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RECLAMATION

Design, Estimating, and Construction Review Report

Kern Fan Groundwater Storage Project

Interior Region 8: Lower Colorado Basin

Kern Fan Groundwater Storage Project Photo (Irvine Ranch Water District/Rosedale-Rio Bravo Storage District)

U.S. Department of the Interior **July 2020**

Mission Statements

The Department of the Interior (DOI) conserves and manages the Nation's natural resources and cultural heritage for the benefit and enjoyment of the American people, provides scientific and other information about natural resources and natural hazards to address societal challenges and create opportunities for the American people, and honors the Nation's trust responsibilities or special commitments to American Indians, Alaska Natives, and affiliated island communities to help them prosper.

The mission of the Bureau of Reclamation is to manage, develop, and protect water and related resources in an environmentally and economically sound manner in the interest of the American public.

Design, Estimating, and Construction Review Report
Kern Fan Groundwater Storage Project

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Acronyms and Abbreviations

ASR	Aquifer Storage and Recovery
cfs	cubic feet per second
COVID-19	Coronavirus Disease 2019
D&S	Reclamation Manual Directives and Standards
DEC	Design, Estimating, and Construction
IRWD	Irvine Ranch Water District
JPA	Kern Fan Joint Powers Authority
KBWA	Kings Bank Water Authority
OM&R	operation, maintenance, and replacement
MCL	Maximum Containment Level
MOU	memorandum of understanding
Project	Kern Fan Groundwater Storage Project
Project Team	Interior Region 8: Lower Colorado Basin and the Design Team
Reclamation	Bureau of Reclamation
RRBWSD	Rosedale-Rio Bravo Water Storage District
SWP	State Water Project
Team	Design, Estimating, and Construction Review Team
TSC	Technical Service Center
WIIN	Water Infrastructure Improvements for the Nation Act

Acknowledgments

The Design, Estimating, and Construction (DEC) Team acknowledges the valuable assistance of Jack Simes, Project Manager, Interior Region 8: Lower Colorado Basin; and the staff of the Irvine Ranch Water District and Rosedale-Rio Bravo Water Storage District.

Executive Summary

A request for a Design, Estimating, and Construction (DEC) Review on the Kern Fan Groundwater Storage Project (Project) was received from Interior Region 8: Lower Colorado Basin, Project Manager, Jack Simes on March 4, 2020. This Project is seeking funding under the Water Infrastructure Improvements for the Nation Act (WIIN) Section 4007 and therefore must perform a DEC Review as stated in Reclamation Manual Directives and Standards (D&S), FAC 10-01 “Identifying Design, Cost Estimating, and Construction Projects for Which Independent Oversight Review is Required, and Performing Those Reviews” [1].

The purpose of the DEC Review process is to provide independent oversight that ensures products related to design, cost estimating, and construction are technically sound and provide a credible basis for decision making by Bureau of Reclamation (Reclamation) leadership and other decision makers.

Project Background

The Kern Fan Groundwater Storage Project (Project) consists of a regional water bank in the Kern County Groundwater Sub-basin of the San Joaquin Groundwater Basin in Kern County, California that will provide water supply, groundwater and ecosystem benefits. Project facilities will be planned, designed, constructed, owned, and operated by the Kern Fan Joint Powers Authority (JPA) that consists of representatives from the Irvine Ranch Water District (IRWD) and the Rosedale-Rio Bravo Water Storage District (RRBWSD). IRWD and RRBWSD share a ten-year history of implementing successful water banking projects in Kern County.

The Project will construct conveyance, recharge, and recovery facilities as necessary to develop a fully functioning water banking project. It includes up to 1,280 acres of land to be developed as recharge facilities located at two different sites containing approximately 640-acres of land each. It includes up to twelve (12) new extraction wells and associated pipelines, and conveyance of up to 500 cfs from the California Aqueduct to the recharge facilities.

DEC Team Findings and Recommendations

The DEC Review Team (DEC Team) acknowledges that considerable effort has been invested by the Regional Project Team and the designers (Project Team) to bring the Project to its current level.

The DEC Team has identified four (4) findings and recommendations as will be detailed later in the document.

I. Introduction

A request for a Design, Estimating, and Construction Review on the Kern Fan Groundwater Storage Project, Project Manager, Jack Simes was received from Interior Region 8: Lower Colorado Basin on March 4, 2020. This Project is seeking funding under the Water Infrastructure Improvements for the Nation Act (WIIN) Section 4007 and therefore must perform a DEC Review as stated in Reclamation Manual Directives and Standards (D&S), FAC 10-01 "Identifying Design, Cost Estimating, and Construction Projects for Which Independent Oversight Review is Required, and Performing Those Reviews" [1].

The purpose of the DEC Review process is to provide independent oversight that ensures products related to design, cost estimating, and construction are technically sound and provide a credible basis for decision making by Reclamation leadership and other decision makers. This includes an emphasis to ensure cost estimates for a project are appropriate for their intended purpose, potential fatal flaws in the designs, estimates, or schedules are identified and major risk, and uncertainties have been fully addressed in the estimates and schedules. These reviews are to be conducted with a broad corporate perspective in mind to identify policy, legal, partner/stakeholder, and/or public issues, impacts, and/or ramifications of a corporate nature. A DEC Review is not a substitute for conducting technical or peer reviews (Reclamation Manual, Directives and Standards FAC 10-01.11.f)

The DEC Review Team (Team) consisted of the following Reclamation members:

- Jason Wagner, PE, DEC Team Leader, Reclamation – Technical Service Center, Denver, Colorado
- Kenneth Brockman, PE, Construction Management Team Member, Reclamation – Technical Service Center, Denver, Colorado
- John Fleming, PhD, PGp, Hydrology Team Member, Reclamation - Yuma Area Office, Yuma, AZ
- Derek Nelson, Cost Estimating Team Member, United States Army Corps of Engineers, Walla Walla, WA
- Michelle Norris, PE, Water Conveyance Team Member, Reclamation – Technical Service Center, Denver, Colorado
- Mark Vandeberg, Geology Team Member, Reclamation – Technical Service Center, Denver, Colorado

The Kern Fan Groundwater Storage Project DEC Review is based on project documents, a technical project briefing, and a site visit. The project documents were provided by the Project Team as the initial step of the DEC Review and are listed in Appendix A.

On Tuesday, June 2, 2020, the Team was briefed by the Project Team and completed a virtual site visit of the Kern Fan Project. The site visit included the location of the turnout from the California Aqueduct, canal alignments, recharge pond locations and recovery well locations . See Appendix B for a list of participants in the briefing.

The DEC Team deliberated remotely via Microsoft Teams on Monday, June 8, 2020 through Thursday, June 11, 2020, including a question and answer session on Tuesday, June 9, 2020 with the Project Team. On Friday, June 12, 2020, the DEC Team presented their draft findings and recommendations. See Appendix C for a list of participants.

IRWD and RRBWSD responded to the draft findings and recommendations on June 9, 2020. The DEC Team reviewed the responses and included revisions to the report based on that review. See Appendix D for the responses received from IRWD and RRBWSD.

II. Project Background

The Kern Fan Groundwater Storage Project (Project) consists of a regional water bank in the Kern County Groundwater Sub-basin of the San Joaquin Groundwater Basin in Kern County, California that will provide water supply, groundwater and ecosystem benefits. Project facilities will be planned, designed, constructed, owned, and operated by the Kern Fan Joint Powers Authority (JPA) that consists of representatives from the IRWD and the RRBWSD. IRWD and RRBWSD share a ten-year history of implementing successful water banking projects in Kern County. The Project concept, sizing, location, features and operations are based on the experience and knowledge gained from IRWD's and RRBWSD's existing water banking projects.

The total storage capacity to be developed by the Project is anticipated to be 100,000 acre-feet. The Project will be supplied primarily by the State Water Project's supplies that exceed the SWP Contractors allocation during a wet year (Article 21 supplies) and also by other wet-year water supplies as available, including Kern River water. In wet years, when it is declared available by the California Department of Water Resources (DWR), the JPA will take delivery of Article 21 supplies to store in the Project. IRWD and RRBWSD will equally share 75 percent of the Article 21 water delivered into storage for water supply and groundwater benefits. The remaining 25 percent of the stored Article 21 water will be held as State Water Project (SWP) system water that will be used for ecosystem benefit purposes. The ecosystem benefits will be derived by exchanging water from the Kern Fan Project to Oroville Reservoir where they will be released as needed for short term pulse flows. This exchange will be coordinated through a separate agreement. Other water supplies that could be available for the Project include other SWP supplies diverted from the California Aqueduct, as well as other supply sources including Central Valley Project Section 215 flood water and high-flow Kern River water.

The Project objectives are to cost-efficiently recharge and store groundwater for subsequent recovery to address the following:

- Enhance water supply reliability;
- Reduce imported water demands on the San Francisco Bay/Sacramento – San Joaquin Delta Estuary to benefit spring and winter-run Chinook salmon;
- Provide water supply during drought conditions;
- Provide water supply for emergency response benefits;
- Establish temporary wetlands through intermittent recharge events that will attract migratory and other waterfowl in Kern County;
- Benefit the water levels in the Kern County Groundwater Sub-basin;
- Provide sustainable water supply for local agricultural use; and
- Be integrated into other water storage projects and storage reservoirs to provide greater statewide benefits.

The Kern Fan Groundwater Storage Project consists of development of a regional water bank in the Kern County Groundwater Sub-basin of the San Joaquin Groundwater Basin in Kern County, California. The Project will construct conveyance, recharge, and recovery facilities as necessary to develop a fully functioning water banking project. It includes up to 1,280 acres of land to be developed as recharge facilities located at two different sites containing approximately 640-acres of land each. It includes up to twelve (12) new extraction wells and associated pipelines, and conveyance of up to 500 cfs from the California Aqueduct to the recharge facilities.

Schedule

The following schedule was presented to the DEC Team by the Project Team in the June 2, 2020 Project Briefing and shows an approximate timeframe of 6 and ½ years.

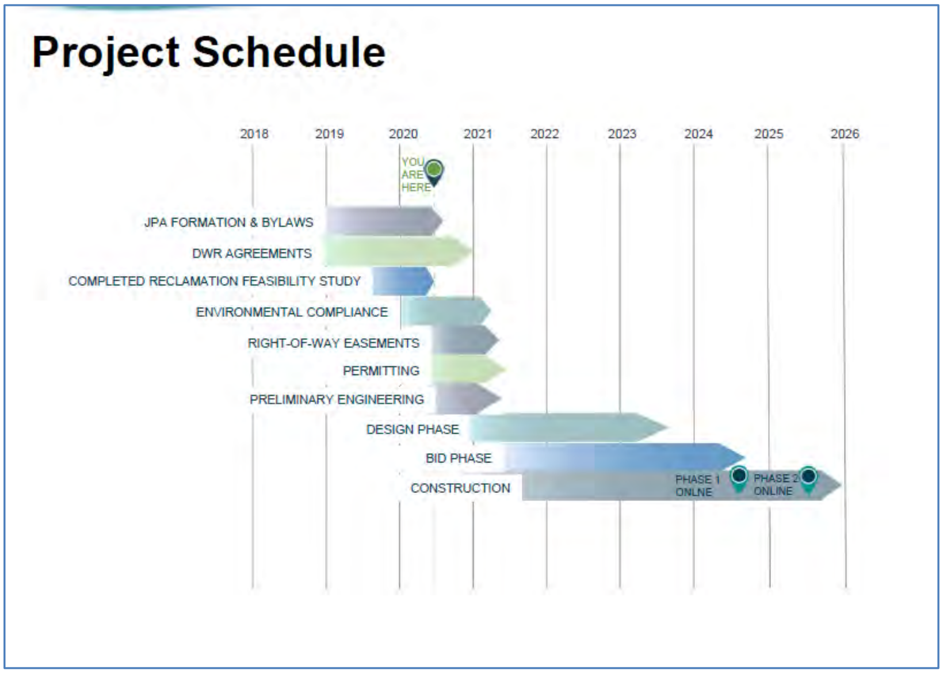

Figure 1 – Project Schedule

Costs of Project

Subtotal cost of the Project is shown in Figure 2 below; total construction cost is shown in Figure 3. Project cost charts were not updated based on the information provided in the responses in Appendix D.

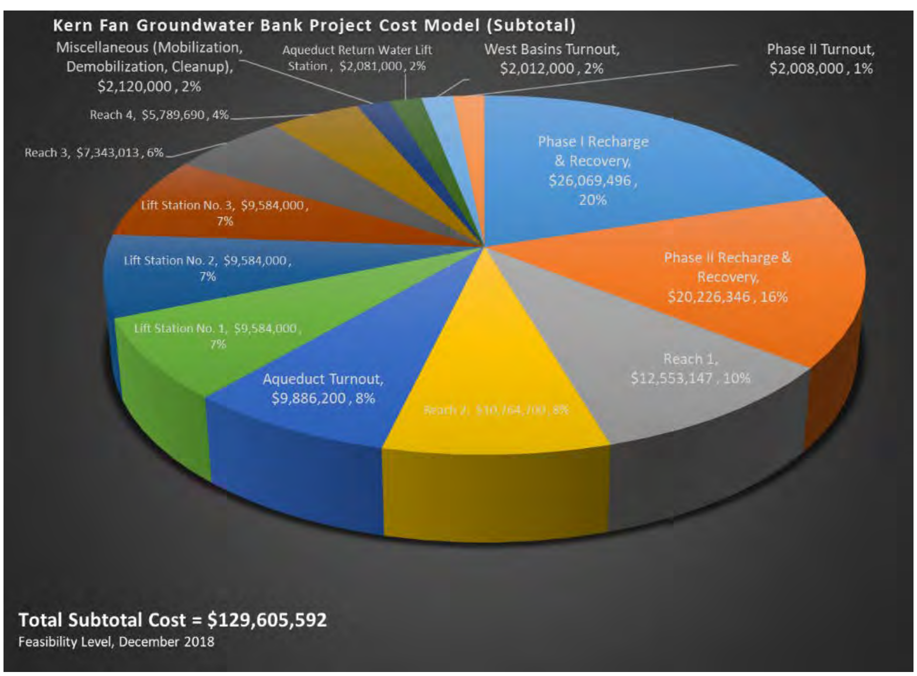

Figure 2 – Total Subtotal Cost

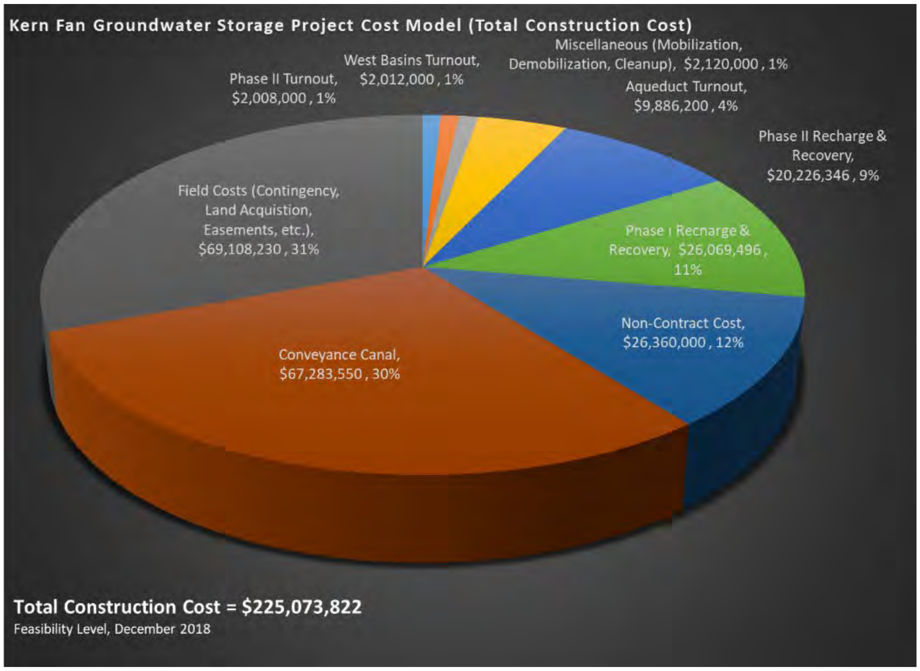

Figure 3 – Total Construction Cost

III. Findings and Recommendations

The Team acknowledges that considerable effort has been invested by the Project Team to bring the Project to its current level. The Team has identified four (4) findings and recommendations. The following are the findings and recommendations of the Team.

DECKERN-01

Finding: There are no operational plans or contingencies to mitigate high arsenic levels during system startup, if arsenic levels increase over time, or arsenic Maximum Containment Level (MCL) is reduced.

Recommendation: Develop operational and monitoring plans with contingencies to handle startup conditions, potential increases in arsenic concentrations, and lower MCLs established in the future.

Discussion: There is a potential for recovered water to exceed the MCL for arsenic and other contaminants of concern.

Arsenic is present in the project area, and local ASR (Aquifer Storage and Recovery) recovery water. An operational plan should be developed to monitor well discharge at startup and adjust as necessary to assure that discharges do not exceed the MCL for arsenic. Existing similar facilities in the project area may have operational plans that can be used or modified for this project, such as blending water from wells that have elevated arsenic with water that has lower levels.

There is a potential for arsenic levels to increase over time as water is infiltrated from the basins. A monitoring plan should be developed to track arsenic concentrations and a contingency plan developed to adjust as needed. The relatively short period of operation for the existing Rosedale-Rio Bravo Management Area may not be able to adequately quantify this risk. The Project Team should investigate any precedence for arsenic levels remaining unchanged after long term intermittent well pumping.

Many jurisdictions are considering reducing MCL levels, and there is a possibility that the MCL for arsenic may be lowered during the life of this project. The MCL for arsenic has been lowered from 50ug/l to 10 ug/l over the last 20 years. A contingency plan for a decreased MCL should be developed, including monitoring and adjustment of operations. If this were to occur in the California Aqueduct, then the amount of recovered water that could be returned to the canal may be reduced.

The Project Team described their system of blending water sources to maintain the MCL level. If the MCL were to be reduced, several wells may become unavailable to supply recovered water to the California Aqueduct. It is unclear to the DEC Team if lowering MCL levels would have any impact on local agricultural use of the recovered water.

Mitigation for high levels of arsenic, such as water treatment, have not been included in the Feasibility Report. Although it may not be feasible, water treatment should be discussed in the Feasibility Report. It is not clear if any of the water recovered in private wells is used for drinking water purposes.

Additional information is included in the General Discussion section.

DECKERN-02

Finding: As currently designed the recharge basins may not meet the requirements for classification as an intermittent wetland.

Recommendation: Determine requirements for creation of intermittent wetlands, and update design and cost estimate to include these features.

Discussion: For areas to be considered jurisdictional wetlands, certain design features and project conditions must be met. These can include sustainability, depth to groundwater, diversity of wetland plant species, transitional zones of vegetation based on available water, presence of hydric soils, and depth of open water. As designed, the ponds may not meet the requirements for jurisdictional wetlands.

The functionality of the recharge ponds as wetlands may be relatively low as designed. Information provided in the Feasibility Study shows that water for recharge of the basins was available 16 of 81 years between 1922 and 2003, or 20% of the time. The remainder of the time the basins will be dry. Recharge is expected to occur in the winter months and the water will likely infiltrate before wetland vegetation could get established. The 4:1 side slopes of the basins provides a relatively narrow riparian area that will be seeded with dryland grass species. Flatter slopes and wetland vegetation should be considered. When full, the majority of the basins area will be open water, providing little habitat.

The addition of these features will increase the project cost. The cost estimate should also include the cost of wetland maintenance, as they may remain dry for long periods.

Additional information is included in the General Discussion section.

DECKERN-03

Finding: The overall project cost contingency appears to be low for the current level of design.

Recommendation: An evaluation of cost risk should be undertaken to determine an adequate level of contingency. Risks should be captured for both project dollars and project schedule.

Discussion: The current estimate on the preferred alternative includes a 20% contingency for construction. That is 20% contingency on $129,605,592 or $25,921,118.

The Total Project Cost of $225,073,822 carries no further contingency. This equates to total project contingency on the total project of 11.5%. Historically at the feasibility level and the current level of design and cost definition the total project contingency is typically in the range of 20-50% on Federal Projects.

DECKERN-04

Finding: There are several deficiencies within the Feasibility Study that as a whole may result in higher project costs or reduced benefits.

Recommendation: Evaluate and document the items listed below.

Discussion: During the review, many additional documents were provided to the DEC Team. The Team had limited ability to review all these additional documents within time constraints. However, many previous concerns were alleviated with the additional information. It is possible that other documents also exist that may document design of the features of concern mentioned below.

A Reclamation Feasibility Report would contain all pertinent documents within the report or its appendices. Although beneficial, this format is not a requirement for non-Reclamation projects.

The items the DEC Team identified, and were unable to locate, or unable to review (due to receiving them during, and not prior to the DEC Review) include the following.

- The proposed lining system is expensive, and other lining systems should be considered. This concern was improved based on information provided and included in Appendix D of this report.

- The basis for cut and fill quantities is unclear.

- The lifespan of facilities may be reduced due to their intermittent usage
- Operation and Maintenance as it relates to wells, well pumps, and lift station pumps is unclear. This concern was improved based on information provided and included in Appendix D of this report.
- This information may be available in one of the documents provided during the DEC Review, but was not reviewed as of the publication of this report.

IV. General Discussion

As a result of the project data review, project briefing, and site visit, the Team has the following general observations as they relate to the technical aspects of the Project. These general observations are not intended to present the Team's findings and recommendations but are only general observations made by the Team during their review.

Design

The following is a general discussion of the Team's findings as they relate to the design elements presented.

Canal Lining Type

The Feasibility Report highlights three canal lining options – concrete, HDPE liner, and earthen (or some combination thereof). While estimates have been generated for each of the three lining options for the preferred alignment, hydraulics have not been calculated for each lining alternative.

The construction of the canal and its lining system is the cost driver of the project. The selection to use concrete lining in the canal appears to be a choice that was made early in the design process. The concrete lining option contains a full hydraulic analysis. However, the other lining options have not been evaluated to the same level.

Concrete lining is the assumed alternative for the hydraulic analysis presented in the Feasibility Report. The hydraulics associated with concrete lining determine the lift station requirements, power costs, and OM&R cost estimates – all of which are lower than they would be with other lining alternatives

The concrete lining is a significant cost contributor for this design. A full hydraulic analysis of each lining alternative, paired with updated lift station requirements/OM&R costs, would better inform the cost decision related to canal lining lifespan vs. initial cost. An option such as shotcrete, for example, may provide a comparable lifespan for a reduced cost, despite reduced hydraulic efficiency.

This concern was improved based on information provided and included in Appendix D of this report.

Turnout from Canal

The connection to the California Aqueduct would be similar to others recently constructed. It is recommended the team evaluate the lessons learned from the other successful connections to aid in the design.

O&MR for Recharge Basins

The accumulation of fine sediments, either windblown or delivered with the recharge waters, coupled with the development of algal mats can result in an appreciable reduction in infiltration performance within the recharge basins. To ensure optimal infiltration rates within the recharge basins, routine periodic maintenance will need to be carried out. Is there a proposed routine O&MR plan to mitigate potential reductions in infiltration performance? During the site visit there was mention of seeding the banks to mitigate Russian Thistle propagation but no mention of seeding the basins themselves. Seeding the basins may be an attractive option.

Operation and Maintenance for Wells

OM&R costs – Assumptions for rehabilitation, maintenance, and possibly replacement of wells was not included in the Feasibility Report, Appendix D – Engineering Designs and Costs. Although typically less for recovery wells than injection wells, periodic well maintenance and rehabilitation programs are often required to maintain well efficiency. Pumps and motors are removed to accommodate chemical and/or physical rehabilitation of the wells.

Chemical methods include injecting solutions (Phosphoric, sulfamic, citric, hydrochloric, hydroxyacetic etc.) and chemicals into the wells to remove specific types of mineral incrustation, biological fouling and physical plugging from silts, sands and clays.

Mechanical methods use high pressure water with either fixed or rotating jetting nozzles at varying pressures to remove incrusted material from the well screen.

Frequency of these cleaning would vary based on many factors such as water quality, duration/rate/frequency of pumping, and amount of time that wells are left idol.

We recommend that a well maintenance and well pump replacement schedule, along with possible well replacements be developed, and appropriate costs represented.

- The lifespan of facilities may be reduced due to their intermittent usage. A project design life is presented; however it is unclear if this includes periodic replacement of components such as well pumps, lift station pump motors and turbines.

- Operation and Maintenance as it relates to wells, well pumps, and lift station pumps is unclear. The Pond OM&R is also unclear. The assumptions related to these should be quantified.

Compatibility of Water Chemistry Between Canal and Aquifer

Water quality of canal water delivered to infiltration ponds is likely of a different quality and water chemistry than native groundwater. A common water quality problem associated with ASR projects is elevated concentrations of dissolved solids, or salts. The major soluble cations (calcium, magnesium and sodium) and anions (sulfate, chloride and bicarbonate) are often higher in recharge water than in native groundwater. Over time, this can lead to mineral precipitation in the vadose zone and a reduction of permeability and infiltration rates. Has the potential for mineral precipitation been identified or quantified?

Non-Recoverable Percentages / MOU rather than science based

Memorandums of understanding (MOUs) for water losses have been established for the project. The Kern Fan Groundwater Storage Project Feasibility Report states that “Surface evaporation losses are assessed at 6%, migration losses are assessed at 4% and water recharged for out-of-County uses is assessed an additional 5%.” These loss percentages were subsequently used in a numerical groundwater model to analyze the portion of the Project water that would remain in the basin and the groundwater level benefits over a 50-year project. However, based on documents that were initially provided, it was not evident as to how these loss values were determined. **This appears to be adequately addressed on page 32 of the Groundwater Sustainability Plan for the Rosedale-Rio Bravo Management Area.**

The recoverable amount of water is unclear. The Feasibility Report provides a reference to a MOU, but it is unclear the science that went into determining the MOU values. The recoverable water percentages should be based on measurable success of neighboring projects. The recovery percentage is a direct factor in quantifying the project feasibility. Monitoring and modeling should be provided to verify that the recoverable water percentages stated in the MOU are being met.

Arsenic

Appendix B: Environmental Documentation in the Feasibility Report states that “Arsenic concentrations in the groundwater typically increase with increasing depth in the aquifer system. Including shallower perforations in the intermediate aquifer, which has lower arsenic concentrations, may provide more blending potential for the wells and result in lower arsenic concentrations in the recovery discharge."

The Feasibility Report does not expand on the potential for exceedance of the arsenic standards or include provisions for monitoring and reporting or procedures for blending water to achieve the standards. However, additional information provided by the irrigation districts indicates that programs have been developed at similar operations in the area to address this risk.

There is an additional risk that the MCL for arsenic may be lowered during the lifetime of this project. The MCL for arsenic has been lowered from 50 ug/l to 10 ug/l over the past 20 years. Lowering the MCL further could make achieving the standard more difficult and costly in the future.

There is also the potential that the arsenic concentration in the groundwater could increase over time as more water is introduced to the aquafer.

Contingency plans could include installing new wells in lower concentration areas, changing pumping rates, or isolating high concentration areas within existing wells. Other options may be obtaining new sources of water with lower concentrations of arsenic or installing more wells in higher quality areas.

Wetland Design

Section 1.4.2 of the Feasibility Report, Ecosystem Benefits, states "The Kern Fan Project will also provide intermittent wetland habitat along the recharge basins where marsh-like environments are established during recharge periods and create ideal habitat for waterfowl, shorebirds, raptors, and other native and migrating birds. These conditions are stated to exist whenever recharge activity occurs on the Project sites. The intermittent wetland habitat provided by the Project will be approximately 1,200 acres in size, which is the area of the recharge ponds. Water will be typically recharged at the Project sites during the winter months and will provide temporary habitat during wet, above normal, and normal water years when recharge activity occurs."

It should be noted that the functionality of the recharge ponds as wetlands may be relatively low as designed. Information provided outside of the FS shows that water to recharge the basins was available 16 of 81 years between 1922 and 2003, or 20% of the time. The remainder of the time the basins will be dry. Recharge is expected to occur in the winter months and the water will likely infiltrate before wetland vegetation could get established. The 4:1 side slopes of the basins provides a relatively narrow riparian area that will be seeded with dryland grass species. When full, the majority of the basins area will be open water, providing little habitat.

Monitoring Wells

Section 2.1.2.2 of the Kern Fan Groundwater Storage Project Feasibility Report states that the agreed upon MOUs include details regarding project monitoring responsibilities. Based on a review of Groundwater Sustainability Plan for the Rosedale-Rio Bravo Management Area, a robust groundwater monitoring system is currently in place. In reviewing Appendix D of the Kern Fan Groundwater Storage Project Feasibility Report, there does not appear to be an accommodation for the installation of additional monitoring wells. However, it is understood that the proposed 12 recovery wells will be fitted with access ports for measuring static water levels. Will there be any additional monitoring wells installed for this project?

Leaching of Embankment Materials; Arsenic, Hazardous materials, Salts

There is a potential to mobilize Arsenic and other contaminants as a result of recharge water infiltration through the vadose zone. The Kern Water Bank Storage Project Within the Kern Groundwater Authority Groundwater Sustainability Plan, August 25, 2019 mentions a concern by DWR regarding the mobilization of contaminants and the potential for degradation of water quality in the underlying the aquifer. This report states that the mitigation measures necessary to reduce this potential impact to a less than significant level would consist primarily monitoring. The report goes further to state that groundwater quality was not being degraded and the aquifer was indeed benefitting from the water banking activities. What monitoring measures would be implemented by this project to ensure that groundwater was not being negatively impacted by mobilization of contaminants? What mitigation measures would be put in place if monitoring were to show mobilization of contaminates?

Within the documents provided there did not appear to be any discussion related to the disposal of potentially contaminated soils. Appendix D (Engineering Designs and Costs) of the Kern Fan Groundwater Storage Project Feasibility Study contains line items for the costs related to disposal of drill cuttings. However, there are no specifics regarding the handling and disposal methods. In In addition there do not appear to be any plans for disposal of potentially contaminated near-surface soils that may be encountered during construction and excavation activities.

Estimating

The following is a general discussion of the Team's findings as they relate to the estimating elements presented.

Location of Recharge Ponds

The virtual site visit revealed that the location of the Phase I recharge basin may change during final design. If the location changes significantly, this could impact the alignment of the canal, land acquisition agreements, and associated costs.

Reclamation of Disturbed Areas

The estimate does not include reclamation of disturbed areas**.** This would include all disturbed areas including contractor use areas, the area adjacent to the canal where equipment or trucks are operating, any constructed haul roads and the recharge basins. Also, if special considerations are required along the alignment to mitigate for habitat loss, nesting seasons etc during construction this likely would impact both project schedule and cost.

Cut and Fill Earthwork

The report did not detail the basis of earthwork volume estimates and costs. Three canal cross-sections were provided. If earthwork volumes were based only on an average of the three presented cross-sections, cost estimates may need significant revision once full topography data is available. A developed cut and fill balance will identify potential needs for specialized materials that need to be imported from off-site and help to determine if there are excess materials that will require disposal or identify a need for additional materials to be imported.

Many times, the materials excavated on projects do not meet the requirements for backfill and will require disposal. The proposed alignment currently goes through existing agricultural lands and may further drive cost for disposal. Rough "rule of thumb" pricing for additional costs are $1/Cubic Yard/Mile addition to the purchase price of materials.

Assumptions for special fill (levees, for example) were not defined. If special fill characteristics (gradation, soil types, compaction effort) were not accounted for, the actual cost will be higher. Imported specialized materials may be required such as riprap armoring, pipe bedding, structural backfill etc. This cost does not appear to be captured in the current estimate and could potentially drive material pricing for the project.

Additionally, any contaminated soil encountered could significantly increase the cost for disposal.

This concern was improved based on information provided and included in Appendix D of this report.

Fuel Pricing

Fuel pricing has recently reduced in response to the COVID-19 pandemic. It is anticipated that fuel pricing will normalize to pre-pandemic levels and may impact future costs if they utilize the recent lower pricing in cost estimates this will understate the cost of the project.

Construction

The following is a general discussion of the Team's findings as they relate to the construction elements presented.

Utility Locations

The drawings do not show locations of overhead and underground utilites. These should be added as the design progresses. Power poles within the alignment of the canal may require relocation and underground utilities such as gas lines and fibre optic lines may need special consideration.

Recharge Facility

The drawings for the recharge facility indicate that the contractor is responsible for excavating the basins to provide a cut/fill balance for the levees. No top elevations for the levees were included. It is difficult to verify what the depth of the basins will be or if there is adequate material to construct the levees. The estimate sheets in the feasibility study show a need for 30,000 cy for the Phase I Pond and 65,000 cy for the Phase II Pond. A borrow area for the additional material should be identified

Also, the tolerance of +/- .01 foot in the bottom of the basin may increase the cost of construction.

Canal Earthwork

The estimate sheets show an excess cut of 70,000 cy for the entire 9 miles of canal but the cut/fill balance per reach varies. If fill is required to be hauled a few miles this could impact the construction costs. Also, a disposal area for excess material should be identified.

Canal Adjacent to Existing Recharge Basin

The reach of canal starting about ¾ mile downstream of the California Aquaduct is adjacent to an existing recharge basin on Hydrogen Energy California LLC property. Concerns were raised that dewatering may be required during construction. A discussion with the design engineers indicated that provisions will be made to construct this reach when the basin is dry or to construct a berm to keep water away from the new canal during construction. These provisions should be added to the specifications to prevent delay in the project or high dewatering costs.

Dust Control

Provisions for dust control should be added to the specifications.

Programmatic

The following is a general discussion of the Team’s findings as they relate to the programmatic aspects presented.

Creation of Regional Water Authority

The Feasibility Report indicates that a Groundwater Banking Authority (a Joint Powers Authority) has been formed between the IRWD and Rosedale to develop and implement the Project. It appears, however, that if the East Side Canal alignment alternative is selected, the conveyance facility would have to be shared and coordinated with other entities, rather than being solely owned and operated by the Kern Fan JPA. Removing the East Side Canal Alternative would reduce the risk to the project.

Shasta Dam Raise

Shasta Dam Raise is an ongoing project Reclamation is undertaking to increase water storage supply. If Shasta Dam Raise is implemented, the need for additional storage may be nullified. However, the Project does provide additional storage diversity which Shasta Dam Raise does not.

California State Park Land

The Kings Basin Water Authority (KBWA) canal alignment passes through the California State Park property. Selection of this alternative would add risk to the project, by constructing a canal through lands which do not currently have access to surface water.

V. References

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Appendix A

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- Irvine Ranch Water District and Rosedale-Rio Bravo Water Storage District. Updated April 13, 2020. *Kern Fan Groundwater Storage Project Feasibility Report: Appendix I: Groundwater Technical Report.* Report Appendix.
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Appendix B

Kern Fan Groundwater Storage Project
Project Briefing, June 2, 2020

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Fiona Sanchez	Irvine Ranch Water District
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Paul Weghorst	Irvine Ranch Water District
Kellie Welch	Irvine Ranch Water District

Appendix C

Kern Fan Groundwater Storage Project
DEC Team Out Briefing, June 12, 2020

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Appendix D

Responses to findings and recommendations from Irvine Ranch Water District and Rosedale-Rio Bravo Water Storage District

Kern Fan Groundwater Storage Project

RESPONSE TO DEC REVIEW FINDINGS

Addendum No. 1: Arsenic Mitigation

July 1, 2020

Irvine Ranch WATER DISTRICT

Rosedale-Rio Bravo WATER STORAGE DISTRICT

Addendum No. 1 – Arsenic Mitigation

Design Estimating and Construction (DEC) Review

Finding #1:

Mitigation for Arsenic: There were no operational plans or contingencies to mitigate for Arsenic during start-up or if the MCL drops from 10 to 5 ppb. Current practice of blending was not addressed in feasibility study. The recommendation is to develop operational plans in the final document to monitor well discharge and adjust as necessary.

Response to Finding #1

- The Rosedale-Rio Bravo Water Storage District (RRBWSD or District) monitoring well data that is closest to the Kern Fan Groundwater Storage Project indicates that the Arsenic concentrations in the groundwater aquifer are going down over time.
- During the construction of the recovery water wells for the Kern Fan Groundwater Storage Project, efforts will be made to identify the high Arsenic concentration areas to be avoided so that a well casing design can be developed that avoids the higher Arsenic concentrations and results in a completed well with Arsenic below the maximum contaminant level (MCL).
- Water pumped from wells are blended together in order to ensure that the Arsenic concentration in the discharge water to the canal will be below the MCL.
- RRBWSD and IRWD will be able to manage and operate the wells in a manner that ensures the Arsenic concentrations are below the MCL prior to discharging to the Cross Valley Canal or the California Aqueduct. Arsenic concentrations are regulated by managing how the wells are pumped (which wells on or varying the speed of the VFD's) and also by blending of the recovery wells.
- It is important to note that pump-in operations are blended with several other local groundwater banking operations. Background Arsenic in the California Aqueduct is about 2.3 parts per billion (ppb). After receiving inflow from the various Kern County banking projects there is a modest increase to only 2.8 ppb, well below the MCL of 10 ppb or a potential 5 ppb MCL in the future.
- The RRBWSD will be responsible for the testing and monitoring of the recovery water wells. They will test the wells as required by the Kern County Water Agency (Cross Valley Canal) and the Department of Water Resources (California Aqueduct). They will be required to test the Arsenic concentration in the recovery wells every three years. In addition, they will test the Arsenic concentration at the discharge to the canal at the beginning of each recovery event when the wells are turned on and quarterly thereafter.
- Of course, water quality can change over time or water quality regulations can become more stringent such as the Arsenic MCL being reduced from 10 ppb to 5 ppb. RRBWSD and IRWD have contingency plans in place for these occurrences. These plans would enable the District to come into compliance for the new MCL without treating the water to remove Arsenic. These plans would involve further testing, and include the following alternatives:
    - Evaluate the cause of the water quality change in the well. Sometimes plugging of the well screen can impact the water quality. Plugging can restrict the portions of

the screen that yield lower Arsenic concentrations and thus increase the amount of water being drawn in from the higher Arsenic concentrations in other parts of the aquifer. In this event the District would remove the pump and mechanically and chemically rehabilitate the well to remove the plugging. Oftentimes this results in the well returning to its historic Arsenic concentrations.

- Reduce the well yield (pumping rate) by reducing the speed of the VFD. A direct correlation is sometimes achieved between the pumping rate and the Arsenic concentration. This is related to the fact that the shallow water has lower Arsenic and the deeper water has higher Arsenic. If the well is pumping less flow and the pump is above the screened interval, oftentimes the water is coming from primarily the upper portion of the well screen and thus reduces the concentration of Arsenic.
- There are District recovery water wells that have an Arsenic concentration less than 5 ppb. The District may utilize these wells as appropriate for blending purposes to ensure that the discharge water to the canal has an Arsenic concentration less than 5 ppb.
- Within the Kern groundwater basin, the deeper water is generally higher in Arsenic. The District can permanently seal a portion of the lowermost screened section of the well with concrete or bentonite in order to reduce the Arsenic level in the well. This will involve filling in a portion of the well bottom (from the bottom of the well casing up a certain distance on the lower screened interval) with concrete or bentonite and plug off the deeper portions of the well that have higher Arsenic concentrations. This will lower the Arsenic concentration in the well and bring the well back into compliance for Arsenic.

Arsenic Control Operations Plan

I. Introduction

Rosedale-Rio Bravo Water Storage District (RRBWSD or District) and the Irvine Ranch Water District (IRWD) have twenty-four (24) recovery water wells that have been developed in and around the area of the proposed project. Based upon this previous work, it is generally accepted that the Arsenic concentrations increase with depth and that wells can be completed in zones that yield Arsenic concentrations that are below the maximum contaminant level (MCL) of 10 ppb. These wells are summarized below and illustrate the Arsenic findings in the area. This data has been utilized to develop the anticipated construction of wells during the Kern Fan Groundwater Storage Project.

The majority of the District wells and agricultural wells in the area have depths in the range of 400-ft to 800-ft, with municipal supply wells usually deeper than those used for agricultural purposes. The direction of groundwater flow in the District is generally to the northwest due to the groundwater mounding that typically occurs under the Kern River which is south of the District. Figure 1 shows the location of the existing RRBWSD and IRWD wells and the proposed Project Phase 1 and Phase 2 locations.

Water quality monitoring for the recovery wells is performed by RRBWSD on a regular basis. The Department of Water Resources (California Aqueduct) and the Kern County Water Agency (Cross Valley Canal) require Title 22 water quality analyses be performed along with a short list of Constituents of Concern (COC) which include Arsenic, Bromide, Chloride, Nitrate, Sulfate, Organic Carbon, and Total Dissolved Solids. Monitoring is conducted for initial well start-up, periodic well re-testing, and on-going testing during operation. Well data should be no more than three years old. COC tests are required for all collection discharge locations at start-up and quarterly thereafter.

RRBWSD and IRWD must provide water of acceptable water quality in the design and construction of the water wells as well as in the management and operation of the recovery wells. The methods of design, construction, management and operations of the wells include mitigation measures for controlling Arsenic concentrations in blended deliveries to canals. These methods are described in greater detail in the sections below.

Redundant recovery capacity is built in by the project using an average well flow rate goal of 2,250 gpm. Flow capacities of wells are typically designed and constructed at 2,500-3,500 gpm (above the assumed average flow rate) so that if any of the mitigation measures are required the construction of additional recovery wells is unnecessary.

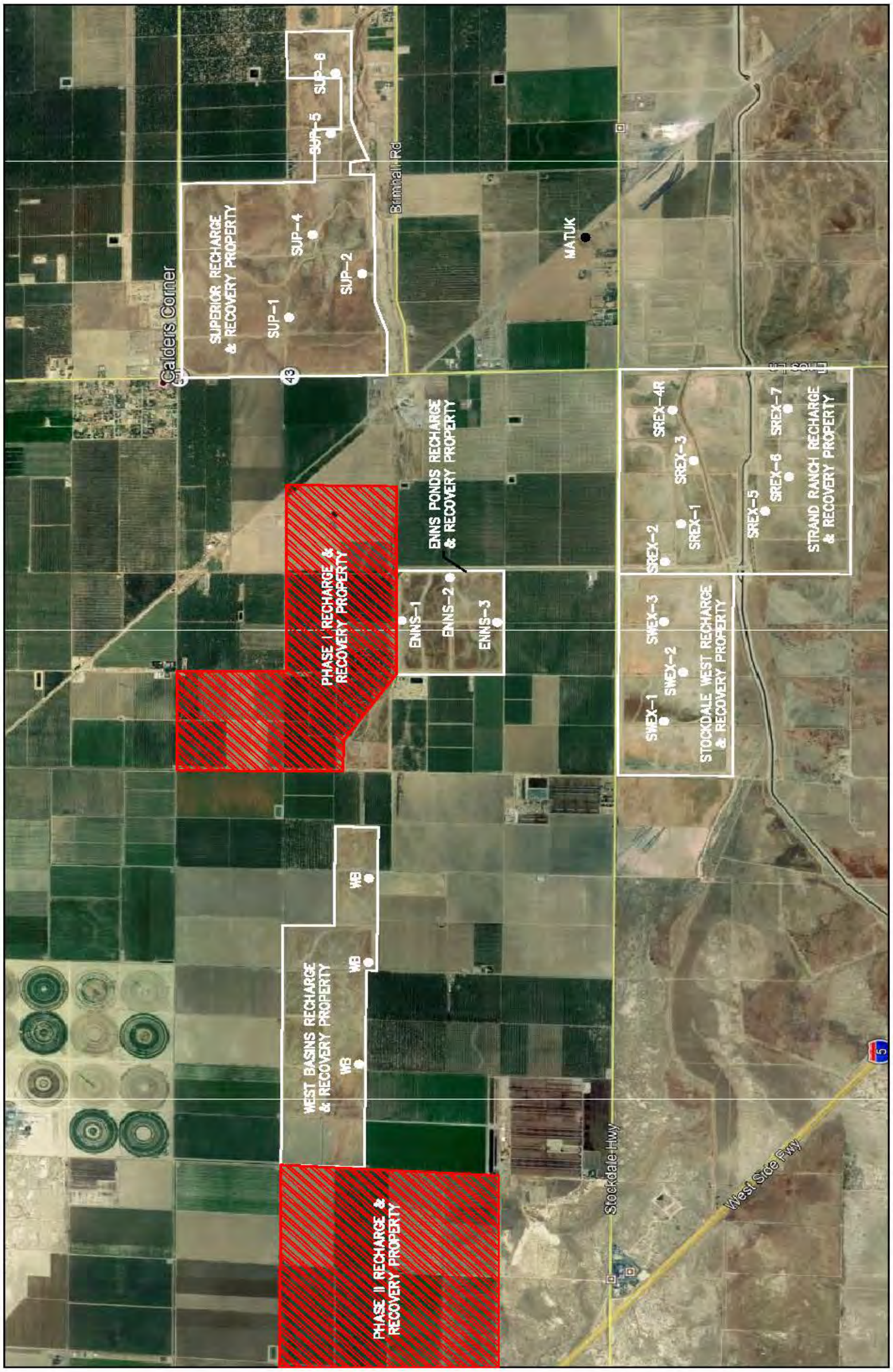


Figure 1: Well Location Map

II. Arsenic Trends Over Time

The District monitoring well data that is closest to the Kern Fan Groundwater Storage Project indicates that the Arsenic concentrations in the groundwater aquifer are going down over time. This is illustrated in Figure 2 below.

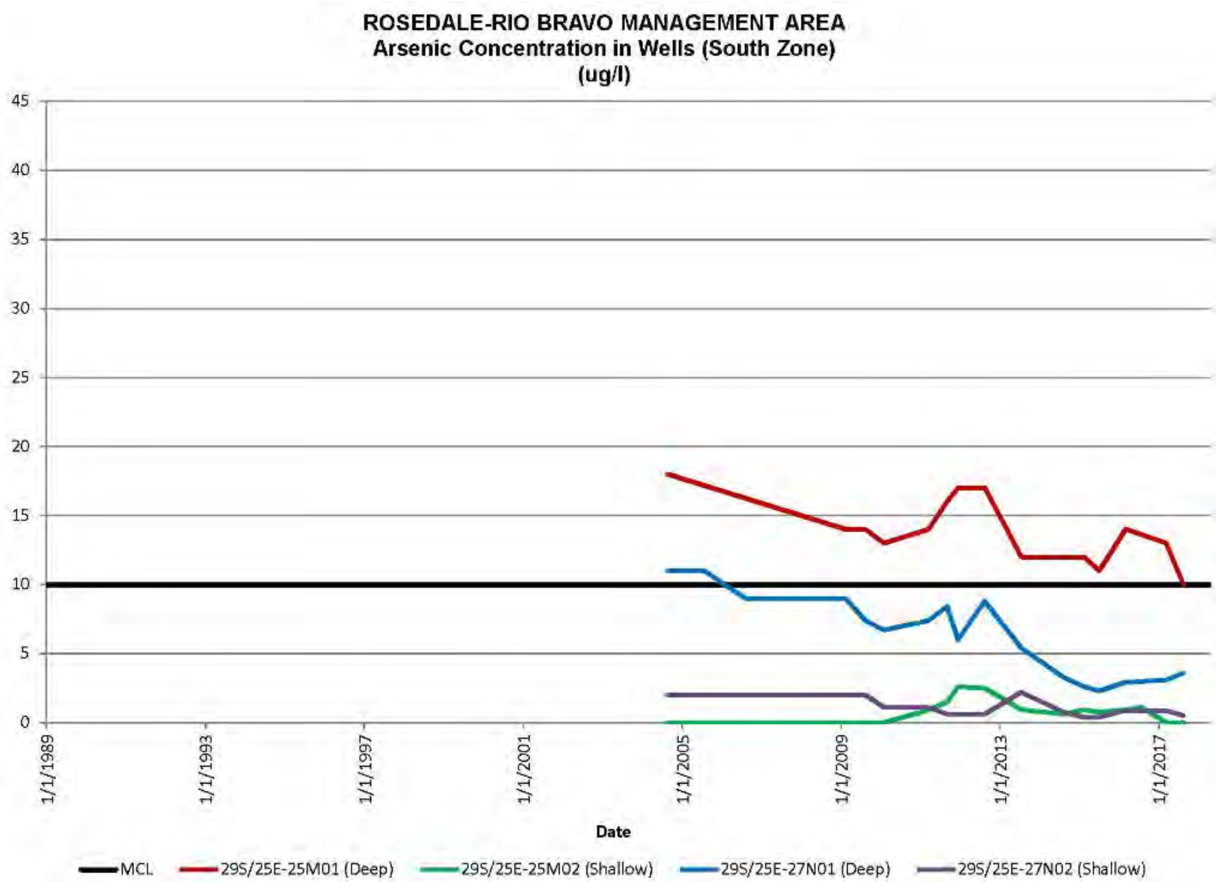


Figure 2: Arsenic Levels in Groundwater Aquifer

III. Previous Well Design and Construction Experience in Mitigating Arsenic Concentrations:

RRBWSD and IRWD have constructed approximately twenty-three (23) recovery wells in the immediate area of the proposed Phase I and Phase II Recharge Facilities for the Kern Fan Groundwater Storage Project. This past experience will be utilized in the design and construction of the project recovery wells. The construction of these previous wells and the Arsenic data compiled from that work is summarized below and tabularized in Table 1.

a. Superior Recovery Wells:

The IRWD and RRBWSD constructed six recovery wells as part of the Drought Relief Project.

SUP-1 is a 20-inch diameter well completed to a depth of 980-ft. The screened interval extends from 370-ft bgs to 535-ft bgs, 565-ft bgs to 660-ft bgs, and also from 790-ft bgs to 960-ft bgs. The Arsenic concentration at the well discharge is approximately 8.4 ppb.

SUP-2 is a 20-inch diameter well completed to a depth of 680-ft. Water quality zone depth sampling was performed in this pilot hole. At a depth of 510-ft bgs to 530-ft bgs the Arsenic concentration was 1.8 ppb. At a depth of 650-ft bgs to 670-ft bgs the Arsenic concentration was 27 ppb. The screened interval extends from 370-ft bgs to 430-ft bgs and also from 460-ft bgs to 630-ft bgs. The Arsenic concentration at the well discharge is approximately 7.6 ppb.

SUP-4 is a 20-inch diameter well completed to a depth of 800-ft. The screened interval extends from 365-ft bgs to 545-ft bgs, 570-ft bgs to 610-ft bgs, and also from 630-ft bgs to 725-ft bgs. The Arsenic concentration at the well discharge is approximately 17.0 ppb.

SUP-5 is a 20-inch diameter well completed to a depth of 690-ft. Water quality zone depth sampling was performed in this pilot hole. The screened interval extends from 370-ft bgs to 560-ft bgs and also from 600-ft bgs to 670-ft bgs. The Arsenic concentration at the well discharge is approximately 9.0 ppb.

SUP-6 is a 20-inch diameter well completed to a depth of 940-ft. Water quality zone depth sampling was performed in this pilot hole. At a depth of 580-ft bgs to 600-ft bgs the Arsenic concentration was 13 ppb. At a depth of 740-ft bgs to 760-ft bgs the Arsenic concentration was 1.2 ppb. At a depth of 1,040-ft bgs to 1,060-ft bgs the Arsenic concentration was 4.6 ppb. At a depth of 1,170-ft bgs to 1,190-ft bgs the Arsenic concentration was 11.0 ppb. The screened interval extends from 410-ft bgs to 610-ft bgs and also from 700-ft bgs to 920-ft bgs. The Arsenic concentration at the well discharge is approximately 15.0 ppb.

Matuk is a 20-inch diameter well completed to a depth of 620-ft. Water quality zone depth sampling was performed in this pilot hole. At a depth of 380-ft to 400-ft bgs the Arsenic concentration was 2.1 ppb. At a depth of 580-ft to 600-ft bgs the Arsenic concentration was 18 ppb. At a depth of 685-ft to 705-ft bgs the Arsenic concentration was 22 ppb. The screened interval extends from 350-ft bgs to 465-ft bgs and also from 495-ft bgs to 600-ft bgs. The Arsenic concentration at the well discharge is approximately 4.2 ppb.

Table 1
Superior Recovery Wells – Arsenic Concentrations

Well Name	Screened Interval	Arsenic Concentration
SUP-1	370-ft to 535-ft, 565-ft to 660-ft, & 790-ft to 960-ft	8.4 ppb
SUP-2	370-ft to 430-ft & 460-ft to 630-ft	7.6 ppb
SUP-4	365-ft to 545-ft, 570-ft to 610-ft, & 630-ft to 725-ft	17.0 ppb
SUP-5	370-ft to 560-ft & 600-ft to 670-ft	9.0 ppb
SUP-6	410-ft to 610-ft & 700-ft to 920-ft	15.0 ppb
Matuk	350-ft to 465-ft & 495-ft to 600-ft	4.2 ppb

The information in Table 1 demonstrates how the Arsenic concentration generally increases with depth in this area and that wells can be completed with Arsenic concentrations below the MCL of 10 ppb if completed generally above a depth of 920-ft. For the two wells above that exceed the MCL of 10 ppb, this was an intentional strategy in order to achieve a greater capacity in the well. It was pre-determined that SUP-4 and 6 would be operated with other Superior and Stockdale East wells and blended in the well discharge piping to a concentration less than 10 ppb prior to being discharged into the Cross Valley Canal.

b. Enns Recovery Wells:
The RRBWSD constructed three recovery wells as part of the Enns Ponds Recharge and Recovery Project. The construction of these previous wells and the Arsenic data compiled from that work is summarized below and tabularized in Table 2.

ENNS-1 is a 20-inch diameter well completed to a depth of 475-ft. Water quality zone depth sampling was performed in this pilot hole. At a depth of 285-ft bgs to 305-ft bgs the Arsenic concentration was <2 ppb. At a depth of 430-ft bgs to 450-ft bgs the Arsenic concentration was 2 ppb. At a depth of 615-ft bgs to 635-ft bgs the Arsenic concentration was 13 ppb. At a depth of 738-ft bgs to 758-ft bgs the Arsenic concentration was 33 ppb. At a depth of 920-ft bgs to 940-ft bgs the Arsenic concentration was 20 ppb. The screened interval extends from 185-ft below ground surface (bgs) to 455-ft below ground surface. The Arsenic concentration at the well discharge is approximately <2 ppb.

ENNS-2 is a 20-inch diameter well completed to a depth of 750-ft. The screened interval extends from 460-ft bgs to 750-ft bgs. The Arsenic concentration at the well discharge is approximately 11 ppb.

ENNS-3 is a 20-inch diameter well completed to a depth of 440-ft. The screened interval extends from 180-ft bgs to 420-ft bgs. The Arsenic concentration at the well discharge is approximately <2 ppb.

The water quality zone sampling performed in ENNS-1 was utilized in the design of all three wells. ENNS-2 was completed deeper and has a higher Arsenic concentration, however the three wells are blended together in order to mitigate the Arsenic level.

Table 2
Enns Recovery Wells – Arsenic Concentrations

Well Name	Screened Interval	Arsenic Concentration
ENNS-1	185-ft to 455-ft	<2 ppb
ENNS-2	460-ft to 750-ft	11 ppb
ENNS-3	180-ft to 420-ft	<2 ppb

As shown in Table 2, the blend of water from these wells was designed to be below the current MCL.

c. Stockdale West Recovery Wells:
The IRWD constructed three recovery wells as part of the Stockdale Integrated Banking Project. The construction of these previous wells and the Arsenic data compiled from that work is summarized below and tabularized in Table 3.

SWEX-1 is a 20-inch diameter well completed to a depth of 640-ft. Water quality zone depth sampling was performed in this pilot hole. At a depth of 461-ft to 481-ft bgs the Arsenic concentration was 2.0 ppb. At a depth of 569-ft to 589-ft bgs the Arsenic concentration was 4.8 ppb. At a depth of 671-ft bgs to 691-ft bgs the Arsenic concentration was 77 ppb. At a depth of 780-ft bgs to 800-ft bgs the Arsenic concentration was 94 ppb. At a depth of 906-ft bgs to 926-ft bgs the Arsenic concentration was 86 ppb. The screened interval extends from 420-ft bgs to 550-ft bgs and also from 570-ft bgs to 620-ft bgs. The Arsenic concentration at the well discharge is approximately 1.8 ppb.

SWEX-2 is a 20-inch diameter well completed to a depth of 650-ft. Water quality zone depth sampling was performed in this pilot hole. At a depth of 465-ft to 485-ft bgs the Arsenic concentration was 2.4 ppb. At a depth of 550-ft to 570-ft bgs the Arsenic concentration was 7.6 ppb. At a depth of 635-ft bgs to 655-ft bgs the Arsenic concentration was 27 ppb. At a depth of 770-ft bgs to 790-ft bgs the Arsenic concentration was 89 ppb. At a depth of 875-ft bgs to 895-ft bgs the Arsenic concentration was 91 ppb. The screened interval extends from 400-ft bgs to 510-ft bgs and also from 550-ft bgs to 610-ft bgs. The Arsenic concentration at the well discharge is approximately 5.9 ppb.

SWEX-3 is a 20-inch diameter well completed to a depth of 640-ft. Water quality zone depth sampling was performed in this pilot hole. At a depth of 490-ft to 510-ft bgs the Arsenic concentration was 2.6 ppb. At a depth of 605-ft to 625-ft bgs the Arsenic concentration was 27 ppb. At a depth of 670-ft bgs to 690-ft bgs the Arsenic concentration was 36 ppb. The screened interval extends from 390-ft bgs to 530-ft bgs and also from 590-ft bgs to 620-ft bgs. The Arsenic concentration at the well discharge is approximately 6.8 ppb.

Table 3
Stockdale West Recovery Wells – Arsenic Concentrations

Well Name	Screened Interval	Arsenic Concentration
SWEX-1	420-ft to 550-ft & 570-ft to 620-ft	1.8 ppb
SWEX-2	400-ft to 510-ft & 550-ft to 610-ft	5.9 ppb
SWEX-3	390-ft to 530-ft & 590-ft to 620-ft	6.8 ppb

The information in Table 3 demonstrates how the Arsenic concentration generally increases with depth in this area and that wells can be completed with Arsenic concentrations below the MCL of 10 ppb if completed generally above a depth of 620-ft.

d. Strand Ranch Recovery Wells:
The IRWD constructed six recovery wells as part of the Strand Ranch Integrated Banking Project. The construction of these previous wells and the Arsenic data compiled from that work is summarized below and tabularized in Table 4.

SREX-1 is a 20-inch diameter well completed to a depth of 670-ft. The screened interval extends from 380-ft below ground surface (bgs) to 650-ft below ground surface. The Arsenic concentration at the well discharge is approximately 6 ppb.

SREX-2 is a 20-inch diameter well completed to a depth of 630-ft. Water quality zone depth sampling was performed in this pilot hole. At a depth of 490-ft bgs to 510-ft bgs the Arsenic concentration was 3.5 ppb. At a depth of 560-ft bgs to 580-ft bgs the Arsenic concentration was 6.0 ppb. The screened interval extends from 410-ft bgs to 610-ft bgs. The Arsenic concentration at the well discharge is approximately 4.3 ppb.

SREX-3 is a 20-inch diameter well completed to a depth of 670-ft. The screened interval extends from 410-ft bgs to 530-ft below ground surface and also from 570-ft bgs to 650-ft bgs. The Arsenic concentration at the well discharge is approximately 5.8 ppb.

SREX-4R is a 20-inch diameter well completed to a depth of 660-ft. The screened interval extends from 410-ft bgs to 560-ft below ground surface and also from 600-ft bgs to 650-ft bgs. The Arsenic concentration at the well discharge is approximately 3.1 ppb.

SREX-5 is a 20-inch diameter well completed to a depth of 690-ft. Water quality zone depth sampling was performed in this pilot hole. At a depth of 250-ft to 270-ft bgs the Arsenic concentration was <2.0 ppb. At a depth of 400-ft to 420-ft bgs the Arsenic concentration was <2.0 ppb. At a depth of 600-ft to 620-ft bgs the Arsenic concentration was 26.0 ppb. The screened interval extends from 410-ft bgs to 505-ft bgs and also from 545-ft bgs to 650-ft bgs. The Arsenic concentration at the well discharge is approximately 16.0 ppb.

SREX-7 is a 20-inch diameter well completed to a depth of 680-ft. Water quality zone depth sampling was performed in this pilot hole. At a depth of 250-ft to 270-ft bgs the Arsenic concentration was <10.0 ppb. At a depth of 400-ft to 420-ft bgs the Arsenic concentration was <10.0 ppb. At a depth of 570-ft to 590-ft bgs the Arsenic concentration was 11.0 ppb. The screened interval extends from 410-ft bgs to 480-ft bgs and also from 520-ft bgs to 660-ft bgs. The Arsenic concentration at the well discharge is approximately 11.0 ppb.

Table 4
Strand Ranch Recovery Wells – Arsenic Concentrations

Well Name	Screened Interval	Arsenic Concentration
SREX-1	380-ft to 650-ft	6.0 ppb
SREX-2	410-ft to 610-ft	4.3 ppb
SREX-3	410-ft to 530-ft & 570-ft to 650-ft	5.8 ppb
SREX-4	410-ft to 560-ft & 600-ft to 650-ft	3.1 ppb
SREX-5	410-ft to 505-ft & 545-ft to 650-ft	16.0 ppb
SREX-6	195-ft to 492-ft	<2.0 ppb
SREX-7	410-ft to 480-ft & 520-ft to 660-ft	11.0 ppb

The information provided in Table 4 demonstrates how the Arsenic concentration generally increases with depth in this area and that wells can be completed with Arsenic concentrations below the MCL of 10 ppb if completed generally above a depth of 650-ft. For the two wells above that exceed the MCL of 10 ppb, this was an intentional strategy in order to achieve a greater capacity in the well. It was pre-determined that SREX-5, 6, & 7 would be operated together and blended in the well discharge piping to a concentration less than 10 ppb prior to being discharged into the Cross Valley Canal.

e. West Basin Recovery Wells:
The RRBWSD constructed three recovery wells as part of the West Basins Recharge and Recovery Project. The construction of these previous wells and the Arsenic data compiled from that work is summarized below and tabularized in Table 5.

WB-1 is a 20-inch diameter well completed to a depth of 810-ft. The screened interval extends from 370-ft bgs to 480-ft bgs, 510-ft bgs to 550-ft bgs, and 610-ft bgs to 790-ft bgs. The Arsenic concentration at the well discharge is approximately 19 ppb.

WB-2 is a 20-inch diameter well completed to a depth of 760-ft. Water quality zone depth sampling was performed in this pilot hole. At a depth of 448-ft bgs to 518-ft bgs the Arsenic concentration was <2 ppb. At a depth of 600-ft bgs to 620-ft bgs the Arsenic concentration was 2.5 ppb. At a depth of 720-ft bgs to 740-ft bgs the Arsenic concentration was 14 ppb. At a depth of 850-ft bgs to 870-ft bgs the Arsenic concentration was 30 ppb. The screened interval extends from 380-ft bgs to 550-ft bgs and from 570-ft bgs to 740-ft bgs. The Arsenic concentration at the well discharge is approximately 2.1 ppb.

WB-3 is a 20-inch diameter well completed to a depth of 770-ft. The screened interval extends from 380-ft bgs to 515-ft bgs and from 540-ft bgs to 750-ft bgs. The Arsenic concentration at the well discharge is approximately 6.0 ppb.

The water quality zone sampling performed in WB-2 was utilized in the design of all three wells. The three wells are blended together in order to ensure that the Arsenic concentration in the discharge water to the canal is below the MCL of 10 ppb.

Table 5
West Basin Recovery Wells – Arsenic Concentrations

Well Name	Screened Interval	Arsenic Concentration
WB-1	370-ft to 480-ft, 510-ft to 550-ft, & 610-ft to 790-ft	19.0 ppb
WB-2	380-ft to 550-ft & 570-ft to 740-ft	2.1 ppb
WB-3	380-ft to 515-ft & 540-ft to 750-ft	6.0 ppb

As shown in Table 5, the blend of water from these wells was designed to be below the current MCL. It was pre-determined that the West Basin wells would be operated with other Enns wells and blended in the well discharge piping to a concentration less than 10 ppb prior to being discharged into the Cross Valley Canal.

f. Stockdale East Recovery Wells:
The RRBWSD constructed two recovery wells as part of the Stockdale Integrated Banking Project. The construction of these previous wells and the Arsenic data compiled from that work is summarized below and tabularized in Table 6.

SE-1 is a 20-inch diameter well completed to a depth of 700-ft. The screened interval extends from 325-ft bgs to 400-ft bgs and 430-ft bgs to 680-ft bgs. The Arsenic concentration at the well discharge is approximately 2.0 ppb.

SE-2 is a 20-inch diameter well completed to a depth of 700-ft. The screened interval extends from 340-ft bgs to 490-ft bgs and from 510-ft bgs to 680-ft bgs. The Arsenic concentration at the well discharge is approximately 1.3 ppb.

The water quality zone sampling performed in Matuk was utilized in the design of these two wells. The wells are blended together, along with the Superior wells, in order to ensure that the Arsenic concentration in the discharge water to the canal is below the MCL of 10 ppb.

Table 6
Stockdale East Recovery Wells – Arsenic Concentrations

Well Name	Screened Interval	Arsenic Concentration
SE-1	325-ft to 400-ft & 430-ft to 680-ft	2.0 ppb
SE-2	340-ft to 490-ft & 510-ft to 680-ft	1.3 ppb

As shown in Table 6, the blend of water from these wells was designed to be below the current MCL.

IV. Project Well Construction to Mitigate Arsenic Concentrations

As illustrated under Section III "Previous Well Design and Construction Experience in Mitigating Arsenic Concentrations", the Arsenic concentrations in this geographic area generally increase with depth. More specifically, Arsenic is known to increase in concentration as the geologic formations change in color from brown to grey in color (which depicts an anoxic condition). This informs the well design and construction and aids in avoiding the water bearing formations that have increased levels of Arsenic.

Prior to Kern Fan Groundwater Storage Project well construction, geophysical logging will be performed in each pilot hole that includes an electric log. The electric log shows the water bearing formations as illustrated in Figure 3 and Figure 4 below. This is a sample electric log from SWEX-2. The lithologic log for the pilot hole is shown on the left hand side of the log as well as the depths where water quality zone sampling was performed.

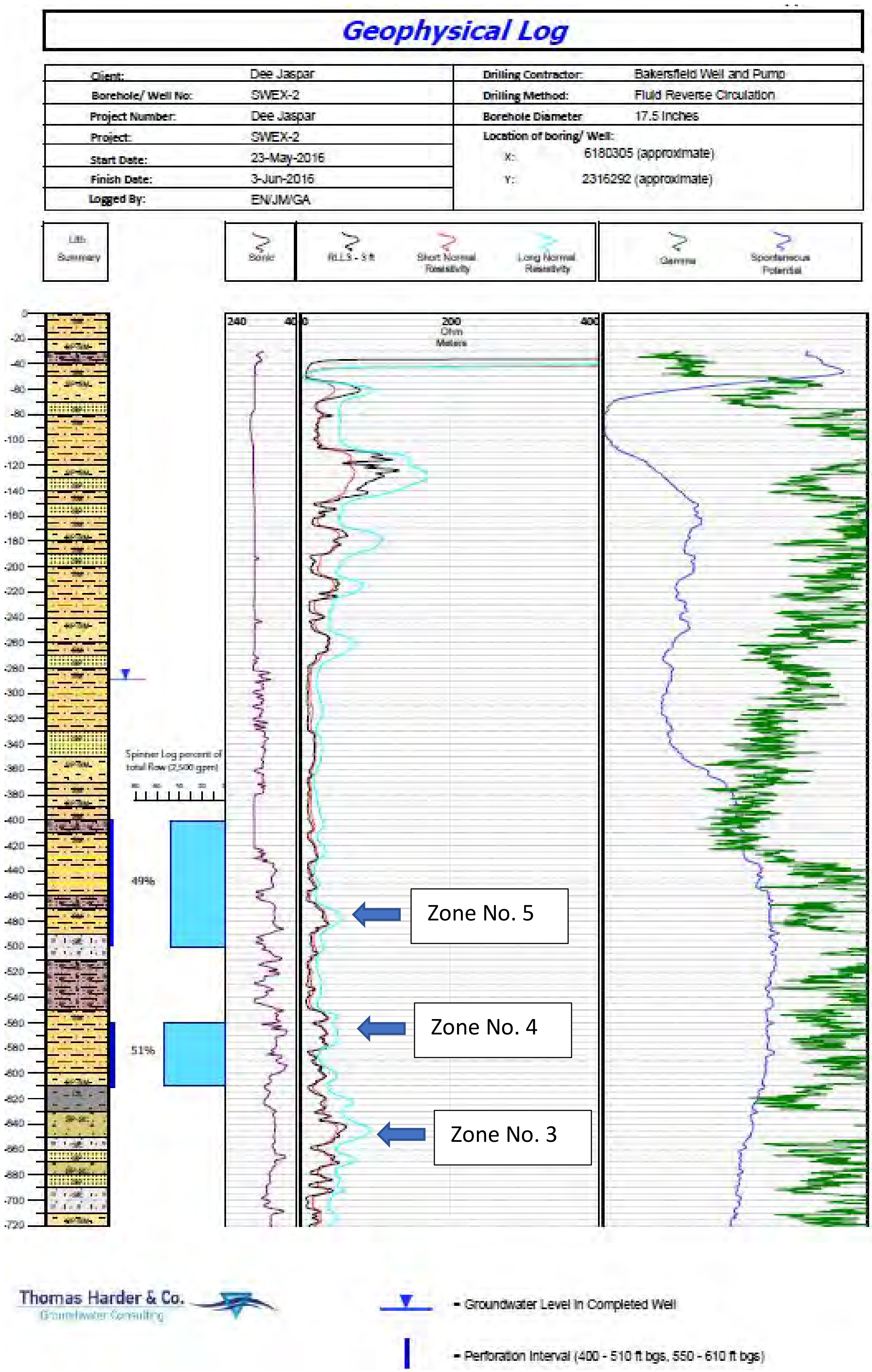


Figure 3: Typical Elog

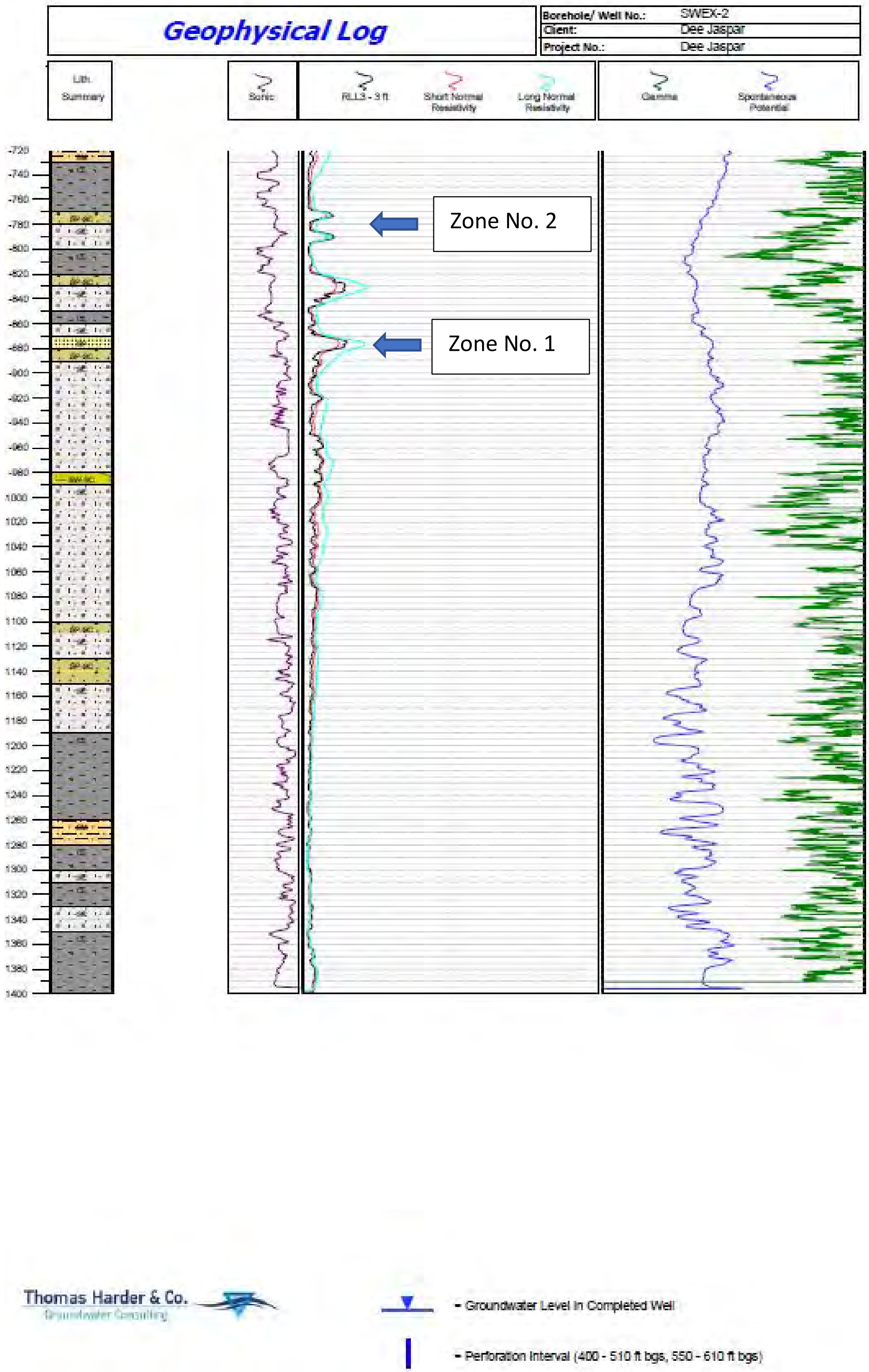


Figure 4: Typical Elog

During the construction of the recovery water wells for the Kern Fan Groundwater Storage Project, water quality depth sampling will be performed in each pilot hole that identifies the Arsenic concentrations with depth so that a well casing design can be developed that avoids the higher Arsenic concentrations and results in a completed well with Arsenic below the MCL of 10 ppb. An example of the water quality depth sampling results is illustrated in Figure 5 using an example from the SWEX-2 well.

Summary of Isolated Aquifer Zone Testing

SWEX-2

			Zone No. 1	Zone No. 2	Zone No. 3	Zone No. 4	Zone No. 5	
	Aquifer Property/ Constituent	Units	875 - 895 ft bgs[1]	770 - 790 ft bgs	635 - 655 ft bgs	550 - 570 ft bgs	465 - 485 ft bgs	Drinking Water Standards / MCL[2]
Water Level and Discharge Rate	Static Water Level	ft bgs	295	297	289	293	293	
	Pumping Water Level	ft bgs	388	349	333	330	386	
	Drawdown	ft	93	52	44	37	107	
	Discharge Rate	gpm[4]	49	144	134	134	78	
	Specific Capacity	gpm/ft	0.5	2.8	3.2	3.6	0.8	
Field Parameters	Temperature	°F[5]	84	79	76	75	74	
	EC	µS/cm[6]	324	198	288	216	346	
	TDS	ppm[7]	270	110	146	131	200	
	pH	Units	7.0	7.2	7.0	7.0	7.0	
Selected Water Chemistry Results	Arsenic	µg/L[8]	91	89	27	7.6	2.4	10[A]

Notes:

[1] ft bgs = Feet below ground surface.
[2] MCL = Maximum contaminant level.
[3] Incomplete recovery following zone testing.
[4] gpm = Gallons per minute.
[5] °F = Degrees Fahrenheit.
[6] µS/cm = Microsiemens per centimeter.
[7] ppm = Parts per million.
[8] µg/L= Micrograms per liter.

[A] California primary MCL.

Highlighted cells indicate results that exceed applicable regulatory standards.

Figure 5: SWEX-2 Zone Test Results

The design of the well casing and screened interval can then be designed to avoid Arsenic. In the above example of SWEX-2, the well was screened from 400-ft to 510-ft and from 550-ft to 610-ft which are the zones where the Arsenic concentration was 2.4 ppb to 7.6 ppb. The completed well had an overall Arsenic concentration of 5.9 ppb. The information above demonstrates that it is feasible to achieve completing wells that are below the MCL for Arsenic. For the wells noted above that exceed the MCL of 10 ppb, this was an intentional design strategy that desired to tap deeper portions of the aquifer. In these cases, it was predetermined that blending of the water with other wells would achieve the desired result of 10 ppb or less prior to discharge of the water to the Cross Valley Canal and the California Aqueduct.

V. Project Well Management and Operation

RRBWSD and IRWD will be able to manage and operate the Kern Fan Groundwater Storage Project wells in a manner that ensures the Arsenic concentration is below the MCL prior to discharging to the Cross Valley Canal or the California Aqueduct. Currently, RRBWSD regularly samples for the Constituents of Concern in the existing wells as required by the Department of Water Resources and the Kern County Water Agency and that sampling frequency is discussed herein.

RRBWSD is able to regulate the Arsenic concentrations by managing how they pump the wells (which wells on or varying the speed of the VFD's) and also by blending of the recovery wells. A blending analysis is outlined below.

Of course, water quality can change over time or water quality regulations can become more stringent such as the Arsenic MCL being reduced from 10 ppb to 5 ppb. RRBWSD and IRWD have contingency plans in place for these occurrences and that is discussed below.

VI. Project Well Arsenic Sampling Frequency

Water quality monitoring will be performed by the District on a regular basis. The Department of Water Resources (California Aqueduct) and the Kern County Water Agency (Cross Valley Canal) require Title 22 water quality analyses be performed along with a short list of Constituents of Concern (COC) which include Arsenic, Bromide, Chloride, Nitrate, Sulfate, Organic Carbon, and Total Dissolved Solids. Monitoring will be conducted for initial well start-up, periodic well re-testing, and on-going testing during operation. Well data should be no more than three years old. COC tests are required for all discharge locations at start-up and quarterly thereafter.

The RRBWSD will responsible for the testing and monitoring of the recovery water wells. They will test the wells as required by the Kern County Water Agency (Cross Valley Canal) and the Department of Water Resources (California Aqueduct). Table 7 shows the required sampling and water quality testing for Arsenic. RRBWSD is required to test the Arsenic concentration in the recovery wells every three years. In addition, they must test the Arsenic concentration at the discharge to the canal at the beginning of each recovery event when the wells are turned on and quarterly thereafter.

Table 7
Arsenic Sampling Frequency

Recovery Facility	Wellhead Sampling	Canal Discharge Sampling
Superior	Every 3 Years	Quarterly while Operating
Enns Ponds	Every 3 Years	Quarterly while Operating
Stockdale West	Every 3 Years	Quarterly while Operating
Strand Ranch	Every 3 Years	Quarterly while Operating
West Basins	Every 3 Years	Quarterly while Operating
Stockdale East	Every 3 Years	Quarterly while Operating

VII. Blending to Mitigate Arsenic Concentrations

Like most existing wells, the Kern Fan Groundwater Storage Project recovery water will connect to a conveyance pipeline that will collect the water from multiple wells prior to discharging into the Cross Valley Canal or in the instance of the Kern Fan Groundwater Storage Project, the project conveyance canal. If any of these wells exceed the MCL of 10 ppb for Arsenic they can be blended with the water from other wells to achieve an Arsenic concentration that is below the MCL. This can be achieved by the District in the following manners:

1. Control which wells are turned on for recovery in order to ensure a proper blend of well water that is less than 10 ppb for Arsenic.

2. Control the yield of the wells by limiting the speed of the variable speed drive (VFD) to ensure a proper blend of well water that is less than 10 ppb for Arsenic.

3. A combination of #1 and #2 above.

The blending of the recovery water wells is an acceptable method of ensuring that the Arsenic concentration is below acceptable limits for returning water to the Cross Valley Canal and California Aqueduct. Blending of multiple water sources prior to discharging water into the State Water Project via the Cross Valley Canal, the project conveyance canal, or the California Aqueduct is an acceptable and sometimes preferred means depending on the water quality of the project water.

Figure 6 below illustrates the "Pump-In" Water Quality Analysis that is performed as part of returning water to the Cross Valley Canal and the California Aqueduct prior to startup of wells. The "Pump-In" operations includes pump-in facilities which are the turn-ins into the Cross Valley Canal. The operation of these pump-in facilities involves the blending of recovery wells and is effective at keeping the Arsenic level below the MCL of 10 ppb. The rare instances when the Arsenic level is shown exceeding the MCL of 10 ppb is the result of not being able to blend with a well that is lower in Arsenic because it is temporarily off-line. Prior to the startup of Kern Fan Groundwater Storage Project wells, a similar "Pump-In" Water Quality Analysis will need to be performed that includes the project wells.

ROSEDALE-RIO BRAVO WATER STORAGE DISTRICT
PUMP-IN WATER QUALITY ANALYSES

Constituent >	Arsenic	Bromide	Chloride	Chromium	Cr+6	EC	NO3	Sulfate	TDS	DOC	123-TCP	Uranium
MCL >	10	—	250	50	—	900	45	—	500	—	0.005	20
Units >	μg/L	mg/L	mg/L	μg/L	μg/L	μmhos/cm	mg/L	mg/L	mg/L	mg/L	ug/L	pCi/L
Date	CENTRAL INTAKE											
2/20/2020	2.3	0.083	22	<0.50	0.55	249	4.7	21	170	0.51	<0.00053	2
3/2/2020	5	0.097	23	<0.50	0.83	249	5.7	20	160	0.55	0.0069	2.1
3/9/2020	2.3	0.11	24	0.97	0.96	262	6.5	20	160	0.55	<0.00053	2.5
3/17/2020	4.9	0.094	22	0.6	0.95	246	5.5	20	170	0.54	<0.00053	2.7
5/22/2020	9.9	0.11	24	1	1	258	5.7	19	170	0.52	<0.00053	2.2
Date	STRAND NTI-2											
2/20/2020	2.6	0.49	92	1.6	1.8	459	9.5	[illegible]	[illegible]	[illegible]	[illegible]	3.5
3/2/2020	3.1	0.48	90	1.2	1.7	437	9.8	24	260	0.82	<0.00053	2.8
3/9/2020	2.7	0.48	90	1.9	1.8	447	10	24	270	0.46	<0.00053	2.7
3/17/2020	2.8	0.47	87	1.3	1.8	440	9.8	24	260	0.58	<0.00053	2.6
5/22/2020	4.6	0.45	83	1.5	1.8	438	9.2	[illegible]	[illegible]	[illegible]	[illegible]	2.4
Date	STRAND STI											
2/20/2020	9.7	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	11	[illegible]	[illegible]	[illegible]	[illegible]	12
3/2/2020	12	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	10	[illegible]	[illegible]	[illegible]	[illegible]	12
3/9/2020	8.8	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	10	30	270	0.4	<0.00053	11
3/17/2020	11	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	9.9	29	270	0.74	0.0044	11
5/22/2020	14	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	8.9	28	270	0.51	<0.00053	11
Date	STRAND NTI-1											
2/20/2020	<0.7	0.37	81	1.1	1.1	492	14	[illegible]	[illegible]	[illegible]	[illegible]	5.3
3/2/2020	1	0.36	78	0.66	1	463	13	33	290	0.47	0.0041	5.2
3/9/2020	1.7	0.35	77	1.3	1.1	477	13	33	280	0.58	0.0054	5.7
3/17/2020	1.6	0.35	76	0.71	1.1	467	13	32	290	0.75	0.0036	5.8
5/22/2020	2.1	0.38	83	1.1	1.1	510	14	[illegible]	[illegible]	[illegible]	[illegible]	4.5
Date	ROSEDALE INLET											
2/20/2020	8.4	0.3	62	1.2	1.2	457	18	[illegible]	[illegible]	[illegible]	[illegible]	10
3/2/2020	6.1	0.31	65	0.92	1.3	469	25	[illegible]	[illegible]	[illegible]	[illegible]	8.8
3/9/2020	5.2	0.31	66	1.4	1.4	487	25	32	300	0.57	0.014	8.5
3/17/2020	5.9	0.3	64	0.85	1.4	477	25	32	300	0.62	0.01	8.8
5/22/2020	6.7	0.28	62	1.4	1.4	488	24	31	300	0.53	<0.00053	7.8
Date	CVC @ TULE ELK BRIDGE											
3/2/2020	3.1	0.18	41	0.52	0.89	353	7	32	320	0.71	<0.00053	5.9
3/9/2020	4.1	0.19	44	0.96	0.96	385	7.9	33	230	0.73	0.0045	6.6
3/17/2020	4.5	0.16	41	0.58	0.95	370	7.1	34	230	0.65	<0.00053	6.1
5/22/2020	5.6	0.16	38	1.2	0.97	348	6.8	24	220	0.68	<0.00053	5.3
Date	CA AQUEDUCT DOWNSTREAM											
3/2/2020	1.7	0.19	61	<0.50	0.34	406	3.1	32	270	2.7	<0.00053	3.2
3/9/2020	1.5	0.2	63	<0.50	0.36	432	3.1	33	250	2.6	<0.00053	3.1
3/17/2020	1.3	0.16	58	<0.50	0.24	412	2.8	32	250	3.2	<0.00053	2.7
5/22/2020	3.3	0.17	48	0.77	0.59	404	3.2	32	250	2.2	<0.00053	4.1
Date	CA AQUEDUCT UPSTREAM											
—												
—												
—												
5/22/2020	1.8	0.19	70	<0.50	0.069	475	0.6	37	290	0.41	<0.00053	1.2

Blending of Superior Wells (→ CENTRAL INTAKE)

Blending of SREX-1 & SREX-2 (→ STRAND NTI-2)

Blending of SREX-5, SREX-6, & SREX-7 (→ STRAND STI)

Arsenic elevated as SREX-6 is temporarily off-line due to needing to rehab the well

Blending of SREX-3 & SREX-4R (→ STRAND NTI-1)

Blending of ENNS Wells & the WB Wells (→ ROSEDALE INLET)

Figure 6: Pump-In Water Quality Analysis

It is important to note that pump-in operations are blended with many other local groundwater banking operations and the overall blending is modeled by the Kern County Water Agency (KCWA), which is the local State Water Contractor (SWP) and operator of the Cross Valley Canal. Prior to introducing any non-SWP water into the California Aqueduct, a Pump-In Proposal (PIP) must be prepared and submitted to the Department of Water Resources (DWR) for approval. The PIP is also reviewed by a State Water Contractor Facilitation Group which includes other SWP Contractors, who can submit comments on the PIP. The PIP must also include a pump-in blending model of all discharges combined with the proposed non-SWP water source from the PIP. The PIP and blending model must be approved by the DWR and Facilitation Group prior to operating any new project wells for discharge into the California Aqueduct. A PIP and blending model will have to be prepared for the Kern Fan Groundwater Storage Project.

Figure 7 below is an excerpt from KCWA's blending model which shows the background Arsenic in the California Aqueduct is about 2.3 ppb. After receiving inflow from the various Kern County banking projects there is a modest increase to only 2.8 ppb, well below the MCL of 10 ppb and below a potential future MCL of 5 ppb.

The approved PIP and blending model for the Strand Ranch wells was previously submitted to the Reclamation DEC Team on June 9, 2019, and it is resubmitted here as Exhibit "A". As shown in Exhibit "A", according to the DWR's Water Quality Policy, the blending of multiple water sources prior to inflow into the SWP is acceptable and may be preferred depending upon water quality of the PIP.

Manifold		Flow	As
		cfs	ug/l
Semitropic*		0	-
CVC Pool 1		41	3.8
CVC Pool 2		67	4.8
CVC Pool 3		70	7.6
CVC Pool 4		81	2.4
CVC Pool 5		6	2.0
CVC Pool 6		41	2.8
CVC Subtotals	East	40	2.8
	West	265	4.6
River Canal		185	3.9
KWB Canal		281	1.6
West Kern		0	-
WRM6		20	2.2
WRM7		15	6.7
WRM8		0	-
WRM9		26	6.2
WRM9A-10		0	-
WRM13A		0	-
WRM15		0	-
WRMWSD Subtotal		61	5.0
Arvin-Edison		0	-
Well Blend in Aqueduct		792	3.4

		Total Flow	As
	Units	cfs	ug/l
	MCL		10
Alejandro in District		0	No Flow
CVC Flow to ID4		0	2.8
CVC Flow into Friant		40	2.8
	Change	40	NA
	% of the MCL	NA	28%
Aqueduct Blends			
Background		1707	2.3
After Semitropic		1587	2.3
After CVC		1346	2.7
After KWB		1812	2.7
After West Kern		1812	2.7
After WRMWSD 6		1580	2.7
After WRMWSD 7		1531	2.7
After WRMWSD 8		1467	2.7
After WRMWSD 9		1450	2.8
After Arvin-Edison		1450	2.8
After WRMWSD 9A-10		1379	2.8
After WRMWSD 13A		1374	2.8
After WRMWSD 15		1320	2.8
	Total Change	-387	0.5
	% of the MCL	NA	4.7%

Figure 7: Pump-In Blending Model

VIII. Project Contingency Plans for Reduced Arsenic MCL

The District has contingency plans in the event the water quality of some Kern Fan Groundwater Storage Project wells changes to exceed the current Arsenic MCL or if the Arsenic MCL is reduced in the future from 10 ppb to 5 ppb. These plans would enable the District to come into compliance for the new MCL without treating the water to remove Arsenic. These plans would involve further investigation, but include the following alternatives:

1. Evaluate the cause of the water quality change in the well. Sometimes plugging of the well screen can impact the water quality. Plugging can restrict the portions of the screen that yield lower Arsenic concentrations and thus increase the amount of water being drawn in from the higher Arsenic concentrations in other parts of the aquifer. In this event the District would remove the pump and mechanically and chemically rehabilitate the well to remove the plugging. Oftentimes this results in the well returning to its historic Arsenic concentrations.

2. Reduce the well yield (pumping rate) by reducing the speed of the VFD. A direct correlation is sometimes achieved between the pumping rate and the Arsenic concentration. This is related to the fact that the shallow water has lower Arsenic and the deeper water has higher Arsenic. If the well is pumping less flow and the pump is above the screened interval, oftentimes the water is coming from primarily the upper portion of the well screen and thus reduces the concentration of Arsenic.

   This correlation is reflected by testing that was performed for the Superior Recovery Water Wells, see Figure 8 below. The well discharge rate was varied between 1,250 gpm and 4,600 gpm and Arsenic samples collected. The Arsenic concentration is lowest at the lower flow rates.

Summary of Arsenic Concentrations
Superior Wells

Well	Date Tested	Test Type	Discharge Rate[1] (gpm)[2]	Arsenic Concentration (µg/L)[3]
SUP-1	17-Aug-15	Step-Drawdown	2,500	4.0
SUP-1	17-Aug-15	Step-Drawdown	3,500	5.4
SUP-1	17-Aug-15	Step-Drawdown	4,500	6.0
SUP-1	20-Aug-15	Constant Rate	3,000	8.4
SUP-2	17-Sep-15	Constant Rate	2,500	7.6
SUP-4	23-Oct-15	Development	1,250	13.0
SUP-4	26-Oct-15	Step-Drawdown	2,000	12.0
SUP-4	26-Oct-15	Step-Drawdown	3,000	14.0
SUP-4	26-Oct-15	Step-Drawdown	4,000	19.0
SUP-4	28-Oct-15	Constant Rate	3,300	17.0
SUP-5	6-Nov-15	Development	4,300	9.5
SUP-5	10-Nov-15	Constant Rate	2,800	9.0
SUP-6	30-Sep-15	Development	4,600	8.1
SUP-6	5-Oct-15	Step-Drawdown	2,050	8.1
SUP-6	5-Oct-15	Step-Drawdown	3,500	11.0
SUP-6	5-Oct-15	Step-Drawdown	4,500	12.0
SUP-6	7-Oct-15	Constant Rate	3,000	15.0

Notes:

[1] Discharge rate at time of sample collection.
[2] gpm = Gallons per minute.
[3] µg/L= Micrograms per liter.

Figure 8: Arsenic Concentration varying with Flow

3. There are District recovery water wells that have an Arsenic concentration less than 5 ppb. The District may utilize these wells as appropriate for blending purposes to ensure that the discharge water to the canal has an Arsenic concentration less than 5 ppb.

4. As mentioned above, the deeper water is generally higher in Arsenic. The District can permanently seal a portion of the lowermost screened section of the well with concrete or bentonite in order to reduce the Arsenic level in the well. This will involve filling in a portion of the well bottom (from the bottom of the well casing up a certain distance on the lower screened interval) with concrete or bentonite and plug off the deeper portions of the well that have higher Arsenic concentrations. This will lower the Arsenic concentration in the well and bring the well back into compliance for Arsenic at less than 5 ppb.

Oftentimes the effectiveness of this modification is first tested with an inflatable packer before actually installing a cement or bentonite plug. The SUP-4 well and the SUP-6 well had Arsenic concentrations that exceed the MCL of 10 ppb. An inflatable packer was installed at different depths and the Arsenic measured. The packer assembly consisted of a 19-inch outer diameter rubber packer (uninflated diameter), inflation airline and a braided metal security cable. The inflatable packer was approximately 5-ft in length. The packer assembly was mounted on a 6-inch diameter pipe extension attached to the end of the test pump. The packer was mounted approximately 60-ft below the pump intake. The packer was inflated with nitrogen to pressures ranging from 250 to 290 psi. The results of the packer testing for each of these wells is shown in Figure 9 below.

Summary of Arsenic Concentrations and Specific Capacity
SUP-4 and SUP-6

Well	Date Tested	Test Type	Packer Setting (ft)	Active Perforated Interval(s) (ft)	Discharge Rate[1] (gpm)[2]	Arsenic Concentration (µg/L)[3]	Arsenic Concentration Verification Testing (µg/L)[3]	Specific Capacity (gpm/ft)[4]
SUP-4	22-Oct-15	Pumping Development	N/A	365-545, 570-610, 630-780	1,250	13	N/A	N/A
SUP-4	26-Oct-15	Step-Drawdown	N/A	365-545, 570-610, 630-780	2,000	12	N/A	60
SUP-4	26-Oct-15	Step-Drawdown	N/A	365-545, 570-610, 630-780	3,000	14	N/A	58
SUP-4	26-Oct-15	Step-Drawdown	N/A	365-545, 570-610, 630-780	4,000	19	N/A	56
SUP-4	28-Oct-15	Constant Rate	N/A	365-545, 570-610, 630-780	3,300	17	N/A	61
SUP-4	**23-May-16**	**Packer Test 1**	**725**	**365-545, 570-610, 630-725**	**2,500**	**<2 (1.4)**	**<2 (0.99)**	**50**
SUP-4	**24-May-16**	**Packer Test 2**	**680**	**365-545, 570-610, 630-680**	**2,500**	**<2 (1.9)**	**<2 (1.2)**	**50**
SUP-4	**26-May-16**	**Packer Test 3 Step 1**	**620**	**365-545, 570-610**	**1,500**	**<2 (1.4)**	**<2 (1.1)**	**34**
SUP-4	**26-May-16**	**Packer Test 3 Step 2**	**620**	**365-545, 570-610**	**2,000**	**<2 (1.5)**	**<2 (1.1)**	**31**
SUP-4	**26-May-16**	**Packer Test 3 Step 3**	**620**	**365-545, 570-610**	**2,500**	**<2 (1.6)**	**<2 (1.2)**	**30**
SUP-6	30-Sep-15	Pumping Development	N/A	410-610, 700-920	4,600	8.1	N/A	N/A
SUP-6	5-Oct-15	Step-Drawdown	N/A	410-610, 700-920	2,050	8.1	N/A	67
SUP-6	5-Oct-15	Step-Drawdown	N/A	410-610, 700-920	3,500	11	N/A	64
SUP-6	5-Oct-15	Step-Drawdown	N/A	410-610, 700-920	4,500	12	N/A	62
SUP-6	7-Oct-15	Constant Rate	N/A	410-610, 700-920	3,000	15	N/A	67
SUP-6	**8-Jun-16**	**Packer Test 1**	**800**	**410-610, 700-800**	**3,000**	**5.3**	**5.0**	**38**
SUP-6	**9-Jun-16**	**Packer Test 2**	**740**	**410-610, 700-740**	**3,000**	**7.8**	**6.3**	**36**
SUP-6	**14-Jun-16**	**Packer Test 3 Step 1**	**565**	**410-565**	**2,000**	**4.7**	**5.1**	**22**
SUP-6	**14-Jun-16**	**Packer Test 3 Step 2**	**565**	**410-565**	**2,500**	**4.7**	**4.5**	**21**
SUP-6	**14-Jun-16**	**Packer Test 3 Step 3**	**565**	**410-565**	**2,800**	**5.2**	**4.9**	**18**

Notes:
[1] Discharge rate at time of sample collection.
[2] gpm = Gallons per minute.
[3] µg/L= Micrograms per liter.
[4] gpm/ft = Gallons per minute per foot measured after 3 hours of pumping.
[5] N/A = Not applicable.
Highlighted yellow cells indicate arsenic concentrations above the Maximum Contaminant Level (MCL) of 10 µg/L.
Bold results are from packer testing.

Figure 9: Packer Testing to Reduce Arsenic Concentration

The packer was effective at reducing the Arsenic concentration in SUP-6 at all three packer depths. At a packer depth of 565-ft, the Arsenic concentration was able to be reduced to 5 ppb or lower while still maintaining the target design rate of 2,250 gpm or 5.0 cfs.

In addition to traditional inflatable packer testing there is an emerging water quality well profiling technology that would help identify Arsenic hot spots in the well profile. The USGS has published technical papers on the efforts of Noah Heller detailing the non-invasive effort to profile existing wells with the intention of blanking off portions of screen intervals that contribute to water quality issues.

<u>Addendum No. 2</u>

Recharge Basin Design and Operation for Intermittent Wetland Benefits

<u>Finding #4:</u>

Feasibility Study:

a. *As currently designed the recharge basins may not meet the requirements for classification as an intermittent wetland.*
b. *Determine requirements for creation of intermittent wetlands, and update design and cost estimate to include these features.*

<u>Response to Finding #4:</u>

- The wetlands that will be incidentally created by the constructed recharge basins will <u>most closely</u> resemble a classification of *Intermittent Flooded Riverine Wetlands with Unconsolidated Sandy Bottoms*.
- The Project will create incidental intermittent during recharge for periods of upward to 12 months. Specific features are incorporated into the design, operation and maintenance of the wetlands, so that during the recharge periods hydric soils conditions will form allowing for the development of hydrophytes and the establishment of habitat for shorebirds and migratory birds.
- Project recharge basins will typically hold water from 1 month upwards to 12 months which allow for the development of hydric soils during the growing season. Hydric soils typically form within existing recharge basins by the third or fourth week of flooding due to gradual saturation of the soils.
- Project berm and island banks will be built at a 4:1 slope with a minimum 1.5' freeboard which will result in at least a 6 to 10-foot-wide vegetative strip above the water line with vegetation extending into shallow water areas.
- Recharge basins will be designed to provide bird habitat in the intermittent wetlands created in the Project recharge ponds. Per the recommendation of the Environmental Defense Fund, recharge basins will be constructed at multiple water depths to benefit both shorebirds and waterfowl. Shorebirds prefer mudflats to a depth of up to 6" with sparse vegetation (<40%) while waterfowl prefer depths of 6" to above 18" with a combination of open water and wetland cover. Dry land (berms or islands) are important for resting areas with dense vegetation.
- The project costs include the design features for the intermittent wetlands such as dry land berms or islands and raptor boxes. The costs for dry land berms or islands are included in the line item for levee embankment fill. The costs for raptor boxes are included in the interbasin structure line item for miscellaneous steel and weir boards.
- The operations and maintenance costs associated with these design features have already been anticipated and therefore does not result in any changes to the project operations cost estimates.

More detailed information is provided below.

<u>Wetland Classifications</u>

The United States Fish and Wildlife Service maintains important documents related to the classification of wetlands in the United States. The most current is the Second Edition – Classification of Wetlands and

Deepwater Habitats of the United States[1]. Based on this document, wetlands are classified as Marine, Estuarine, Riverine, Lacustrine, and Palustrine. A Riverine System has four subsystems: Tidal, Lower Perennial, Upper Perennial, and Intermittent. Wetland classes are further defined based on bottom substrate and flooding regime as well as dominant vegetation types.

Project Recharge Basins as Intermittent Wetlands

Since the Project recharge basins will be intermittently flooded with captured stream flows that are diverted into the California Aqueduct, through the Project canal and into man-made impoundments, the wetlands that will be incidentally created by the constructed recharge basins will most closely resemble a classification of *Intermittent Flooded Riverine Wetlands with Unconsolidated Sandy Bottoms*. Accordingly, the recharge basins constructed for the Project will be designed to meet intermittent wetland requirements during recharge operations. The following explains the application of design criteria used to meet the project goals of establishing intermittent wetlands and providing bird habitat in the recharge basins.

As described in the Project Feasibility Report (Sections 1.4.3, 2.1.3, 4.1.4.2 and 5.1.3.2), the Project will establish intermittent wetland habitat through intermittent recharge events. The primary purpose of the Project lands is to construct and operated recharge basins that allow water to infiltrate and recharge into the underlying aquifer for storage until it is needed. During the years that the Project takes and recharges water into storage, the basins will be inundated with water and will provide intermittent wetland habitat to support waterfowl, shorebirds, raptors and other migratory birds along the Pacific Flyway. The wetlands to be established by the Project are considered intermittent because the water supply delivered for recharge may not be available for recharge year-round or during periods of drought. The term “incidental” is also used to describe these intermittent wetlands because they are incidentally created as a result of water recharging in the Project basins.

In addition to Rosedale-Rio Bravo Water Storage District (RRBWSD) and Irvine Ranch Water District’s (IRWD) existing recharge basins, which support similar intermittent wetland habitat, the Kern Water Bank, located south of the Project, represents a larger reference site for the future conditions of the Project recharge basins and the intermittent wetland establishment. The Kern Water Bank spans 20,000 acres of water recharge and recovery infrastructure. Their recharge basins were established and are operated and managed as a habitat matrix of upland and intermittent wetland habitat. Through 2018, over 206 species of birds have been identified on Kern Water Bank lands (Kern Water Bank Authority 2019). It is anticipated that the Project will result in similar habitat conditions as established through the existing RRBWSD and IRWD basins and within the Kern Water Bank.

[1] Wetlands Subcommittee of the Federal Geographic Data Committee, August 2013. “Classification of Wetland and Deepwater habitats for the United States”, Adapted from Cowardin, Carter, Golet and LaRoe (1979). Available at: https://www.fws.gov/wetlands/data/wetland-codes.html

Intermittent Wetland Requirements

Project recharge basin design and operation will align with the ecological requirements of intermittent wetlands. Intermittent wetland ecological features include:

(1) The intermittent presence of water at the surface or within the root zone;
(2) Saturated soil conditions that result in anaerobic conditions in the upper part (i.e., hydric soil);
(3) Water tolerant (i.e., hydrophytic) vegetation; and
(4) Establishing habitat for waterfowl and shorebirds.

For intermittent wetlands, the presence of water is variable and spans a variety of wetland types. For example, vernal pools, pond or lake fringes, and seasonal riverine wetlands are all considered intermittent wetlands.

Recharge Basin Design and Operation Criteria to Create Intermittent Wetlands

The design, construction and operation of the Project recharge basins fulfill the requirements of Intermittent Wetlands described above. Since the Project recharge basins will be intermittently flooded with captured stream flows diverted into the California Aqueduct, through the Project canal and into man-made impoundments, the wetlands that will be incidentally formed by the constructed recharge basins will be intermittent wetlands. The Project recharge basins include design features that will function as intermittent wetlands to support and benefit water birds and wetland-dependent upland birds and wildlife. The variable presence of water, soil, and vegetation, as well as bird habitat features, were considered in the design and operation criteria for the recharge basins as described in the following.

Design Criteria #1: Allow water to be maintained on site during recharge operations -- Recharge basins use man-made berms to maintain water on site. Several thousand acres of groundwater recharge basins have been constructed on the Kern River Fan over the past 30 years. Some are in the primary flood plain that was not previously developed, but most are on previously farmed and leveled properties. Typical construction matches the existing field boundaries as they neighbor existing agricultural production.

Slope and Berm Construction: The Project area has a predominate land slope of 2 feet per mile which will remain after recharge basin construction. Project recharge basin berms will be constructed with compacted earth from the project site at approximately two to six feet in height. Berms may also serve as roadways. Project recharge basin water depths will range from 0 up to 24 inches.

Ponding duration and timing: Project water will provide wetland habitat during the winter months of wet, above normal and normal water years when recharge activity occurs. Water is expected to be in the recharge basins for an average duration of 1.5 months during years in which active recharge of Article 21 water occurs in the winter months. Based on historical availability of other water supplies during normal and wet years, the benefits from the intermittent wetland habitat could be extended by upwards of 12 operating months.

Design Criteria #2: Develop hydric soils during recharge operations -- The United States Department of Agriculture defines hydric soil as a soil that formed under conditions of saturation, flooding or ponding long enough during the growing season to develop anaerobic conditions in the upper part[2]. Soils that are sufficiently wet because of artificial measures, such as operations of recharge basins, are included in the concept of hydric soils.

Presence of Hydric Soils: Project recharge basins will typically hold water from 1 month to upwards of 12 months which allow for the development of hydric soils during the growing season. RRBWSD finds that hydric soils typically form within existing recharge basins by the third or fourth week of flooding due to gradual saturation of the soils. This is expected to occur at the Project recharge basins. During this period, typical recharge rates within the basins are expected to slow from an initial infiltration rate of up to 1 acre-foot per day to a maintenance rate of about 0.4 acre-feet per day.

Design Criteria #3: Establish hydrophytic vegetation during recharge operations -- Hydric soils result in sufficiently wet conditions to support the natural growth and regeneration of hydrophytic vegetation. Recharge basin design, operation, and maintenance also allow for the planting and establishment of hydrophytic vegetation.

Project Berms and Islands: Project berm and island banks will be built at a 4:1 slope with a minimum 1.5' freeboard which will result in at least a 6 to 10 foot wide vegetative strip above the water line with vegetation extending into shallow water areas. Each basin would include 1-2 islands with similar gradual sloped banks and freeboard requirements. During recharge periods mowing of the berms and islands is limited to support growth of significant vegetation ranging from 6 to 36 inches tall. Shallow water areas would also experience vegetation growth of variable height. Established hydrophytic vegetation is expected to include common spikerush (*Eleocharis macrostachya*), Baltic rush (*Juncus balticus*), common knotweed (*Polygonum lapathifolium*), annual beard grass (*Polypogon monspeliensis*), broadleaf cattail (*Typha latifolia*) Fremont cottonwood (*Populus fremontii*), and Goodding's black willow (*Salix gooddingii*).

Design Criteria #4: Establish habitat for birds during recharge operations – RRBWSD has been working with the Environmental Defense Fund (EDF) in an effort to construct and operate recharge facilities that have multi-benefits, including intermittent wetlands and bird habitat. EDF partnered with Point Blue Conservation Science, Audubon California and Sustainable Conservation to develop a guide on how to build this kind of preferred recharge basin that provides operational benefits to basin management while also creating valuable water bird habitat. Figure 9, included at the end of this addendum, is the guide prepared by EDF. This guide describes the wildlife benefits associated with the multi-uses of recharge basins as intermittent wetlands.

Basin Design: The Project basins are designed to improve recharge and are less likely to plug with fine sediments while also incidentally creating habitat through the formation of hydric soils. Additional recharge basin design considerations are included to provide bird habitat in the intermittent wetlands created in the Project recharge ponds. Per EDF's recommendation, recharge basins will be constructed at multiple water depths to benefit both shorebirds and waterfowl. Shorebirds prefer mudflats to a depth of up to 6" with sparse vegetation (<40%) while waterfowl prefer depths of 6" to above 18" with a combination of open water

[2] US Department Agriculture, Natural Resources Conservation Service: https://www.nrcs.usda.gov/wps/portal/nrcs/detail/soils/use/hydric/?cid=nrcs142p2_053961

and wetland cover (see Figures 1, 2 and 3). Dry land (berms or islands) are important for resting areas with dense vegetation (see Figures 4, 5 and 6).

Basin Depths: Each typical basin would yield 1/3 of the depths suitable for shorebird mudflats and 2/3 suitable for waterfowl preferred depths (see Figures 2, 3 and 7).

Ponding Duration: The project is expected to provide wetland habitat to migratory birds whenever recharge activity occurs on the project sites. Based on historical availability of all water supplies, the duration of incidental wetland habitat from water ponding could range from 1.5 months to upwards of 12 operating months, which allows for the development of hydric soils during the growing season (see Figure 1).

Berms and Islands: Earthen berms and islands will also provide necessary resting areas on the banks. During recharge periods, mowing is limited on the berms and islands to support vegetation growth from 6 to 36 inches tall (see Figures 4, 5 and 6). The costs for dry land berms and islands are included in the Project cost line item for levee embankment fill. These costs are included in the earthwork quantities in the recharge basin construction costs. The cost of maintaining the berms and islands, including occasionally mowing, are included in the Project's operations and maintenance (O&M) costs.

Raptor Boxes: Burrowing rodents can cause structural damage to earthen berms. To offset harmful effects of rodenticides on wildlife --- owl and hawk boxes and perching structures will be installed every 0.25 mile of berm. The Project will rely on raptor boxes and perches and use of rodenticides only as necessary to protect berm stability and to thus protect the intermittent wetlands created by the operation of the Project recharge basins. The costs for installing raptor boxes are included in the interbasin structure line item for miscellaneous steel and weir boards. The estimated cost of occasionally maintenance or repair of raptor boxes is included in the Project's O&M costs.

Managing Basins During Non-Recharge

The Project recharge basins will allow native vegetation (non-noxious weeds) and seeded forage crops to provide dry cover crop and wildlife cover and forage during non-recharge periods (see photos in Figure 8). In order to promote future cover crops or natural vegetation growth each year, basins would be grazed by sheep or cattle or mowed as necessary. No-till planting methods, rather than disking, would be used to seed forage crops. Disking operations promotes noxious weed growth and would be avoided. The cost of the seeding and mowing activities is included in the Project's O&M costs.

Managing sediments: RRBWSD's managed recharge basins have not experienced recharge impacts from settlement of fine sediments or bacterial fowling. Sediment is typically settled prior to reaching this portion of the service area. To the extent that this does occur, these materials would be scraped and placed on islands. The estimated cost of occasional scraping of the basins is included in the Project's O&M costs.

Adaptive Management of Intermittent Wetlands

Land and wildlife management is dynamic. As weather and climatic patterns change -- landscapes, including intermittent wetlands, will react. Plants and wildlife will adapt to these changes on a variable basis, so it is recognized that recharge basin management will need to adapt as well to optimize wetland benefits. To meet the demands of the environment and Project an adaptive management plan will be developed and implemented for the management of the Project recharge basins as well as the management of the intermittent wetlands created during the operation of the basins. This plan will include annual biota reports including adaptive management recommendations to be considered and implemented, as appropriate to optimize project water management and wildlife goals.

Figure 1. Example of a RRBWSD recharge basin with ponded water during the growing season that allows for the establishment of hydric soils and vegetation.

Figure 2. Typical RRBWSD Recharge Basin with mix of mudflats and open water

Figure 3. Mudflats with shorebirds on Strand Recharge Basins

Figure 4. Upland vegetation on recharge basin berm provides habitat for birds.

Figure 5. Typical RRBWSD Recharge Basin Berm Water Line Habitat

Figure 6. Typical RRBWSD Recharge Basin Island

Figure 7. Three Photos of typical waterfowl in Strand Recharge Basins during Recharge Periods

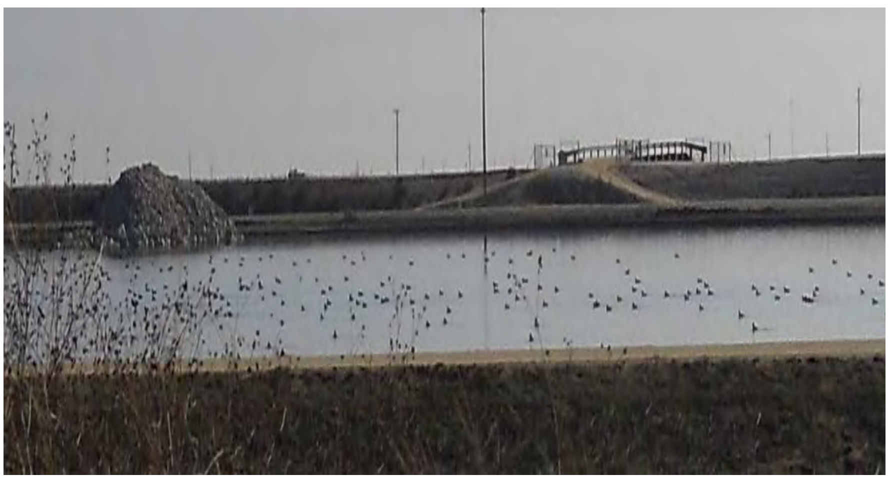
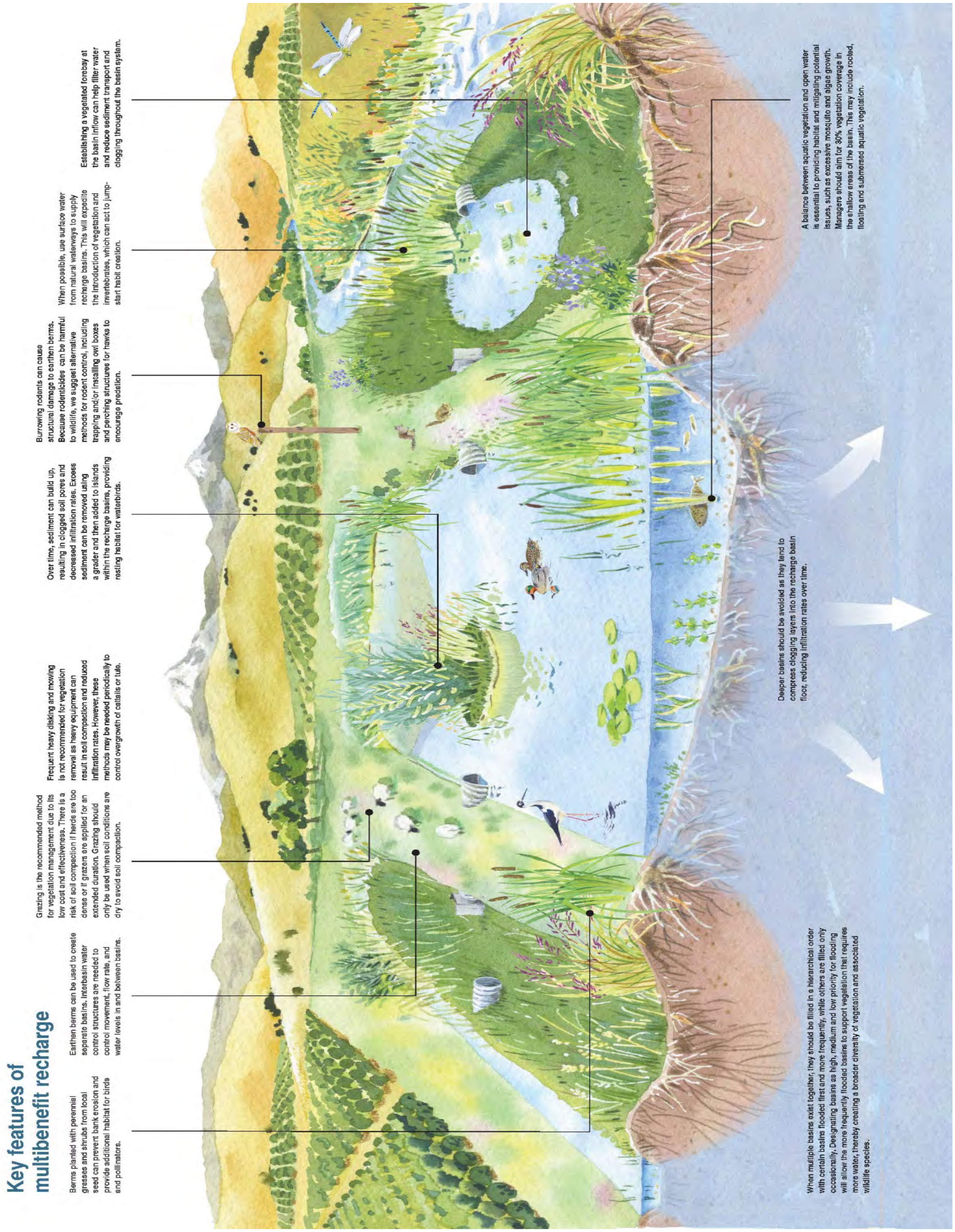


Figure 8. Three Photos of typical RRBWSD Recharge Basins During Non-Recharge Periods

Figure 9. Environmental Defense Fund Guide on Building Multi-Benefit Basins



Building multibenefit recharge basins

As California faces an unpredictable water future, policy makers and water managers across the state are seeking solutions to build resilience into our water supply system. Groundwater recharge is an excellent tool to replenish depleted aquifers and bank water for future use. In addition to helping water managers balance their water budget, groundwater recharge also provides an opportunity to create habitat for wildlife. This guide highlights recharge basin management strategies that create wildlife habitat and provide operational benefits to basin managers.

Audubon California

EDF Environmental Defense Fund – Finding the ways that work

Point Blue Conservation Science

Sustainable Conservation

Operational Benefits

Reduce sediment and clogging

Sediment buildup and pore clogging can greatly diminish the efficiency of basin recharge. Creating multiple subbasins within a series can allow for the first receiving basin to act as a settling area, enabling the successive basins to recharge more efficiently over time. Settling basins filter fine sediment in the water and minimize clogging of successive recharge ponds. Creating basins with a sloped floor will result in sediment accumulation in a smaller area, reducing the operational cost of removing sediment buildup.

Planting vegetation on basin bottoms during dry spells can also help maintain recharge rates over time as roots create channels for water to infiltrate the soil.

Stabilize basins

Planting vegetation along the sides of basins will help prevent erosion and stabilize berms. These plantings can also inhibit the establishment of nuisance weeds such as Russian thistle. Installing perching structures for hawks can help control burrowing rodents that can compromise berms.

Funding Sources

Potential federal, state and local funding sources for multibenefit recharge projects that create waterbird habitat include:

- Wildlife Conservation Board Pacific Flyway Program
- U.S. Fish and Wildlife Service Partners for Fish and Wildlife Program
- Natural Resources Conservation Service Environmental Quality Incentives Program
- California Department of Fish and Wildlife California Waterfowl Habitat Program

WILDLIFE TARGET

Shorebirds

- Legs are often long and thin.
- Bills thin. If long, then used to probe in the soil. If short, then used to peck food off the surface of the ground.
- Eat various bugs, worms and other invertebrates.
- 13 species use the Central Valley regularly.
- Some populations are declining; others are stable.

Waterfowl

- Ducks, geese and swans.
- Most have flat bills that filter plants, seeds and invertebrates from the water and mud for food.
- Webbed feet make them strong swimmers.
- Some populations are declining; others are stable.

Pollinators

- More than 1,000 species of honey bees, native bees, butterflies and beetles.
- Wide range of sizes and colors, from tiny sweat bees less than ¼" long to monarch butterflies larger than 3".
- Nearly all populations are declining.

HABITAT CHARACTERISTICS

Shorebirds

- Open mudflats or shallowly flooded environments.
- Some short, sparse vegetation is OK.
- Less than 40% vegetation cover is recommended.
- Remaining vegetation should be smashed or incorporated.

Waterfowl

- Open water is generally preferred for feeding.
- Some species like vegetation (cattails/tules) to hide in.
- Some dry land (berms or islands) is important for resting areas.
- Vegetation on resting areas should not be very dense. However, some species that breed in Central Valley would use denser vegetation for nesting.
- Forage plants for waterfowl (watergrass, smartweed and swamp timothy) will provide food during winter.

Pollinators

- Prefer a diversity of native vegetation that flowers (providing food and cover) throughout the year.
- Plant vegetation along the sides and throughout the basin bottom.
- Drier areas should remain undisturbed (no disking) to provide nesting habitat in soil.

WATER MANAGEMENT

Shorebirds

Timing

- Shorebirds are present in the Central Valley year-round.
- Migration is a critical period when habitat is needed: spring (March to May) and fall (July to September).

Depth

- Saturated mudflat to 6 inches deep.
- Variable water depth is ideal and will benefit a wider diversity of shorebirds and other waterbirds.

Waterfowl

Timing

- Winter (October to March) is the most important time to provide habitat for waterfowl in the Central Valley.
- Some species breed in the Central Valley from March to mid-July.

Depth

- Water depths from 6 inches to 18 inches are recommended.
- Some species will use depths greater than 18 inches.
- Forage plants may require additional irrigation in dry periods.

Pollinators

Timing

- Water should not inundate vegetation for long periods in areas designated as a dry zone because it can kill the plants and drowns the burrowing insects.

Depth

- Plant in zones related to how much water each will likely receive. Some will only get winter rain, some flooded only occasionally, others flooded regularly.

This document highlights best practices as understood by wildlife experts and practitioners as of February 2020.
If you are interested in participating in a pilot project or providing feedback, please contact **recharge@pointblue.org**

Kern Fan Groundwater Storage Project

RESPONSE TO DEC REVIEW FINDINGS

Addendum No. 3: Project Contingency

July 1, 2020

Irvine Ranch
WATER DISTRICT

Rosedale-Rio Bravo WATER STORAGE DISTRICT

Addendum No. 3 – Project Contingency

Design Estimating and Construction (DEC) Review

Finding #3:

Project Contingency Cost Low: Contingency appears low for current level of design. 20% only applied to construction, but not to rest of project. Should be in range of 20-30% for entire project. Recommend updating in final feasibility report.

Response to Finding #3

I. Project Contingency

- The project contingency was estimated based on the guidelines of Reclamation Manual FAC 09-01 Directives and Standards for Cost Estimating that recommends the project contingency be applied to the contract cost and not applied to non-contract costs. The recommended allowance for construction contingency normally ranges from 20 to 25 percent of the subtotal of all listed pay items including the allowance for design contingencies and allowance for procurement strategies. The contingency amount applied to the Kern Fan Groundwater Storage Project is in line with the normal contingency range, however it is near the low end of this range as a result of cost information from recent bids, as well as the experience that Irvine Ranch Water District and Rosedale-Rio Bravo Water Storage District have with turnouts, conveyance facilities, lift stations, and recharge and recovery facilities and their general knowledge of the site conditions.
- The project costs include the design features for the intermittent wetlands such as dry land berms or islands and raptor boxes. The costs for dry land berms or islands are included in the line item for levee embankment fill. The costs for raptor boxes are included in the interbasin structure line item for miscellaneous steel and weir boards.
- The unit price level for the estimate is from December 2018. A construction cost escalator has been included since the project will be developed over an extended period of time. The first phases of construction are estimated to begin around the fall of 2021 and all remaining aspects of the project will be bid by December 2023. Therefore, a five-year escalation (2018 to 2023) has been factored in at an approximate inflation rate of 2.0% per year based upon recent CPI estimates. The escalator has been applied to the Construction Cost while excluding the Land Acquisition and Rights of Way ($226,000,000 - $37,000,000 = $189,000,000). The reason for this is that the Land Acquisition and Rights of Way are expected to be completed within the next 12 months. The escalator increases the Construction Cost for the project to approximately $246,000,000.
- The modification to the contingency resulted in an increase to the overall Project cost, and therefore changes the benefit-cost ratio for the preferred alternative to 1.23. Revised Benefit-Cost spreadsheet for all of the alternatives are provided as Exhibits B, C and D. The increased Project Cost also increases the eligible federal funding for the Project to $70.4 million.

II. Project Costs

The project costs presented in the March 27, 2020 30% Design report have been updated so that the construction contingency is applied to the Contract Costs (listed pay items) as well as the allowances for design contingencies. In addition, a Construction Cost Escalator has been applied to account for the bidding phases of the project ending around December 2023. Table 1 presents a summary of the Original and Revised Costs that have increased from $225,000,000 to $246,000,000. The following sections describe the Project Cost updates in more detail.

Table 1
Project Summary Costs

	Original Costs	*Updated Costs*
Capital Cost (without Project Mobilization):	$127,785,592	$128,165,797
Project Mobilization (1.4% 1.4%):	$1,820,000	$1,820,000
Capital Cost:	**$129,605,592**	**$129,985,797**
Design Contingency (2.0% / 2.3%):	$2,592,112	$3,014,203
Contract Cost:	**$133,000,000**	**$133,000,000**
Construction Contingency (20.0% / 20.3%):	$26,000,000	$27,000,000
Field Cost:	**$159,000,000**	**$160,000,000**
Non-Contract Costs:	$66,000,000	$66,000,000
Construction Cost (Unit Price Level Dec 2018):	**$225,000,000**	**$226,000,000**
Escalation at 2.0% for 5 years to Dec 2023 on Construction Cost less Land Acquisition and Rights of Way	NA	$20,000,000
Construction Cost (with Escalation to Dec 2023):	**NA**	**$246,000,000**

Capital Cost: The Capital Cost including mobilization was refined from an original amount of $129,605,592 to an updated amount of 129,985,797.

Design Contingency: The design contingency for unlisted items was originally 2% of the Capital Cost and totaled $2,600,000. The design contingency has been revised to 2.3% and amounts to $3,014,203. This increase is a Special Allowance for Design Contingencies as listed under Section 5.E of the Reclamation Manual FAC 09-01 Directives and Standards for Cost Estimating. This is to account for minor items required to construct the project for which it is not practical to develop designs and quantities during the early stages of the project. The allowance for design contingency normally ranges from 2 to 20 percent of the subtotal of all listed pay items. The low end of this range has been used for the contingency due to the significant experience that Irvine Ranch Water District and Rosedale-Rio Bravo Water Storage District have with turnouts, conveyance facilities, lift stations, and recharge and recovery facilities, as well as information from recent bids. Recent bid documents are provided as Exhibits E and F. These are the same documents that were provided to the DEC team in response to questions.

Contract Cost: The Contract Cost for the project is $133,000,000 including mobilization costs and design contingencies. See Exhibit G for the detailed cost breakdown. In addition, Exhibit H provides back-up documentation for the preparation of the project costs and unit prices including recently bid projects and material quotes.

Construction Contingency: A construction contingency of twenty-percent (20.0%) of the Contract Cost or approximately $26,000,000 was originally applied to the Kern Fan Groundwater Storage Project. This construction contingency has been increased to approximately $27,000,000 as a result of including the Design Contingencies. The $27,000,000 contingency divided by the Contract Cost of $133,000,000 is a contingency of 20.3%.

The allowance for construction contingency normally ranges from 20 to 25 percent of the subtotal of all listed pay items including the allowance for design contingencies and allowance for procurement strategies. The contingency amount applied to the Kern Fan Groundwater Storage Project is in line with the normal contingency range, however it is near the low end of this range as a result of the experience that Irvine Ranch Water District and Rosedale-Rio Bravo Water Storage District have with turnouts, conveyance facilities, lift stations, and recharge and recovery facilities, their understanding of the site conditions, and recent bid documents.

Field Cost: The field cost is an estimate of the capital costs from award to construction close-out and includes construction contingency. The total Field Cost for the project is $160,000,000.

Non-Contract Costs: The non-contract costs equate to approximately $66,000,000 and are comprised of the costs outlined in Table 2 below.

Table 2

Non-Contract Costs

Land Acquisition and Rights of Way:	$37,000,000
HCP Fees:	$3,200,000
Project Management:	$6,500,000
Engineering & Design:	$6,900,000
Environmental:	$600,000
Permitting:	$600,000
Labor Compliance:	$500,000
PG&E Electrical Service:	$1,500,000
Bid Advertisement & Legal:	$250,000
Project Surveying:	$1,600,000
Construction Management & Inspection:	$7,800,000
Non-Contract Costs (rounded):	**$66,000,000**

Land Purchase, Easements and Right of Way (R/W) costs represent about $37 million (56%) of the of the Project's Non-Contract cost. In accordance with Reclamation standards, they are included as part of the Non-Contract Costs. They do not include a contingency, since the land acquisition process has been initiated and is expected to occur within the next 12 months. Exhibit I shows recent property sales in the Rosedale-Rio Bravo Water Storage District service area from 2013 to 2019. As shown, the average cost is about $24,700 per acre. This estimate is consistent with the $26,500 and $21,500 per acre used to estimate land purchase costs for the Project.

Construction Cost: The total Construction Cost for the Kern Fan Groundwater Storage Project was previously $225,000,000. The total Construction Cost has been revised to $226,000,000. It is important to note that future design efforts will include additional value engineering efforts.

Construction Cost Escalator: The Project's unit price level for the construction cost estimate is from December 2018. A construction cost escalator has been included since the project will be developed over an extended period of time. It has been estimated that the first phases of construction will begin around the fall of 2021 and that all aspects of the project will be bid by December 2023. Therefore, a five-year escalation (2018 to 2023) has been factored in at an approximate inflation rate of 2.0% per year based upon recent CPI estimates. The escalator has been applied to the Construction Cost without the Land Acquisition and Rights of Way cost ($226,000,000 - $37,000,000 = $189,000,000). The reason for this is that the Land Acquisition and Rights of Way are expected to be completed within the next 12 months. The Construction Cost with the construction cost escalator is approximately $246,000,000.

<u>Addendum No. 4 – Addressing Feasibility Study Comments</u>

Design Estimating and Construction (DEC) Review

<u>Finding #4:</u>

Feasibility Study:

a. *Concrete lining expensive; others should be considered. Hydraulics weren't considered in the selection. Need to revise and include info on the hydraulics.*
b. *Basis for cut and fill quantities unclear. Should include regular intervals full length of conveyance.*
c. *Lifespan of facilities may be reduced due to intermittent usage – need to address. O&M as it relates to wells and pumps unclear.*
d. *Recharge basin O&M unclear. How are fines and algal mats addressed?*

Response to Finding #4

Summary

- <u>Conveyance Lining:</u> A total of four lining alternatives have been considered herein; 1) Earth Lined Canal, 2) HDPE Lined Canal, 3) Shotcrete Lined Canal, and 4) Concrete Lined Canal. The material quantities, the constructability, the capital costs, the hydraulic impacts, and any issues or concerns have been discussed for each alternative. It appears that the HDPE Lined Canal is the most economical, however depending on the actual useful life of the HDPE lining it may be about the same cost or even more expensive than the concrete lining alternative over a sixty year period. The cost difference between the shotcrete lining and the concrete lining also is not very significant. Both of these lining systems are quality canal linings and result in a long useful life, however the shotcrete lining requires greater skill and quality control during application. Therefore, the concrete lining is the preferred alternative, although the project may bid other alternatives and consider the HDPE lining or shotcrete as value engineering options.
- <u>Canal Cut and Fill Quantities:</u> Cross-sections have been prepared for each reach of the canal at approximate 1,000-ft intervals and illustrate the estimated "neat-line" cut and fill area for the conveyance canal. The earthwork volume calculations utilizing the average end area method are attached. The calculations demonstrate the estimated cut and fill volumes for each reach of the canal resulting in a total of 244,227 cubic yards of cut and 716,381 cubic yards of fill for the entire conveyance canal. In addition, calculations for the subgrade preparation (over-excavation and re-compaction beneath the canal and embankments) have been prepared and estimate a "neat-line" volume of 226,189 cubic yards for the entire conveyance canal. Borrow material is anticipated to be obtained from areas in close proximity to the canal including, but not limited to, the Buena Vista Water Storage District recharge basins, the West Kern Water District recharge basins, the Phase II recharge basins, and the West Basins. Costs associated with the borrow material have been included in the unit prices utilized for the earthwork cut, fill, and subgrade preparation.

- Lifespan of Facilities: The lifespans for critical components of the project have been outlined. These lifespan estimates are based upon the significant experience of Rosedale-Rio Bravo Water Storage District with similar facilities and account for the typical intermittent usage that is associated with these types of recharge and recovery projects.
- O&M Project Costs: The O&M costs for the project has been defined in greater detail for wet periods when water is being recharged, for dry periods when water is being recovered from the groundwater basin, and for idle periods when water is neither being recharged or recovered. The O&M costs related to wells and pumps as well as for recharge basins are included.
  Well O&M costs include the following:
    - Pump Maintenance (Annual Pump Tests, Cleaning, Oil Testing, etc.)
    - Oil Lubrication
    - Weed Control around Well Sites
    - Rodent Control around Well Sites
    - Electricity
    - Remote Monitoring (Mission Unit Costs)
    - Office Staff and Overhead Costs

  Recharge basin O&M costs include the following:
    - Pond Maintenance (Weir board replacement, cleaning, etc.)
    - Weed Control along levee embankments
    - Rodent Control along levee embankments
    - Raptor box repairs/maintenance
    - Seeding and Plantings in basin bottoms
    - Occasional removal of fines from basin bottoms (scraping)
    - Office Staff and Overhead Costs

a. *Concrete lining expensive; others should be considered. Hydraulics weren't considered in the selection. Need to revise and include info on the hydraulics.*

I. Conveyance Canal Lining

This addendum serves to consider the following potential canal lining alternatives:

1. Earth Lined Canal
2. HDPE Lined Canal
3. Shotcrete Lined Canal
4. Concrete Lined Canal

The conveyance canal is approximately 8.80 miles long or 46,400-ft. The canal cross-section is approximately 8-ft deep with a 20-ft wide bottom and 1.5:1 side slopes. This equates to a cross-sectional area of approximately 51 sq. feet per lineal ft when including a 1-ft lip. The lip is the portion of the concrete lining that is outside of the canal prism at the top hinge point of the canal on both sides of the conveyance canal. The cross-sectional area for an earth lined canal with 3:1 side slopes is approximately 73 sq. feet per lineal ft when including a 1-ft lip on both sides of the conveyance canal.

1. Earth Lined Canal

Quantities:
The earthwork for the conveyance canal has been considered separately and will be roughly the same for any of the above lining alternatives. The earth lined canal is planned to have 3:1 side slopes to reduce velocities and minimize erosion and sediment transport. Typically, seepage in the earth lined canal for this project would not be a concern since the seepage can be accounted for as groundwater recharge under the project. However, seepage is a concern when operating the canal in the reverse direction for recovery of water and the return of water to the Aqueduct. Therefore, a return pipeline would need to be constructed parallel to the canal or a special earth liner such as a clay liner or bentonite liner constructed.

Constructability:
The earth lined canal will be constructed to the lines and grades shown on the project drawings. The side slopes of an earth lined canal shall be revised to be 3:1 in order to alleviate erosion and provide for canal maintenance. The material for the canal shall not be expansive or dispersive. Expansive soils could result in swelling, drying, and shrinkage that results in cracking and problems with seepage or a levee breach. Dispersive soils can pose a threat as they move away from water and could result in piping or a levee breach. The soils should have less than 15% finer than a 5 micron sieve so that there is not too much clay but also greater than 20% material finer than a 75 micron sieve so that there are fine sands and silts that provide good cohesion. The canal and levee material shall be compacted to a minimum 90% relative compaction.

A 1-ft thick liner of the earthen canal prism shall have a minimum clay content of 12% to 15%. Fill material that has a clay content less than this will require some form of soil amendment or importation of a soil with adequate clay content. Powdered bentonite could be used as a soil amendment. The percentage of bentonite added would be the difference between the natural site clay content and the required minimum clay content. The minimum pounds of bentonite per square foot of amended area will be the percentage bentonite times the compacted dry density of the site soil times the liner thickness. Bentonite shall be evenly spread by a computerized spreading truck which is directly fed by the bulk delivery truck. Spread rate shall be confirmed by a pan test. The amended area shall be uniformly mixed and moisture conditioned by a cross-shafted mixer directly connected to the water truck. This equipment is standard for a specialty soil stabilization contractor. Stabilization contractors typically only spread the amendment, moisture condition, and compact the amended soil. They do not move material to achieve rough grade or fine grade, therefore they generally subcontract to a general earthwork contractor. However, in some instances soil amendment can be performed in-place for a liner thickness up to 1.5 feet with the typical cross-shafted mixer and open-hub compactors and this may be an option.

For an earth lined canal there are concerns with rodent holes, piping, and levee breaches particularly in areas of levee embankment fill. In order to mitigate these concerns, synthetic sheet piling is included. Sheet piling would be installed along both sides of the canal in areas of levee embankment fill and extend down to approximately 5-ft below the invert of the canal (sheetpile depth of 15-ft).

Capital Cost:

The capital cost estimates compare the costs of different lining materials. However, the earth lined canal will require a different canal cross-section in order to mitigate soil erosion and prevent seepage. Therefore, capital costs for the canal earthwork are also included.

The capital cost estimate for the canal earthwork is $7,148,566. This adds approximately $1,551,360 ($7,148,566 - $5,597,206) to the cost of the earthwork over and above the cost for the canal earthwork on the other three alternatives because of the wider canal cross-section.

The option to install a return water pipeline and not line the earthen canal involves installing approximately 45,000 feet of 48” pipe which at $280/lf equates to approximately $12,600,000. However, this does eliminate the need for the Return Water Pump Station in turn saving approximately $2,081,000. This results in an additional cost of $10,519,000 or $12,600,000 - $2,081,000.

The soil amendment cost to treat/amend, mix, and compact the soil for a 1-ft thick liner is estimated at $3.93 per square foot. There are approximately 73 sf/lf x 46,400 lf or 3,387,200 square feet.

The earth lining alternative also includes the installation of synthetic sheet piling to mitigate rodent holes. There is approximately 53,550-ft of sheet piling and 15-ft deep which equates to approximately 803,250 square feet. A unit cost of $35/sf has been used. This equates to a capital cost of $28,113,750 which effectively makes the earth lined canal relatively expensive and not practical.

As presented below and summarized in Table 1 of Section II - Summary of Canal Lining Alternatives, the cost of an earth lined canal liner is about $43,000,000 with a clay liner and $40,000,000 with a return water pipeline.

• Additional Earthwork	$1,551,360
• 1-ft Thick Clay Liner at $3.93/sf	$13,311,696
• Sheet Piling to Mitigate Rodent Holes	$28,113,750
Total Earth Lined Canal with Bentonite:	$42,976,806

Or

• Additional Earthwork	$1,551,360
• Return Water Pipeline	$10,519,000
• Sheet Piling to Mitigate Rodent Holes	$28,113,750
Total Earth Lined Canal with Return Pipeline:	$40,184,110

Canal Hydraulics:

The earth lined canal has a 20-ft wide bottom with 3:1 side slopes. A Manning's coefficient of 0.035 was utilized which is for an earth lined canal with light brush on the levee slopes. The velocities of an earth lined canal are less than that of a lined canal and have been maintained in the range of 1.0 to 2.5 fps to minimize erosion and sediment transport. The water depth varies from approximately 6-ft to 8.22-ft. This increases the canal depth from 8-ft to approximately 10-ft as a result of the higher Manning's coefficient.

Issues/Concerns:

An earth lined canal is not the most desirable alternative. There are significant portions of the canal that will be elevated above the natural ground surface. In addition, there may be long periods of time where this canal is not being utilized and is in a dry condition thus providing suitable habitat for rodents. The major concern is with rodent holes over time that could lead to piping and a levee breach and the potential for property damage to adjacent agricultural crops, homes, equipment, etc.

In order to mitigate the above concerns, synthetic sheet piling was considered in an effort to provide a barrier from rodent holes and potential piping. However, this appears to be cost prohibitive.

In addition, an earth lined canal will require greater maintenance. The maintenance includes:

- Levee monitoring for rodent holes and areas of significant erosion that require earthwork maintenance
- Weed control on levee slopes and the canal bottom
- Removal of sediment and debris potentially at siphon crossings, turnouts, and lift stations

2. Geosynthetic (HDPE) Lined Canal

Quantities:
A 60 mil thick membrane HDPE lining is recommended for canal conveyance. The HDPE lining material will be approximately 2,830,400 sf based upon a canal length of 46,400 ft and a cross sectional area of 61 sf/ft which includes an anchor trench on each side of the canal.

Constructability:
The HDPE lined canal will be constructed to the lines and grades shown on the project drawings. The side slopes of a HDPE lined canal shall be 1.5:1 as originally outlined above. The subgrade material for the canal shall not be expansive or dispersive. The soils should have less than 15% finer than a 5 micron sieve so that there is not too much clay but also greater than 20% material finer than a 75 micron sieve so that there are fine sands and silts that provide good cohesion. The canal and levee material shall be compacted to a minimum 90% relative compaction and graded to provide a smooth and uniform surface for the installation of the HDPE lining.

An anchor trench will need to be excavated parallel to the canal on each side of the conveyance canal, the HDPE liner installed in the trench, and the trench backfilled and compacted. In addition, the HDPE liner will need to be connected to the concrete at all structures, turnouts, and lift stations.

Capital Cost:

The capital cost estimates compare the costs of different lining materials. The HDPE lined canal is estimated to utilize approximately 2,830,400 sf of material. In addition, there will be locations where the lining must be connected to the concrete structures in the canal such as the transition structures, turnouts, and lift stations. This is estimated to be approximately 1,500 lineal feet. There will also be the need for underdrains where the canal is in cut adjacent to recharge basins.

The capital cost estimate for the canal earthwork is $5,597,206. The cost of adding an HDPE lining adds $5,291,400 as presented below and summarized in Table 1 of Section II - Summary of Canal Lining Alternatives.

• HDPE Lining at $1/sf	$2,830,400
• HDPE Anchor Trench Installation	$928,000
• Connection to Structures at $23/lf	$34,500
• Underdrain System	$1,498,500
Total HDPE Lining:	$5,291,400

Canal Hydraulics:

The Manning's coefficient utilized for a HDPE lined canal is 0.011. The velocities of the HDPE lined canal range from approximately 2.0 fps to 3.5 fps. The water depth varies from approximately 6-ft to 6.76-ft. This maintains a minimum of 1-ft of freeboard from the top of canal lining.

Issues/Concerns:

A HDPE lined canal is an economical alternative and worth considering. The HDPE lining can be prone to surface deterioration and tearing from UV damage and wind. The canal will have long periods of time when it is not in operation and is empty thus subject to sun exposure and damage. The anticipated useful life of a typical HDPE liner that is exposed to the elements is 10 to 20 years.

3. Shotcrete Lined Canal

Quantities:
Shotcrete is a pneumatically applied Portland cement mortar lining. The shotcrete lining is recommended to have a minimum 3" thickness. The shotcrete lining material would be approximately 2,366,400 sf based upon a canal length of 46,400 ft and a cross sectional area of 51 sf/ft. (Approximately 21,911 cubic yards).

Constructability:

The shotcrete lined canal will be constructed to the lines and grades shown on the project drawings. The side slopes of a shotcrete lined canal shall be 1.5:1 as originally outlined above. The subgrade material for the canal shall not be expansive or dispersive. The soils should have less than 15% finer than a 5 micron sieve so that there is not too much clay but also greater than 20% material finer than a 75 micron sieve so that there are fine sands and silts that provide good cohesion. The canal and levee material shall be compacted to a minimum 90% relative compaction and graded to provide a smooth and uniform surface for the installation of the shotcrete lining.

The application of shotcrete is highly specialized and requires a certified nozzleman in order to ensure against rebound which results from a portion of the mortar bouncing away from the surface to which it is applied. It is recommended that the shotcrete lining have a smooth trowel surface in order to improve the hydraulic characteristics.

Capital Cost:

The capital cost estimates compare the costs of different lining materials only. The shotcrete lined canal is estimated to utilize approximately 2,366,400 sf of material. There will also be the need for underdrains where the canal is in cut adjacent to recharge basins.

The capital cost estimate for the canal earthwork is $5,597,206. The cost of adding a shotcrete lining adds $13,330,500 as presented below and summarized in Table 1 of Section II- Summary of Canal Lining Alternatives.

• Shotcrete Lining at $5/sf	$11,832,00
• Underdrain System	$1,498,500
Total Shotcrete Lining:	$13,330,500

Canal Hydraulics:

The Manning's coefficient utilized for a shotcrete lined canal is 0.017. The Manning's coefficient assumes that the shotcrete surface will not be as smooth as conventional concrete placement and finishing. The velocities of the shotcrete lined canal range from approximately 2.0 fps to 3.0 fps. The water depth varies from approximately 6-ft to 7.33-ft. This would require the canal depth to be increased by approximately 0.5-ft in some locations to an 8.5-ft depth in order to maintain the minimum of 1-ft of freeboard to the top of canal lining.

Issues/Concerns:

A shotcrete lined canal is an economical alternative and worth considering. However, in general this type of lining is only slightly more economical than formed in place concrete when considering long, un-impacted stretches of canal. The shotcrete lining requires skilled operating personnel, additional quality control measures to ensure against excessive rebound and to ensure application at the proper thickness. If a concrete lined canal is the selected alternative, it is recommended that the concrete lining be allowed to be constructed by shotcrete application, slip-form placed, or formed in place.

4. Concrete Lined Canal

Quantities:
Concrete lining can be placed by slip-lining, using a rolling screed, or by cast in place methods. The concrete lining is recommended to have a minimum 3" thickness and crack control spacing at approximate 10'-0" spacing. The concrete lining material would be approximately 2,366,400 sf based upon a canal length of 46,400 ft and a cross sectional area of 51 sf/ft. (Approximately 21,911 cubic yards).

Constructability:

The concrete lined canal will be constructed to the lines and grades shown on the project drawings. The side slopes of a concrete lined canal shall be 1.5:1 as originally outlined above. The subgrade material for the canal shall not be expansive or dispersive. The soils should have less than 15% finer than a 5 micron sieve so that there is not too much clay but also greater than 20% material finer than a 75 micron sieve so that there are fine sands and silts that provide good cohesion. The canal and levee material shall be compacted to a minimum 90% relative compaction and graded to provide a smooth and uniform surface for the installation of the concrete lining.

Capital Cost:

The capital cost estimates compare the costs of different lining materials only. The concrete lined canal is estimated to utilize approximately 2,366,400 sf of material. There will also be the need for underdrains where the canal is in cut adjacent to recharge basins.

The capital cost estimate for the canal earthwork is $5,597,206. The cost of adding a concrete lining adds $15,696,900 as presented below and summarized in Table 1 of Section II.

- Concrete Lining at $6/sf — $14,198,400
- Underdrain System — $1,498,500

Total Concrete Lining: $15,696,900

Canal Hydraulics:

The Manning's coefficient utilized for the concrete lined canal is 0.014. The velocities of the concrete lined canal range from approximately 2.0 fps to 3.2 fps. The water depth varies from approximately 6-ft to 7-ft. This maintains a minimum of 1-ft of freeboard from the top of canal lining and has slightly better hydraulic characteristics than the shotcrete lining.

Issues/Concerns:

A concrete lined canal is an expensive alternative, but also has the longest useful life. Concrete lining has a typical useful life of beyond 60 years if well maintained and protected. The concrete lined canal will also require the smallest amount of maintenance and has better hydraulic characteristics than the shotcrete lining. Typical maintenance is the cleaning and removal of sediment and mud, if applicable, and then the replacement of cracked panels if it occurs.

II. Summary of Canal Lining Alternatives

Four lining options for the conveyance canal were evaluated as summarized in Table 1.

Table 1
Canal Lining Alternatives

Lining Alternative	Estimated Unit Cost	Estimated Total Cost
HDPE Lined	$1.87/SF	$5,291,400
Shotcrete Lined	$5.63/SF	$13,330,500
Concrete Lined	$6.63/SF	$15,696,900
Earth Lined	$11.86/SF	$40,184,110

The earth lined canal is not considered a good alternative due to concerns with rodent holes and piping failures, liability due to adjacent landowners, and overall increased canal maintenance with weed control, sedimentation, and rodent hole control. In order to mitigate these concerns, a clay liner has been included to mitigate canal seepage when returning water to the Aqueduct along with geosynthetic sheet piling to mitigate concerns with rodent holes and piping or levee failures. This in turn drives the cost up significantly thereby making this alternative cost prohibitive.

The HDPE canal lining is an economical alternative, has the best hydraulic properties, and is easier to maintain than an earth lined canal. The drawback to the HDPE canal lining is the estimated useful life of 10 to 20 years.

The cost difference between the shotcrete lining and the concrete lining is also not very significant. Both of these lining systems are quality canal linings and result in a long useful life, however the shotcrete lining requires greater skill and quality control during application. It is recommended that the conventional concrete lining be selected between these two options, however the contract documents could allow for both application methods and the most economical alternative could be selected at bid time.

The choice of canal lining appears to be a decision between a HDPE liner and concrete lining. The concrete lined canal has a useful life that is approximately three times greater than the HDPE lining (60 yrs versus 20 yrs). Assuming a 2% inflation rate at approximately the consumer price index (CPI) to replace the HDPE lining in 20 years would result in a future replacement cost of $7,862,742. To replace the HDPE lining in 40 years would result in a future replacement cost of $11,683,621. Assuming the future replacement costs in year 20 and 40 are invested at 2% interest, the present value the HDPE lining over 60 years is approximately $$15,874,200 (3 * $5,291,400) which is slightly greater than the cost of a concrete lined canal over that same period of time. A concrete lined canal is the recommended alternative at this time, although both the HDPE lining and the concrete lining may be bid as a value engineering consideration.

b. Basis for cut and fill quantities unclear. Should include regular intervals full length of conveyance.

I. <u>Canal Cut and Fill Quantities</u>

Canal cross-sections have been prepared for the canal conveyance alignment and are included in Exhibit J.

Cross-sections have been prepared for each reach of the canal at approximate 1,000-ft intervals and illustrate the estimated "neat-line" cut and fill area for the conveyance canal. The earthwork volume calculations utilizing the average end area method are attached in Exhibit K. The calculations demonstrate the estimated cut and fill volumes for each reach of the canal resulting in a total of 244,227 cubic yards of cut and 716,381 cubic yards of fill for the entire conveyance canal. In addition, calculations for the subgrade preparation (over-excavation and re-compaction beneath the canal and embankments) have been prepared and estimate a "neat-line" volume of 226,189 cubic yards for the entire conveyance canal. Borrow material is anticipated to be obtained from areas in close proximity to the canal including, but not limited to, the Buena Vista Water Storage District recharge basins, the West Kern Water District recharge basins, the Phase II recharge basins, and the West Basins. Costs associated with the borrow material have been included in the unit prices utilized for the earthwork cut, fill, and subgrade preparation.

c. *Lifespan of facilities may be reduced due to intermittent usage – need to address. O&M as it relates to wells and pumps unclear.*

I. <u>Lifespan of Facilities</u>

The Rosedale-Rio Bravo Water Storage District and Irvine Ranch Water District have similar facilities installed including, but not limited to, well pumps and motors, well piping and appurtenances, flow meters, slide gates and actuators, electrical equipment, VFD's, and earth levees. The lifespans listed below are based upon their significant experience operating and maintaining these facilities, and already account for the typical intermittent usage that is associated with these types of recharge and recovery projects.

The lifespan of concrete structures such as transition structures, siphon crossings, turnouts, and lift stations are estimated to be 50 years.

Lift Station pumps and motors have an estimated useful life of approximately 10 to 15 years and will require regular maintenance to keep them in good operating order given the intermittent usage.

Lift Station valves, electrical, and appurtenances are estimated to have a useful life of approximately 20 to 25 years.

Turnout slide gates, actuators, meters, and electrical are estimated to have a useful life of approximately 25 years.

Well pump and motors have an estimated useful life of approximately 10 to 15 years and will require regular maintenance to keep them in good operating order given the intermittent usage. The District performs annual maintenance on the well pumps and motors including, but not limited to, the cleaning of electrical equipment and the replacement of filter screens, the manual turning of lineshafts, replacement of motor oil and grease, and preventative maintenance on motor starter panels and VFD's.

The well site valves, electrical, and appurtenances are estimated to have a useful life of approximately 20 to 25 years.

The canal useful life will depend on the canal lining as discussed under item 4.a above. The useful life of a concrete lined canal is estimated to be 60 years and should not be impacted by the intermittent usage. However, a HDPE liner is estimated to have a useful life of 10 to 20 years given the intermittent usage and the exposure to UV and wind.

II. <u>O&M for Wells and Pumps</u>

See item 4.d below in which all of the O&M costs are discussed in detail.

d. Recharge basin O&M unclear. How are fines and algal mats addressed?

I. O&M Project Costs

Operation, maintenance and replacement costs were prepared for the Project and are presented in Section 4 of the 30% Design Report for three types of operating years: Idle, Recharge and Recovery. Idle year conditions are expected to occur 5 times every 10 years, include no recharge or recovery operations, and cost about $227,000 per year. Dry year conditions are expected to occur 3 times every 10 years, include recovery operations and cost on average approximately $3,966,000 per year. Wet year conditions are expected to occur 2 times every 10 years, include recharge operations and cost about $3,040,000 per year. In addition to the year type, the operations and maintenance (O&M) costs have been estimated for the canal conveyance facilities, groundwater recharge operations, and water recovery operations. The estimated O&M costs are based on RRBWSD's extensive experience operating and maintaining recharge basins, recovery wells and facilities, pump stations and canals.

Well O&M costs primarily occur during idle periods and recovery operations and include the following:

- Pump Maintenance (Annual Pump Tests, Inspection, Cleaning, Oil Testing, Calibration, Water Quality Testing)
- Oil Lubrication
- Weed Control around Well Sites
- Rodent Control around Well Sites
- Electricity
- Remote Monitoring (Mission Unit Costs)
- Office Staff and Overhead Costs

Recharge basin O&M costs primarily occur during idle periods and recharge operations and include the following:

- Pond Maintenance (Weir board replacement, inspection, cleaning, etc.)
- Weed Control along levee embankments
- Rodent Control along levee embankments
- Raptor box repair/maintenance
- Seeding and Planting in basin bottoms
- Mowing in basin bottoms
- Occasional removal of fines or algal mats from basin bottoms (scraping)
- Office Staff and Overhead Costs

Managing sediments, fines and algal mats: It has been RRBWSD's experience that the existing recharge basins have not been significantly affected by the settlement of fine sediments or bacterial fowling. Sediment is typically settled prior to reaching this portion of the service area. To the extent that this may occasionally occur, these materials would be scraped and placed on islands during idle periods as needed. The estimated costs for basin maintenance associated with occasional fine sediment accumulation or potential algae mat growth are included in the staff time under the idle operating periods and are based on actual operating experience for similar facilities.

Idle Periods

Idle periods are months in which there is no groundwater recharge activities taking place and no water recovery activities taking place. However, there are still on-going O&M costs that must be taken into consideration. Idle periods are estimated to occur an average of 5 years out of every 10 years.

The canal O&M costs during an idle period (idle year) are outlined below:

- RRBWSD Operation Cost: $4,100 per month
  This cost includes field staff time for canal maintenance (cleaning, repair of floats, etc.), weed control around roads and embankments, rodent control, equipment maintenance, office staff, and overhead cost.
- Electricity Cost: $1,500 per month
  This cost is a standby charge for three lift stations along the canal.
- Mission Unit Cost: $158.33 per month
  This is the average monthly cost for cellular service to three (3) mission units based upon what is currently being paid.
- Total Monthly Cost: $5,758.33 per month
- Total Conveyance O&M Cost: $69,100 per year in an idle year

The conveyance O&M costs for the Goose Lake Lift Station during an idle period (idle year) are outlined below:

- RRBWSD Operation Cost: $1,000 per month
  This cost includes field staff time for lift station maintenance (cleaning, repairs, etc.), weed control around lift station, rodent control, equipment maintenance, office staff, and overhead cost.
- Electricity Cost: $300 per month
  This cost is a standby charge for the lift station.
- Mission Unit Cost: $52.78 per month
  This is the average monthly cost for cellular service to one (1) mission unit based upon what is currently being paid.
- Total Monthly Cost: $1,352.78 per month
- Total Annual Conveyance Cost: $16,233.33 per year in an idle year

The Phase I recharge basin and well equipment O&M costs during an idle period (idle year) are outlined below:

- RRBWSD Operation Cost: $4,100 per month
  This cost includes field staff time for pond maintenance (inspection, cleaning, repairs to berms and levees as needed), weed control around levees, rodent

control, seeding and plantings in basin bottoms, mowing basin bottoms as needed, occasional scraping of basin bottoms as needed, well equipment maintenance (inspection, cleaning, testing, calibration of meters), scheduled water quality testing, cattle or sheep grazing to control weed growth, repair and gravel roads as needed, raptor box maintenance as needed, office staff, and overhead cost.

- Electricity Cost: $1,500 per month
  This cost is the estimated monthly standby charges for six recovery wells.
- Mission Unit Cost: $316.67 per month
  This is the average monthly cost for cellular service to six (6) mission units based upon what is currently being paid.
- Total Monthly Cost: $5,916.67 per month
- Total Annual Recharge Facility Cost: $71,000 per year in an idle year

The Phase II recharge basin and well equipment O&M costs during an idle period (idle year) are outlined below:

- RRBWSD Operation Cost: $4,100 per month
  This cost includes field staff time for pond maintenance (inspection, cleaning, repairs to berms and levees as needed), weed control around levees, rodent control, seeding and planting in basin bottoms, mowing basin bottoms as needed, occasional scraping of basin bottoms as needed, well equipment maintenance (inspection, cleaning, testing, calibration of meters), scheduled water quality testing, cattle or sheep grazing to control weed growth, repair and gravel roads as needed, raptor box maintenance as needed, office staff, and overhead cost.
- Electricity Cost: $1,500 per month
  This cost is the estimated monthly standby charges for six recovery wells.
- Mission Unit Cost: $316.67 per month
  This is the average monthly cost for cellular service to six (6) mission units based upon what is currently being paid.
- Total Monthly Cost: $5,916.67 per month
- Total Annual Recharge Facility Cost: $71,000 per year in an idle year

<u>The total O&M costs during an idle period (idle year) are outlined below:</u>

- Canal Conveyance O&M Costs: $5,758.33 per month
- Goose Lake Lift Station O&M Costs: $1,352.78 per month
- Phase I Recharge Basin O&M Costs: $5,916.67 per month
- Phase II Recharge Basin O&M Costs: <u>$5,916.67 per month</u>

Total Monthly O&M Costs (idle year): $18,944.45 per month
Total Annual O&M Costs (12 months): $227,333.40 per idle year

<u>Water Recharge Periods</u>

A water recharge period is anticipated to occur for a total of approximately 2 years out of every 10 years, however these events are oftentimes during a short period of time while Article 21 water is available. Therefore, the objective of the project is to convey the maximum amount of water to the recharge facilities that can be recharged into the groundwater basin while the water is available. Based on RRBWSD's long term experience in maintaining basins, sediments are typically settled prior to reaching this portion of the service area. Existing recharge basins are very seldomly affected by fine sediments or bacterial fowling. The maintenance costs estimated during idle periods includes the occasional scraping of these materials which would be deposited on islands.

The canal O&M costs during a recharge event (wet year) are outlined below:

- RRBWSD Operation Cost: $9,000 per month
  This cost includes field staff time for canal maintenance (cleaning, repair of floats, etc.), weed control around roads and embankments, rodent control, equipment maintenance, office staff, and overhead cost.
- Electricity Cost: $230,400 per month
  This cost is predicated on moving 460 cfs at a 40-ft TDH to get the water from the Aqueduct to the Phase II property and West Basins property. It is estimated that a total of 56,250 ac-ft would be recharged into the Phase II property and 56,250 ac-ft would be recharged to the West Basins. The power cost is estimated at an average of $0.13/kwh. This total cost has been divided by 4 to account for recharging this volume of water over a four-month period.
- Mission Unit Cost: $158.33 per month
  This is the average monthly cost for cellular service to three (3) mission units based upon what is currently being paid.
- DWR Conveyance Cost: $404,296.88 per month
  The cost of Article 21 water is approximately $23.00 per acre-foot for 112,500 ac-ft, however the IRWD share, which is 37.5%, is paid through an agreement with the Metropolitan Water District (MWD). Therefore, the estimated monthly water costs include $23 per ac-ft for 70,312.5 ac-ft or 62.5% of 112,500 ac-ft. The recharge event is estimated to be a four-month period therefore the total cost of $23/ac-ft x 70,312.5 ac-ft has been divided by 4 to obtain a monthly cost.
- Total Monthly Cost: $643,855.21 per month
  This cost is the estimated monthly cost to recharge approximately 112,500 ac-ft of water over a four-month period.
- Total Annual Conveyance Cost: $2,621,487.50 per year or $46.60/ac-ft

The conveyance O&M costs to lift water up to the Phase I recharge property (Goose Lake Lift Station) during a recharge event (wet year) are outlined below:

- RRBWSD Operation Cost: $4,000 per month
  This cost includes field staff time for lift station maintenance (cleaning, repairs, etc.), weed control around lift station, rodent control, equipment maintenance, office staff, and overhead cost.
- Electricity Cost: $52,500 per month
  This cost is predicated on moving 240 cfs at an 18-ft TDH through the lift station to get the water from the Goose Lake Channel to the Phase I property. It is estimated that a total of 56,250 ac-ft would be recharged into the Phase I property. The power cost is estimated at an average of $0.13/kwh. This total cost has been divided by 4 to account for recharging this volume of water over a four-month period.
- Mission Unit Cost: $52.78 per month
  This is the average monthly cost for cellular service to one (1) mission unit based upon what is currently being paid.
- Total Monthly Cost: $56,552.78 per month
  This cost is the estimated monthly cost to recharge approximately 56,250 ac-ft of water over a four-month period.
- Total Annual Conveyance Cost: $237,033.33 per year or $4.21/ac-ft

The Phase I recharge basin O&M costs during a recharge event (wet year) are outlined below:

- RRBWSD Operation Cost: $9,000 per month
  This cost includes field staff time for pond and basin control structure maintenance (inspection, cleaning, repairs as needed), weed control around levees, rodent control, limit mowing to allow for bank vegetation growth, control of algal mats as needed, raptor box maintenance as needed, office staff, and overhead cost.
- Electricity Cost: $1,500 per month
  This cost is the estimated monthly standby charges for six recovery wells.
- Mission Unit Cost: $316.67 per month
  This is the average monthly cost for cellular service to six (6) mission units based upon what is currently being paid.
- Total Monthly Cost: $10,816.67 per month
  This cost is the estimated monthly cost to recharge approximately 56,250 ac-ft of water over a four-month period.
- Total Annual Recharge Facility Cost: $90,600 per year or $1.61/ac-ft

The Phase II recharge basin O&M costs during a recharge event (wet year) are outlined below:

- RRBWSD Operation Cost: $9,000 per month
  This cost includes field staff time for pond and basin control structure maintenance (inspection, cleaning, repairs as needed), weed control around levees, rodent

control, limit mowing to allow for bank vegetation growth, control of algal mats as needed, raptor box maintenance as needed, office staff, and overhead cost.

- Electricity Cost: $1,500 per month
  This cost is the estimated monthly standby charges for six recovery wells.
- Mission Unit Cost: $316.67 per month
  This is the average monthly cost for cellular service to six (6) mission units based upon what is currently being paid.
- Total Monthly Cost: $10,816.67 per month
  This cost is the estimated monthly cost to recharge approximately 56,250 ac-ft of water over a four-month period.
- Total Annual Recharge Facility Cost: $90,600 per year or $1.61/ac-ft

<u>The total O&M costs during a recharge event (wet year) are outlined below</u>:

- Canal Conveyance O&M Costs: $643,855.21 per month
- Goose Lake Lift Station O&M Costs: $56,552.78 per month
- Phase I Recharge Basin O&M Costs: $10,816.67 per month
- Phase II Recharge Basin O&M Costs: <u>$10,816.67 per month</u>

  Total Monthly O&M Costs (wet year): $722,041.33 per month
  Total Annual O&M Costs (4 months): $2,888,165.32 per year
  Total Idle Year O&M Costs (8 months): $151,555.52 per year
  Total Annual O&M Costs (12 months): $3,039,720.84 per year
  Average Cost per acre-foot: $27.02 per ac-ft for 112,500 ac-ft/year

<u>Water Recovery Periods</u>

A water recovery period is anticipated to occur for a total of approximately 3 years out of every 10 years. The wells are operated to recover stored groundwater during drought type conditions for agricultural use within the Rosedale-Rio Bravo Water Storage District, conveyance to IRWD, or to exchange with water in the Delta for ecosystem benefits.

The canal O&M costs during a recovery event (dry year) are outlined below:

- RRBWSD Operation Cost: $8,000 per month
  This cost includes field staff time for canal maintenance (cleaning, repair of floats, etc.), weed control around roads and embankments, rodent control, equipment maintenance, office staff, and overhead cost.
- Electricity Cost: $14,040 per month
  This cost is predicated on moving 70 cfs at a 33-ft TDH through the return water lift station to convey the water from the conveyance canal to the Aqueduct. It is estimated that a total of 25,000 ac-ft would be returned to the California Aqueduct. The power cost is estimated at an average of $0.13/kwh. This total cost has been

divided by 12 to account for recharging this volume of water over a twelve-month period.

- Mission Unit Cost: $158.33 per month
  This is the average monthly cost for cellular service to three (3) mission units based upon what is currently being paid.
- Total Monthly Cost: $22,198.33 per month
  This cost is the estimated monthly cost to recover approximately 25,000 ac-ft of water over a twelve-month period.
- Total Annual Conveyance Cost: $266,380 per year or $10.66/ac-ft

The O&M costs for the Goose Lake Lift Station during a recovery event (dry year) are outlined below:

- RRBWSD Operation Cost: $1,500 per month
  This cost includes field staff time for lift station maintenance (cleaning, repairs, etc.), weed control around lift station, rodent control, equipment maintenance, office staff, and overhead cost.
- Electricity Cost: $300 per month
  This cost is the estimated monthly standby charge for the lift station.
- Mission Unit Cost: $52.78 per month
  This is the average monthly cost for cellular service to one (1) mission unit based upon what is currently being paid.
- Total Monthly Cost: $1,852.78 per month
- Total Annual Lift Station Cost: $22,233.33 per year or $0.89/ac-ft

The Phase I recovery well O&M costs during a recovery event (dry year) are outlined below:

- RRBWSD Operation Cost: $8,000 per month
  This cost includes field staff time for pump maintenance, oil for pumps, weed control around well sites, rodent control, scheduled water quality testing, office staff, and overhead cost.
- Electricity Cost: $144,900 per month
  This cost is predicated on moving 35 cfs (6 wells at 6 cfs each and an approximate TDH of 340-ft) for a 30 day period for a total of approximately 2,083 ac-ft of water recovered per month or 25,000 ac-ft per year. The power cost is estimated at an average of $0.13/kwh. This total cost has been divided by 12 to account for recovering this volume of water over a twelve-month period. This is approximately $24,150 per well per month.
- Mission Unit Cost: $316.67 per month
  This is the average monthly cost for cellular service to six (6) mission units based upon what is currently being paid.
- Total Monthly Cost: $153,216.67 per month
  This cost is the estimated monthly cost to recover approximately 25,000 ac-ft of water over a twelve-month period.
- Total Annual Recovery Facility Cost: $1,838,600 per year or $73.54/ac-ft

The Phase II recovery well O&M costs during a recovery event (dry year) are outlined below:

- RRBWSD Operation Cost: $8,000 per month
  This cost includes field staff time for pump maintenance, oil for pumps, weed control around well sites, rodent control, scheduled water quality testing, office staff, and overhead cost.
- Electricity Cost: $144,900 per month
  This cost is predicated on moving 35 cfs (6 wells at 6 cfs each and an approximate TDH of 340-ft) for a 30 day period for a total of approximately 2,083 ac-ft of water recovered per month or 25,000 ac-ft per year. The power cost is estimated at an average of $0.13/kwh. This total cost has been divided by 12 to account for recovering this volume of water over a twelve-month period. This is approximately $24,150 per well per month.
- Mission Unit Cost: $316.67 per month
  This is the average monthly cost for cellular service to six (6) mission units based upon what is currently being paid.
- Total Monthly Cost: $153,216.67 per month
  This cost is the estimated monthly cost to recover approximately 25,000 ac-ft of water over a twelve-month period.
- Total Annual Recovery Facility Cost: $1,838,600 per year or $73.54/ac-ft

<u>The total O&M costs during a recovery event (dry year) are outlined below</u>:

- Canal Reverse Flow O&M Costs: $22,198.33 per month
- Goose Lake Lift Station O&M Costs: $1,852.78 per month
- Phase I Recovery Well O&M Costs: $153,216.67 per month
- Phase II Recovery Well O&M Costs: <u>$153,216.67 per month</u>

  Total Monthly O&M Costs (dry year): $330,484.45 per month

  Total Annual O&M Costs (12 months): $3,965,813.33 per year
  Average Cost per acre-foot: $79.32 per ac-ft for 50,000 ac-ft/year

Figure 1 below shows a summary of all project O&M costs by facility and by operating year type.

Irvine Ranch Water District

Operation & Maintenance Cost Estimate

Phase I Well Field Operation Costs

Type of Year	Monthly RRBWSD Operation Cost[1,2]	Monthly PG&E Cost[3,5]	Monthly Mission Unit Cost[4]	DWR Conveyance Cost	Total Monthly Cost	Total Annual Cost if Utilized for 12 Months[6]	Average Cost per Ac-Ft[7]
Dry Year (Pumping Wells)	$ 8,000.00	$ 144,900.00	$ 316.67	$ -	$ 153,216.67	$ 1,838,600.00	$ 73.54
Wet Year (Recharging Water)	$ 9,000.00	$ 1,500.00	$ 316.67	$ -	$ 10,816.67	$ 90,600.00	$ 1.61
Idle Year	$ 4,100.00	$ 1,500.00	$ 316.67	$ -	$ 5,916.67	$ 71,000.00	

1. Rosedale's operation cost includes pond maintenance, oil for reservoirs, field staff time, equipment cost, weed control cost, rodent control cost, office staff, overhead cost,
2. Cost includes one additional piece of equipment for property maintenance
3. Monthly PG&E cost to operate (6) 400 hp wells
4. Average monthly cost for cellular service to (6) Mission Units
5. Assumed 35 cfs flow rate for a 30 day month for a total of 2,083 ac-ft of water recovered per month or 25,000 ac-ft/yr
6. Dry year annual cost based on operating 12 months out of the year. Wet year annual cost based on 4 months of recharging water up to 56,250 ac-ft and 8 months at idle
7. Dry year pumping 25,000 ac-ft and a wet year recharging 56,250 ac-ft.

Canal Operation Costs

Type of Year	Monthly RRBWSD Operation Cost[1,2]	Monthly PG&E Cost[3]	Monthly Mission Unit Cost[4]	DWR Conveyance Cost[5]	Total Monthly Cost	Total Annual Cost[6]	Average Cost per Ac-Ft[7]
Dry Year (Pumping Wells)	$ 8,000.00	$ 14,040.00	$ 158.33	$ -	$ 22,198.33	$ 266,380.00	$ 10.66
Wet Year (Recharging Water)	$ 9,000.00	$ 230,400.00	$ 158.33	$ 404,296.88	$ 643,855.21	$ 2,621,487.50	$ 46.60
Idle Year	$ 4,100.00	$ 1,500.00	$ 158.33	$ -	$ 5,758.33	$ 69,100.00	

1. Rosedale's operation cost includes pond maintenance, oil for reservoirs, field staff time, equipment cost, weed control cost, rodent control cost, office staff, overhead cost,
2. Cost includes one additional piece of equipment for canal maintenance
3. Monthly PG&E cost to operate two lift stations moving 230 cfs at a 20-ft TDH each, Total 56,250 ac-ft / year for wet years. Monthly PG&E cost to operate Return Water Lift Station moving 35 cfs at a 25-ft TDH, total 25,000 ac-ft/yr.
4. Average monthly cost for cellular service to (3) Mission Units
5. Article 21 water cost estimated at $23.00/AF for 112,500 ac-ft, however IRWD's share (37.5%) is paid through agreement with Metropolitan Water District. Therefore the estimated monthly water costs include $23/AF for 70,312.5 ac-ft.
6. Dry year annual cost based on operating 12 months out of the year. Wet year annual cost based on 4 months of recharging water up to 56,250 ac-ft and 8 months at idle
7. Dry year conveying 25,000 ac-ft to aqueduct and a wet year recharging 112,500 ac-ft.

Goose Lake Channel Turnout Operation Costs

Type of Year	Monthly RRBWSD Operation Cost[1]	Monthly PG&E Cost[2]	Monthly Mission Unit Cost[3]	DWR Conveyance Cost	Total Monthly Cost	Total Annual Cost[4]	Average Cost per Ac-Ft[5]
Dry Year (Pumping Wells)	$ 1,500.00	$ 300.00	$ 52.78	$ -	$ 1,852.78	$ 22,233.33	$ 0.89
Wet Year (Recharging Water)	$ 4,000.00	$ 52,500.00	$ 52.78	$ -	$ 56,552.78	$ 237,033.33	$ 4.21
Idle Year	$ 1,000.00	$ 300.00	$ 52.78	$ -	$ 1,352.78	$ 16,233.33	

1. Rosedale's operation cost includes pond maintenance, oil for reservoirs, field staff time, equipment cost, weed control cost, rodent control cost, office staff, overhead cost,
2. Monthly PG&E cost to operate (4) 200 hp lift pumps moving 240 cfs, Total 56,250 ac-ft / year
3. Average monthly cost for cellular service to (1) Mission Units
4. Dry year annual cost based on operating 12 months out of the year. Wet year annual cost based on 4 months of recharging water up to 56,250 ac-ft and 8 months at idle
5. Dry year pumping 25,000 ac-ft and a wet year recharging 56,250 ac-ft.

Phase II Well Field Operation Costs

Type of Year	Monthly RRBWSD Operation Cost[1,2]	Monthly PG&E Cost[3]	Monthly Mission Unit Cost[4]	DWR Conveyance Cost	Total Monthly Cost	Total Annual Cost if Utilized for 12 Months[6]	Average Cost per Ac-Ft[7]
Dry Year (Pumping Wells)	$ 8,000.00	$ 144,900.00	$ 316.67	$ -	$ 153,216.67	$ 1,838,600.00	$ 73.54
Wet Year (Recharging Water)	$ 9,000.00	$ 1,500.00	$ 316.67	$ -	$ 10,816.67	$ 90,600.00	$ 1.61
Idle Year	$ 4,100.00	$ 1,500.00	$ 316.67	$ -	$ 5,916.67	$ 71,000.00	

1. Rosedale's operation cost includes pond maintenance, oil for reservoirs, field staff time, equipment cost, weed control cost, rodent control cost, office staff, overhead cost,
2. Cost includes one additional piece of equipment for property maintenance
3. Monthly PG&E cost to operate (6) wells
4. Average monthly cost for cellular service to (6) Mission Units
5. Assumed 35 cfs flow rate for a 30 day month for a total of 2,083 ac-ft of water recovered per month or 25,000 ac-ft/yr
6. Dry year annual cost based on operating 12 months out of the year. Wet year annual cost based on 4 months of recharging water up to 56,250 ac-ft and 8 months at idle
7. Dry year pumping 25,000 ac-ft and a wet year recharging 56,250 ac-ft.

Total Project Operation Costs

Type of Year	Monthly RRBWSD Operation Cost[1,2]	Monthly PG&E Cost[3]	Monthly Mission Unit Cost[4]	DWR Conveyance Cost	Total Monthly Cost	Total Annual Cost if Utilized for 12 Months[6]	Average Cost per Ac-Ft[7]
Dry Year (Pumping Wells and Returning Wate	$ 25,500.00	$ 304,140.00	$ 844.44	$ -	$ 330,484.44	$ 3,965,813.33	$ 79.32
Wet Year (Conveying and Recharging Water)	$ 31,000.00	$ 285,900.00	$ 844.44	$ 404,296.88	$ 722,041.32	$ 3,039,720.83	$ 27.02
Idle Year	$ 13,300.00	$ 4,800.00	$ 844.44	$ -	$ 18,944.44	$ 227,333.33	