and the project implementor would also need to include

the cost of water, wheeling charges, provisions for an interruptible supply, and other terms as requested by each party's board.

Alternatively, a similar multi-year contract could be developed between Butte County for Table A water.

The MOA or contract would provide the project implementer with some assurance that their investment in infrastructure for this Project will generate benefits. The annual water service contract maintains discretion for the water supplier to make an annual decision about water availability based on hydrology.

The project implementer would in turn develop landowner agreements with those who will receive surface water deliveries under the Project. These landowner agreements would include commitments that the landowners would take surface water from the water supplier, when available, in exchange for investments made by the project implementer. This ensures the subbasin is receiving the groundwater benefits that the infrastructure investments are intended to effectuate.

In addition, agreements would be needed with landowners who own existing laterals off WCWD's main canal to determine the terms for access to the laterals. WCWD does not have the authority to enter into these agreements on the landowners' behalf. Without these agreements, it is not possible to deliver the water from WCWD's main canal to the project lands.

Section 2.6 Groundwater Sustainability Implications

Section 1.3 provided an overview of the sustainability indicators of importance to the Vina Subbasin and this Project, primarily groundwater levels which are also a proxy for groundwater storage, subsidence, and interconnected surface waters. This section provides an analysis of the monitoring wells relevant to the South Vina Extension Project and the potential benefits of this project on the groundwater levels for those wells.

Section 2.6.1 Current Groundwater Levels

For this analysis, the project team selected monitoring wells near the project areas with a consistent history of data. These wells, along with the monitoring wells utilized for the Ridge to Valley Project, are shown in Figure 8 below. Monitoring wells in the area of the South Vina Extension Project show a trend of modest groundwater decline (see Figure 9 and Figure 10), indicating that reducing groundwater pumping in these areas would be beneficial for the subbasin. Dry domestic wells have also been reported north of this area.

An additional monitoring well (09G001M) is included in Appendix H.

Figure 8. Monitoring Wells for South Vina Extension and Ridge to Valley Projects.

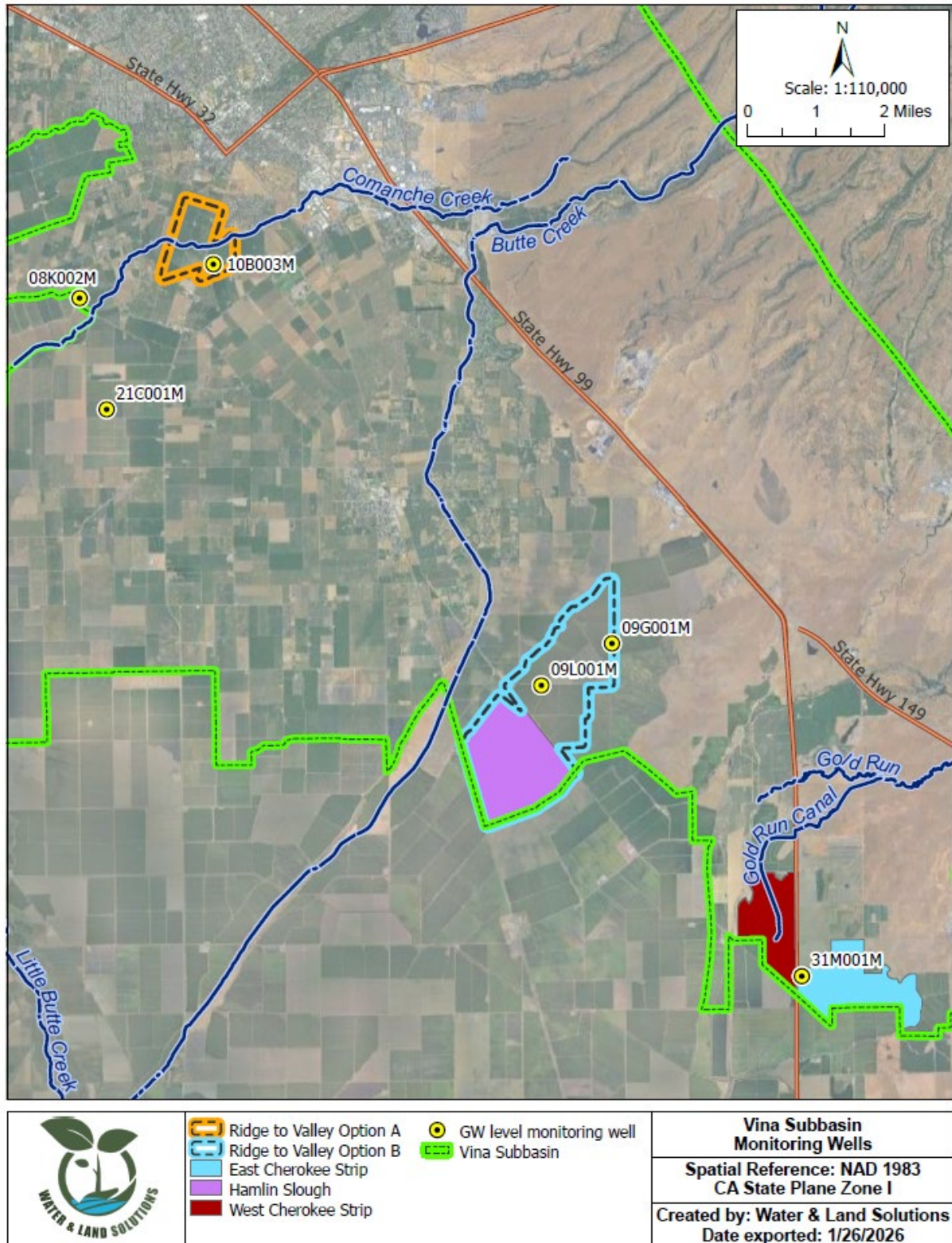


Figure 9. Hydrograph of groundwater monitoring well near Hamlin Slough property

Site Code: 396066N1217586W001 State Well Number: 20N02E09L001M Local Well Name: 20N02E09L001M

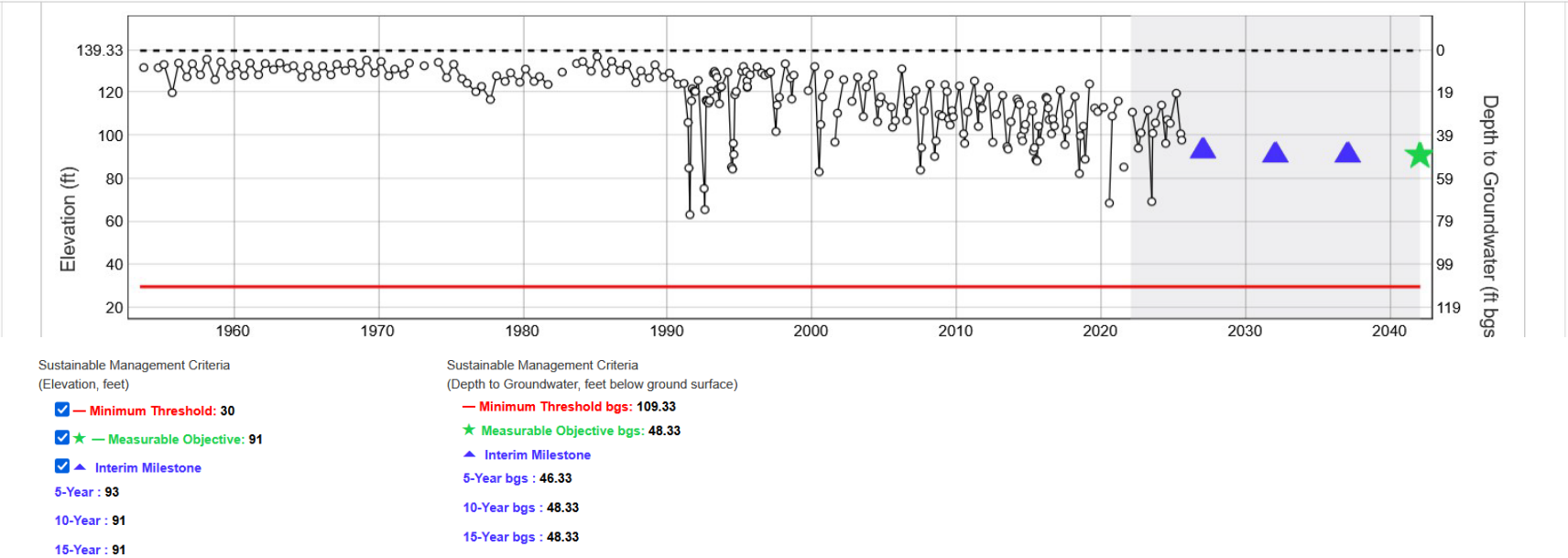
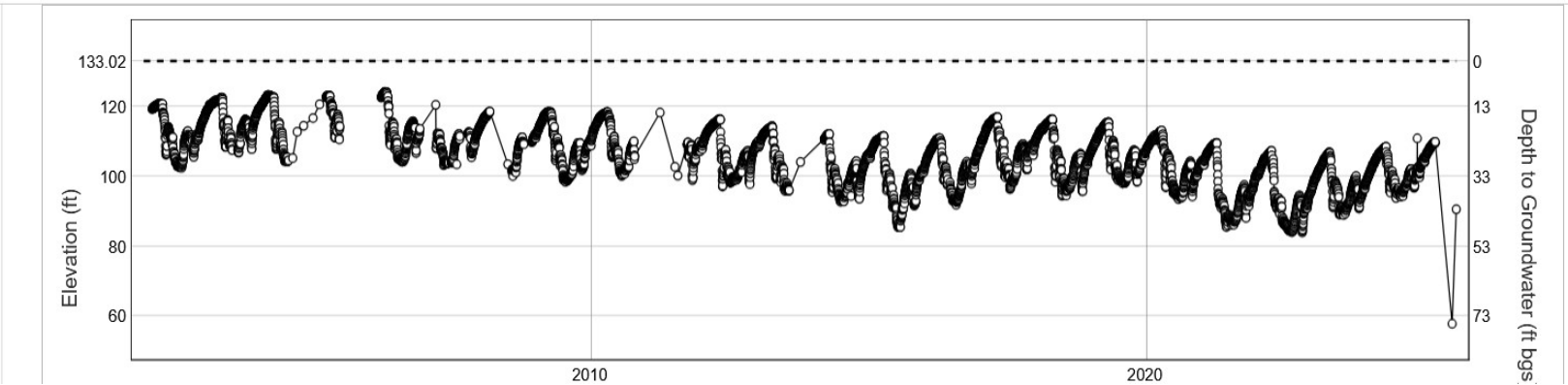


Figure 10. Hydrograph of groundwater monitoring well near Cherokee Strip properties

Site Code: 395446N1216873W001 State Well Number: 20N03E31M001M Local Well Name: 20N03E31M001M



Section 2.6.2 Project Benefits to Groundwater Levels

The Projects could improve groundwater levels in the subbasin as a result of decreased groundwater pumping that would be replaced by delivery of supplemental surface water for irrigation. Combined, the Project could offset at least 6,970 AF per year of groundwater pumping, increasing groundwater levels by a commensurate amount. The farmland served by the South Vina Extension Project would become more resilient by limiting their groundwater use in normal and wet years, thereby ensuring sufficient groundwater is available in dry years. Because Butte County's Table A contract includes a minimum allocation of 3,000 AF, described further in Section 2.1.2, lands served by this Project could have at least some surface water available to them even in dry years.

In addition to benefits to the Vina Subbasin, this Project would also provide groundwater level benefits to the neighboring Butte Subbasin. The Project is located nearly on the boundary between the Butte and Vina Subbasins, so benefits may be realized by both subbasins. Projects that also provide benefits to the Vina Subbasin's neighboring basins are consistent with the Vina GSP's commitment to inter-basin coordination and mutually beneficial activities.

Section 2.7: Costs

Implementation of the South Vina Extension Project includes upfront capital costs for infrastructure and on-going expenses such as the cost of water, wheeling charges, and operations and maintenance costs.

If the surface water cost is greater than the cost to pump groundwater, participating landowners would likely require an incentive to use surface water. The project team determined the cost of groundwater by interviewing local farmers. For example, the Hamlin Slough ranch currently charges its lessees an all-in price of \$240/acre for irrigation water, which is pumped groundwater. Assuming 4 AF per acre of water is delivered, the groundwater cost is \$60/AF. To avoid increasing water charges to lessees on the portion of the ranch that could receive water from WCWD, the water cost for these lands—including private wheeling charges—must be less than or equal to \$60/AF. Alternatively, if surface water costs exceed \$60/AF, farmers at this property would need to be incentivized through a cost subsidy to use surface water instead of pumping groundwater. Funding opportunities for such a subsidy were discussed in Section 1.5.

Section 2.7.1: Water Rate – WCWD

WCWD's delivery charge for other outside-district lands that have historically received water from the district, is typically double the water rate for district lands. In 2025, the water rate for outside-district lands was \$14/AF. WCWD's water rate for this Project has not been determined by WCWD's Board of Directors, but is anticipated to be greater than \$14/AF and lower than the current Table A water cost discussed in Section 2.6.2.

In discussions with the WCWD Board of Directors at their September 16, 2025 Board Meeting, two primary reasons were provided for a water rate in excess of their existing outside district lands rate. First, the current lands served by WCWD that are not within the district have been served for decades—and in many cases those deliveries pre-date the district’s formation in 1984 even though they were not included in the WCWD boundaries during formation. Although the district continues to serve those lands, they would not begin new outside lands water deliveries with the same terms. Secondly, the district’s current water rates do not fully meet the district’s revenue needs. The district occasionally participates in water transfers, which provide necessary revenues to reduce water rates to their water users. For newly served lands outside the district, WCWD would charge water rates that fully recover their costs to deliver the water.

Additional wheeling charges may be assessed by private landowners within WCWD, whose existing irrigation systems would be used to wheel water. For example, water management for the Hamlin Slough property would include scheduling deliveries with the existing water user on that system, who solely owns and operates the system. Increased energy and management costs will be built into a wheeling fee.

Section 2.6.2: Water Rate – Table A

When Butte County contracts its Table A water for in county use, it is a wholesaler of water. The cost of Butte County’s Table A water from the SWP is approximately \$96/AF. Butte County has water supply agreements with two in-county water providers at a fee of \$106.70/AF. Butte County charges its existing external lessees outside of Butte County an additional service charge, currently about \$80/AF, for a total of \$176/AF. For the purpose of this analysis, it is assumed that Butte County would charge between \$106.60/AF and \$176/AF to new local users to cover its DWR SWP costs and program administration costs.

Section 2.7.3: Operation & Maintenance

The 2018 study [Evaluation of Restoration and Recharge within the Butte County Groundwater Basins](#) (ERR) includes a tool for estimating conjunctive use costs prepared by Davids Engineering and ERA Economics. That tool estimates an annual surface water pumping cost of \$51/AF, which includes electricity for conveyance and distribution with a 5-foot lift, and other operation and maintenance costs associated with pumping infrastructure.

Section 2.7.4: Capital Costs

Upfront capital costs for infrastructure to implement the projects described above include permitting, design, and construction costs and are detailed in Appendix C, presented in Table 4, and summarized below.

A 10-year planning horizon was used for amortizing capital costs. Water from WCWD is anticipated to be available in 7 of 10 years, so 7 years of water deliveries is used to calculate costs per AF. As presented in Table 4, for each site the total estimated construction cost is

divided by 7 of 10 years of water deliveries. For Hamlin Slough the estimated construction cost is \$749,000 with 15,687 AF delivered 7 of 10 years, resulting in a cost of \$47.75/AF. For West Cherokee Strip the estimated construction cost is \$3,298,000 with 17,395 AF delivered 7 out of 10 years, resulting in a cost of \$174.60/AF. For East Cherokee Strip the estimated construction cost is \$1,091,000 with 15,708 AF delivered 7 out of 10 years, resulting in a cost of \$56.82/AF.

Table 4. Capital cost estimates for project infrastructure (10-year planning horizon)

Project/Site	Total Estimated Construction Cost	Acre feet (7 in 10 yrs)	\$/AF
Hamlin Slough	\$749,000	15,687	\$ 47.75
West Cherokee Strip	\$3,298,000	17,395	\$ 174.60
East Cherokee Strip	\$1,091,000	15,708	\$ 56.82
TOTAL	\$5,067,200	48,790	\$ 105.31

Construction costs listed in Table 4 may be eligible for public funding, as described in Section 1.5.

Section 2.7.5: Total Cost-Benefit

Taken together, the cumulative costs of water rates, operating and maintaining lift pumps, and capital costs for infrastructure for each project area are shown in Table 5 below. Total costs per AF per year (for a 10-year planning horizon) range from \$189.30 to \$520.15.

Table 5. Total cost per AF of water

Table A* Costs per Acre-foot					
Property	Total AF/yr	Water Rate	O&M'	Capital	Total Cost
Hamlin Slough^	2,240	\$ 141.55	\$ -	\$ 47.75	\$ 189.30
West Cherokee Strip	2,485	\$ 141.55	\$ 204.00	\$ 174.60	\$ 520.15
East Cherokee Strip	2,244	\$ 141.55	\$ 102.00	\$ 56.82	\$ 300.37

*Table A water rate used is the median between Butte County's 2025 charges to in-county buyers and SOD buyers

'Calculation based on \$51/AF for each lift

^Additional wheeling charge is likely, but not yet determined. It is assumed that O&M costs would be factored into a wheeling charge.

If public funding were secured for capital costs, total costs would be reduced to \$141.55/AF/year for the Hamlin Slough projects, \$345.55/AF/year for the West Cherokee Strip projects, and \$243.55/AF/year for the East Cherokee Strip properties.

Section 2.8: Conclusion

The South Vina Extension Project to convey surface water through Western Canal Water District to the southern Vina Subbasin is feasible and could offset at least 6,970 AF per year of groundwater pumping, improving groundwater levels by a commensurate amount for the Vina Subbasin and likely the neighboring Butte Subbasin.

Further evaluation should consider the following:

1. Define roles of agencies for project implementation. Butte County implemented this Feasibility Study on behalf of the Vina GSA, but may not be best suited to pursue it long term. The Vina GSA would have an important role as could the Tuscan Water District and the local landowners.
2. Grant funding could be pursued for one-time capital costs. Having these costs paid for with grant funding, would reduce total costs for Vina Subbasin stakeholders by as much as \$5,067, 200 and improve the Project's financial feasibility.
3. Initiate the permitting process for Cottonwood Creek infrastructure improvements early. With an estimated 18-month timeline, permitting could begin in parallel with governance and rate negotiations to avoid delaying project readiness for construction funding opportunities.
4. Work with the Project Implementer and WCWD to refine the water rates for both water sources. Water rates have a significant impact on financial feasibility and will help determine the competitiveness of surface water supply projects relative to other potential projects in the Vina Subbasin.
5. Develop financial incentives for landowner participation as needed. Given current Water Rate and Operation and Maintenance cost estimates, a financial incentive would be needed for landowners to participate in the Project to create parity between surface water costs and groundwater costs.

Section 3: Ridge to Valley

"The Ridge," a term used by locals to describe the mountain ridge east of Chico, primarily encompasses the towns of Paradise and Magalia. PID, formed in 1916 as a California irrigation district, supplies potable water primarily to the Town of Paradise and surrounding areas using surface water diverted from Little Butte Creek and stored in Paradise Lake and Magalia Reservoir and treated at PID's treatment plant. In recent years there have been feasibility studies and proposals to intertie PID's system with Chico's water supply to help address Chico's groundwater depletion and provide a revenue source for Paradise following the Camp Fire. To date, constructing a pipeline for delivery of treated water to Chico has proven too expensive.

Alternatively, this project proposes to convey raw water through Butte Creek for agricultural uses, reducing the costs associated with treating the water and constructing a pipeline to convey already-treated water. The Ridge to Valley Project would utilize existing PID water right supplies and transfer them, on a temporary basis, to groundwater dependent farmers in the Vina Subbasin for conjunctive use direct irrigation. The water would be discharged from PID's reservoirs into Little Butte Creek to be re-diverted further down Butte Creek, as shown in

Figure 3 above.

Section 3.1: Water Source

PID derives the right to divert water from Little Butte Creek and store it in the Paradise and Magalia reservoirs, through the SWRCB. PID has a pre-1914 appropriative right and two post-1914 appropriate rights. The Pre-1914 right entitles PID to approximately 2,500 AF from Little Butte Creek at the Magalia Dam. This water is not available for transfer. Their 1916 permit entitles PID to 9,500 AF stored between Paradise Lake and Magalia Reservoir, and their 1965 permit entitles PID to 8,800 AF stored in Paradise Lake. These rights are presented in Table 6 below.

Table 6. Paradise Irrigation District Water Rights

SWRCB Permit or Application Number	Priority Date	Source	Quantity	Notes
S008459	Pre-1914	Little Butte Creek at Magalia Dam	8 cfs (approx. 2,500 AF/yr)	Not available for transfer
A000476	1916	Paradise Lake and Magalia Reservoir	9,500 AF (6,700 AF Paradise Reservoir; 2,800 Magalia Reservoir)	Currently constrained by Magalia Dam deficiencies
22061	1965	Paradise Lake	8,800 AF	October 1 – May 31. Subject to Term 91

Cubic Feet per Second (cfs), Acre Feet (AF)

Section 3.2: Project Locations

As shown in Figure 3, two areas have been identified for conjunctive use projects, utilizing the PID water. Option A would deliver water to one landowner with three adjacent orchards, currently irrigated by groundwater only, off the existing Butte Creek Diversion Dam and Parrott-Phelan Canal. Option B would deliver water to one landowner with rice acreage that is currently irrigated by groundwater, but has infrastructure to divert Butte Creek surface water for irrigation on other fields on the property. The property has an existing Butte Creek diversion and canal system. Either or both options could be utilized for the Project. Option B has sufficient demand for the entire amount of available water, while Option A would require a smaller amount. What demand is further described in Section 3.3.

These areas were selected based on existing infrastructure, land use, landowner interest, and current groundwater usage. Option A was identified because the land belongs to a single landowner who has connectivity to Butte Creek via the Parrott-Phelan Canal and has shown a willingness to invest in additional infrastructure and modify current irrigation practices in order to reduce groundwater usage. This property has also been the site of groundwater

recharge pilot projects conducted by Butte County WRC¹³, that could be integrated into infrastructure improvements and could be benefitted by additional surface water deliveries. Option B was identified because it is a single landowner with an existing diversion on Butte Creek that is primarily flood irrigating on the property, while still using groundwater. This means that virtually no infrastructure modifications are needed to divert and integrate additional surface water into their irrigation system.

The Project Team conducted site visits and interviews with representatives of the landowners to confirm suitability.

Section 3.3: Water Demand and Availability

PID's General Manager indicated in a February 5, 2025, Butte County Water Commission meeting and individual meetings on June 26, 2025 and September 8, 2025, with the Project team that the district currently has 1,500 AF available for transfer under their existing water rights. In addition, PID is currently in the process of repairing the Magalia Dam to comply with dam safety requirements. When these repairs are completed, as much as 2,000 AF of additional water could be available for use. These repairs are estimated to be completed in 2028. The reservoirs routinely fill to capacity, even during drought years, indicating that the ability to receive water from these sources would be very consistent.

The Ridge to Valley Project water would be conveyed through Butte Creek. PID's existing system discharges water from Paradise Lake and Magalia Reservoir directly into Little Butte Creek, eventually joining Butte Creek. Downstream, existing diversions allow for delivery of water to Option A and Option B. Under Option A, shown above in Figure 3, the transfer water would be diverted at the Butte Creek Diversion Dam, into the Parrott-Phelan Canal which leads into Comanche Creek. Comanche Creek bisects the properties identified in Option A. Assuming the water would be delivered over the approximately 5-month (150 day) irrigation season, a range of 10-23 AF per day (or 5-11.6 cfs) would be delivered to the properties identified for Option A. The operators of the Butte Creek Diversion Dam and Parrott-Phelan Canal, which is privately owned and operated by an adjacent farming company, have indicated to the Project team that diversion and canal capacity will not be a constraint for the amount of water available under PID's existing right. This infrastructure is further described in Section 3.4.

For Option B, the transfer water would be diverted at the landowner's existing Butte Creek diversion, Adams Diversion, and into their existing, private canal system. This landowner has also indicated to the Project team that infrastructure will not provide a constraint for this amount of water. A capacity analysis of this system was outside of the scope of this report. Fall

¹³ Vina Groundwater Sustainability Agency. *Water Supply and Recharge Project - Implemented by Butte County*. Vina Groundwater Sustainability Agency. <https://www.vinagsa.org/water-supply-and-recharge-project-implemented-by-butte-county> (Vina Groundwater Sustainability Agency)

water for rice decomposition was not considered for this project option as current irrigation season demand is greater than the amount available from PID.

Section 3.4: Delivery and Infrastructure

Section 3.4.1: Conveyance

One of the major benefits of the Project is the utilization of Butte Creek as a natural conveyance facility, negating the need for new construction. PID's Magalia and Paradise reservoirs are already designed to discharge into Little Butte Creek. The transfer water would then travel down the natural course of Butte Creek to be diverted to either Comanche Creek (Option A) or to Butte Creek adjacent properties (Option B). No modifications are needed to facilitate this conveyance.

Section 3.4.2: Diversions

The irrigated lands within Project Option A and Option B have existing diversion dams in place on Butte Creek, equipped with fish screens, fish ladders, and operated and maintained in close coordination with the Butte Creek water master. Project Option A would utilize the Butte Creek Diversion Dam to the Parrott-Phelan which turns into Comanche Creek and Option B would utilize the Adams Diversion Dam on Butte Creek.

The project team estimated diversion capacity based on the capacity of their fish screens, which is 150 cfs for the Butte Creek Diversion Dam and 135 cfs for the Adams Diversion Dam¹⁴. The Project team met with the diversion owners and operators, who confirmed sufficient capacity at the existing diversion facilities to divert an additional 1,500 – 3,500 AF (5-11.6 cfs) for the Ridge to Valley Project. No additional infrastructure changes would be required at the two diversion dams.

Diversion capacity for the Butte Creek Diversion Dam was confirmed by a desktop review by the project team that found the capacity of the fish screen at the diversion is 150 cfs¹⁵ and the maximum mean daily flow recorded at the DWR stream gage on the canal (BPD) between 2015 – 2025 was 65 cfs (July 2017). Similar publicly available data on diversion rates was not available for the Adams Diversion Dam.

For Option A, the Project beneficiaries would be responsible for a portion of maintenance and operation costs at the Butte Creek Diversion Dam. For Option B, the water would be utilized by the current diversion owners. Additional operation and maintenance costs would be minimal. These costs are described further in Section 3.8, below.

¹⁴ California Department of Fish and Game. (n.d.). *Butte Creek spring-run chinook salmon life history investigation* (Summary information) [PDF].

¹⁵ California Department of Fish and Game. (n.d.). *Butte Creek spring-run chinook salmon life history investigation* (Summary information) [PDF].

Section 3.4.3: Delivery to Farms

Existing canals would deliver the water from the two diversion dams to the farms. For Option A, the Parrott-Phelan Canal becomes Comanche Creek and connects the Butte Creek Diversion Dam to agricultural land to the west near the Sacramento River. The properties proposed to be served by Option A are located between the diversion point and the canal owner's property (Figure 3). The owners and operators of the canal have confirmed that the canal has sufficient capacity to deliver the additional 1,500 – 3,500 AF (5-11.6 cfs) contemplated in this Project. The canal is currently maintained to sufficient operating standards. The Project beneficiaries would share in these operation and maintenance costs, which are described further in Section 3.8 below. New turnout gates and pump stations will be needed, which are described further in the On-Farm Improvements subsection below.

For Option B, as stated above, the existing landowner would utilize the additional water. This property is already set up to divert water from Butte Creek into an existing canal system on the property, with large portions of the property set up to irrigate with surface water from Butte Creek (Figure 3). There is sufficient capacity in the existing canal systems to utilize the additional water contemplated in Option B. The on-farm canals are currently maintained to sufficient operating standards and additional operation and maintenance costs would be minimal.

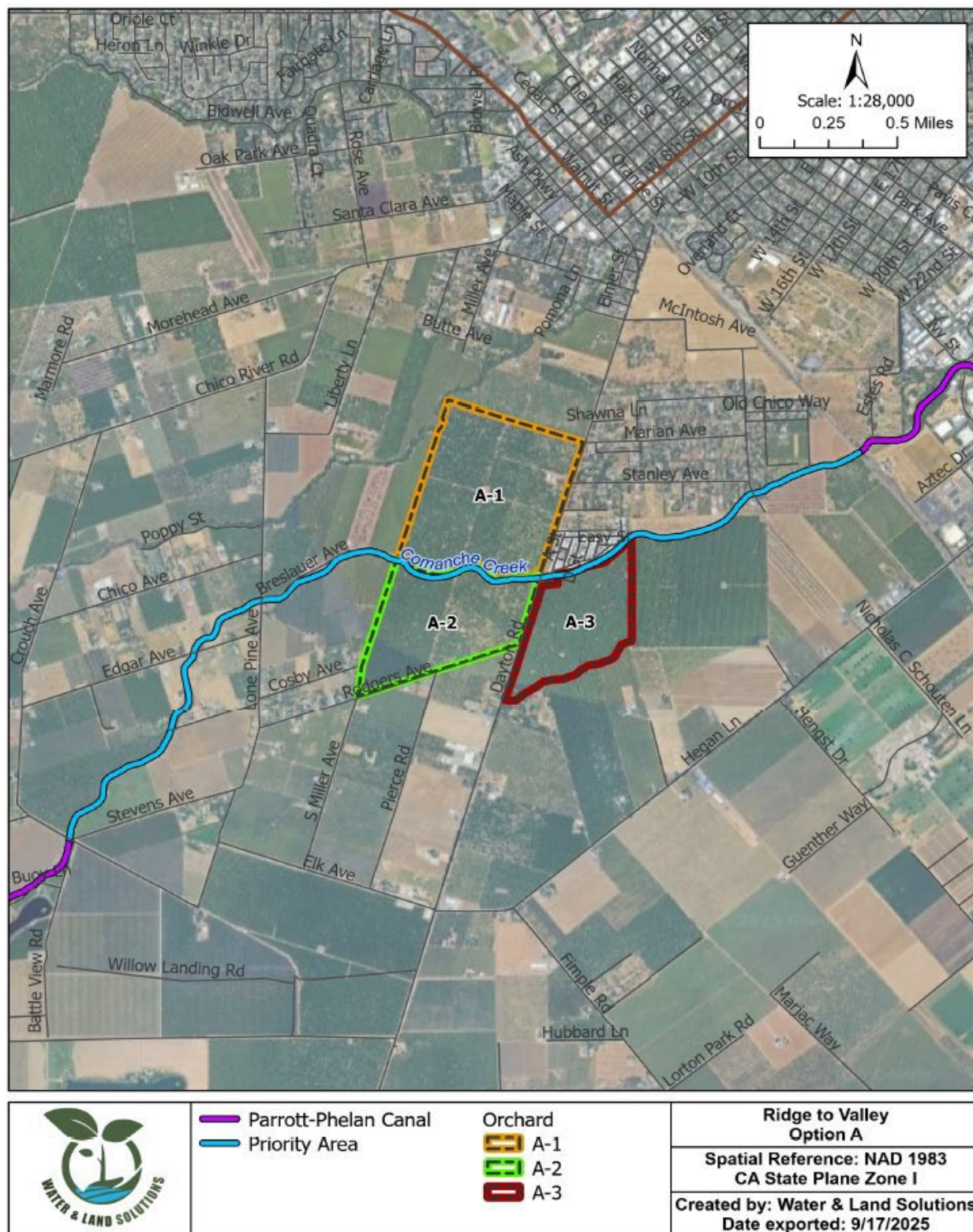
Additional modifications to the delivery infrastructure are not needed.

Section 3.4.4: On-Farm Improvements

Option A would deliver water to one 95-acre walnut orchard, and one 375-acre walnut orchard that is bisected by Comanche Creek, as shown below in Figure 11. Option A growers currently irrigate solely with groundwater and a precision irrigation system. Modifications to their on-farm irrigation systems would be needed to utilize surface water. The project team utilized the ERR to determine potential on-farm improvements required for this project option. Understanding that modifications will be site specific, the ERR assumed the following modifications would be required for a 250-acre walnut orchard.

"... the orchard will be irrigated by up to three (3) separate pump stations, including existing well pump stations and up to two (2) additional dual source pump stations. Both potential dual source pump stations will include a turnout out from the canal, a sump, or 'can', a groundwater well with a low head vertical turbine pump, and a second vertical turbine pump installed in the sump to pressurize the water for sprinkler irrigation (pressure pump). Both the turnout and well will discharge to the sump, allowing for either source to be pressurized for irrigation. The pressure pump will lift water from the sump and pressurize it for filtration and irrigation."

Figure 11. Map of individual orchards needing separate irrigation design for Project Option A.



If project Option A were to proceed, farm specific irrigation system designs would be required. However, to provide a general picture of the type of on-farm improvements that would be needed, the Project team utilized the design assumptions contained in the ERR, described above. These designs are detailed further in Appendix F. Additional design specifics and rationale can be found in the [ERR](#). To summarize, Orchard A-1 required three pump stations and Orchards A-2 and A-3 each got their own pump stations.

The costs for these on-farm improvements are discussed in Section 3.8 below.

Option B growers currently utilize surface water sources for a portion of their flood irrigation needs, however they still rely on groundwater for the balance of their crop demand. As previously described, additional surface water would be diverted at an existing diversion and moved through existing on-farm canals to a central holding pond where it could then be distributed to irrigate rice. Rice is a flood irrigated crop, so on-farm improvements would not be needed at this time and the ERR tool was not utilized for that project area.

Section 3.5: Legal and Regulatory Considerations

Multiple legal and regulatory implications should be considered with this Project, including surface water rights, environmental review, SGMA compliance, and landowner agreements.

Section 3.5.1: Surface Water Transfers

To transfer the water from PID to the beneficiaries, State Water Resources Control Board (SWRCB) approval is needed. This could be accomplished in two different ways: a temporary (less than one year) or a long-term transfer. There are tradeoffs to each approach, including timeline and resources required for regulatory compliance and court proceedings. California Water Code section 1729 exempts temporary transfers, from CEQA requirements. Long-term transfers are not exempt. CEQA requirements and costs are discussed further below. While there would be time and financial savings associated with completing multiple successive temporary transfers that enjoy CEQA exemptions, an annual transfer petition to the SWRCB would be required.

Prior to submitting the petition to the SWRCB, California Water Code Section 1726(C) requires the petitioner to notify CDFW and the Butte County Board of Supervisors, because the water is currently stored in Butte County and is proposed to be transferred to a location in Butte County, as well as meeting other California Water Code requirements.

For a long-term transfer, additional review is required, including CEQA. In addition to impacts considered under CEQA, the SWRCB has a separate obligation to consider the effects of the transfer on public trust resources. Specifically, before granting the petition, the SWRCB must find that (1) the transfer does not initiate a new water right; (2) the transfer can be made without substantial injury to other legal users of water, and (3) the transfer can be made

without unreasonable effect on fish, wildlife, or other instream beneficial uses. If the SWRCB determines that the transfer, as proposed in the petition, does not meet these criteria, they may choose to impose additional terms. For long-term transfers, it may take up to a year, or more, for the SWRCB to issue a determination, depending on the complexity of the proposed transfer.

In addition to SWRCB approval, PID's water rights are subject to the Butte Creek adjudication (No. 18917). The adjudication requires approval from the Butte County Superior Court for any alterations to the adjudication, including transfers of this nature. While there is precedent for approval of such transfers, this step will add additional time and expense.

The court approval process would consider any terms to PID's adjudicated right that would be proposed to change under the transfer, such as place of use, point of diversion, or beneficial use. During this process, other parties to the adjudication have the opportunity to object or provide comments.

PID staff have indicated a preference for developing a pilot program spanning approximately three years, where three successive temporary transfers would be used. At the conclusion of the pilot project period, if the pilot were successful, project beneficiaries could negotiate a longer-term transfer. At this time, the Magalia Dam retrofit may be complete, and additional water may also be available for transfer.

Section 3.5.2 Water Agreements

Water deliveries from PID to Vina Subbasin could be facilitated through the transfer process described above and additionally through agreements between the water supplier and project implementer described in Section 1.4. For example, a 3-year MOA allowing for successive temporary transfers with the option for a longer-term extension (5 or 10 years) could be signed by the project implementer and PID before infrastructure improvements are made. Each year during that term, PID's Board of Directors can determine water availability for that season. An MOA between PID and the project implementor would also need to include the cost of water, transfer costs to be borne by each party, and other terms as requested by each party's board.

The MOA provides Vina Subbasin with some assurance that their investment in infrastructure for this Project will generate benefits. The MOA maintains discretion for the water supplier to make an annual decision about water availability based on hydrology, water demand within the district, and water markets.

The project implementor would in turn develop landowner agreements with those who will receive surface water deliveries under the Project. These landowner agreements would include commitments that the landowners would take surface water from the water supplier, when available, in exchange for investments made by the project implementer. This ensures the subbasin is receiving the groundwater benefits that the infrastructure investments are intended to effectuate.

In addition, for Option A wheeling agreements would be needed between the landowner taking the surface water and the owner and operators of the diversion and canal.

Section 3.6: Environmental Considerations

The project team found the most significant environmental considerations to be related to additional water releases into Little Butte Creek and Butte Creek created by implementation of this water transfer. The water rights relied on for this the Ridge to Valley Project are existing, meaning that the effects of diverting this water from the greater Butte Creek watershed has already been studied and total water available to the watershed will not be reduced.

The water diversions proposed under the Ridge to Valley Project are 12-20 miles downstream of current PID diversions and place of use, so more water should remain in Butte Creek for longer. Regulatory agencies have frequently recommended additional flow to decrease temperature in the creek. If the Project were to deliver a minimum of 1,500 AF over this time period, it would likely increase flows by 4-5 cfs in Butte Creek between Magalia Reservoir and the Parrott-Phelan Diversion Dam, or further downstream at Adams Diversion.

Butte Creek provides critical habitat for California's largest naturally spawning Central Valley spring-run Chinook Salmon and Central Valley steelhead populations. Both species are listed as threatened under the federal Endangered Species Act (ESA). Spring-run Chinook return to the Sacramento River between late March through September, holding in cold water pools through the summer, and ultimately spawning from mid-August through early October. Warm water temperatures during summer adult holding periods have been identified as a threat to spring-run Chinook¹⁶. Specifically, the National Marine Fisheries Service (NMFS) has stated that, "Water temperatures between the Parrot-Phelan Diversion Dam and the Centerville Head Dam in Butte Creek frequently exceed the reported optimum temperatures for spring-run Chinook spawning. Water temperatures frequently exceed 59°F from July through September."¹⁷

Additionally, NMFS has cited concern with temperature for juvenile rearing in Butte Creek, downstream of Centerville Head Dam, "Although summer flows of 40 cfs generally keep water temperature below 68°F throughout most of the reach (Kimmerer and Carpenter, 1989), water temperature often exceeds 76°F in the canyon between Butte Creek Head Dam and Centerville Head Dam in July and August."¹⁸

Consistent with the 40 cfs recommendation cited by NMFS, CDFW developed recommended

¹⁶ *Recovery Plan for the Evolutionarily Significant Units of Sacramento River Winter-run Chinook Salmon, Central Valley Spring-run Chinook Salmon, and the Distinct Population Segment of California Central Valley Steelhead*, Appendix A, p. 69 (National Marine Fisheries Service, U.S. Department of Commerce, July 2014).

¹⁷ NMFS, 2014. Appendix A, p. 79.

¹⁸ NMFS, 2014. Appendix A, p. 79.

minimum instream flow requirements for Butte Creek, by month. These are listed in Table 7 below.

Table 7. CDFW’s recommended minimum instream flows (cfs).

Month	Normal Water Year	Dry Water Year
October	100	75
November	100	75
December	100	75
January	100	75
February	100	75
March 1-14	100	75
March 15-31	80	75
April	80	75
May	80	65
June	40	40
July	40	40
August	40	40
September	100	75

Source: NMFS, 2014. Appendix A, p. 78

The Project team completed an analysis to confirm that recent Butte Creek flows were consistent with the CDFW recommendations listed in Table 7, using stream gauge data for the USGS stream gauge “Butte Creek Near Chico (BCK)” for April-September of 2015-2025. Butte Creek flows continue to decrease as the water year progresses, reaching a low in late summer or early fall before the rainy season starts. During the period analyzed, which included three critical water years, the minimum flows in Butte Creek was never lower than 57 cfs. This is greater than the recommended minimum flows for June-August. While Butte Creek flows currently meet CDFW recommendations, the Project could provide additional flows during a time period (June – August) and in a location where temperature is a concern, according to NMFS.

Section 3.6.1: California Environmental Quality Act Review

Any additional environmental impacts would be studied during a CEQA review, which long-term water transfers are subject to. The lead agency would determine the potential environmental impacts associated with the project after completing an environmental study and preparing the appropriate environmental documentation, which is subject to public review and comment. As discussed in Section 3.5.1, CEQA review is required for long-term transfers. The SWRCB will consider the Ridge to Valley Project’s potential environmental impacts, while determining whether mitigation will be needed.

The project applicant, in this case the water transfer petitioner (PID), is responsible for the

cost of the CEQA process and any study or document preparation. CEQA costs can vary depending on the complexity of Project impacts and the potential for public comment or objection, however the Project team estimates, that CEQA costs for a transfer of this nature would be approximately \$35,000 and would be passed on by PID to the project beneficiaries. This arrangement would be outlined in the agreements between the water supplier (PID) and the project implementer, described in Section 3.5.2.

Section 3.7: Groundwater Sustainability Implications

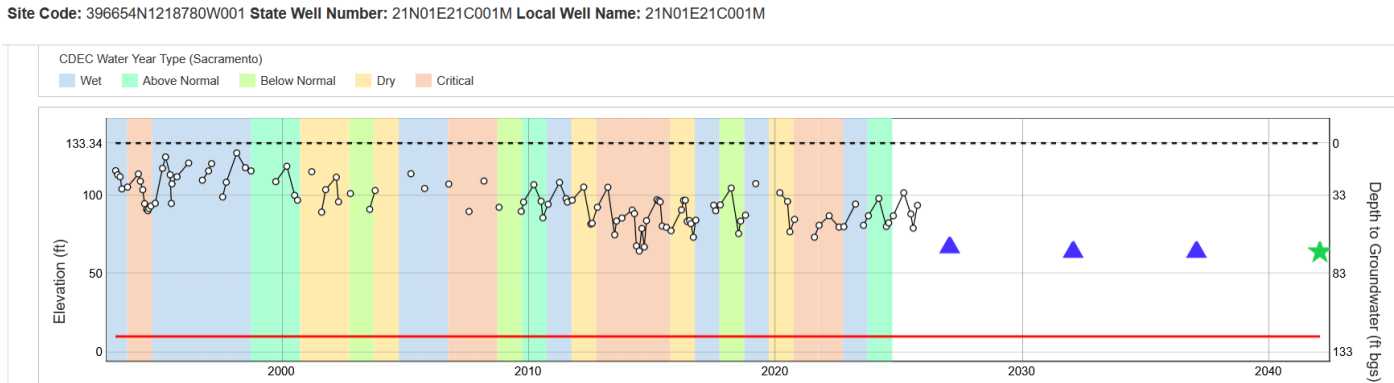
Section 1.3 provided an overview of the sustainability indicators of importance to the Vina Subbasin, primarily groundwater levels which are also a proxy for groundwater storage, subsidence, and interconnected surface waters. This section provides an analysis of the monitoring wells relevant to the Ridge to Valley Project and the potential benefits of this project on the groundwater levels for those wells.

Section 3.7.1 Current Groundwater Levels

Figure 8, above, shows relevant groundwater level monitoring wells for the Project area.

For Ridge to Valley project Option A, the nearest RMS well, 21N01E21C001M, has declined 17.2 feet between 2002 and 2023, with an average rate of change of -0.82 feet per year (ft/yr). Recent measurements are above the measurable objective (MO), minimum threshold (MT), and interim milestones specified in the GSP. This well’s hydrograph is shown in Figure 12 below.

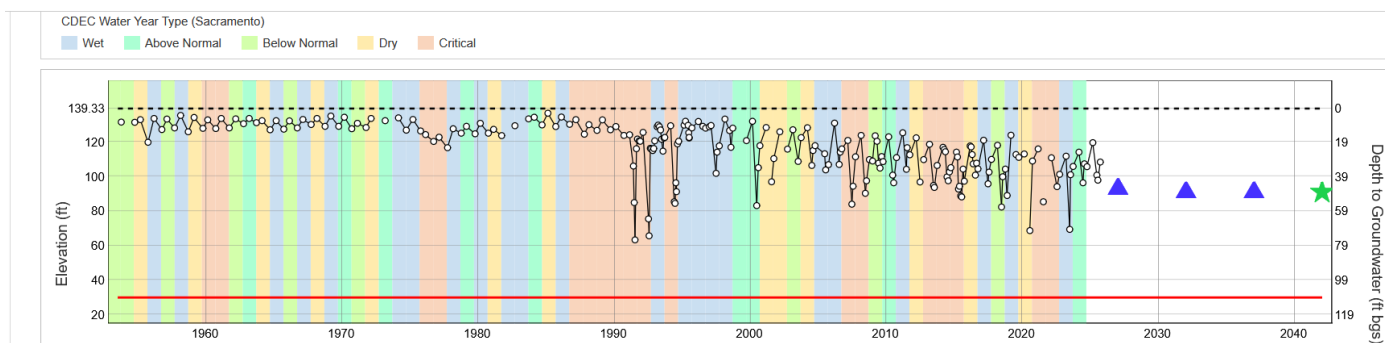
Figure 12. Hydrograph of groundwater RMS well near Project Option A.



For Project Option B, the area is represented by RMS well 20N02E09L001M, which has shown a total decline of 15.35 feet between 2003 and 2023 and an average rate of change of -0.77 ft/yr. Recent levels are above the GSP’s MT, MO, and interim milestone. However, as shown in Figure 13 below, in some years seasonal low groundwater levels at this well have dropped below the MO. These trends indicate that Option B could reduce groundwater usage, further bolstering groundwater levels, helping to reduce the drawdown of groundwater levels in years when less surface water is available and mitigate for seasonal fluctuations.

Figure 13. Hydrograph of groundwater RMS well near Project Option B.

Site Code: 396066N1217586W001 State Well Number: 20N02E09L001M Local Well Name: 20N02E09L001M



Additional monitoring well hydrographs for alternate nearby monitoring wells shown in Figure 8, are included in Appendix H.

Section 3.7.2 Project Benefits to Groundwater Levels

This Project could deliver base supplemental supplies of at least 1,500 AF and up to as much as 3,500 AF. Benefits to groundwater levels are expected to be commensurate with the volume of surface water delivered to the project area. The project implementer could require landowners to agree to reducing groundwater usage in an equal amount to the surface water delivered, in exchange for any infrastructure investments or surface water subsidies. These agreements are further described in Section 3.5.2.

The rate of groundwater decline shown in Figures 12 and 13 are similar, so project benefits are expected to have similar effects for each of the project areas.

Section 3.8: Costs

The following section will provide a discussion of benefits, culminating in a cost-benefit analysis. Estimated Project costs are shown in a dollar per AF (\$/AF) basis and will provide for a comparison to the current cost of groundwater only irrigation, as well as available funding options.

Section 3.8.1: Water Rate

PID has not yet identified the Project's costs for water. For comparison, recent Northern California lease contracts and water transfers were used to identify a range of water rates.

Table 8. Example water transfer and lease contract water rates.

Seller	Buyer/Leasee	\$/AF	Amount (AF)	Year	Location
Glenn Colusa Irrigation District	Sutter Mutual Water Company	\$55.07	20,000	2024	North-of-Delta
Butte County*	Del Oro Water Company/Cal Water- Oroville	\$106.70	668	2025	North-of-Delta
Butte County*	Palmdale Water District/Westside Districts	\$176.40	24,000	2025	South-of-Delta
Yuba County Water Agency	Healthy River and Landscape Program	\$290	41,000	2025 - 2033	In-Delta
South Sutter Water District	Woodland-Davis Clean Water Authority	\$550	2,000	2024-25	North-of-Delta
Butte Water District	Santa Clara Valley Water District	\$650+	21,000	2025	South-of-Delta
Western Canal Water District	Metropolitan Water District of Southern California	\$600	Up to 26,400	2025	South-of-Delta

***State Water Project Table A water includes DWR SWP charges**

It is important to note that the sellers listed in Table 8 derive their water supplies from a variety of sources including direct water rights from the water source (Sacramento River, Yuba River, etc.) or developed water (SWP or Central Valley Project). These various sources affect the price of water, and may not be a direct comparison to PID. However, virtually every water transaction is unique, and a direct comparison may not be available. To provide a range of comparisons, the median price of the transfers in Table 8 was used, which is \$297.50/AF; rounded to \$300/AF. Water transfer administrative costs include:

- SWRCB permit fees of \$2,745 - \$3,245¹⁹.

¹⁹ SWRCB fee for Change Petition involving a transfer of water, under California Water Code §1064(a)(1)(A)(ii), is equal to \$2,000

- Administrative and legal costs incurred by PID.

These costs assume that the transfer would be exempt from CEQA requirements as a temporary short-term transfer, but would be subject to any applicable environmental requirements (i.e. in stream flows etc.). If the project beneficiaries and PID later decide to apply for a long-term transfer, CEQA would be required which would be an additional cost estimated at \$35,000. Cost could be re-couped on a \$/AF basis and spread out over the entire long-term transfer period.

Additionally, Project Option A would require a wheeling fee, estimated to be \$25/AF, to the owners and operators of the Parrott-Phelan Canal.

The total cost per AF for surface water delivery for Project Option A is estimated to be \$325/AF. For Project Option B, the total cost per AF for surface water delivery is estimated to be \$300/AF.

Section 3.8.2: Capital, Operation & Maintenance Costs

Modifications to Option A's irrigation systems would be needed to utilize surface water, as described above. The ERR included development of a cost estimator tool, which the Project team utilized to estimate dual-source system costs for the on-farm improvements necessary for this project option, as described in Section 3.4. The project team ran cost estimates for three separate walnut blocks located within Option A (alternatives A-1, A-2, and A-3). The project team adjusted the 2018 cost estimates based on the Consumer Price Index. The costs are presented as "Extended Costs" meaning total costs and Annual Costs based on a 10-year amortization. A longer amortization period would decrease annual costs. Additionally, as discussed in Section 1.5, public funding could be secured to offset these costs to landowners.

The operating costs, including cost of water, are not included in the figures below.

plus \$0.50 per each acre-foot greater than 10 acre-feet based on the total annual amount of water sought to be transferred annually or \$674,481, whichever is less.
<https://www.waterboards.ca.gov/resources/fees/stakeholder/docs/2024/fy2425-fee-schedule-summary.pdf>

Figure 14. ERR Annual Capital and Maintenance Costs for Project Option A, Orchard A-1.

Annual Capital and Maintenance Costs							
Input Parameters				Calculated Parameters			
Crop	Walnuts			Flow (gpm)	2,940	Lift (ft)	5
Field size (Acres)	245			Raw Pipe Dia. (in)	15	Friction loss (ft)	3
Field distance from canal (ft)	50			Nominal Pipe diameter (in)	18	Filter loss (psi)	3
Field elevation above canal (ft)	5			Actual Pipe diameter (in)	17.7	Field Pressure (psi)	50
Electrical connection distance (ft)	50			Water Velocity (ft/s)	3.8	SW TDH (ft)	130
System type	Sprinkler			Screen filter present	TRUE	Pump power (hp)	148
Turnout Present	FALSE			Media filter present	FALSE		
				On-field conn. distance (ft)	1,000		

Item Description	QTY	UNIT	Unit Cost	Extended Cost	Equivalent Annual Cost	Annual Maint.	Annual Cost
Category 1							
Turnout	1	ea	\$ 4,000	\$ 4,000	\$ 493	\$ 40	\$ 533
Supply Connection Pipeline	50	ft	\$ 56	\$ 2,800	\$ 345	\$ 28	\$ 373
Pressure Pump	1	ea	\$ 33,200	\$ 33,200	\$ 4,093	\$ 996	\$ 5,089
Screen Filter(s)	1	ea	\$ 14,700	\$ 14,700	\$ 1,812	\$ 441	\$ 2,253
Media Filter(s)	0	ea	\$ 28,000	\$ -	\$ -	\$ -	\$ -
On-Field Connection Pipeline	1,000	ft	\$ 56	\$ 56,000	\$ 6,904	\$ 560	\$ 7,464
Flow Meter	1	ea	\$ 7,200	\$ 7,200	\$ 888	\$ 216	\$ 1,104
Electrical Line Extension	50	ft	\$ 30	\$ 1,500	\$ 70	\$ 15	\$ 85
Subtotal of Pay Items=				\$ 119,400	\$ 14,606	\$ 2,296	\$ 16,902
Contingencies and Indirect Costs			30%	\$ 35,820	\$ 4,382	\$ 689	\$ 5,071
2018 Project Cost =				\$ 155,220	\$ 18,988	\$ 2,985	\$ 21,972
Inflation Adjustment over 2018			2025 Project Cost	\$ 202,300	\$ 24,747	\$ 3,890	\$ 28,637

Figure 15. ERR Annual Capital and Maintenance Costs for Project Option A, Orchard A-2.

Annual Capital and Maintenance Costs							
Input Parameters			Calculated Parameters				
Crop	Walnuts		Flow (gpm)	1,560	Lift (ft)	5	
Field size (Acres)	130		Raw Pipe Dia. (in)	11	Friction loss (ft)	5	
Field distance from canal (ft)	50		Nominal Pipe diameter (in)	12	Filter loss (psi)	3	
Field elevation above canal (ft)	5		Actual Pipe diameter (in)	12.1	Field Pressure (psi)	50	
Electrical connection distance (ft)	50		Water Velocity (ft/s)	4.4	SW TDH (ft)	132	
System type	Sprinkler		Screen filter present	TRUE	Pump power (hp)	80	
Turnout Present	FALSE		Media filter present	FALSE			
			On-field conn. distance (ft)	1,000			
Item Description	QTY	UNIT	Unit Cost	Extended Cost	Equivalent Annual Cost	Annual Maint.	Annual Cost
Category 1							
Turnout	1	ea	\$ 2,800	\$ 2,800	\$ 345	\$ 28	\$ 373
Supply Connection Pipeline	50	ft	\$ 38	\$ 1,900	\$ 234	\$ 19	\$ 253
Pressure Pump	1	ea	\$ 22,500	\$ 22,500	\$ 2,774	\$ 675	\$ 3,449
Screen Filter(s)	1	ea	\$ 7,800	\$ 7,800	\$ 962	\$ 234	\$ 1,196
Media Filter(s)	0	ea	\$ 15,400	\$ -	\$ -	\$ -	\$ -
On-Field Connection Pipeline	1,000	ft	\$ 38	\$ 38,000	\$ 4,685	\$ 380	\$ 5,065
Flow Meter	1	ea	\$ 5,100	\$ 5,100	\$ 629	\$ 153	\$ 782
Electrical Line Extension	50	ft	\$ 30	\$ 1,500	\$ 70	\$ 15	\$ 85
			Subtotal of Pay Items=	\$ 79,600	\$ 9,699	\$ 1,504	\$ 11,203
Contingencies and Indirect Costs			30%	\$ 23,880	\$ 2,910	\$ 451	\$ 3,361
			2018 Project Cost =	\$ 103,480	\$ 12,609	\$ 1,955	\$ 14,564
Inflation Adjustment over 2018			2025 Project Cost	\$ 134,867	\$ 16,433	\$ 2,548	\$ 18,981

Figure 16. ERR Annual Capital and Maintenance Costs for Project Option A, Orchard A-3.

Annual Capital and Maintenance Costs							
Input Parameters			Calculated Parameters				
Crop	Walnuts		Flow (gpm)	1,140	Lift (ft)	5	
Field size (Acres)	95		Raw Pipe Dia. (in)	10	Friction loss (ft)	6	
Field distance from canal (ft)	50		Nominal Pipe diameter (in)	10	Filter loss (psi)	3	
Field elevation above canal (ft)	5		Actual Pipe diameter (in)	10.2	Field Pressure (psi)	50	
Electrical connection distance (ft)	50		Water Velocity (ft/s)	4.5	SW TDH (ft)	134	
System type	Sprinkler		Screen filter present	TRUE	Pump power (hp)	59	
Turnout Present	FALSE		Media filter present	FALSE			
			On-field conn. distance (ft)	1,000			
Item Description	QTY	UNIT	Unit Cost	Extended Cost	Equivalent Annual Cost	Annual Maint.	Annual Cost
Category 1							
Turnout	1	ea	\$ 2,400	\$ 2,400	\$ 296	\$ 24	\$ 320
Supply Connection Pipeline	50	ft	\$ 32	\$ 1,600	\$ 197	\$ 16	\$ 213
Pressure Pump	1	ea	\$ 18,000	\$ 18,000	\$ 2,219	\$ 540	\$ 2,759
Screen Filter(s)	1	ea	\$ 5,700	\$ 5,700	\$ 703	\$ 171	\$ 874
Media Filter(s)	0	ea	\$ 11,500	\$ -	\$ -	\$ -	\$ -
On-Field Connection Pipeline	1,000	ft	\$ 32	\$ 32,000	\$ 3,945	\$ 320	\$ 4,265
Flow Meter	1	ea	\$ 4,300	\$ 4,300	\$ 530	\$ 129	\$ 659
Electrical Line Extension	50	ft	\$ 30	\$ 1,500	\$ 70	\$ 15	\$ 85
			Subtotal of Pay Items=	\$ 65,500	\$ 7,960	\$ 1,215	\$ 9,175
Contingencies and Indirect Costs			30%	\$ 19,650	\$ 2,388	\$ 365	\$ 2,753
			2018 Project Cost =	\$ 85,150	\$ 10,349	\$ 1,580	\$ 11,928
Inflation Adjustment over 2018			2025 Project Cost	\$ 110,977	\$ 13,487	\$ 2,059	\$ 15,546

Total capital costs for all orchard blocks in Option A are estimated to be \$448, 144. As discussed in Section 1.5 these costs could be offset with public funding.

For all orchard blocks in Option A, surface water costs and wheeling fees are estimated to be \$325/AF plus estimated surface water pumping costs of \$55/AF, totaling \$380/AF. This compares to estimated groundwater pumping costs of \$88/AF²⁰.

Project Option B

As discussed above, on-farm irrigation modifications are not needed for the rice fields at Project Option B. Surface water is estimated to be \$300/AF. Wheeling fees are not required. There will not be material surface water pumping costs to move the water because the property utilizes a gravity fed diversion and canal system. Current groundwater pumping costs are also estimated to be \$88/AF.

Section 3.8.3: Total Cost-Benefit

After completing the above analysis of estimated project costs, the project team spread these costs over the potential benefit to the subbasin, on a \$/AF basis.

Taken together, the cumulative costs of water rates, operating and maintaining the irrigation systems, and capital costs for each project area are shown in Table 9 below. Total costs per AF per year (for a 10-year planning horizon) is \$425.12 for Project Area A and \$300 for Project Area B.

Table 9. Total cost per AF of water

PID* Costs per Acre-foot					
Property	Total AF/yr	Water Rate	O&M [^]	Capital [±]	Total Cost
A	1,400	\$ 300.00	\$ 86.07	\$ 39.05	\$ 425.12
B	3,500	\$ 300.00	\$ 0.00	\$ 0.00	\$ 300.00

**PID water rate based on median water rate from Table 7, rounded to \$300/AF*

^Calculation based on estimated pumping costs of \$55/AF plus wheeling fees of \$25/AF plus maintenance costs specified in Figures 14, 15, and 16 spread over 1,400 AF.

±Capital costs were calculated by totaling 2025 Project Costs, Equivalent Annual Cost from Figures 14, 15, and 16 spread over over 1,400 AF.

If public funding were secured for capital costs, total costs would be reduced to \$386.07/AF/year for Option A and would remain the same for Option B as no capital

²⁰ Groundwater cost estimate was developed utilizing the ERR tool, assuming energy costs of \$0.26 kWh and a maximum well drawdown of 25 feet. Well drawdown estimates were based on California's Groundwater Update 2013: A Compilation of Enhanced Content for California Water Plan Update 2013.

improvements are required.

The Project will offset approximately 1,400 to 3,500 AF of groundwater pumping in the Vina Subbasin. Project Option A could offset approximately 1,400 AF and Option B could offset up to 3,500 AF.

As discussed in Section 3.7, offsetting existing groundwater pumping would improve groundwater levels in the subbasin. Groundwater levels are a proxy for groundwater storage, subsidence, and interconnected surface waters, so the Project could provide benefits to these sustainability indicators as well. Both project options could be completed for a greater diversity of subbasin benefits, for 3,500 AF of total groundwater pumping offset.

Additionally, there may be benefits to federally threatened Central Valley spring-run Chinook Salmon and Central Valley steelhead by leaving additional water in Butte Creek between Magalia Reservoir and at least the Butte Creek Diversion Dam from April to September, when Butte Creek temperatures may affect juvenile salmon rearing.

Section 3.9: Conclusions

The Ridge to Valley Project would offset 1,400 – 3,500 AF of groundwater usage in the Vina Subbasin through the establishment of a conjunctive use program that relies on existing infrastructure, although it would necessitate on-farm improvements for those within the area of Option A.

If the Project is selected for implementation, the Project team recommends the following:

1. A phased approach should be implemented to allow for PID and Vina Subbasin landowners to become accustomed to a surface water transfer using existing water rights.
 - a. Phase 1 would span approximately 3 years and would include successive temporary (less than 1 year) transfers of up to 1,500 AF.
 - b. If Phase 1 is successful, Phase 2 would include a longer-term transfer of up to 3,500 AF that will include CEQA compliance.
2. Funding strategies should consider cost share programs between involved parties that would help with offsetting the additional cost of surface water and necessary on-farm improvements. This might include a subsidy for water rates from the Vina GSA or other interested party.
3. Given that project Option A would require the additional expense of on-

farm improvements, project Option B would be a more cost-effective option. Project option B could also utilize the entire 3,500 AF, negating the need for an additional project area that requires on-farm improvements.

4. Consider further exploration of groundwater level benefits of the two project areas potentially using the Butte Basin Groundwater Model to evaluate effects on groundwater levels.



P.O. BOX 2657, 643 "J" STREET, LOS BANOS, CALIFORNIA 93635 • WWW. WATERANDLANDSOLUTIONS.COM

Memorandum

To: Butte County Water Commission
From: Jenny Scheer and Maddie Munson, Water & Land Solutions, LLC (WLS)
Date: December 4, 2024
RE: Vina Subbasin – Surface Water Supply Projects

The Vina Subbasin Surface Water Supply Project evaluates the potential for expanded surface water use for irrigation to reduce groundwater pumping in the Vina Subbasin. The role of the Water Commission at its December 4, 2024 meeting is to review the potential surface water supply projects and recommend up to four projects to proceed to fatal flaw analysis. The projects selected should be those that are optimal considering factors like site suitability, water availability, legal aspects, and sustainability goals. The ultimate goal of this Project is to identify two potential surface water supply projects and develop feasibility studies for those projects. In Spring 2025, fatal flaw analyses will be presented to the Butte County Water Commission for selection of two potential projects to proceed to feasibility studies. This Project is funded by the Sustainable Groundwater Management Grant received from the California Department of Water Resources and is implemented by Butte County through Geosyntec/Water and Land Solutions, LLC.

Fatal flaw analysis – A fatal flaw analysis identifies potential challenges that could prevent a project from being implemented. In this context, it includes an intermediate level of project information to eliminate weaker alternatives and refine the two strongest projects ultimately selected for feasibility studies. The fatal flaw analysis report will evaluate water conveyance, place of use options, environmental concerns, financing options, and water right concerns.

Feasibility study – A feasibility study aims to objectively and rationally uncover the strengths and weaknesses of a proposed venture. In this context, the feasibility studies will address critical facets of each project, provide reconnaissance-level project designs, develop cost estimates to quantify a dollar per acre-foot cost-benefit ratio for each project, and will be developed so as to be useable for future grant applications for implementation.

Project Descriptions

1. **Sacramento/ Feather River exchange** – Unused water from water rights held on the Feather River or stored in Lake Oroville could be purchased and exchanged for diversion off the Sacramento River. Options to be explored with the State Water Resources Control Board (SWRCB) could include short-term or long-term in-county transfers. Such an exchange would leverage existing surface water rights in Butte County that are outside of the Vina Subbasin, without the need for new major water conveyance.

An exchange would require approvals from the SWRCB, California Department of Water Resources (DWR), and the U.S. Bureau of Reclamation (USBR), at a minimum. In addition, approvals from USBR, California Department of Fish and Wildlife (CDFW), U.S. Fish and Wildlife Service (USFWS), the National Marine Fisheries Service (NMFS), and the U.S. Army Corps of Engineers would likely be needed for new diversion facilities on the Sacramento River.

Potential existing water sources include Butte County's Table A State Water Project contract or surplus water supplies from South Feather Water and Power Agency (SFWPA), Paradise Irrigation District (PID), or another local irrigation district such as Western Canal Water District (WCWD) or one of the Joint Districts in Butte County (including Biggs-West Gridley Water District, Butte Water District, and Richvale Irrigation District). A long-term lease agreement may be of interest for Table A water, whereas local water districts with excess water would most likely be interested in a shorter term agreement between one and five years. Although these water rights holders can transfer water south of the Delta (SOD) for a higher price per acre-foot, transfers through the Delta are increasingly complicated and less frequent.

New pipelines or canals to deliver water from the Sacramento River to farmland in the northern part of the Vina Subbasin would be needed, and on-farm improvements would likely be required for farmers to incorporate this water source into their irrigation systems. Permitting and construction of new diversions would be costly and time consuming, but given the number of local water rights holders with surplus water supplies totaling tens of thousands of acre-feet, this option provides great potential.

Recommendation: Proceed to fatal flaw analysis

2. **Feather River/ Butte Creek exchange** – Excess water from water rights held on the Feather River or stored in Lake Oroville could be imported to Butte Creek through Pacific Gas & Electric's (PG&E) canals—or potentially a new canal—for diversion off Butte Creek.

Water is already imported from the West Branch of the Feather River to Butte Creek, providing critical flows in the summer months, supporting California's last and best run

of spring run Chinook salmon. Additional flows in upper Butte Creek could potentially increase salmon survival. However, fisheries interests have raised concerns with importation of additional surface water from the Feather River to Butte Creek, as the comingling of foreign water may confuse spawning signals for salmon. Consultation or approval would be needed from the SWRCB, DWR, and CDFW. In addition, there is some degree of uncertainty about the reliability of future flows on Butte Creek.

Existing conveyance and distribution systems—such as those owned by Durham Mutual Water Company (MWC), Rancho Esquon, or the Parrott-Phelan Canal—could be utilized, reducing the need for capital investment. Potential water sources are the same as those discussed in Project 1 above and could include short-term or long-term in-county transfers.

Recommendation: Proceed to fatal flaw analysis

- 3. Feather River-South Vina extension** – This project proposes transferring water from water rights held on the Feather River or stored in Lake Oroville through WCWD’s main canal and new pipelines or canals to target areas in the Vina Subbasin. This approach minimizes the need for extensive new infrastructure by leveraging existing conveyance facilities, significantly reducing capital costs compared to other projects. New pipelines or canals to deliver water from WCWD’s main canal to farmland in the southern part of the Vina Subbasin would be needed, and on-farm improvements would likely be required for farmers to incorporate this water source into their irrigation systems.

Recommendation: Proceed to fatal flaw analysis

- 4. Maximize existing Butte Creek water rights** – Delivery of existing water rights on Butte Creek could be maximized for agricultural irrigation. Water right holders include Durham Mutual Water Company, Dayton Mutual Water Company, and Rancho Esquon. However, based on initial discussions with stakeholders, most existing water rights on Butte Creek are maximized given water availability, and additional flow in Butte Creek from imported water would be needed to increase water deliveries from the creek.

Dayton Mutual Water Company does hold promise, with 9-10 cfs currently unused that can be conveyed through the Parrot-Phelan canal. If 10 cfs was applied for irrigation for 120 days, it could reduce groundwater pumping by 2,380 acre-feet. To make use of this unused surface water, on-farm irrigation equipment such as filters and potentially a reservoir and/or booster pump would be needed.

Recommendation: Proceed to fatal flaw analysis

- 5. Oroville-Chico Pipeline** – Excess water from water rights held on the Feather River or stored in Lake Oroville (including but not limited to Table A) could be delivered to the Vina Subbasin through a new, dedicated pipeline or canal. Assuming the ultimate use of

the surface water is on lands not currently using surface water, extensive new distribution pipelines would also need to be built. On-farm improvements would likely be required by farmers to incorporate this water source into their irrigation systems. Water sources are the same as those discussed in Project 1 above.

Prior iterations of this project have been considered over the years, however, they were grander in scale and the Sustainable Groundwater Management Act (SGMA) provides additional motivation for such a project. Nonetheless, this is likely one of the most capital intensive of the projects considered.

Recommendation: Do Not proceed to fatal flaw analysis

6. **Paradise-Chico Intertie** – The Vina GSP anticipates 27,500 acre-feet of urban and industrial water use through 2070, indicating sufficient urban water demand in the city of Chico to make use of available surface water from Paradise Irrigation District, PG&E’s Miocene Canal water right, or other potential supplies in the Paradise area.

According to the 2022 Paradise Options Study, Paradise has 3,000 to 5,000 acre-feet of water available for transfer each year. Treated water from Paradise Irrigation District’s water treatment plant in Magalia could be delivered to the city of Chico via a new pipeline, which could potentially be constructed concurrently with the Paradise Sewer Project, if it proceeds. This option requires retrofits to Magalia Dam and spillway (estimated at \$163 million) and may require expansion or modification of PID’s water treatment plant to deliver water to the city during normal and wet years. The cost of the Chico intertie is estimated at \$372 million.

By adding a surface water source to Chico’s water supply portfolio, this project improves water supply reliability and resiliency for the city of over 100,000 people. California Water Service (Cal Water) is the water purveyor in Chico and would need to be engaged in the project if it proceeds to fatal flaw analysis. Paradise Irrigation District has indicated they are not interested in pursuing this project at this time.

Recommendation: Do Not proceed to fatal flaw analysis

7. **Other local creeks** – Water right permits could be sought for other local creeks, including Pine Creek, Mud Creek, Rock Creek, Dry Creek, Big Chico Creek, Little Chico Creek, and Hamlin Slough. However, only Big Chico Creek is perennial, and all other creeks are ephemeral or seasonal with limited, if any, flow during the irrigation season. Given the timing and infrequency of flows, direct recharge from these creeks is most suitable.

Recommendation: Do Not proceed to fatal flaw analysis

- 8. Sacramento River riparian rights** – Landowners in the Vina Subbasin who are adjacent to the Sacramento River and are not currently exercising their riparian Sacramento River water rights could begin exercising those rights instead of pumping groundwater. Diversion infrastructure to remove water from the Sacramento River may need to be constructed or upgraded and on-farm improvements would likely be required for farmers to incorporate this water source into their irrigation systems. However, riparian rights can be significantly limited. Diversions may only be applied to lands contiguous to the river and past sales of land—even if a ranch has since been reunited—can sever parcels from riparian water access. Given the expense of new diversions and the relatively small amount of acreage that can be served by riparian water, this project option is not preferred.

Recommendation: Do Not proceed to fatal flaw analysis

- 9. New water right application** – A new water right application could theoretically be sought for Butte Creek, the Feather River, or the Sacramento River. Developing a new water right would also require new diversions, conveyance, and distribution systems to deliver the water. However, given the timing of this project with its focus on irrigation supplies from roughly April to October, none of those waterbodies are deemed to regularly have available water supplies in those months. The waterbodies are all part of the larger Sacramento-San Joaquin Delta watershed, which is effectively viewed as fully appropriated in the summer months in all but the wettest of years. Applying for a new water right is not considered to be a viable option, and certainly not a preferred alternative to the projects recommended for fatal flaw analysis.

Recommendation: Do Not proceed to fatal flaw analysis

Project	Water Source	Partners/ Responsible Agencies	Diversion/ Conveyance	Distribution	Cost	Potential Volume (AFY)	Timeline	Challenges
1. Sacramento/ Feather River exchange	Feather River water right diverted from Sac River	USBR, DWR, SWRCB, Landowners, TWD	New diversion on Sac River	Extensive new pipelines or canals needed to deliver the water to farmland in North Vina.	Mid	30,000	Slow	Requires SWRCB, USBR, and DWR approval. New pipelines would require easements.
2. Feather River/ Butte Creek exchange	Feather River water right diverted into Butte Creek	SWRCB, CDFW, Butte Creek Watermaster, Friends of Butte Creek, USFWS, TWD	Use existing diversion points. May require increasing capacity and new pipelines.	Use existing infrastructure of water rights holders such as Durham MWC, Parrott- Phelan Canal, WCWD, or Rancho Esquon	Low	30,000	Slow	Impact to salmon from moving water between watersheds. Butte Creek projects uncertain due to concern about SWRCB intervention. Limitations of PG&E canal capacity.
3. Feather River - South Vina extension	Table A, Miocene, WCWD, Joint Districts, SFWPA, PID	WCWD, TWD	Use existing WCWD canals plus new pipelines/canals to convey water	New pipelines or canals needed to deliver the water to farmland in the southern portion of Vina Subbasin.	Mid	30,000	Mid	Easements
4. Maximize existing Butte Creek water rights	Durham MWC, Dayton MWC	Butte Creek Watermaster, SWRCB, Rancho Esquon	Use existing diversions	Use existing on-farm and district distribution	Low	2,380	Fast	Most existing rights are fully exercised. Environmental interests would want any currently unused supply to remain in the creek.
5. Oroville - Chico pipeline	Feather River water right conveyed to farmland for irrigation or to city of Chico for municipal use	Butte County, WCWD, Joint Districts, SFWPA, PID, TWD, Cal Water, City of Chico	Minimum 10 miles of conveyance	Extensive new pipelines or canals needed to deliver water to farmland in South Vina.	High	30,000	Slow	Easements

6. Paradise - Chico Intertie	PID, Miocene, other water sources for municipal use	PID, Cal Water, City of Chico	New pipeline from the ridge to Chico	Use existing Cal Water delivery system in Chico.	High	3,000-5,000	Slow	PID would need to fix Magalia Dam and may need to increase treated water capacity. PID indicated they are not interested in this project at this time.
7. Other local creeks	Pine, Mud, Rock, Dry, Big Chico, Little Chico, Hamlin Slough	SWRCB	New diversions would be needed	New distribution would be needed	Mid	0	Mid	Mostly ephemeral or seasonal and do not have water in them during the irrigation season. Big Chico Creek flows year-round.
8. Sacramento River riparian rights	Sacramento River	Landowners	New diversion on Sac River	New pipelines needed to deliver the water to irrigated farmland	Mid	1,800	Slow	Riparian rights severed in some instances, which reduces acreage that can be served per diversion.
9. New water right application	Butte Creek, Feather River, Sacramento River	SWRCB	New diversion(s)	New pipelines needed to deliver the water to irrigated farmland	Mid	0	Slow	Waterbodies are fully appropriated during the irrigation season in all but the wettest years

AFY – Acre-feet per year
Cal Water – California Water Service
CDFW – California Department of Fish and Wildlife
DWR – California Department of Water Resources
MWC – Mutual Water Company
PID – Paradise Irrigation District
PG&E – Pacifica Gas & Electric
Sac – Sacramento
SFWPA – South Feather Water and Power Agency
SOD – South of Delta
SWRCB – State Water Resources Control Board
TWD – Tuscan Water District
USBR – U.S. Bureau of Reclamation
USFWS – U.S. Fish and Wildlife Service
WCWD – Western Canal Water District



Item: 4.17

Butte County Board of Supervisors Agenda Transmittal

Subject: Approval of Projects for the Sustainable Groundwater Management Grant Program Surface Water Supply

Department: Department of Water & Resource Conservation

Meeting Date: May 27, 2025

Contact:

Christina Buck, Assistant Director, 5305523593

Department Summary:

The Department of Water and Resource Conservation is a sub-recipient of the Sustainable Groundwater Management Grant Program through the Vina Groundwater Sustainability Agency. A goal of the project under the grant program is to identify ways to use additional surface water in the Vina subbasin to reduce groundwater pumping and to complete feasibility analysis for two selected projects. The Department is the sub-recipient as the grant project considers the use of the County's State Water Project Table Water as a potential water source for local use. The Department retained Geosyntec and Water and Land Solutions, LLC., to complete a Surface Water Supply Feasibility Analysis. The first step of the process was the completion of a Fatal Flaw Analysis to help identify viable projects. The Fatal Flaw Analysis Report describes four potential projects and key considerations to help identify the two most viable projects to advance to feasibility analysis. The second step of the process includes a more thorough evaluation of the selected projects.

On April 2, 2025, the Butte County Water Commission discussed the four projects and voted 6-1 to recommend advancing the Feather River South Vina Extension and the Ridge to Valley projects for feasibility analysis for the use of additional surface water to reduce groundwater pumping. Consistent with Water Commission recommendation and discussion, the Department recommends the Board of Supervisors approve the two projects to advance to feasibility analysis.

Fiscal Impact:

The feasibility analysis is funded by the Sustainable Groundwater Management Grant Program.

Personnel Impact:

None.

Action Requested:

Approve the Feather River South Vina Extension and Ridge to Valley projects for feasibility analysis.



MEMORANDUM

DATE: May 9, 2025

TO: Butte County Board of Supervisors

FROM: Christina Buck, Assistant Director

RE: Selection of Two Water Supply Projects for Feasibility Analysis

Background

The Vina Groundwater Sustainability Agency (GSA) received funding from the California Department of Water Resources through a Sustainable Groundwater Management Grant to identify ways to use additional surface water in the Vina Subbasin to reduce groundwater pumping, also called in-lieu recharge. Using more surface water to offset groundwater use is one component of the County's portfolio approach to reaching and maintaining sustainability in the Vina Subbasin, in combination with direct groundwater recharge and demand reduction. The Department of Water and Resource Conservation, through a contract with Geosyntec and Water and Land Solutions, LLC, is implementing the grant-funded Surface Water Supply Feasibility Analysis Project (Project) on behalf of the Vina GSA. This is due to the project's close connection to the County's Recharge Action Plan and because the key water supply being considered for multiple project options is the County's State Water Project Table A allocation from Lake Oroville.

[Vina Subbasin Surface Water Supply Feasibility Analysis Project](#)

The grant funds for the Project are sufficient for completing feasibility analysis for two water supply projects. In order to focus the bulk of the effort on the two most promising projects, the following approach is underway: 1. Develop a list of potential water supply projects under consideration, 2. Identify four projects of greatest interest and complete Fatal Flaw Analysis, 3. Select two of the four projects for completion of a Feasibility Analysis report.

The Project began with stakeholder meetings and research to develop a list of potential projects. On August 7, 2024, the Butte County Water Commission (Commission) discussed general priorities for water supply projects and formed an adhoc committee comprised of Commissioners Washington, Arvonon, and Raymond. Nine potential projects were presented to the Commission on December 4, 2024 and four projects were selected to proceed to fatal flaw analysis. The adhoc committee met on March 17, 2025 with other interested parties and the consultant team to discuss and provide feedback on initial findings of the draft Fatal Flaw Analysis. At its April 2, 2025 meeting, the Commission recommended two projects advance to feasibility analysis. The Butte County Board of Supervisors is being asked to make the final selection of the two projects to be evaluated by the feasibility analysis.

The Fatal Flaw Analysis report identifies potential challenges that could prevent a project from being implemented. It includes an intermediate level of project information to refine projects and eliminate the more constrained alternatives. The Feasibility Analysis report will describe in greater detail the critical facets of each project, provide reconnaissance-level designs, develop cost estimates to quantify a dollar per acre-foot cost-benefit ratio, and will be developed to assist with future grant applications for implementation.

[Projects Considered](#)

The attached Fatal Flaw Analysis (Attachment 1) describes the following four water supply projects and evaluates them for fatal flaws:

1. Feather River -- South Vina Extension
2. Ridge to Valley
3. Feather River -- Sacramento River Exchange
4. Feather River -- Butte Creek Diversion

[Water Commission Recommendation](#)

On April 2, 2025, the Commission considered the Draft Fatal Flaw Analysis and held a robust discussion. The Commission voted 6-1 in favor of recommending advancement of the Feather River - South Vina Extension (Project 1) and Ridge to Valley (Project 2) projects to feasibility analysis and noted that the other options would still be potentially viable upon additional grant funding and more information. Commission deliberation suggested additional discussion on Projects 3 and 4 occur with the adhoc committee.

[Key Feedback from Water Commissioners:](#)

Davin Arvonen: Made the motion to advance Project 1 and 2 to feasibility analysis and to note to the Board the other projects could still be viable given additional grant funding.

Donna Bayless: Voiced concern about economic sustainability related to agriculture and potential oversupply of agricultural acreage, opposing the Feather River -- South Vina Extension due to current market conditions.

Tovey Giezentanner: Strongly supported advancing projects 1 and 2, noting their simplicity, cost-effectiveness, and potential near-term implementation.

Fred Montgomery: Highlighted the importance of low-cost, effective solutions, expressing support for projects 1 and 2 as pragmatic approaches to reducing groundwater use.

Aimee Raymond: Expressed concerns about agricultural economic viability, particularly rice markets, but supported advancing the Feather River -- South Vina and Ridge to Valley projects to optimize conveyance and maximize local benefit. Also advocated for additional discussions related to the Feather-River -- Sacramento River Exchange and alternative Butte Creek solutions.

Peter Rystrom: Asked a question about the cost of using surface water versus the cost of groundwater pumping and voted to advance the Feather River and Ridge to Valley projects to feasibility.

Ernie Washington: Emphasized the importance of economic viability, recommending the Feather River -- South Vina and Ridge to Valley projects as economically sensible, while noting regulatory complexities around Sacramento River diversions.

Public Comment Summary:

Comments included concerns from Butte Environmental Council and individuals advocating for additional considerations from the Integrated Water Resources Plan (2005) and potential alternatives for future exploration.

Marty Dunlap posed key questions summarized as follows: How much of the groundwater deficit can be resolved by each of the projects? What approaches will maximize the decrease of the groundwater deficit for the least cost and maintain long-term benefits for the Vina Subbasin and Butte County at large? What approaches will maintain a conveyance system that benefits the Vina Subbasin yet minimizes the likelihood that local groundwater will be incorporated into the statewide water management system?

The result of the feasibility analysis for the two selected projects is intended to answer these important questions.

Action Requested

Based on the detailed analysis and comprehensive Water Commission discussion, staff recommends the Board of Supervisors:

1. Approve the Feather River -- South Vina Extension and Ridge to Valley projects for advancement to feasibility analysis.
2. Provide direction to staff regarding any future exploration of the Feather River -- Sacramento River Exchange and alternative Butte Creek solutions.

Attachments

1. Vina Subbasin Surface Water Supply Feasibility Analysis Project - Fatal Flaw Analysis



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Vina Subbasin – Surface Water Supply Feasibility Analysis Project

Fatal Flaw Analysis

Introduction

Using surface water for irrigation—also referred to as in-lieu recharge—offsets groundwater pumping and can help ensure long-term sustainability in the Vina Subbasin. Maximizing the use of existing surface water rights is also a goal of the [Butte County Recharge Action Plan](#). In-lieu recharge is one component of a portfolio approach to sustainability in the Vina Subbasin, in combination with direct recharge and demand reduction. This report outlines the findings of the Vina Subbasin Surface Water Supply Fatal Flaw Analysis and recommends two projects to proceed to feasibility analysis.

Background

The Vina Subbasin received funding from the California Department of Water Resources through a Sustainable Groundwater Management Grant to identify ways to use additional surface water in the subbasin to reduce groundwater pumping. This planning project is being implemented by the Butte County Department of Water and Resource Conservation through Geosyntec and Water and Land Solutions, LLC.

The Vina Subbasin Surface Water Supply Feasibility Analysis planning project began with stakeholder meetings and research to develop a list of potential projects. The Butte County led 2018 study, [Evaluation of Restoration and Recharge within the Butte County Groundwater Basins](#), is the most recent work to describe project alternatives for in-lieu recharge project opportunities in the County. It frequently referenced and built off of options described in the County's 2005 *Integrated Water Resources Program* document. In addition, the 2023 Butte County Recharge Action Plan, Action 4 - Maximize Use of Existing and Underutilized Surface Water Supplies informed the development of the project list for this analysis. Nine potential projects were presented to the Butte County Water Commission on December 4, 2024 (Attachment A) and four potential projects were selected to proceed to fatal flaw analysis. At its

April 2, 2025, meeting, the Butte County Water Commission recommended projects 1 and 2, described below, to advance to feasibility analysis. The Butte County Board of Supervisors will make the final selection of two projects at their May 27, 2025 meeting.

This fatal flaw analysis identifies potential challenges that could prevent a project from being implemented. It includes an intermediate level of project information to refine projects and ultimately identify weaker alternatives. The current grant funds are sufficient to complete feasibility analysis for two projects. This stepwise approach ensures that current grant funds are spent on the two most promising project options. Feasibility analysis will go into greater detail on the critical facets of each project, provide reconnaissance-level designs, develop cost estimates to quantify a dollar per acre-foot cost-benefit ratio, and will be developed so as to be useable for future grant applications to move feasible projects toward implementation in the near term.

Projects Considered

At its December 4, 2024 meeting, the Butte County Water Commission selected four potential Vina Subbasin surface water projects to proceed to fatal flaw analysis. The four projects analyzed in this report include:

1. Feather River -- South Vina Extension
2. Ridge to Valley
3. Feather River -- Sacramento River Exchange
4. Feather River -- Butte Creek Diversion

Key Considerations

For each project, six key considerations were analyzed to identify fatal flaws that would prevent the project from being implemented. The six key considerations include:

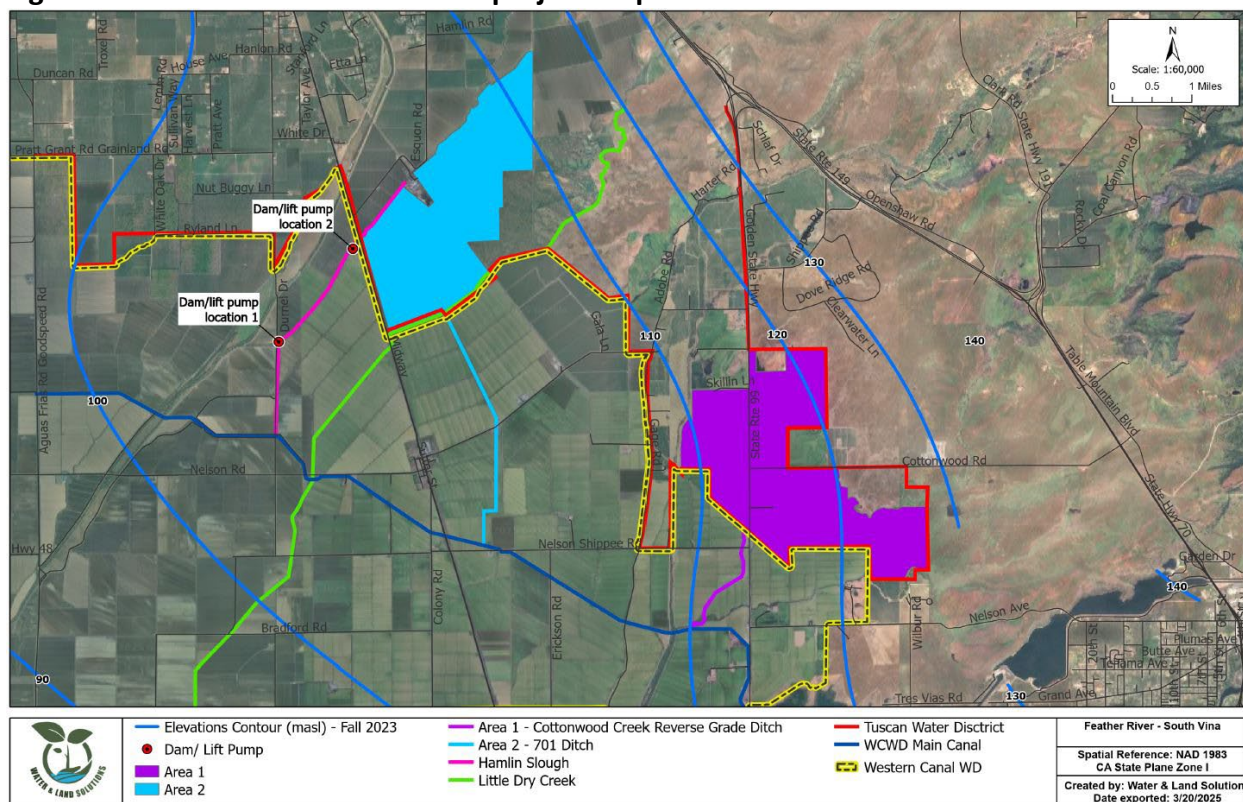
- Water availability
- Water right concerns
- Regulatory and legal aspects
- Environmental considerations
- Sustainability goals
- Costs and funding options

1. Feather River -- South Vina Extension

No Fatal Flaw Identified.

The water for this project would be sourced from the Feather River or Lake Oroville and conveyed through the Western Canal Water District's (WCWD) main canal into the southern Vina Subbasin. The water would be delivered to existing irrigated farmland south of Butte Creek using primarily existing ditches and extending them as needed. This approach minimizes the need for extensive new infrastructure by leveraging existing conveyance facilities, significantly reducing capital costs. Of the irrigated farmland south of Butte Creek and north of WCWD, two areas were selected for further analysis. These two areas are in rice production with existing on-farm ditches that can deliver surface water without the need for filtration. There are three potential options to deliver water to the north from the Western Canal: Hamlin Slough, 701 ditch, and Cottonwood Creek reverse grade ditch. Figure 1 shows areas that could potentially be irrigated through this project and existing conveyance to reach them.

Figure 1. Feather River -- South Vina project map



1.1. Water Availability

Area 1 mapped in Figure 1 includes 2,700 acres and Area 2 includes 2,300 acres. Given the acreage, irrigation demand for rice production, and other surface water already available to

these properties, this project presents a demand of 10,000-12,000 acre-feet/year of surface water that could be delivered through this project to offset groundwater pumping.

Up to 27,000 acre-feet of Butte County's State Water Project (SWP) Table A water is potentially available for new uses in Butte County each year, subject to SWP allocations. Table 1 below shows SWP water allocations since 2014 and compares the allocations to a benchmark of 10,000 acre-feet (AF). Due to the Area of Origin (AOO) settlement, Butte County's SWP Table A contract ensures a minimum of 3,000 acre-feet is available for local use, even in 0% allocation years. 190,125 AF of Table A water have been available to Butte County from 2014-2025, an average of 15,844 AF per year. The County currently leases its Table A water to south-of-delta contractors under agreements that expire in 2031. The agreements include provisions that the County can terminate the existing south-of-delta lease agreements if the water is put to use within the county.

Table 1. SWP Allocations for Butte County Table A water, 2014-2025

Year	AOO Allocation (%)	Allocation (AF)	Relative to 10,000 AF benchmark
2014	11	3,000	<10,000
2015	22	6,000	<10,000
2016	100	27,500	>10,000
2017	100	27,500	>10,000
2018	65	17,875	>10,000
2019	100	27,500	>10,000
2020	22	6,000	<10,000
2021	11	3,000	<10,000
2022	11	3,000	<10,000
2023	100	27,500	>10,000
2024	70	19,250	>10,000
2025*	80	22,000	>10,000

*Allocation as of May 1, 2025.

Water from WCWD could also be used for surface water deliveries, subject to availability, as the primary or supplemental source of water supply for this project. As shown in Table 1 above, Table A allocations may be insufficient to meet demand in some years. In those years, WCWD may have water available. However, over the last 10 years, Table A allocations have only dropped below 10,000 acre-feet in three years and WCWD also faced reductions in water supply in two of those three years. This suggests that water would be available to meet the full 10,000-12,000 AF demand of this project in roughly 8 in 10 years.

An analysis is needed to determine the amount of available capacity and the timing of such capacity in WCWD's main canal and in privately-owned ditches. Depending on the findings of

the capacity analysis, actions such as vegetation management and sediment removal may be needed to restore capacity.

1.2. Water Right Concerns

All of Butte County is within the SWP Place of Use, which enables any land within the county to legally receive SWP Table A water. Butte County serves as a water wholesaler when its Table A water is used in-county and therefore a water transfer is not required. WCWD's pre-1914 water right enables them to deliver water outside their boundary and their diversion agreement with the California Department of Water Resources (DWR) allows them to do so. If WCWD is delivering the water as is contemplated in this project, then it is considered a water delivery rather than a water transfer and is not subject to water transfer processes or requirements.

1.3. Regulatory and Legal Aspects

Regulatory and legal considerations in addition to water right concerns addressed above include landowner agreements and potentially California Environmental Quality Act (CEQA) or National Environmental Protection Act (NEPA) compliance if new conveyance is needed and state or federal funding is used. Agreements would be needed with landowners who own and use existing laterals off WCWD's main canal to determine the terms for access to the laterals. An agreement between WCWD and Vina Groundwater Sustainability Agency (GSA) would also be needed to facilitate this project and would include the cost of water, wheeling charges, provisions for an interruptible supply, and other terms. Vina GSA would in turn develop landowner agreements with those who will receive surface water deliveries under the project.

1.4. Environmental Considerations

If existing ditches are extended to deliver surface water into the southern Vina Subbasin, ground disturbing activities could have minimal impacts on terrestrial species. No impacts to fish were identified in this fatal flaw analysis. Groundwater dependent ecosystems are mapped in these areas and may benefit from the project through improved groundwater levels.

1.5. Sustainability Analysis

This project improves the sustainability of Vina Subbasin by reducing groundwater pumping in the subbasin and offsetting that groundwater use with surface water use. Monitoring wells in these areas show a trend of modest groundwater decline, indicating that reducing groundwater pumping in these areas would be beneficial for the subbasin. Dry wells have also been reported nearby, northwest of these areas. The farmland served by the project would become more climate resilient by limiting their groundwater use in normal and wet years, thereby ensuring sufficient groundwater is available in dry years. Because Butte County's Table A contract includes a minimum allocation of 3,000 acre-feet, lands served by this project would have at least some surface water available to them even in dry years.

1.6. Costs and Funding Options

Costs for the Feather River-South Vina project include one-time capital costs for infrastructure improvements such as additional pumps and extended ditches. Costs are not yet known at this stage but are expected to be less than \$5 million.

The project also includes on-going costs such as the cost of water and wheeling charges, including operations and maintenance charges. If the surface water cost is greater than the cost to pump groundwater, participating landowners would likely require an incentive to use surface water. The cost of Butte County's Table A water to the State Water Project is currently about \$96/AF and the County charges its existing south of delta lessees an additional service charge, currently about \$80/AF. A surface water cost of \$176/AF would almost certainly require a subsidy to incentivize landowner participation. WCWD's water cost has not been determined, but is anticipated to be lower than the current Table A water cost.

One-time capital costs and ongoing operational costs would be further developed in feasibility analysis. Potential grant funding for infrastructure is available through California's Prop 4 and federal WaterSMART programs. Feasibility analysis will consider these grant programs to identify aspects of project development likely to make them more competitive for upcoming grants.

1.6.1. Proposition 4 funding

California voters approved \$10 billion in bonds through [Proposition 4](#) the "Safe Drinking Water, Wildfire Prevention, Drought Preparedness, and Clean Air Bond Act of 2024" in November 2024. Funding for water infrastructure projects is a major component of the ballot measure, including the funding opportunities below that could be useful for Vina Subbasin projects.

- \$100 million for Integrated Regional Water Management
- \$386 million for Groundwater management
- \$75 million for Regional conveyance projects and repairs

1.7. Conclusion

The Feather River – South Vina project option does not have any known fatal flaws that would prevent the project from being implemented. Groundwater pumping could be reduced by 10,000-12,000 acre-feet at a cost of less than \$5 million.

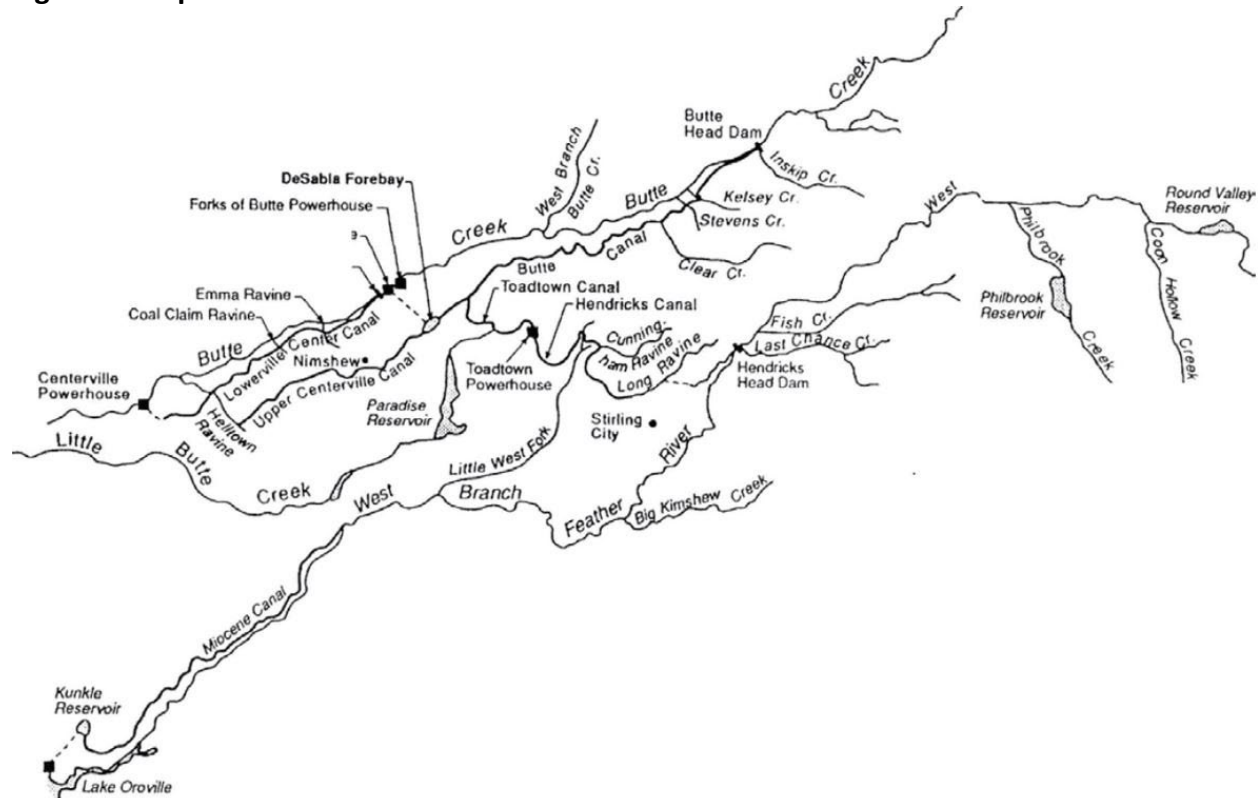
2. Ridge to Valley

No Fatal Flaw Identified.

This project option involves transferring surface water from Paradise irrigation District (PID) to the Vina Subbasin. Water stored in Paradise Lake or Magalia Reservoir would be released into

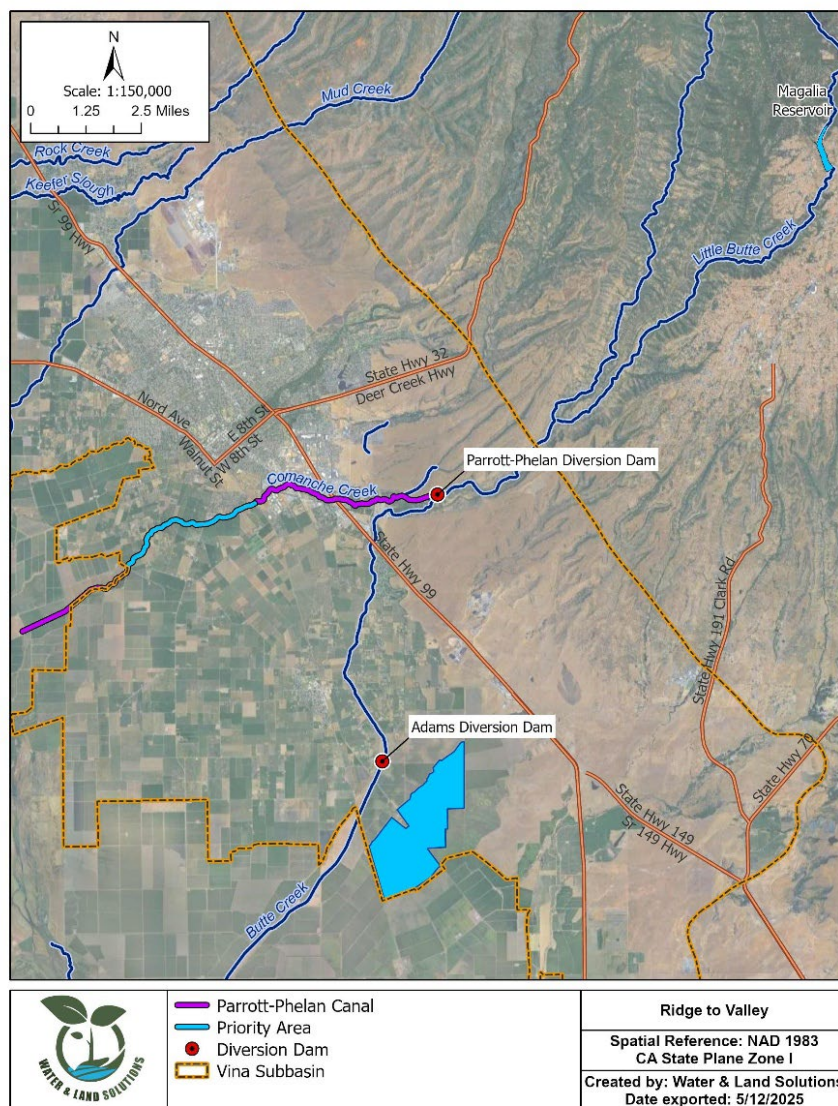
Little Butte Creek to reach downstream surface water users on Butte Creek. Figure 2 below shows Paradise Lake and Little Butte Creek.

Figure 2. Map of the West Branch Feather River and Butte Creek infrastructure



There are two options for delivery from Butte Creek. In Option A, water would be diverted at the Parrott-Phelan Diversion Dam into the Parrott-Phelan Canal and ultimately to farmland south and southwest of Chico. Under Option B, the water would continue further down Butte Creek to the Adams Diversion Dam for use on farmland at the southern edge of the Vina Subbasin, as shown in Figure 3 below.

Figure 3. Ridge to Valley project options map



Three additional alternatives involving PID were discussed but not found to be ready for implementation at this time. These include:

Paradise-Chico treated water intertie: This project involves delivering treated surface water to California Water Service Company (Cal Water) for urban use in Chico. This project is included in the [2022 Paradise Options Study](#) and was discussed extensively between PID and Cal Water but ran into non-technical challenges for which conditions have not changed.

Paradise sewer project: The Town of Paradise was considering installing a pipeline to Chico to convey wastewater for treatment at Chico's water treatment plant, which may have provided an opportunity to co-locate the Paradise-Chico intertie discussed above. The Town of Paradise is now planning to treat wastewater on the ridge rather than developing a pipeline to Chico. If wastewater is treated in Paradise, it is unlikely that it can be discharged into a local waterbody

and there is not sufficient land within town to spread the treated wastewater for infiltration. As plans develop, Paradise may seek a partnership with Vina Subbasin for direct or in-lieu recharge using treated wastewater in the subbasin.

Kunkle Reservoir: Kunkle Reservoir is a small reservoir along Pentz Road, south of Paradise, that was fed by the Miocene Canal before it burned in the Camp Fire. If water could be conveyed to the reservoir, it could be delivered to the Lower Miocene Canal or to the Vina Subbasin.

2.1. Water Availability

Little Butte Creek water stored in Paradise Lake or Magalia Reservoir could be available for 1,000 – 2,000 acre-feet of water transfers in the near term. Upon completion of the Magalia Dam retrofit in 2028, up to 5,000 acre-feet may be available for water transfers.

At the Butte County Water Commission’s February 5, 2025 meeting, Kevin Phillips, PID’s General Manager, noted that PID does not expect to use their full water supply for the foreseeable future, due to a reduced population in Paradise coupled with modern construction and landscape standards to conserve water. Phillips indicated that PID wants to be at the table to discuss potential partnerships with the Vina Subbasin.

A planned repair of Magalia Dam, which will restore PID’s reservoir capacity, could make additional water supplies available for transfer in the summer months. Current California Division of Dam Safety restrictions limit storage in Magalia Dam to 800 AF, compared to a design capacity of 2,250 AF. The estimated project cost is \$69 million, with design costs fully funded and construction costs 60 percent funded. PID is confident the additional funding will be obtained to restore full capacity by 2028.

The Parrott-Phelan Canal (also known as Commanche Creek or Edgar Slough) has available capacity of 30 cubic feet per second (cfs), which could deliver approximately 9,000 acre-feet over the irrigation season to roughly 3,000 acres, if sufficient water supplies were available.

2.2. Water Right Concerns

PID has three water rights as shown in Table 2 below. PID could use their 1916 appropriative right to transfer water to downstream users on Butte Creek, which would require reservoir reoperation. The [water transfer process](#) is governed by the State Water Resources Control Board (State Water Board).

PID has never participated in a water transfer, though water transfers have been a topic of discussion since the 2022 Paradise Options Study. Conversations with the PID board of directors will be needed to familiarize the board with water transfers and habituate them to the project.

Option A – delivering water southwest of Chico – reduces groundwater pumping for irrigation, which supports the sustainability of domestic and public supply wells in the area.

Another potential benefit specific to Option A is the opportunity to utilize excess winter flows. These excess flows could be diverted through the Parrott-Phelan Canal during periods of high runoff and directed onto fallowed farmland, enabling groundwater recharge through intentional spreading. Such managed recharge practices could further support the subbasin’s sustainability goals by increasing groundwater storage and improving drought resiliency.

2.6. Costs and Funding Options

Costs vary between Option A and Option B. Option A includes additional costs for distribution pipelines to serve farmland, whereas Option B would use existing on-farm distribution systems. Option A would also require on-farm irrigation system improvements for orchards to be able to use surface water, such as booster pumps and filters. The 2018 Evaluation of Restoration and Recharge within the Butte County Groundwater Subbasins report estimates the cost to install irrigation equipment to use surface water in an existing orchard is \$86,580 for a 100-acre walnut farm. This cost of \$865.80 per acre over 3,000 acres amounts to \$2.6 million for on-farm improvements, according to the 2018 estimate. Based on the 2018 cost estimate, price increases since 2018, and additional infrastructure for pumping and distribution, costs for Option A are preliminarily estimated to be \$5 million. Option B would have minimal, if any, cost.

Wheeling charges to compensate the operators of the Parrott-Phelan canal for additional operations and maintenance costs would be included in the long-term implementation costs of the project. One-time capital costs and ongoing operational costs would be further developed in feasibility analysis. As discussed in Section 1.6, grant funding may be available for infrastructure for this project.

2.7. Conclusion

The Ridge to Valley project option does not have any known fatal flaws that would prevent the project from being implemented. Paradise Irrigation District has indicated that up to 5,000 acre-feet may be available for transfer to reduce groundwater pumping, and the preliminary project cost is estimated to be up to \$5 million.

3. Feather River -- Sacramento River Exchange

No Fatal Flaw Identified.

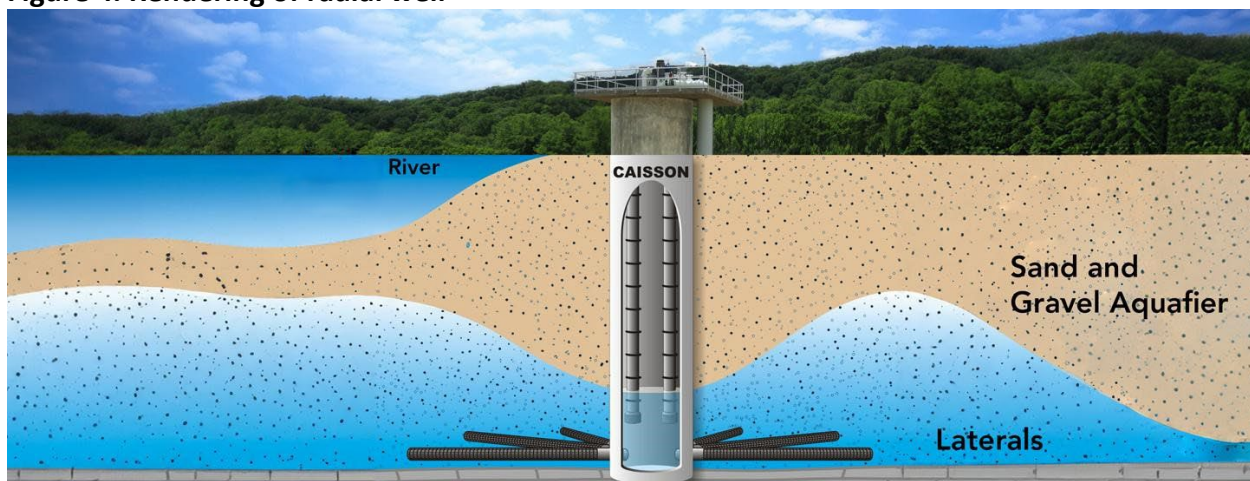
The Feather River – Sacramento River Exchange project involves sourcing water from the Feather River or Lake Oroville by diverting an equal amount from the Sacramento River for irrigation in northern Vina Subbasin. This exchange would occur between Butte County—or another existing Feather River water right holder—and a Sacramento River Settlement Contractor (SRSC) south of the confluence of the Sacramento and Feather River. The exchange

would require the SWP to release an amount of water into the Feather River from Lake Oroville in exchange for a like amount of water provided by the SRSC from Lake Shasta for diversion from the Sacramento River in the Vina Subbasin.

Given the Sacramento River's location along the western edge of the subbasin, this approach moves an existing surface water right closer to groundwater users in Vina Subbasin. An exchange would leverage existing surface water rights in Butte County that are outside of the Vina Subbasin, without the need for new major water conveyance. Existing ditches along farmland north of Chico may be useable to distribute water to farmland, and at least some new pipelines or canals would also be needed.

To reduce environmental impacts, permitting limitations, and maintenance challenges, the project team analyzed the use of a [radial collector well](#) to divert the water rather than a traditional surface water diversion on the river. Radial collector wells, also known as Ranney collector wells, are sited near a river or stream with collector shafts that radiate through different locations in the subsurface to collect water that is interconnected to the nearby river. A rendering of a radial well is shown in Figure 4 below. Large radial wells can divert 40 cfs, which means each radial well could serve 3,000 acres with 10,000+ acre-feet of water per year.

Figure 4. Rendering of radial well



Source: Granite Construction

3.1. Water Availability

Table A water that could be exchanged to be diverted off the Sacramento River is discussed further in Section 1.1. The exchange involves a SRSC and an SWP contractor and water availability would be subject to SWP and CVP allocations. SRSCs are water districts and individuals that hold senior water rights on the Sacramento River that pre-date the Central Valley Project (CVP) who subsequently signed CVP settlement contracts with the U. S. Bureau of Reclamation (USBR).

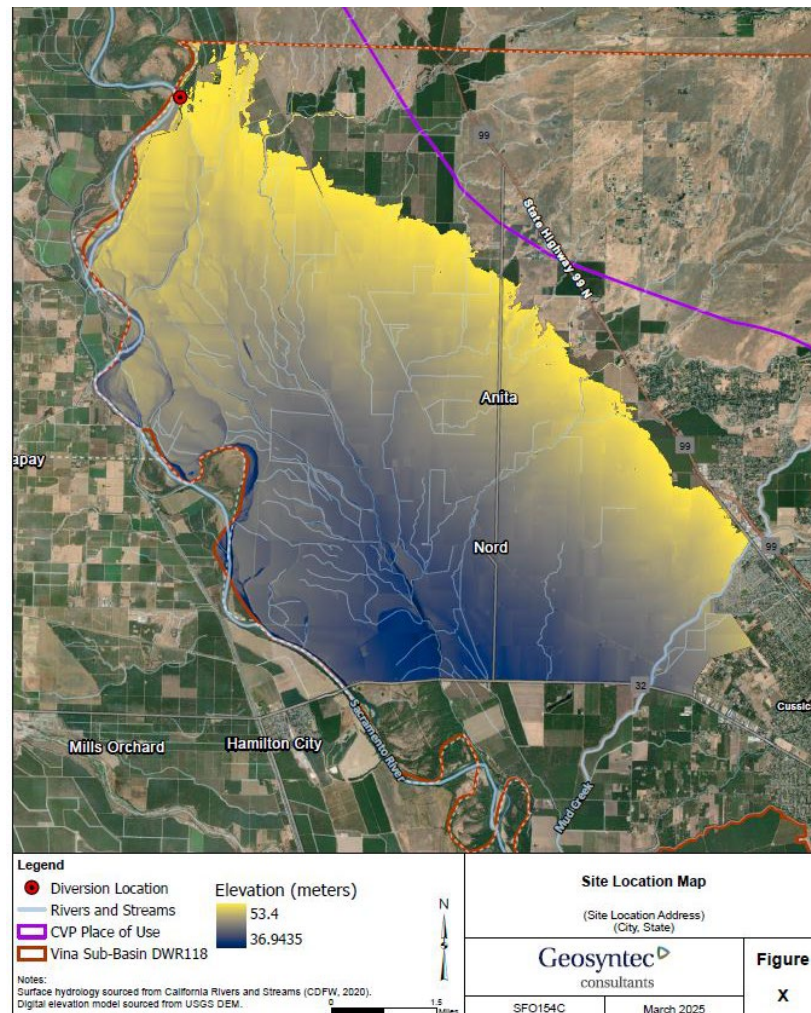
Alternatively, water supplies from Feather River diverters (such as Butte Water District or Western Canal Water District) could also be used, with an estimated 25,000 AF available from these districts. Table A and other Feather River water sources could potentially combine to 50,000 AF of exchange water. A local water district would most likely be interested in an agreement between one and five years that would vary based on water availability. Although these water rights holders can transfer water south of the Delta (SOD) for a higher price per acre-foot, transfers through the Delta are increasingly complicated and less reliable. Having a local market for the water with consistent demand every year may be an attractive option.

There are also landowners in the northern Vina Subbasin with riparian water rights. Riparian water rights may only be utilized on the specific parcels associated with those rights and may have been severed over time. Analysis would need to be conducted with these landowners to determine the extent of legal riparian water rights.

Figure 5 below illustrates a conceptual diversion point off the Sacramento River. The total shaded area on the map encompasses approximately 30,00 acres. Given that each radial well is estimated to serve roughly 3,000 acres, approximately 10% of the northern Vina Subbasin could potentially be served by a single radial well. Acres selected to be served by a radial well could be based on a number of factors including a radial well location with suitable soils, a stable riverbank without erosion, avoidance of impacts to GDEs, existing opportunities for distribution, etc.

Engineering considerations should also include opportunities for gravity-fed water distribution, minimizing the need for pumping infrastructure and operations. Areas shaded in yellow on the map are at or below the elevation of that specific diversion point. Areas in blue are significantly lower in elevation than the diversion elevation. The eastern boundary of the shaded area has an average fall of 1% per mile.

Figure 5. Map showing farmland areas with lower elevation than a specified diversion point on the Sacramento River in northern Vina Subbasin

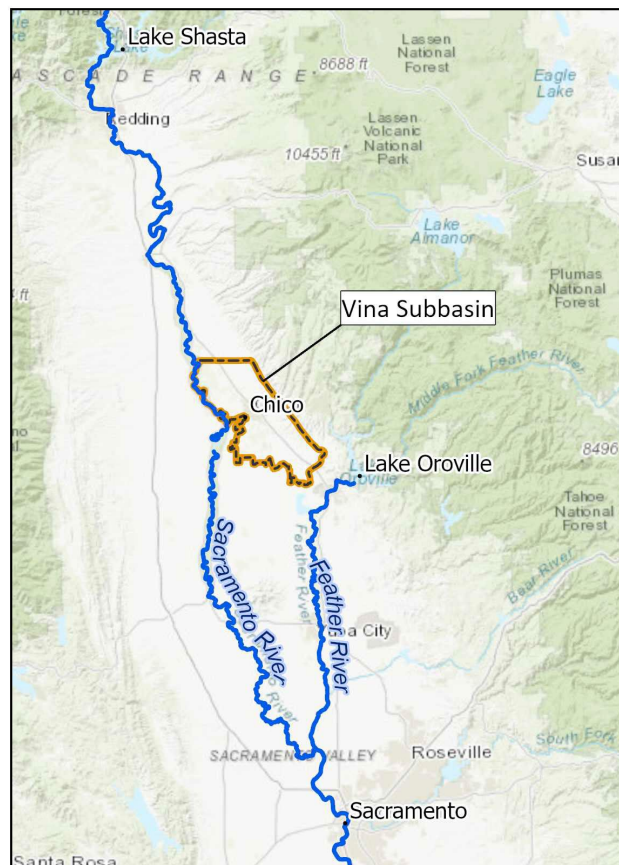


3.2. Water Right Concerns

An exchange of Table A water to the Sacramento River would require approval from DWR. Article 56.F of Butte County’s SWP contract enables a balanced, bona fide exchange such as this where like amounts of water are released from the SWP to the Sac River Settlement Contractor downstream and from the CVP to the SWP users in Vina Subbasin. Figure 6 shows the vicinity of the exchange including key features of the CVP and SWP.

As shown in Figure 5 above, the potential project area is within the CVP Place of Use. Since all of Butte County is within the SWP Place of Use, lands that would receive exchanged water in northern Vina Subbasin are within both the CVP and SWP places of use and therefore the exchange would not require approval from the State Water Board. USBR would be involved in the exchange as the operator of the CVP.

Figure 6. Sacramento River exchange project vicinity map



An appropriate SRSC would need to be identified to facilitate the exchange, and discussions can be initiated if the project proceeds to feasibility analysis. Pleasant Grove Verona Mutual Water Company, Natomas Mutual Water Company, or Conaway Preservation Group are all SRSCs downstream of the confluence of the Feather River and Sacramento River that could potentially facilitate the exchange.

3.3. Regulatory and Legal Aspects

The radial well avoids permitting a diversion on the river and additional permitting for long-term operations and maintenance of the diversion. Consultation and potentially permitting may still be needed with California Department of Fish and Wildlife (CDFW), U.S. Fish and Wildlife Service (USFWS), National Marine Fisheries Service (NMFS), and the U.S. Army Corps of Engineers. These agencies are responsible for ensuring that impacts to fish in the river and infrastructure on the river are minimized. CEQA analysis is required for the exchange through DWR and NEPA may be required by USBR.

Butte County currently restricts placement of groundwater wells close to the Sacramento River. A waiver may be needed to permit the radial well. Butte County Environmental Health should be consulted to discuss well permitting considerations.

Easements may be needed for extensive new conveyance and distribution. An easement or fee title acquisition would be needed for the pump house above the radial well. CEQA environmental review would likely be needed for new conveyance and distribution.

3.4. Environmental Considerations

Radial collector wells have the benefit of reducing habitat impacts associated with the physical construction of a diversion point in a river with species of concern. Environmental considerations related to the change in water availability to the Sacramento and Feather Rivers would still need to be vetted with USFWS, CDFW, NMFS, and SWRCB. The Sacramento River Basin is home to multiple fish identified as threatened or endangered under the Endangered Species Act (ESA), including Sacramento River winter-run Chinook salmon, Central Valley spring-run Chinook salmon, California Central Valley steelhead trout, and Southern Distinct Population Segment green sturgeon. Any project option that proposes to alter the habitat of these species through changes in water availability or physical changes to the river itself will require analyses to ensure avoidance of project impacts on these species. If project impacts are unavoidable, mitigation measures will be required.

Lake Shasta is operated with consideration for protecting the cold-water pool in the reservoir to benefit listed species in the Sacramento River with cold water releases. Cold-water pool operations may be prioritized over the fulfillment of an exchange. Additional discussion with USBR staff would be needed to verify the reliability in frequency and amount of water delivered by the proposed exchange.

If new conveyance and distribution pipelines or canals are needed to deliver water to the irrigated farmland in the service area, ground disturbing activities could have minimal impacts on terrestrial species.

3.5. Sustainability Analysis

Diversion through a radial well rather than direct diversion was selected for the proposed project due to the difficulties and expense of developing and maintaining a diversion on the river. A direct diversion from the Sacramento River involves an extensive permitting and mitigation process including consultation with multiple fish agencies. A diversion would need to have an advanced fish screen on the diversion, which increases the cost of the structure. Long-term operation and maintenance of a diversion on the river is also considerably more complex for a direct diversion. The riverbank where the diversion's intake is located can become eroded away, a gravel bar can develop and impede operations, or the river channel can shift away from the diversion and leave it stranded. To fix any of these challenges would require additional work in the river, which would require additional permits. Diverters operating existing diversions on the Sacramento River face uncertainty and complexity in maintaining them.

3.6. Costs and Funding Options

The 2018 Evaluation of Restoration and Recharge within the Butte County Groundwater Subbasins report estimates the cost of installing two radial collector wells along the Sacramento River with a pipeline to Chico to be \$28 million. The cost estimate is seven years old as of the writing of this report and costs would be significantly higher today. In addition, laterals for water distribution and on-farm irrigation system improvements would further increase the cost of the current project proposal compared to the 2018 cost estimate. The 2018 report estimates the cost to install irrigation equipment to use surface water in an existing orchard is \$86,580 for a 100-acre walnut farm. This cost of \$865.80 per acre over 3,000 acres amounts to \$2.6 million for on-farm improvements. One-time capital costs and ongoing operational costs would be further developed in feasibility analysis.

Without an updated cost estimate, \$15 million per radial well is used in this report for illustrative purposes. A \$15 million radial well serving 3,000 acres equates to \$5,000/acre. Infrastructure costs of \$5,000 per acre are well beyond what landowners would reasonably invest to develop a second source of water supply. Significant grant funding would be required to offset infrastructure costs for landowners, or the project would be infeasible. Potential grant funding may be available through California's Prop 4 and federal WaterSMART programs, as discussed further in Section 1.6.

In addition to capital costs, water costs would need to be considered in a feasibility analysis. The \$176/AF cost of Butte County's Table A water (see Section 1.6) is likely greater than the cost to pump groundwater in the northern Vina Subbasin, which means the water cost would need to be subsidized to incentivize landowners to use surface water instead of groundwater. If the new diversion could also deliver riparian rights, this water would not have an acre-foot cost in addition to pumping costs from the radial well.

3.7. Conclusion

The Feather River -- Sacramento River project option does not have any known fatal flaws that would prevent the project from being implemented. If more than one radial well is developed, up to 27,000 acre-feet of groundwater pumping can be offset by surface water use. Cost estimates would need to be developed to better understand current costs, and each radial well is anticipated to cost more than \$15 million.

4. Feather River -- Butte Creek Diversion

Fatal Flaw Identified.

This project proposes importing additional water from the Feather River system for re-diversion off Butte Creek. Existing water rights on Butte Creek are fully maximized under almost any conditions during the irrigation season. Butte Creek is also a critically important salmon run in California and additional diversions under current conditions may interfere with salmon

restoration requirements. Additional diversions from Butte Creek may be possible if supplementary water is imported to the creek. This would provide multiple benefits, such as water supplies for agricultural users in the Vina Subbasin and additional flows to support salmon.

Water from existing water rights held on the Feather River or stored in Lake Oroville could be imported to Butte Creek through Pacific Gas & Electric's (PG&E) canals—or potentially a new canal—for diversion off Butte Creek. PG&E's Hendricks Canal has moved water from the West Branch Feather River (WBFR) to Butte Creek for 100 years. No other existing infrastructure was identified that could move water from the Feather River to Butte Creek. For this analysis, the focus is on using existing infrastructure i.e. the Hendricks Canal. Options for new infrastructure to deliver water from the Feather River system into Butte Creek are explored further in the [Integrated Water Resources Program](#) report prepared for the Butte County Department of Water and Resource Conservation in May 2005.

The Hendricks Canal is a 9-mile canal constructed in the early 1900s of mostly earthen ditch with several flume and tunnel sections. The canal is owned by PG&E and it conveys water from the WBFR to Butte Creek via Toadtown powerhouse and then into the Toadtown Canal, eventually reaching the DeSabra Forebay, as shown in Figure 7.

Figure 7. Map of DeSabra-Centerville project



4.1. Water Availability

One source of water that could be diverted from the WBFR to Butte Creek is Butte County's Table A water, which is discussed further in Section 1.1. The current capacity of the Hendricks Canal is reduced from a design capacity of 125 cfs when the canal was built. Table 3 below shows flows imported from the Hendricks Canal via Toadtown Canal into Butte Creek. Maximum flow reported during the irrigation season last year was 86 cfs. Recorded flows were below 70 cfs for 143 of the 200 days shown in Table 3, indicating there may be available capacity throughout the irrigation season. However, according to PG&E, the Hendricks Canal is fully allocated for PG&E operations.

Table 3. Water imported to Butte Creek, April – October 2024

Flow (CFS)	Number of Days
0-10	16
11-20	22
21-30	12
31-40	10
41-50	11
51-60	9
61-70	63
71-80	51
81-90	6
>90	0

Source: <https://cdec.water.ca.gov/dynamicapp/QueryDaily?s=BBW>

As noted above, no other existing means of transferring water from WBFR to Butte Creek have been identified, making it infeasible to move more water into Butte Creek without using the Hendricks Canal. This constitutes a fatal flaw hindering further analysis of this project at this time.

4.2. Water Right Concerns

As noted in Section 1.2, Butte County's Table A water can be legally delivered anywhere within the county. Butte Creek is an adjudicated stream with a watermaster. Any changes in Butte Creek diversion would be subject to additional oversight from the watermaster. The Butte Creek adjudication addresses "imported water", meaning the existing diversions from WBFR into Butte Creek. Additional water imported to the creek would need to be protected from diversion by existing users with rights to "imported water."

4.3. Regulatory and Legal Aspects

CEQA permitting would likely be required for major upgrades to the Hendricks Canal. If existing Butte Creek diverters in the Vina Subbasin use the additional imported water envisioned in this project, it is not anticipated that additional conveyance or distribution would be needed to deliver the water to irrigated agricultural lands.

4.4. Environmental Considerations

For more than 100 years, summer flows in Butte Creek have been augmented by storage releases from PG&E's DeSabra-Centerville Hydroelectric Project, including an inter-basin diversion from the WBFR. This has created favorable conditions for Central Valley spring-run Chinook salmon, a threatened species under the federal and state Endangered Species Act. The Butte Creek population of Central Valley spring-run Chinook salmon is now the [largest naturally spawning population](#) remaining in the Central Valley.

Additional flows in Butte Creek during the summer months are assumed to be beneficial, particularly in improving fish passage over the Lahar Formation. It is also assumed to be infeasible to divert more water from Butte Creek during the summer months without harming salmon or injuring other Butte Creek water rights holders, unless additional water is imported into the creek.

In discussions related to this project, fishery interests have raised concerns with importation of additional surface water from the WBFR to Butte Creek, as the comingling of foreign water may confuse spawning signals for salmon. Central Valley Constant Fractional Marking/Tagging Program (CFM) [data do not support a hypothesis of a straying problem](#) from the Feather River to Butte Creek. In the last five years for which data are available (2016-2020), there were zero Feather River hatchery fish recorded in Butte Creek. Further, salmon migrating up the Sacramento River from the Pacific Ocean reach the Feather River before they reach Butte Creek. Straying salmon originating from the Feather River would have to pass this larger, stronger waterbody and continue to Butte Creek.

4.5. Sustainability Analysis

Existing diversions through the Hendricks Canal into Butte Creek are critical for salmon survival. Additional flows could further support fish in hotter, drier summers.

The future of the Hendricks Canal and the DeSabra-Centerville project are uncertain. In 2007, PG&E filed an application for a new Federal Energy Regulatory Commission (FERC) license. Their application included plans for a fish ladder and canal fish screen on the Hendricks Dam facilities. In February 2017, PG&E announced that it would withdraw its application for a new FERC license. In May 2017, PG&E proposed a schedule to move forward with the sale of the Project to a new, undisclosed owner. FERC indicated that if negotiations did not result in a sale of the DeSabra-Centerville project, FERC would initiate an "orphaned project" proceeding which [could result in decommissioning](#). If the project is decommissioned at any time in the future, actions

must be taken to ensure salmon continue to be supported by diversions from WBFR into Butte Creek. New diversions to provide surface water supplies for irrigation in Vina Subbasin may not be supported.

4.6. Costs and Funding Options

Cost estimates to restore capacity in the Hendricks Canal are not available from PG&E. PG&E staff and PG&E's online documents library were consulted for information on the nature of capacity reductions on the Hendricks Canal, extraordinary maintenance work needed to restore capacity, and cost estimates for the extraordinary maintenance. However, PG&E does not share non-public data related to the design, operation, or costs of PG&E facilities unless a transaction or regulatory proceeding necessitates or requires a disclosure.

In the absence of cost estimates from PG&E for the Hendricks Canal, costs for the Miocene Canal can be used as a proxy. Although the terrain and design characteristics between the two canals differ, the scale of the costs are likely comparable. The [cost to restore the Miocene Canal](#) after the Camp Fire was estimated at \$40-\$60 million. Annual maintenance costs for the Miocene Canal were estimated at \$1-\$2 million. If the Hendricks Canal was used to deliver irrigation water to the Vina Subbasin, water users would be responsible for some portion of the canal's maintenance costs.

4.7. Conclusion

The Feather River -- Butte Creek project evaluated existing infrastructure to move additional water into Butte Creek. PG&E has indicated that the existing infrastructure (Hendricks Canal) is fully allocated for PG&E's operations. PG&E also indicated they are unwilling to share information about the DeSabra-Centerville project. Groundwater pumping cannot be offset by surface water supplies in this scenario, since PG&E has indicated it cannot deliver additional surface water for irrigation. Further feasibility analysis of this project would require a willingness from PG&E to explore possibilities and provide information. An unwilling partner is a fatal flaw.

Recommendations

The fatal flaw analysis indicates the following:

- a. The Feather River -- South Vina Extension, Ridge to Valley, and Feather River -- Sacramento River projects do not have known fatal flaws.
- b. The two least expensive options for bringing additional surface water into the Vina Subbasin are the Feather River -- South Vina Extension and Ridge to Valley project options.
- c. The Feather River -- South Vina Extension and Ridge to Valley projects should proceed to feasibility analysis, considering their potential water availability, regulatory and legal aspects, environmental benefits, long-term sustainability and funding opportunities.

- d. The Feather River—Butte Creek project was found to have a fatal flaw at this time. However, due to the importance of Butte Creek’s salmon fishery and water supplies, it will be important to continue to track developments by PG&E or others that may affect the Butte Creek system.

Attachment A.

Memorandum to the Butte County Water Commission, December 4, 2025 (revised April 29, 2025)



P.O. BOX 2657, 643 "J" STREET, LOS BANOS, CALIFORNIA 93635 • WWW. WATERANDLANDSOLUTIONS.COM

Memorandum

To: Butte County Water Commission
From: Jenny Scheer and Maddie Munson, Water & Land Solutions, LLC (WLS)
Date: December 4, 2024, Revised April 29, 2025
RE: Vina Subbasin – Surface Water Supply Feasibility Analysis project

The Vina Subbasin Surface Water Supply Feasibility Analysis project (Project) evaluates the potential for expanded surface water use for irrigation to reduce groundwater pumping in the Vina Subbasin. The role of the Water Commission at its December 4, 2024 meeting is to review the potential surface water supply projects and recommend up to four projects to proceed to fatal flaw analysis. The projects selected should be those that are optimal considering factors like site suitability, water availability, legal aspects, and sustainability goals. The ultimate goal of this Project is to identify two potential surface water supply projects and develop feasibility studies for those projects. In Spring 2025, fatal flaw analyses will be presented to the Butte County Water Commission for selection of two potential projects to proceed to feasibility studies. This Project is funded by the Sustainable Groundwater Management Grant received from the California Department of Water Resources and is implemented by Butte County through Geosyntec/Water and Land Solutions, LLC.

Fatal flaw analysis – A fatal flaw analysis identifies potential challenges that could prevent a project from being implemented. In this context, it includes an intermediate level of project information to eliminate weaker alternatives and refine the two strongest projects ultimately selected for feasibility studies. The fatal flaw analysis report will evaluate water conveyance, place of use options, environmental concerns, financing options, and water right concerns.

Feasibility study – A feasibility study aims to objectively and rationally uncover the strengths and weaknesses of a proposed venture. In this context, the feasibility studies will address critical facets of each project, provide reconnaissance-level project designs, develop cost estimates to quantify a dollar per acre-foot cost-benefit ratio for each project, and will be developed so as to be useable for future grant applications.

Project Descriptions (revised April 29, 2025)

The Project began with stakeholder meetings and research to develop a list of potential projects. The Butte County led 2018 study, *Evaluation of Restoration and Recharge within the Butte County Groundwater Basins*, is the most recent work to describe project alternatives for in-lieu recharge project opportunities in the County. It frequently referenced and built off of options described in the County's 2005 *Integrated Water Resources Program* document. In addition, the 2023 Butte County Recharge Action Plan, Action 4 - Maximize Use of Existing and Underutilized Surface Water Supplies informed the development of the project list for this analysis. Nine potential projects are described below for the Commission's consideration.

- 1. Sacramento/ Feather River exchange** – Unused water from water rights held on the Feather River or stored in Lake Oroville could be purchased and exchanged for diversion off the Sacramento River. Options to be explored with the State Water Resources Control Board (SWRCB) could include permanent transfer of rights, short-term transfers, and long-term transfers. Such an exchange would leverage existing surface water rights in Butte County that are outside of the Vina Subbasin, without the need for new major water conveyance.

An exchange would require approvals from the SWRCB, California Department of Water Resources (DWR), and the U.S. Bureau of Reclamation (USBR), at a minimum. In addition, approvals from USBR, California Department of Fish and Wildlife (CDFW), U.S. Fish and Wildlife Service (USFWS), the National Marine Fisheries Service (NMFS), and the U.S. Army Corps of Engineers would likely be needed for new diversion facilities on the Sacramento River.

Potential existing water sources include Butte County's Table A contract or surplus water supplies from South Feather Water and Power Agency (SFWPA), Paradise Irrigation District (PID), or another local irrigation district such as Western Canal Water District (WCWD) or one of the Joint Districts (especially Biggs-West Gridley Water District, Butte Water District, or Richvale Irrigation District in Butte County). A long-term transfer agreement may be of interest for Table A water, whereas local water districts with excess water would most likely be interested in a shorter term agreement of between one and five years. Although these water rights holders can transfer water south of the Delta (SOD) for a higher price per acre-foot, transfers through the Delta are increasingly complicated and less frequent.

New pipelines to deliver water from the Sacramento River to farmland in the northern part of the Vina Subbasin would be needed, and on-farm improvements may be required for farmers to incorporate this water source into their irrigation systems. Permitting and construction of new diversions would be costly and time consuming, but

given the number of local water rights holders with surplus water supplies totaling tens of thousands of acre-feet, this option provides great potential.

Recommendation: Proceed to fatal flaw analysis

- 2. Feather River/ Butte Creek exchange** – Excess water from water rights held on the Feather River or stored in Lake Oroville could be imported to Butte Creek through Pacific Gas & Electric’s (PG&E) canals—or potentially a new canal—for diversion off Butte Creek.

Water is already imported from the West Branch of the Feather River to Butte Creek, providing critical flows in the summer months. Without these flows, California’s last, best run of spring run Chinook salmon may be in peril. Additional flows in upper Butte Creek could potentially increase salmon survival. However, fisheries interests have raised concerns with importation of additional surface water from the Feather River to Butte Creek, as the comingling of foreign water may confuse spawning signals for salmon. Consultation or approval would be needed from the SWRCB, DWR, and CDFW. In addition, there is some degree of uncertainty about the reliability of future flows on Butte Creek.

Existing conveyance and distribution systems—such as those owned by Durham Mutual Water Company (MWC), Rancho Esquon, or the Parrott-Phelan Canal—would be utilized, reducing the need for capital investment. Potential water sources are the same as those discussed in Project 1 above, and could include permanent transfer of rights, short-term transfers, and long-term transfers.

Recommendation: Proceed to fatal flaw analysis

- 3. Feather River-South Vina extension** – This project proposes transferring water from water rights held on the Feather River or stored in Lake Oroville through Western Canal and new pipelines to target areas in the Vina Subbasin. This approach minimizes the need for extensive new infrastructure by leveraging existing conveyance facilities, significantly reducing capital costs compared to other projects. New pipelines to deliver water from Western Canal to farmland in the southern part of the Vina Subbasin would be needed, and on-farm improvements may be required for farmers to incorporate this water source into their irrigation systems.

Recommendation: Proceed to fatal flaw analysis

- 4. Maximize existing Butte Creek water rights** – Delivery of existing water rights on Butte Creek could be maximized for agricultural irrigation. Water right holders include Durham MWC, Dayton Mutual Water Company, and Ranch Esquon. However, based on initial discussions with stakeholders, most existing water rights on Butte Creek are maximized

given water availability, and additional flow in Butte Creek from imported water would be needed to increase water deliveries from the creek.

Durham MWC encompasses lands that have converted to low-volume irrigation—such as micro sprinklers or drip irrigation—and no longer use surface water. To resume surface water deliveries to these properties, on-farm infrastructure such as booster pumps and filters would be needed. However, Durham MWC operates on a rotational basis, meaning each property only has access to surface water every 12 days or so. Orchards set up with low-volume irrigation need to be irrigated more frequently than once every 12 days, so some portion of groundwater use would continue.

Dayton Mutual Water Company holds promise, with 9-10 cfs currently unused that can be conveyed through the Parrot-Phelan canal. If 10 cfs was applied for irrigation for 120 days, it could reduce groundwater pumping by 2,380 acre-feet. To make use of this unused surface water, on-farm irrigation equipment like filters and potentially a reservoir and/or booster pump would be needed.

Recommendation: Proceed to fatal flaw analysis

5. **Oroville-Chico Pipeline** – Excess water from water rights held on the Feather River or stored in Lake Oroville (including but not limited to Table A) could be delivered to the Vina Subbasin through a new, dedicated pipeline or canal. Assuming the ultimate use of the surface water is on lands not currently in irrigation districts, extensive new distribution pipelines would also need to be built. On-farm improvements may be required by farmers to incorporate this water source into their irrigation systems. Water sources are the same as those discussed in Project 1 above.

Prior iterations of this project have been considered over the years, however, they were grander in scale and the Sustainable Groundwater Management Act (SGMA) provides additional motivation for such a project. The recently formed Tuscan Water District could provide the governance and organization needed for end users. Nonetheless, this is likely the most capital intensive of the projects considered.

Recommendation: Do Not proceed to fatal flaw analysis

6. **West Branch-Chico Intertie** – Treated water from Paradise Irrigation District's water treatment plant in Magalia could be delivered to the city of Chico via a new pipeline, which could potentially be constructed concurrently with the Paradise Sewer Project, if it proceeds. This option requires retrofits to Magalia Dam and spillway (estimated at \$163 million) and may require expansion or modification of PID's water treatment plant to deliver water to the city during normal and wet years. The cost of the Chico intertie is estimated at \$372 million.

According to the 2022 Paradise Options Study, Paradise has 3,000 to 5,000 acre-feet of water available for transfer each year. The Vina GSP anticipates 27,500 acre-feet of urban and industrial water use through 2070, indicating sufficient urban water demand in the city of Chico to make use of available surface water from Paradise Irrigation District, PG&E's Miocene Canal water right, or other potential supplies in the Paradise area.

By adding a surface water source to Chico's water supply portfolio, this project improves water supply reliability and resiliency for the city of over 100,000 people. California Water Service (Cal Water) is the water purveyor in Chico and would need to be engaged in the project if it proceeds to fatal flaw analysis. Paradise Irrigation District has indicated they are not interested in pursuing this project at this time.

Recommendation: Do Not proceed to fatal flaw analysis

7. **Other local creeks** – Water right permits could be sought for other local creeks, including Pine Creek, Mud Creek, Rock Creek, Dry Creek, Big Chico Creek, Little Chico Creek, and Hamlin Slough. However, only Big Chico Creek is perennial, and all other creeks are ephemeral or seasonal with limited, if any, flow during the irrigation season. Given the timing and infrequency of flows, direct recharge from these creeks is most suitable.

Recommendation: Do Not proceed to fatal flaw analysis

8. **Sacramento River riparian rights** – Landowners in the Vina Subbasin who are adjacent to the Sacramento River and are not currently exercising their riparian Sacramento River water rights could begin exercising those rights instead of pumping groundwater. Diversion infrastructure to remove water from the Sacramento River may need to be constructed or upgraded and on-farm improvements may be required for farmers to incorporate this water source into their irrigation systems. However, riparian rights can be significantly limited. Diversions may only be applied to lands contiguous to the river and past sales of land—even if a ranch has since been reunited—can sever parcels from riparian water access. Given the expense of new diversions and the relatively small amount of acreage that can be served by riparian water, this project option is not preferred.

Recommendation: Do Not proceed to fatal flaw analysis

9. **New water right application** – A new water right application could theoretically be sought for Butte Creek, the Feather River, or the Sacramento River. Developing a new water right would also require new diversions, conveyance, and distribution systems to deliver the water. However, given the timing of this project with its focus on irrigation supplies from roughly April to October, none of those waterbodies are deemed to regularly have available water supplies in those months. The waterbodies are all part of

the larger Sacramento-San Joaquin Delta watershed, which is effectively viewed as fully appropriated in the summer months in all but the wettest of years. Applying for a new water right is not considered to be a viable option, and certainly not a preferred alternative to the projects recommended for fatal flaw analysis.

Recommendation: Do Not proceed to fatal flaw analysis

Project	Water Source	Partners/ Responsible Agencies	Diversion/ Conveyance	Distribution	Cost	Potential Volume (AFY)	Timeline	Challenges
1. Sacramento/ Feather River exchange	Feather River water right diverted from Sac River	USBR, DWR, SWRCB, Landowners, TWD	New diversion on Sac River	Extensive new pipelines or canals needed to deliver the water to farmland in North Vina.	Mid	30,000	Slow	Requires SWRCB, USBR, and DWR approval. New pipelines would require easements.
2. Feather River/ Butte Creek exchange	Feather River water right diverted into Butte Creek	SWRCB, CDFW, Butte Creek Watermaster, Friends of Butte Creek, USFWS, TWD	Use existing diversion points. May require increasing capacity and new pipelines.	Use existing infrastructure of water rights holders such as Durham MWC, Parrott- Phelan Canal, WCWD, or Rancho Esquon	Low	30,000	Slow	Impact to salmon from moving water between watersheds. Butte Creek projects uncertain due to concern about SWRCB intervention. Limitations of PG&E canal capacity.
3. Feather River - South Vina extension	Table A, Miocene, WCWD, Joint Districts, SFWPA, PID	WCWD, TWD	Use existing WCWD canals plus new pipelines/canals to convey water	New pipelines or canals needed to deliver the water to farmland in the southern portion of Vina Subbasin.	Mid	30,000	Mid	Easements
4. Maximize existing Butte Creek water rights	Durham MWC, Dayton MWC	Butte Creek Watermaster, SWRCB, Rancho Esquon	Use existing diversions	Use existing on-farm and district distribution	Low	2,380	Fast	Most existing rights are fully exercised. Environmental interests would want any currently unused supply to remain in the creek.
5. Oroville - Chico pipeline	Feather River water right conveyed to farmland for irrigation or to city of Chico for municipal use	Butte County, WCWD, Joint Districts, SFWPA, PID, TWD, Cal Water, City of Chico	Minimum 10 miles of conveyance	Extensive new pipelines or canals needed to deliver water to farmland in South Vina.	High	30,000	Slow	Easements

6. Paradise - Chico Intertie	PID, Miocene, other water sources for municipal use	PID, Cal Water, City of Chico	New pipeline from the ridge to Chico	Use existing Cal Water delivery system in Chico.	High	3,000-5,000	Slow	PID would need to fix Magalia Dam and may need to increase treated water capacity. PID indicated they are not interested in this project at this time.
7. Other local creeks	Pine, Mud, Rock, Dry, Big Chico, Little Chico, Hamlin Slough	SWRCB	New diversions would be needed	New distribution would be needed	Mid	0	Mid	Mostly ephemeral or seasonal and do not have water in them during the irrigation season. Big Chico Creek flows year-round.
8. Sacramento River riparian rights	Sacramento River	Landowners	New diversion on Sac River	New pipelines needed to deliver the water to irrigated farmland	Mid	1,800	Slow	Riparian rights severed in some instances, which reduces acreage that can be served per diversion.
9. New water right application	Butte Creek, Feather River, Sacramento River	SWRCB	New diversion(s)	New pipelines needed to deliver the water to irrigated farmland	Mid	0	Slow	Waterbodies are fully appropriated during the irrigation season in all but the wettest years

AFY – Acre-feet per year
Cal Water – California Water Service
CDFW – California Department of Fish and Wildlife
DWR – California Department of Water Resources
MWC – Mutual Water Company
PID – Paradise Irrigation District
PG&E – Pacifica Gas & Electric
Sac – Sacramento
SFWPA – South Feather Water and Power Agency
SOD – South of Delta
SWRCB – State Water Resources Control Board
TWD – Tuscan Water District
USBR – U.S. Bureau of Reclamation
USFWS – U.S. Fish and Wildlife Service
WCWD – Western Canal Water District

Vina Subbasin **Surface Water Supply Project**

Butte County Board of Supervisors

May 27, 2025

Jenny Scheer

Water and Land Solutions, LLC



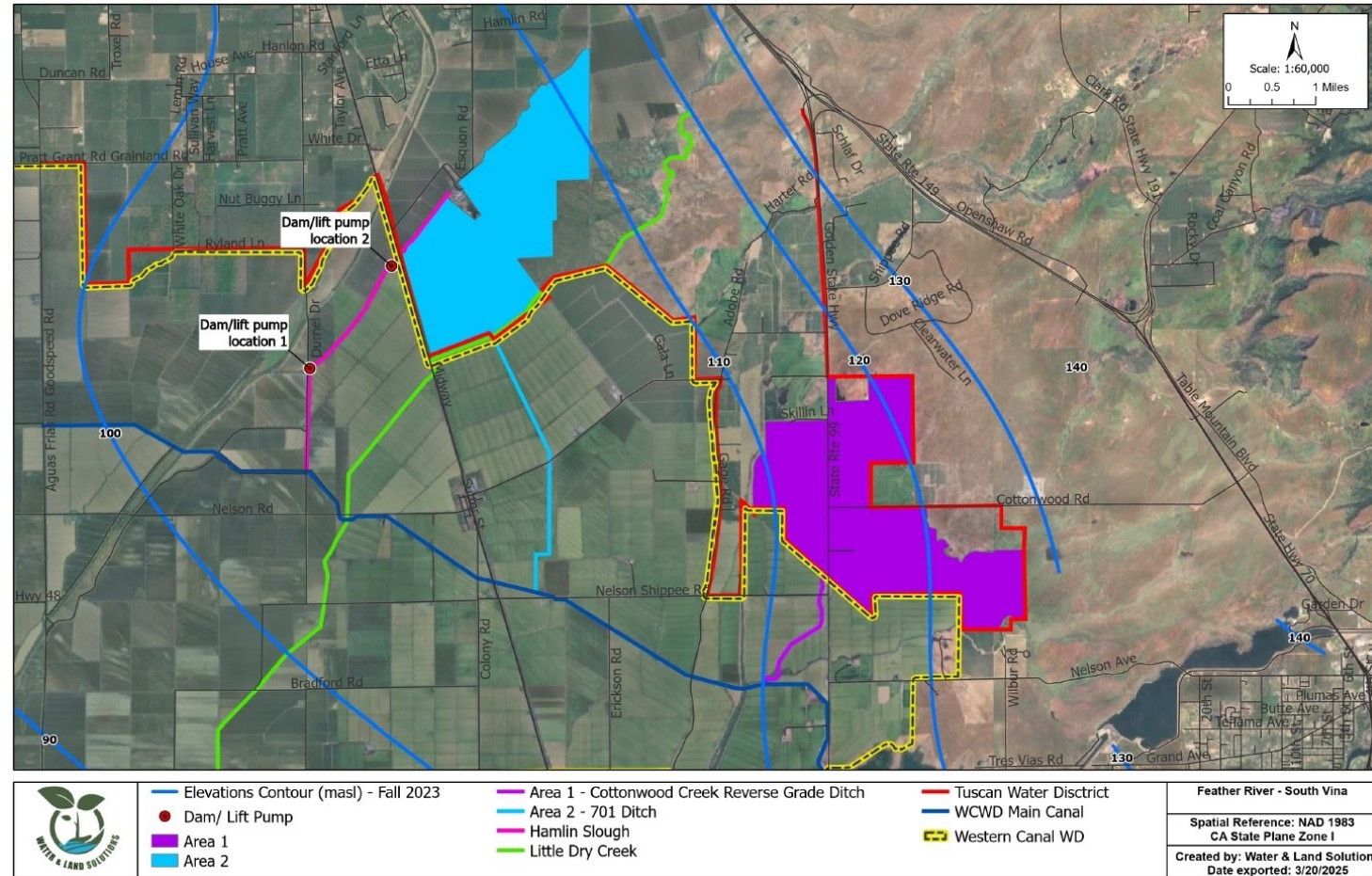
Project Timeline

- August 7, 2024 – Butte County Water Commission meets, discusses priorities, and forms ad-hoc
- December 4, 2024 – 9 projects presented to Water Commission, Commission selects 4 projects for fatal flaw analysis
- April 2, 2025 – Water Commission recommends 2 projects to proceed to feasibility analysis
- **May 27, 2025 – Butte County Board of Supervisors select 2 projects to proceed to feasibility analysis**
- October 1, 2025 – Feasibility Analysis report presented to the Water Commission

Key Considerations

- 15,000-25,000 AF goal for surface water projects
- How best to increase surface water use in the subbasin
- Fatal flaw analysis:
 1. Water availability
 2. Water right concerns
 3. Legal and regulatory aspects
 4. Environmental considerations
 5. Sustainability goals
 6. Costs and Funding options

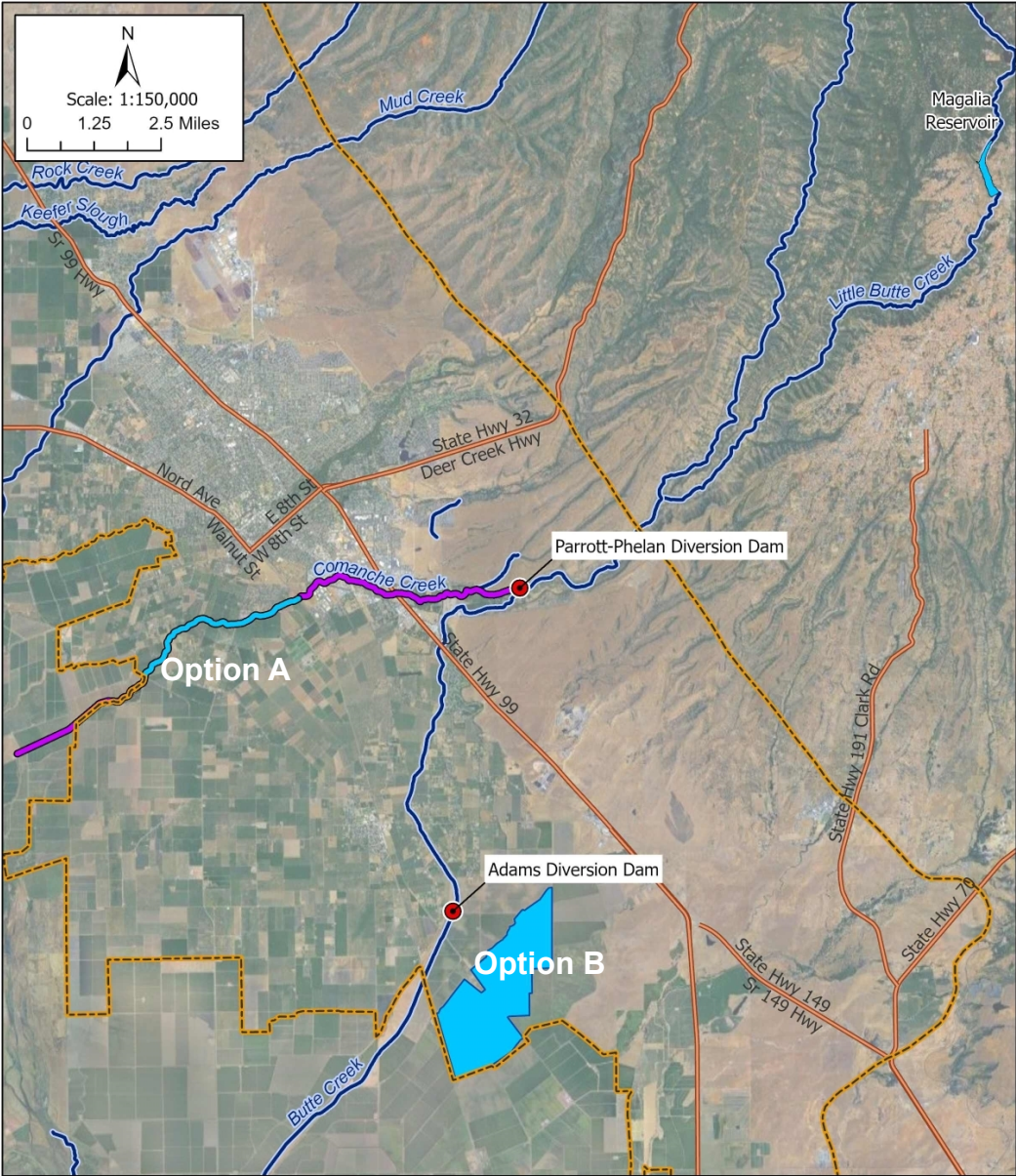
1. Feather River – South Vina



No Fatal Flaw

Water Commission recommendation: Advance to feasibility analysis

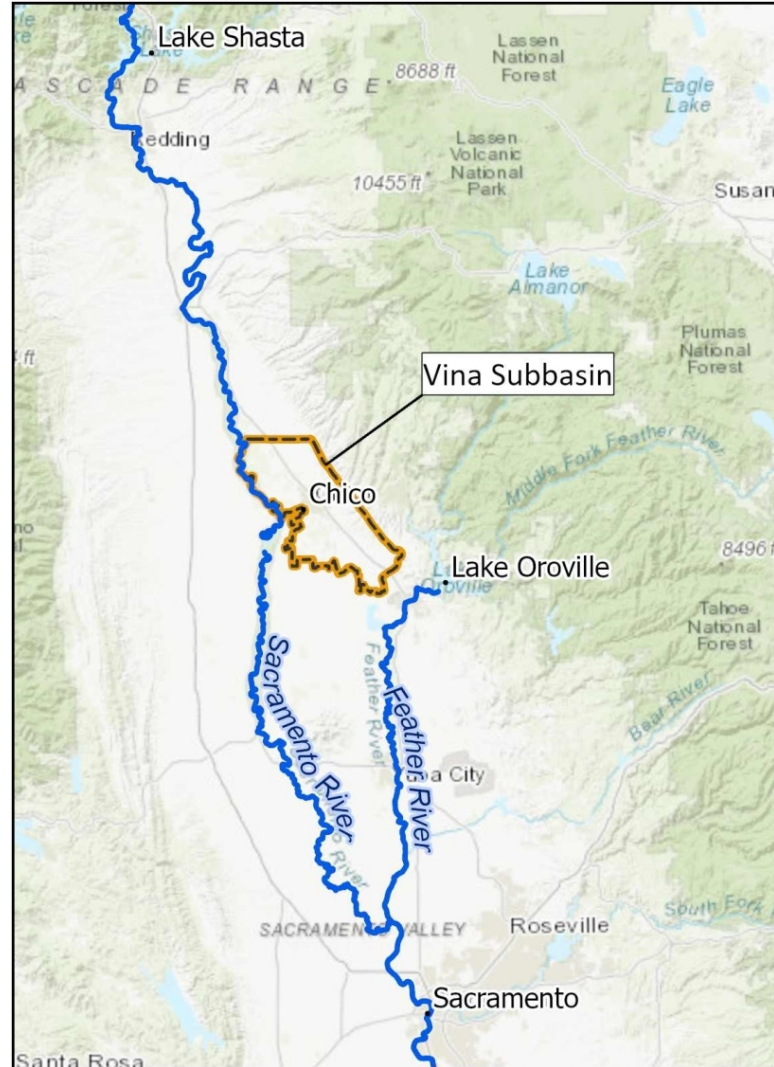
2. Ridge to Valley



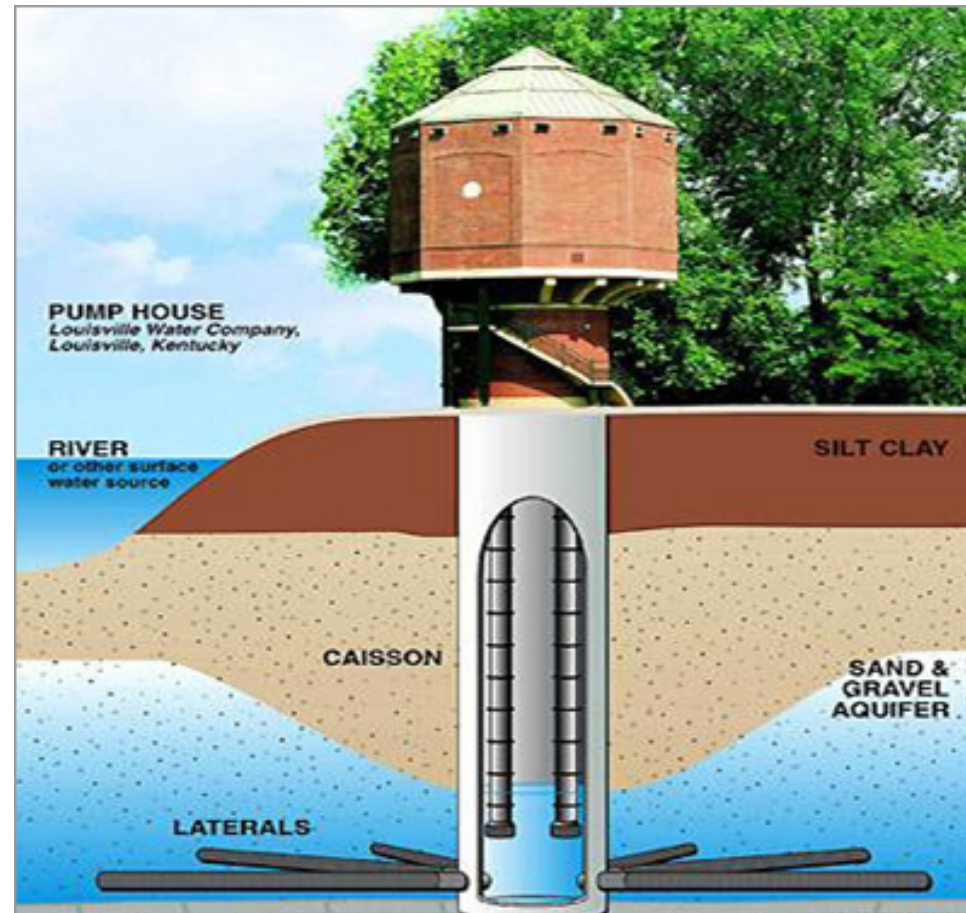
No Fatal Flaw
Water Commission recommendation: Advance to feasibility analysis

	- Parrott-Phelan Canal - Priority Area - Diversion Dam - Vina Subbasin	Ridge to Valley
		Spatial Reference: NAD 1983 CA State Plane Zone I
		Created by: Water & Land Solutions Date exported: 5/12/2025

3. Feather River -- Sacramento exchange



Radial well



No Fatal Flaw

4. Feather River -- Butte Creek diversion



Fatal Flaws Identified

Summary

Project Option	Acre-feet	Preliminary Capital Cost Estimate	Fatal Flaw Findings	Water Commission Recommendation
1. Feather River--South Vina extension	10,000-12,000	<\$5 million	No fatal flaw	Proceed to feasibility analysis
2. Ridge to Valley	Up to 5,000	Up to \$5 million	No fatal flaw	Proceed to feasibility analysis
3. Feather River--Sacramento River exchange	12,000	>\$15 million	No fatal flaw	Convene additional discussions
4. Feather River--Butte Creek diversion	0	N/A	Fatal flaws	Convene additional discussions

Technical Memorandum

Date: October 8, 2025
To: Jenny Scheer– Water and Land Solutions, Inc.
Copies to: Joe Turner, Mike Rudd – Geosyntec Consultants, Inc.
From: Miguel Parames, Donnie Land – Geosyntec Consultants, Inc.
Subject: Feasibility Analysis for Water Supply Improvements – Vina Subbasin
Project # SFO154C

INTRODUCTION

The Vina Subbasin, located in Butte County, California, is managed under the Sustainable Groundwater Management Act (SGMA) to ensure long-term groundwater sustainability. The County of Butte, through its Department of Water and Resource Conservation, has engaged Geosyntec Consultants, Inc. to conduct a comprehensive feasibility analysis for water supply and recharge projects in the Vina Subbasin. This effort is funded by the Department of Water Resources (DWR) SGMA Implementation Grant.

A significant portion of the project activities and potential recharge sites are located within or near the service area of the Western Canal Water District (WCWD), headquartered west of Nelson, CA. WCWD manages water supply and delivery through the historic Western Canal system, originally constructed in 1911. The District holds significant water rights from the Feather River and Butte Creek, and coordinates closely with state agencies to ensure reliable irrigation for local agriculture.

The feasibility analysis aims to identify and evaluate potential water delivery projects from Western Canal that can enhance surface water supply and groundwater recharge within the Vina Subbasin. As part of a larger study, key considerations including water conveyance methods, place of use, environmental impacts, financing strategies, and water rights were evaluated prior to the selection of the project locations identified in this report. Geosyntec was tasked with conducting an engineering evaluation of the conveyance methods (i.e., pumps and gravity diversions) for the pre-selected projects and preparing concept-screening level designs and cost estimates for selected projects.

PROJECT SUMMARY

Project Location

The Project Area is located within Butte County, California north of Richvale, south of Chico, and between Butte Creek and extending just west of Highway 99 (see Figure 1). Major transportation corridors traversing the Project Area include Nelson Ave, Nelson Shippee Road, Skillin Lane in the North-South direction, and Midway and Highway 99 in the east-west direction. Land use

within this area is characterized by a mix of agricultural lands (rice farming), managed wetlands, and small urban communities (i.e., Richvale, Nelson). Major surface water features within the Project Area include Butte Creek, Dry Creek, Cottonwood Creek, Hamlin Slough, Western Canal, and Thermalito Afterbay.

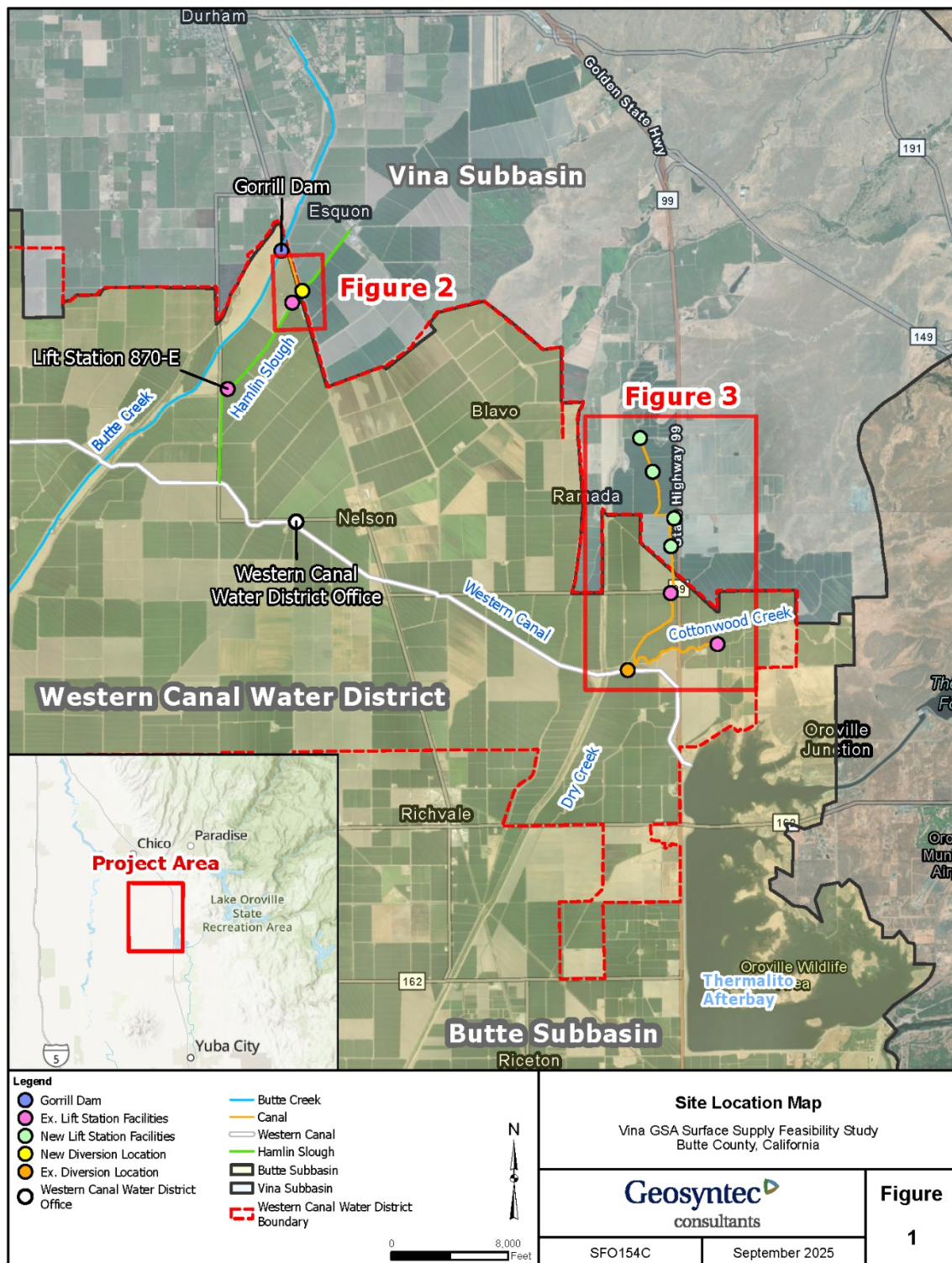
Two groundwater subbasins bisect the Project Area: Butte Subbasin located to the south and the Vina Subbasin located to the north (see **Figure 1**). These subbasins are part of the larger Sacramento Valley groundwater system and are managed by local Groundwater Sustainability Agencies (GSAs). The Vina Subbasin is a primary area of interest for surface water supply and groundwater recharge feasibility.

Water Supply Projects

Several potential water supply projects within the Project Area were identified by Water & Land Solutions. A site reconnaissance was conducted on 8/20/2025 and included representatives from Geosyntec, Water & Land Solutions, WCWD, Butte County, and local stakeholders. The purpose of the field visit was for Geosyntec to observe existing pump facilities, gravity diversion locations, and proposed improvement locations (upgrades or new facilities), as well as to obtain field notes. A total of nine (9) project sites were visited and are listed in **Table 1** and further described in the following sections. **Figure 1** shows the locations of each site within the project area. A photo log documenting photos of each site is included in **Attachment A** for reference.

Table 1. Project Names and Locations

Name	Type	Receiving Water	Lat	Long
Hamlin Slough Lift Station	New	Upper Hamlin Slough	39.5924°	-121.7825°
Hamlin Slough Diversion	New	Irrigation Canal	39.5947°	-121.7801°
Cottonwood Creek Diversion	Existing (Upgrade)	Cottonwood Creek	39.5231°	-121.7012°
East Cherokee Strip Lift Station	Existing (Replacements)	Cottonwood Creek	39.5279°	-121.6794°
West Cherokee Strip Lift Station	Existing (Upgrade)	Irrigation Canal	39.5375°	-121.6907°
West Cherokee Strip Lift Station 1	New	Irrigation Canal	39.5463°	-121.6906°
West Cherokee Strip Lift Station 2	New	Irrigation Canal	39.5516°	-121.6898°
West Cherokee Strip Lift Station 3	New	Irrigation Canal	39.5603°	-121.6950°
West Cherokee Strip Lift Station 4	New	Irrigation Canal	39.5667°	-121.6980°



Existing Facility Information

Information for each facility was obtained through discussions with WCWD, Water and Land Solutions, and information obtained during the site visit. As-builts for existing facilities were not provided prior to this study and it is unknown if they exist. **Table 2** summarizes details and performance characteristics for each facility. A narrative description for each facility is provided below.

Table 2. Existing Facility Information

Location	System Type	Component ID	Pump Size (HP)	Existing Capacity (cfs)	Pipe Diameter (in)	Metered (Y/N)
870-E	Lift Station	Pump 1	25	15	24	Yes
		Pump 2	50	25	24	Yes
		Pump 3	50	10	20	Yes
Hamlin Slough	Lift Station	Pump 1	40	Note 1	18	No
		Pump 2	40	Note 1	18	No
Cottonwood Creek	Culvert	Pipe 1	N/A	37	24	Yes
		Pipe 2			30	Yes
West Cherokee Strip	Lift Station	Pump	40	6	12	No
East Cherokee Strip	Lift Station	Pump East	Note 1	8	16	No
		Pump Center	10	10	20	No
		Pump West	Note 1	15	21	No
1. Information was not confirmed from field observations or documentation; values were not critical to progressing the study objectives.						

870-E Lift Station

The 870-E Lift Station is owned by WCWD. The lift station is supplied by water from Western Canal by a diversion culvert located adjacent to Dumel Drive. Water from the diversion flows north in a canal then northwest to the pump intake. The lift station consists of three pumps (Pumps 1, 2, and 3) which pump water into Lower Hamlin Slough and flows are monitored with meters. Lift Station 870-E was not included in this analysis and is shown here for reference only.

Hamlin Slough Lift Station

The Hamlin Slough Lift Station is privately owned and is located adjacent to Gorrill Ranch off Midway. The lift station is supplied by water from Lower Hamlin Slough. Water in Lower Hamlin Slough flows northwest to the pump intake. The lift station consists of two pumps (Pumps 1 and 2) where water is pumped from Lower Hamlin Slough to Upper Hamlin Slough. Water in Upper Hamlin Slough commingles with groundwater pumped from two wells and surface water diverted from Butte Creek at the Gorrill Dam. Several culverts and gate valves are located within the

vicinity of the dam (check) at Upper Hamlin Slough. Flow meters were only observed at the Butte Creek diversion.

Cottonwood Creek Diversion

The Cottonwood Creek Diversion, owned by WCWD, conveys water from the Western Canal through a diversion culvert located between Dry Creek and Highway 99. Water from the diversion flows under the Canal Access Road and the Cottonwood Creek Levee before discharging into Cottonwood Creek. A dam (check) is located nearby on Cottonwood Creek that raises the water surface elevation to allow pumping at East and West Cherokee Strip lift stations. The diversion structure consists of two culverts (24" and 30") with knife gates and flow meters. The culverts beneath the Cottonwood Creek Levee were not documented during the field visit. A depressed area between the access road and levee forms a pool of standing water.

East Cherokee Strip Lift Station

The East Cherokee Strip Lift Station is privately owned and is located east of Highway 99 and north of Nelson Ave. The lift station receives water from Cottonwood Creek west of the pump intake. The lift station consists of three pumps (Pump East, Middle, and West), however one pump (Middle) has been removed. Water is pumped into a canal and flow meters were not observed. Several culverts and gate valves are located above the dam (check) to provide water delivery to the east and north.

West Cherokee Strip Lift Station

The West Cherokee Strip Lift Station is privately owned and is located at the corner of Highway 99 and Nelson Shippee Road. The lift station receives water from Cottonwood Creek south of the pump intake. The lift station consists of three pumps, however one pump has been removed. Water is pumped into a canal and flow meters were not observed. The landowner indicated that the pump intake requires frequent maintenance to remove aquatic vegetation and remains an ongoing maintenance concern.

Proposed Improvements

Proposed improvements, including replacements and upgrades, were identified by Water and Land Solutions to enhance water conveyance capacity and reliability at existing facilities. In addition, locations for new facilities were also identified to provide water delivery at locations where no facilities exist. These proposed improvements generally fall into three categories:

1. **Replacements** to maintain existing capacities for systems nearing the end of service life.
2. **Upgrades** to existing facilities, where higher flow conveyance is necessary to accommodate increased operational demands.
3. **New installations** to provide additional flow conveyance infrastructure where none currently exists and to meet identified needs.

The proposed improvements include new lift stations, new culverts, culvert upgrades, lift station upgrades with higher-capacity pumps, and pump replacements within existing lift stations. Proposed capacity information was provided by Water and Land Solutions and were used to develop preliminary engineering calculations to size facilities to meet the proposed demand. The following subsections provide a description of the location of only the new facilities. Descriptions of existing facilities were discussed previously. A summary of the proposed improvements and proposed capacities is presented in **Table 3. Figures 2 and 3** show the locations of each improvement.

Hamlin Slough Diversion

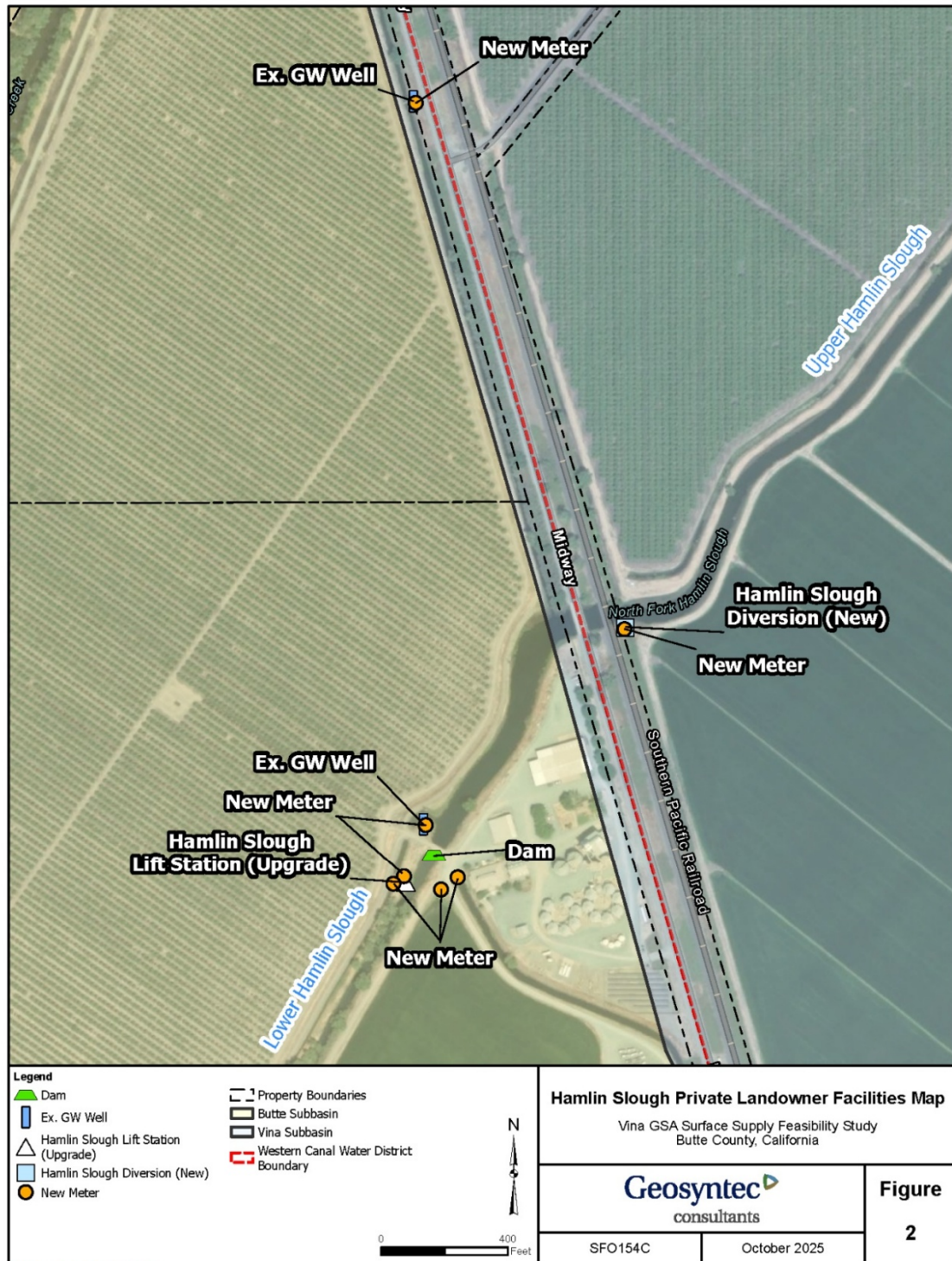
The proposed Hamlin Slough Diversion is located on the southeast corner of Midway and Upper Hamlin Slough. The anticipated demand needed to deliver water to the field located east of Midway is 20 cfs. The proposed diversion location is adjacent to Upper Hamlin Slough at an existing embankment. South of the embankment is an existing channel that was observed to be heavily vegetated during the site visit.

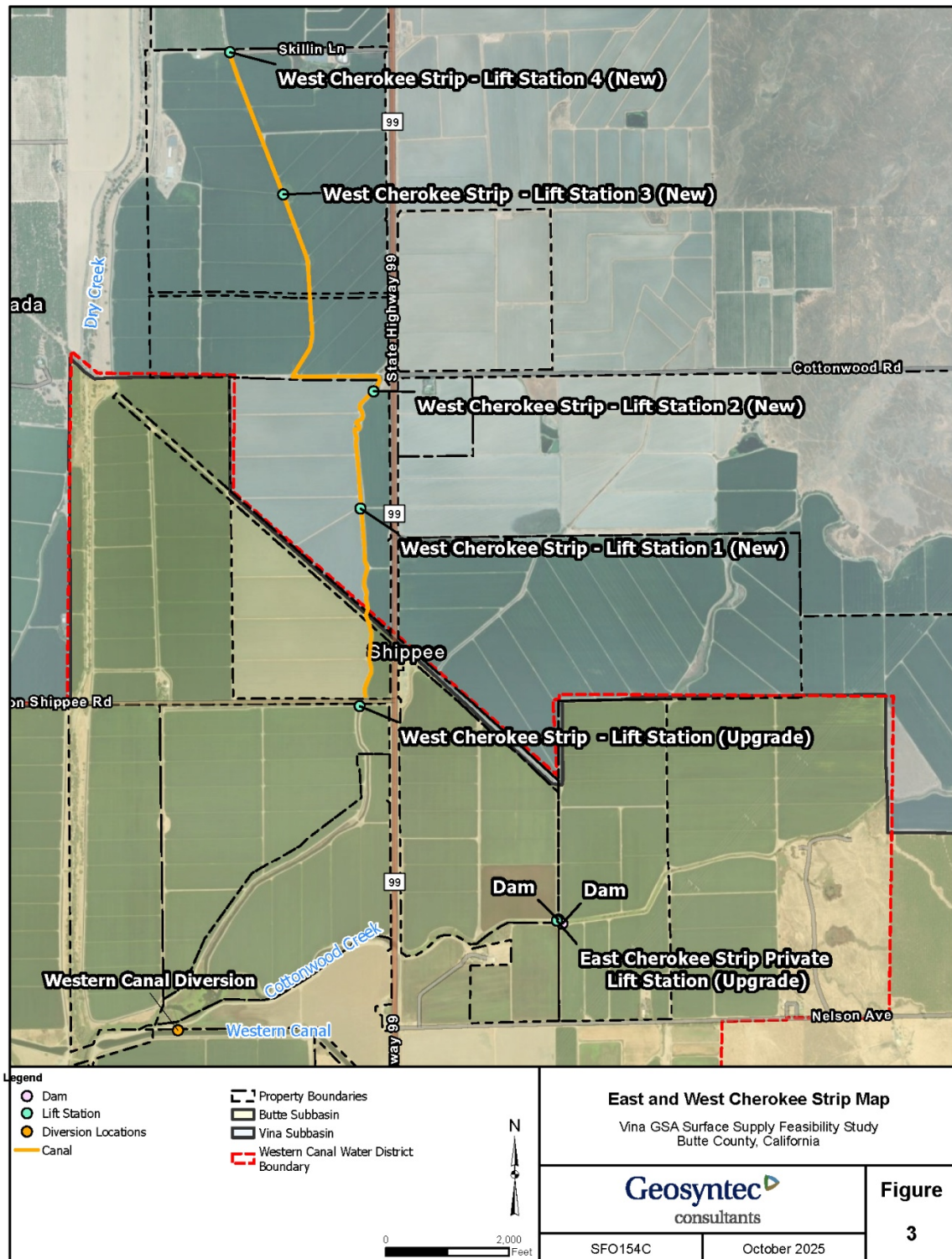
West Cherokee Strip Lift Station

Four new lift stations are proposed along an existing canal north of West Cherokee Strip Lift Station. These stations would operate in sequence to provide service where no existing infrastructure currently exists. Collectively, the facilities would increase water delivery to fields north of Nelson Shippee Road and west of Highway 99.

Table 3. Proposed Improvements

Location	Upgrade Description^a	Upgrade ID	Existing Capacity (cfs)	Proposed Capacity (cfs)
Hamlin Slough	New Lift Station	Lift Station 2	Unknown	20 ^b
Hamlin Slough	New Culvert	Pipe 1	None	20
Cottonwood Creek	(E) Culvert Upgrade	Pipe 1	37	90
		Pipe 2		
		Pipe 3		
West Cherokee Strip	(E) Lift Station Upgrade	Lift Station Main	6	22
	New Lift Station	Lift Station 1	None	16
	New Lift Station	Lift Station 2	None	12
	New Lift Station	Lift Station 3	None	12
	New Lift Station	Lift Station 4	None	12
East Cherokee Strip	(E) Pump Replacement	Pump East	10	10
	(E) Pump Replacement	Pump Center	8	8
	(E) Pump Replacement	Pump West	15	15
a. "(E)" denotes existing facilities that are being replaced or upgraded. b. Capacity at existing Hamlin Slough Lift Station unknown. Additional capacity needed is 20 cfs.				





ENGINEERING CALCULATIONS APPROACH

The engineering calculations approach presented in this section provides the technical basis for assessing the proposed improvements. This approach was developed to establish appropriate facility sizing and support the development of conceptual designs and cost estimates. The methodology applied reflects industry-standard hydraulic practices, given the operational requirements of the proposed improvements.

Two primary facility types were evaluated:

- 1. Lift Stations:** Hydraulic calculations were performed to determine the total dynamic head (TDH) requirements to inform the pump sizing based on the anticipated operational flow rates at each facility. These analyses informed both the replacement of the existing pumps and the design of the new lift stations.
- 2. Culverts:** Hydraulic capacity analyses were conducted to size culvert crossings consistent with the proposed design flowrates at the diversions. The calculations accounted for the conveyance demands, headwater and tailwater conditions, and applicable design criteria.

Lift Stations

The first step in sizing a new lift station was the development of a conceptual facility layout. This layout identified the lift station location, force main alignment, and the associated valves, fittings, and appurtenances. From this configuration, system head losses were broken into three primary categories: static head, friction losses, and minor losses. These values were then combined to determine the total dynamic head (TDH) acting on the pump under the anticipated flow conditions.

Static Head

Static head represents the vertical elevation difference the pump must overcome between the water surface at the lift station intake and the discharge point. For free discharge conditions, the discharge elevation is taken as the pipe outlet invert; for submerged conditions, the controlling elevation is the receiving water surface above the outlet. For this project, the static head was estimated by comparing the intake water surface elevation to the discharge elevation observed during the field visit. The governing equation is shown below:

$$\Delta H = \text{Static head} = \text{elev}_2 - \text{elev}_1 \text{ (ft)}$$

Where:

elev_2 = water surface/force main elevation at discharge
 elev_1 = water surface elevation at the lift station

Friction Loss

Friction losses occur as water flows through the force main due to pipe wall roughness and fluid viscosity. These losses were calculated based on the proposed force main length, diameter, and material using the Hazen-Williams method. The equation is provided here:

$$h_f = (L)10.5(Q/C)^{1.85}D^{-4.87}$$

Where:

h_f = head loss due to friction (feet/feet)
 L = force main length (ft)
 Q = flow (gpm)
 C = Hazen Williams friction coefficient
 D = pipe diameter (in)

Minor Losses

Minor losses result from localized energy losses at appurtenances such as bends, valves, and transitions within the force main. These losses were estimated using head loss coefficients (K values) for each appurtenance type identified in the conceptual layout. The corresponding calculation is here:

$$h_m = \sum K(v^2/2g)$$

Where:

h_m = minor headloss (ft)
 K = K coefficient (unitless)
 v = velocity of fluid in pipe (ft/s)
 g = gravity = 32.2 ft/s

Total Dynamic Head

The total dynamic head was calculated as the sum of the static head, friction losses, and minor losses for the proposed system. These calculations established the head conditions the pump must overcome at the anticipated flow rates. The resulting TDH values were then used to develop preliminary pump selections and budgetary quotes in consultation with a pump manufacturer. A summary of the TDH calculations is provided in **Attachment C**, and the preliminary pump selections and associated performance curves are provided in **Attachment D**.

Culverts

The Federal Highway Administration's (FHWA) HY-8 software is a hydraulic analysis tool that was used to estimate pipe sizing for diversions. HY-8 computes headwater elevations, flow capacity, outlet velocities, and energy losses for both inlet and outlet control conditions, and can account for multiple barrels, roadway overtopping, and tailwater effects.

Elevation Data and Headwater Conditions

The headwater water surface elevation (WSE) represents the upstream water surface in the canal or slough that drives flow into the culvert. HY-8 uses this headwater WSE to determine the hydraulic grade line and the flow regime, indicating whether the culvert operates under inlet control, outlet control, or full flow conditions. WCWD surveyed the Hamlin Slough Diversion and Cottonwood Creek Diversion locations using a rod and level to obtain relative elevation data for headwater, tailwater, and top of road/embankment. Because these surveyed elevations are relative, USGS contour elevation data at the top of road was used to convert the surveyed points into elevations above mean sea level (amsl). **Tables 4 and 5** provide a summary of the elevation data for each culvert.

Table 4. Hamlin Slough Diversion Culvert (New)

Surveyed Locations	Survey Data (ft)	Elevation (ft, amsl)
Hamlin Slough Water Elevation (headwater)	5.5	129.8
Top of Road	2.8	132
Bottom of Delivery Ditch (downstream invert)	9	125.8

Table 5. Cottonwood Creek Diversion Culvert (Upgrade)

Surveyed Locations	Survey Data (ft)	Elevation (ft, amsl)
Western Canal Water Elevation (headwater)	6.95	122.95
Canal Road	3.35	126.55
Cottonwood Creek Levee	2.9	127
Cottonwood Creek (tailwater)	7.5	122.4

Proposed culverts were sized by maintaining observed headwater elevations and selecting a pipe size that would provide sufficient capacity to meet demand. Downstream tailwater elevations were adjusted as needed to maintain headwater elevations.

Pipe Material, Slope, and Inverts

The pipe material selected for the analysis was reinforced concrete pipe with an associated Manning's Roughness value of $N=0.012$. Pipe slopes were conservatively estimated at 0% slope. Inverts were estimated based on field observations and maintaining a minimum of 2-ft of cover below the embankment or access road.

FEASIBILITY ANALYSIS RESULTS

Engineering calculations were performed for each facility to estimate the sizing of pumps or culverts needed to meet the proposed capacity. Conceptual design layouts were developed for each improvement using information obtained from the field visit and review of aerial imagery (see **Attachment B**). These conceptual designs include locations of structures (i.e., headwalls, lift

stations), alignment of pipes (i.e., force mains, culverts), and other required infrastructure (i.e., slide gates, flap gates, meters). Dimensions from these designs were used in the engineering calculations discussed below. A summary of the calculation inputs and results for pump facilities and culverts are presented in **Table 6** and **Table 7**. Supporting calculations including HY-8 output files are included in **Attachment C**.

Table 6. Proposed Pump Facility Calculation Results

Location	Pump ID	Proposed Capacity (cfs)	Static Head (ft)	TDH (ft)	Pump Size (HP)	Force Main Diameter (in)	Force Main Length (ft)	Exit Velocity (ft/s)
Hamlin Slough	Lift Station 2	20	10	11.47	60	24	45	6.5
West Cherokee Strip	Lift Station Main	22	10	12.96	75	24	215	7
	Lift Station 1	16	6	8.05	40	20	45	7
	Lift Station 2	12	6	7.17	25	20	45	5.5
	Lift Station 3	12	6	7.17	25	20	45	5.5
	Lift Station 4	12	6	7.17	25	20	45	5.5
East Cherokee Strip	Pump East	10	10	11.01	20	16	20	5.5
	Pump Center	8	10	10.67	20	20	30	4.5
	Pump West	15	10	11.69	40	21	80	6

Table 7. Proposed Diversion Facility Calculation Results

Location	Culvert ID	Proposed Capacity (cfs)	Headwater Elevation (ft, amsl)	Diameter (in)	Inlet/Outlet Elevation (ft, asml)	Road Elevation (ft, asml)	Length (ft)	Outlet Velocity (ft/s)
Hamlin Slough	Pipe 1	20	129.8	24	125.8	132	40	6.4
Cottonwood Creek	Pipe 1	90	122.9	36	117.0	126.6	24	4.2
	Pipe 2							
	Pipe 3							

Hamlin Slough New Lift Station

The existing Hamlin Slough lift station, consisting of two pumps discharging through 18-inch force mains, was found to be operating at design capacity. In addition, the existing lift station did not appear to have adequate space to accommodate a third pump. To provide an additional 20 cfs of conveyance capacity, the most feasible option identified was the addition of a new lift station.

The proposed facility would consist of an 8-ft by 8-ft, 16-ft deep structure housing a 20 cfs axial flow pump. It would be located immediately northeast of the existing station in the Lower Hamlin Slough. Flows would be conveyed through an approximately 45-ft long, 24-inch diameter ductile iron force main to a precast headwall discharge at the Upper Hamlin Slough.

Hamlin Slough New Culvert

In order to meet the anticipated demand of 20 cfs, a 40-foot long, 24” diameter culvert is needed at Hamlin Slough Diversion. The culvert would be installed within the existing embankment and discharge into the existing canal south of Upper Hamlin Slough.

Cottonwood Creek Culvert Upgrade

The existing Cottonwood Creek culvert was analyzed using the provided headwater elevation to estimate the current capacity. The current configuration of 1-24” culvert and 1-30” culvert provides a capacity of 37 cfs (see **Attachment C** for supporting calculations). In order to meet the design capacity of 90 cfs, 3-36” culverts are needed beneath the Canal Road and Cottonwood Creek Levee. The culverts would be installed at the same location as the existing culverts. The ponded water between the Canal Road and Cottonwood Creek Levee will remain.

East Cherokee Strip Pump Replacements

The existing East Cherokee Strip lift station, which includes three pumps discharging through 16-inch, 20-inch, and 21-inch force mains, was found to be nearing the end-of-life for the pump units based on field observations and discussions with the landowner. The proposed improvements would retain the existing lift station structure and force main infrastructure, focusing solely on replacing the pumps and adding flow metering for each force main.

West Cherokee Strip Lift Station Upgrade

The existing West Cherokee Strip lift station, consisting of a 6-cfs pump and a 12-inch diameter force main, was found to be operating at design capacity and could not be effectively retrofitted with new pumps or motors to achieve the desired 22 cfs capacity. In addition, the lift station and force main infrastructure were observed to be in poor condition, with evidence of structural deterioration at the lift station and an inefficient force main alignment containing unnecessary bends.

To provide 22 cfs of flow capacity and improve the overall reliability of the water supply system, a complete removal and reconstruction of the lift station was proposed. The new facility would consist of a 10-ft by 10-ft, 17-ft deep structure housing a 22 cfs axial flow pump. It would be installed at the location of the existing lift station, with flows conveyed through an approximately 185-ft long, 24-inch diameter ductile iron force main to a precast headwall discharge to the West Cherokee Strip irrigation canal.

West Cherokee New Lift Stations

To extend water supply capacity along the West Cherokee Strip canal alignment and increase water delivery to fields north of Nelson Shippee Road, four new lift stations are proposed. These facilities will operate in series to provide additional conveyance where no existing infrastructure is currently in place.

The first new lift station would be designed to convey 16 cfs, while the subsequent three stations going north would each convey 12 cfs. Each facility would consist of a new lift station structure housing an axial flow pump sized for the respective design capacity. Discharge from each station would be conveyed through approximately 40 linear feet of 20-inch diameter ductile iron force main to a precast headwall at the canal.

COST ESTIMATES

Basis of Estimate

The cost estimates presented herein were developed to provide a concept screening opinion of probable costs for design and construction of the proposed improvements. The estimates are intended for feasibility-level evaluation and are based on the following key assumptions:

- **Design Basis** – Conceptual layouts prepared for lift stations, force mains, pump replacements, and culvert improvements (see **Attachment B**).
- **Power Supply** – Assumed availability of electrical service in proximity to each lift station site. Each lift station is also assumed to require a new electrical control panel with programmable logic controller (PLC) and associated appurtenances to support pump operations, alarms, and remote monitoring capability.
- **Construction Methods** – Conventional excavation and installation were assumed, including groundwater dewatering, flow diversion, and traffic control, as appropriate for site conditions.
- **Design, Construction, and Commissioning Support** – An allowance equal to 10-30% of the construction subtotal was applied to cover design, construction, and commissioning support for each individual improvement depending on the size and complexity of the project.
- **General Conditions and Requirements** – An allowance equal to 5-10% of the construction subtotal was applied to cover contractor indirect costs such as temporary facilities, project management and supervision, insurance and bonds, safety compliance, and miscellaneous site support.
- **Permit Allowances** – An allowance of 0-3% of the construction subtotal was applied to cover anticipated agency permit and approval costs, including local construction permits and inspection charges.
- **Contingency** – A planning-level contingency of -25% to +50% was applied to account for uncertainty at this stage of design, consistent with AACE International Class 5 estimates for concept-screening level detail.

- **Exclusions** – Estimates exclude land acquisition and any environmental permitting requirements by the federal government.

ROM Costs for Design and Construction

Rough order-of-magnitude (ROM) cost estimates for design and construction of the proposed improvements are summarized below. These estimates reflect feasibility-level planning and are intended to support comparison of alternatives rather than serve as a basis for final project budgeting. A more detailed breakdown of costs for each facility is provided in **Attachment E**.

For purposes of presenting the estimates, facilities have been grouped by service area:

- **Table 8:** Hamlin Slough Improvements – representing improvements serving the Upper Hamlin Slough.
- **Table 9:** Cottonwood Creek and Cherokee Strip Improvements – representing improvements serving lands irrigated by Cottonwood Creek.

Table 8. ROM Cost Estimate Summary for Hamlin Slough Improvements

Location	Improvement Description	Proposed Capacity (cfs)	Construction Cost (\$)	Design, GC&R, and Permits ¹ (\$)	Total Estimated Project Cost (\$)
Hamlin Slough	New Lift Station	20	\$477,000	\$81,000	\$559,000
Hamlin Slough	New Culvert	20	\$133,000	\$57,000	\$190,000
Hamlin Slough Improvements Subtotal(s):			\$595,000	\$136,000	\$731,000

1. Includes Design, Construction and Commissioning Support, General Conditions and Requirements, and Permit Allowances. For project-specific cost details, see Appendix D.

Table 9. ROM Cost Estimate Summary for Cottonwood Creek and Cherokee Strip Improvements

Location	Improvement Description	Proposed Capacity (cfs)	Construction Cost (\$)	Design, GC&R, and Permits ¹ (\$)	Total Estimated Project Cost (\$)
Cottonwood Creek	Culvert Upgrade	36	\$617,000	\$216,000	\$833,000
West Cherokee Strip	Lift Station Upgrade	22	\$623,000	\$106,000	\$729,000
West Cherokee Strip	New Lift Station 1	16	\$468,000	\$80,000	\$548,000
West Cherokee Strip	New Lift Station 2	12	\$420,000	\$71,000	\$491,000
West Cherokee Strip	New Lift Station 3	12	\$420,000	\$71,000	\$491,000
West Cherokee Strip	New Lift Station 4	12	\$420,000	\$71,000	\$491,000
East Cherokee Strip	Pump Replacements	8, 10, 15	\$508,000	\$86,000	\$594,000
Cottonwood Creek and Cherokee Strip Improvements Subtotal(s):			\$3,476,000	\$701,000	\$4,177,000

1. Includes Design, Construction and Commissioning Support, General Conditions and Requirements, and Permit Allowances. For project-specific cost details, see Appendix D.

SUMMARY AND LIMITATIONS

Summary

This feasibility study assessed multiple water delivery improvement options within the Vina Subbasin, focusing on new lift stations, pump replacements, culvert upgrades, and enhancements to existing infrastructure to address both capacity limitations and aging assets. Engineering calculations established preliminary sizing for lift stations (including static head, friction, and total dynamic head) and for culvert conveyance capacity. Conceptual layouts and reconnaissance-level cost estimates (AACE Class 5) were developed, with results summarized in **Tables 8 and 9** and detailed in **Attachments A–E**. The resulting ROM cost estimates, which include design, construction, permitting, and contingency allowances, provide a comparative planning-level basis for Butte County, WCWD, and local stakeholders to evaluate and prioritize potential projects.

Limitations

This feasibility analysis is subject to several important limitations. The evaluations were conducted at a conceptual level, relying on reconnaissance field observations and limited site data. Key data gaps include the absence of as-built documentation for some facilities, incomplete subsurface and environmental information, and preliminary assumptions regarding utility conflicts and permitting requirements. As a result, future investigations including detailed site surveys, geotechnical studies, environmental reviews, and coordination with permitting agencies will be necessary to confirm constructability and refine project designs.

The cost estimates presented are intended solely for planning and comparative purposes. They are not suitable for detailed budgeting or construction bidding, as actual costs may vary significantly due to market conditions, labor and material availability, site-specific constraints, and the results of subsequent design phases. Additionally, evolving environmental and regulatory requirements may impact project feasibility, design, and implementation schedules.

* * * * *

ATTACHMENT A

Site Visit Photo Log

GEOSYNTEC CONSULTANTS

Photographic Record

Client: Butte County

Project Number: SFO154C

Data: 8/20/2025

Latitude: 39.5763° **Longitude:** -121.7983°

Site Name: 870-E Lift Station

Photograph 1

Description:

Lower Hamlin Slough looking upstream. Slat dam located in foreground. Force main discharge location located right with knife gates.



Photograph 2

Description:

Lower Hamlin Slough looking downstream. Pump intake located in foreground with vegetated screen.



GEOSYNTEC CONSULTANTS

Photographic Record

Client: Butte County

Project Number: SFO154C

Data: 8/20/2025

Latitude: 39.5763° **Longitude:** -121.7983°

Site Name: 870-E Lift Station

Photograph 3

Description:

Lift Station 870-E.
Electrical panel located left.

Pump 1 (Left): 24-inch

Pump 2 (Middle): 24-inch

Pump 3 (Right): 16-inch



Photograph 4

Description:

Close up view of pump motors.

Pump 1 (Left): 24-inch

Pump 2 (Middle): 24-inch

Pump 3 (Right): 16-inch



GEOSYNTEC CONSULTANTS

Photographic Record

Client: Butte County

Project Number: SFO154C

Data: 8/20/2025

Latitude: 39.5763° **Longitude:** -121.7983°

Site Name: 870-E Lift Station

Photograph 5

Description:

Pump 1 manufacturer's name plate.



Photograph 6

Description:

Pump 2 manufacturer's name plate.



GEOSYNTEC CONSULTANTS

Photographic Record

Client: Butte County

Project Number: SFO154C

Data: 8/20/2025

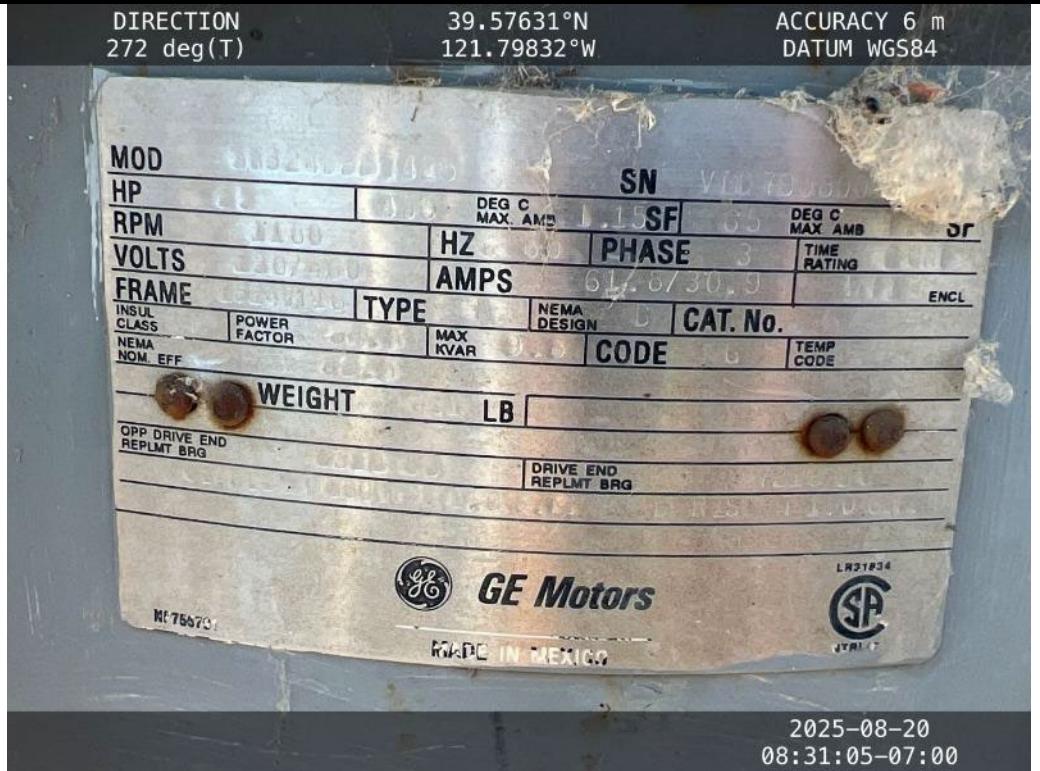
Latitude: 39.5763° **Longitude:** -121.7983°

Site Name: 870-E Lift Station

Photograph 7

Description:

Pump 2 manufacturer's name plate.



Photograph 8

Description:

Lift station electrical panel.



GEOSYNTEC CONSULTANTS

Photographic Record

Client: Butte County

Project Number: SFO154C

Data: 8/20/2025

Latitude: 39.5924° **Longitude:** -121.7825°

Site Name: **Hamlin Slough Private Landowner Facilities**

Photograph 5

Description:

Lower Hamlin Slough looking upstream at slat dam.



Photograph 6

Description:

Upper Hamlin Slough looking downstream at slat dam. Two culvert inlets with knife gates are located between the bridge and slat dam.



GEOSYNTEC CONSULTANTS Photographic Record	
Client: Butte County	Project Number: SFO154C
Data: 8/20/2025	Latitude: 39.5924° Longitude: -121.7825°
Site Name: Hamlin Slough Private Landowner Facilities	
Photograph 7 Description: Lift station discharge location. Flap gates were observed on headwall to prevent backflow. Knife gate to the left provides control for water delivery to canal running adjacent to Lower Hamlin Slough.	
Photograph 8 Description: Lift Station. Pump 1 (Left): 18-inch Pump 2 (Right): 18-inch	

GEOSYNTEC CONSULTANTS

Photographic Record

Client: Butte County

Project Number: SFO154C

Data: 8/20/2025

Latitude: 39.5924° **Longitude:** -121.7825°

Site Name: Hamlin Slough Private Landowner Facilities

Photograph 5

Description:

Pump 1 manufacturer's name plate.



Photograph 6

Description:

Pump 2 manufacturer's name plate.



GEOSYNTEC CONSULTANTS Photographic Record	
Client: Butte County	Project Number: SFO154C
Data: 8/20/2025	Latitude: 39.5924° Longitude: -121.7825°
Site Name: Hamlin Slough Private Landowner Facilities	
Photograph 7 Description: Lift station electrical panel.	
Photograph 8 Description: Groundwater well located approximately 50 yards upstream of lift station. Pump groundwater discharges directly into Upper Hamlin Slough.	

GEOSYNTEC CONSULTANTS

Photographic Record

Client: Butte County

Project Number: SFO154C

Data: 8/20/2025

Latitude: 39.5924° **Longitude:** -121.7825°

Site Name: Hamlin Slough Private Landowner Facilities

Photograph 9

Description:

Diversion from Butte Creek at Gorrill Dam. 3 knife gates visible with two operating.



Photograph 10

Description:

Diversion from Butte Creek at Gorrill Dam looking upstream. Two flow meters observed and water flows into Upper Hamlin Slough.



GEOSYNTEC CONSULTANTS Photographic Record	
Client: Butte County	Project Number: SFO154C
Data: 8/20/2025	Latitude: 39.5947° Longitude: -121.7801°
Site Name: Hamlin Slough Private Landowner Facilities	
Photograph 9 Description: Proposed diversion location looking downstream at receiving canal. Ditch heavily overgrown and maintenance is expected.	DIRECTION 175 deg(T) 39.59472°N 121.78009°W ACCURACY 7 m DATUM WGS84  2025-08-20 09:43:07-07:00
Photograph 10 Description: Proposed diversion location looking upstream at Upper Hamlin Slough. Diversion culvert proposed at embankment between Upper Hamlin Slough and receiving canal. Local landowner indicated that an abandoned siphon is located running perpendicular to the slough and would require removal.	DIRECTION 303 deg(T) 39.59473°N 121.78005°W ACCURACY 6 m DATUM WGS84  2025-08-20 09:57:49-07:00

GEOSYNTEC CONSULTANTS Photographic Record	
Client: Butte County	Project Number: SFO154C
Data: 8/20/2025	Latitude: 39.5231° Longitude: -121.7012°
Site Name: Cottonwood Creek Diversion	
Photograph 11 Description: Western Canal looking downstream near Cottonwood Creek Diversion.	DIRECTION 228 deg(T) 39.52318°N 121.70123°W ACCURACY 6 m DATUM WGS84  2025-08-20 10:30:27-07:00
Photograph 12 Description: Existing Cottonwood Creek diversion with headwall and knife gates. Culvert 1: 24-inch Culvert 2: 30-inch	DIRECTION 133 deg(T) 39.52318°N 121.70123°W ACCURACY 6 m DATUM WGS84  2025-08-20 10:30:25-07:00

GEOSYNTEC CONSULTANTS Photographic Record	
Client: Butte County	Project Number: SFO154C
Data: 8/20/2025	Latitude: 39.5231° Longitude: -121.7012°
Site Name: Cottonwood Creek Diversion	
Photograph 3 Description: Downstream side of Cottonwood Creek diversion showing headwall and pool between access road and levee road. Flow meters observed adjacent to headwall. WCWD personnel indicated that this area is experience undermining.	DIRECTION 54 deg(T) 39.52321°N 121.70127°W ACCURACY 4 m DATUM WGS84  2025-08-20 10:29:58-07:00
Photograph 4 Description: Downstream side of Cottonwood Creek diversion looking downstream toward Cottonwood Creek. Road in background is the levee road adjacent to Cottonwood Creek. Culverts delivering water to Cottonwood Creek are located to left in the background.	DIRECTION 355 deg(T) 39.52321°N 121.70124°W ACCURACY 10 m DATUM WGS84  2025-08-20 10:36:54-07:00

GEOSYNTEC CONSULTANTS

Photographic Record

Client: Butte County

Project Number: SFO154C

Data: 8/20/2025

Latitude: 39.5279° **Longitude:** -121.6794°

Site Name: **East Cherokee Strip Private Landowner Lift Station**

Photograph 13

Description:

Lift Station looking upstream from Cottonwood Creek. Lift station located to left of slat dam. Electrical panels and electric drop located to the right of the slat dam.



Photograph 2

Description:

Lift Station

Pump East (Left): 15-inch

Pump Middle (Center): 20-inch

Pump West (Right): 21-inch



GEOSYNTEC CONSULTANTS

Photographic Record

Client: Butte County

Project Number: SFO154C

Data: 8/20/2025

Latitude: 39.5279° **Longitude:** -121.6794°

Site Name: East Cherokee Strip Private Landowner Lift Station

Photograph 3

Description:

Pump East
manufacturer's name
plate.



Photograph 4

Description:

Pump Middle
manufacturer's name
plate.

DIRECTION
68 deg(T)

39.52797°N
121.67942°W

ACCURACY 5 m
DATUM WGS84



2025-08-20
11:05:16-07:00

GEOSYNTEC CONSULTANTS

Photographic Record

Client: Butte County

Project Number: SFO154C

Data: 8/20/2025

Latitude: 39.5279° **Longitude:** -121.6794°

Site Name: East Cherokee Strip Private Landowner Lift Station

Photograph 5

Description:

Pump West manufacturer's name plate.



Photograph 6

Description:

Looking downstream at slat dam. Lift station force mains discharge at the headwall in the background. Flap gates were observed installed at the headwall to prevent backflow. A culvert was observed at the headwall in the foreground delivering water to the slat dam located east of the lift station.



GEOSYNTEC CONSULTANTS

Photographic Record

Client: Butte County

Project Number: SFO154C

Data: 8/20/2025

Latitude: 39.5375° **Longitude:** -121.6907°

Site Name: **West Cherokee Strip Private Landowner Lift Station**

Photograph 14

Description:

Cottonwood Creek looking downstream from Existing Lift Station. Landowner noted that aquatic vegetation frequently obstructs pump intake screen and requires daily maintenance when pumps are active.



Photograph 2

Description:

Existing Lift Station. Several force mains deliver water from Cottonwood Creek toward irrigation canals upstream. Force main with 90 degree discharges upstream to irrigation canal.



GEOSYNTEC CONSULTANTS Photographic Record	
Client: Butte County	Project Number: SFO154C
Data: 8/20/2025	Latitude: 39.5375° Longitude: -121.6907°
Site Name: West Cherokee Strip Private Landowner Lift Station	
Photograph 3 Description: Existing Lift Station. Several force mains deliver water from Cottonwood Creek toward irrigation canals upstream.	DIRECTION 103 deg(T) 39.53761°N 121.69083°W ACCURACY 7 m DATUM WGS84  2025-08-20 11:54:56-07:00
Photograph 4 Description: Lift station manufacturer's name plate.	DIRECTION 133 deg(T) 39.53759°N 121.69072°W ACCURACY 7 m DATUM WGS84  2025-08-20 11:56:33-07:00

GEOSYNTEC CONSULTANTS

Photographic Record

Client: Butte County

Project Number: SFO154C

Data: 8/20/2025

Latitude: 39.5375° **Longitude:** -121.6907°

Site Name: **West Cherokee Strip Private Landowner Lift Station**

Photograph 5

Description:

Lift station
manufacturer's name
plate.



Photograph 6

Description:

Force mains adjacent to
and underneath Nelson
Shippee Road. Force
main with 90 degree
discharges upstream to
irrigation canal.



GEOSYNTEC CONSULTANTS

Photographic Record

Client: Butte County

Project Number: SFO154C

Data: 8/20/2025

Latitude: 39.5463° **Longitude:** -121.6906°

Site Name: **West Cherokee Strip Private Landowner Proposed Lift Station Location 1**

Photograph 15

Description:

Looking downstream at proposed location of Lift Station 1.

DIRECTION
173 deg(T)

39.54638°N
121.69064°W

ACCURACY 12 m
DATUM WGS84



Photograph 16

Description:

Looking upstream at proposed location of Lift Station 1.

DIRECTION
56 deg(T)

39.54640°N
121.69063°W

ACCURACY 13 m
DATUM WGS84



GEOSYNTEC CONSULTANTS Photographic Record	
Client: Butte County	Project Number: SFO154C
Data: 8/20/2025	Latitude: 39.5516° Longitude: -121.6898°
Site Name: West Cherokee Strip Private Landowner Proposed Lift Station Location 2	
Photograph 17	
Description: Looking upstream at proposed location of Lift Station 2.	

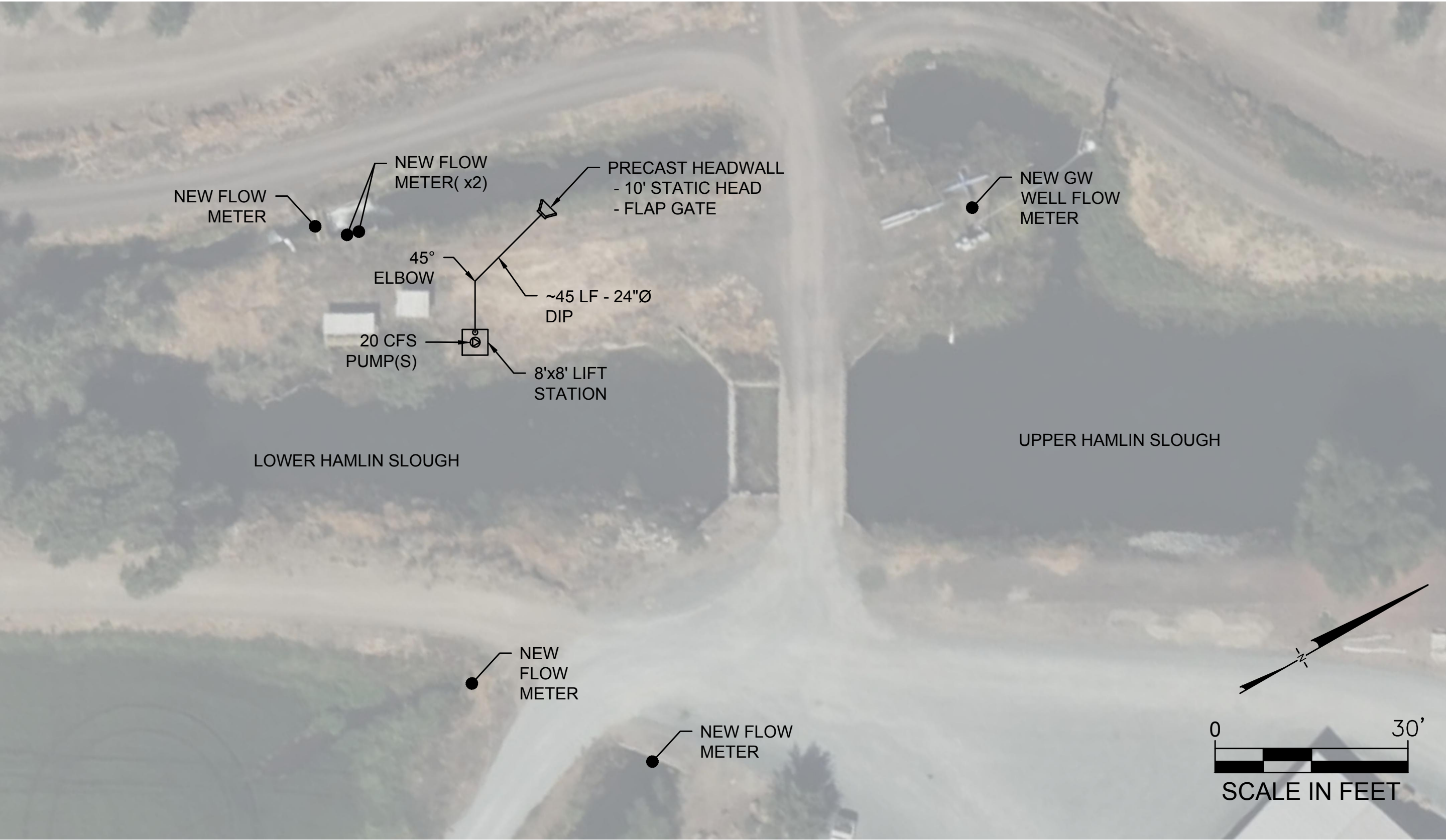
GEOSYNTEC CONSULTANTS Photographic Record	
Client: Butte County	Project Number: SFO154C
Data: 8/20/2025	Latitude: 39.5603° Longitude: -121.6950°
Site Name: West Cherokee Strip Private Landowner Proposed Lift Station Location 3	
Photograph 18 Description: Looking downstream at proposed location of Lift Station 3.	DIRECTION 173 deg(T) 39.56039°N 121.69502°W ACCURACY 11 m DATUM WGS84  2025-08-20 12:35:18-07:00
Photograph 19 Description: Looking upstream at proposed location of Lift Station 3.	DIRECTION 320 deg(T) 39.56039°N 121.69502°W ACCURACY 11 m DATUM WGS84  2025-08-20 12:35:14-07:00

GEOSYNTEC CONSULTANTS Photographic Record	
Client: Butte County	Project Number: SFO154C
Data: 8/20/2025	Latitude: 39.5667° Longitude: -121.6980°
Site Name: West Cherokee Strip Private Landowner Proposed Lift Station Location 4	
Photograph 20 Description: Looking downstream at proposed location of Lift Station 4 (image from Google Maps)	
Photograph 21 Description: Looking upstream at proposed location of Lift Station 4 (image from Google Maps)	

ATTACHMENT B

Proposed Improvement Exhibits

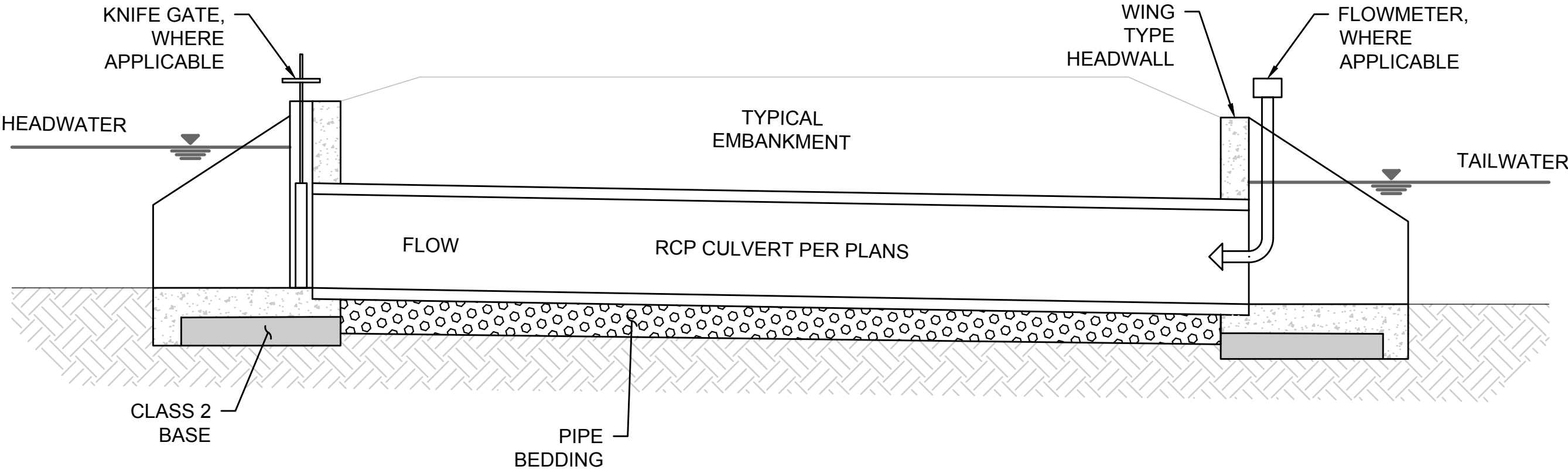
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HAMLIN SLOUGH LIFT STATION
SCALE: 1" = 30'



HAMLIN SLOUGH DIVERSION
SCALE: 1" = 30'



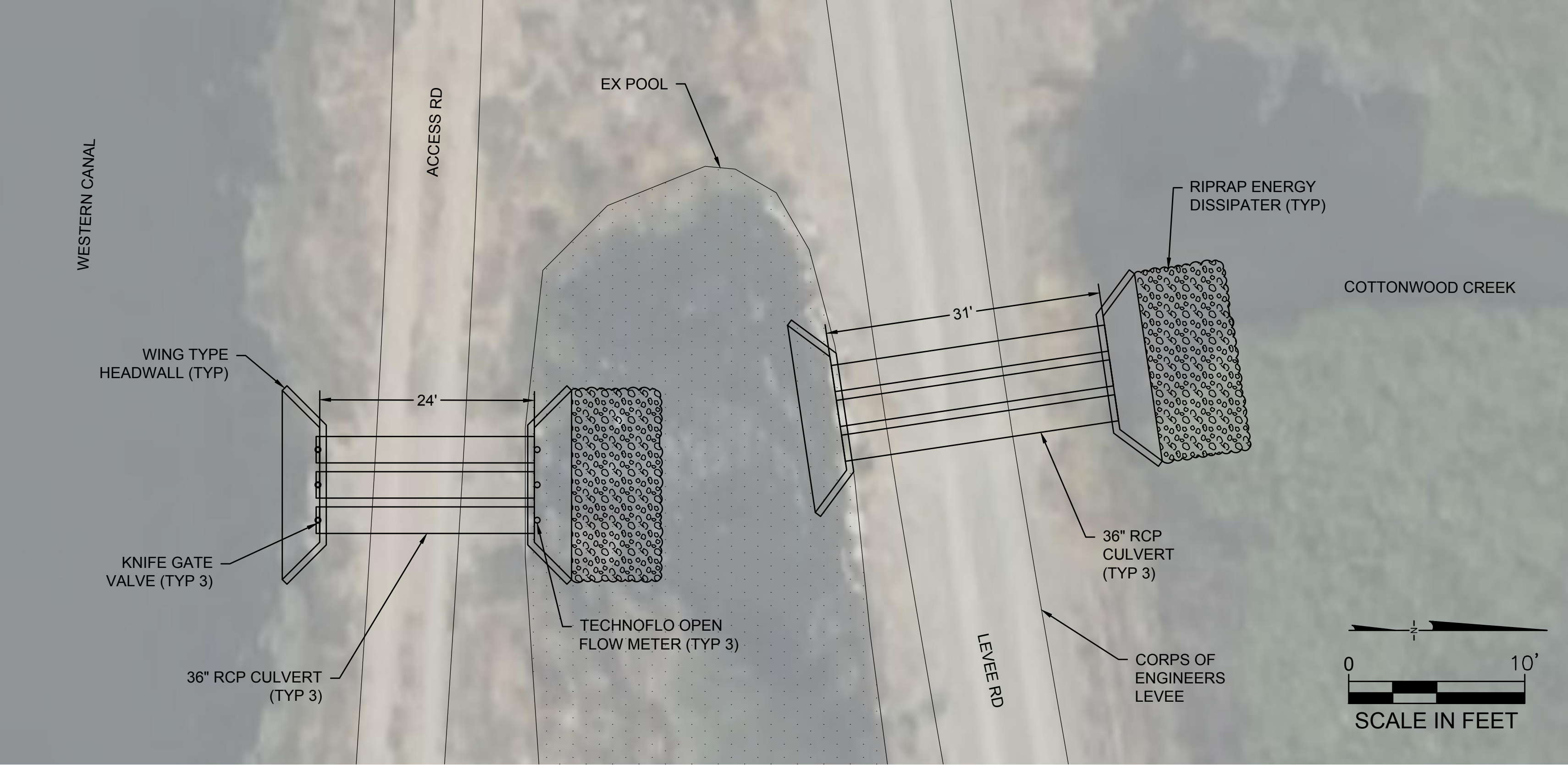
TYPICAL CULVERT PROFILE VIEW
NOT TO SCALE

- MAP NOTES:
- SERVICE LAYER SOURCE CREDITS: AUTODESK MAP
 - COORDINATE SYSTEM: NAD83 CA STATE PLANES, ZONE II, US FOOT.

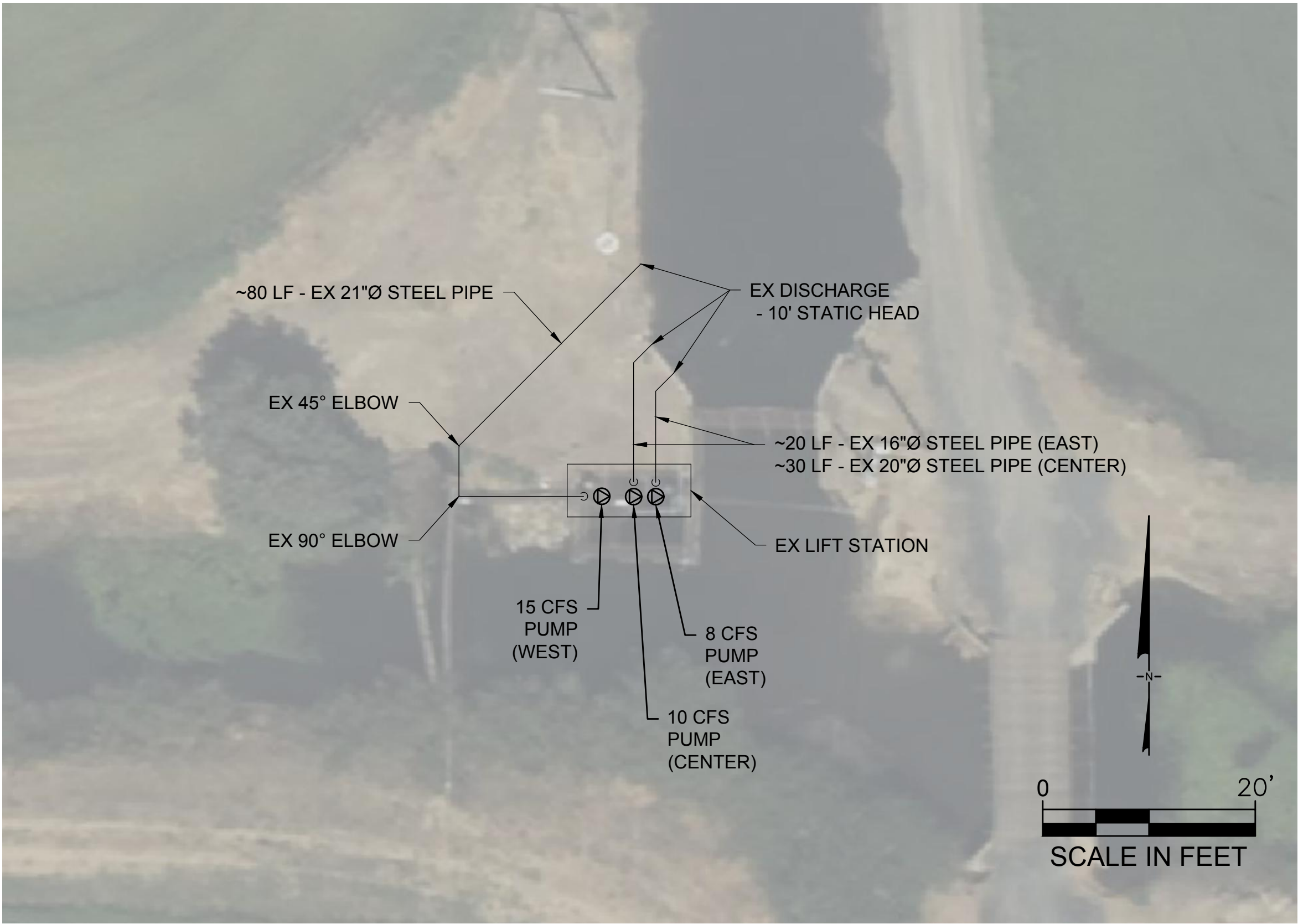
HAMLIN SLOUGH IMPROVEMENTS	
VINA SUBBASIN PROJECT	
	
PROJECT NO: SFO154C	OCT 2025

FIGURE 1

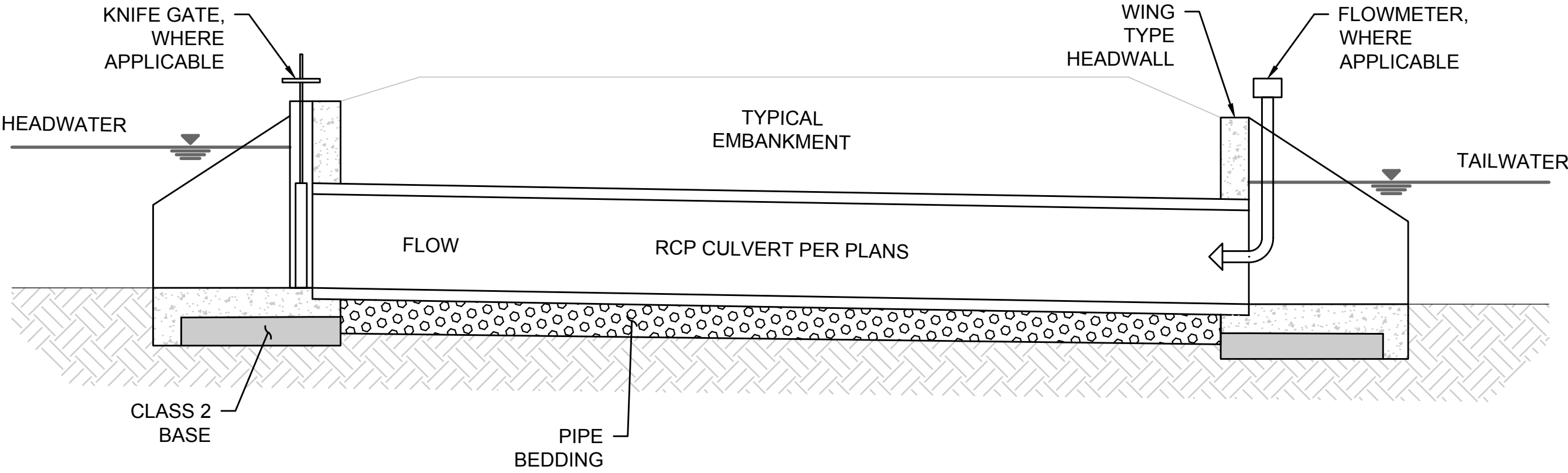
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COTTONWOOD CREEK CULVERT
SCALE: 1" = 10'



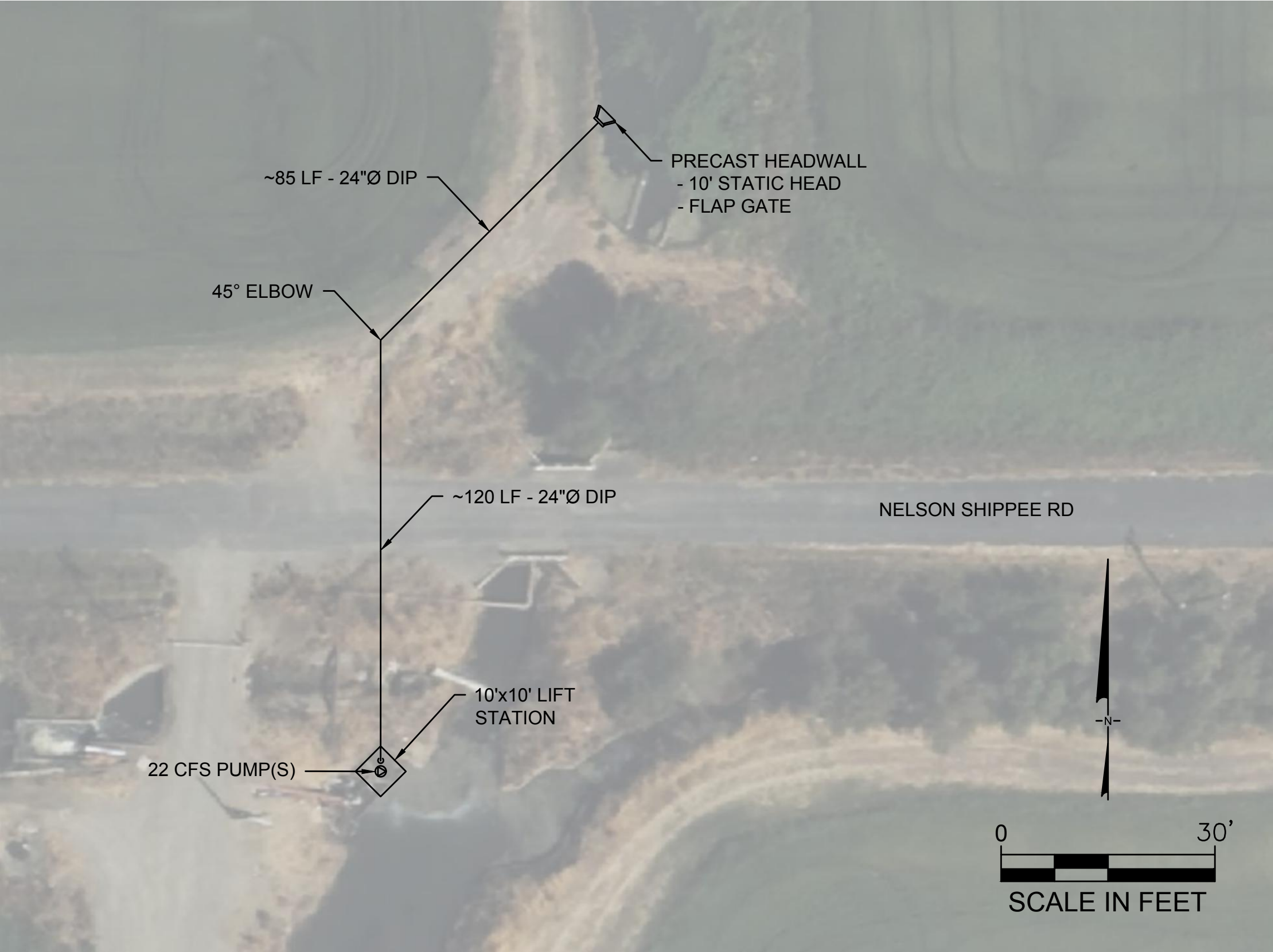
EAST CHEROKEE STRIP PUMP REPLACEMENTS
SCALE: 1" = 20'



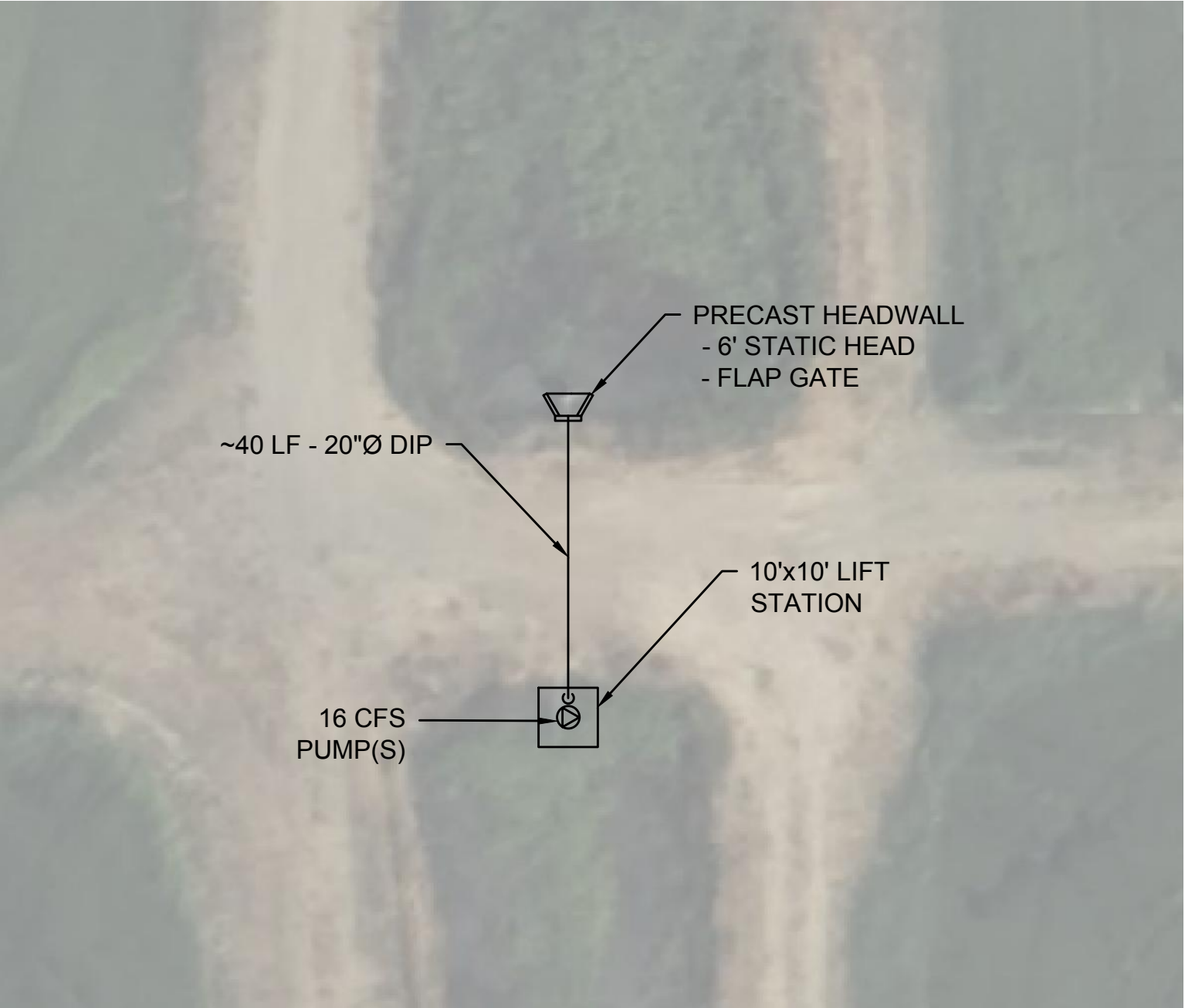
TYPICAL CULVERT PROFILE VIEW
NOT TO SCALE

MAP NOTES:
1. SERVICE LAYER SOURCE CREDITS: AUTODESK MAP
2. COORDINATE SYSTEM: NAD83 CA STATE PLANES, ZONE II, US FOOT.

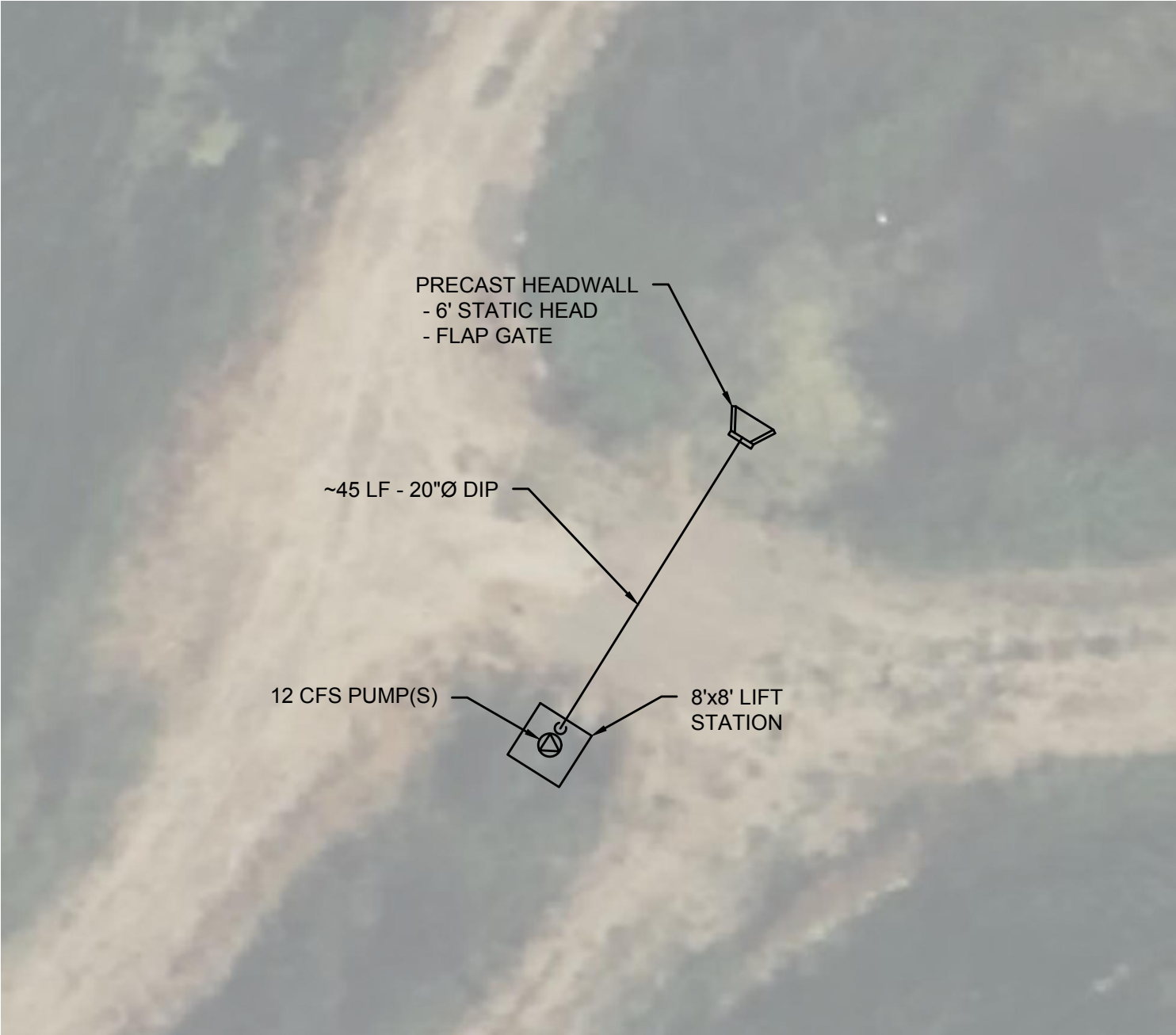
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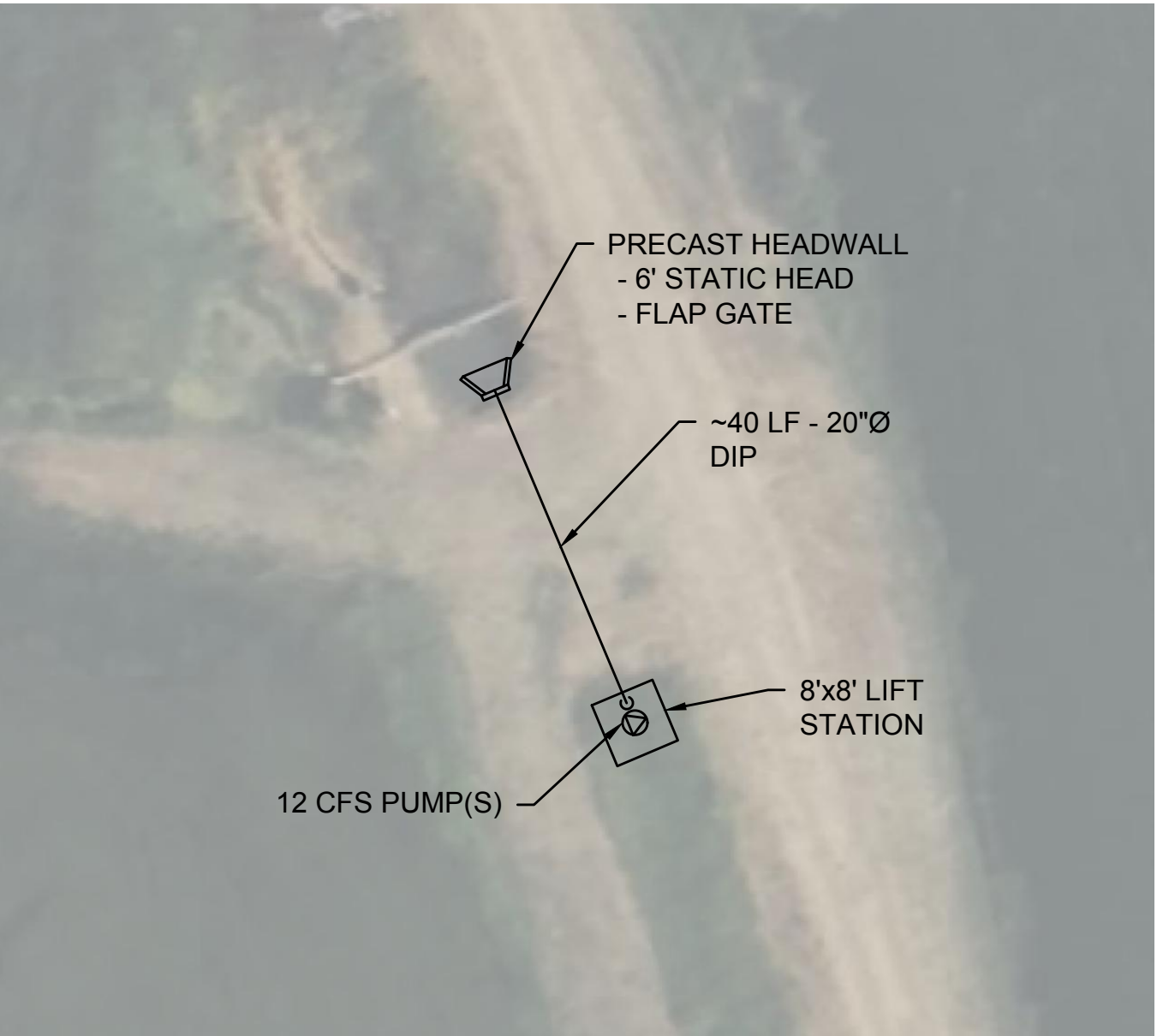
LIFT STATION UPGRADE
SCALE: 1" = 30'



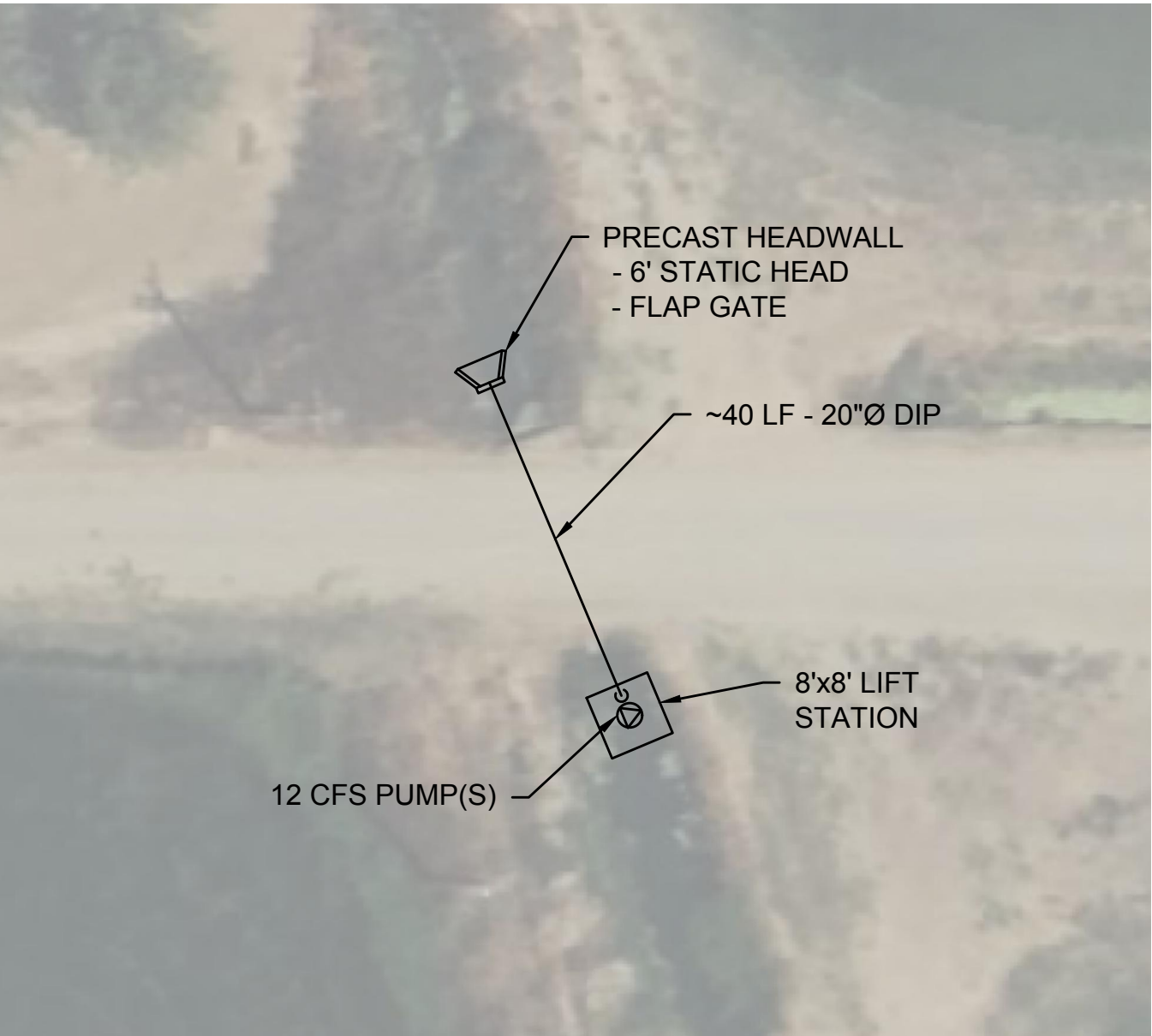
NEW LIFT STATION 1
SCALE: 1" = 20'



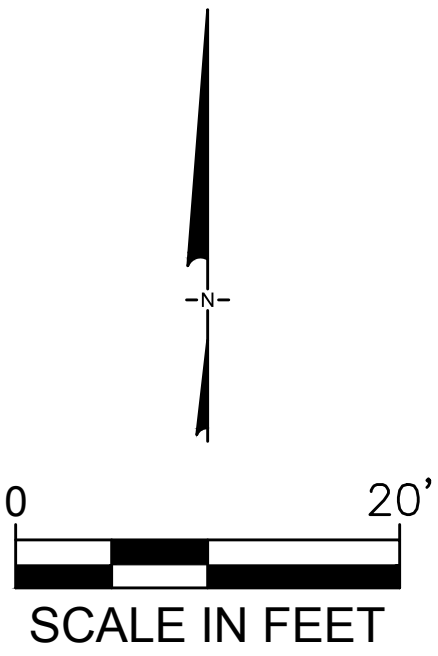
NEW LIFT STATION 2
SCALE: 1" = 20'



NEW LIFT STATION 3
SCALE: 1" = 20'



NEW LIFT STATION 4
SCALE: 1" = 20'



- MAP NOTES:**
- SERVICE LAYER SOURCE CREDITS: AUTODESK MAP
 - COORDINATE SYSTEM: NAD83 CA STATE PLANES, ZONE II, US FOOT.

WEST CHEROKEE STRIP IMPROVEMENTS	
VINA SUBBASIN PROJECT	
	
PROJECT NO: SFO154C	OCT 2025

FIGURE 3

ATTACHMENT C

Supporting Calculations

Pump Location:		Hamlin Slough New Lift Station
Input Project Design Criteria		Notes
1.) Peak Design Flow (gpm):	8977	Manual Entry
1.1) Peak Design Flow (cfs):	20.001	
2.) Peak Design Velocity (fps):	6.5	2-5 Recommended
2.) Force Main Length (ft):	45	Manual Entry - Length of pipe from pump inlet to discharge.
3.) Force Main diameter (in.):	24.00	Based on flow velocity
4.) Force Main Type:	DI - unlined	Select from dropdown menu.
5.) Water Type:	Water	Select from dropdown menu.
7.) Start Piping Elevation (ft):	0	Manual Entry
8.) Discharge Piping Elevation (ft):	10	Manual Entry
1. Static Losses		See tab 1
$\Delta H(\text{ft}):$	10.00	static head between pump and point of discharge
2. Friction Losses		See tab 2
$h_f(\text{ft}):$	0.37	total friction loss
3. Minor Losses		See tab 3
$h_m(\text{ft}):$	1.10	total minor losses
4. Total Dynamic Head for given flowrate		
TDH (ft):	11.47	

Pump Location:		East Cherokee Strip Lift Station - West
Input Project Design Criteria		Notes
1.) Peak Design Flow (gpm):	6731.25	Manual Entry
1.1) Peak Design Flow (cfs):	15.00	
2.) Peak Design Velocity (fps):	6	2-5 Recommended
2.) Force Main Length (ft):	80	Manual Entry - Length of pipe from pump inlet to discharge.
3.) Force Main diameter (in.):	21.00	Based on flow velocity
4.) Force Main Type:	Steel - unlined	Select from dropdown menu.
5.) Water Type:	Water	Select from dropdown menu.
7.) Start Piping Elevation (ft):	0	Manual Entry
8.) Discharge Piping Elevation (ft):	10	Manual Entry

1. Static Losses		See tab 1
$\Delta H(\text{ft}):$	10.00	static head between pump and point of discharge
2. Friction Losses		See tab 2
$h_f(\text{ft}):$	0.53	total friction loss
3. Minor Losses		See tab 3
$h_m(\text{ft}):$	1.17	total minor loss
4. Total Dynamic Head for given flowrate		
TDH (ft):	11.69	

Pump Location:		East Cherokee Strip Lift Station - Center
Input Project Design Criteria		Notes
1.) Peak Design Flow (gpm):	4490	Manual Entry
1.1) Peak Design Flow (cfs):	10.00	
2.) Peak Design Velocity (fps):	4.5	2-5 Recommended
2.) Force Main Length (ft):	30	Manual Entry - Length of pipe from pump inlet to discharge.
3.) Force Main diameter (in.):	20.00	Based on flow velocity
4.) Force Main Type:	Steel - unlined	Select from dropdown menu.
5.) Water Type:	Water	Select from dropdown menu.
7.) Start Piping Elevation (ft):	0	Manual Entry
8.) Discharge Piping Elevation (ft):	10	Manual Entry

1. Static Losses		See tab 1
$\Delta H(\text{ft}):$	10.00	static head between pump and point of discharge
2. Friction Losses		See tab 2
$h_f(\text{ft}):$	0.12	total friction loss
3. Minor Losses		See tab 3
$h_m(\text{ft}):$	0.55	total minor loss
4. Total Dynamic Head for given flowrate		
TDH (ft):	10.67	

Pump Location:		East Cherokee Strip Lift Station - East
Input Project Design Criteria		Notes
1.) Peak Design Flow (gpm):	3592	Manual Entry
1.1) Peak Design Flow (cfs):	8.00	
2.) Peak Design Velocity (fps):	5.5	2-5 Recommended
2.) Force Main Length (ft):	20	Manual Entry - Length of pipe from pump inlet to discharge.
3.) Force Main diameter (in.):	16.00	Based on flow velocity
4.) Force Main Type:	Steel - unlined	Select from dropdown menu.
5.) Water Type:	Water	Select from dropdown menu.
7.) Start Piping Elevation (ft):	0	Manual Entry
8.) Discharge Piping Elevation (ft):	10	Manual Entry

1. Static Losses		See tab 1
$\Delta H(\text{ft}):$	10.00	static head between pump and point of discharge
2. Friction Losses		See tab 2
$h_f(\text{ft}):$	0.15	total friction loss
3. Minor Losses		See tab 3
$h_m(\text{ft}):$	0.86	total minor loss
4. Total Dynamic Head <i>for given flowrate</i>		
TDH (ft):	11.01	

Pump Location:		West Cherokee Strip - Lift Station Upgrade
Input Project Design Criteria		Notes
1.) Peak Design Flow (gpm):	9878	Manual Entry
1.1) Peak Design Flow (cfs):	22.01	
2.) Peak Design Velocity (fps):	7	2-5 Recommended
2.) Force Main Length (ft):	213	Manual Entry - Length of pipe from pump inlet to discharge.
3.) Force Main diameter (in.):	24.00	Based on flow velocity
4.) Force Main Type:	Steel - unlined	Select from dropdown menu.
5.) Water Type:	Water	Select from dropdown menu.
7.) Start Piping Elevation (ft):	0	Manual Entry
8.) Discharge Piping Elevation (ft):	10	Manual Entry

1. Static Losses		See tab 1
$\Delta H(\text{ft}):$	10.00	static head between pump and point of discharge
2. Friction Losses		See tab 2
$h_f(\text{ft}):$	1.48	total friction loss
3. Minor Losses		See tab 3
$h_m(\text{ft}):$	1.47	total minor loss
4. Total Dynamic Head for given flowrate		
TDH (ft):	12.96	

Pump Location:		West Cherokee Strip New Lift Station 1
Input Project Design Criteria		Notes
1.) Peak Design Flow (gpm):	7180	Manual Entry
1.1) Peak Design Flow (cfs):	16.00	
2.) Peak Design Velocity (fps):	7	2-5 Recommended
2.) Force Main Length (ft):	45	Manual Entry - Length of pipe from pump inlet to discharge.
3.) Force Main diameter (in.):	20.00	Based on flow velocity.
4.) Force Main Type:	DI - unlined	Select from dropdown menu.
5.) Water Type:	Water	Select from dropdown menu.
7.) Start Piping Elevation (ft):	0	Manual Entry
8.) Discharge Piping Elevation (ft):	6	Manual Entry

1. Static Losses		See tab 1
$\Delta H(\text{ft}):$	6.00	static head between pump and point of discharge
2. Friction Losses		See tab 2
$h_f(\text{ft}):$	0.59	total friction loss
3. Minor Losses		See tab 3
$h_m(\text{ft}):$	1.46	total minor loss
4. Total Dynamic Head for given flowrate		
TDH (ft):	8.05	

Pump Location:		West Cherokee Strip New Lift Station 2-4
Input Project Design Criteria		Notes
1.) Peak Design Flow (gpm):	5388	Manual Entry
1.1) Peak Design Flow (cfs):	12.00	
2.) Peak Design Velocity (fps):	5.5	2-5 Recommended
2.) Force Main Length (ft):	45	Manual Entry - Length of pipe from pump inlet to discharge.
3.) Force Main diameter (in.):	20.00	Based on flow velocity.
4.) Force Main Type:	DI - unlined	Select from dropdown menu.
5.) Water Type:	Water	Select from dropdown menu.
7.) Start Piping Elevation (ft):	0	Manual Entry
8.) Discharge Piping Elevation (ft):	6	Manual Entry

1. Static Losses		See tab 1
$\Delta H(\text{ft}):$	6.00	static head between pump and point of discharge
2. Friction Losses		See tab 2
$h_f(\text{ft}):$	0.35	total friction loss
3. Minor Losses		See tab 3
$h_m(\text{ft}):$	0.82	total minor loss
4. Total Dynamic Head for given flowrate		
TDH (ft):	7.17	

Cottonwood Creek Diversion – Existing Conditions

HY-8 Culvert Analysis Report

Crossing Discharge Data

Discharge Selection Method: Specify Minimum, Design, and Maximum Flow

Minimum Flow: 1 cfs

Design Flow: 37 cfs

Maximum Flow: 100 cfs

Site Data - Existing 30

Site Data Option: Culvert Invert Data

Inlet Station: 0.00 ft

Inlet Elevation: 117.00 ft

Outlet Station: 24.00 ft

Outlet Elevation: 117.00 ft

Number of Barrels: 1

Culvert Data Summary - Existing 30

Barrel Shape: Circular

Barrel Diameter: 2.50 ft

Barrel Material: Concrete

Embedment: 0.00 in

Barrel Manning's n: 0.0120

Culvert Type: Straight

Inlet Configuration: Square Edge with Headwall

Inlet Depression: None

Site Data - Existing 24

Site Data Option: Culvert Invert Data

Inlet Station: 0.00 ft

Inlet Elevation: 117.00 ft

Outlet Station: 25.00 ft

Outlet Elevation: 117.00 ft

Number of Barrels: 1

Cottonwood Creek Diversion – Existing Conditions

Culvert Data Summary - Existing 24

Barrel Shape: Circular

Barrel Diameter: 2.00 ft

Barrel Material: Concrete

Embedment: 0.00 in

Barrel Manning's n: 0.0120

Culvert Type: Straight

Inlet Configuration: Square Edge with Headwall

Inlet Depression: None

Tailwater Channel Data - Cottonwood Creek Diversion (Existing)

Tailwater Channel Option: Enter Constant Tailwater Elevation

Constant Tailwater Elevation: 122.40 ft

Roadway Data for Crossing: Cottonwood Creek Diversion (Existing)

Roadway Profile Shape: Constant Roadway Elevation

Crest Length: 25.00 ft

Crest Elevation: 126.55 ft

Roadway Surface: Gravel

Roadway Top Width: 10.00 ft

Table 1 - Summary of Culvert Flows at Crossing: Cottonwood Creek Diversion

Headwater Elevation (ft)	Total Discharge (cfs)	Existing 30 Discharge (cfs)	Existing 24 Discharge (cfs)	Roadway Discharge (cfs)	Iterations
122.40	1.00	0.69	0.44	0.00	7
122.45	10.90	6.75	4.21	0.00	8
122.58	20.80	12.80	8.02	0.00	6
122.79	30.70	18.88	11.83	0.00	5
122.96	37.00	22.76	14.25	0.00	4
123.45	50.50	31.06	19.45	0.00	5
123.90	60.40	37.15	23.26	0.00	4
124.43	70.30	43.23	27.07	0.00	4
125.05	80.20	49.32	30.88	0.00	4
125.74	90.10	55.42	34.69	0.00	3
126.51	100.00	61.48	38.49	0.00	11
126.55	100.44	61.77	38.68	0.00	Overtopping

Cottonwood Creek Diversion – Existing Conditions

Table 2 - Culvert Summary Table: Existing 30

Total Discharge (cfs)	Culvert Discharge (cfs)	Headwater Elevation (ft)	Inlet Control Depth (ft)	Outlet Control Depth (ft)	Flow Type	Normal Depth (ft)	Critical Depth (ft)	Outlet Depth (ft)	Tailwater Depth (ft)	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)
1.00	0.69	122.40	0.366	5.401	4-FFf	-1.000	0.265	2.500	5.400	0.141	0.000
10.90	6.75	122.45	1.191	5.450	4-FFf	-1.000	0.856	2.500	5.400	1.376	0.000
20.80	12.80	122.58	1.762	5.578	4-FFf	-1.000	1.202	2.500	5.400	2.607	0.000
30.70	18.88	122.79	2.241	5.788	4-FFf	-1.000	1.469	2.500	5.400	3.847	0.000
37.00	22.76	122.96	2.541	5.963	4-FFf	-1.000	1.620	2.500	5.400	4.637	0.000
50.50	31.06	123.45	3.270	6.449	4-FFf	-1.000	1.897	2.500	5.400	6.327	0.000
60.40	37.15	123.90	3.936	6.901	4-FFf	-1.000	2.062	2.500	5.400	7.568	0.000
70.30	43.23	124.43	4.734	7.433	4-FFf	-1.000	2.194	2.500	5.400	8.807	0.000
80.20	49.32	125.05	5.669	8.045	4-FFf	-1.000	2.291	2.500	5.400	10.047	0.000
90.10	55.42	125.74	6.734	8.740	4-FFf	-1.000	2.360	2.500	5.400	11.289	0.000
100.00	61.48	126.51	7.935	9.510	4-FFf	-1.000	2.295	2.500	5.400	12.524	0.000

Table 3 - Culvert Summary Table: Existing 24

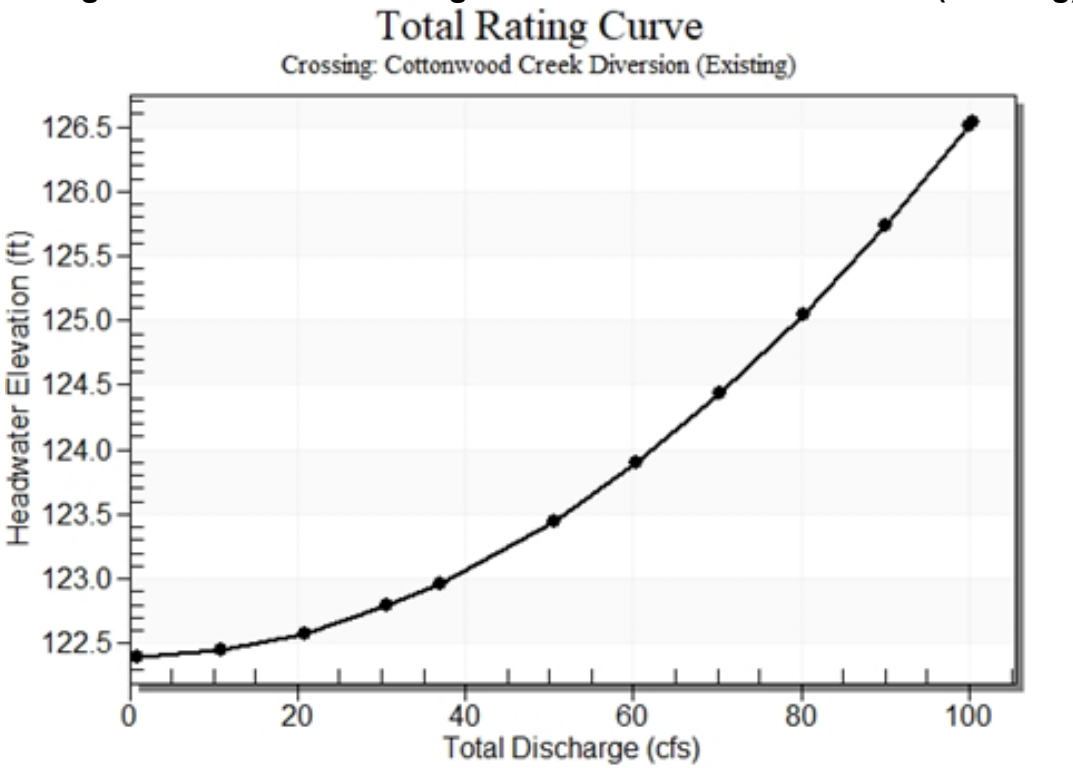
Total Discharge (cfs)	Culvert Discharge (cfs)	Headwater Elevation (ft)	Inlet Control Depth (ft)	Outlet Control Depth (ft)	Flow Type	Normal Depth (ft)	Critical Depth (ft)	Outlet Depth (ft)	Tailwater Depth (ft)	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)
1.00	0.44	122.40	0.308	5.401	4-FFf	-1.000	0.223	2.000	5.400	0.139	0.000
10.90	4.21	122.45	0.998	5.449	4-FFf	-1.000	0.717	2.000	5.400	1.340	0.000
20.80	8.02	122.58	1.490	5.579	4-FFf	-1.000	1.008	2.000	5.400	2.554	0.000
30.70	11.83	122.79	1.902	5.788	4-FFf	-1.000	1.230	2.000	5.400	3.766	0.000
37.00	14.25	122.96	2.171	5.963	4-FFf	-1.000	1.356	2.000	5.400	4.536	0.000
50.50	19.45	123.45	2.858	6.449	4-FFf	-1.000	1.584	2.000	5.400	6.190	0.000
60.40	23.26	123.90	3.500	6.900	4-FFf	-1.000	1.713	2.000	5.400	7.403	0.000
70.30	27.07	124.43	4.274	7.433	4-FFf	-1.000	1.810	2.000	5.400	8.617	0.000
80.20	30.88	125.05	5.173	8.045	4-FFf	-1.000	1.878	2.000	5.400	9.830	0.000
90.10	34.69	125.74	6.198	8.739	4-FFf	-1.000	1.860	2.000	5.400	11.044	0.000
100.00	38.49	126.51	7.398	9.510	4-FFf	-1.000	1.942	2.000	5.400	12.252	0.000

Table 4 - Downstream Channel Rating Curve (Crossing: Cottonwood Creek Diversion)

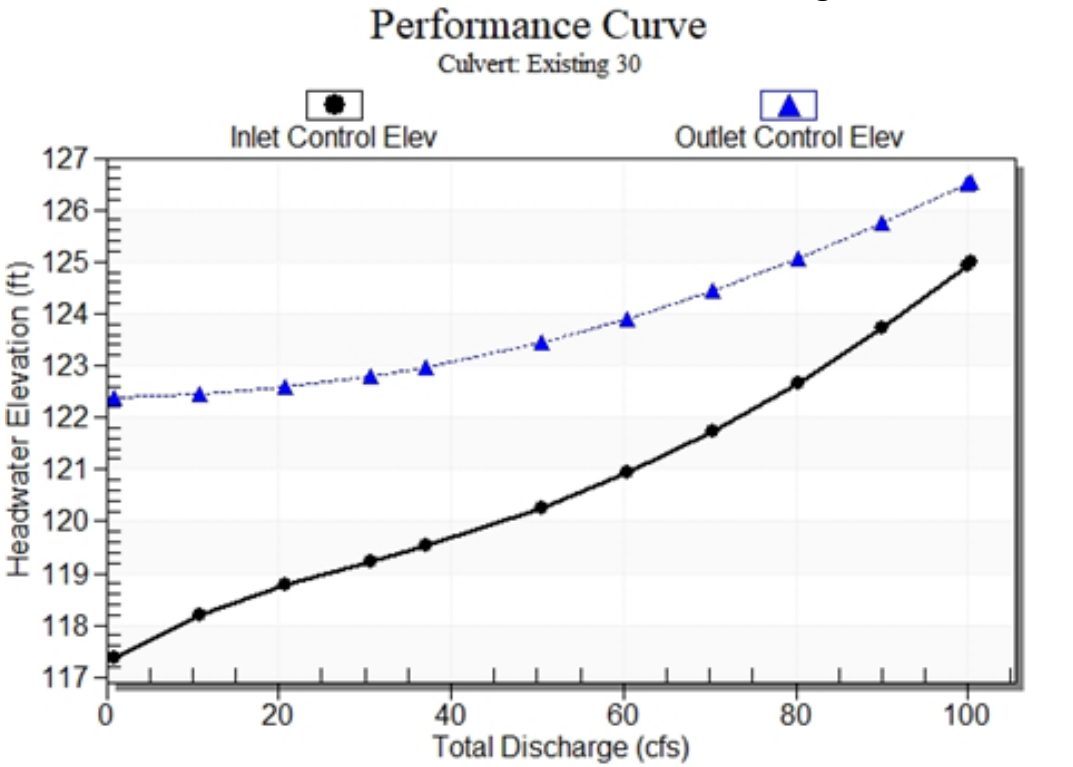
Flow (cfs)	Water Surface Elev (ft)	Depth (ft)
1.00	122.40	5.40
10.90	122.40	5.40
20.80	122.40	5.40
30.70	122.40	5.40
37.00	122.40	5.40
50.50	122.40	5.40
60.40	122.40	5.40
70.30	122.40	5.40
80.20	122.40	5.40
90.10	122.40	5.40
100.00	122.40	5.40

Cottonwood Creek Diversion – Existing Conditions

Rating Curve Plot for Crossing: Cottonwood Creek Diversion (Existing)



Culvert Performance Curve Plot: Existing 30

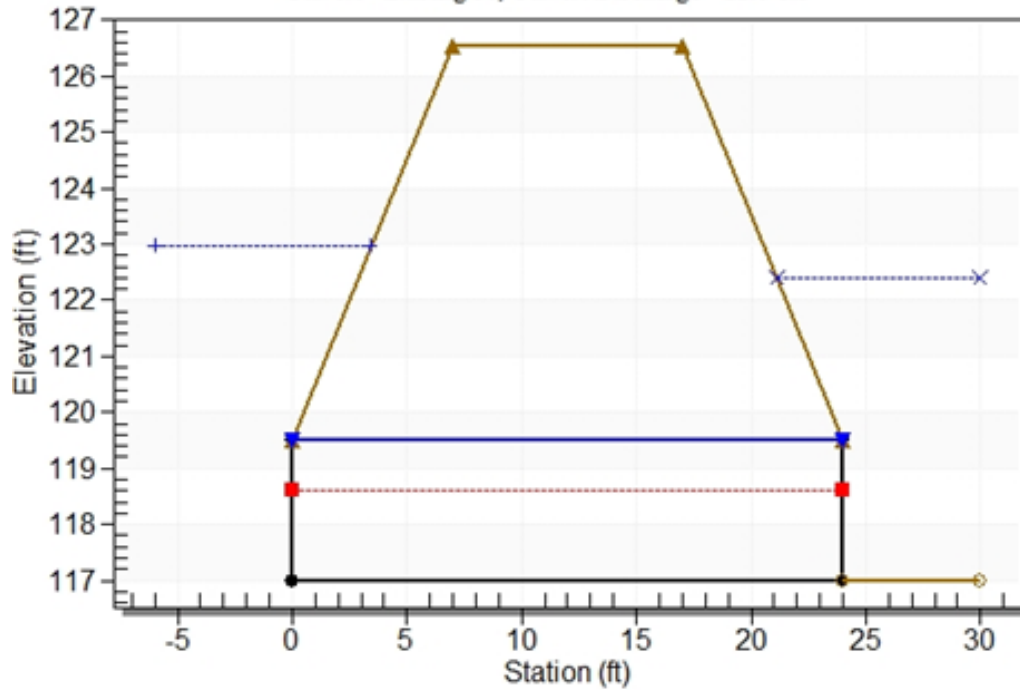


Cottonwood Creek Diversion – Existing Conditions

Water Surface Profile Plot for Culvert: Existing 30

Crossing - Cottonwood Creek Diversion (Existing), Design Discharge - 37.0 cfs

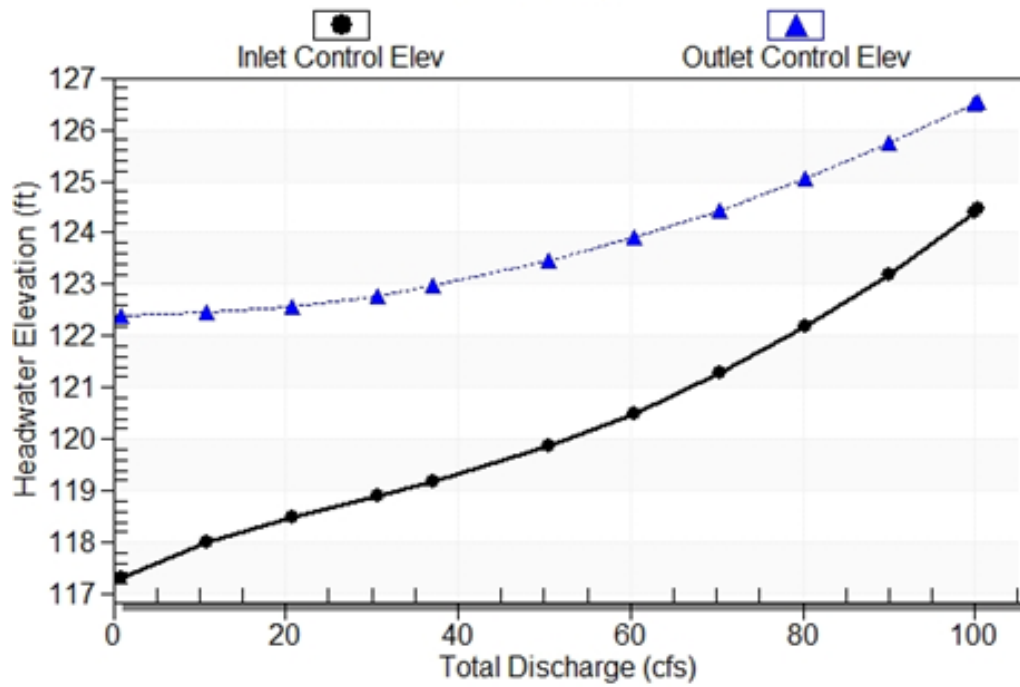
Culvert - Existing 30, Culvert Discharge - 22.8 cfs



Culvert Performance Curve Plot: Existing 24

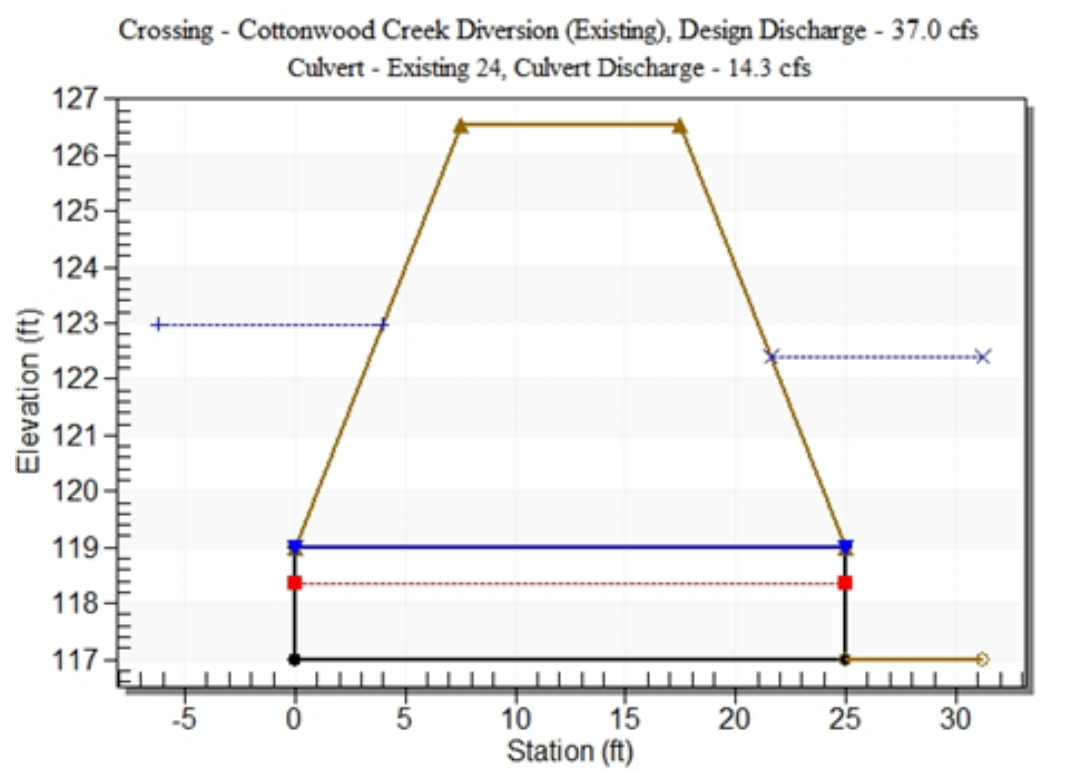
Performance Curve

Culvert: Existing 24



Cottonwood Creek Diversion – Existing Conditions

Water Surface Profile Plot for Culvert: Existing 24



Cottonwood Creek Diversion – Proposed Conditions

HY-8 Culvert Analysis Report

Crossing Discharge Data

Discharge Selection Method: Specify Minimum, Design, and Maximum Flow

Minimum Flow: 1 cfs

Design Flow: 90 cfs

Maximum Flow: 100 cfs

Site Data - Proposed 36

Site Data Option: Culvert Invert Data

Inlet Station: 0.00 ft

Inlet Elevation: 117.00 ft

Outlet Station: 24.00 ft

Outlet Elevation: 117.00 ft

Number of Barrels: 3

Culvert Data Summary - Proposed 36

Barrel Shape: Circular

Barrel Diameter: 3.00 ft

Barrel Material: Concrete

Embedment: 0.00 in

Barrel Manning's n: 0.0120

Culvert Type: Straight

Inlet Configuration: Square Edge with Headwall

Inlet Depression: None

Tailwater Channel Data - Cottonwood Creek Diversion (Proposed)

Tailwater Channel Option: Enter Constant Tailwater Elevation

Constant Tailwater Elevation: 122.49 ft

Roadway Data for Crossing: Cottonwood Creek Diversion (Proposed)

Roadway Profile Shape: Constant Roadway Elevation

Crest Length: 25.00 ft

Crest Elevation: 126.55 ft

Roadway Surface: Gravel

Roadway Top Width: 10.00 ft

Cottonwood Creek Diversion – Proposed Conditions

Table 1 - Summary of Culvert Flows at Crossing: Cottonwood Creek Diversion

Headwater Elevation (ft)	Total Discharge (cfs)	Proposed 36 Discharge (cfs)	Roadway Discharge (cfs)	Iterations
122.49	1.00	1.00	0.00	1
122.50	10.90	10.90	0.00	1
122.51	20.80	20.80	0.00	1
122.54	30.70	30.70	0.00	1
122.58	40.60	40.60	0.00	1
122.64	50.50	50.50	0.00	1
122.70	60.40	60.40	0.00	1
122.77	70.30	70.30	0.00	1
122.86	80.20	80.20	0.00	1
122.95	90.00	90.00	0.00	1
123.06	100.00	100.00	0.00	1
126.55	267.17	267.17	0.00	Overtopping

Table 2 - Culvert Summary Table: Proposed 36

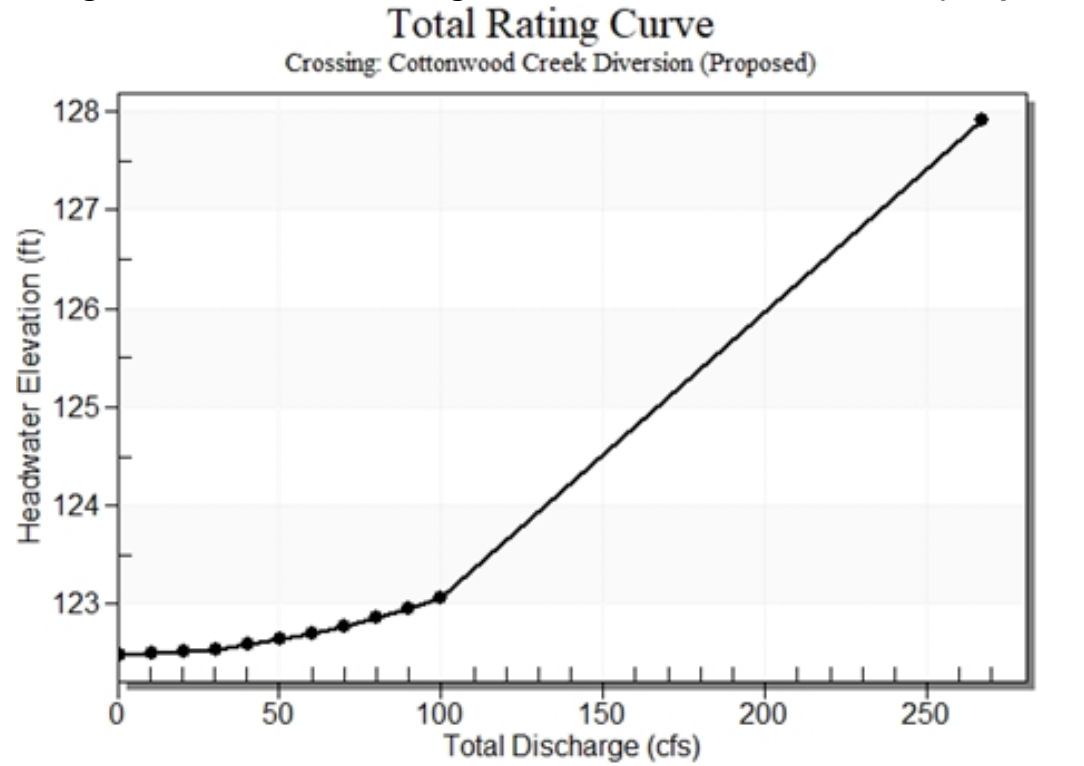
Total Discharge (cfs)	Culvert Discharge (cfs)	Headwater Elevation (ft)	Inlet Control Depth (ft)	Outlet Control Depth (ft)	Flow Type	Normal Depth (ft)	Critical Depth (ft)	Outlet Depth (ft)	Tailwater Depth (ft)	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)
1.00	1.00	122.49	0.244	5.490	4-FFf	-1.000	0.173	3.000	5.490	0.047	0.000
10.90	10.90	122.50	0.811	5.497	4-FFf	-1.000	0.590	3.000	5.490	0.514	0.000
20.80	20.80	122.51	1.137	5.515	4-FFf	-1.000	0.826	3.000	5.490	0.981	0.000
30.70	30.70	122.54	1.399	5.544	4-FFf	-1.000	1.010	3.000	5.490	1.448	0.000
40.60	40.60	122.58	1.650	5.584	4-FFf	-1.000	1.168	3.000	5.490	1.915	0.000
50.50	50.50	122.64	1.891	5.635	4-FFf	-1.000	1.310	3.000	5.490	2.381	0.000
60.40	60.40	122.70	2.111	5.697	4-FFf	-1.000	1.440	3.000	5.490	2.848	0.000
70.30	70.30	122.77	2.316	5.771	4-FFf	-1.000	1.558	3.000	5.490	3.315	0.000
80.20	80.20	122.86	2.512	5.856	4-FFf	-1.000	1.668	3.000	5.490	3.782	0.000
90.00	90.00	122.95	2.701	5.951	4-FFf	-1.000	1.769	3.000	5.490	4.244	0.000
100.00	100.00	123.06	2.896	6.059	4-FFf	-1.000	1.871	3.000	5.490	4.716	0.000

Table 3 - Downstream Channel Rating Curve Crossing: Cottonwood Creek Diversion

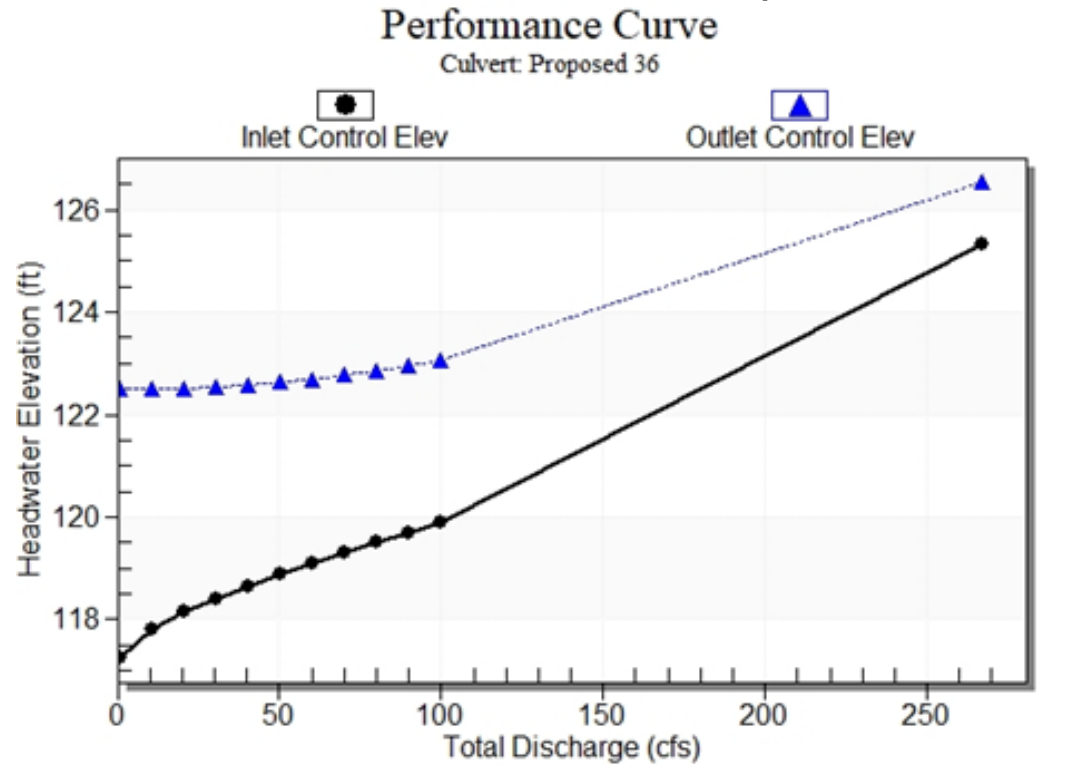
Flow (cfs)	Water Surface Elev (ft)	Depth (ft)
1.00	122.49	5.49
10.90	122.49	5.49
20.80	122.49	5.49
30.70	122.49	5.49
40.60	122.49	5.49
50.50	122.49	5.49
60.40	122.49	5.49
70.30	122.49	5.49
80.20	122.49	5.49
90.00	122.49	5.49
100.00	122.49	5.49

Cottonwood Creek Diversion – Proposed Conditions

Rating Curve Plot for Crossing: Cottonwood Creek Diversion (Proposed)

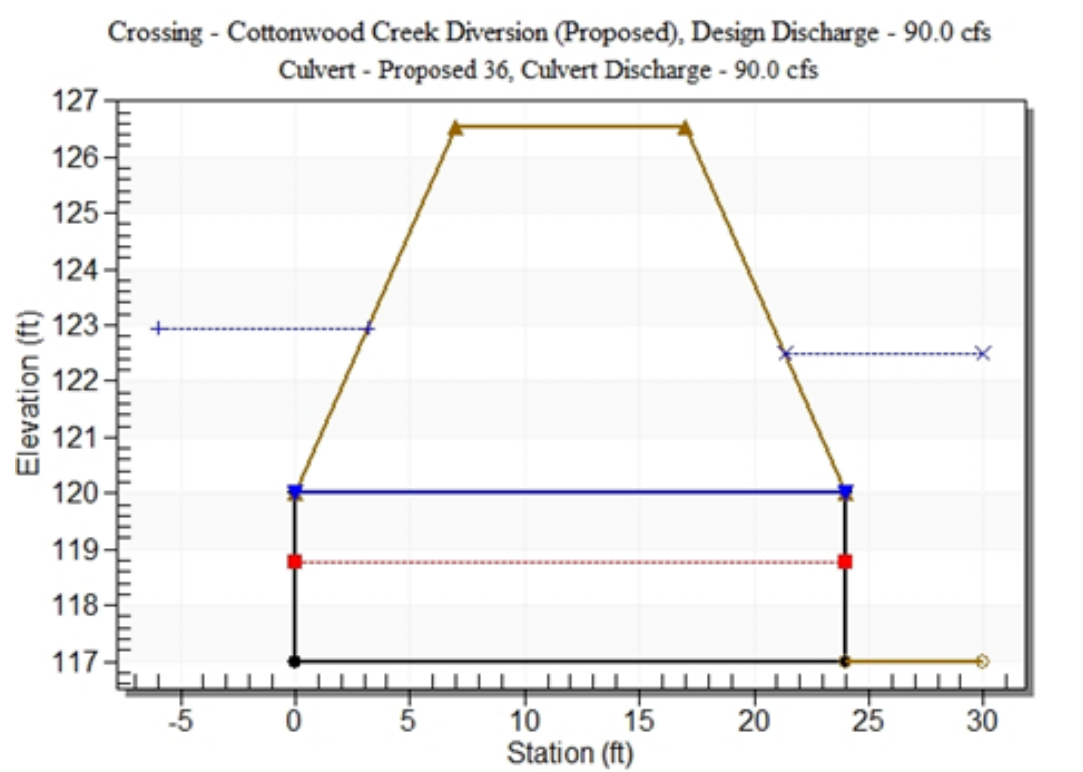


Culvert Performance Curve Plot: Proposed 36



Cottonwood Creek Diversion – Proposed Conditions

Water Surface Profile Plot for Culvert: Proposed 36



Hamlin Slough Diversion

HY-8 Culvert Analysis Report

Crossing Discharge Data

Discharge Selection Method: Specify Minimum, Design, and Maximum Flow

Minimum Flow: 1 cfs

Design Flow: 20 cfs

Maximum Flow: 40 cfs

Site Data - Proposed 24

Site Data Option: Culvert Invert Data

Inlet Station: 0.00 ft

Inlet Elevation: 125.80 ft

Outlet Station: 40.00 ft

Outlet Elevation: 125.80 ft

Number of Barrels: 1

Culvert Data Summary - Proposed 24

Barrel Shape: Circular

Barrel Diameter: 2.00 ft

Barrel Material: Concrete

Embedment: 0.00 in

Barrel Manning's n: 0.0120

Culvert Type: Straight

Inlet Configuration: Square Edge with Headwall

Inlet Depression: None

Tailwater Channel Data - Hamlin Slough Diversion TWC

Tailwater Channel Option: Enter Constant Tailwater Elevation

Constant Tailwater Elevation: 128.60 ft

Roadway Data for Crossing: Hamlin Slough Diversion TWC

Roadway Profile Shape: Constant Roadway Elevation

Crest Length: 25.00 ft

Crest Elevation: 132.00 ft

Roadway Surface: Paved

Roadway Top Width: 15.00 ft

Hamlin Slough Diversion

Table 1 - Summary of Culvert Flows at Crossing: Hamlin Slough Diversion TWC

Headwater Elevation (ft)	Total Discharge (cfs)	Proposed 24 Discharge (cfs)	Roadway Discharge (cfs)	Iterations
128.60	1.00	1.00	0.00	1
128.67	4.90	4.90	0.00	1
128.83	8.80	8.80	0.00	1
129.09	12.70	12.70	0.00	1
129.43	16.60	16.60	0.00	1
129.81	20.00	20.00	0.00	1
130.40	24.40	24.40	0.00	1
131.02	28.30	28.30	0.00	1
131.73	32.20	32.20	0.00	1
132.09	36.10	33.99	2.07	12
132.18	40.00	34.40	5.53	5
132.00	33.54	33.54	0.00	Overtopping

Table 2 - Culvert Summary Table: Proposed 24

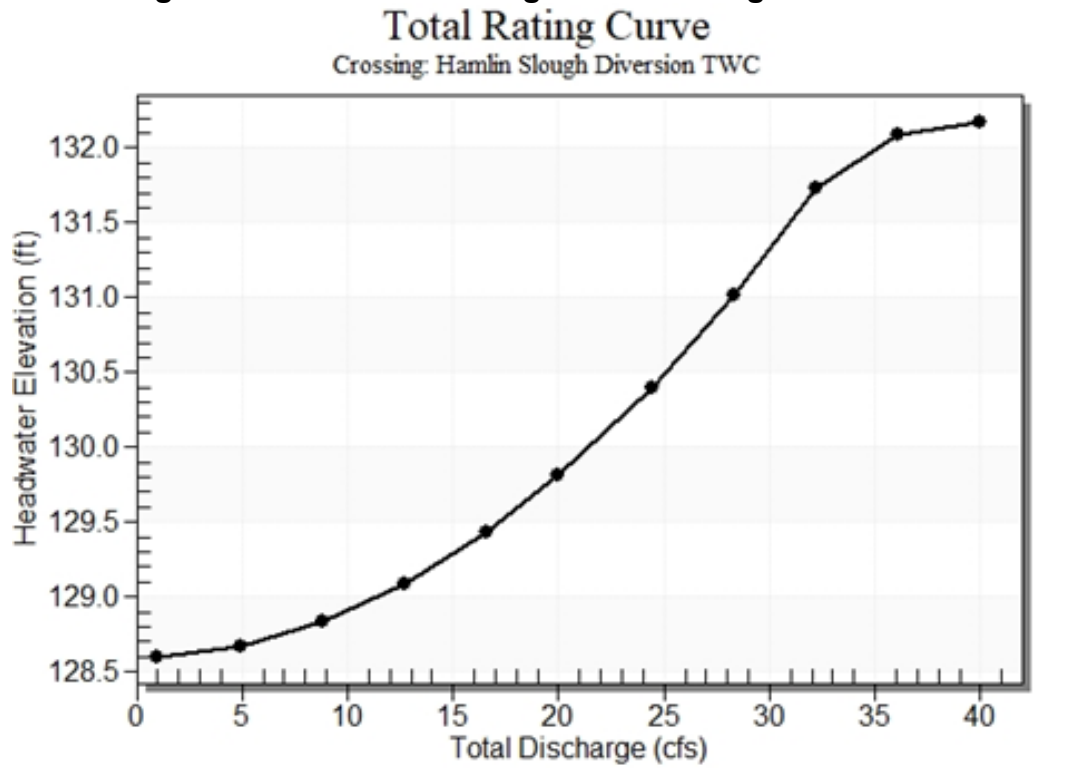
Total Discharge (cfs)	Culvert Discharge (cfs)	Headwater Elevation (ft)	Inlet Control Depth (ft)	Outlet Control Depth (ft)	Flow Type	Normal Depth (ft)	Critical Depth (ft)	Outlet Depth (ft)	Tailwater Depth (ft)	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)
1.00	1.00	128.60	0.471	2.803	4-FFf	-1.000	0.340	2.000	2.800	0.318	0.000
4.90	4.90	128.67	1.098	2.873	4-FFf	-1.000	0.774	2.000	2.800	1.560	0.000
8.80	8.80	128.83	1.577	3.034	4-FFf	-1.000	1.057	2.000	2.800	2.801	0.000
12.70	12.70	129.09	1.996	3.287	4-FFf	-1.000	1.279	2.000	2.800	4.043	0.000
16.60	16.60	129.43	2.458	3.633	4-FFf	-1.000	1.467	2.000	2.800	5.284	0.000
20.00	20.00	129.81	2.944	4.009	4-FFf	-1.000	1.604	2.000	2.800	6.366	0.000
24.40	24.40	130.40	3.718	4.599	4-FFf	-1.000	1.746	2.000	2.800	7.767	0.000
28.30	28.30	131.02	4.550	5.220	4-FFf	-1.000	1.834	2.000	2.800	9.008	0.000
32.20	32.20	131.73	5.511	5.934	4-FFf	-1.000	1.896	2.000	2.800	10.250	0.000
36.10	33.99	132.09	5.993	6.293	4-FFf	-1.000	1.906	2.000	2.800	10.821	0.000
40.00	34.40	132.18	6.111	6.377	4-FFf	-1.000	1.880	2.000	2.800	10.951	0.000

Table 3 - Downstream Channel Rating Curve (Crossing: Hamlin Slough Diversion TWC)

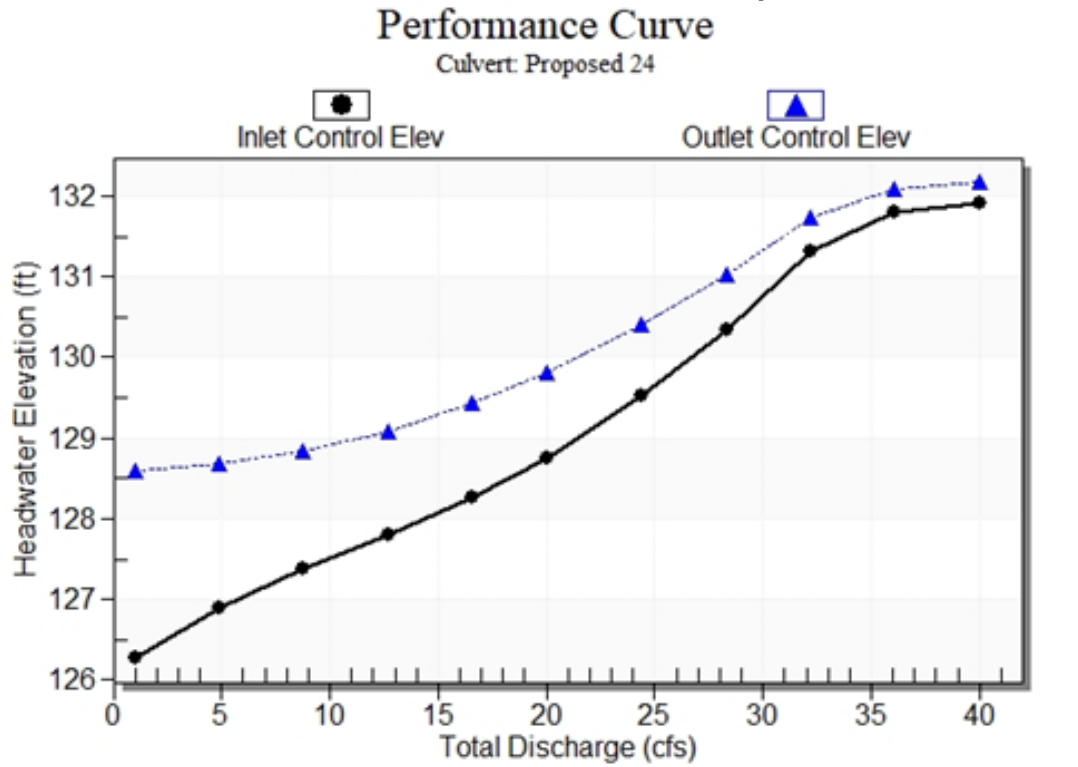
Flow (cfs)	Water Surface Elev (ft)	Depth (ft)
1.00	128.60	2.80
4.90	128.60	2.80
8.80	128.60	2.80
12.70	128.60	2.80
16.60	128.60	2.80
20.00	128.60	2.80
24.40	128.60	2.80
28.30	128.60	2.80
32.20	128.60	2.80
36.10	128.60	2.80
40.00	128.60	2.80

Hamlin Slough Diversion

Rating Curve Plot for Crossing: Hamlin Slough Diversion TWC



Culvert Performance Curve Plot: Proposed 24

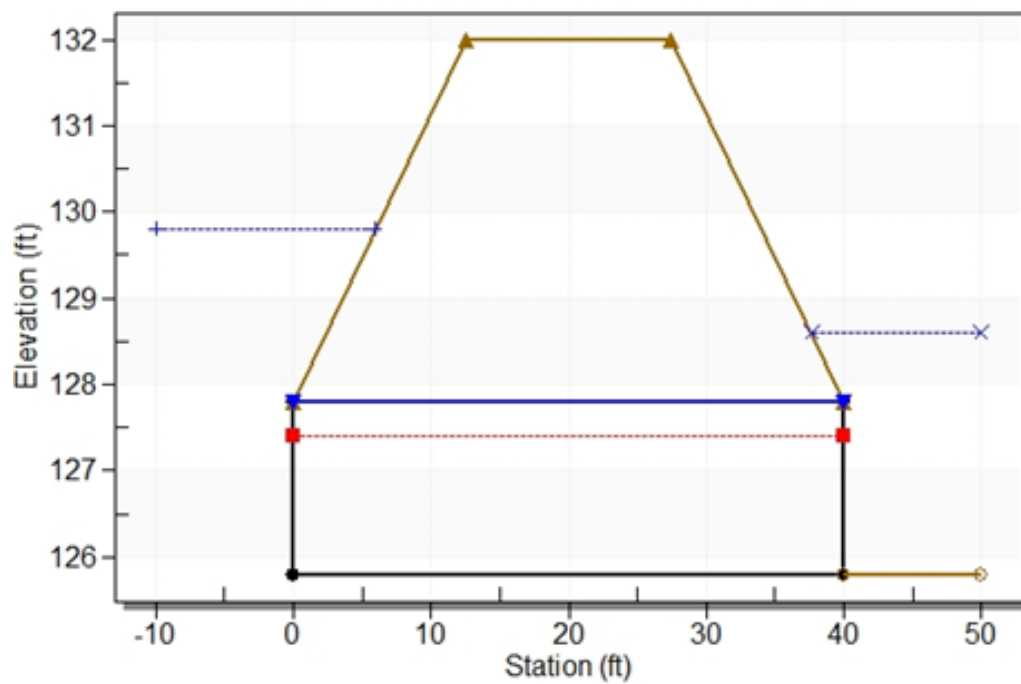


Hamlin Slough Diversion

Water Surface Profile Plot for Culvert: Proposed 24

Crossing - Hamlin Slough Diversion TWC, Design Discharge - 20.0 cfs

Culvert - Proposed 24, Culvert Discharge - 20.0 cfs



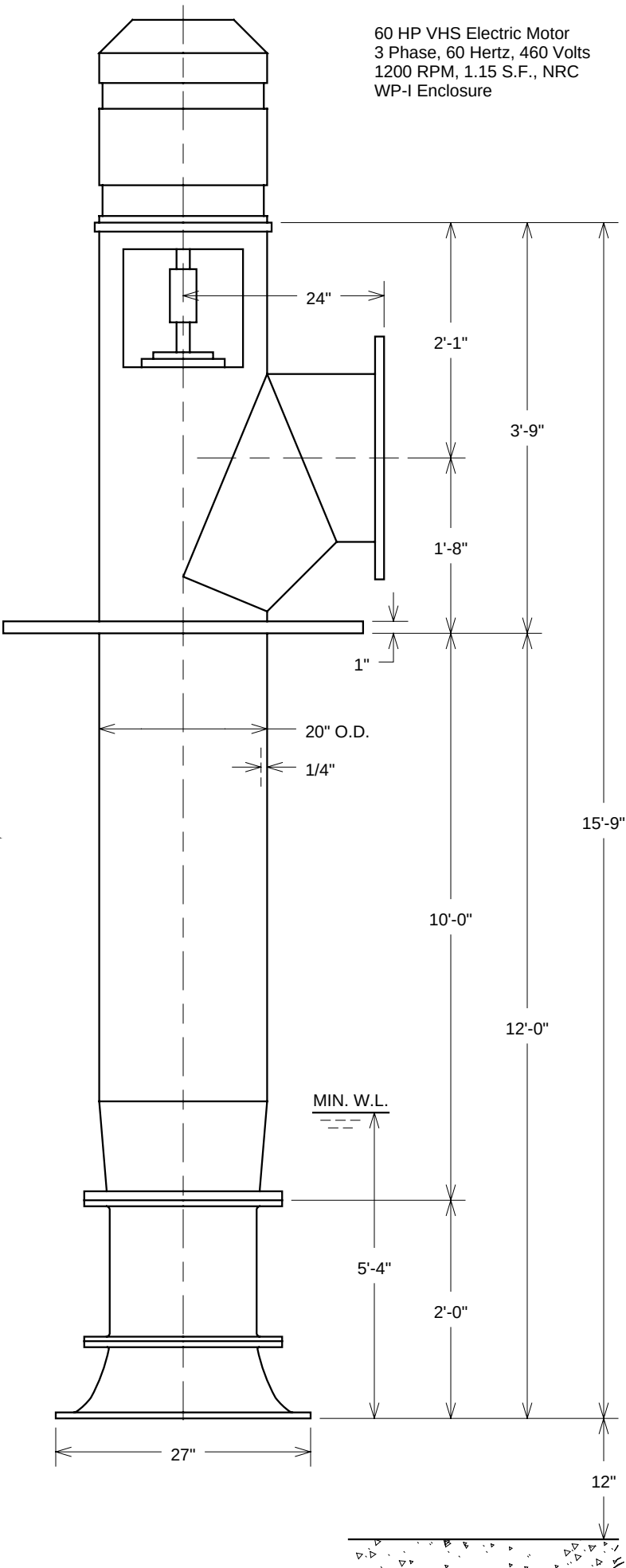
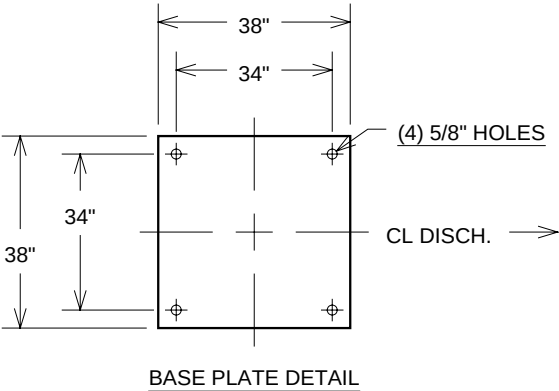
ATTACHMENT D

Preliminary Pump Selection, Curves, and Quotes

Hamlin Slough
New Lift Station

Oil Lubrication

60 HP VHS Electric Motor
3 Phase, 60 Hertz, 460 Volts
1200 RPM, 1.15 S.F., NRC
WP-I Enclosure



Customer Name: G3 ENGINEERING / GEOSYNTEC CONSULTANTS

Job Name: BUTTE COUNTY IRRIGATION PROJECT
PUMP LS-G3

CASCADE PUMP COMPANY
SANTA FE SPRINGS, CALIFORNIA

#16AF Axial Flow Pump
20"-125# ASA Flanged Discharge

DATE	09/16/25	SCALE	NONE
DRAWN	DMT	CHECKED	
CQ2761-A			

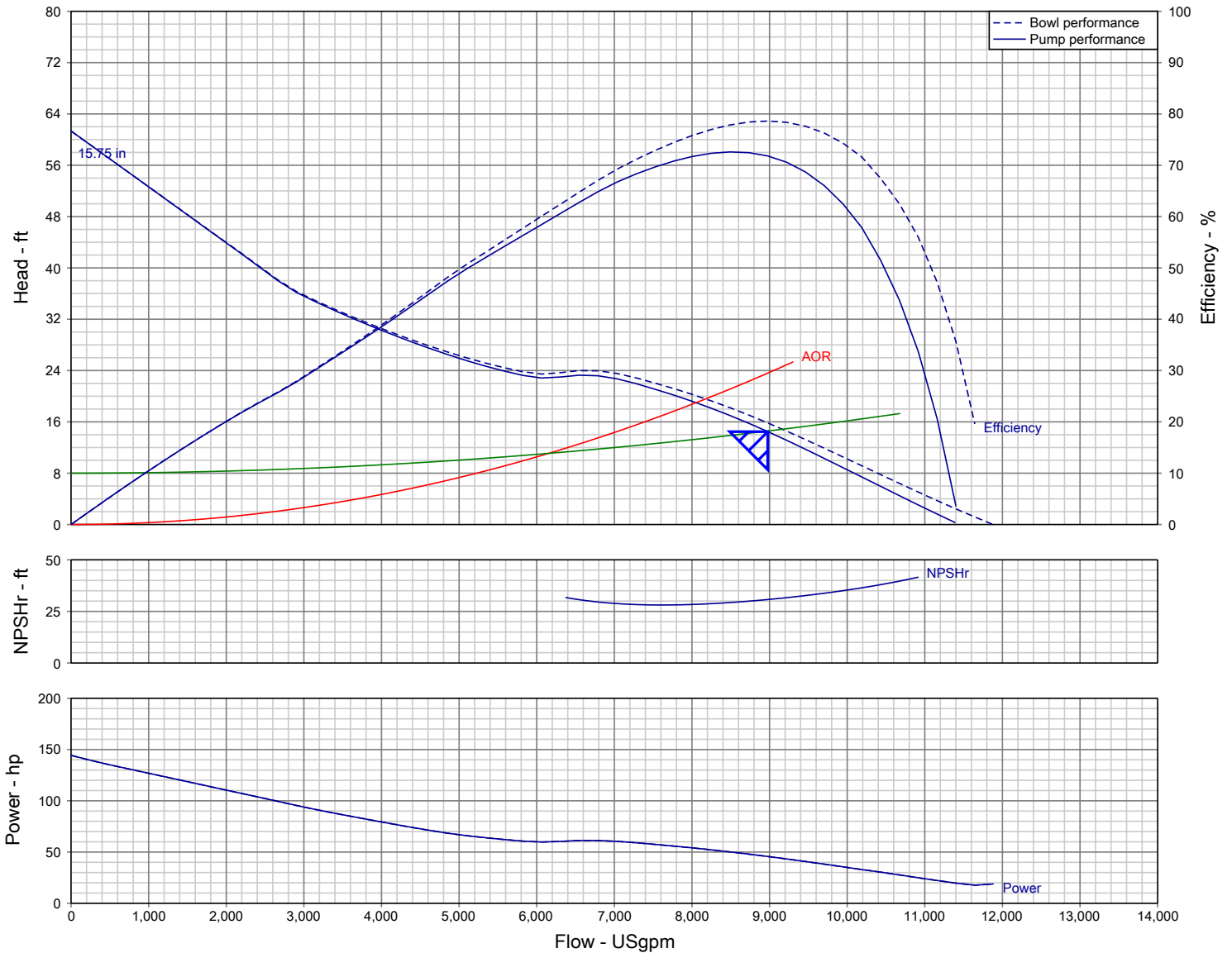


CASCADE PUMP COMPANY

Customer : G3 ENGINEERING, INC.
Customer Reference :
Job Name : Butte County Irr Project
Pump LS-G3

Pump Model : 16AF_RPM1190
Quote/Serial No. : CQ2761

Pump and bowl (dashed) performance.



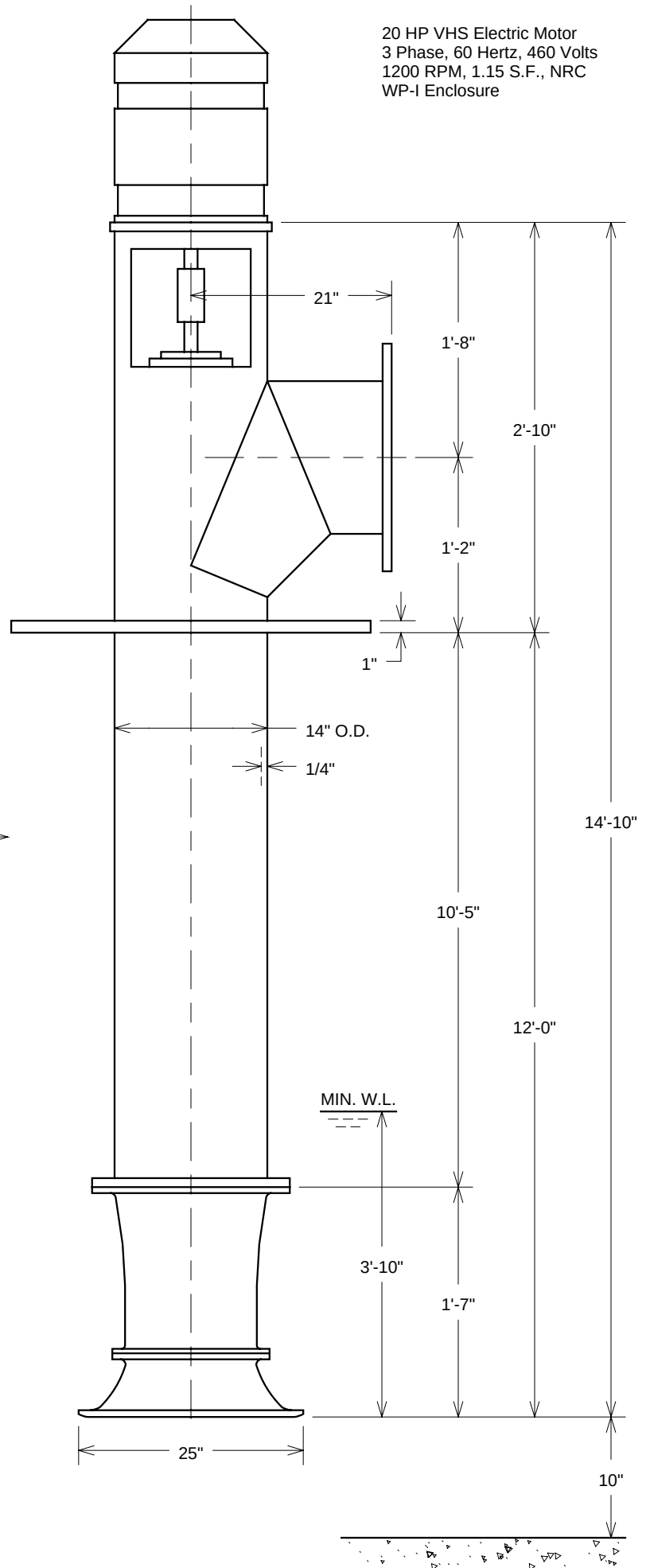
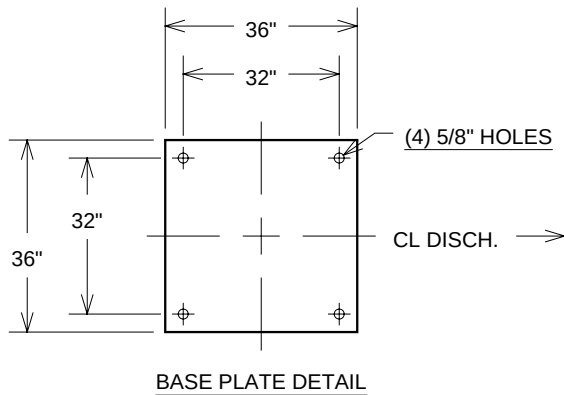
Curves show approximately the characteristics when pumping clear non-aerated water. No guarantee is made except for the rated point.

Quantity	: 1	Stages	: 1
Flow, rated	: 8,976.0 USgpm	Speed, rated	: 1190 rpm
Differential head / pressure, rated / TDH	: 14.47 ft	Efficiency (bowl / pump)	: 78.62 / 71.81 %
Fluid density, rated / max	: 1.000 / 1.000 SG	Power, rated	: 45.66 hp
Date	: 09/15/2025	NPSH required	: 30.75 ft
Item Number	: A		
Application	:		

East Cherokee Strip Center Pump Replacement

Oil Lubrication

20 HP VHS Electric Motor
3 Phase, 60 Hertz, 460 Volts
1200 RPM, 1.15 S.F., NRC
WP-I Enclosure



Customer Name: G3 ENGINEERING / GEOSYNTEC CONSULTANTS

Job Name: BUTTE COUNTY IRRIGATION PROJECT
PUMP LS-LC

CASCADE PUMP COMPANY
SANTA FE SPRINGS, CALIFORNIA

#14AP Propeller Pump
14"-125# ASA Flanged Discharge

DATE 09/22/25 SCALE NONE

DRAWN DMT CHECKED

CQ2761-E

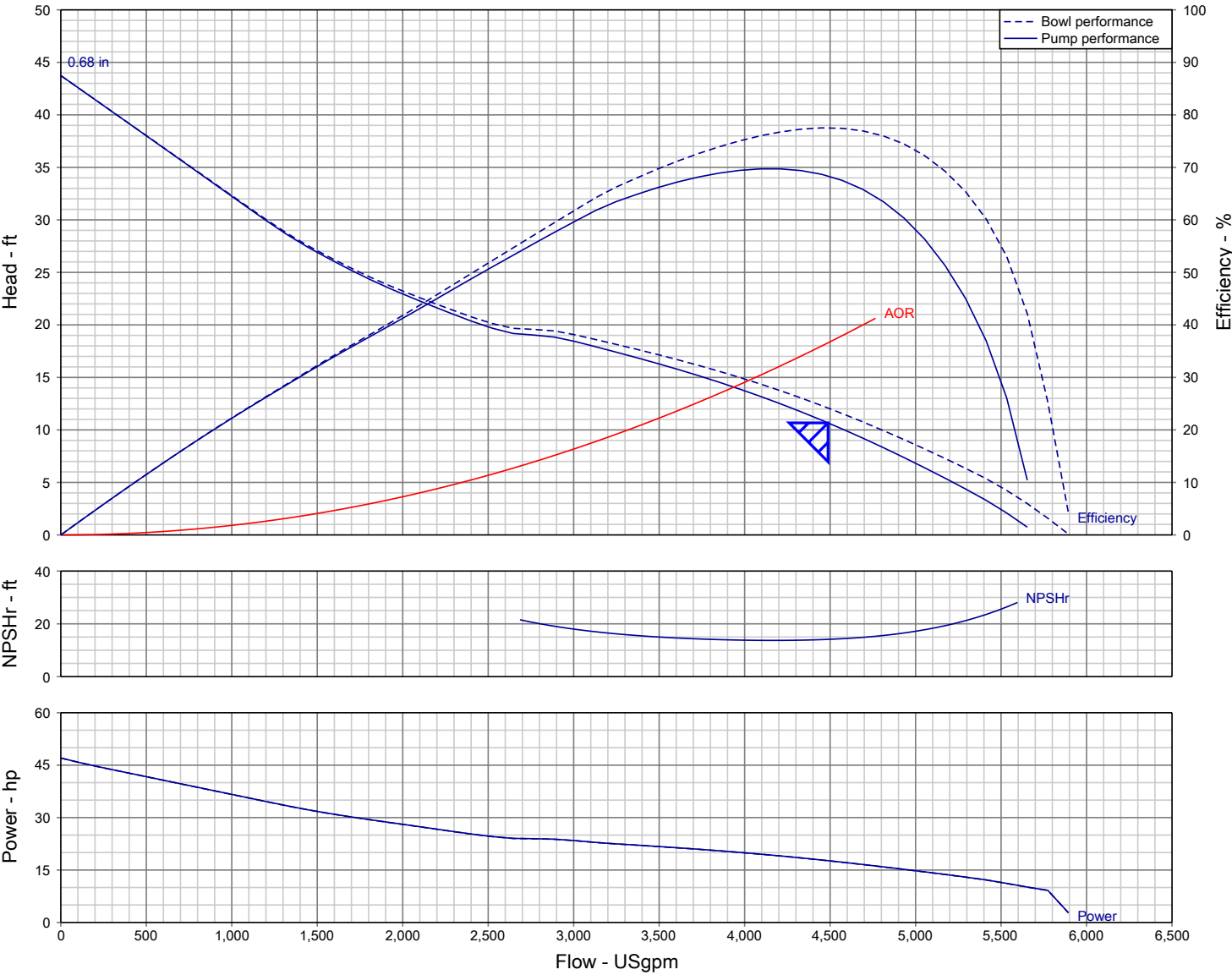


CASCADE PUMP COMPANY

Customer : G3 ENGINEERING, INC.
Customer Reference :
Job Name : Butte County Irr Project
Pump LS-LC

Pump Model : 14AP_RPM1175
Quote/Serial No. : CQ2761

Pump and bowl (dashed) performance.



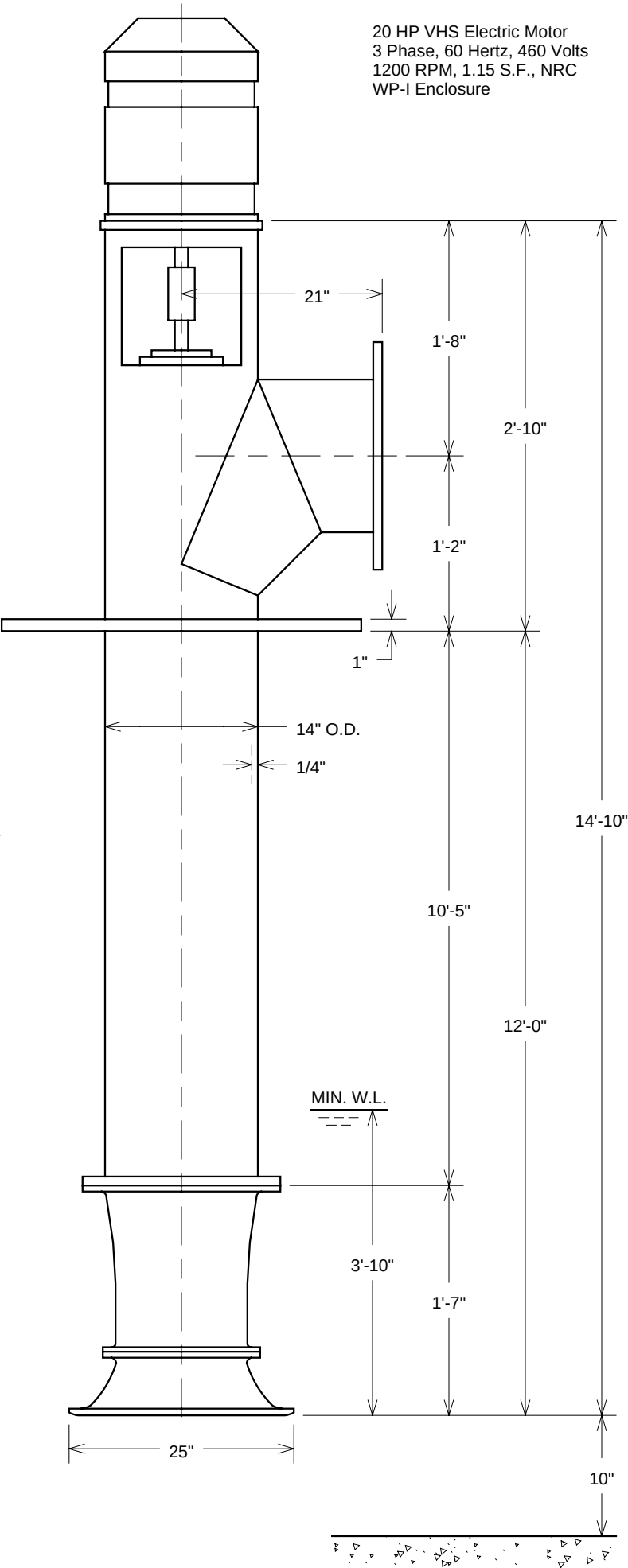
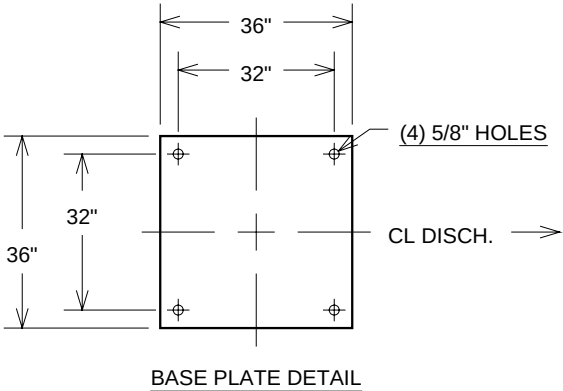
Curves show approximately the characteristics when pumping clear non-aerated water. No guarantee is made except for the rated point.

Quantity	: 1	Stages	: 1
Flow, rated	: 4,488.0 USgpm	Speed, rated	: 1175 rpm
Differential head / pressure, rated / TDH	: 10.67 ft	Efficiency (bowl / pump)	: 77.53 / 68.37 %
Fluid density, rated / max	: 1.000 / 1.000 SG	Power, rated	: 17.66 hp
Date	: 09/22/2025	NPSH required	: 14.11 ft
Item Number	: E		
Application	:		

East Cherokee Strip

East Pump Replacement

Oil Lubrication



Customer Name: G3 ENGINEERING / GEOSYNTEC CONSULTANTS
Job Name: BUTTE COUNTY IRRIGATION PROJECT
PUMP LS-LE

CASCADE PUMP COMPANY
SANTA FE SPRINGS, CALIFORNIA

#14AP Propeller Pump
14"-125# ASA Flanged Discharge

DATE	09/22/25	SCALE	NONE
DRAWN	DMT	CHECKED	
CQ2761-F			



East Cherokee Strip
East Pump Replacement

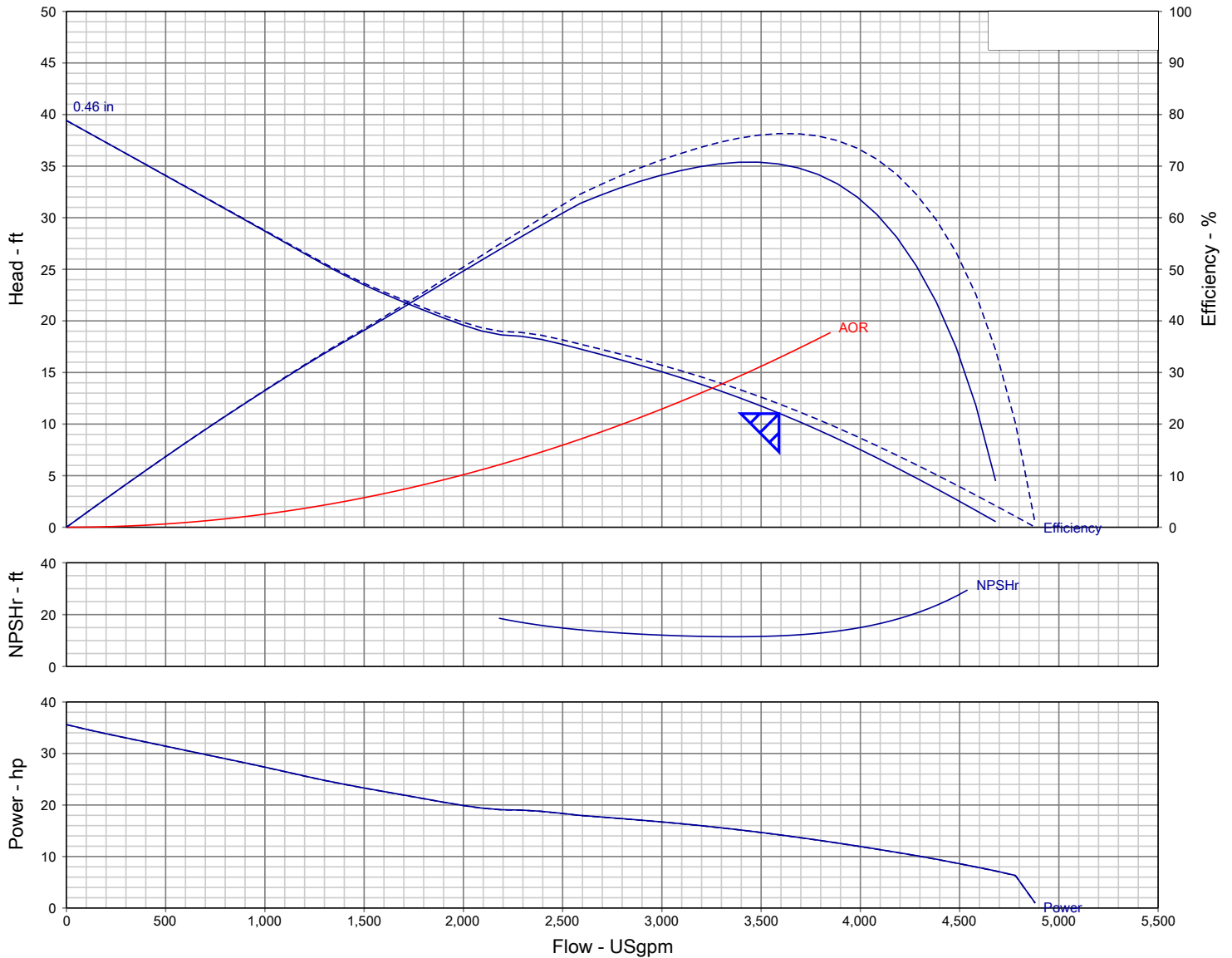
Pump and Bowl Performance Curve
Page 1 of 1

CASCADE PUMP COMPANY

Customer : G3 ENGINEERING, INC.
Customer Reference :
Job Name : Butte County Irr Project
Pump LS-LE

Pump Model : 14AP_RPM1175
Quote/Serial No. : CQ2761

Pump and bowl (dashed) performance.



Curves show approximately the characteristics when pumping clear non-aerated water. No guarantee is made except for the rated point.

Quantity	: 1	Stages	: 1
Flow, rated	: 3,590.0 USgpm	Speed, rated	: 1175 rpm
Differential head / pressure, rated / TDH	: 11.01 ft	Efficiency (bowl / pump)	: 76.31 / 70.41 %
Fluid density, rated / max	: 1.000 / 1.000 SG	Power, rated	: 14.21 hp
Date	: 09/22/2025	NPSH required	: 11.81 ft
Item Number	: F		
Application	:		

40 HP VHS Electric Motor
3 Phase, 60 Hertz, 460 Volts
1200 RPM, 1.15 S.F., NRC
WP-I Enclosure

40 HP VHS Electric Motor
3 Phase, 60 Hertz, 460 Volts
1200 RPM, 1.15 S.F., NRC
WP-I Enclosure

22"

2'-0"

3'-6"

1'-6"

1"

18" O.D.

1/4"

15'-6"

10'-0"

12'-0"

MIN. W.L.

4'-7"

2'-0"

27"

12"

Technical drawing of a square plate with the following specifications:

- Overall width: 38"
- Overall height: 38"
- Distance between hole centers (pitch): 34"
- Number of holes: (4) 5/8" HOLES
- Reference: CL DISCH. →

CASCADE PUMP COMPANY
SANTA FE SPRINGS, CALIFORNIA

DATE	09/22/25	SCALE	NONE
------	----------	-------	------

CHECKED

CQ2761-G

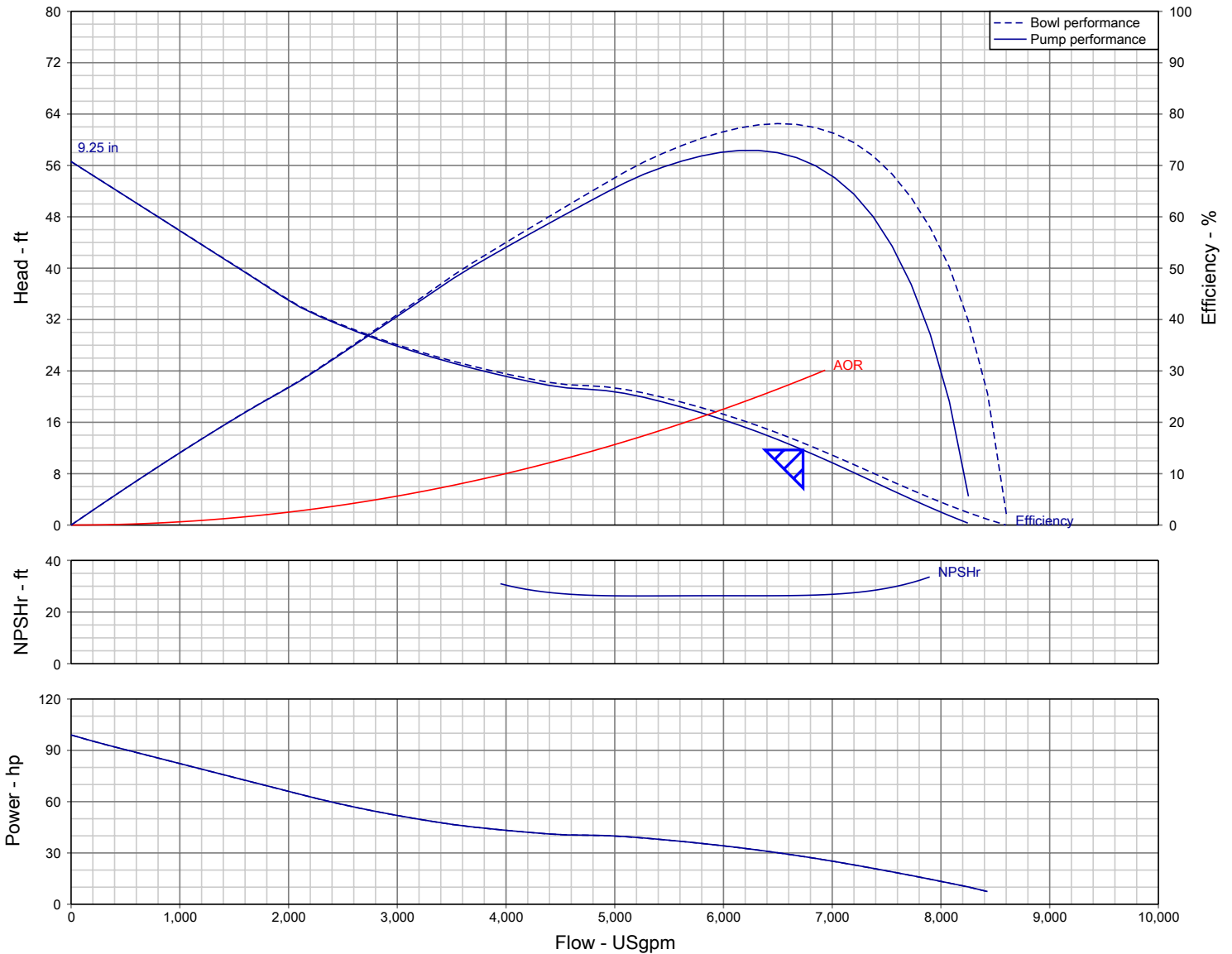


CASCADE PUMP COMPANY

Customer : G3 ENGINEERING, INC.
Customer Reference :
Job Name : Butte County Irr Project
Pump LS-LW

Pump Model : 16AF_RPM1190
Quote/Serial No. : CQ2761

Pump and bowl (dashed) performance.



Curves show approximately the characteristics when pumping clear non-aerated water. No guarantee is made except for the rated point.

Quantity	: 1	Stages	: 1
Flow, rated	: 6,732.0 USgpm	Speed, rated	: 1190 rpm
Differential head / pressure, rated / TDH	: 11.69 ft	Efficiency (bowl / pump)	: 77.83 / 71.05 %
Fluid density, rated / max	: 1.000 / 1.000 SG	Power, rated	: 27.93 hp
Date	: 09/22/2025	NPSH required	: 26.45 ft
Item Number	: G		
Application	:		



West Cherokee Strip Pump Upgrade

Pump and Bowl Performance Curve

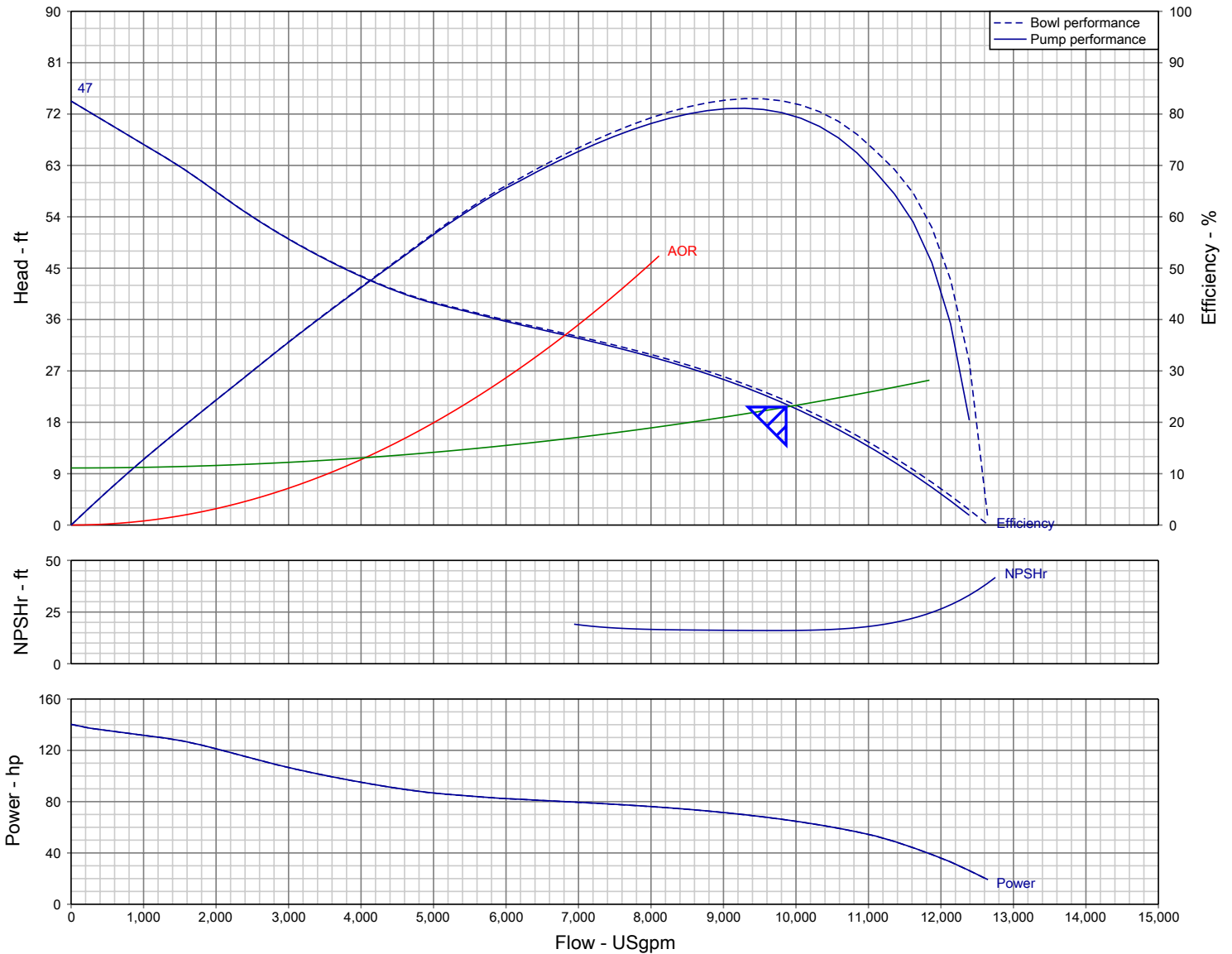
Page 1 of 1

CASCADE PUMP COMPANY

Customer : G3 ENGINEERING, INC.
Customer Reference :
Job Name : Butte County Irr Project
Pump LS-SM

Pump Model : 20MF_AA4_B_RPM890
Quote/Serial No. : CQ2761

Pump and bowl (dashed) performance.



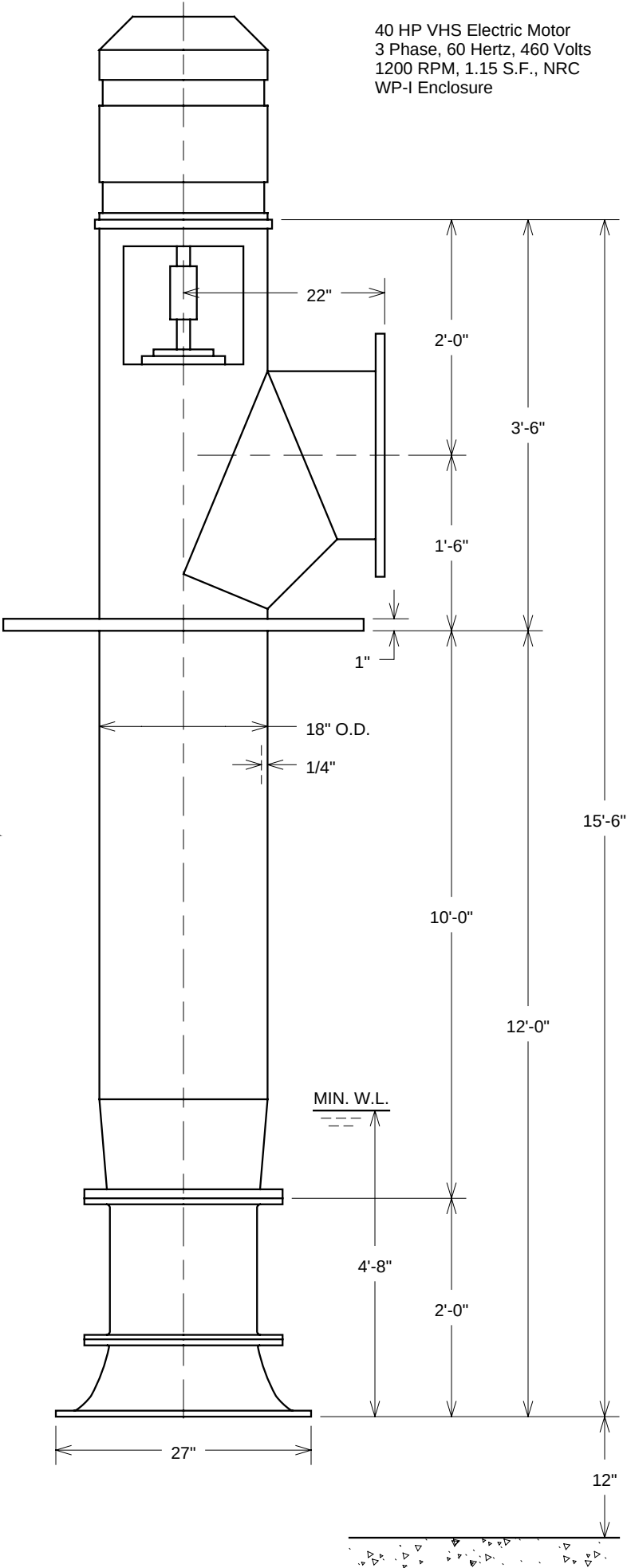
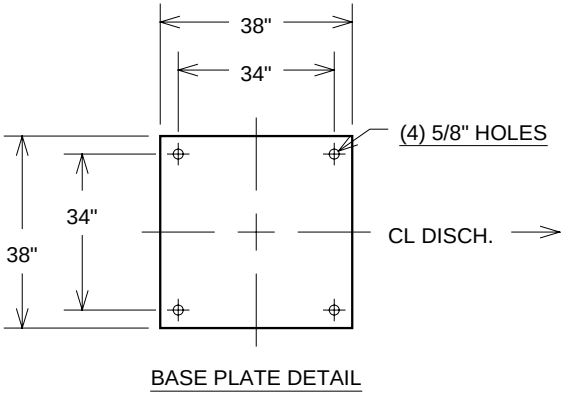
Curves show approximately the characteristics when pumping clear non-aerated water. No guarantee is made except for the rated point.

Quantity	: 1	Stages	: 1
Flow, rated	: 9,864.0 USgpm	Speed, rated	: 890 rpm
Differential head / pressure, rated / TDH	: 20.67 ft	Efficiency (bowl / pump)	: 82.43 / 80.07 %
Fluid density, rated / max	: 1.000 / 1.000 SG	Power, rated	: 65.76 hp
Date	: 09/15/2025	NPSH required	: 16.07 ft
Item Number	: B		
Application	:		

West Cherokee Strip

New Lift Station 1

Oil Lubrication



Customer Name: G3 ENGINEERING / GEOSYNTEC CONSULTANTS
Job Name: BUTTE COUNTY IRRIGATION PROJECT
PUMP LS-S1

CASCADE PUMP COMPANY			
SANTA FE SPRINGS, CALIFORNIA			
#16AF Axial Flow Pump			
18"-125# ASA Flanged Discharge			
DATE	09/16/25	SCALE	NONE
DRAWN	DMT	CHECKED	
CQ2761-C			

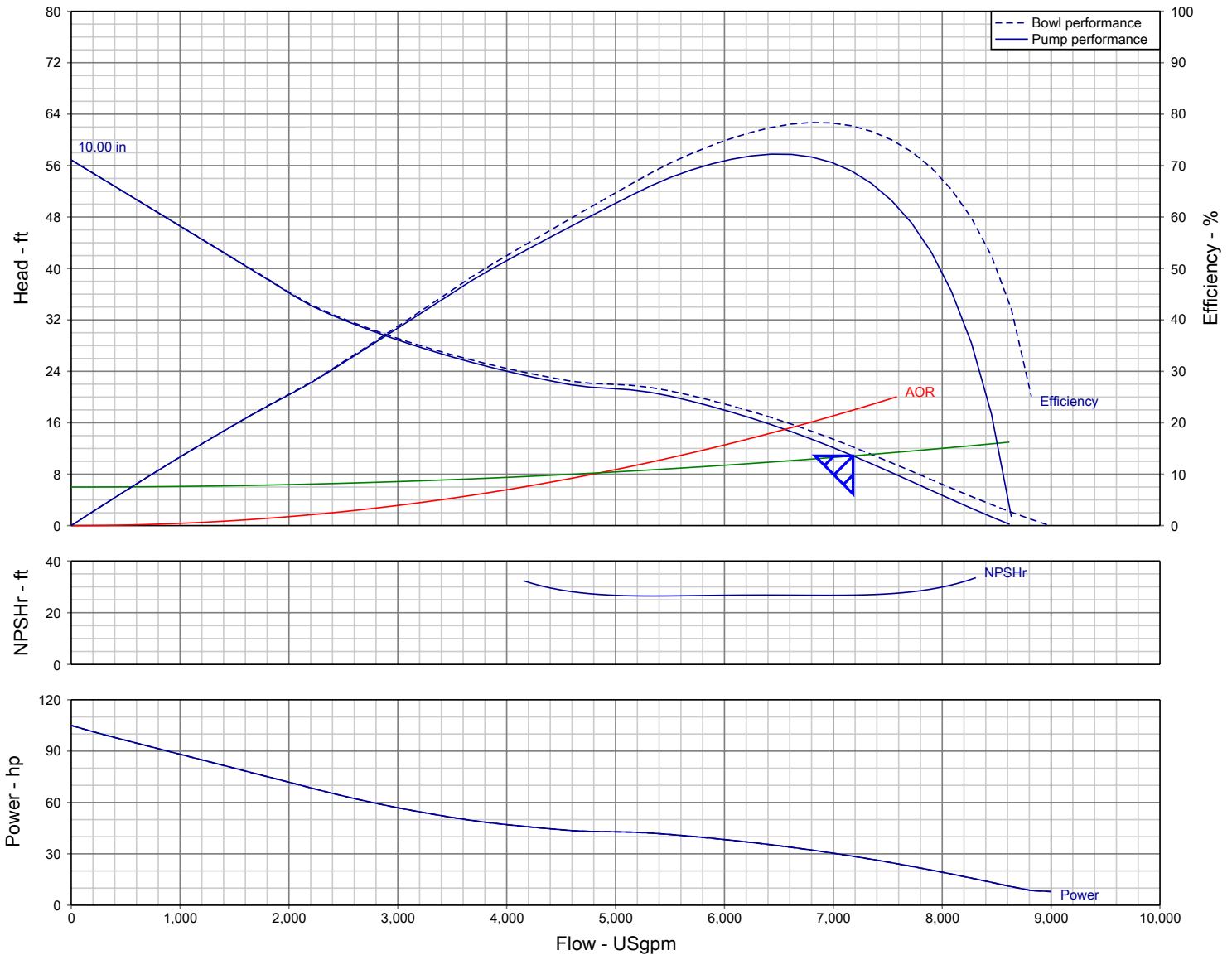


CASCADE PUMP COMPANY

Customer : G3 ENGINEERING, INC.
Customer Reference :
Job Name : Butte County Irr Project
Pump LS-S1

Pump Model : 16AF_RPM1190
Quote/Serial No. : CQ2761

Pump and bowl (dashed) performance.



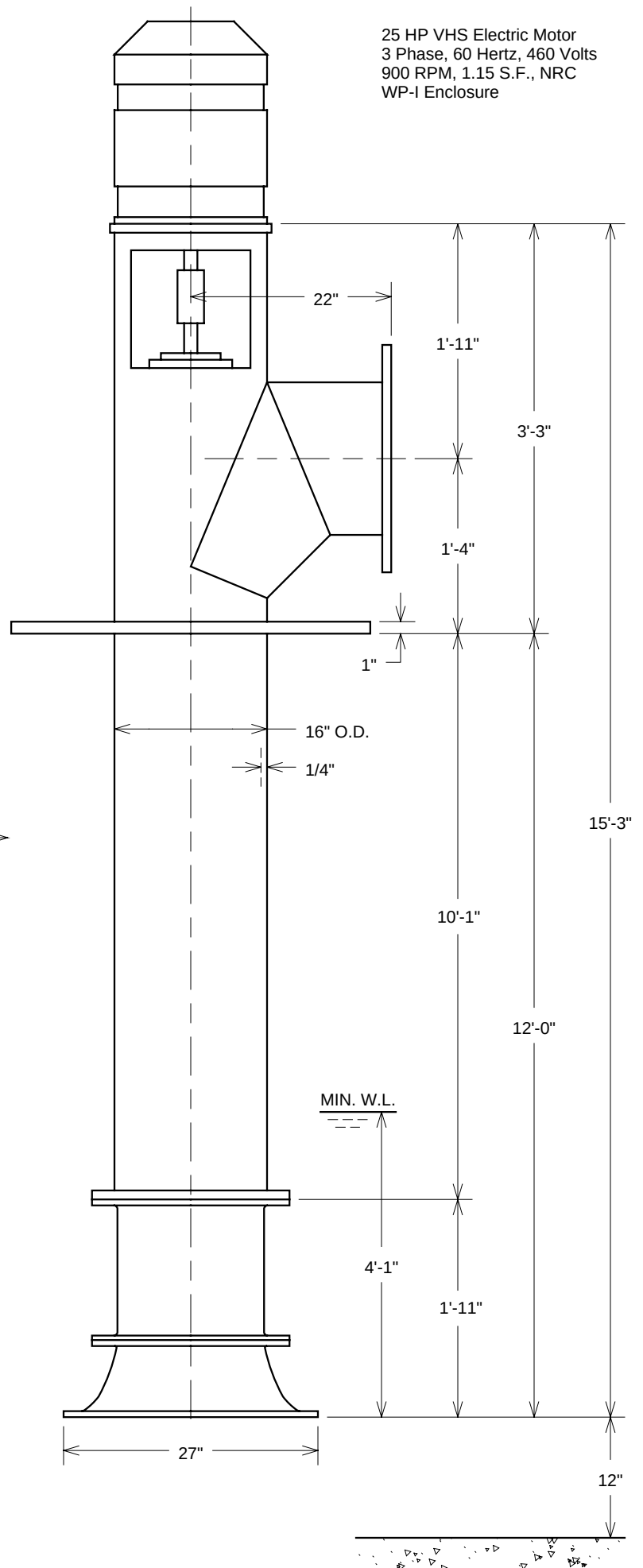
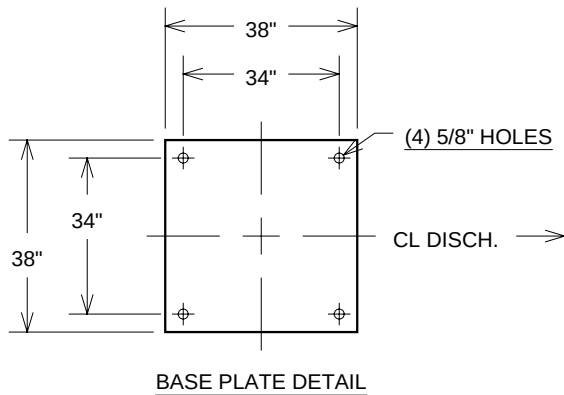
Curves show approximately the characteristics when pumping clear non-aerated water. No guarantee is made except for the rated point.

Quantity	: 1	Stages	: 1
Flow, rated	: 7,181.0 USgpm	Speed, rated	: 1190 rpm
Differential head / pressure, rated / TDH	: 10.85 ft	Efficiency (bowl / pump)	: 77.67 / 68.79 %
Fluid density, rated / max	: 1.000 / 1.000 SG	Power, rated	: 28.56 hp
Date	: 09/15/2025	NPSH required	: 26.81 ft
Item Number	: C		
Application	:		

West Cherokee Strip New Lift Station 2-4

Oil Lubrication

25 HP VHS Electric Motor
3 Phase, 60 Hertz, 460 Volts
900 RPM, 1.15 S.F., NRC
WP-I Enclosure



Customer Name: G3 ENGINEERING / GEOSYNTEC CONSULTANTS

**Job Name: BUTTE COUNTY IRRIGATION PROJECT
PUMPS LS-S2 / S3 / S4**

CASCADE PUMP COMPANY
SANTA FE SPRINGS, CALIFORNIA

#16AM Pump
16"-125# ASA Flanged Discharge

DATE	09/16/25	SCALE	NONE	
DRAWN		CHECKED		
DMT				CQ2761-D

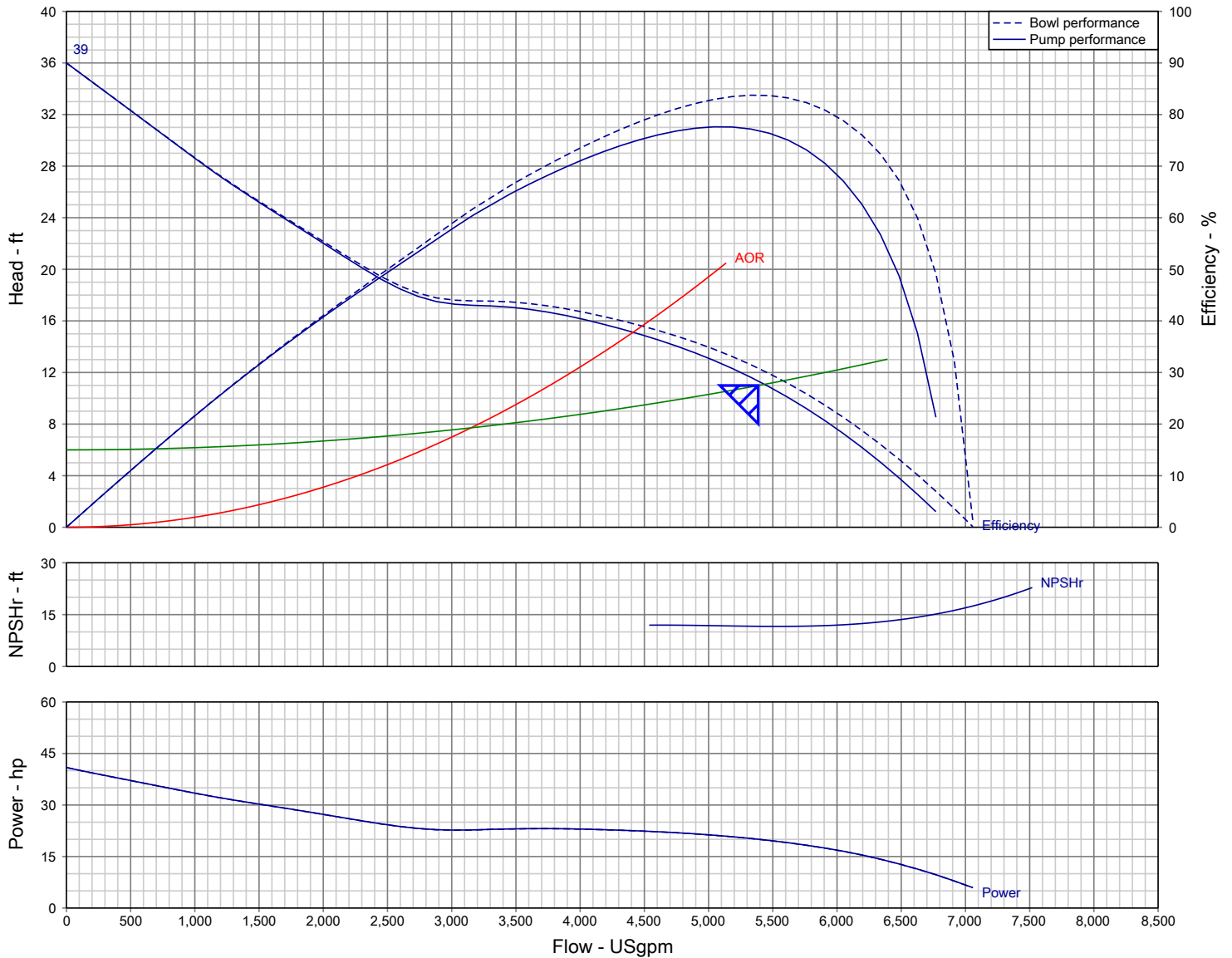


CASCADE PUMP COMPANY

Customer : G3 ENGINEERING, INC.
Customer Reference :
Job Name : Butte County Irr Project
Pump LS-S2/S3/S4

Pump Model : 16AM_A5_B_RPM890
Quote/Serial No. : CQ2761

Pump and bowl (dashed) performance.



Curves show approximately the characteristics when pumping clear non-aerated water. No guarantee is made except for the rated point.

Quantity	: 1	Stages	: 1
Flow, rated	: 5,386.0 USgpm	Speed, rated	: 890 rpm
Differential head / pressure, rated / TDH	: 10.99 ft	Efficiency (bowl / pump)	: 83.76 / 76.92 %
Fluid density, rated / max	: 1.000 / 1.000 SG	Power, rated	: 20.02 hp
Date	: 09/15/2025	NPSH required	: 11.61 ft
Item Number	: D		
Application	:		

G3 Engineering, Inc.

P.O. Box 2148
Granite Bay, CA 95746
Phone: (925) 765-8015
Email: m.kheir@g3engineering.com

Quotation

Date: 9/25/2025
Quotation #: 1058
Revision: 0

Attention: Donnie Land
Reference: Geosyntec Consultants
Subject: Butte County Irrigation Project

Item	Qty	Description	Unit Price	Net Price
1	1	Pump ID LS-G3 16AF 1-stage with 20" above base discharge COS - 8,976 gpm @ 14.47' TDH Motor: 60 HP, 1200 RPM <i>Weights - Pump: 2,750 lbs. (dry weight) / Motor: 1,090 lbs.</i>	\$115,300.00	\$115,300.00
2	1	Pump ID LS-SM 20MF 1-stage with 20" above base discharge COS - 9,864 gpm @ 20.67' TDH Motor: 75 HP, 900 RPM motor <i>Weights - Pump: 3,600 lbs. (dry weight) / Motor: 2,230 lbs.</i>	\$147,800.00	\$147,800.00
3	1	PUMP ID LS-S1 16AF 1-stage with 18" above base discharge COS - 7,181 gpm @ 10.85' TDH Motor: 40 HP, 1200 RPM <i>Weights - Pump: 2,600 lbs. (dry weight) / Motor: 800 lbs.</i>	\$105,800.00	\$105,800.00
4	3	PUMP IDs LS-S2/S3/S4 16AM 1-stage with 16" above base discharge COS - 5,368 gpm @ 10.99' TDH Motor: 250 HP, 900 RPM <i>Weights - Pump: 2,750 lbs. (dry weight) / Motor: 690 lbs.</i>	\$101,600.00	\$304,800.00
5	1	PUMP ID LS-LC 14AP 1-stage with 14" above base discharge COS - 4,488 gpm @ 10.67' TDH Motor: 20 HP, 1200 RPM <i>Weights - Pump: 1,850 lbs. (dry weight) / Motor: 380 lbs.</i>	\$94,900.00	\$94,900.00
6	1	PUMP ID LS-LE 14AP 1-stage with 14" above base discharge COS - 3,590 gpm @ 11.01' TDH Motor: 20 HP, 1200 RPM <i>Weights - Pump: 1,850 lbs. (dry weight) / Motor: 380 lbs.</i>	\$94,900.00	\$94,900.00
7	1	PUMP ID LS-LW 16AF 1-stage with 18" above base discharge COS - 6,732 gpm @ 11.69' TDH Motor: 40 HP, 1200 RPM <i>Weights - Pump: 2,450 lbs. (dry weight) / Motor: 800 lbs.</i>	\$115,300.00	\$115,300.00
			Subtotal:	\$978,800.00

Budget Prices above include the following:

PUMP

- Enclosed Lineshaft Oil Lubricated with 1-Gal Oiler + TBDv Solenoid Valve
- Grease-Packed Suction Bowl Bushing
- Seismic / Anchor calcs (note that existing anchor bolts, if any, may not meet UBC requirements)
- Dynamically balanced bronze impeller
- Stainless Steel bolting
- 416 Stainless Steel Bowl Shaft
- 416 Stainless Steel Lineshaft with threaded / keyed Lineshaft couplings
- AWWA Class D Flat-Faced Flanged Discharge
- Headshaft and adjusting nut for VHS driver
- Epoxy Paint (Carboline Hydroplate 1086 or equal)
- N/W Perf test of job bowl assy with lab motor/elbow in accordance with H.I. 14.6, test grade 2B
- All other pump features/materials per Cascade's std design.
- Dimensions per attached outline drawings CQ2761-A / B / C / D
- Performance per attached predicted performance curves CQ2761-A / B / C / D

MOTOR

- 460/3/60
- VHS
- WP-I enclosure
- Constant Speed
- +40°C
- Premium Eff
- Thermostats
- Space Heaters
- 1.15 SF on sine wave power
- Non-Reverse Ratchet
- Routine Test

Terms:

- 1) All pricing is budgetary.
- 2) Pricing does not include sales tax.
- 3) Payment terms are net 30 days after shipment.
- 4) Purchase order shall be made out to G3 Engineering, Inc.
- 5) Items not specifically listed on this quote are not included in the scope and are to be supplied by others. Quote is furnish only, installation is not included.
Sale is subject to G3 Engineering, Inc. standard terms and conditions.

ATTACHMENT E

Site Specific ROM Cost Estimates

Project: Vina Subbasin Improvements
Project Number: SF0154C
Completed by: Donnie Land
Date: 9/25/2025



1111 Broadway, 6th Floor
Oakland, CA 94607

HAMLIN SLOUGH NEW LIFT STATION ROUGH ORDER OF MAGNITUDE COST ESTIMATE					
Item	Quantity	Unit	Unit Cost	Total	Assumptions
Mobilization	1	LS	\$ 13,884	\$ 13,900	0% to 7% of construction costs, used 3%
Temporary Flow Diversion & Groundwater Dewatering	1	LS	\$ 20,000	\$ 20,000	Dewatering for dry weather flows and groundwater up to 15 ft deep in 20 ft deep excavation(s)
Pump Station	1	LS	\$ 267,044	\$ 267,000	8' Wide, 8' long, 16' deep cast-in-place, steel reinforced pump station with 20 cfs axial flow pump and motor. Includes excavation, shoring, installation, backfill, compaction, pipe manifold, and assembly.
24" Ductile Iron Pipe	45	LF	\$ 676	\$ 30,400	Excavation up to 6' deep, bedding material, 24-inch ductile iron pipe installation, flap gate, backfill, haul-off and site restoration
Saddle Flow Meter	5	EA	\$ 5,000	\$ 25,000	Cost provided by WCWD
Technoflo Open Flow Meter	3	EA	\$ 4,000	\$ 12,000	Cost provided by WCWD
Precast Concrete Headwall	1	LS	\$ 11,905	\$ 11,900	Excavation up to 6' deep, bedding material, precast concrete headwall installation, backfill, haul-off and site restoration.
Flap Gate	1	EA	\$ 3,000	\$ 3,000	Materials, delivery, and installation.
Electrical Power Supply	1	LS	\$ 93,466	\$ 93,500	New electrical service power supply, control center, and PLC for pump station. 35% of pump station cost.
Construction Subtotal				\$ 477,000	
Design, Construction, and Commissioning Support				\$ 48,000	10-20% of Construction Subtotal, used 10%
General Conditions and Requirements				\$ 24,000	5-10% of Construction Subtotal, used 5%
Permit Allowances				\$ 10,000	0% to 3% of Construction Subtotal, used 2%
Total Estimated Project Construction Cost				\$ 559,000	
AACE International Class 5 Estimate - High Cost (+50%)				\$ 839,000	
AACE International Class 5 Estimate - Low Cost (-25%)				\$ 419,000	

Project: Vina Subbasin Improvements
Project Number: SF0154C
Completed by: Donnie Land
Date: 9/25/2025



1111 Broadway, 6th Floor
Oakland, CA 94607

HAMLIN SLOUGH NEW CULVERT ROUGH ORDER OF MAGNITUDE COST ESTIMATE					
Item	Quantity	Unit	Unit Cost	Total	Assumptions
Mobilization	1	LS	\$ 6,335	\$ 6,300	0% to 7% of construction costs, used 5%
Temporary Flow Diversion & Groundwater Dewatering	1	LS	\$ 25,000	\$ 25,000	Dewatering and water exclusion zone, including groundwater up to 3 ft deep in 10 ft deep excavation.
24" Reinforced Concrete Pipe	40	LF	\$ 974	\$ 39,000	Excavation up to 10' deep, trenching, bedding material, 24-inch reinforced concrete pipe installation, backfill, haul-off and site restoration.
Technoflo Open Flow Meter	1	EA	\$ 4,000	\$ 4,000	Cost provided by WCWD
Precast Concrete Headwall	2	EA	\$ 14,196	\$ 28,400	Excavation up to 10' deep, bedding material, precast concrete headwall installation, backfill, haul-off and site restoration.
Fabricated 24"x24" SS Slide Gate	1	EA	\$ 27,561	\$ 27,600	Materials, delivery, crane support, labor, and installation.
Riprap Energy Dissipater	6	CY	\$ 450	\$ 2,700	Class I riprap.
Construction Subtotal				\$ 133,000	
Design, Construction, and Commissioning Support				\$ 40,000	10-30% of Construction Subtotal, used 30% for smaller project
General Conditions and Requirements				\$ 13,000	5-10% of Construction Subtotal, used 10%
Permit Allowances				\$ 4,000	0% to 3% of Construction Subtotal, used 3%
Total Estimated Project Construction Cost				\$ 190,000	
AACE International Class 5 Estimate - High Cost (+50%)				\$ 285,000	
AACE International Class 5 Estimate - Low Cost (-25%)				\$ 142,500	

Project: Vina Subbasin Improvements
Project Number: SF0154C
Completed by: Donnie Land
Date: 9/25/2025



1111 Broadway, 6th Floor
Oakland, CA 94607

COTTONWOOD CREEK CULVERT UPGRADE ROUGH ORDER OF MAGNITUDE COST ESTIMATE					
Item	Quantity	Unit	Unit Cost	Total	Assumptions
Mobilization	1	LS	\$ 29,395	\$ 29,400	0% to 7% of construction costs, used 5%
Temporary Flow Diversion & Groundwater Dewatering	1	LS	\$ 75,000	\$ 75,000	Dewatering and water exclusion zone, including groundwater up to 3 ft deep in 10 ft deep excavation.
36" Reinforced Concrete Pipe	165	LF	\$ 874	\$ 144,100	Excavation up to 10' deep, trenching, bedding material, 36-inch reinforced concrete pipe installation, backfill, haul-off and site restoration.
Technoflo Open Flow Meter	3	EA	\$ 4,000	\$ 12,000	Cost provided by WCWD
Three-pipe Concrete Headwall	4	EA	\$ 58,855	\$ 235,400	Excavation up to 10' deep, bedding material, concrete headwall installation, backfill, haul-off and site restoration.
Fabricated 36"x36" SS Slide Gate	3	EA	\$ 35,712	\$ 107,100	Materials, delivery, crane support, labor, and installation.
Riprap Energy Dissipater	32	CY	\$ 450	\$ 14,300	Class I riprap.
Construction Subtotal				\$ 617,000	
Design, Construction, and Commissioning Support				\$ 123,000	10-20% of Construction Subtotal, used 20%
General Conditions and Requirements				\$ 62,000	5-10% of Construction Subtotal, used 10%
Permit Allowances				\$ 31,000	0% to 5% of Construction Subtotal, used 5% due to coordination with USACE on Cottonwood Levee
Total Estimated Project Construction Cost				\$ 833,000	
AACE International Class 5 Estimate - High Cost (+50%)				\$ 1,250,000	
AACE International Class 5 Estimate - Low Cost (-25%)				\$ 625,000	

Project: Vina Subbasin Improvements
Project Number: SF0154C
Completed by: Donnie Land
Date: 9/25/2025



1111 Broadway, 6th Floor
Oakland, CA 94607

EAST CHEROKEE PUMP REPLACEMENTS ROUGH ORDER OF MAGNITUDE COST ESTIMATE					
Item	Quantity	Unit	Unit Cost	Total	Assumptions
Mobilization	1	LS	\$ 14,793	\$ 14,800	0% to 7% of construction costs, used 3%
Temporary Flow Diversion & Management	1	LS	\$ 20,000	\$ 20,000	Dewatering within pump well and waer intrusion prevention for installation.
West Pump Replacement (15 CFS)	1	LS	\$ 172,129	\$ 172,100	Removal and disposal of existing pump and motor, installation of new pump and motor, alignment and connection to existing manifold piping, testing, and assembly.
Center Pump Replacement (10 CFS)	1	LS	\$ 142,957	\$ 143,000	Removal and disposal of existing pump and motor, installation of new pump and motor, alignment and connection to existing manifold piping, testing, and assembly.
East Pump Replacement (8 CFS)	1	LS	\$ 142,957	\$ 143,000	Removal and disposal of existing pump and motor, installation of new pump and motor, alignment and connection to existing manifold piping, testing, and assembly.
Saddle Flow Meter	3	EA	\$ 5,000	\$ 15,000	Cost provided by WCWD
Construction Subtotal				\$ 508,000	
Design, Construction, and Commissioning Support				\$ 51,000	10-20% of Construction Subtotal, used 10%
General Conditions and Requirements				\$ 25,000	5-10% of Construction Subtotal, used 5%
Permit Allowances				\$ 10,000	0% to 3% of Construction Subtotal, used 2%
Total Estimated Project Construction Cost				\$ 594,000	
AACE International Class 5 Estimate - High Cost (+50%)				\$ 891,000	
AACE International Class 5 Estimate - Low Cost (-25%)				\$ 446,000	

Project: Vina Subbasin Improvements
Project Number: SF0154C
Completed by: Donnie Land
Date: 9/25/2025



1111 Broadway, 6th Floor
Oakland, CA 94607

WEST CHEROKEE STRIP LIFT STATION UPGRADE ROUGH ORDER OF MAGNITUDE COST ESTIMATE					
Item	Quantity	Unit	Unit Cost	Total	Assumptions
Mobilization	1	LS	\$ 18,078	\$ 18,100	0% to 7% of construction costs, used 3%
Traffic Control	1	LS	\$ 2,560	\$ 2,600	Traffic control plan and labor on Nelson Shippee Rd
Temporary Flow Diversion & Groundwater Dewatering	1	LS	\$ 20,000	\$ 20,000	Dewatering for dry weather flows and groundwater up to 15 ft deep in 20 ft deep excavation
Pump Station	1	LS	\$ 360,563	\$ 360,600	10' Wide, 10' long, 17' deep cast-in-place, steel reinforced pump station with 22 cfs axial flow pump and motor. Includes excavation, shoring, installation, backfill, compaction, pipe manifold, and assembly.
24" Ductile Iron Pipe	205	LF	\$ 585	\$ 120,000	Excavation up to 6' deep, bedding material, 24-inch ductile iron pipe installation, flap gate, backfill, haul-off and site restoration
Weed Screen	1	LS	\$ 10,000	\$ 10,000	Field-fabricated, stainless steel filter screen at pump station water intake.
Saddle Flow Meter	1	EA	\$ 5,000	\$ 5,000	Cost provided by WCWD
Precast Concrete Headwall	1	LS	\$ 11,905	\$ 11,900	Excavation up to 6' deep, bedding material, precast concrete headwall installation, backfill, haul-off and site restoration.
Flap Gate	1	EA	\$ 3,000	\$ 3,000	Materials, delivery, and installation.
Electrical Power Supply	1	LS	\$ 72,113	\$ 72,100	Existing electrical service power supply. New control center, and PLC for pump station. 20% of pump station cost.
Construction Subtotal				\$ 623,000	
Design, Construction, and Commissioning Support				\$ 62,000	10-20% of Construction Subtotal, used 10%
General Conditions and Requirements				\$ 31,000	5-10% of Construction Subtotal, used 5%
Permit Allowances				\$ 12,000	0% to 3% of Construction Subtotal, used 2%
Total Estimated Project Construction Cost				\$ 728,000	
AACE International Class 5 Estimate - High Cost (+50%)				\$ 1,092,000	
AACE International Class 5 Estimate - Low Cost (-25%)				\$ 546,000	

Project: Vina Subbasin Improvements
Project Number: SF0154C
Completed by: Donnie Land
Date: 9/25/2025



1111 Broadway, 6th Floor
Oakland, CA 94607

WEST CHEROKEE STRIP NEW LIFT STATION 1 ROUGH ORDER OF MAGNITUDE COST ESTIMATE					
Item	Quantity	Unit	Unit Cost	Total	Assumptions
Mobilization	1	LS	\$ 13,620	\$ 13,600	0% to 7% of construction costs, used 3%
Groundwater Dewatering	1	LS	\$ 20,000	\$ 20,000	Dewatering for groundwater up to 8 ft deep in 20 ft deep excavation(s)
Pump Station	1	LS	\$ 291,263	\$ 291,300	10' Wide, 10' long, 16' deep cast-in-place, steel reinforced pump station with 16 cfs axial flow pump and motor. Includes excavation, shoring, installation, backfill, compaction, pipe manifold, and assembly.
20" Ductile Iron Pipe	40	LF	\$ 521	\$ 20,900	Excavation up to 6' deep, bedding material, 20-inch ductile iron pipe installation, flap gate, backfill, haul-off and site restoration
Saddle Flow Meter	1	EA	\$ 5,000	\$ 5,000	Cost provided by WCWD
Precast Concrete Headwall	1	LS	\$ 11,905	\$ 11,900	Excavation up to 6' deep, bedding material, precast concrete headwall installation, backfill, haul-off and site restoration.
Flap Gate	1	EA	\$ 3,000	\$ 3,000	Materials, delivery, and installation.
Electrical Power Supply	1	LS	\$ 101,942	\$ 101,900	New electrical service power supply, control center, and PLC for pump station. 35% of pump station cost.
Construction Subtotal				\$ 468,000	
Design, Construction, and Commissioning Support				\$ 47,000	10-20% of Construction Subtotal, used 10%
General Conditions and Requirements				\$ 23,000	5-10% of Construction Subtotal, used 5%
Permit Allowances				\$ 9,000	0% to 3% of Construction Subtotal, used 2%
Total Estimated Project Construction Cost				\$ 547,000	
AACE International Class 5 Estimate - High Cost (+50%)				\$ 820,500	
AACE International Class 5 Estimate - Low Cost (-25%)				\$ 410,250	

Project: Vina Subbasin Improvements
Project Number: SF0154C
Completed by: Donnie Land
Date: 9/25/2025



1111 Broadway, 6th Floor
Oakland, CA 94607

WEST CHEROKEE STRIP NEW LIFT STATION 2 TO 4 ROUGH ORDER OF MAGNITUDE COST ESTIMATE					
Item	Quantity	Unit	Unit Cost	Total	Assumptions
Mobilization	1	LS	\$ 12,246	\$ 12,200	0% to 7% of construction costs, used 3%
Groundwater Dewatering	1	LS	\$ 20,000	\$ 20,000	Dewatering for groundwater up to 8 ft deep in 20 ft deep excavation(s)
Pump Station	1	LS	\$ 255,375	\$ 255,400	8' Wide, 8' long, 16' deep cast-in-place, steel reinforced pump station with 20 cfs axial flow pump and motor. Includes excavation, shoring, installation, backfill, compaction, pipe manifold, and assembly.
20" Ductile Iron Pipe	45	LF	\$ 521	\$ 23,500	Excavation up to 6' deep, bedding material, 20-inch ductile iron pipe installation, flap gate, backfill, haul-off and site restoration
Saddle Flow Meter	1	EA	\$ 5,000	\$ 5,000	Cost provided by WCWD
Precast Concrete Headwall	1	LS	\$ 11,905	\$ 11,900	Excavation up to 6' deep, bedding material, precast concrete headwall installation, backfill, haul-off and site restoration.
Flap Gate	1	EA	\$ 3,000	\$ 3,000	Materials, delivery, and installation.
Electrical Power Supply	1	LS	\$ 89,381	\$ 89,400	New electrical service power supply, control center, and PLC for pump station. 35% of pump station cost.
Construction Subtotal				\$ 420,000	
Design, Construction, and Commissioning Support				\$ 42,000	10-20% of Construction Subtotal, used 10%
General Conditions and Requirements				\$ 21,000	5-10% of Construction Subtotal, used 5%
Permit Allowances				\$ 8,000	0% to 3% of Construction Subtotal, used 2%
Total Estimated Project Construction Cost				\$ 491,000	
AACE International Class 5 Estimate - High Cost (+50%)				\$ 737,000	
AACE International Class 5 Estimate - Low Cost (-25%)				\$ 368,000	

Scope of Work & Estimated Fee

This scope and estimated fee were prepared in response to a request from Jenny Scheer (Water and Land Solutions [WLS]) to Eric Ginney (ESA) in late September 2025.

Background and Context

To contribute to sustainable groundwater management the Vina Groundwater Sustainability Agency (GSA) is considering recharge projects. Water and Land Solutions (WLS) is performing a feasibility analysis for delivering water from Western Canal Water District (WCWD) to Vina Subbasin. Three properties that could potentially receive water from WCWD have been identified; two of them would need to address a conveyance bottleneck at Cottonwood Creek first. Currently, there are two pipes leading from the canal to an area outboard of the canal that inundates in a shallow depression (approx. 0.1 acre in size), with another two pipes running through the Cottonwood Creek levee that are 24" and 30" diameter in size. Neither pipe through the levee is permitted by the Central Valley Flood Protection Board (CVFPB). The current plan envisions replacing the two existing pipes and adding a third pipe so they are all 36" diameter. Additionally, the preference is for these pipes to go directly from the canal, through the levee, to flap gates at the fields. This would result in elimination of canal water from entering the ponded area, which may or may not have an impact on the potential aquatic resources in this area. The approximate location of the pipes/inundated area is 39°31'24.02"N, 121°42'4.64"W.

WLS requested that Environmental Science Associates (ESA) help them with the following questions:

1. What permits will be required?
2. What is the estimated cost, timeline, and uncertainty for permitting such a project?
3. Do you foresee additional permits needed to de-water the existing pond? If so, we may consider an alternative engineering solution.

The following response comprehensively addresses these questions. Importantly, this assumes that a formal wetlands delineation will be required to determine permitting needs related to the ponded area. Further, it assumes that because the Cottonwood Creek levee to be penetrated for replacement/installation of the new pipes is a part of the federal Sacramento River Flood Control Project, it will require both an encroachment permit from the CVFPB but also a Section 408 permit. Pursuant to Section 14 of the Rivers and Harbors Appropriations Act of 1899 (33 USC 408) projects that modify federal infrastructure facilities are required to obtain a "Section 408 permit". The CVFPB initiates the Section 408 process with the USACE after the CVFPB permit application has been made. National Environmental Policy Act (NEPA) compliance would be required prior to a final Section 408 decision from the USACE.

Scope of Work

ESA will support CLIENT in the following tasks:

- Task 1 Project Management Coordination and Meetings
- Task 2 Permitting Strategy
- Task 3 CEQA IS/MND
- Task 4 Biological Surveys and Wetland Delineation
- Task 5 Cultural Surveys
- Task 6 Permitting Support

For purposes of this scope of work, it is assumed the following permits will be required for the proposed project:

- Central Valley Flood Protection Board Encroachment Permit.

- United States Army Corps of Engineers (USACE) Section 408 Permit.
- USACE Section 404 Permit - Either no Waters of the US are determined in the project area and/or a 404 exemption applies. However, the scope includes preparation of a Section Nationwide (NWP) 404 permit, if it is determined a NWP permit is needed.
- California Department of Fish and Wildlife (CDFW) Streambed Alteration Agreement.
- CDFW Section 2081 Incidental Take Permit.
- Biological Opinion from USFWS for FESA Section 7 Biological Assessment (BA)
- Regional Water Quality Control Board (Regional Board) Waste Discharge Requirement.

However, which permits will be required will be confirmed through development of Task 2 Permitting Strategy, Task 4 Biological Surveys and Wetland Delineation, and Task 5 Cultural Surveys. Note: Given that the Giant Garter Snake (*Thamnophis gigas*) is known to be present in this area, we assume that this project will include the need for a California Endangered Species Act (CESA) "incidental take permit" from the California Department of Fish and Wildlife under the California Endangered Species Act and a federal Endangered Species Act (FESA) Incidental Take Permits from the U.S. Fish and Wildlife Service under the federal Endangered Species Act.

Task 1 Project Management Coordination and Meetings

Overall coordination and administration of project tasks. Assume duration is 18 months.

Task 2 Permitting Strategy

Prepare a permitting strategy for the proposed project. The permitting strategy will provide a description of the possible federal and state permits for the proposed project upon completion of initial reconnaissance of the site and relevant surveys.

Task 3 CEQA IS/MND

Prepare an IS/MND for the proposed project based on information provided by project engineer. The IS/MND will provide a description of impacts and appropriate mitigation measures, if necessary, to be incorporated. Resource topics will be analyzed based on construction and operation of the proposed project. Information from Tasks 4 and 5 will be relied upon for their related CEQA sections and analysis. Mitigation measures would be developed, as necessary. It is anticipated that the proposed project would have no resulting significant adverse impacts after mitigation. At the close of the 30-day public review period for the Public Draft IS/MND, prepare responses to comments received and an errata outlining any recommended changes to the text of the Public Draft IS/MND. It is assumed that up to 5 substantive comments will be received on the Public Draft IS/MND.

Assumptions:

- Deliverables in electronic format
- Formal government-to-government contact will remain the purview of the CLIENT (AB52)
- It is assumed modeling (e.g., hydrologic, hydraulic, air quality, etc.) is not needed for the project.
- Additional project specific analysis and/or mitigation measures may be required if projects vary significantly from what is analyzed as part of the Project.
- Minor clarifying revisions may be made to the project description during development of the Public Draft IS/MND.
- Edits on the Public Draft IS/MND and Final IS/MND will be limited to confirming prior edits.
- CLIENT will post notices to adjoining land owners.
- CLIENT shall upload an electronic copy of the CEQA documents to the State Clearinghouse's CEQAnet website.
- The IS/MND does not need to be ADA-compliant.
- Responses to public comments shall involve explanation, clarification, or amplification of the contents of the Draft IS/MND; no new technical analyses shall be required; and completed technical studies shall not need to

be substantially revised based on changes to the project or pre-approved assumptions as part of the response to comments.

- The CEQA fees (approx. \$4k) are included in the costs for this task.

Task 4 Biological Surveys and Preliminary Aquatic Resources Delineation

Biologists will conduct reconnaissance-level surveys for the proposed project to document and characterize land cover, biological communities, and suitable habitat for special-status species. Carry out database searches including: the U.S. Fish and Wildlife Service's Information for Planning and Consultation (IPaC) data base, the California Natural Diversity Data Base (CNDDB), and the California Native Plant Society's Inventory of Rare and Endangered Plants of California to generate a list of special-status species with potential to occur in the region and will do preliminary mapping of habitats within the restoration areas based on aerial imagery (e.g., Google Earth or NAIP imagery). Under this scope of work, the mapping will be field verified through field surveys and the list of special-status species will be used during the reconnaissance site visits to assess habitat suitability. Wetland specialists will conduct a preliminary aquatic resources delineation to determine the location and extent of potential jurisdictional waters of the U.S and State. Once the delineation survey is complete, prepare a delineation report, which will include a map identifying potentially jurisdictional waters within the delineation study area and will describe the environmental setting with respect to soils, hydrology, and biological communities.

Assumptions:

1. Biological Resources surveys do not include protocol-level surveys for special-status species, nor do they include a formal aquatic resources delineation or arborist survey. Additional costs may be incurred if evidence for presence of special-status species is found and additional surveys are required.
2. CLIENT will arrange for access to survey areas.
3. CLIENT will provide files with footprint of project areas in Autocad or ArcGIS formats, if available.

Task 5 Cultural Surveys

Establish a proposed project Area of Potential Effects (APE); conduct background research on the history of the APE and vicinity; conduct a records search of the California Historical Resources Information System (CHRIS) for the APE and areas within 0.25 mile; conduct an intensive-level cultural resources pedestrian survey of all accessible portions of the APE; and develop a CEQA- and Section 106-compliant Archaeological and Architectural Resources Inventory Report (AARIR) documenting the results of the aforementioned tasks. The AARIR will include: methods and findings of the background research, CHRIS records search results, communication with Tribes, maps, results of the field surveys, evaluations of eligibility for listing in the California Register of Historical Resources (California Register) and National Register of Historic Places (National Register) for no more than one architectural resource and one archaeological resource, if no additional fieldwork is required, proposed project impacts/effects assessment, and recommendations.

Assumptions:

1. The APE will comprise the Project Area of Direct Impact only, including all areas of proposed ground disturbance as well as staging and construction access areas.
2. Up to one architectural resources and one archaeological resource will be identified in the APE.
3. Any cultural resources identified in the APE can be evaluated for California Register- and National Register-eligibility without additional fieldwork or archival research.
4. No archaeological excavation (subsurface survey, evaluative testing) will be required.

Task 6 Permitting Support

Prepare applications and analyses required to support regulatory permitting and approvals. This scope of work assumes that at least 30 % project designs will be available. The scope of work may increase or decrease depending upon resource agency comments, and additional budget may be necessary to accomplish permit issuance or project approval by individual agencies.

6.1 United States Army Corps of Engineers (USACE) Section 404 & FESA BA

A formal wetland delineation survey will be required, and the wetland delineation will be based on identification of Waters of the United States and the ordinary high-water mark (OHWM). The aquatic resources delineation will determine the extent of waters subject to Sections 404 and 401 of the Clean Water Act and Section 10 of the Rivers and Harbors Act including documentation of the information necessary to determine the extent of aquatic resources as regulated under State law (such as the Porter-Cologne Water Quality Control Act and State Wetland Dredge and Fill Procedures). Perform an aquatic resources delineation field survey of the project area and develop and deliver data electronically. Prepare a biological resources technical memorandum which will summarize habitat conditions within the project site and preliminary best management practices and/or mitigation measures for those species with a potential to occur. Prepare a memorandum to document Section 404 of the Federal Clean Water Act exemptions or waivers to certain aquatic permitting requirements available to proposed project. If it is found that a Section 404 permit is needed, prepare a Section 404 NWP application. This task includes preparation of all supporting documents required in requests for authorization under an NWP, including a cover letter, 404 permit application Engineering Form, and attachments for submittal to the USACE, tracking the USACE action, and responding to their questions.

Assumptions:

1. CLIENT will provide the necessary design footprint in an appropriate format for analysis of potential impacts to waters of the U.S.
2. A federal Endangered Species Act (FESA) Biological Assessment (BA) will be completed.
3. The USACE Nationwide Permit application will include:
 - Cover letter, ENG Form
 - 404 NWP Application attachment
 - Section 106 of the National Historic Preservation Act (Section 106) Report, and
 - FESA Section 7 Biological Assessment (BA)

6.2 Section 1602 Streambed Alteration Notification

Develop and submit a Notification of Lake or Streambed Alteration via CDFW's Environmental Permit Information Management System (EPIMS) Permitting Portal.

Assumptions:

4. CLIENT will provide detailed design drawings to support this application package.
5. Only a single set of consolidated comments on the draft Notification of Lake or Streambed Alteration will be provided.
6. CLIENT will be responsible for the application fees (amount to be determined), which will be submitted to CDFW concurrently with the Notification on EPIMS.

6.3 Section 2081 Incidental Take Permit

Prepare and submit an application for an Incidental Take Permit for California Endangered Species pursuant to Section 2081 of the California Fish and Game Code through CDFW's EPIMS Permitting Portal.

Assumptions:

1. Only a single set of consolidated comments on the draft Section 2081 application will be provided.
2. CLIENT will be responsible for the application fees (amount to be determined), which will be submitted to CDFW concurrently with the application on EPIMS.

6.4 USACE Section 401 / Regional Board Waste Discharge Requirement

If required, prepare Section 401 Water Quality Certification / Waste Discharge Requirements (WDR) for the proposed project. A meeting request (sent via email) will be sent to the Central Valley Regional Water Quality Control Board at least 30 days prior to submitting the Section 401/WDR application.

6.5 Central Valley Flood Protection Board Encroachment Permit Support

Prepare the application (including the environmental portion) of the Central Valley Flood Protection Board Encroachment Permit.

Assumptions:

1. CLIENT will be responsible for the application (estimated at approx. \$4k).

6.6 United States Army Corps of Engineers (USACE) Section 408

Prepare the application (including the environmental portion) of the Central Valley Flood Protection Board Encroachment Permit. This includes providing environmental documentation for a Categorical Permission, if applicable, or for USACE to prepare a NEPA Environmental Assessment. Information provided to USACE will meet the requirements of 33 CFR 333 and largely use information developed for the CEQA IS/MND (Task 3). This task does not include development of engineering drawings or hydraulic analysis.

Cost Estimate

Task	Cost Estimate
Task 1 Project Management Coordination and Meetings	\$18,000
Task 2 Permitting Strategy	\$6,000
Task 3 CEQA IS/MND	\$45,000
Task 4 Biological Surveys and Preliminary Aquatic Resources Delineation	\$30,000
Task 5 Cultural Surveys	\$20,000
Task 6 Permitting Support	\$80,000
Total	\$199,000

Appendix E: Lands that could be served by Miocene water right

Using Pacific Gas and Electric's (PG&E) Miocene water right to irrigate rice in the Vina Subbasin is another potential way to bring more surface water into the Subbasin. This alternative was proposed late into the feasibility analysis phase of this Project and was not fully analyzed, but is included here as a potential alternative for further study.

PG&E holds a water right to 53,000 AF¹⁷ of water from the West Branch Feather River primarily for hydro water use in the Miocene Canal system. The Miocene Canal system is a PG&E hydroelectric conveyance facility that includes PG&E's Upper Miocene and Middle Miocene Canals and California Water Service's Lower Miocene. The 2018 Camp Fire destroyed the Upper Miocene, thus, preventing water from entering the Miocene Canal system. As the cost of repairs and operation have become a prohibitive factor, PG&E is actively pursuing an entity to acquire the Upper and Middle Miocene Canal. The [cost to restore the Miocene Canal](#) after the Camp Fire was estimated at \$40-\$60 million in 2021. Annual maintenance costs for the Miocene Canal were estimated at \$1-\$2 million.

Prior to 2018, PG&E provided water from the Miocene Canal to agricultural operations, wetland habitat, and a portion of the water supply for California Water Service, the water purveyor in the City of Oroville and had a contractual agreement with 13 agricultural landowners to provide water "when available." Separate actions may need to be taken in order to change the specific type of use and place of use for the Miocene water right. It is unclear the extent that these changes are feasible.

The West Cherokee Strip property maintains a water right for a portion of water from the Middle Miocene. Prior to the Camp Fire, that water right was used to irrigate a portion of the rice acreage included in this analysis via the existing Gold Run canal. If access to that water was restored, surface water deliveries could resume. If a portion of the Miocene water rights was acquired, both the West Cherokee Strip and East Cherokee Strip properties and other adjacent lands could receive surface water from the Miocene. The landowner at the West Cherokee Strip property indicated interest in working with Butte County to acquire a portion of the Miocene water right for irrigation use. That landowner has 1,000 acres that could be gravity irrigated with water from the Miocene using existing infrastructure and another 600 acres that could be irrigated with Miocene water if a new ditch was developed, represented in yellow in Figure C.1.

¹⁷ https://buttecounty.granicus.com/MetaViewer.php?view_id=2&clip_id=984&meta_id=152447

Appendix F: Ridge to Valley Option A Walnut Orchard Dual Irrigation System Design

In order to provide a general picture of the on-farm improvements that would be needed to set up a dual source irrigation system for the Walnut Orchards in the Ridge to Valley Project Option A, the Project team utilized the design assumptions contained in the 2018 study [*Evaluation of Restoration and Recharge within the Butte County Groundwater Basins*](#) (ERR). The ERR was prepared by GEI Consulting Engineers and Scientists, David's Engineering, and ERA Economics and includes a tool for determining what equipment might be needed for conjunctive use projects, and estimated costs.

To account for the separate delivery areas, it is assumed that one of the systems described above from the ERR will be utilized for orchard A-1, the approximately 245-acre orchard on the north side of the canal. Two similar but smaller systems will be utilized for orchard A-2, the approximately 130-acre orchard on the south side of the canal, and orchard A-3, the 95-acre orchard. The smaller systems for orchards A-2 and A-3 would each consist of only one pump station, a turnout, a sump, a groundwater well with low head vertical turbine pump, and a second vertical turbine pump installed in the sump to pressurize the water for sprinkler irrigation (pressure pump). All equipment needed for the three systems is summarized in Table F-1 below.

Table F-1. Irrigation equipment needed for Project Option A.

Component	1 Station 1	1 Station 2	1 Station 3	2	3
Well Pump	150 hp, vfd*	100 hp flood	100 hp flood	150 hp, vfd*	150 hp, vfd*
Can	n/a	48" CMP**	48" CMP**	n/a	n/a
Pressure Pump	Yardney R100LA	n/a	n/a	Yardney R100LA	Yardney R100LA
Sand Separator Filter(s)	2 Filtaworx FW08 self-cleaning screens, 120 micron	2 Filtaworx FW08 self-cleaning screens, 120 micron	2 Filtaworx FW08 self-cleaning screens, 120 micron	2 Filtaworx FW08 self-cleaning screens, 120 micron	2 Filtaworx FW08 self-cleaning screens, 120 micron
Flow meter	10" SeaMetrics Magmeter	10" SeaMetrics Magmeter	10" SeaMetrics Magmeter	10" SeaMetrics Magmeter	10" SeaMetrics Magmeter
Manifold	10" steel pipe	10" steel pipe	10" steel pipe	10" steel pipe	10" steel pipe

Vina Subbasin Surface Water Supply Feasibility Analysis

Jenny Scheer
Maddie Munson



Project Options

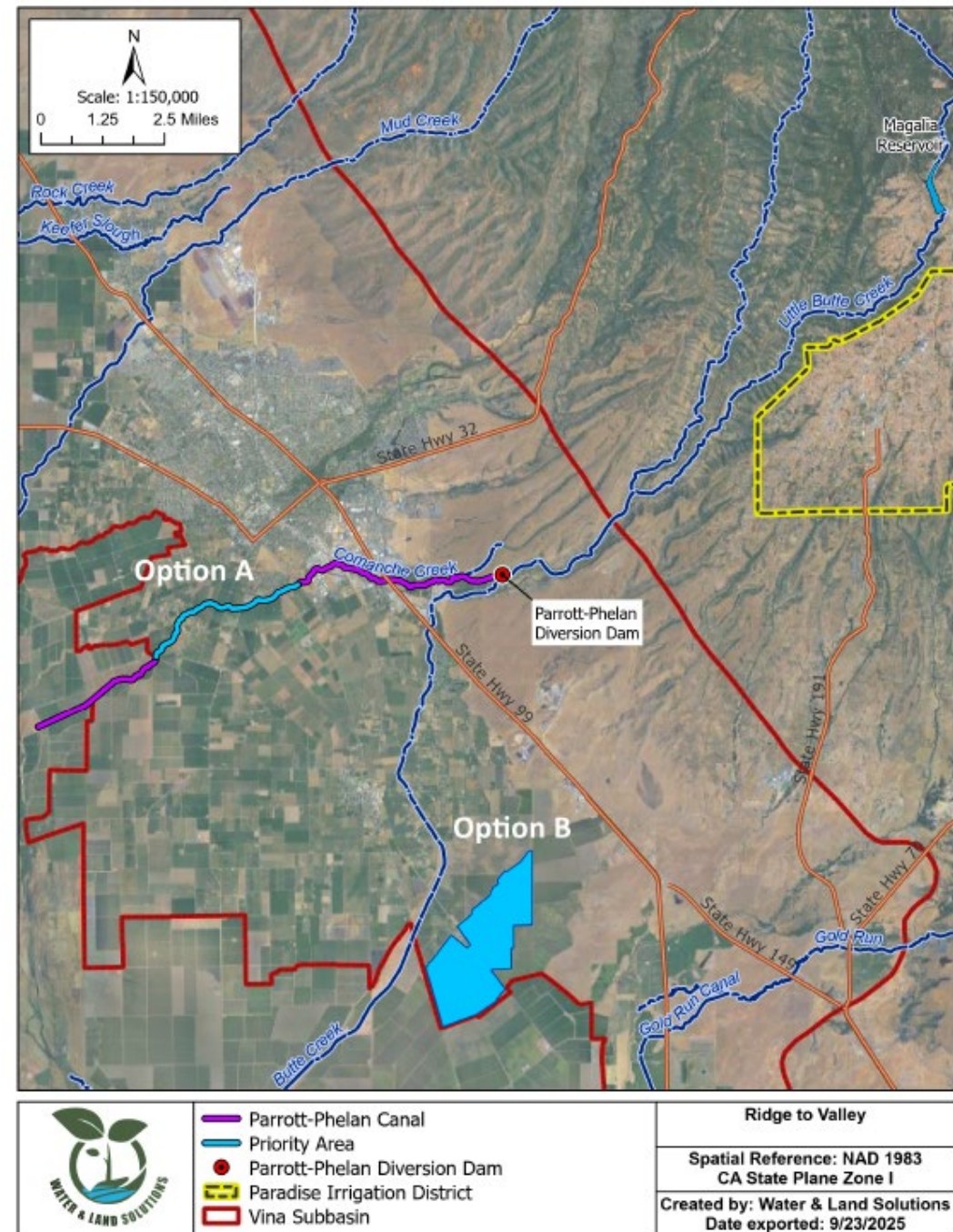
- South Vina Extension
- Ridge to Valley



Ridge to Valley

Convey underutilized Paradise Irrigation District water through Butte Creek to farmland in Vina Subbasin.

1,500 - 3,500 acre-feet (AF)



Legal Considerations

- SWRCB – temporary v long-term transfer
 - Court Approval for amendments for Butte Creek adjudication
 - CEQA Review
- 

Environmental Considerations

A solid green horizontal bar.

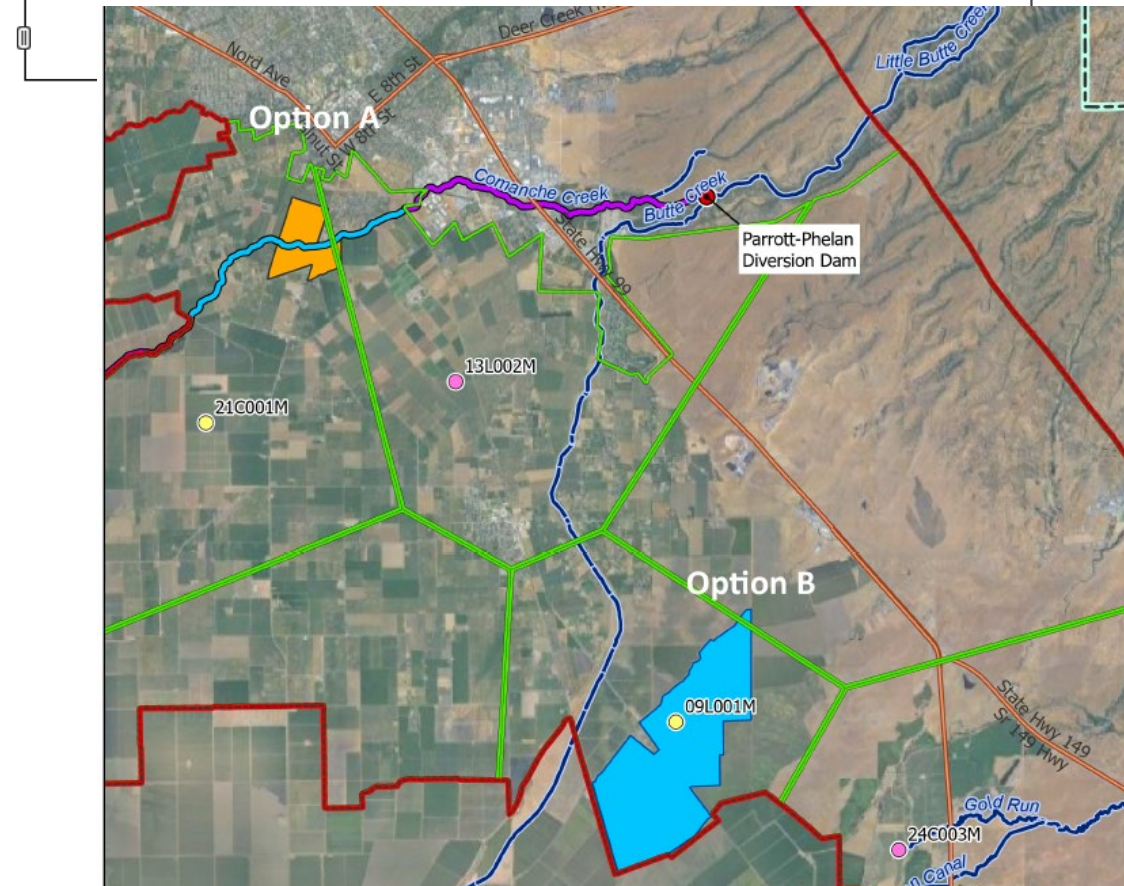
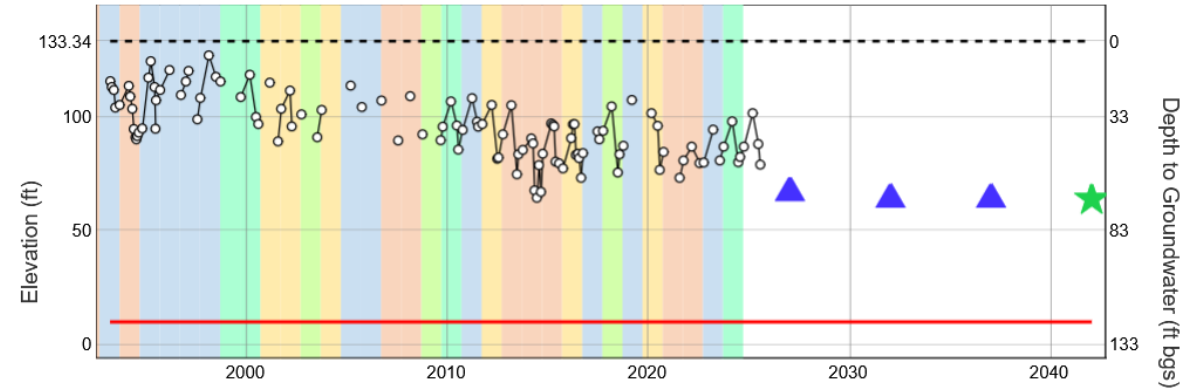
- No known significant negative impacts
 - Utilization of an existing water right means water available to watershed will not be reduced
 - Potential fishery benefits July – September, when Butte Creek temperature has been identified as a concern for adult spring-run Chinook Salmon.
- 
- A teal triangle pointing right, a yellow triangle pointing left, and a green triangle pointing right, all overlapping in the bottom-left corner.

Groundwater Sustainability

- **21N01E21C001M**
GW Levels declined 17.2 feet from 2002-2023,
Average rate: 0.82 ft/yr decline
Currently above MO, MT, and interim milestones

CDEC Water Year Type (Sacramento)

Wet Above Normal Below Normal Dry Critical



Groundwater Sustainability

- 20N02E09L001M

GW levels declined 15.35 feet from 2003-2023

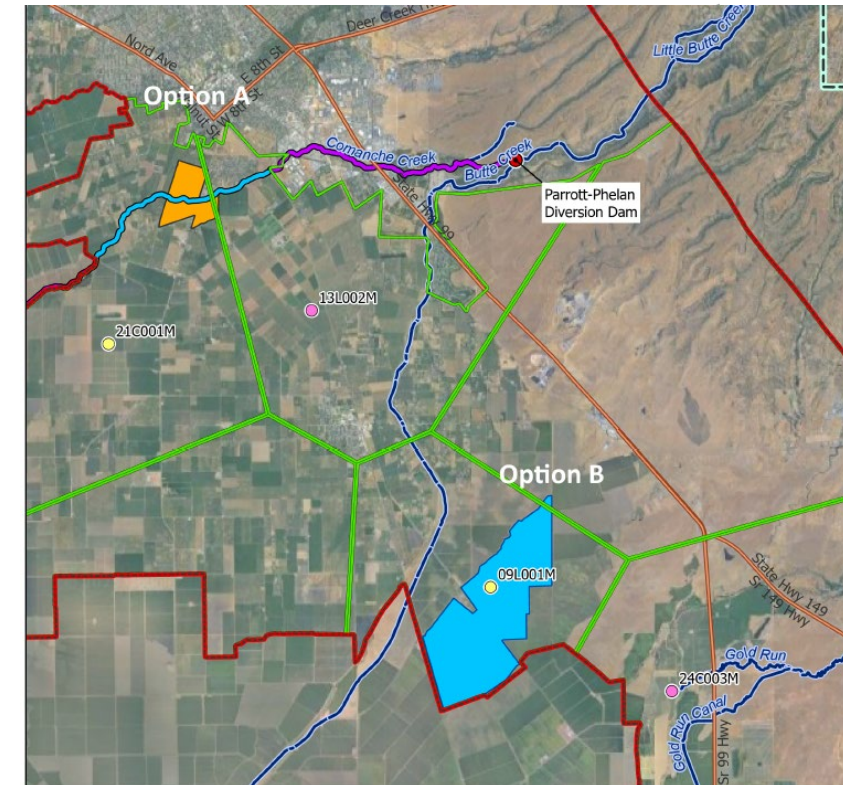
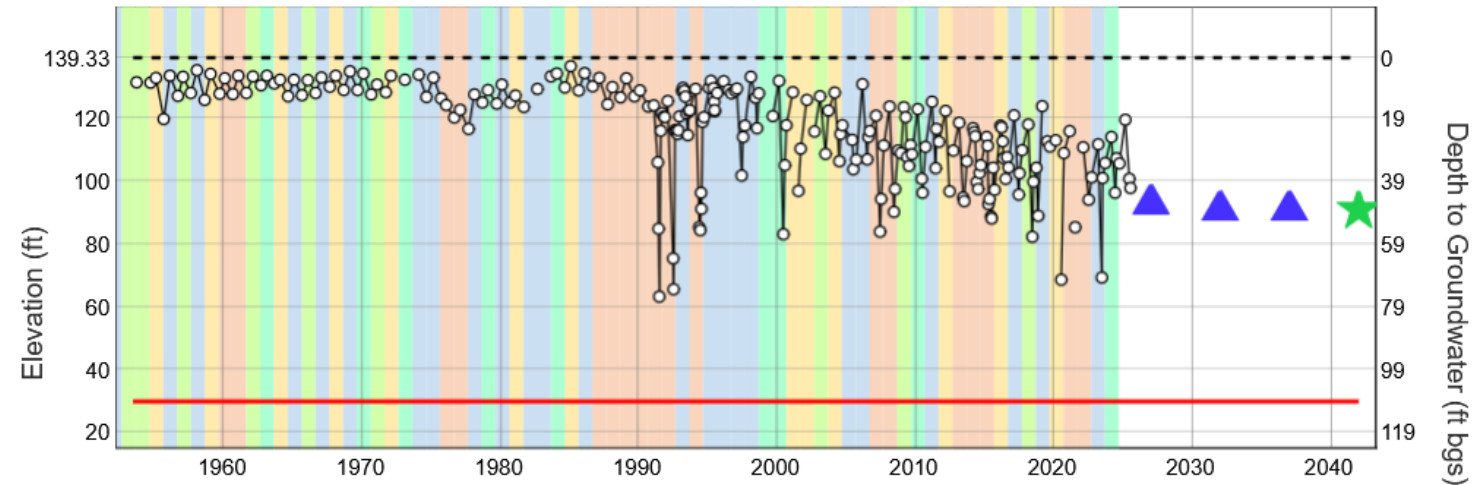
Average rate: 0.77 ft/yr decline

Above interim milestone, MO, and MT

Seasonal lows groundwater levels can drop below the MO.

CDEC Water Year Type (Sacramento)

Wet Above Normal Below Normal Dry Critical



Infrastructure Needs

- Conveyance – existing natural infrastructure
- Diversions – no additional
- Delivery to farm – no additional
- On-farm improvements
 - For option A, up to 3 pump stations with filters, etc needed to create a dual source system for walnuts
 - For option B, no additional improvements needed to flood irrigate rice

Costs & Funding Options

- Cost of water – TBD by PID Board
- Median price here is \$297.50/AF, rounded to \$300/AF
- Additional cost for legal expenses & CEQA
- Option A wheeling cost: \$25/AF

Seller	Buyer/Leasee	\$/AF	Amount (AF)	Year	Location
Glenn Colusa Irrigation District	Sutter Mutual Water Company	\$55.07	20,000	2024	North-of-Delta
Butte County	Del Oro Water Company/Cal Water-Oroville	\$106.70	668	2025	North-of-Delta
Butte County	Palmdale Water District/Westside Districts	\$176.40	24,000	2025	South-of-Delta
Yuba County Water Agency	Healthy River and Landscape Program	\$290	41,000	2025 - 2033	In-Delta
South Sutter Water District	Woodland-Davis Clean Water Authority	\$550	2,000	2024-25	North-of-Delta
Butte Water District	Santa Clara Valley Water District	\$650+	21,000	2025	South-of-Delta
Western Canal Water District	Metropolitan Water District of Southern California	\$600	Up to 26,400	2025	South-of-Delta

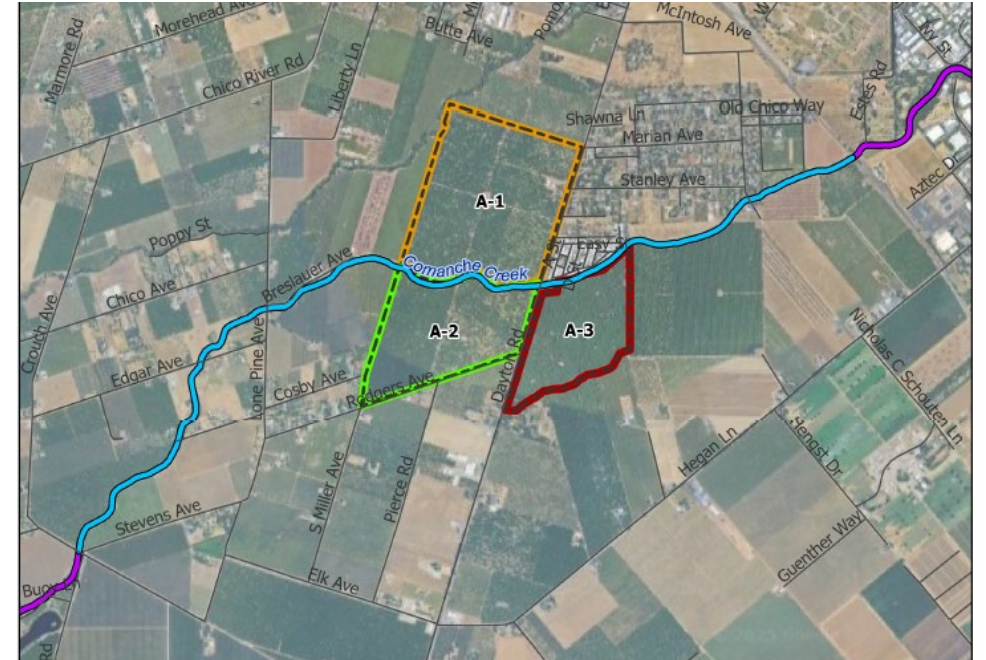
Costs & Funding Options (cont'd)

- On-Farm Improvements – Option A

	Total AF	Annual Capital & Maintenance (\$/AF)
A-1	700	\$45
A-2	400	\$50
A-3	300	\$55

- On-Farm Improvements – Option B

N/A



Costs & Funding Options (cont'd)

- Cost-Benefit

	Total Benefit (AF)	Total Annual Cost per AF Recharge (\$/AF)
A	1,400	\$430/AF
B	3,500	\$300/AF

- Funding options:

- On-farm improvements: State, Federal, local, private
- Cost of Water: private and local

Conclusions & Recommendations

1. Adopt a Phased approach:

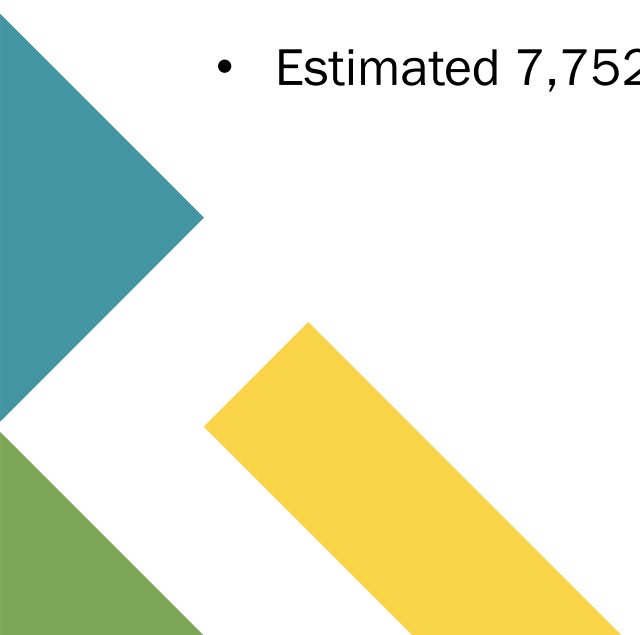
Phase 1: 1,500 AF to Option B for three years, with temporary annual transfers

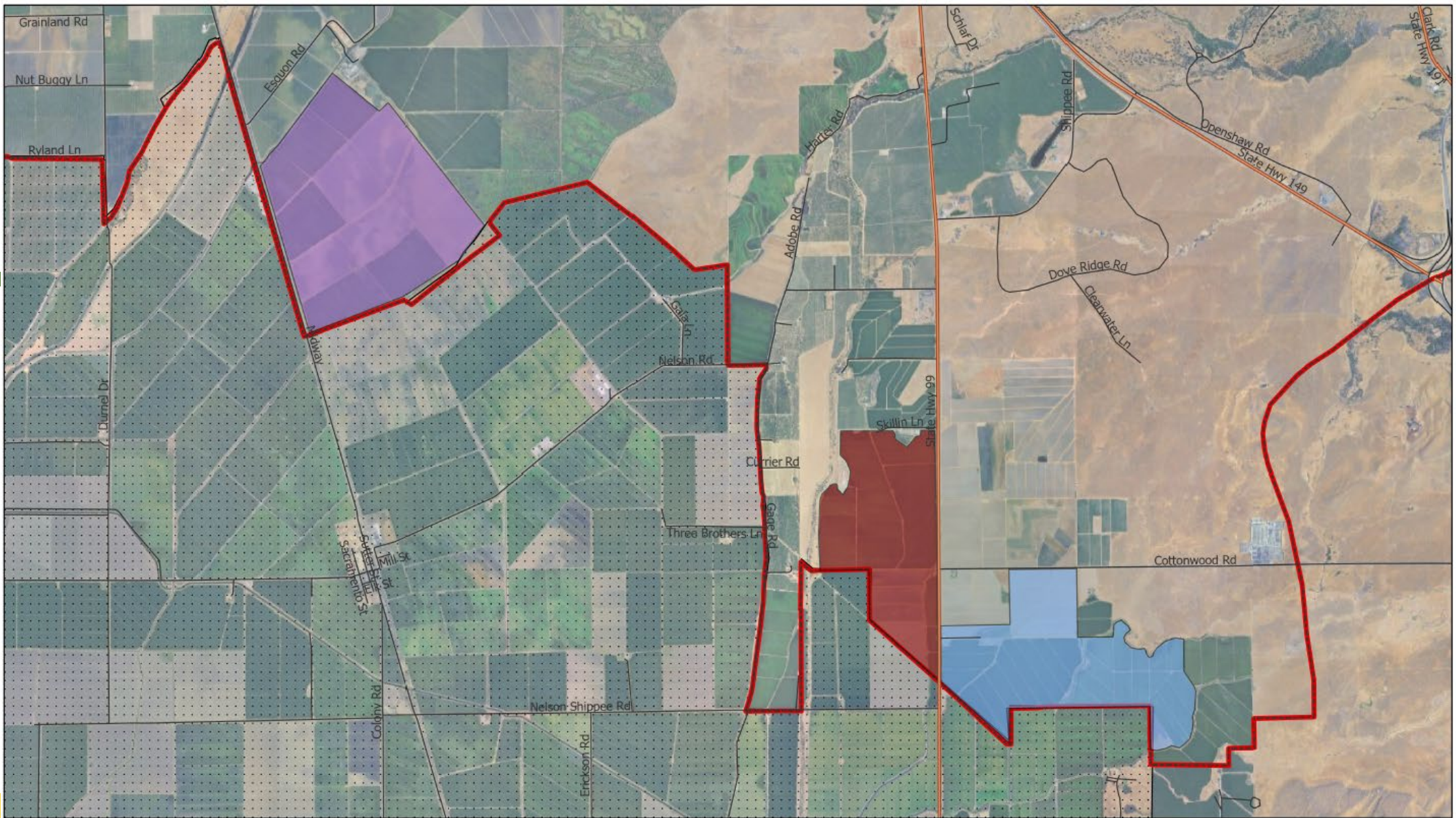
Phase 2: Up to 3,500 AF with a long-term multi-year transfer

2. GSA cost share

3. Focus on Option B

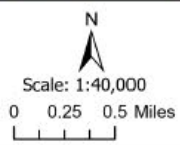
South Vina Extension

- Western Canal Water District deliver water outside their district into Vina Subbasin
 - 2,476 acres of rice across three landowners
 - Estimated 7,752 acre-feet annually
- 



- East Cherokee Strip - 782 acres (1)
- Hamlin Slough - 1052 acres (1)
- West Cherokee Strip - 642 acres (1)

- Western Canal Water District
- Vina Subbasin



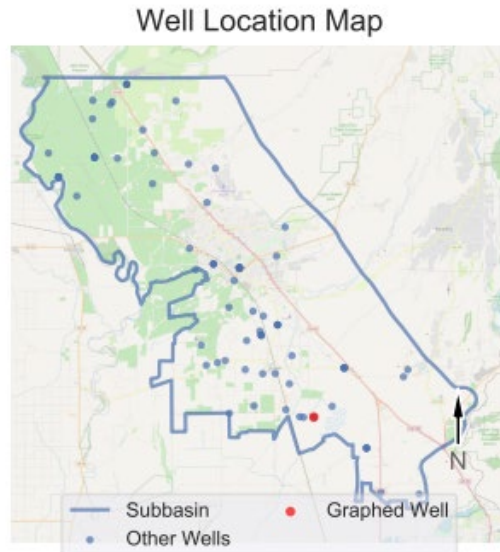
**Vina Subbasin
Surface Water**

**Spatial Reference: NAD 1983
CA State Plane Zone II**

Created by: Water & Land Solutions
Date exported: 9/11/2025

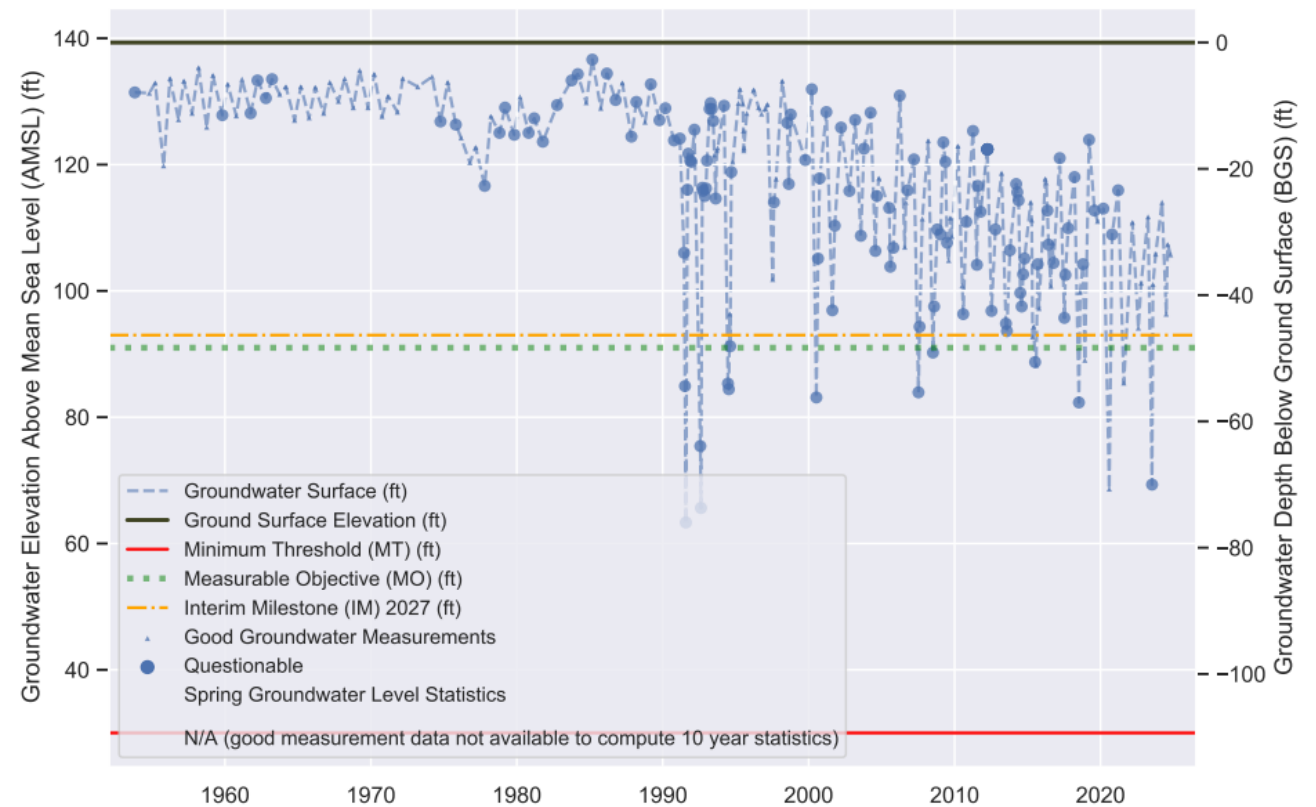
Groundwater Sustainability

- RMS well near Hamlin Slough property

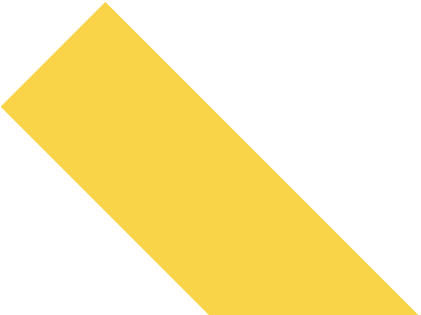


VINA Subbasin - State Well Number (SWN): 20N02E09L001M

Perforation 1: 460.0 - 710.0 ft BGS

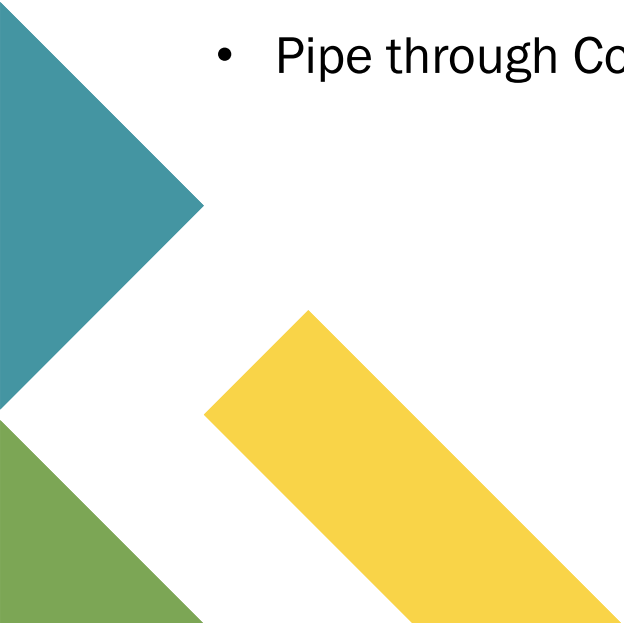


Water Availability



- Discussions have been based on a 10-year memorandum of agreement with an annual decision by the Western Canal Water District board on water availability
- Estimate water will be available in 8 in 10 years
- Limited conveyance capacity in July and early August incorporated into 7,752 AF annual estimate

Infrastructure



- 9 new or upgraded lift pumps
- 12 new meters
- Pipe through Cottonwood Creek levee

Legal Considerations

- Permitting required for pipe through Cottonwood Creek levee
 - Central Valley Flood Protection Board
 - U.S. Army Corps of Engineers
 - CEQA
- Additional permitting may be needed for other aspects of Hamlin Slough or Cottonwood Creek projects

Cost Estimates – Upfront Costs

- Draft capital costs for infrastructure, including permitting, design, and construction

Project/Site	Total Estimated Construction Cost	High (+50%)	Low (–25%)	Acre-feet	\$/AF
Cottonwood Creek Culvert	\$917,200	\$1,054,800	\$527,400	55,110	\$ 17
East Cherokee Strip	\$676,800	\$1,015,200	\$507,600	30,260	\$ 22
West Cherokee Strip	\$2,790,500	\$4,185,750	\$2,092,875	24,850	\$112
Hamlin Slough	\$682,700	\$1,024,050	\$512,025	22,410	\$ 30
TOTAL	\$5,067,200	\$7,279,800	\$3,639,900	77,520	

Cost Estimates – Water Cost

- To be determined by Western Canal Water District with project proponents
- Likely higher than current out of district fee of \$14/AF
- Additional wheeling charge for Hamlin Slough project

Thank you

Jenny Scheer

Maddie Munson

mmunson@waterandlandsolutions.com



Groundwater Sustainability Implications

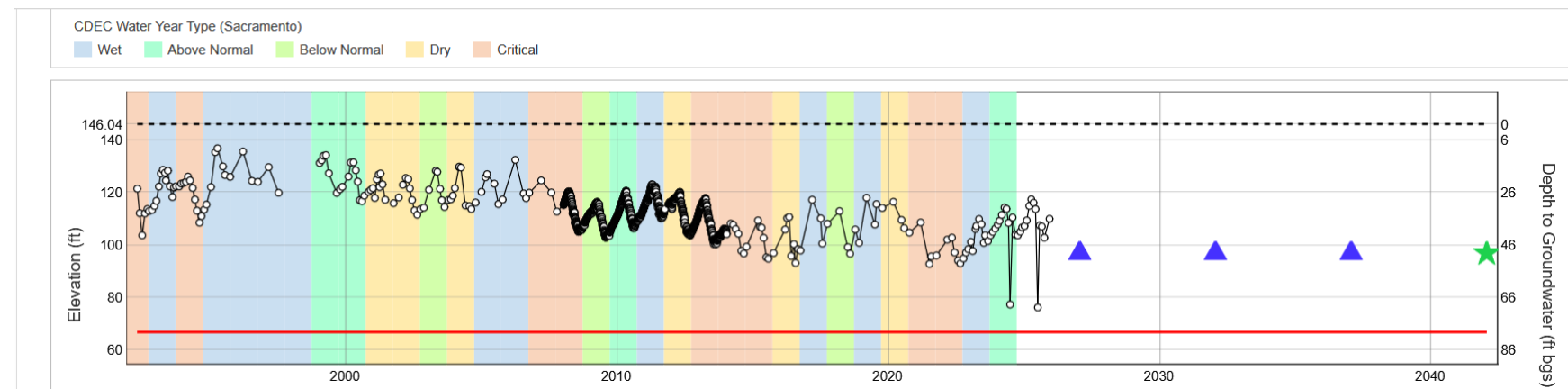


- GSP showed downward trend in groundwater levels
- Groundwater levels are a GSP proxy for storage, subsidence, and interconnected surface waters
- No known in-elastic subsidence
- GSP tracks high calcium, high nitrates and total dissolved solids in the Chico area .
- Seawater intrusion not relevant to Vina

Appendix H: Hydrographs of Additional Monitoring Wells in Ridge to Valley Project Area

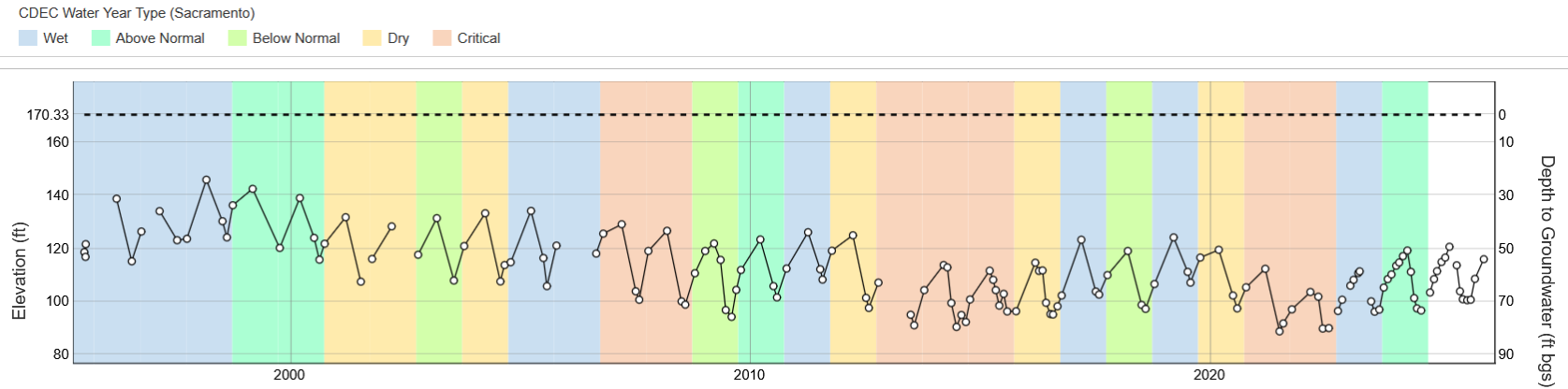
Hydrograph of groundwater well near Project Option A.

Site Code: 396891N1218854W001 State Well Number: 21N01E08K002M Local Well Name: 21N01E08K002M



Hydrograph of groundwater well near Project Option A.

Site Code: 396963N1218486W001 State Well Number: 21N01E10B003M Local Well Name: 21N01E10B003M



Hydrograph of groundwater well near Project Option B.

Site Code: 396154N1217391W001 State Well Number: 20N02E09G001M Local Well Name: 20N02E09G001M

