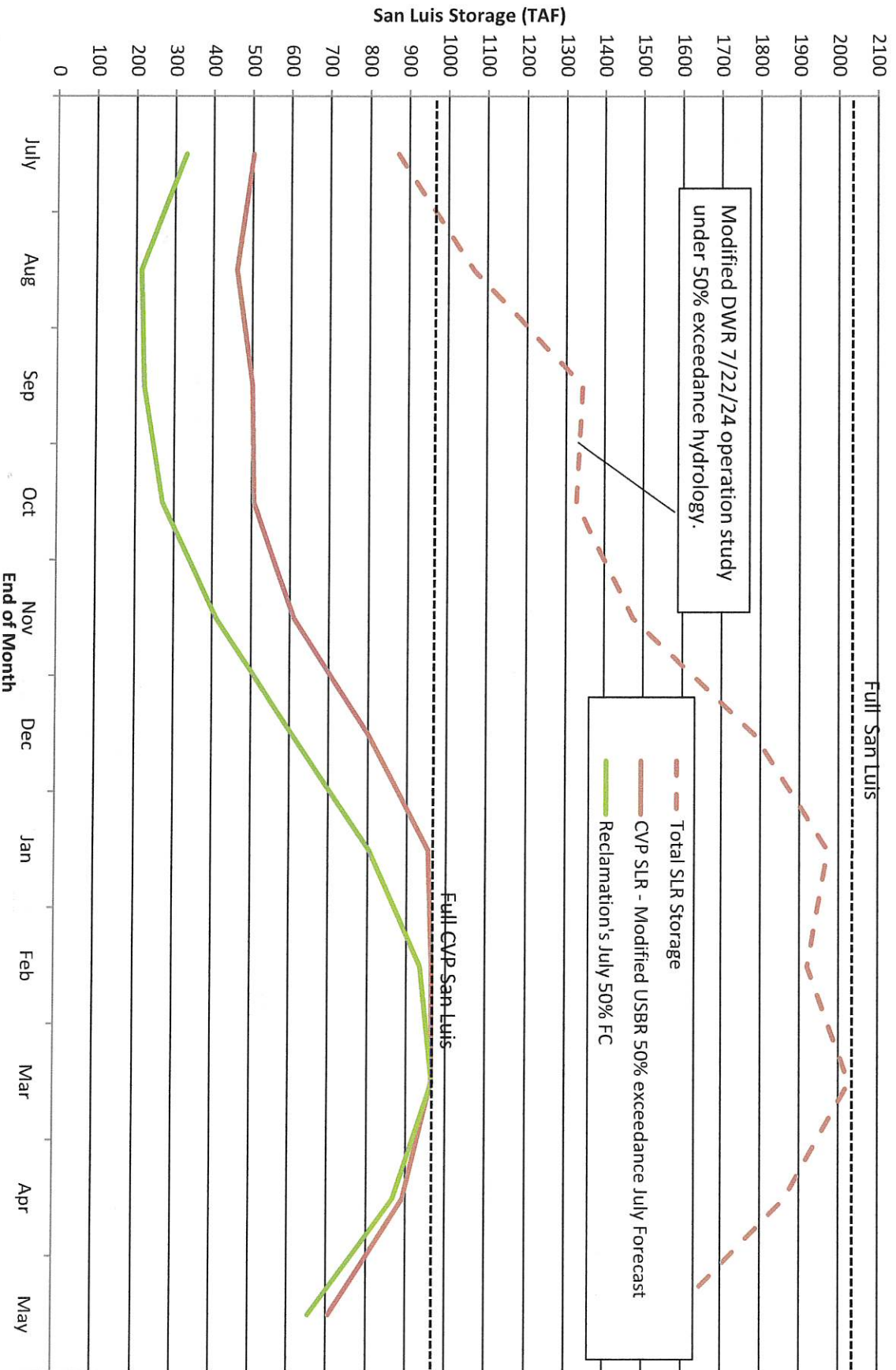
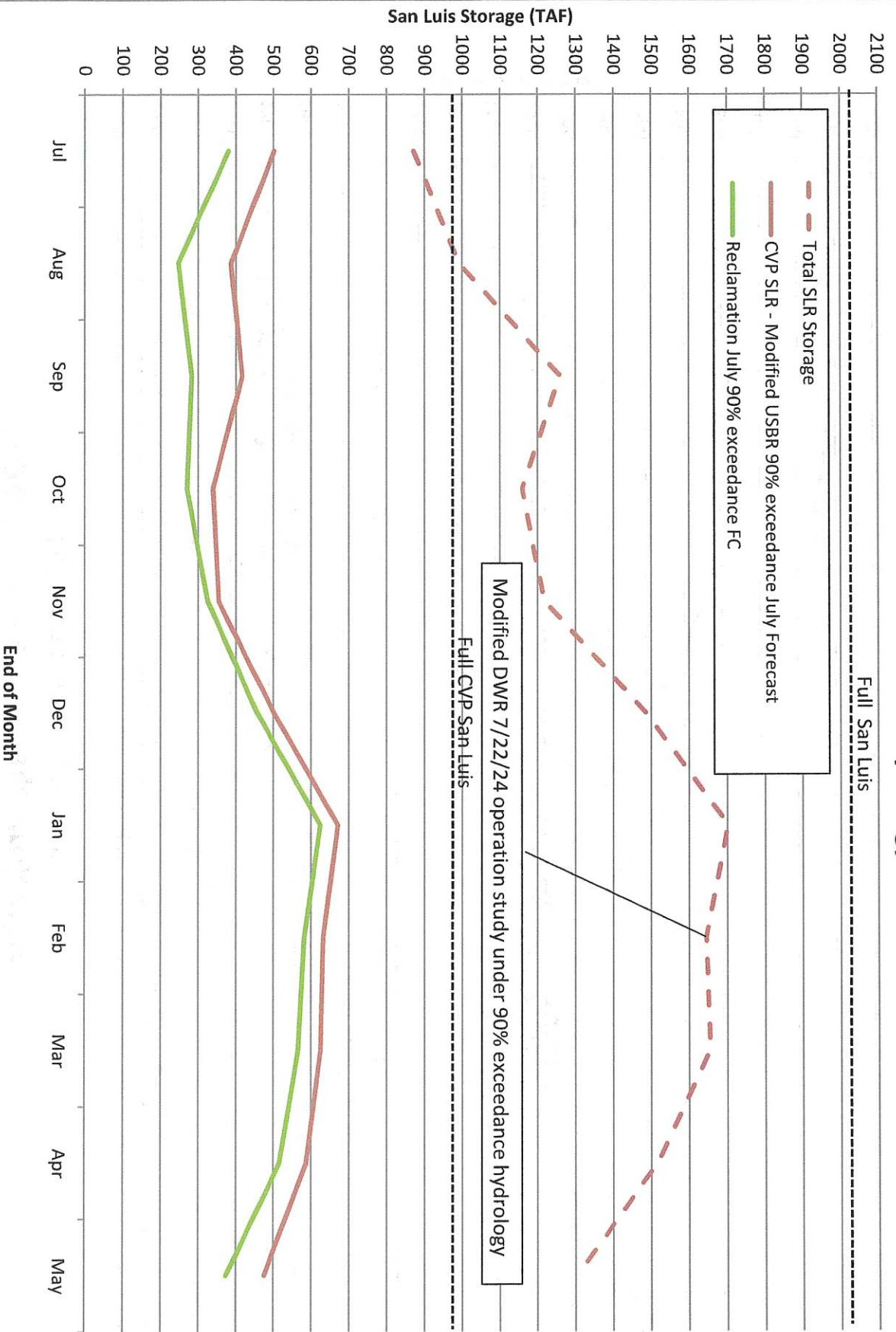


2024-25 San Luis Storage Projection 50% Exceedance Hydrology



2024-25 San Luis Storage Projection 90% Exceedance Hydrology



DEL PUERTO WATER DISTRICT 2024-25 SUPPLY/USE/COMPLETED TRANSACTIONS SUMMARY
as of July 31, 2024

Supply Type	2024-25
2023-24 Rescheduled NVRRWP Supply	8,694
2023-24 Rescheduled CVP Supply	14,021
Less: Monthly 1% Storage Loss Est.	(274)
Sub-Total: Rescheduled Supplies	22,441
2024 CVP Allocation (50%)	70,105
2024 NVRRWP	18,982
Sub-Total: Current Year Customer Supplies	89,087
2015 City of Huron Exchange (Rtn)	100
2024 SLCC Pump-in Exchange	171
Subtotal: Outside Purchases	271
Total Gross Projected Supply Available	111,799

July 2024 Quantity	Completed to Date
-----------------------	----------------------

2235	11100
------	-------

100	100
0	171

2023-24 IN DISTRICT USE		2024-25 IN DISTRICT USE	2024-25 OCRRP USE	2024-25 TRANSFERS OUT	2024-25 MONTHLY USE
135	MAR	2,281		4,474	6,755
4,057	APR	4,039	55	290	4,384
7,900	MAY	12,161		3,028	15,189
11,855	JUN	14,294		4,581	18,875
14,380	JUL	14,683		1,258	15,941
11,283	AUG				0
6,662	SEP				0
4,429	OCT				0
1,518	NOV				0
930	DEC				0
18	JAN				0
151	FEB				0
63,318		47,458	55	13,631	
		TOTAL USED & TRANSFERRED OUT			61,144
				TOTAL SCHEDULED	33,300
		TOTAL ESTIMATED FOR RESCHEDULING INTO 2024-25			17,355
		TOTAL GROSS PROJECTED SUPPLY AVAILABLE			111,799

Stored Supplies: 3,209 AF - AEWSO 2020, 1,952 AF - LTRID 2020, 4,934 AF - AEWSO 2023, 1,445 AF - OCRRP 2023, 49 AF - OCRRP 2024.

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2024-25 Annual Additional Supplies Pool

08.19.24

YEAR 2024-25	759	100	952	1811
	AEWSD Return '19	City of Huron	LTRID Return	Misc
SLDMWA				
BOR Rate	\$25.00	\$25.00	\$25.00	2024 Rev
Other	\$212.04			2024 COS
To Seller	\$237.04	\$150.00	\$101.31	2023 loss
Est Cost	759	\$175.00	\$126.31	
	\$179,913.36	100	952	
		\$17,500.00	\$120,247.12	
				1,811
				\$350,840.22
				\$193.73

VWC

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VIII D

15

Del Puerto Water District
Active Permits and Licenses
As of July 31, 2024

Active Permits

Permit No.	Issued Date	Expires	Project	Landowner/Entity	Location
P2402020	8/11/2023	8/11/2024	Drafting Water for Landfill Dust Control	Stan. Co./Fink Road Landfill	45.77R/Davis Rd.
P2402035	12/13/2023	10/30/2024	Drafting of Construction Water - NextEra Solar Project	Stan. Co./Cupertino Elec.	45.78R/Davis Rd.
P2502002	4/1/2024	9/30/2024	Grazing of DMC Right-of-Way	Azevedo	60.65L to 62.09L
P2502004	4/23/2024	10/31/2024	Temporary Pipeline on DMC Right-of-Way	Yamamoto	28.19L
P2502006	4/29/2024	4/29/2025	Monthly Water Samples for Trihalomethanes (THM's)	City of Turlock/NVRRWP	37.24 to 45.77
P2502015	7/2/2024	8/31/2024	PG&E to reestablish electrical service	Amaravati	56.85L
P2502016	7/9/2024	7/26/2024	Drafting of Spray Water	DePauw	47.89R

Active Licenses

Permit No.	Issued Date	Expires	Project	Landowner/Entity	Location
23-LC-20-3085	9/11/2023	9/11/2048	Orestimba Creek Recharge and Recovery Project	CCID/DPWD	51.65L/O-Creek

51

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JULY 2024

CITIES OF MODESTO AND TURLOCK IN ASSOCIATION WITH DEL
PUERTO WATER DISTRICT

Far-Field Dilution Study Work Plan

North Valley Regional Recycled Water Program

*Evaluation of Recycled Water Fraction in the Delta-Mendota Canal, O'Neill
Forebay, and San Luis Reservoir*

PREPARED BY:



LARRY WALKER
ASSOCIATES
science | policy | solutions



PREPARED FOR:



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Appendix A. Consultation Meeting Summaries
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EXECUTIVE SUMMARY

The Cities of Modesto and Turlock (Cities) are permittees in National Pollutant Discharge Elimination System (NPDES) permit No. CA0085316, Order No. R5-2022-0034, regulating the discharge of recycled water to the Delta-Mendota Canal (DMC) that meets reuse requirements for agricultural use. Even though the DMC is a man-made conveyance where flows are fully managed, it is considered a surface water in the NPDES permit. The Cities and Del Puerto Water District (DPWD), collectively "Project Partners," operate the North Valley Regional Recycled Water Program (NVRWP) to beneficially recycle Title 22 of California's Code of Regulations (CCR) (Title 22) compliant treated wastewater. NVRWP is a water recycling project intended only for agricultural or wildlife refuge supply. The NVRWP discharge is not a direct or indirect potable water supply project and the NVRWP does **not** meet the definition of a Surface Water Source Augmentation Project in the Surface Water Source Augmentation rules.

The Central Valley Regional Water Quality Control Board (Central Valley Water Board) NPDES permit requires the Cities to perform a far-field dilution special study to estimate the percent of recycled water present in the DMC, O'Neill Forebay, and San Luis Reservoir under critical conditions. The NPDES permit also requires that the Cities consult with the State Water Resources Control Board (State Water Board)'s Division of Drinking Water (DDW).

The Project Partners consulted with the Central Valley Water Board, DDW, and the State Water Contractors (SWC) during a total of three meetings in April and May 2024 to introduce work plan components and identify specific items to include. Two broad suggestions from the consulting agencies were 1) provide description of assumptions with their justifications and 2) summarize findings early in technical documents.

The Project Partners propose to perform modeling computations using outputs from the California Department of Water Resources (DWR) water resources planning model CalSim 3 to identify critical conditions for the fraction of NVRWP recycled water at specific nodes in the simulation that are representative of the two NPDES permit specified locations where mixing with raw municipal supply water (prior to drinking water treatment) may occur. Because the NVRWP is not considered in CalSim 3, the Project Partners propose to develop a NVRWP operational model to run with CalSim 3 outputs and then close the water balance, as necessary. The Project Partners determined that a tracer study to verify the fraction of NVRWP recycled water would provide only limited benefit because of variabilities with tracer degradation over the long distances and time (~30 miles to O'Neill Forebay and significant detention time in O'Neill Forebay and San Luis Reservoir). However, the Project Partners propose to report on the outcomes from the modeling study at an earlier date than required in the NPDES permit, as a consultation point to determine if any follow-up field studies or data collection are recommended.

The NPDES permit specifies that the study report be submitted on or before July 31, 2026 along with the Report of Waste Discharge.

1 INTRODUCTION

The Cities of Modesto and Turlock (Cities) are co-permittees in National Pollutant Discharge Elimination System (NPDES) permit No. CA0085316, Order No. R5-2022-0034, regulating the discharge of recycled water to the Delta-Mendota Canal (DMC) that meets reuse requirements for agricultural use. The City of Modesto operates its Water Quality Control Facility (WQCF) and the City of Turlock operates its Regional Water Quality Control Facility (RWQCF) to produce the recycled water that can be conveyed to the DMC through a constructed pipeline.

The Cities and Del Puerto Water District (DPWD) are collectively “Project Partners” for the North Valley Regional Recycled Water Program (NVRWP), which provides agricultural irrigation water to DPWD and downstream wildlife refuges through turnouts on the DMC. The Central Valley Regional Water Quality Control Board (Central Valley Water Board) originally permitted the discharge in early 2016 (Order No. 2016-0010) and renewed the NPDES permit again in 2022. The NPDES permit includes special studies to evaluate conditions in the DMC and downstream locations. The Cities of Modesto and Turlock began discharge to the DMC on December 11, 2017 and March 12, 2020, respectively. The NVRWP project components (treatment facilities and pipeline) along with the DMC, DPWD service area, and DPWD turnouts (points of diversion) are shown in **Figure 1**. Both Cities also have separate NPDES permits for discharge to the San Joaquin River and to beneficially recycle water at their facilities and through separate reclamation permits not related to the DMC discharge.

The DMC is a manmade conveyance facility operated by the United States Bureau of Reclamation (USBR) in coordination with other agencies and downstream water users. The DMC transports Delta water pumped near the City of Tracy at the Jones Pumping Plant to users located in the North San Joaquin Valley and to south of Delta wildlife refuges. Approximately 33 miles downstream of the discharge point, water from the DMC can be diverted to the O’Neill Forebay and mixes with water from the California Aqueduct, which is operated by the California Department of Water Resources (DWR) and can be stored in San Luis Reservoir based on operational needs and requirements. The California Aqueduct and San Luis Reservoir provide raw municipal drinking water (i.e., before required drinking water treatment) to Southern California and the San Francisco Bay Area.

The NVRWP is a critical agricultural supply project for DPWD, especially during years when Central Valley Project (CVP) deliveries are limited. The NVRWP also reduces the need to augment supply with groundwater pumping.

The NPDES permit (page F-16) summarizes the previous NPDES permit consultation the Central Valley Water Board received¹ from DDW:

DDW staff considered the information provided and the definition of Surface Water Source Augmentation Project in Title 22, Section 60301.851 in Title 22, CCR defines what constitutes a Surface Water Source Augmentation Project. Specifically, it states that the project involves the planned placement of recycled water for the purpose of supplementing the source of

¹ State Water Board Division of Drinking Water. Letter to Central Valley Water Board. March 20, 2022.

domestic drinking water supply. Given that the purpose of the NVRWP is not for supplementing the source of domestic drinking water supply, as well as taking into consideration the modeling information provided by the NVRWP for wastewater contributions to O'Neill Forebay and San Luis Reservoir, DDW determined that the NVRWP is not a surface water augmentation project. DDW staff recommends collecting additional information as part of the NPDES permit requirements to ensure the determination remains appropriate during the next NPDES permit renewal.

1.1 NPDES PERMIT REQUIREMENTS

The DMC NPDES permit requires that both Cities oxidize, coagulate, filter, and adequately disinfect pursuant to the State Water Resources Control Board (State Water Board)'s Department of Drinking Water (DDW) reclamation criteria, California's Code of Regulations (CCR), Title 22, Division 4, Chapter 3 (Title 22), or equivalent. Title 22 is not directly applicable to surface water discharges pursuant to NPDES, however, the Central Valley Water Board found that it is appropriate to apply an equivalent level of treatment to that required by the DDW's reclamation criteria because the intended use is for crop irrigation. The NPDES permit limits the Cities discharge to 14.2 million gallons per day (MGD) and 14.9 MGD for Turlock and Modesto, respectively.

The NPDES permit requires an updated study to evaluate the fraction of recycled water at downstream points to better assess protection of municipal drinking water beneficial uses (MUN):

The Discharger shall conduct a far-field dilution study to estimate the monthly average effluent fractions at O'Neill Forebay and San Luis Reservoir. The Far-Field Dilution Study shall be conducted using the appropriate critical design flow based on the appropriate time period that captures expected reasonable-worst case flow conditions for the Delta-Mendota Canal to evaluate the far-field impacts to protect the MUN beneficial use. The evaluation shall be conducted for the current combined permitted average dry weather flow of 29.1 MGD and the full build-out combined design average dry weather flow of 52.7 MGD. The modeling shall also consider diversions by the Del Puerto Water District and other users from the Delta-Mendota Canal upstream and downstream of the discharge, as well as pump-ins to the Delta-Mendota Canal upstream and downstream of the discharge, as appropriate.

The Discharger shall develop a workplan in consultation with staff from the Central Valley Water Board and State Water Board Division of Drinking Water. The workplan and Far-Field Dilution Study shall be submitted by the due dates in the Technical Reports Table (Attachment E, Section X.D, Table E-11). [NPDES permit page 19]

FAR-FIELD DILUTION MODEL

The NPDES permit requires a modeling study that estimates the fraction of NVRWP recycled water at two downstream locations under reasonable worst case conditions. The modeling is required to consider diversions and pump-ins upstream and downstream from the discharge location to the DMC.

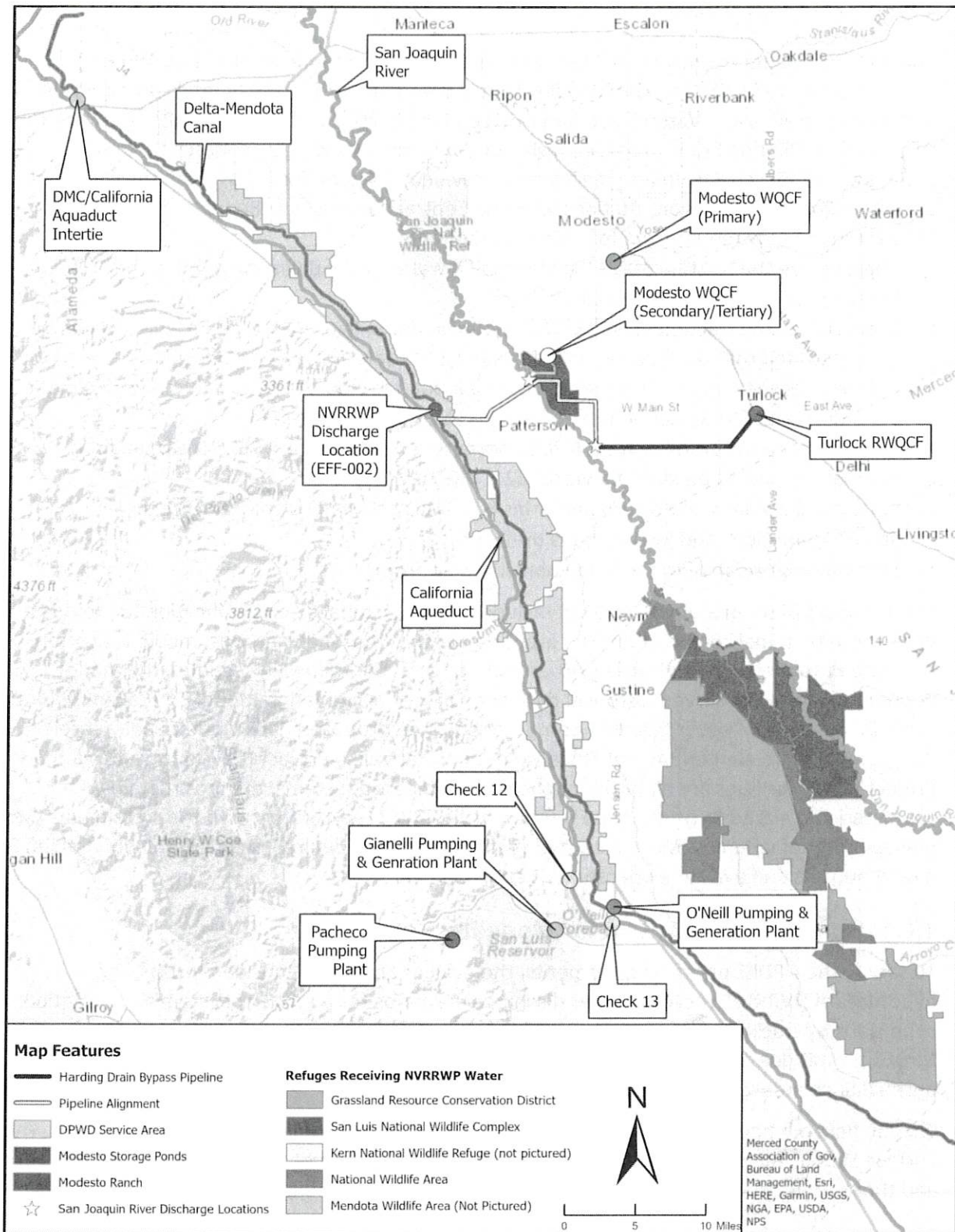


Figure 1. North Valley Regional Recycled Water Program Facilities and Agricultural Application Area

1.2 STUDY OBJECTIVES

This Far-Field Dilution Study Work Plan satisfies the NPDES permit requirement. The Project Partners consulted with the Central Valley Water Board on April 10, 2024, and subsequently with the Central Valley Water Board and DDW on May 9, 2024 and May 28, 2024 regarding both this Far-Field Dilution Study and a separate contaminants of emerging concern (CEC) study. Summaries of these consultation meetings is provided in **Appendix A**. Based on the NPDES permit language and the consultations with the Central Valley Water Board and DDW, the Far-Field Dilution Study requires the following components:

- Characterize the fraction of NVRRWP recycled water at the diversion point in the O'Neill Forebay to the San Luis Reservoir.
- Characterize the fraction of NVRRWP recycled water in San Luis Reservoir unless it can be demonstrated that the fraction entering San Luis Reservoir is not significant.
- Evaluate reasonable critical conditions using input data that represents a range of climatic conditions and CVP water delivery scenarios at a monthly timestep.
- Analyze scenarios of the current NPDES permitted discharge rate (29.1 MGD) and the originally expected buildout flowrate (52.7 MGD).
- Consider diversions and return pump-ins by DPWD and other significant users.
- State assumptions and justifications up-front.
- State findings relative to the study objectives up-front.

This Far-Field Dilution Study Work Plan includes technical details and justification to provide a basis for data model construction. The input data, computational methods, model validation, and data output elements of this effort are described in the following sections. The model approach relies on observed historical data and California Simulation Model 3² (CalSim 3) model outputs to perform “water balance” computations. The proposed data model is not a three-dimensional finite element model. Because the Central Valley Project (CVP) and State Water Project (SWP) facilities are highly managed and engineered systems, the most dominant characteristic related to tracking the fraction of NVRRWP recycled water in the system was the management of volumes. Moreover, the monthly timestep required is consistent with CalSim 3 model outputs and available operational reporting.

1.2.1 Purpose and Context for Modeling Work

To satisfy the NPDES permit requirements, the evaluation should consider current and hypothetical NVRRWP recycled water discharge scenarios for a range of system and climatic conditions by tracking water volumes on a monthly timestep to identify critical conditions. The NPDES permit does not require an evaluation of constituent concentrations or specific performance metrics.

The far-field dilution modeling is not intended as an assessment of the applicability of the Surface Water Augmentation Rule because the NVRRWP does not provide drinking supply water and those regulations are not applicable based on the project objective. However, the findings

² California Department of Water Resources and United States Bureau of Reclamation Great Basin Region. *CalSim 3 Report . A Water Resources System Planning Model for State Water Project & Central Valley Project*. August 2022.

of the study may be used to better understand the occurrence of reasonable worst case conditions in the context of protection of MUN beneficial uses.

2 CONSTRAINTS AND ASSUMPTIONS

The NPDES permit requires an evaluation of discharge scenarios under a range of potential CVP and SWP operational conditions to determine and characterize critical conditions (frequency, duration, conditions, contributing factors, etc.) when the fraction of NVRRWP recycled water is highest. This far-field dilution modeling effort has the benefit of an extensive flow volume dataset to characterize climatic and operational conditions. However, in any modeling framework some parameters may be unknown or certain system assumptions are required to resolve the model construction to provide meaningful results. Sensitivity analyses around any identified assumptions will be performed to develop a ranges of outcomes. The conservative (higher fraction of NVRRWP recycled water) evaluations may require follow-up during the study as discussed in **Section 4 (Adaptive Management)**.

2.1 MODEL TOOL SELECTION

While substantial elements within the model domain have been modeled by others using hydrodynamic models³, the project objectives in this case do not require evaluations of the fate and transport of specific constituents, but rather only require an evaluation of relative volumes (i.e., volume NVRRWP to all other volumes). The project objectives can be achieved with volumetric modeling under a broad range of climatic and operational conditions. The proposed modeling work (see **Section 3 Methods**) is not designed as a finite element model to replicate molecular movement through the model domain. The proposed approach does not introduce new modeling tools, but instead uses output from CalSim 3. CalSim 3 is a fully vetted DWR model for estimating conditions in all model domain facilities for 94 years of observed climatic conditions. However, CalSim 3 does not consider NVRRWP facilities or operations, and the proposed far-field dilution modeling approach would supplement CalSim 3 outputs with NVRRWP operational rules and rebalance CalSim 3 outputs. Hydrodynamic modeling would not provide additional detail on volumetric fractions on a monthly timestep and CalSim 3 volumetric water balance scenarios are sufficient to meet study objectives.

2.2 MODEL DOMAIN

The proposed water balance model approach includes the facilities, inflows, and outflows in the spatial area shown in the **Figure 2** schematic. The water balance will track volumes from the boundary conditions, exit points, and internal nodes that generally follow CalSim 3 nodes and NVRRWP introduced nodes.

³ CH2M Hill. *DSM2 Extension for the California Aqueduct, South Bay Aqueduct, and Delta-Mendota Canal*. Prepared for State Water Contractors and Municipal Water Quality Investigation Program. June 2005.

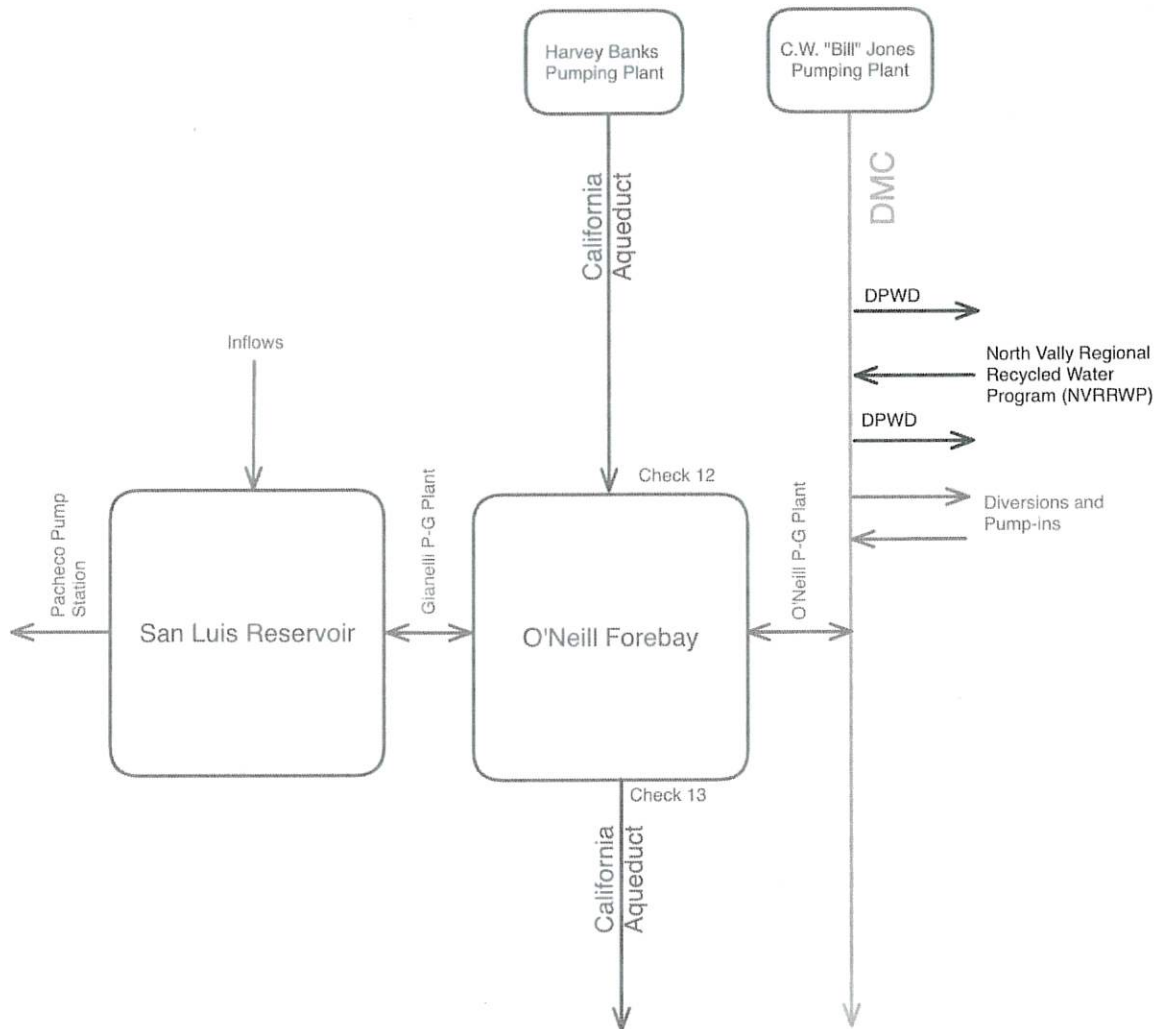


Figure 2. NVRRWP Model Domain

2.3 CRITICAL TIME PERIODS

The NVRRWP discharges at a near constant rate throughout the year and year-to-year (see **Figure 3**). The NPDES permit Far-Field Dilution Study requirement specifies evaluation at the permitted flow and an expected build-out flow (not permitted). The NVRRWP recycled water fraction in the DMC is then highest when the DMC flow is lowest. However, these lower periods of DMC flow may not occur during periods when DMC water is pumped to O'Neill Forebay or San Luis Reservoir (i.e., the study endpoints). As shown in **Figure 4**, lower Delta pumping conditions (i.e., lower DMC flows) typically occur from April through June while the peak flow from the DMC to O'Neill occurs in January on average (**Figure 5**). Identifying the critical periods requires evaluation of these dynamic conditions over different water year types and different seasons. While averages are shown in the figures to provide a general characterization for this work plan, an evaluation of the long CalSim 3 history allows development of other critical condition metrics (e.g., five or twenty year return periods).

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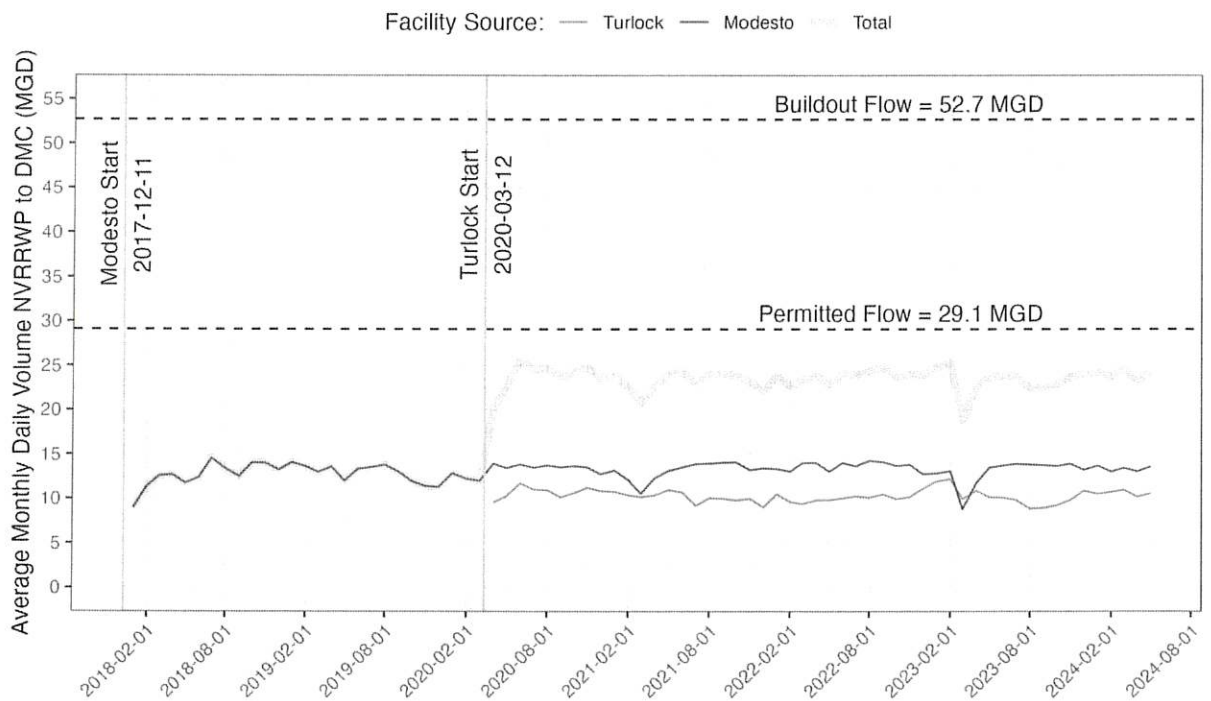


Figure 3. NVRWP Monthly Average Flowrate to Delta-Mendota Canal (CIWQS)

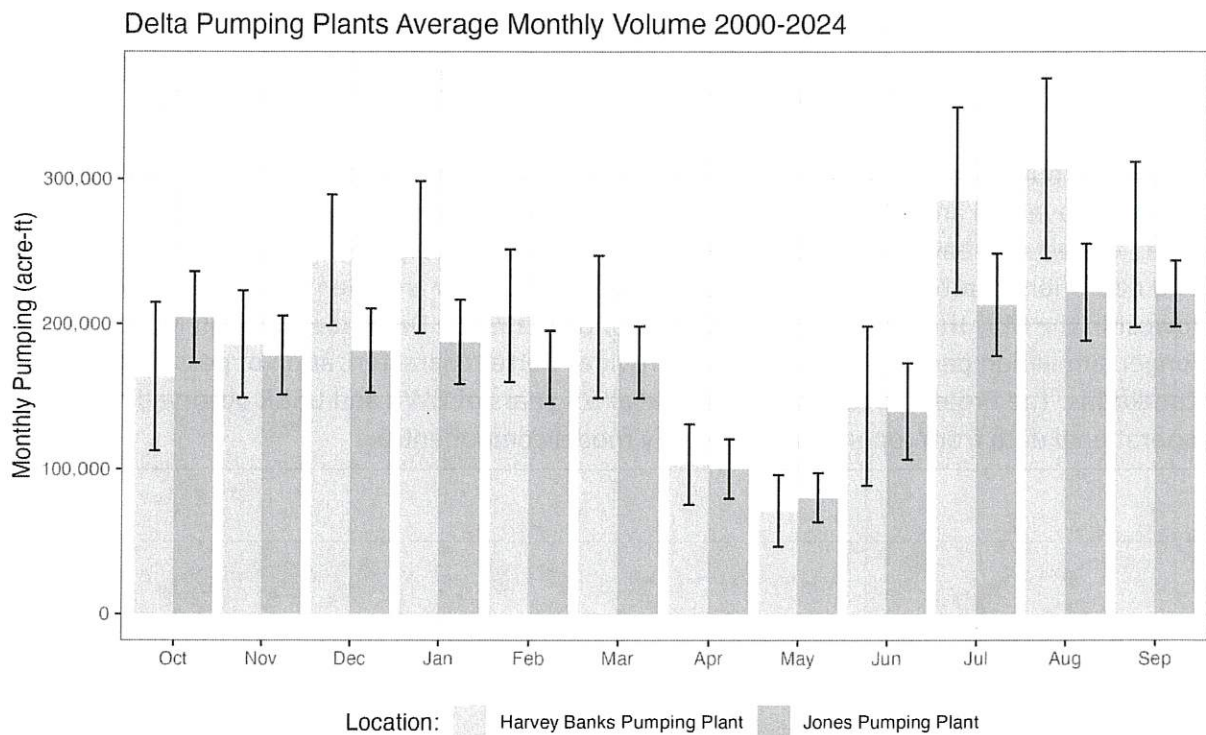


Figure 4. Delta Average and 95th Confidence Interval Monthly Pumping (CDEC)

O'Neill Forebay transfers from the DMC also vary throughout the year (see **Figure 5**) such that volumes during April through November are lower and can be negative (generation from the O'Neill Forebay to the DMC) during the fall. **Figure 5** summarizes a shorter evaluation period and is not representative of a broad range of operational and climatic conditions.

DMC at Jones Pumping Plant and O'Neill Pump Station Monthly Volumes
2019-01-01 to 2024-05-31 based on USBR Reports and CDEC

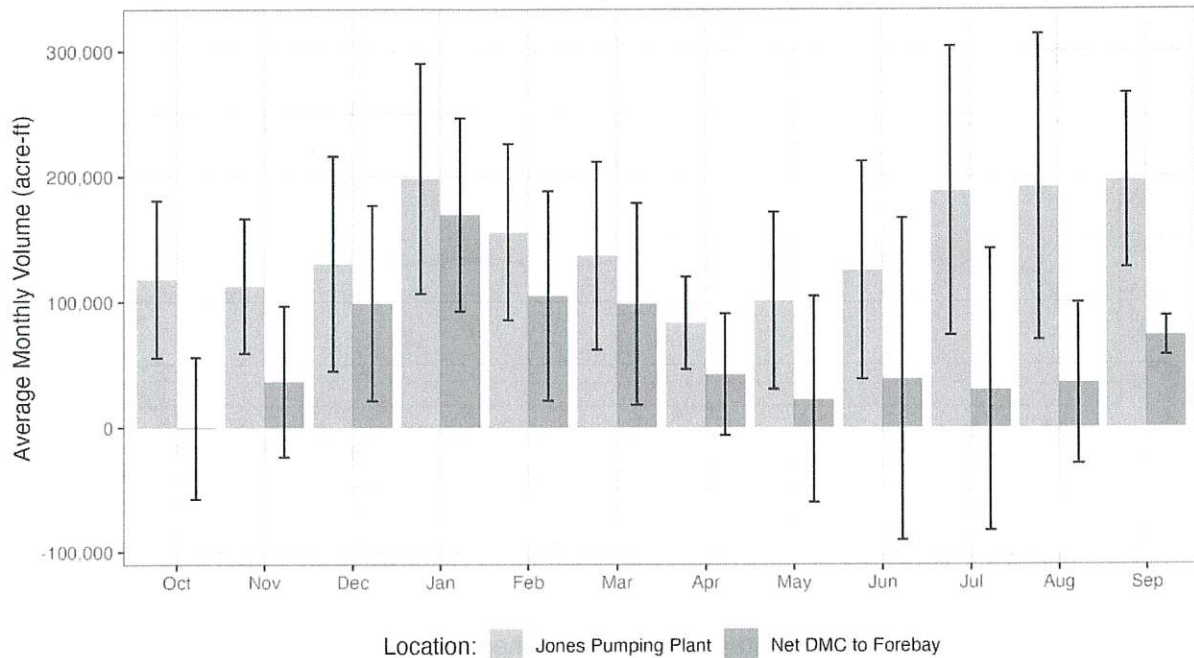


Figure 5. O'Neill Average and 95th Confidence Interval Monthly Pumping

Figure 6 through **Figure 8** present CalSim 3 July 2021 Baseline Model 1922 to 2015 simulation output as average and 95% confidence interval monthly volumes at key study locations in the DMC, O'Neill Forebay, and the California Aqueduct, respectively. The dynamic system conditions and operational patterns in DMC pumping to O'Neill Forebay and then to San Luis Reservoir are lowest in the May through September period and greatest in December through March. The longer simulation period of CalSim 3 data provides better characterization of possible conditions. The Project Partners will compile all 25 years of DWR and USBR observed historical operational data from report tables to verify model components.

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Delta Mendota Canal

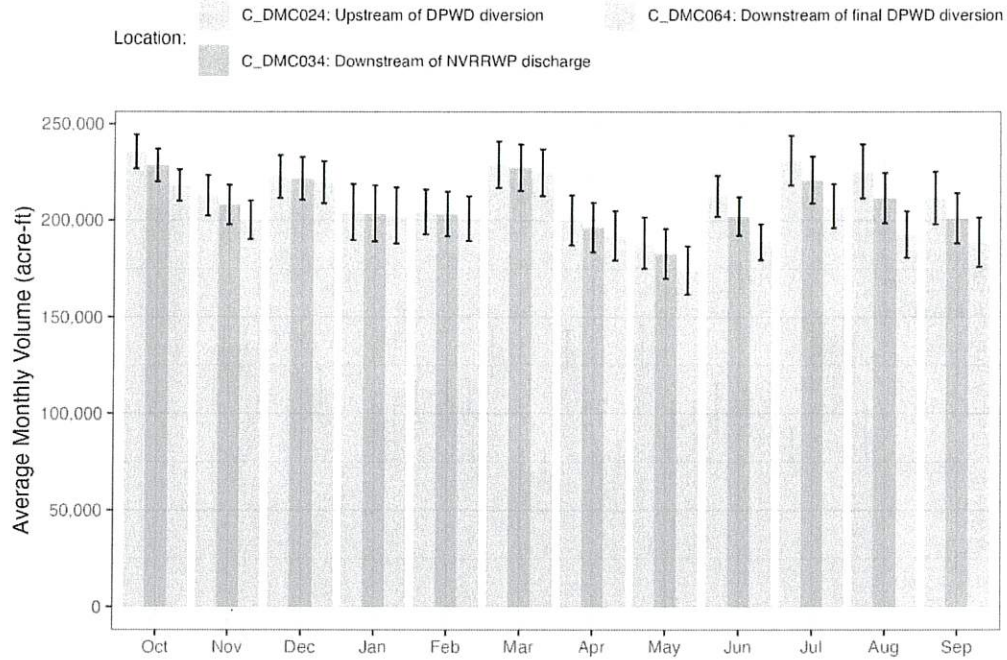


Figure 6. CalSim 3 July 2021 Baseline Model Average and 95% Confidence Interval Monthly Volumes at DMC Nodes

O'Neill Forebay

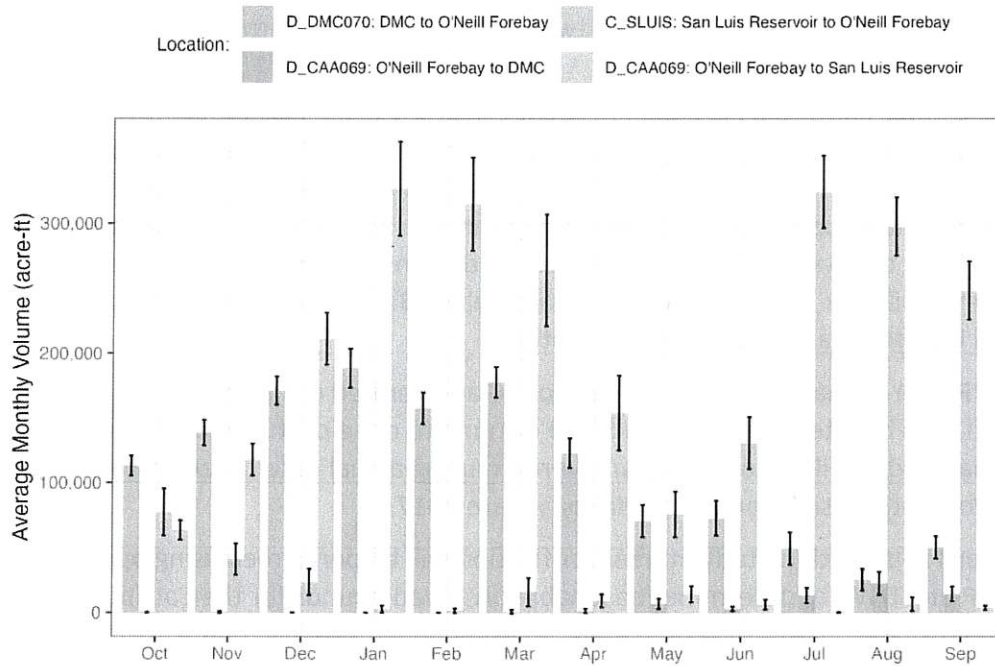


Figure 7. CalSim 3 July 2021 Baseline Model Average and 95% Confidence Interval Monthly Volumes at O'Neill Forebay Nodes

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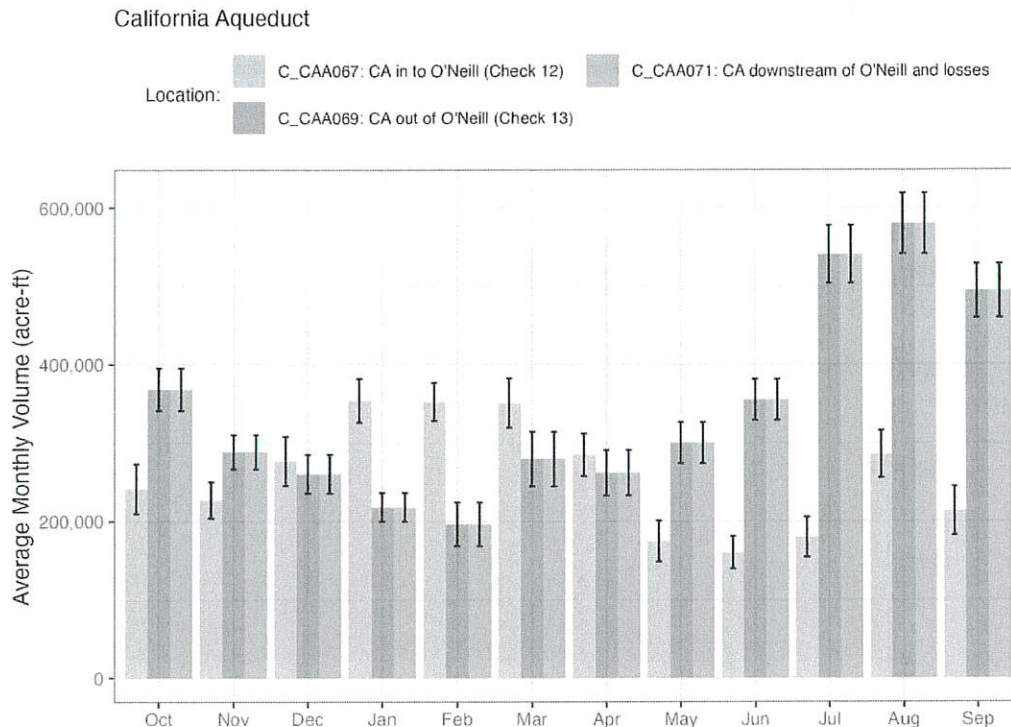


Figure 8. CalSim 3 July 2021 Baseline Model Average and 95% Confidence Interval Monthly Volumes at California Aqueduct Nodes

The study will evaluate all conditions to determine the most critical periods when NVRRWP recycled water fractions are highest in a twenty and five year return periods.

2.4 MODEL VERIFICATION

CalSim 3 does not output conditions that actually occurred during the simulation years, but rather applies model rulesets and volume balancing for a time series of climatic conditions. The output then reflects application of complex agreements (i.e., scenarios) and operational logic to determine how the system would have performed in any year according to the CalSim 3 rules. It will not be possible or necessary to recalibrate CalSim 3 because it is the assumed trusted data source on hypothetical CVP and SWP operations.

A NVRRWP operational model will be developed and verified using observed data. The NVRRWP model will then be integrated with CalSim 3 outputs to close of the water balance. The NVRRWP operational model will be calibrated and verified using actual data collected by DPWD during NVRRWP operations since project initiation in late 2017.

For this Far-Field Dilution Study, model verification will be performed using operational reports from USBR and DWR to determine reasonable observed bounds for the CalSim 3 based evaluation.

2.5 MODEL TIMESTEP

DWR, USBR, and DPWD operational data are available in daily timesteps and CalSim 3 outputs are all monthly timesteps. For the purpose of evaluating MUN beneficial use protection, the Central Valley Water Board generally relies on monthly averaging periods. Spatially, the model domain includes thirty three miles of conveyance and two large reservoirs, which are assumed to have cumulative residence times near to or greater than a month under most conditions.

Conveyance time (i.e., “float time”) in the DMC to the O’Neill Forebay can be estimated based on DMC flow rate and the channel cross section. Float times for the thirty-three-mile conveyance are estimated in **Figure 9** based on daily flow measurement at the Jones Pumping Plant and a range of operationally reasonable depths along the DMC. As shown in **Figure 4**, DMC flows are lowest in April through June. Calculation of the DMC float times was then split into the two apparent flow distributions for April through June and July through March.

The Project Partners estimated average residence time in the reservoirs using daily storage volume reported in the California Data Exchange Center (CDEC) and daily flow rates leaving each facility from USBR reporting. **Figure 10** and **Figure 11** estimate average monthly residence times for the period of available CDEC storage data. The outflow used for San Luis Reservoir is both the Pacheco Pumping Plant, but also pumping back to the O’Neill Forebay at the Gianelli Pumping-Generating Plant.

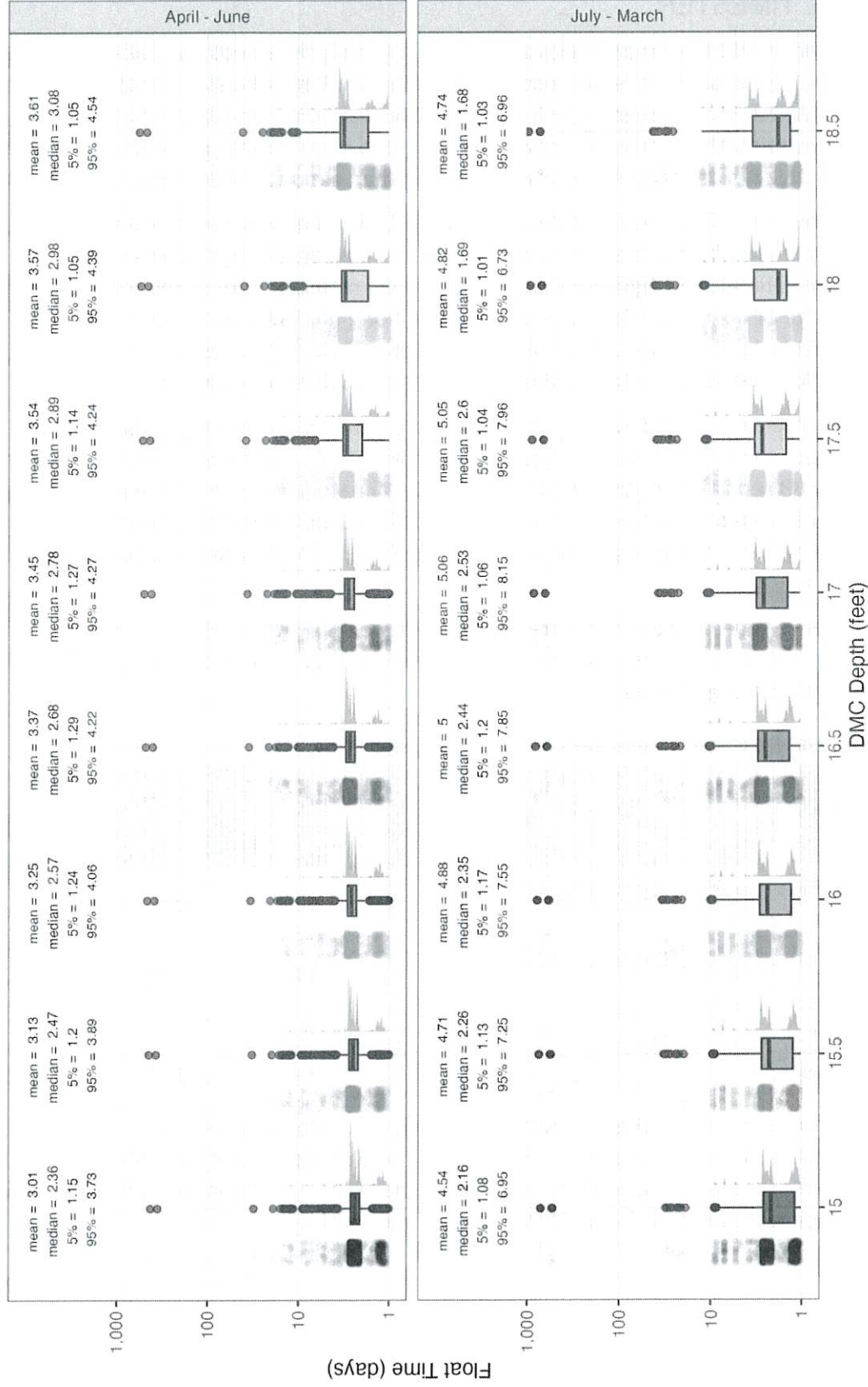
Average residence time is an approximate of a mean parcel of water under fully mixed conditions. The **Table 1** summary provides an initial estimate of a range of total detention times based on **Figure 9** through **Figure 11**.

Table 1. Float and Residence Times for NVRRWP Recycled Water

Location	Median Duration (days)	Lower End Duration (days)	Upper End Duration (days)
DMC from NVRRWP to O’Neill Forebay (April through June)	2.2	0.49	3.81
DMC from NVRRWP to O’Neill Forebay (July through March)	0.73	0.48	3.5
O’Neill Forebay	9.8	2.1	49
San Luis Reservoir	250	44.1	1,180

The residence times will be further evaluated to understand averaging periods and mixing rates for fraction of NVRRWP recycled water. The study will evaluate daily and monthly variance in DMC flow, NVRRWP recycled water flow, and DPWD management actions as part of the model validation and development of the NVRRWP operational model.

NVRRWP to O'Neill Forebay Float Time vs. DMC Depth (1999-10-01 to 2024-06-10)

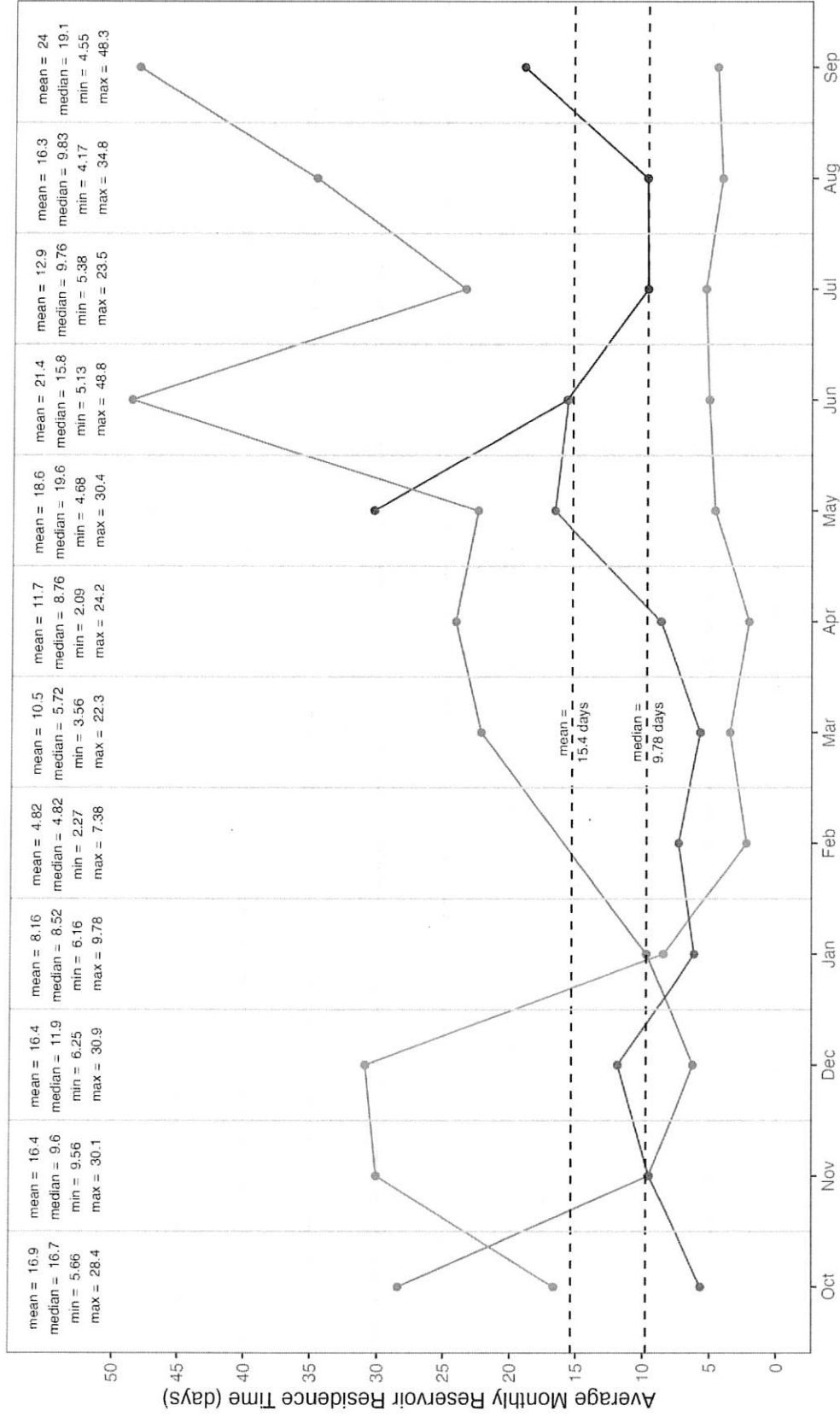


Calculated using CDEC flows and channel geometry.
 April to June: mean float time = 2.6 days; median float time = 2.2 days
 July to March: mean float time = 0.73 days; median float time = 0.73 days

Figure 9. Estimated DMC Float Times vs. Depth for Observed Flow Rates at Jones Pumping Plant

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O'Neill Forebay 2021-04-01 to 2024-05-31



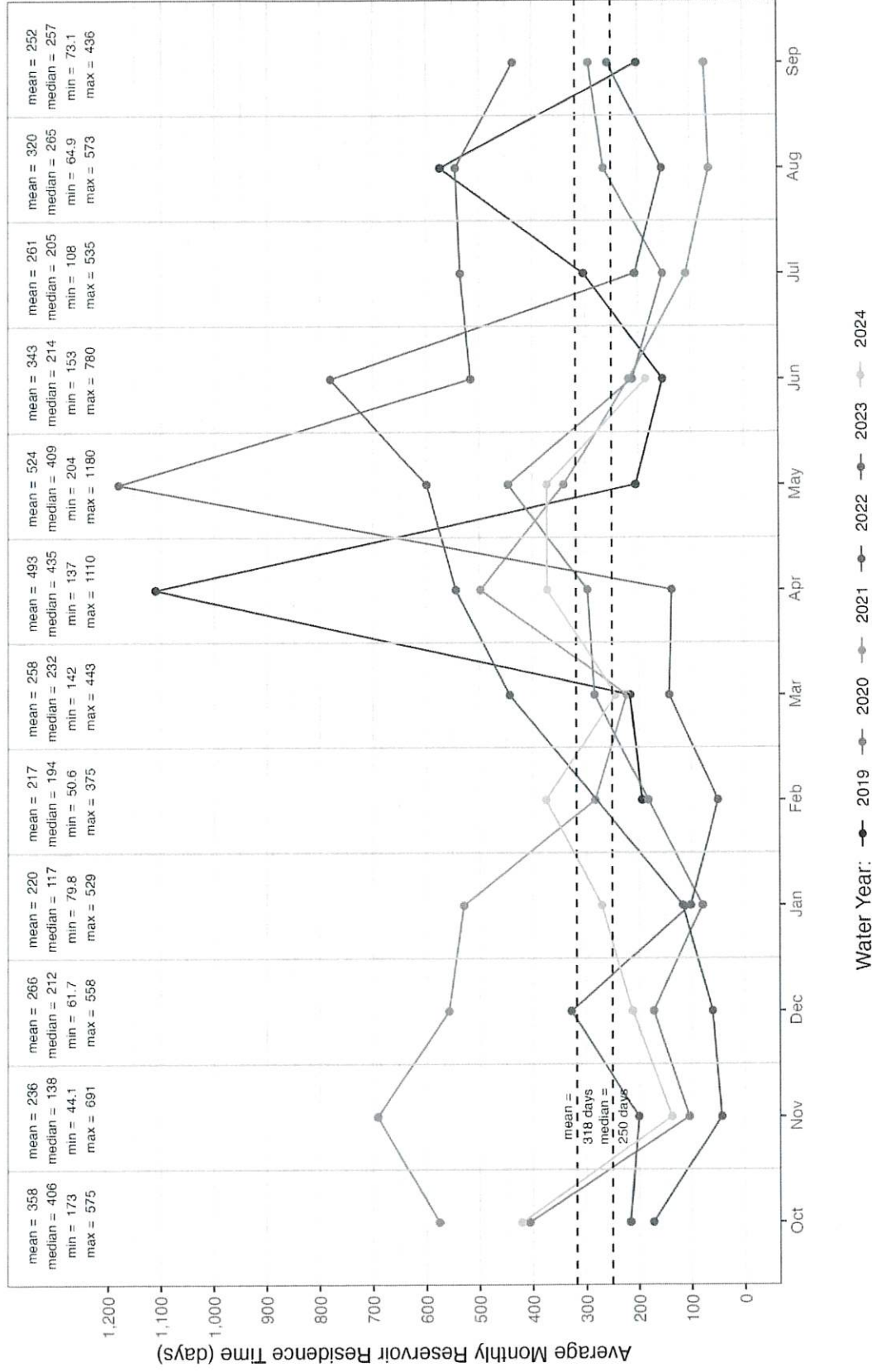
Water Year: 2021 2022 2023 2024

Calculated using CDEC daily storage volume and USBR daily flowrates leaving O'Neill Forebay

Figure 10. Estimated O'Neill Forebay Average Monthly Residence Time

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San Luis Reservoir 2019-01-01 to 2024-05-31



Calculated using CDEC daily storage volume and USBR daily flowrates leaving San Luis Reservoir

Figure 11. Estimated San Luis Reservoir Average Monthly Residence Time

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2.6 HYDRAULIC MIXING

Hydrodynamic mixing could influence NVRRWP recycled water tracking in that incomplete mixing can lead to disproportionate fractions of NVRRWP recycled water to occur at points in the system. In 2015 and 2021 studies, the City of Turlock determined that complete mixing in the DMC occurs within the first 2,000 meters from the discharge.^{4,5} Mixing in the O'Neill Forebay and San Luis Reservoir are more complex, but have longer residence times. Conservative mixing assumptions can also be evaluated during the study to ensure that a critical condition is evaluated.

Hydrodynamic mixing models and dye studies are typical tools to evaluate the spatial movement of introduced volumes of water mixing through physical interactions and dispersion. The City of Turlock's study verified DMC complete mixing with a hydrodynamic model and dye field study. Other key locations where mixing assumptions or analysis might be necessary are DMC pump-ins to the O'Neill Forebay and general conditions for longer detention times in the San Luis Reservoir. Simplified mixing models will be evaluated to determine the sensitivity of the overall outcomes to mixing assumptions for O'Neill Forebay and San Luis Reservoir (see **Sections 3.2.2** and **3.2.3**, respectively).

2.6.1 Dye Tracers for Larger Model Domains

Rhodamine WT (RWT) dye was used for the near field mixing verification study described in **Section 3.2** and is often considered an ideal candidate for dye tracer studies due to easy use, low toxicity, and rapid detection over a large range of concentrations (1,000 - 0.01 parts per billion, ppb) using *in situ* field sensors⁶. While RWT has been used to evaluate the hydrodynamics of river and canal systems⁷ and to field-verify surface water augmentation modeling studies⁸, the DMC-O'Neill Forebay-San Luis Reservoir system has several characteristics that make application of RWT challenging. Central among these are 1) the distance and travel time along the DMC from the NVRRWP recycled water outfall to the O'Neill Forebay intertie, and 2) the large volumes of water under consideration in both the O'Neill Forebay and San Luis Reservoir (see **Table 1**).

While RWT is considered relatively stable compared to other fluorescent dyes, RWT is still lost from the water column due to a variety of factors including photodegradation, oxidation by

⁴ Larry Walker Associates. *North Valley Regional Recycled Water. Delta-Mendota Canal Mixing Zone Study*. Technical Memorandum to Dan Madden, City of Turlock and William Wong, City of Modesto. October 10, 2015.

⁵ Robertson-Bryan, Incorporated. *Mixing Zone Validation Study Report for the City of Turlock Regional Water Quality Control Facility Discharge to the Delta Mendota Canal*. June 2021.

⁶ Smith, S. (2021). *EXO Sonde Rhodamine Sensor*. <https://www.ysi.com/ysi-blog/water-blogged-blog/2020/04/what-is-rhodamine-get-the-rho-down>

⁷ Runkel, R. L. (2015). *On the use of rhodamine WT for the characterization of stream hydrodynamics and transient storage*. *Water Resources Research*, 51(8), 6125-6142.

⁸ Thiemann, M., James, D., Saber, A., Hannoun, I., Cerri, C., & Pasek, J. (2021). *Evaluation of Approaches to Determine Mixing and Assimilation of Reuse Effluent*. US Bureau of Reclamation Final Report No. ST-2021-7100-01. https://cms3.revize.com/revize/lakearrowheadcsd/Document/Document%20Center/Planning/S&T%20Final%20Report_7100_508.pdf

chlorine and other compounds, and particle sorption, all of which increase with environmental exposure.⁹ These factors, combined with the fact that ‘slugs’ of RWT introduced to canal or river systems will experience continual dispersion with progressive travel downstream, all present challenges in quantitative application. While downstream mass inventory of RWT using high frequency measurements may help characterize dye loss during transit, the length of the DMC following addition of NVRRWP recycled water and estimated travel time to the O’Neill Forebay (see **Table 1** and **Figure 9** through **Figure 11**) introduce considerable uncertainty. Despite RWT’s utility for qualitative assessments and instances in which strict concentration accounting are not required, other investigators caution against quantitative application in surface water settings¹⁰. These challenges become more problematic when considering the very large volumes of the O’Neill Forebay and San Luis Reservoir relative to the amount of RWT that could feasibly be added to the DMC.

Assuming that no RWT is lost following dye introduction to NVRRWP effluent, subsequent discharge to the DMC and transit of ~33 miles, detection limits of available sensors are prohibitive to track recycled water effluent through the O’Neill Forebay and San Luis Reservoir. Assuming that 0.5 acre-foot (AF) of DMC water entering the O’Neill Forebay could be perfectly mixed to achieve the upper RWT sensor detection limit of 1,000 ppb, complete mixing with the O’Neill Forebay’s water volume (~49,953 AF, see **Table 1**) would result in RWT concentrations below the instrument detection limit of 0.01 ppb¹¹. Doubling the volume of DMC water entering with a concentration of 1,000 ppb would allow for detection of DMC water movement through O’Neill Forebay, but would not allow for tracking of DMC contribution through the 647,351 AF San Luis Reservoir (**Table 1**). To achieve a uniformly mixed RWT concentration of 0.05 ppb (five times the detection limit) in the San Luis Reservoir, approximately 64 AF of DMC water mixed to a concentration of 1,000 ppb would need to be added to the O’Neill Forebay. This assumes that half of the DMC water that enters the O’Neill Forebay makes it to the San Luis Reservoir and ignores any RWT loss that would occur during potentially long residence times before discharge through the Pacheco Pump Station (see **Table 1**).

2.7 NVRRWP OPERATIONAL MODEL

DPWD is a member of the San Luis & Delta-Mendota Water Authority (SLDMWA), which assumes responsibility from USBR on certain DMC facilities and coordinates operations for members. Both DPWD and SLDMWA maintain records of diversions and operations. As part of this modeling study, a DPWD NVRRWP operational model will be developed to represent and characterize water diversions and return pump-ins not included in CalSim 3. NVRRWP provides DPWD with more operational control to meet its members’ needs, especially when CVP allocations are reduced or not available during certain years. The DPWD operational model will be based on data from the start of the NVRRWP and be developed to ensure water balance

⁹ Runkel, R. L. (2015). On the use of rhodamine WT for the characterization of stream hydrodynamics and transient storage. *Water Resources Research*, 51(8), 6125-6142.

¹⁰ Ibid.

¹¹ Smith, S. (2021). *EXO Sonde Rhodamine Sensor*. <https://www.ysi.com/ysi-blog/water-blogged-blog/2020/04/what-is-rhodamine-get-the-rho-down>

closure with CalSim 3 outputs. The NVRRWP operational model will consider a ruleset based on evaluation of historical data using regression, iterative solution, or other methods.

2.8 ENDPOINTS, THRESHOLDS, AND EXPECTED DATA PRODUCTS

There are no established thresholds or NPDES regulatory requirements for Title 22 compliant recycled water discharged to surface waters for the purpose of agricultural irrigation downstream. The Central Valley Water Board implements NPDES permit requirements based on protection of beneficial use assessments, including consultation with DDW, and requirements of the State Implementation Policy (SIP)¹² for relevant toxic constituents.

During the Far-Field Dilution Study, the following data products, in addition to any requested or key intermediate work products, will be developed:

- Identification of critical water year types and month periods when the fraction of NVRRWP recycled water is greatest at three points of interest.
- Fraction of NVRRWP recycled water at the point of complete mixing in the DMC, O'Neill Forebay, and San Luis Reservoir. Conservative estimates may result in a "value not greater than".
- Point estimate summary statistics for each site and month-of-year.
- Point estimates will include frequency statistics for critical conditions (highest monthly fraction NVRRWP recycled water) for five and twenty year return periods.
- Distributional plots for each month at each site (boxplots with frequency distribution).
- Sensitivity analysis (i.e., range-setting of point estimates) on key assumptions for mixing and mixing models, ranges of NVRRWP operational model scenarios, and NVRRWP discharge conditions (current, permitted, build-out, etc.).
- Identification of any follow-up field investigations or additional model development necessary to further evaluate beneficial use protection or any assumptions identified by a sensitivity analysis as significant.

3 METHODS

The Far-Field Dilution Study will utilize a combination of the CalSim 3 output data and a DPWD historical operational model to estimate the percent NVRRWP recycled water in the DMC, O'Neill Forebay, and San Luis Reservoir. The simulations will be performed for a long period of climatic conditions and the associated operational rules to identify and characterize critical conditions (i.e., maximum fraction of NVRRWP recycled water for return period). The proposed approach uses data compiled from the sources identified in **Table 2** and discussed in the following sections. Additional data may be included or data sources/timeframe may be modified or omitted, as needed, to meet the project goals and data quality assurance review.

The overall steps in the computation using **Table 2** data are as follows and described in the following sections:

¹² State Water Resources Control Board. *Policy for Implementation of Toxics Standards for Inland Surface Waters, Enclosed Bays, and Estuaries of California*. 2005.

CalSim 3

- Arrange model structure for CalSim 3 baseline data for points at domain boundary and at internal locations to summarize pre-project conditions.

Mixing Parameters

- Develop mixing parameters for the DMC based on previous modeling and dye study, including identification of diversions before NVRWWP is completely mixed.
- Develop mixing assumptions for O'Neill Forebay. The initial evaluation may consider coarse completely mixed grid elements in O'Neill Forebay to model velocity movement and dispersion between grid elements to estimate the fraction of NVRWWP recycled water at input-output points. San Luis Reservoir characterization will initially be based on point of input from O'Neill Forebay.

NVRWWP and DPWD Operational Model

- Adjust model structure to consider NVRWWP (or others in the model domain not included in CalSim 3) inputs and return water.
- Compile DPWD rulesets and operational data.
- Develop rules for DPWD deliveries by location and for DPWD storage in San Luis Reservoir by year type.
- Develop model of NVRWWP operational use, storage, and return based on operational rules.
- Verify NVRWWP operational model with available operational data.
- Apply NVRWWP operational model to CalSim 3 dataset.
- Add nodes to model system to rebalance water volumes, as necessary, including adjustment to NVRWWP operational model.

Computations and Sensitivity Analysis

- Calculate percent NVRWWP at endpoints.
- Identify critical conditions where NVRWWP recycled water fraction is highest.
- Perform sensitivity analysis on assumptions to develop range of NVRWWP recycled water fraction.

The actual steps may not be performed sequentially or may be modified based on intermediate results or identification of new datasets or tools. Computations will be documented as codebase and intermediate output data tables and/or summaries.

Table 2. Far-Field Dilution Study Input Data Types

Data Source	Data Range	Data Description
NVRRWP California Integrated Water Quality System (CIWQS) Reporting	2017-12-11 to current	Daily NVRRWP discharge volume from both facilities. Water quality data also available
CalSim 3	1921 to 2015 simulation period	Flow rate or volume on monthly timestep at specific nodes
DPWD Operational Reports	2000 to current	Monthly and daily diversion reports
SLDMWA non-CVP Credits	1951 to current	SLDMWA monthly reports for non-CVP deliveries
DWR CDEC	1994 to current	Jones Pumping Plant (TRP) daily flow rate
	1992 to current	Harvey O. Banks Pumping Plant (HRO) daily flow rate
	2021 to current	O'Neill Forebay (ONF) daily storage (monthly data available from 1966)
		Gianelli Pumping Plant (GPP) daily discharge pumping
		California Aqueduct Check 12 (C12) daily flow rate
USBR Operational Reports	2000 to current	<u>Monthly volume reports for CVP</u>
	1985 to current (optional)	<u>Monthly delivery reports for CVP</u>
DWR Operational Reports	1999 to current provided, prior data may become available	<u>Monthly volume reports for SWP</u> via Public Records Act request (2024-06-10)

3.1 CALSIM 3 MODEL

CalSim 3 is a general-purpose planning simulation model developed by USBR and DWR to simulate operations of California's water resources system, specifically the CVP and SWP. On a monthly timestep, CalSim 3 optimizes water routing throughout the CVP and SWP systems. A linear programming (LP)/mixed integer linear programming (MILP) solver determines an optimal set of decisions for each time period with a given set of weights and system constraints. CalSim 3 does not simulate the operation of the NVRRWP or the storage of DPWD water in the San Luis

Reservoir. CalSim 3 does include all other significant known contractor diversions and return flows.

The Project Partners will use model outputs from the version of CalSim 3 developed by DWR for the *Draft State Water Project Delivery Capability Report 2023* (DWR 2024)¹³ for the far-field assessment. This version of the model simulates CVP and SWP operations and a current level of development and reflects the best available representation of the current operations of the CVP and SWP systems over a long enough period of record to develop representative characterizations of operations and climate conditions. The flow and delivery outputs from this version of the model will be post-processed to simulate the effects of the introduction of NVRRWP water into the DMC and of DPWD operations not reflected in CalSim 3. The evaluation then tracks volumes of water on a monthly timestep as opposed to “paper” tracking of water allocations and storage for the purpose of utilizing available water allocations.

3.1.1 Evaluation Period

CalSim 3 simulates CVP and SWP system operations for the period from October 1921 through September 2015 using a monthly timestep, reflecting a period of 94 water years. As noted above, “current” operations are assumed for this period based on historical hydrology. The Far-Field Dilution Study will utilize the time series outputs from the CalSim 3 simulation, with adjustments made for NVRRWP and DPWD operations, to estimate flows on a monthly timestep for the full CalSim 3 simulation period. Utilizing the CalSim 3 time series provides 94 years of data that can be reported by long-term average, by water year type, or for multi-year drought periods.

3.1.2 Flow Evaluation Locations

The Project Partners will assess flow volumes for the Far-Field Dilution Study at the locations shown in **Table 3**. These locations will allow for tracking of overall flows, and the proportion of those flows consisting of NVRRWP water, from the point where DPWD starts taking diversions in CalSim 3 until the point where water enters San Luis Reservoir. Under the proposed approach, the CalSim 3 flow outputs at these locations will be modified through post-processing to develop an updated flow time series at each location that reflects the effects of the introduction of NVRRWP flows and of DPWD operations.

¹³ <https://data.cnra.ca.gov/dataset/state-water-project-delivery-capability-report-dcr-2023/resource/e6319787-5219-4bc5-852f-111c800f8dd7>

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Table 3. CalSim 3 Model Flow Volume Evaluation Nodes

Location	CALSIM Flow Arc	Description
Banks Pumping Plant	C_CAA003	Flow at Banks Pumping Plant into the California Aqueduct
Jones Pumping Plant	C_DMC003	Flow at Jones Pumping Plant into the Delta Mendota Canal
DMC Just Upstream of Milepost 30	C_DMC024	Upstream of DPWD diversion points in CALSIM 3
DMC Just Downstream of NVRRWP discharge location at Milepost 37	C_DMC034	Just downstream of NVRRWP discharge location at milepost 37. Note that the CALSIM flow at this location reflects diversions through milepost 34 only, the flow will need to be adjusted to reflect diversions between mileposts 34 and 37
DMC Between Mileposts 64 and 70	C_DMC064	Downstream of final DPWD diversion locations points and upstream of O'Neill Forebay
DMC Milepost 70	D_DMC070_CAA069	Delta-Mendota Canal diversion into O'Neill Forebay
O'Neill Forebay through Gianelli Pumping and Generation	D_CAA069_SLUIS	Total flow from O'Neill Forebay into San Luis Reservoir
California Aqueduct	C_CAA067	California Aqueduct flow into O'Neill Forebay (north)
California Aqueduct	C_CAA069	Flow out of O'Neill Forebay into California Aqueduct (south)

3.2 MIXING PARAMETERS

Mixing parameters are considered when volumes from different sources enter a waterway or storage facility and are mixed through physical forces and dispersion. Mixing can be evaluated with physics based models and verified with dye studies. **Section 2.6** discussed the completed DMC modeling and dye study in the DMC and the difficulties with dye studies in the larger O'Neill Forebay and San Luis Forebay systems. However, conservative assumptions and simplified models for the larger systems may provide a sufficiently protective evaluation of mixing conditions at the points of interest.

3.2.1 Near Field

NVRRWP recycled water is discharged to the DMC as a side-stream discharge and then mixes across the DMC within 2,000 meters, according to a modeling and field (dye) verification study performed by the City of Turlock. Mixing is complete prior to any diversion to the O'Neill Forebay. However, depending on the location of the DPWD diversions in the first 2,000 meters, a higher or lower fraction of NVRRWP recycled water than the fully mixed fraction may be diverted. The study will evaluate the potential sensitivity to this initial mixing assumption. To evaluate the mixing effect directly downstream of milepost 37, detailed data from DPWD would be required to provide the actual diversions at each point of diversion between milepost 37 and milepost 38.2 (~2,000 meters downstream). If these data are available, a flow estimate may be made at each DPWD point of diversion location.

3.2.2 O'Neill Forebay

Mixing in the O'Neill Forebay from the DMC pump-in to the San Luis Reservoir pump-in is more complex because operations move water in both directions (i.e., "pumping" and "generation" between the DMC and O'Neill Forebay and the O'Neill Forebay and San Luis Reservoir) and the input from the California Aqueduct is significant (see **Figure 2**). The Check 12 flow from the California Aqueduct is nearer to the San Luis Reservoir pump-in location such that DMC pump-in would have to mix with the California Aqueduct source water before pump-in to San Luis Reservoir. A full mixing assumption is then conservative under most conditions when considering San Luis Reservoir, and would underestimate higher NVRRWP fractions conveyed to the DMC or to the California Aqueduct through Check 13 (downstream). Depending on model performance and outcomes, the study may evaluate mixing assumptions using a gridded series of continuously stirred tank reactors within the monthly timestep. This evaluation may indicate the need for a field verification study which could be completed as part of the effort or recommended as a follow-up activity.

3.2.3 San Luis Reservoir

Mixing in the San Luis Reservoir has much longer timescales and can be conservatively (i.e., higher NVRRWP recycled water fractions) considered because inputs are primarily the O'Neill Forebay as other inputs are limited to natural wet weather flows from tributary drainages. These flows would tend to dilute NVRRWP influence such that assumptions of no other inputs would be conservative. Depending on model performance and outcomes, the study may evaluate mixing assumptions using a gridded series of continuously stirred tank reactors. Field dye verification would likely not be possible because of the extended residence time in the San Luis Reservoir, but the study may recommend alternate future studies if conservative assumptions are insufficient to characterize protection of beneficial uses.

3.3 NVRRWP AND DPWD OPERATION

NVRRWP recycled water volume will be introduced at monthly timestep at the permitted and buildout flows and additional scenarios necessary to evaluate performance. CalSim 3 divides DPWD's CVP contract deliveries into four delivery nodes as shown in **Table 4**. DPWD deliveries are made proportionally for the contract amounts assigned to each node according to a

prescribed monthly pattern. As noted above, CalSim 3 assumes that the DPWD will take its full CVP allocation during each year according to an assumed monthly delivery schedule and does not simulate the storage of DPWD water in San Luis Reservoir.

The following adjustments will be made to the CalSim 3 flows in the above arcs using the available NVRRWP and DPWD operational data (all adjustments made on a monthly timestep):

- Assumed NVRRWP discharge will be added to the DMC at milepost 37.
- The total DPWD diversions provided by CalSim 3 will be adjusted for each water year to 1) reflect the assumed storage into or taken out of the San Luis Reservoir by DPWD during that year; 2) incorporate the NVRRWP flow as additional diversion amount; 3) match the split between diversions above and below milepost 37; and 4) match the monthly pattern determined by the DPWD data.
- The adjustments to DPWD diversion timing and location will be applied to the flow arcs listed above to determine total flow at each arc and the proportion of that flow that originated from the NVRRWP discharge.

Since the CalSim 3 simulation period does not correspond with actual periods of historical NVRRWP operations, historical data provided by DPWD will be used to develop assumed DPWD deliveries and San Luis Reservoir storage rules for different year types, which will be applied to the CalSim 3 time series data.

Table 4. Delta-Mendota Canal – Del Puerto Water District Diversions Included in CALSIM 3 Model

CALSIM Diversion Flow Arc	CVP Contractor(s) prior to Consolidation	Contract Amount (AF/year)	DMC Location
D_DMC030	Hospital WD	34,105	Check 5 (includes diversions up to milepost 30)
D_DMC034	Kern Canon WD	7,700	Check 6 (includes diversions between milepost 30 and 34)
D_DMC044	Del Puerto WD, Salado WD, Orestimba WD, Sunflower WD	53,675	Check 8 (includes diversions between milepost 34 and 44)
D_DMC064	Davis WD, Foothill WD, Mustang WD, Quinto WD, Romero WD	44,730	Check 12 (includes DPWD diversions past milepost 44)

3.3.1 NVRRWP and DPWD Operational Data

Daily records of the NVRRWP recycled water discharge into the DMC are available for the project duration (2018 to current, see **Figure 3**). This data along with the uniform current permitted discharge and project buildout flow can be used to develop an assumed monthly pattern of NVRRWP discharge for the CalSim 3 simulation period. The Project Partners will also assume that

DPWD will take this water as additional delivered supply on top of the delivered supply determined by CalSim 3.

Monthly records of total CVP deliveries to DPWD are available for water years 2003 through 2023. For the last two water years, these deliveries have been subdivided into deliveries upstream and downstream of the NVRRWP discharge location. These data can be used to develop a breakdown of DPWD deliveries upstream and downstream of the NVRRWP discharge location and distributed by month for dry, average, and wet years. In some cases, daily DPWD records may be available for model development.

In addition, DPWD has records of years where they stored water and withdrawn from the San Luis Reservoir. These data can be used to identify years when DPWD deliveries should be reduced (due to water being stored in the San Luis Reservoir) and increased (due to DPWD taking delivery of the water stored in the San Luis Reservoir).

3.4 VERIFICATION DATA

Section 2.4 describes a model verification approach for the overall simulation whereby a CalSim 3 simulation year(s) are compared to similar climatic years where data are available. Additionally, to develop the NVRRWP operational representation, observed data will be used to verify the NVRRWP water balance that will be incorporated into the CalSim3 outputs. These data include operational reports from USBR, DWR, DPWD, and SLDMWA (see **Table 2**). Introduced losses and gains will be considered and closure errors will be evaluated to determine if they result in changes to project endpoints.

4 ADAPTIVE MANAGEMENT

Variances from the work plan may be necessary based on data availability and initial results or findings that identify significant uncertainty, systematic bias, or incomplete data. The Project Partners will make all efforts to characterize sensitivity to assumptions and other uncertainty, but there may be limitations in that CalSim 3 provides idealized conditions for known factors.

The NVRRWP-adjusted CalSim 3 simulation will provide sufficient data to identify critical periods for the fraction of NVRRWP recycled water at the NPDES permit-specified locations. Following the data evaluation and modeling, the Project Partners will develop conclusions and recommendations for the fraction of NVRRWP recycled water at various locations under critical conditions. It is feasible to accelerate this evaluation into an early project report or technical memorandum. Based on this accelerated report recommendations and with consultation from the Central Valley Water Board and DDW, the effort may be concluded or amended. The early report may find that no further evaluation is necessary or that additional field verification or data collection is necessary. Any additional work could be targeted to critical spatial or temporal domains.

The Project Partners may also deviate in the methodologies or assumptions as the work is performed that are not significant, improve model performance, or otherwise address errors or data gaps. Any deviations will be documented and justified in the project report.

5 SCHEDULE

As proposed, this Far-Field Dilution Study Work Plan can be completed before the Report of Waste Discharge (ROWD) is due in July 2026 as shown in the **Table 5** schedule, assuming this Far-Field Dilution Study Work Plan is approved. The NPDES permit does not specify that this Far-Field Dilution Study Work Plan must be approved. However, the Project Partners will work in good faith to address comments received. Delays in resolution of comments may require modification to the intermediate schedule or scope of work. However, the final due dates cannot be adjusted without an amendment to the NPDES permit. To facilitate timely completion of this Far-Field Dilution Study Work Plan, the Project Partners propose to submit an accelerated modeling and assessment report. It is expected that those modeling findings will be sufficient to satisfy the NPDES permit requirement. This accelerated reporting would allow additional consultation and time to address comments as determined by the Project Partners or through consultation with the Central Valley Water Board and DDW. The accelerated reporting would consider any additional investigation steps and the implementation schedule necessary to resolve data gaps or further evaluate conservative assumptions.

Table 5. Far-Field Dilution Study Schedule

Milestone	Date (on or before)
Submittal of Work Plan*	August 1, 2024
Initiate project work pending Central Valley Water Board notice of Work Plan approval	November 1, 2024
Accelerated Study Report (approximate)	June 1, 2025
Report of Waste Discharge and Final Report Due Date*	July 31, 2026

Notes: *NPDES permit required reporting date

Far-Field Dilution Study Work Plan Appendices

Appendix A: Consultation Meeting Summaries

APPENDIX A

Consultation Meeting Summaries

Meeting No. 1 April 10, 2024

Meeting No. 2 May 9, 2024

Meeting No. 3 May 28, 2024

Cities of Modesto and Turlock with Del Puerto Water District
Delta Mendota Canal NPDES Far-Field and CEC Special Studies

April 10, 2024 10:00-11:00 AM

MEETING SUMMARY

Attendees:

Danielle Goode, Anne Walters, and Adam Laputz	Central Valley Water Board
David Huff and Jeanne White	City of Turlock
Paul Stearns and Adam Scheuber	Del Puerto Water District
Ben Koehler and Melissa Holden	City of Modesto
Brian Van Lienden	Woodard & Curran
Brian Laurenson and Sophie McFadin	Larry Walker Associates

Meeting Objectives:

Receive initial input from Central Valley Water Board on key study elements.

Determine communication process and schedule for consultations in work plan development.

Action Items and Summary Points:

- Far-Field Dilution Study:
 - Water balance approach will move forward in the work plan with higher resolution (monthly), more computational flexibility (coded, more detailed statistics, etc.), and better documentation of methods compared to the 2015 spreadsheet model. Model would be developed to use CalSim3 data and available data from water agencies on DMC diversions and returns, as made available.
 - Address the Central Valley Water Board key concern that came up with the 2015 far-field model version related to percent recycled water tracking at the same resolution of the model and/or better. Explain the methodology.
 - LWA will coordinate a meeting with Central Valley Water Board Staff, DDW, SWC, and technical staff, in early May to go over the details and methods of the technical approach and how the CalSim3 water balance is applied, to provide transparency on how exports and mixing intra-canal are estimated.
- Constituents of Emerging Concern (CEC) Study:
 - Program would include monitoring of effluent, upstream DMC, and 1-2 downstream locations. There will be four events across multiple quarters (i.e., quarterly for one year). The working CEC list will incorporate the example constituent list in the permit and also pull from the Water Recycling Policy, plus a few additions generally as it makes sense, but there might be modifications based on available labs, methods, and other optimizations that are mutually agreeable with all parties. It is expected that each of the analytical methods would provide a longer list of constituents.

- Preferred Communication Approach
 - LWA to coordinate and schedule meetings directly with all parties as needed (i.e., Central Valley Water Board staff don't need to be intermediaries). LWA will keep the Central Valley Water Board informed of any substantial communications directly with DDW or SWC.
 - LWA will target the next "technical approach" meetings with all parties for early May.
 - Danielle Goode will provide the DDW contacts to Brian Laurensen for him to schedule with.
 - Brian Laurensen has already been in contact with Leslie Palencia (SWC consultant) to start SWC coordination.

Cities of Modesto and Turlock with Del Puerto Water District
Delta Mendota Canal NPDES Far-Field Special Study

May 9, 2024 12:30-2:00 PM

Meeting Summary

Attendees:

Jeanne White and David Huff, City of Turlock

Danielle Goode, Adam Laputz, and Anne Walters, Central Valley Water Board

Melissa Holden and Ben Koehler, City of Modesto

Randy Barnard, Thomas Tsui, and Sherly Rosilela, State Water Board Division of Drinking Water

Brian Van Lienden, Woodard & Curran

Paul Stearns, Del Puerto Water District

Brian Laurenson (facilitator), José Tomás Díaz Casanueva, and Sophie McFadin (notetaker), Larry Walker Associates

Meeting Objective:

Receive initial input from Central Valley Water Board and DDW on key study elements and project scope

FAR-FIELD MODELING STUDY

This summary captures the nature of the input provided so that the work plan can best address any key concepts or requirements.

The far-field meeting is intended as a kick-off in the consultation process with Division of Drinking Water (DDW). There will be additional opportunities for input from DDW, including review of the draft work plan which is due to the Central Valley Water Board on August 1, 2024. The completed modeling study report is due to the Central Valley Water Board July 31, 2026.

- LWA is the consultant for the Cities of Turlock and Modesto and Del Puerto Water District – the North Valley Regional Recycled Water Program (NVRWP) project partners.
- The NVRWP is a water recycling project was developed to only deliver water for irrigation purposes only by the Del Puerto Water District and downstream restoration areas. The NVRWP does not deliver water for the purpose of domestic or municipal water supply.
- The NPDES permit requirement is to report estimates of the percent recycled water at the O'Neill Forebay and in San Luis Reservoir using monthly timesteps and consider the diversions/returns by the NVRWP. There are no other specific technical requirements (e.g., modeling type, tracer study, etc.) or acceptance criteria (allowed error, verification measures, etc.).
- DDW noted that they will need time to review the work plan and would appreciate any early versions if possible so they can reasonably react/comment. LWA noted that the project partners would need to be consulted about an early distribution version, but that there should also be time after August 1, 2024 submittal to resolve questions. LWA does want to identify any critical work plan components to include or resolve any significant concerns.



- LWA is proposing to use CalSim3 to generate the balanced “base” volume outputs (monthly flow volumes at all nodes, etc.) for multiple years and add on a computational ruleset to consider the NVRRWP discharge and diversion/return patterns that could be reasonably expected that also makes sure the water balance closes.
- The proposed model approach is not a finite element model, primarily because the system is so highly managed that only CalSim could reasonably represent the expected range of conditions. The model is then a complex water balance where the NVRRWP volume would be tracked to the specific downstream points.
- DDW inquired about assumptions on complete mixing at various points in the model domain. LWA responded that the discharge plume had been modeled and field verified within the DMC. The DMC is fully mixed at 2 km. The model domain is close to 50 km. LWA will discuss mixing assumptions in the work plan and a means to estimate outcome sensitivity. There were not as many mixing concerns about the O’Neill Forebay on a monthly time step, but there might need to be an assessment of San Luis Reservoir, depending on the magnitude of NVRRWP input and overall sensitivity to any assumptions.
- Central Valley Water Board noted that a monthly time step is required and wanted to make sure a range water year types were considered. LWA confirmed that the plan would be to look at a longer period of CalSim3 outputs to incorporate different water years
- DDW emphasized that it was important in the document to set things up front so that the reviewer had a good sense of the bottom line, scope, context, and requirements.
- DDW emphasized that it would be important to clearly state assumptions and their basis. DDW will consult their field branch to review the Far Field Study and that their main objective will be to evaluate that it meets the permit statements and that all assumptions are stated with the reasoning, even if they are “obvious” assumptions. For example, the work plan should state why the calculation method was chosen over/instead of a tracer, why simple reservoir mixing is reasonable, etc.
- DDW reviews with emphasis on public health perspective – for example - “which points make the most sense for public health.” Justify and explain why points were picked, etc.
- Central Valley Water Board noted that their objective was also to be able to understand nutrient (or other key constituents) loading in the system and from NVRRWP as harmful algal blooms are a concern in the downstream parts of the system.

CEC STUDY

- CEC meeting is scheduled for May 28, 2024 along with the State Water Contractors
- Study approach follows the previous nutrient study – upstream, effluent, and two downstream. LWA confirmed that the SWC DMC sample points selected match up with the proposed sample points of DMC-001 and DMC-002. An additional site would be much further downstream before O’Neill Forebay.
- The example analyte list in the NPDES permit will be the starting point for the next meeting.

Action Items:

- LWA will send out meeting summary and slides.
- LWA will send out preparation materials ahead of the CEC meeting.
- LWA will evaluate progress before work plan submittal, consultant with project partners.

Cities of Modesto and Turlock with Del Puerto Water District
Delta Mendota Canal NPDES CEC Special Study

May 28, 2024 10:30 AM-12:00 PM

Meeting Summary

Attendees:

Jeanne White and David Huff, City of Turlock

Danielle Goode, Anne Walters, and Kurt Souza, Central Valley Water Board

Melissa Holden and Ben Koehler, City of Modesto

Randy Barnard, Kurt Souza, and Sherly Rosilela, State Water Board Division of Drinking Water

Leslie Palencia (Palencia Consult.), Atlasi Daneshvar (Santa Clara Valley Water District), Mauricio Santos (Metropolitan District of Southern California), Jeff Tice and Brandon L. Ladd (Central Coast Water Authority)

Brian Van Lienden, Woodard & Curran

Paul Stearns, Del Puerto Water District

Brian Laurenson (facilitator) and Sophie McFadin (notetaker), Larry Walker Associates

Meeting Objective:

Receive input from Central Valley Water Board, State Water Contractors, and DDW on key study elements and project scope to support work plan development.

CEC STUDY.

The DMC CEC Special Study is required in the Cities of Turlock and Modesto joint NPDES permit. The work plan or monitoring plan is required to describe locations, frequency, and constituents. The draft work plan is due to the Central Valley Water Board on August 1, 2024. The completed study report is due to the Central Valley Water Board July 31, 2026.

- Study approach follows an upstream, effluent, and two downstream ("gradient") approach. An alternative sampling point, located at the DMC Check Dam (2,200 m downstream of effluent outfall) where the NVRRWP effluent is fully mixed, will be considered rather than the DMC-002 site (1,300 m downstream of effluent outfall) where substantial mixing has occurred. The primary site will be selected based on accessibility and safety concerns. The other downstream sampling location (DMC-MCR) is much further downstream before O'Neill Forebay.
- In addition to the target constituents, the study report will provide all other constituent results included in the analytical method suite if there is no additional analytical cost.
- Currently, Eurofins is the expected lab, but it is subject to change based on promised performance and logistics.
- SWC emphasized that it's important to capture different flow rates in the DMC (for the quarterly sampling events that will be conducted. For example, the SWC was able to monitor conditions when the percentage of treated wastewater in the DMC ranged from 1 to 4 percent. Measurement of flow rates in the canal at each sampling location is also necessary to accurately estimate the mass flux of CECs, not just concentration. This also applies to the NVRRWP Joint

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outfall flow rate. SWC noted that they were able to measure the flow in the canal with assistance from the San Luis Delta Mendota Authority. Leslie forwarded flow-velocity spreadsheets to LWA after the meeting. A section on flow measurement will be included in the work plan.

- SWC noted the importance of tracking pump inputs to the canal and documenting pumping conditions at the time of a sampling event. The work plan will consider an approach to characterize pump-in conditions as feasible (i.e., qualitative vs. quantitative).
- The San Joaquin River Restoration recaptured water inputs were identified as an input to consider. It was not known if CalSim3 included this flow, but the work plan will address it.
- April to May is the DMC low flow period, and will be targeted for one event.
- SWC mentioned the importance of tracking the flow travel time between each sampling site location to best capture a single plume during a sampling event. LWA proposes a practical approach to characterize the timing of flow as it is feasible within a sampling event time frame. The near field samples should be feasible, but further downstream at McCabe may not be feasible.

FAR-FIELD MODELING STUDY

- LWA is the consultant for the Cities of Turlock and Modesto and Del Puerto Water District – the North Valley Regional Recycled Water Program (NVRWP) project partners.
- The NVRWP is a water recycling project that was developed to deliver water for irrigation purposes only by the Del Puerto Water District and to downstream restoration areas. The NVRWP does not deliver water for the purpose of domestic or municipal water supply.
- SWC inquired about if a range of storage conditions in the O'Neill Forebay and San Luis Reservoir will be investigated to better characterize the worst-case scenario. SWC noted that in the previous 2015 study, the average storage conditions were assumed rather than a range and that critical conditions are of greatest interest. LWA plans to include longer evaluation periods so that a range of conditions is assessed.

Action Items:

- LWA will send out draft work plans to the Central Valley Water Board by June 15th for review.
- LWA will send out meeting summary and slides.
- LWA will evaluate progress before work plan submittal, consultant with project partners.
- Leslie will send LWA the previous Eurofins analytical method constituent list and the flow-velocity tables [completed]
- The Central Valley Water Board will verify the need to include *E. coli*, THMs, and any other non-CEC constituents already part of other monitoring.
- The Central Valley Water Board will internally determine the review process and schedule to communicate to the group, as appropriate.

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JULY 2024

CITIES OF MODESTO AND TURLOCK IN ASSOCIATION WITH DEL
PUERTO WATER DISTRICT

Constituents of Emerging Concern and Pathogens Study Work Plan

North Valley Regional Recycled Water Program

PREPARED BY:



LARRY WALKER
ASSOCIATES
science | policy | solutions



Woodard
& Curran

PREPARED FOR:



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LIST OF APPENDICIES

Appendix A. Summary of Consultation Meetings
Appendix B. List of Constituents Included in Lab Methods

1 INTRODUCTION

The City of Turlock, the City of Modesto (collectively, “the Cities”), and the Del Puerto Water District (DPWD) jointly manage the North Valley Regional Recycled Water Program (NVRWP) to beneficially recycle municipally treated wastewater to the Delta-Mendota Canal (DMC) for agricultural or restoration irrigation supply as well as municipal, industrial, and wildlife refuge usage. In 2022, the Central Valley Regional Water Quality Control Board (Central Valley Water Board) issued a National Pollutant Discharge Elimination System (NPDES) permit (No. CA0085316, Order No. R5-2022-0034) regulating discharges of municipally treated wastewater from both the City of Turlock’s Regional Water Quality Control Facility (Turlock RWQCF) and the City of Modesto’s Water Quality Control Facility (Modesto WQCF) to the DMC¹. Both Cities also have separate coverage under NPDES permits for discharge to the San Joaquin River and to beneficially recycle water at their facilities and through separate reclamation permits not related to the DMC discharge.

The NPDES permit for the combined discharge to the DMC includes a requirement to conduct a Constituents of Emerging Concern (CEC) and pathogen study due to concerns about impacts to downstream drinking water facilities, as raw drinking water is used as a source by the State Water Contractors (SWC) through the State Water Project (SWP). The consulting engineering firms of Larry Walker Associates (LWA) and Woodard & Curran (W&C) were contracted to support the Cities and DPWD in developing the work plan and implementing the approved study, collectively as the “Project Team.” The State Water Resources Control Board (State Water Board) and regional water boards are currently developing CEC monitoring approaches for inclusion in NPDES permits. The Project Team developed this CEC and Pathogen Study Work Plan in consultation with the Central Valley Water Board, the Division of Drinking Water (DDW), and the SWC. Documentation of consultation meetings is attached as **Appendix A**. The monitoring study objective is to satisfy the NPDES permit requirement and characterize CECs and pathogens in the NVRWP’s effluent discharged to the DMC and at DMC locations upstream and downstream to further evaluate the protection of drinking water (human health) Municipal and Domestic Supply (MUN) beneficial uses.

This CEC and Pathogen Study Work Plan provides background information, technical monitoring strategies, and specifications for a one-year study. Key planning aspects include a recommended CEC and pathogen monitoring list based on human health and performance indicators, sampling procedures and schedule, site identification, and summarization of historical data and findings based on available CEC data that is relevant to the study, including data collected by the Delta Regional Monitoring Program (Delta RMP), the SWC, and other readily available data.

The Project Team will prepare a sampling and analysis plan (SAP) based on this work plan, that specifies field protocols, logistical details, and analytical methods. The monitoring program will target implementation to begin in early 2025 (see the **Section 5** schedule). The study schedule

¹ https://www.waterboards.ca.gov/centralvalley/board_decisions/adopted_orders/stanislaus/r5-2022-0034.pdf

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may be delayed if comments on the CEC and Pathogen Study Work Plan are received after November 1, 2024.

1.1 NPDES PERMIT REQUIREMENTS

The NPDES permit requirement for a CEC and pathogen study was based on the March 30, 2020, letter from DDW to the Central Valley Water Board. The Central Valley Board included DDWs recommendation in Provision VI.C.2.c. of the NPDES Permit:

CEC and Pathogen Study

The NPDES permit requires a work plan that at a minimum determines a list of CECs and pathogens to be analyzed, sampling locations, and sampling frequency.

The Discharger shall conduct a CEC study due to concerns of impacts to downstream drinking water facilities. The Discharger shall develop a monitoring plan for collecting and analyzing effluent and receiving water samples for CECs that have health concerns (e.g., Perfluorooctanoic Acid, Perfluorooctanesulfonic acid, N-Nitroso-dimethylamine, N-Nitrosomorpholine, 1,4-dioxane, total trihalomethanes), that do not readily biodegrade and generally occur in relatively high concentrations (e.g., Sucralose, Carbamazepine, and Iohexol), and pathogen indicators (e.g., Clostridium perfringens and Escherichia coli). The Discharger shall develop the monitoring plan in consultation with staff from the Central Valley Water Board, State Water Contractors, and DDW, that at a minimum determines a specific list of CECs to be analyzed, sampling locations, and sampling frequency. The monitoring plan and final CEC Study shall be submitted by the due dates in the Technical Reports Table (Attachment E, Section X.D, Table E-11). [NPDES permit page 19]

1.2 PURPOSE

This CEC and Pathogen Study Work Plan satisfies the NPDES permit requirement to develop a monitoring work plan that specifies individual analytes, sampling locations, and sampling frequency. The final CEC and Pathogen Study Report is due along with the Report of Waste Discharge (ROWD) for permit reissuance by July 31, 2026.

The Project Team developed this CEC and Pathogen Study Work Plan in consultation with the Central Valley Water Board, DDW, and SWC to characterize CECs and pathogens and begin to assess beneficial use protection in the DMC for municipal downstream drinking water facilities (i.e., MUN beneficial uses). This study is not expected to provide statistically significant differences between sites for all constituents.

1.3 PROJECT TEAM

The Project Team members and their responsibilities are defined in **Table 1**. Over the course of the project, the personnel may change and should be updated with revisions or as an addendum to the SAP.

Table 1. Project Team and Responsibilities

Role	Person(s)	Responsibility
Project Partners	David Huff and Jeanne White, City of Turlock	Coordination with the Central Valley Water Board; general project oversight, as-needed support to access NVRWP or city-owned facilities, review and submittal of NPDES permit required reporting documents.
	Melissa Holden and Ben Koehler, City of Modesto	
	Paul Stearns, Adam Scheuber, and Anthea Hansen, DPWD	General project oversight; assistance with DMC access, flow and operational data, and review of project materials.
Project Manager	Brian Laurenson, LWA	Project coordination and oversight, communication with Project Team and stakeholders on project status, and overall project responsibility.
Task and Monitoring Manager	Sophie McFadin, LWA	Coordination of monitoring activities with analytical laboratory and Project Team, ensure sampling and analysis plan adherence, preparation of deviation forms, health and safety oversight, oversight of Field Team, and preparation of final study report.
QA Manager	To be specified in Sampling and Analysis Plan (LWA or W&C)	Ensure that the laboratory quality assurance criteria are met through routine auditing of the systems.
Field Team	LWA and W&C	Fieldwork preparation and execution, including drafting field forms, contracting analytical laboratory; conducting monitoring per sampling and analysis plan; data compilation, including data quality review; analysis and reporting of monitoring results.

1.4 PREVIOUS DMC AND CENTRAL VALLEY CEC MONITORING

Previous CEC monitoring efforts in the Central Valley were reviewed and used as guidance in the development of this CEC and Pathogen Study Work Plan. The data collected by NPDES dischargers, the Delta RMP, and SWC are preliminary and unpublished in some cases, but the Project Team reviewed the data to better define project data objectives and conceptual models. The Project Team compiled the data sources and summarized the results for Perfluorooctanesulfonic acid (PFOS) and Perfluorooctanoic acid (PFOA) in **Figure 1** and **Figure 2**, respectively. These CECs were selected because they were common to all three investigations. These “forever chemicals” are also expected to be stable (i.e., not decaying or growing) within the study areas. SWC and publicly owned treatment works (POTW) data were not collected concurrently. The Delta RMP data were collected from effluent-dominated waters (EDW) in contrast to the DMC, which provides significant upstream dilution.

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1.4.1 State Water Board Required PFAS Monitoring for POTWs

On July 9, 2020, the State Water Board issued a statewide investigative order to POTWs, which included the Turlock RWQCF and the Modesto WQCF, to monitor per- and polyfluoroalkyl substances (PFAS) due to concern that these compounds do not naturally degrade in the environment and are toxic to human life at low concentrations². The Cities collected samples between October 2020 and September 2021 and reported the results to the State Water Board through GeoTracker³.

1.4.2 Delta Regional Monitoring Program Pilot CEC Study

The Delta RMP monitored CECs in the Central Valley, primarily around the Sacramento-San Joaquin Delta. The Delta RMP developed the pilot study to address the targeted CEC study elements described in the CECs Statewide Pilot Study Monitoring Plan⁴. The pilot study evaluates a so-called “Gradient Study” to better understand the attenuation of CEC concentrations downstream from a POTW in an EDW. Dilution conditions in the Delta RMP study areas are significantly different than the conditions in the DMC, which consistently provides upstream dilution. The Delta RMP CEC Study sample collection began in 2020 and ended in 2023 (data were finalized by Technical Advisory Committee on July 23, 2024). **Figure 1** and **Figure 2** show Delta RMP monitoring results for PFOS and PFOA, respectively, at two POTW discharge points as well as corresponding upstream and downstream locations.

1.4.3 State Water Contractors DMC CEC Monitoring

SWC conducted exploratory CEC monitoring in the DMC upstream and downstream of the NVRRWP outfall due to concerns about the presence of CECs in treated wastewater. The independent monitoring consisted of an extensive CEC analyte list, including multiple CECs that overlapped with the recommended list for this study: Carbamazepine, Sulfamethoxazole, Sucralose, PFOS, PFOA, and NDMA. Samples were collected in February 2020, July 2020, November 2020, March 2021, and August 2021. The results of the PFOS and PFOA monitoring are summarized in **Figure 1** and **Figure 2**, respectively, as a comparison between the NVRRWP POTW effluent monitoring and the independently monitored upstream and downstream data points in the DMC. Additional information on the independent monitoring effort can be found in the California State Water Project 2021 Watershed Sanitary Survey Update (June 2022)⁵, including detailed results for all constituents monitored.

²https://www.waterboards.ca.gov/pfas/ca_pfas_timeline.html#:~:text=On%20July%209%2C%202020%2C%20the,biosolids%2C%20and%20reverse%20osmosis%20concentrate.

³<https://geotracker.waterboards.ca.gov/>

⁴Dawitt Tadesse, Office of Information Management and Analysis, State Water Resources Control Board. “Statewide Monitoring Plan. Constituents of Emerging Concern (CECs) Statewide Pilot Study Monitoring Plan.” January 2016.

⁵https://rtdf.info/public_docs/Miscellaneous%20RTDF%20Web%20Page%20Information/Sanitary%20Surveys/2021%20SWP%20WSS%20FINAL%20JUNE%202022.pdf

1.5 RECYCLED WATER POLICY

The State Water Board adopted the Water Quality Control Policy for Recycled Water⁶ (Recycled Water Policy) to encourage the safe use of recycled water from wastewater sources that meets the definition in California Water Code Section 13050(n) in a manner that implements state and federal water quality laws and protects public health and the environment. The policy promotes the increased use of recycled water and encourages utilities to consider recycling treated wastewater for beneficial use rather than disposing of it. The State Water Board updated the Recycled Water Policy on December 11, 2018, to include the most recent monitoring requirements and criteria for CEC monitoring evaluation based on recommendations from the Science Advisory Panel and stakeholders. For landscape irrigation projects and other non-potable recycled water applications, the Recycled Water Policy does not require monitoring for CECs. However, CEC monitoring guidance is required for recycled water intended for potable application, specifically through processes like groundwater recharge and reservoir water augmentation.

The NVRRWP recycled water project is intended to provide the DPWD with recycled water to supplement agricultural irrigation water demands and support downstream restoration areas. The Recycled Water Policy monitoring requirements are not directly applicable to the NVRRWP. However, because the NPDES permit references the Recycled Water Policy constituent list, this CEC and Pathogen Study Work Plan incorporates guidance from the Recycled Water Policy, where applicable, to select CECs and acceptable reporting limits.

⁶https://www.waterboards.ca.gov/board_decisions/adopted_orders/resolutions/2018/121118_7_final_amendment_oal.pdf

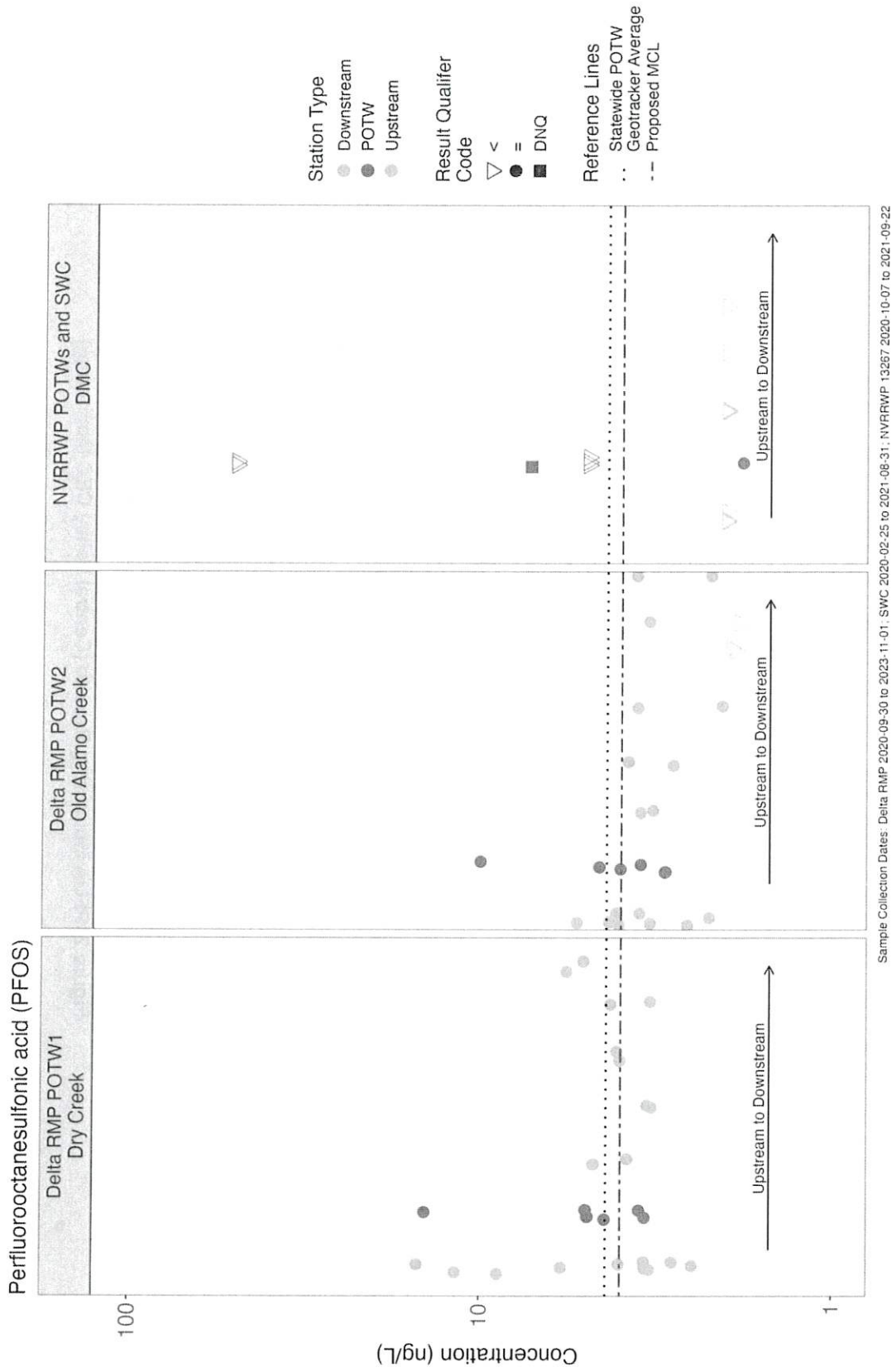


Figure 1. PFOS Monitoring Results (Central Valley CEC Monitoring)

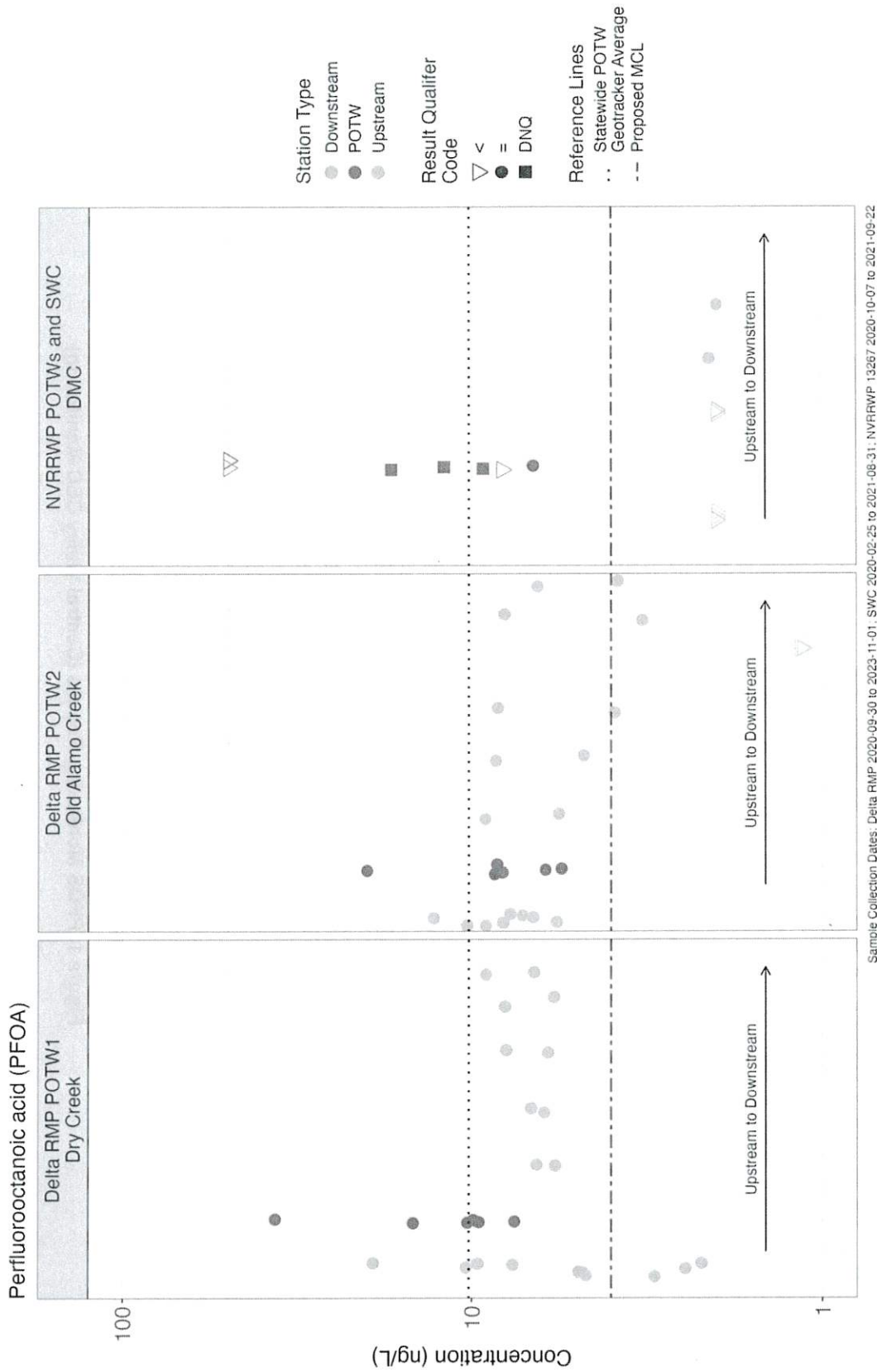


Figure 2. PFOA Monitoring Results (Central Valley CEC Monitoring)

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2 MONITORING DESIGN

This CEC and Pathogen Study Work Plan specifies a CEC and pathogen monitoring list, monitoring locations, and frequency as required by the NPDES permit. Any changes made to these monitoring elements after this CEC and Pathogen Study Work Plan is submitted will be reported to the Central Valley Water Board (see **Section 2.6 Adaptive Management**). Additional details such as detection and quantification limits, sampling methods, and study reporting are also provided in this CEC and Pathogen Study Work Plan. The Monitoring Manager (**Table 1**) will develop the SAP to specify sample collection standard operating procedures and data quality evaluation for the constituents in this CEC and Pathogen Study Work Plan. The SAP will be included in the final CEC and Pathogen Study Report.

2.1 MONITORING CONSTITUENTS

The Project Team will use grab samples to monitor the NVRRWP effluent and DMC for the constituents listed in **Table 2**. This constituent list is based on the NVRRWP NPDES permit requirements and the consultation-agreed list (see **Appendix A** notes) plus standard field parameters. The CECs to be monitored due to potential human health risks include PFOS, PFOA, NDMA, NMOR, 1,4-Dioxane and Total Trihalomethanes. Additional CECs selected include Sucralose, Carbamazepine, Sulfamethoxazole, and Iohexol. The pathogens *Clostridium perfringens* and *E. coli* were also specified in the NPDES permit as potential risks for human health.

Table 2. Study Constituent List

CECs	Pathogens	Field Parameters ³
1,4-Dioxane ^{1,2}	<i>Clostridium perfringens</i> ¹	Temperature
N-Nitrosodimethylamine (NDMA) ^{1,2}	<i>E. coli</i> ¹	Conductivity
N-Nitrosomorpholine (NMOR) ^{1,2}		pH
Perfluorooctane sulfonate (PFOS) ^{1,2}		Dissolved Oxygen
Perfluorooctanoic acid (PFOA) ^{1,2}		Turbidity
Sucralose ^{1,2}		
Sulfamethoxazole ²		
Iohexol ¹		
Carbamazepine ¹		
Total trihalomethanes ¹		

1. Suggested by the NVRRWP NPDES Permit

2. Required in the Recycled Water Policy

3. Field parameters shall be recorded at the time of grab sample collection with a hand-held field meter, provided the meter utilizes a U.S. EPA-approved algorithm/method and is calibrated and maintained in accordance with the manufacturer's instructions.

2.2 SAMPLING LOCATIONS

The Field Team will collect samples at the NVRRWP effluent discharge point and the DMC at one location upstream and two locations downstream. The four monitoring locations were

selected with consideration for safety, accessibility, and to characterize and compare CEC concentrations and pathogen counts in this defined reach of the DMC. The upstream site (DMC-001) is located approximately 845 meters upstream of the NVRRWP outfall and was selected for sample collection to assess background concentrations of CECs and pathogen counts in the DMC prior to the addition of the NVRRWP effluent. The NVRRWP discharge will be sampled directly from the outfall (EFF-002) to assess the CEC concentrations and pathogen counts prior to mixing with the DMC flows. The first downstream site (DMC-CD) is located approximately 2,200 meters downstream of the NVRRWP outfall and was selected based on a previous Mixing Zone Validation Study⁷ conducted on behalf of the City of Turlock, which determined that full mixing of the NVRRWP discharge in the DMC was achieved at a distance downstream, no further than the check dam (DMC-CD), and full mixing was likely achieved upstream of the check dam. This sample point will assess CEC concentrations and pathogen counts in the DMC at a distance where the NVRRWP effluent is fully mixed. A site approximately 1,300 meters downstream of the NVRRWP discharge (DMC-002), where substantial mixing will have occurred, has been selected as an alternative sampling location to DMC-CD in the event of any access or safety concerns during an event. Lastly, a far-field downstream location (DMC-MCR) that is approximately 48 kilometers downstream of DMC-CD was selected to assess CEC concentrations and pathogen counts in the DMC prior to flow entering the O'Neill Forebay and the San Luis Reservoir.

The proposed monitoring sites and their coordinates are shown in **Table 3** and in the **Figure 3** site location map. The sites EFF-002, DMC-001, and DMC-002 are also described in the NPDES permit. Each monitoring location is described in greater detail in **Section 2.2.1** through **Section 2.2.5**.

⁷ Robertson-Bryan, Inc. (RBI). *Mixing Zone Validation Study for the Regional Water Quality Control Facility Discharge to the Delta Mendota Canal*. Prepared for the Central Valley Regional Water Quality Control Board, on behalf of the City of Turlock, Regional Water Quality Control Facility. June 2021.

Table 3. Monitoring Locations for Delta-Mendota Canal CEC Study

Station Code	Station Description	DMC Mile No.	Latitude	Longitude
DMC-001	DMC upstream of NVRRWP outfall	36.81	37° 30' 00.32" N	121° 11' 45.91" W
EFF-002	NVRRWP Joint effluent outfall	37.33	37° 29' 37.00" N	121° 11' 40.00" W
DMC-CD	DMC at Check Dam	38.69	37° 28' 34.00" N	121° 11' 05.00" W
DMC-MCR	DMC at McCabe Road	68.03	37° 07' 05.47" N	121° 02' 03.67" W
Alternate Downstream Site¹				
DMC-002	DMC downstream of NVRRWP outfall	38.14	37° 28' 56.83" N	121° 11' 17.81" W

1. DMC-002 is an alternative sampling location to DMC-CD in the event of any access or safety concerns during an event.

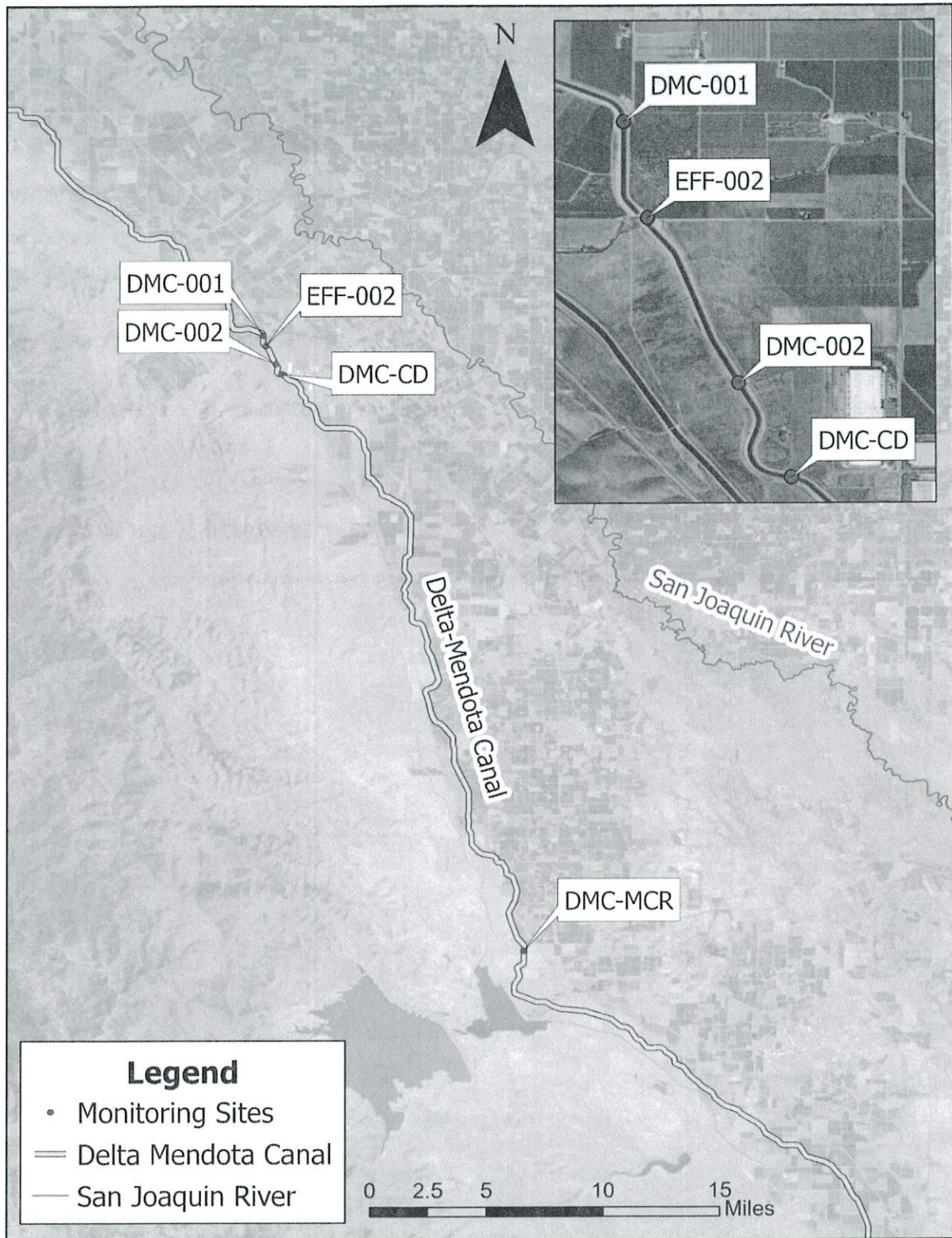


Figure 3. Proposed Delta-Mendota Canal CEC and Pathogen Study Monitoring Locations

2.2.1 DMC-001

Site DMC-001 (see **Figure 4**) is located at DMC mile 36.81 and is approximately 0.5 miles upstream of the NVRWP effluent outfall, EFF-002. The Field Team will collect grab samples from the farm bridge at this location, which can be accessed from Donkin Road. Access to this site is not restricted by any locked gates. Collection from the side bank of the channel will only occur if the bridge is not accessible and the side bank sample collection is deemed safe.

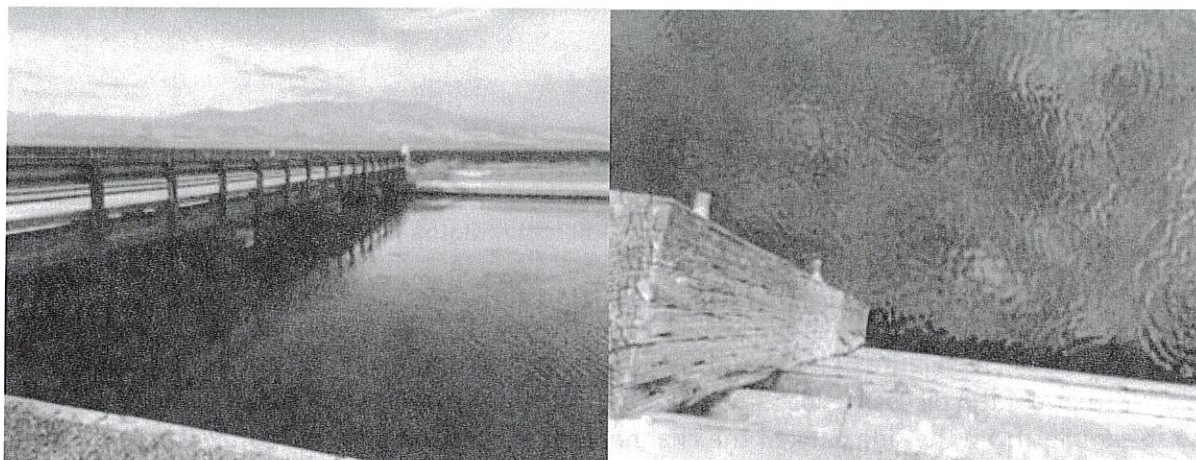


Figure 4. DMC-001 Site Photos

2.2.2 EFF-002

Site EFF-002 is an outfall structure located at DMC mile 37.33 that discharges directly into the DMC. The Field Team will collect grab samples directly from the outfall's discharge or an access point just prior to discharge. Access to this site is restricted by a locked gate and should be scheduled in advance with the appropriate NVRWP staff.

2.2.3 DMC-CD

Site DMC-CD is located at a check dam at DMC mile 38.69 and is approximately 1.4 miles downstream of the NVRWP effluent outfall, EFF-002. The Field Team will collect grab samples from the check dam structure. Access to the site is restricted by a locked gate and should be scheduled in advance with DPWD. Collection from the side bank of the channel will only occur if the bridge is not accessible and the side bank sample collection is deemed safe.

2.2.4 DMC-002 (Back-up Site Only)

Site DMC-002 (see **Figure 5**) is located at DMC mile 38.14 and is approximately 0.8 miles downstream of the NVRWP effluent outfall, EFF-002. This site has been selected as a backup option to sample collection at DMC-CD. In the event of safety or accessibility issues at DMC-CD, the Field Team will collect grab samples from the farm bridge at DMC-002. Access to the site is restricted by a locked gate and should be scheduled in advance with the DPWD. Collection from the side bank of the channel will only occur if the bridge is not accessible and the side bank sample collection is deemed safe.

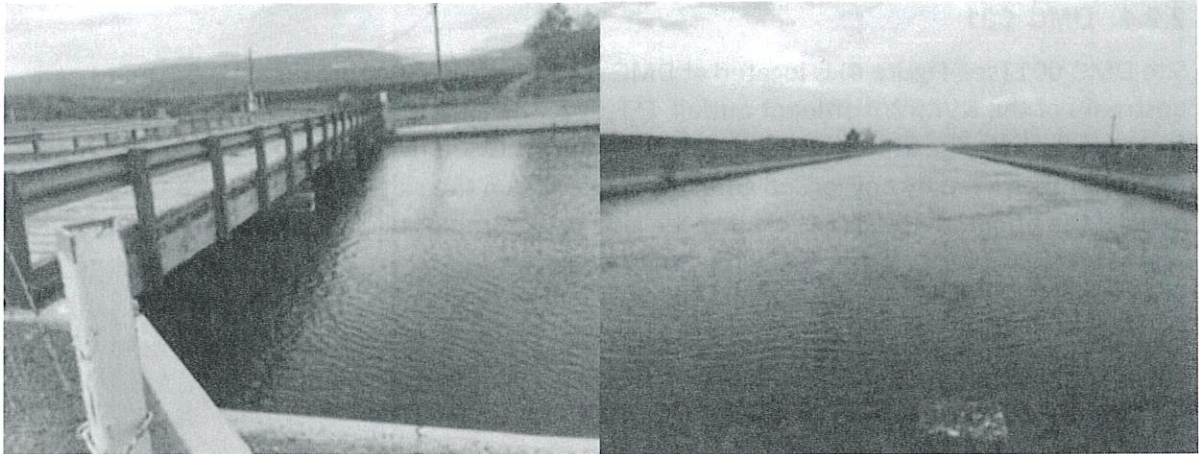


Figure 5. DMC-002 Site Photos

2.2.5 DMC at McCabe Road (DMC-MCR)

Site DMC-MCR (see Figure 6) is located at DMC mile 68.03 and is approximately 30.68 miles downstream of the discharge location, EFF-002. For safety reasons, the Field Team will collect grab samples from the side bank of the channel on the opposite bank from any pumps.

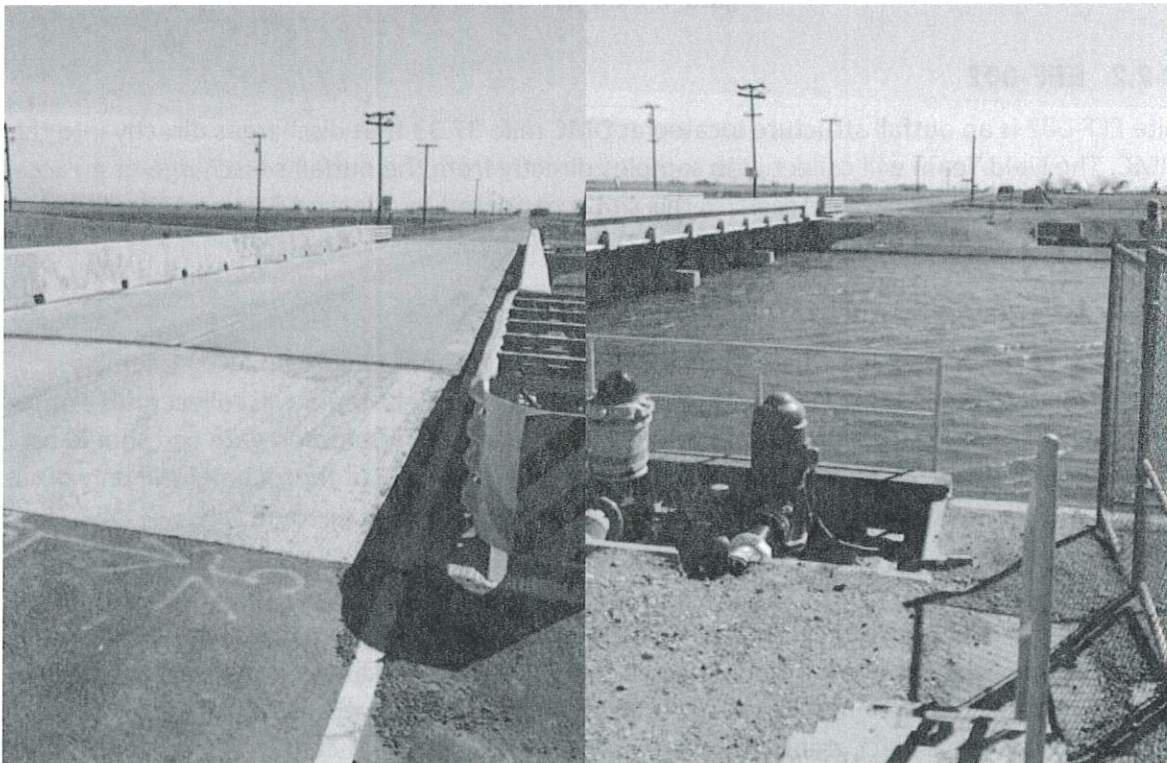


Figure 6. DMC-MCR Site Photos

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2.3 MONITORING FREQUENCY AND SCHEDULE

The Project Tam will collect samples quarterly during a one-year period, with monitoring efforts beginning in early 2025 (see **Section 5** schedule). The Project Team will monitor CECs, pathogens, and field parameters quarterly (for a total of four events) at EFF-002, DMC-001, DMC-CD, and DMC-MCR monitoring locations.

Sample event timing will be based upon targeting a range of operational flow conditions within the DMC based on the mean monthly historic discharges to the DMC from the Jones Pumping Plant (see **Figure 7**) as well as the pump-in to the O'Neill Forebay from the DMC (see **Figure 8**). **Figure 8** shows monthly pumping volumes during concurrent periods reported by separate entities. The net O'Neill flow refers to the difference between pump-in to the O'Neill Forebay and generation back from the O'Neill Forebay to the DMC. Flow conditions are seasonal in that the operation of the State Water Project and the Central Valley Project follow water year patterns. The events are tentatively planned for the months of January-February (Event No. 1), April-May (Event No. 2), August-September (Event No. 3), and November-December (Event No. 4). The Project Team will target Event No. 1 to characterize the generally high DMC flows and high net volume pumped into the O'Neill Forebay. The Project Team will target Event No. 2 to characterize low DMC flows. No specific target conditions are prescribed for the remaining events within the two-month sample collection window. Sample event timing may be adjusted earlier or later within a given two-month window, depending on the best logistical conditions. Monitoring during rain events will be avoided due to safety concerns and potential sample contamination. The Central Valley Water Board will be notified if an event is moved outside its targeted two-month window.

Jones Pumping Plant Monthly Volumes to DMC 1999-10-01 to 2024-06-01 based on CDEC Reporting

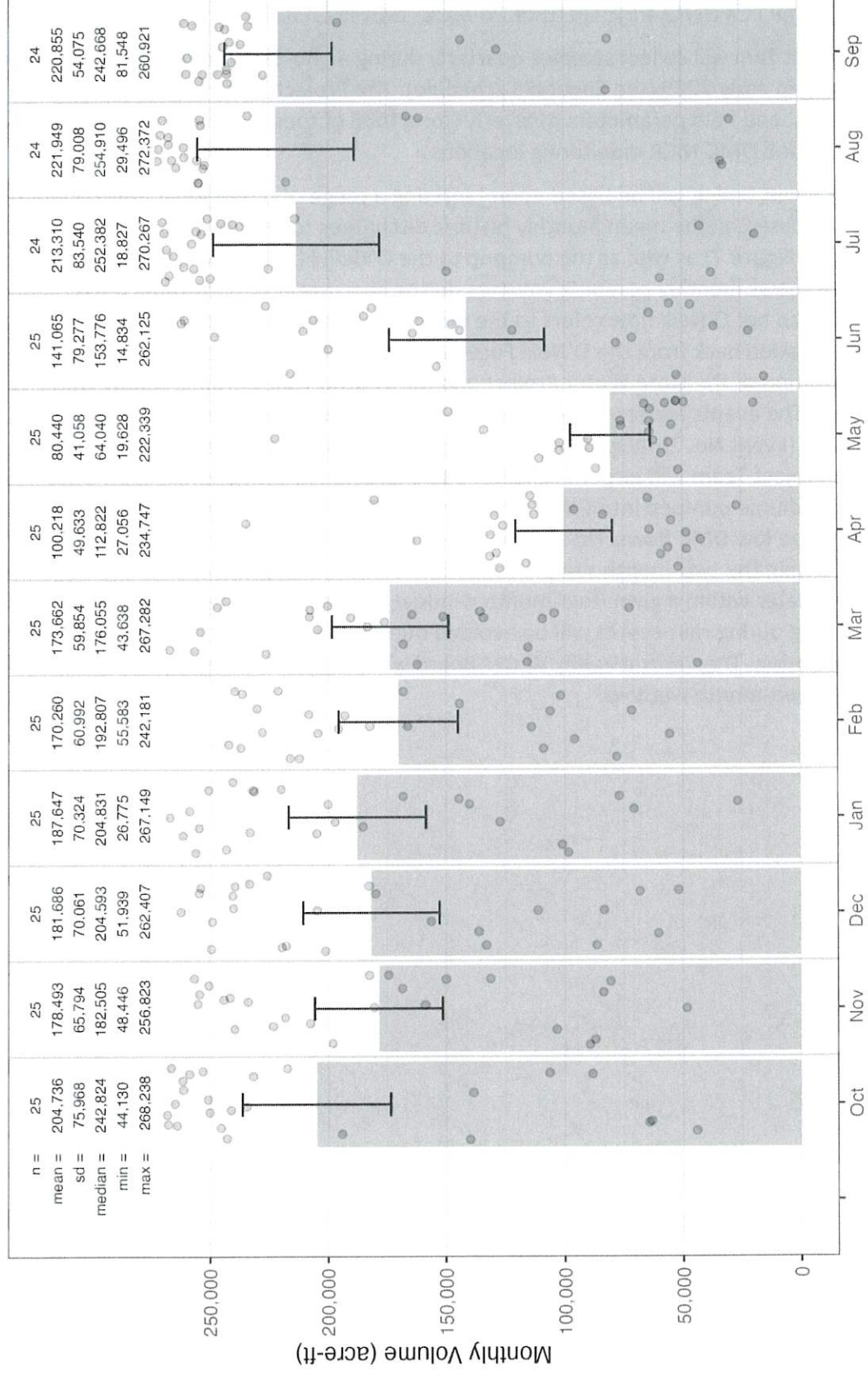


Figure 7. Jones Pumping Plant Monthly Average Volumes to the DMC (California Data Exchange Center, 1999-2024)

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DMC at Jones Pumping Plant and O'Neill Pump Station Monthly Volumes
 2019-01-01 to 2024-05-31 based on USBR Reports and CDEC

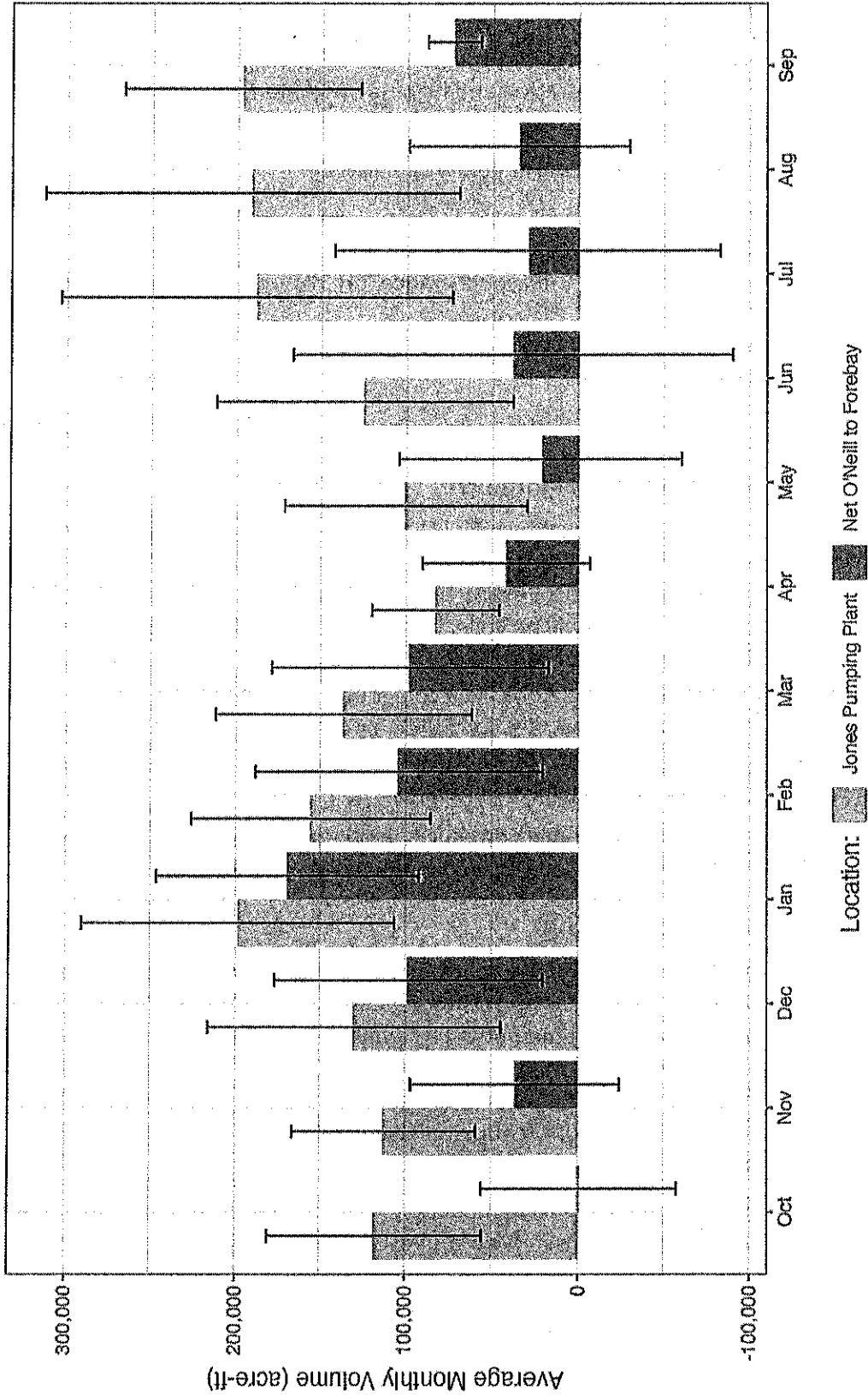


Figure 8. Jones Pumping Plant (DMC source) and O'Neill Pump Station Monthly Volumes

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2.4 SAMPLING COLLECTION STRATEGY

The Project Team will collect samples according to SAP detailed protocols. The protocols will consider the low detection concentration and high risk of contamination for the target analytes. These protocols may be modified to address identified contamination or safety issues.

At all site locations, the following data should be collected:

- DMC velocity and depth;
- Photographs of the site location and surrounding conditions;
- Field measurements for specific conductance, pH, dissolved oxygen, turbidity, and temperature;
- Observations of return flows and pump-ins to DMC; and
- Weather conditions.

More detailed sample collection logistics and requirements will be included in the SAP.

2.4.1 Sample Collection and Handling

The Field Team will collect water quality samples as grab samples during daylight hours from all four sampling locations. The Field Team will collect samples at approximately 2 feet depth directly into bottles using a sample collection pole from a bridge or safe location on the channel side bank. Samples from a bridge will be collected at approximately mid-channel. An intermediate bottle may be used for sample collection, as appropriate for sample bottles with preservatives. Samples will then be stored in a cooler at a temperature of $<6^{\circ}\text{C}$, in accordance with the Standard Methods (23rd ed., Section 1060), or other analyte-specific requirements (e.g., preservation), and delivered to the analytical laboratory promptly so that analysis can be completed within the required analytical hold times.

The specific sampling methods, sample containers, hold times, sample preservation, and chain of custody protocols for the proposed CEC and Pathogen Study will be described in the SAP.

2.4.2 Sample Collection Timing

Historical DMC flow data and velocity estimates based on a DMC velocity calculator spreadsheet provided by the San Luis and Delta Mendota Water Authority (SLDMWA) and SWC, were used to estimate flow travel time between sampling locations to capture the movement of the discharge volume sampled. An assumed water depth of 17 feet was used to calculate average velocity from the reported flow as summarized in **Table 4**. These time estimates do not account for plume dispersion and only estimate median arrival times during those months where the event is targeted.

The Project Team will sample DMC-CD immediately after collecting effluent samples and considering DMC velocity conditions in order to best capture the same parcel of effluent water sampled. Timing performance will then be evaluated and documented for each event. The order of tasks and potential staffing options will be adjusted to prioritize sample collection in a timely manner to match expected effluent volume parcel movement, but sample collection will not be postponed or repeated if the target timing schedule is not strictly matched due to

logistical constraints. The DMC-MCR site may be sampled at the end of the event on the same day or on the following day to optimize the timing and logistics. The Field Team will adaptively decide when to sample the site based on flow conditions and logistical constraints.

Table 4. Estimated Float Times in DMC Based on DMC Velocities Observed (1999-2024) During Proposed Event Sample Windows

Event No.	Median Float Times (hours) Relative to Point of Discharge (EFF-002)		
	DMC-001	DMC-CD	DMC-MCR
1 (January-February)	-0.3	0.7	15.9
2 (April-May)	-1.0	2.5	56.6
3 (August-September)	-0.2	0.6	13.7
4 (November-December)	-0.3	0.7	15.9

1. The negative float times indicate that DMC-001 is located upstream from EFF-002.

2.4.3 Flow Measurement

Flow measurement at each location is necessary to calculate mass flux at the time of sample collection and gain a better understanding of the fate and transport of the CECs. Pathogens will be evaluated as organism count flux rather than mass flux. The Field Team will measure stream velocity and depth of flow at the three ambient DMC sites (DMC-001, DMC-CD, and DMC-MCR) and download electronic flow records for the NVRRWP discharge site (EFF-002) from the California Integrated Water Quality System (CIWQS). The flows, along with constituent concentrations, can then be used to characterize the mass flux of CECs for each event.

The preferred method for measuring in-stream flow will be the use of the Sontek RS5 Acoustic Doppler Current Profiler⁸ (ADCP), which generates a cross-sectional velocity profile. Potential flow measurement method scenarios are listed below in order of preference:

- The preferred method uses the ADCP “tethered boat” mode. This method uses a tether while walking across a bridge or equivalent access structure to move the ADCP across the channel. Initially, the Field Team will conduct multiple trials to compare the data for consistency.
- The first back-up method uses the ADCP “bank-operated cableway” mode. This method uses a temporary rope and pulley apparatus to tow the tethered boat back and forth across the channel, upstream or downstream of the bridge.
- The third scenario uses the “stationary boat” method for the ADCP to counter any issues with bottom tracking. This method involves using a tether or cableway and stopping at fixed intervals.
- The fourth scenario is a backup method to using the ADCP (i.e., ADCP methods all fail). Instead, an electromagnetic flow meter would be used, such as the Marsh-McBirney Flo-

⁸ https://hydroacoustics.usgs.gov/publications/QStandards_COE_Final.pdf

mate 2000, to measure velocity cross-sectionally or at mid-channel and mid-depth as well as record the total water depth. The Field Team will adaptively select the flow measurement method to maximize accuracy and efficiency and to work within site accessibility constraints. The Field Team will attempt to keep methods between sites and events consistent, but the overall goal is to collect the most representative average velocity of the cross section at the time of sample collection.

2.4.4 Documentation of DMC Flow Conditions

Diversion and pump-out flow records are helpful to understand possible mass sources when evaluating mass flux in the system. The Project Team will work with the DPWD to compile a summary of the daily diversion and pump-out conditions along the DMC during an event. The San Joaquin River Restoration Program has a pump-out location in the Banta-Carbona Irrigation District, located approximately 16.4 miles upstream from DMC-001, and a pump-out location in the Patterson Irrigation District, located approximately 3.25 miles downstream from DMC-CD. Daily flow records may be requested from the San Luis Delta Mendota Water Authority (SLDMWA) if records are not available from DPWD.

2.5 QUALITY CONTROL SAMPLES

The SAP will provide data quality evaluation protocols for all constituents in this CEC and Pathogen Study. Field blank, field duplicate, and inter-laboratory duplicate samples will be included in a quality control sample collection schedule. Quality control (QC) samples will be collected during each event. A field blank and a sample replicate will be collected during every event. The QC sample location will be specified in the SAP for each event and the locations will be rotated so that both types of quality control samples are ideally collected at each site over the course of the study.

2.6 ADAPTIVE MANAGEMENT

Monitoring strategies may be adaptively managed as needed during the one-year study period to facilitate sample collection despite barriers encountered in the field. Selected sampling sites are known to be accessible with access from the Project Partners or the SLDMWA. Sites may become inaccessible due to changes in DMC conditions, flooding, fires, or other unavoidable circumstances or hazards. Under these conditions, the Project Team will develop an action plan, such as sampling at an alternate location, identifying a new permanent location, or suspending sampling until adequate access is reestablished. For in-field decisions that deviate from the SAP, the Field Team will coordinate with the Project Manager to devise an alternative solution. Temporary changes as allowed in the SAP will be communicated to the Project Partners no less than 48 hours before the event. For more permanent, the Project Partners and the Central Valley Water Board will be consulted to discuss the rationale for the decision to implement alternative approaches.

Any deviation from the SAP will be documented in a deviation form. Event deviation forms will be included in event summaries provided to the Project Partners following each event and reported in the final study report. An example of the deviation form will be included in the SAP.

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2.7 QUALITY OBJECTIVES AND CRITERIA

The objective of this project is to collect high-quality data to characterize concentrations and mass fluxes of CECs and pathogens counts upstream and downstream in the DMC and in NVRRWP effluent. This objective will be achieved by using standard, accepted methods to collect and analyze the ambient water and recycled wastewater effluent. The QA Manager will meet this objective by evaluating laboratory data for consistency with appropriate detection limits, precision, accuracy, representativeness, comparability, and completeness objectives to be specified in the SAP. The NPDES permit does not specify any thresholds for comparison or follow-up action.

2.7.1 Measurement Quality Objectives

Measurement quality objectives (MQO) will be used in this study to evaluate the performance of methods used to quantify water column concentrations and pathogen counts. Data may be qualified based on the quality assurance and quality control (QA/QC) review of laboratory report performance data and quality control sample results. The QA/QC evaluation considers all MQOs, including maximum holding time, reporting limit, method detection limit, and project acceptance criteria:

- Field meters will meet or exceed the **Table 5** performance criteria.
- Method detection limit (MDL) and reporting limit (RL) will be reported by the laboratory and in the study report. The analytical methods and reporting limits for pathogens are presented in **Table 6**. Recommended analysis methods and RLs for the CECs included in the Recycled Water Policy are provided in **Table 7**. This reference is used for the maximum allowable reporting limits for laboratory data reporting.
- Project QA/QC acceptance criteria are provided in **Table 8**.

Variances from the required reporting limits must be approved by the Project Manager. If systematic MQO variances are observed that result in unquantified results, data rejection, or data qualification, an alternate analytical approach will be considered.

Table 5. Analytical Methods and Study Reporting Limits for Field Parameters

Constituent	Method	Units	Reporting Limit
pH	Electrometric	std. units	0.01
Conductivity	Graphite Electrodes	µs/cm	1
Temperature	High Stability Thermistor	deg C	0.1
Turbidity	4-Beam	NTU	0.01
Dissolved Oxygen	Optical	mg/L	0.5

Table 6. Analytical Methods and Study Reporting Limits for Pathogens

Pathogen	Method	Units	Reporting Limit
<i>E. Coli</i>	SM 9221 F	MPN/100mL	1
<i>Clostridium perfringens</i>	mTEC Agar, Modified	MPN/100mL	1

Table 7. Recycled Water Policy CEC Laboratory Analytical Methods and Reporting Limits

CEC	Available Methods ¹	Units	Reporting Limit ²
1,4-dioxane	EPA 522	µg/L	0.1
Iohexol	EPA 1694	µg/L	0.05
NDMA	EPA 521, EPA 607, EPA 1625	µg/L	0.002
NMOR	EPA 521, EPA 607, EPA 1625	µg/L	0.002
PFOS	EPA 537, ASTM D7979	µg/L	0.0065
PFOA	EPA 537, ASTM D7979	µg/L	0.007
Sucralose	EPA 1694	µg/L	0.1
Sulfamethoxazole	EPA 1694, EPA 542, SM 6810	µg/L	0.01

1. Source: Recycled Water Policy Amendment, Table 4-3 Available Analytical Chemistry Methods for CECs (pg. 80).

2. Source: Recycled Water Policy, Table 1 Health-Based and Performance Indicator CECs and Required Reporting Limits (pg. A-4).

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Table 8. Project Acceptance Criteria for Sensor Measurements and Laboratory Analyses

Parameter	Accuracy	Precision	Recovery	Completeness
Sensor Measurements				
pH	±0.2 pH units	±0.5 pH units	NA	95%
Temperature	±0.5 °C	5%	NA	95%
Dissolved Oxygen	±0.5 mg/L	10%	NA	95%
Turbidity	5%	5%	NA	95%
Conductivity	5%	5%	NA	95%
Laboratory Analyses				
CECs	80 – 120%	0 – 25%	80 – 120%	95%

3 DATA GENERATION AND AQUISITION

Upon completion of each individual event, the Field Team will generate and provide a post event summary to the Project Team, available upon request to others and included in the final study report. These event summaries will summarize the event, background conditions, and other relevant conditions that could affect sample results or field measurements.

The Task Manager will compile data, perform a QA/QC review, and analyze the monitoring CEC concentrations, pathogen counts, and flow data collected. The Project Team will generate a final study report presenting the analytical results. Since the study includes only four event data points at each monitoring site, statistically significant conclusions from the data may not be possible. However, multiple approaches to presenting the data will be explored to best convey the results through data deliverables. The data will provide preliminary information to characterize CECs and pathogens and begin to assess the relative impact of the NVRRWP's discharge on the DMC and downstream drinking water facilities compared to upstream sources.

3.1 ANALYTICAL AND SAMPLE COLLECTION METHODS

The analytical methods available for the recommended list of CECs and pathogens are included in this work plan. Due to the potentially low effect levels and concentrations of CECs, the sample collection and analysis methods used must be carefully planned and implemented to avoid contamination and other systematic biases. The proposed laboratories and analytical methods are shown in **Table 9**. The laboratories and methods were identified to optimize performance, logistics, and cost for this study. Additionally, the Eurofins Eaton Analytical Laboratory is listed by the State Water Board as a recommended laboratory for the targeted analysis of multiple CECs to comply with the Recycled Water Policy. A full list of the constituents included for different laboratory methods by Eurofins Eaton Analytical is attached as **Appendix B**.

Table 9. CECs and Pathogens Analytical Method and Laboratories

Constituent	Primary Laboratory Method ¹	Primary Laboratory ¹	Secondary Laboratory ¹
CECs			
1,4-Dioxane	EPA 522	Eurofins Eaton Analytical	Caltest Analytical Laboratory
N-Nitrosodimethylamine (NDMA)	EPA 521.1	Eurofins Eaton Analytical	Caltest Analytical Laboratory
N-Nitrosomorpholine (NMOR)			NA
Perfluorooctane sulfonate (PFOS)	EPA 537.1	Eurofins Eaton Analytical	SGS AXYS Analytical Services Ltd.
Perfluorooctanoic acid (PFOA)			SGS AXYS Analytical Services Ltd.
Sucralose	PPCP NEG	Eurofins Eaton Analytical	SGS AXYS Analytical Services Ltd.
Iohexol			NA
Sulfamethoxazole	PPCP POS	Eurofins Eaton Analytical	SGS AXYS Analytical Services Ltd.
Carbamazepine			SGS AXYS Analytical Services Ltd.
Total trihalomethanes	EPA 524.2	Eurofins Eaton Analytical	Caltest Analytical Laboratory
Pathogens			
<i>Clostridium Perfringens</i>	Subcontract	Eurofins Eaton Analytical	Cel Analytical Inc.
<i>E. Coli</i>	SM 9221 F	SacSewer Environmental Laboratory	Other local lab ²

1. Primary and secondary laboratories are identified for preliminary budgeting purposes. Other qualified laboratories may be considered during SAP development and as funding is available.
2. Other qualified laboratories located near the project location may be considered to optimize logistics regarding hold time constraints.

3.2 QA/QC REVIEW

The Task Manager will review and validate all data. The Task Manager (**Table 1**) will be responsible for determining if the validated laboratory data meet the project acceptance criteria. MQOs will be used to accept, reject, or qualify the data generated by the laboratory. The QA/QC review will then be reviewed and approved by QA Manager (**Table 1**) to confirm the and finalize the reported results as accepted or rejected.

4 DATA ANALYSIS AND REPORTING

The Project Team will prepare a final report that summarizes the study results and findings, which is due to the Central Valley Water Board by July 31, 2026. The report will include a summary of the work performed, methods, and data analysis to characterize CECs and pathogens, and assess the relative impact of the NVRWP's discharge on the DMC and

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downstream drinking water facilities compared to upstream sources. Electronic reporting of monitoring data will be consistent with NPDES permit requirements.

4.1 DATA PRODUCTS

Once all the study data have been collected, the Task manager will develop the following data deliverables in the final report to synthesize data results, document background conditions, and characterize concentration/count and attenuation:

- Spreadsheet attachment with all data results.
- Summary tables for each recommended CEC and pathogen constituent showing the data results for each site and each event.
- Figures for the recommended CECs and pathogens that show the data result gradient upstream to downstream for each event (similar to **Figure 1** and **Figure 2**).
- A flow measurements table for all events.
- A field measurement parameters table for all events.
- A background DMC flow conditions table for all events, including pump-ins.
- Figures showing 2025 pump-ins to the DMC and net pump-outs to the O'Neill Forebay (similar to **Figure 8**).
- Tables for percent detection summary statistics for all CECs and pathogens.
- Paired analyses to evaluate differences between sites, comparing DMC upstream, NVRRWP effluent, and DMC downstream (e.g., sign test).
- Figure(s) and Table(s) that display mass flux of CEC(s) and pathogens showing upstream to downstream progression.

5 SCHEDULE

The **Table 10** schedule summarizes key CEC and Pathogen Study dates and requirements. The NPDES permit does not require that the CEC and Pathogen Study Work Plan be approved. However, the Project Partners may delay sample collection if CEC and Pathogen Study Work Plan comments are received later than November 1, 2024, or other delays are incurred to resolve comments.

Table 10. CEC and Pathogen Study Schedule

Milestone	Date (on or before)
Work Plan submitted to Central Valley Water Board	August 1, 2024*
Work Plan comments from the Central Valley Water Board, Division of Drinking Water, and State Water Contractors received	November 1, 2024
Sampling and Analysis Plan completed	January 1, 2025
Event No. 1 completed	January-February 2025
Event No. 2 completed	April-May 2025
Event No. 3 completed	August-September 2025
Event No. 4 completed	November-December 2025
Final Study Report submitted	July 31, 2026*
NVRRWP Report of Waste Discharge (ROWD) submitted	July 31, 2026*

*Requirement of the NPDES Permit

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APPENDIX

CEC and Pathogen Study Work Plan Appendices

Appendix A: Summary of Consultation Meetings

Appendix B: List of Constituents Included in Lab Methods

APPENDIX A

Summary of Consultation Meetings

Meeting No. 1 April 10, 2024

Meeting No. 2 May 9, 2024

Meeting No. 3 May 28, 2024

Cities of Modesto and Turlock with Del Puerto Water District
Delta Mendota Canal NPDES Far-Field and CEC Special Studies
April 10, 2024 10:00-11:00 AM

MEETING SUMMARY

Attendees:

Danielle Goode, Anne Walters, and Adam Laputz	Central Valley Water Board
David Huff and Jeanne White	City of Turlock
Paul Stearns and Adam Scheuber	Del Puerto Water District
Ben Koehler and Melissa Holden	City of Modesto
Brian Van Lienden	Woodard & Curran
Brian Laurenson and Sophie McFadin	Larry Walker Associates

Meeting Objectives:

Receive initial input from Central Valley Water Board on key study elements.

Determine communication process and schedule for consultations in work plan development.

Action Items and Summary Points:

- Far-Field Dilution Study:
 - Water balance approach will move forward in the work plan with higher resolution (monthly), more computational flexibility (coded, more detailed statistics, etc.), and better documentation of methods compared to the 2015 spreadsheet model. Model would be developed to use CalSim3 data and available data from water agencies on DMC diversions and returns, as made available.
 - Address the Central Valley Water Board key concern that came up with the 2015 far-field model version related to percent recycled water tracking at the same resolution of the model and/or better. Explain the methodology.
 - LWA will coordinate a meeting with Central Valley Water Board Staff, DDW, SWC, and technical staff, in early May to go over the details and methods of the technical approach and how the CalSim3 water balance is applied, to provide transparency on how exports and mixing intra-canal are estimated.
- Constituents of Emerging Concern (CEC) Study:
 - Program would include monitoring of effluent, upstream DMC, and 1-2 downstream locations. There will be four events across multiple quarters (i.e., quarterly for one year). The working CEC list will incorporate the example constituent list in the permit and also pull from the Water Recycling Policy, plus a few additions generally as it makes sense, but there might be modifications based on available labs, methods, and other optimizations that are mutually agreeable with all parties. It is expected that each of the analytical methods would provide a longer list of constituents.

- Preferred Communication Approach
 - LWA to coordinate and schedule meetings directly with all parties as needed (i.e., Central Valley Water Board staff don't need to be intermediaries). LWA will keep the Central Valley Water Board informed of any substantial communications directly with DDW or SWC.
 - LWA will target the next "technical approach" meetings with all parties for early May.
 - Danielle Goode will provide the DDW contacts to Brian Laurenson for him to schedule with.
 - Brian Laurenson has already been in contact with Leslie Palencia (SWC consultant) to start SWC coordination.

Cities of Modesto and Turlock with Del Puerto Water District
Delta Mendota Canal NPDES Far-Field Special Study

May 9, 2024 12:30-2:00 PM

Meeting Summary

Attendees:

Jeanne White and David Huff, City of Turlock

Danielle Goode, Adam Laputz, and Anne Walters, Central Valley Water Board

Melissa Holden and Ben Koehler, City of Modesto

Randy Barnard, Thomas Tsui, and Sherly Rosilela, State Water Board Division of Drinking Water

Brian Van Lienden, Woodard & Curran

Paul Stearns, Del Puerto Water District

Brian Laurenson (facilitator), José Tomás Díaz Casanueva, and Sophie McFadin (notetaker), Larry Walker Associates

Meeting Objective:

Receive initial input from Central Valley Water Board and DDW on key study elements and project scope

FAR-FIELD MODELING STUDY

This summary captures the nature of the input provided so that the work plan can best address any key concepts or requirements.

The far-field meeting is intended as a kick-off in the consultation process with Division of Drinking Water (DDW). There will be additional opportunities for input from DDW, including review of the draft work plan which is due to the Central Valley Water Board on August 1, 2024. The completed modeling study report is due to the Central Valley Water Board July 31, 2026.

- LWA is the consultant for the Cities of Turlock and Modesto and Del Puerto Water District – the North Valley Regional Recycled Water Program (NVRWP) project partners.
- The NVRWP is a water recycling project was developed to only deliver water for irrigation purposes only by the Del Puerto Water District and downstream restoration areas. The NVRWP does not deliver water for the purpose of domestic or municipal water supply.
- The NPDES permit requirement is to report estimates of the percent recycled water at the O'Neill Forebay and in San Luis Reservoir using monthly timesteps and consider the diversions/returns by the NVRWP. There are no other specific technical requirements (e.g., modeling type, tracer study, etc.) or acceptance criteria (allowed error, verification measures, etc.).
- DDW noted that they will need time to review the work plan and would appreciate any early versions if possible so they can reasonably react/comment. LWA noted that the project partners would need to be consulted about an early distribution version, but that there should also be time after August 1, 2024 submittal to resolve questions. LWA does want to identify any critical work plan components to include or resolve any significant concerns.

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- LWA is proposing to use CalSim3 to generate the balanced “base” volume outputs (monthly flow volumes at all nodes, etc.) for multiple years and add on a computational ruleset to consider the NVRRWP discharge and diversion/return patterns that could be reasonably expected that also makes sure the water balance closes.
- The proposed model approach is not a finite element model, primarily because the system is so highly managed that only CalSim could reasonably represent the expected range of conditions. The model is then a complex water balance where the NVRRWP volume would be tracked to the specific downstream points.
- DDW inquired about assumptions on complete mixing at various points in the model domain. LWA responded that the discharge plume had been modeled and field verified within the DMC. The DMC is fully mixed at 2 km. The model domain is close to 50 km. LWA will discuss mixing assumptions in the work plan and a means to estimate outcome sensitivity. There were not as many mixing concerns about the O’Neill Forebay on a monthly time step, but there might need to be an assessment of San Luis Reservoir, depending on the magnitude of NVRRWP input and overall sensitivity to any assumptions.
- Central Valley Water Board noted that a monthly time step is required and wanted to make sure a range water year types were considered. LWA confirmed that the plan would be to look at a longer period of CalSim3 outputs to incorporate different water years
- DDW emphasized that it was important in the document to set things up front so that the reviewer had a good sense of the bottom line, scope, context, and requirements.
- DDW emphasized that it would be important to clearly state assumptions and their basis. DDW will consult their field branch to review the Far Field Study and that their main objective will be to evaluate that it meets the permit statements and that all assumptions are stated with the reasoning, even if they are “obvious” assumptions. For example, the work plan should state why the calculation method was chosen over/instead of a tracer, why simple reservoir mixing is reasonable, etc.
- DDW reviews with emphasis on public health perspective – for example - “which points make the most sense for public health.” Justify and explain why points were picked, etc.
- Central Valley Water Board noted that their objective was also to be able to understand nutrient (or other key constituents) loading in the system and from NVRRWP as harmful algal blooms are a concern in the downstream parts of the system.

CEC STUDY

- CEC meeting is scheduled for May 28, 2024 along with the State Water Contractors
- Study approach follows the previous nutrient study – upstream, effluent, and two downstream. LWA confirmed that the SWC DMC sample points selected match up with the proposed sample points of DMC-001 and DMC-002. An additional site would be much further downstream before O’Neill Forebay.
- The example analyte list in the NPDES permit will be the starting point for the next meeting.

Action Items:

- LWA will send out meeting summary and slides.
- LWA will send out preparation materials ahead of the CEC meeting.
- LWA will evaluate progress before work plan submittal, consultant with project partners.

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Cities of Modesto and Turlock with Del Puerto Water District
Delta Mendota Canal NPDES CEC Special Study

May 28, 2024 10:30 AM-12:00 PM

Meeting Summary

Attendees:

Jeanne White and David Huff, City of Turlock

Danielle Goode, Anne Walters, and Kurt Souza, Central Valley Water Board

Melissa Holden and Ben Koehler, City of Modesto

Randy Barnard, Kurt Souza, and Sherly Rosilela, State Water Board Division of Drinking Water

Leslie Palencia (Palencia Consult.), Atlasi Daneshvar (Santa Clara Valley Water District), Mauricio Santos (Metropolitan District of Southern California), Jeff Tice and Brandon L. Ladd (Central Coast Water Authority)

Brian Van Lienden, Woodard & Curran

Paul Stearns, Del Puerto Water District

Brian Laurenson (facilitator) and Sophie McFadin (notetaker), Larry Walker Associates

Meeting Objective:

Receive input from Central Valley Water Board, State Water Contractors, and DDW on key study elements and project scope to support work plan development.

CEC STUDY.

The DMC CEC Special Study is required in the Cities of Turlock and Modesto joint NPDES permit. The work plan or monitoring plan is required to describe locations, frequency, and constituents. The draft work plan is due to the Central Valley Water Board on August 1, 2024. The completed study report is due to the Central Valley Water Board July 31, 2026.

- Study approach follows an upstream, effluent, and two downstream ("gradient") approach. An alternative sampling point, located at the DMC Check Dam (2,200 m downstream of effluent outfall) where the NVRRWP effluent is fully mixed, will be considered rather than the DMC-002 site (1,300 m downstream of effluent outfall) where substantial mixing has occurred. The primary site will be selected based on accessibility and safety concerns. The other downstream sampling location (DMC-MCR) is much further downstream before O'Neill Forebay.
- In addition to the target constituents, the study report will provide all other constituent results included in the analytical method suite if there is no additional analytical cost.
- Currently, Eurofins is the expected lab, but it is subject to change based on promised performance and logistics.
- SWC emphasized that it's important to capture different flow rates in the DMC (for the quarterly sampling events that will be conducted. For example, the SWC was able to monitor conditions when the percentage of treated wastewater in the DMC ranged from 1 to 4 percent. Measurement of flow rates in the canal at each sampling location is also necessary to accurately estimate the mass flux of CECs, not just concentration. This also applies to the NVRRWP Joint

outfall flow rate. SWC noted that they were able to measure the flow in the canal with assistance from the San Luis Delta Mendota Authority. Leslie forwarded flow-velocity spreadsheets to LWA after the meeting. A section on flow measurement will be included in the work plan.

- SWC noted the importance of tracking pump inputs to the canal and documenting pumping conditions at the time of a sampling event. The work plan will consider an approach to characterize pump-in conditions as feasible (i.e., qualitative vs. quantitative).
- The San Joaquin River Restoration recaptured water inputs were identified as an input to consider. It was not known if CalSim3 included this flow, but the work plan will address it.
- April to May is the DMC low flow period, and will be targeted for one event.
- SWC mentioned the importance of tracking the flow travel time between each sampling site location to best capture a single plume during a sampling event. LWA proposes a practical approach to characterize the timing of flow as it is feasible within a sampling event time frame. The near field samples should be feasible, but further downstream at McCabe may not be feasible.

FAR-FIELD MODELING STUDY

- LWA is the consultant for the Cities of Turlock and Modesto and Del Puerto Water District – the North Valley Regional Recycled Water Program (NVRWP) project partners.
- The NVRWP is a water recycling project that was developed to deliver water for irrigation purposes only by the Del Puerto Water District and to downstream restoration areas. The NVRWP does not deliver water for the purpose of domestic or municipal water supply.
- SWC inquired about if a range of storage conditions in the O'Neill Forebay and San Luis Reservoir will be investigated to better characterize the worst-case scenario. SWC noted that in the previous 2015 study, the average storage conditions were assumed rather than a range and that critical conditions are of greatest interest. LWA plans to include longer evaluation periods so that a range of conditions is assessed.

Action Items:

- LWA will send out draft work plans to the Central Valley Water Board by June 15th for review.
- LWA will send out meeting summary and slides.
- LWA will evaluate progress before work plan submittal, consultant with project partners.
- Leslie will send LWA the previous Eurofins analytical method constituent list and the flow-velocity tables [completed]
- The Central Valley Water Board will verify the need to include *E. coli*, THMs, and any other non-CEC constituents already part of other monitoring.
- The Central Valley Water Board will internally determine the review process and schedule to communicate to the group, as appropriate.